SHOP MANUAL

KOMATSU

PW170ES-6K

MACHINE MODEL	SERIAL NUMBER
PW170ES-6K	**K32001 and up** **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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CONTENTS

No. of page

01 GENERAL 01-1

10 STRUCTURE AND FUNCTION 10-1

20 TESTING AND ADJUSTING 20-1

30 DISASSEMBLY AND ASSEMBLY 30-1

40 MAINTENANCE STANDARD 40-1

The affected pages are indicated by the use of the following marks. It is requested that necessary actions be taken to these pages according to the table below.

Mark	Indication	Action required
○	Page to be newly added	Add
●	Page to be replaced	Replace
( )	Page to be deleted	Discard

Pages having no marks are those previously revised or made additions.

LIST OF REVISED PAGES

Mark	Page	Time of revision	Mark	Page	Time of revision	Mark	Page	Time of revision	Mark	Page	Time of revision	Mark	Page	Time of revision
•	00-1	①		10-16			10-37			10-77			10-116	
◦	00-2	①		10-17			10-38			10-78			10-117	
◦	00-2-1	①		10-18			10-39			10-79			10-118	
◦	00-2-2	①		10-19			10-40			10-80			10-119	
◦	00-2-3	①		10-20			10-41			10-81			10-120	
◦	00-2-4	①		10-21			10-42			10-82			10-121	
◦	00-3	①		10-22			10-43			10-83			10-122	
◦	00-4	①		10-23			10-44			10-84			10-123	
◦	00-5	①		10-23A			10-45			10-85			10-124	
◦	00-6	①	•	10-24	①		10-46			10-86			10-125	
◦	00-7	①	◦	10-24-1	①		10-47			10-87			10-126	
◦	00-8	①		10-25			10-48			10-88			10-127	
◦	00-9	①		10-26			10-49			10-89			10-128	
◦	00-10	①		10-27			10-50			10-90			10-129	
◦	00-11	①		10-28			10-51			10-91			10-130	
◦	00-12	①		10-29			10-52			10-92			10-130-1	
◦	00-13	①		10-30			10-53			10-93			10-130-2	
◦	00-14	①		10-31			10-54			10-94			10-130-3	
◦	00-15	①		10-31A			10-55			10-95			10-131	
◦	00-16	①		10-31B			10-56			10-96			10-132	
◦	00-17	①		10-31C			10-57			10-97			10-133	
				10-31D			10-58			10-98			10-134	
•	10-1	①		10-31E			10-59			10-99			10-135	
	10-2			10-31F			10-60			10-100			10-136	
	10-3			10-31G			10-61			10-101			10-137	
	10-4			10-31H			10-62			10-102			10-138	
	10-5			10-31I			10-63			10-103			10-139	
	10-6			10-31J			10-64			10-104			10-140	
	10-7			10-31K			10-65			10-105			10-141	
	10-8			10-31L			10-66			10-106			10-142	
	10-9			10-32			10-67			10-107			10-143	
	10-9A			10-33			10-68			10-108			10-144	
	10-9B			10-34			10-69			10-109			10-145	
	10-10			10-34A			10-70			10-110			10-146	
	10-11			10-34B			10-71			10-111			10-147	
	10-12			10-35			10-72			10-112			10-148	
	10-13			10-36			10-73			10-113			10-149	
	10-14			10-36A			10-74			10-114			10-150	
	10-15			10-36B			10-76			10-115			10-151	

Mark	Page	Time of revision	Mark	Page	Time of revision	Mark	Page	Time of revision	Mark	Page	Time of revision	Mark	Page	Time of revision
	20-1			20-58			20-113			20-170			20-227	
	20-2			20-59			20-114			20-171			20-228	
	20-3			20-60			20-115			20-172			20-229	
	20-4		•	20-61	①		20-116			20-173			20-230	
	20-5		•	20-62	①		20-117			20-174			20-231	
	20-6		◦	20-62-1	①		20-118			20-175			20-232	
	20-7		◦	20-62-2	①		20-119			20-176			20-233	
	20-8		•	20-63	①		20-120			20-177			20-234	
	20-9			20-64			20-121			20-178			20-235	
	20-10			20-65			20-122			20-179			20-236	
	20-11			20-66			20-123			20-180			20-237	
	20-12			20-67			20-124			20-181			20-238	
	20-13			20-68			20-125			20-182			20-239	
	20-14			20-69			20-126			20-183			20-240	
	20-15			20-70			20-127			20-184			20-241	
	20-16			20-71			20-128			20-185			20-242	
	20-17			20-72			20-129			20-186			20-243	
	20-18			20-73			20-130			20-187			20-244	
	20-19			20-74			20-131			20-188			20-245	
	20-20			20-75			20-132			20-189			20-246	
	20-21			20-76			20-133			20-190			20-247	
	20-22			20-77			20-134			20-191			20-248	
	20-23			20-78			20-135			20-192			20-249	
	20-24			20-79			20-136			20-193			20-250	
	20-25			20-80			20-137			20-194			20-251	
	20-26			20-81			20-138			20-195			20-252	
	20-27			20-82			20-139			20-196			20-253	
	20-28			20-83			20-140			20-197			20-254	
	20-29			20-84			20-141			20-198			20-255	
	20-30			20-85			20-142			20-199			20-256	
	20-31			20-86			20-143			20-200			20-257	
	20-32			20-87			20-144			20-201			20-258	
	20-33			20-88			20-145			20-202			20-259	
	20-34			20-89			20-146			20-203			20-260	
	20-35			20-90			20-147			20-204			20-261	
	20-36			20-91			20-148			20-205			20-262	
	20-37			20-92			20-149			20-206			20-263	
	20-38			20-93			20-150			20-207			20-264	
	20-39			20-94			20-151			20-208				
	20-40			20-95			20-152			20-209			30-1	
	20-41			20-96			20-153			20-210			30-2	
	20-42			20-97			20-154			20-211			30-3	
	20-43			20-98			20-155			20-212			30-4	
	20-44			20-99			20-156			20-213			30-5	
	20-45			20-100			20-157			20-214			30-6	
	20-46			20-101			20-158			20-215			30-7	
	20-47			20-102			20-159			20-216			30-8	
	20-48			20-103			20-160			20-217			30-9	
	20-49			20-104			20-161			20-218			30-10	
	20-50			20-105			20-162			20-219			30-11	
	20-51			20-106			20-163			20-220			30-12	
	20-52			20-107			20-164			20-221			30-13	
	20-53			20-108			20-165			20-222			30-14	
	20-54			20-109			20-166			20-223			30-15	
	20-55			20-110			20-167			20-224			30-16	
	20-56			20-111			20-168			20-225			30-17	
	20-57			20-112			20-169			20-226			30-18	

Mark	Page	Time of revision	Mark	Page	Time of revision	Mark	Page	Time of revision	Mark	Page	Time of revision	Mark	Page	Time of revision
	30-19			30-73			30-127			30-181			40-22	
	30-20			30-74			30-128			30-182			40-23	
	30-21			30-75			30-129			30-183			40-24	
	30-22			30-76			30-130			30-184			40-25	
	30-23			30-77			30-131			30-185			40-26	
	30-24			30-78			30-132			30-186			40-27	
	30-25			30-79			30-133			30-187			40-28	
	30-26			30-80			30-134			30-188			40-29	
	30-27			30-81			30-135			30-189			40-30	
	30-28			30-82			30-136			30-190			40-31	
	30-29			30-83			30-137			30-191			40-32	
	30-30			30-84			30-138			30-192			40-33	
	30-31			30-85			30-139			30-193			40-34	
	30-32			30-86			30-140			30-194				
	30-33			30-87			30-141			30-195				
	30-34			30-88			30-142			30-196				
	30-35			30-89			30-143			30-197				
	30-36			30-90			30-144			30-198				
	30-37			30-91			30-145			30-199				
	30-38			30-92			30-146			30-200				
	30-39			30-93			30-147			30-201				
	30-40			30-94			30-148			30-202				
	30-41			30-95			30-149			30-203				
	30-42			30-96			30-150			30-204				
	30-43			30-97			30-151			30-205				
	30-44			30-98			30-152			30-206				
	30-45			30-99			30-153			30-207				
	30-46			30-100			30-154			30-208				
	30-47			30-101			30-155			30-209				
	30-48			30-102			30-156			30-210				
	30-49			30-103			30-157			30-211				
	30-50			30-104			30-158			30-212				
	30-51			30-105			30-159							
	30-52			30-106			30-160			40-1				
	30-53			30-107			30-161			40-2				
	30-54			30-108			30-162			40-3				
	30-55			30-109			30-163			40-4				
	30-56			30-110			30-164			40-5				
	30-57			30-111			30-165			40-6				
	30-58			30-112			30-166			40-7				
	30-59			30-113			30-167			40-8				
	30-60			30-114			30-168			40-9				
	30-61			30-115			30-169			40-10				
	30-62			30-116			30-170			40-11				
	30-63			30-117			30-171			40-12				
	30-64			30-118			30-172			40-13				
	30-65			30-119			30-173			40-14				
	30-66			30-120			30-174			40-15				
	30-67			30-121			30-175			40-16				
	30-68			30-122			30-176			40-17				
	30-69			30-123			30-177			40-18				
	30-70			30-124			30-178			40-19				
	30-71			30-125			30-179			40-20				
	30-72			30-126			30-180			40-21				

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

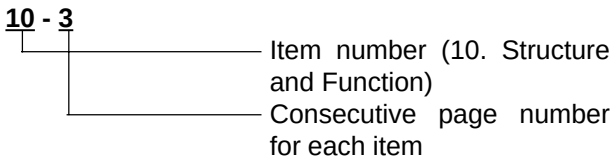
These various volumes are designed to avoid duplicating the same information. Therefore, to deal with all repairs for any model, it is necessary that chassis, engine , electrical and attachement volumes be available.

DISTRIBUTION AND UPDATING

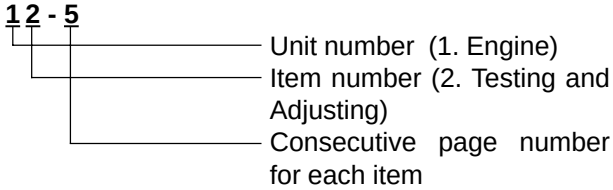
Any additions, amendments or other changes will be sent to KOMATSU distributors. Get the most up-to-date information before you start any work.

FILING METHOD

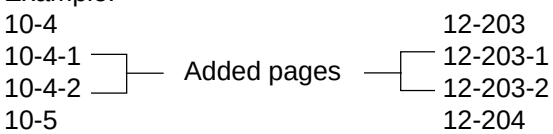
1. See the page number on the bottom of the page. File the pages in correct order.
2. Following examples show how to read the page number
   Example 1 (Chassis volume:)



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:



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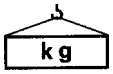
When a manual is revised, an edition mark (1,2,3,...) is recorded on the bottom of the pages.

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:

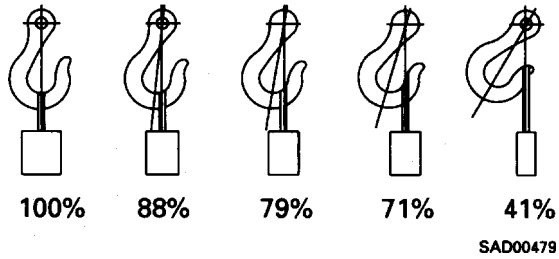
Wire ropes
(Standard "Z" or "S" twist ropes
without galvanizing

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.

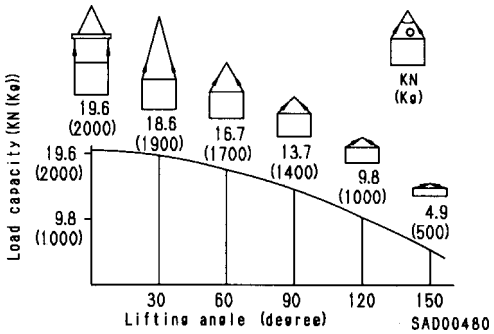
2) Sling wire ropes from the middle portion of the hook.

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

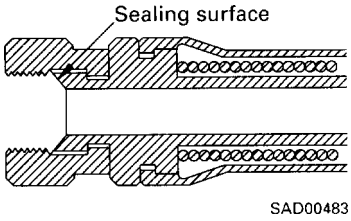
★ This torque table does not apply to the bolts with nylon packaging or other nonferrous metal washers are to be used, or which require tightening to otherwise specified torque.

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.

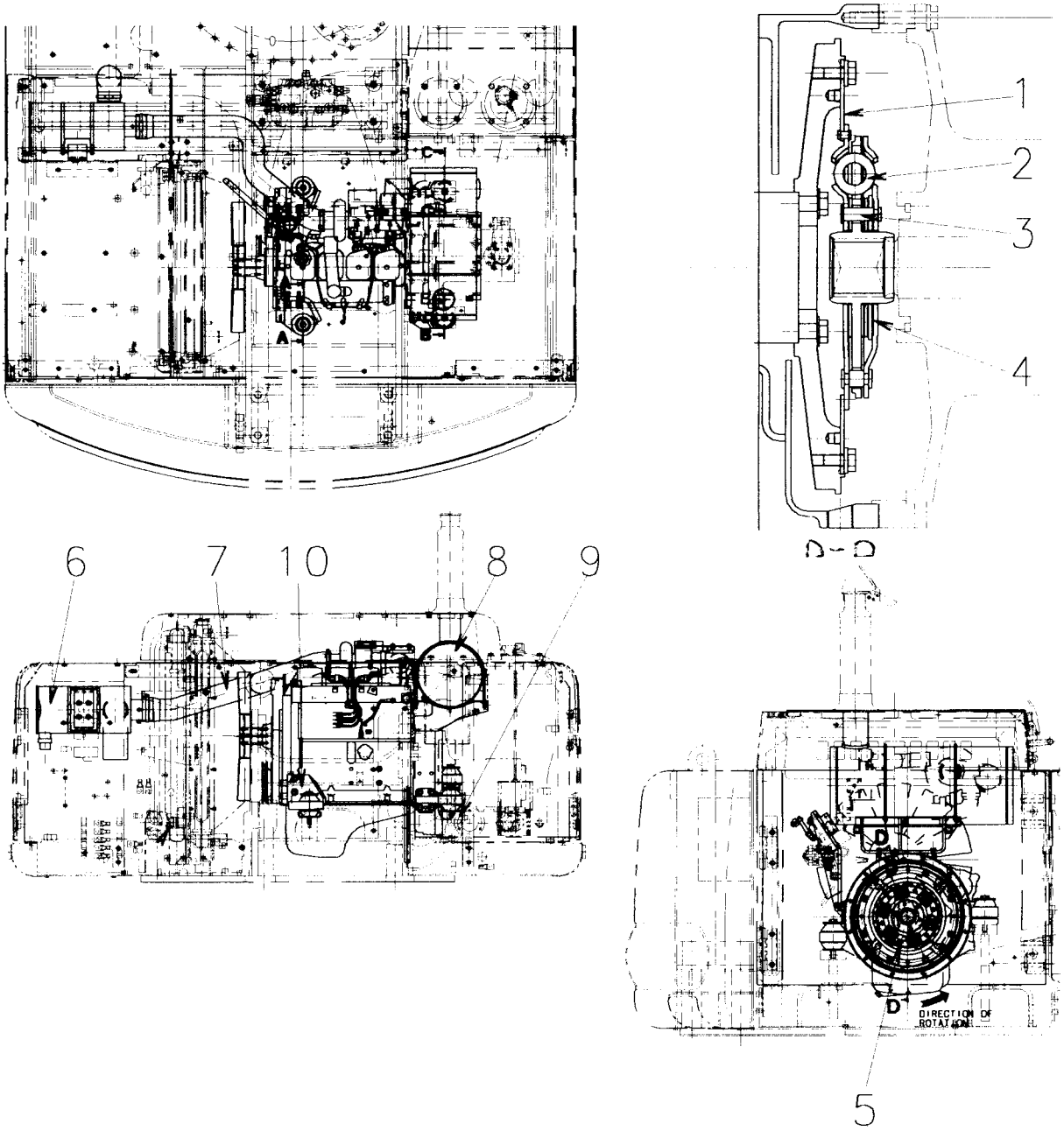
1°C = 33.8°F

°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

Engine related parts 10-2
Radiator, oil cooler, aftercooler 10-3
Power train 10-4
Swing circle 10-5
Swing machinery 10-6
Undercarriage 10-9
Clutch control circuit 10-9A
Axle 10-10
Suspension Lock Cylinder 10-14
Braking train 10-16
Brake pedal 10-17
Brake valve 10-18
Accumulator For Brake System 10-19
Steering train 10-20
Steering column 10-22
Hydraulic circuit diagram 10-23
Hydraulic tank 10-24
Hydraulic pump 10-25
Control valve 10-32
CLSS 10-38
Swing motor 10-69
Center swivel joint 10-72
Travel motor (Front, Rear) 10-73
Work equipment, swing PPC valve 10-78
Travel PPC valve 10-82
Service PPC valve 10-85
Safety lock switch 10-88
PPC manifold block 10-89
PPC manifold block pressure switches 10-90
Solenoid valve 10-91
Boom safety valve 10-100
Hydraulic cylinder 10-103
Work equipment 10-107
Electrical wiring diagram 10-109
..... 10-111
Engine control system 10-113
Electronic control system 10-119
Machine monitor system 10-142
Overload warning device 10-149
Breaker mode hydraulic performance 10-150

ENGINE RELATED PARTS

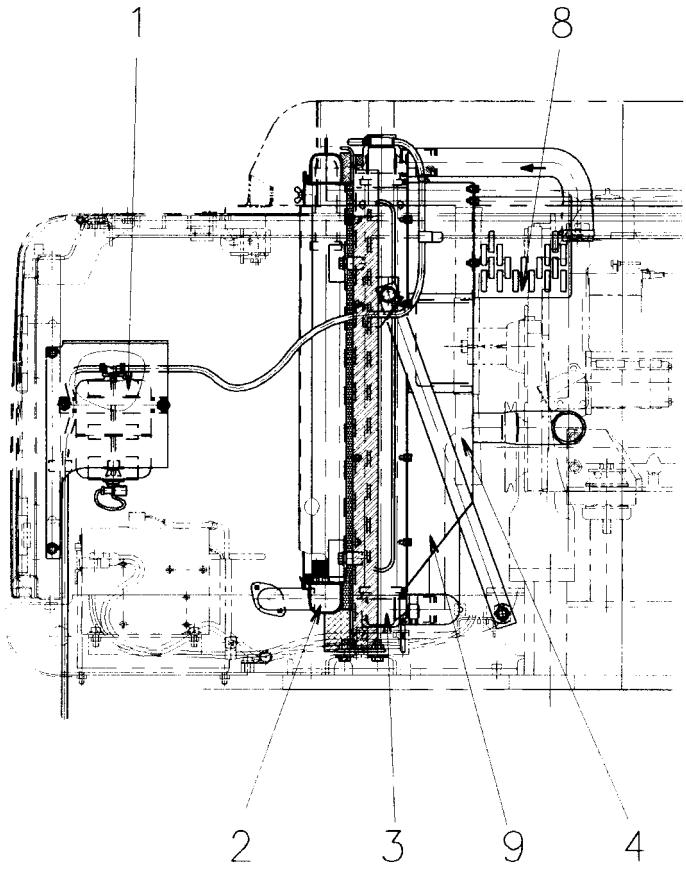


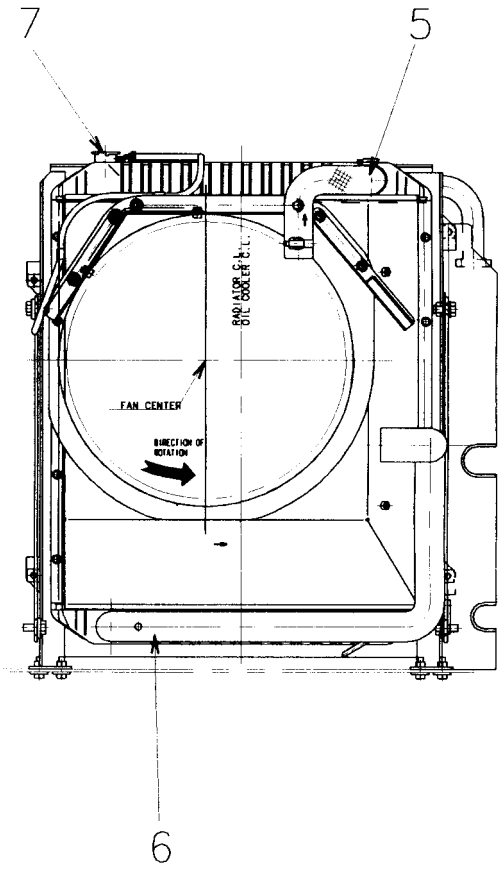
1. Drive plate
2. Torsion spring
3. Stopper pin
4. Friction plate
5. Damper assembly
6. Air cleaner
7. Intake connector
8. Muffler
9. Rear engine mount
10. Front engine mount

OUTLINE

- The damper assembly is a dry type.

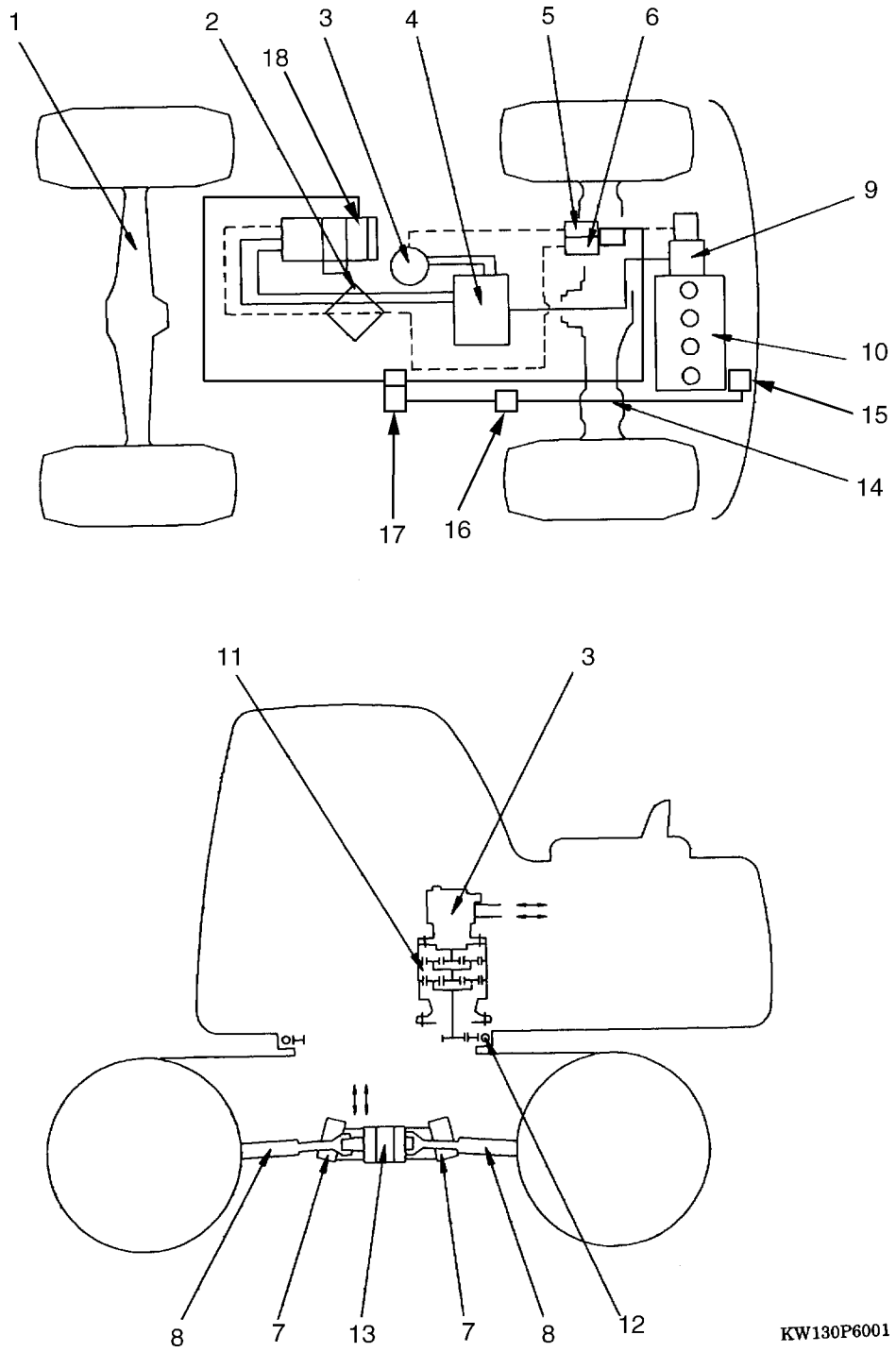
RADIATOR • OIL COOLER





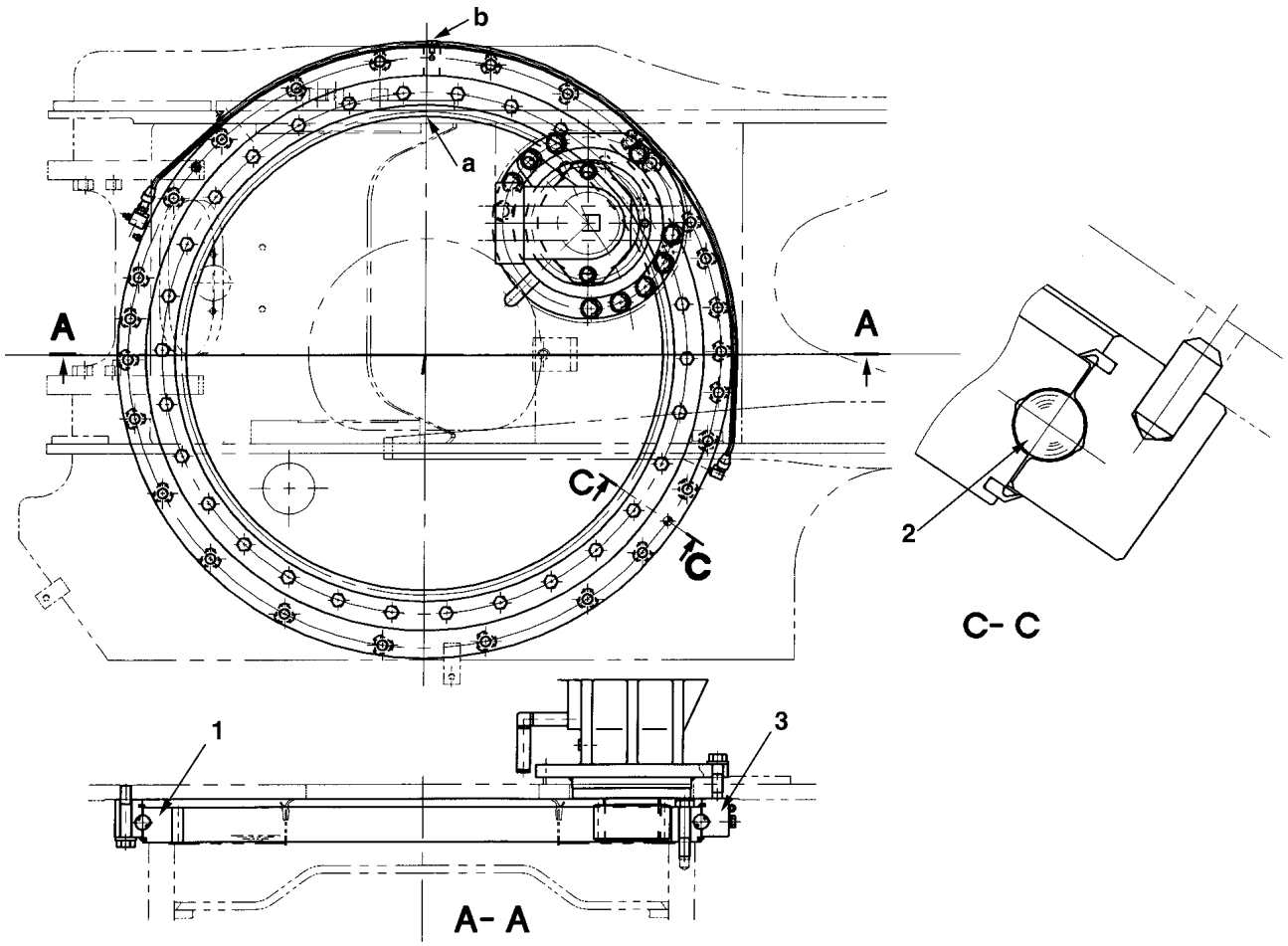
1. Reservoir tank
2. Oil cooler
3. Radiator
4. Fan
5. Radiator inlet hose
6. Radiator outlet hose
7. Radiator cap
8. Net
9. Shroud

SPECIFICATIONS
Radiator: CWX-4
Oil cooler: SF-3



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



1. Swing circle inner race (No. of teeth: 94)
2. Ball
3. Swing circle outer race

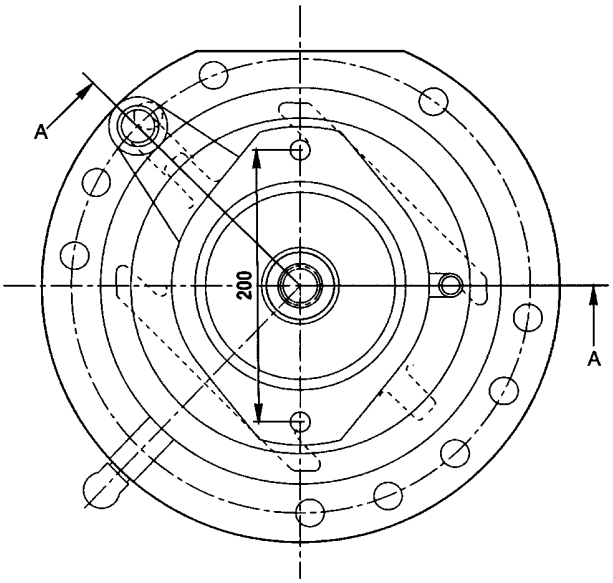
a. Inner race soft zone **S** position
b. Outer race soft zone **S** position

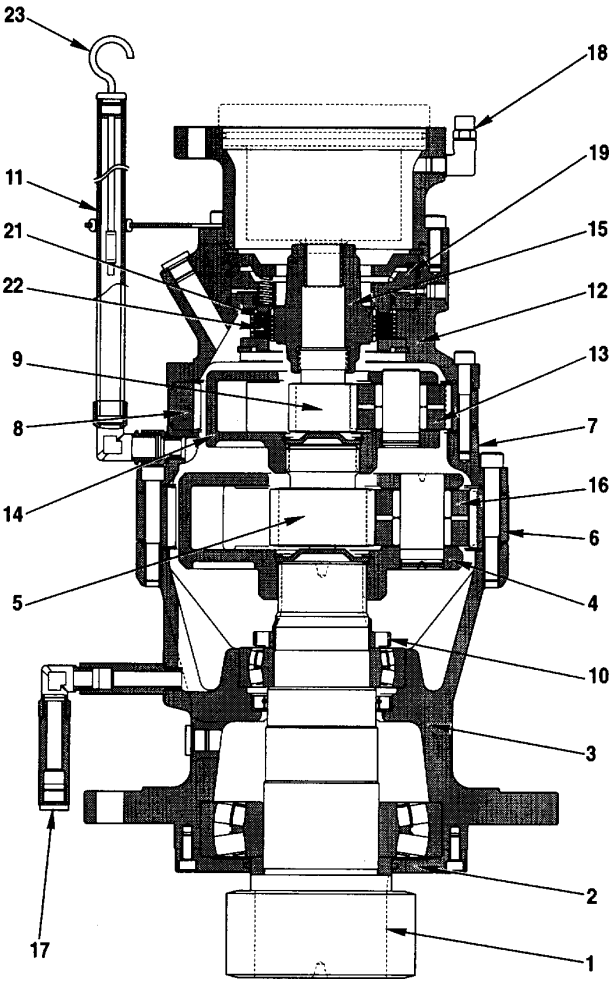
SPECIFICATIONS

reduction ratio: $\frac{94}{12}$ = 7.833

amount of grease: 8/(G2-LI)

SWING MACHINERY





1. Swing pinion (No. of teeth: 12)
2. Cover
3. Case
4. No. 2 of planetary carrier
5. No. 2 sun gear (No. of teeth: 24)
6. No. 2 ring gear (No. of teeth: 78)
7. Case
8. No. 1 ring gear (No. of teeth: 78)
9. No. 1 sun gear (No. of teeth: 18)
10. Retainer
11. Oil level gauge
12. Cover
13. No. 1 planetary gear (No. of teeth: 29)
14. No. 1 planetary carrier
15. Coupling
16. No. 2 planetary gear (No. of teeth: 26)
17. Drain plug
18. Breather
19. Parking brake piston
20. Parking brake spring
21. Parking brake disc
22. Parking brake plate
23. Gauge rod

SPECIFICATIONS

reduction ratio: $\frac{24+78}{24} \times \frac{18+78}{18} = 22.667$

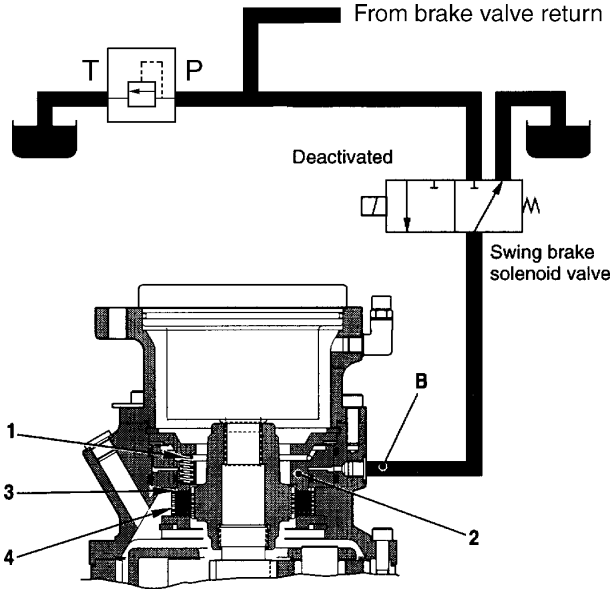
SWING HOLDING BRAKE

OPERATION

1) When swing brake solenoid valve is deactivated

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

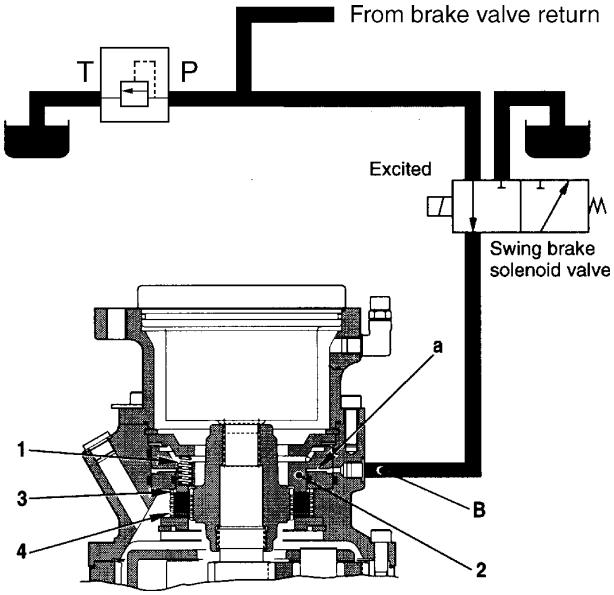
Because of this, brake piston (2) is pushed down in the direction of the arrow by brake spring (1), so disc (3) and plate (4) are pushed together and the brake is applied.



2) When swing brake solenoid valve is excited

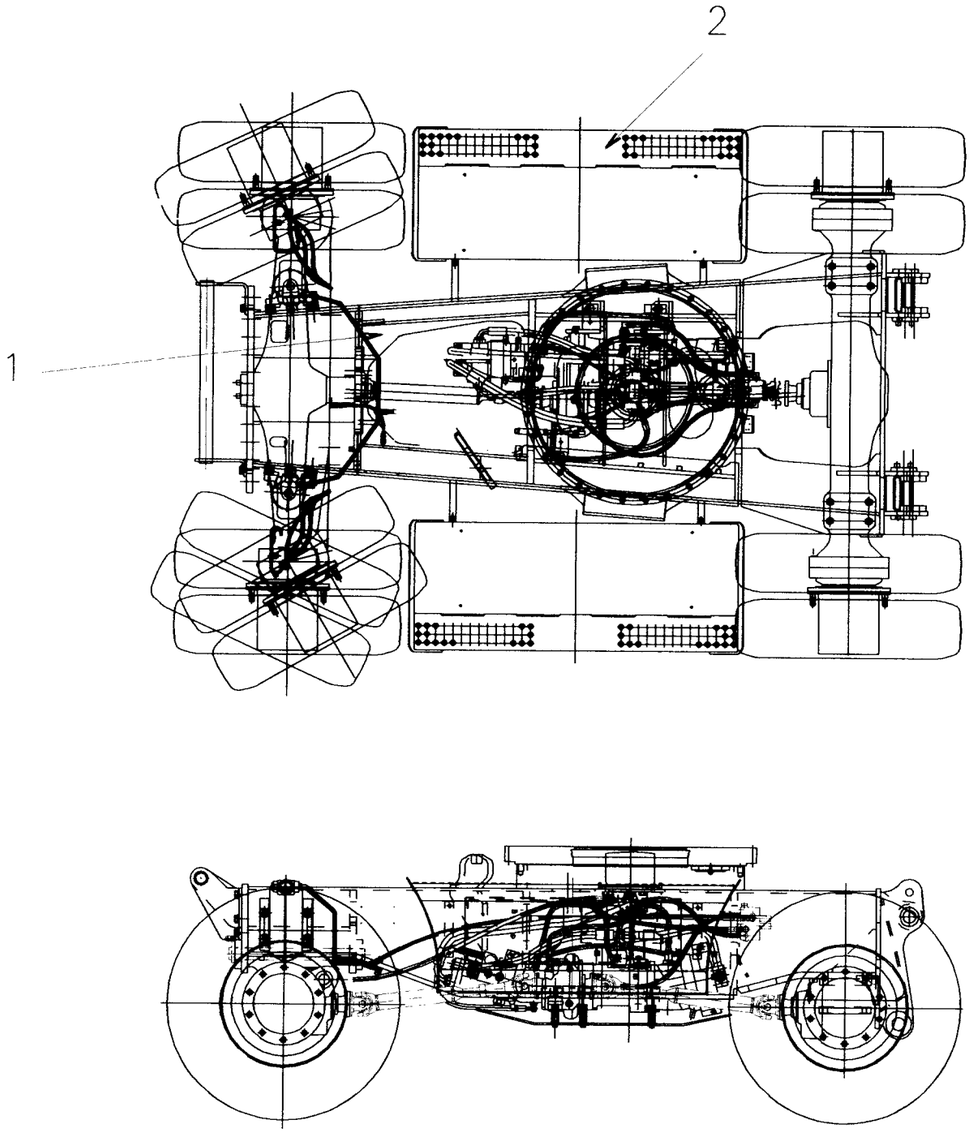
When the swing solenoid valve is excited, the valve is switched, and the pressurized oil from the PPC pressure reducing valve enters port **B** and flows to brake chamber "**a**".

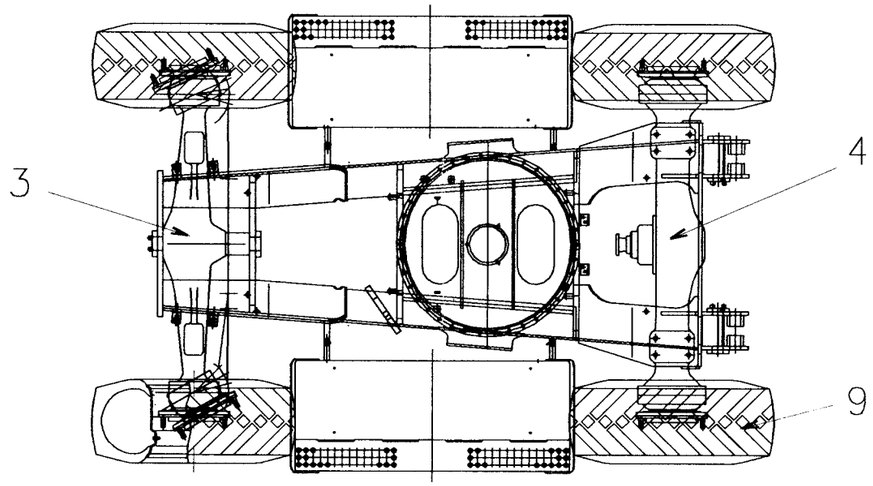
The pressurized oil entering chamber "**a**" overcomes the force of brake spring (1), and brake piston (2) is pushed up in the direction of the arrow. Because of this, disc (3) and plate (4) separate, and the brake is released.

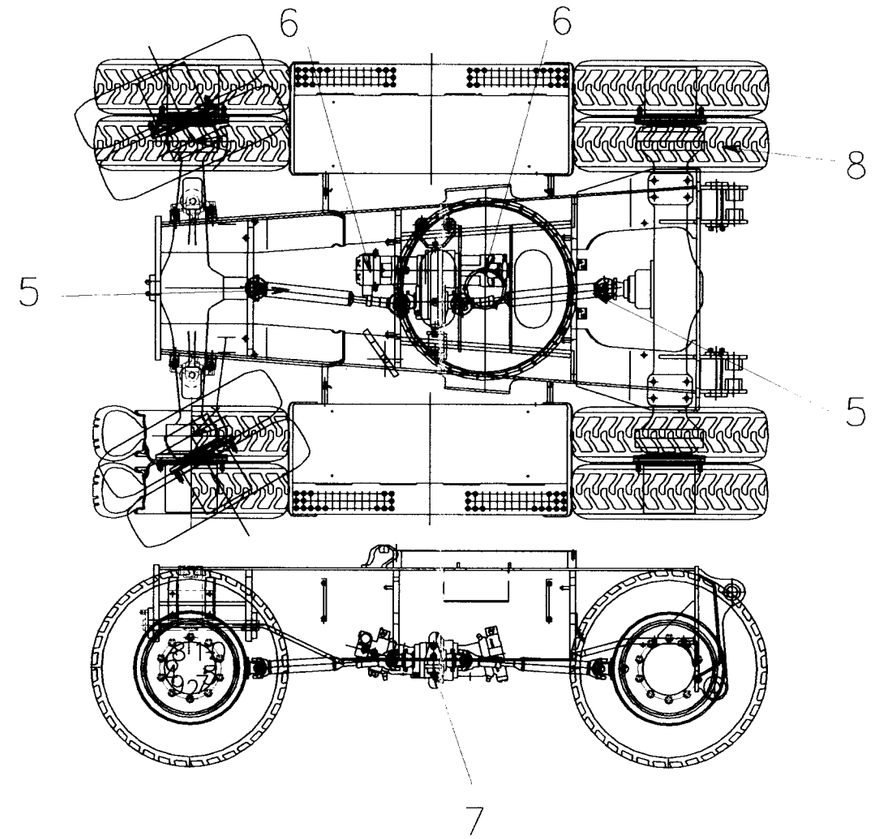


1. Brake spring
2. Brake piston
3. Disc
4. Plate

UNDERCARRIAGE



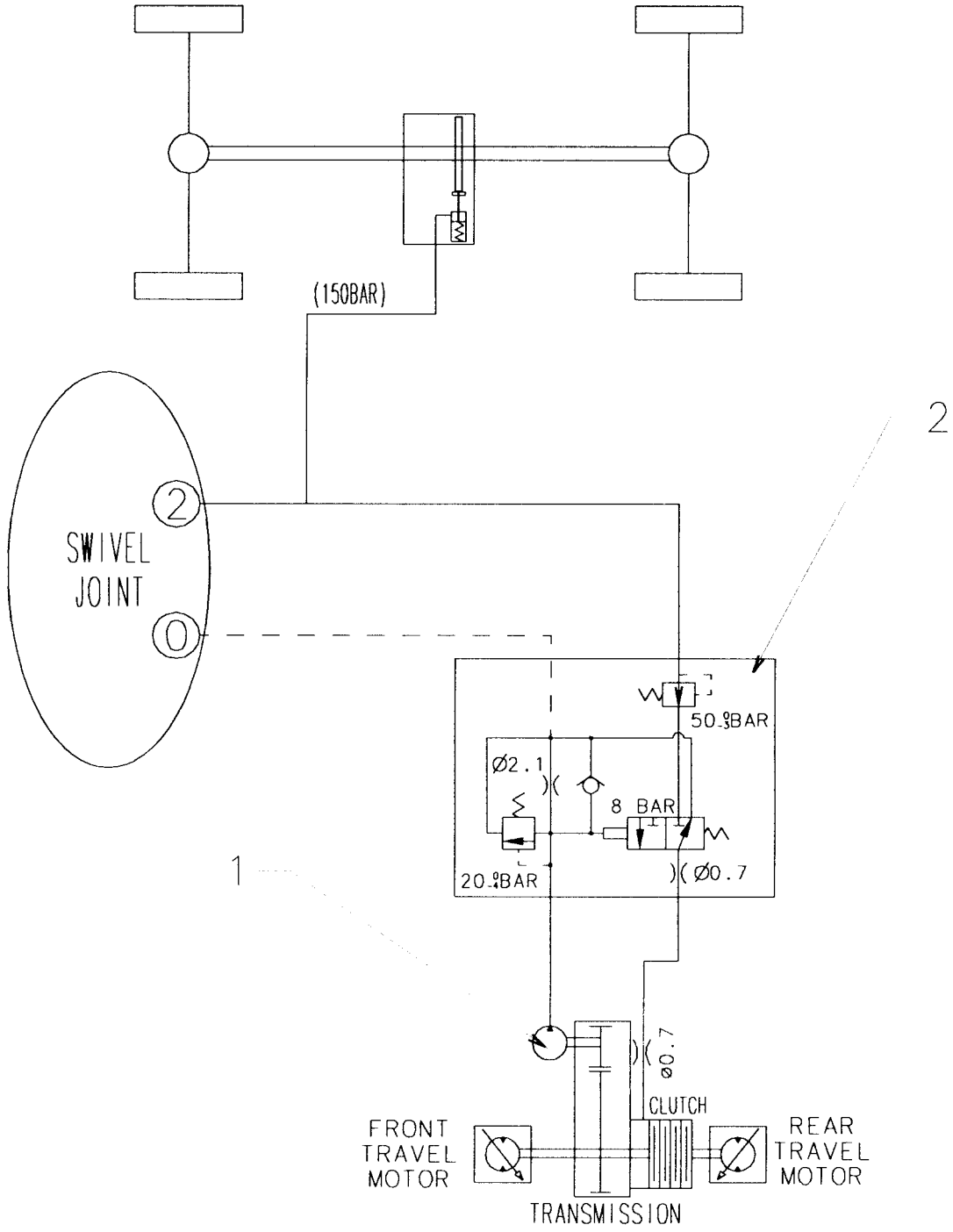




1. Undercarriage
2. Step
3. Front oscillating steering axle
4. Rear axle
5. Propshaft
6. Travel motor
7. Transmission
8. Double wheel assembly
9. Single wheel assembly

CLUTCH CONTROL CIRCUIT

STRUCTURE



1. Clutch control pump
2. Clutch control valve

FUNCTION

The clutch is a device which automatically disengages the drive between the large displacement (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 Kph again.

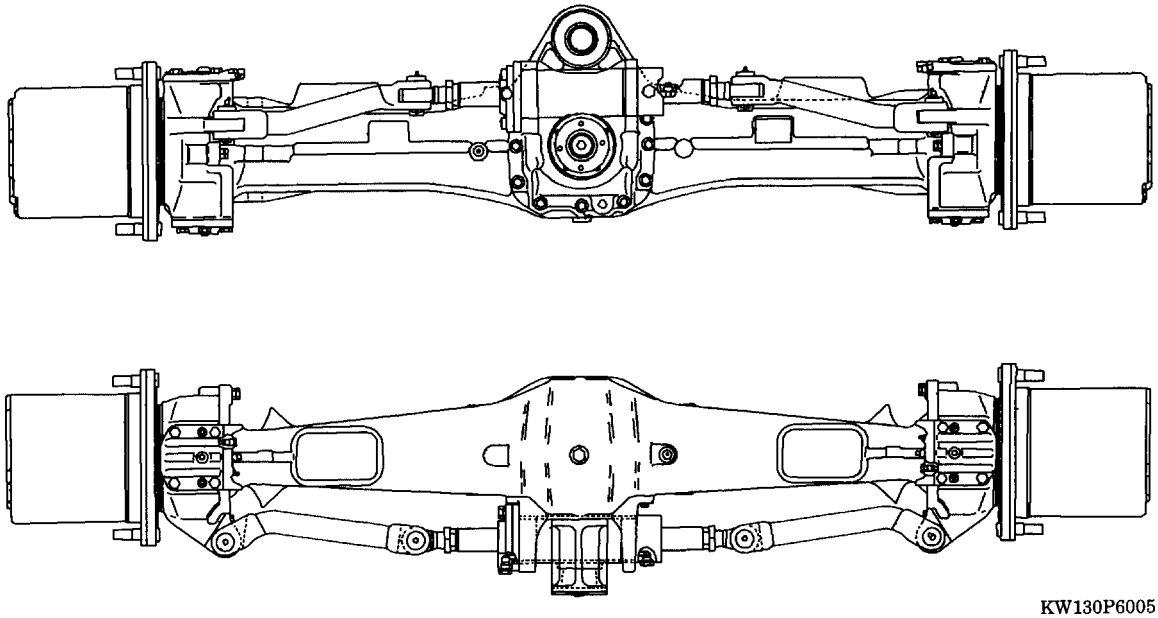
AXLE

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 and.

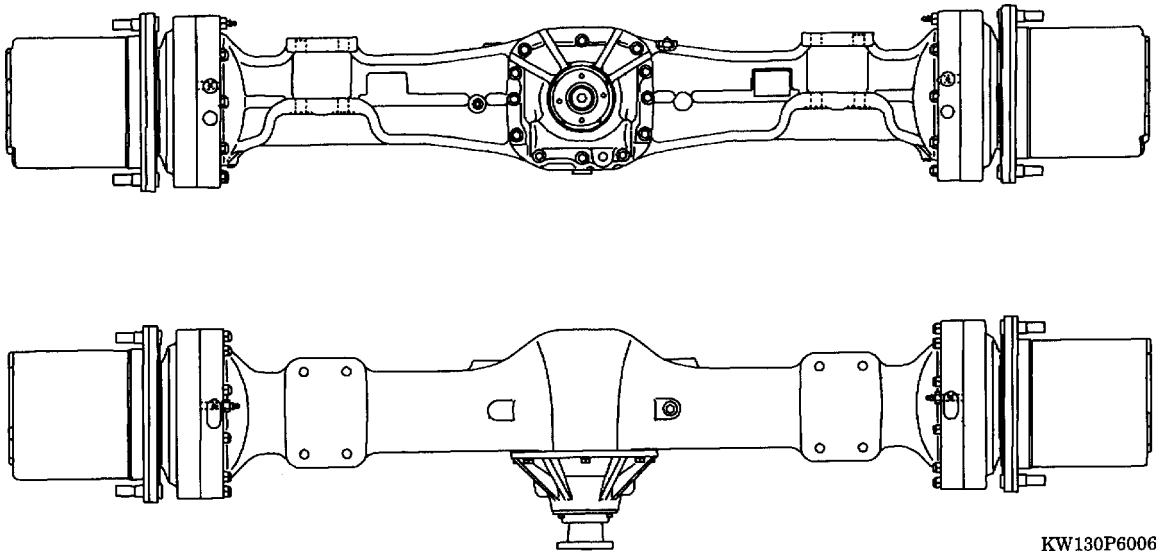
- A trunnion-type axle shaft with a king pin at the final drive end is used to enable the direction of travel of the machine to be changed.

FRONT AXLE

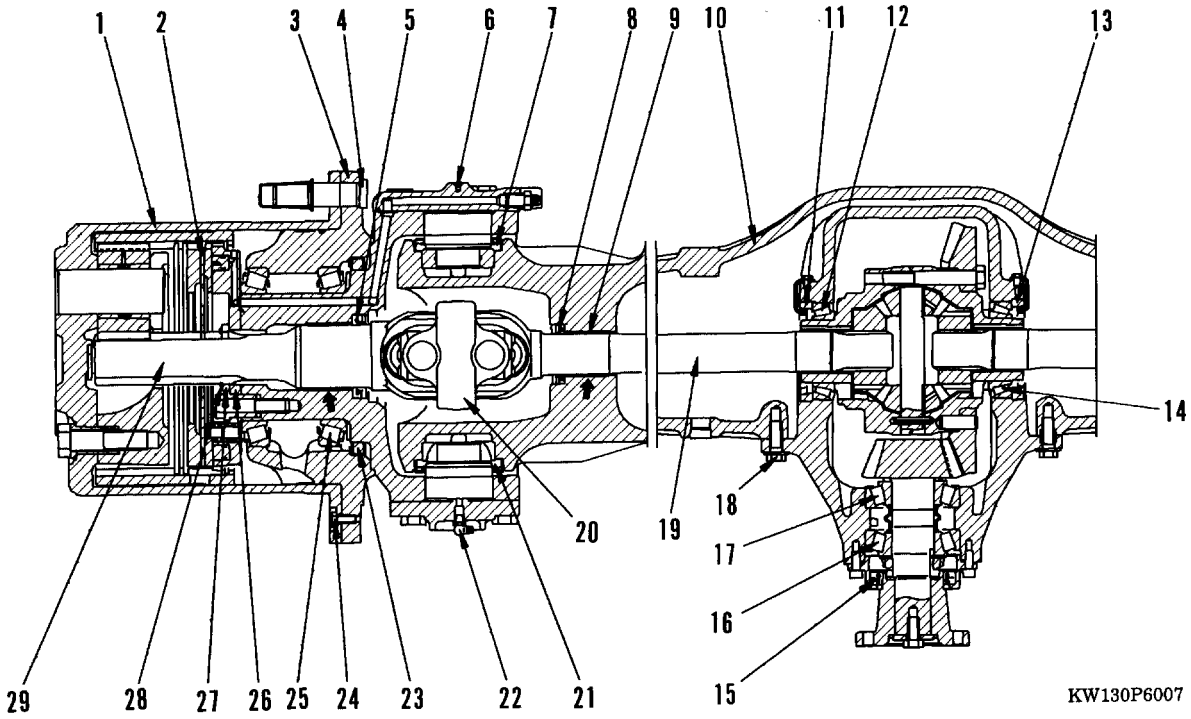


KW130P6005

REAR AXLE



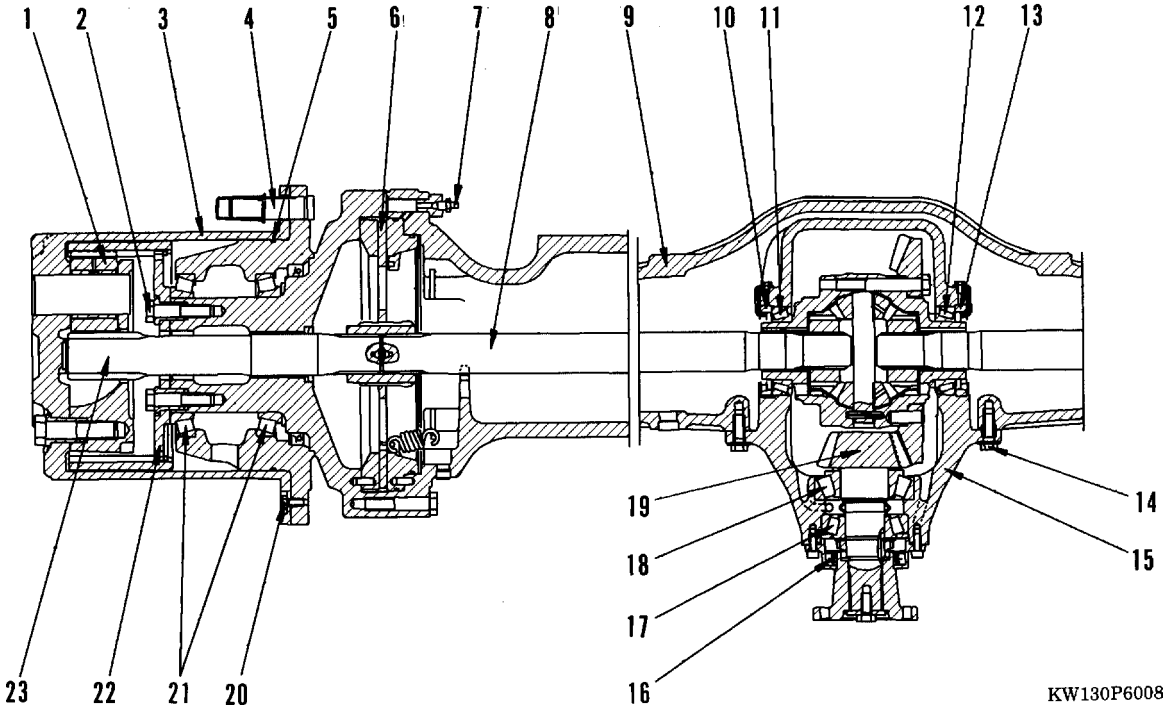
FRONT AXLE



Axle reduction ratio = 17, 73:1

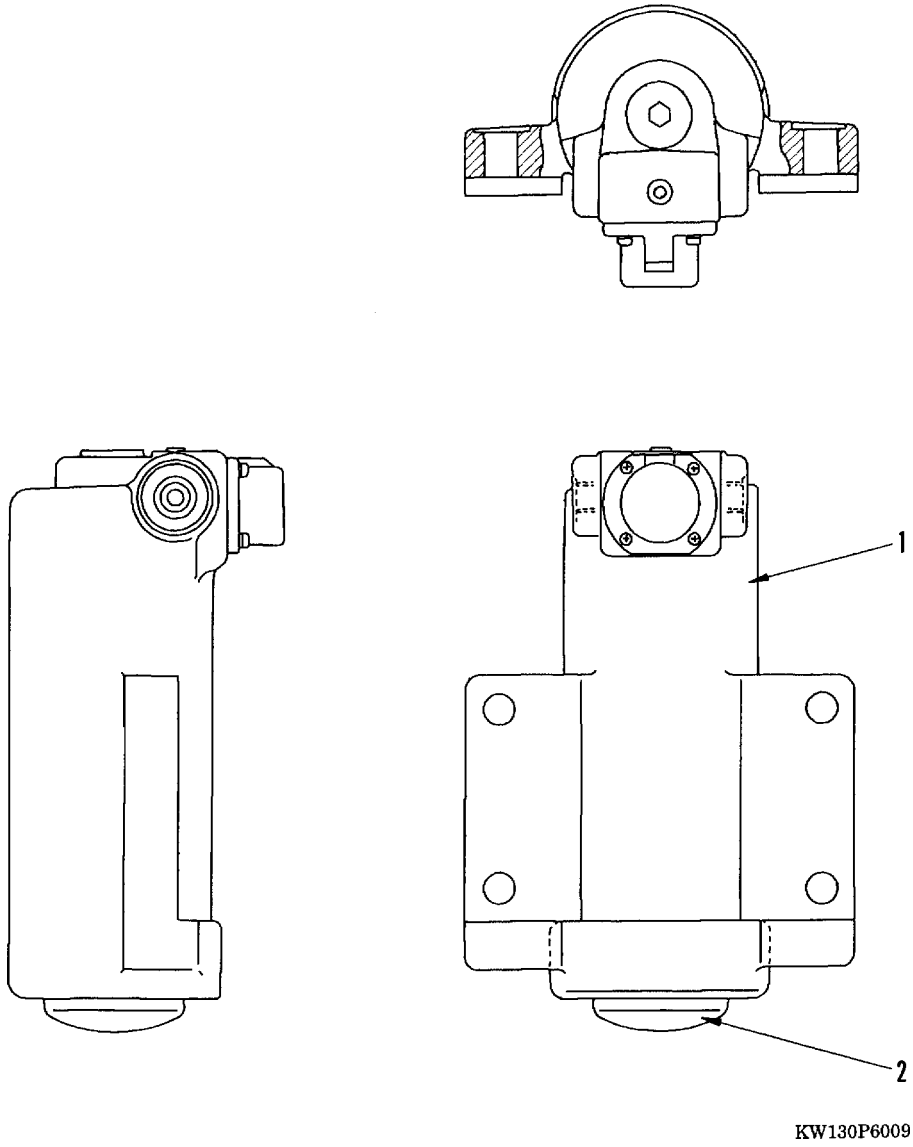
1. Planetary carrier
2. Washer
3. Brake drum
4. Pin
5. Seal ring
6. Grease nipple
7. Seal ring
8. Seal ring
9. Bushing
10. Axle tube
11. Ring nut
12. Ball bearing
13. Ring nut
14. Ball bearing
15. Seal ring
16. Roller bearing
17. Roller bearing
18. Hexagon head screw
19. Shaft
20. Joint
21. Bushing
22. Brease 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: ø100mm
Stroke: 155mm
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

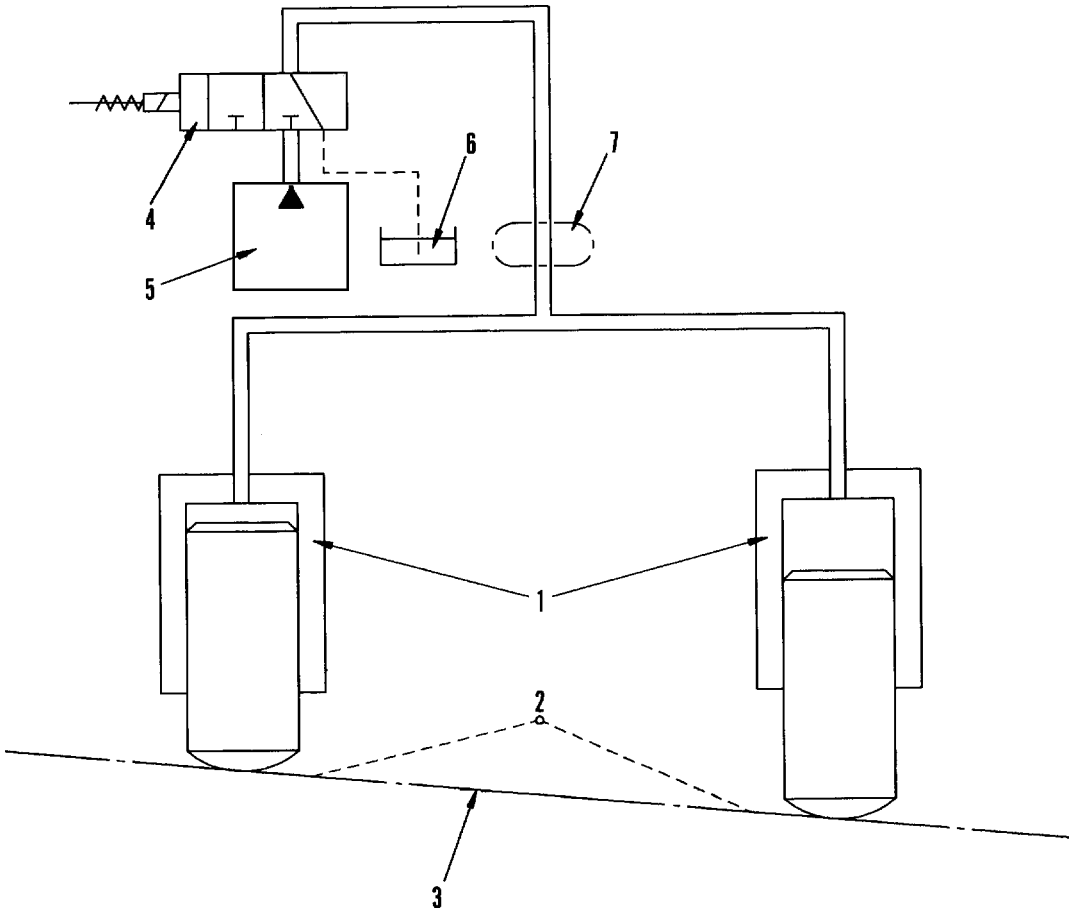
Purpose

The undercarriage 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 oscillating 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.

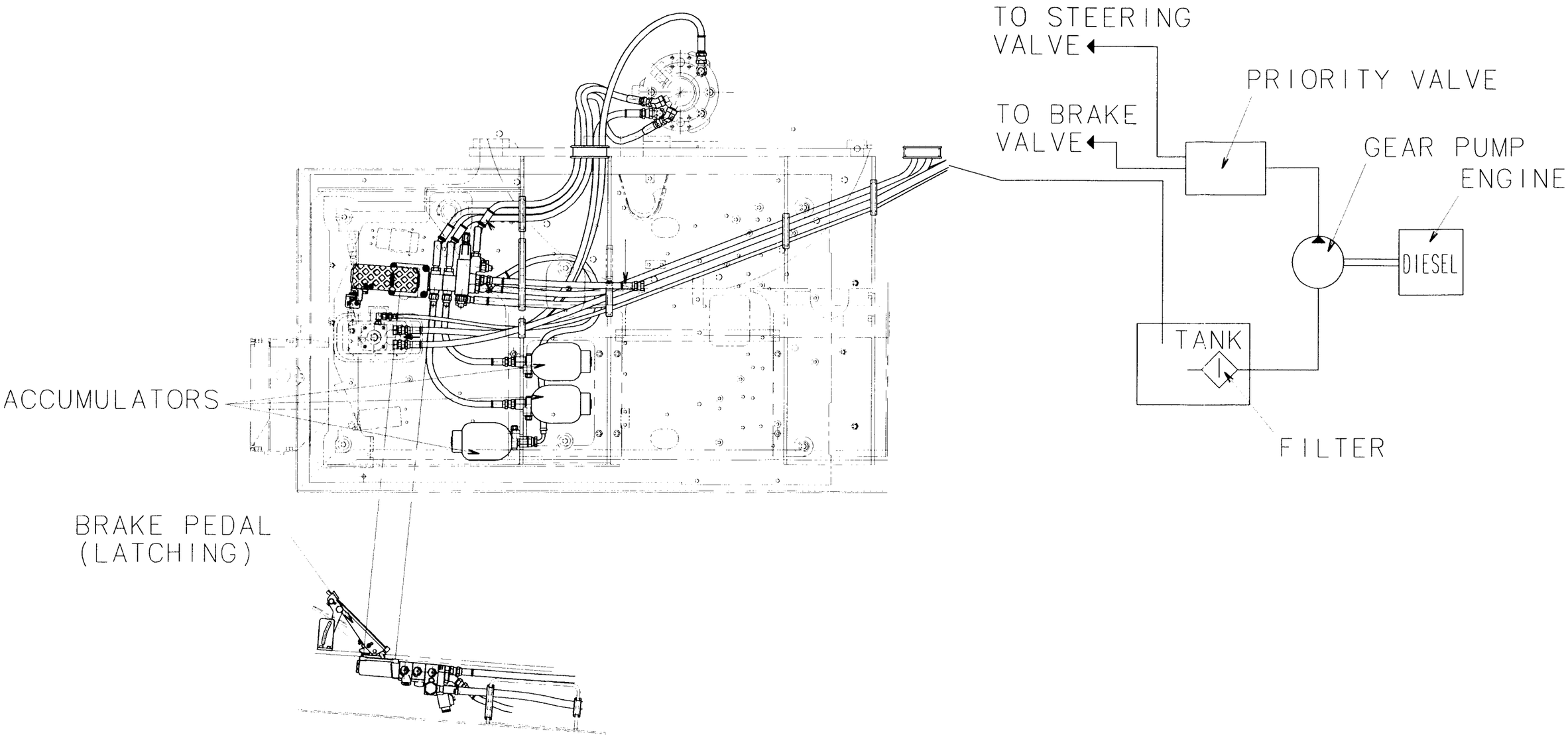
1. Ram
2. Axle oscillating point
3. Oscillating axle
4. Oscillation lock solenoid valve
5. PPC pressure reducing valve
6. Hydraulic tank
7. Swivel joint

Function

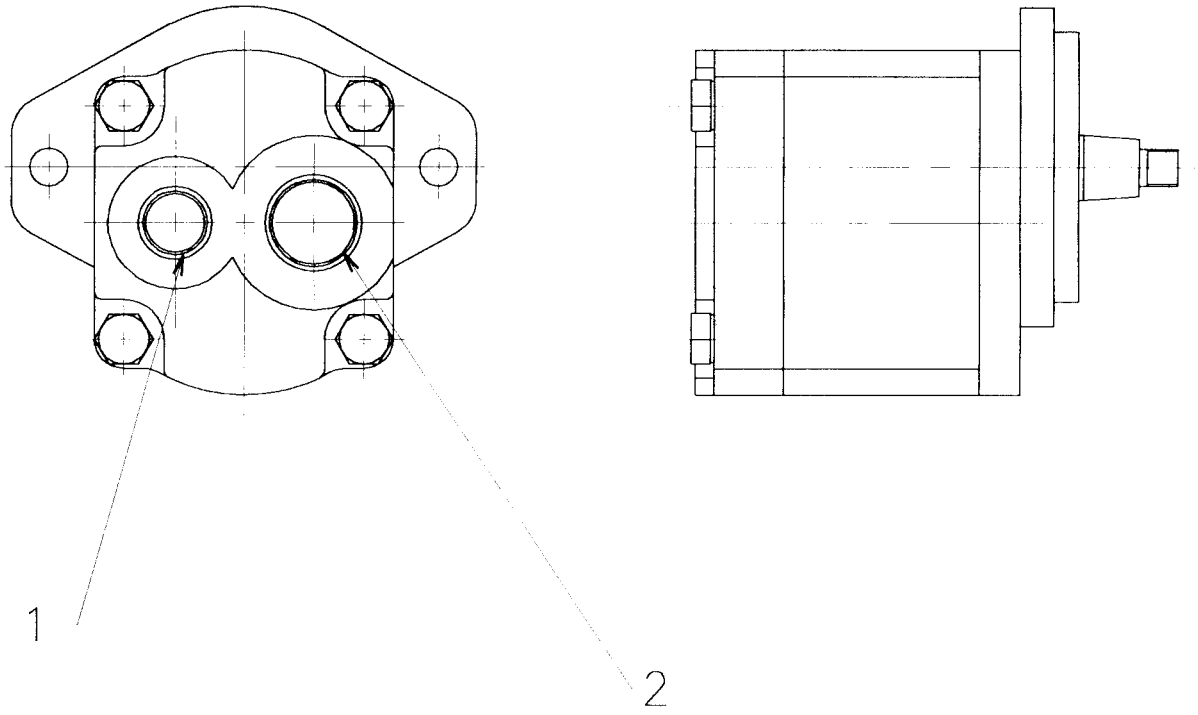
The oscillating axle (3) is mounted in bearing (2) in the middle of the excavator. The two rams (1) which are full of hydraulic oil are connected through pipelines to the oscillation lock solenoid valve (4).
When the excavator is being moved, the oscillation lock solenoid valve should be de-energized 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.



BRAKING TRAIN



BRAKE PEDAL

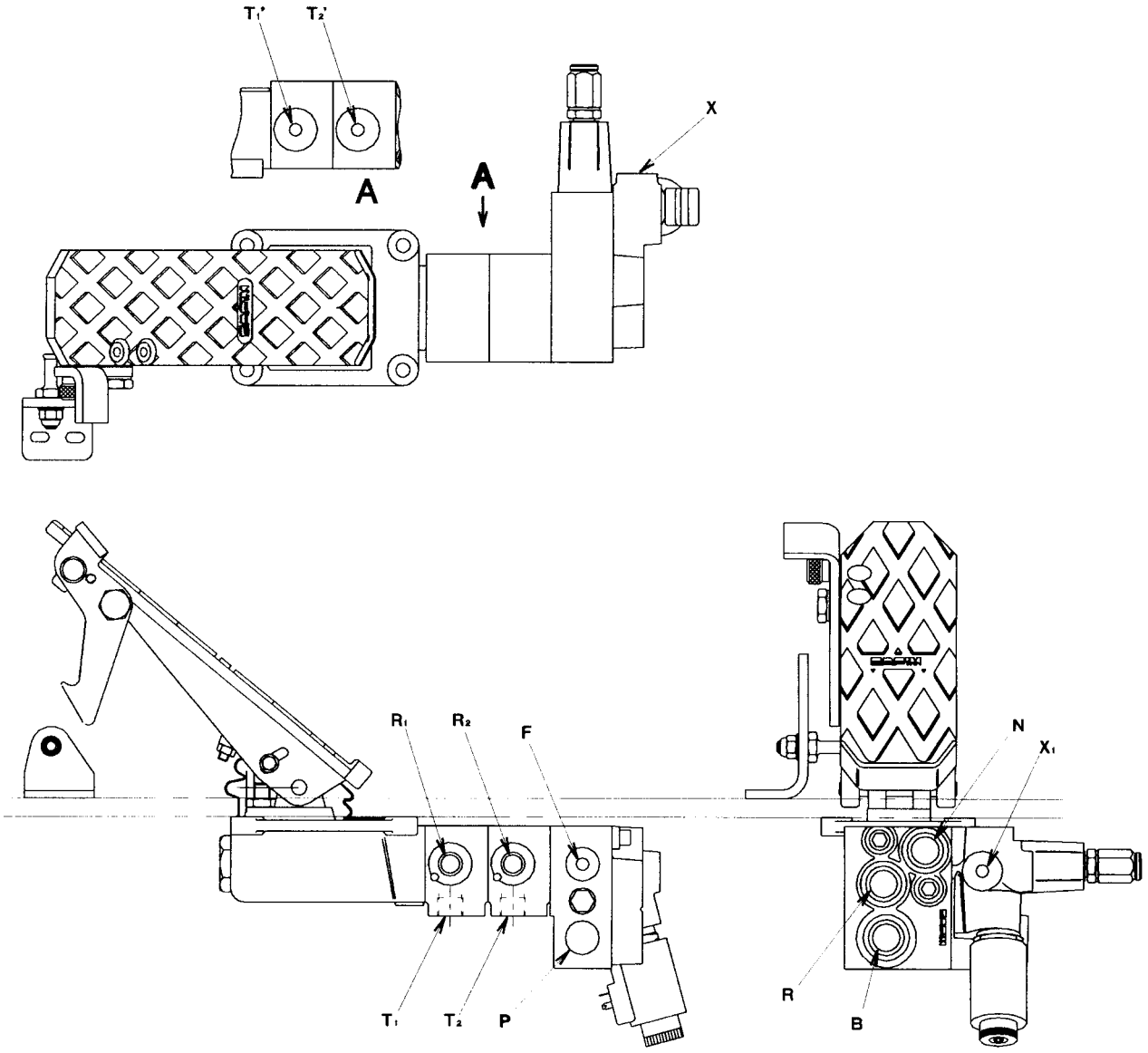


1. Delivery port
2. Suction port

Specifications

Rated speed: 2400 RPM
Displacement: 19cc/REV
Rated pressure: 250bar
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

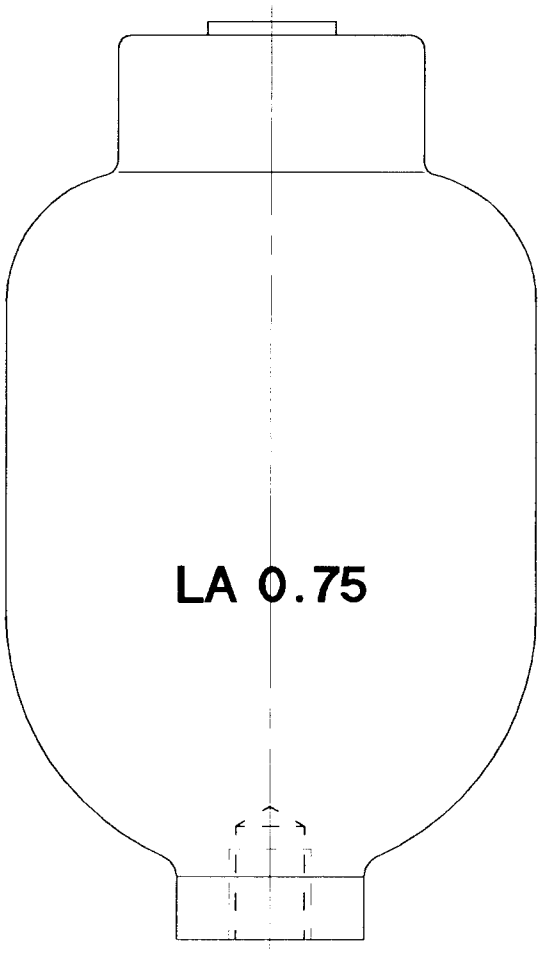
Specifications

Accumulator charge pressure

(cut in) = 122^{+6}_{-5} bar

(cut out) = 150^{+8}_{-4} bar

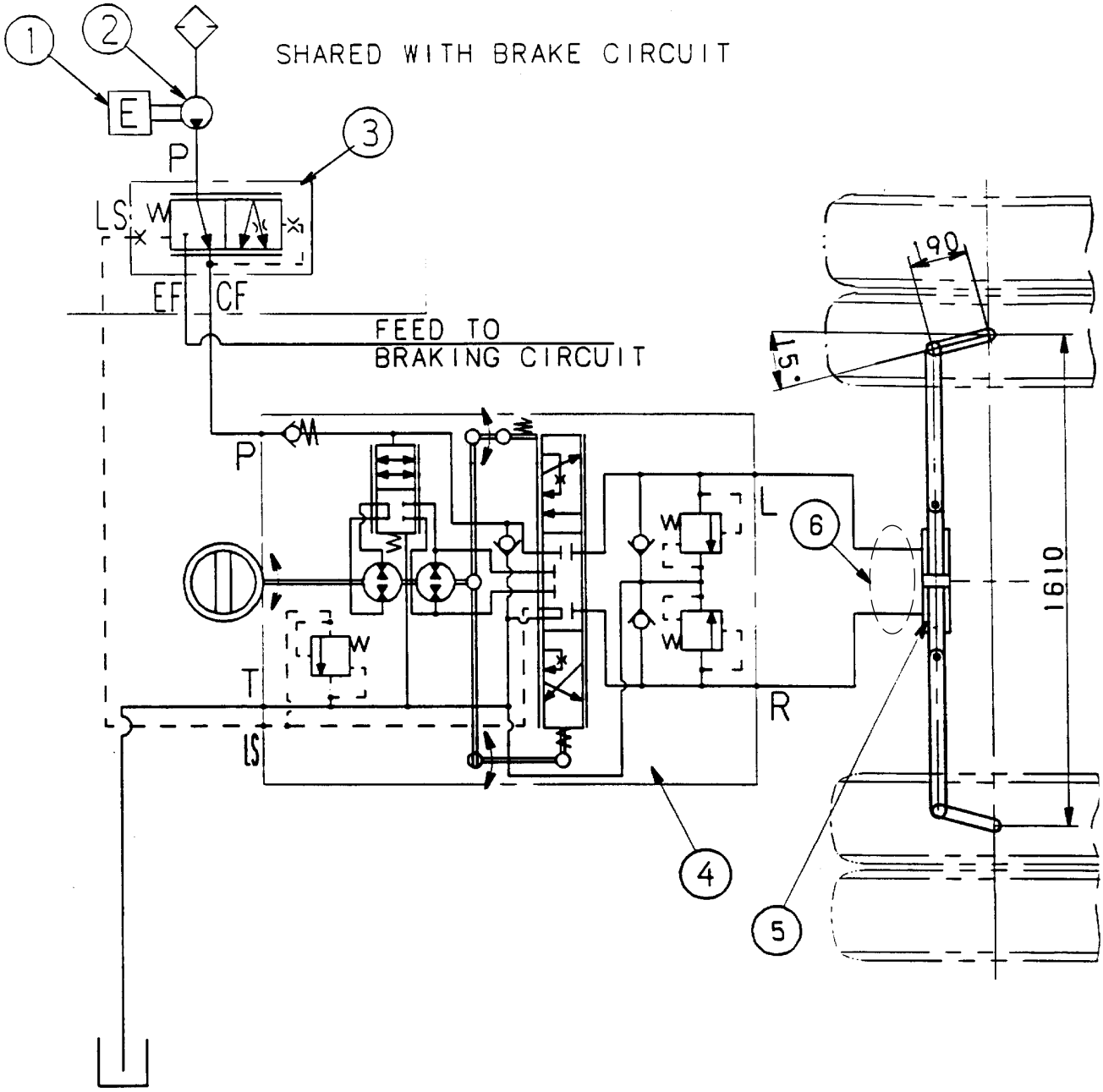
ACCUMULATOR FOR BRAKE SYSTEM



Specifications

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

STEERING TRAIN



STRUCTURE AND FUNCTION

- The steering is fully hydraulic. The oil sent by steering pump (2) mounted on the steering PTO at the front of the engine (1) flows to steering valve (4). From here it is passed through swivel joint (6) and is sent to steering cylinder (5). The steering cylinder then extends or retracts to move tie-rod and steer the machine.

- The hydraulic power from steering pump (2) is sent to the steering cylinder and converted back to mechanical power to operate the steering.

ITEM
POSITIONS

1. HYDRAULIC OIL FILTER

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 CILINDER ..... D=Ø90, d=Ø50, STROKE=170^{0}_{-1}
   STEERING CILINDER VOLUME = $\frac{(9 - 5) \times}{4}$ x 17 = 748 cmm^2

6. STEERING WHEEL Ø352

QUANTITIY OF STEERING TURNS

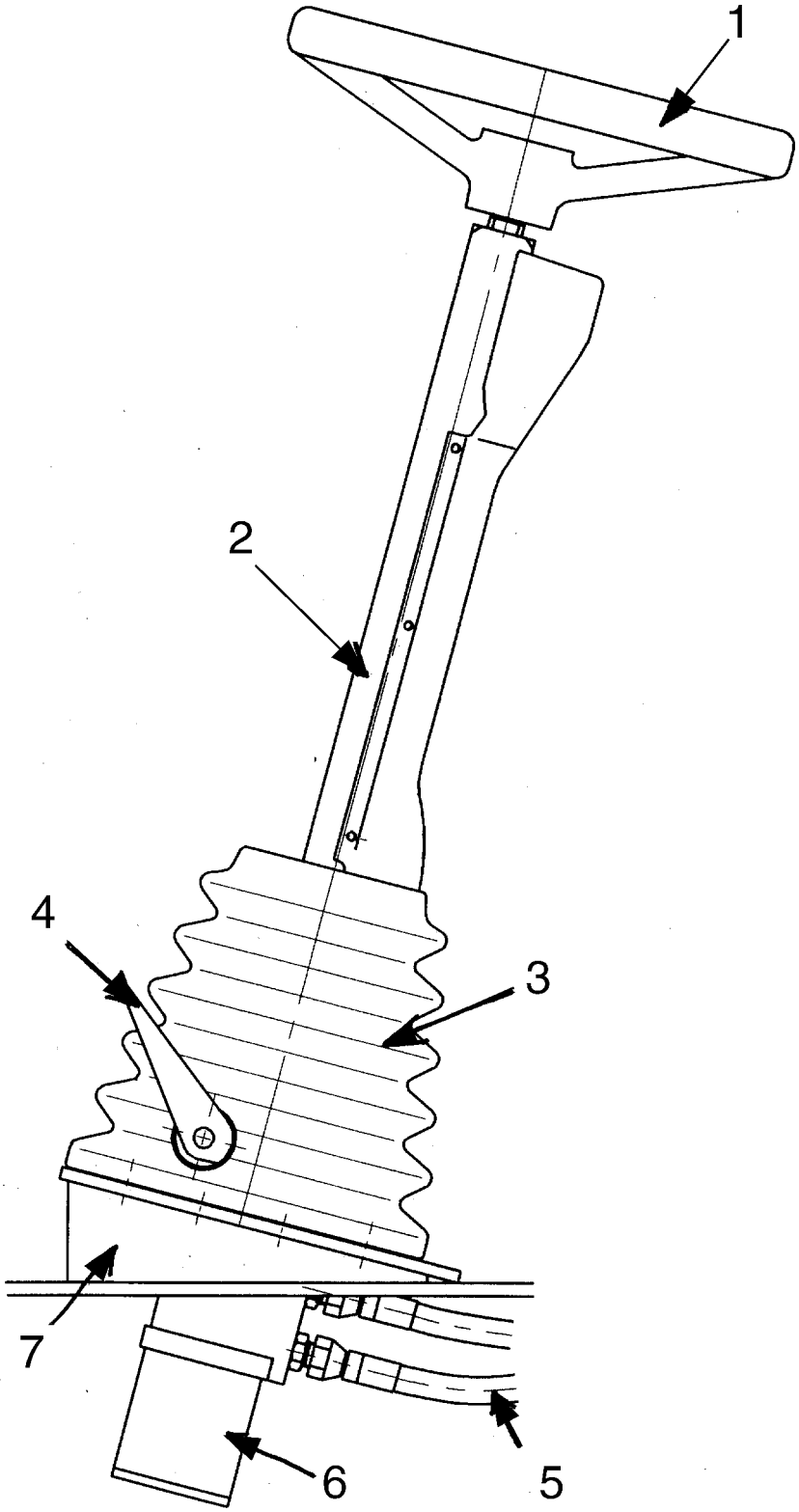
NORMAL

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

EMERGENCY

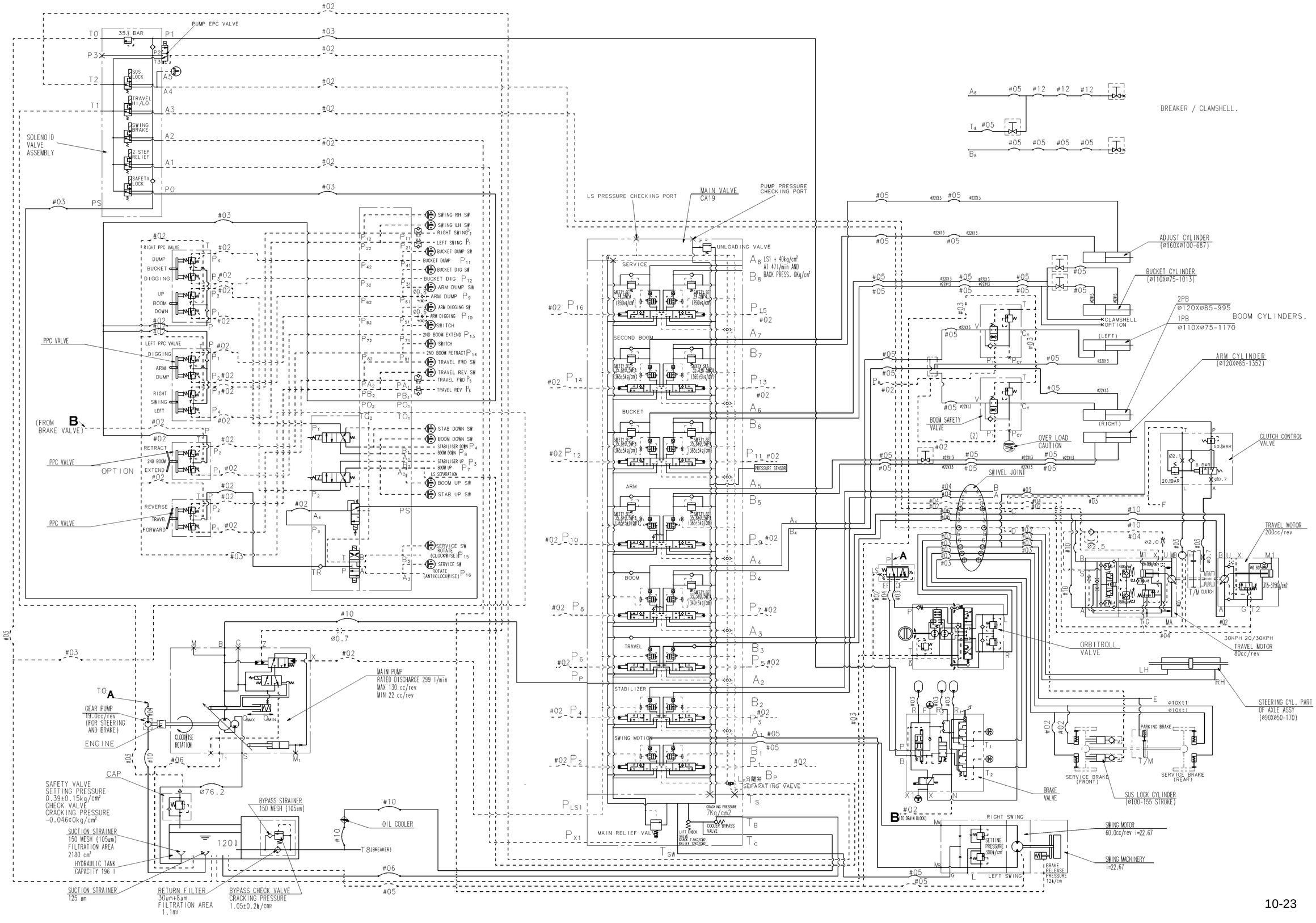
$$1 = \frac{\text{CYL.VOL}}{\text{PUMP.VOL}} = \frac{748\ cm^3}{70\ cm^3} = 10.7 \text{ TURNS}$$

STEERING COLUMN

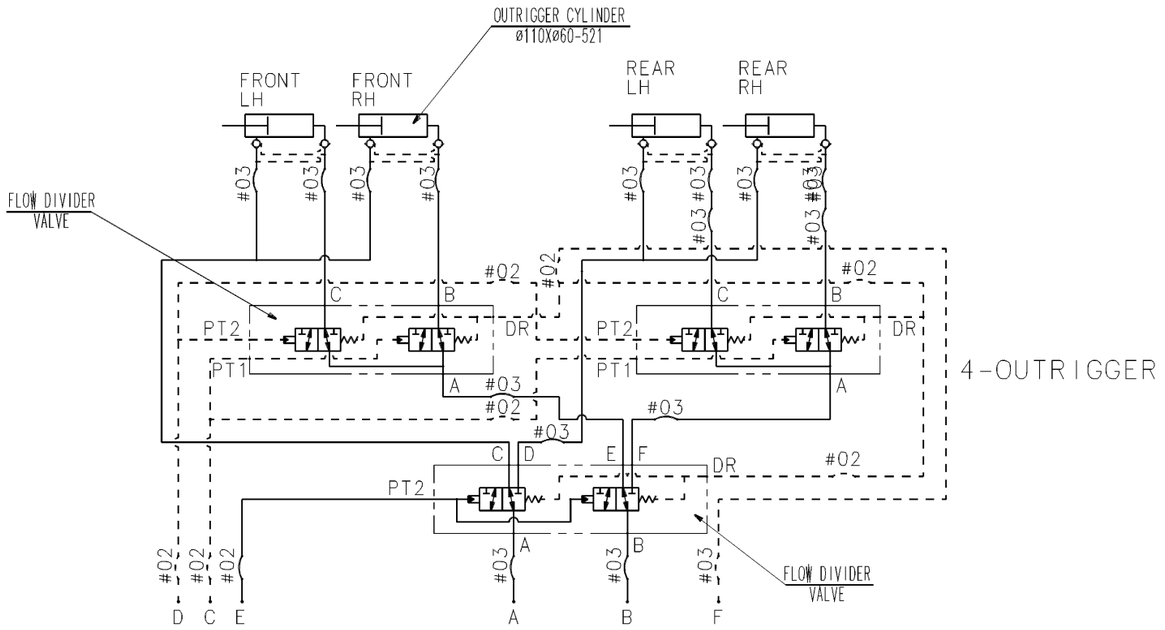


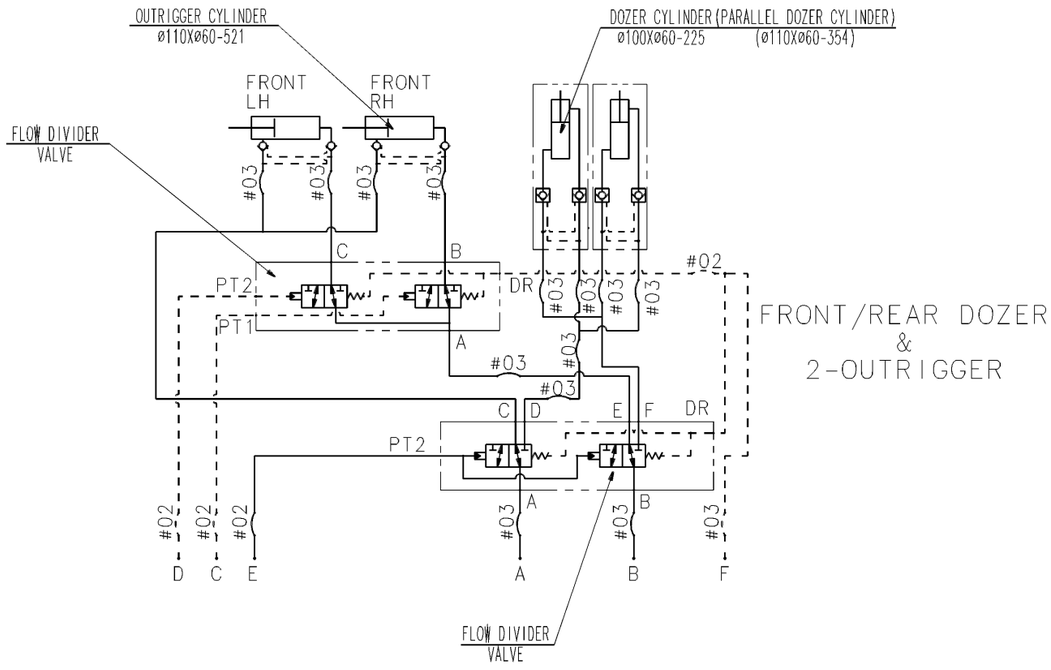
1. Steering wheel
2. Steering column
3. Gaiter
4. Pedal
5. Hose
6. Orbitroll valve
7. Mounting bracket

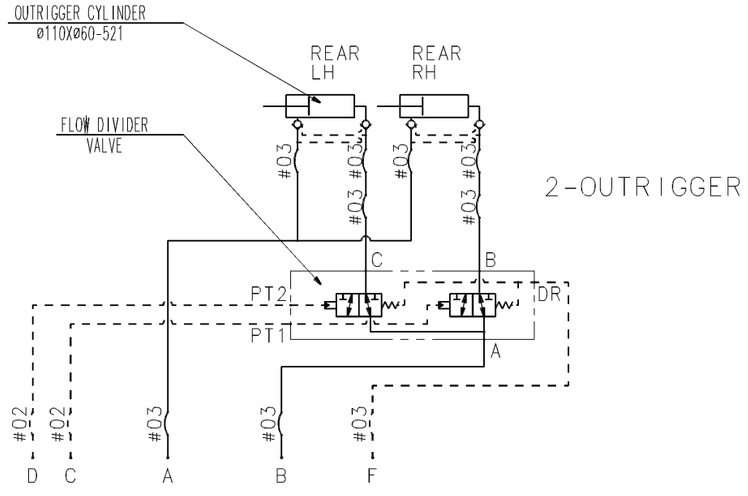
HYDRAULIC CIRCUIT DIAGRAM

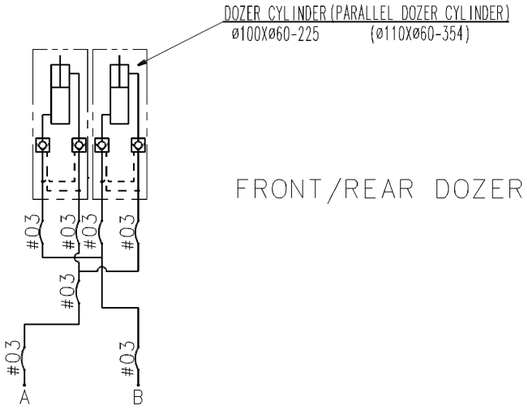


HYDRAULIC CIRCUIT DIAGRAM



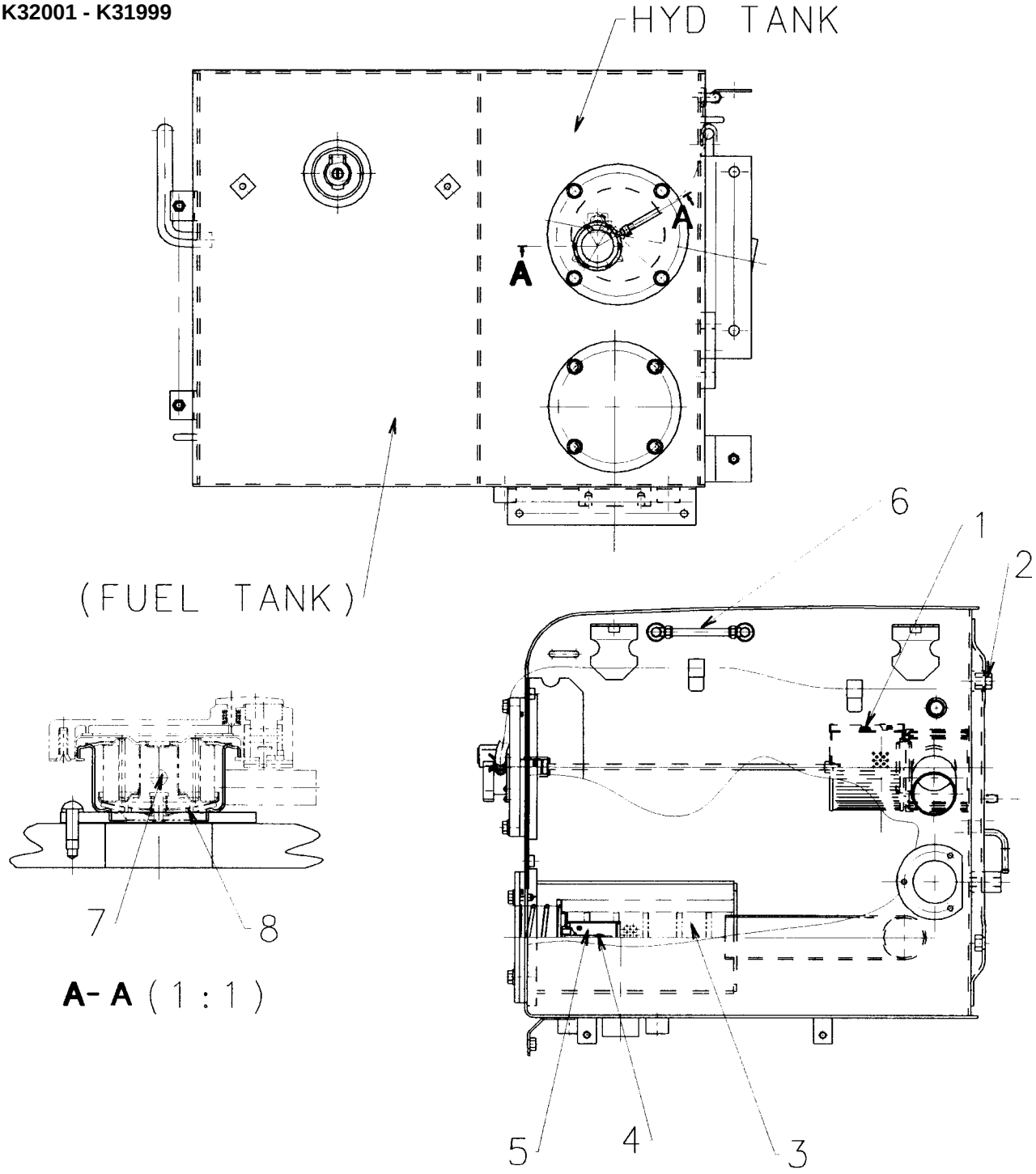






HYDRAULIC TANK

K32001 - K31999



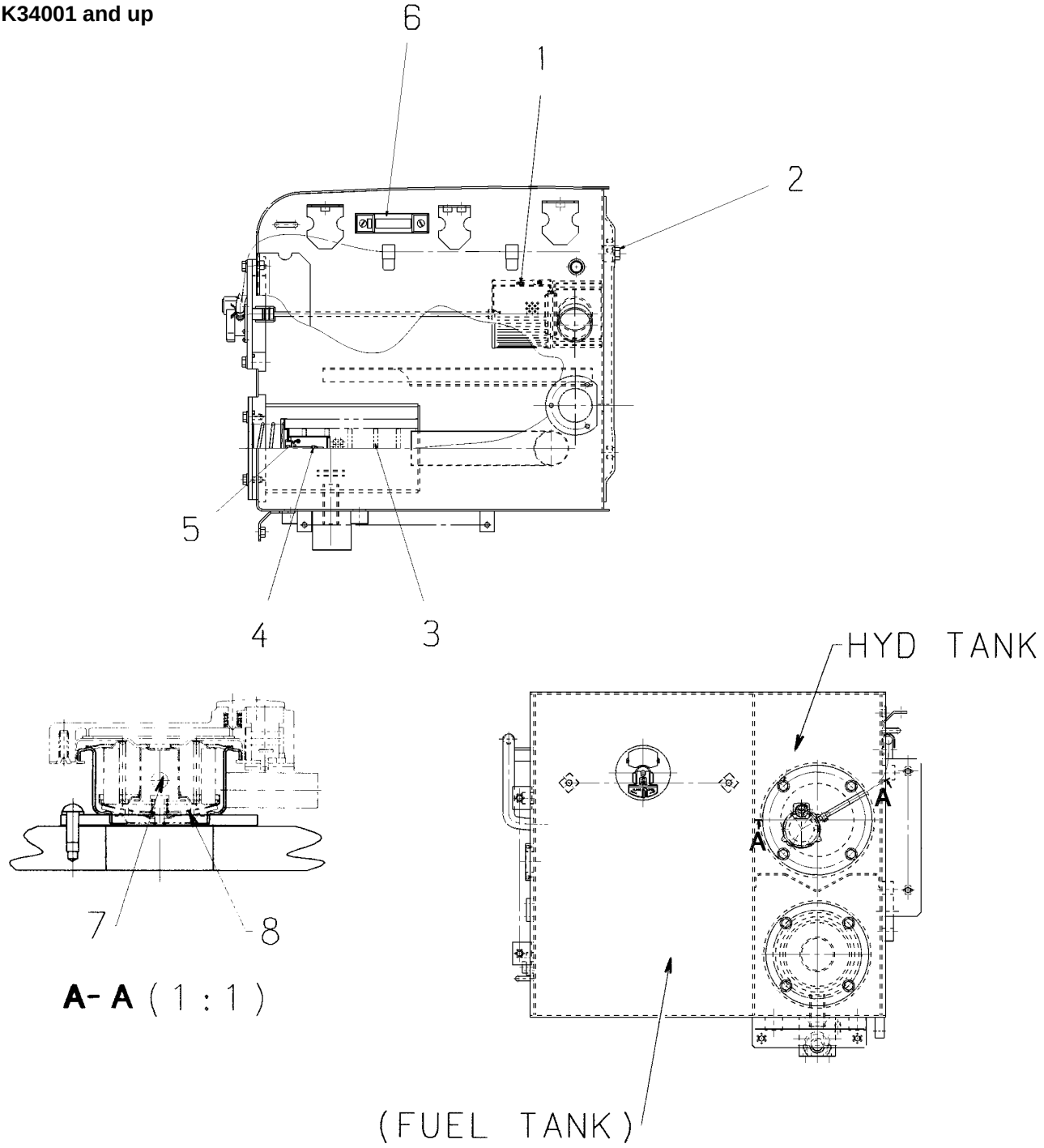
1. Suction strainer
2. Drain plug
3. Filter element
4. Bypass valve
5. Bypass strainer
6. Sight gauge
7. Vacuum valve
8. Pressure valve

Specifications

Tank capacity:	196l
Amount of oil inside tank:	120l
Pressure valve cracking pressure:	
	38.3 ± 14 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 TANK

K34001 and up

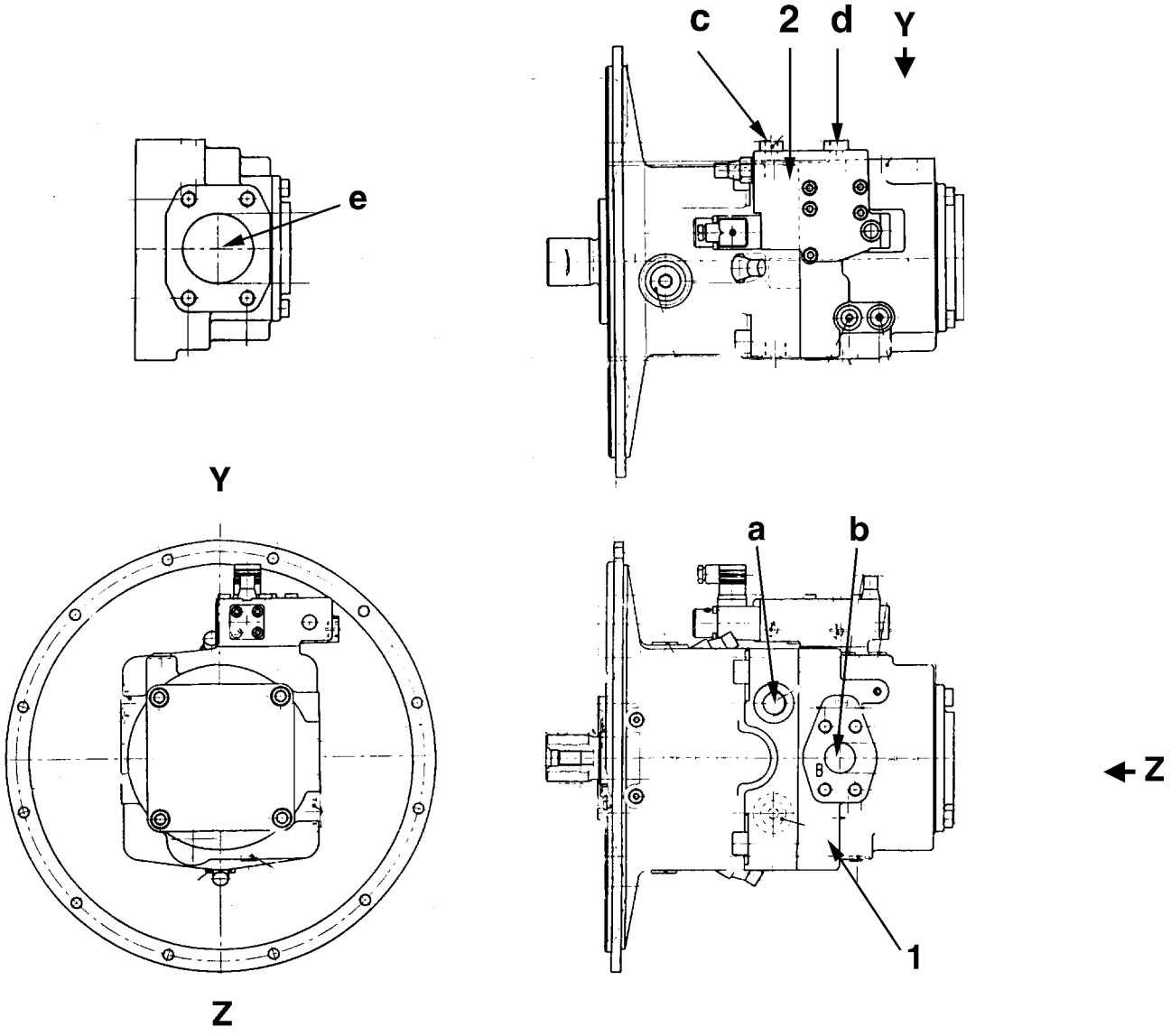


1. Suction strainer
2. Drain plug
3. Filter element
4. Bypass valve
5. Bypass strainer
6. Sight gauge
7. Vacuum valve
8. Pressure valve

Specifications

Tank capacity:	196l
Amount of oil inside tank:	120l
Pressure valve cracking pressure:	
	38.3 ± 14 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



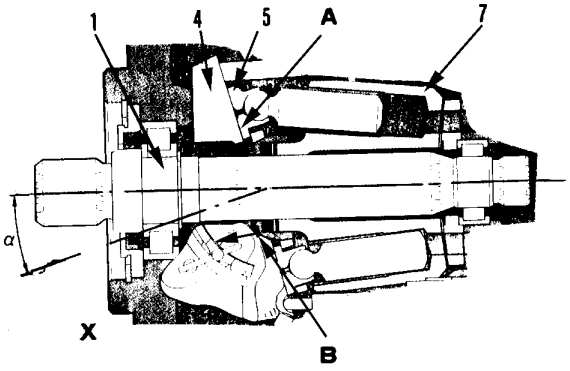
a. Pump drain port **PD**
b. Pump delivery port **PA**
c. Pump LS pressure port **PLS**
d. LS control EPC pressure port **PSIG**
e. Main pump suction port **PS**

1. Main pump
2. TVC•LS valve

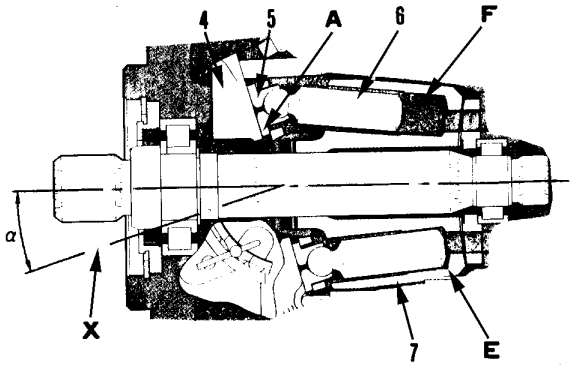
OPERATION

1. Operation of pump

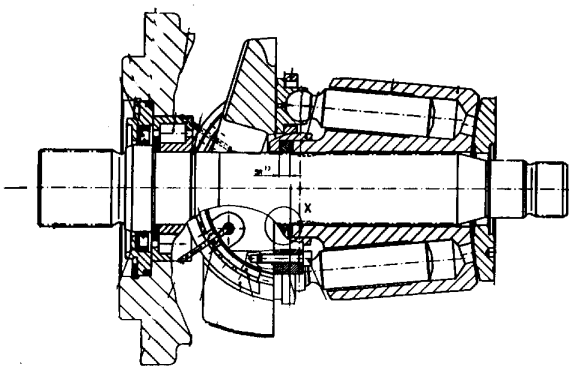
1) cylinder block (7) rotates together with shaft (1), and shoe (5) slides on flat surface **A**.
When this happens, rocker cam (4) moves along cylindrical surface **B**, so angle α between center line **X** of rocker cam (4) and the axial direction of cylinder block (7) changes. (Angle α is called the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



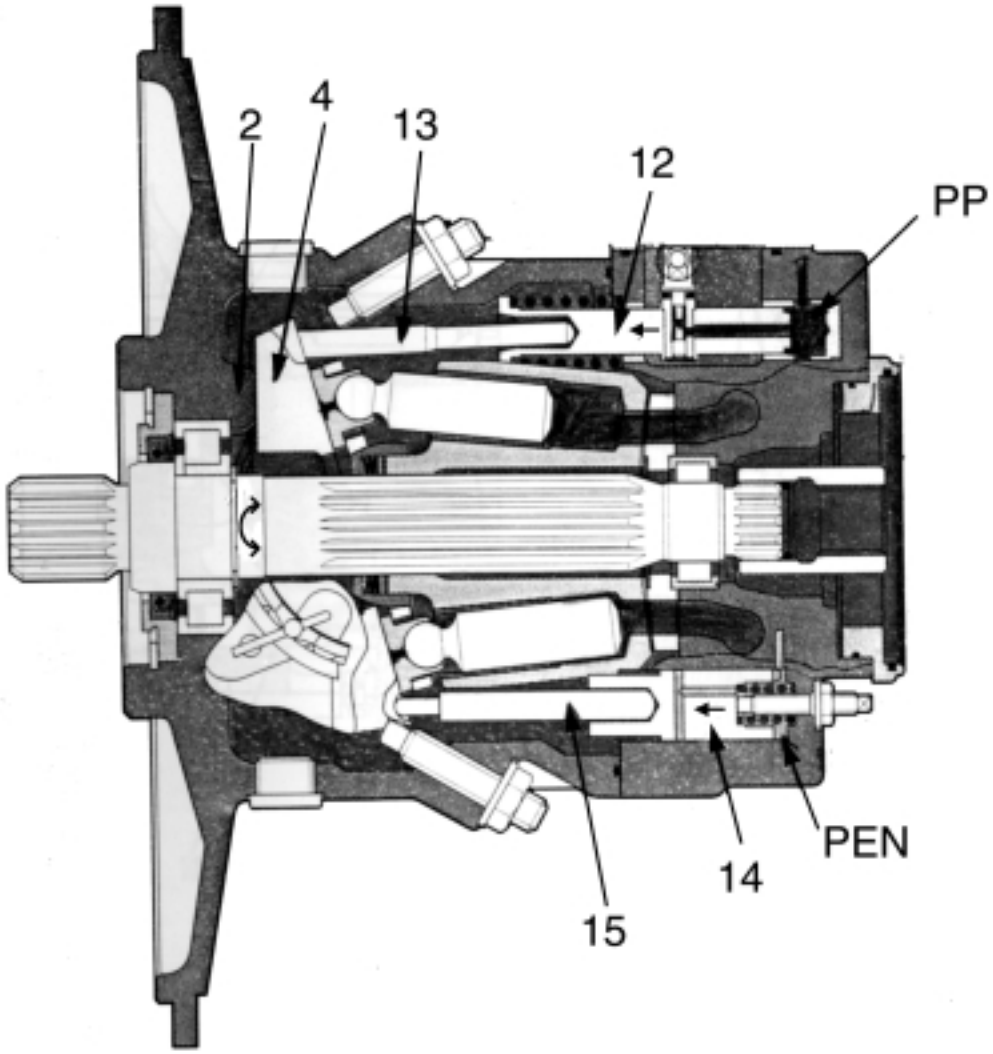
2) Center line **X** of rocker cam (4) maintains swash plate angle α in relation to the axial direction of cylinder block (7), and flat surface **A** moves as a cam in relation to shoe (5).
In this way, piston (6) slides on the inside of cylinder block (7), so a difference between volume **E** and **F** 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, and as the volume becomes bigger, the oil is sucked in.



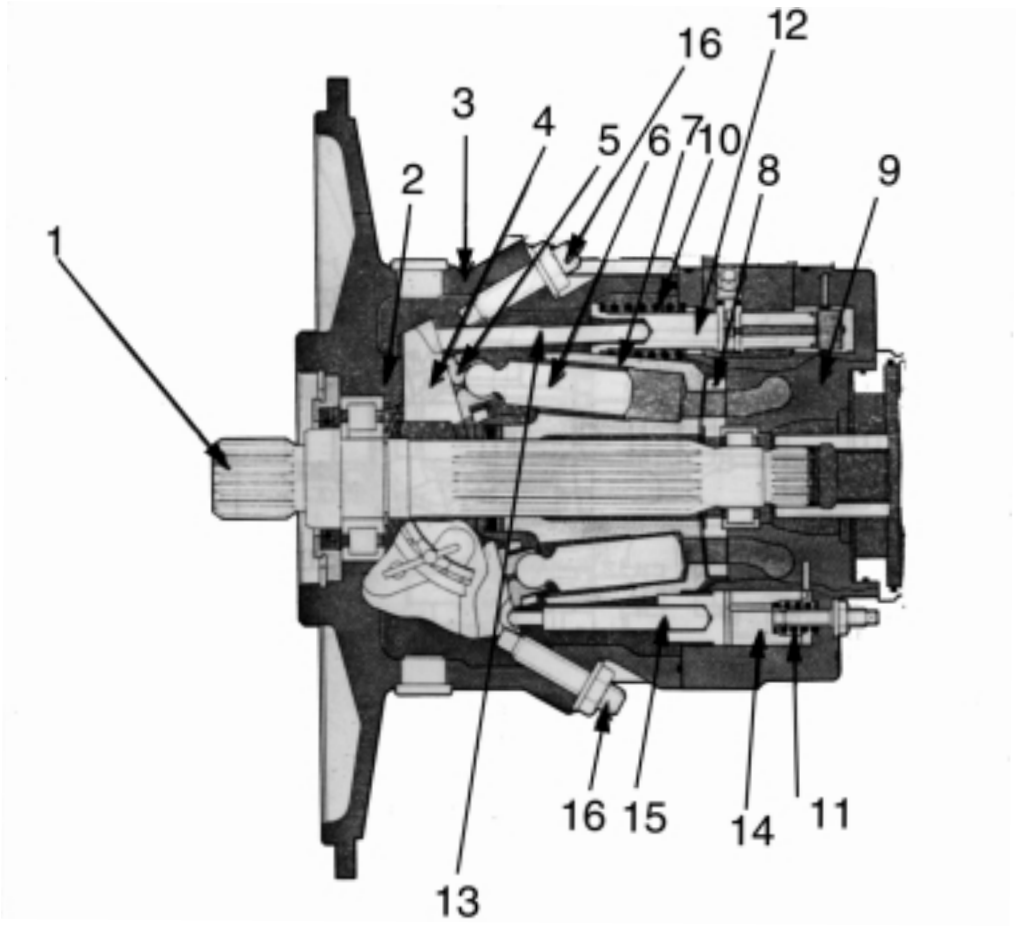
3) If center line X of rocker cam (4) is in line with the axial direction of cylinder block (7) (swash plate angle = 0), the difference between volumes **E**' and **F**' inside cylinder block (7) becomes 0, so the pump does not carry out any suction or discharge of oil. (In actual fact, the swash plate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



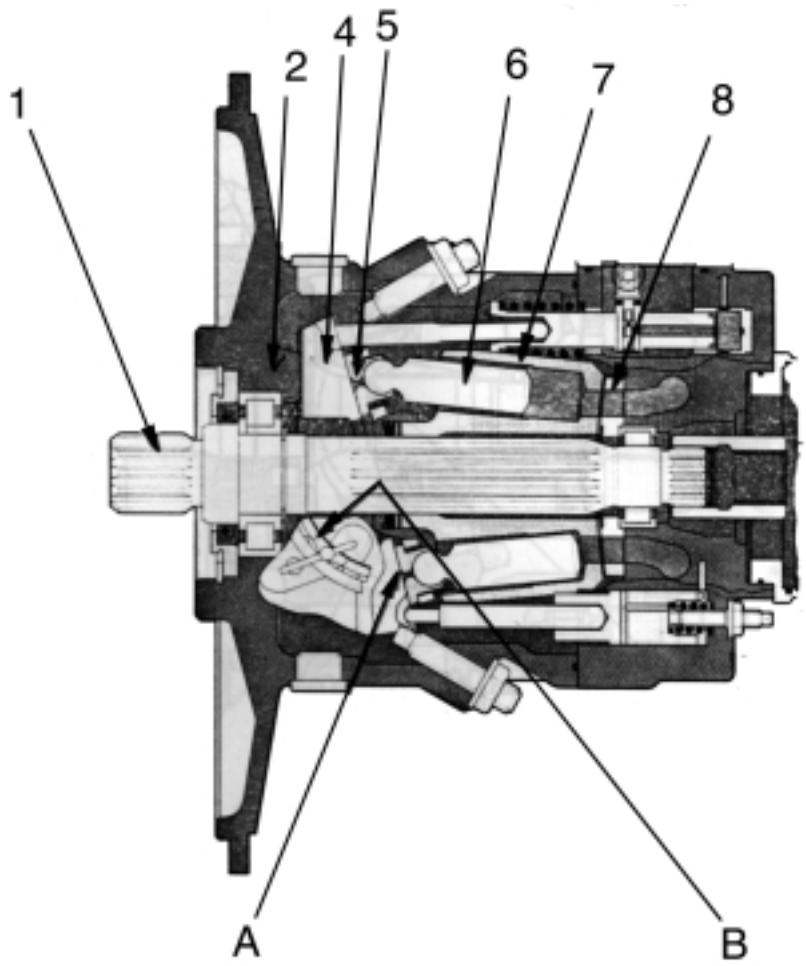
2. CONTROL OF DISCHARGE AMOUNT



- 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 positioning piston (12) and return piston (14).
- Servo piston (12) moves in a reciprocal movement ($\longleftrightarrow$) according to the spring force and pump output pressure.
- This straight line movement is transmitted through rod (13) and (15) to rocker cam (4), and rocker cam (4), which is supported by the cylindrical surface to cradle (2), moves in a swinging movement on the cylindrical surface in (direction).
- Piston (14) moves in a reciprocal movement ($\longleftrightarrow$) according to the command from the TVC•LS valve and the spring force.
- Main pump discharge pressure (self-pressure) **PP** is always connected to the chamber receiving the pressure on piston (12) end. (the self-pressure is brought in).
- Output pressure **PEN** of the LS valve is brought to the chamber receiving the pressure at piston (14) end.
- The relationship between piston (12) and piston (14) controls swash plate (4) angle.



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. Spring
12. Positioning piston
13. Rod
14. Return piston
15. Rod
16. Stopper



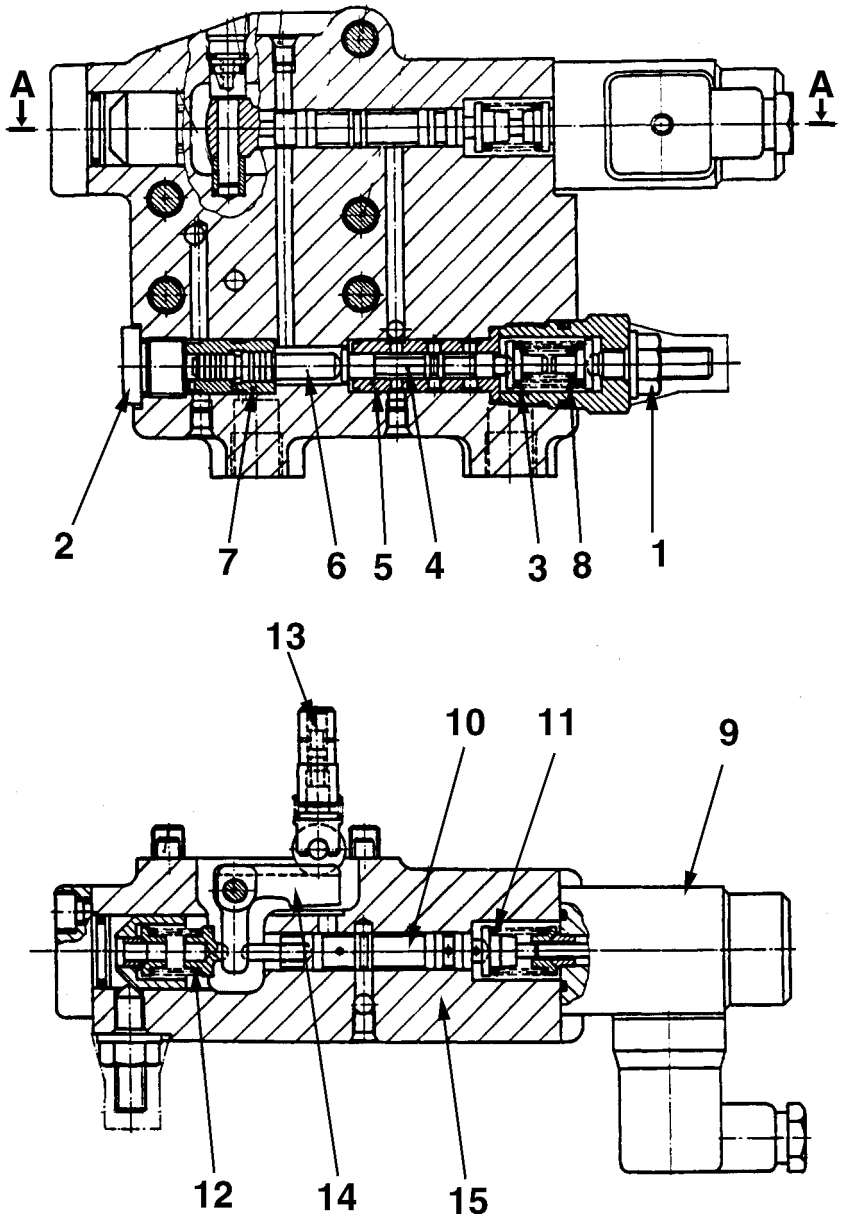
FUNCTION

- 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 a spline, and shaft (1) is supported by the front and rear bearings.
- The tip of piston (6) is a convex ball, and shoe (5) is pressed in to form one unit. Piston (6) and shoe (5) form a spherical bearing.
- Rocker cam (4) has flat surface **A**, and shoe (5) is always pressed against this surface while sliding in a circular movement.
- Rocker cam (4) brings high pressure oil at cylindrical surface **B** with cradle (2), which is secured to the case, and forms a static pressure bearing when it slides.
- Piston (6) carries out relative movement in the axial direction inside each cylinder chamber of cylinder block (7).
- The cylinder block seals the pressure oil to valve plate (8) and carries out relative rotation. This surface is disigned 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).

2. TVC. LS valve



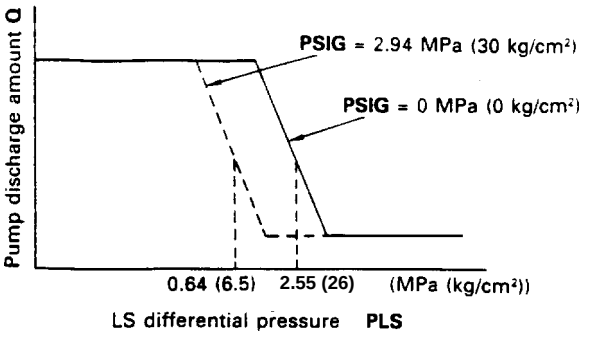
LS VALVE
1. Locknut
2. Plug
3. Spring
4. Spool
5. Sleeve
6. Piston
7. Sleeve
8. Spring

TVC VALVE
9. Solenoid
10. Piston
11. Spring
12. Spring
13. Piston
14 Lever
15 Valve body

FUNCTION

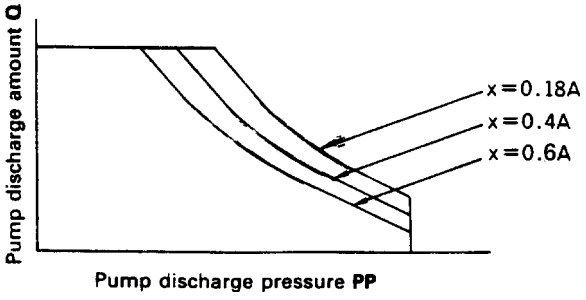
1. LS VALVE

- The **LS** valve detects the load and controls the discharge amount.
  This valve controls main pump discharge amount **Q** according to differential pressure △**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** selection pressure) from the proportional solenoid vlve enter this valve. The reletionship 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 pressure **PSIG**.
- When **PSIG** changes between 0 and 2.94 MPa (0 and 30 kg/ cm^2), the spool load changes according to this, and the selector point for the pump discharge amount changes at the rated central value between 0.64 and 2.55 MPa (6.5 and 26 kg/cm^2).

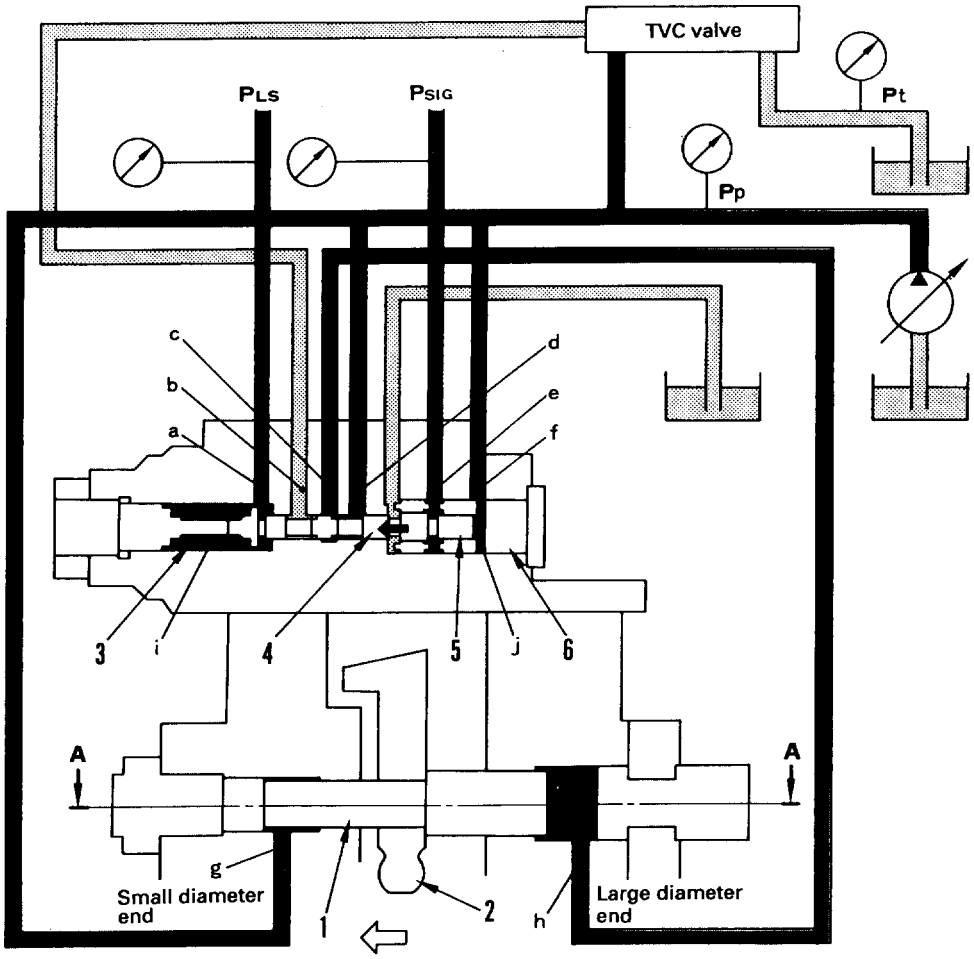


2. TVC VALVE

- When the pump discharge pressure **PP** (selfpressure) is high, the TVC valve controls the pump so that no more oil than the constant flow (in accordance with the discharge pressure) flows even if the stroke of the control valve becomes larger. In this way it carries out equal horsepower control so that the horsepower absorbed by the pump does not exceed the engine horsepower.
- In other words, if the load during the operation becomes larger and the pump discharge pressure rises, it reduces the discharge amount from the pump; and if the pump discharge pressure drops, it increases the discharge amount from the pump. The relation between the pump discharge pressure **PP** and pump discharge amount **Q** is shown on the right, with the current given to the TVC 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 drops below the set value, the command to the TVC valve solenoid from the controller increases according to the drop in the engine speed to reduce the pump swash plate angle.



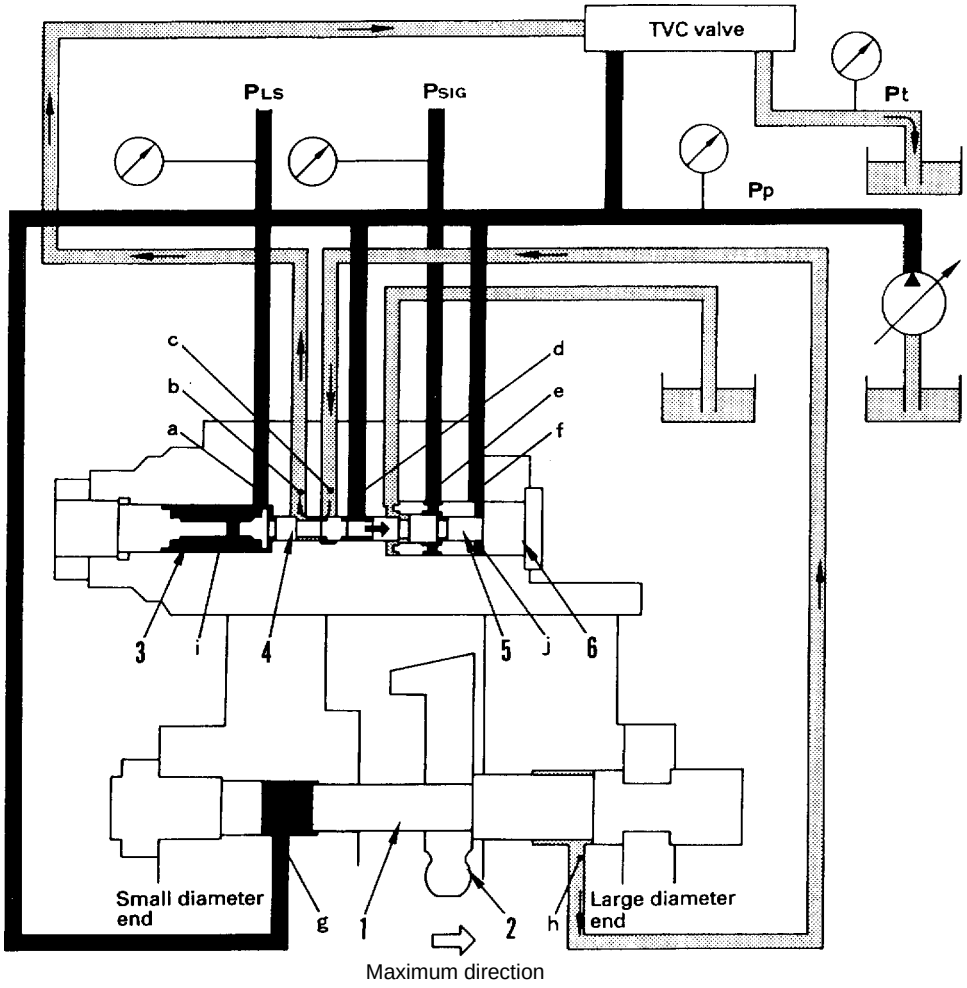
OPERATION



1. LS valve

1) When control valve is at "NEUTRAL" position

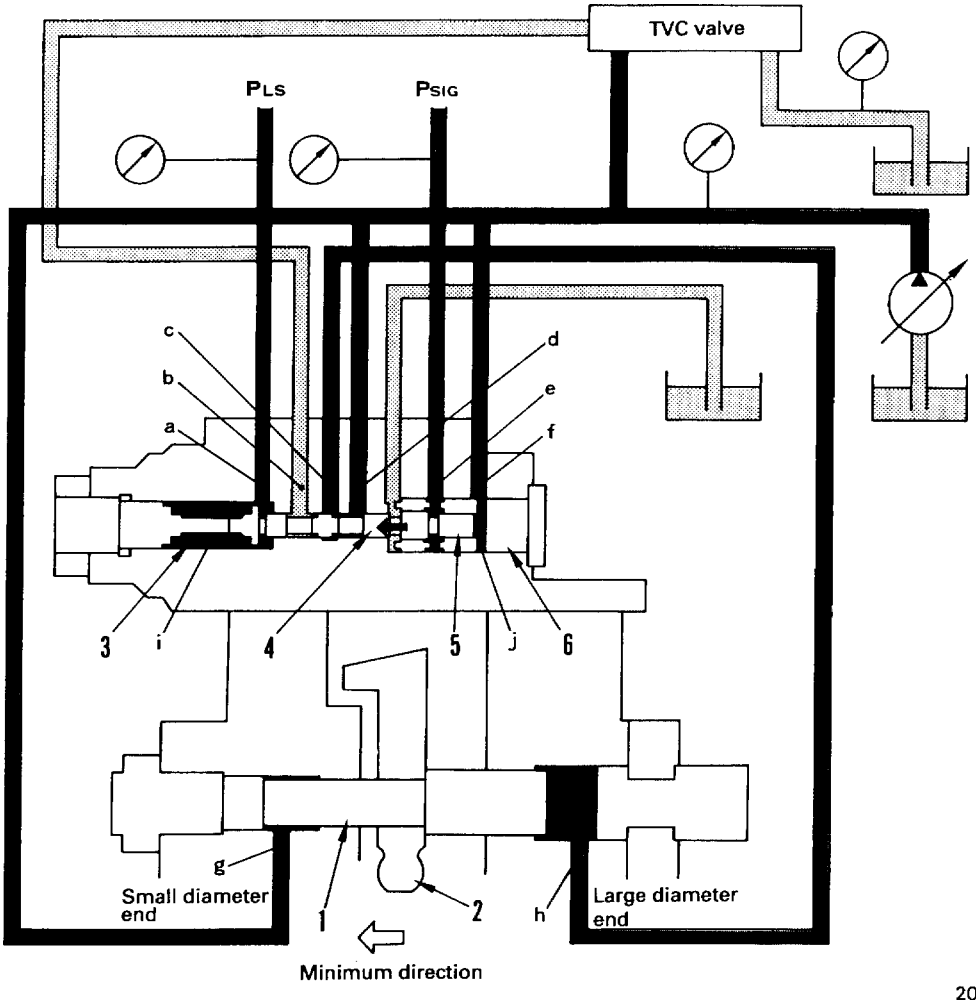
- The LS valve is a three-way selector valve, with pressure **PLs** (LS pressure) from the outlet port of the control valve brought to spring chamber **i**, and main pump discharge pressure PP brought to chamber **j** of plug (6). The size of this LS pressure **PLs** + force **F** of spring (3) and the main pump pressure (self pressure) **Pp** determines the position of spool (4). However, the size of the output pressure **Psig** (the LS selection pressure) of the EPC valve for the LS valve entering port **e** also changes the position of spool (4). (The set pressure of the spring changes.)
- Before the engine is started, servo piston (1) is pushed to the right by spring (7) installed to rod (2). (See the diagram on the right.)
- When the engine is started and the control lever is at the "NEUTRAL" position, LS 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 (4) is pushed to the left, and port **d** and port C are connected. Pump pressure **Pp** enters the large diameter end of the piston from port **h**, and the same pump pressure **Pp** also enters the small diameter end of the piston, so the swash plate is moved to the minimum angle by the difference in area of piston (1).



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2) Operation in maximum direction for pump discharge amount

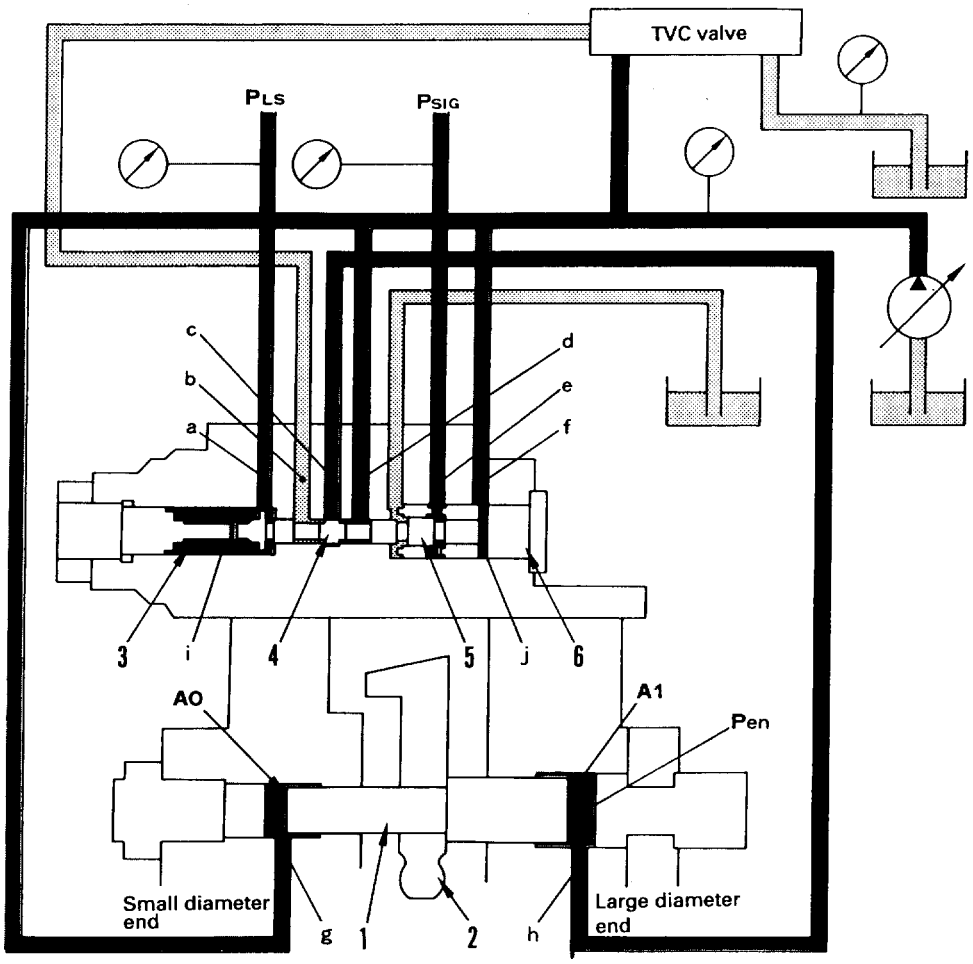
- When the difference between main pump pressure **Pp** and LS pressure **PLs**, in other words, LS differential pressure **PLs**, becomes smaller (for example, when the area of opening of the control valve becomes larger and pump pressure **Pp** drops), spool (4) is pushed to the right by the combined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



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3) Operation in minimum direction for pump discharge amount

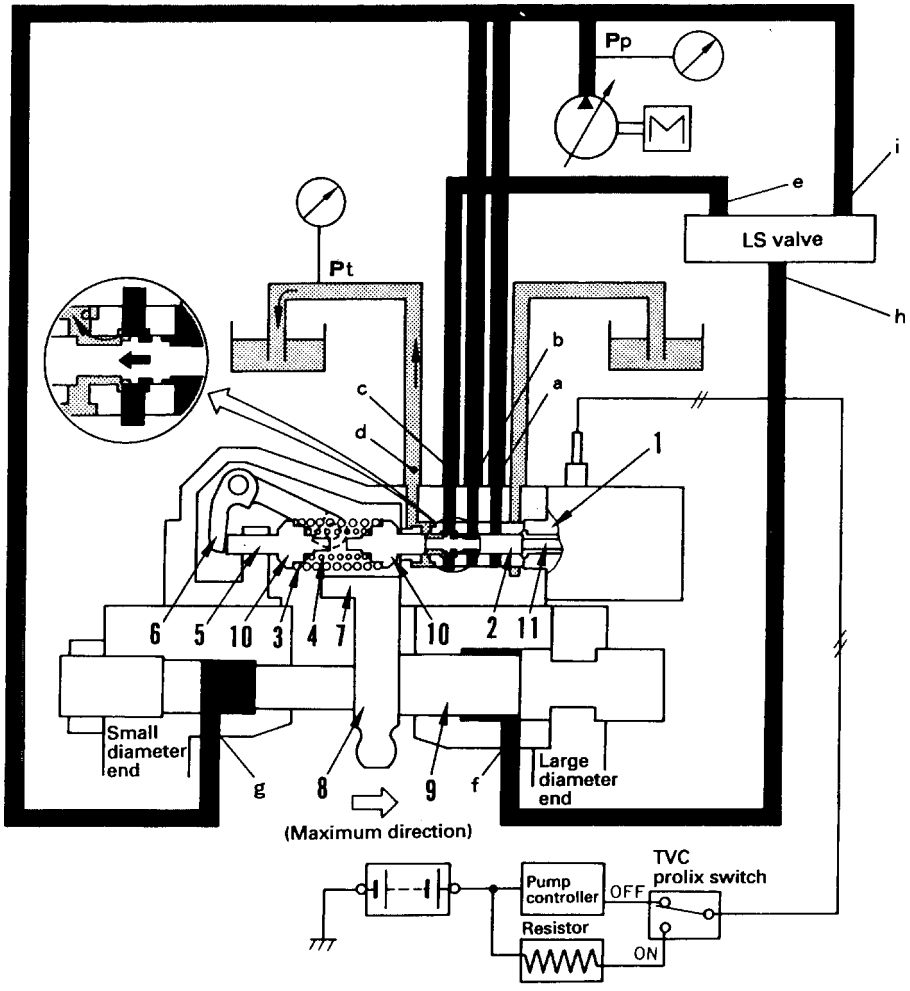
- The following explains the situation if servo piston (1) moves to the left (the discharge amount becomes smaller). When LS pressure △**PLs** becomes larger (for example, when the area of opening of the control valve becomes smaller and pump pressure **Pp** rises), pump pressure **P**p pushes spool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



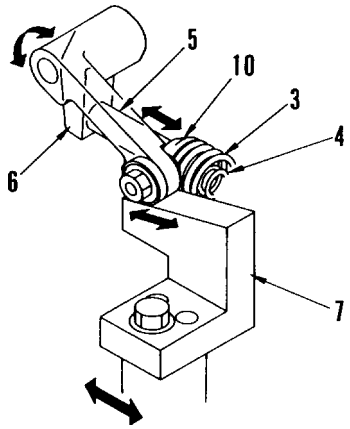
202F06037

4) When servo piston is balanced

- Let us take the area receiving the pressure at the large piston diameter end as **A1**, the area receiving the pressure at the small diameter end as **A0**, and the pressure flowing into the large piston diameter end as **Pen**. If the main pump pressure **Pp** of the LS valve and the combined force of force **F** of spring (3) and LS pressure **PLs** are balanced, and the relationship is **A0** x **Pp** = **A1** x **Pen**, servo piston (1) will stop in that position, and the swash plate will be kept at an intermediate position. (It will stop at a position where the opening from port **b** to port **c** and from port **d** to port **c** of spool (4) is approximately the same.)
- At this point, the relationship between the area receiving the pressure at both ends of piston (1) is **A0:A1** = 1:2, so the pressure applied to both ends of the piston when it is balanced becomes **Pp**: **Pen** = 2:1.
- The position where spool (4) is balanced and stopped is the standard center, and the force of spring (3) is adjusted so that it is determined when **Pp** - **PLs** = 2.55 MPa (26 kg/cm^2). However, if **Psig** (the output pressure of 0 - 2.94 MPa (0 - 30 kg/cm^2) of the EPC valve of the LS valve) is applied to port **e**, the balance stop position will change in proportion to pressure **Psig** between **Pp** - **Pls** = 2.55 $\longleftrightarrow$ 1.34 MPa (26 $\longleftrightarrow$ 13.7 kg/cm^2).



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2. TVC valve

1) When pump controller is normal

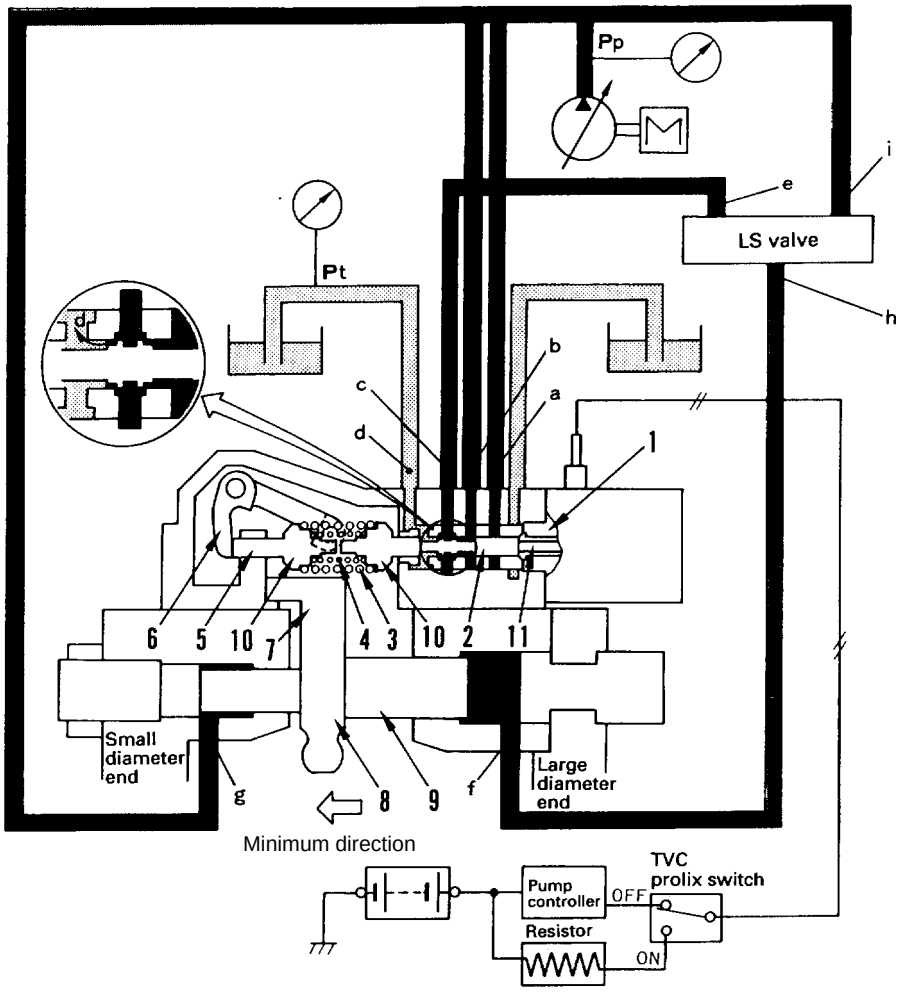
a. When the load on the actuator is small and pump pressure Pp is low

(1) Movement of solenoid (1)

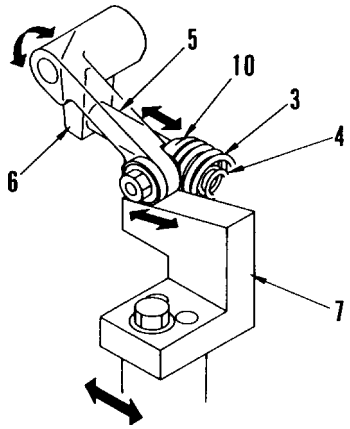
- The command current from the pump controller flows to solenoid (1). This command current changes the internal force pushing solenoid push pin (11).
- On the opposite site to the force pushing this solenoid push pin (11) is the spring set pressure of springs (3) and (4) and pump pressure **Pp**. Piston (2) stops at a position where the combined force pushing piston (2) is balanced, and the pressure (pressure of port **c**) output from the TVC valve changes according to this piston.
- 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) Movement of spring

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



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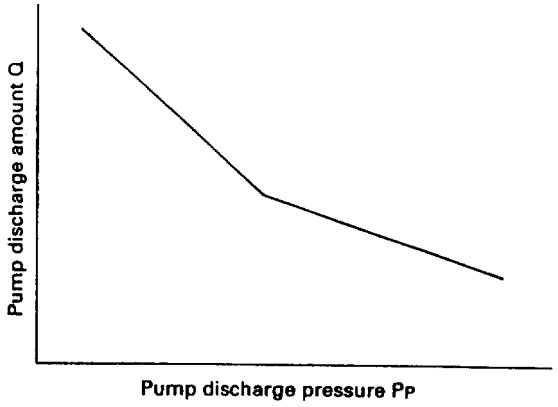


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b. When load on actuator is small and pump discharge pressure is high

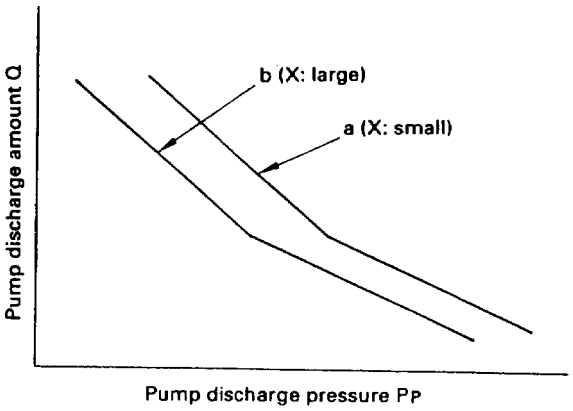
- When the load is large and pump discharge pressure **Pp** is high, the force pushing piston (2) to the left becomes larger and piston (2) moves to the position shown in the diagram above. When this happens, as shown in the diagram above, part of the pressurized oil from port **b** flows out to port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

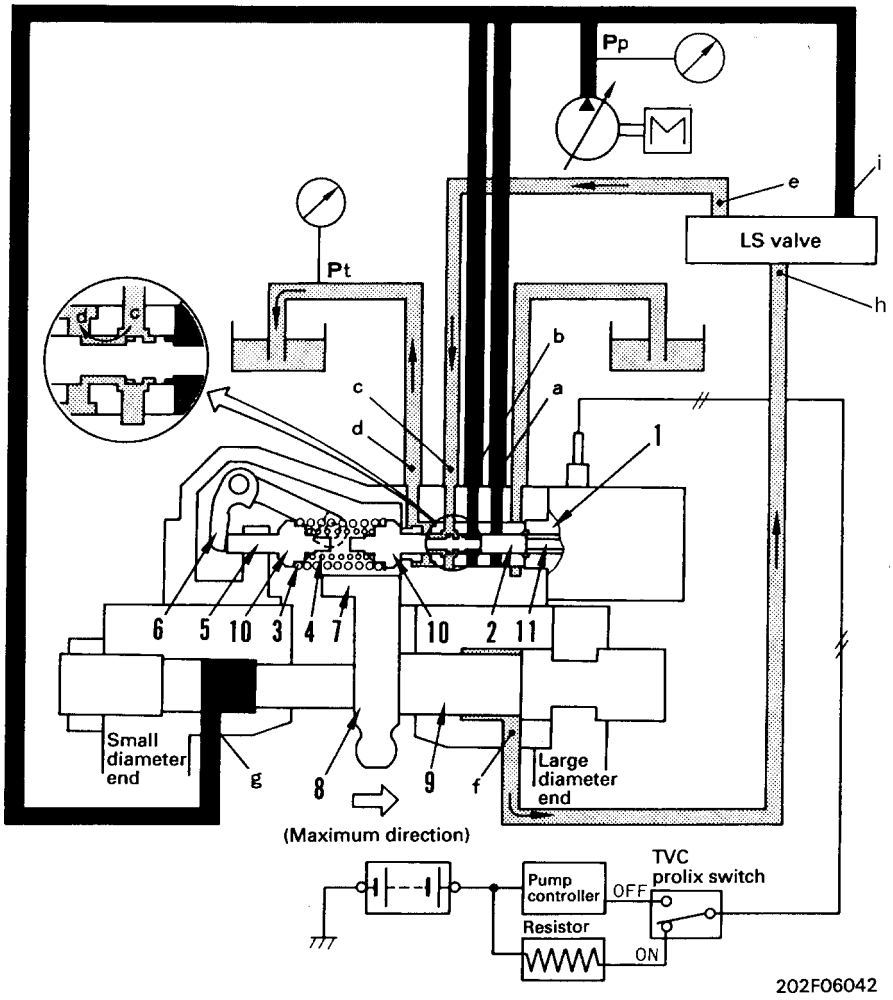


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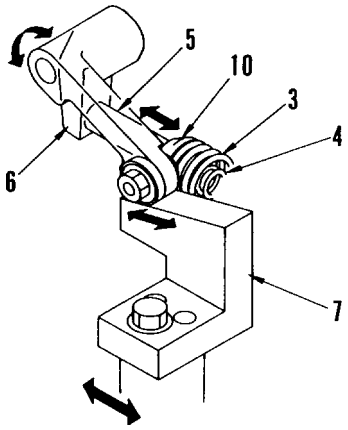
- If command current **X** sent to solenoid (1) increases further, the relationship between pump pressure **Pp** and pump discharge amount **Q** is proportional to the pushing force of the solenoid and moves in parallel. In other words, if the pushing force of solenoid (1) is added to the force pushing to the left because of the pump pressure applied to the piston (2), the relationship between **Pp** and **Q** moves from **a** to **b** in accordance with the increase.



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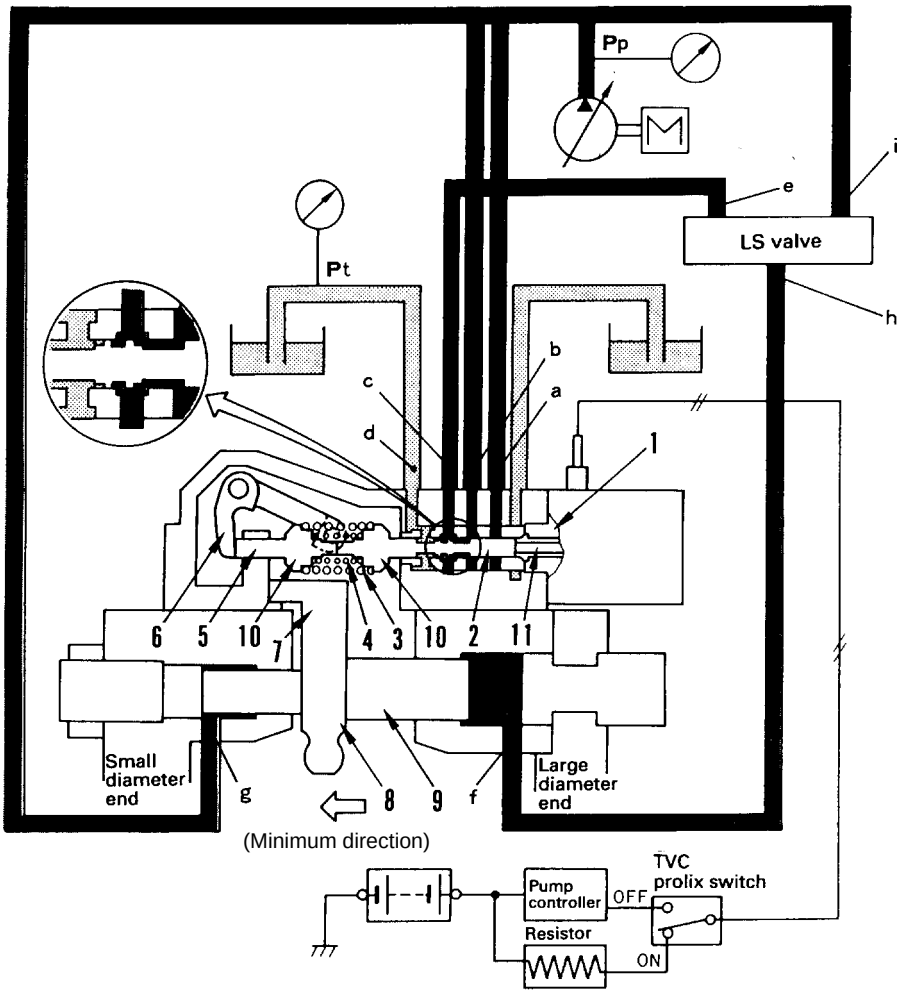


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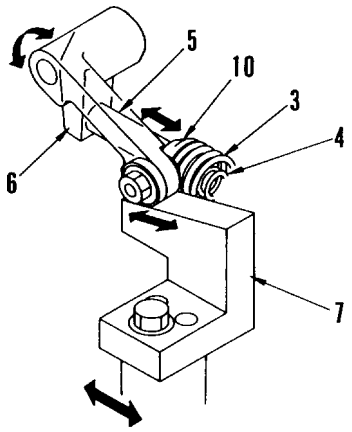
2) When pump controller is abnormal and TVC prolix switch is "ON"

a. When load on main pump is light

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



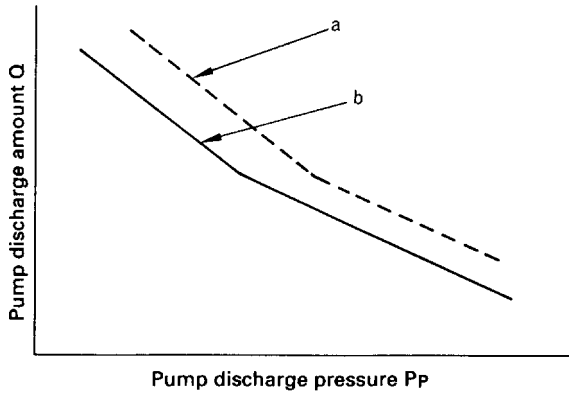
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b. When main pump load is heavy

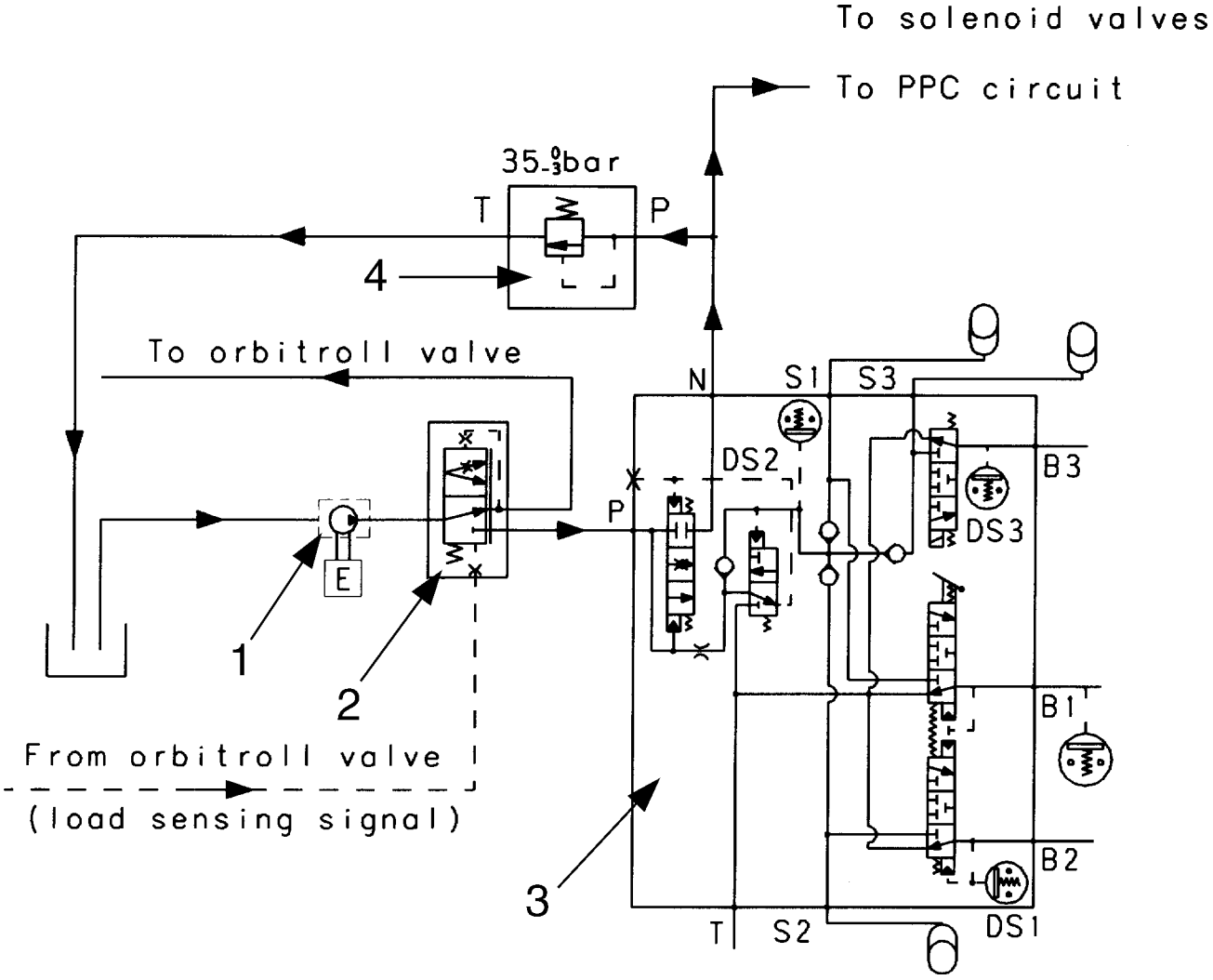
- In the same way as in the previous item, when the TVC prolix switch is "ON", the command current sent to solenoid (1) becomes constant. For this reason, the force of solenoid push pin (11) pushing piston (2) is constant.
- If main pump pressure **Pp** increases, piston (2) moves further to the left when the main pump load is light, and is balanced at the position shown in the diagram above.
- In this case, the pressure from port **b** flows to port **c**, so servo piston (9) moves to the left (to make the discharge amount smaller) by the same mechanism as explained in Item 2)-b. In other words, even when the TVC 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 solenoid through the resistor. The curve when the TVC prolix switch is "ON" is curve **b**, which is to the left of curve **a** for when the pump controller is normal.



202F06044

PPC PUMPLESS SYSTEM

STRUCTURE



1. Gear Pump.
2. Steering/Braking Priority Valve.
3. Power Brake Valve.
4. Pressure Reducing Valve.

FUNCTION

- The PPC Pumpless system discharges pressurized oil to operate the PPC circuit and solenoid valve assemblies.

OPERATION

- The PPC pumpless system utilises 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 prioritised to the steering circuit via a 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^{+3}_{0} bar. This pressure is utilised 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.

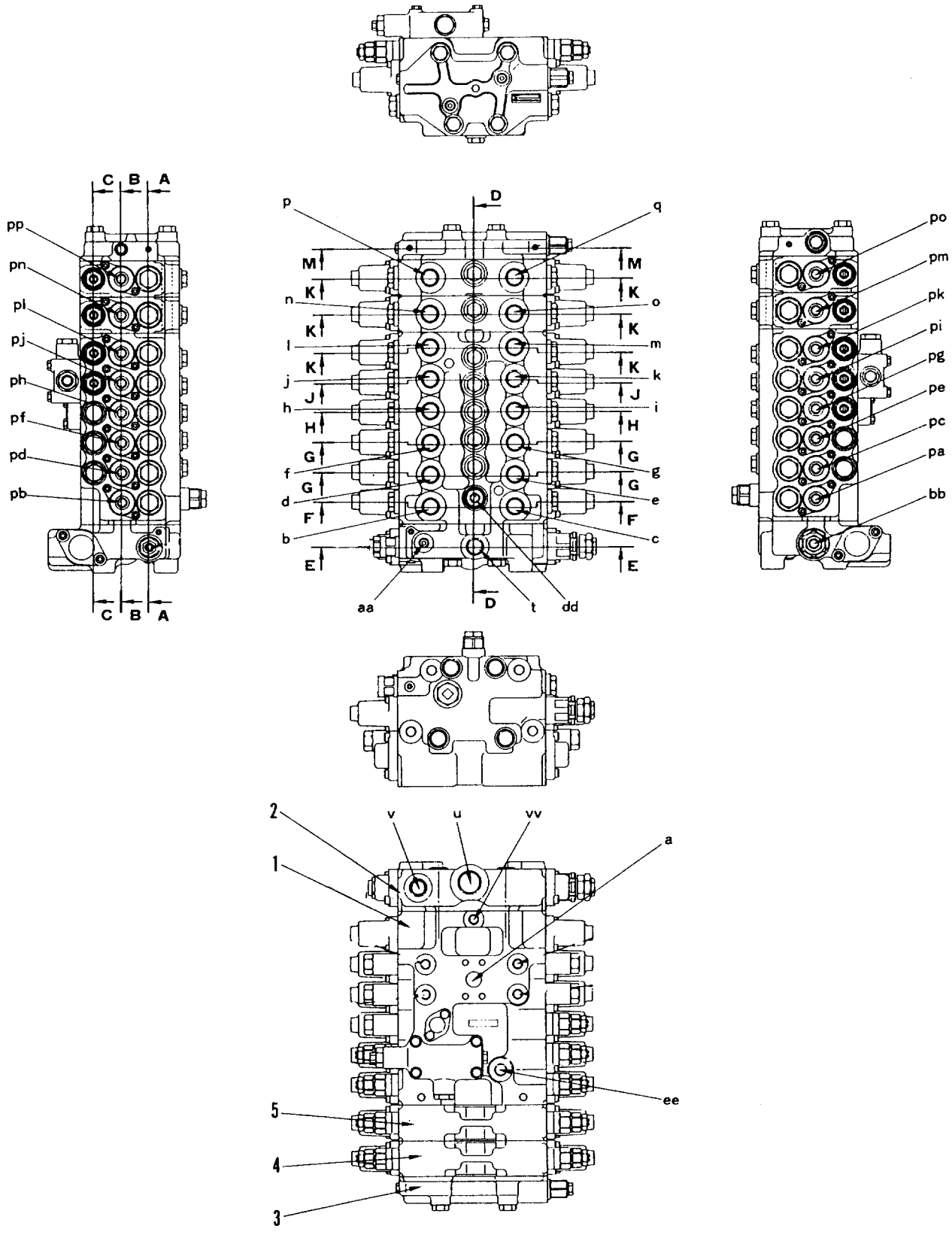
General locations and names of ports (common for each external view diagram)

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 **T** (to tank)
aa. Port **Pls** (to pump LS valve)
bb. Port **Px1** (from 2-stage relief solenoid valve)
dd. Port **Bp** (from PPC shuttle valve)
ee. Pressure sensor port (pressure sensor installed)
vv. Port **T** (to tank)
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 **P-1** (from boom adjust EXTEND PPC valve)
Pn. Port **P-2** (from boom adjust RETRACT PPC valve)
Po. Port **P-3** (from service PPC valve)
Pp. Port **P-4** (from service PPC valve)

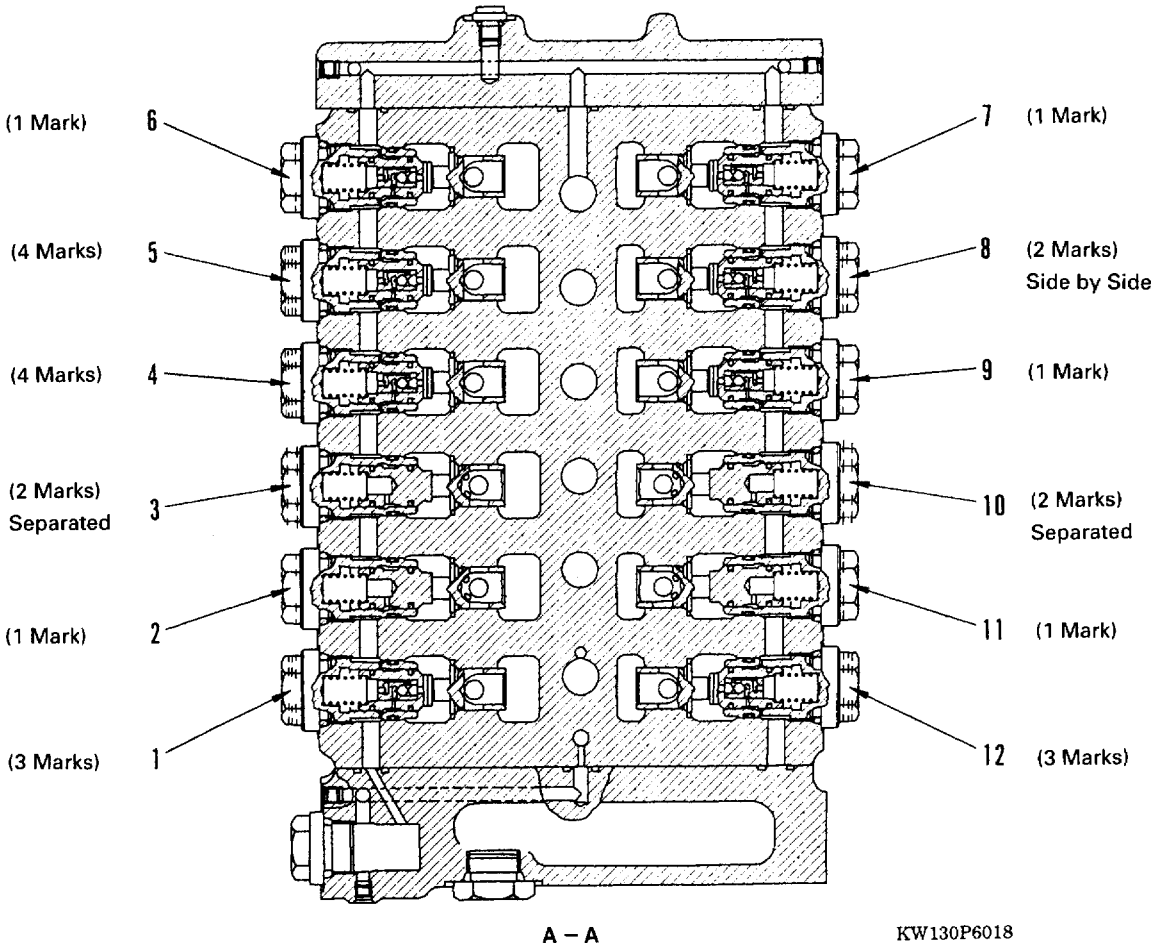
EXTERNAL VIEW

8-spool valve (includes 2 service valves)



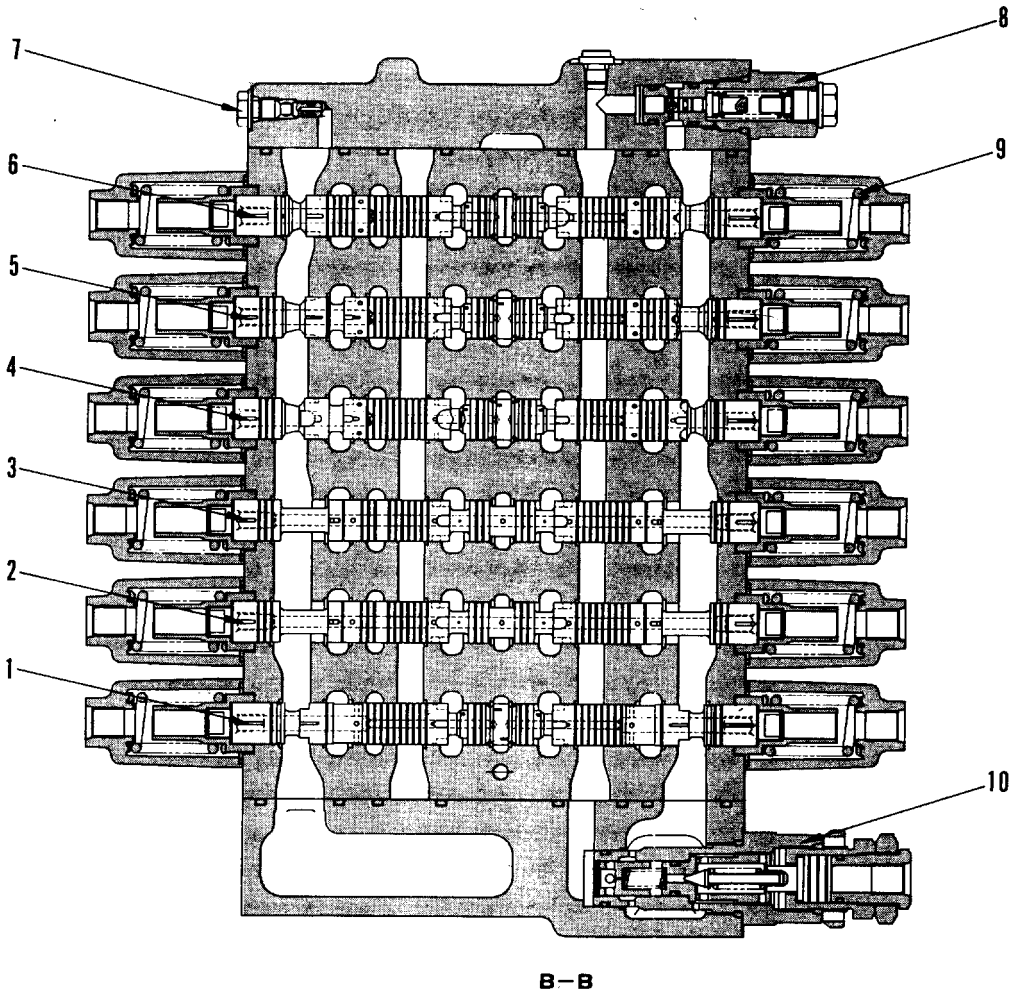
Cross-sectional drawing

✶ 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 is the same as the structure of the bucket valve, so refer to the bucket valve for details.



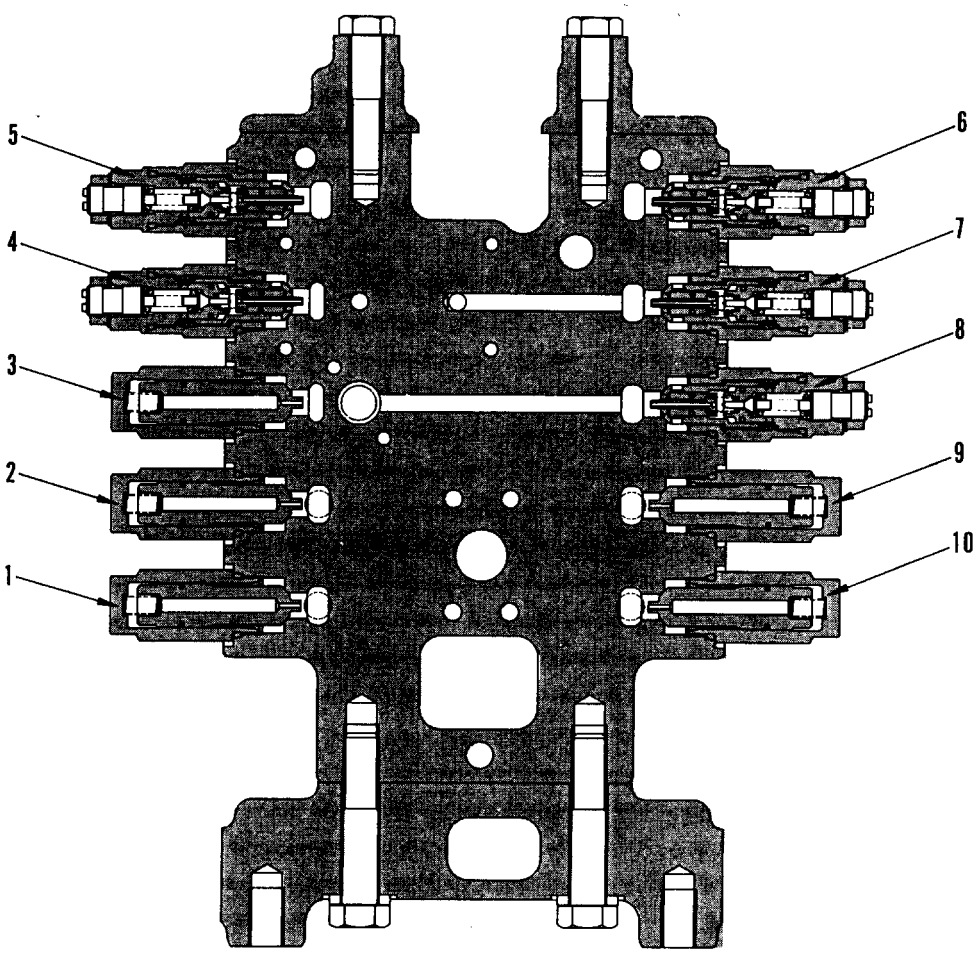
1. Pressure compensation valve (swing left)
2. Pressure compensation valve (stabilizer EXTEND)
3. Pressure compensation valve (travel FORWARD)
4. Pressure compensation valve (boom RAISE)
5. Pressure compensation valve (arm OUT)
6. Pressure compensation valve (bucket DUMP)
7. Pressure compensation valve (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 markings on the valve assembly. (See disassembly and assembly section 30-42 for details.)



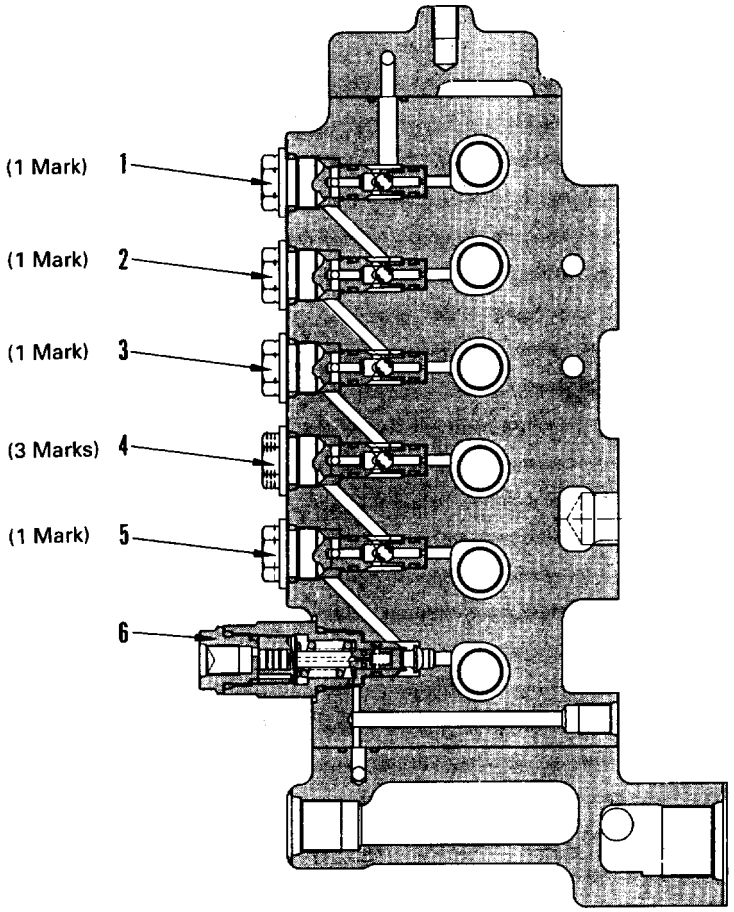
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1. Spool (swing)
2. Spool (stabilizer)
3. spool (travel)
4. Spool (boom)
5. Spool (arm)
6. Spool (bucket)
7. LS bypass plug
8. Unload valve
9. Spool return spring
10. Main relief valve



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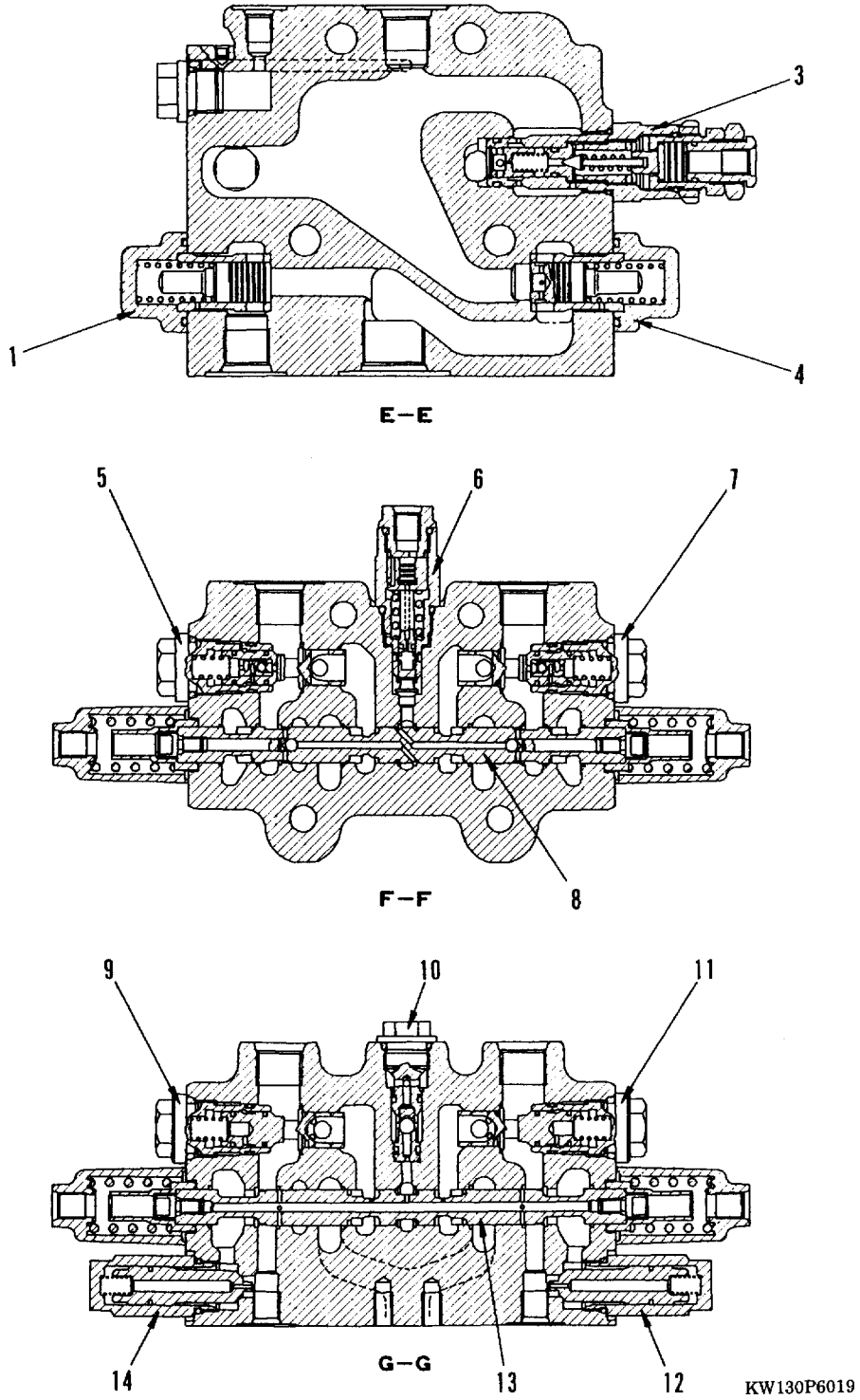
1. Suction valve (stabilizer head)
2. Suction valve (travel motor A)
3. Suction valve (boom lift cylinder bottom)
4. Safety-suction valve (arm head)
5. Safety-suction valve (bucket head)
6. Safety-suction valve (bucket bottom)
7. Safety-suction valve (arm bottom)
8. Safety-suction valve (boom lift cylinder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



202F06053

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 30-42 for details.)



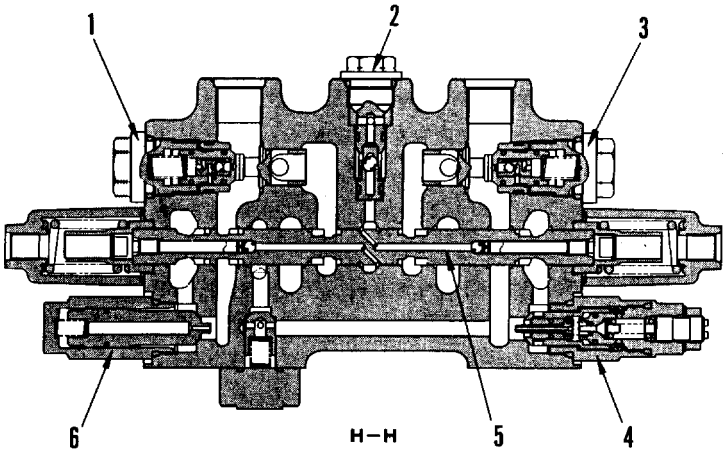
1. Cooler bypass valve
3. Main relief valve
4. Lift check valve

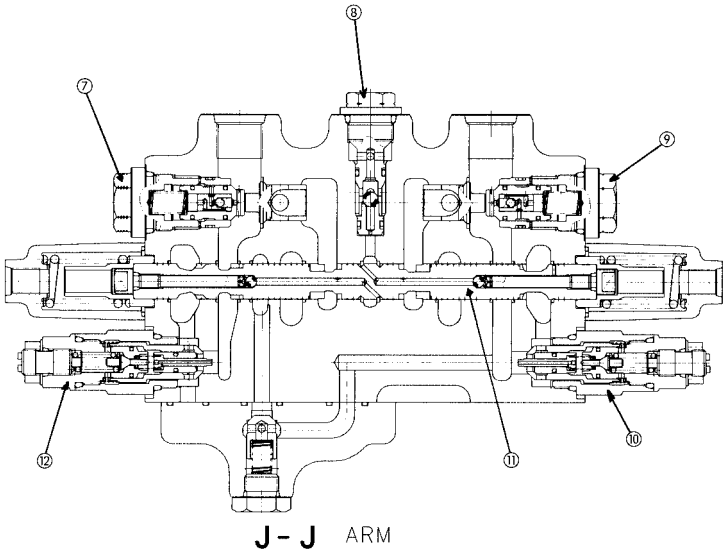
Swing valve

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

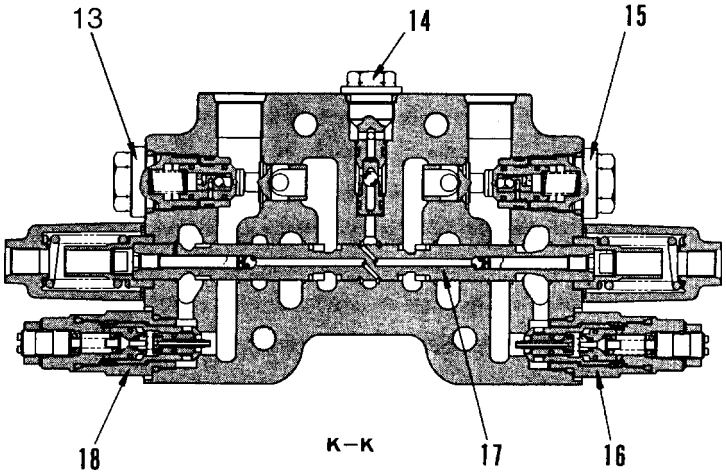
Stabilizer valve

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





J – J ARM



Boom valve

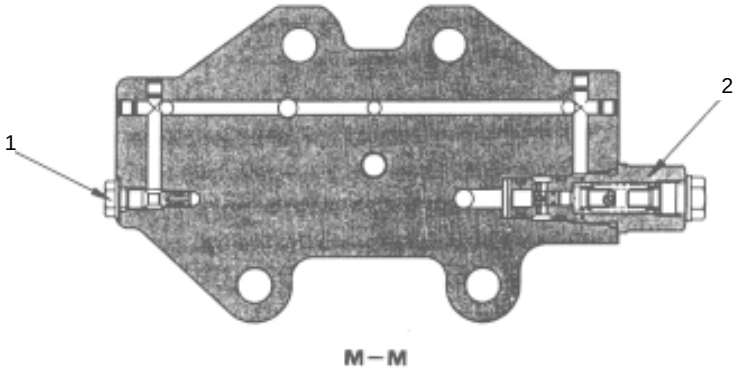
1. Pressure compensation valve (RAISE)
2. LS shuttle valve
3. Pressure compensation valve (LOWER)
4. Safety-suction valve
5. Spool
6. Suction valve

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)

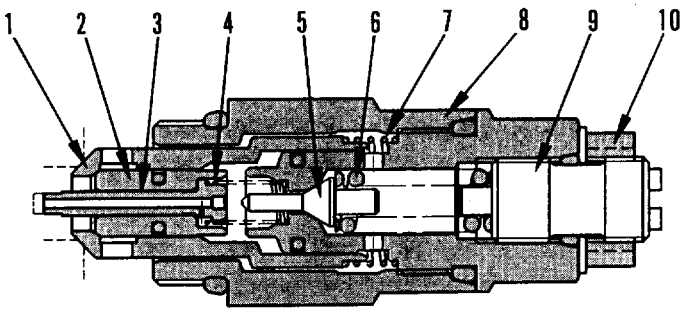
13. Pressure compensation valve (DUMP)
14. LS shuttle valve
15. Pressure compensation valve (CURL)
16. Safety-suction valve
17. Spool
18. Safety-suction valve



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1. LS bypass plug
2. Unload valve

SAFETY-SUCTION VALVE FOR SERVICE VALVE



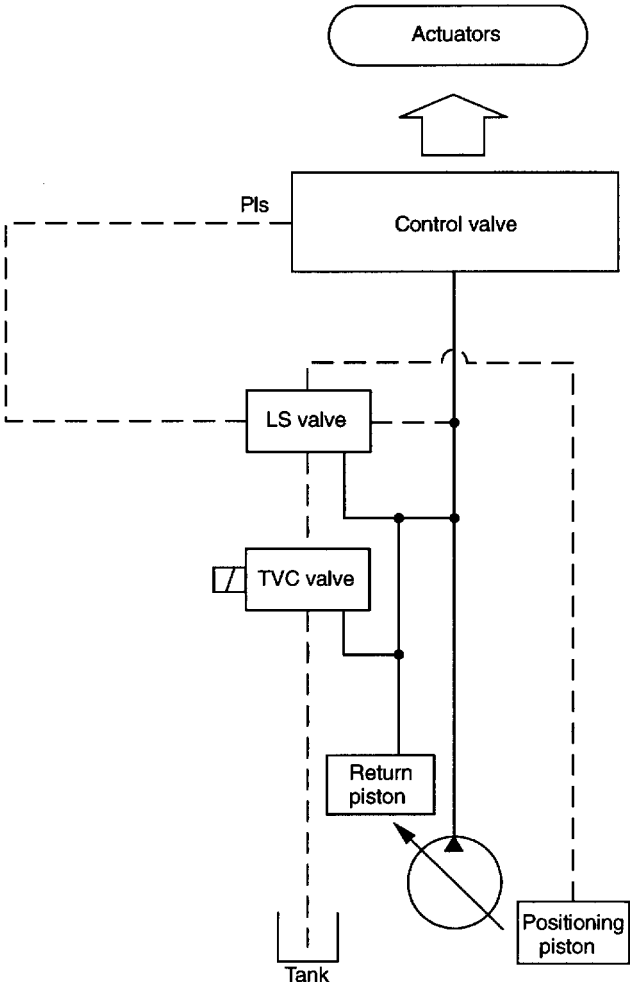
202F06057

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 / /min)	Clam shell/Breaker
	709-70-74302	35.79 MPa (365 kg/cm^2) (at 5 / /min)	2 piece/Breaker (Boom adjust cylinder)
	709-70-74600	24.5 MPa (250 kg/cm^2) (at 5 / /min)	For crusher (Okada)

CLSS
OUTLINE OF CLSS



Features
- CLSS stands for **C**losed center **L**oad **S**ensing **S**ystem, and has the following features.

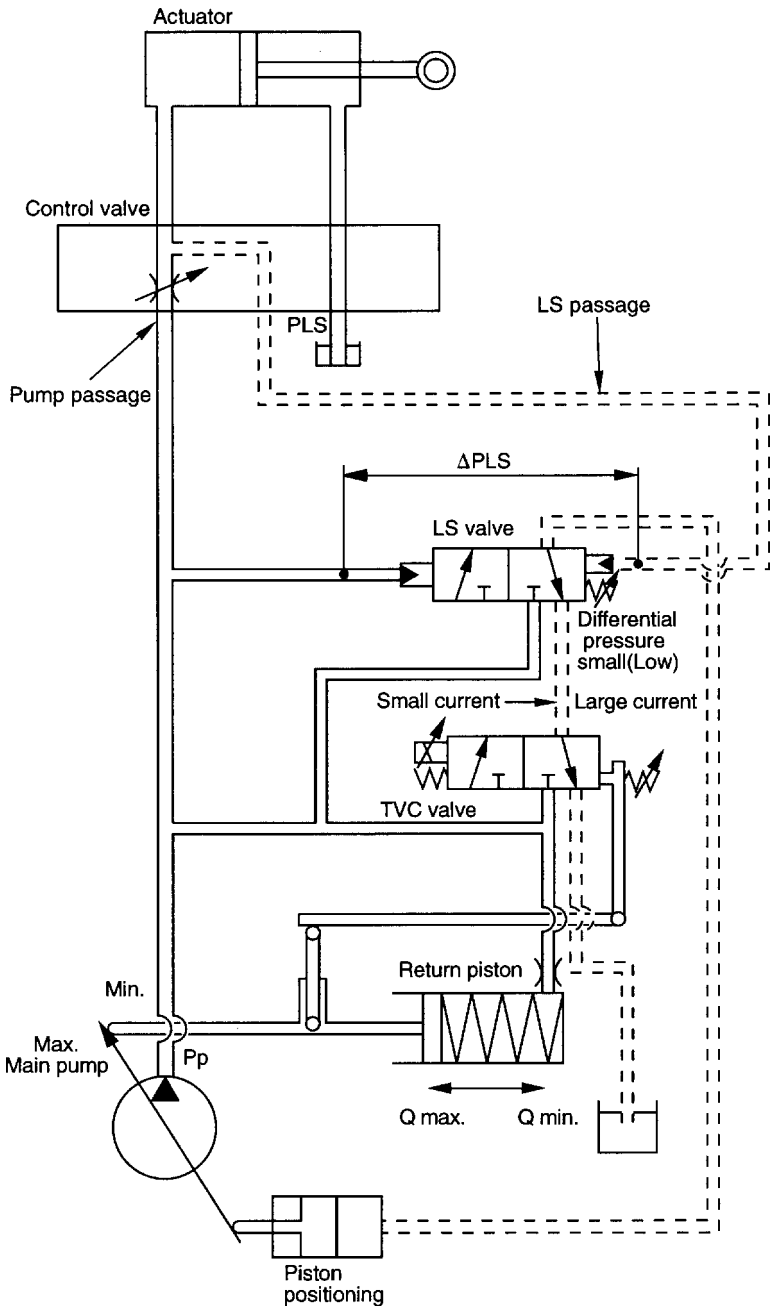
1) Fine control not influenced by load.
2) Control enabling digging even with fine control.
3) Ease of compound operation ensured by flow divider function using area of opening of spool during compound operations. Energy saving using variable pump control.

Structure
- The CLSS consists of a main pump control valve, and actuators for the work equipment.
- The main pump body consists of the pump itself, the TVC valve and the LS valve.

BASIC PRINCIPLE

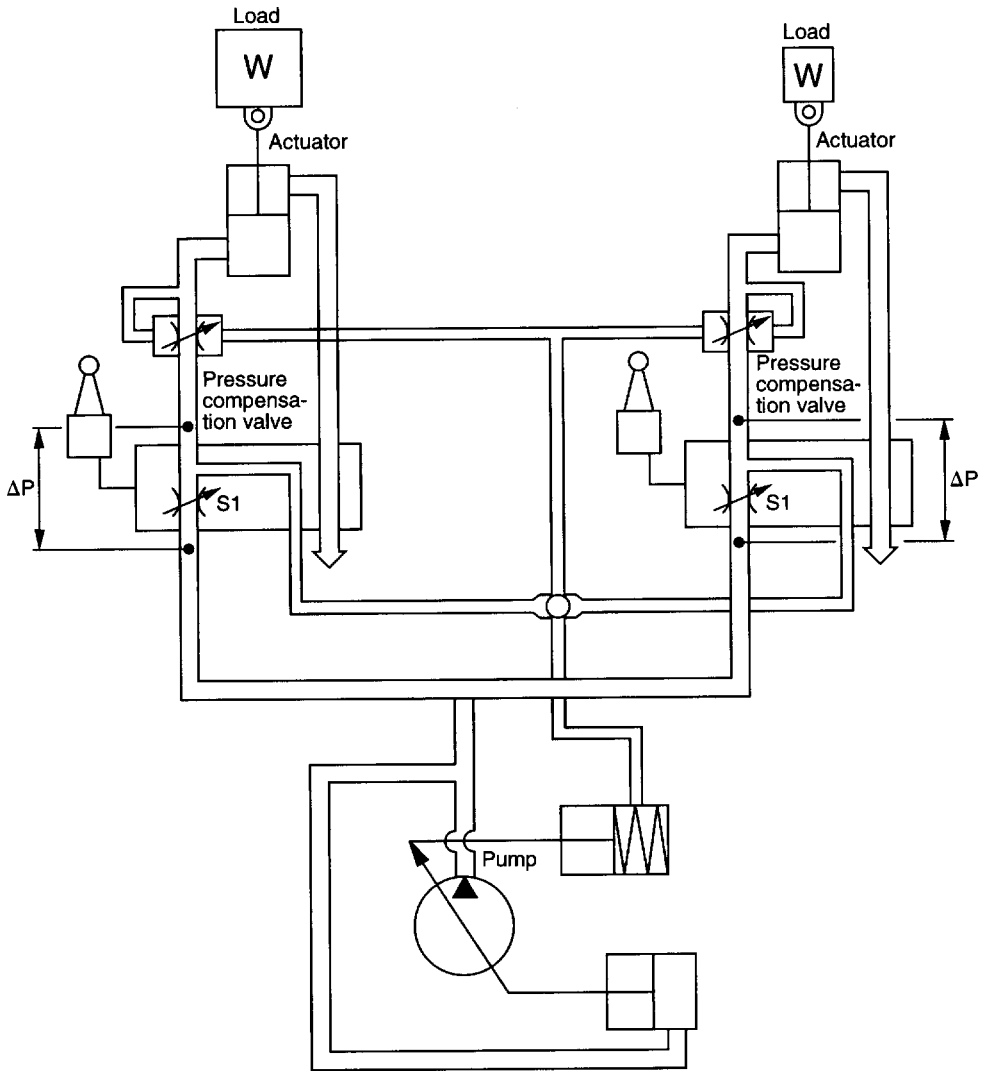
1) Control of pump swash plate angle

- The pump swash plate angle (pump discharge amount) is controlled so that LS differential pressure △**PLS** is constant. LS differential pressure △**PLS**, which is the differential pressure between pump discharge pressure **PP** and LS pressure **PLS** (actuator load pressure) at the outlet port of the control valve (LS differential pressure △**PLS** = Pump discharge pressure **PP** - LS pressure **PLS**).
- If LS differential pressure △**PLS** becomes lower than the set differential pressure of the LS valve, the pump swash plate angle becomes greater, and if it becomes higher, the pump swash plate angle becomes smaller.



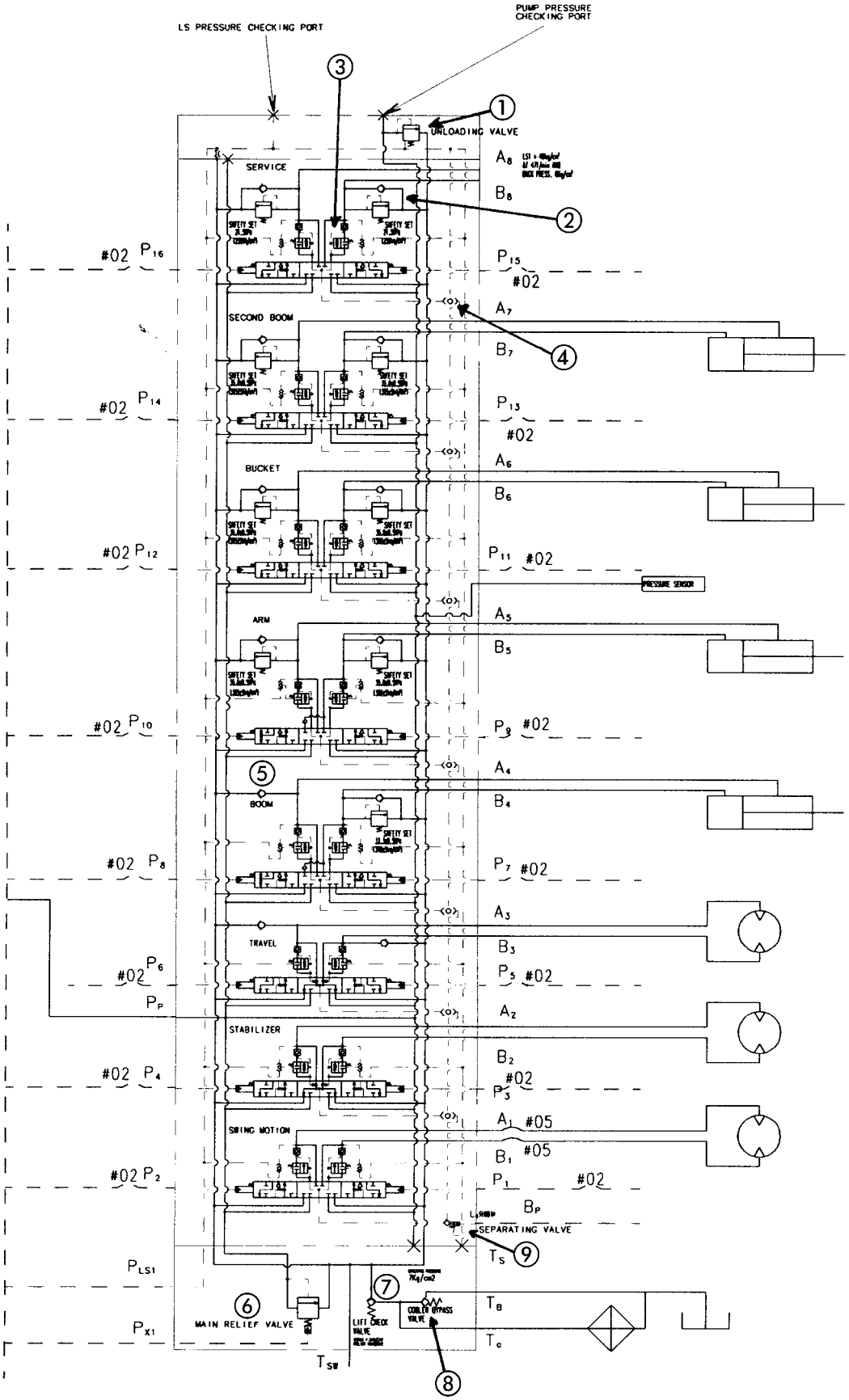
2) Pressure compensation control

- 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 flow (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.



OPERATION FOR EACH FUNCTION OF CLSS

Hydraulic circuit diagram for system

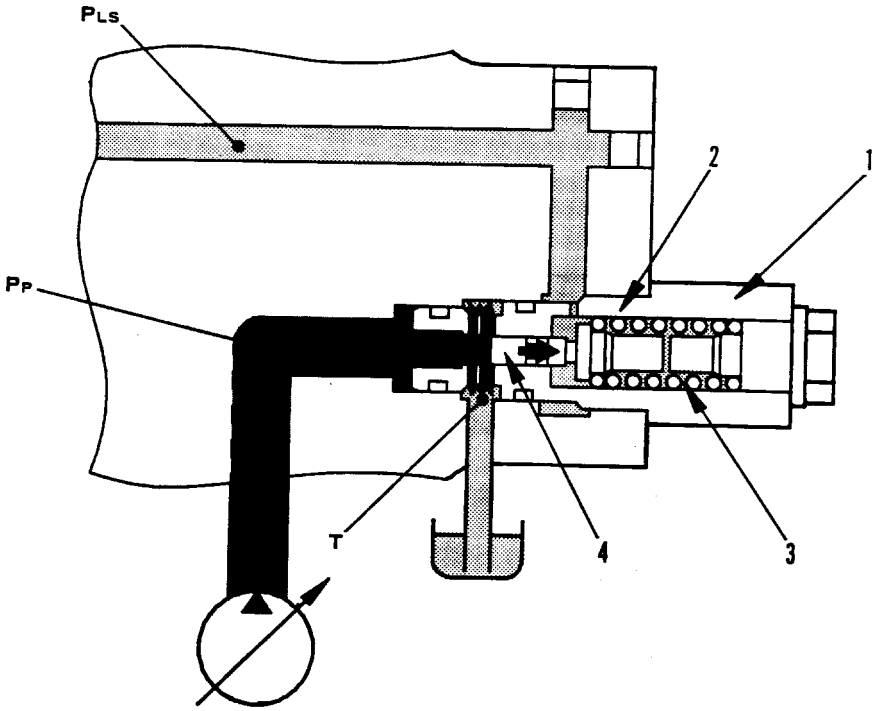


1. Unload valve
   (LS pressure + 3.92 MPa (40 kg/cm^2))
2. Safety-suction valve
   (33.77 MPa (365 kg/cm^2) - Arm,
   Bucket, Second Boom)
   (33.32 MPa (340 kg/cm^2) - Boom)
3. Pressure compensation valve
4. LS shuttle valve
5. Suction valve
6. Main relief valve
   (normal: 31.85 MPa (325 kg/cm^2),
   When pressure rises:
   34.79 MPa (355 kg/cm^2))
7. Lift check valve
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 eleased to the tank circuit. When this happens, pump discharge pressure **Pp** is set at 3.92 MPa (40 kg/cm^2) by spring (3) inside the valve. (LS pressure **PLS**: 0 MPa (0 kg/cm^2).



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Operation

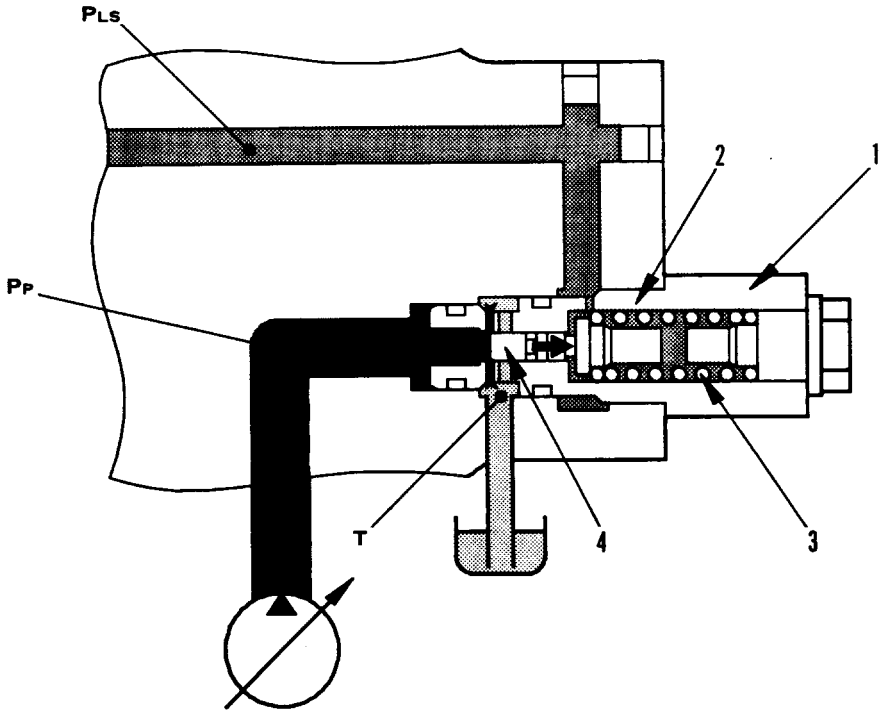
When control valve is at neutral

- Pnmp 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) (3.92 MPa (40 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 the tank circuit **T**.
- In this way, pump discharge pressure **Pp** is set to 3.92 MPa (40 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** + 3.92 MPa (40 kg/cm^2). When the differential pressure between pump discharge pressure **Pp** and LS pressure **Pls** reaches the load of spring (3) 3.92 MPa (40 kg/cm^2), the unload valve opens, so LS differential pressure △**Pls** becomes 3.92 MPa (40 kg/cm^2).



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Operation

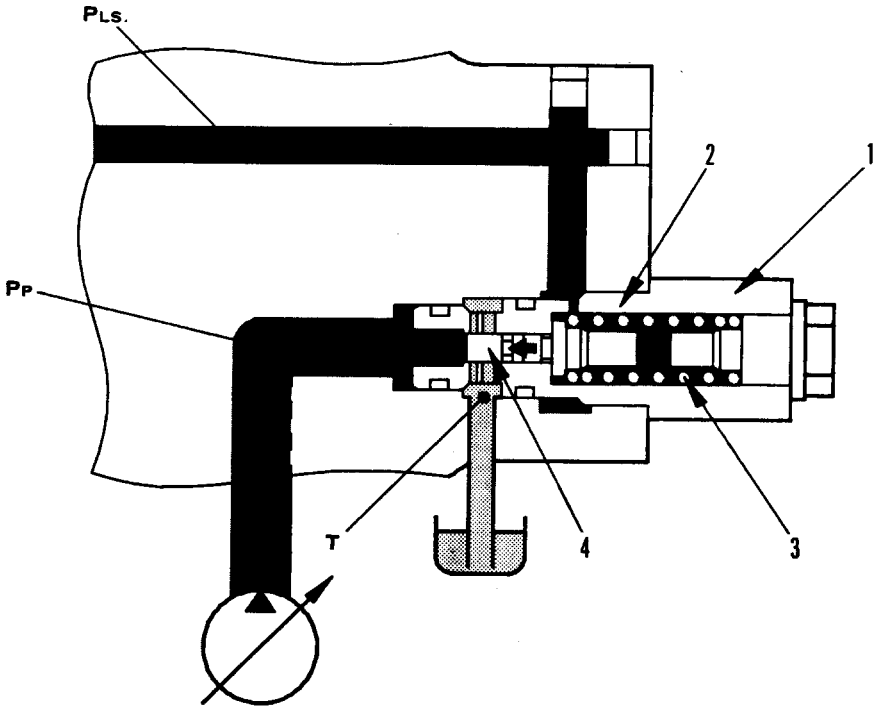
Fine control of control valve

- 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 is small, so there is a big difference between LS pressure **Pls** and pump discharge pressure **Pp**.
- When the diffferential pressure between pump discharge pressure **Pp** and LS pressure **Pls** reaches the load of spring (3) 3.92 MPa (40 kg/cm^2), spool (4) moves tot he 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 3.92 MPa (40 kg/cm^2) + LS pressure **Pls**, and LS differential pressure **Pls** becomes 3.92 MPa (40 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 **Q** flows to the actuator circuit.



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Operation

Control valve operated

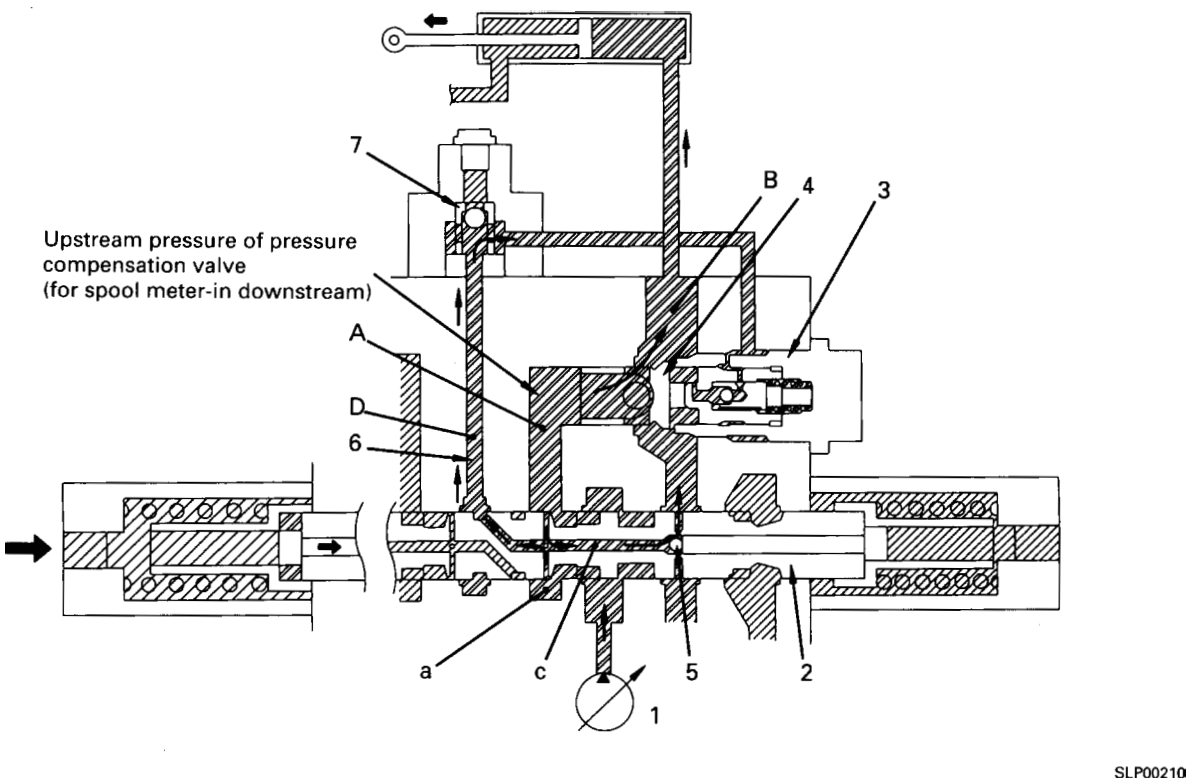
- When the control valve is operated to a bigger stroke, LS pressure **Pls** is generated and acts on the right end of spool (4). When this happens, the area of the opening of the control valve spool is large, so the difference between LS pressure **Pls** and pump discharge pressure **Pp** is small.
- For this reason, the differential pressure between pump discharge pressure **Pp** and LS pressure **Pls** does not reach the load of spring (3) (3.92 MPa (40 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

★ The diagram shows the condition for arm IN.



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

Function

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

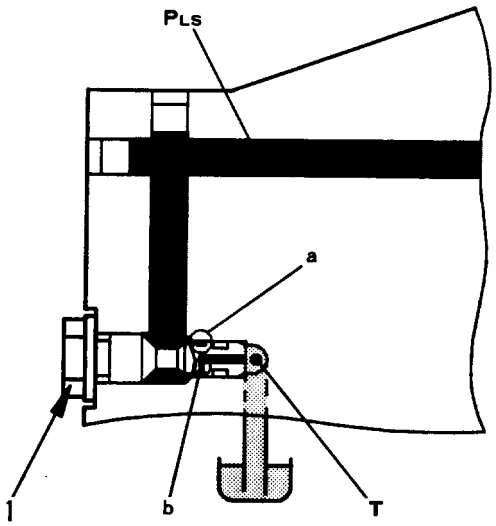
Operation

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

3) LS bypass plug

Outline

1. This releases the residual pressure of LS pressure **Pls**.
2. This make the speed of the rise in pressure of LS pressure **Pls** more gentle. In addition, with this discarded throttled 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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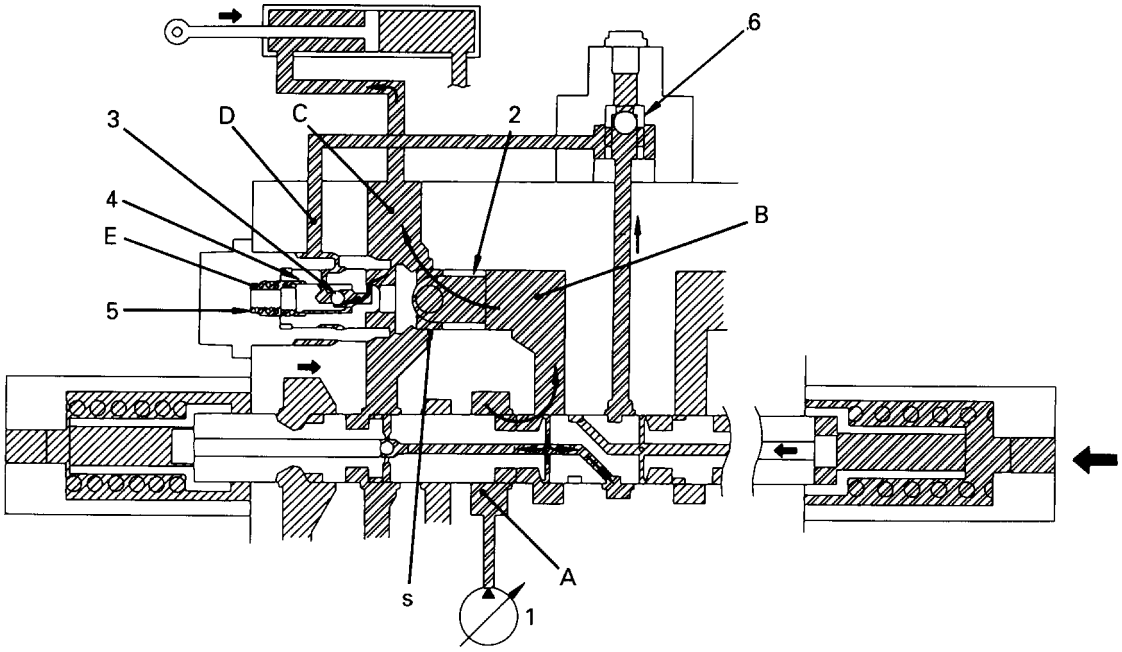
Operation

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

1. LS bypass plug

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

4) Pressure compensation valve



SLP00212

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

Function

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

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

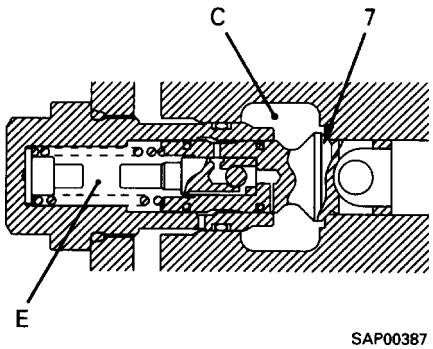
Operations

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

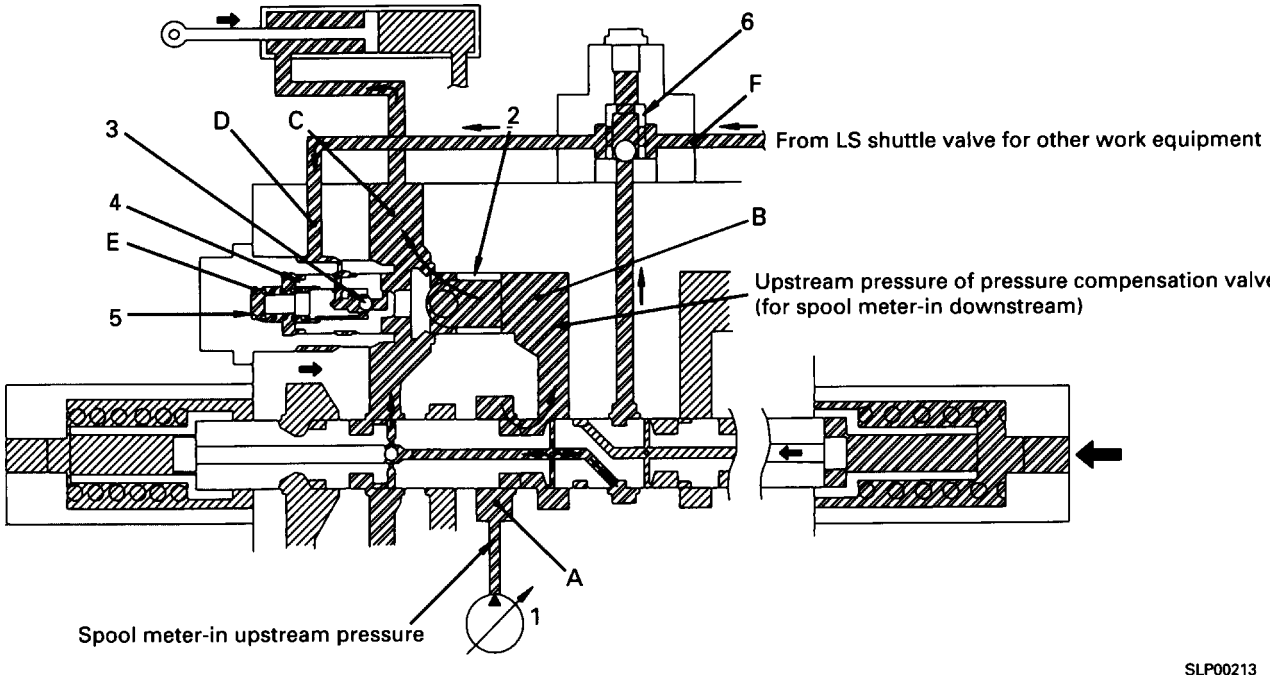
Reference: Intergrated pressure compensation valve

- When high peak pressure is generated in the actuator circuit or when peak pressure is generated repeatedly over a continuous period (such as when using a breaker), valve (2) may hit valve chamber seat **s** and generate a high stress. To prevent this, an integrated pressure compensation valve (2) and piston (4) is used.

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



SAP00387



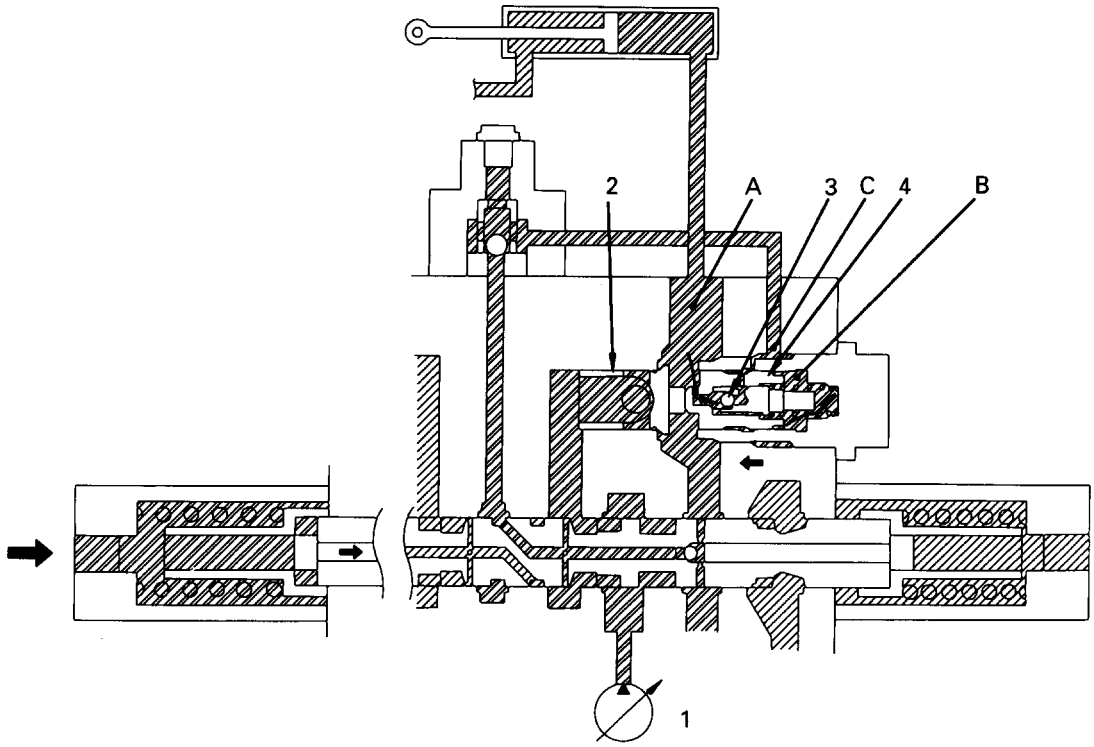
2. When receiving compensation (during compound operations, when load pressure is lower than other work equipment)

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

Operation

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

5) Shuttle valve inside pressure compensation valve



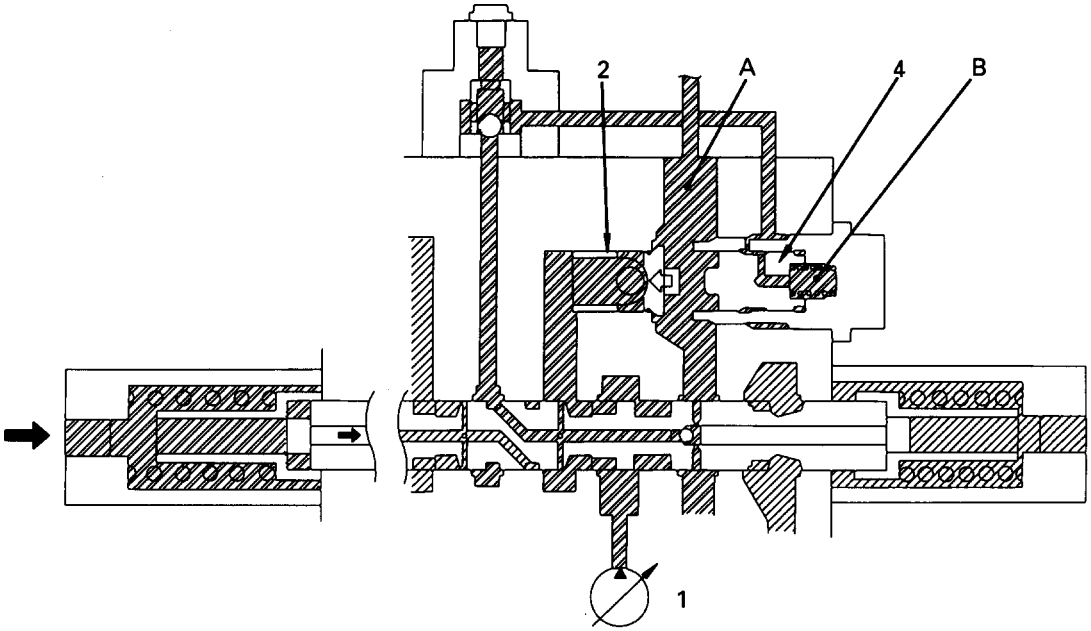
SLP00214

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

Function

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

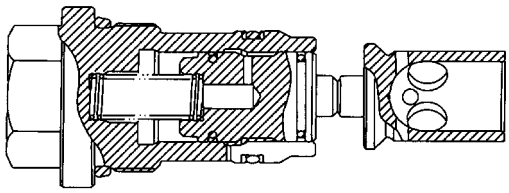
- Shuttle valve (3) is pushed to the right by the pressure of port **A**, and the circuit between ports **A** and **C** is shut off. In this condition, the holding pressure at port **A** is taken to spring chamber **B**, and pushes piston (4) to the left to prevent piston (4) and valve (2) from seperating.



SLP00215

<For travel>

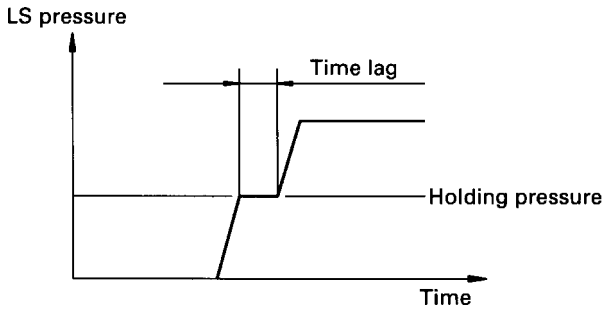
- No holding pressure is generated at port **A** in the travel circuit, so a pressure compensation valve without a shuttle valve is used.



SBP00216

Reference: When there is no shuttle valve

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

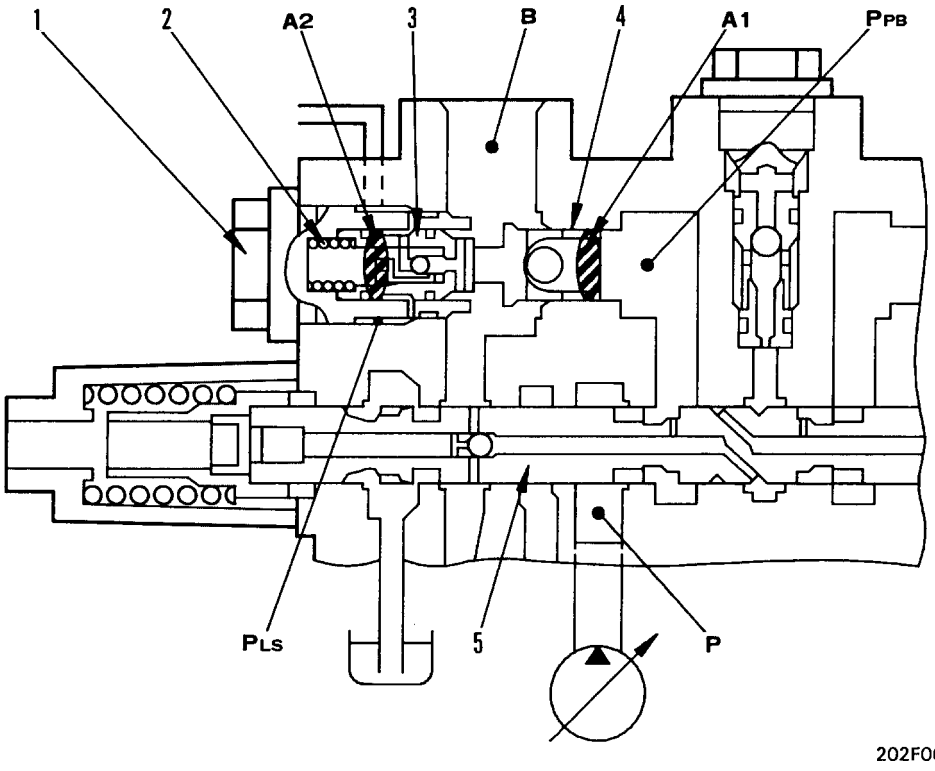


SAP00217

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 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).

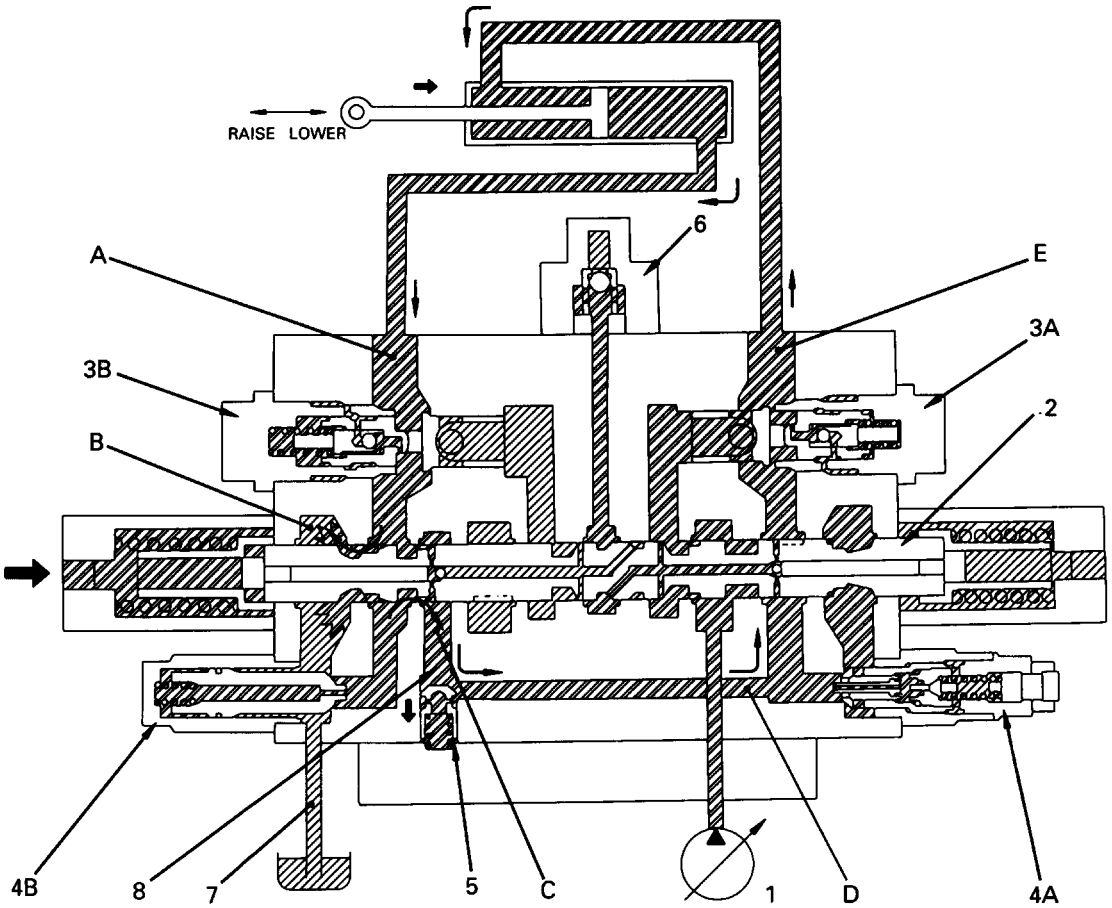
- **Area ratio of each pressure compensation valve**

Valve	Port A		Port B		Remarks
Service		1.00		1.00	
Bucket	DUMP	1.00	CURL	1.00	
Arm	OUT	0.96	IN	1.00	
Boom	RAISE	0.96	LOWER	1.00	
Travel	FORWARD	1.00	REVERSE	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



SLP00220

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

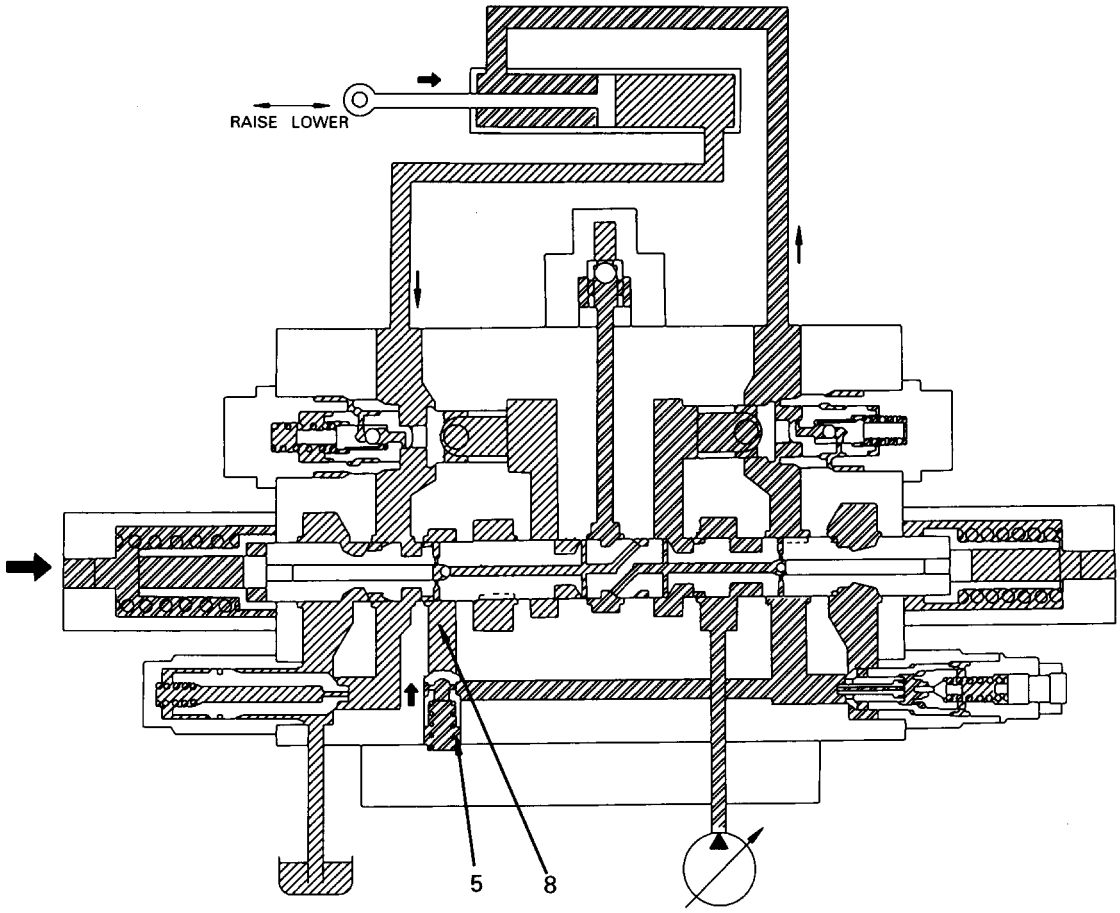
Function

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

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

Operation

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

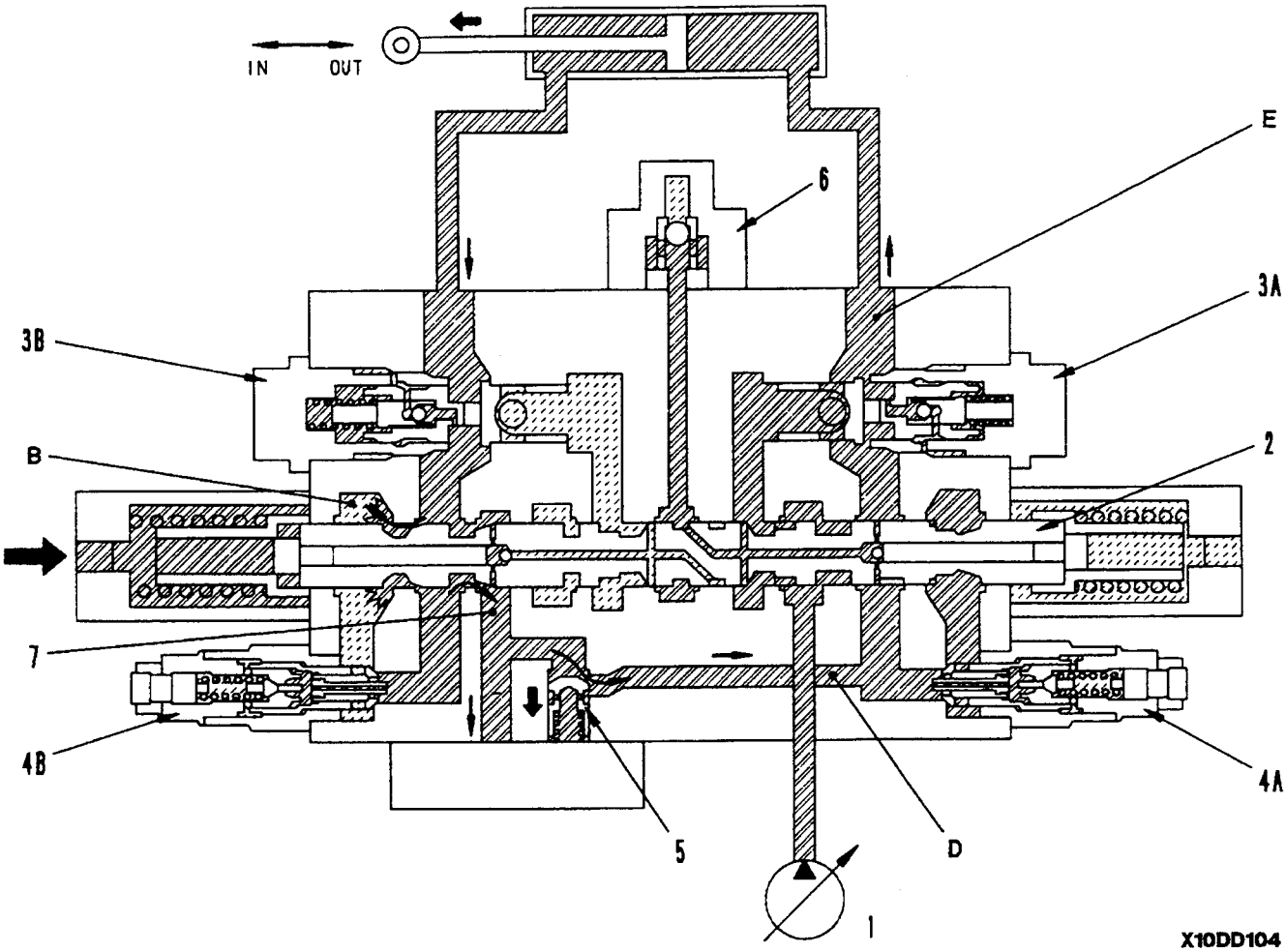


S LP00221

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

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

8. Arm regenearation circuit



1. Main pump
2. Main spool

3A. Pressure compensation valve

3B. Pressure compensation valve

4A. Safety valve

4B. Safety valve

5. Check valve
6. LS shuttle valve
7. 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

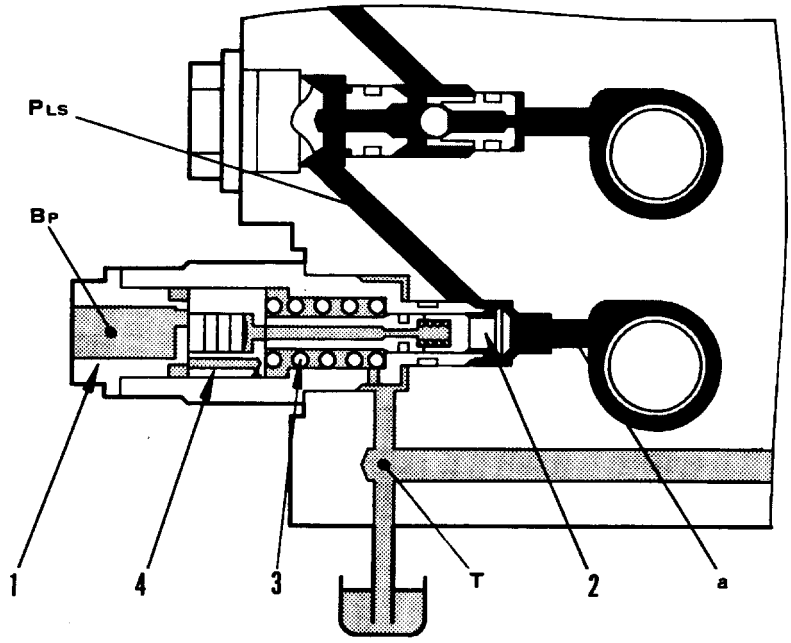
1. When the cylinder head pressure >> cylinder bottom pressure, the pressurized oil from the cylinder head passes through the notch in spool (2), enters regeneration circuit (7) and opens check valve (5), then passes through ports **D** and **E** to flow back to the cylinder bottom.

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**.

Operation



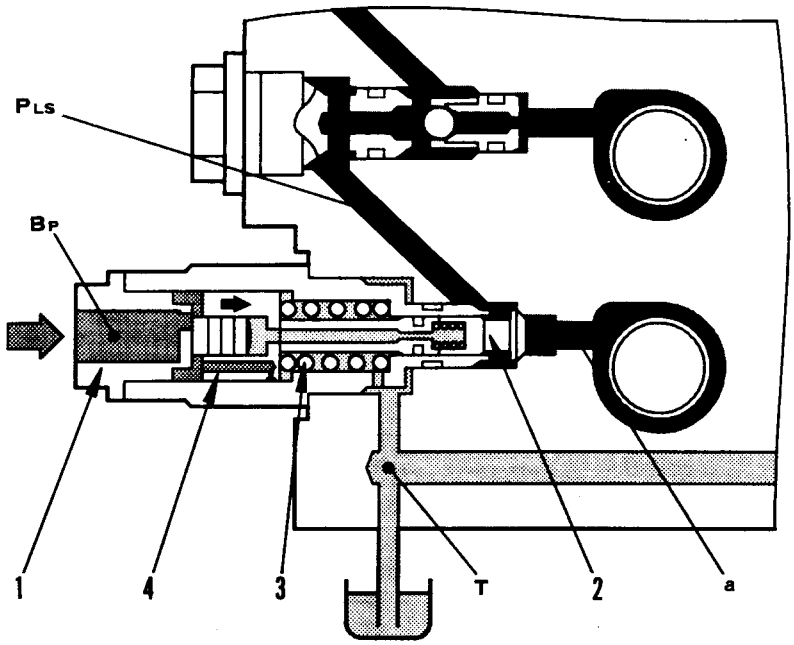
202F06081

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 on pilot port **Bp**.
- In this condition, swing LS pressure 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)



202F06082

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.

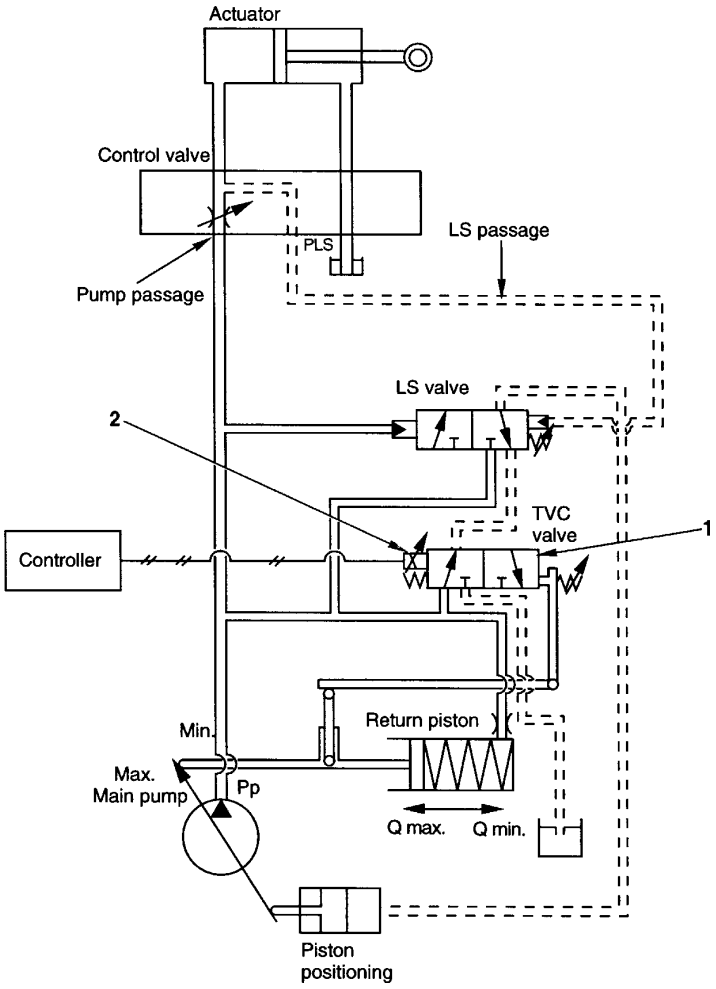
1. LS select valve
2. Valve
3. Spring
4. Piston

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

10. Cut-off function

Function

- This function uses the TVC valve, pump controller, and pump pressure sensor, and if pump discharge pressure **Pp** exceeds the set pressure, it makes pump discharge amount **Q** the minimum.



A: Cut off
B: Cut off cancel

Operation

- If the pump pressure sensor detects that the pump discharge pressure **Pp** has gone above the set pressure, it sends this information to the pump controller.
- When the pump controller receives this signal, it increases the signal current to TVC valve (1), and makes the pump discharge amount (swash plate angle) **Q** the minimum.

1. TVC valve
2. Solenoid

	Swing lock switch		
	On (Brake on)	Off (Brake off)	
			Power max. or speed down + knob s/w on
HO	B	B	B
GO	B	A	B
FO	B	A	A
BO	B	A	A
LO	B	B	B
Travel	B	B	B

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) is being operated, so the LS pressure **Pls** is not generated. At the same time, the LS pressure **Pls** 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. TVC valve
4. LS valve

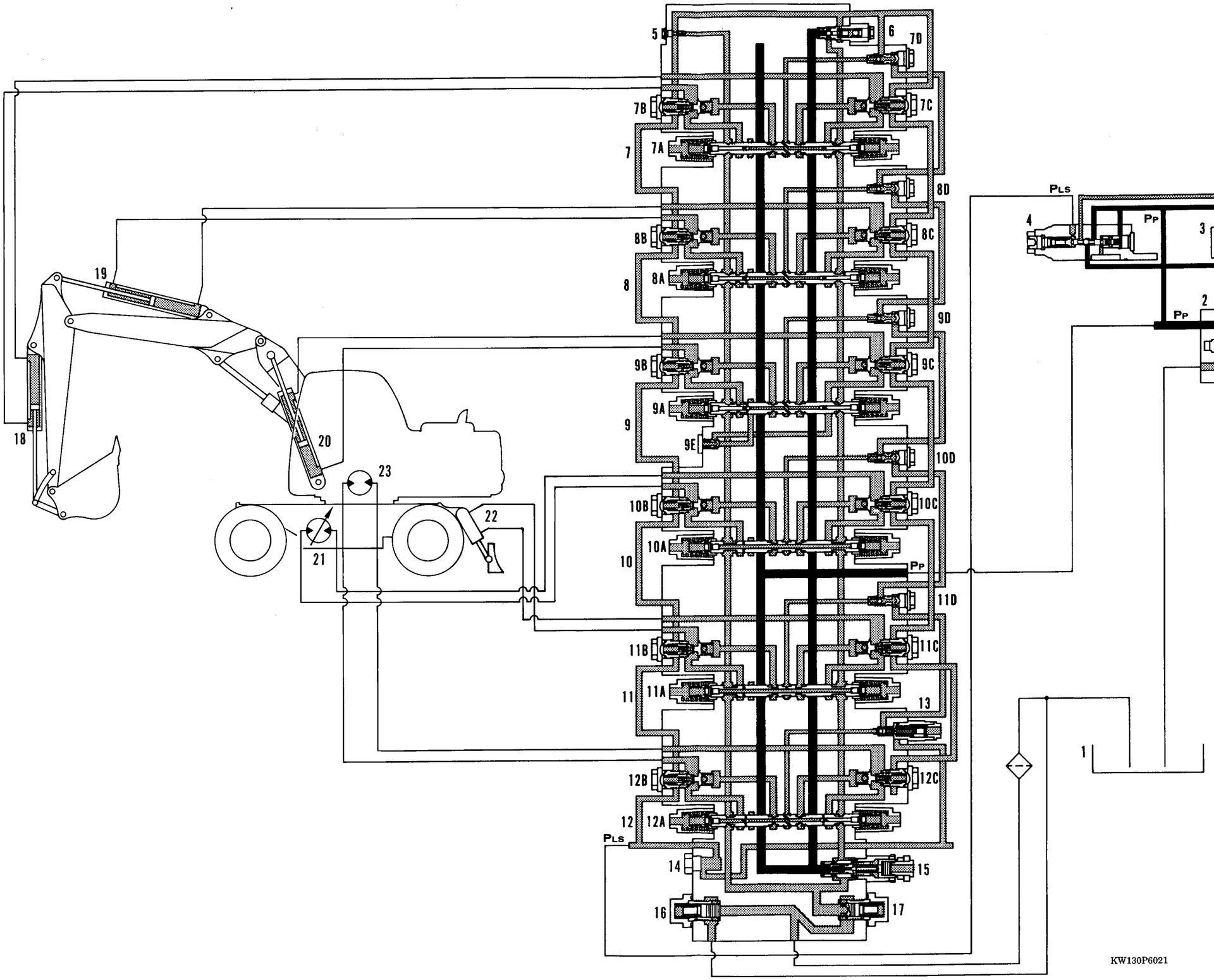
Control valve

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.


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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 of boom cylinder (20), and at the same time, LS pressure **Pls** is generated and unload valve (6) closes.
- LS pressure **Pls** 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 **Pls** (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. TVC valve
4. LS valve

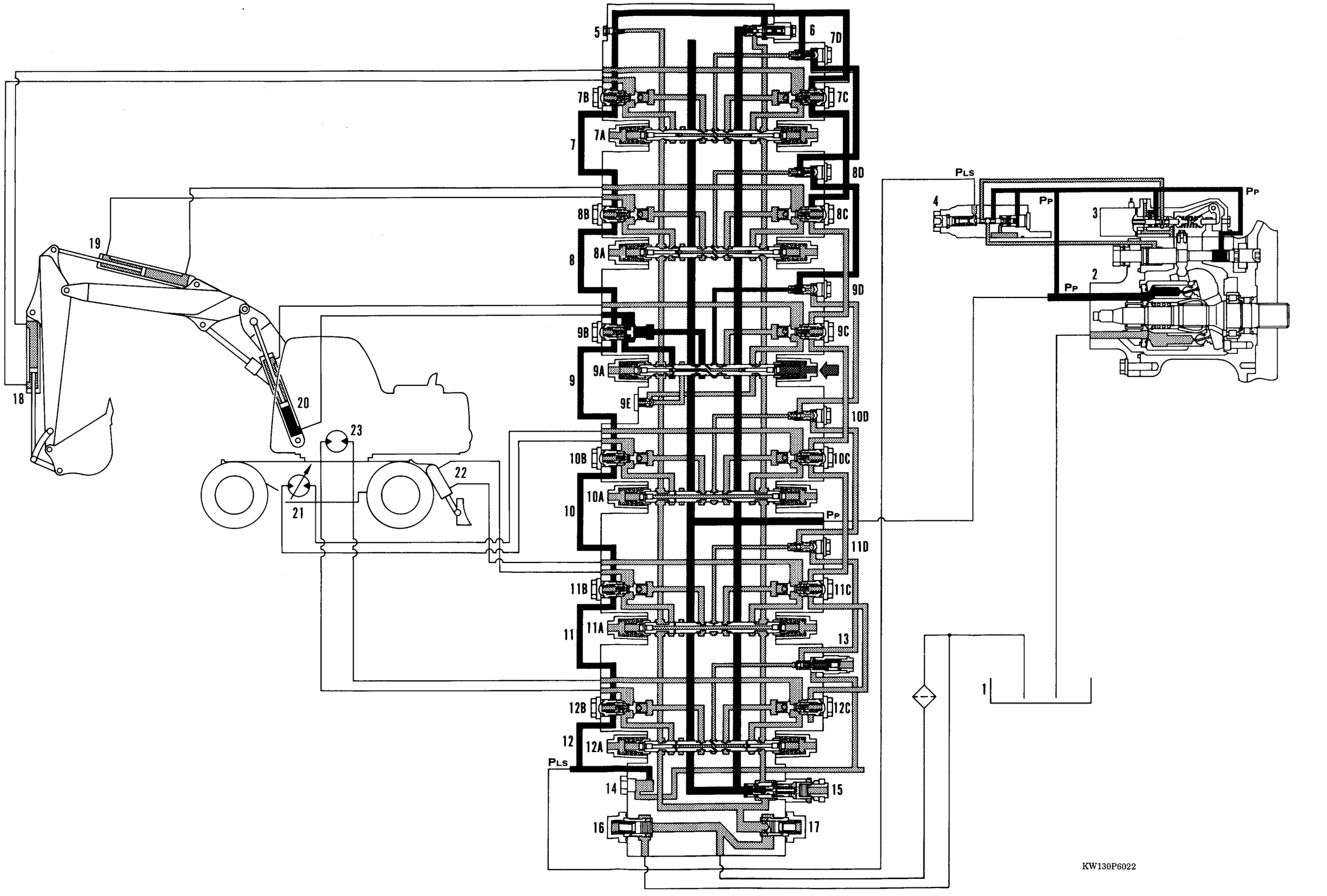
Control valve

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)
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.


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Pp
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KW130P6022

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 **Pls** 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 **Pls** (LS differential pressure △**Pls**) 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. TVC valve
4. LS valve

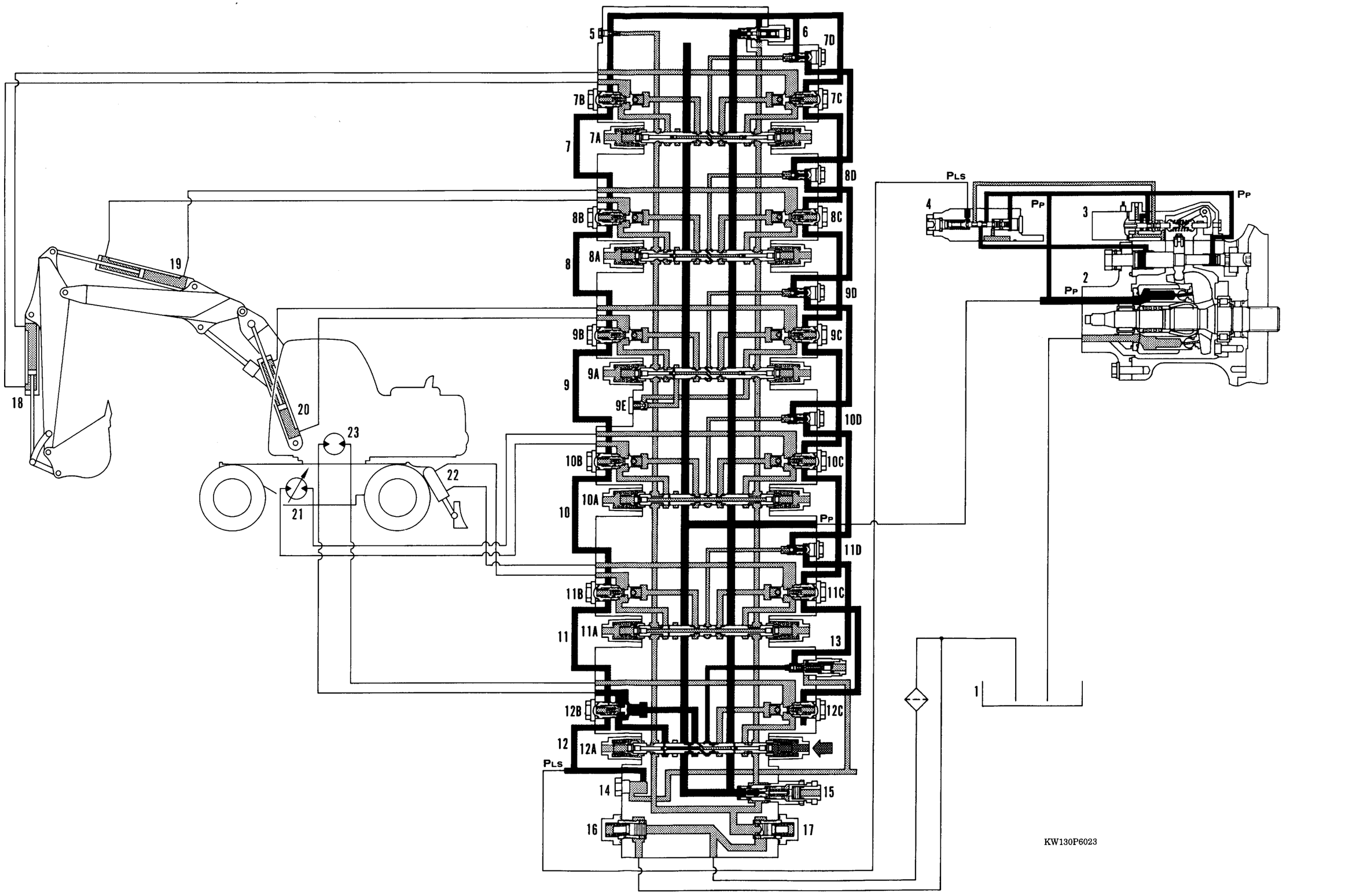
Control valve

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.


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PLS
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PLS
Pp
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KW130P6023

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 Pp and LS pressure Pls (LS differential pressure PLS) becomes smaller.
- This LS differential pressure PLS is lower than the LS 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. TVC valve
4. LS valve

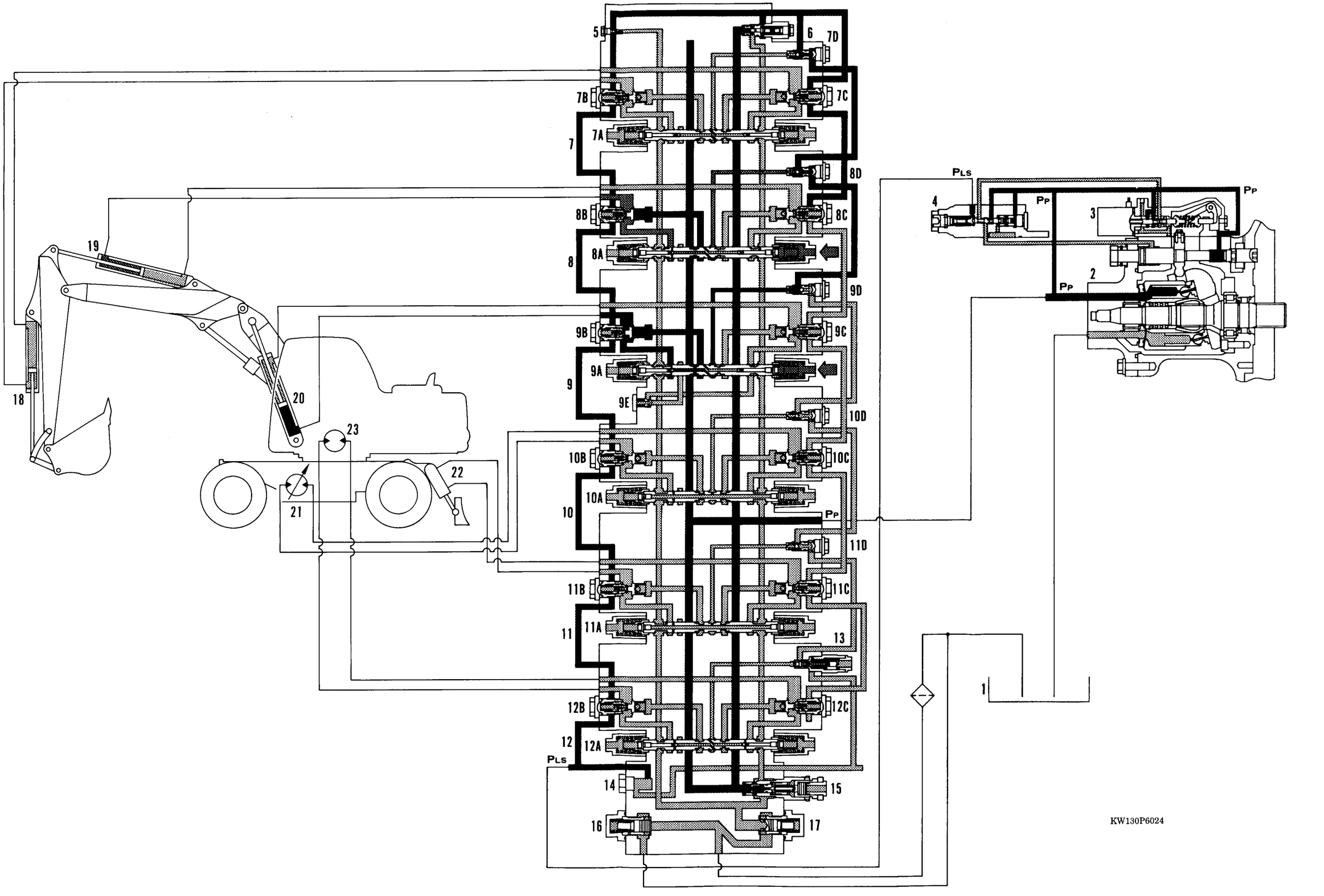
Control valve

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)
   - 8C. 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 (EXTRACT)
    - 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.


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19
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21
22
23
PLS
PP
4
3
2
1
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 **Pp** comes close to the relief pressure, the pump controller sends a signal to the solenoid of TVC 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 **Pp** and LS pressure **Pls** are the same pressure, and Ls differential pressure △**Pls** becomes 0.
- LS differential pressure △**Pls** 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 TVC 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-off function of TVC valve (3).

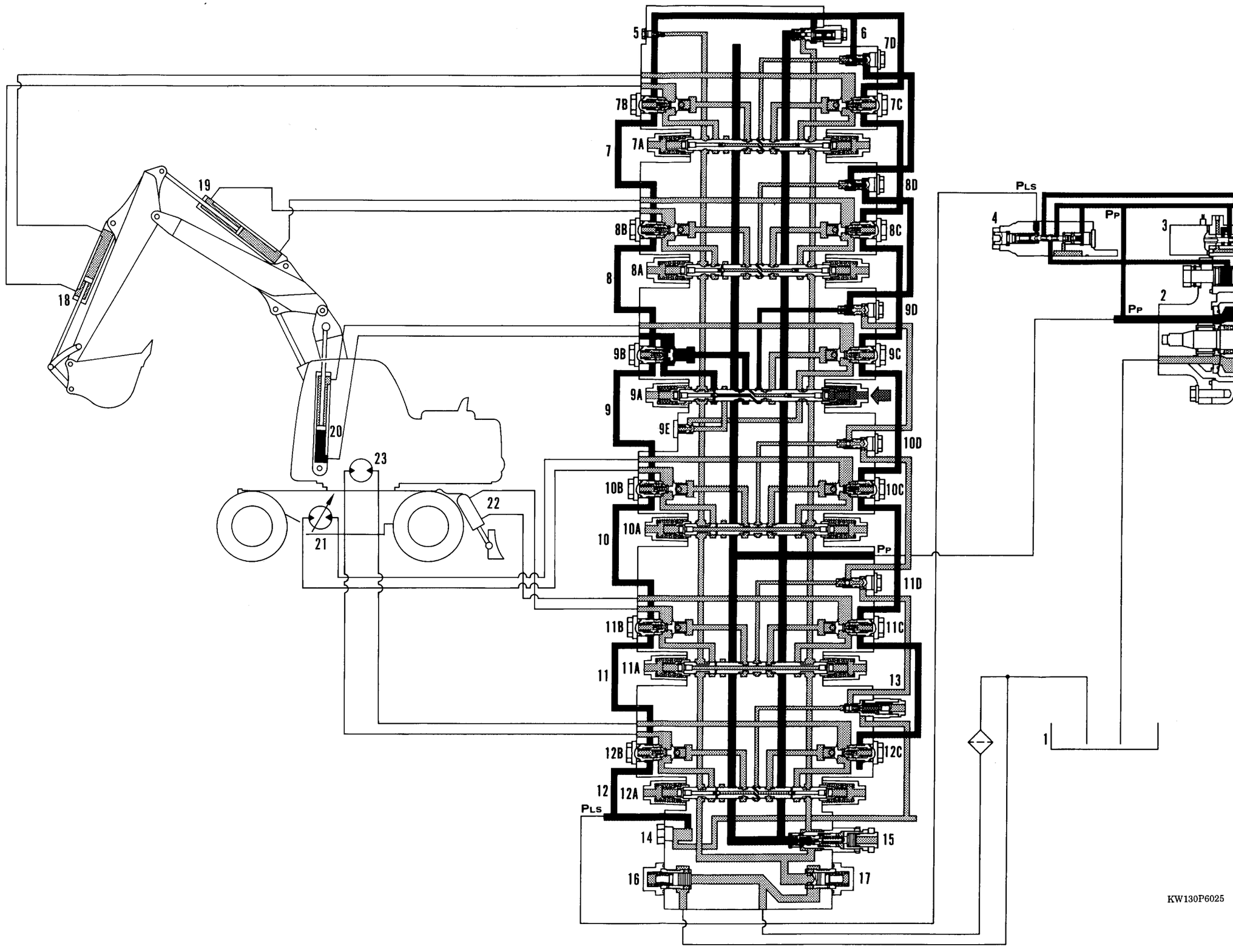
1. Hydraulic tank

Hydraulic Pump
2. Main pump
3. TVC valve
4. LS valve

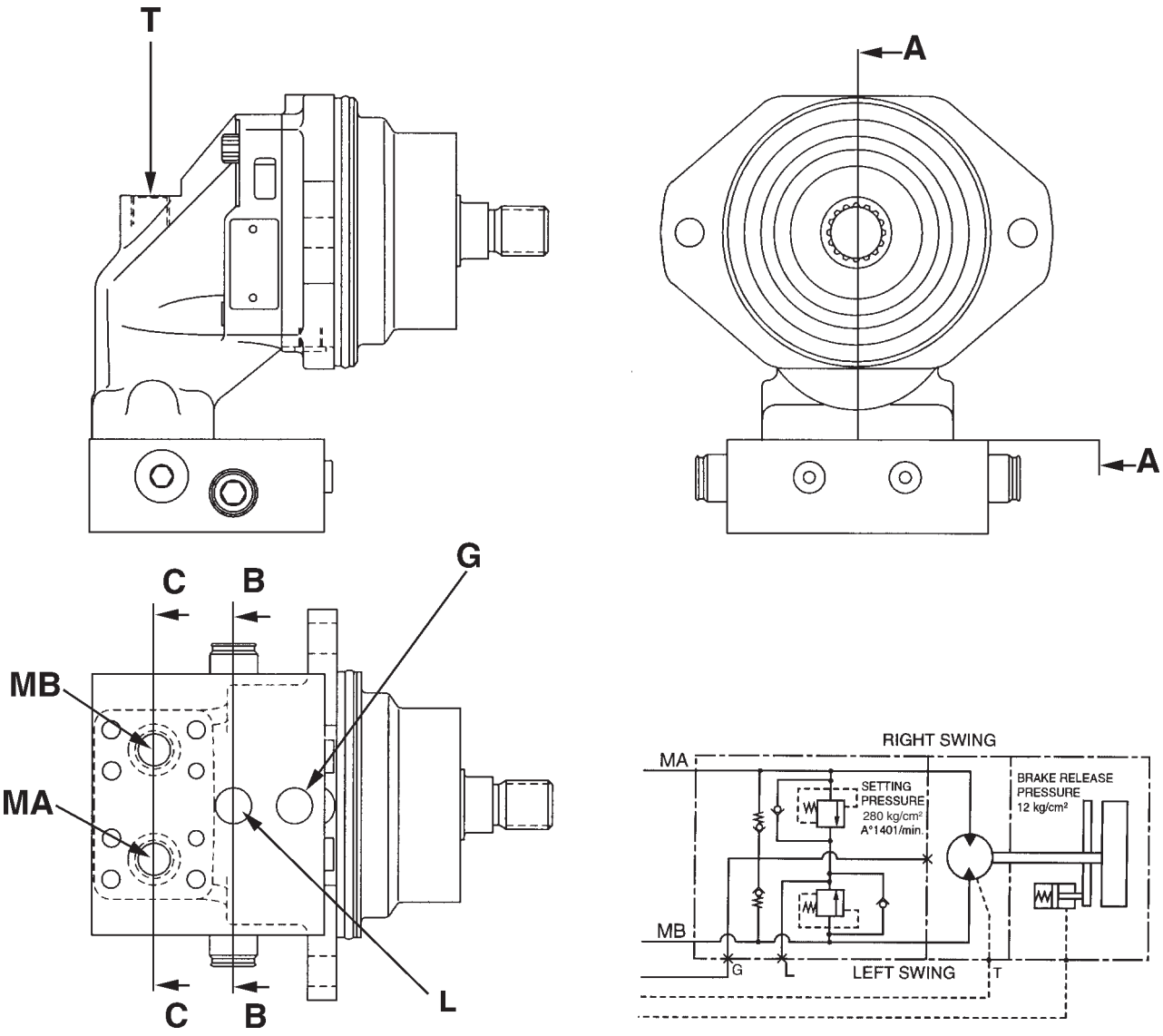
Control valve
5. LS bypass plug
6. Unload valve
7. Bucket valve
   - 7A. Spool
   - 7B. Pressure compensation valve (DUMP)
   - 7C. Pressure compensation valve (CURL)
   - 7D. LS shuttle valve
8. Arm valve
   - 8A. Spool
   - 8B. Pressure compensation valve (OUT)
   - 8C. Pressure compensation valve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


5
6
7D
7B
7C
7
7A
8D
8B
8C
8
8A
9D
9B
9C
9
9A
9E
10D
10B
10C
10
10A
Pp
11D
11B
11C
11
11A
13
12B
12C
12
12A
PLS
14
15
16
17
18
19
20
21
22
23
PLS
Pp
Pp
Pp
4
3
2
1
KW130P6025

SWING MOTOR



a. Port **G** (to control valve TSW port)
b. Port **MB** (from control valve)
c. Port **MA** (from control valve)
d. Port **T** (to tank)
e. Port **L** (plugged)

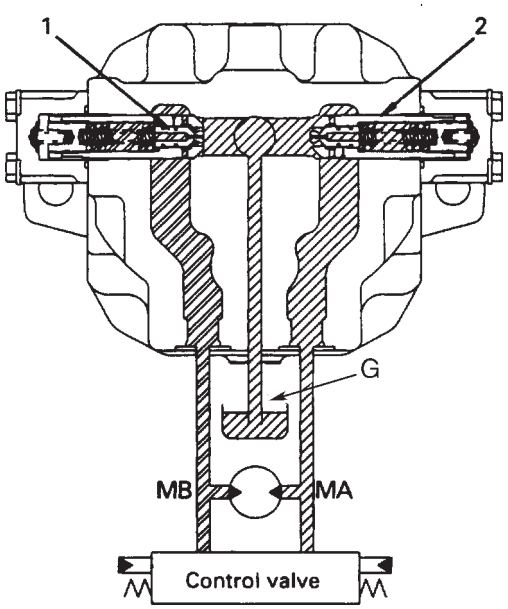
SPECIFICATIONS

Type	F12-060-MF-CV-C-509
Theoretical delivery	59.8 cc/rev
Safety valve set pressure	27.47 MPa (280 kg/cm²)
Rated speed	2250 rpm

SUCTION-SAFETY VALVE

Function

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



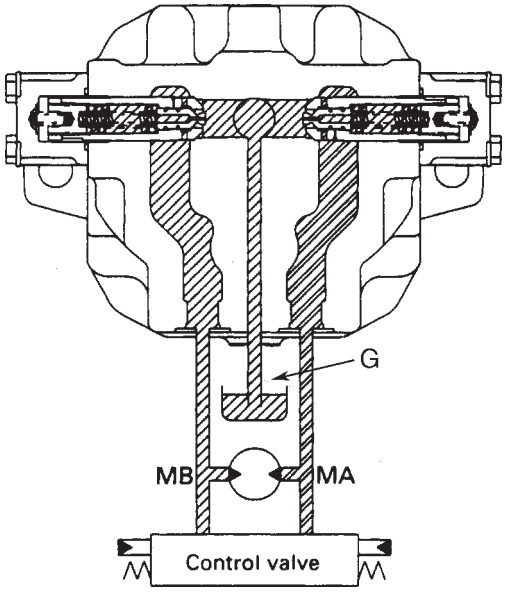
Operation

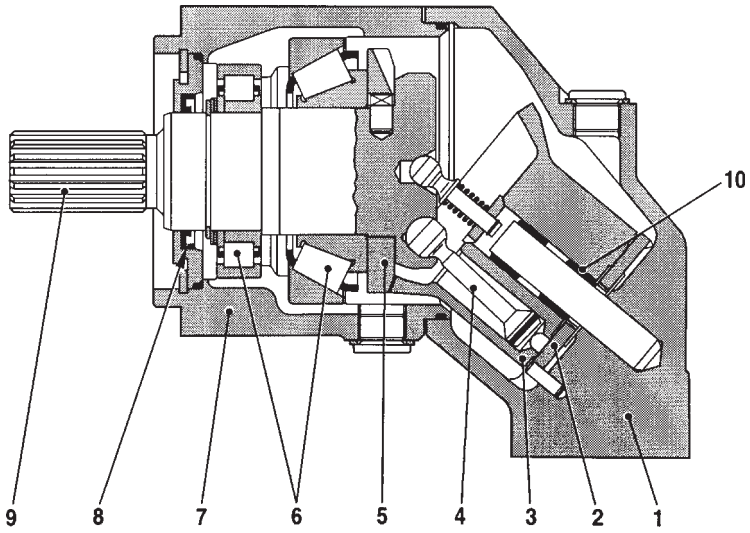
1. When starting swing

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

2. When stopping swing

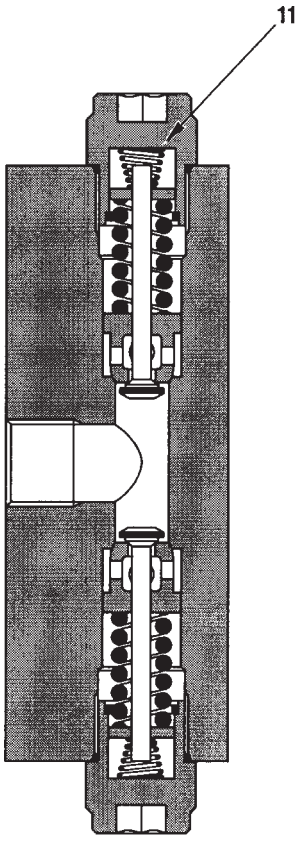
- When the swing control lever is returned to the neutral position, no more pressurized oil is supplied from the pump to port **MA**.
  At the same time, the oil from the outlet port of the motor returns from the control valve to the tank, and the circuit is closed.
- The pressure at port **MB** rises,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



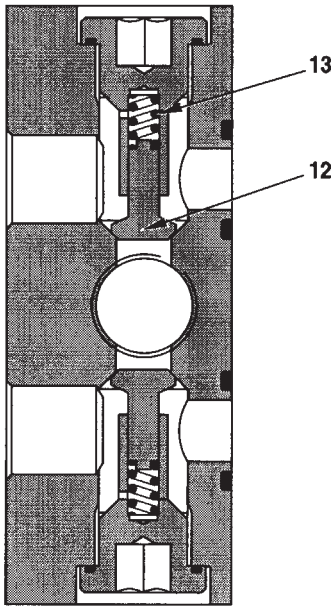


Section A-A

1. Barrel housing
2. Valve plate
3. Cylinder barrel
4. Piston with piston rings
5. Timing gear
6. Roller bearings
7. Bearing housing
8. Shaft seal
9. Output/input shaft
10. Needle bearings
11. Safety valve with check valve
12. Check valve
13. Check valve spring

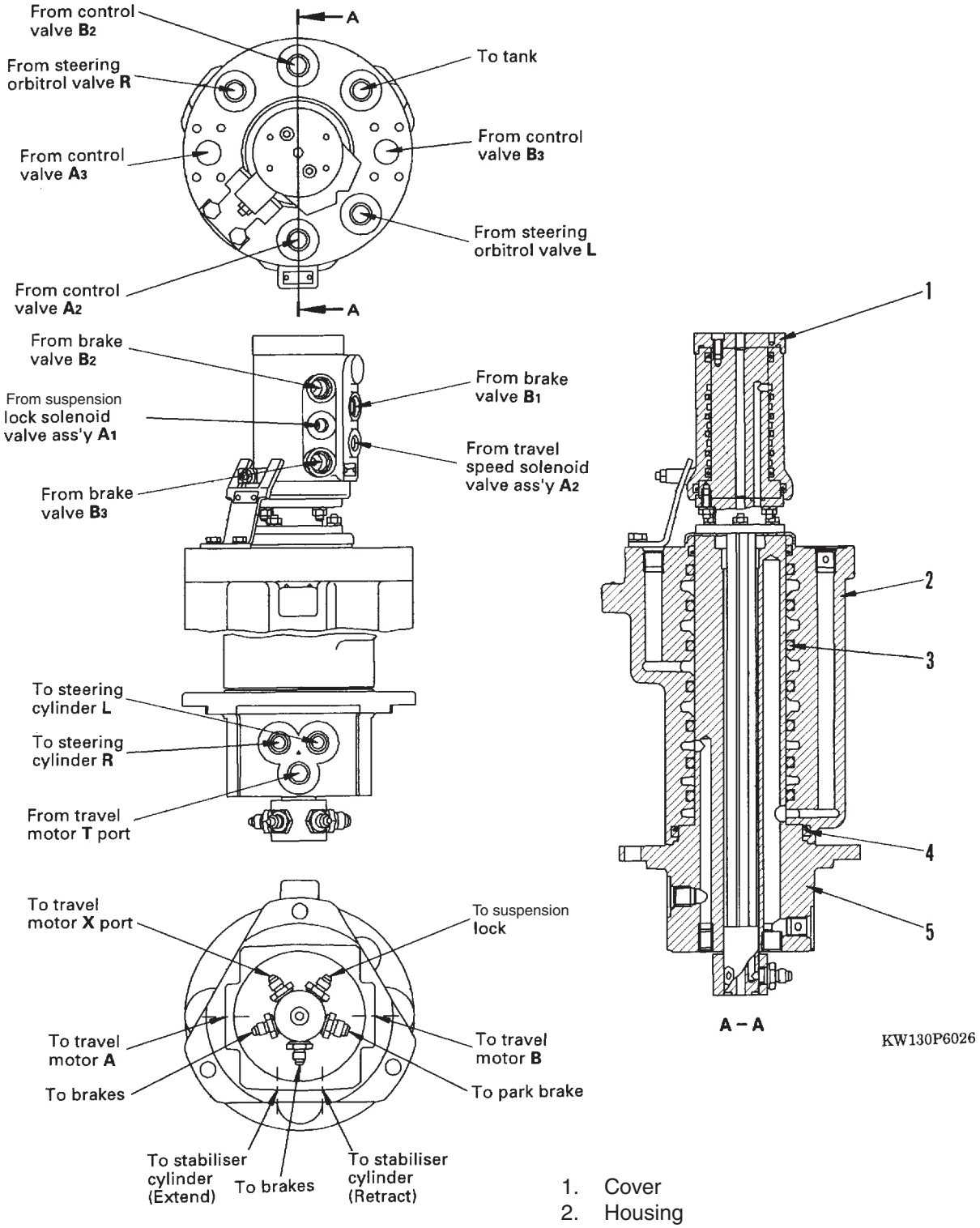


Section B-B



Section C-C

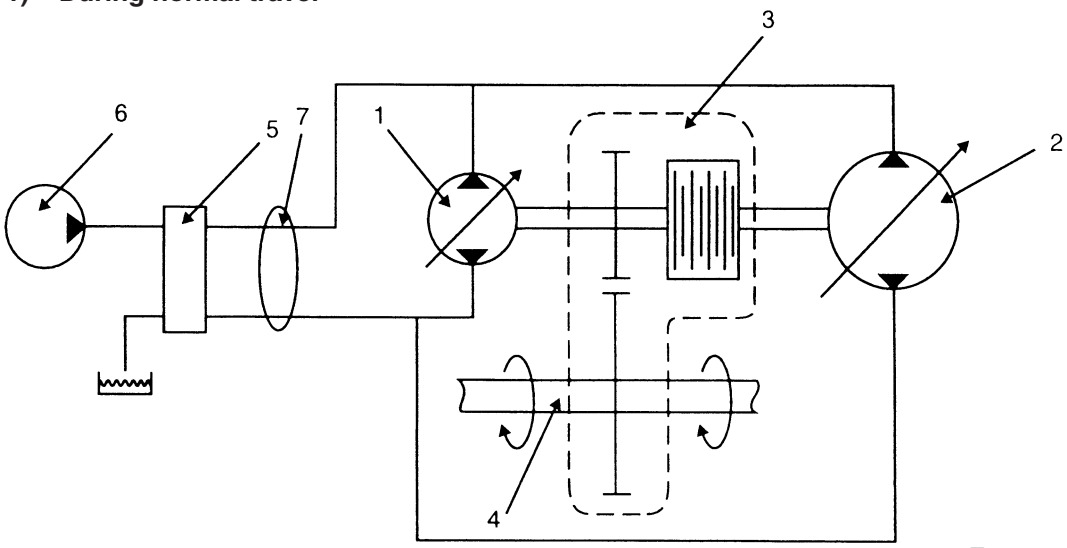
CENTER SWIVEL JOINT



1. Cover
2. Housing
3. Sealing ring
4. Lip seal
5. Rotor

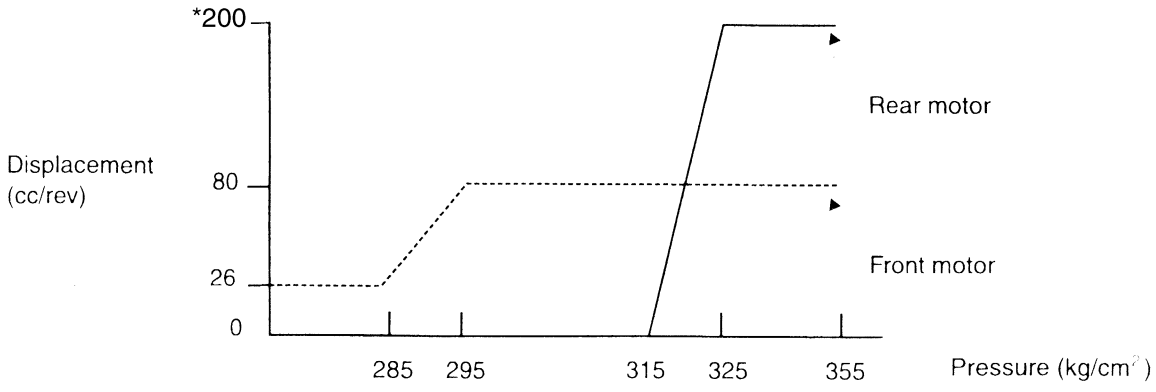
OPERATION OF TRAVEL MOTORS (30 Km/h TRAVEL SPEED SPEC.)

1) During normal travel



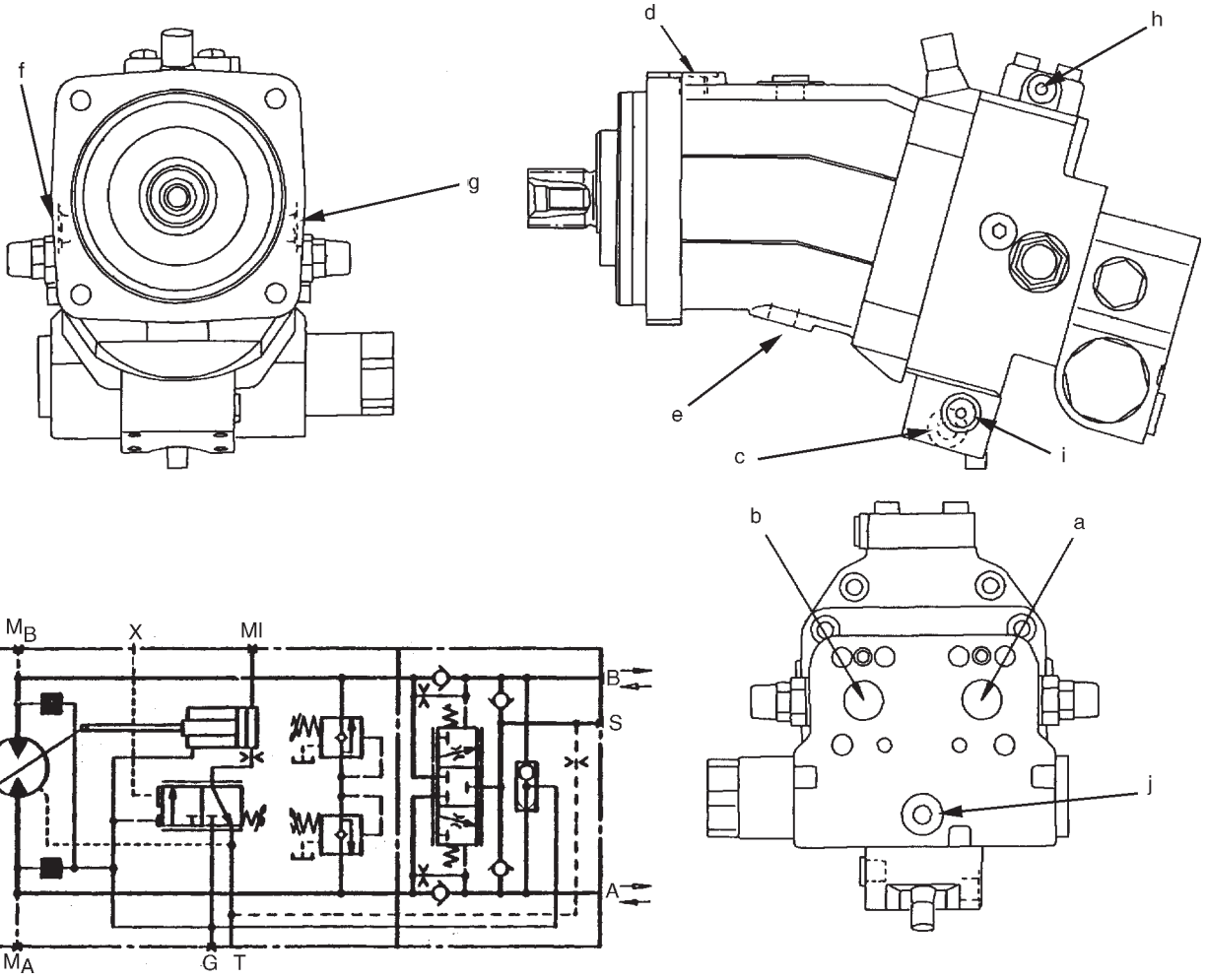
1. Front motor
2. Rear motor
3. Transmission and clutch
4. Drive shafts
5. Main control valve
6. Main pump
7. Swivel joint

- 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.



* Displacement value dependent on machine spec. Displacement either 200 or 241 cc/rev.

FRONT TRAVEL MOTOR (20KPH SPEC)



Hydraulic Schematic Diagram

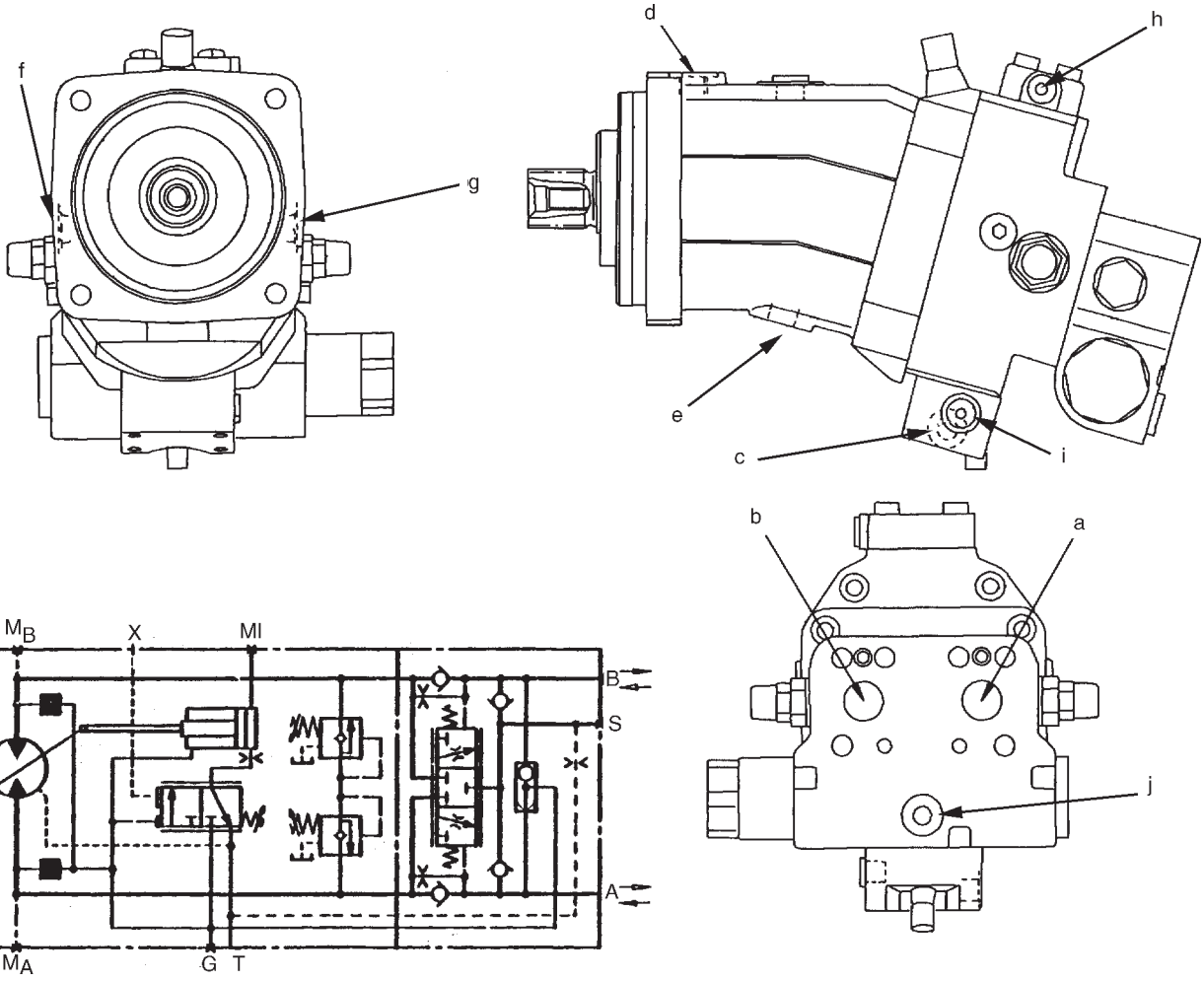
a. Motor inlet (A)
b. Motor outlet (B)
c. Override pressure port (X)
d. Drain port (V)
e. Drain port (T)
f. Pressure test port (MB)
g. Pressure test port (MA)
h. Pressure test port (MI)
i. Pressure test port (G)

SPECIFICATIONS

Type: Variable displacement

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)

FRONT TRAVEL MOTOR (30KPH SPEC)



Hydraulic Schematic Diagram

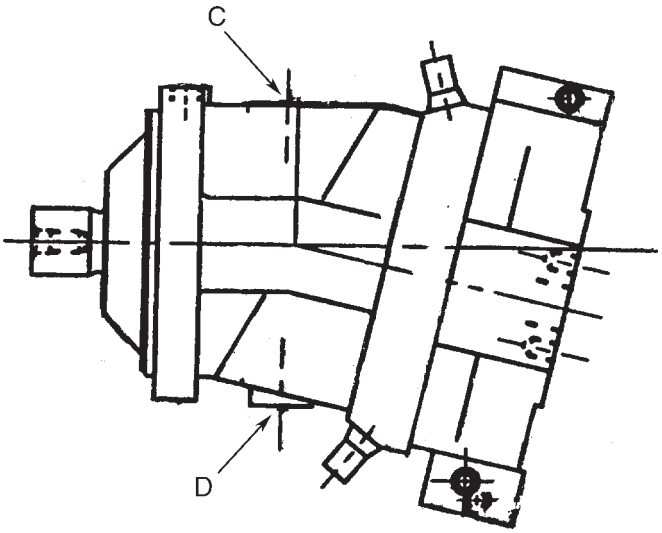
a. Motor inlet (A)
b. Motor outlet (B)
c. Override pressure port (X)
d. Drain port (V)
e. Drain port (T)
f. Pressure test port (MB)
g. Pressure test port (MA)
h. Pressure test port (MI)
i. Pressure test port (G)

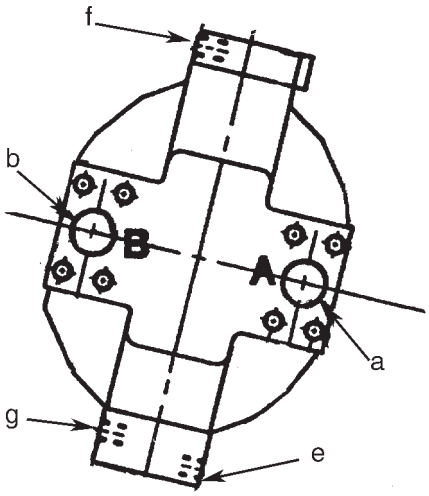
SPECIFICATIONS

Type: Variable displacement

Theoretical delivery:	Min. 26 cc/rev
	Max. 80 cc/rev
Hi-Lo switching-pressure:	2.94 MPa (30 kg/cm^2)
Rated speed:	5240 rpm (Max)

REAR TRAVEL MOTOR





Hydraulic Schematic Diagram

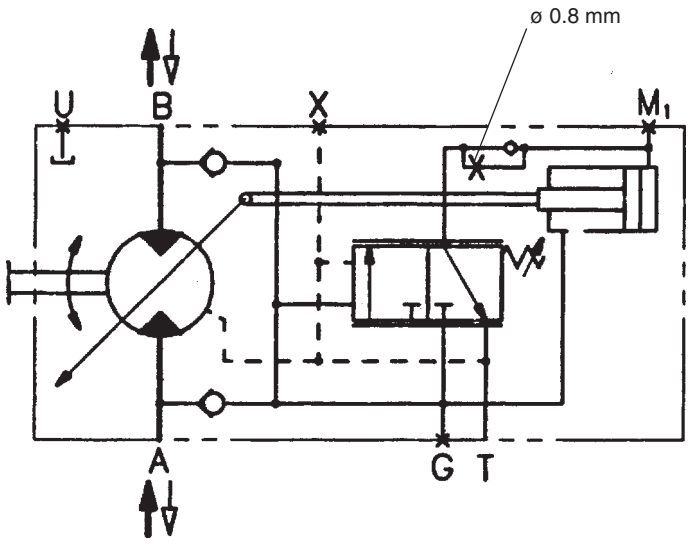
a. Motor inlet (A)
b. Motor outlet (B)
c. Drain port (T)
d. Drain port (T)
e. Overide pressure port (X)
f. Pressure test port (MI)
g. Pressure test port (G)

SPECIFICATON

Type: variable displacement

Theoretical delivery: Min 0
*Max 200 cc/rev or 241 cc/rev

Rated speed: 5240 rpm

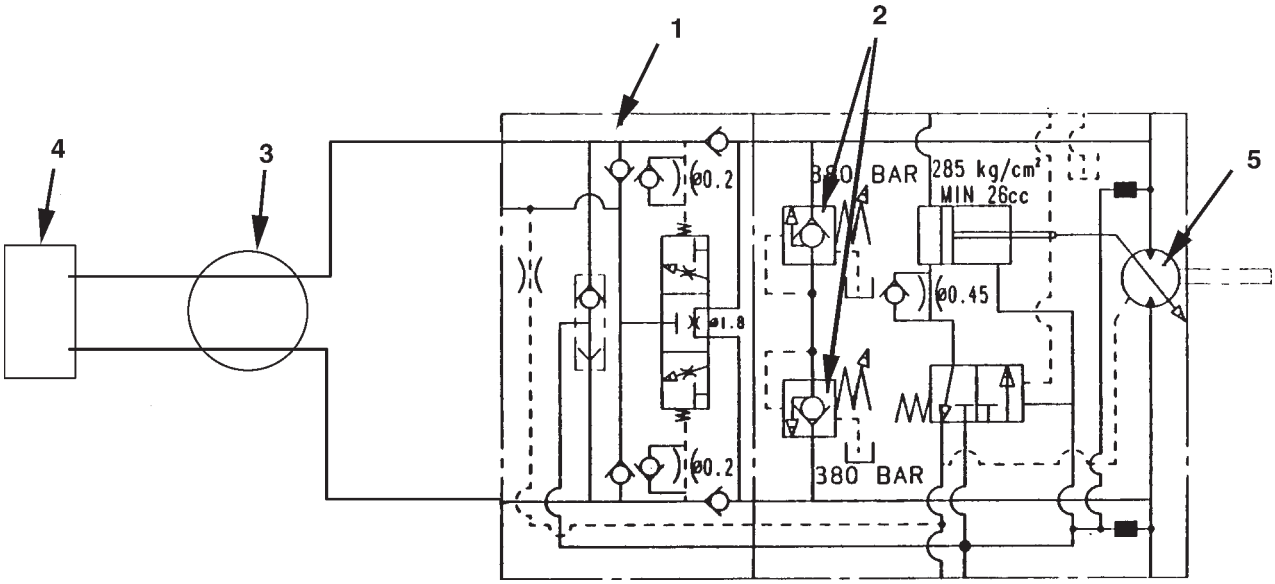


Hydraulic Schematic Diagram

* Max displacement dependent on machine spec.

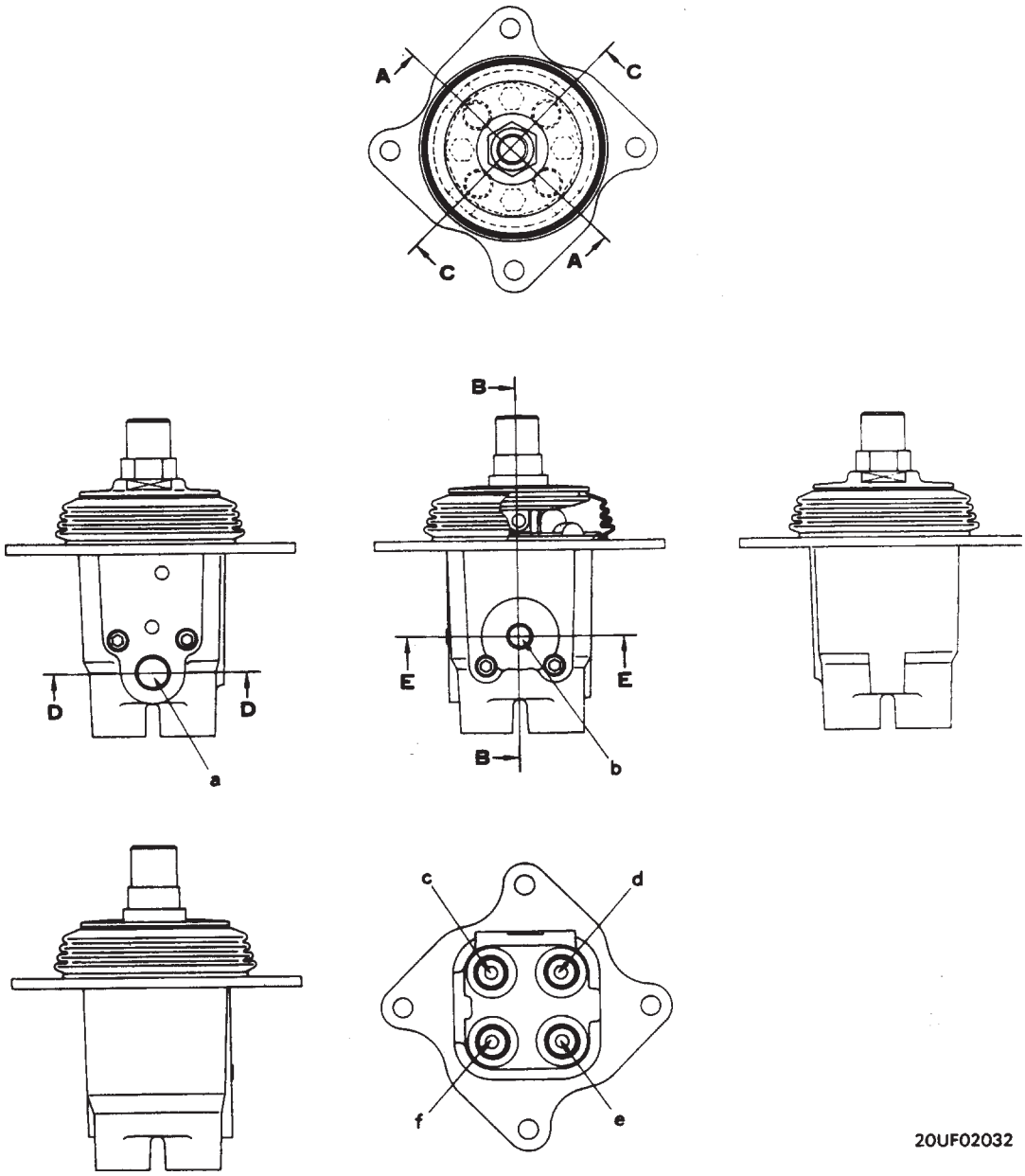
2) Control of speed downhill

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.

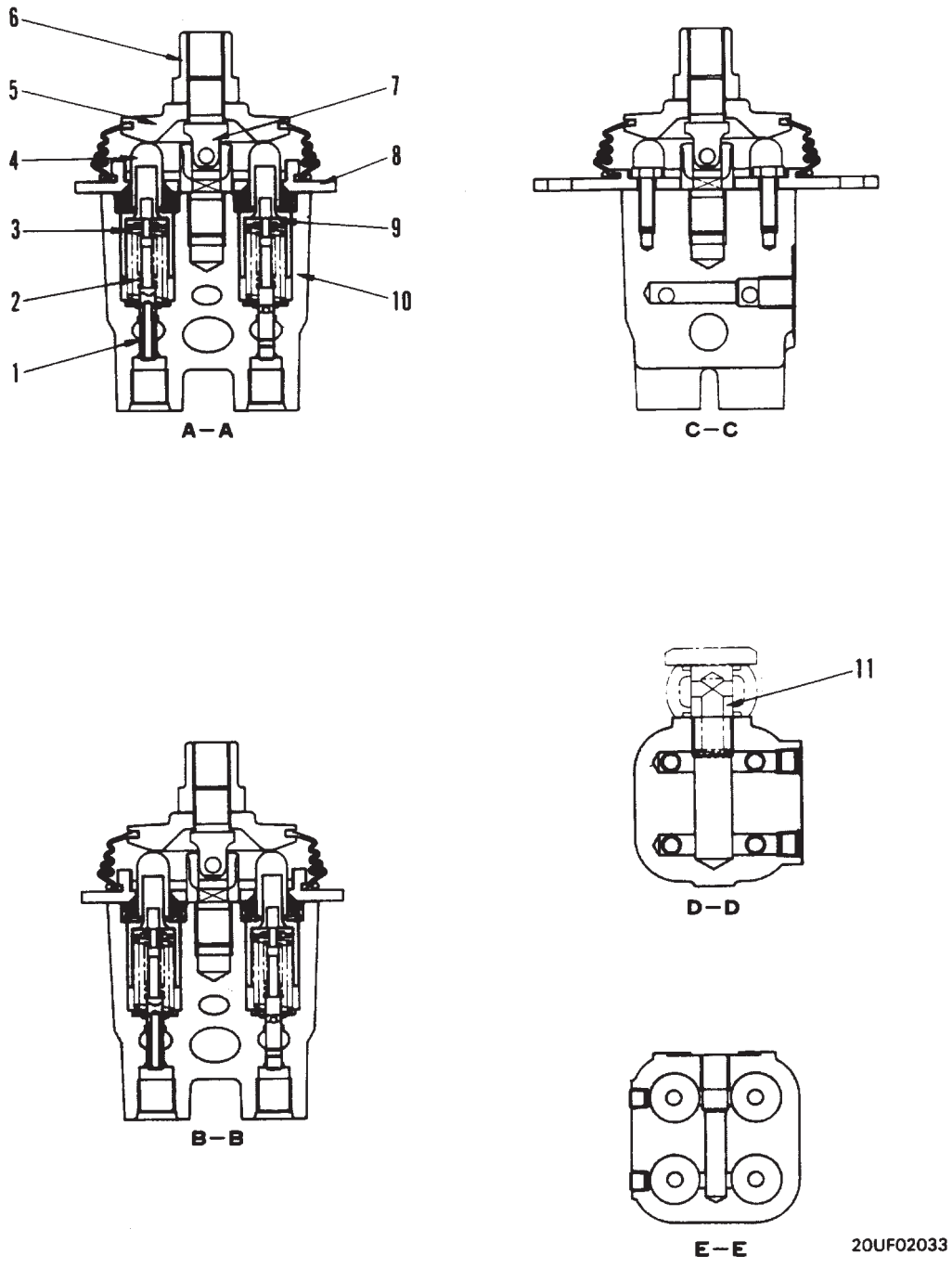


1. Counterbalance valve
2. Brake valve
3. Swivel joint
4. Main control valve
5. Front travel motor

WORK EQUIPMENT • SWING PPC VALVE



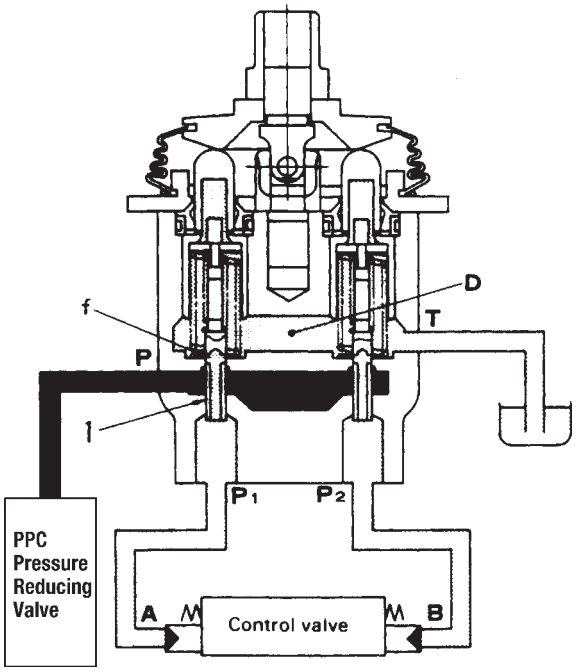
a. Port **P** (from PPC Pressure Reducing Valve)
b. Port **T** (to tank)
c. Port **P2** (L.H.: Arm IN/R.H.: Boom RAISE)
d. Port **P4** (L.H.: Swing LEFT/R.H.: Bucket DUMP)
e. Port **P1** (L.H.: Arm OUT/R.H.: Boom LOWER)
f. Port **P3** (L.H.: Swing RIGHT/R.H.: Bucket CURL)



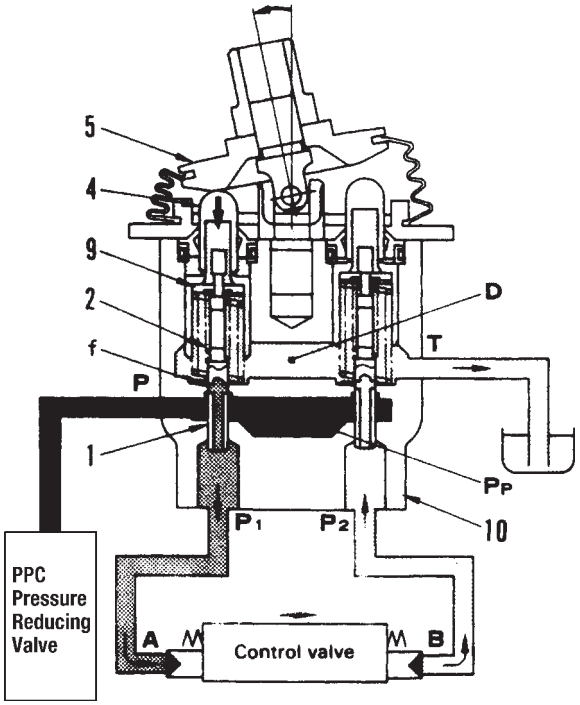
1. Spool
2. Metering spring
3. Centering spring
4. Piston
5. Disc
6. Nut (for connecting lever)
7. Joint
8. Plate
9. Retainer
10. Body
11. Filter

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 control pump passes through fine control hole "**f**" and goes from port **P1** to port **A**.
   Whe 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)



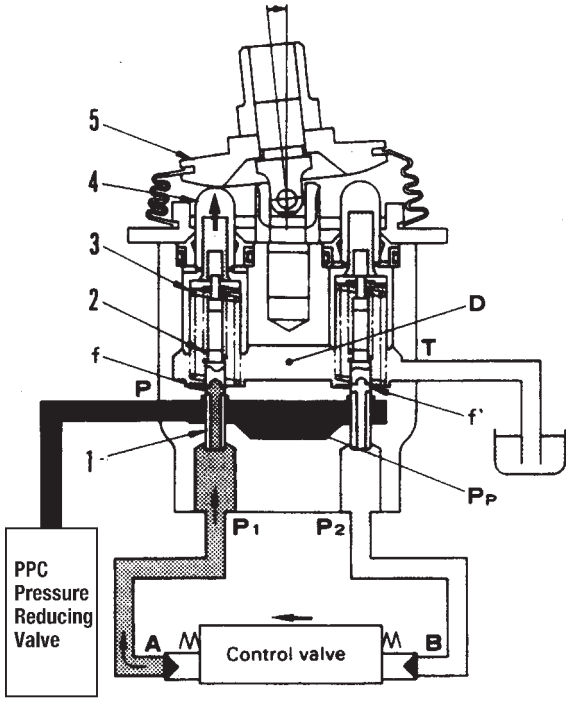
3. During fine control
(When control lever is returned)

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)

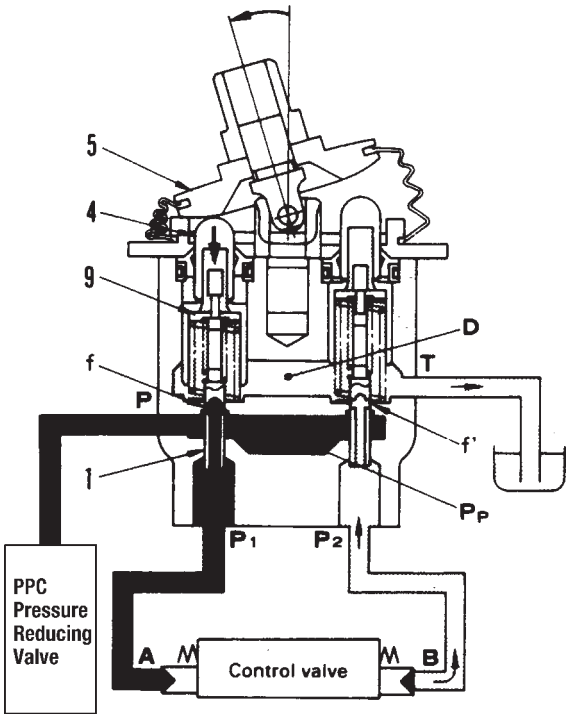


4. At full stroke

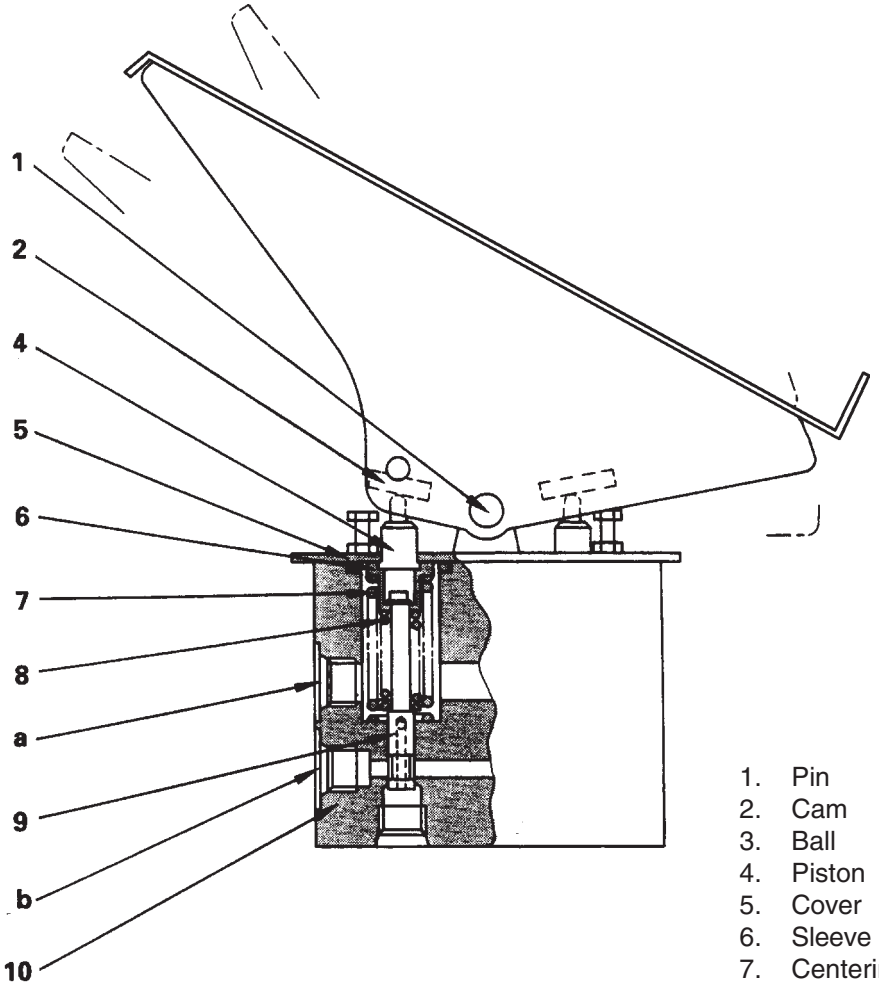
When disc (5) pushes down piston (4), and retainer (9) pushes down spool (1), fine control hole "**f**" is shut off from drain chamber **D**, and is connected with pump pressure chamber **Pp**.

Therefore, the pilot pressure oil from the control pump passes through fine control hole "**f**" and flows to chamber **A** from port **P1**, and pushes 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)

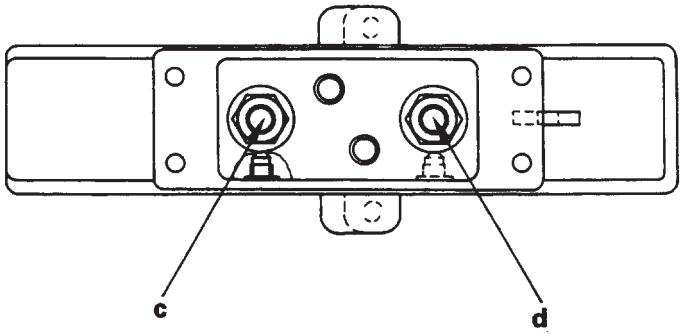


TRAVEL PPC VALVE PEDAL



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

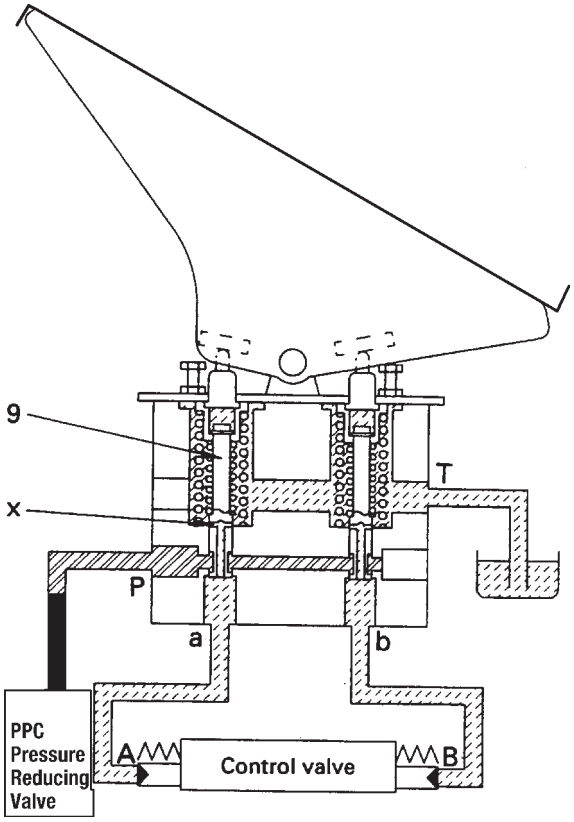
a. Port **T** (to tank)
b. Port **P** (from PPC pressure reducing valve)
c. Port **A** (travel FWD)
d. Port **B** (travel REV)



OPERATION

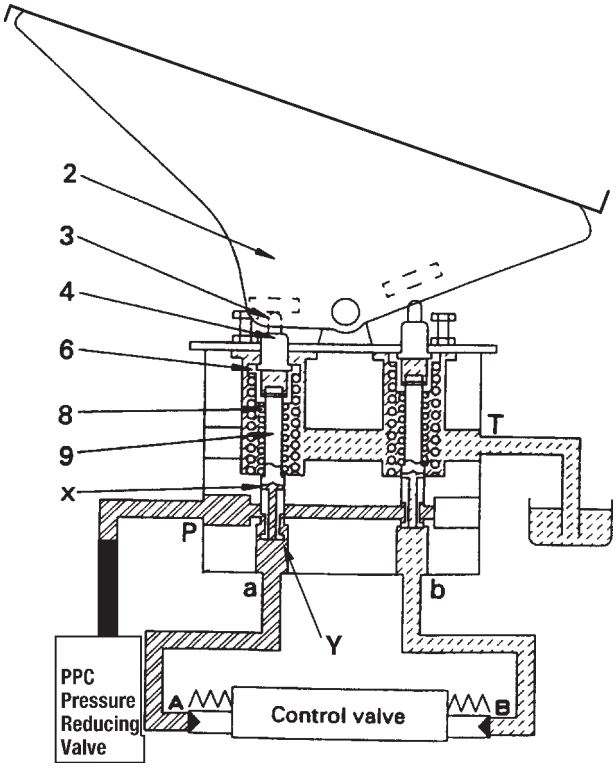
At neutral

- 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 fine control hole **X** of spool (9).

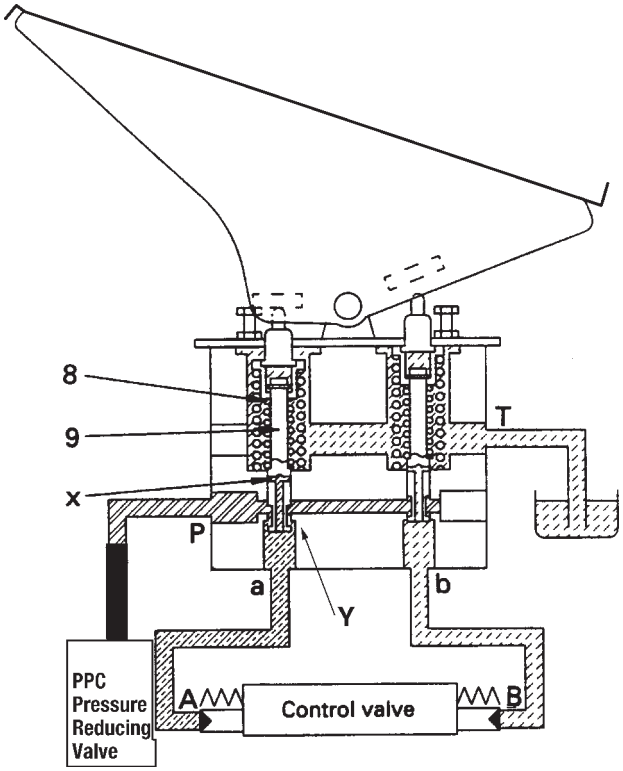


When operated

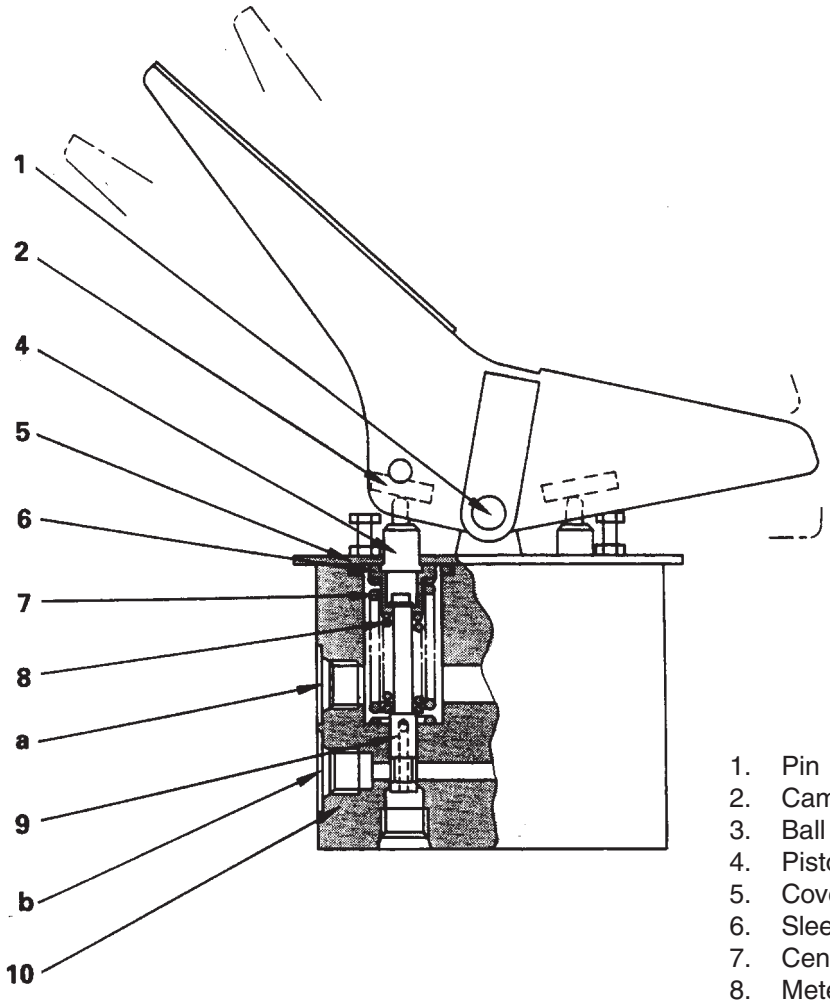
- When cam (2) is moved, metering spring (8) is pushed by ball (3), piston (4) and sleeve (6), and spool (9) is also pushed down by this.
- As a result, fine control hole **X** is shut off from the drain circuit. At almost the same time, fine control portion **Y** is connected with port "**a**", and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

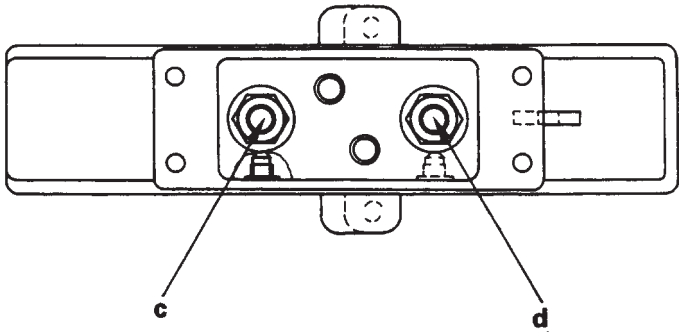


SERVICE PPC VALVE



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

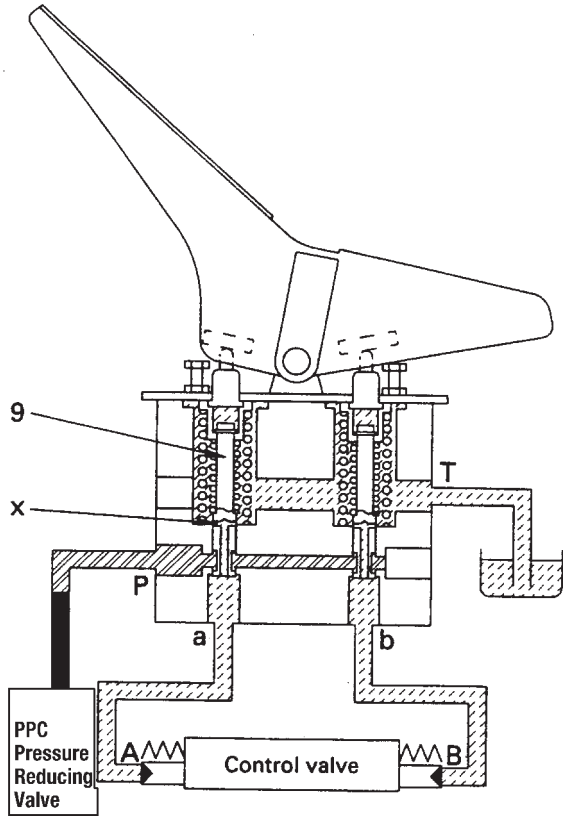
a. Port **T** (to tank)
b. Port **P** (from PPC pressure reducing valve)
c. Port **A** (to service valve P1)
d. Port **B** (to service valve P2)



OPERATION

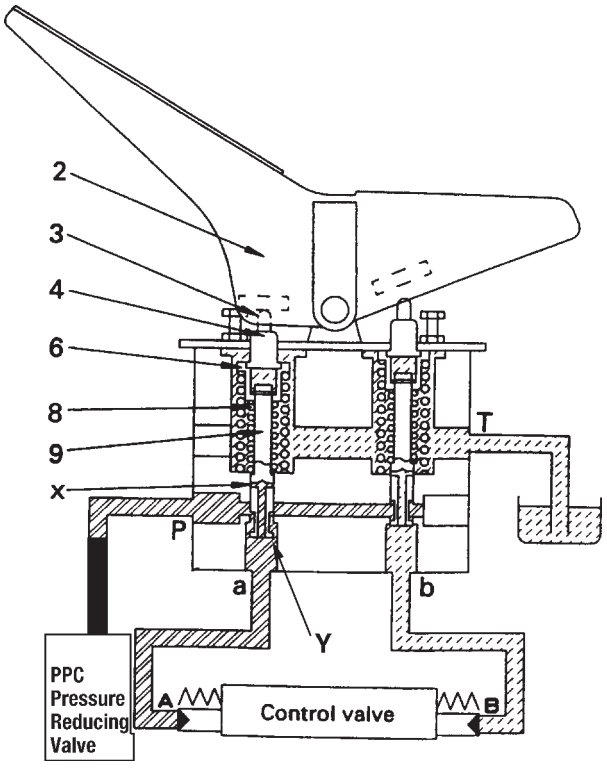
At neutral

- 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 fine control hole **X** of spool (9).

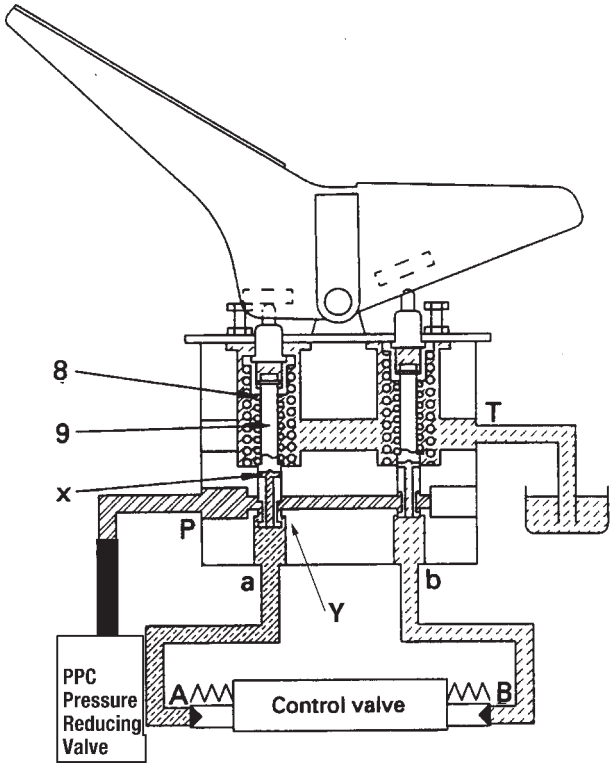


When operated

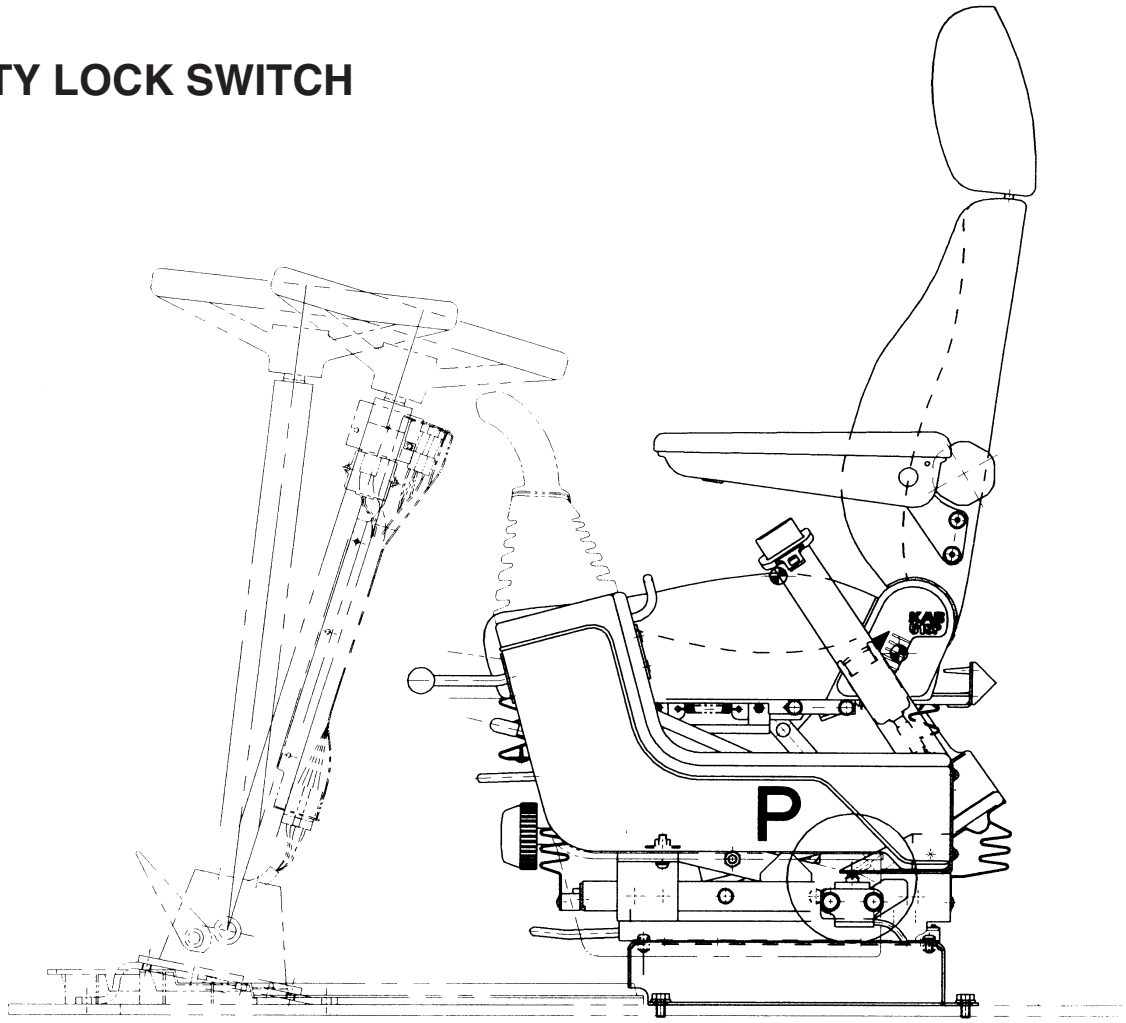
- When cam (2) is moved, metering spring (8) is pushed by ball (3), piston (4) and sleeve (6), and spool (9) is also pushed down by this.
- As a result, fine control hole **X** is shut off from the drain circuit. At almost the same time, fine control portion **Y** is connected with port "**a**", and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

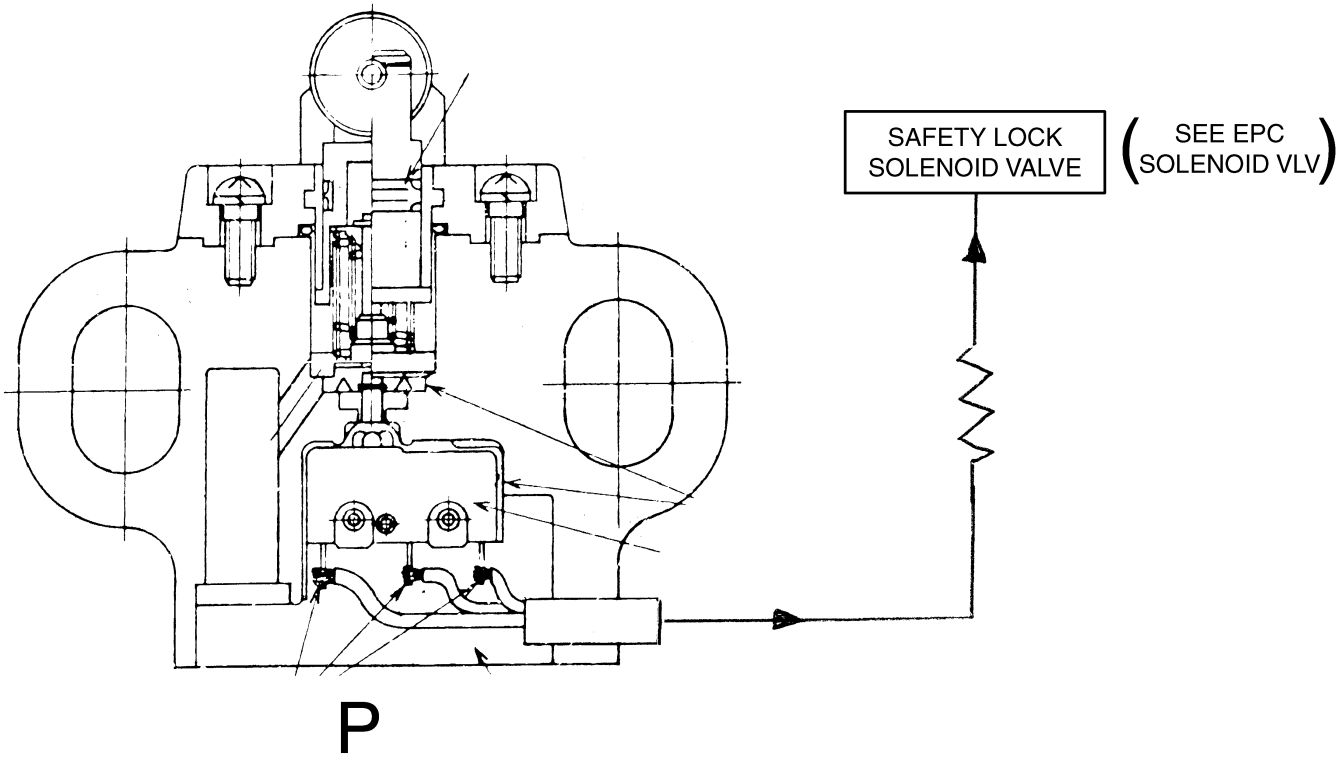


- When the pressure at port "**a**" becomes higher, spool (9) is pushed back by the force acting on the end of the spool. When fine control portion **Y** closes, fine control hole **X** is connected to the drain circuit at almost the same time.
- As a result, spool (9) moves up and down to balance the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

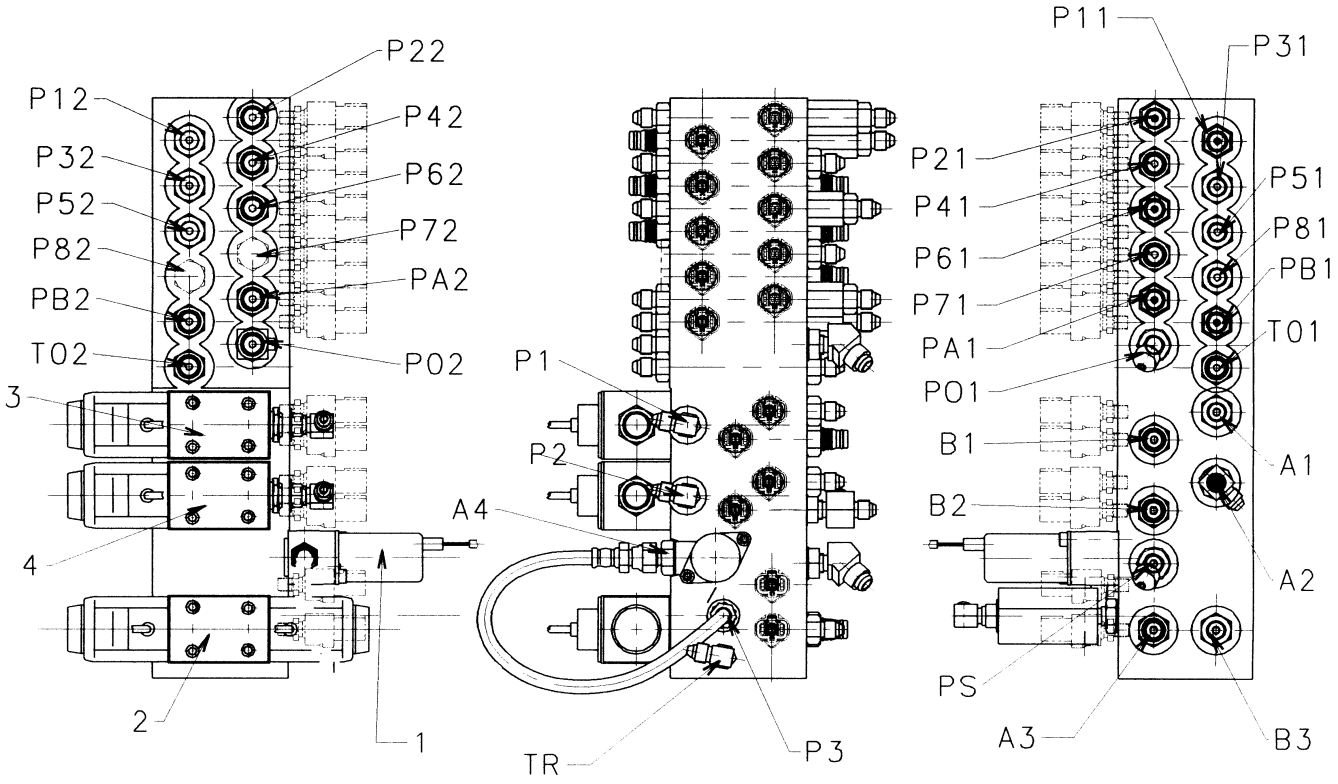


SAFETY LOCK SWITCH



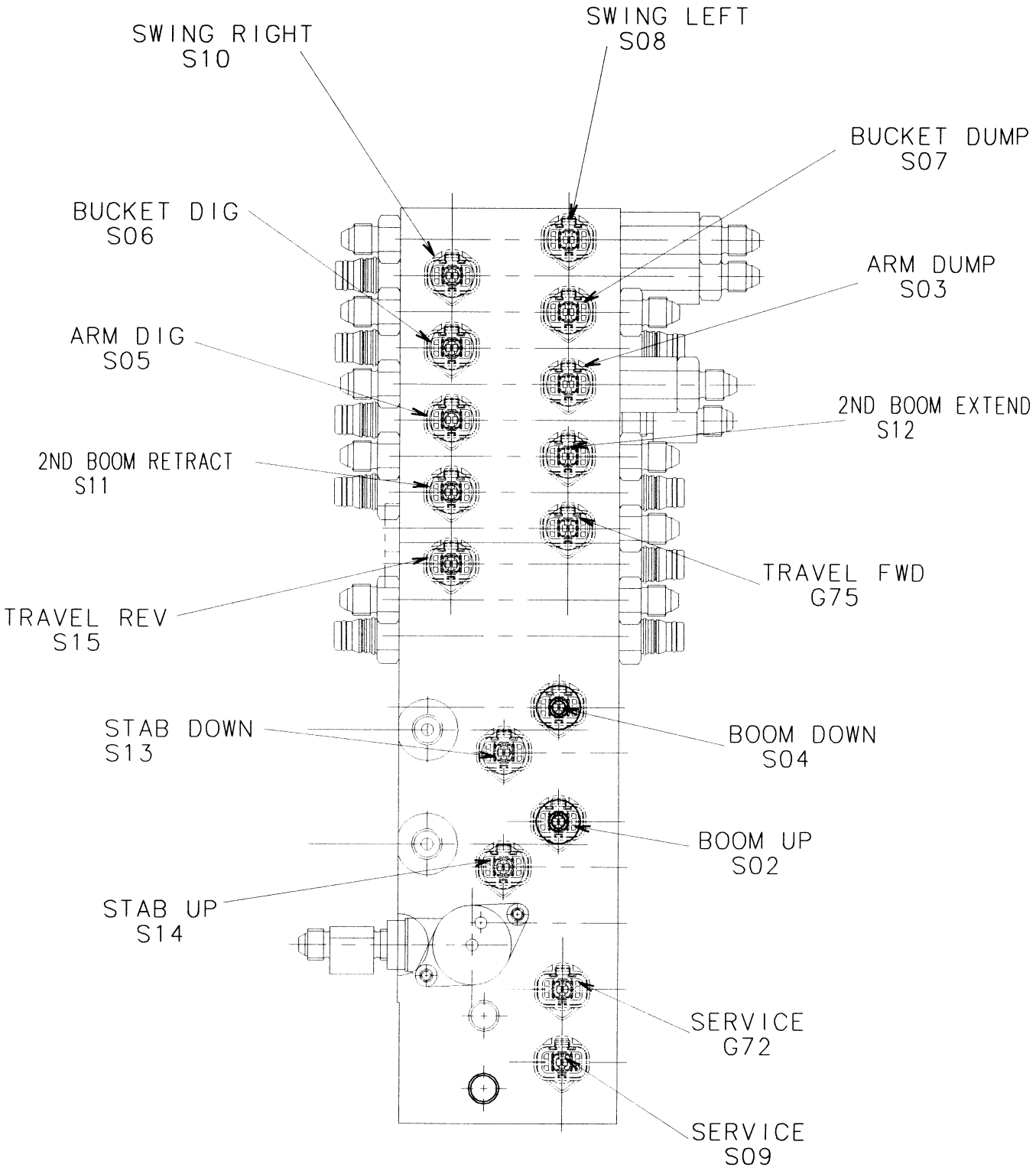


PPC MANIFOLD BLOCK

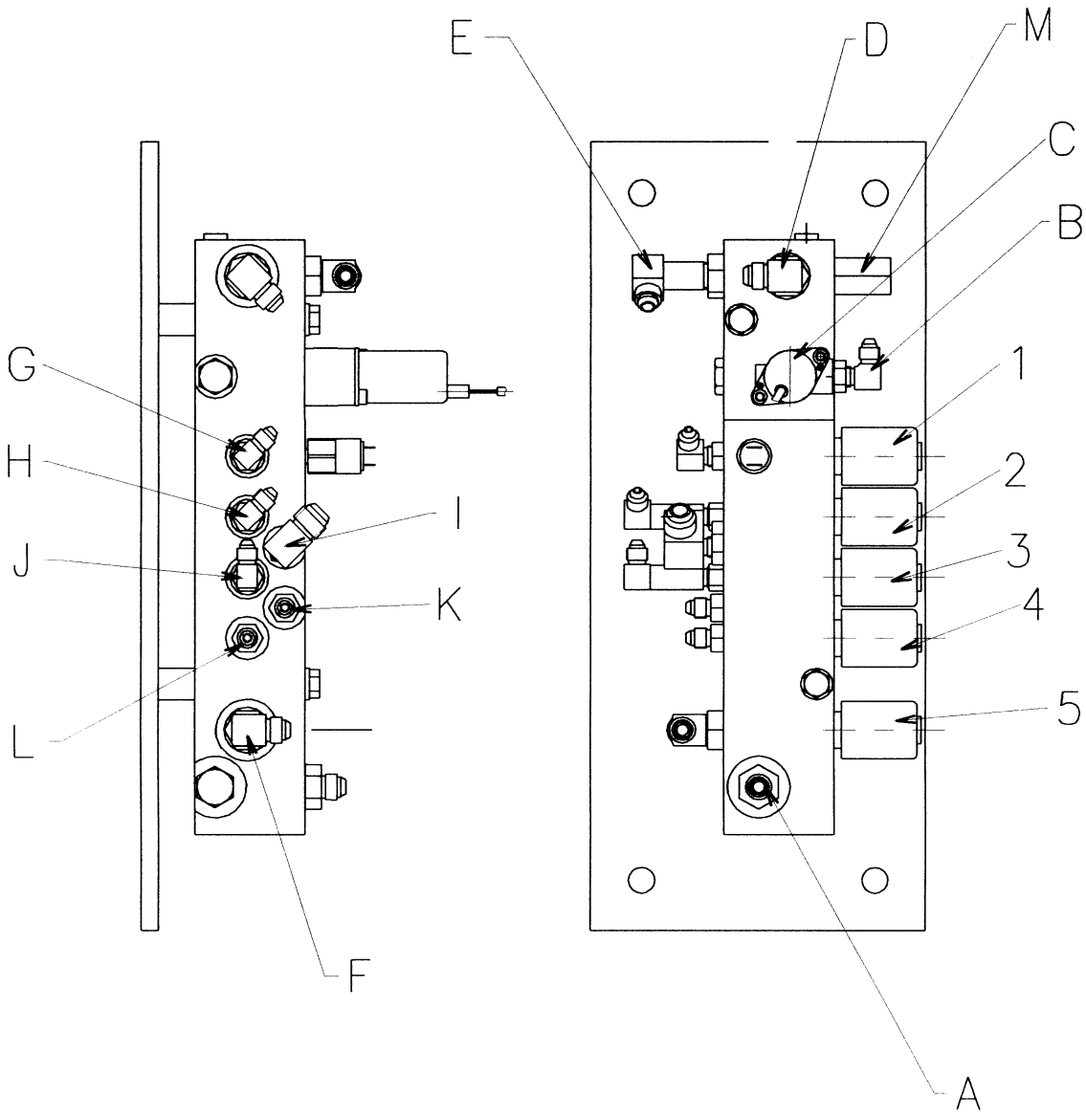


P11	to control valve [L swing]
P12	from swing PPC valve
P21	to control valve [R swing]
P22	from swing PPC valve
P31	to control valve [bucket]
P32	from buck PPC valve
P41	to control valve [bucket dump]
P42	from buck PPC valve
P51	to control valve [arm dig]
P52	from arm PPC valve
P61	to control valve [arm dump]
P62	from arm PPC valve
P71	to control valve [2nd boom ext]
P72	from pedal 2nd boom
P81	to control valve [2nd boom retract]
P82	from pedal 2nd boom
PA1	to control valve [travel fwd]
PA2	from pedal travel
PB1	to control valve [travel rev]
PB2	from pedal travel
PO1	from solenoid PPC feed
PO2	to P block
TO1	to tank
TO2	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
B1	to control valve [stab up]
A4	to port P3
P3	to port A3
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



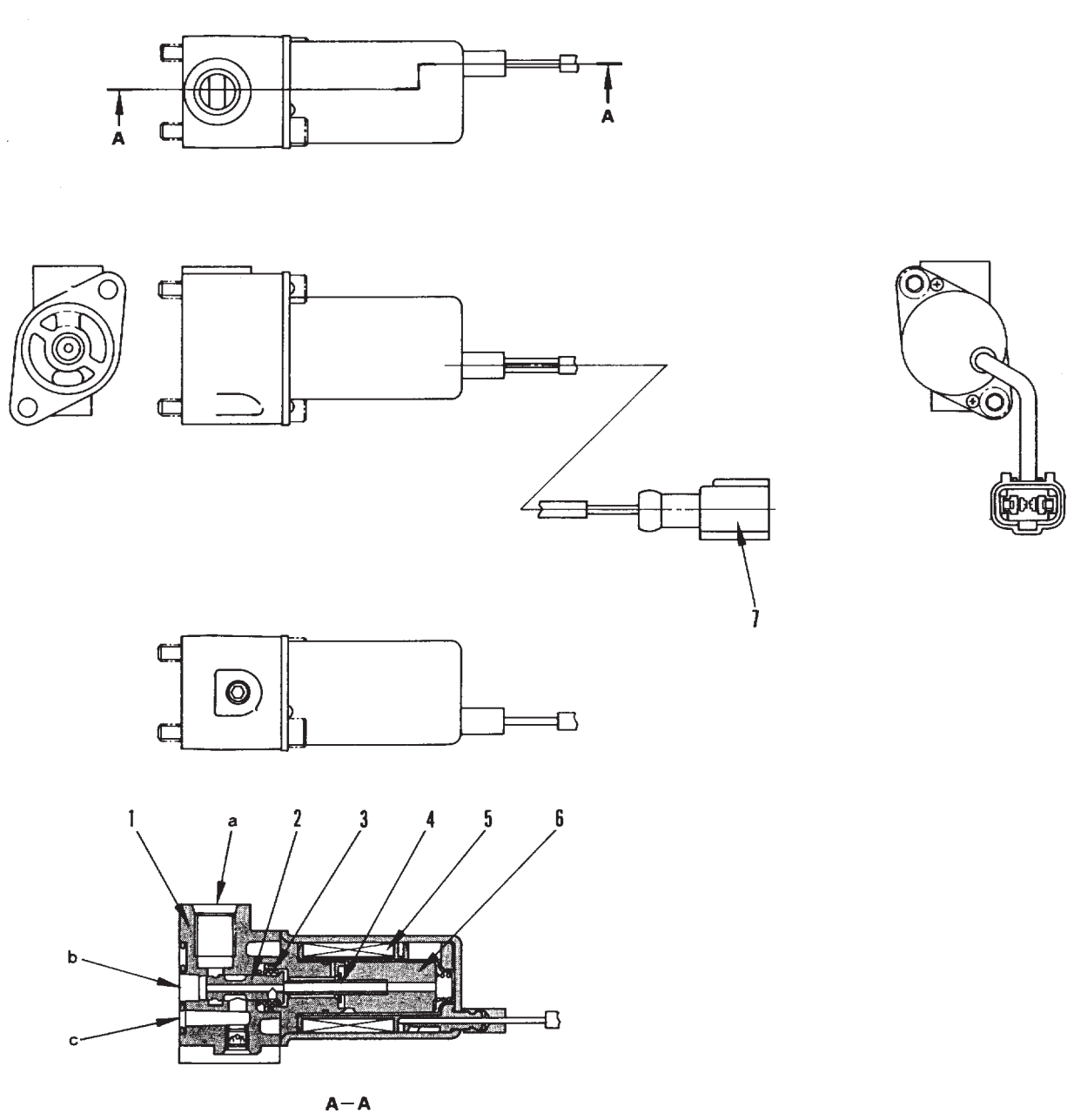
SOLENOID VALVE



a. Port **PS** (PPC manifold)
b. Port **A5** (pump PSIG)
c. EPC valve
d. Port **T0** (main valve)
e. Port **P1** (feed from brake valve)
f. Port **P0** (pressure PPC)
g. Port **A4** (suspension 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 PX2)
m. PPC control valve (fixed)

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

LS CONTROL EPC VALVE



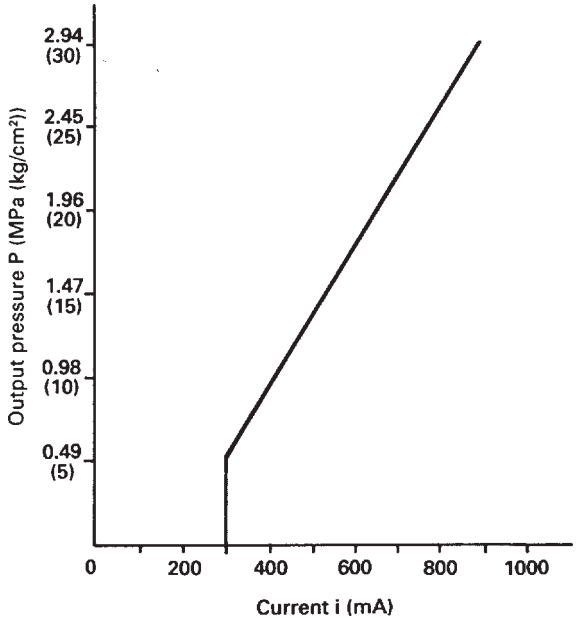
202F06124

a. Port **C** (to LS valve)
b. Port **T** (to tank)
c. Port **P** (from PPC pressure reducing valve)

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

Function

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

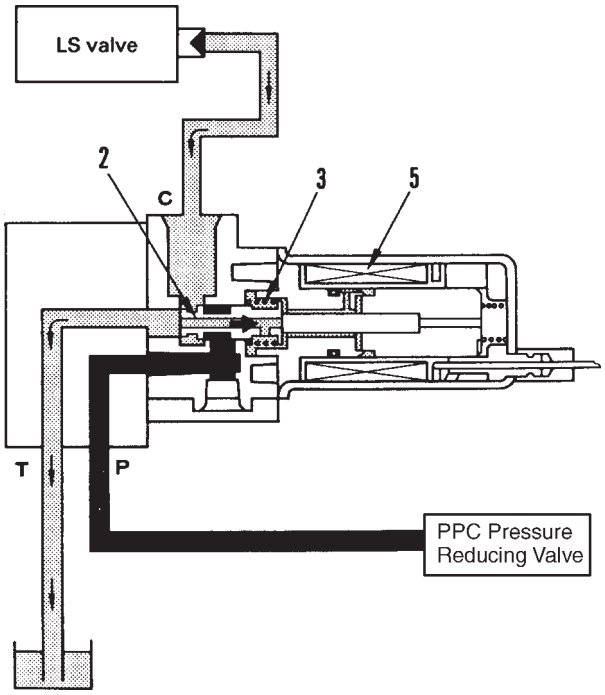


202F06113

Operation

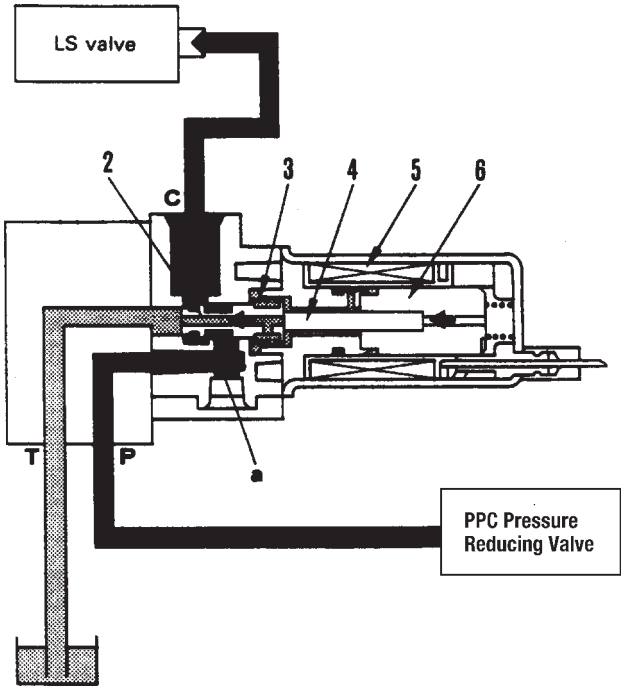
1. When signal current is 0 (coil deactivated)

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



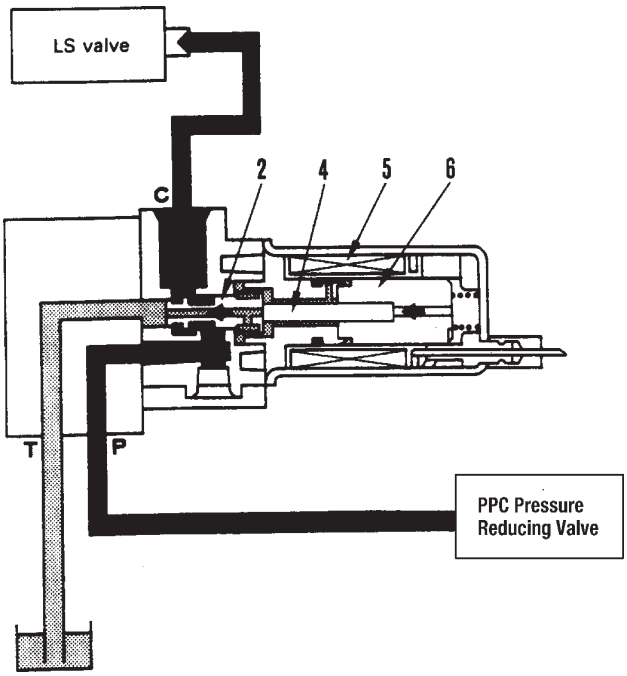
2. When signal current is very small (coil excited)

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

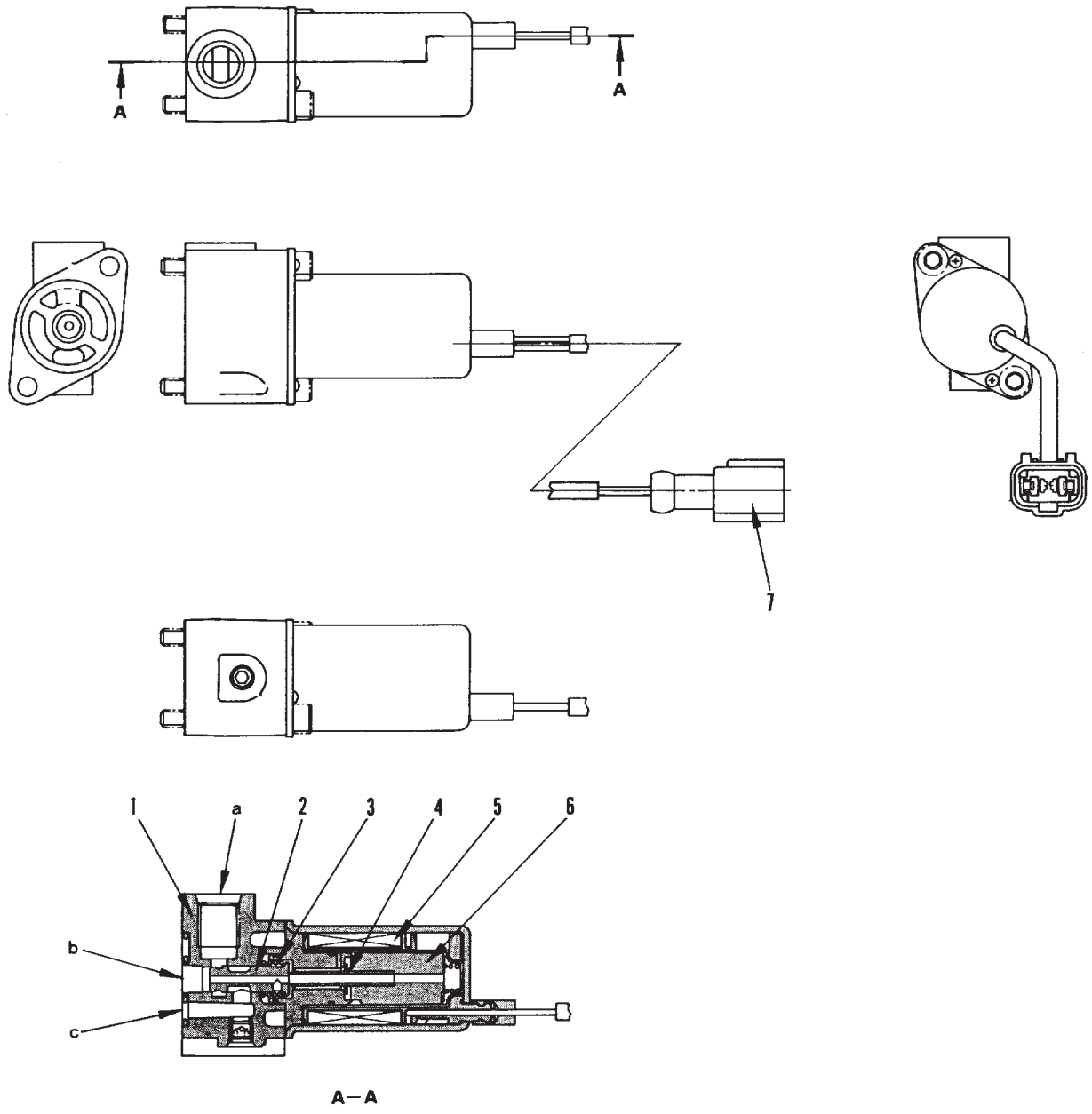


3. When signal current is maximum (coil excited)

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



TRAVEL SPEED GOVERNOR EPC VALVE



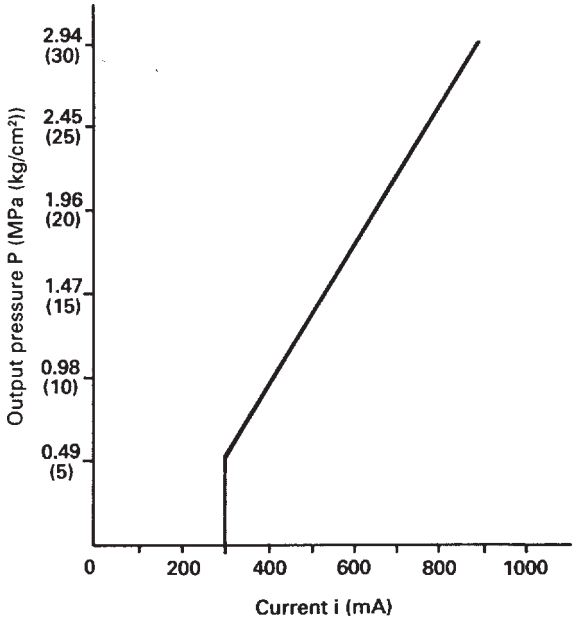
202F06124

a. Port C (to travel pedal PPC valve)
b. Port T (to tank)
c. Port P (from PPC pressure recuding valve)

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

Function

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

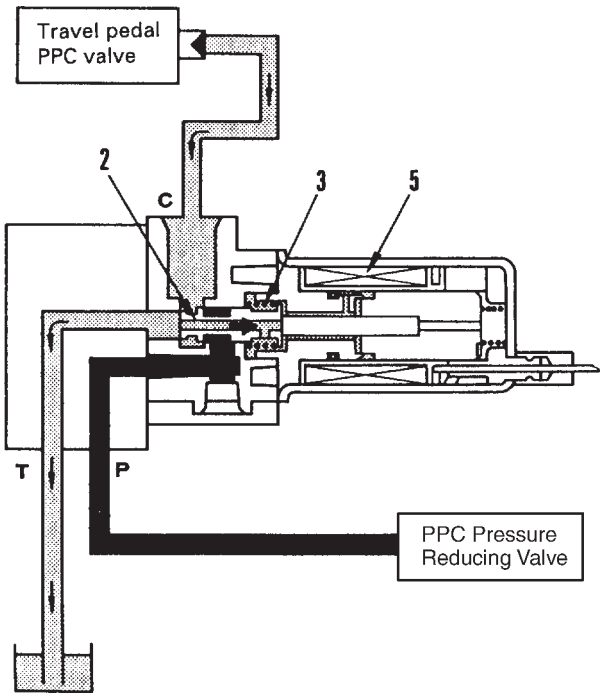


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Operation

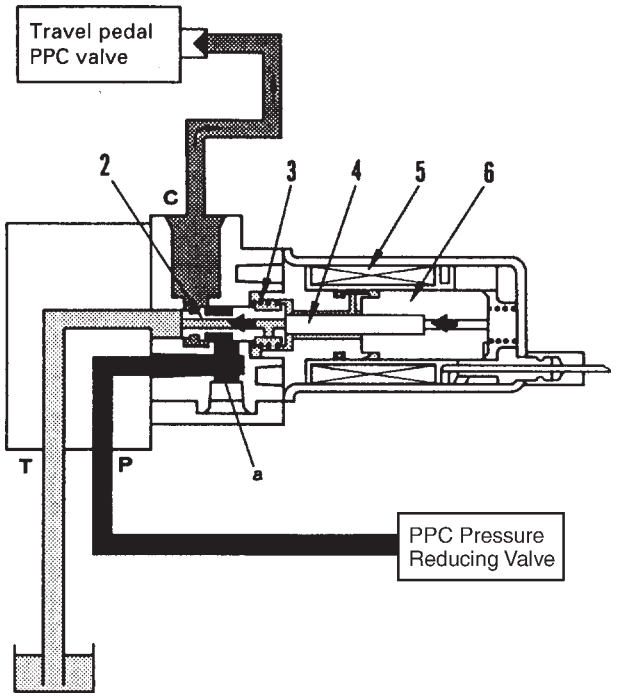
1. When signal current is 0 (coil deactivated)

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



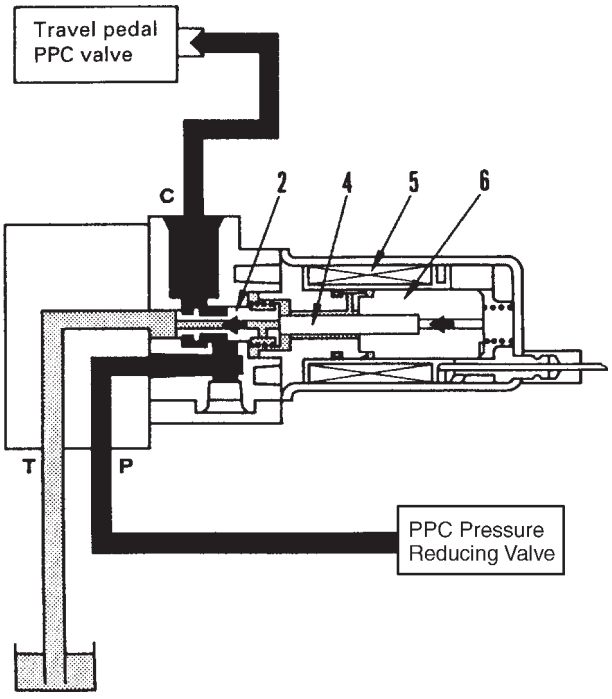
2. When signal current is very small (coil excited)

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

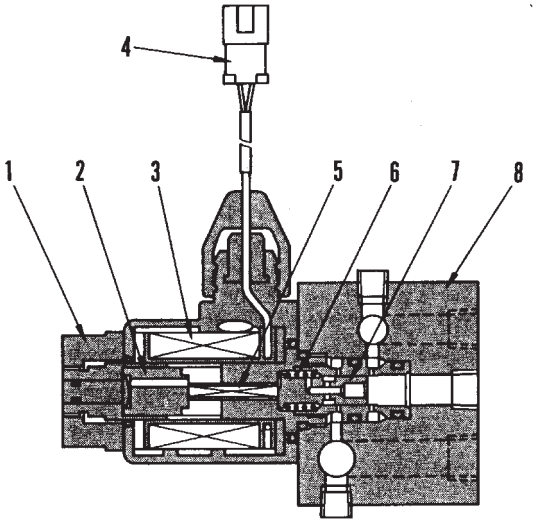


3. When signal current is maximum (coil excited)

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



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



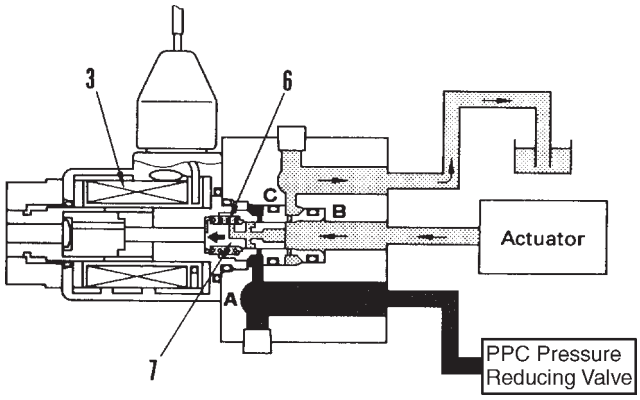
202F06131

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

Operation

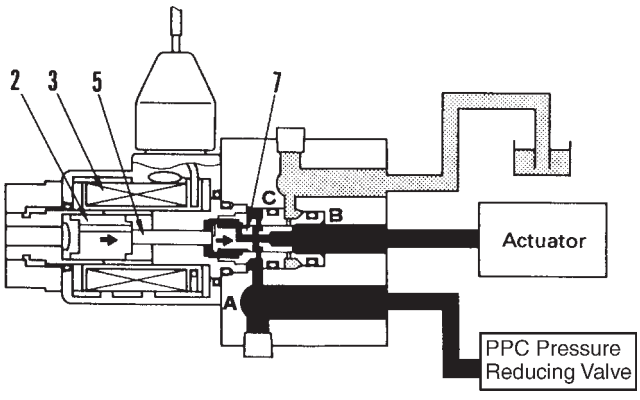
When solenoid is deactiviated

- 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.

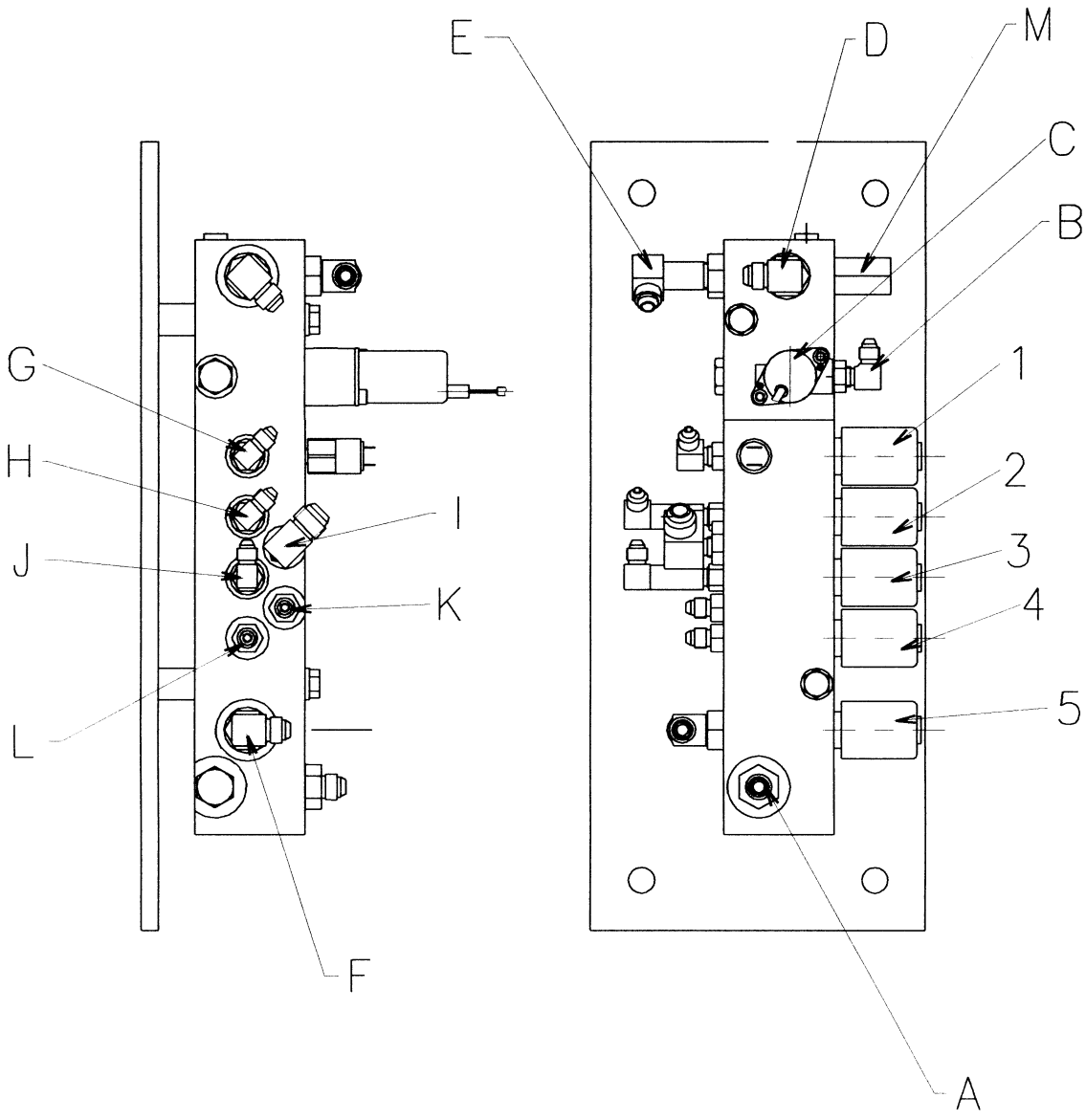


When solenoid is excited

- When the signal current flowsfromthe 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.



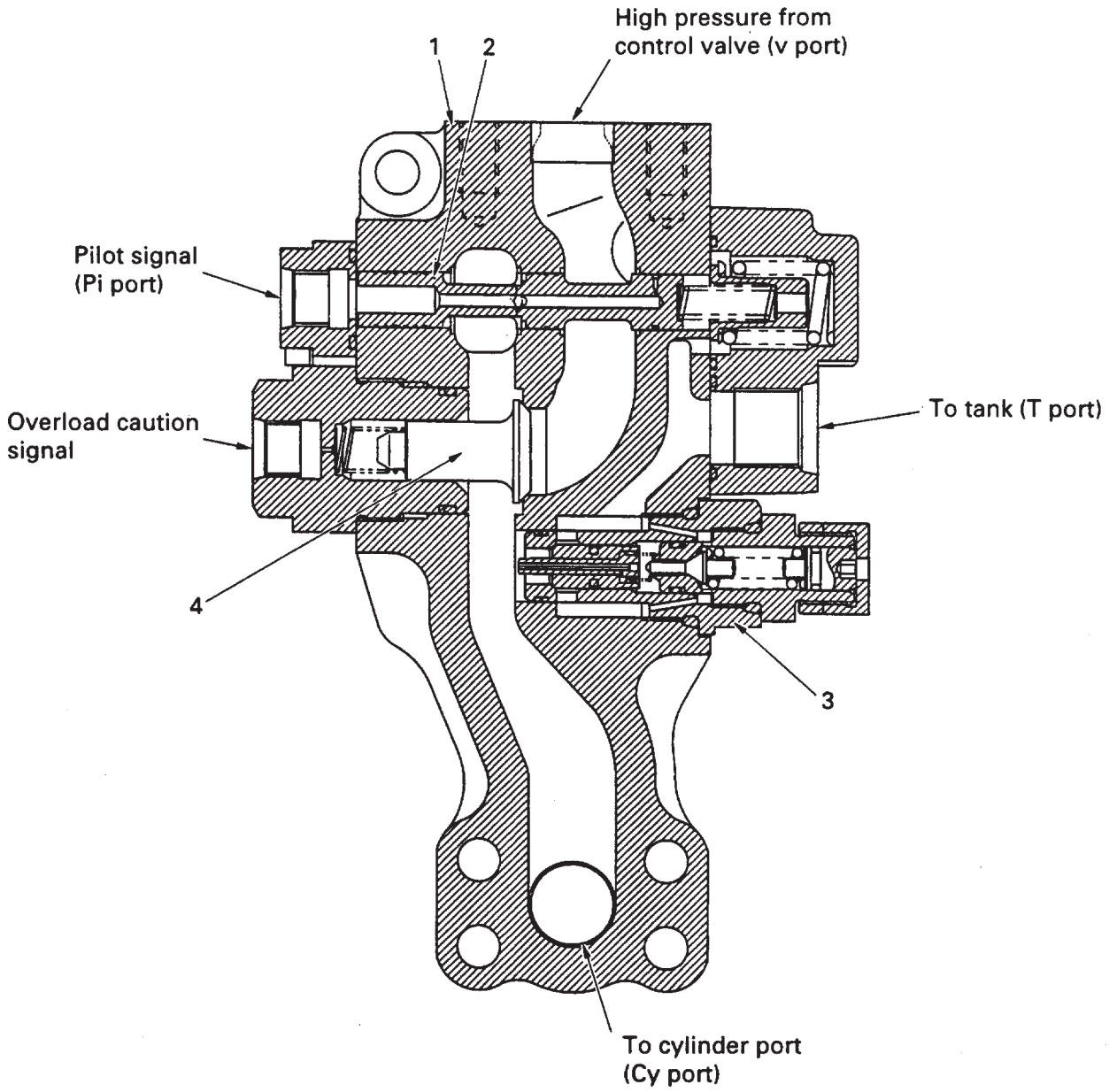
SOLENOID VALVE



a. Port **PS** (PPC manifold)
b. Port **A5** (pump PSIG)
c. EPC valve
d. Port **T0** (main valve)
e. Port **P1** (feed from brake valve)
f. Port **P0** (pressure PPC)
g. Port **A4** (suspension 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 PX2)
m. PPC control valve (fixed)

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

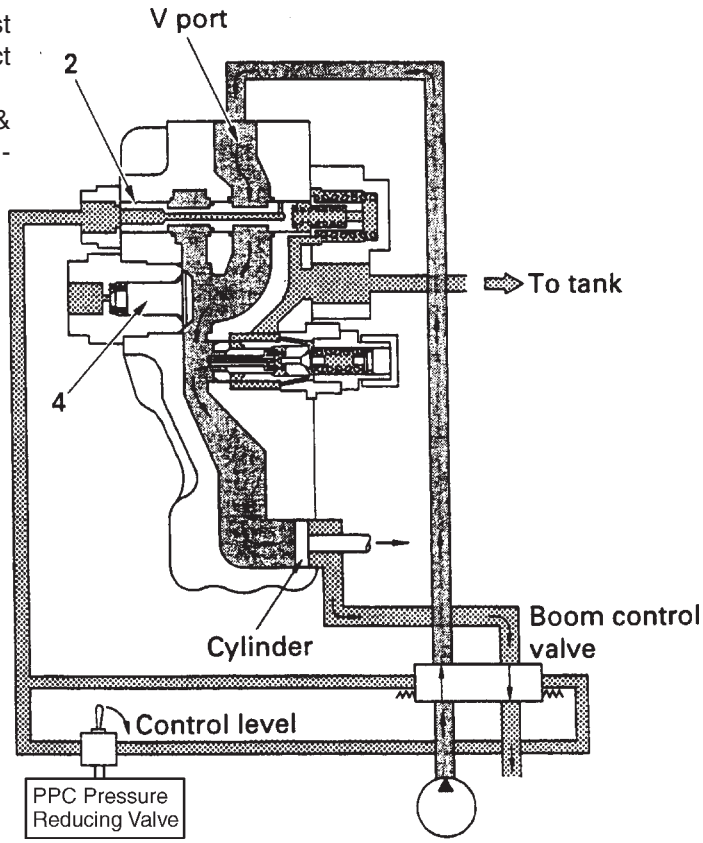
BOOM SAFETY VALVE



OPERATION

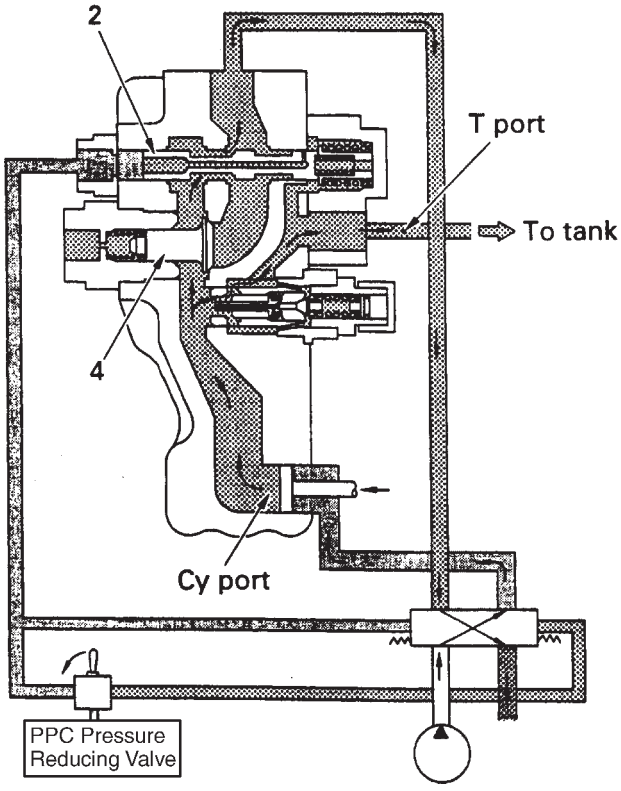
BOOM RAISE

- 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.



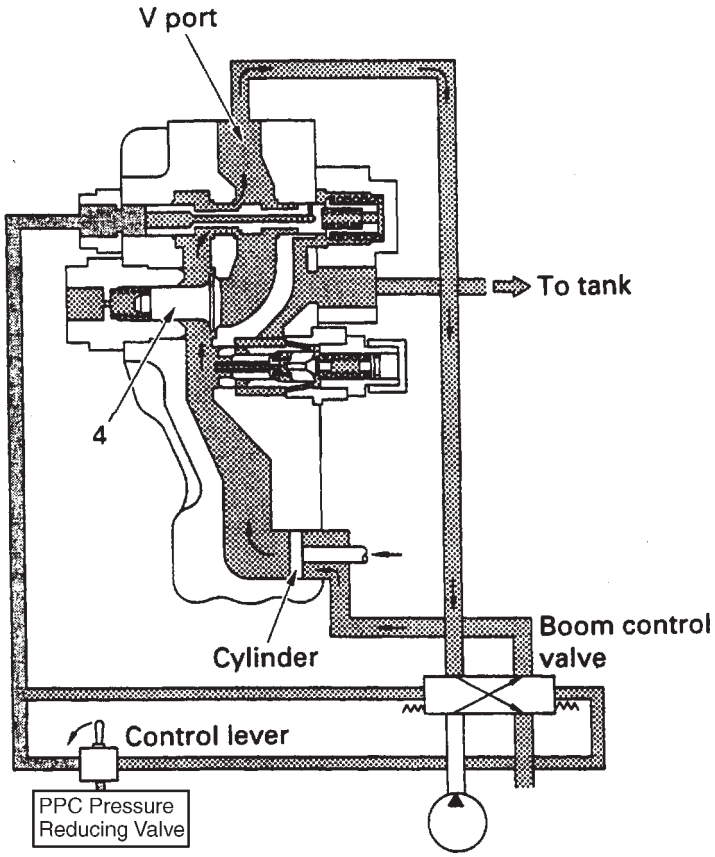
BOOM LOWER

- 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.



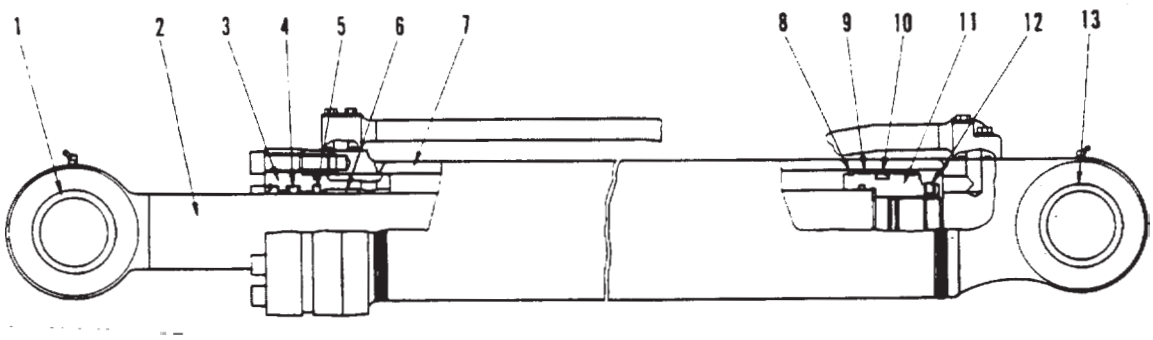
When hose burst occurs
(Operation to lower safety)

- 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 lowerd in a controlled way by operating the wirst control in the normal way.



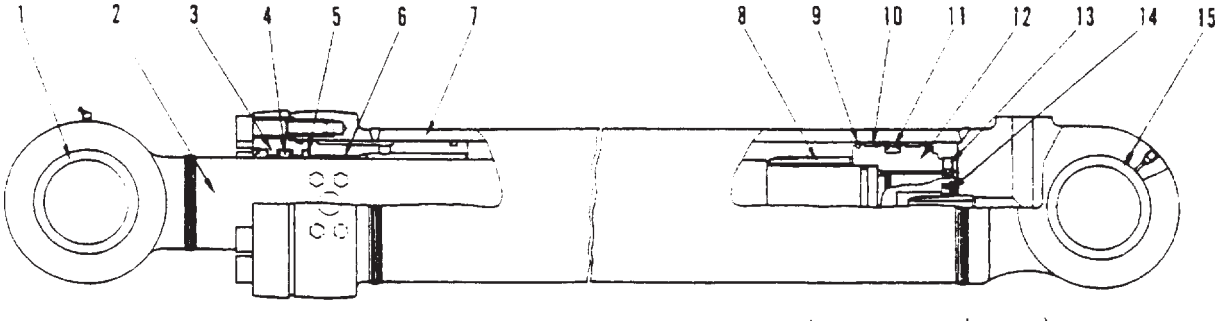
HYDRAULIC CYLINDERS (Boom & Arm)

BOOM LIFT CYLINDER



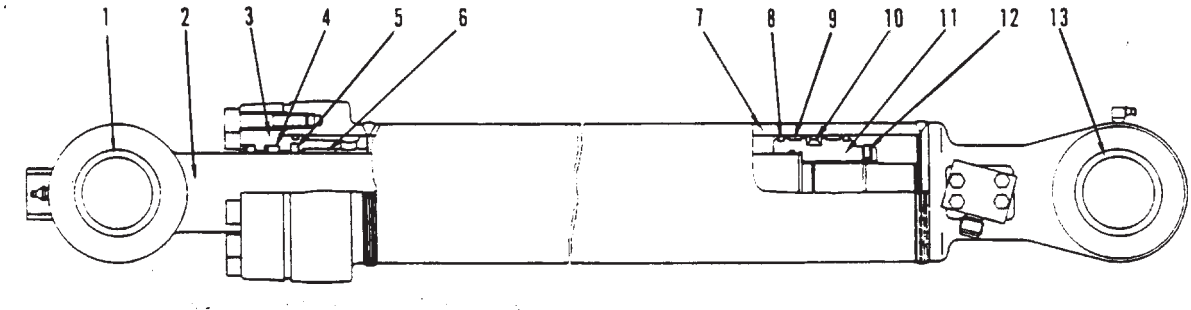
1. Rod side bushing
2. Piston rod
3. Cylinder head
4. Rod packing
5. Buffer ring
6. Wear ring
7. Cylinder
8. Casting ring
9. Wear ring
10. Piston ring
11. Piston
12. Set screws
13. Bottom side bushing

ARM CYLINDER



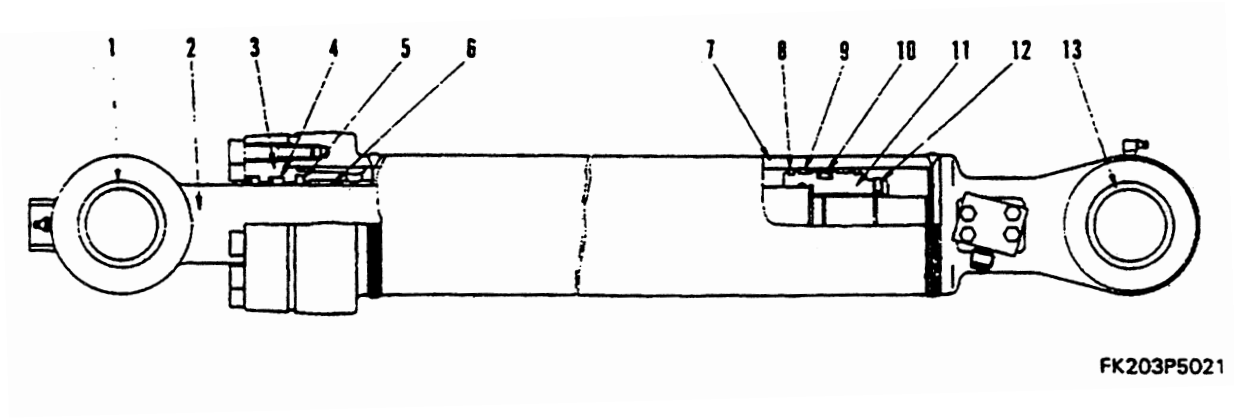
1. Rod side bushing
2. Piston rod
3. Cylinder head
4. Rod packing
5. Buffer ring
6. Wear ring
7. Cylinder
8. Head side cushion plunger
9. Casting ring
10. Wear ring
11. Piston ring
12. Piston
13. Set screw
14. Bottom side cushion plunger
15. Bottom side bushing

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



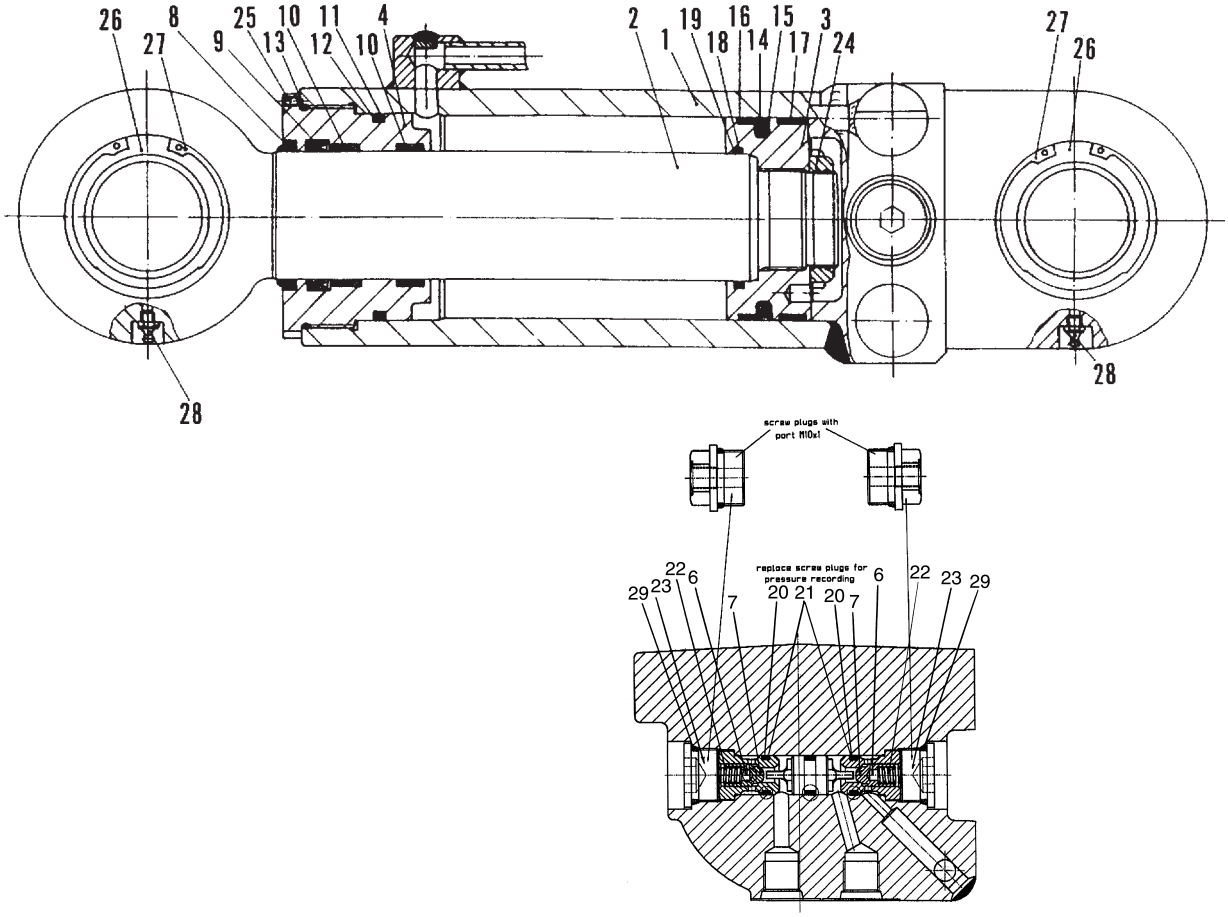
1. Rod side bushing
2. Piston rod
3. Cylinder head
4. Rod packing
5. Buffer ring
6. Wear ring
7. Cylinder
8. Casting ring
9. Wear ring
10. Piston ring
11. Piston
12. Set screw
13. Bottom side bushing

Specifications

Unit: mm

Cylinder	Boom lift	Arm	Bucket	Boom adjust
Inside diameter of cylinder	120	120	110	160
Outside diameter of piston rod	85	85	75	100
Stroke	995	1352	1013	687
Max. stroke	2522	3285	2560	1962
Min. stroke	1527	1933	1547	1275

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

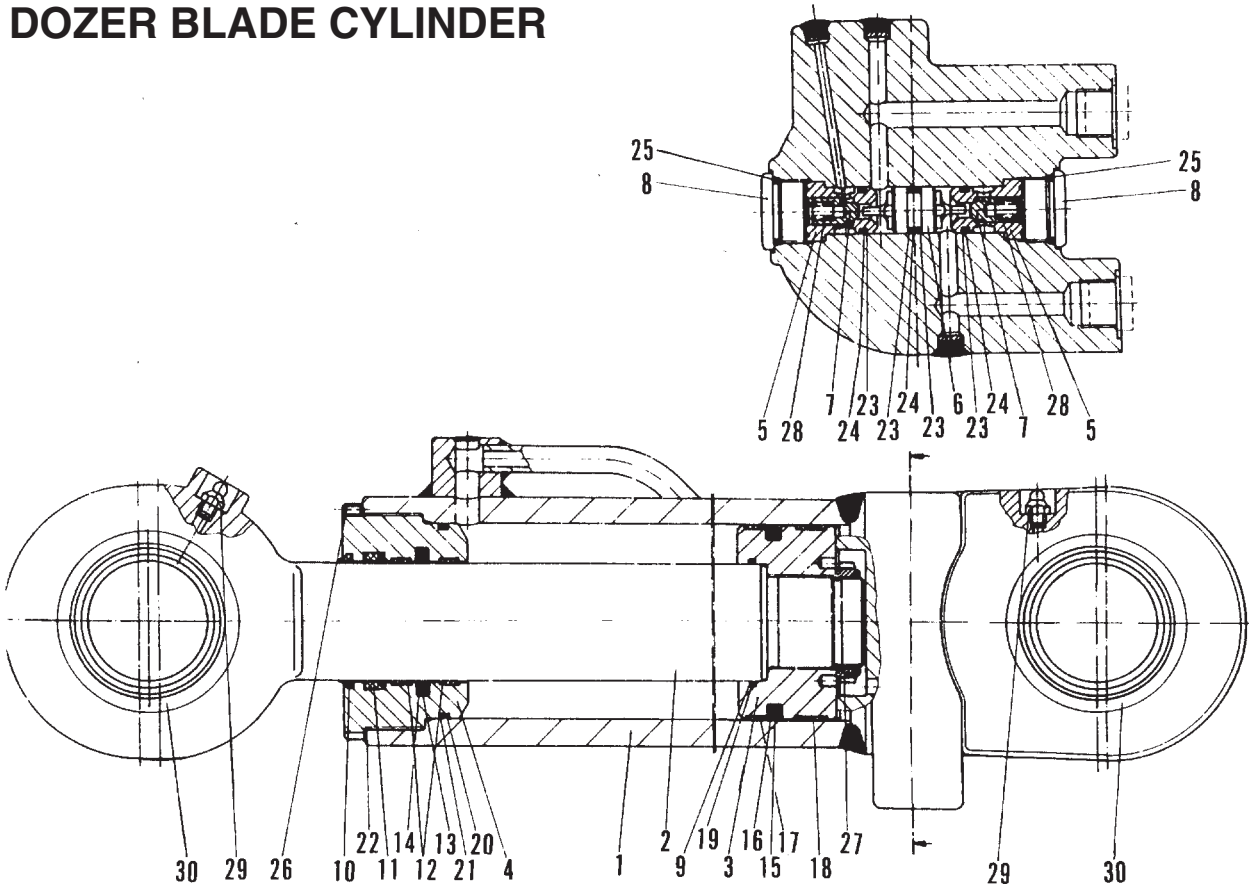
The check valve built into the cylinder prevents any cylinder movement due to oil leakage within the control block or sudden loss of hydraulic pressure due to a hose burst.

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. O-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** 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 (18). It is sealed by the piston ring (16). The cylinder head is sealed against the cylinder by O-ring (20).

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

Important

Depressurizing the cylinder

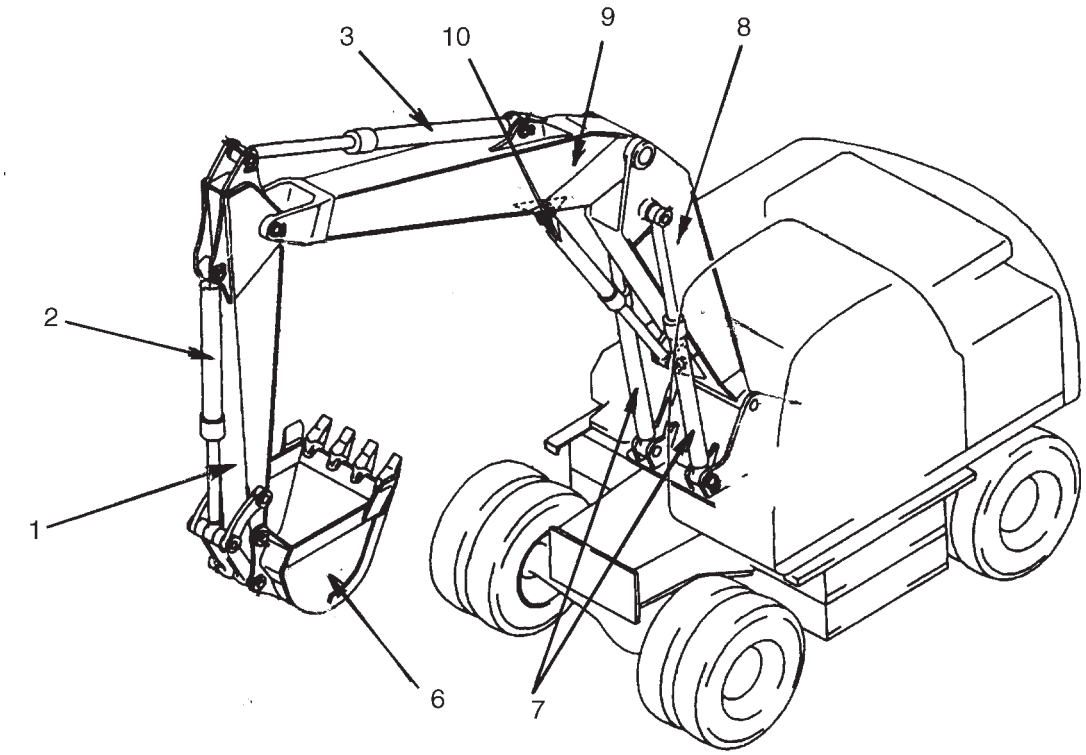
The check valve built into the cylinder prevents any cylinder movement due to oil leakage within the control block or sudden loss of hydraulic pressure due to a hose burst.

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

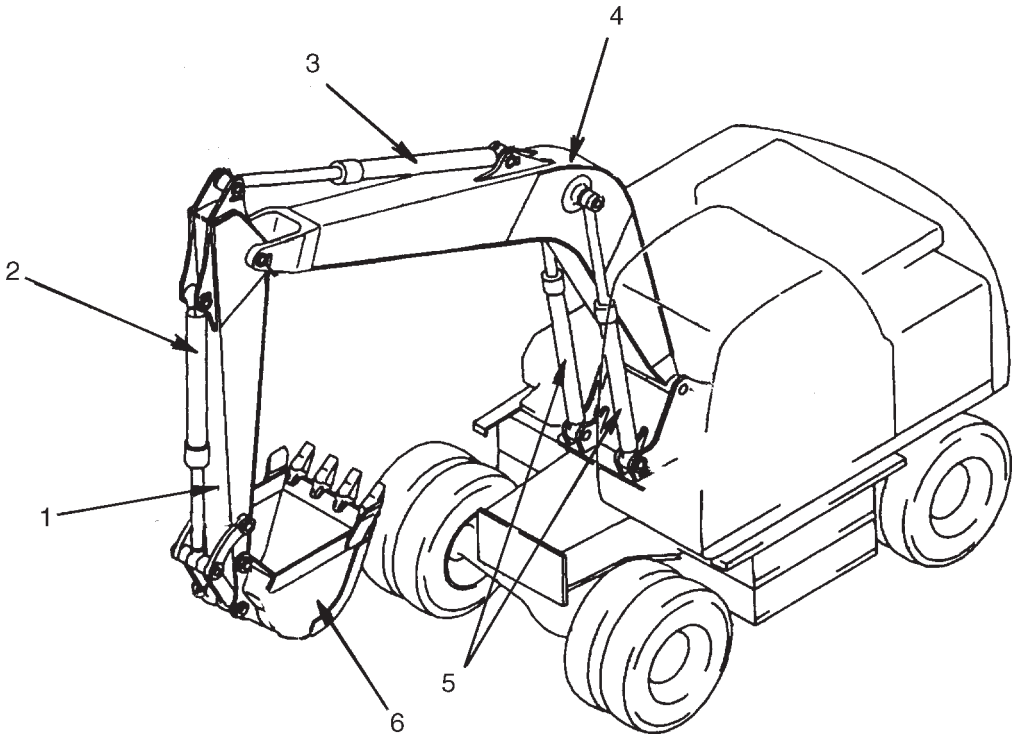
⚠ Depressurize the cylinder before opening

To depressurize the cylinder, loosen the plug (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 - TWO PIECE BOOM

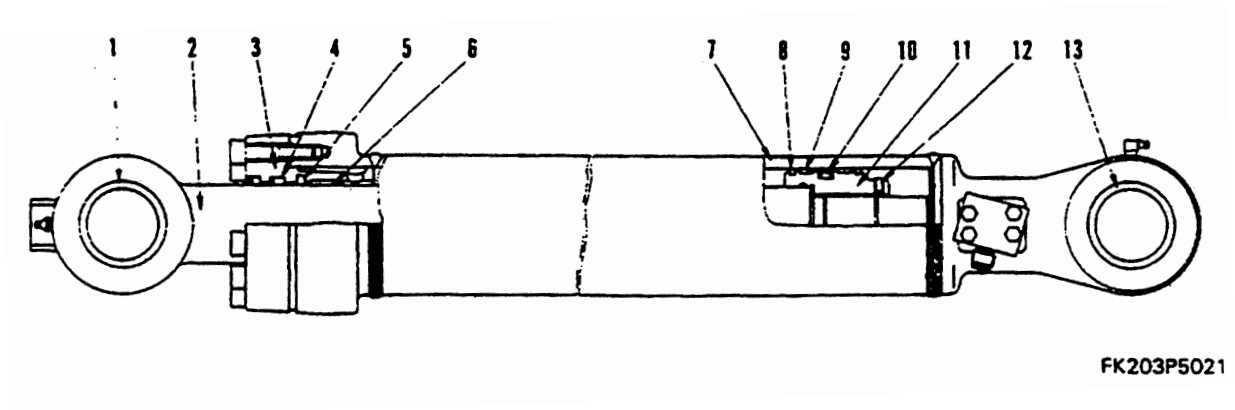


WORK EQUIPMENT - ONE PIECE BOOM



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

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

	1 P/B	2 P/B			
Cylinder	Boom lift		Arm	Bucket	Boom adjust
Inside diameter of cylinder	110	120	120	110	160
Outside diameter of piston rod	75	85	85	75	100
Stroke	1170	996	1352	1013	687
Max. stroke	2805	2523	3285	2560	1962
Min. stroke	1635	1527	1933	1547	1275

FUSE BOX CONNECTION TABLE.

FUSE NO.	CONNECTION TABLE
1	GOVERNOR & PUMP CONTOLLER + BREAKER SWITCH
2	SOLENOID VALVE
3	AIR CONDITIONER
4	LIGHT(REAR,BOOM RIGHT)
5	CIGAR LIGHTER,SAFETY LOCK SOL, HEATER,WINDOW WASHER,LEFT KNOB SWITCH
6	STOP LIGHTS
7	HORN
8	WIPER MOTOR CONTROLLER
9	LIGHT(CAB X2), BEACON, OPT
10	LOWER WIPER, REFUELING PUMP
11	KEY ON SIG,HEATED SEAT,INDICATORS
12	ROAD LIGHTS
13	HEAD LIGHTS, ENGINE ROOM, HAZARD
14	ALARM, BUZZER, MONITOR
15	STARTER SWITCH
16	ROOM LAMP, ADDITIONAL POWER SUPPLY

1.SYMBOLS IN THE DRAWING SHOW FOLLOWING CONNECTORS.

- [S] YAZAKI "S" TYPE. D08056-XXXXX
- [M] YAZAKI "M" TYPE. D08056-XXXXX
- [L] YAZAKI "L" TYPE. D08056-XXXXX
- [X] YAZAKI "X" TYPE. D08055-XXXXX
- [SWP] YAZAKI "SWP" TYPE. D08055-XXXXX
- [KES0] KES D08027-0XXXX
- [KES1] KES D08027-1XXXX
- [250] AMP 250 TYPE
- [040] AMP 040 TYPE
- [070] AMP 070 TYPE
- [MIC] MIC TYPE
- [SHI] SHINAGAWA JIDOSHA DENSEN"SR-5P" TYPE 22W-06-13460
- [PA] YAZAKI "PA" TYPE. 20Y-06-13590

2.INDICATES SHIELDED WIRE.

3.INDICATES TWISTED WIRE.

4.CN-XXX IN THE DRAWING SHOWS CONNECTOR NO. IN ACTUAL MACHINE "CN-" IS OMITTED, ONLY "XXX" IS INDICATED.

SWING REDUNDANCY SW.
ON-FREE
OFF-NORMAL
CN-SW01

RESISTER 30Ω
CN-C06

PUMP REDUNDANCY CIRCUIT SWITCH
ON:PUMP CONTROLLER REDUNDANCY
OFF:NORMAL
CN-SW02

FUEL DIAL
CN-E06

STARTER SWITCH
R1 OFF ACC ST

ADDITIONAL POWER SUPPLY

CIGAR LIGHTER

RELAY FOR LOWER WIPER
RELAY FOR HEADLIGHTS
RELAY FOR LIGHT
RELAY FOR OPT LIGHT
RELAY FOR HORN
CN-G36 CN-G35 CN-R04 CN-R05 CN-G55

FUSE BOX
CN-X07 (MIC)

CN-G01 RADIO (12V)

CN-A13 BATTERY RELAY DRIVE

MODEL SELECT CN-G153

CN-G60 NOT USED

CN-A2 SWING PARK BRAKE SOLENOID

8A CN-G02 FUSEHOLDER

CN-G69 TO LOWER WIPER

CN-X01 (MIC) TO (2/2)

CN-M46 FOR CHECK

WIPER MOTOR CN-W04

HEATED SEAT ASSY 7.5A CN-G33 (KES1)

MONITOR (040)
CN-P02
CN-P01 (14P)

WIPER MOTOR CONTROLLER (07P) CN-W08
GND(POWER)
REAR LIMIT SW.SIG.
VB
WIPER MOTOR +24V(HI-SIDE)
WIPER MOTOR -24V(HI-REVERSAL)
GND(LO-SIDE)
WIPER MOTOR SIG(P-COMMON)
WIPER MOTOR SIG.(MID)
WIPER MOTOR SIG.(P1)
WIPER SW. COMON
WIPER SW. WASHER SIG.(L)
WIPER SW. WASHER SIG.(H)
WIPER SW. INT SIG.(1)
WASHER MOTOR (GND)
REAR LIMIT SW.COM

CN-W10 REAR LIMIT SW.
WITHOUT POWER WINDOW

CN-M45 NET WORK BUS

ALARM BUZZER CN-P04
CN-A11 (KES1)
CN-M39 OPT2

TOKAIRIKA BASE ASSY
ROOM LAMP CN-M71
CAB GND
PANEL GND

CN-H12 WHITE
CN-H13 BLUE 青
CN-H14
CN-H15

GOVERNOR-PUMP CONTROLLER (MIC) CN-G01
BATTERY RELAY DRIVE
SWING PARKING SOLENOID
TRAVEL SPEED SOLENOID
2-STAGE RELIEF SOLENOID
POWER SUPPLY(24V)

(MIC) CN-G02
SOLENOID POWER SUPPLY
MOTOR DRIVE A1(+)
MOTOR DRIVE A1(-)
MOTOR DRIVE B1(+)
MOTOR DRIVE B1(-)
LS-EPC SOLENOID(+)
TVC SOLENOID (+)
TRAV EPC SOLENOID(+)
PGND
SOLENOID POWER SUPPLY
TRAV EPC SOLENOID(-)

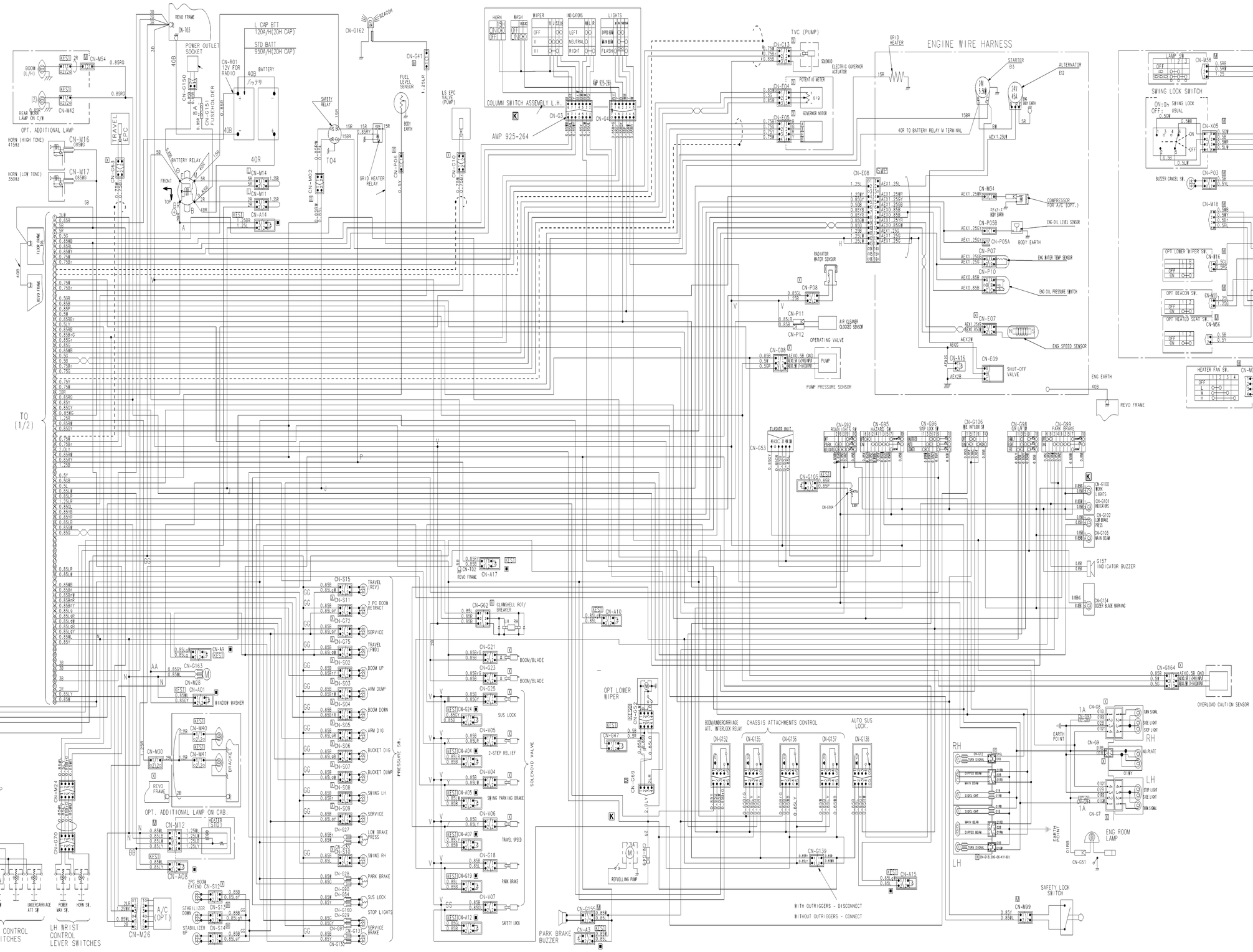
(14P) CN-C07
COOLANT TEMP
FUEL LEVEL
PRESSURE SENSOR
FUEL DIAL
OVERLOAD CAUTION
PRSSURE SNSR POWER SUPPLY
POWER SUPPLY FOR FUEL DIAL
START SWITCH (ACC)
KNOB SWITCH
CHARGING LEVEL
FEEDBACK SIGNAL
GND
START SWITCH (C)
TRAV. EPC CONTROL

(14P) CN-C17
BOOM RAISE SWITCH
ARM CURL SWITCH
NETWORK (+)
MACHINE SELECT 1
MACHINE SELECT 3
MACHINE SELECT 5
SWING PROLIX SWITCH
LOWER WIPER
BOOM LOWER SWITCH
ARM DUMP SWITCH
NETWORK (-)
MACHINE SELECT 2
MACHINE SELECT 4
SPEED SELECT
SWING LOCK SWITCH

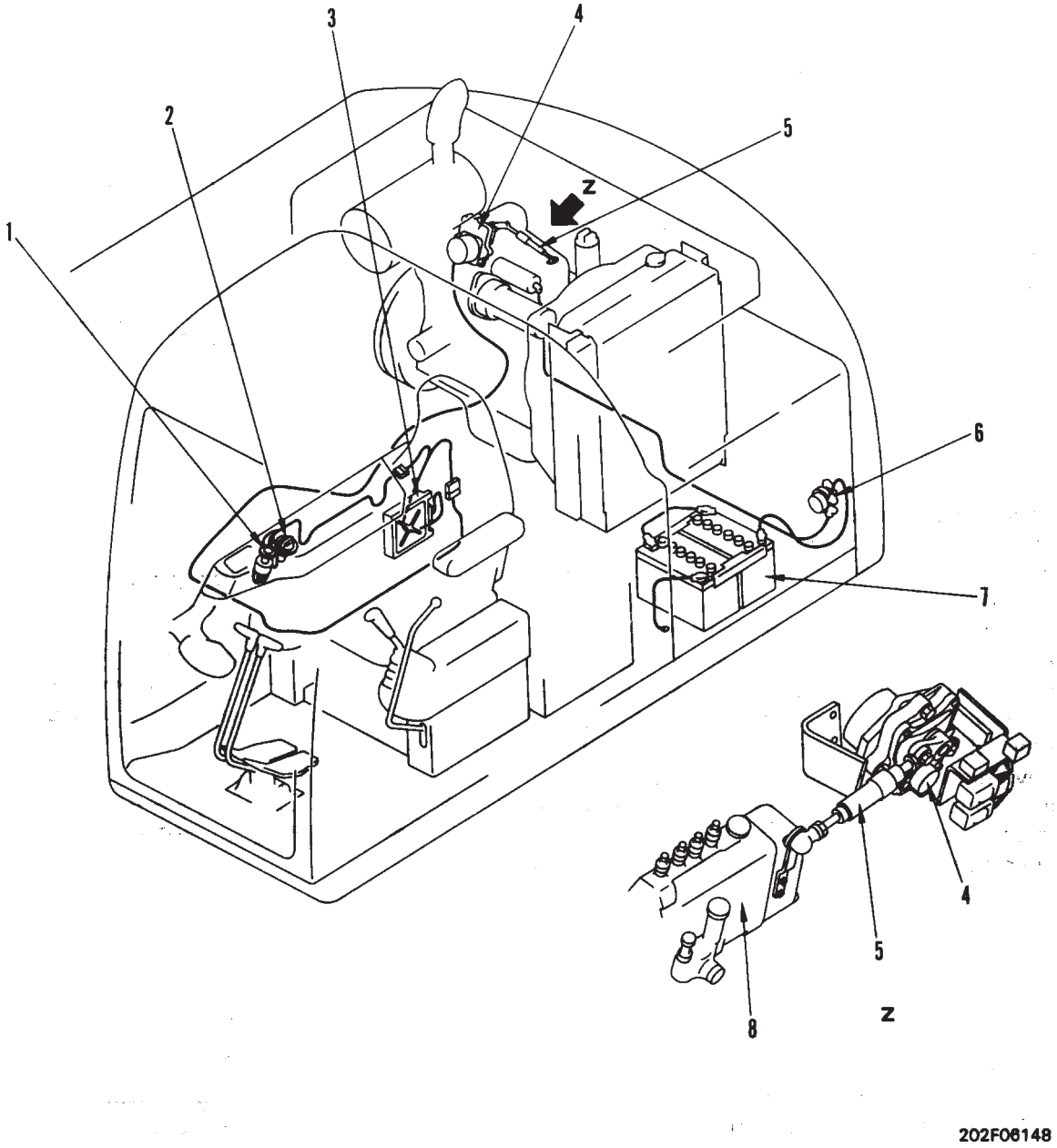
(MIC) CN-C18
ENG SPEED(GND)
ENG SPEED
NETWORK(-)
GND
SWING SWITCH
SERVICE SWITCH
ENG. OIL PRESS (HIGH)
COOLANT LEVEL
NC
NC
BUCKET CURL SWITCH
BUCKET DUMP SWITCH
TRAVEL SWITCH
PARK BRAKE
ENG. OIL PRESS (LOW)
ENG. OIL LEVEL
AIR CLEANER

MAIN HARNESS

TO (2/2)


ENGINE WIRE HARNESS
PANEL ASS'Y
TVC (PUMP)
GRID HEATER
STARTER E13
ALTERNATOR E12
ELECTRIC GOVERNOR ACTUATOR
POTENTIOMETER
GOVERNOR MOTOR
COMPRESSOR FOR A/C (OPT.)
ENG OIL LEVEL SENSOR
ENG WATER TEMP SENSOR
ENG OIL PRESSURE SWITCH
ENG SPEED SENSOR
SHUT-OFF VALVE
RADIATOR WATER SENSOR
AIR CLEANER CLOGGED SENSOR
OPERATING VALVE
PUMP
PUMP PRESSURE SENSOR
BODY EARTH
ENG EARTH
REVO FRAME
TO (1/2)
(TO 1/2)
LAMP SW.
SWING LOCK SWITCH
BUZZER CANCEL SW.
OPT LOWER WIPER SW.
OPT BEACON SW.
OPT HEATED SEAT SW.
HEATER FAN SW.
COLUMN SWITCH ASSEMBLY L.H.
AMP 925-265
HORN
WASH
WIPER
INDICATORS
LIGHTS
BEACON
L CAP BTT 120A/H(20H CAP)
STD BATT 950A/H(20H CAP)
POWER OUTLET SOCKET
BATTERY
BATTERY RELAY
SAFETY RELAY
FUEL LEVEL SENSOR
LS EPC VALVE (PUMP)
GRID HEATER RELAY
BOOM (L/H)
REAR BOOM LAMP ON C/W
OPT. ADDITIONAL LAMP
HORN (HIGH TONE) 415Hz
HORN (LOW TONE) 350Hz
TRAVEL ETC
FLOOR FRAME
OPT. ADDITIONAL LAMP ON CAB.
HEATER (OPT)
WINDOW WASHER
BREAKER
A/C (OPT)
FLASHER UNIT
ROOM/UNDERCARRIAGE ATT. INTERLOCK RELAY
CHASSIS ATTACHMENTS CONTROL
AUTO SUS LOCK
OPT LOWER WIPER
REFUELLING PUMP
PARK BRAKE BUZZER
WITH OUTRIGGERS - DISCONNECT
WITHOUT OUTRIGGERS - CONNECT
SAFETY LOCK SWITCH
OVERLOAD CAUTION SENSOR
ENG ROOM LAMP
RH WRIST CONTROL LEVER SWITCHES
LH WRIST CONTROL LEVER SWITCHES
PRESSURE SW.
SOLENOID VALVE
2PC BOOM EXTEND
STABILIZER DOWN
STABILIZER UP
SUS LOCK
2-STEP RELIEF
SWING PARKING BRAKE
TRAVEL SPEED
PARK BRAKE
SAFETY LOCK
CLAMSHELL ROT/ BREAKER
BOOM/BLADE
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
SUS LOCK
STOP LIGHTS
SERVICE BRAKE
TURN SIGNAL
SIDE LIGHT
STOP LIGHT
NO.PLATE
WORK LIGHTS
INDICATORS
LOW BRAKE PRESS
MAIN BEAM
G157 INDICATOR BUZZER
G029 BLADE WARNING
PARK BRAKE
SWING LOCK
HAZARD SW.
WORK LIGHT SW.
WIPER SW.
HORN SW.
POWER MAX SW.
UNDERCARRIAGE ATT SW.
R-CLAMSHELL ROT/BREAKER SW.
BOOM/BLADE SW.

ENGINE CONTROL SYSTEM



202F08148

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

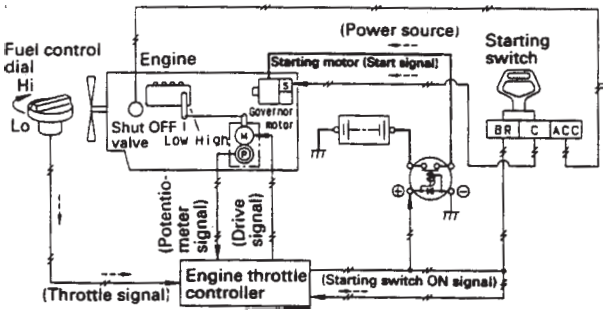
FUNCTION

- 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

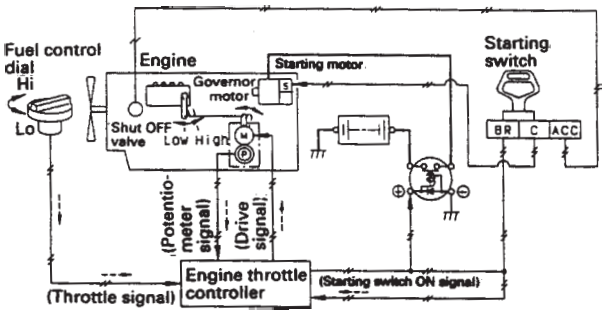
Starting engine

- 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.



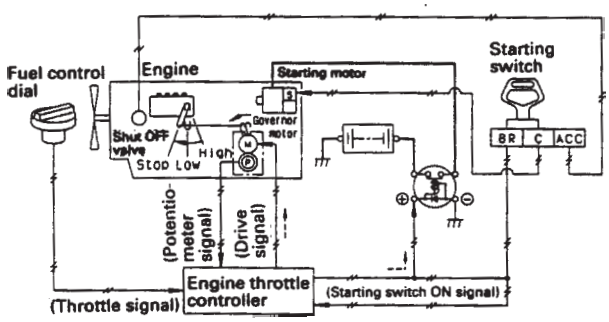
Engine speed control

- 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 this signal, and sends a signal to rave 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.



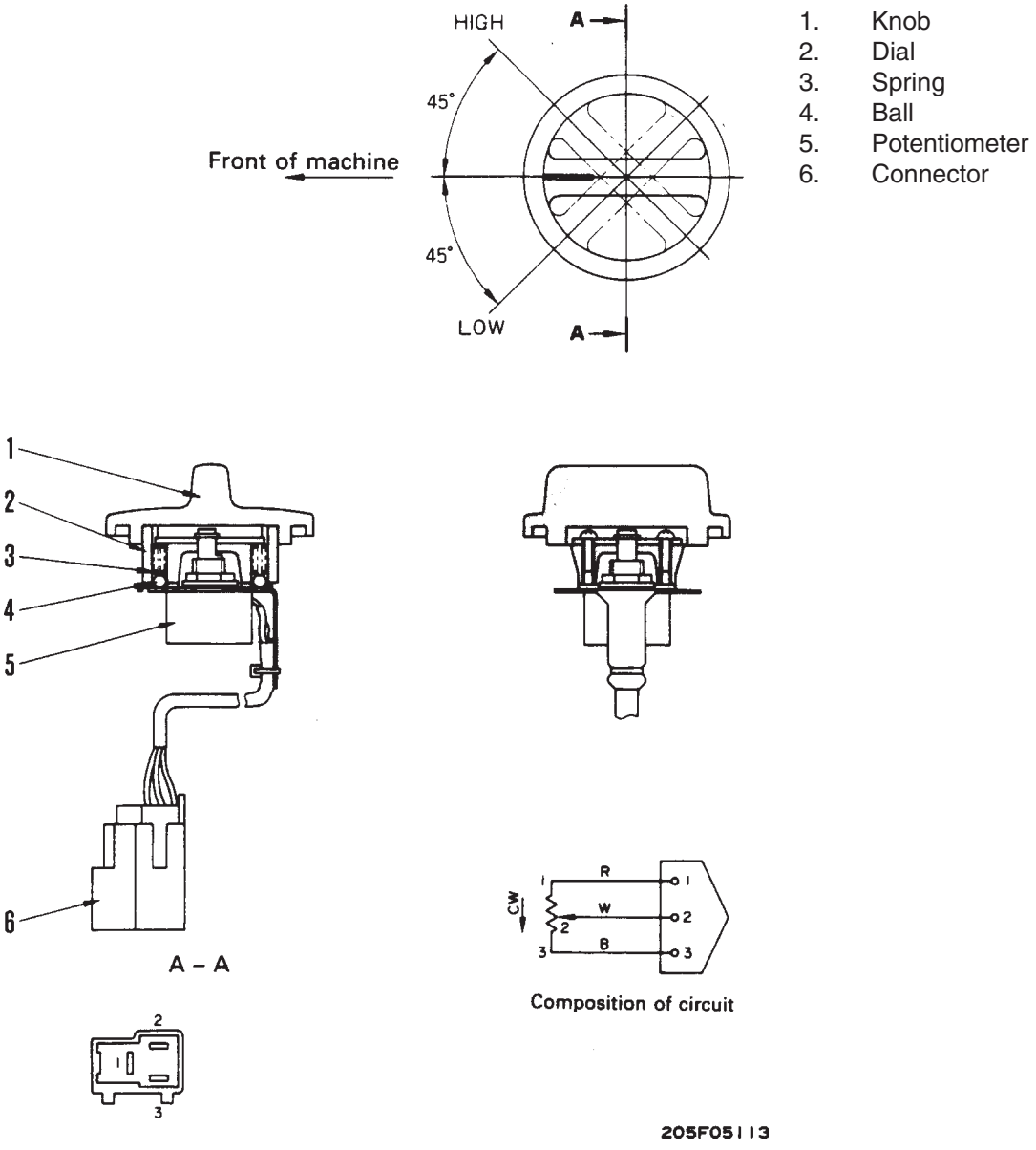
Stopping engine

- 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

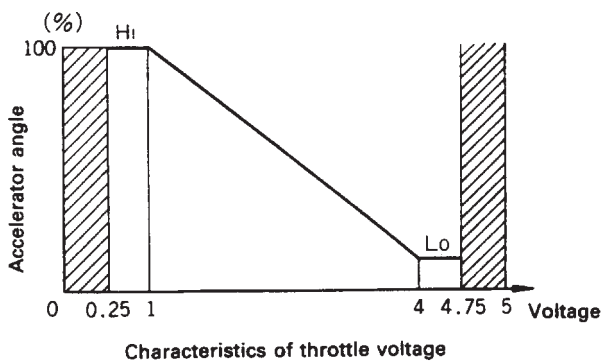


1. Knob
2. Dial
3. Spring
4. Ball
5. Potentiometer
6. Connector

205F05113

FUNCTION

- The fuel control dial is installed at the bottom of the monitor panel. A potentiometer is installed under the knob, and when the knob is turned, it rotates the potentiometer shaft.
  When the shaft rotates, the resistance of the variable resistor inside the potentiometer changes, and the desired throttle signal is sent to the 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.

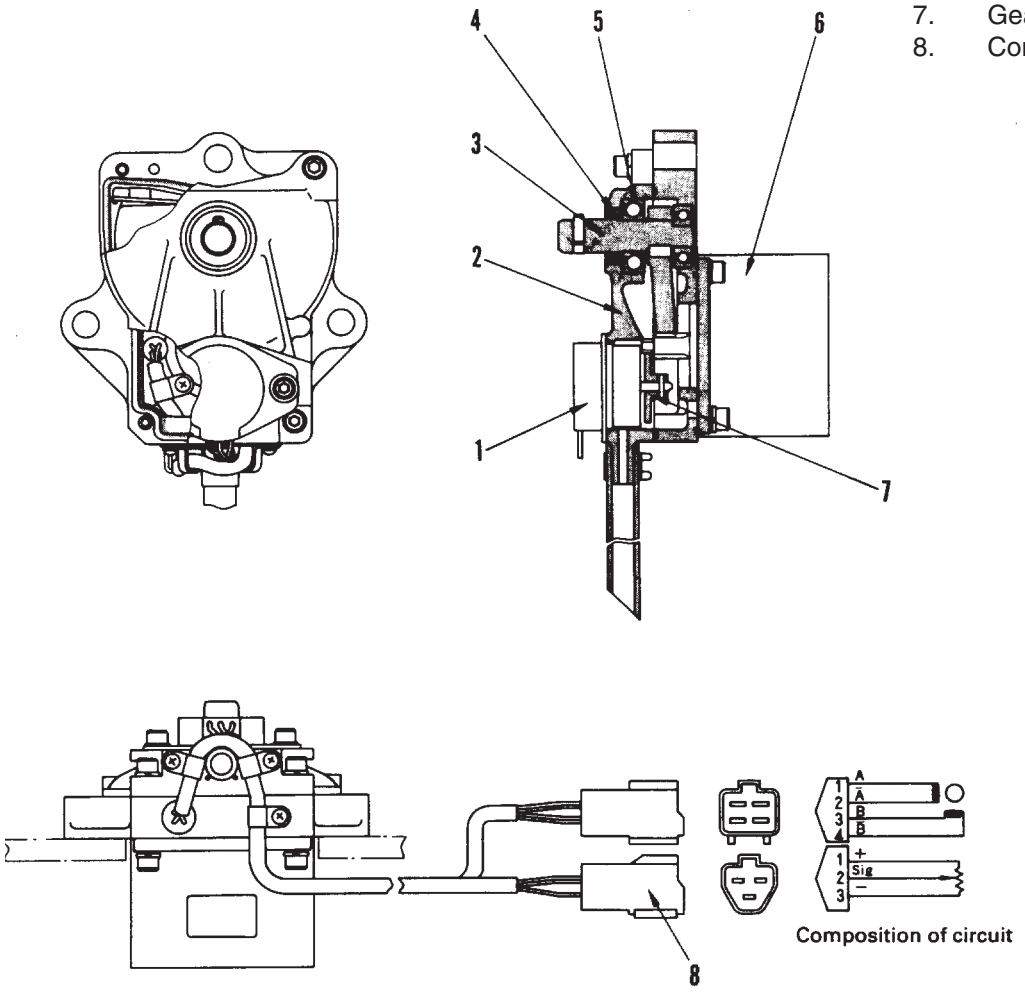


Characteristics of throttle voltage

205F05114

2. GOVERNOR MOTOR

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



202F06149

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

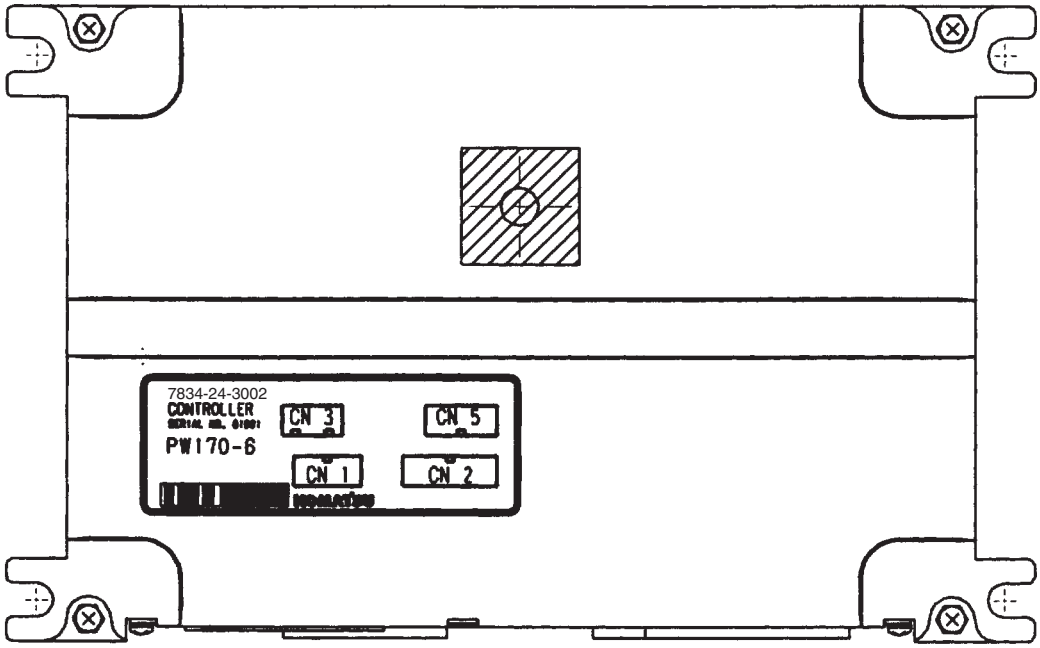
Motor stationary

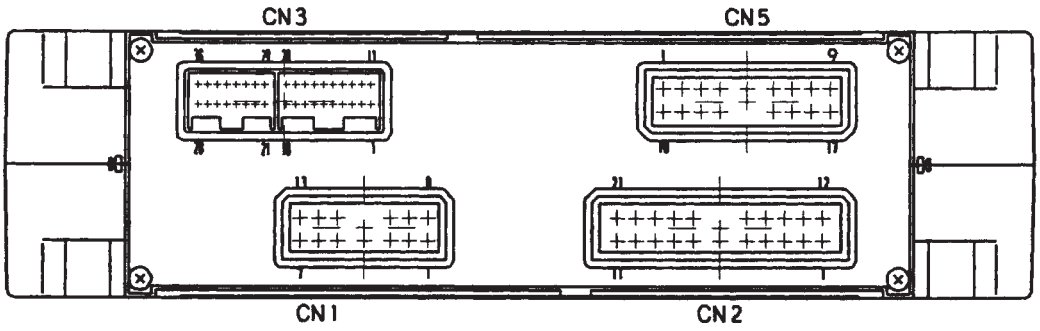
- Both A phase and B phase of the motor a continuous, and a holding torque is generated in the motor.

Motor rotating

- A pulse current is applied to the A phase and B phase from the engine throttle controller to geve 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 (+24V)	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

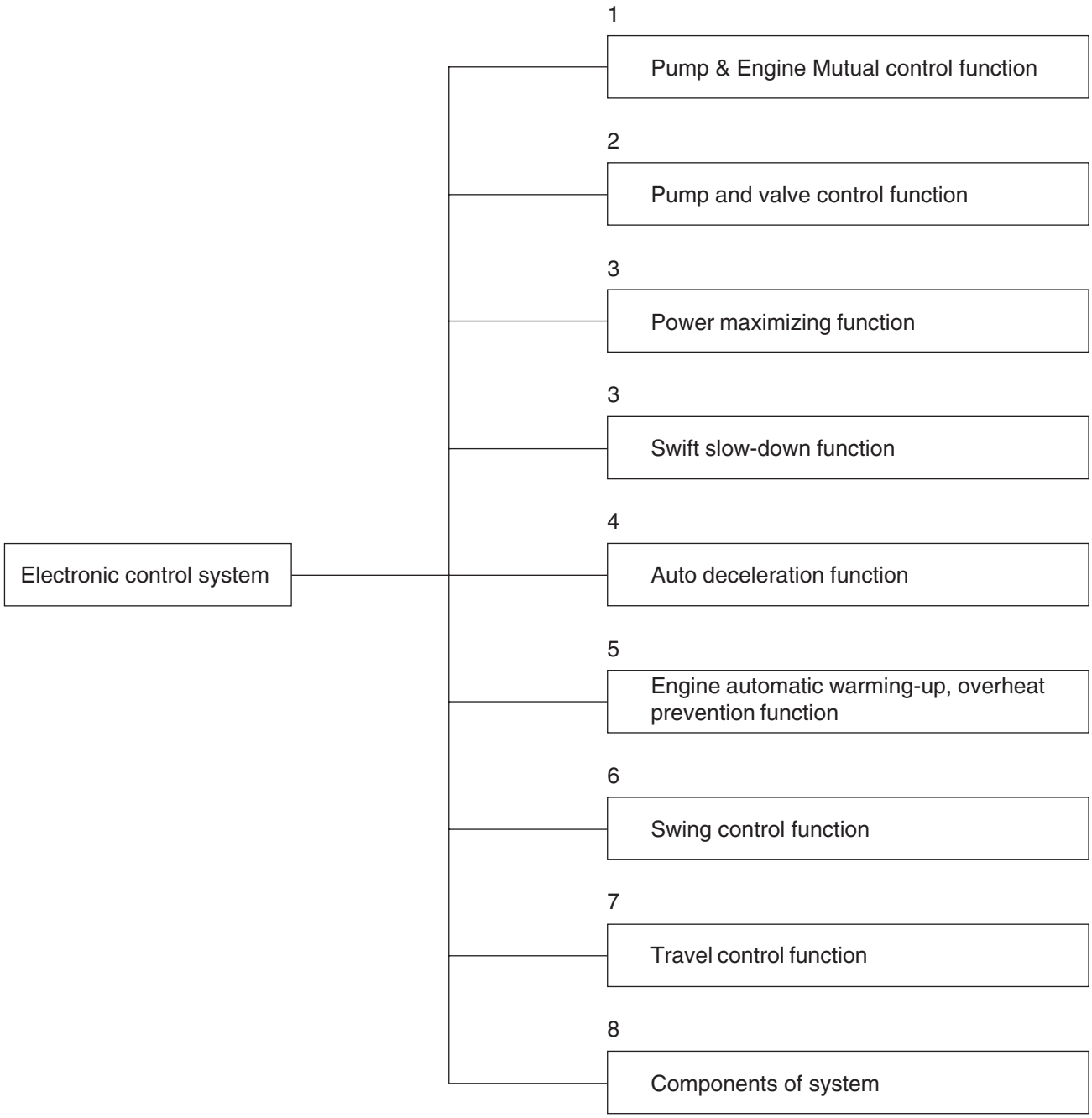
CN-3

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	Travel EPC control	
20	NC	
21	NC	
22	Boom RAISE pressure switch	Input
23	Arm IN pressure switch	Input
24	S-NET(+)	Input, output
25	Model selection 1	Input
26	Model selection 3	Input
27	Model selection 5	Input
28	Swing prolix switch	Input
29	LOWER wiper	Input
30	Boom LOWER pressure switch	Input
31	Arm OUT pressure switch	Input
32	S-NET(+)	Input, output
33	Model selection 2	Input
34	Model selection 4	Input
35	Speed select	Input
36	Swing lock switch	Input

CN-5

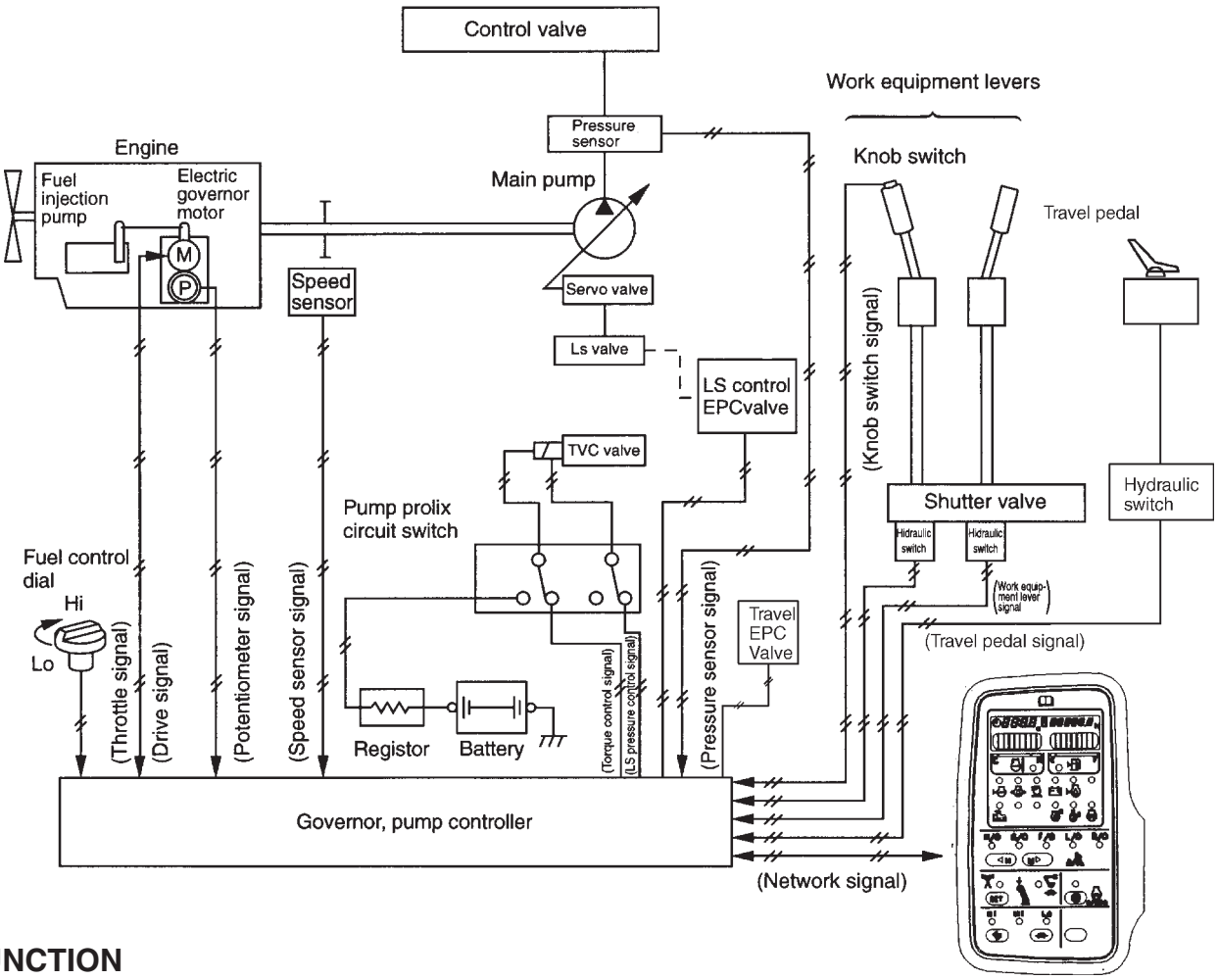
Pin. No.	Name of signal	Input/ output
1	Engine speed sensor GND	Input
2	Engine speed sensor	Input
3	S-NET (-)	Input/ output
4	GND	Input
5	Swing pressure switch	Input
6	Service valve pressure switch	Input
7	Engine oil pressure sensor High	Input
8	Radiator water level sensor	Input
9	NC	
10	NC	
11	Bucket CURL pressure switch	Input
12	Bucket DUMP pressure switch	Input
13	Travel pressure switch	Input
14	Park brake	Input
15	Engine oil pressure sensor Low	Input
16	Engine oil level sensor	Input
17	Air cleaner clogging sensor	Input

ELECTRONIC CONTROL SYSTEM
CONTROL FUNCTION



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

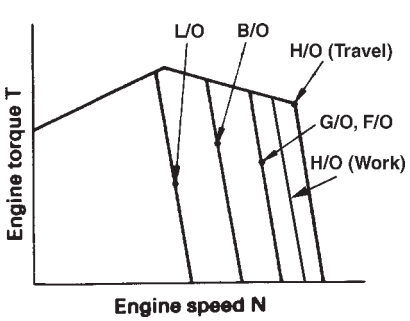
1) Pump & Engine Mutual control system



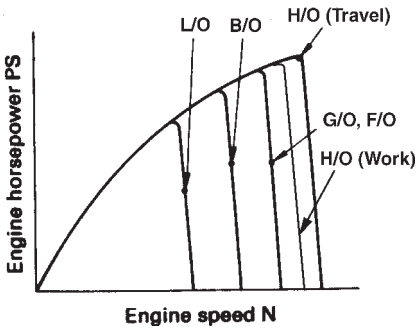
FUNCTION

- There are five modes available for selection with the working mode switch on the monitor panel. These modes are the heavy-duty operation (H/O) mode, general operation (G/O) mode, lifting operation (L/O) mode, and the 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.

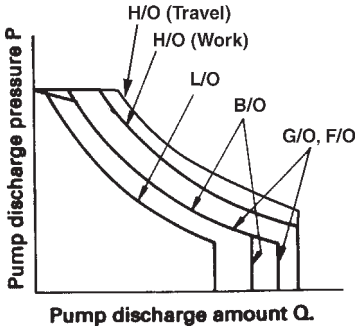
- **Engine torque curve**



- **Engine horsepower curve**



- **Pump output curve**

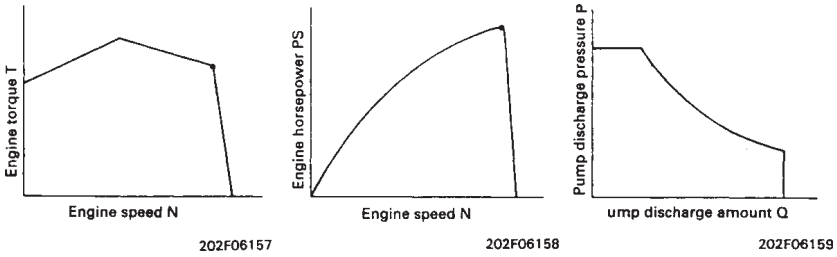


1. Control method in each mode Heavy-duty travel operation (H/O) travel mode

- 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 dischrge amount is reduced, and the engine speed is controlled so that it becomes the 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 operation (H/O) travel	85 kW (116 PS) 2280 rpm

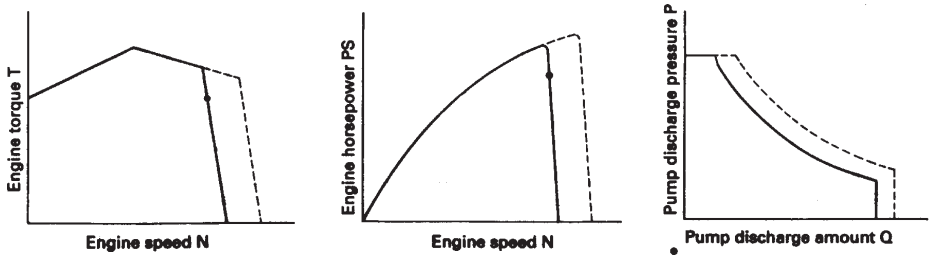
Heavy Duty working (H/O work) mode



- **Matching point in Heavyt Duty working 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,l 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.

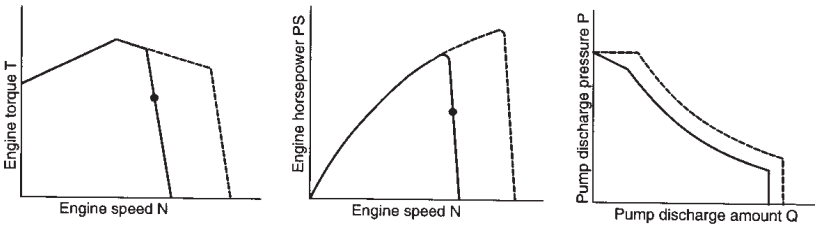
Heavy Duty Working operation (HO work)	79 kW (108 PS) 1900 rpm

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



- Matching point in general operation and finishing operation modes: 75 % 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,l 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.

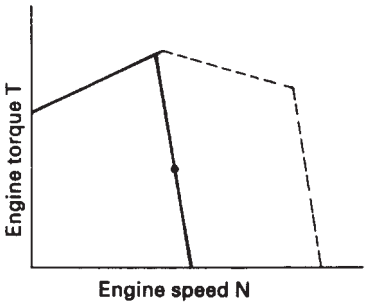
General operation (G/O), Finishing operation (F/O)	63 kW (86 PS) 1900 rpm



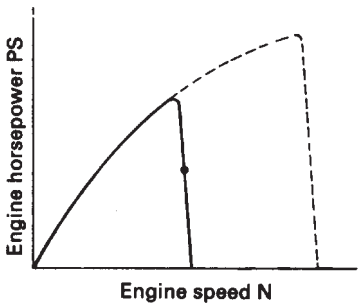
Lifting operation (L/O) mode

- Matching point in lifting operation mode: 60 % partial output point
- When the lifting operation mode is selected, the engine speed is automatically lowered to the partial postion.
  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.

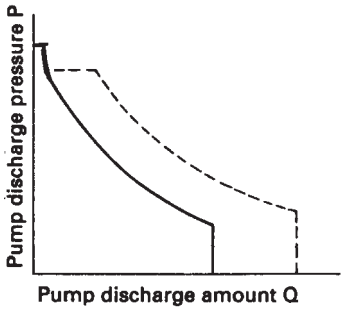
Lifting operation (L/O)	53 kW (71 PS) 1780 rpm



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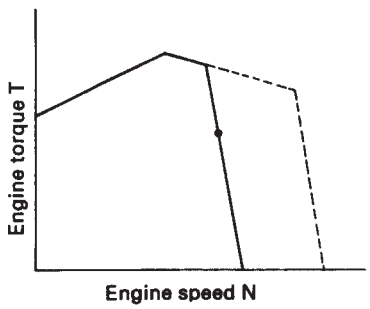


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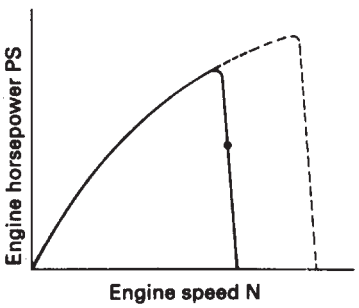
Breaker operation (B/O) mode

- Matching point in lifting operation mode: 70 % 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 theengine is used in a range that provides a much better fuel comsumption ration than for the general operation mode or finishing mode.

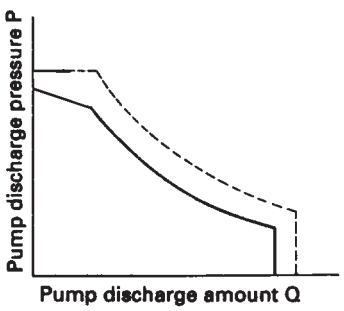
Breaker operation (B/O)	63kW (86 PS) 1850 rpm



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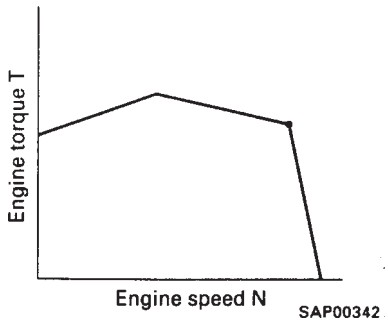


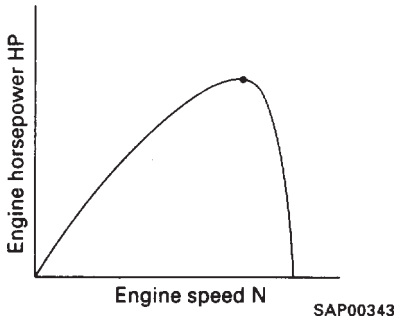
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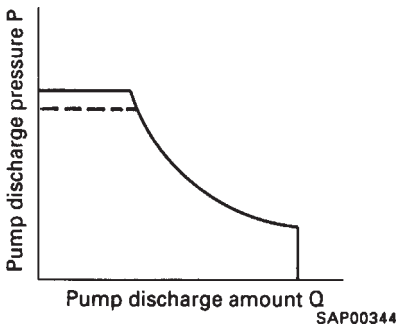


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Power max. mode







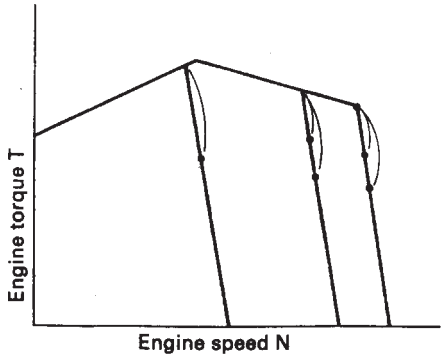
- Matching point in power max. mode:
  Rated output point

Mode \ Model	PW170ES-6K
Power max	85 kW (116 PS) 2280 rpm

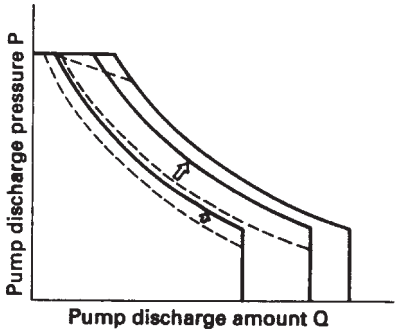
- When the pump load increases, the engine speed drops.
  When this happens, the pump discharge is reduced to prevent the engine speed from going down and to ensure that the engine is used at near the rated output point.
  The cut-off at relief is cancelled and the oil flow at relief is increased. And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

2. Pump control function when travelling

- 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.



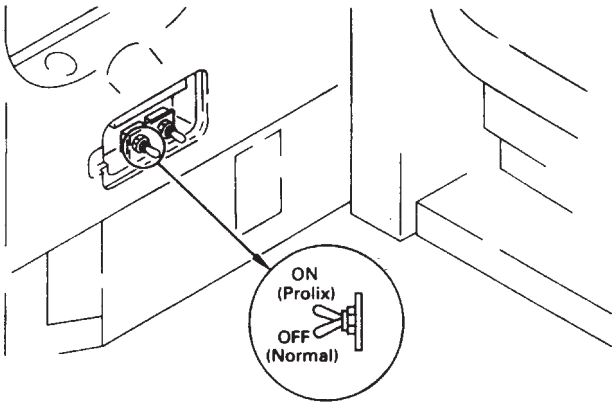
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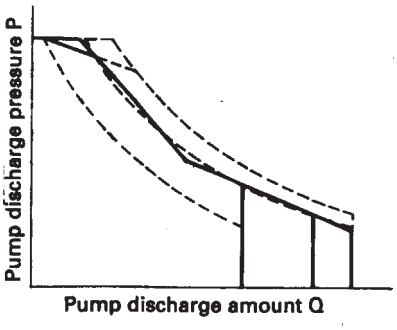
202F06170

3. control function TVC prolix switch is ON

- Even if any abnormality should occur in the controller or sensor, the TVC 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 TVC valve, so oil pressure sensing is carried out only by the TVC valve.

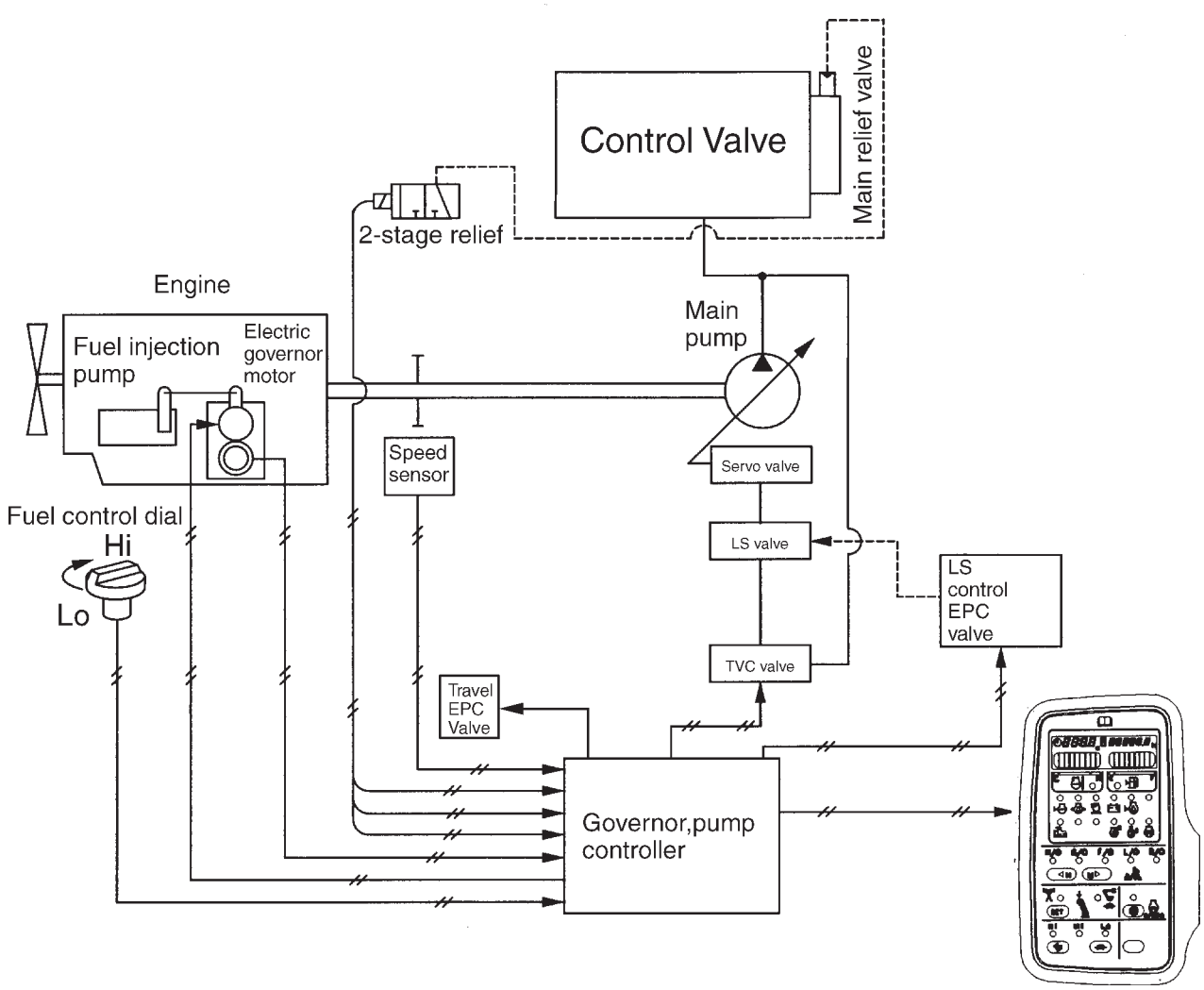


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2) Pump and valve control function



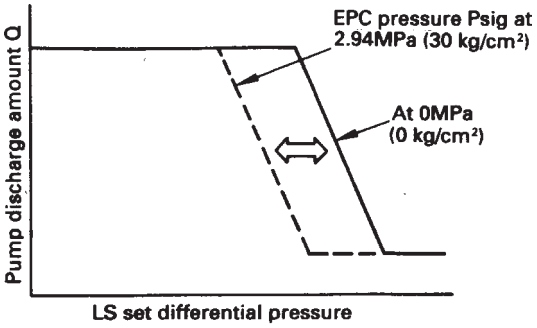
FUNCTION

- 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.

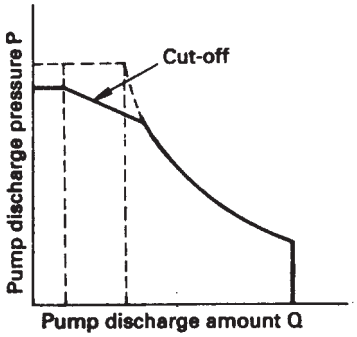


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2. Cut-off function

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

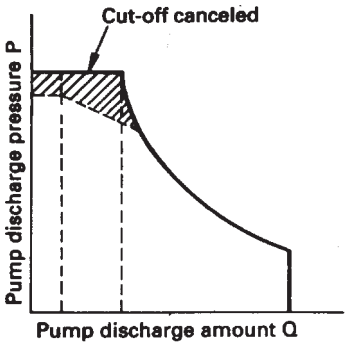
★ For detalis of the operation, see CLSS



202F06175

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. 34.8 MPa (355 kg/cm^2).
- Actuation conditions for cut-off cancel function



202F06176

	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	Canceled	Actuated	Canceled	Canceled	Canceled	Actuated	Canceled	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, and the 2-stage relief function is actuated.
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 traveling • When swing lock switch is ON • In lifting operation (L/O) mode • When power max. fucntion or swift slow-down function are actuated	31.85 MPa ($325kg/cm^2$) ⇩ 34.79 MPa ($355kg/cm^2$)

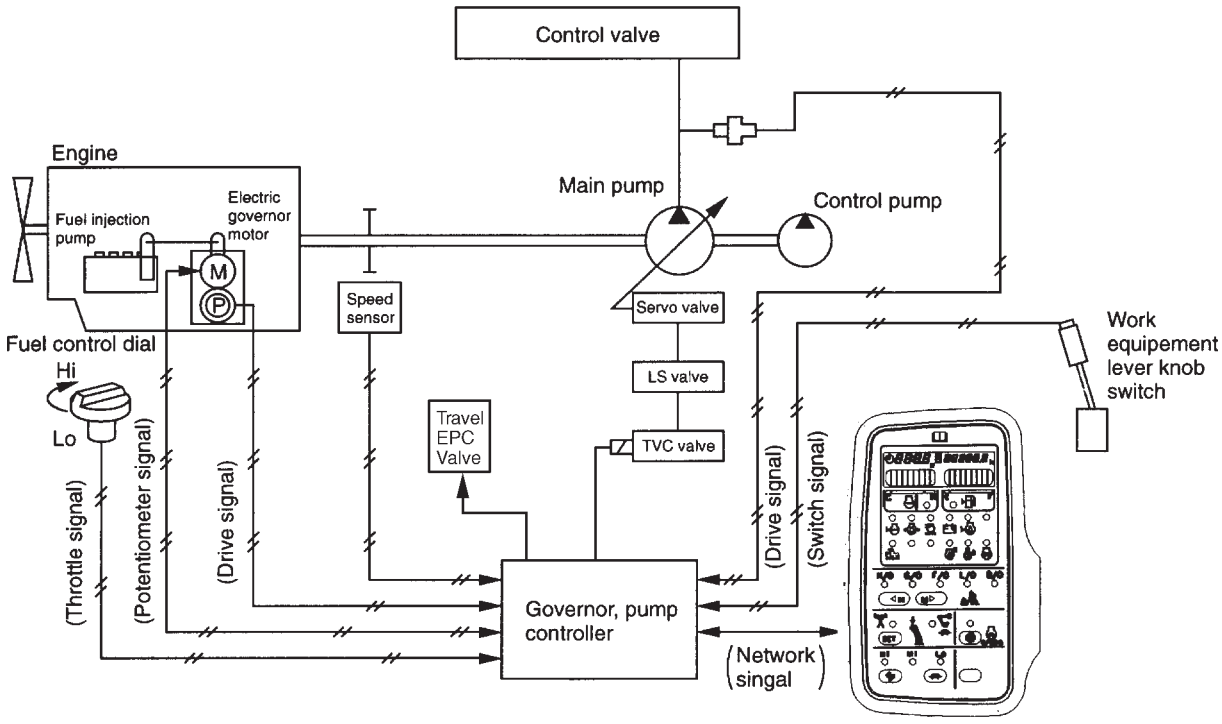
5. Fine control mode function

- 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) (%)

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

3) Power max. function, 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 slow-down 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

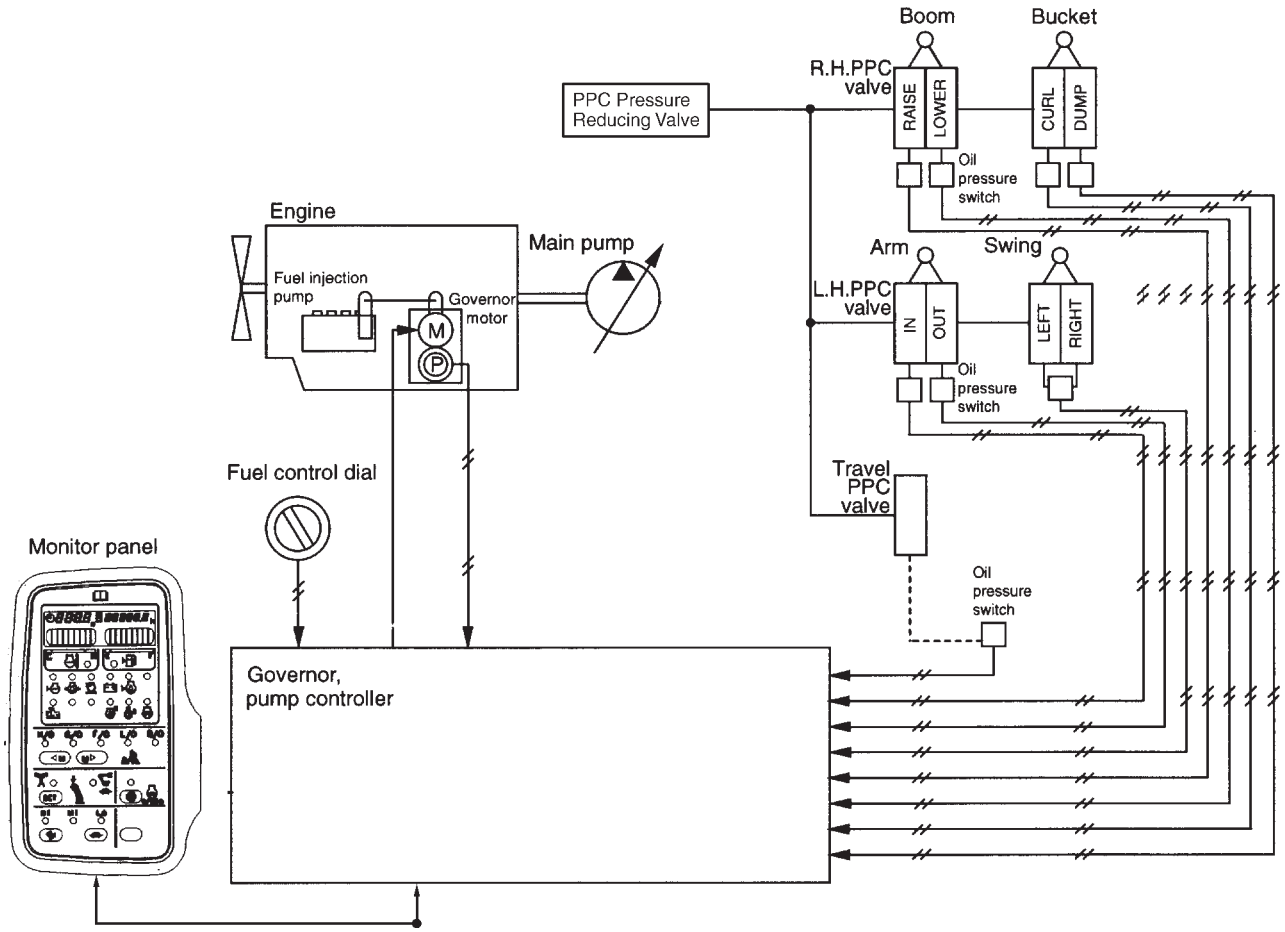
2. Swift slow-down function

- 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 (LO) mode by operating the L.H. knob switch p.
- 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 recuded to a midrange speed to reduce fuel consumption and noise.
- If any lever is operated, the engine speed returns immediately to the set speed.

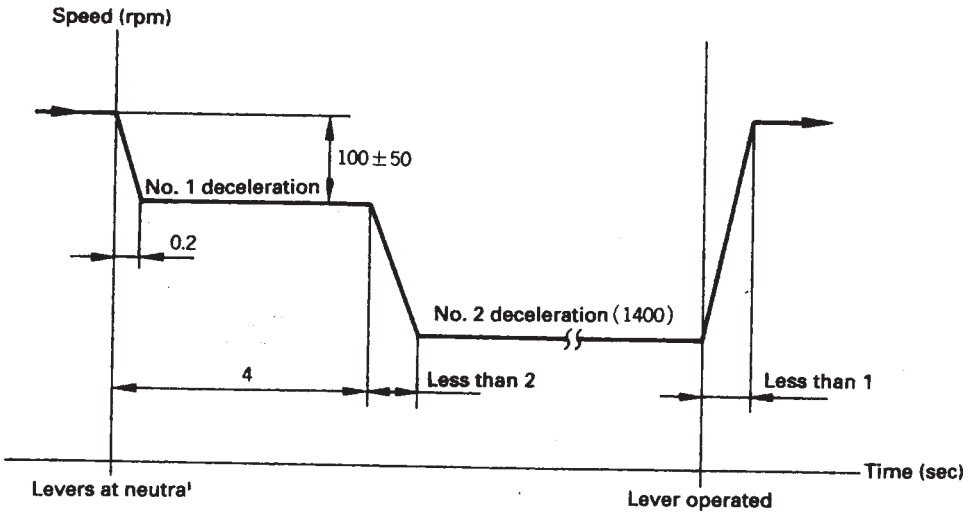
Operation

Control levers at neutral

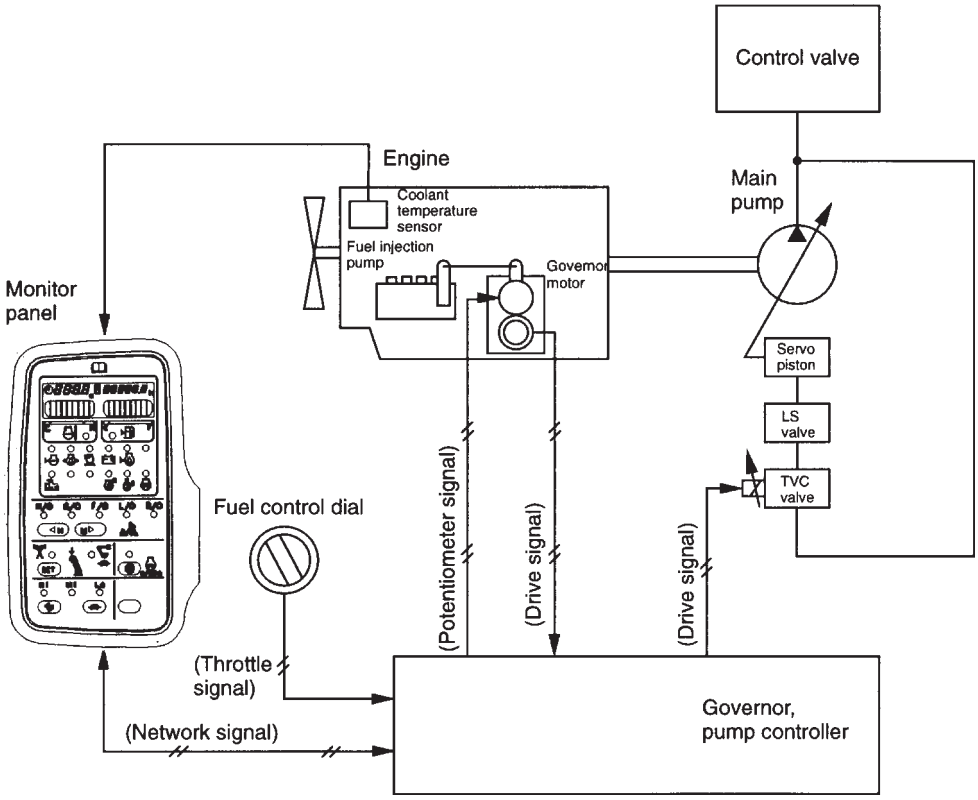
- If the engine is running at above the deceleration actuation speed (approx. 1,400 rpm), and all the control levers are returned to neutral, the engine speed drops immediately to approx. 100 rpm below the set speed to the No. 1 deceleration position.
- If another 4 seconds pass, the engine speed is reduced to the No. 2 deceleration position (approx. 1,400 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 1,400 rpm

⇒

Actuation	
Engine speed:	1,250 rpm or below

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

⇒

Cancellation
Engine speed: As desired

2. Engine overheat prevention function

- This function protects the engine by lowering the pump load and engine speed to prevent overheating when the engine coolant temperature has risen too far.
- This system is actuated 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 temperture 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).

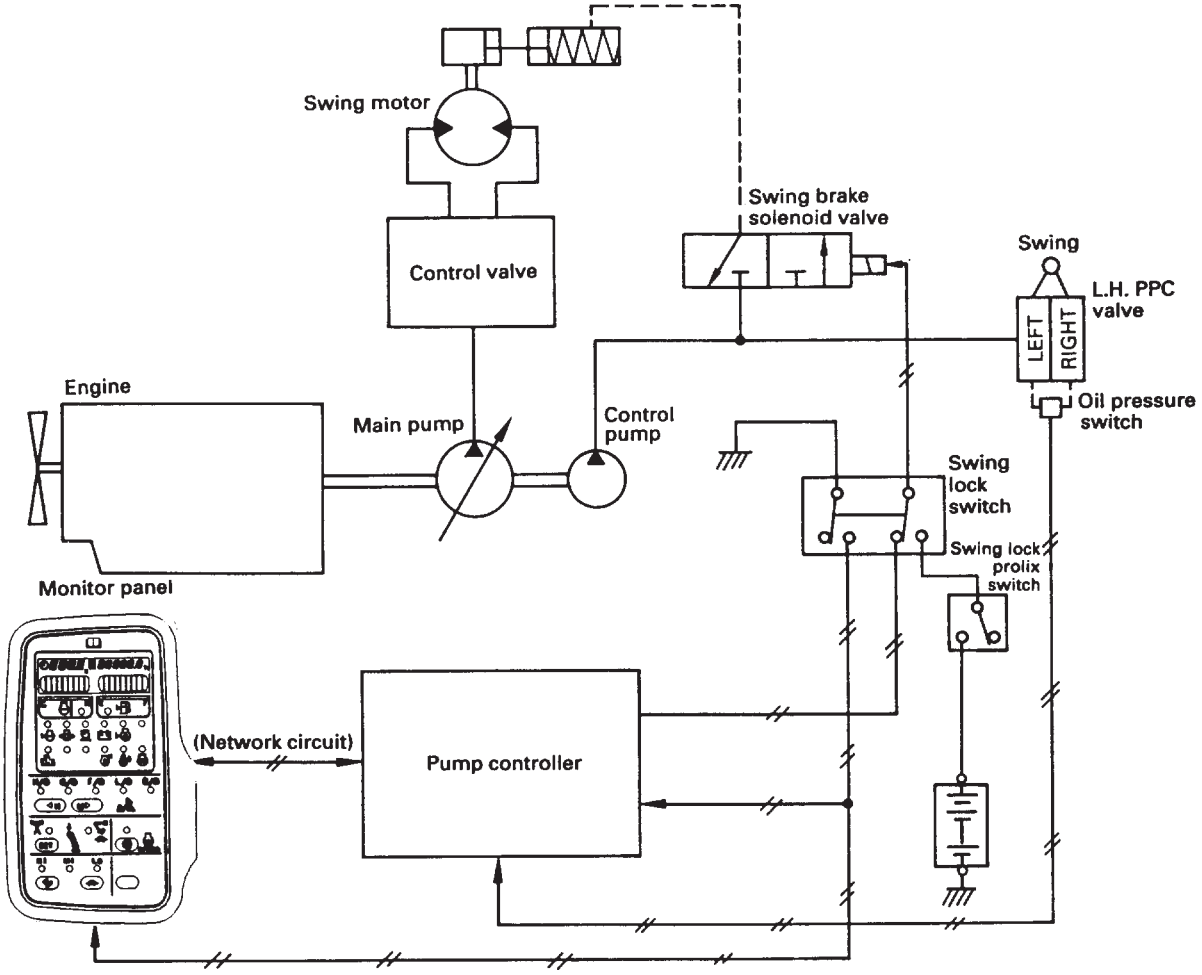
2nd stage (coolant temperature 105°C and above)

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 postion 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 positon, and the swing holding brake (automatic) is interconnected with the swing, so it prevents any hydraulic drift after the swing is stopped.

- 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 canceld and swing does not move.

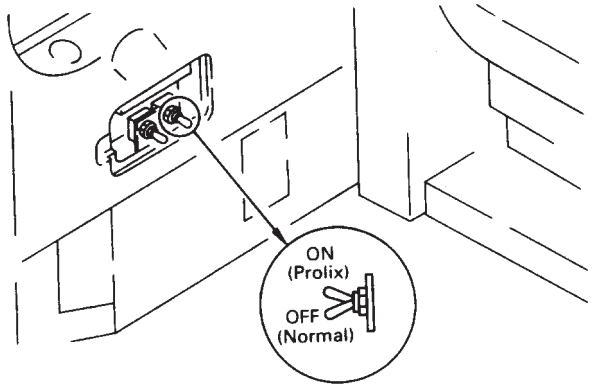
❊ Operation of swing lock prolix switch

- If any abnormality should occur in the controller, and the swing holding brake is not actuated noramlly 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 cancelled.

★ When the swing brake is cancelled, 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.

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

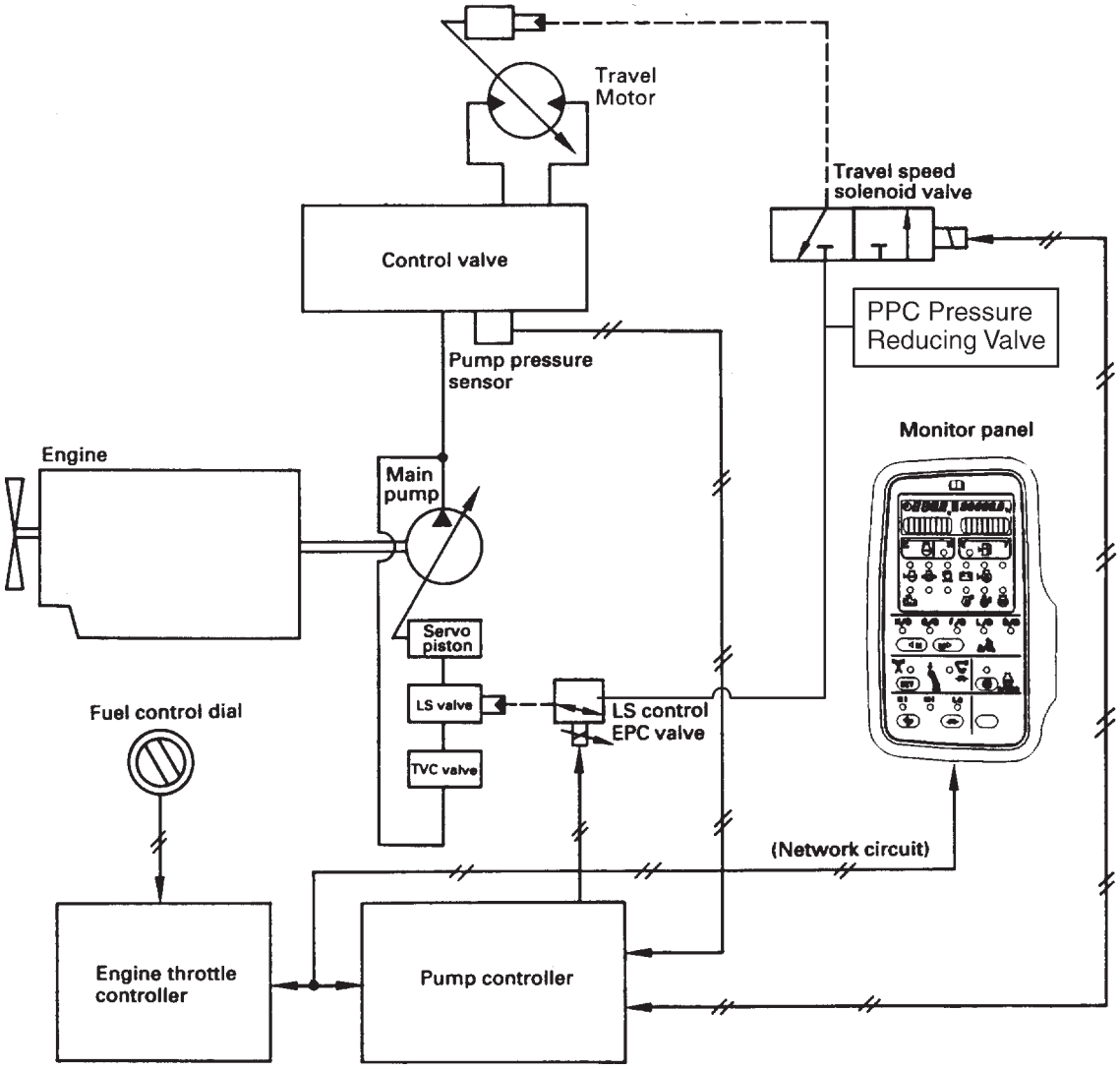


202F06182

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

★ For details, see PUMP AND VALVE CONTROL FUNCTION

7) Travel control function



Function

- When travelling, 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 MUTUAL CONTROL FUNCTION

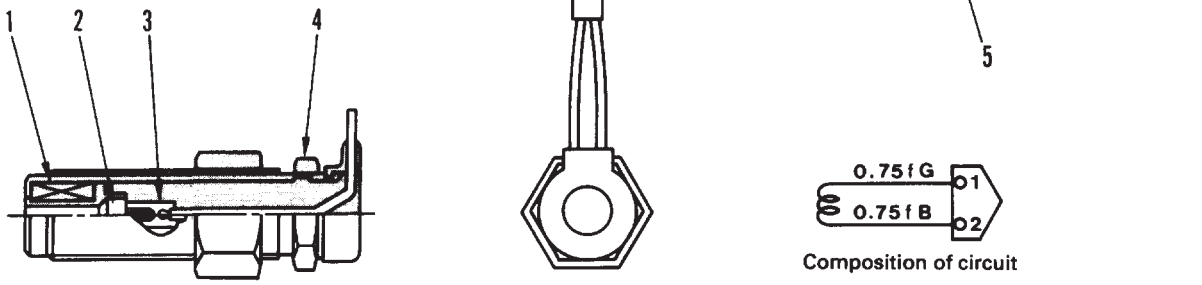
2. Travel speed selection function

- 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.

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)	5	10	30

8) Components of system

1. Engine speed sensor



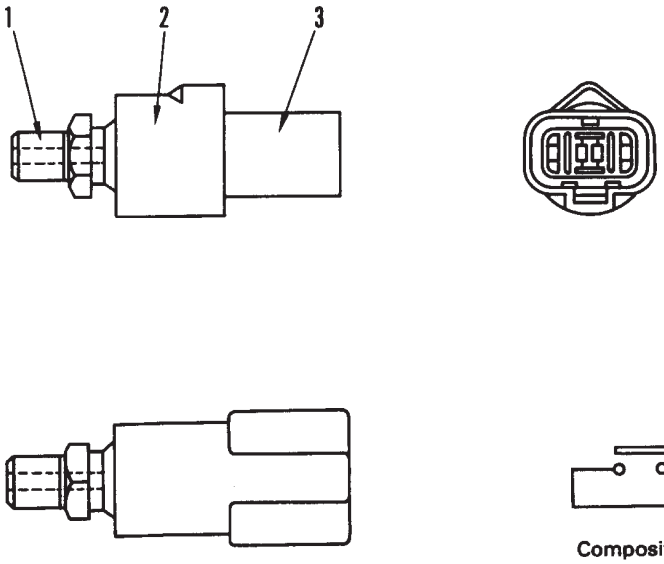
202F06185

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 result 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. Plut
2. Switch
3. Connector

SPECIFICATONS

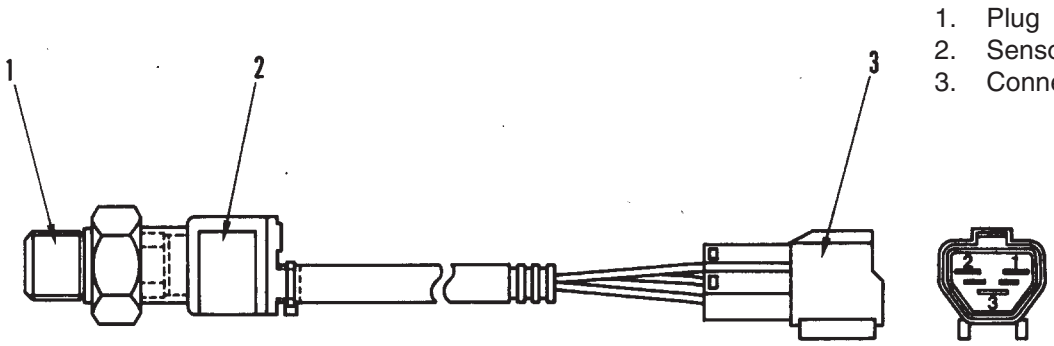
Composition of points: N.O. points
Actuation (ON) pressure:
0.49 ± 0.1 MPa (5.0 ± 1.0 kg/cm^2)
Reset (OFF) pressure:
0.29 ± 0.05 MPa (3.0 ± 0.5 kg/cm^2)

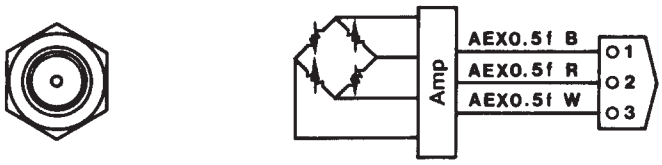
Function

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

202F06186

3. Pump pressure sensor





Composition of circuit

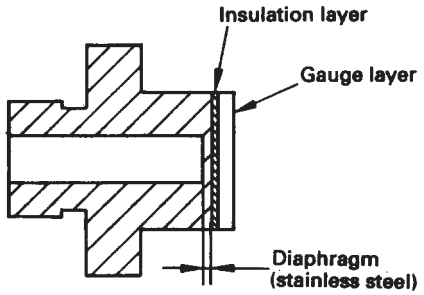
202F06187

Function

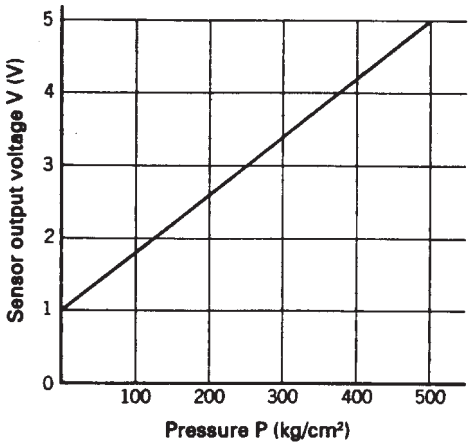
- This sensor is installed to the inlet port circuit of the control valve. It converts the pump discharge pressure to a voltage and sends this to the controller.

Operation

- When the pressurized oil entering from the pressure introduction portion pressurized 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/cm^2) and output voltage (v)
  V = 0.008 x P + 1.0
  ★ 1 kg/cm2 = 0.098 MPa

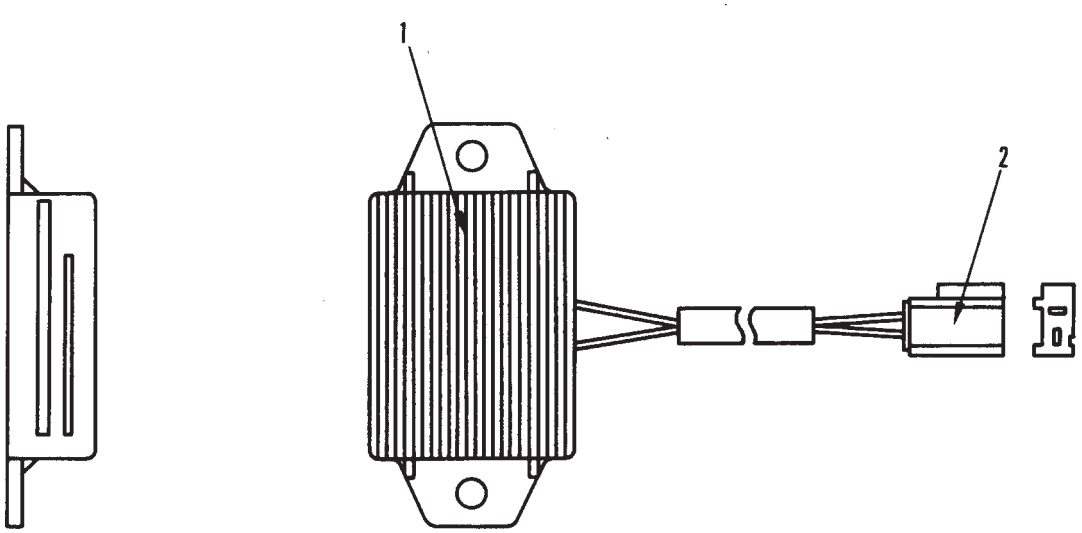


202F06188



202F05163

4. TVC prolix resistor



202F06216

1. Resistor
2. Connector

SPECIFICATION
Resistance: 30 Ω

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

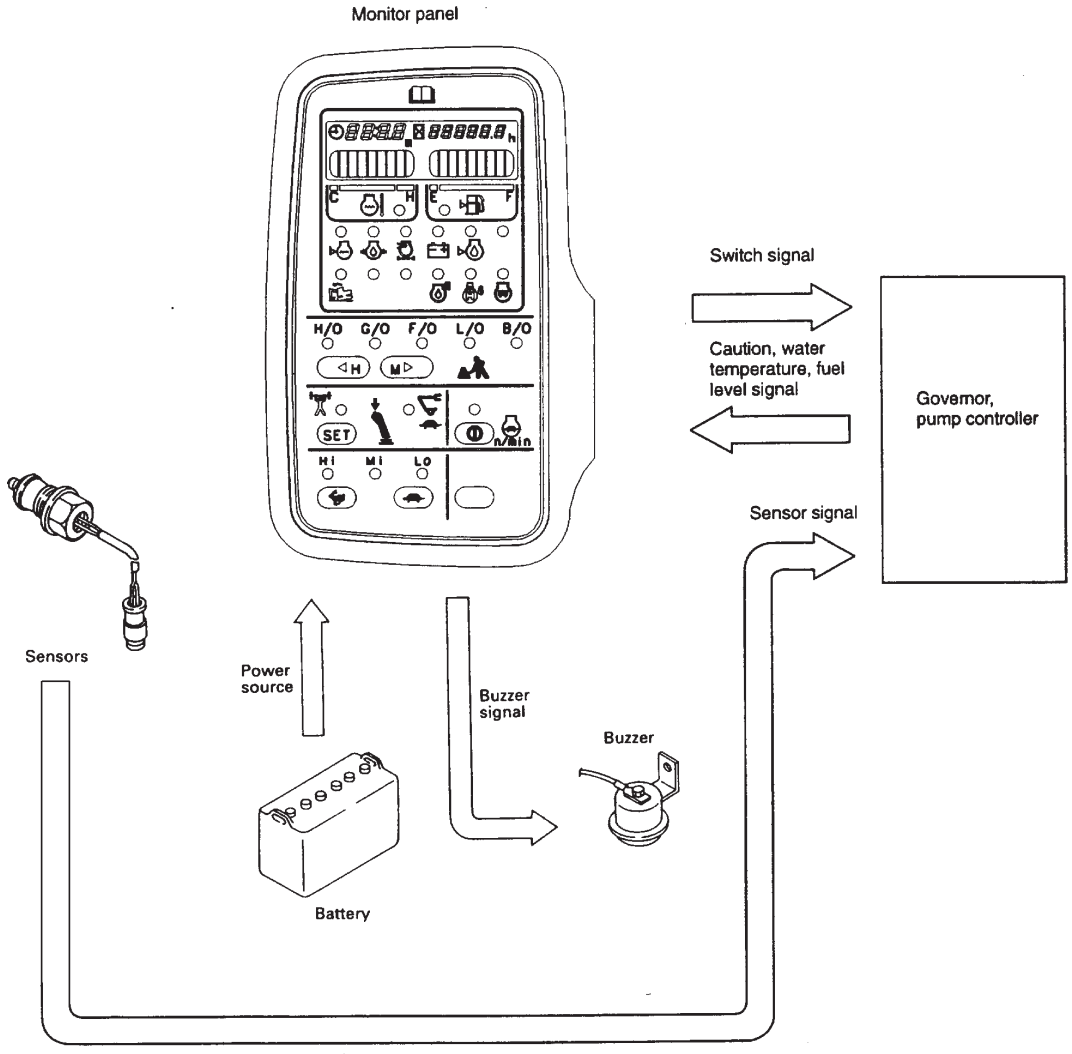
5. Fuel control dial, governor motor, engine throttle controller
★ See ENGINE CONTROL SYSTEM

6. Monitor panel
★ See MONITORING SYSTEM

7. TVC valve
★ See HYDRAULIC PUMP

8. 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**

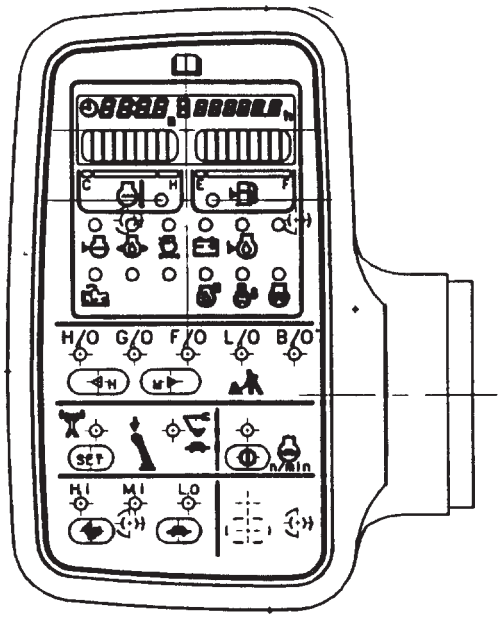
MACHINE MONITOR SYSTEM

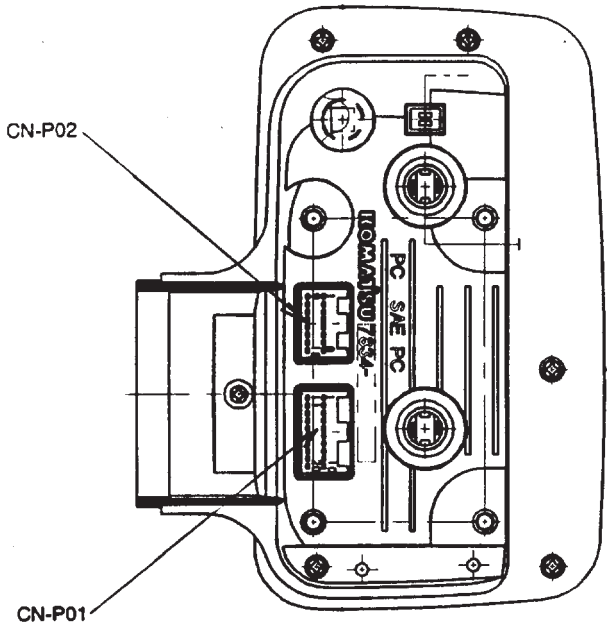


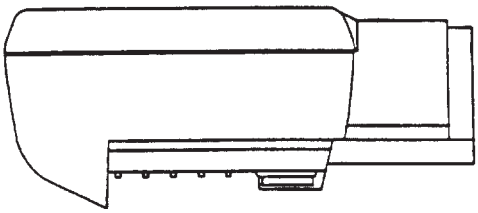
Function

- the machine monitor system uses the sensors installed to all parts of the machine to observe the conditon of the machine. It processes this information swiftly, and displays it on a panel to inform the operator of the conditon of the machine.
  The content of the information displayed on the machine can broadly be devided as follows.
  1. Monitor portion
     This gives an alarm if any abnormality occurs in the machine
  2. Gauge portion
     This always displays the conditon of the machine (coolant temperature, fuel level).
- The monitor panel also has various built-in mode slector switches, and functions as the control panel for the machine control system.

1. Monitor panel







Outline

- The monitor panel consists of the switchesfor 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

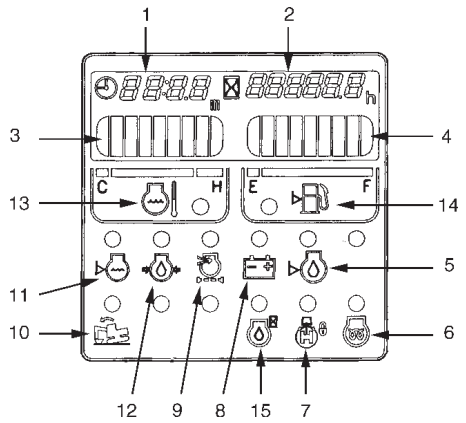
CN-P01

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

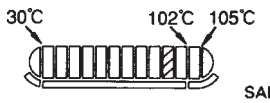
Pin No.	Name of signal
1	GND
2	NC
3	NC
4	NC
5	NC
6	NC
7	NC
8	Power supply (24V)
9	GND
10	NC
11	NC
12	NC
13	NC
14	Power supply (24V)
15	NC
16	NC

DISPLAY MONITOR

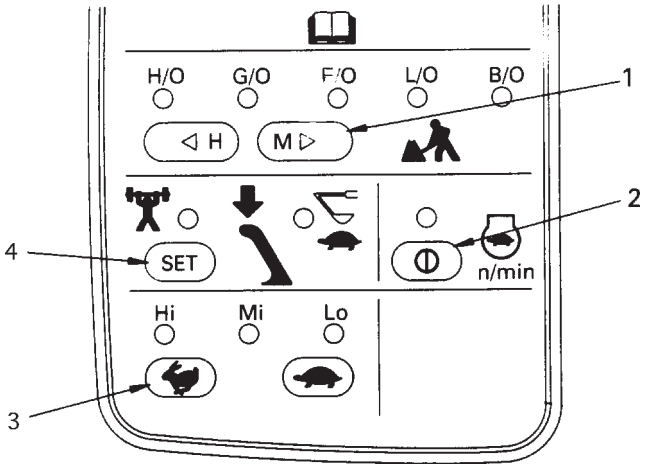


1. Clock (displays error code when error occurs)
2. Service meter
3. Coolant temperature gauge
4. Fuel gauge
5. Engine oil level caution lamp
6. Preheating pilot lamp
7. Swing holding brake pilot lamp
8. Charge level caution lamp
9. air cleaner clogging caution lamp
10. Overload caution lamp
11. Coolant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

Content of display

Symbol	Display item	Display range	When engine is stopped	When engine is running
SAP00519	Coolant level	Below low level	Flashes when abnormal	Flashes and buzzer sounds when abnormal
SAP00520	Engine oil pressure	Below 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 nay switchis pressed. The LED above the switch lights up to display the present condition of the machine.

Switch actuation table

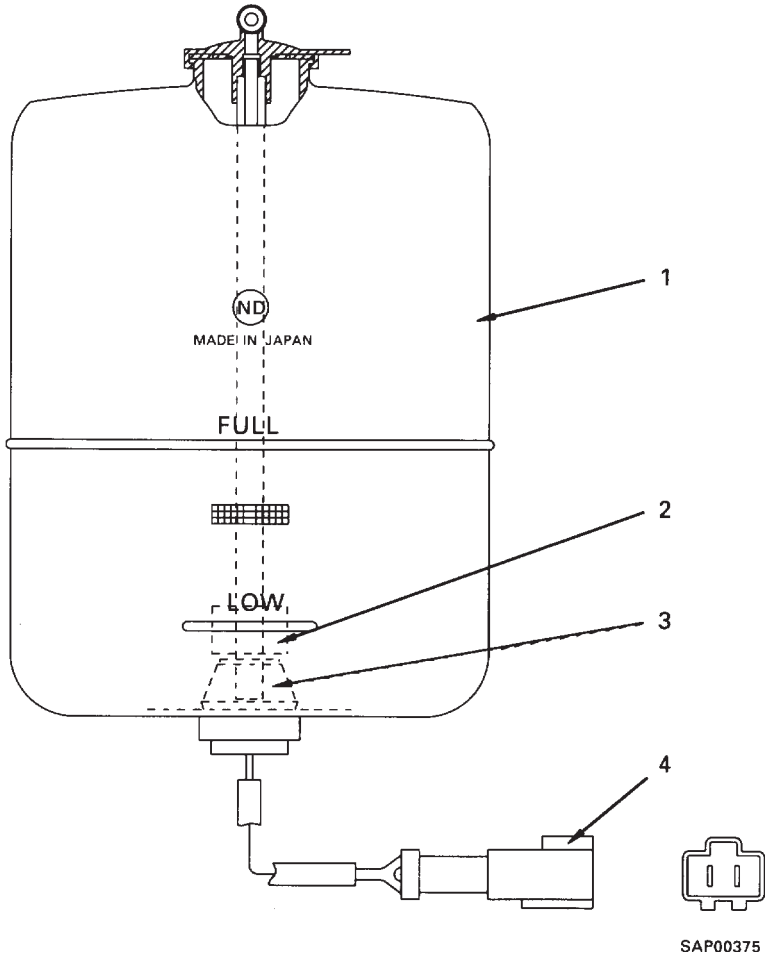
Switch	Item	Action
◁ H M ▷ SDP00692	WORKING MODE	H/0 ⟷ **G/O** ⟷ F/O ⟷ L/O ⟷ B/O
SET SDP00693	KNOB BUTTON	(POWER UP) ⟷ (SPEED DOWN) SDP00694
n/min SDP00695	AUTO DECEL	**ON** ⟷ OFF
SDP00696	TRAVEL SPEED	Hi ⟷ Mi ⟷ **Lo**

2. Sensors

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

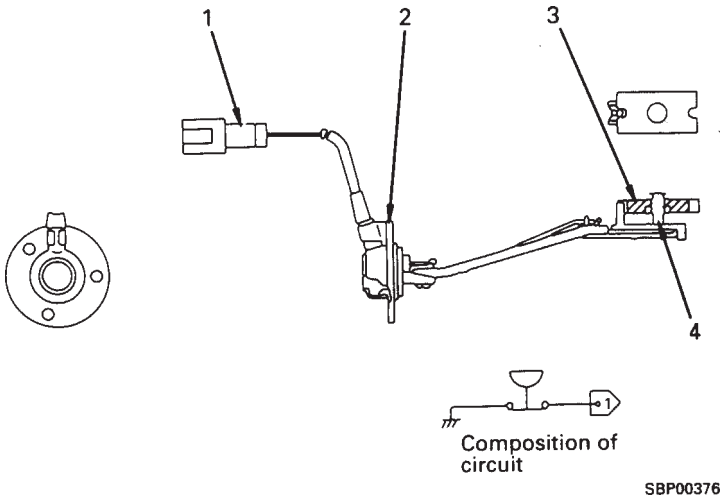
Name of sensor	Type of sensor	When normal	When abnormal
Coolant level	Contact type	ON (closed)	OFF (open)
Engine oil level	Contact type	ON (closed)	OFF (open)
Engine oil pressure	Contact type	OFF (open)	ON (closed)
Coolant temperature	Resistance type	-	-
Fuel level	Resistance type	-	-
Air cleaner clogging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

Cooland level sensor



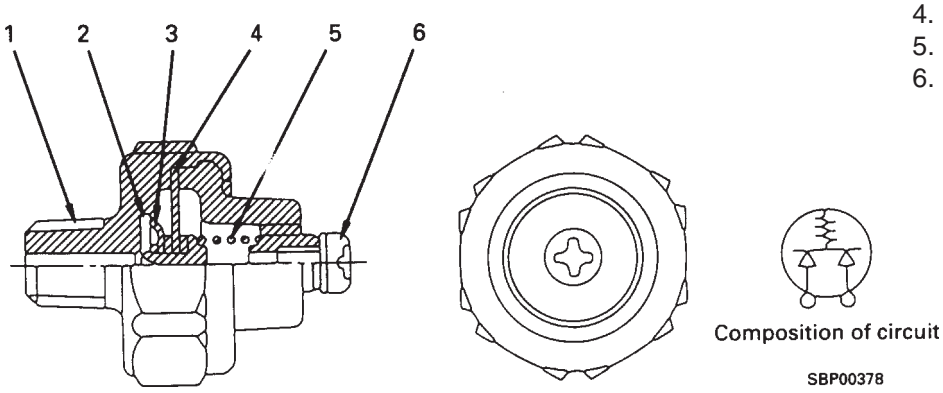
1. Sub-tank
2. Float
3. Sensor
4. Connector

Engine oil level sensor



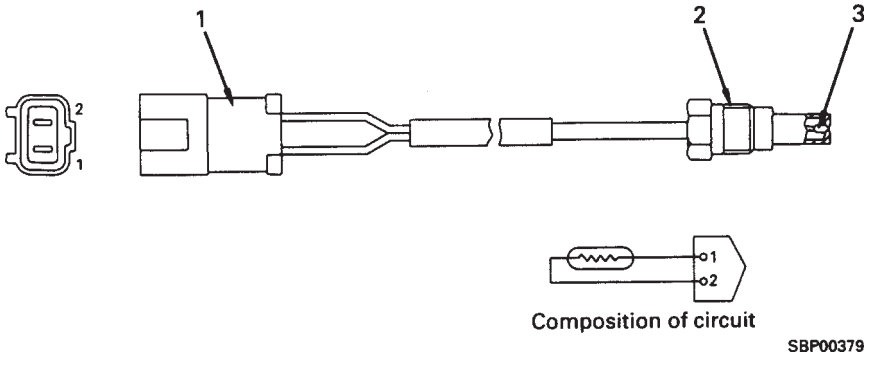
1. Connector
2. Bracket
3. Float
4. Switch

Engine oil pressure sensor (both Lo and Hi)



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

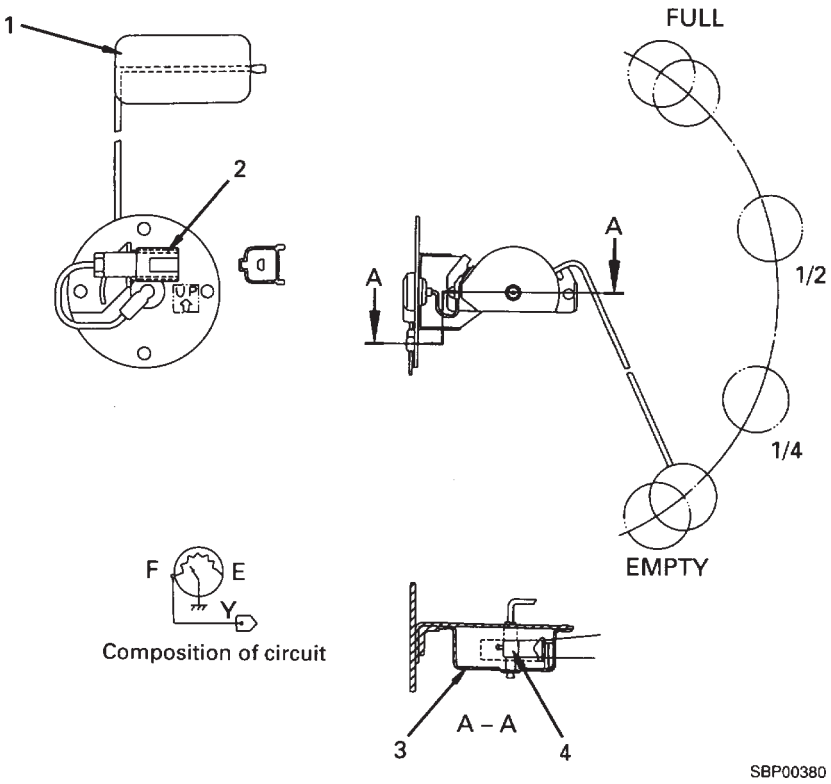
Coolant temperature sensor



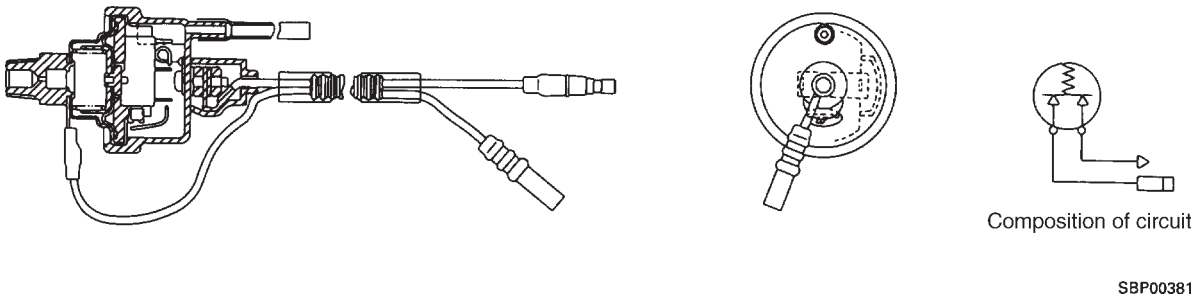
1. Connector
2. Plug
3. Thermistor

Fuel level sensor

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

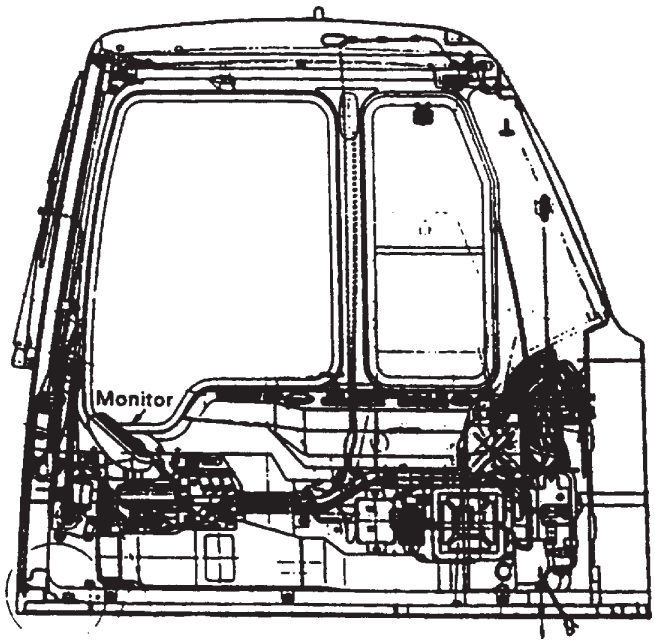


Air cleaner clogging sensor



OVERLOAD WARNING DEVICE

1) OUTLINE



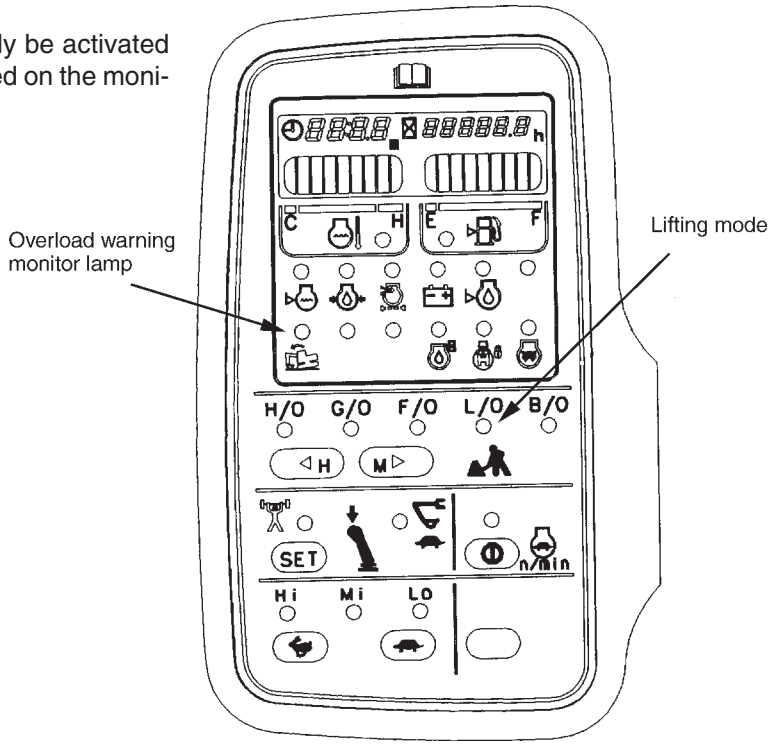
Function

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

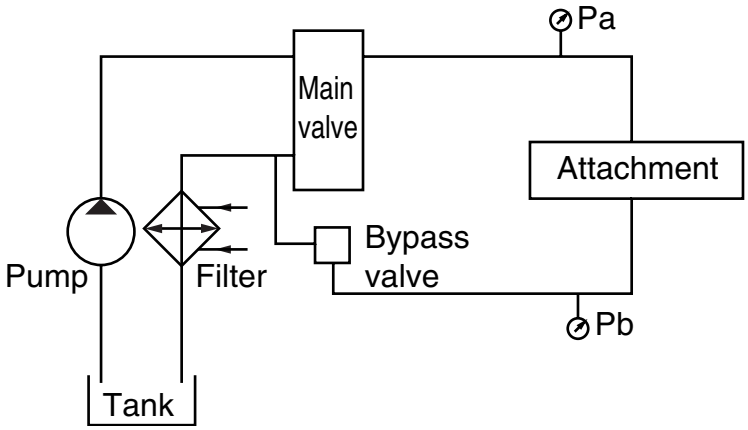
Structure

- 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)

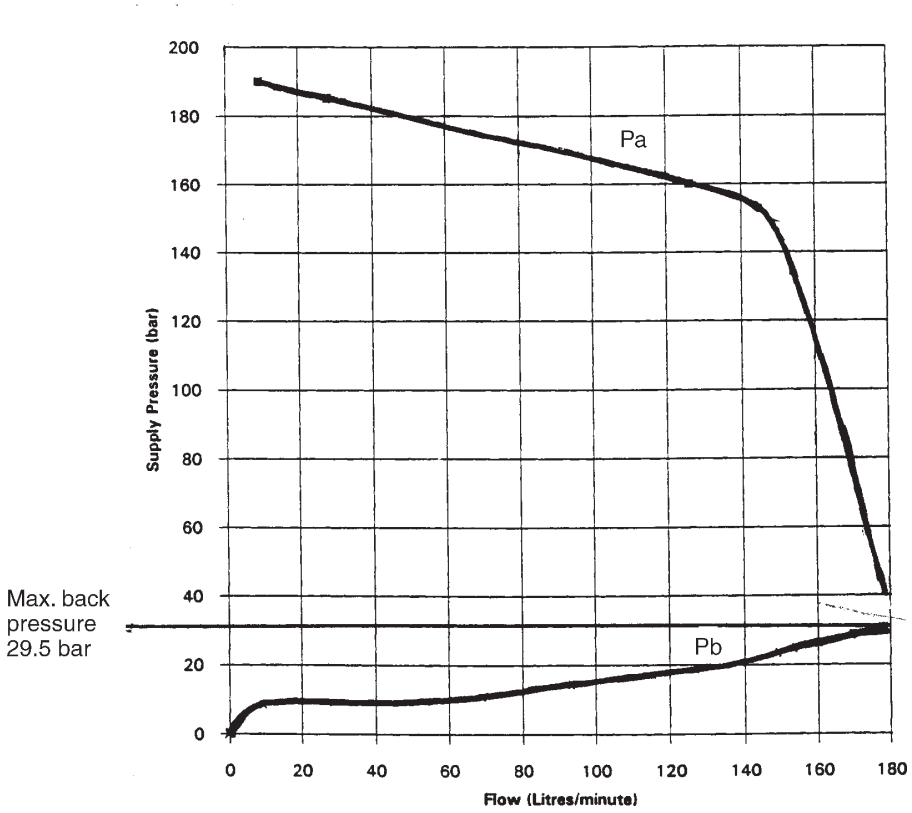


The performance of the hydraulic system when used in the B.O. mode for attachment operation, is shown below.

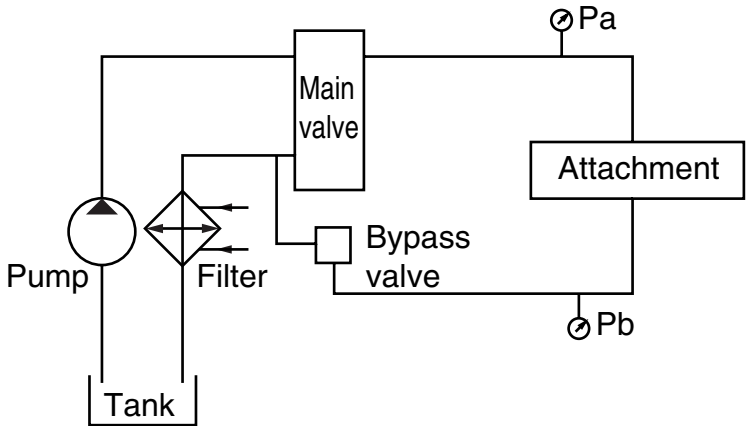
The pressure **Pa** is that which is observed at the inlet to the Attachment.

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)

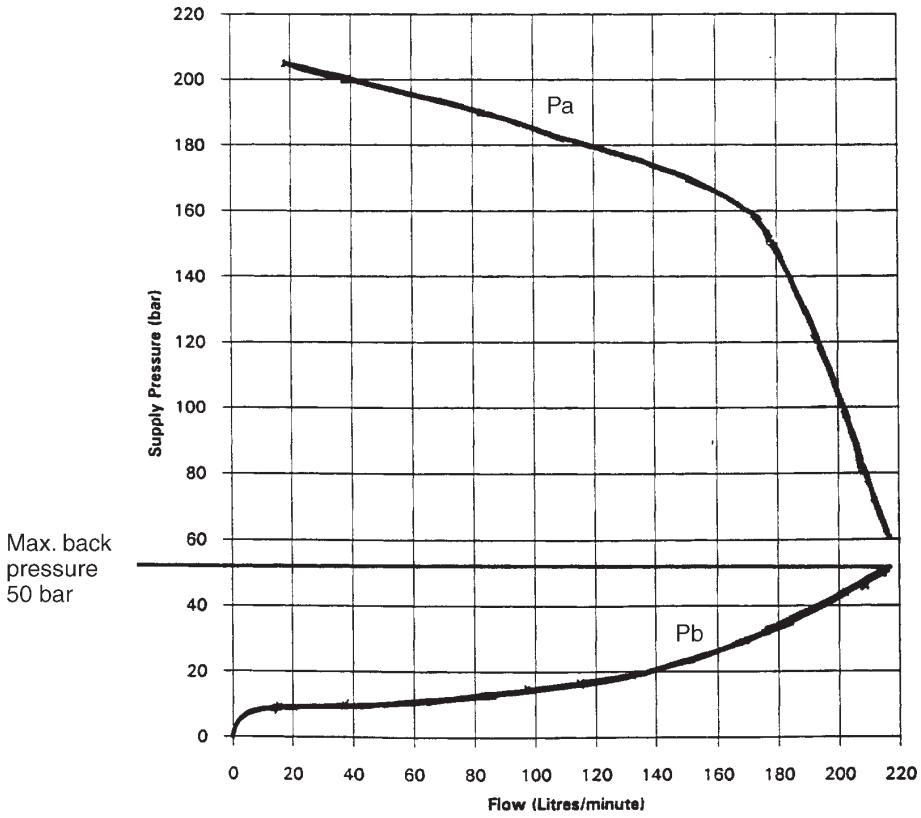


The figure below shows the pressures at points A and B for varying flow through the attachment.

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).



20 TESTING AND ADJUSTING

Table of judgement standard value 20- 2
Standard value table for electrical parts 20- 12
Checking and adjusting belt tension for air conditioner compression 20- 20
Adjusting engine speed sensor 20- 21
Testing and adjusting governor motor lever stroke 20- 22
Testing clearance of swing circle bearing ..... 20 -24
Testing and adjusting hydraulic pressure in work equipment, swing, travel circuit 20- 25
Testing and adjusting TVC valve output pressure (servo piston input pressure) 20- 28
Testing and adjusting LS valve output pressure (servo piston input pressure) and LS differential 20- 30
Testing and adjusting PPC pressure 20- 33
Testing EPC valve, solenoid valve output pressure 20- 35
Measuring PPC valve output pressure and testing PPC shuttle valve 20- 37
Adjusting work equipment
• swing PPC valve 20- 39
Testing locations causing hydraulic drift of working equipment 20- 40
Measuring oil leakage 20- 42
Releasing remaining pressure in hydraulic circuit 20- 43
Bleeding air 20- 44
Accumulators 20- 46
Troubleshooting 20- 50



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.

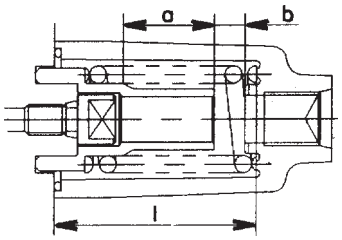
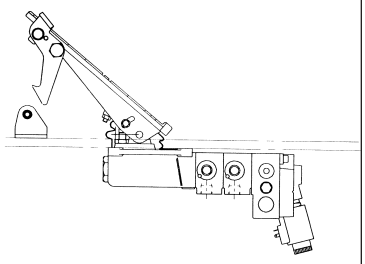
TABLE OF JUDGEMENT STANDARD VALUE

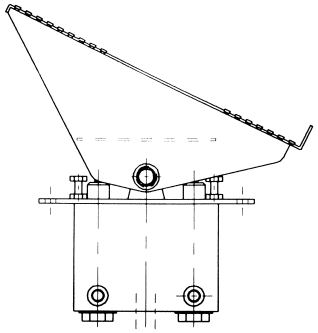
• FOR ENGINE

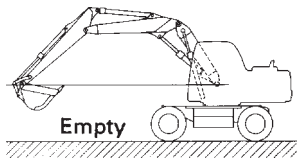
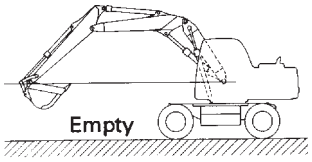
Machine model			PW170-6K	
Engine			SA4D102E	
Item	Measurement conditions	Unit	Standard value	Permissible value
Engine speed	High idling	rpm	2545	2545 ± 50
	Low idling	rpm	900 ± 50	900 ± 50
	Rated speed	rpm	2300	2300 ± 50

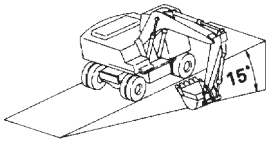
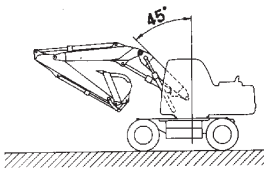
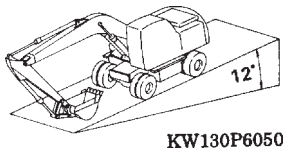
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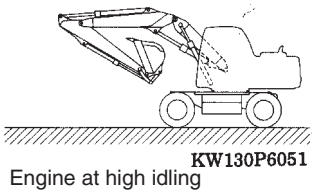
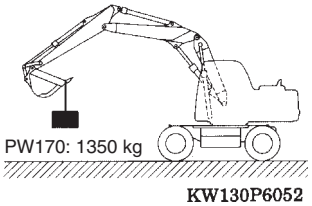
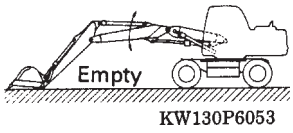
★ The standard values and permissible values shown in this table are all values for H/O (heavy-duty operation) mode.

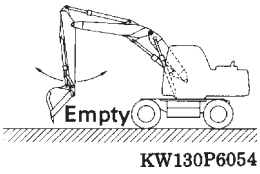
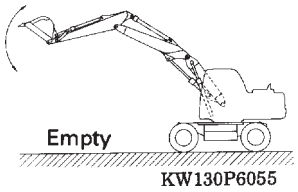
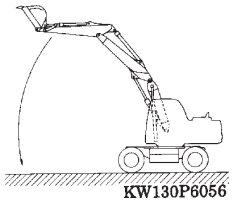
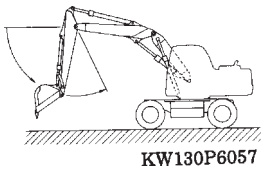
Machine model				PW170-6K					
Category	Item	Measurement conditions	Unit	Standard value			Permissible value		
Engine speed	At pump relief (LS relief)	• Hydraulic oil temperature 45 - 55°C • Coolant temperature: whithin operating range • Pump relief: Arm relief	rpm	Min. 1,900			1,900 ± 100		
	At pump relief (power max)			Min. 2,280			2,280 ± 100		
	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	l	a	b	l	a	b
	Arm control valve			53 ± 0.5	12 ± 0.5	8 ± 0.5	53 ± 0.5	12 ± 0.5	8 ± 0.5
	Service valve								
	Bucket control valve								
	2nd Boom control valve								
	Swing control valve								
	Stabiliser 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	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	• Engine at high idling • Hydraulic oil temperature 45 - 55°C • Fit push-pull scal to center of control lever knob to measure • Measure max. value to end of travel • Tip of pedal	N(kg)	15.7 ± 2.9 (1.6 ± 0.3)			Max. 24.5 (Max. 2.5)		
	Armj control lever			15.7 ± 2.9 (1.6 ± 0.3)			Max. 24.5 (Max. 2.5)		
	bucket control lever			12.7 ± 2.9 (1.3 ± 0.3)			Max 21.6 (Max 2.2)		
	Swing control lever			12.7 ± 2.9 (1.3 ± 0.3)			Max 21.6 (Max 2.2)		
	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)		

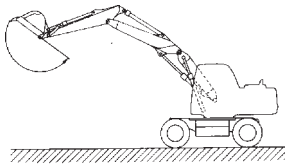
Machine model					PW170-6K	
Category	Item	Measurement conditions		Unit	Standard value	Permissible value
Operating force of control levers	Travel control pedal	• Engine at high idling • Hydraulic oil temperature: 45 - 55°C • Measure max. value to end of travel 		N(kg)	337.5±107.5 (34.5±11)	Max. 506 (Max. 52)
Hydraulic pressure	Boom	• Hydraulic oil temperature 45 - 55°C • Relief pressure with engine at high idling (Relieve only circuit • to be measured) • In H/O mode	RAISE Normal	Mpa (kg/cm²)	31.85±1.47 (325±15)	31.85±2.45 (325±25)
			RAISE 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)
			LOWER 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				31.85±1.47 (325±15)	31.85±2.45 (325±25)
	Travel				34.79±0.98 (355±10)	34.79±1.96 (355±20)
	Stabiliser					
	LS differential pressure	• Hydraulic oil temperature 45 - 55°C • Engine at high idling • In H/O mode	Levers neutral		3.92±1.0 (40±10)	Max. 4.92 (Max. 50) Min. 2.92 (Min. 30)
			Suspended travel under no load measured at control valve		$2.52^{+0.1}_{-0}$ (24.7^{+1}_{-0})	Max. 2.62 (Max. 25.7) Min. 2.52 (Min. 24.7)
			Suspended travel under no load measured at the pump		$2.42^{+0.1}_{-0}$ (26.7^{+1}_{-0})	Max. 2.82 (Max. 27.7) Min. 2.72 (Min. 26.7)

Machine model					PW170-6K	
Category	Item	Measurement conditions		Unit	Standard value	Permissable value
Swing	Time taken to start swing	Work equipment posture Max. reach  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 180°	90°	Sec	2.6±0.3	Max. 3.5
			180°		4.0±0.5	Max. 5.1
	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±1.5	Max. 30

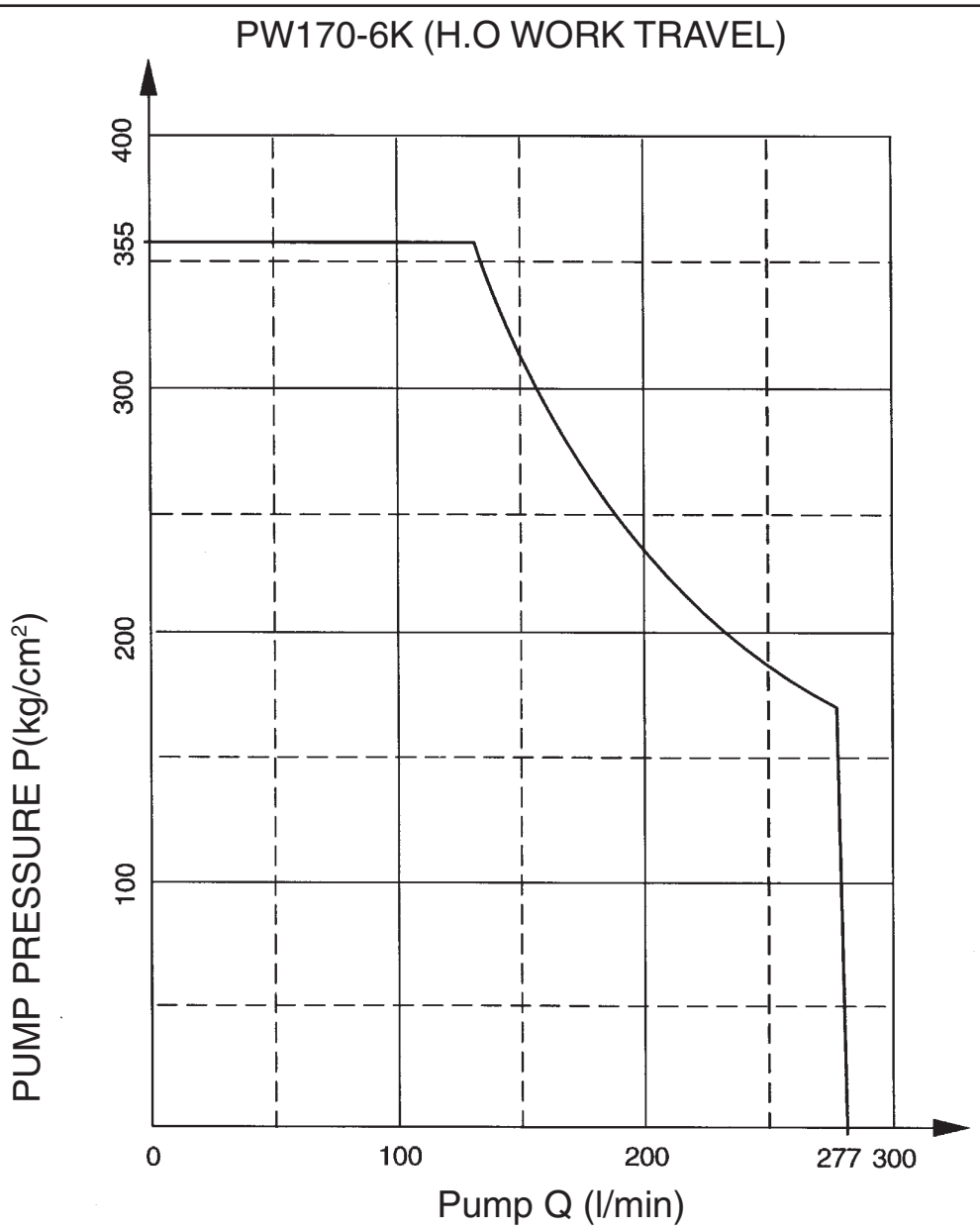
Machine model				PW170-6K	
Category	Item	Measurement conditions	Unit	Standard value	Permissible value
Swing	Hydraulic drift of swing	 KW130P6048 • Engine stopped • Hydraulic oil temperature: 45 - 55°C • Set machine on 15° slope, and set upper structure at 90° to the side • Make match marks on swing circle outer race and track frame • Measure distance that match marks move apart after 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	cc/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 50 m on flat ground.	Lo	sec.	36	30-42
			Mi		18	15-21
			Hi	20 kph sec	9	8.6 - 9.4
				30 kph sec	6	5.8 - 6.2
	Hydraulic drift of travel	 KW130P6050 • Engine stopped • Hydraulic oil temperature: 45 - 55°C • Stop machine on 12° slope • Apply park brake • Measure the distance the machine moves in 5 minutes	mm	0	0

Applicable model					PW170-6K	
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 • Disconnect flushing line	ℓ/min	Front travel motor (80 cc displacement): 4.0 max. Rear travel motor (200 cc displacement): 5.3 max.	-
Work equipment	Hydraulic drift of work equipment	Total work equipment (hydraulic drift at tip of bucket teeth)	Posture for measurement  PW170: 1350 kg 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. 265	Max. 400
		Boom cylinder (amount of retraction of cylinder)			Max. 5	Max. 7.5
		2nd Boom cylinder (amount of extension of cylinder)			Max. 5	Max. 7.5
		Arm cylinder (amount of extension of cylinder)			Max. 30	Max. 45
		Bucket cylinder (amount of retraction of cylinder)			0	0
	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	3.7±0.4	Max. 4.5
				LOWER	2.8±0.3	Max. 3.2
					sec.	

Applicable model						PW170-6K	
Cate-gory	Item		Measurement conditions		Unit	Standard value	Permissible value
	Work equipment speed	Arm cylinder fully retracted ↕ fully extended	 KW130P6054 • Engine at high idling • Hydraulic oil temperature: 45 - 55°C	IN	sec	3.7±0.4	Max. 4.6
				OUT		3.2±0.3	Max. 3.8
		Bucket cylinder fully retracted ↕ fully extended	 KW130P6055 • Engine at high idling • Hydraulic oil temperature: 45 - 55°C	CURL		3.8±0.4	Max. 4.6
				DUMP		2.6±0.3	Max. 3.2
Work equipment	Time lag	Boom	 KW130P6056 • Lower boom and measure time taken from point where bucket contact ground to point where chassis rises from ground • Engine at low idling • Hydraulic oil temperature: 45 - 55°C			Max. 2.0	Max. 3.0
		Arm	 KW130P6057 • Stop arm suddenly and measure time taken for arm to stop • Engine at low idling • Hydraulic oil temperature: 45 - 55°C			Max. 1.0	Max. 2.8

Applicable model					PW170-6K	
Category	Item		Measurement conditions	Unit	Standard value	Permissible value
Work equipment	Time lag	Bucket Cylinders Center swivel joint	 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. 2.0	Max. 3.0
	Internal leakage		• Engine at high idling • Hydraulic oil temperature: 45 - 55°C • Relieve circuit to be measured	cc/min	Max. 3.5	15
					10	50

Category: Performance of hydraulic pump



- pump speed: At 2.200 rpm, TVC current 330 mA

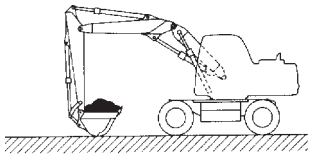
Check point	Test pump discharge pressure (MPa (kg/cm²)	Standard value for discharge amount Q(l/min)	Judgement standard lower limit Q(l/min)
As desired	P	See graph	See graph

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

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

Flow control characteristics of TVC valve (STD)

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

Cate-gory	Item	Measurement conditions	Unit	PW170-6K
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	4.2±0.2

STANDARD VALUE TABLE FOR ELECTRICAL PARTS

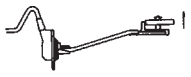
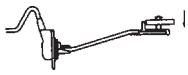
System	Name of component	Connector No.	Inspection method	Judgement table	Measurement conditions
Control system	Fuel control dial	E06 (male)	Measure resistance	If the condition is within the range shown in the table below, it is normal Between (1) - (2): 0.25 - 7 kΩ Between (2) - (3): 0.25 - 7 kΩ Between (1) - (3): 4 - 6 kΩ	1) Turn starting switch OFF. 2) Disconnect connector.
	Governor motor: Potentiometer	E04 (male)	Measure resistance	If the condition is within the range shown in the table below, it is normal Between (1) - (2): 0.25 - 7 kΩ Between (2) - (3): 0.25 - 7 kΩ Between (1) - (3): 4 - 6 kΩ	1) Turn starting switch OFF. 2) Disconnect connector.
	Governor motor: Motor	E05 (male)	Measure resistance	If the condition is as shown in the table below, it is normal Between (1) - (2): 2.5 - 7.5 Ω Between (3) - (4): 2.5 - 7.5 Ω Between (1) - (3): No continuity Between (1) - chassis: No continuity Between (3) - chassis: No continuity	1) Turn starting switch OFF. 2) Disconnect connector.
	Engine speed sensor	E07	Measure resistance	If the condition is within the range shown in the table below, it is normal Between(male) (1) - (2): 500 - 1,000 Ω Between(male) (2) - chassis: Min. 1 MΩ	1) Turn starting switch OFF. 2) Disconnect connector.
			Measure voltage	Measure with AC range Between (1) - (2): 0.5 - 3.0 V	1) Start engine. 2) Insert T-adapter.
			Adjust	1) Screw in rotation sensor until it contacts ring gear, then turn back 1 ± 1/6 turns. 2) It must work normally when adjusted as above.	
	PPC oil pressure switch	Travel (Auto\decel) G75/S15 Travel (Park brake buzzer) G156 Travel (Auto' susp' lock) G132 2 piece boom/ stabiliser S12, S13, S14 Service S09 Service G72 boom RAISE S02 arm OUT S03 boom LOWER S04 arm IN S05 bucket CURL S06 bucket DUMP S07 swing S08/S10	Measure resistance	If the condition is as shown in the table below, it is normal When boom, arm, and bucket levers are operated Between (male) (1) - (2): All levers at neutral: Min 1 MΩ Between (male) (1) - (2): Levers operated: Max. 1 Ω Between (male) (1), (2) - chassis: Min. 1MΩ	1) Start engine (or with engine stopped and accumulator charged) 2) Disconnect connectors S01 - S08
	Fuel shut-off valve	E09 (male)	Measure resistance	If the condition is within the range shown in the table below, it is normal Between (A) - (C): 46.5 - 56.9 kΩ Between (B) - (C): 0.87 - 1.07 kΩ	1) Turn starting switch OFF 2) Disconnect connector

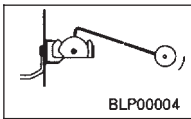
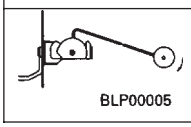
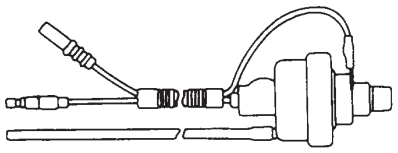
System	Name of component	Connector No.	Inspection method	Judgement table	Measurement conditions
Control system	Pump pressure sensor	C08 (male) (front)	Measure voltage	If the condition is as shown in the table below, it is normal Between (2) - (1): 18 - 28 V Between (3) - (1): All levers at neutral: 0.5 - 1.5 V; At arm IN relief: 3.1 - 4.5 V	1) Start engine. 2) Turn fuel control dial to MAX position 3) Insert T - adapter
	Swing lock switch	X05 (female)	Measure resistance	It the condition is as shown in the table below, it is normal Between (1) - (2) / Between (3) - (4): When switch is OFF: Min. 1 MΩ; When switch is ON: Max. 1 Ω	1) Turn starting switch OFF. 2) Disconnect connector C02
	TVC solenoid valve	C13 (male)	Measure resistance	If the condition is as shown in the table below, it is normal Between (1) - (2): 10 - 22 Ω Between (1), (2) - chassis: Min. 1 MΩ	1) Turn TVC prolix switch OFF. 2) Turn starting switch OFF. 3) Disconnect connector C13
	Swing holding brake solenoid valve	V04 (male)	Measure resistance	If the condition is within the range shown in the table below, it is normal Between (1) - (2): 20 -60 Ω Between (1), (2) - chassis: Min. 1 MΩ	1) Turn starting switch OFF. 2) Disconnect connector VO6
	Travel speed solenoid valve	V06 (male)	Measure resistance	If the condition is within the range shown in the table below, it is normal Between (1) - (2): 20 -60 Ω Between (1), (2) - chassis: Min. 1 MΩ	1) Turn starting switch OFF. 2) Disconnect connector V04
	Suspension lock solenoid valve	G25 (male)	Measure resistance	If the condition is within the range shown in the table below, it is normal Between (1) - (2): 20 -60 Ω Between (1), (2) - chassis: Min. 1 MΩ	1) Turn starting switch OFF. 2) Disconnect connector V05.
	2 step relief solenoid valve	V05 (male)	Measure resistance	If the condition is within the range shown in the table below, it is normal Between (1) - (2): 20 -60 Ω Between (1), (2) - chassis: Min. 1 MΩ	1) Turn starting switch OFF. 2) Disconnect connector V25
	Safety lock solenoid valve	V07 (male)	Measure resistance	If the condition is within the range shown in the table below, it is normal Between (1) - (2): 20 -60 Ω Between (1), (2) - chassis: Min. 1 MΩ	1) Turn starting switch OFF. 2) Disconnect connector V07

System	Name of component		Connector No.	Inspection method	Judgement table	Measurement conditions
Control system	LS-EPC solenoid		C10 (male)	Measure resistance	If the condition is within the range shown in the table below, it is normal Between (1) - (2): 7 - 14 Ω Between (1), (2) - chassis: Min. 1 MΩ	1) Turn starting switch OFF. 2) Disconnect connector C10.
	Covernor, pump controller	Power source voltage	C01 C02	Measure voltage	If the condition is within the range shown in the table below, it is normal Between C01 (7), (13) - (6), (12): 20 - 30 V Between C02 (11), (21) - (12): 20 - 30 V	1) Turn starting switch ON. 2) Insert T - adapter
		Fuel control dial	C03	Measure voltage	If the condition is as shown in the table below, it is normal Between (7) - (17) (power source): 4.75 - 5.25 V Between (4) - (17) (low idling): 4.0 - 4.75 V Between (4) - (17) (high idling): 0.25 - 1.0 V	1) Turn starting switch ON. 2) Insert T - adapter
		Governor potentiometer	C03	Measure voltage	If the condition is as shown in the table below, it is normal Between (14) - (17) (low idling): 2.9 - 3.3 V Between (14) - (17) (high idling): 0.5 - 0.9 V Between (7) - (17) (power source): 4.75 - 5.25 V	1) Turn starting switch ON. 2) Insert T - adapter
		Coolant temperature sensor	P07 (male)	Measure resistance	If the condition is as shown in the table below, it is normal Normal temperature (25°C): Aprrox. 37 - 50 kΩ 100°C: Aprrox. 3.5 - 4.0 kΩ	1) Turn starting switch OFF. 2) Disconnect connector P07 3) Insert T - adapter into connector at sensor end.
		Governor motor	C02	Measure voltage	If the condition is as shown in the table below, it is normal Between (2) - (3): 1.8 - 4.6 V Between (4) - (5): 1.8 - 4.6 V	1) Turn starting switch ON. 2) Insert T - adapter.
		Battery relay	C01	Measure voltage	If the condition is within the range shown in the table below, it is normal Between (1) - (6): 20 - 30 V ★This is only for 2.5 sec after the starting switch 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	Governor, pump controller	Swing holding brake solenoid	C01	Measure voltage	If the condition is as shown in the table below, it is normal When either swing or work equipment control lever is operated (solenoid ON, swing holding brake cancelled) — Between (3) - (6), (12) — 0 - 3 V Approx. 5 sec after swing lever and work equipment control levers are placed at neutral (solenoid OFF, swing holding brake applied) — Between (3) - (6), (12) — 20 - 30 V	1) Start engine. 2) Turn swing lock switch OFF. 3) Turn swing lock prolix switch OFF. 4) Insert T - adapter. ★ The lever can be operated slightly (without moving the equipment).
		Travel speed solenoid	C01	Measure voltage	If the condition is as shown in the table below, it is normal With travel speed switch at Hi (solenoid OFF) — Between (9) - (6), (12) — 20 - 30 V When travel speed switch is at Lo or Mi (solenoid ON) — Between (9) - (6), (12) — 0 - 3 V	1) Start engine. 2) Insert T - adapter. 3) Turn fuel control dial to MAX position. 4) Operate the lever slightly not enough to move the machine. To check that the solenoid is OFF, measure with the fuel control dial at LOW (1200 rpm or below)
		Suspension lock	C01	Measure voltage	If the condition is as shown in the table below, it is normal When the suspension lock switch is in the "Axle Locked" position (solenoid ON, axle cylinders locked) — Between (2) - (6), (12) — 0 - 3 V When the suspension lock switch is in the "Axle Free" position (solenoid OFF, axle cylinders unlocked) — Between (2) - (6), (12) — 20 - 30 V	1) Turn starting switch ON. 2) Isert T - adapter. ★ The lever can be operated slightly (without moving the equipment).
		2-stage relief solenoid	C01	Measure voltage	If the condition is as shown in the table below, it is normal. When travel is operated independently (solenoid ON) — Between (10) - (6), (12) — 0 - 3 V When levers and pedals are at neutral (solenoid OFF) — Between (10) - (6), (12) — 20 - 30 V	1) Turn starting switch ON. 2) Insert T - adapter. ★ The lever can be operated slightly (without moving the equipment).

<table>
<tr><th>System</th><th colspan="2">Name of component</th><th>Connector No.</th><th>Inspection method</th><th>Judgement table</th><th>Measurement conditions</th></tr>
<tr><td rowspan="6">Control system</td><td rowspan="6">Governor, pump controller</td><td>TVC solenoid valve (default value)</td><td>C02</td><td>Measure current</td><td>If the condition is as shown in the table below, it is normal
• G/O mode (Hi-idle, swing lock off lever neutral
<table><tr><td>Between front (8) - (18)</td><td>410 ± 40 mA</td></tr></table></td><td>1) Turn starting switch ON.
2) Turn fuel control dial to MAX positon
3) Turn prolix switch OFF.</td></tr>
<tr><td>LS-EPC solenoid valve (default value)</td><td>C02</td><td>Measure current</td><td>If the condition is as shown in the table below, it is normal
• G/O mode
<table><tr><td>Between (7) - (17)</td><td>800 ± 80 mA</td></tr></table></td><td>1) Turn starting switch ON.
2) Turn fuel control dial to MAX position
3) All levers at neutral.</td></tr>
<tr><td>RH and LH lever switches</td><td>C03</td><td>Measure voltage</td><td>If the condition is as shown in the table below, it is normal
<table><tr><td>When switch is ON</td><td rowspan="2">Between (9) - GND</td><td>20 - 28 V</td></tr><tr><td>When switch is OFF</td><td>0 - 1 V</td></tr></table></td><td>1) Turn starting switch ON.
2) Insert T - adapter.</td></tr>
<tr><td>S-NET</td><td>C17</td><td>Measure voltage</td><td>If the condition is as shown in the table below, it is normal
<table><tr><td>Between (4), (12) - GND</td><td>4 - 8 V</td></tr></table></td><td>1) Turn starting switch ON.
2) Insert T - adapter</td></tr>
<tr><td>No. 2 throttle signal</td><td>Monitoring code 16</td><td>Engine speed</td><td>If the condition is as shown in the table below, it is normal
High idling (rpm)
<table><tr><td>H/O</td><td>Approx. 2100</td></tr><tr><td>G/O</td><td>Approx. 2100</td></tr><tr><td>F/O</td><td>Approx. 2100</td></tr><tr><td>L/O</td><td>Approx. 1990</td></tr><tr><td>Power max. (H/O) (G/O)</td><td>Approx. 2500</td></tr><tr><td>Swift slow-down (H/O) (G/O)</td><td>Approx. 1990</td></tr></table></td><td>1) Start engine.
2) Set monitoring code to 10 or 16 (command value).
3) Operate working mode switch and L.H. knob switch.</td></tr>
<tr><td>Model selection</td><td>C17 - C02</td><td>Continuity</td><td>If the condition is as shown in the table below, it is normal
<table><tr><td>Between selection 1</td><td>C17 (5) - C02 (11)</td><td>No continuity</td></tr><tr><td>Between selection 2</td><td>C17 (13) - C02 (11)</td><td>Continuity</td></tr><tr><td>Between selection 3</td><td>C17 (6) - C02 (11)</td><td>No continuity</td></tr><tr><td>Between selection 4</td><td>C17 (14) - C02 (11)</td><td>No continuity</td></tr><tr><td>Between selection 5</td><td>C17 (7) - C02 (11)</td><td>No continuity</td></tr></table></td><td>1) Turn starting switch OFF.
2) Disconnect connector.
3) Connect T - adapter to wiring harness end.</td></tr>
</table>

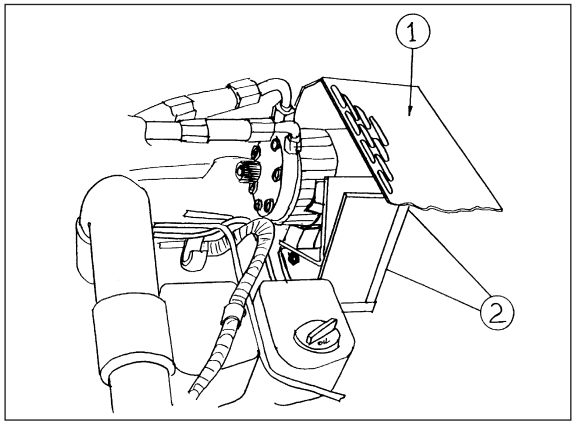
<table>
<tr><th>System</th><th>Name of component</th><th>Connector No.</th><th>Inspection method</th><th>Judgement table</th><th>Measurement conditions</th></tr>
<tr><td rowspan="4">Monitor</td><td rowspan="3">Engine speed sensor</td><td rowspan="3">E07</td><td>Measure resistance</td><td>If the condition is within the range shown in the table below, it is
<table><tr><td>Between (1) - (2)</td><td>500 - 1000 Ω</td></tr><tr><td>Between (2) - chassis</td><td>Min. 1 MΩ</td></tr></table></td><td>1) Turn starting switch OFF.
3) Disconnect connector.</td></tr>
<tr><td>Measure voltage</td><td>Measure with AC range
<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 rotation sensor until it contacts 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 resistance</td><td>If the condition is as shown in the table below, it is normal
<table><tr><td>Above LOW level in sub-tank</td><td>Max. 1Ω</td></tr><tr><td>Below LOW level in sub-tank</td><td>Min. 1MΩ</td></tr></table></td><td>1) Turn starting switch OFF.
2) Disconnect connecter 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 resistance</td><td>If the condition is as shown in the table below, it is normal
<table><tr><td> 
BLP00002</td><td>Raise float</td><td>Max. 1Ω</td></tr><tr><td> 
BLP00003</td><td>Lower float</td><td>Min. 1MΩ</td></tr></table></td><td>1) Turn starting switch OFF.
2) Disconnect connector P05
3) Drain oil, then remove sensor.</td></tr>
</table>

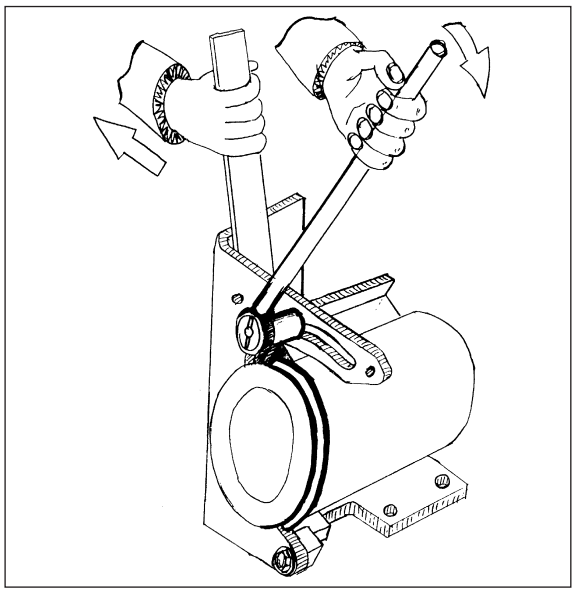
<table>
<tr><th>System</th><th>Name of component</th><th>Connector No.</th><th>Inspection method</th><th>Judgement table</th><th>Measurement conditions</th></tr>
<tr><td rowspan="3">Monitor</td><td>Engine oil pressure sensor</td><td>P10</td><td>Measure resistance</td><td>If the condition is as shown in the table below, it is normal.
Low pressure sensor
<table><tr><td>Pressure rising</td><td>Opens at 0.110 ± 0.014 MPa (Non continuity) (1.12 ± 0.14 kg/cm²)</td></tr><tr><td>Pressure dropping</td><td>Closes at 0.08 ± 0.014 MPa (Continuity) (0.85 ± 0.14 kg/cm²)</td></tr></table>Sensor connector
 
</td><td>1) Install oil pressure measuring gauge.
2) Remove wiring harness terminal.
3) Start engine.
4) Put tester in contact between sensor terminals A & C.</td></tr>
<tr><td>Fuel level sensor</td><td>P06 (male)</td><td>Measure resistance</td><td>If the condition is as shown in the table below, it is normal
<table><tr><td> 
BLP00004</td><td>Raise float to stopper</td><td>Approx. 12 Ω or below</td></tr><tr><td> 
BLP00005</td><td>Lower float to stopper</td><td>Approx. 85 - 110 Ω</td></tr></table></td><td>1) Turn starting switch OFF.
2) Disconnect 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> 
BLP00006</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>When engine is running (1/2 throttle or above) below, the sensor is defective.
→ 27.5 - 29.5 V
★ If the battery is old, or after starting in cold areas, the voltage may not rise for some time.</td><td>1) Start engine</td></tr>
<tr><td>Gauges</td><td colspan="3">
<table>
<tr><td></td><td>Position of gauge display</td><td>Display level resistance kΩ (Monitor panel input resistance)</td></tr>
<tr><td></td><td>Starting switch ON</td><td>Starting switch OFF</td></tr>
<tr><td>Measure resistance between coolant temperature gauge C03 (female) (1) - C03 (female) (16)</td><td>Right side
ALL OFF (15)
14
13
12
↑
11
10
9
Display position
8
7
6
↓
5
4
3
2
Left side
1</td><td>Min. - Max.
- 0.646
0.575 - 3.420
3.156 - 3.708
3.422 - 3.804
3.512 - 3.900
3.600 - 4.125
3.807 - 4.349
4.015 - 5.122
4.728 - 5.899
5.445 - 6.818
6.294 - 7.910
7.302 - 9.210
8.502 - 10.774
9.946 - 36.535
33.725 -</td></tr>
</table>
★ Levels 13 and 14 flash
<table>
<tr><td></td><td>Position of gauge display</td><td>Display level resistance kΩ (Monitor panel input resistance)</td></tr>
<tr><td></td><td>Starting switch ON</td><td>Starting switch OFF</td></tr>
<tr><td>Measure resistance between fuel level gauge C03 (female) (2) - chassis</td><td>Right side
14
13
12
11
↑
10
9
8
Display position
7
6
5
4
↓
3
2
1
Left side
ALL OFF (0)</td><td>Min. - Max.
- 13.82
11.71 - 17.43
15.18 - 21.25
18.90 - 25.05
22.59 - 28.45
25.82 - 31.85
29.18 - 35.22
32.45 - 39.91
37.00 - 44.60
41.77 - 48.72
45.52 - 55.14
50.42 - 64.35
60.61 - 77.07
72.98 - 69.15
638.00 - 69.15</td></tr>
</table>
★ Level 1 flashes.</td><td>1) Insert a dummy resistance with the starting switch OFF, or measure the resistance of the sensor.
2) Check the display with the starting switch ON.

1) Insert a dummy resistance with the starting OFF, or measure the resistance of the sensor.
2) Check the display with the starting switch ON.</td></tr>
</table>

CHECKING AND ADJUSTING BELT TENSION FOR AIR CONDITIONER COMPRESSOR





CHECKING

1. Remove belt guard ①.
2. 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. 6kg (13 1b.)

ADJUSTING

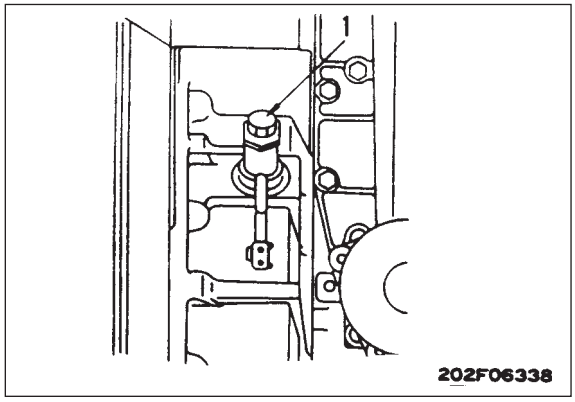
1. Loosen two nuts and bolts ②.
2. Carefully lever compressor housing as shown to tighten belt to tightness criteria. Tighten upper bolt to hold in position.
3. Tighten lower bolt.
4. Check each pulley for damage, wear of the V-groove and wear of the V-belt. In particular, be sure to check the V-belt is not touching the bottom of the V-groove.
5. Replace belt if it has streched, 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.

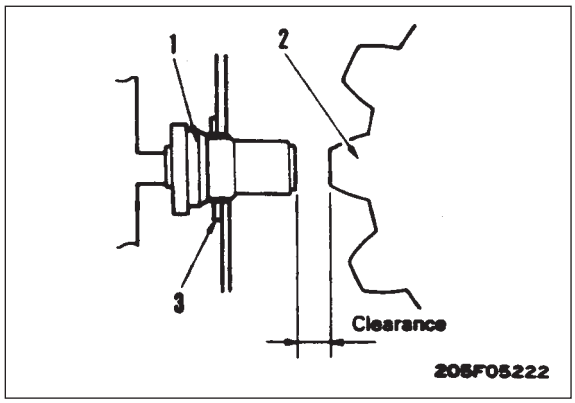
ADJUSTING ENGINE SPEED SENSOR

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).

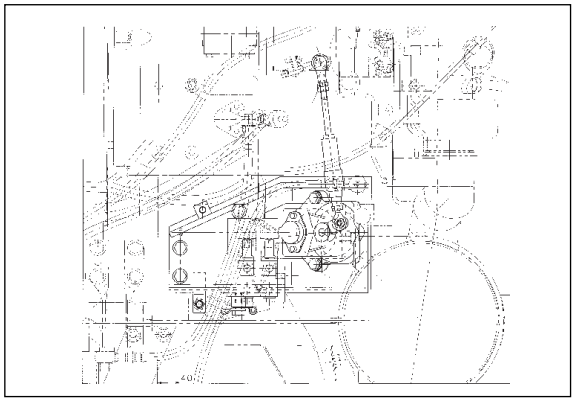
★ Be particularly careful when securing the sensor wiring to ensure that no excessive force is brought to bear on the wiring.

★ 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

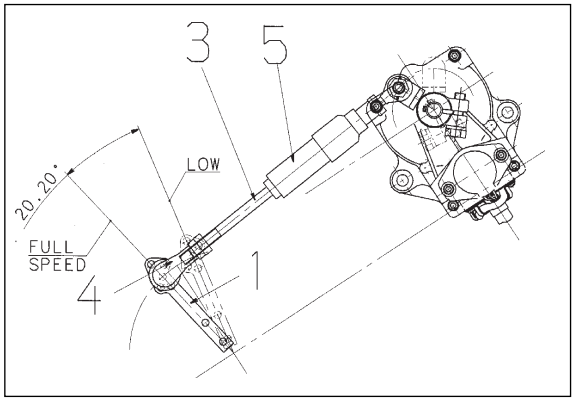


TESTING

1. Check engine speed at high idling in H/O work mode (ref: 20.23). If outside tolerance adjust as below
2. Check engine speed in H/O travelmode (lightly depress travel pedal until engine speed rises without machine moving) and at low idling.
3. If within tolerance checkis OK (ref 20.23)

ADJUSTMENT

Set engine speed at high idling in H/O work mode to standard value by adjusting linkage (ref: 20.23)



5. Confirm engine speeds are within tolerance according to:

No load engine speeds

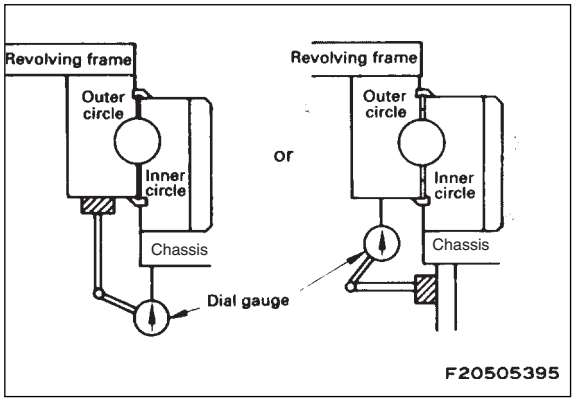
Condition	Fuel dial	PW170-6K
Low idle	Min.	950 ± 100
Auto decel	Max.	1400 ± 150
L.O.	Max.	1990 ± 100
G.O., F.O.	Max.	2100 ± 100
H.O.	Max.	2100 ± 100
H.O. + Arm*	Max.	2180 ± 100
*H.O. + Travel	Max.	2500 ± 100

★ To check these points ensure H.O. working mode is selected & then move either the arm wrist control or the travel pedal as required so that auto decel is cancelled but the machine does not move.

TESTING CLEARANCE OF SWING CIRCLE BEARING

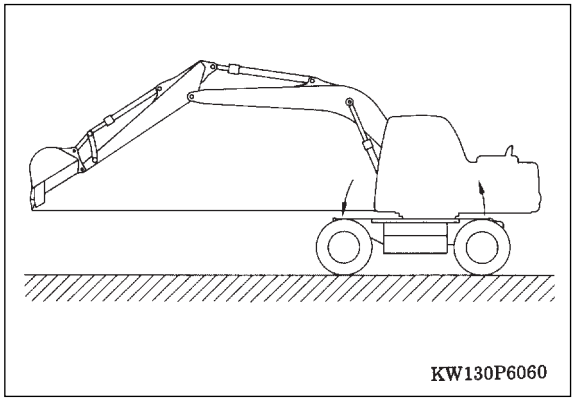
Method of testing clearance of swing circle bearing when mounted on machine

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.

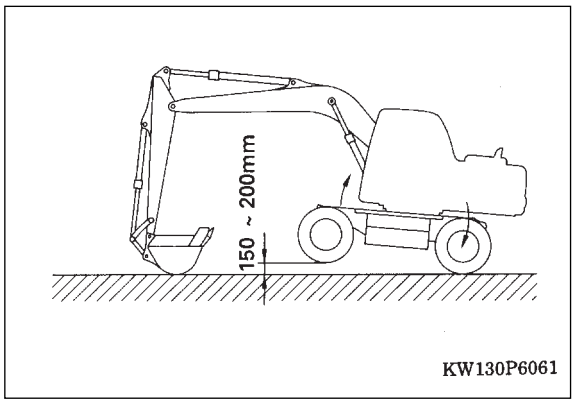


4. Set the arm more or less at right angles to the ground surface, then lower the boom until the front of the machine comes off the ground.
   When this is done, the upper structure will tilt back, so the front will rise and the rear will go down.

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 zero point. If it has not returned to 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.

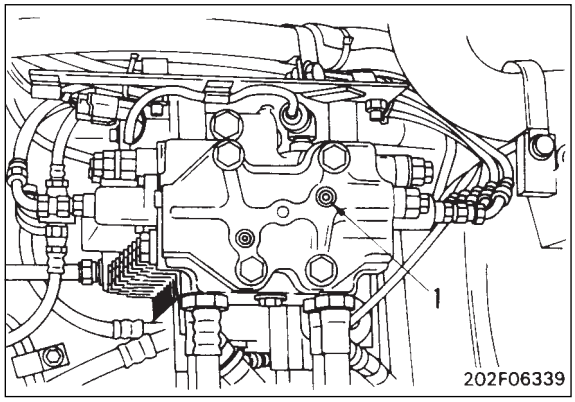
- Remove pressure pick-up plug (1) (Thread dia = 10 pitch = 1.25 mm) from the circuit to be measured, then install oil pressure gauge **C1** (58.8 MPa (600 kg/cm^2)).

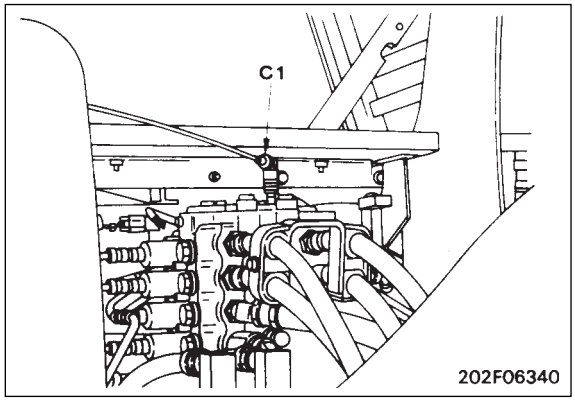
- **Measuring unload pressure**

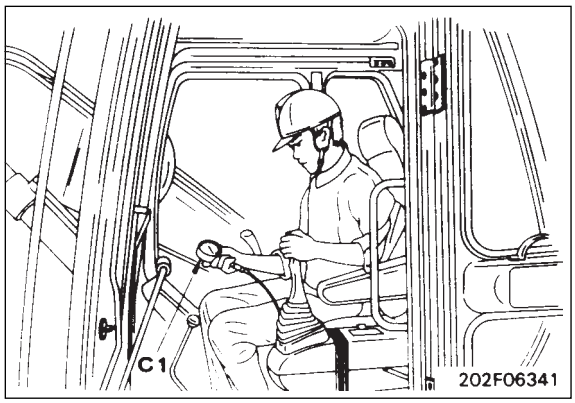
1. Measure the oil pressure in H/O mode with the engine at high idling and the control levers at neutral.

- **Measuring pump relief pressure**

1. Oil pressure when main relief pressure is at normal setting (31.9 MPa, 325 kg/cm^2)
   1) Measure the pressure when each actuator except the travel is relieved in G/O mode with 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.







2. When main relief pressure is raised (34.8 MPa (355kg/cm^2)).
   1) When travel is operated
      Measure the oil pressure 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 the boom, arm, or bucket circuits, and measure the oil pressure.

ADJUSTING

1. Main relief valve

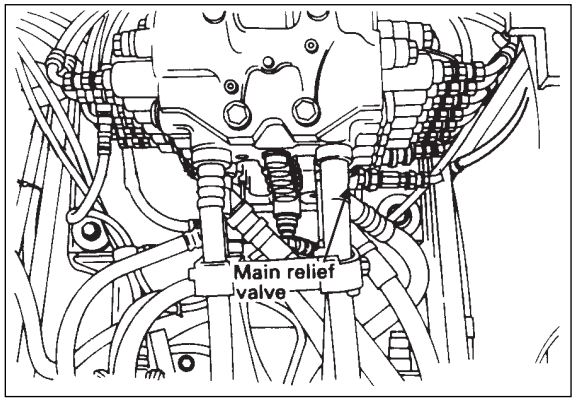
- Adjusting high set pressure end
  1) Loosen locknut (5)
     ★ Check that elbow (6) can move.
  2) Loosen locknut (3), then turn holder (4) to adjust.
     ★ Turn the holder to adjust as follows.
       - To INCREASE pressure, turn CLOCKWISE.
       - To DECREASE pressure, turn COUNTERCLOCKWISE.
  ★ Amount of adjustment for one turn of adjustment screw: 12.6 MPa (128kg/cm2).

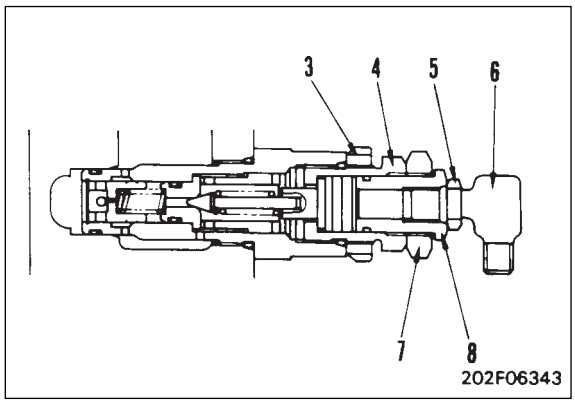
  kgm Locknut:
  58.8 ± 4.9 Nm (6 ± 0.5 kgm)

  ★ When the high pressure end is adjusted, the low pressure end also changes, so adjust the low pressure end also.
- Adjusting low set pressure end
  1) Loosen locknut (5).
     ★ Check that elbow (6) can move.
  2) 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 adjustment screw: 12.6 MPa (128 kg/cm^2).

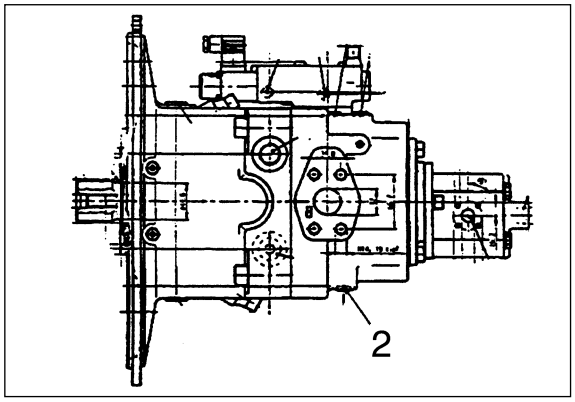
  kgm Locknut:
  44.1 ± 4.9 Nm (4.5 ± 0.5 kgm)

  ★ Normally, there is a pressure of approx. 1.27 MPa (13 kg/cm^2) or less applied to port Pr, but at the high pressure setting the pressure is approx. 2.94 MPa (30 kg/cm^2).





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



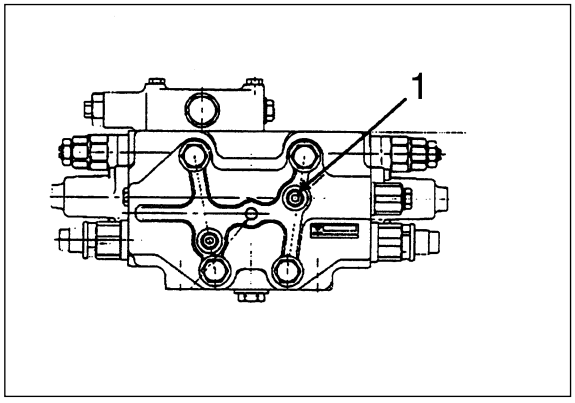
MEASURING

★ Hydraulic oil temperature when measuring: 45 - 55°C

• Measure the oil pressure when the circuit is relieved in the pressure rise mode.

1. Remove pressure measurement plugs (1) and (2) and install oil pressure gauge C1.
   ★ Install a 39.2 MPa (400 kg/cm^2) gauge to the servo end, and a 58.8 MPa (600 kg/cm^2) gauge to the pump outlet port end.
2. Set the swing lock switch ON.
3. Set the working mode to H/O mode.
4. Run the engine at high idling, push the L.H. knob switch ON, and measure the oil pressure when the arm IN circuit is relieved.

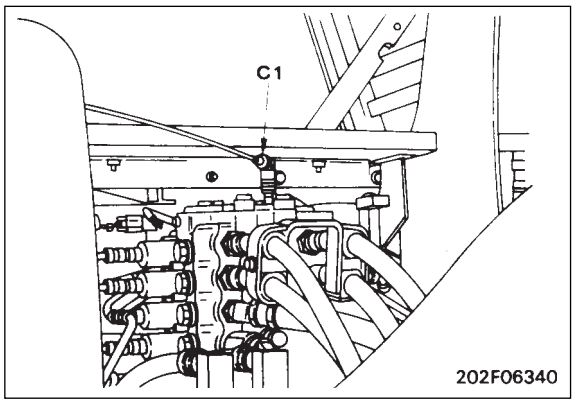
• Check that the servo piston input pressure is APPROX. 1/3 of the pump discharge pressure.

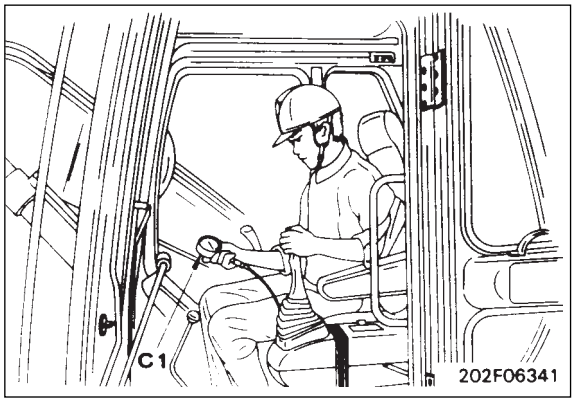


[Reference]

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

★ (1) Thread dia. = 10mm, Pitch = 1.25mm
(2) Thread dia. = 12mm, Pitch = 1.5mm





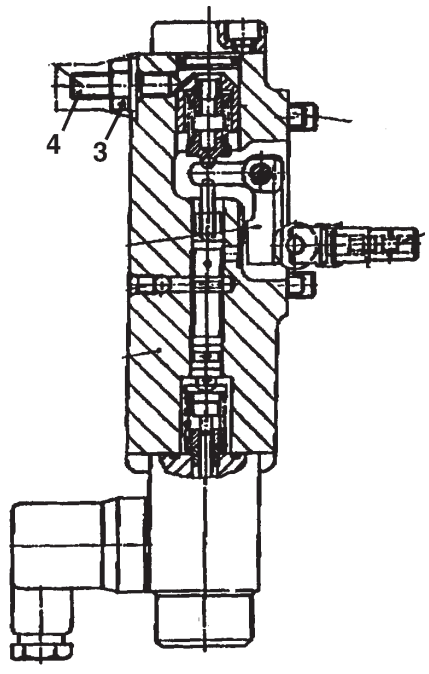
ADJUSTING

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

1. Loosen locknut (3), and if the speed is slow, turn screw (4) to the left; if the engine speed drops, turn the screw to the right.
   ★ If the screw is turned to clockwise the pump absorption torque will be increased, and if it is turned to anticlockwise pump absorption torque will be reduced.
2. After completing the adjustment, tighten thr locknut.

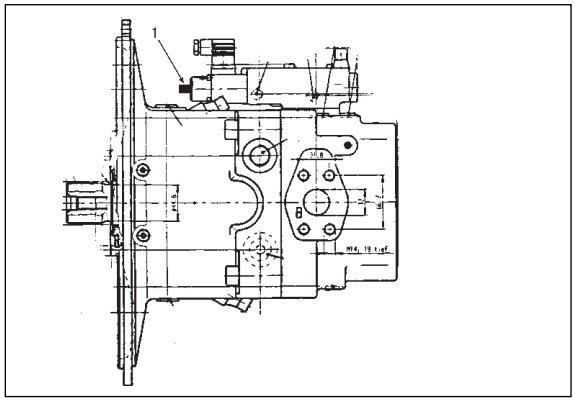
kgm Locknut:Nm (kgm)

★ Before the screw is adjusted please mark there to make clear the original position of the screw.



(TCV valve of main pump)

TESTING AND ADJUSTING LS DIFFERENTIAL PRESSURE

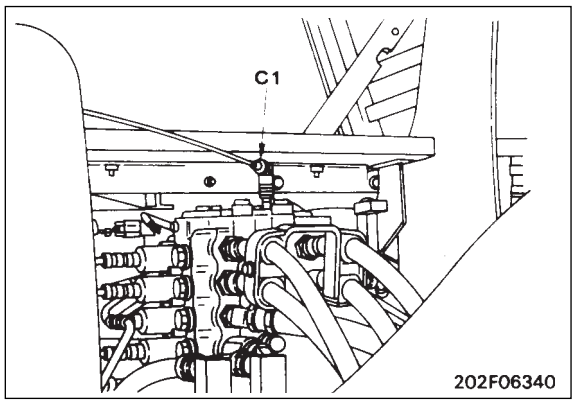


1. Measuring LS differential pressure
   1) Measuring with a differential pressure gauge
      I) Remove oil pressure measurement plug (1) (Thread dia. = 10 mm, Pitch = 1.25 mm), and install differential pressure gauge **C4**.
      II) Set to the conditions in Table 2 and measure the LS differential pressure.

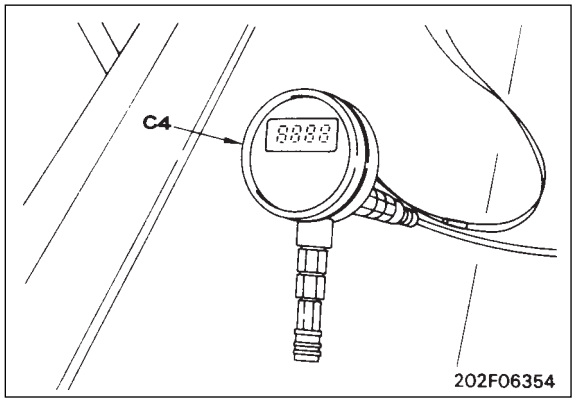
Table 2

Working mode	Fuel control dial	Operation	Differential pressure (MPa (kg/cm^2))
H/O mode	MAX	Pedal at neutral	3.9 ± 1.0 (40 ± 10)
H/O mode	MAX	Travel speed: Hi Travel circuit under no load (pedal fully operated)	$2.6\ ^{+0.1}_{-0}$ $(26\ ^{+1}_{-0})$

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

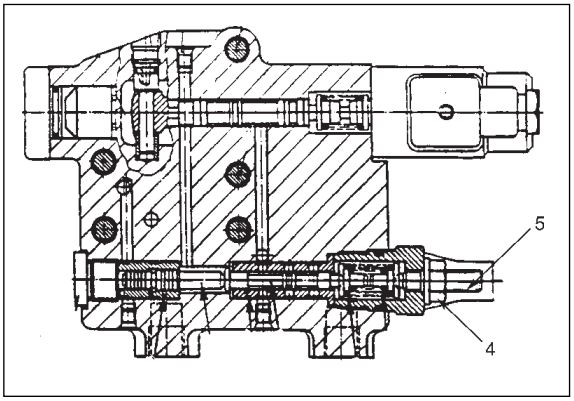


2) Measuring with oil pressure gauge
   ★ The maximum differential pressure is 3.9 MPa (40kg/cm^2), so measure with the same gauge.
   I) Remove oil pressure measurement plug (1) (thread dia. = 10mm, pitch = 1.25 mm), and install hydraulic tester **C1**.
   II) Install oil pressure gauge **C1** (58.8 MPa (600kb/cm^2)) to the measurement plug for the pump discharge pressure.
      ★ Use a gaugewith a scale in units of 0.98MPa (10kg/cm^2).
      If no 58.8 MPa (600kg/cm^2) pressure gauge is available, a 39.2 MPa (400kg/cm^2) pressure gauge can be used.
   III) Set to the conditions in Table 2 and measure the pump discharge pressure.
      ★ Stand directly in front of the indicator and be sure to read it correctly.
   IV) Remove oil pressure gauge **C1**, then install the LS pressure measurement plug.
   V) Set to the conditions in Table 2 and measure the LS pressure.
      ★ Stand directly in front of the indicator and be sure to read it correctly. (Pump discharge pressure) - (LS pressure) = differential pressure.



ADJUSTING

1. 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 the differential pressure as follows.
      - To INCREASE pressure, turn CLOCKWISE
      - To DECREASE pressure, turn COUNTER-CLOCKWISE
   2) After adjusting, tighten locknut (4)



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

Note: Always measure the differential pressure while adjusting. While adjusting as the wheels are rotating, care should be taken when leaning into the pump compartment. No loose clothing.

TESTING AND ADJUSTING PILOT CIRCUIT OIL PRESSURE

MEASURING

★ Hydraulic oil temperature when measuring 45 - 55°C

1. Remove pressure pick-up plug ① 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

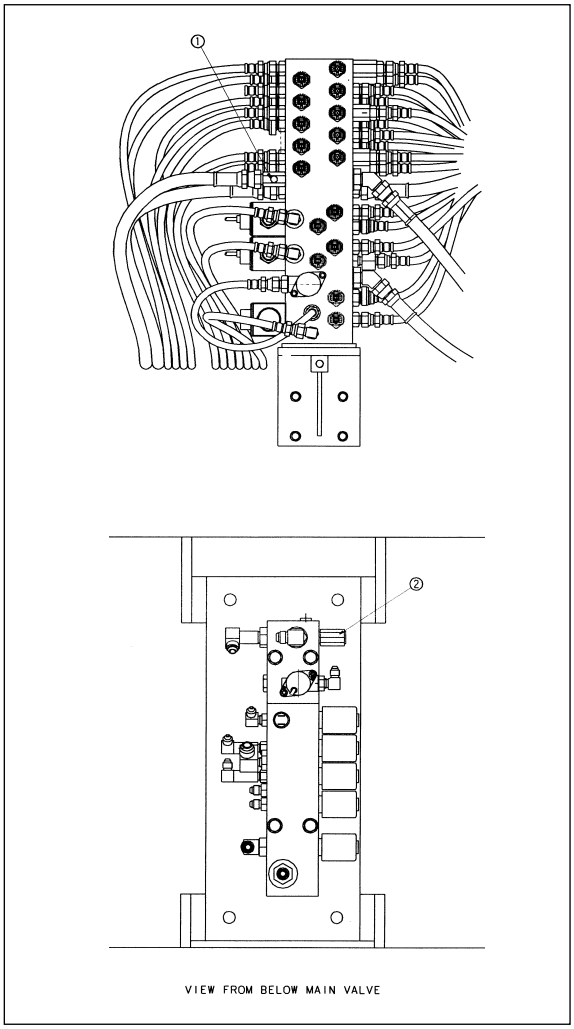
ALWAYS MEASURE WHILST ADJUSTING

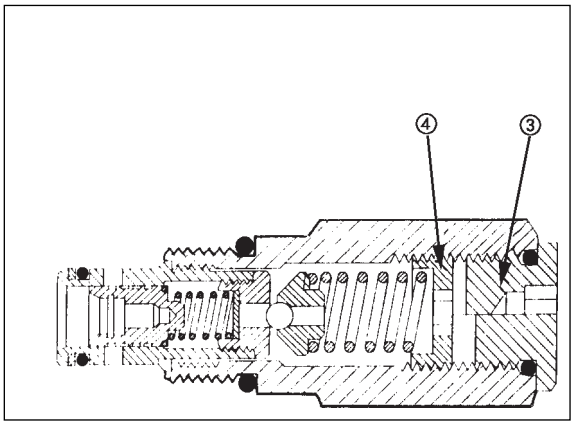
1. Remove cap ③ from PPC pressure reducing valve. Turn the adjustment sleeve ④ as follows:
   - To INCREASE pressure, turn CLOCKWISE.
   - To DECREASE pressure, turn COUNTERCLOCKWISE.

2. After adjustment tighten cap ③

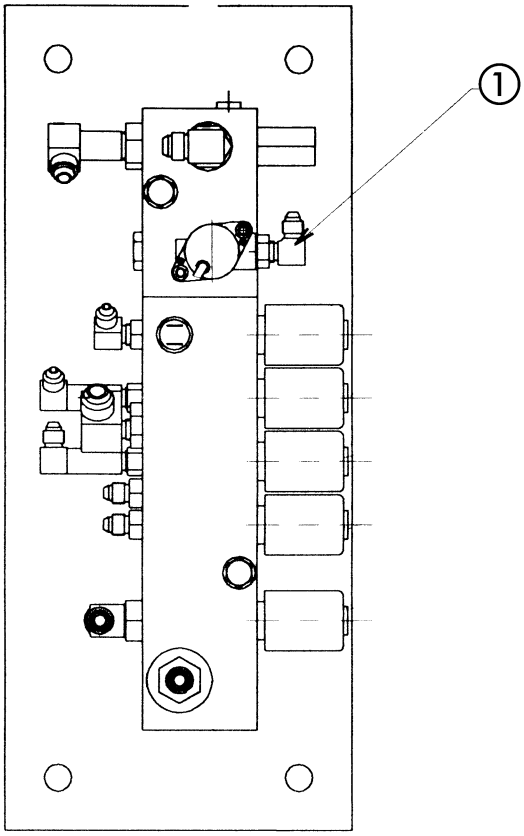
JUDGEMENT TABLE

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 EPC VALVE SOLENOID VALVE OUTPUT PRESSURE



MEASURING

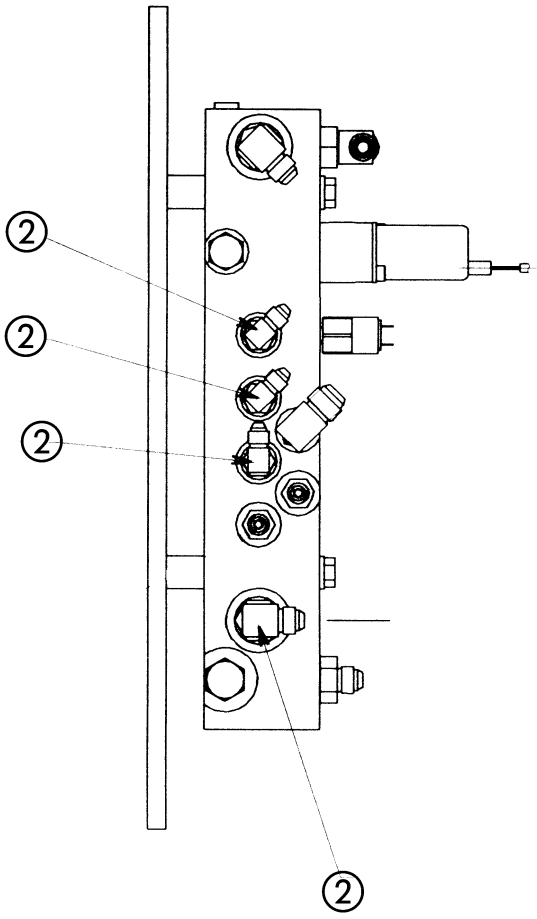
★ Hydraulic oil temperature when measuring 45 - 55°C

1. Measuring output pressure of LS control EPC solenoid valve
   1) Disconnect output hose (1) of the LS control EPC valve, then use adaptor C3 in the oil pressure gauge kit to install oil pressure gauge C1 (5.9MPa (60kg/cm²)).
   2. Measure the output pressure under the conditons in Table 1.

Table 1

Operation	Engine speed (rpm)	Output pressure MPa (kg/cm²)	(Reference) Current (A)
All control levers at neutral	Min. 1100	2.5 (26)	800 ± 80
Travel pedal operated, travel speed Hi	Max. 2500	0.2 ± 0.2 (2 ± 2)	0

★ Monitoring code 10 or 40 for engine speed
Monitoring code 15 for LS control EPC current



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

Table 2

Name of solenoid		Measurement conditions	Operating condition	Condition of solenoid	Oil pressure (MPa (kg/cm²))	Remarks
1	Swing brake	Swing or work equipment lever operated	Brake cancelled	ON	2.94±0.49 (30±5)	
		All levers except travel at neutral (5 sec after returning to neutral)	Brake actuated	OFF	0	
2	Travel speed	Travel speed switch at Hi Engine speed 1500 rpm or above Travel pedal operated	Travel speed Hi	OFF	0	Motor swash plate angle at minimum
		Travel speed selector switch at Lo or engine speed 1500 rpm or below	Trave speed Lo	ON	2.94±0.49 (30±5)	Motor swash plate angle at maximum
3	2-stage relief	Swing lock switch ON + work equipment lever operated	Pressure rise	ON	2.94±0.49 (30±5)	
		All levers at neutral	Normal pressure	OFF	0	
4	Suspension lock	Suspension lock switch ON	Sus lock actuated	ON	2.94±0.49 (30±5)	
		Suspension lock switch OFF	Sus lock cancelled	OFF	0	

Operation of solenoid valve

ON: Continuous (oil pressure generated)
OFF: Not continuous (oil pressure: 0)

MEASURING PPC VALVE OUTPUT PRESSURE AND TESTING PPC SHUTTLE VALVE

★ Hydraulic oil temperature when measuring:
45 - 55°C

1. Measuring PPC valve output pressure

1) Disconnect the hose of the circuit to be measured (see next page).
2) Install adapter **C3** between the hose and elbow.
3) Install oil pressure gauge **C1** (5.9 MPa (60kg/cm^2)) to adapter **C3**
4) Run the engine at high idling, operate the control lever of the circuit to be measured, and measure the oil pressure.

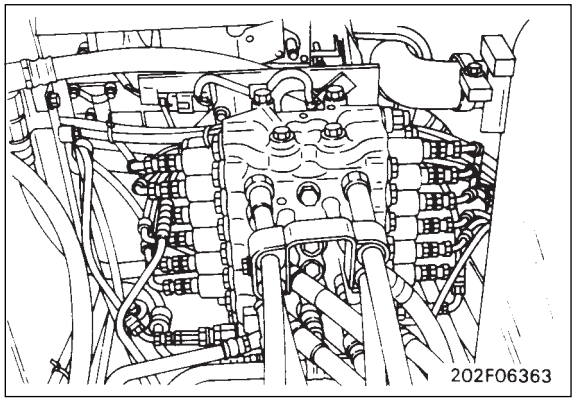
2. Checking PPC shuttle valve

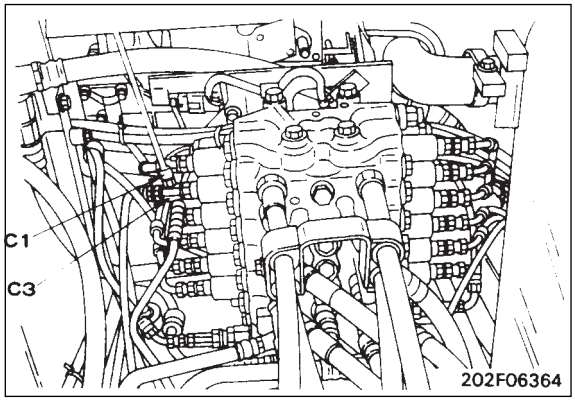
If the output pressure at the control valve end is low, check for leakage of oil from the PPC shuttle valve as follows.

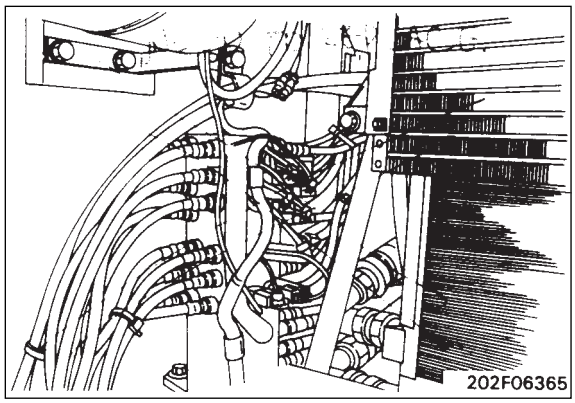
1) Disconnect the hose between the PPC valve and the shuttle block at the block end.
2) Install an adapter for measuring the oil pressure to the tip of the hose, then install blind plugs to the tip and shuttle block end.
3) Operate the control lever and measure the output pressure.
   ★ If the output pressure becomes normal, there is leakage from the PPC shuttle valve; if there is no change, the PPC valve is defective.

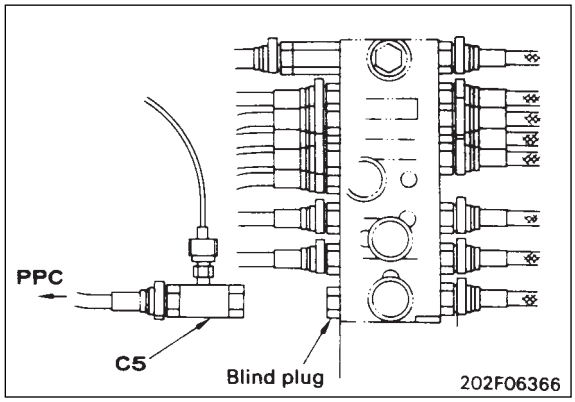
3. Checking defective operatio of PPC shuttle valve

1) Remove the oil pressure switch, fit adapter **C5**, then install oil pressure gauge **C1** (5.9 MPa (60kg/cm^2)).
2) Operate the applicable lever.
   ★ If no oil pressure is generated or if oil pressure is generated when another lever is operated, the operation of the PPC shuttle valve is defective.



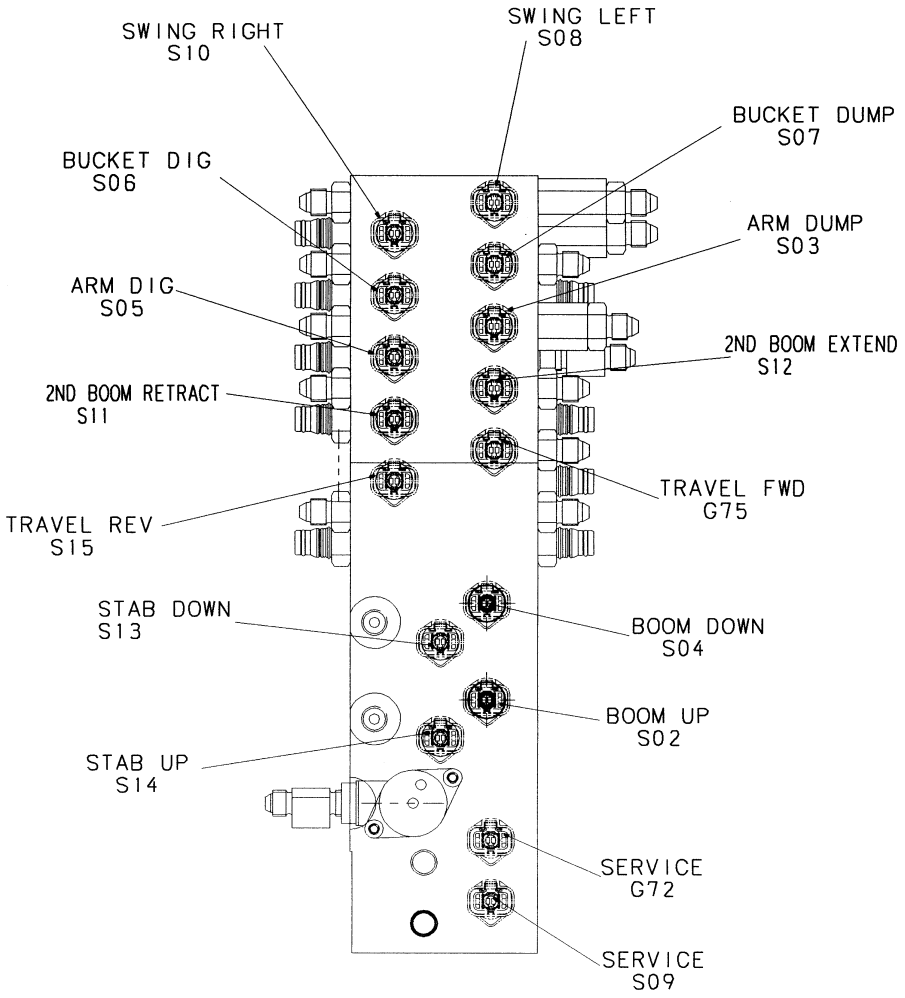


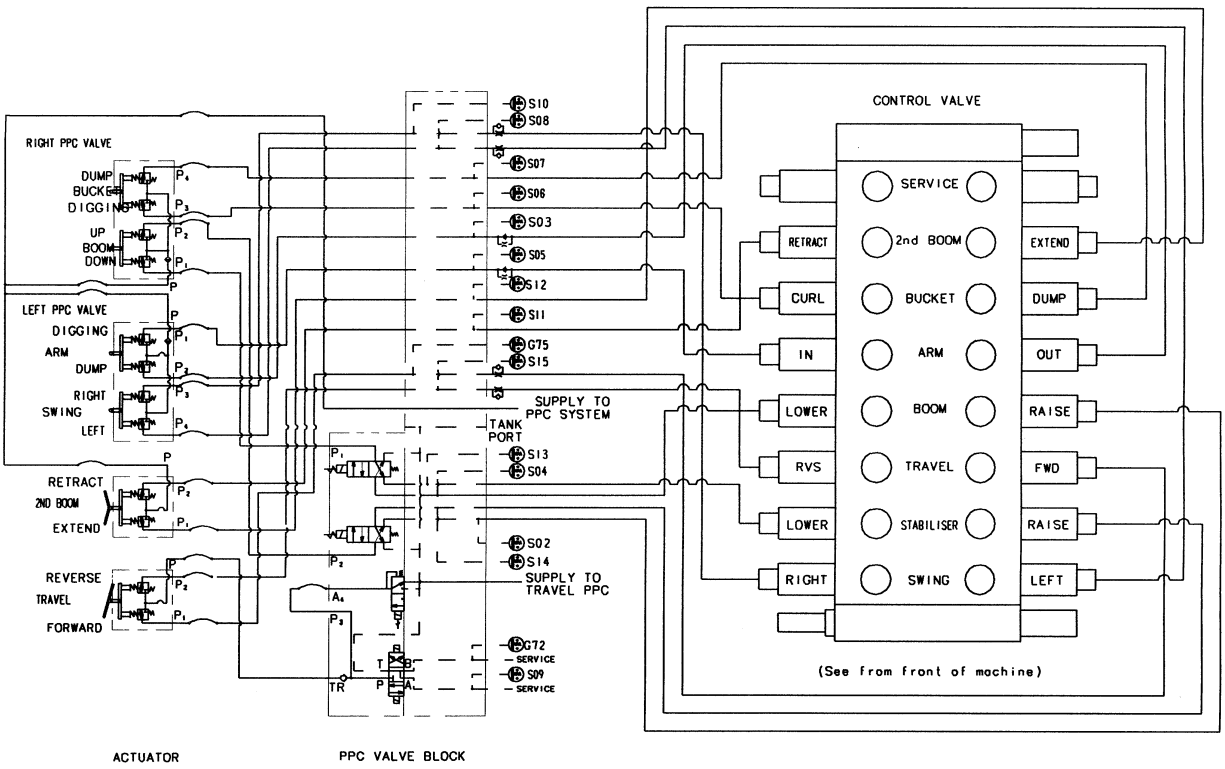




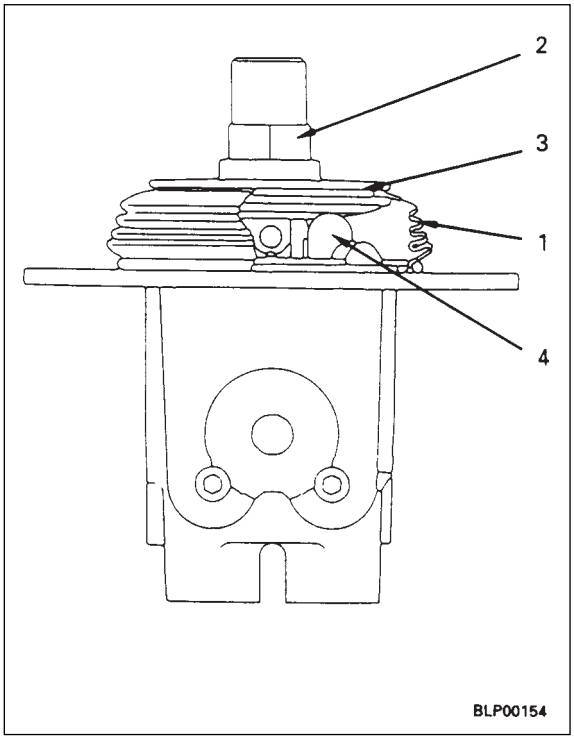
Pressure switch location diagram

Shuttle block seen from rear of machine





ADJUSTING WORK EQUIPMENT, SWING PPC VALVE



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

⚠ Lower the work equipment to the ground and stop the engine. Loosen the oil filler cap slowly to release the pressure inside the hydraulic tank.

1. Remove the PPC valve

2. Remove boot (1)

3. Loosen locknut (2), then screw in disc (3) until it contacts the 4 heads of piston (4).
   • When doing this do not move the piston.

4. Secure disc (3) in position, then tighten locknut (2) to the specified torque.
   kgm Locknut:
   45~55Nm (4.59±5.6kgm)

5. Install boot (1).

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

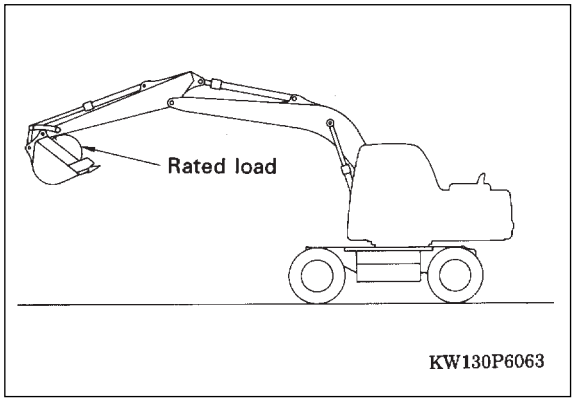
TESTING LOCATIONS CAUSING HYDRAULIC DRIFT OF WORK EQUIPMENT

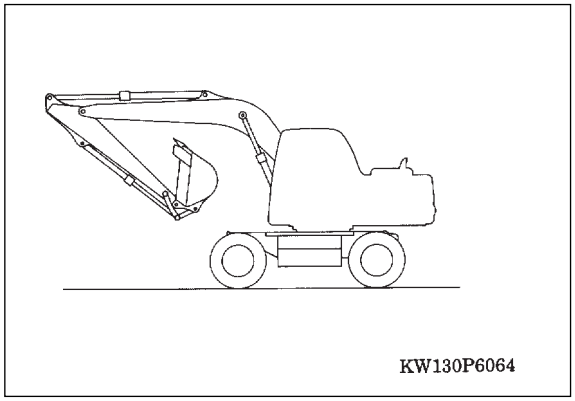
★ If there is any hydraulic drift in the work equipment (cylinders), check as follows to determine if the cause is in the cylinder packing or in the control valve.

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 valve), so the oil at the head end flows to the drain circuit and the downward movement becomes faster.

MEASURING OIL LEAKAGE

★ Hydraulic oil temperature when measuring:
45 - 55°C

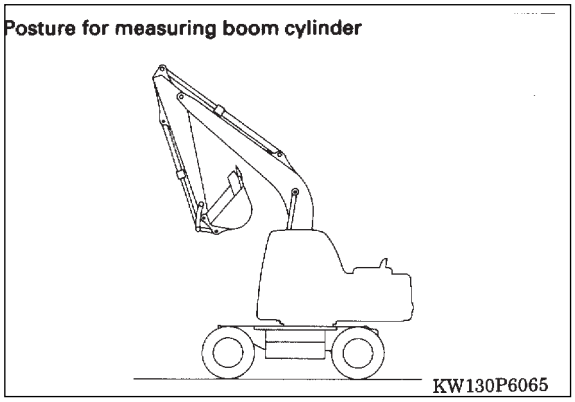
1. Work equipment cylinder

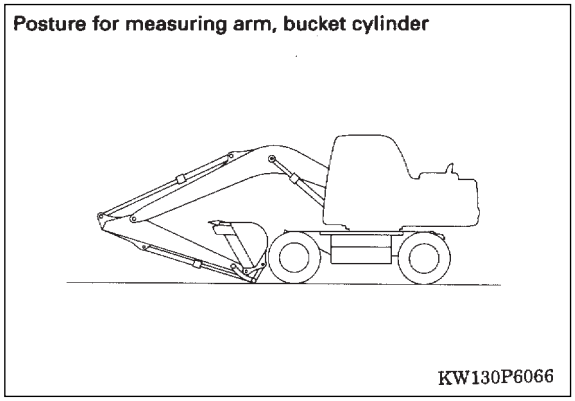
★ If the hydraulic drift of the work equipment is outside the standard value, measure the leakage inside the cylinder as follows, and judge if the cause of the hydraulic drift is in the cylinder or in the control valve.
- If the leakage is within the standard value, the problem is in the control valve.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

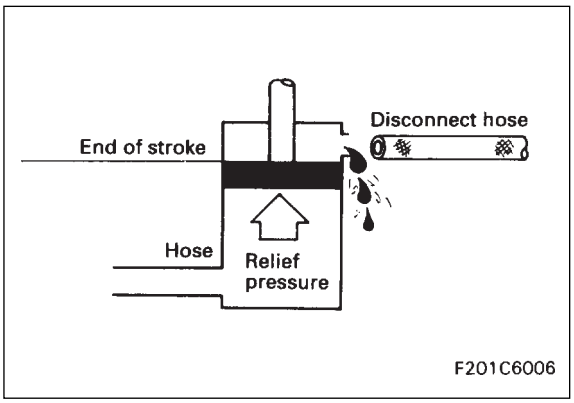
1) Fully extend the rod of the cylinder to be measured, then stop the engine.
2) Disconnect piping (1) at the head end, then block the piping at the chassis end with a blind plug.

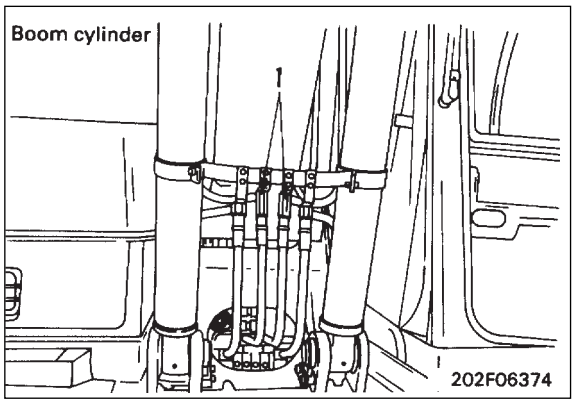
⚠ Be careful not to disconnect piping at the bottom end.

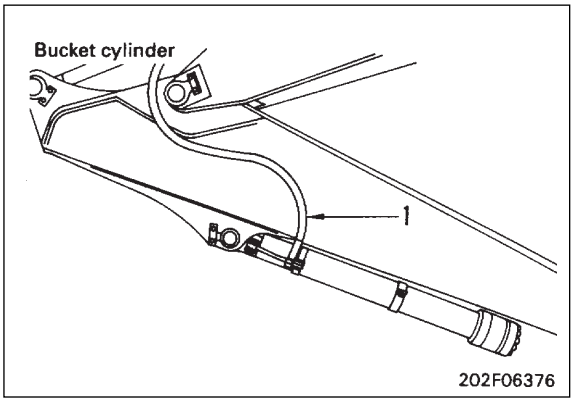
3) Start engine and apply relief pressure to the bottom end of the cylinder with the engine at high idling.
4) Continue this condition for 30 seconds, then measure the oil leakage for the next one minute.

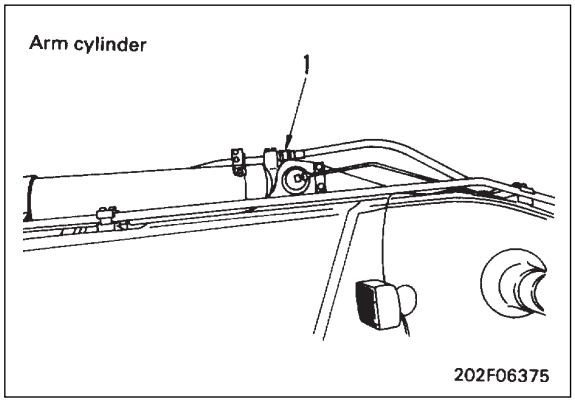




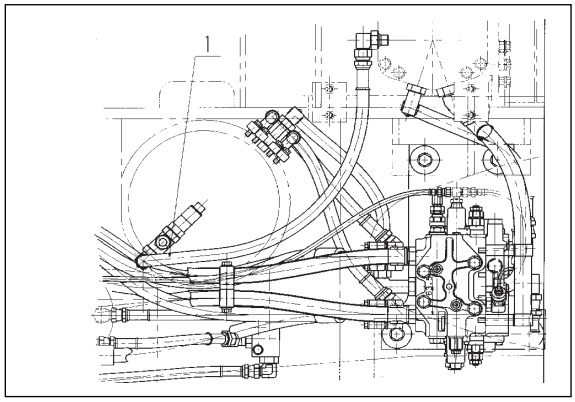








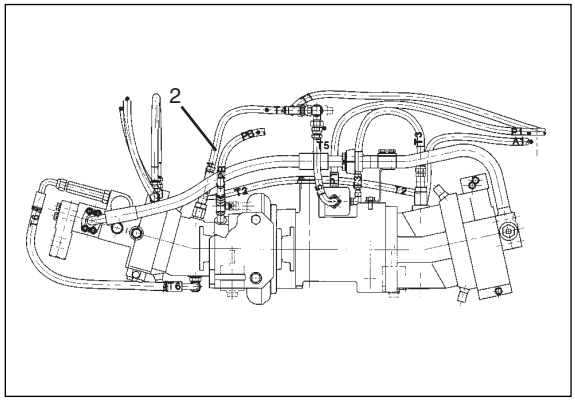
2. Swing motor
   1) Disconnect drain hose (1) from the swing motor, then fit a blind plug at the tank end.
   2) Turn the swing lock switch ON.
   3) Start the engine and operate the swing relief with the engine at high idling.
   4) Continue this condition for 30 seconds, then measure the oil leakage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



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

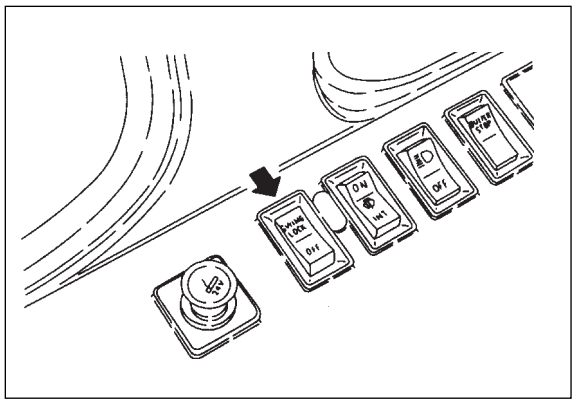
   ⚠ When measuring the oil leakage from the travel motor, mistaken operation of the control lever may lead to a serious accident, so always use signals and check when carrying out this operation.

   4) Continue this condition for 30 seconds, then measure the oil leakage for the next one minute.
      ★ When measuring move the motor slightly (to change the position between the valve plate and cylinder, and piston and cylinder), and measure several times.



RELEASING REMAINING PRESSURE IN HYDRAULIC CIRCUIT

★ No accumulator is installed, so the pressure remaining in the piping between the control valve and the hydralic 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 form pump	Start engine	Bleeding air form cylinder	Bleeding air form swing motor	Bleeding air form travel motor	Start operations
• Replace hydraulic oil • Clean strainer	○ →	○ →	○ →	○ (note 1) →	○ (note 1)	○
• 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 • Remove travel motor, swivel piping		○ →	→	→	○	○

Note 1: Bleed the air from the swing and travel motors only when the oil inside the motor case has been drained.

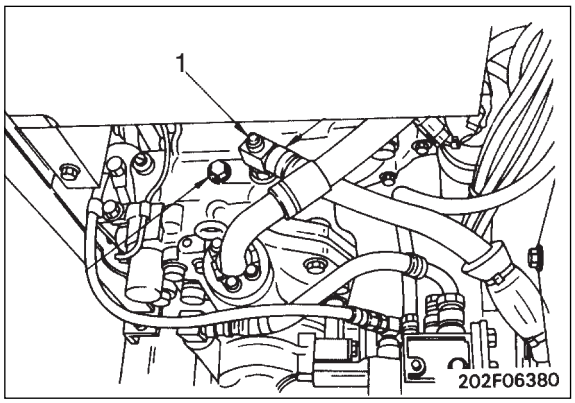
1. Bleeding air from pump

1) Loosen air bleed plug (1)
2) When oil oozes out tighten plug (1)

kgm Plug:
17.15±2.45Nm (1.75±0.25kgm)

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

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

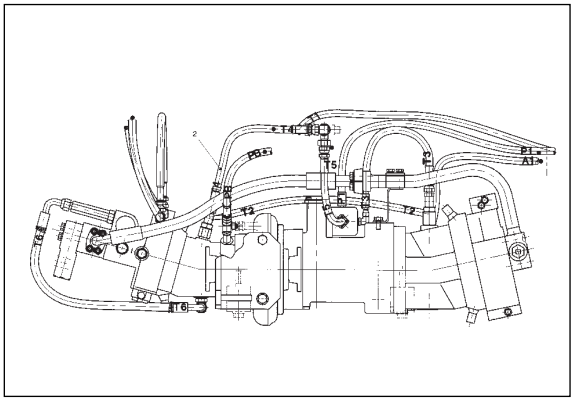


2. Bleeding air from hydraulic cylinders

1) Start the engine and run at idling for approx. 5 minutes.
2) Run the engine at low idling, then raise and lower the boom 4 - 5 times in succession.
   ★ Operate the piston rod to approx. 100 mm before the end of its stroke. Do not releive the circuit under any circumstances.
3) Run the engine at high idling 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.

4. Bleeding air from travel motor

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



TROUBLESHOOTING

Points to remember when troubleshooting 20- 51
Sequence of events in troubleshooting 20- 52
Precautions when carrying out maintenance 20- 53
Checks before troubleshooting 20- 60
Connector types 20- 61
Connection table for connector pin numbers 20- 64
Explanation of control mechanism of electrical system 20- 77
Display method and special functions of monitor panel 20- 78
Method of using judgement table 20- 86
Method of using troubleshooting charts 20- 88
Details of troubleshooting and troubleshooting procedure 20- 90
Service code table 20- 95
Troubleshooting of communication abnormality system (N mode) 20- 97
Troubleshooting of governor, pump controller [governor control system] (E mode) 20- 100
Troubleshooting of engine (S mode) 20- 129
Troubleshooting of governor, pump controller system [pump control system] (C mode) 20- 152
Troubleshooting of governor, pump controller [input signal system] (F mode) 20- 183
Troubleshooting of hydraulic, mechanical system (H mode) 20- 197
Troubleshooting of monitor panel system (M mode) 20- 229

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 signal, and do not allow any unauthorized person to come near.
⚠ If the radiator cap is removed when the engine is hot, hot water may spurt out and cause burns, so wait for the engine to cool down before starting troubleshooting.
⚠ Be extremely careful not to touch any hot parts or to get caught in any rotating parts.
⚠ When disconnecting wiring, always disconnect the negative (-) terminal of the battery first.
⚠ When removing the plug or cap from a location which is under pressure from oil, water, or air, always release the internal pressure first. When installing measuring equipment, be sure to connect it properly.

The aim of troubleshooting is to pinpoint the basic cause of the failure, to carry out repairs swiftly, and to prevent reoccurrence of the failure.
When carrying out troubleshooting, 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 cuases of the failure that would produce the reported symptoms.

1. When carrying out thoubleshooting, 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.

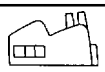
   It will also cause a waste of manhours, parts, or oil or grease, and at the same time, will also loose the confidence of the user or operator.
   For this reason, when carrying out troubleshooting, it is necessary to carry out thorough prior investigation and to carry out troubleshooting in accordance with the fixed procedure.
2. Points to ask user or operator
   1) Have any other problems occurred apart from the problem that has been reported?
   2) Was there anything strange about the machine before the failure occurred?
   3) Did the failure occur suddenly, or were there problems with the machine condition before this?
   4) Under what conditions did the failure occur?
   5) Had any repairs been carried out before the failure?

   When were these repairs carried out?
   6) Has the same kind of failure occurred before?
3. Check before troubleshooting
   1) Check the oil level
   2) Check for any external leakage of oil from the piping or hydraulic equipment.
   3) Check the travel of the control levers
   4) Check the stroke of the control valve spool
   5) Other maintenance items can be checked externally, so check any item that is considered to be necessary.
4. Confirming failure
   - Confirm the extent of the failure yourself, and judge whether to handle it as a real failure or as a problem with the method of operation etc.
     ★ When operating the machine to reenact the troubleshooting symptoms, do not carry out any investigation or measurement that may make the problem worse.
5. Troubleshooting
   - Use the results of the investigation and inspection in items 2-4 to narrow down the causes of failure, then use the troubleshooting flowchart to locate the position of the failure exactly.
     ★ The basic procedure for troubleshooting is as follows.
       1) Start from the simple points
       2) Start from the most likely points
       3) Investigate other related parts or information.
6. Measures to remove root cause of failure
   - Even if the failure is repaired, if the root cause of the failure is not repaired, the same failure will occur again.

   To prevent this, always investigate why the problem occurred. Then, remove the root cause.

SEQUENCE OF EVENTS IN TROUBLESHOOTING

Office, shop



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Jobsite



TEW00181

Step 1

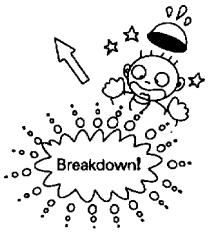
Examination, confirmation of symptoms

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



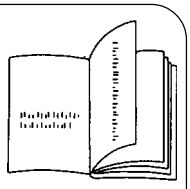


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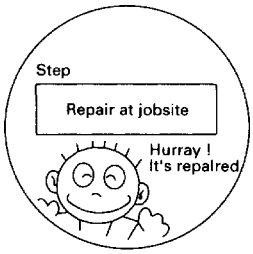
Step 2

Determining probable location of cause

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



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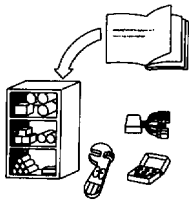


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Step 3

Preparation of troubleshooting tools

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



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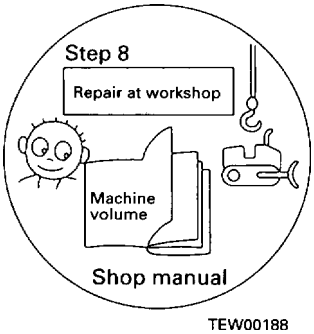
Step 7

- 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



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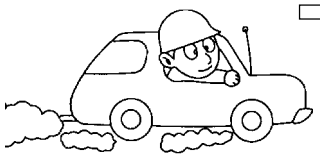
Step 6

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

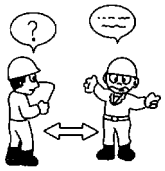


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Step 5

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?



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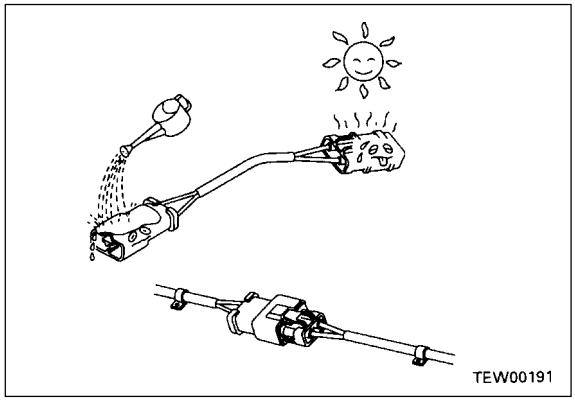
PRECAUTIONS WHEN CARRYING OUT MAINTENANCE

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 hydraulic oil).

1. PRECAUTIONS WHEN HANDLING ELECTRIC EQUIPMENT

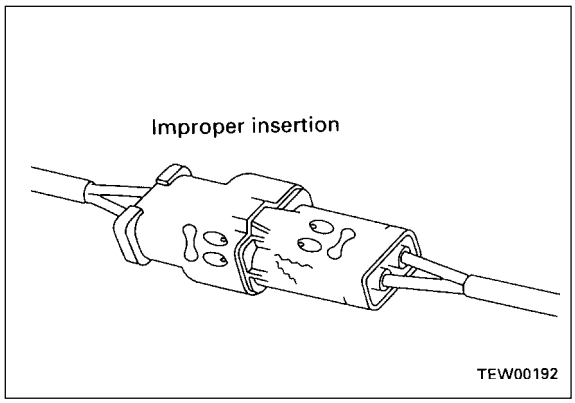
1) Handling wiring harnesses and connectors

Wiring harnesses consist of wiring connecting one component to another component, connectors used for connecting and disconnecting one wire from another wire, and protector 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.

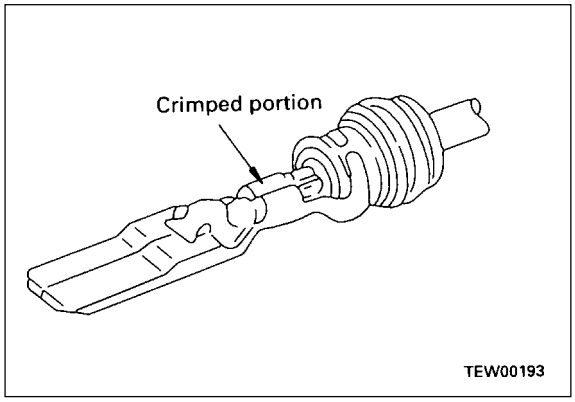


Main failures occurring in wiring harnesses

(1) Defective contact of connectors (defective contact between male and female) Problems with defective contact are likely 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.

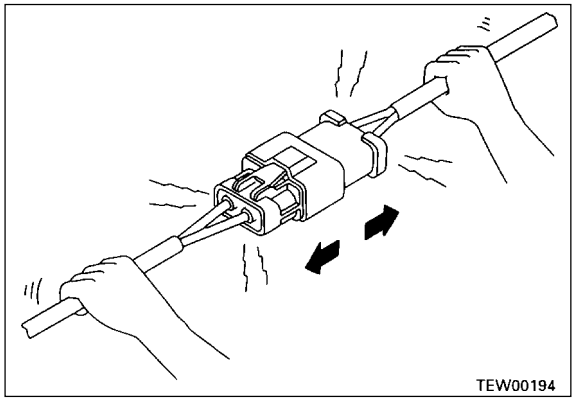


(2) Defective compression or soldering of connectors. The pins of the male and female connectors are in contact at the compressed terminal or solered portion, but there is excessive force on the wiring, and the plating peels to cause improper correction or breakage.



(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 compression of the connector may be lost, or the soldering may be damaged, or the wiring may be broken.

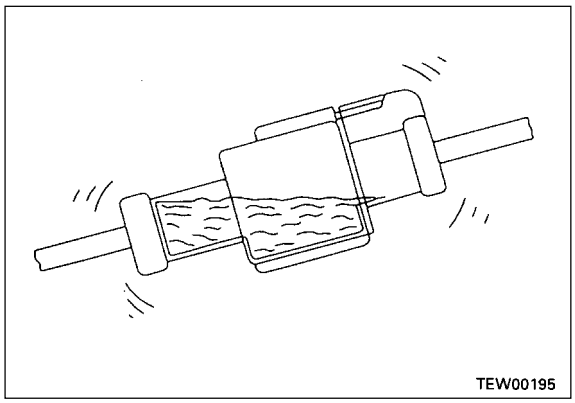
(4) High pressure water entering connector
The connector is designed to make it difficult for water to enter (drip-proof structure), but if high pressure water is sprayed directly on the connector water may enter the connector depending on the direction of the water jet.
The connector is designed to prevent water from entering, but at the same time, if the 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.

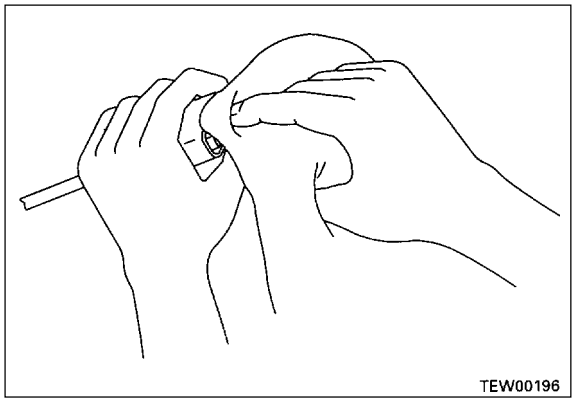


(5) Oil or dirt stuck to the connector
If oil or grease are stuck to the connector and an oil film is formed on the mating surface between the male and female pins, the oil will not let the electricity pass, so there will be defective contact. If there is oil or grease or dirt stuck to the connector, wipe it off with a dry cloth or blow dry with 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 water or oil in the air, it will increase the contamination of the points, so clean with air from which all the water and oil has been removed.

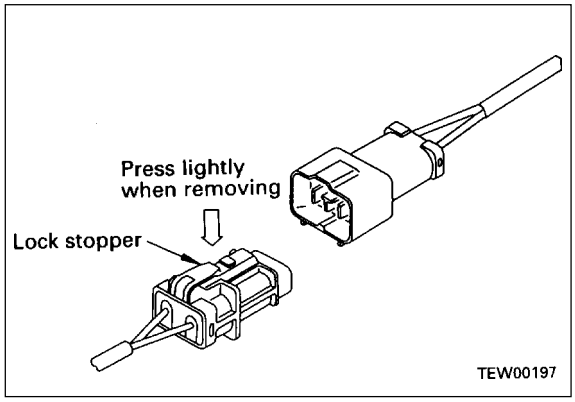




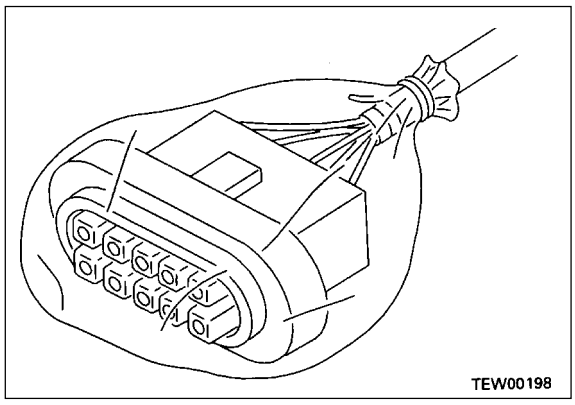
2) Removing, installing, and drying connectors and wiring harness

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 an pull apart. For connectors which have a lock stopper, press down the stopper with your thumb and pull the connectors apart.



(2) 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.



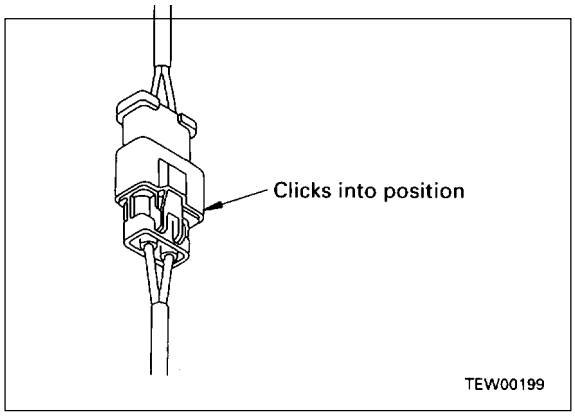
Connecting connectors

(1) Check the connector visually
- a. Check that there is no oil, dirt or water stuck to the connector pins (mating portion).
- b. Check that there is no deformation, defective contact, corrosion, or damage to the connector pins.
- c. Check that there is no damage or breakage to the outside of the connector.

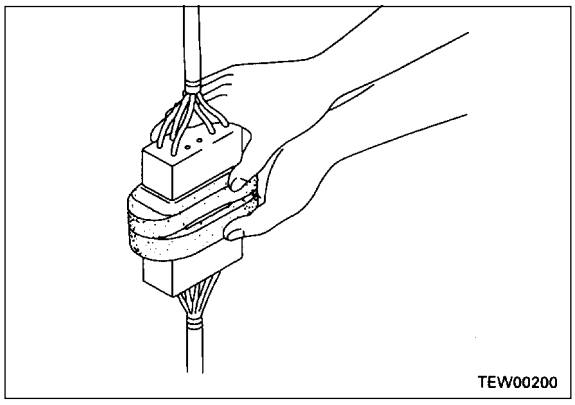
★ If there is any oil, water, or dirt stuck to the connector, wipe it off with a dry cloth. If any water has got inside the connector, warm the inside of the wiring with a dryer, but be carful no to make it too hot as this will cause short circuits.

★ 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.

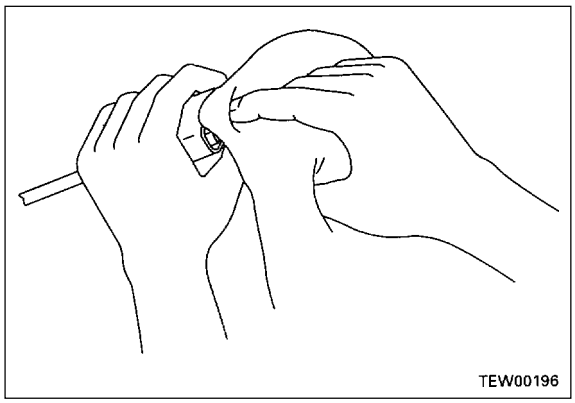


(3) Correct any protrusion of the boot and any misalignment of the wiring harness. For connectors fitted with boots, correct any protrusion of the boot. In addition, if the wiring harness is misaligned, or the clamp is out of position, adjust it to its correct position.
★ When blowing with dry air, there is danger that the oil in the air may cause improper contact, so clean with air from which all the water and oil has been removed.

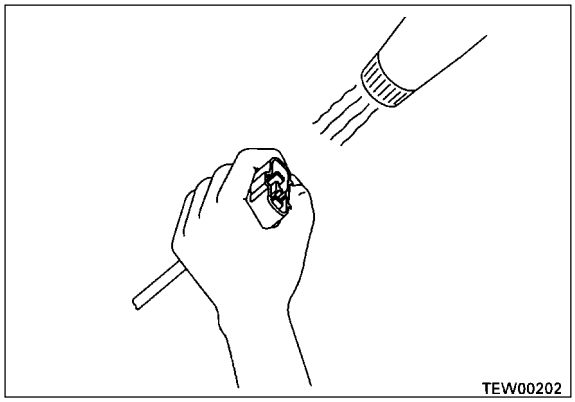


Drying wiring harness
If there is any oil or dirt on the wiring harness, wipe it off with a dry cloth. Avoid washing it in water or using steam. If the connector must be washed in water, do not use high pressure water or steam directly on the wiring harness. If water gets directly on the connector, do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

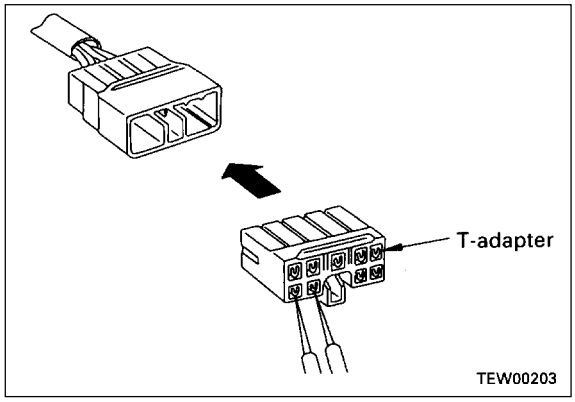
(1) Disconnect the connector and wipe off the water with a dry cloth.
★ If the connector is blown dry with air, there is the risk that oil in the air may cause defective contact, so avoid blowing with air.



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

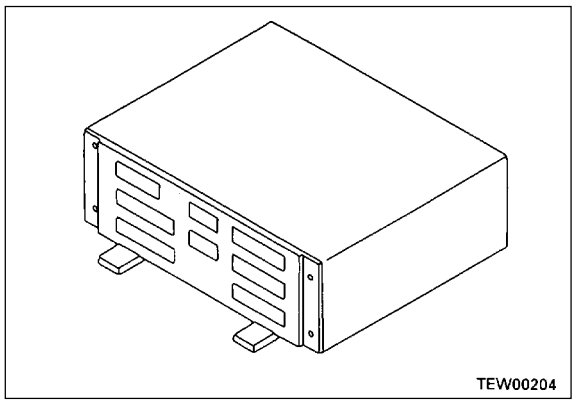


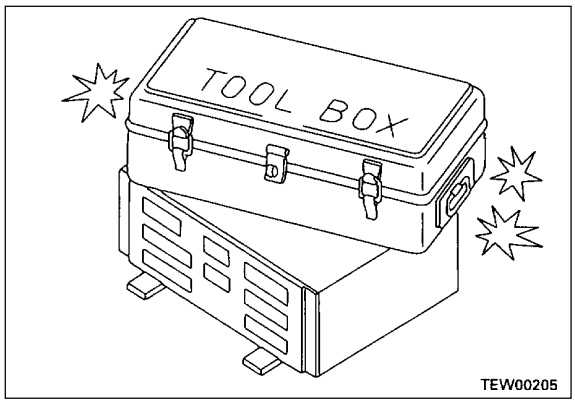
(3) Carry out a continuity test on the connector. After drying, leave the wiring harness disconnected and carry out a continuity test to check for any short circuits between pins caused by water.
★ After completely drying the connector, blow it with contact restorer and reassemble.

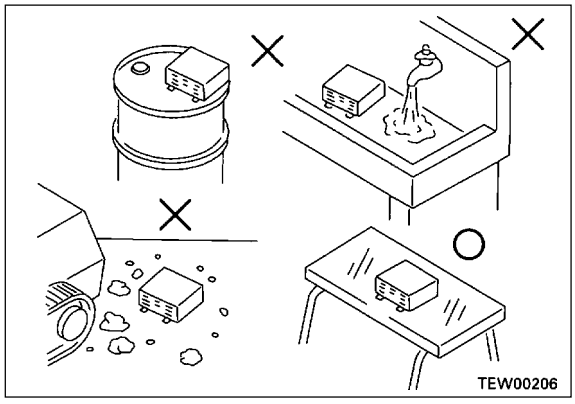


3) Handling control box

(1) The control box contains a microcomputer and electronic control circuits. These control all of the electronic circuits onthe 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.
(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 on the body, disconnect all wiring harness connectors connected to the control box. Fit an arc welding ground close to the welding point.



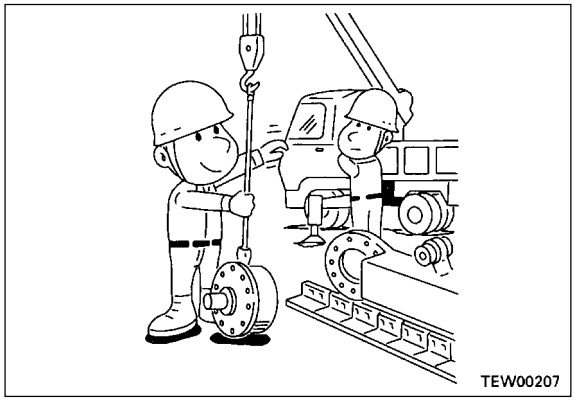




2. POINTS TO REMEMBER WHEN HANDLING HYDRAULIC EQUIPMENT

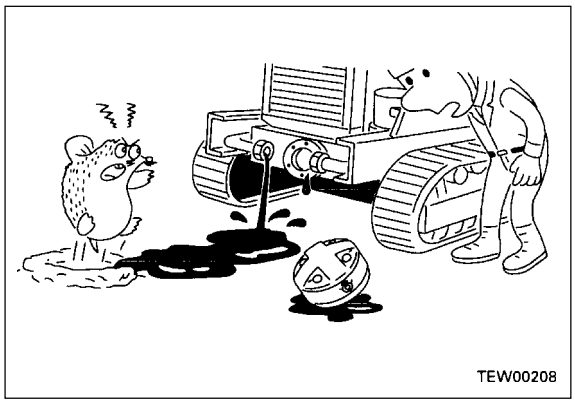
With the increase in pressure and precision of hydraulic equipment, the most common cause of failure is dirt (foreign material) in the hydraulic circuit. When adding hydraulic oil, or when disassembling or assembling hydraulic equipment, it is necessary to be particularly careful.

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.

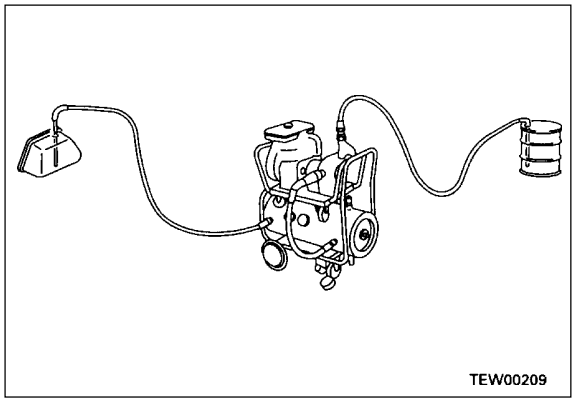

TEW00207

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.

3) Sealing openings
After any piping or equipment is removed, the openings should be sealed with caps, tapes, or vinyl bags to prevent any dirt or dust from entering. If the opening is left open or is blocked with a rag, there is danger of dirt entering or of the surrounding area being made dirty by leaking oil so never do this. Do not simply drain oil out on to the ground, collect it and ask the customer to dispose of it, or take it 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.

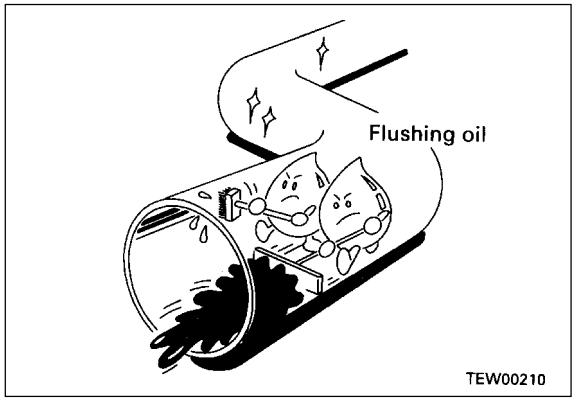

TEW00209

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. (Do not drain the oil from the hydraulic tank; also drain the oil from the filter and from the drain plug in the circuit.) If any old oil is left, the contaminants and sludge in it will mix with the new oil and will shorten the life of the hydraulic oil.

6) Flushing operations

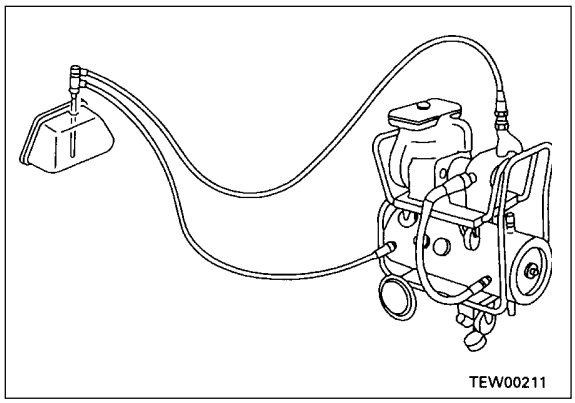
After disassembling and assembling the equipment, or changing the oil, use flushing oil to remove the contaminants, sludge and old oil from the hydraulic circuit. Normally flushing is carried out twice: primary flushing is carried out with flushing oil, and secondary flushing is carried out with the specified hydraulic oil.



7) Cleaning operations

After repairing the hydraulic equipment (pump, control valve, etc.) or when running the machine, carry out oil cleaning toi remove the sludge or contaminants in the hydraulic oil circuit.

The oil cleaning equipment is used to remove the ultrafine (about 3 u) particles that the filter built into the hydraulic equipment cannot remove, so it is an extremely effective device.



CHECKS BEFORE TROUBLESHOOTING

	Item	Judgement standard	Action
Lubricating oil, cooling water	1. Check fuel level	-	Add fuel
	2. Check for dirt or water in fuel	-	Clean, drain
	3. Check hydraulic oil lever	-	Add oil
	4. Check hydraulic oil strainer	-	Clean, drain
	5. Check swing machinery oil level	-	Add oil
	6. Check engine oil level (Level of oil in oil pan)	-	Add oil
	7. Check cooling water level	-	Add water
	8. Check condition of dust indicator	-	Clean or replace
	9. Check hydraulic oil filter		Replace
Electrical equipments	1. Check for loose or corroded battery terminals	-	Tighten or replace
	2. Check for loose or corroded alternator terminals	-	Tighten or replace
	3. Check for loose or corroded straight motor terminals	-	Tighten or replace
Hydraulic, mechanical equipments	1. Check for abnormal noise or smell		Repaire
	2. Check for oil leakage	-	Repaire
	3. Bleed air from system	-	Bleed air
Electrical components	1. Check battery voltage (engine stopped)	20 - 30 V	Replace
	2. Check level of battery electrolyte	-	Add or replace
	3. Check for discolored, burnt, or bare wiring	-	Replace
	4. Check for missing wiring clamps, hanging wires	-	Repair
	5. Check for getting wet onto wiring (check carefully getting wet at connectors and terminals)	-	Disconnect connector and dry connection
	6. Check for broken or corroded fuses	-	Replace
	7. Check alternator voltage (engine running at over half throttle)	27.5 - 29.6 V	Replace
	8. Noise when battery relay is operated (switch starting switch from ON to OFF)	-	Replace

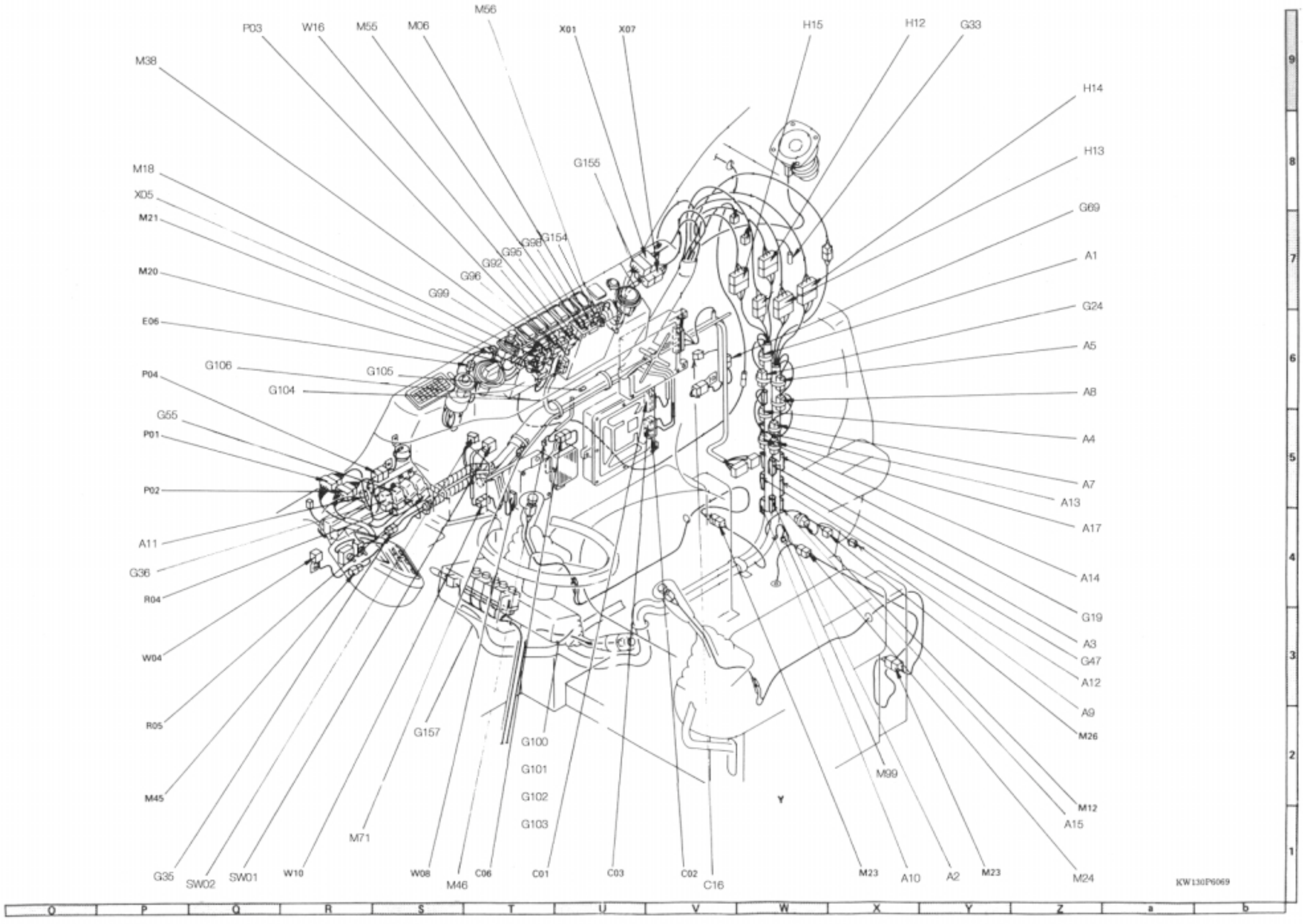
CONNECTOR TYPES

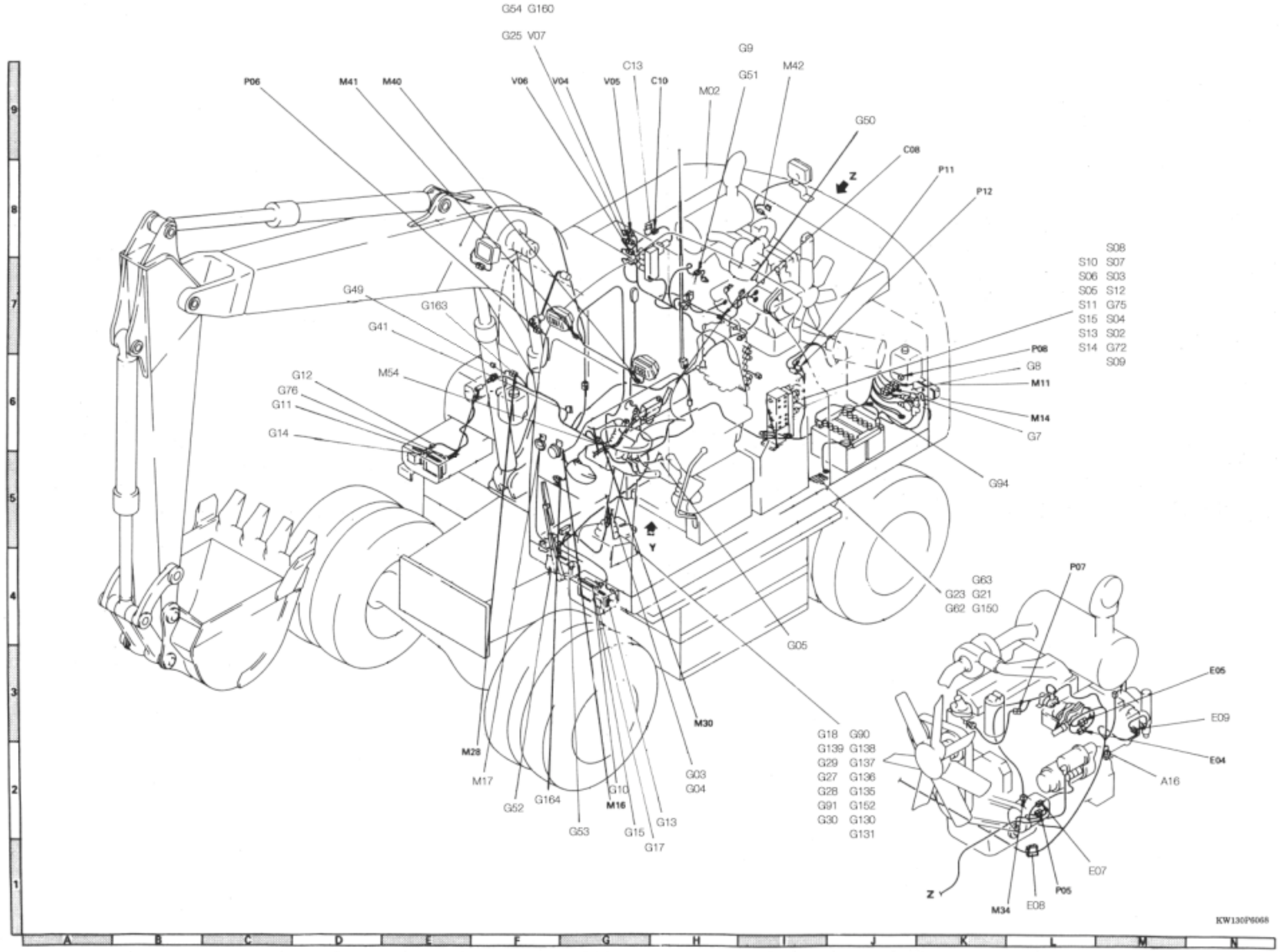
Con-nector No.	Type	No. of pins	Mounting location	Add-ress
A01	KES1	2	Window washer circuit	Z7
A02	KES1	2	Swing park brake sol	Y1
A03	KES1	2	Diode	Z3
A04	KES1	2	2stage relief sol	Z5
A05	KES1	2	Swing park sol circuit	Z6
A07	KES1	2	Travel speed sol circuit	Z5
A08	KES1	2	Heater circuit	Z6
A9	KES1	2	Travel 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	L6
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

Con-nector No.	Type	No. of pins	Mounting location	Add-ress
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

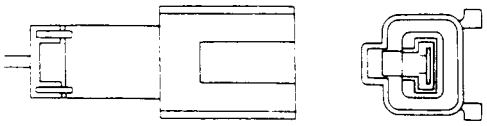
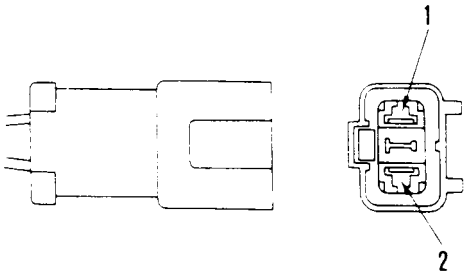
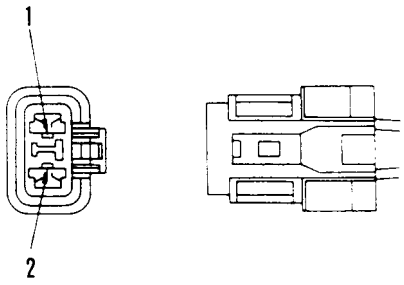
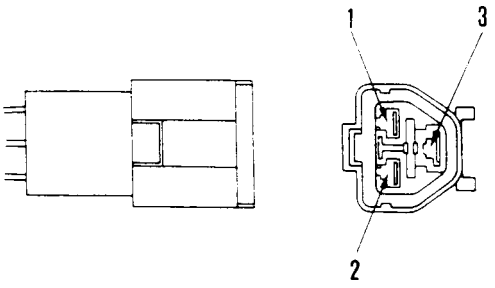
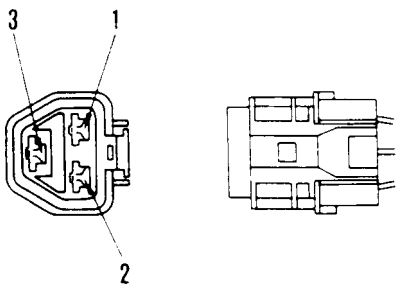
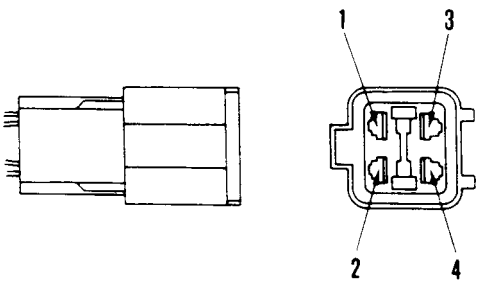
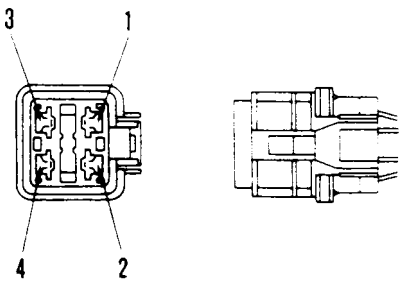
Con-nector No.	Type	No. of pins	Mounting location	Add-ress
P01	40	20	Monitor panel	P5
P02	M	16	Monitor panel	P5
P03	M	2	Buzzer cancel switch	Q9
P04	X	2	Alarm buzzer	P6
P05	X	1	Engine oil level sensor	L1
P06	X	1	Fuel level sensor	D9
P07	X	2	Coolant temperature sensor	K4
P08	X	2	Coolant level sensor	L7
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

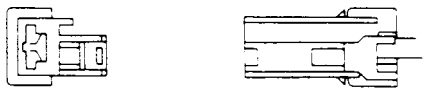
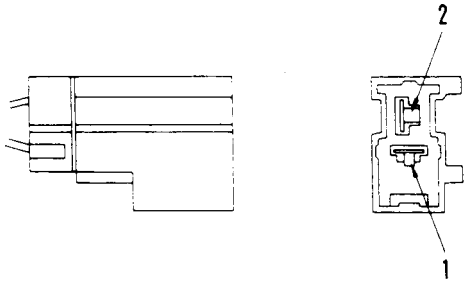
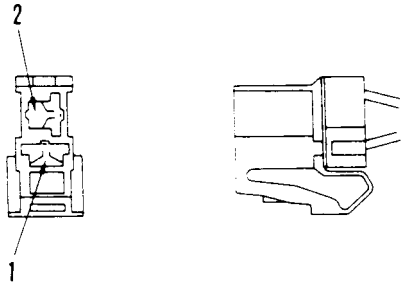
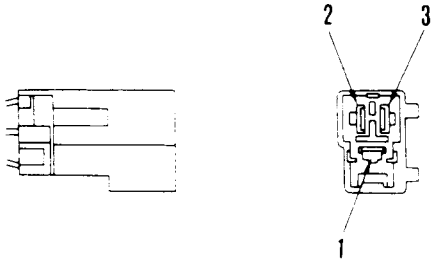
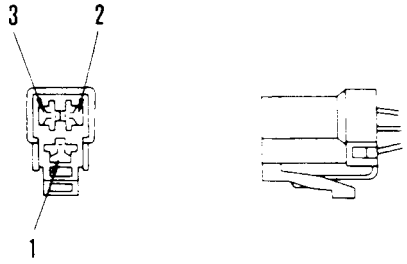
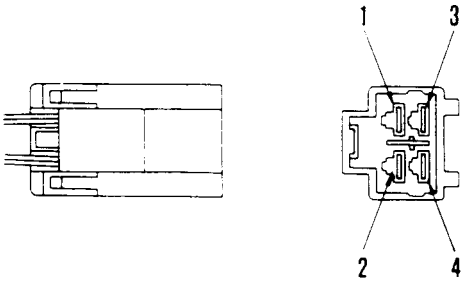
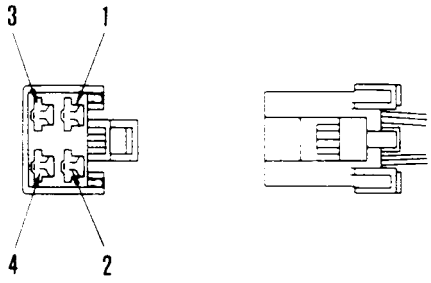

M56
P03
W16
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X01
X07
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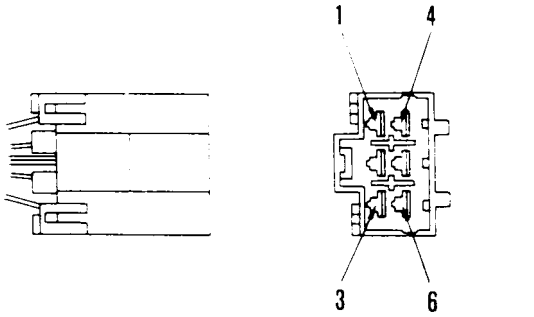
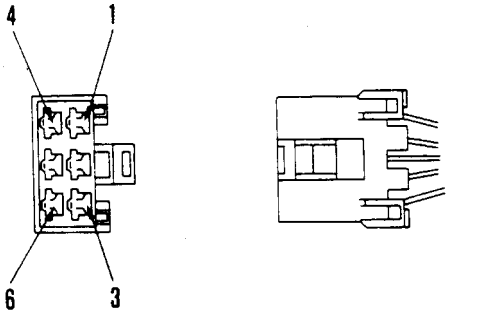

G54 G160
G25 V07
G9
C13
M42
P06
M41
M40
V06
V04
V05
C10
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M02
G50
C08
P11
P12
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S08
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S06 S03
S05 S12
S11 G75
S15 S04
S13 S02
S14 G72
S09
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G163
G41
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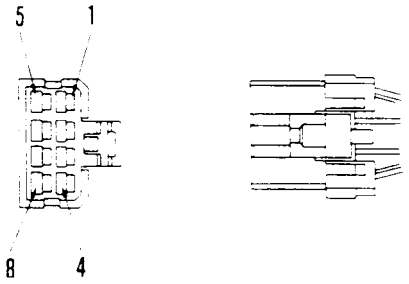
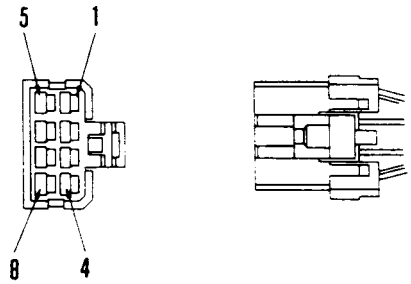
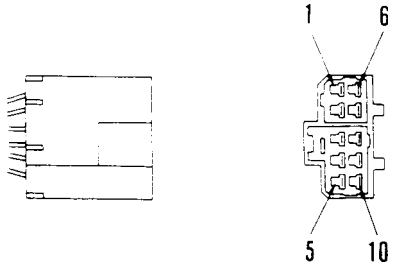
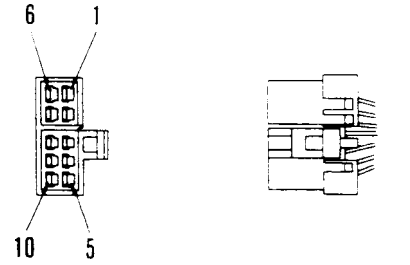
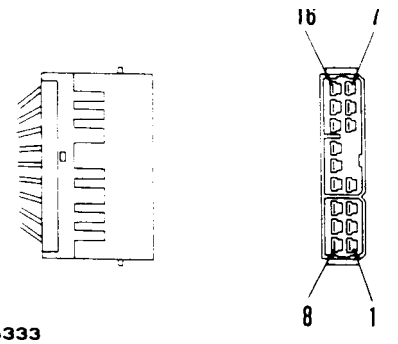
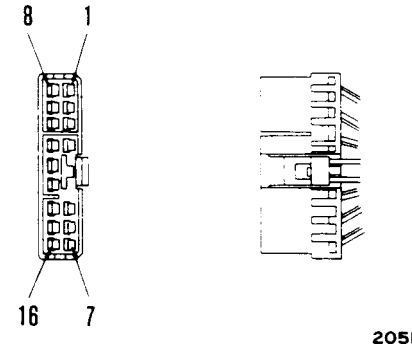
CONNECTION TABLE FOR CONNECTOR PIN NUMBERS

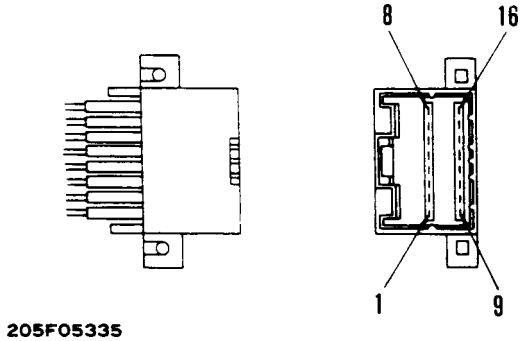
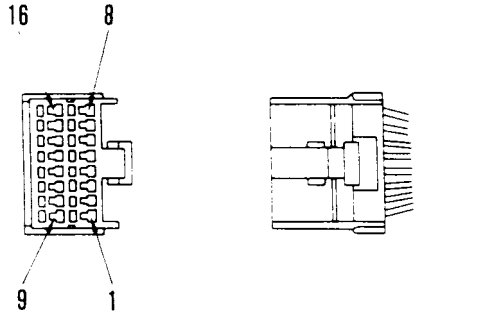
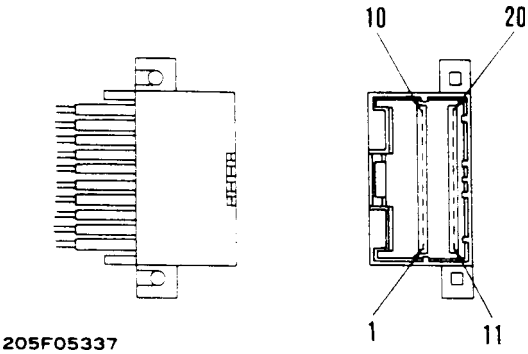
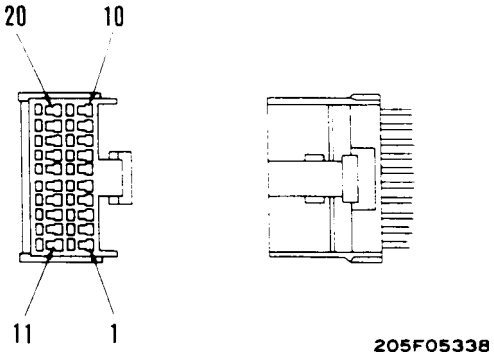
★ The terms male and female refer to the pins, while the terms male housing and female housing refer to the mating portion of the housing.

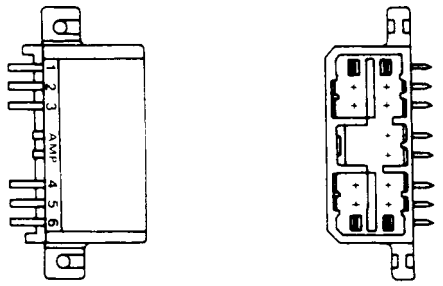
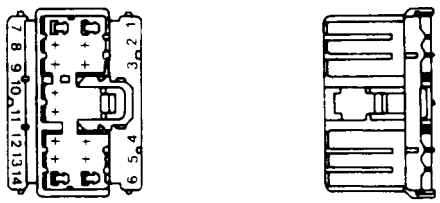
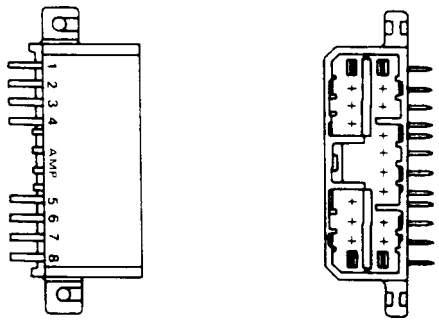
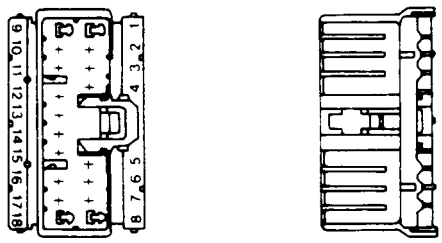
No. of pins	X type connector	
	Male (female housing)	Female (male housing)
1	 205F05309	 205F05310
2	 205F05311	 205F05312
3	 205F05313	 205F05314
4	 205F05315	 205F05316

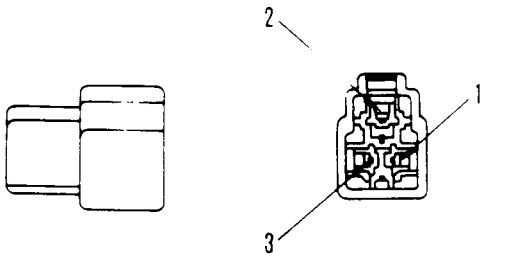
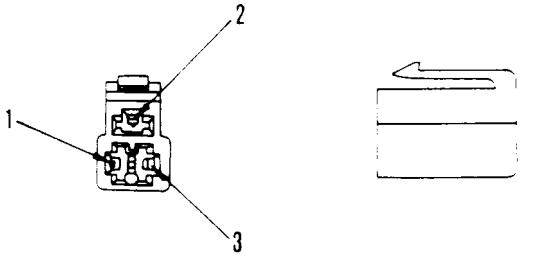
No. of pins	M type connector	
	Male (female housing)	Female (male housing)
1	 205F05317	 205F05318
2	 205F05319	 205F05320
3	 205F05321	 205F05322
4	 205F05323	 205F05324

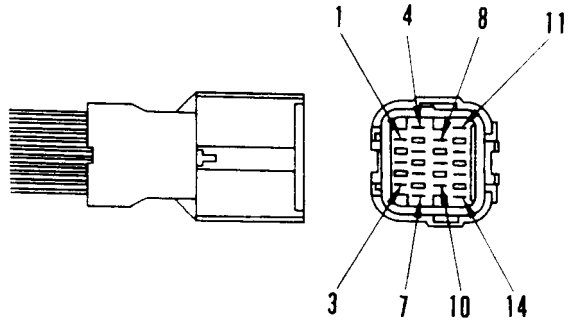
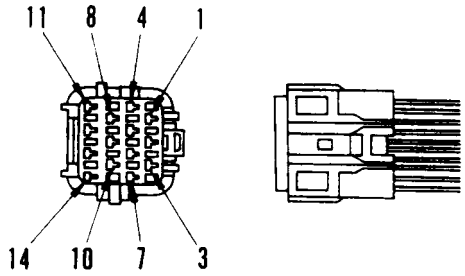
No. of pins	M type connector	
	Male (female housing)	Female (male housing)
6	 205F05325	 205F05326

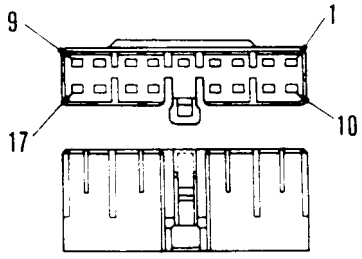
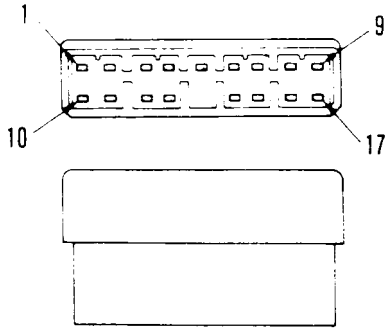
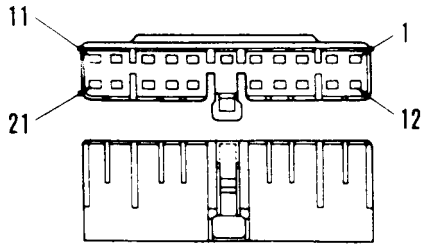
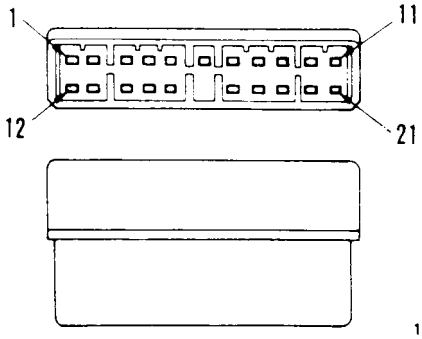
No. of pins	S type connector	
	Male (female housing)	Female (male housing)
8	 205F05327	 205F05328
10	 205F05329	 205F05330
16	 205F05333	 205F05334

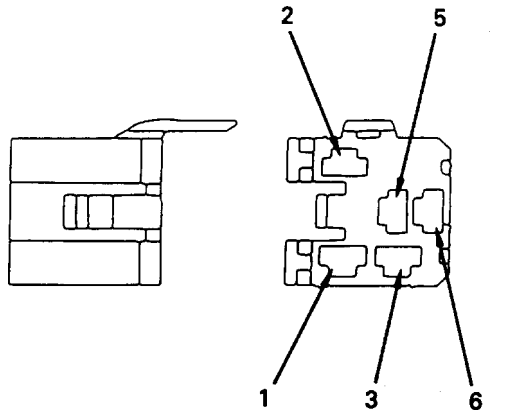
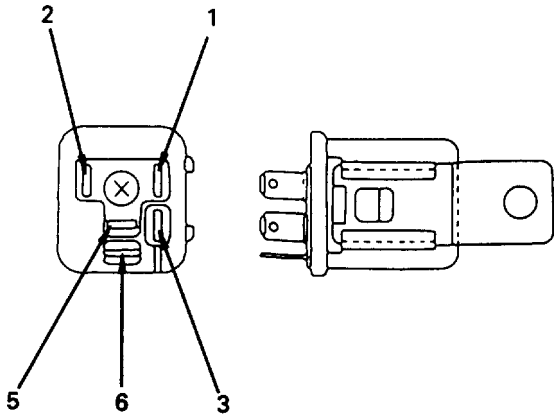
No. of pins	AMP040 type connector	
	Male (female housing)	Female (male housing)
16	 205F05335	 205F05336
20	 205F05337	 205F05338

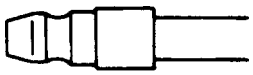
No. of pins	AMP070 type connector	
	Male (female housing)	Female (male housing)
14	 205F06364	 205F06365
18	 205F06366	 205F06367

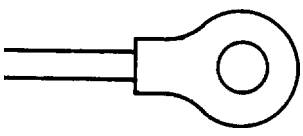
No. of pins	AMP250 type connector	
	Male (female housing)	Female (male housing)
3	 205F06368	 205F06369

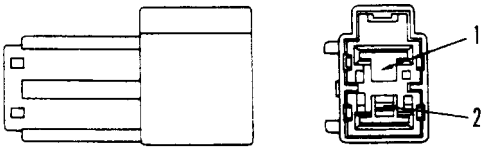
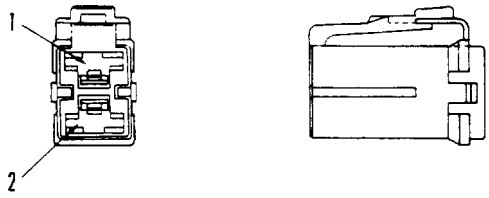
No. of pins	SWP type connector	
	Male (female housing)	Female (male housing)
14	 F56103087	 F56103088

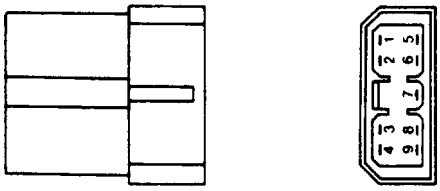
No. of pins	MIC connector	
	Male (female housing)	Female (male housing)
17	 142F414	 142F415
21	 142F416	 142F417

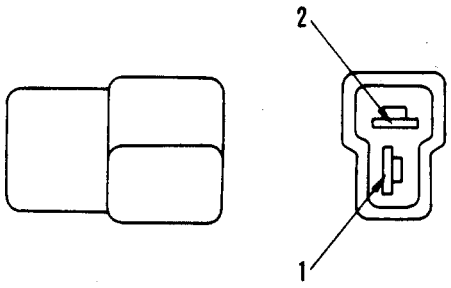
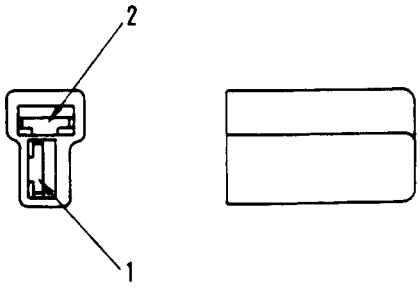
No. of pins	Relay connector	
	Male (female housing)	Female (male housing)
5		

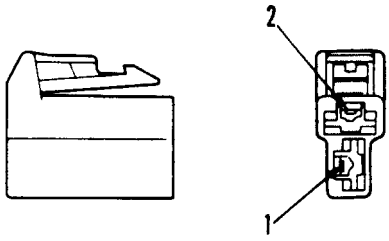
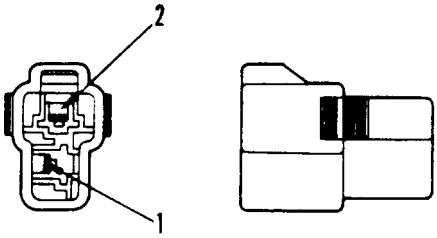
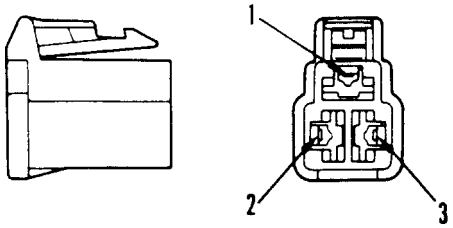
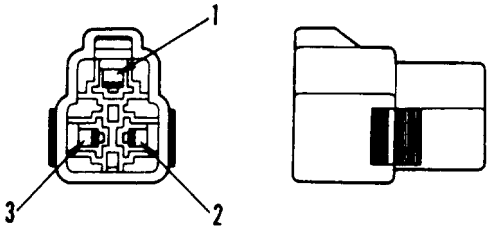
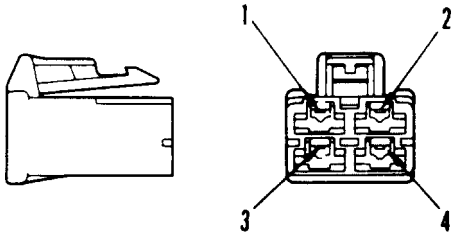
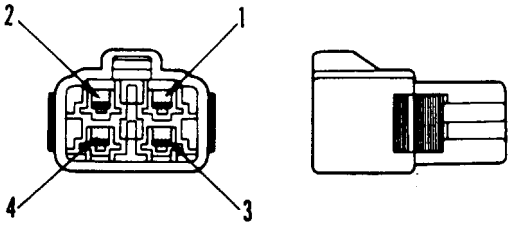
No. of pins	Simple connector	
	Male (male housing)	Female (female housing)
1		

No. of pins	Ring connector
1	

No. of pins	L type connector	
	Male (female housing)	Female (male housing)
2	 20TF01149	 20TF01150

No. of pins	PA type connector	
	Male (female housing)	Female (male housing)
9	 205F06370	 205F06371

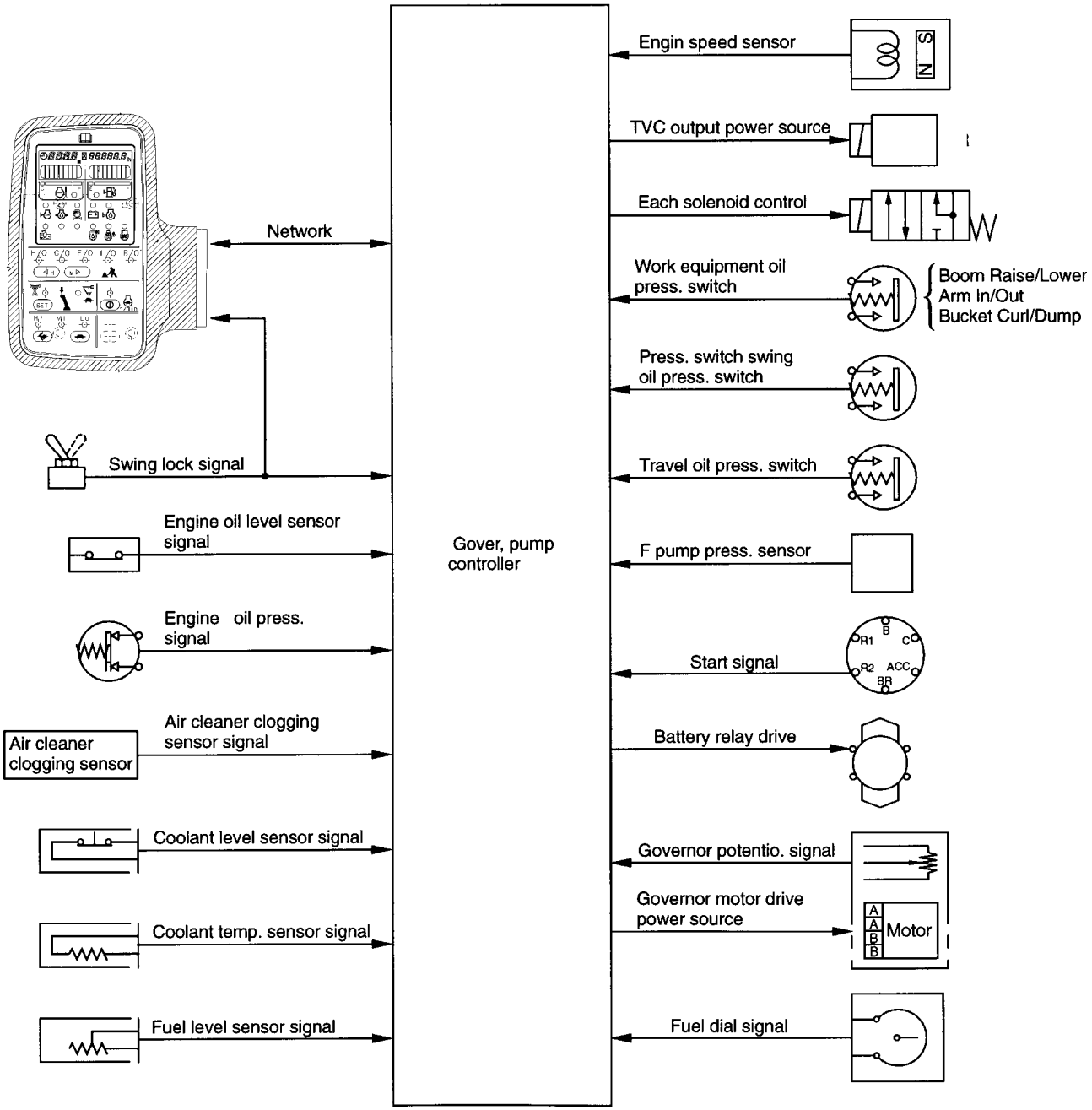
No. of pins	Automobile conector (KES1)	
	Female (male housing)	Male (female housing)
2	 205F06372	 205F06373
3		
4		

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

EXPLANATION OF CONTROL MACHANISM FOR ELECTRICAL SYSTEM

1. Explanation of machine control functions

The control mechanism for the electrical system consists of the monitor panel and governor and pump controller. The monitor panel and the governor and pump controller input the signals that are necessary, and together with the signals selected by the monitor panel, the governor and pump controller outputs or inputs the necessary signals and control the pump absorption torque and engine output.



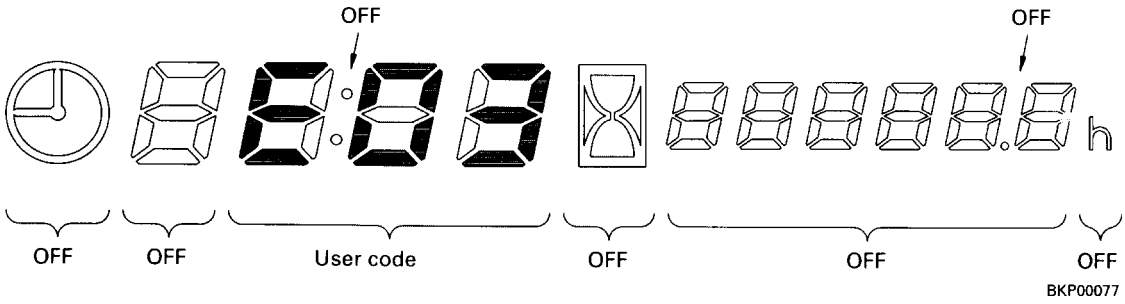
DISPLAY METHOD AND SPECIAL FUNCTIONS OF MONITOR PANEL

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 governor and pump controller is sent to the monitor panel. When the monitor panel receives this data, it records the abnormality data, and at the same time, depending on the nature of the abnormality, it displays the user code on the time display panel to advice the operator of the action to take. However, in cases of abnormalities which are not urgent and do not require the user code to be displayed, only the content of the abnormality is recorded, and no display is given.

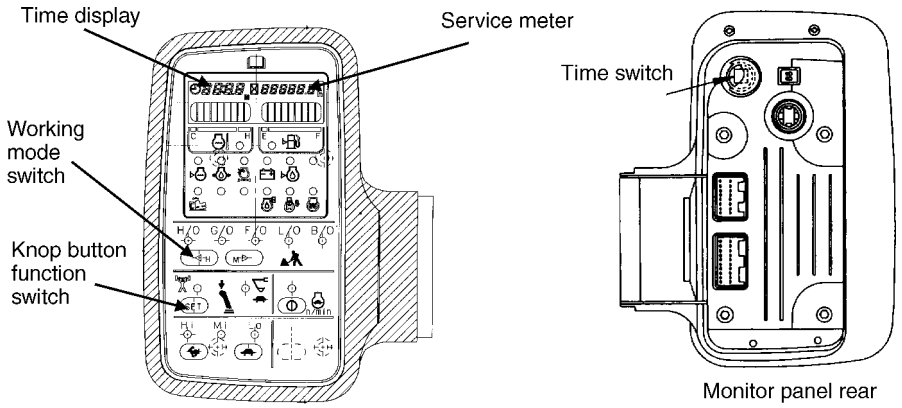
   2) Types of user codes and system
      E02 (TVC system)
      E03 (Swing holding brake system)
      E05 (Governor motor system)
      ★ For details of the service codes included in the user code, see the action taken by the controller when an abnormality occurs, the symptoms on the machine or the judgement table.

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

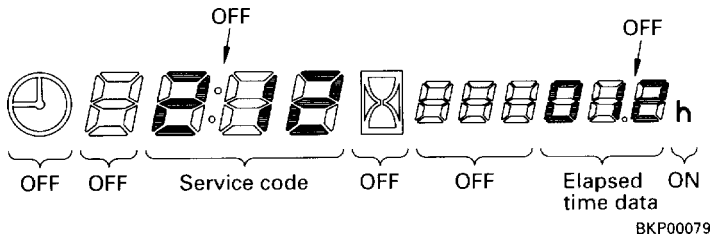
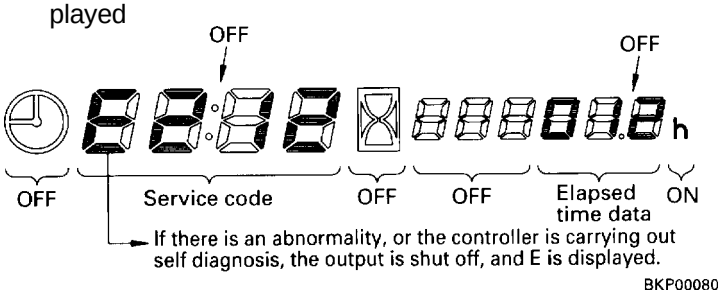


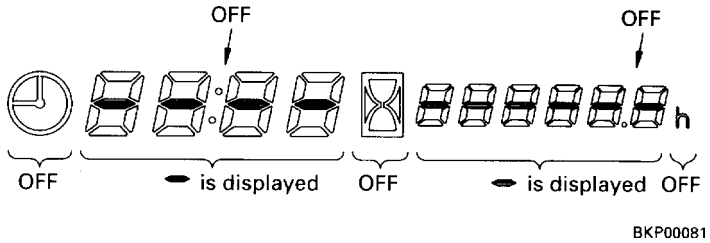
4) Display of trouble data
The monitor panel records both service codes which are included in the user code, and service codes which are not included. This data can be displayed on the time display as follows.

★ For details of the service codes that are not included in the user code, see ACTION TAKEN BY CONTROLLER WHEN ABNORMALITY OCCURS AND PROBLEMS ON MACHINE or the JUDGEMENT TABLE.



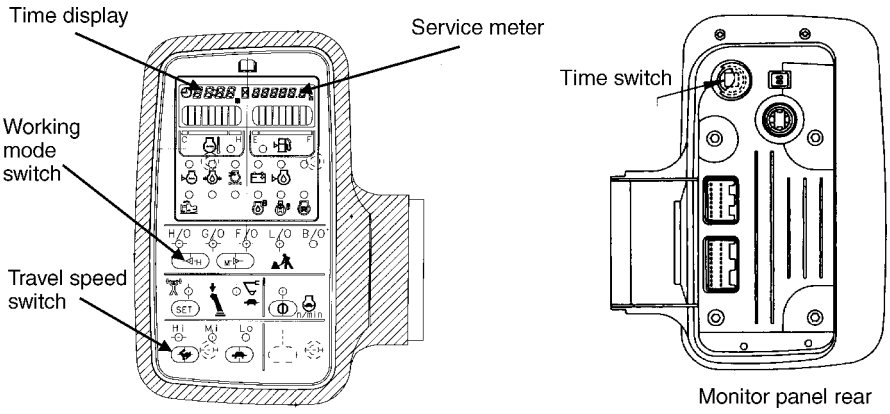
i) Method of displaying trouble data

Operation	Display
1. To set to the trouble data display mode. Keep the TIME switch + L.H. travel speed switch pressed for 2.5 seconds. Note: It is possible to call it up at the following times. 1) In the normal mode 2) In the user code display mode 3) In the machine data monitoring mode 4) In the time adjustment mode 2. To go to the next service code display, press the time switch + R.H. woking mode switch. 3. To go back to the previous service code display, press the time switch + L.H. woking mode switch.	1. On the tme display and service meter display, the service code and number of hours (service meter hours) that have elapsed since the occurrense of the abnormality are displayed. • Example of display : When E212 has occured 12 hours before (service meter) 1) Display of service code 2) Display of elapsed time  BKP00079 3) If any abnormality exists at this time, the E mark is displayed  BKP00080

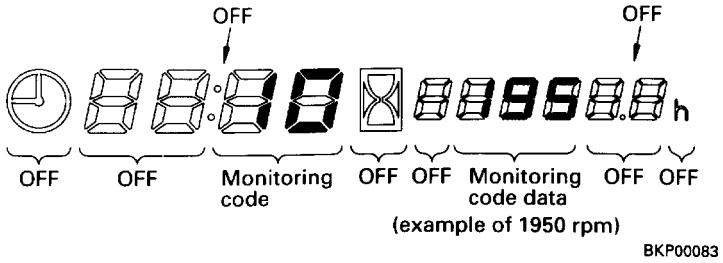
Operation	Display
4. To finish with the trouble data display mode, keep the TIME switch + L.H. travel speed switch pressed for 2.5 seconds. 5. To erase the memory, keep the time switch pressed, turn the starting switch from OFF to ON, and keep the time switch pressed for 5 seconds.	4. If there is no abnormality code in memory  BKP00081

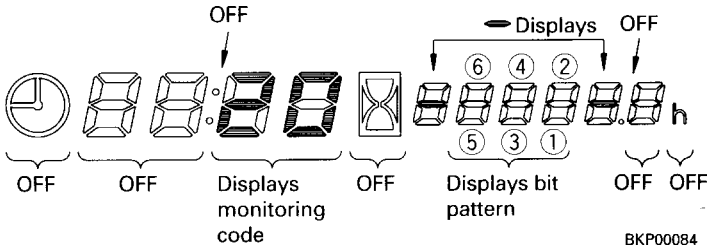
3. Machine data monitoring function

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



1) Method of displaying monitoring code

Operation	Display
1. To set the machine data monitoring mode, do as follows. Keep the time switch + knob button function switch pressed for 2.5 seconds. Note: this is possible at the following times. 1) During the normal code 2) During the user code display 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 monitoring (monitoring code 10)  BKP00083

Operation	Display
2. To go to the next monitoring code display, press the time switch + R.H. working mode switch. 3. To go back to the previous monitoring code display, press the time switch + L.H. working mode switch. 4. To finish with the machine data monitoring code mode, keep the time switch + knob button function switch pressed for 2.5 seconds.	2) When displaying bit pattern • For monitoring codes 08, 20 - 24, 36, 37, 47 - 49, 4A, display the bit pattern. • Example of monitoring code 20  • The code no. is displayed in the monitoring code portion, and the display lights up to display bit patterns (1) - (6).

2) Table of machine data monitoring codes

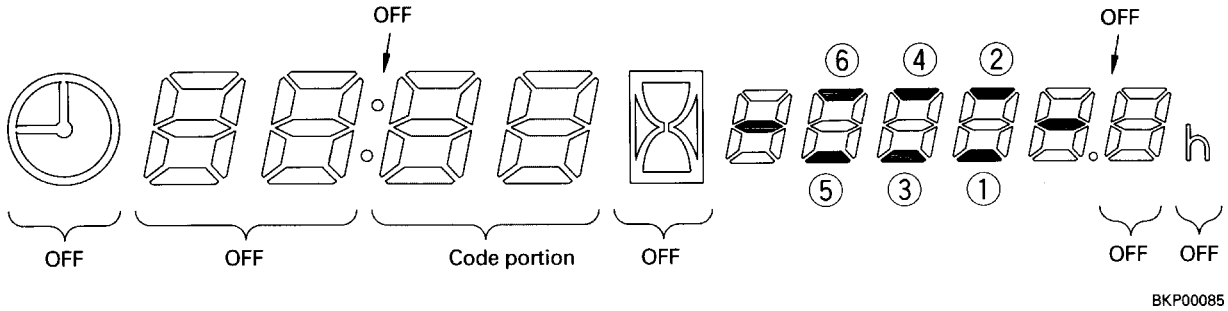
★ For detalis of the B in the Unit column, see the bit pattern chart in the next section.

No.	Item	Unit	Name of component
01	Monitor model code	-	Monitor panel
02	Governor, pump controller model code	-	Governor, pump controller
03	Governor, pump controller model code	-	Governor, pump controller
08	S-NET component condition display	B	Governor, pump controller
10	Engine speed	10rpm	Governor, pump controller
11	Pump discharge pressure input	MPa (kg/cm^2)	Governor, pump controller
13	TVC current output	10mA	Governor, pump controller
14	Travel EPC current	10mA	EPC
15	LS-EPC current output	10mA	Governor, pump controller
16	No. 2 throttle command	10mA	Governor, pump controller
20	Governor, pump controller PPC oil pressure switch input signal (1)	B	Governor, pump controller
21	Governor, pump controller PPC oil pressure switch input signal (2)	B	Governor, pump controller
22	Governor, pump controller PPC oil pressure switch input signal (3)	B	Governor, pump controller
23	Governor, pump controller solenoid actuation	B	Governor, pump controller
24	Input condition of sensor for governor, pump controller monitor warning 1	B	Governor, pump controller
30	Fuel control dial input value	10mV	Governor, pump controller
31	Potentiometer voltage	10mV	Governor, pump controller
32	VBB voltage (battery voltage)	100mV	
25	Input condition of sensor for governor, pump controller monitor warning 2	B	Governor, pump controller

★ For detalis of the B in the Unit column, see the bit pattern chart in the next section.

No.	Item	Unit	Name of component
33	Governor motor A phase current	10mV	Governor, pump controller
34	Governor motor B phase current	10mV	Governor, pump controller
35	Battery relay output voltage	100MV	Governor, pump controller
36	Governor governor input condition	B	Governor, pump cotnroller
37	Governor governor output condition	B	Governor, pump controller
40	Engine speed	10rpm	Governor, pump controller
41	Coolant temperature sensor voltage	10mV	Governor, pump controller
42	Fuel sensor input voltage	10mV	Governor, pump controller
43	Battery charge input voltage	100mV	Governor, pump controller
47	Monitor panel output condition 1	B	Governor, pump controller
48	Monitor panel input condition 1	B	Governor, pump controller
49	Monitor panel input condition 2	B	Governor, pump conroller
4A	Monitor panel input condition 3	B	Governor, pump controller
4C	Monitor panel output condition 2	B	Governor, pump controller

3) Bit pattern chart
As shown in the diagram below, the time display has bit numbers light up to show that the signal is being transmitted. (For details, see METHOD OF DISPLAY MONITORING CODE.)



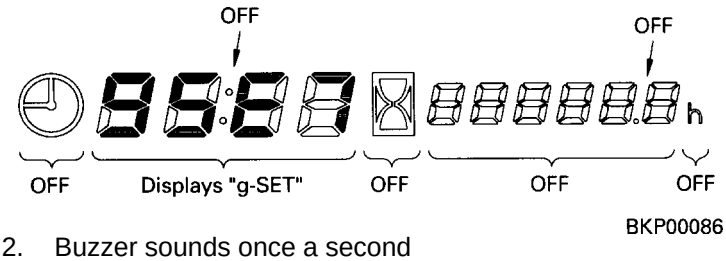
Code	Content	Bit	Details (condition when lighted up)
08	Connection of S-NET components	(1)	Governor, pump controller connected (ID=2)
		(2)	Governor, pump controller connected (ID=3)
		(3)	
		(4)	
		(5)	
		(6)	
20	Input condition of governor, pump controller PPC switches	(1)	Swing switch ON
		(2)	Travel switch ON
		(3)	Boom LOWER switch ON
		(4)	Boom RAISE switch ON
		(5)	Arm IN switch ON
		(6)	Arm OUT switch ON
21	Input condition of governor, pump controller PPC switches and other switches	(1)	Bucket CURL switch ON
		(2)	Bucket DUMP switch ON
		(3)	Swing lock switch ON
		(4)	Service switch ON
		(5)	Model selection 5
		(6)	Swing prolix switch ON
22	Input condition of governor, pump controller model selection and other switches Drive condition of governor,	(1)	Model selection 1 GND connected
		(2)	Model selection 2 GND connected
		(3)	Model selection 3 GNC connected
		(4)	Model selection 4 GND connected
		(5)	Kerosene mode input GND connected
		(6)	Knob switch ON
23	Main controller ON/OFF solenoid valves	(1)	
		(2)	
		(3)	Swing holding brake ON
		(4)	
		(5)	2 stage relief solenoid ON
		(6)	Travel speed solenoid ON

Code	Content	Bit	Details (condition when lighted up)	
24	Input condition 1 of sensor for governor, pump controller monitor warning	(1)	Above engine oil pressure sensor Lo set pressure	
		(2)	Above engine oil pressure sensor Hi set pressure	
		(3)	Radiator water level sensor abnormal	
		(4)	Engine oil level sensor abnormal	
		(5)	Hydraulic oil level sensor abnormal	
		(6)	Air cleaner clogging sensor abnormal	
25	Input condition 2 of sensor for governor, pump controller monitor warning	(1)		
		(2)	Overload sensor Open	
		(3)		
		(4)		
		(5)		
		(6)		
36	Input condition of governor, pump controller	(1)		
		(2)		
		(3)		
		(4)		
		(5)	Starting switch ON	
		(6)		
37	Output condition of governor, pump controller	(1)	Battery relay: Actuated	
		(2)		
		(3)		
		(4)		
		(5)		
		(6)		
47	Monitor panel output condition 1	(1)		
		(2)	Alarm buzzer: when operated machine	
		(3)		
		(4)		
		(5)		
		(6)		
49	Monitor panel input condition 2	(1)	KEY ON SW	OFF
		(2)	Terminal BR	Voltage Hi
		(3)	LIGHT SW	OFF
		(4)	Preheating switch	OFF
		(5)	START C	Sometimes turns ON
		(6)		

Code	Content	Bit	Details (condition when lighted up)	
4A	Monitor panel INPUT condition 3	(1)	Time switch	OFF
		(2)	PPC oil pressure selector switch	OFF
		(3)	Overload selector switch	OFF
		(4)	STD/DLX selection	STD
		(5)	Swing lock switch	OFF
		(6)	Buzzer cancel switch	OFF

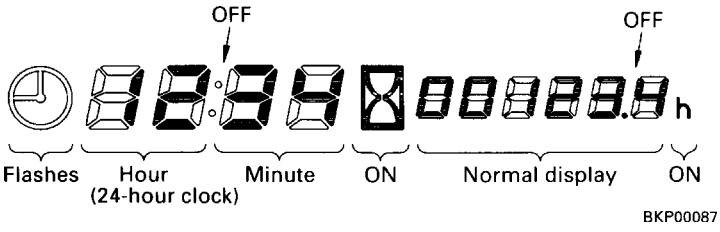
4. Governor motor adjustment mode

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

Operation	Display
1. To set the governor motor adjustment mode, press the time switch + R.H. working mode switch.	1.  BKP00086
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 the time adjustment mode, keep the time switch depressed for 2.5 seconds. 2. Use the L.H. working mode switch to advance the hour. 3. Use the R.H. working mode switch to advance the minute. 4. To return to the time display mode use the same procedure as in Step 1.	1. The time mark portion flashes  BKP00087 ★ The example shows the situation when setting to 12:34.

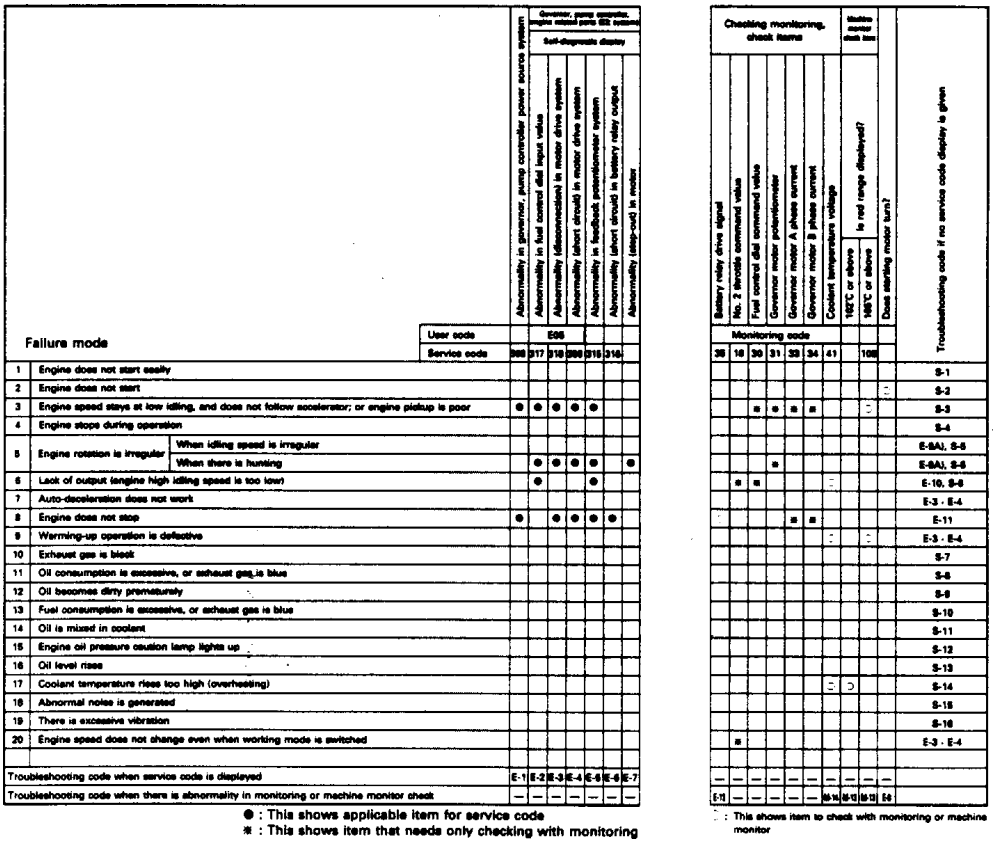
METHOD OF USING JUDGEMENT TABLE

This judgement table is a tool to determine if the problem with the machine is caused by an abnormality in the electrical system or by an abnormality in the hydraulic or mechanical system. the symptoms are then used to decide which troubleshooting table (E-◯◯, S-◯◯, C-◯◯, F-◯◯, H-◯◯, M-◯◯) matches the symptoms. The judgement table is designed so that it is easy to determine from the user code and service code which troubleshooting table to go to.

★ The abnormality display (warning) given by the monitor panel leads directly to troublehsooting of the machine monitor (M-◯◯). (See troubleshooting of the machine monitor system).

1. When using judgement table for governor, pump controller (governor control system) and engine related parts

- If a service code is displayed on the monitor panel, go to the troubleshooting code at the bottom of the judgement table (E-◯◯).
  (A ● Mark is put at the places where the failure mode and service code match).
- If a problem has appeared but no service code is displayed on the monitor panel, go to the point where the failure mode matches the troubleshooting code on the right of the judgement table (E- or S-).
  <Example> Failure mode "Engine does not start".
  Procedure: Check if the service code is being displayed on the monitor panel.



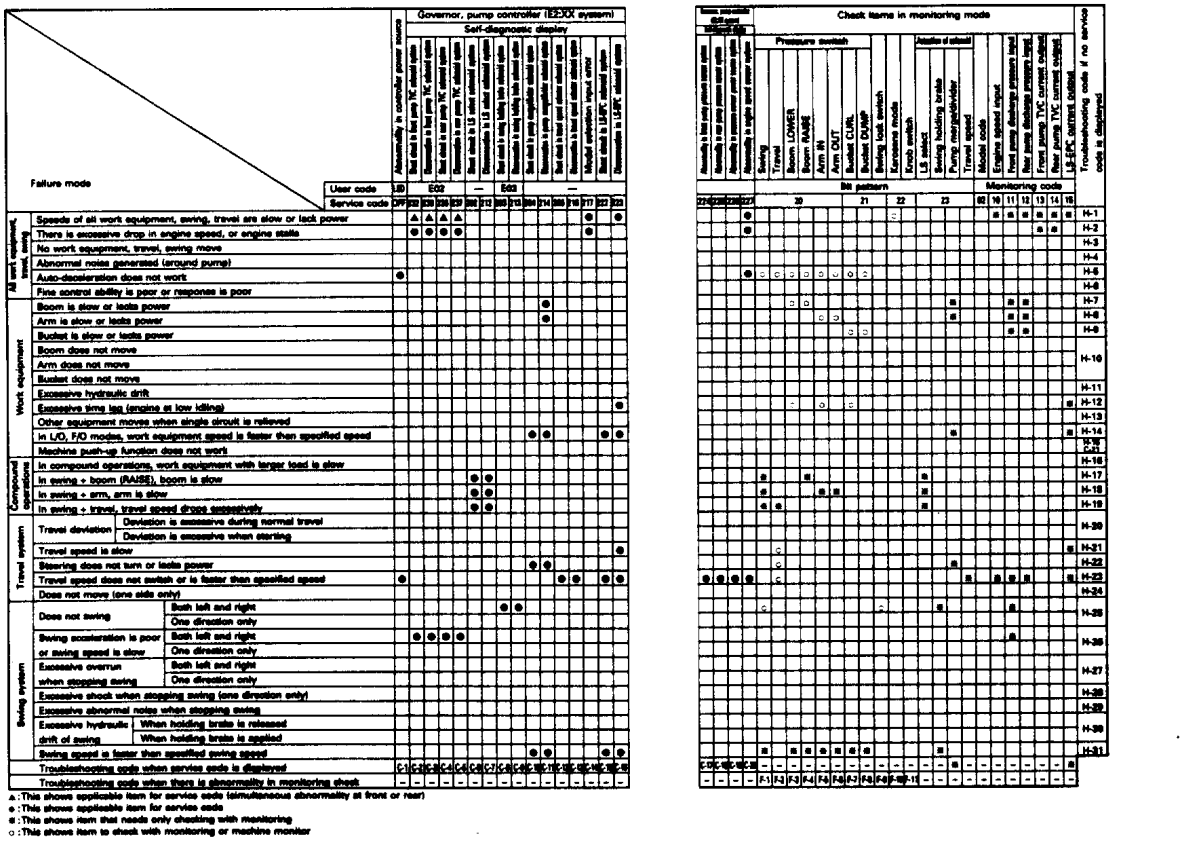
[Judgement]

1) If a service code is being displayed on the monitor panel…go to troubleshooting [E3:◯◯] for the governor, pump controller (governor control system).
2) If no service code is displayed on the monitor panel, and the engine does not start:

- Check that starting motor rotates
  - Starting motor rotates ..... Go to troubleshooting S-2 of mechanical system
  - Starting motor does not rotate ..... Go to troubleshooting E-8 of electical system

2. When using judgement table for governor, pump controller (governor control sustem) 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 mark).
     - If it is displayed normally, go to the troubleshooting code on the right of the judgement table (H-◯◯).
     - If the input signal is not displayed on the monitor panel, go to the troubleshooting code at the bottom of the judgement table (F-◯◯).

<Example> Failure mode "Upper structure does not swing".



Procedure: check if the service code is being displayed on the monitor panel.

[Judgement]

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

- Check governor, pump controller input signal (Check in monitoring mode)
  - There is a signal ..... Go to troubleshooting H-25 of mechanical system
  - There is no signal ..... Go to troubleshooting F-◯◯ of governor, pump controller input signal system (F mode for applicable system)

METHOD OF USING TROUBLESHOOTING CHARTS

1. Category of troubleshooting code number

Troubleshooting Code No.	Component	Service code
N-◯◯	Troubleshooting of communication abnormality system	E218 group
E-◯◯	Troubleshooting of electrical system for governor, pump controller (governor control system)	E3-◯◯ group
S-◯◯	Troubleshooting of engine related parts	-
C-◯◯	Troubleshooting of electrical system for governor, pump controller (pump control system)	E2- ◯◯ group
F-◯◯	Troubleshooting of governor, pump controller (input signal system)	-
H-◯◯	Troubleshooting of hydraulic, mechanical system	-
M-◯◯	Troubleshooting of machine monitor	E1-◯◯ group

2. Method of using troubleshooting table for each troubleshooting mode

1) Troubleshooting code number and problem. The title of the troubleshooting chart gives the troubleshooting code, and failure mode (problem with the machine). (See Example (1)).
2) Distinguishing conditions. Even with the same failure mode (problem), the method of troubleshooting may differ according to the model, component, or problem. In such cases, the failure mode (problem) is further divided into sections marked with small letters (for example a), so go to the appropriate section to carry out troubleshooting. (See Example (2)). If the troubleshooting table is not divided into sections, start troubleshooting from the first check item in the failure mode.
3) Method of following troubleshooting chart
   - Check or measure the item inside ▭ and according to the answer follow either the YES line or the NO line to go to the next ▭. (Note: The number written at the top right corner of the ▭ is an index number; it does not indicate the order to follow).
   - Following the YES or NO lines according to the results of the check or measurement will lead finally to the Cause column. Check the cause and take the action given in the Remedy column on the right. (See Example (3)).
   - Below the ▭ there are the 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 it may cause mistaken judgement, or the equipment may be damaged. Therefore, before starting inspection or measurement, always read the instructions carefully, and start the work in order from item (1).
4) General precautions. When carrying out troubleshooting for the failure mode (problem), precautions that apply to all items are given at the top of the page and marked with ★ (See Example (4)). The precautions marked ★ are not given in the ▭, but must always be followed when carrying out the check inside the ▭.
5) Troubleshooting tools. When carrying out the troubleshooting, prepare the necesarry troubleshooting tools. For details, see TOOLS FOR TESTING, ADJUSTING, AND TROUBLESHOOTING.

6) Installation position, pin number
A diagram or chart is given for the connector type, installation position, and connector pin number connection. When carrying out troubleshooting, see this chart for details of the connector pin number and location for inspection and measurement of the wiring connector number appearing in the troubleshooting flow chart for each failure mode (problem).

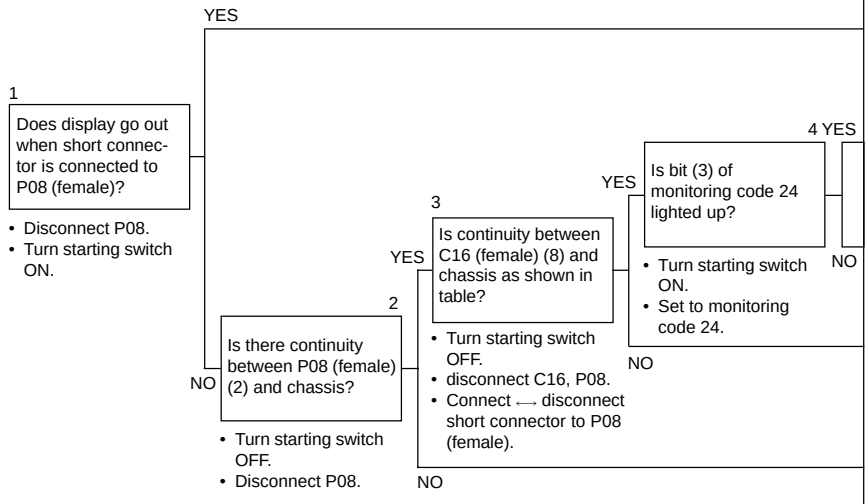
<Example>

(1) M-9 When starting switch is turned ON (engine stopped), check item for previous troubleshooting flashes

(4) ★ Before carrying out troubleshooting, check that all the related connectors are properly inserted.
★ Always connect any disconnected connectors before going on the next step.
★ Check that the coolant is at the specifies level before carrying out troubleshooting.

(2) a)  (coolant level) light flashes
SAP00519 Devided into sections a) and b)
b)  (engine oil level) light flashes
SAP00523

(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

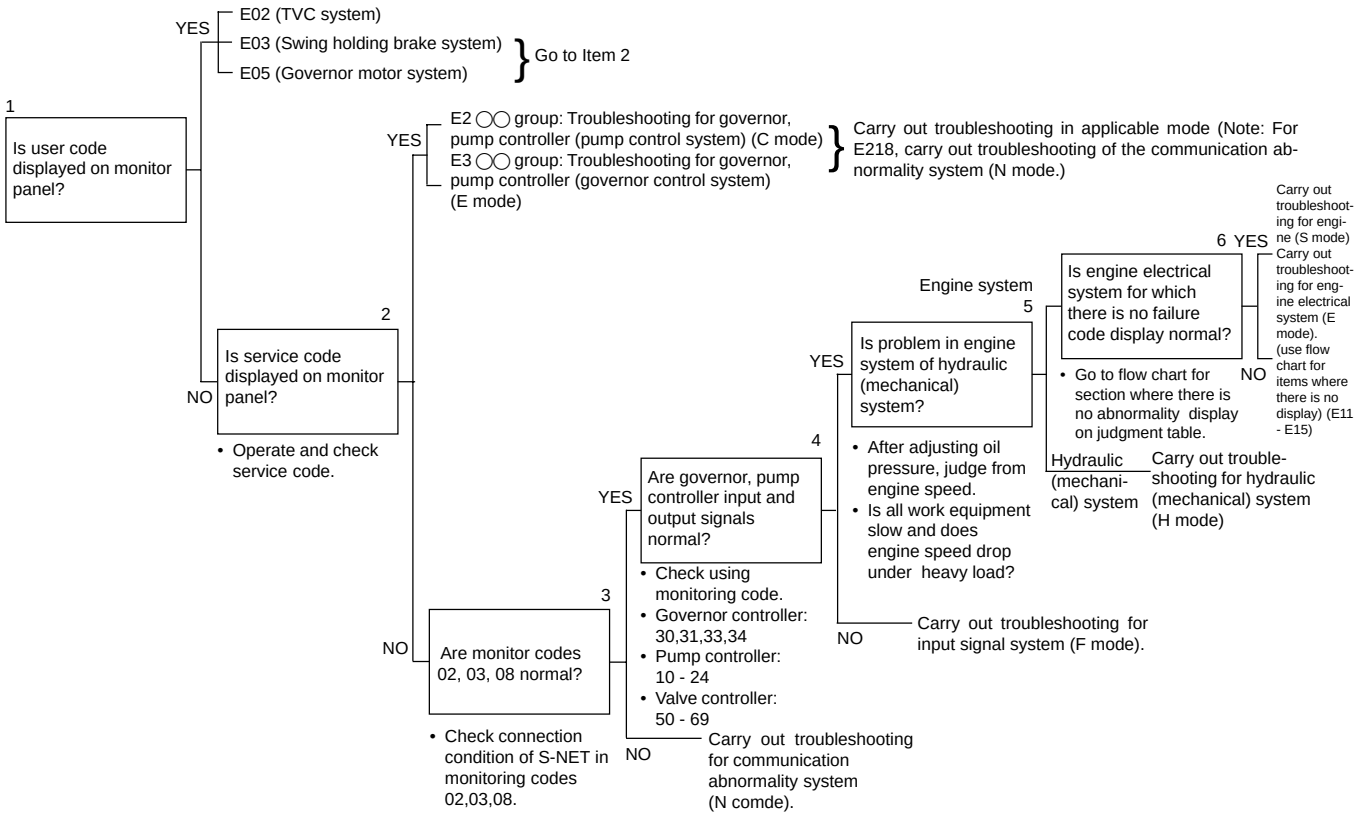
Table

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 (governor, pump controller (governor control system) and governor, pump controller (pump control system). For details of the troubleshooting and troubleshooting procedure, refer to this flow chart.
When carrying out troubleshooting, ask the operator as much as possible about the condition of the machine, and check the following items before starting.
(1) Condition of controller connection (check with monitoring codes 02 - 03)
(2) Blown fuses
(3) Battery voltage (monitoring mode 32)
(4) Electricity generation (charge input) voltage (monitoring code 43)

The procedure for carrying out check items No. 3 and 4 in the flow chart below is given on the following pages.



★ For details, see governor, pump controller (governor control system) (pump control system) in the JUDGEMENT TABLE.

If there is no abnormality display in the communications system transmitted in S-NET, it can be taken that the output signal from the monitor panel has been transmitted. However, even if there is no abnormality display, if the operation is defective, use the following procedure when checking directly. If any abnormality occurs in the S-NET system, the system is automatically switched to the following default mode, so be careful when carrying out troubleshooting.

Default Mode when communications cannot be carried out for the monitor and governor, pump controller

Set mode	Pump Control	Governor control
1 Working mode	G/O mode	H/O mode
2 Throttle signal	FULL	FULL
3 Auto-deceleration	ON (deceleration mode)	ON (deceleration mode)
4 Coolant temperature signal	OFF	-
6 Power max. mode	ON (power max. possible)	-
7 Travel speed	Lo	-
8 Automatic warming up	_	ON (automatic warming-up mode)

1. Procedure for checking monitor panel output signal

★ For details of operating the monitoring mode, see MONITOR PANEL DISPLAY AND SPECIAL FUNCTIONS.

1. Connnection condition of components
   1) Set to the monitoring mode and display monitoring code 08.
   2) The time display (bits) will light up to display the components that are connected.
      ★ Governor, pump controller (pump control system) (1) and governor, pump controller (governor control system) (2) will light up.

2. Checking working mode signal (check No. 2 throttle signal monitoring code 16) at the same time)
   1) Set to the monitoring mode and display monitoring code 10.
   2) Switch the working mode as shown in Table 1 and check that the engine speed changes.

Table 1

Working mode	High idling speed (rpm) [The figures in ( ) are the rated speed]
H/O	Approx. 2180 (1900) ✶
G/O	Approx. 2100 (1900) ※
L/O	Approx. 1990 (1780)

※ 1 Swing Lock ON

✶ To measure H/O idle speed move one of the wrist controls just enough to cancel auto decel but not so much that the excevator work equipment moves.

3. Checking travel speed selection signal
   1) Set to the monitoring mode and display monitoring code 23.
   2) Change the speed selector to Mi or Lo. Check that bit (6) lights up when travelling in these speeds only.
      N.B. Ensure that the travel speed change interlock is operated correctly when selecting Mi or Lo. See the operator manual for instructions.

2 Checking input signal of governor, pump controller

★ Check the input signals for each controller as follows.

• Pump control system

1. Checking input signal
   1) Check hydraulic switch
      i) Set to the monitoring mode, and display monitoring code 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
   i) Check LS-EPC solenoid output current.
   ii) Run the engine at high idling with all the levers at neutral and in the G/O or H/O mode, and measure the current.
      ★ All levers at neutral: 900 ± 80 mA. Engine at high idling, any lever operated (other than travel):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 applicabel bit light 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 ON release	Travel operated independently	(5)
Travel speed selector	Travel speed selector switch Mi or Lo	(6)

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

4) Check TVC solenoid output current
   i) Set to the monitoring mode, and display monitoring code 13
   ii) With the starting switch kept at the ON position (G/O mode), measure the current when the fuel control dial is turned to the MAX position.
   • Current with starting switch ON (G/O mode) and the fuel control dial at MAX 410 ± 80 (mA).

- Governor control sustem
  1. Check input signal
     1) Check fuel control dial input voltage
        i) Set to the monitoring mode, and display monitoring code 30.
        ii) Measure the voltage when the fuel control dial is turned from low idling to high idling.
            ★ Voltage: 0.25 - 4.75 V
     2) Check governor potentiometer voltage
        i) Set to the monitoring mode, and display monitoring code 31.
        ii) Measure the potentiometer voltage when the fuel control dial is turned from low idling to high idling.
            ★ Voltage: 0.5 - 3.3 V

  2. Check outout signal
     1) Check governor moter drive current
        i) Set to the monitorong mode, and display monitoring codes 33 and 34.
            ★ Code 33 is the A phase (engine speed acceleration direction) and code 34 is the B phase (engine speed deceleration direction)
        ii) Measure the governor motor drive current when the fuel control dial is turned in the acceleration direction and deceleration direction.
            ★ Current: 700 ± 70 (mA)

     2) Measure battery relay drive output voltage
        i) Set to the monitoring mode, and display monitoring code 35.
        ii) Measure the battery relay drive output voltage when the starting switch is turned from ON to OFF. or
        iii) Set to the monitoring mode, and display monitoring code 37.
        iv) Check that bit (1) lights up when the starting switch is turned from ON to OFF.

SERVICE CODE TABLE

Service code	Abnormal system	User code
E101	Abnormality in error history data	
E102	Abnormality in time data	
E103	Short circuit in buzzer output, contact with 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 105*C	
E201	Short circuit in suspension lock solenoid system	
E203	Short circuit in swing holding brake solenoid system	E03
E206	Short circuit in 2-stage relief solenoid system	
E206	Short circuit in travel speed solenoid system	
E211	Disconnection in LS bypass solenoid system	
E213	Disconnection in swing holding brake solenoid system	
E215	Disconnection in 2-stage relief solenoid system	E03
E216	Disconnection in travel speed solenoid system	
E217	Error in model selection input	
E218	Network response overtime error	
E222	Short circuit in LS-EPC solenoid system	
E223	Disconnect 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 TVC solenoid system	E02
E233	Disconnection in pump TVC solenoid system	E02
E306	Abnormality in feedback potentiometer system	
E308	Abnormality in fuel control dial input value	E05
E315	Short circuit in battery relay output system	
E316	Step-out in governor motor	
E317	Disconnection in governor motor system	E05
E318	Short circuit in governor motor system	E05

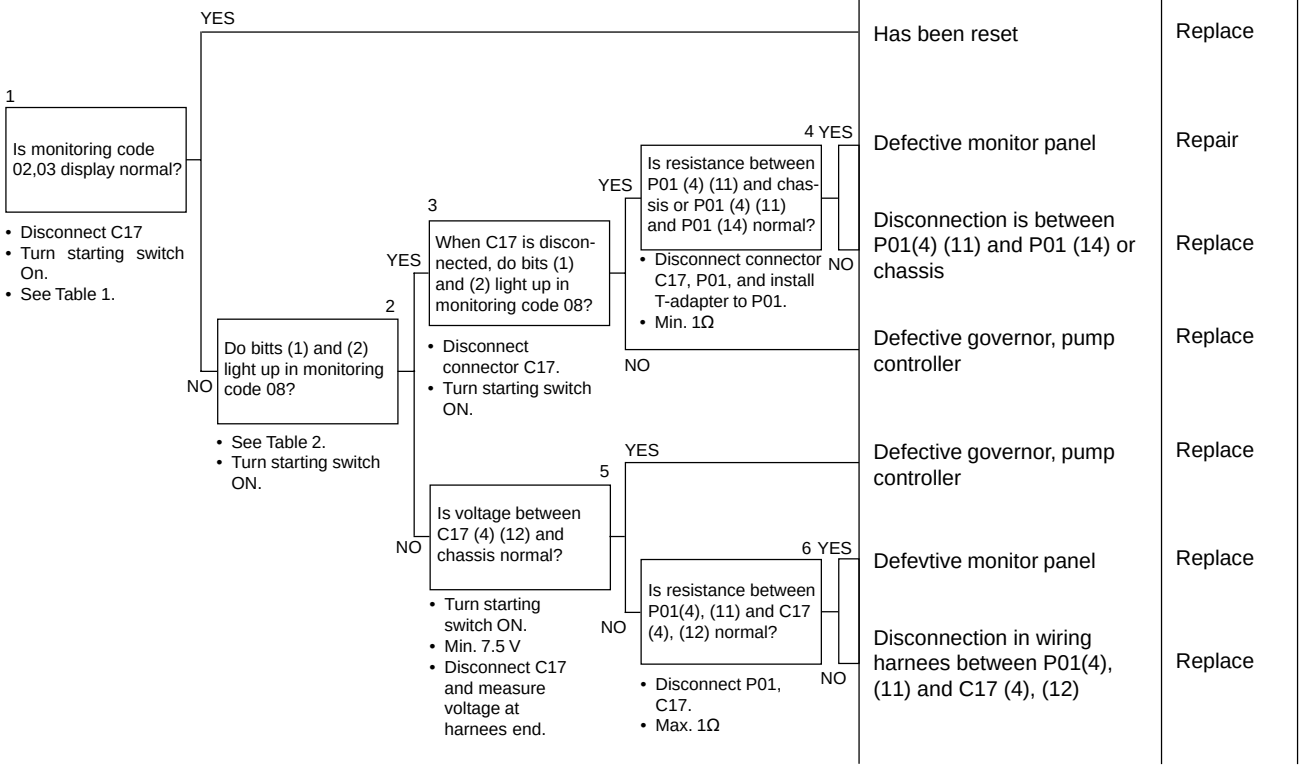
Service code	Abnormal system	User code
E112	Short circuit in relay drive R	
E113	Short circuit in relay drive L	
E114	Short circuit in window washer drive	

TROUBLESHOOTING OF COMMUNICATION ABNORMALITY SYSTEM (N MODE)

N-1 [E218] Communication abnormality 20-98

N-1 [E218] Communication abnormality

★ This troubleshooting is carried out when there is still an abnormality, so when disconnecting the connector and inserting the T-adapter, or when removing the T-adapter and returning the connector to its original position, if the service code E is not displayed, the problem has been removed.
★ If the starting switch was turned off after the abnormality occurred, turn the starting switch on and check that the service code displays E. (If it is not displayed, the problem has been removed.)
★ Before carrying out troubleshooting, check that all the related connectors are properly inserted.
★ Always connect any disconnected connectors before going on the next step.



Cause	Remedy
Has been reset	Replace
Defective monitor panel	Repair
Disconnection is between P01(4) (11) and P01 (14) or chassis	Replace
Defective governor, pump controller	Replace
Defective governor, pump controller	Replace
Defevtive monitor panel	Replace
Disconnection in wiring harnees between P01(4), (11) and C17 (4), (12)	Replace

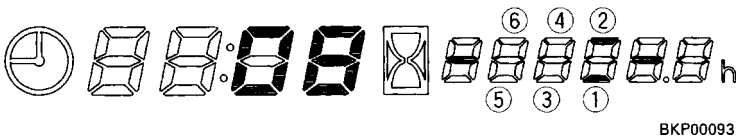
Table 1

Monitoring code		Display
01	Monitor panel model code	150
02	Governor, pump controller model code	170
03	Governor, pump controller model code	170

- When each controller is connected to the network,"_" is displayed. If the correct alphanumerics are not displayed (another model is displayed), each controller shows model selection abnormal.

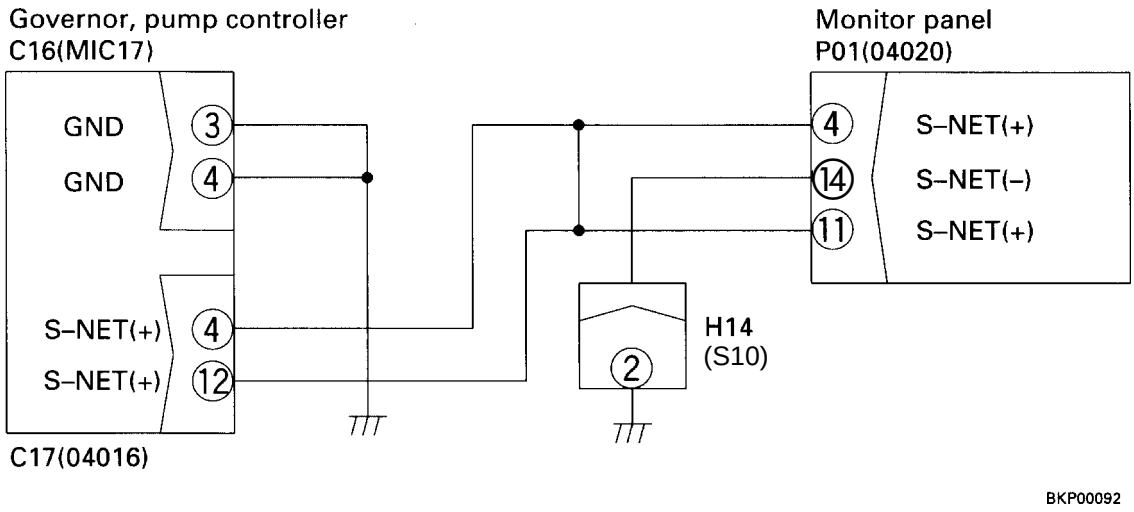
Table 2

Monitoring code \ Display	
08	Network connection condition



- Light up when connected
  (1) Governor, pump controller
  (2) Governor, pump controller
- Note: Checks can be carried out with code 08 only when there is a disconnection. The display does not change when there is a short circuit.
  Therefore, checks when there is a short circuit should be carried out basically using Table 1

N-1 Related electric circuit diagram



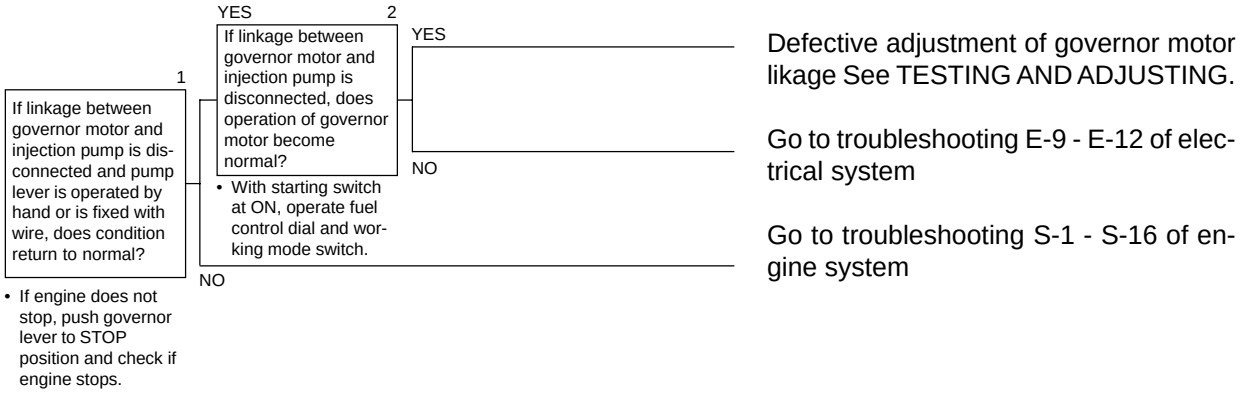
TROUBLESHOOTING OF GOVERNOR, PUMP CONTROLLER (GOVERNOR CONTROL SYSTEM) (E MODE)

Points to remember when carrying out troubleshooting of governor, pump controller system 20-101
Action taken by controller and condition of machine when abnormality occurs 20-102
Judgement table for governor, pump controller (governor control system)
and engine related parts 20-106
Electrical circuit diagram of governor, pump controller (governor control system) 20-108
E- 1 Abnormality in governor, pump controller power sosurce (controller LED is OFF) 20-110
E-2 [E308] Abnormality in fuel control dial input value is displayed.... 20-111
E-3 [E317] Abnormality (disconnection) in governor motor drive system is displayed.... 20-112
E-4 [E318] Abnormality (short circuit) in governor motor drive system is displayed.... 20-113
E-5 [E306] Abnormality in feedback potentiometer system is displayed.... 20-114
E-6 [E315] Abnormality (short circuit) in battery relay output system is displayed.... 20-115
E-7 [E316] Abnormality (step-out) in motor is displayed.... 20-116
E-8 Engine does not start.... 20-118
E-9 Engine speed is irregular.... 20-120
a) Idling speed is irregular.... 20-120
b) There is hunting.... 20-122
E-10 Lack of output (engine high idling speed is to low).... 20-124
E-11 Engine does not stop.... 20-126
E-12 Defective operation of battery relay system (engine does not stop).... 20-128

POINTS TO REMEMBER WHEN CARRYING OUT TROUBLE-SHOOTING OF GOVERNOR, PUMP CONTROLLER SYSTEM

1. Points to remember when there is abnormality which is not displayed by user code. The engine is controlled by the governor and pump controller. The problem that may occur with this system include the following.
   1. Idling speed is too high (too low)
   2. High idling speed is too low
   3. Auto-deceleration speed is too high (too low)
   4. Engine speed for automatic warming-up operation is too high (too low)
   5. There is hunting
   6. Engine does not stop

   If any abnormality occurs, and the abnormality is displayed on the time display portion of the monitor panel, use the troubleshooting table to determine the appropriate troubleshooting flow chart form E-1 to E-12. However, if there is any abnormality in the machine and no abnormality display is given, it is necessary to determine whether the problem is in the mechanical system or in the electrical system. If the linkage between the governor motor and the injectionpump 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 above has occured, carry out troubleshooting as follows.



Disconnect the linkage as explained above, or check the adjustment and go to the troubleshooting flow chart for the mechanidal 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-adepter is inserted, or the T-adepter 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 disolay 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, note down the content of the display, then erase the display. After trying to re-enact the problem, carry out troubleshooting according to the failure code that is displayed. (There are cases where mistaken operation or abnormalities that occur when the connector is disconnected are recorded by the memory retention function. Erasing the data in this way saves any wasted work).

ACTION TAKEN BY CONTROLLER WHEN ABNORMALITY OCCURS AND PROBLEMS ON MACHINE

User code	Service code	Abnormal system	Nature of abnormality
E05	E308	Abnormality in fuel control dial input valvue	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. Sisconnection in wiring harness between C02 (2) - E05 (1) 3. Disconnection in wiring harness between C02 (4) - E05 (3) 4. Disconnection in wiring harness between C02 (3) - E05 (2) 5. Disconnection in wiring harness between C02 (5) - E05 (4) 6. Defective contact of E05 connector
	E318	Abnormality (short circuit) in motor drive system	1. Short circuit inside governor motor 2. Wiring harness between C02 (2) - E05 (1) and between C02 (4) - E05 (3) short circuiting with wiring harness between C02 (3) - E05 (2) 3. Wiring harness between C02 (4) - E05 (3) and between C02 (2) - E05 (1) short circuiting with wiring harness between C02 (5) - E05 (4) 4. Wiring harness in Items 2 and 3 short circuiting with ground

<table>
<tr><th>Condition when normal (voltage, current, resistance)</th><th>Action by controller when abnormality is detected</th><th>Problem that appears on machine when there is abnormality</th></tr>
<tr>
<td>
<table>
<tr><th>C03 (female)</th><th>E06 (male)</th><th>Resistance value</th></tr>
<tr><td>(7) - (4)</td><td>(1) - (2)</td><td>0.25 - 7kΩ</td></tr>
<tr><td>(4) - (17)</td><td>(2) - (3)</td><td>0.25 - 7kΩ</td></tr>
<tr><td>(7) - (17)</td><td>-</td><td>2 - 3kΩ</td></tr>
<tr><td>-</td><td>(1) - (3)</td><td>4 - 6kΩ</td></tr>
<tr><td>Between each pin and chassis</td><td>-</td><td>Min. 1 MΩ</td></tr>
</table>
</td>
<td>Maintains engine speed at position of fuel control dial immediately before abnormality occurred</td>
<td>1. Does not become partial speed when set at MAX position
2. Does not reach high idling when set at partial speed
3. There are cases of hunting
4. Lacks output (max. speed of engine is too low)</td>
</tr>
<tr>
<td>
<table>
<tr><th>E05 (male)</th><th>C02 (female)</th><th>Resistance value</th></tr>
<tr><td>(1) - (2)</td><td>(2) - (3)</td><td>0.25 - 7kΩ</td></tr>
<tr><td>(3) - (4)</td><td>(4) - (5)</td><td>0.25 - 7kΩ</td></tr>
<tr><td>(1) - (3)</td><td>(2) - (4)</td><td>Min. 1 MΩ</td></tr>
<tr><td>(1) _ 94)</td><td>(2) - (5)</td><td>Min. 1 MΩ</td></tr>
<tr><td>Between pins (1), (2), (3), (4) and chassis</td><td>Between pins (2), (3), (4), and (5) and chassis</td><td>Min. 1 MΩ</td></tr>
</table>
Motor drive current: Hold: 0.7 A
Start: 0.84 A
</td>
<td>Takes no particular action</td>
<td>1. When there is a disconnection in both the A phase and B pahse at the same time, the problem is the same as for a short circuit in the governor motor system
2. When there is a disconnection in only one of A phase or B phase
1) Engine does not stop
2) Stops moving at position immediately before failure, so engine speed cannot be controlled
3) There are cases of hunting</td>
</tr>
<tr>
<td>
<table>
<tr><th>E05 (male)</th><th>C02 (female)</th><th>Resistance value</th></tr>
<tr><td>(1) - (2)</td><td>(2) - (3)</td><td>0.25 - 7kΩ</td></tr>
<tr><td>(3) - (4)</td><td>(4) - (5)</td><td>0.25 - 7kΩ</td></tr>
<tr><td>(1) - (3)</td><td>(2) - (4)</td><td>Min. 1 MΩ</td></tr>
<tr><td>(1) - (4)</td><td>(2) - (5)</td><td>Min. 1 MΩ</td></tr>
<tr><td>Between pins (1), (2), (3), (4) and chassis</td><td>Between pins (2), (3), (4), and (5) and chassis</td><td>Min. 1 MΩ</td></tr>
</table>
Motor drive current: Hold: 0.7 A
Start: 0.84 A
</td>
<td>Sets motor drive current to 0</td>
<td>1. If during operation
1) Set to low idling
2) Engine does not stop
3) There are cases of hunting
2. When stopped
1) Engine starts, but stays at low idling
2) Engine does not stop after starting
3) There are cases of hunting</td>
</tr>
</table>

User code	Service code	Abnormal system	Nature of abnormality
-	E306	Abnormality in feedback potentiometer system	1. Short circuit in wiring harness between C03 (7) - (14), (7) - (17), (14) - (17) 2. Short circuit in wiring harness between E04 (1) - (2), (1) - (3), (2) - (3) 3. Short circuit in wiring harness between E06 (1) - (2), (10 - (3), (2) - (3) 4. Short circuit in wiring harness between C03 (7) - (4), (4) - (17) 5. Disconnection in wiring harness between C03 (7) - E04 (1) 6. Disconnection in wiring harness between C03 (14) - E04 (2) 7. Disconnection in wiring harness between C03 (17) - E04 (3) 8. Defective governor motor potentiometer 9. Defective contact of C03, E04 connectors
-	E315	Abnormality (short circuit) in battery relay output system	If excess current flows between C03 (1) and battery relay ★ This occurs only when turning starting switch to OFF and stopping engine
-	E316	Abnormality (step-out) in motor	1. Defective adjustment of rod or scuffing of loose spring
			2. Abnormality in governor motor
			3. Abnormality in govenor, pump controller

<table>
<tr><th>Condition when normal
(voltage, current, resistance)</th><th>Action by controller when abnormality is detected</th><th>Problem that appears on machine when there is abnormality</th></tr>
<tr><td>
<table>
<tr><th>C03
(female)</th><th>E04
(male)</th><th>Resistance value</th></tr>
<tr><td>(7) - (14)</td><td>(1) - (2)</td><td>0.25 - 7kΩ</td></tr>
<tr><td>(7) - (17)</td><td>(2) - (3)</td><td>0.25 - 7kΩ</td></tr>
<tr><td>(14) - (17)</td><td>-</td><td>2 - 3kΩ</td></tr>
<tr><td>-</td><td>(1) - (3)</td><td>4 - 6kΩ</td></tr>
<tr><td>Between each pin and chassis</td><td>-</td><td>Min. 1 MΩ</td></tr>
</table>
</td><td>Calculates position of motor and carries out control from value of voltage immediately befor abnormality occurred</td><td>1. Precision of engine speed control may be reduced.
For example:
1) Engine does not rise to high idling speed (a little too low)
2) Engine does not go down to low idling speed (a little too high)
3) Defective engine speed for autodeceleration or automatic warming-up
4) Engine may not stop
★ The governor motor moves in the direction to stop the engine, but the motor may not move completely to the position to stop the engine.
5) There are cases of hunting</td></tr>
<tr><td>Between C03 (1) and chassis: 20 - 30 V
★ Holds with the motor in the stop position for 2 - 2.5 sec, returns to the low idling position, the turns then battery relay OFF.</td><td>Sets battery relay drive current to 0</td><td>Engine does not stop</td></tr>
<tr><td>1. Linkage adjustment correct</td><td rowspan="3">1. Displays when returning from high idling to low idling
★ Starts again (repeats step-out)
2. In some cases it may not display when returning from partial speed to low idling</td><td rowspan="3">Engine speed cannot be controlled (particularly at high idling), so there is hunting</td></tr>
<tr><td>2. Must move lightly when connector is removed</td></tr>
<tr><td>3. Normal</td></tr>
</table>

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

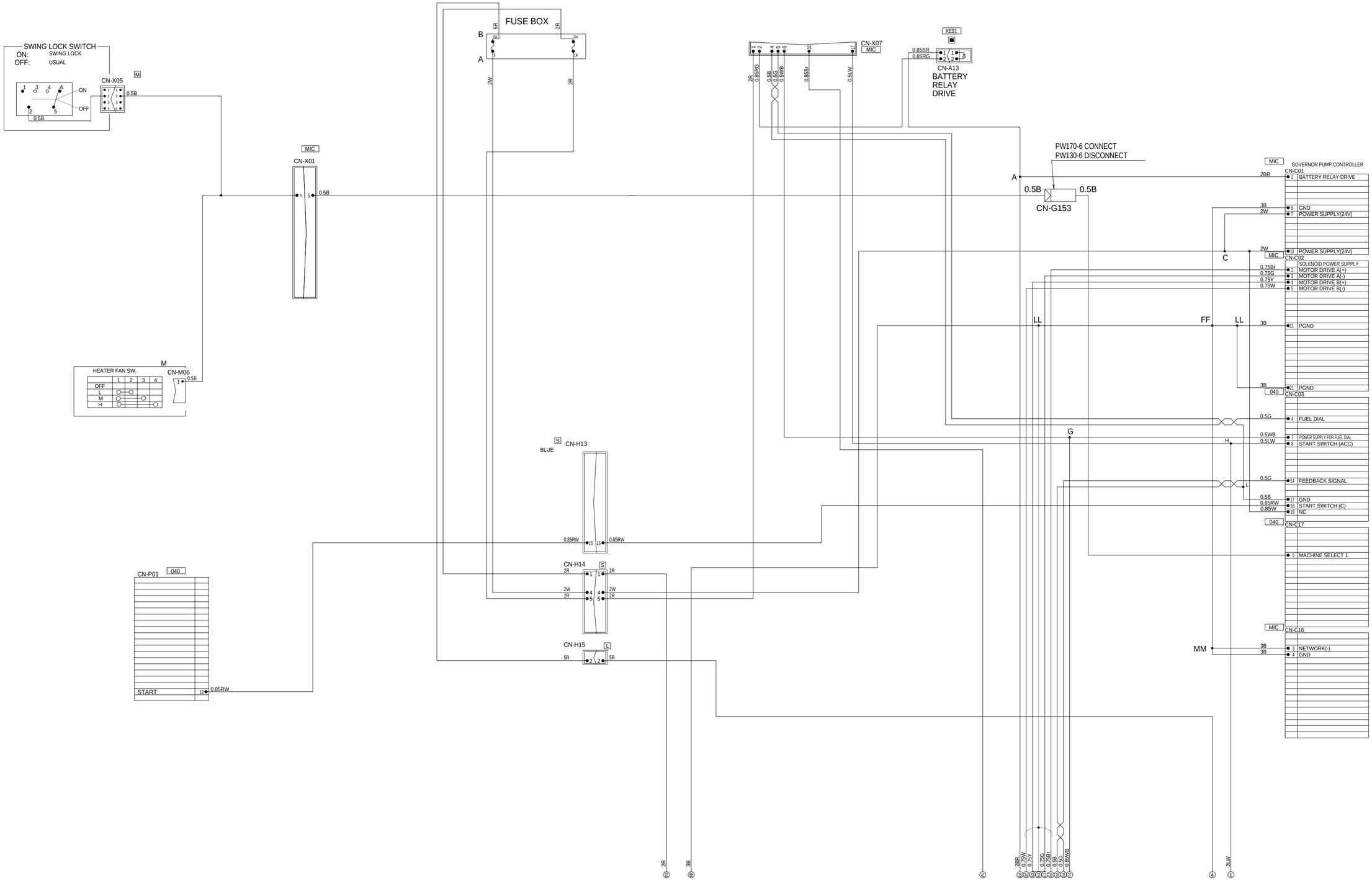
Failure mode			Abnormality in governor, pump controller power source system	Governor, pump controller, engine related parts (E3: system)					
				Self-diagnostic display					
				Abnormality in fuel control dial input value	Abnormality (disconnection) in motor drive system	Abnormality (short circuit) in motor drive system	Abnormality in feedback potentiometer system	Abnormality (short circuit) in battery relay output	Abnromality (step-out) in motor
		User code		E05					
		Service code	308	317	318	306	315	316	
1	Engine does not start easily								
2	Engine does not start								
3	Engine speed stays at low idling, and does not follow accelerator; or engine pickup is poor		●	●	●	●	●		
4	Engine stops during operation								
5	Engine rotation is irregular	When idling speed is irregular							
		When there is hunting		●	●	●	●		●
6	Lack of output (engine high idling speed is too low)			●			●		
7	Auto-deceleration does not work								
8	Engine does not stop		●		●	●	●	●	●
9	Warming-up operation is defective								
10	Exhaust gas is black								
11	Oil consumption is excessive, or exhaust gas is blue								
12	Oil becomes dirty prematurely								
13	Fuel consumption is excessive, or exhaust gas is blue								
14	Oil is mixed in coolant								
15	Engine oil pressure caution lamp lights up								
16	Oil level rises								
17	Coolant temperature rises too high (overheating)								
18	Abnormal noise is generated								
19	There is excessive vibration								
20	Engine speed does not change even when working mode is switched								
Troubleshooting code when service code is displayed			E-1	E-2	E-3	E-4	E-5	E-6	E-7
Troubleshooting code when there is abnormality in monitoring or machine monitor check			-	-	-	-	-	-	-

• : This shows applicable item for service code
★ : This shows item that needs only checking with monitoring

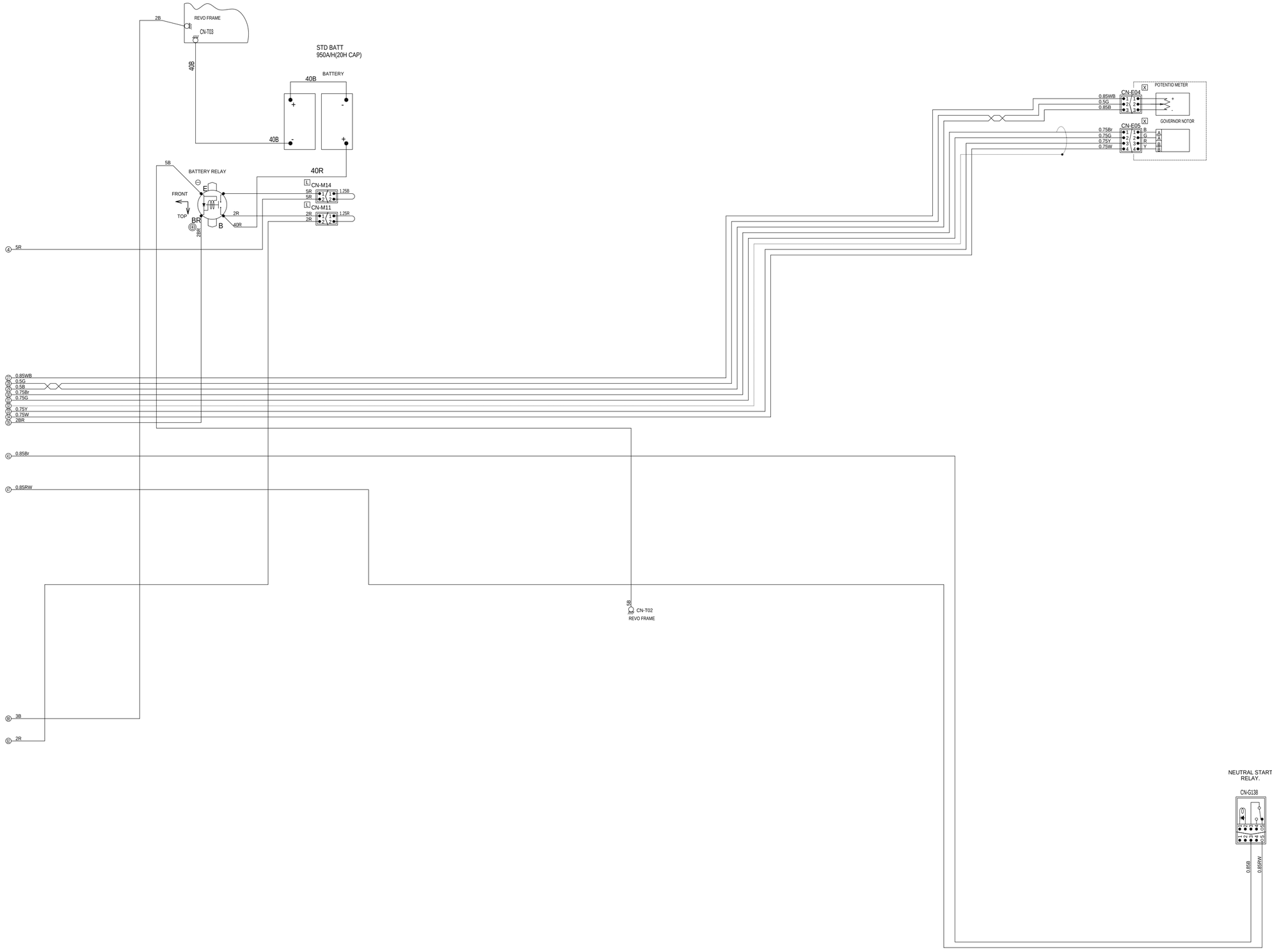
Checking monitoring, check items							Machine monitor check item			Troubleshooting code if no service code display is given
Battery relay drive signal	No. 2 throttle command value	Fuel control dial command value	Governor motor potentiometer	Governor motor A phase current	Governor motor B phase current	Coolant temperature voltage	Is the range displayed? 102°C or above	Is the range displayed? 105°C or above	Does starting motor turn?	
Monitoring code										
35	16	30	31	33	34	41		108		
										S-1
									○	S-2
		※	※	※	※			○		S-3
										S-4
										E-9A), S-5
			※							E-9A), S-5
	※	※				○				E-10, S-6
										E-3. E-4
○				※	※					E-11
						○		○		E-3 . E-4
										S-7
										S-8
										S-9
										S-10
										S-11
										S-12
										S-13
						○	○			S-14
										S-15
										S-16
	※									E-3 . E-4
-	-	-	-	-	-	-	-	-	-	
E-12	-	-	-	-	-	M-14	M-13	M-13	E-8	

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

ELECTRICAL CIRCUIT DIAGRAM FOR E MODE 1/2

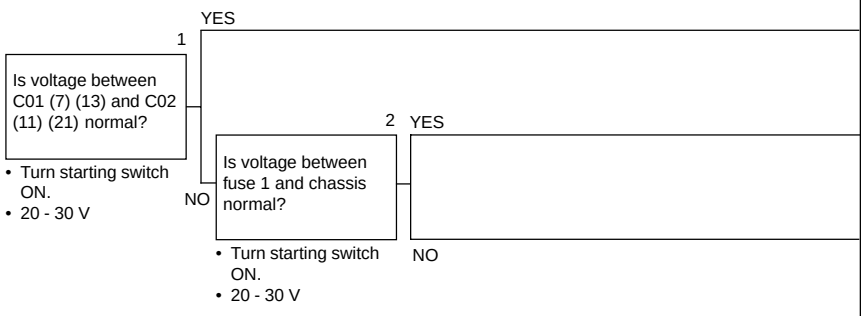


ELECTRICAL CIRCUIT DIAGRAM FOR E MODE 2/2



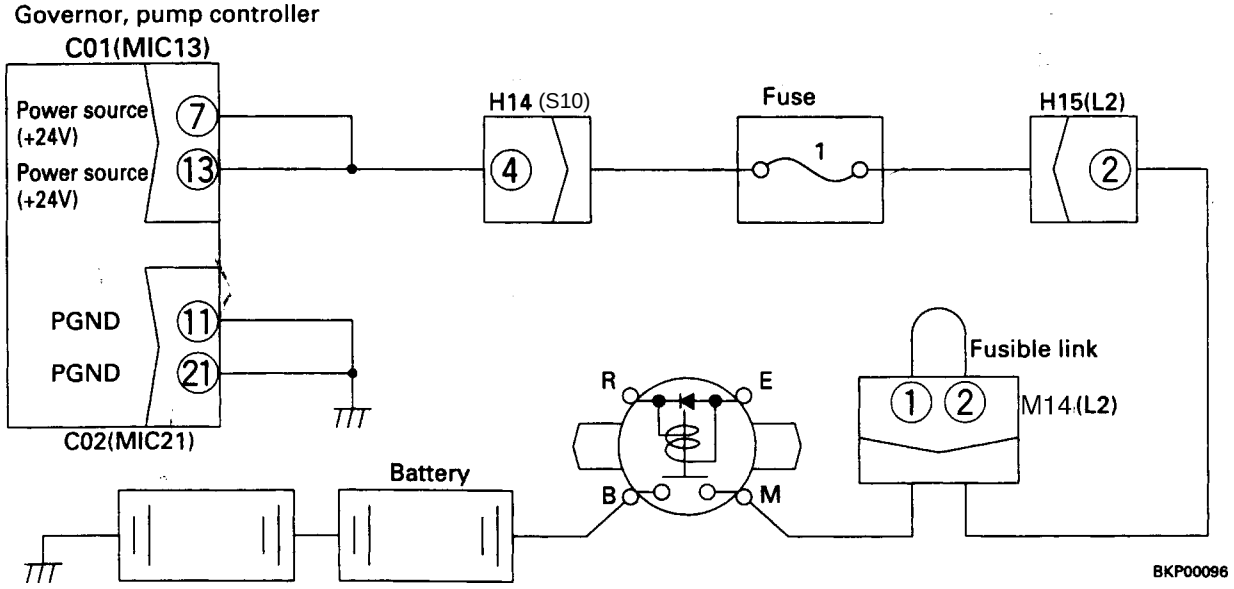
E-1 Abnormality in governor, pump controller power source (controller LED is OFF)

★ **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 connecotrs are properly inserted.
★ Always connect any disconnected connectors before going on the next step.
★ When the starting motor rotates correctly. (If the starting motor also does not rotate, 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

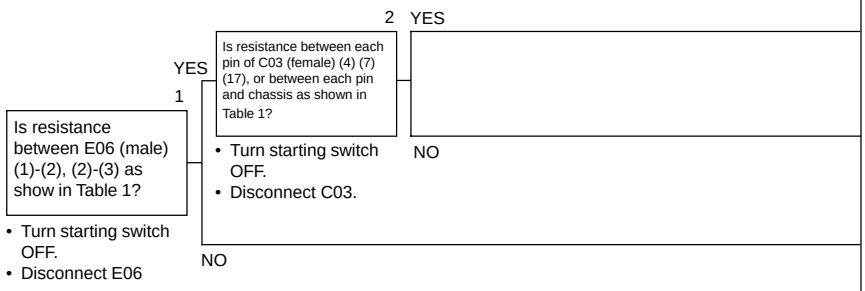


E-2 [E308] Abnormality in fuel control dial input value is displayed

★ **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 the next step.



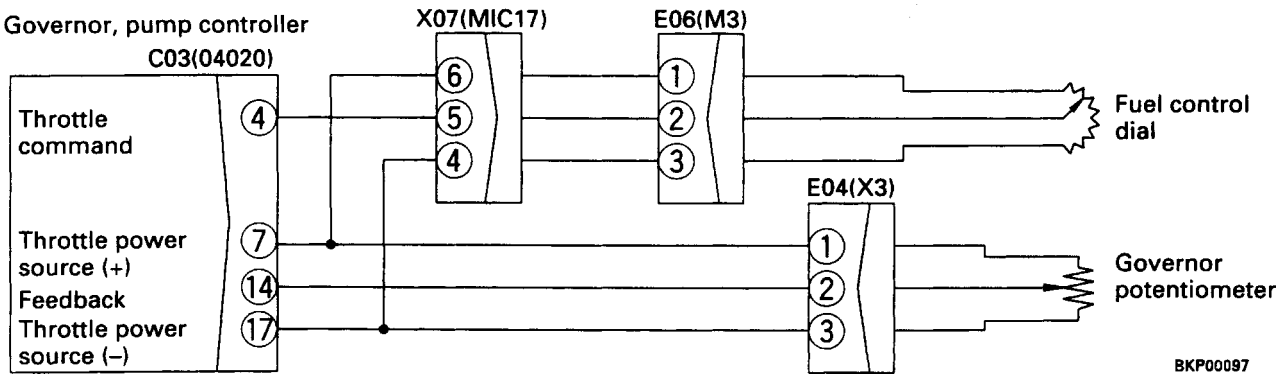
Cause	Remedy
Defective governor, pump controller	Replace
Defective wiring harness in system with defective resistance	Replace
Defective fuel control dial	Replace

★ 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 groud, or contact with other wiring harness

Table 1

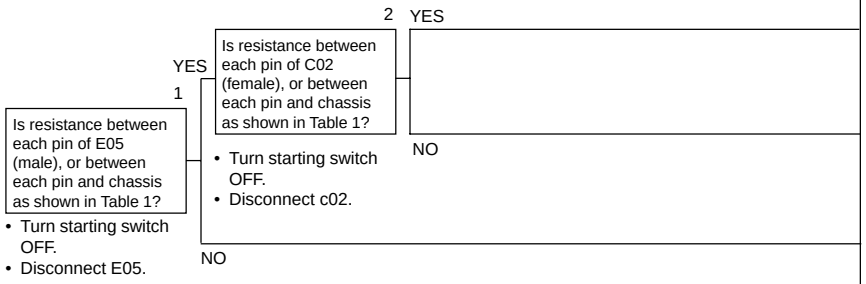
C03 (female)	E04 (male)	Resistance value
(7) - (4)	(1) - (2)	0.25 - 7kΩ
(4) - (17)	(2) - (3)	0.25 - 7kΩ
(7) - (17)	-	2 - 3kΩ
-	(1) - (3)	4 - 6kΩ
Between each pin and chassis	-	Min. 1 MΩ

E-2 Related electric circuit diagram



E-3 [E317] Abnormality (disconnection) in motor drive system is displayed

★ **This troubleshooting is carried out when there is still an abnormality, so when disconnecting the connecotr 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 connected any disconnected connectors before going on the next step.

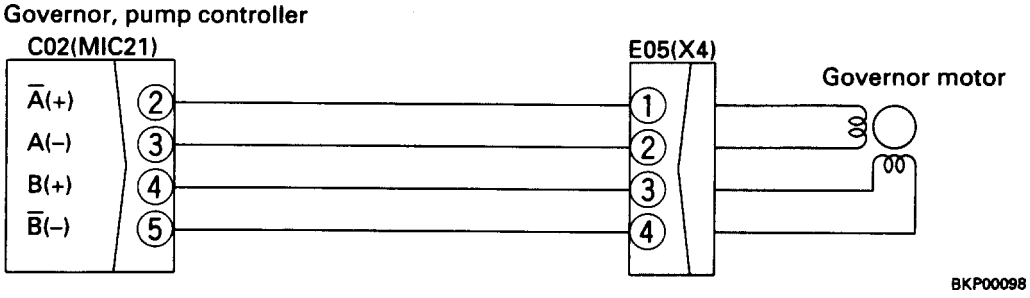


Cause	Remedy
Defective governor, pump controller	Replace
Defective wiring harness in system with defective resistance	Replace
Defective governor motor	Replace

Table 1

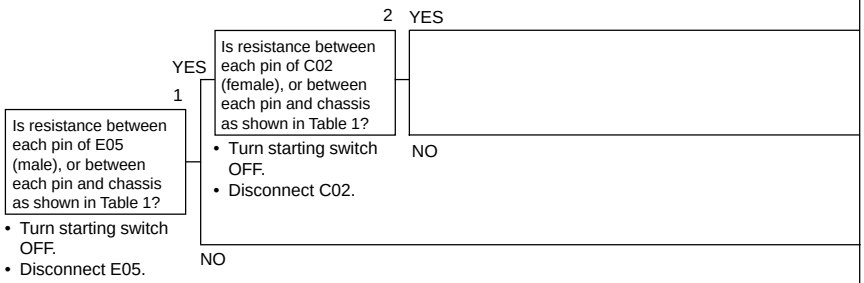
E05 (male)	C02 (female)	Resistance value
(1) - (2)	(2) - (3)	2.5 - 7.5 kΩ
(3) - (4)	(4) - (5)	2.5 - 7.5 kΩ

E-3 Related electric circuit diagram



E-4 [E318] 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 postion, 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 connertors before going on the next step.

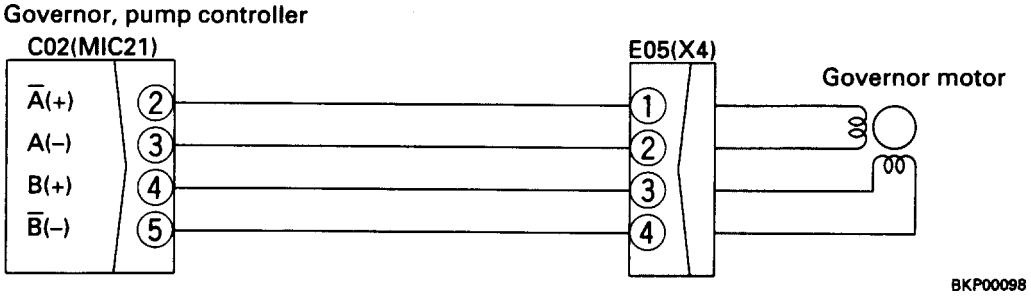


Cause	Remedy
Defective governor, pump controller	Replace
Defective wiring harness in system with defective resistance	Replace
Defective governor motor	Replace

Table 1

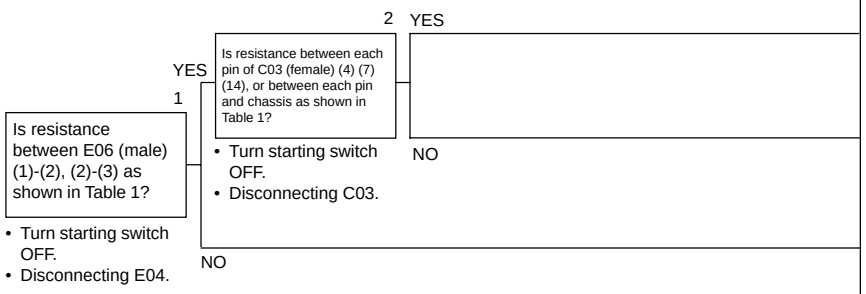
E05 (male)	C02 (female)	Resistance value
91) - (2)	(2) - (3)	2.5 - 7.5 kΩ
(3) - (4)	(4) - (5)	2.5 - 7.5 kΩ
(1) - (3)	(2) - (4)	Min. 1 MΩ
(1) - (4)	(2) - (5)	Min. 1 MΩ
Between chassis and pins (1) (2) (3) (4)	Between chassis and pins (2) (3) (4) (5)	Min. 1 MΩ

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.



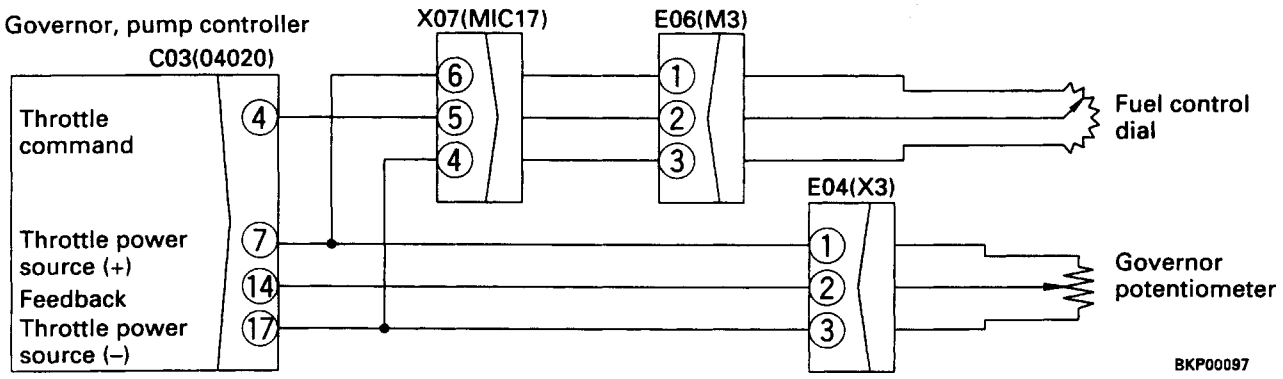
Cause	Remedy
Defective governor, pump controller	Replace
Defective wiring harness in system with defective resistance	Replace
Defective governor motor	Replace

★ 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

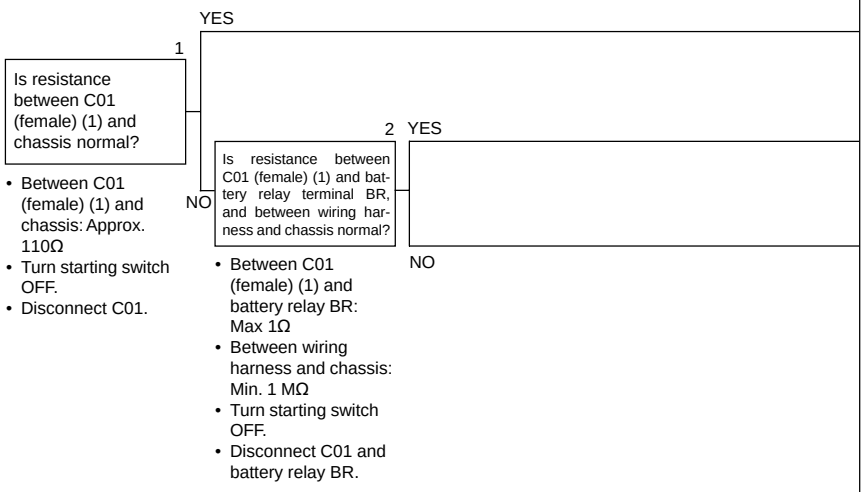
★ This troubleshooting is carried out when there is still an abnormality, so when disconnecting the connector and inserting the T-adapter, or when removing the T-adapter and returning the connector to its oringinal position, if the service code E is not displayed, the problem has been removed.

⚠ 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.

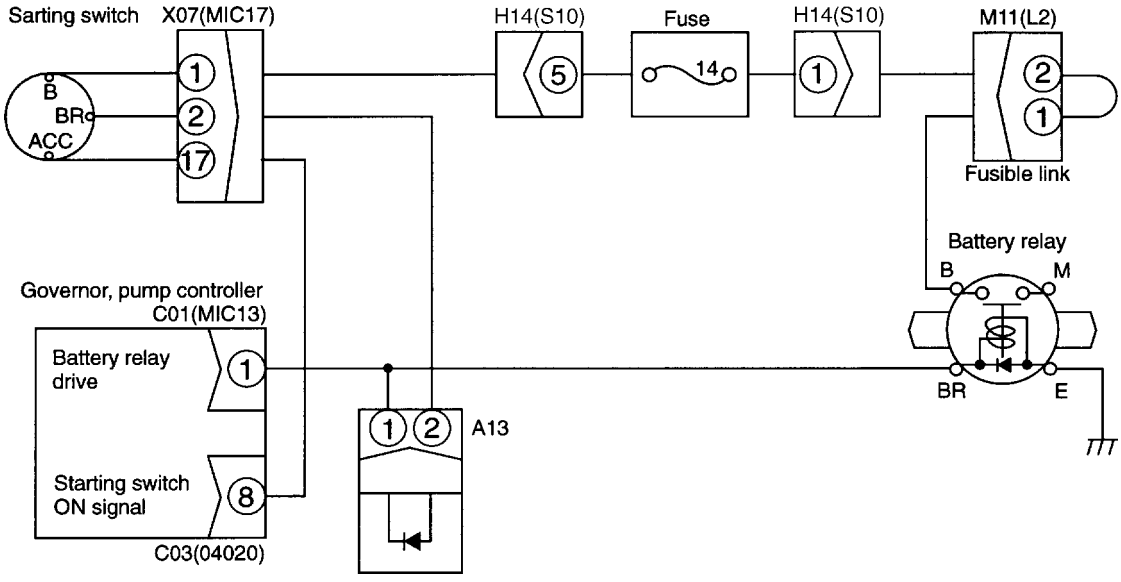
★ Always connect any disconnected connectors before going on the next step.

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



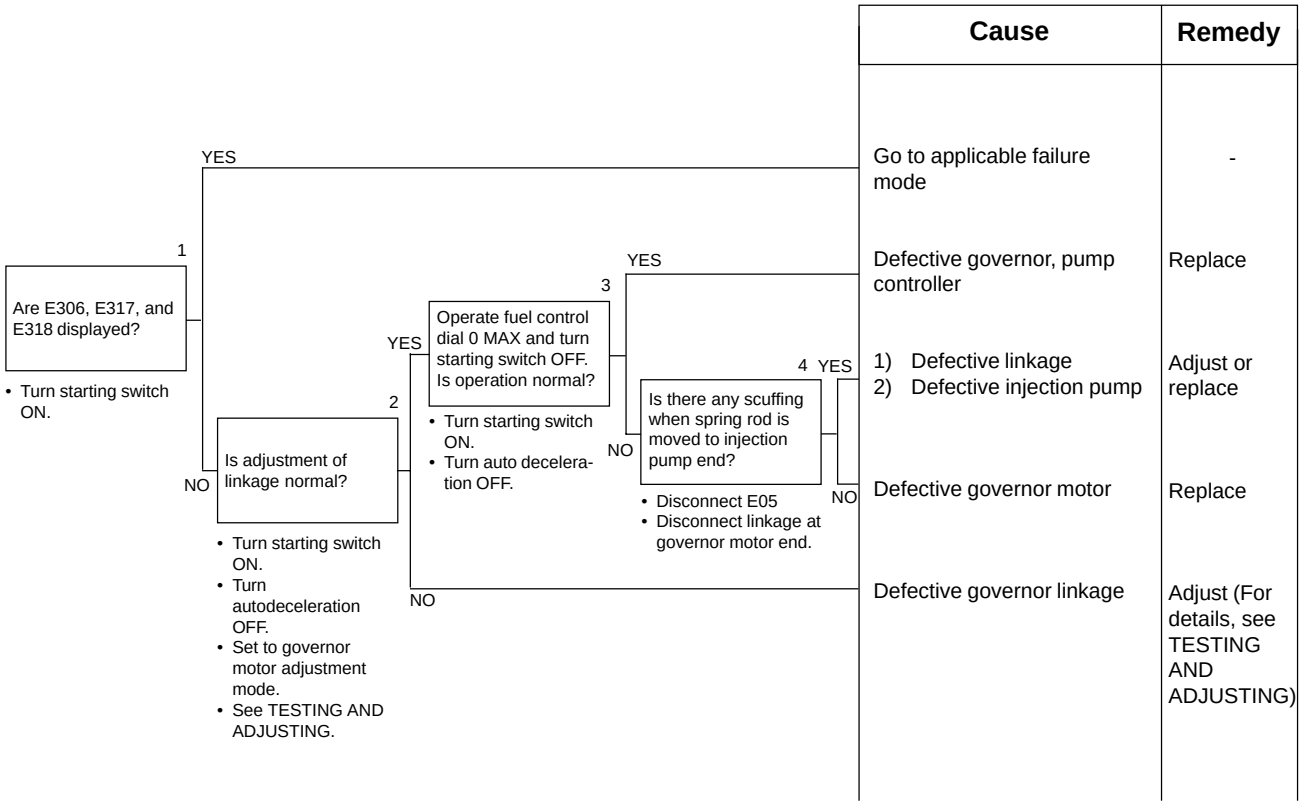
Cause	Remedy
Defective governor, pump controller	Replace
Defective battery relay	Replace
1) Contact between other wiring harness and wiring harness between C01 (female) (1)-battery relay BR. 2) When light is connected	Replace

E-6 Related electric circuit diagram



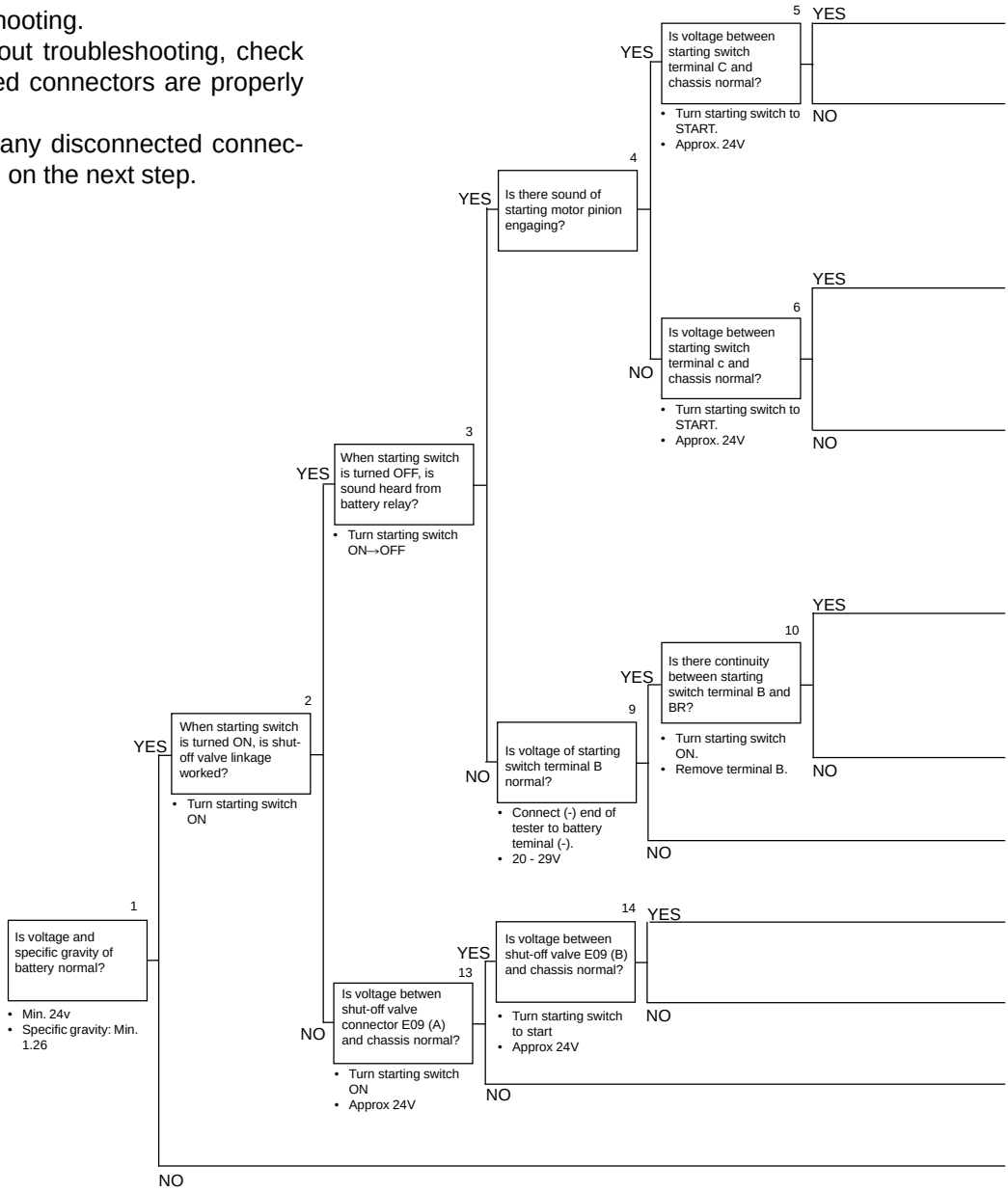
E-7 [E316] Abnormality (step-out) in motor is displayed

★ **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.

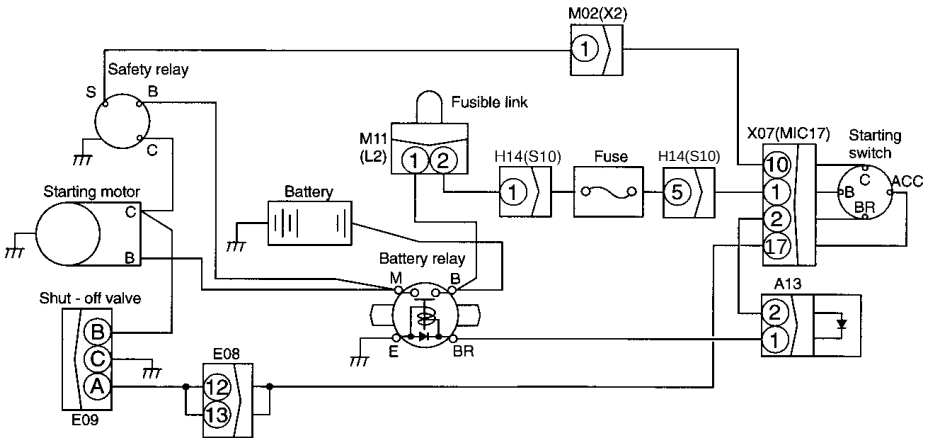


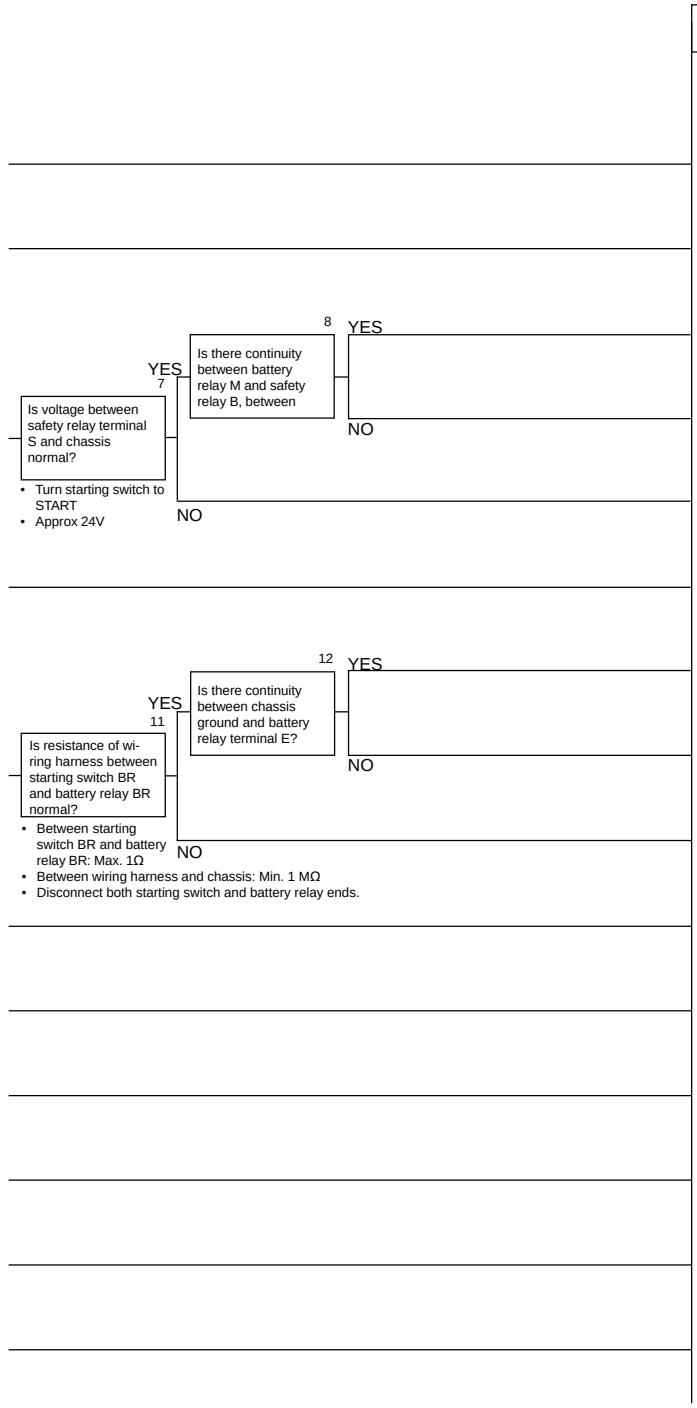
E-8 Engine does not start

★ 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-A13-battery relay terminal BR	Replace
Defective starting switch (between B and BR)	Replace
Defective contact, or disconnection in wiring harness between battery terminal (+)-M11-H05 (6)-X07 (1)-starting switch terminal B (including fusible link)	Replace
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(17)-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

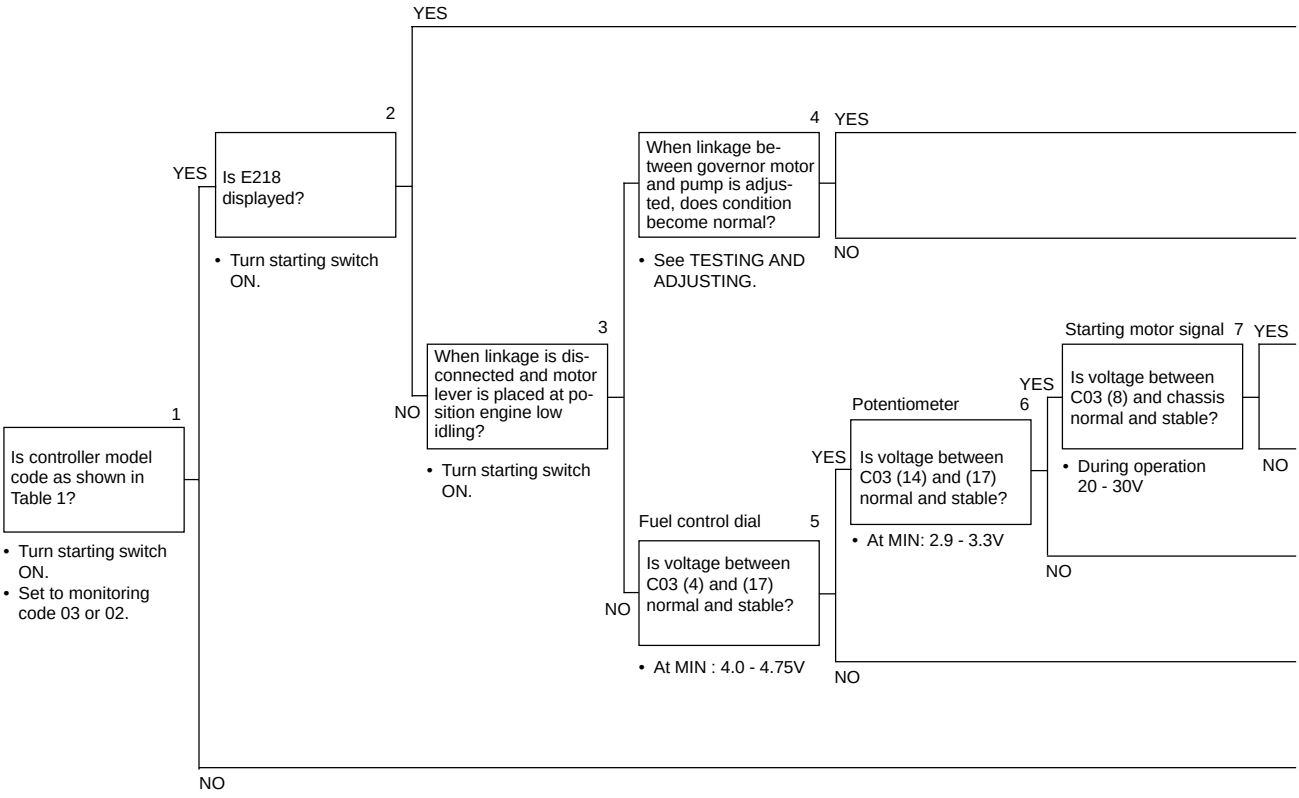


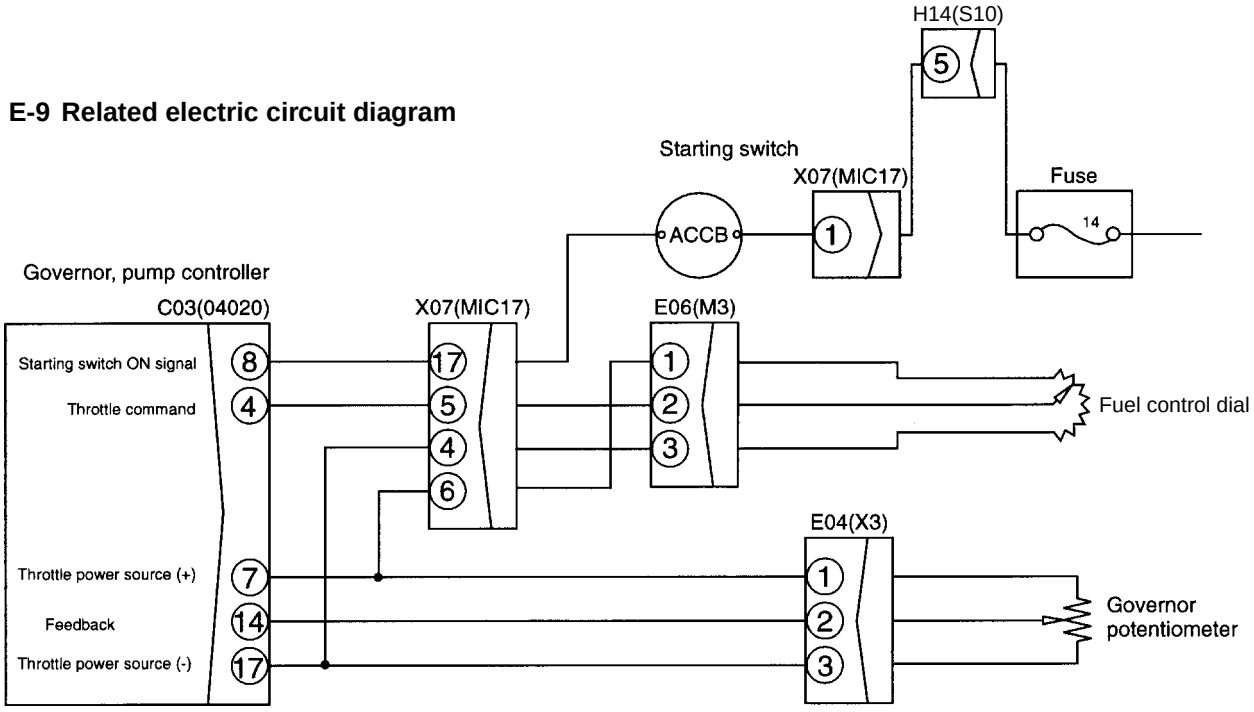
Table 1

Controller model code
03 170

★ 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

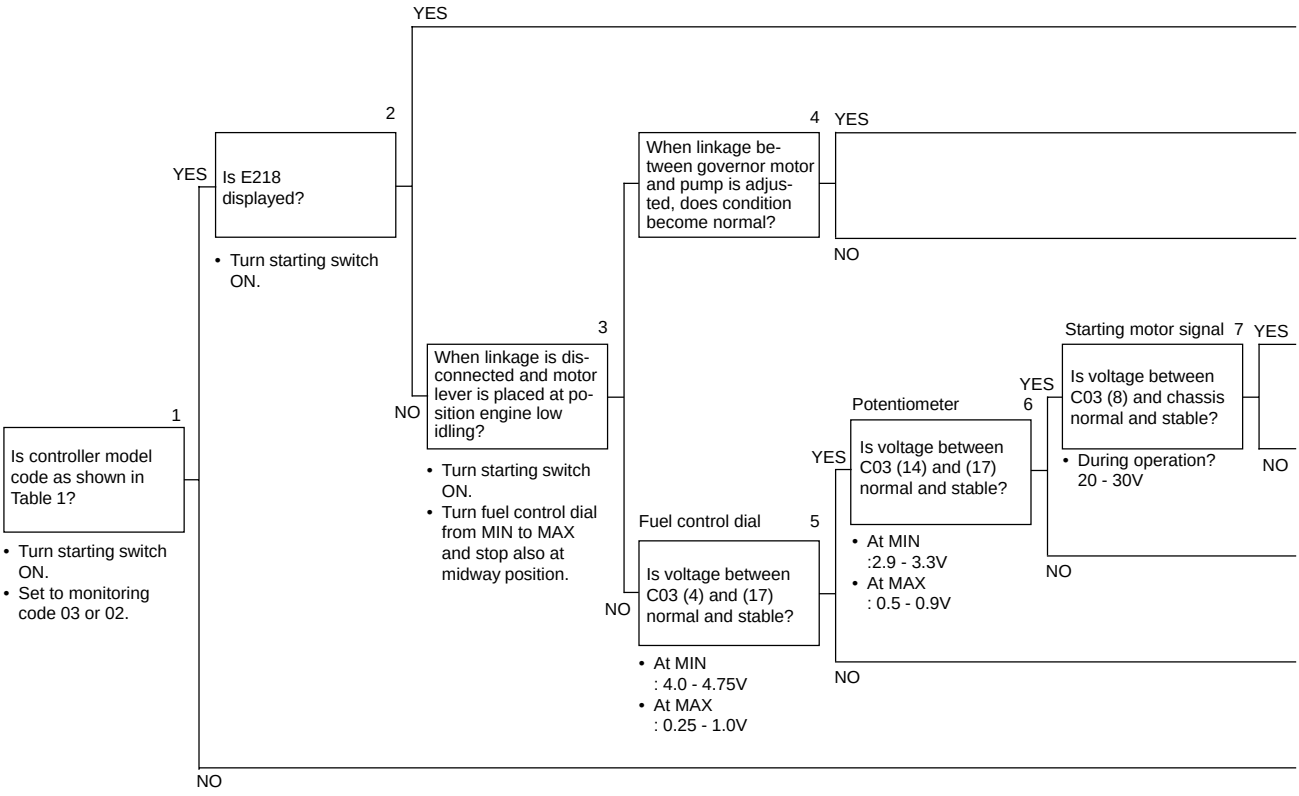


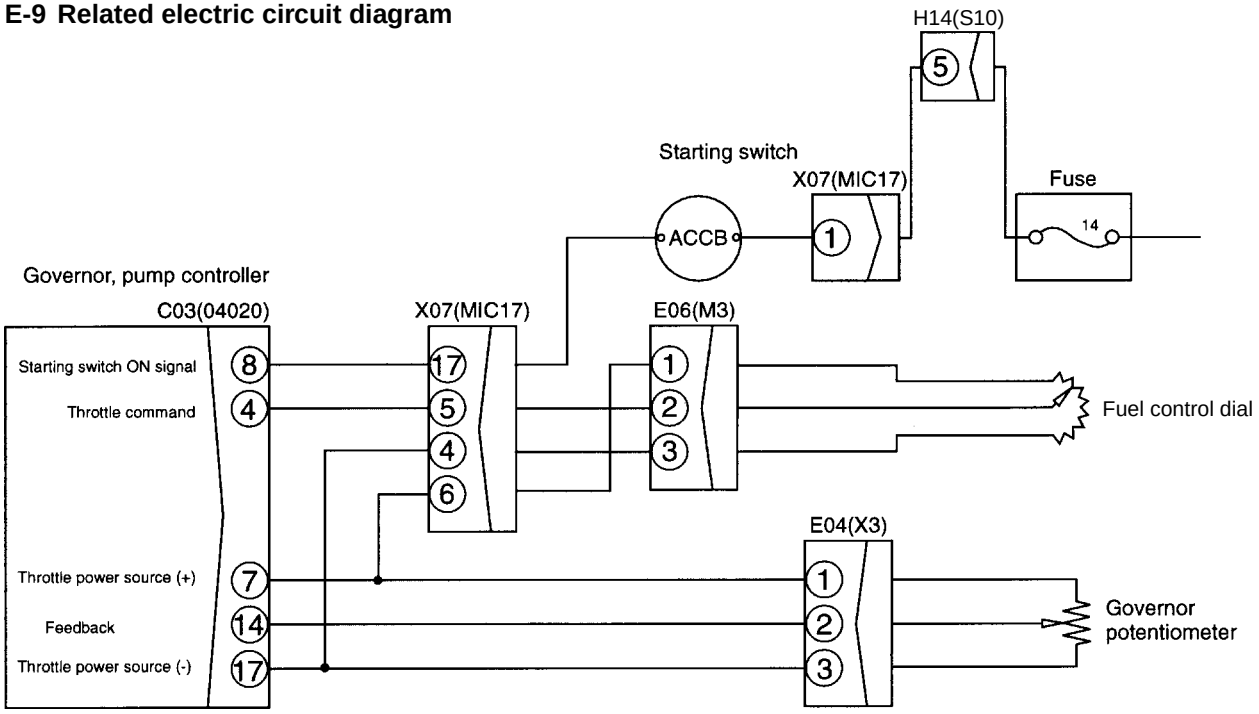
Table 1

Controller model code
03 170

★ 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.

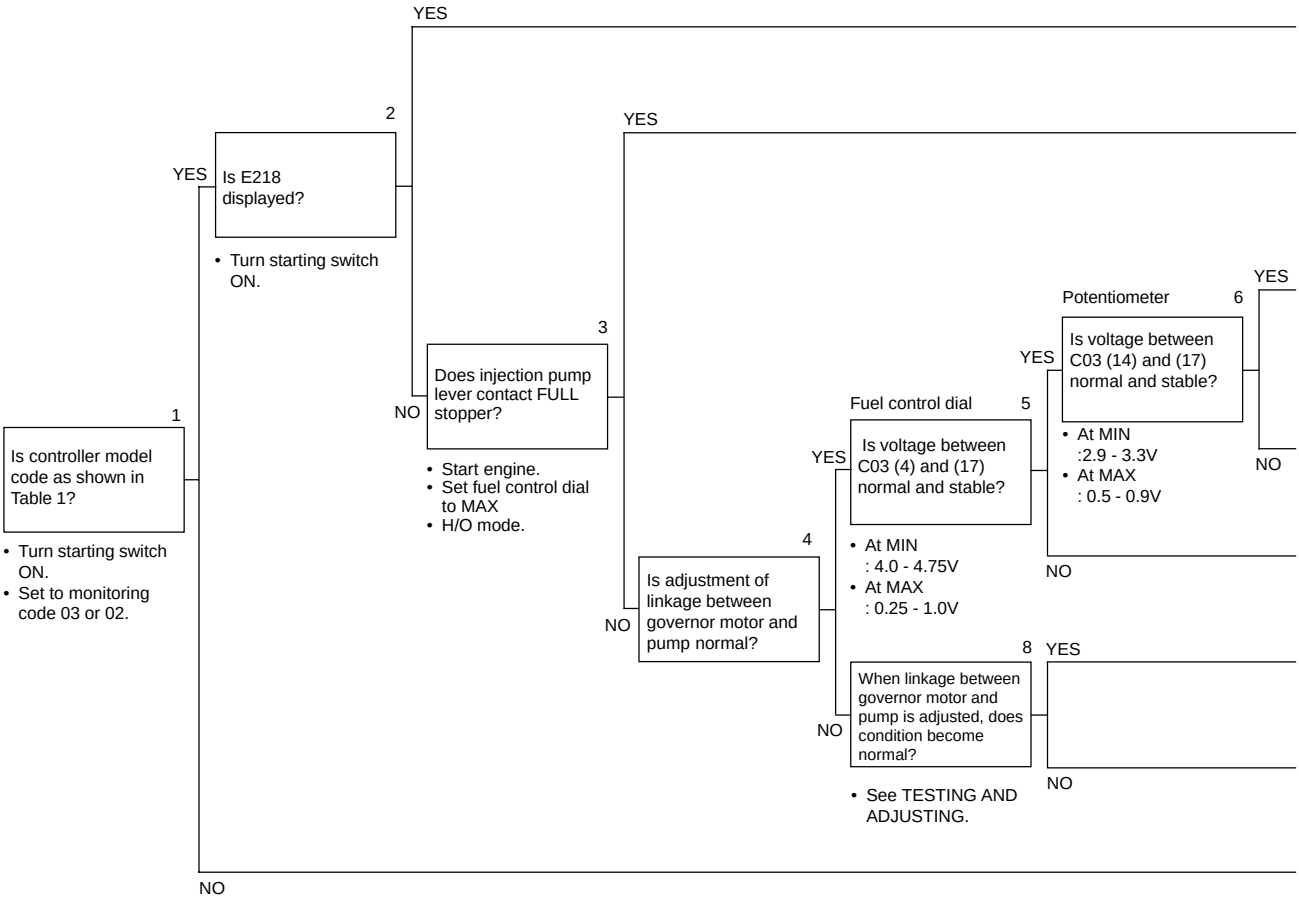


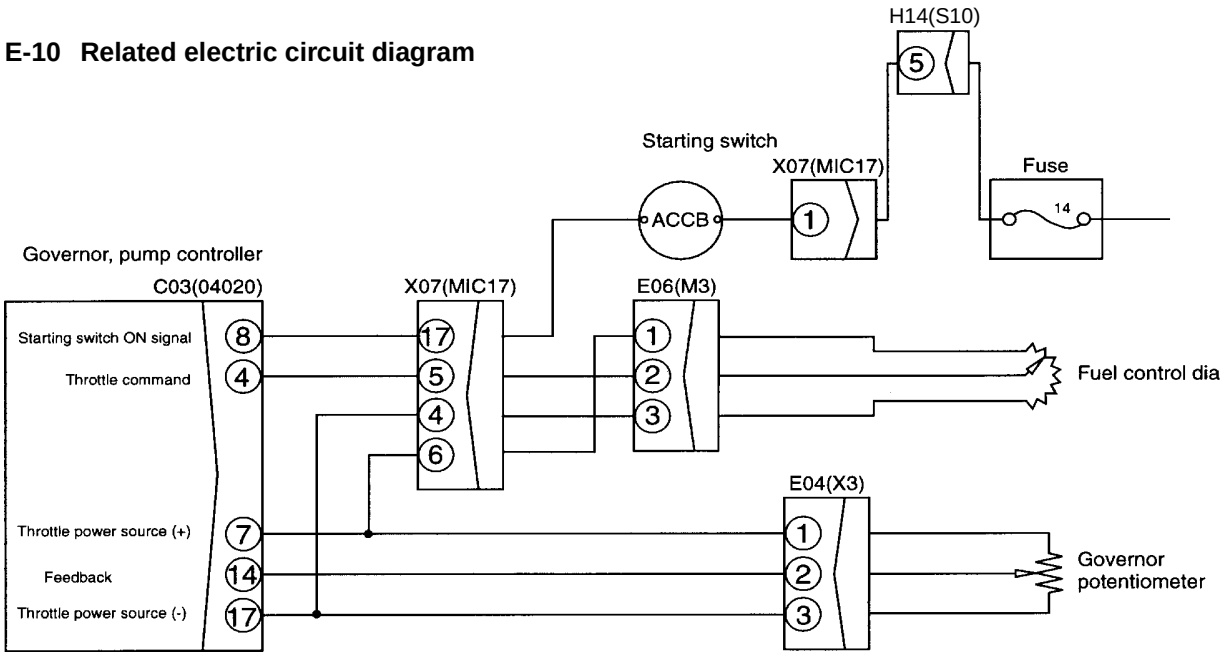
Table 1

Controller model code
03 170

★ 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.

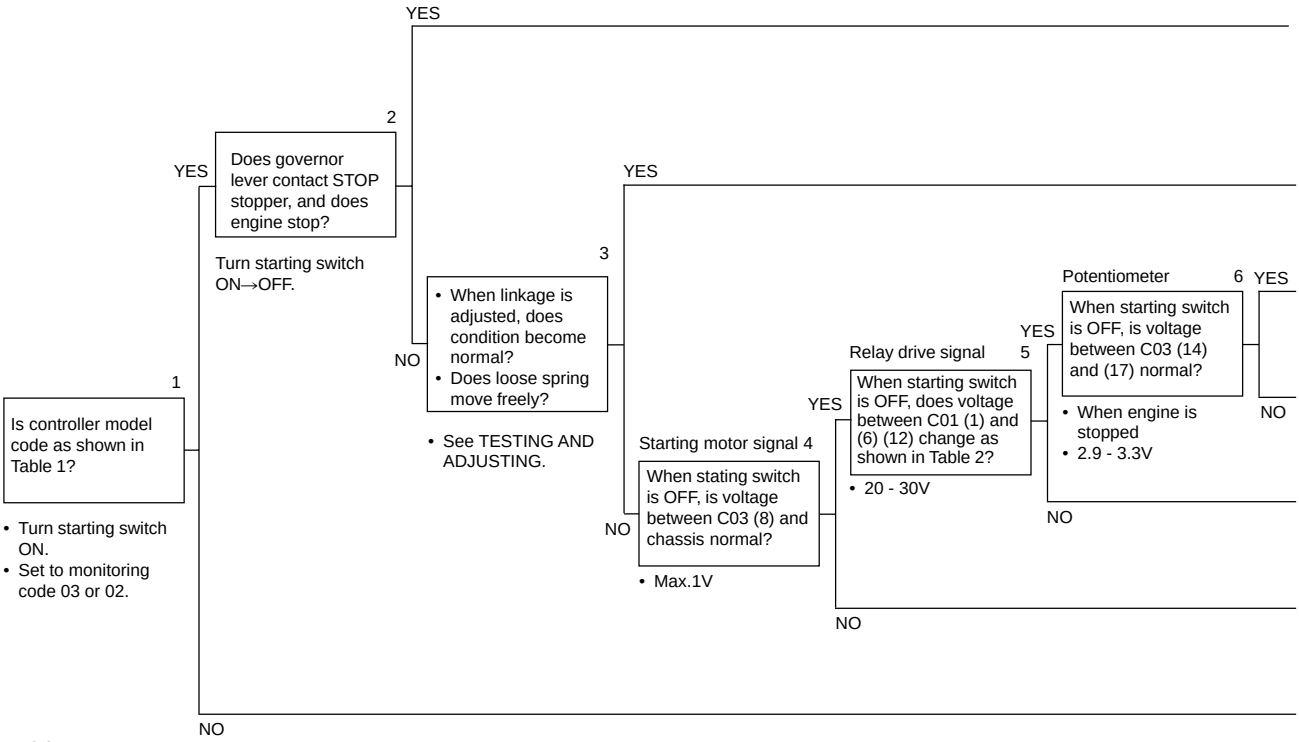
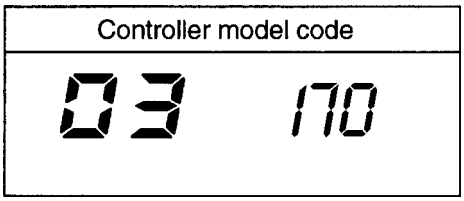
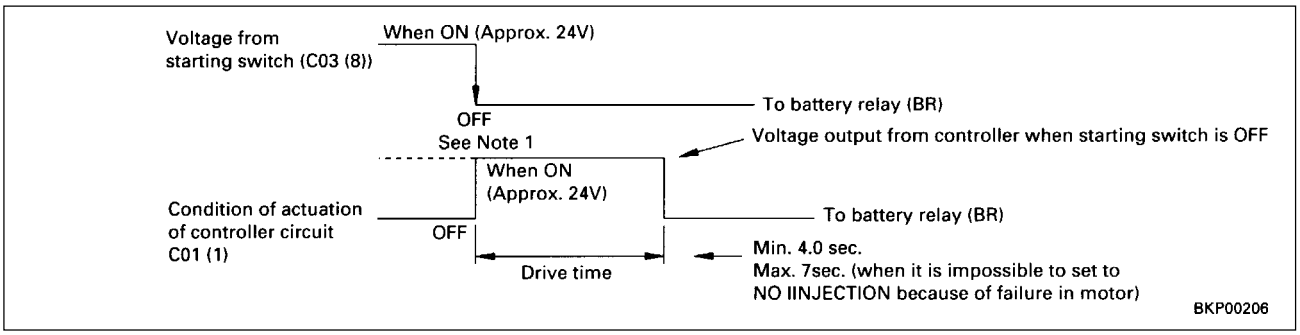


Table 1



★ The diagram shows monitoring code 03.

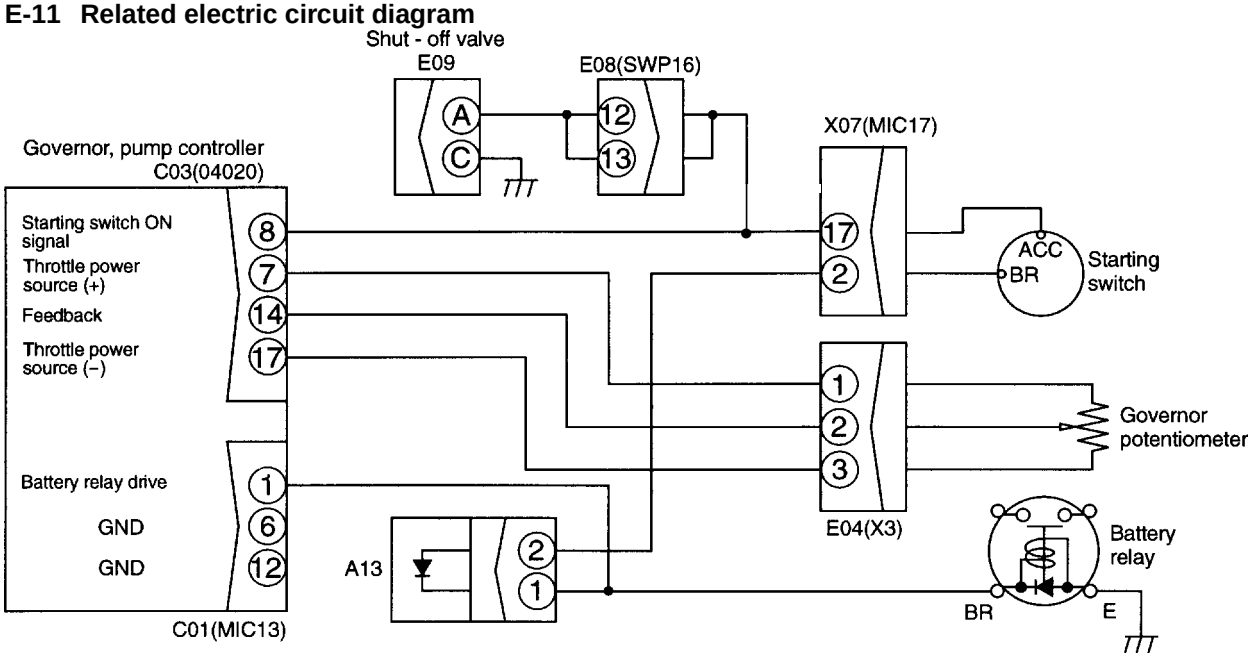
Table 2



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

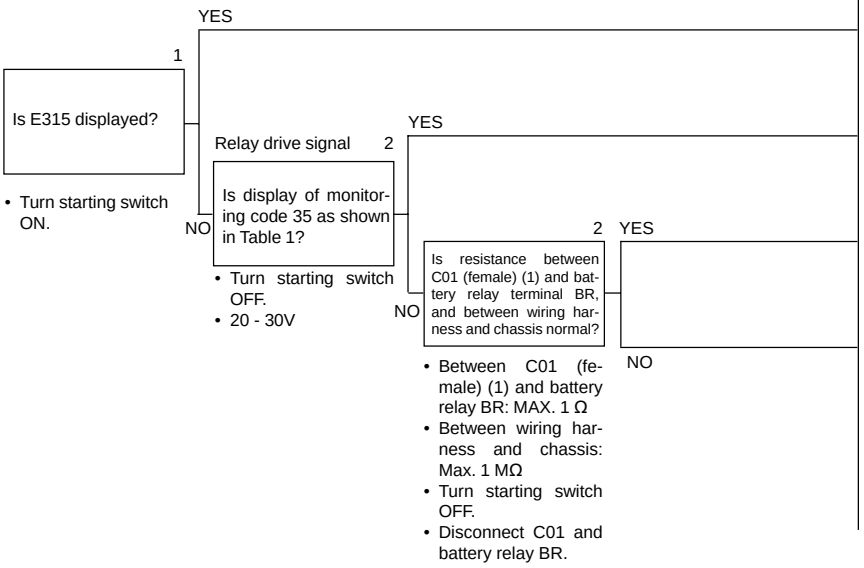
	Cause	Remedy
7 When shut-off vlave connector E09 is disconnected, does Engine stop? YES	Defective wiring harness between starting switch Terminal ACC-X07 (17) -E08 (12, 13) -shut-off valve connecter E09 (A)	Replace
NO	Defective shut-off valve	See S mode
	Defective adjustment of linkage	Adjust
	Defective 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



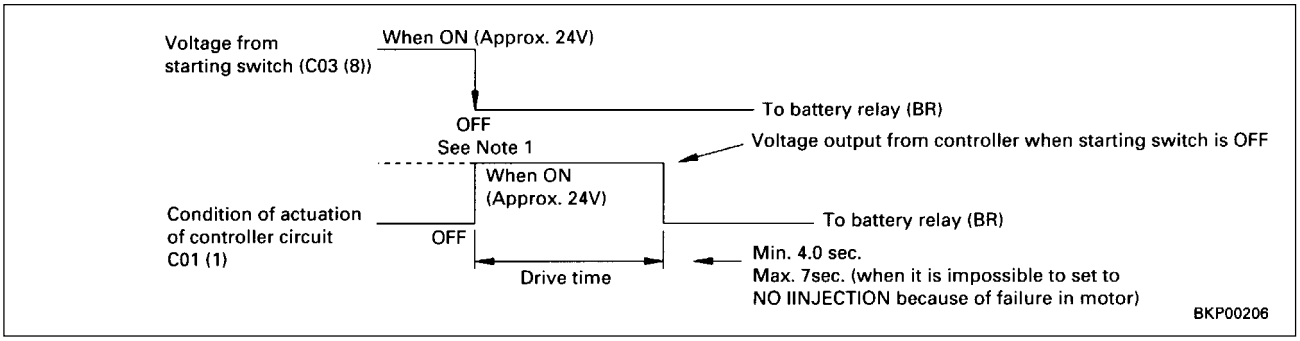
E-12 Defective operation of battery relay system (engine does not stop)

★ 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 2) When light is connected	Replace

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.

TROUBLESHOOTING OF ENGINE SYSTEM (S MODE)

Method of using troubleshooting charts 20-130
S- 1 Starting performance is poor (starting always takes time).. 20-134
S- 2 Engine does not start 20-135
(1) Engine does not run 20-135
(2) Engine turns but no exhaust smoke comes out (fuel is not being injected) 20-136
(3) Exhaust smoke comes out, but engine does not start (fuel is being injected) 20-137
S- 3 Engine does not pick up smoothly 20-138
S- 4 Engine stops during operations 20-139
S- 5 Engine does not rotates smoothly (hunting) 20-140
S- 6 Engine lacks output (no power) 20-141
S- 7 Exhaust smoke is black 20-142
S- 8 Oil consumption is excessive, or exhaust gas is blue 20-143
S- 9 Oil becomes contaminated quickly 20-144
S-10 Fuel consumption is excessive 20-145
S-11 Oil is in cooling water 20-146
S-12 Oil pressure caution lamp lights up (drop in oil pressure) 20-147
S-13 Oil level rises (water, fuel in oil 20-148
S-14 Water temperature becomes too high (overheating) 20-149
S-15 Abnormal noise is made 20-150
S-16 Vibration is excessive 20-151

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

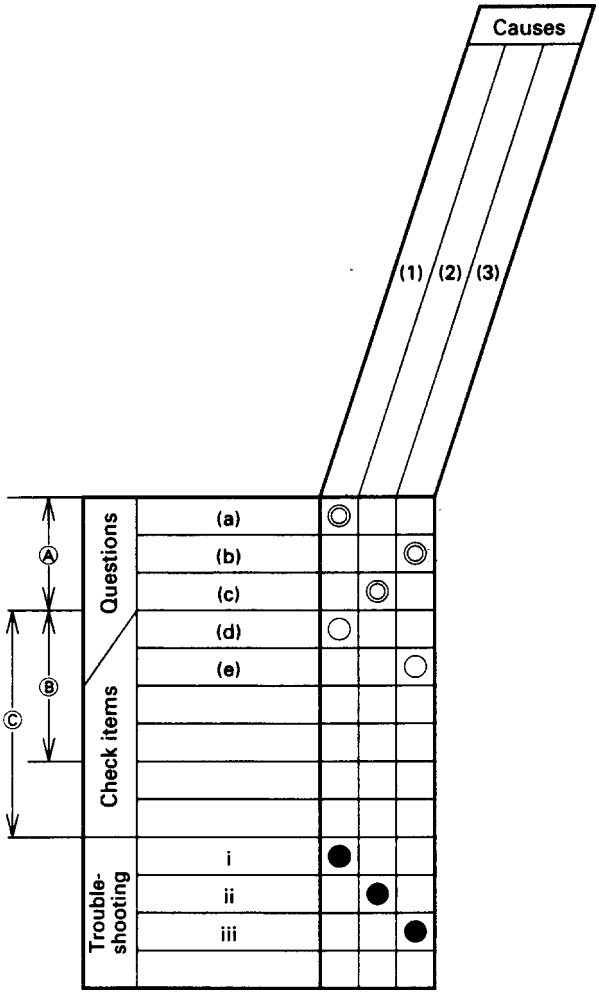
[Check items]

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

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

[Troubleshooting]

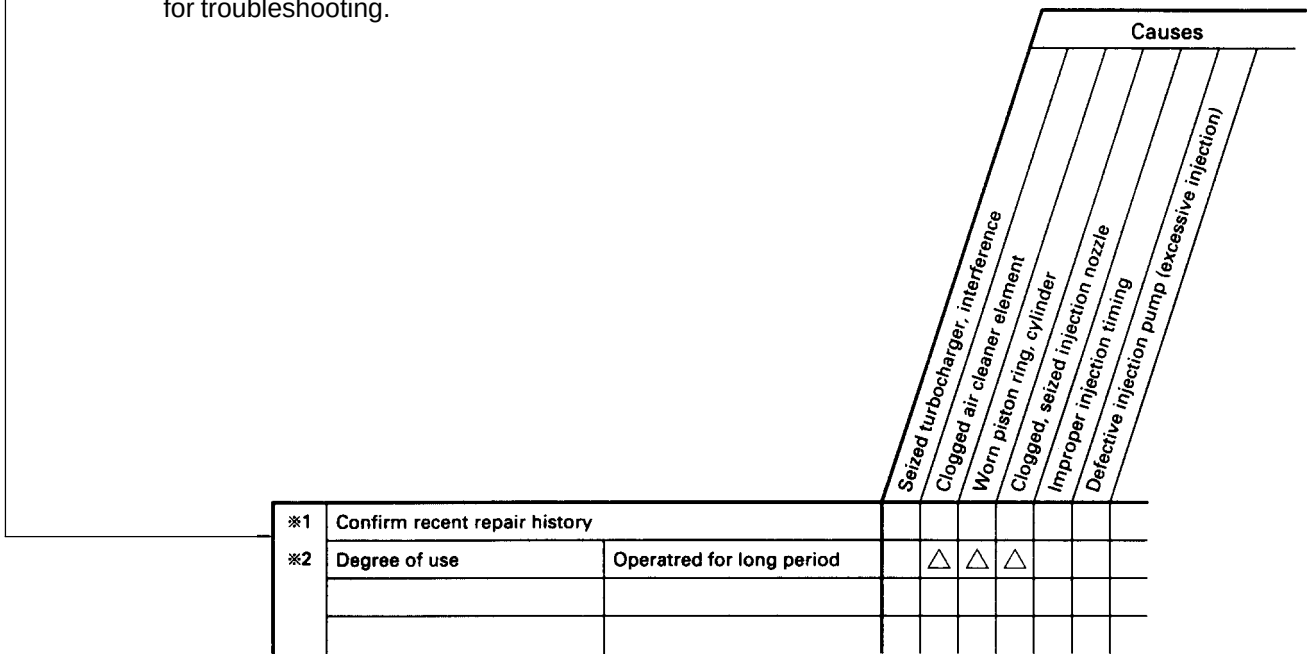
Troubleshooting is carried out in the order of probability, starting with the causes that have been marked as having the highest probability from information gained from **[Questions]** and **[Check items]**.



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 ○, and of these, causes that thave a high probability are marked with ◎.
check each of the **[Questions]** and **[Check items]** in turn, and marked the ○ or ◎ 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 column 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.



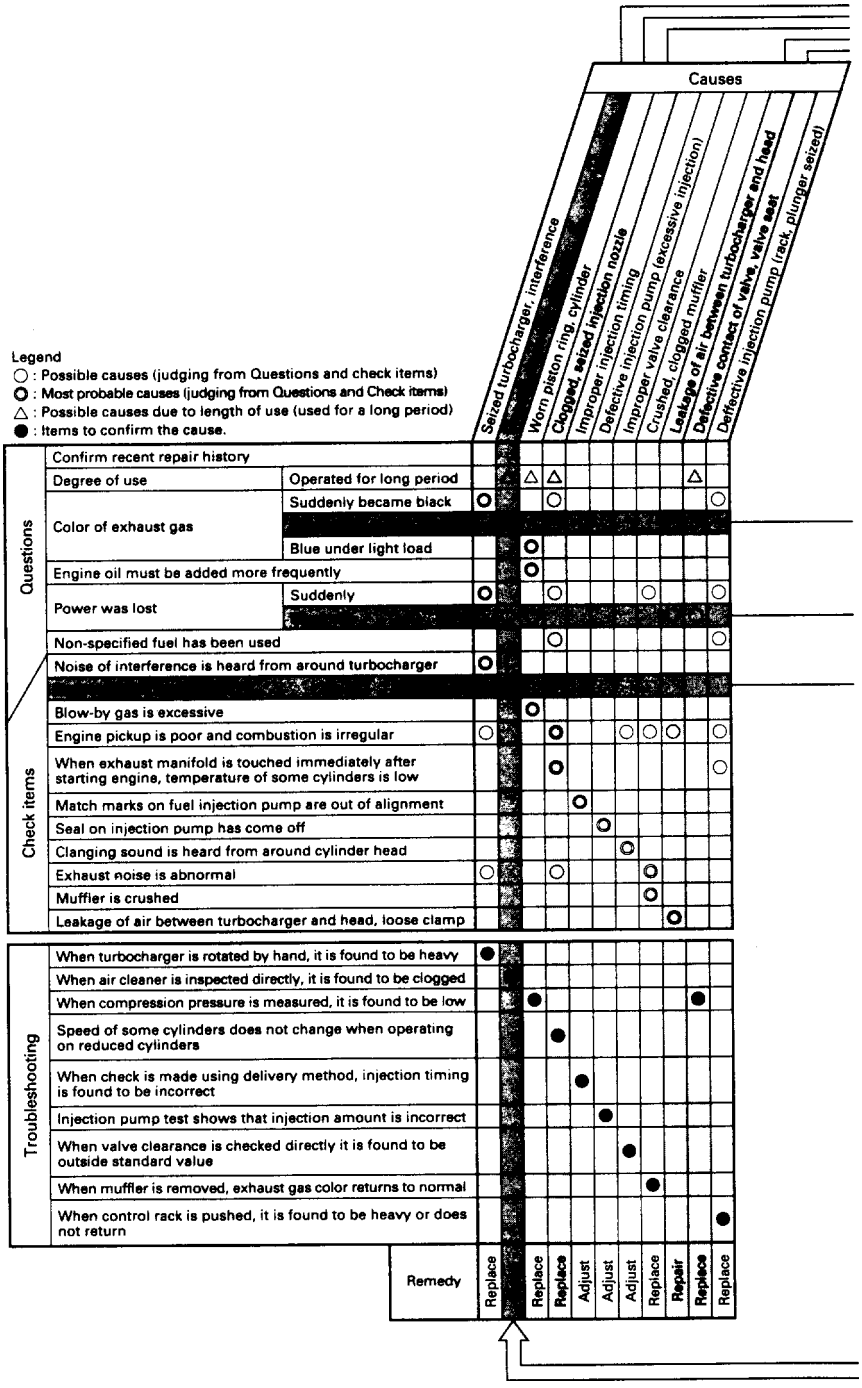
- **Example of troubleshooting when exhaust gas is black**

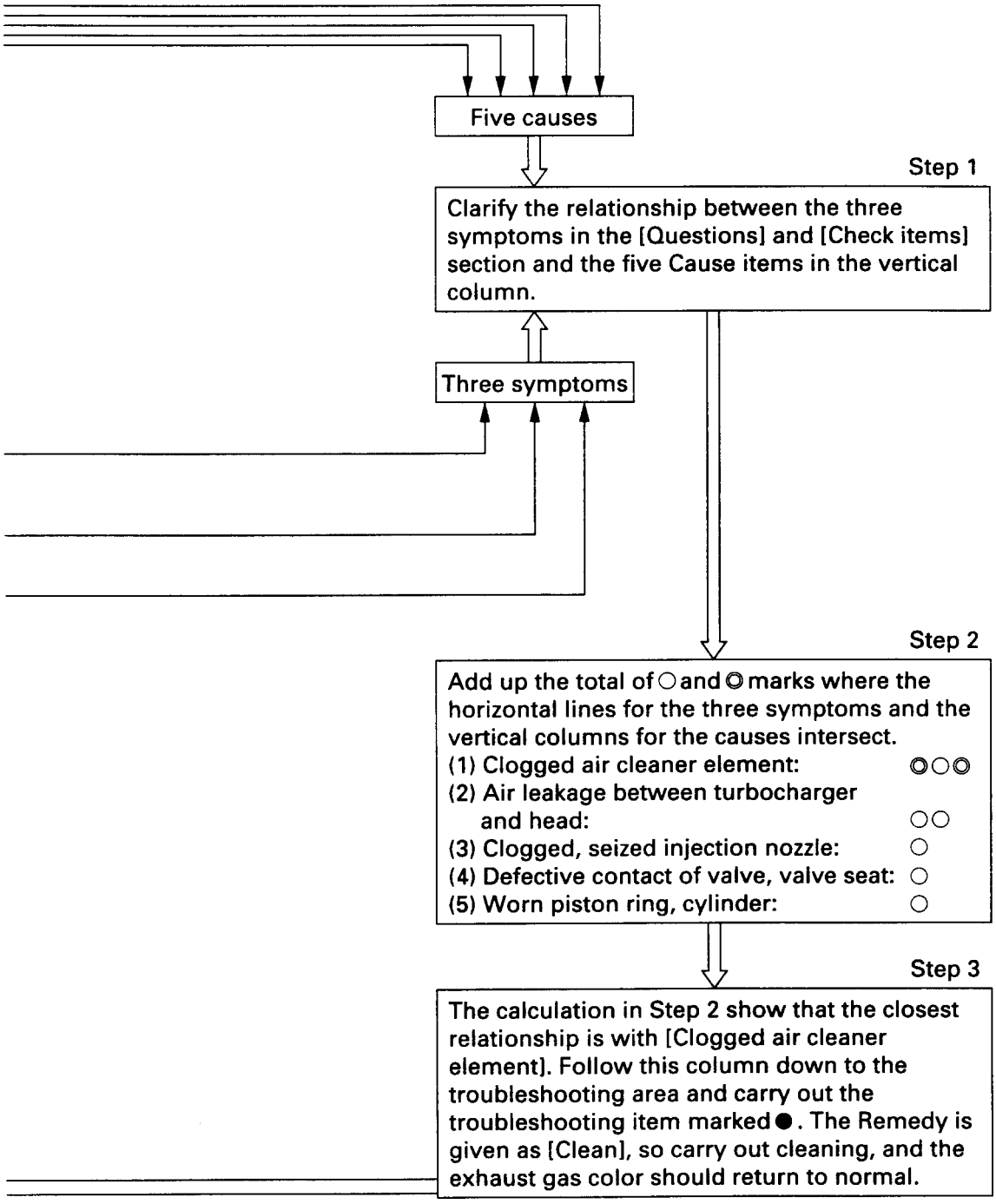
Let us assume that [clogged air cleaner] is taken to be the cause of black exhaust gas. Three symptoms have causal relationship with this problem: [Exhaust gas slowly became black], [Power slowly became weaker], and [dust indicator is red]. If we look from these three symptoms to find the causes, we 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 ezhaust 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 sustem. 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 10°C 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 gravety 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: Defective alternator	Defective or deteriorated battery	Intake air heater: Defective injection nozzle	Defective injection timing	Leakage, clogging, air in fuel piping	Defective injection pump (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					○	○				○		○			
	Battery charge lamp is ON							◎	◎							
	Starting motor cranks engine slowly									◎						
Check items	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	Adjust	Replace	Correct	Clean	

※ It is not permitted to replace only the regulator.

S-2 Engine does not start

(1) Engine does not run

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 / Check items	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		◎						
	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 been injected)

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

General causes why engine turns but no exhaust smoke comes out.

- Supply of fuel impossible
- Supply of fuel is extremely small
- Improper selection of fuel (particulary 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
- 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

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	Clogged fuel filter, strainer	Clogged feed pump strainer	Clogged injection nozzle, defective spray	Seized injection pump plunger	Worn piston ring, cylinder liner	Seized turbocharger, interference	Improper valve clearance	Clogged air breather hole in fuel tank cap	Clogged, leaking fuel piping	Defective contact of valve and valve seat
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 fuel is being used			◎	◎	◎	◎						
	Engine oil must be added more frequently							◎					
Check items	Rust and water are found when fuel tank is drained		◎										
	Air cleaner clogging caution lamp flashes			◎	◎								
	Noise of interference is heard from around turbocharger								◎				
	Engine pick-up suddenly became poor					◯			◎		◯	◯	
	Color of exhaust gas	Blue under light load						◎					
		Black	◎			◎			◎				◯
	Clanging sound is heard from around cylinder head									◎			
	Mud is stuck to fuel tank cap										◎		
	There is leakage from fuel piping											◎	
	High idling speed under no load is normal, but speed suddenly drops when load is applied			◎	◎						◯		
	There is hunting from engine (rotation is irregular)			◯	◎	◯					◯		
	When exhaust manifold is touched immediately after starting engine, temperature of some cylinders is low					◎	◯						
	20. Blow-by gas is excessive							◎					
Troubleshooting	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				●								
	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 compression pressure is measured, it is found to be low							●					●
	When turbocharger is rotated by hand, it is found to be heavy								●				
	When valve clearance is checked directly, it is found to be outside standard value									●			
	When fuel cap is inspected directly, it is found to be clogged										●		
	When feed pump is operated, operation is too light or too heavy											●	
		Remedy	Clean	Clean	Clean	Correct	Replace	Replace	Replace	Adjust	Clean	Correct	Replace

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 rarts 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		●	●										See troubleshooting of hydraulic, mechanical system (H mode)
	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	Replace	Clean	Clean	Replace	Correct	Clean	Replace	—

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	◯	◯	◯						◯
	Replacement of filters has not been carried out according to Operation Manual						◎	◎			
Check items	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 clearance	Defective contact of valve and valve seat	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					◎	◎	◎	◎					
Check items	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				◎									
	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												●	
		Remedy	Clean	Replace	Replace	Clean	Clean	Correct	Replace	Adjust	Replace	Adjust	Correct	Clean	—	Carry out troubleshooting for overheating

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					◯							◯
Check items	Noise of interference is heard from around turbocharger		◎										
	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 idking for more than 20 minutes continuously. (Both low and high idling)

General causes why oil consumption is excessive

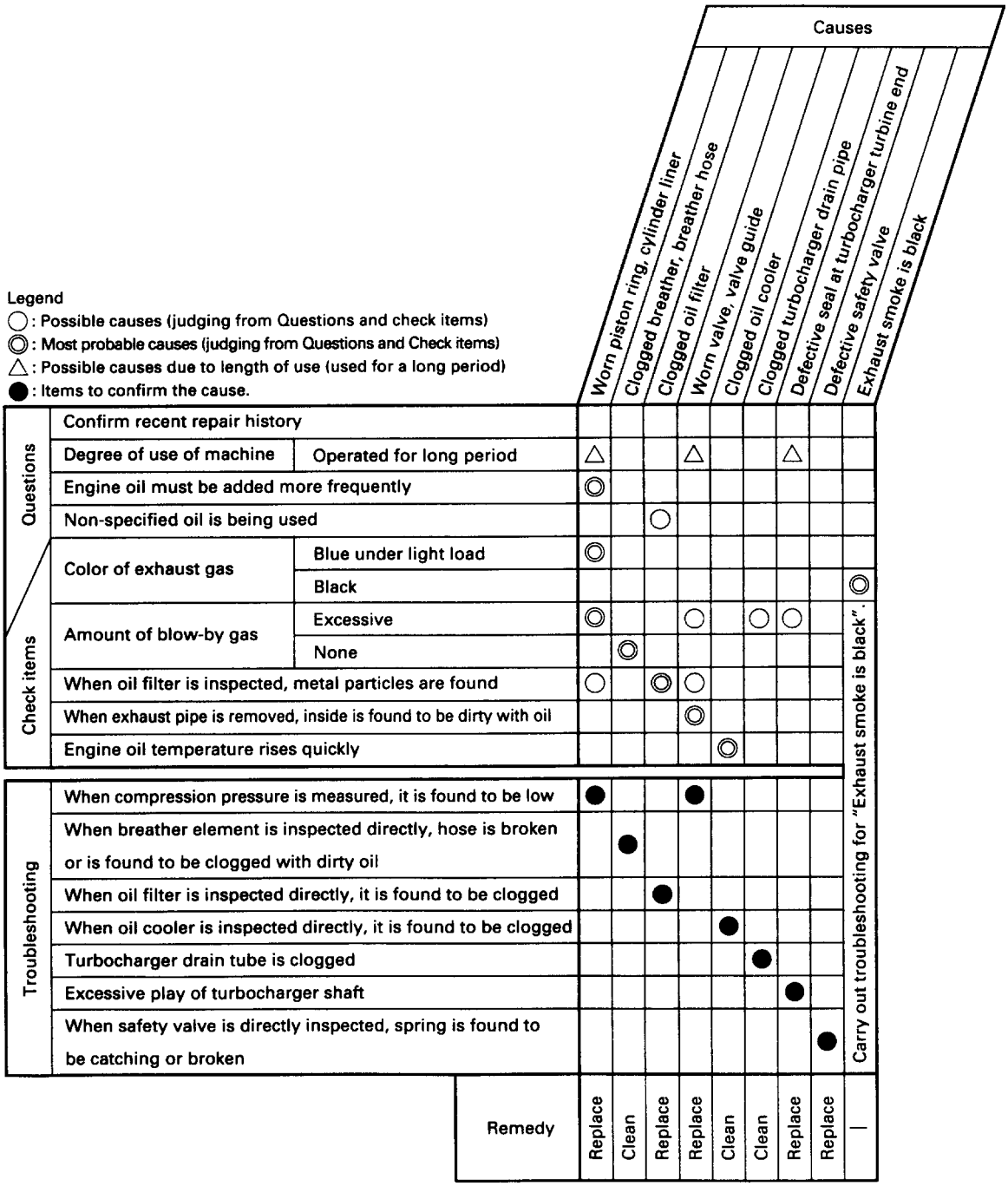
- Abnormal combustion of oil
- Eternal leakage of oil
- Wear of lubrication system

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

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 injection pump (excessive injection)	Defective nozzle holder spray	Defective injection pump plunger	Defective fuel injection timing	External leakage from fuel piping, fuel filter	Leakage of fuel inside head cover	Defective oil seal inside feed pump (piston)	Defective adjustment of fuel control linkage
Questions	Confirm recent repair history									
	Degree of use of machine	Operated for long period		△	△				△	
	Condition of fuel consumption	More than for other machines of same model	◎			◯				
		Gradually increased		◯	◯					
		Suddenly increased					◯	◯		
Check items	Exhaust smoke color	Black	◎	◯		◯				◯
		White						◯		
	Seal on injection pump has come off		◎							
	There is irregular combustion			◎						
	When exhaust manifold is touched immediately after starting engine, temperature of some cylinders is low			◎	◯					
	Match mark on injection pump is misaligned					◎				
	There is external leakage of fuel from engine						◎			
	Engine oil level rises and smells of diesel fuel		◯					◎	◎	
	Engine low idling speed is high		◯							◎
Troubleshooting	Injection pump measurement shows that injection amount is excessive		●							
	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 check is made using delivery method, injection timing is found to be incorrect					●				
	Remove head cover and inspect directly							●		
	Remove feed pump and inspect directly								●	
	When engine speed is measured, low idling speed is found to be high									●
Remedy			Adjust	Replace	Replace	Adjust	Correct	Correct	Correct	Adjust

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 lubrication system
- Defective oil pressure control
- Improper oil used (improper viscosity)
- Deterioration of oil due to overheating

★ Standards for engine oil selection

Kind of fuel	Ambient temperature
	-22 -4 14 32 50 68 86 104 122°F -30 -20 -10 0 10 20 30 40 50°C
Engine oil (API CE or CF-4)	SAE 30 SAE 10W SAE 10W-30 SAE 15W-40 SAE 5W-30

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		◎					◯		◯	◯	
	There is oil in radiator cooling water	◎	◯	◯							◯	◯
Check items	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 lighted 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 bushing	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		◎											
	Color of exhaust gas	Blue under light load	◎											
		Black		◎						◯			◯	
Check items	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 noise is excessive

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

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 connecting rod, main bearing	Worn balancer, cam bushing	Loose engine mounting bolts, broken cushion	Broken part inside output shaft (damper)	Improper gear train backlash	Defective dynamic valve system (valve, rocker lever, etc.)	Defective injection pump (excessive injection)
Questions	Confirm recent repair history								
	Degree of use of machine	Operated for long period	△	△	△				
	Condition of vibration	Suddenly increased				○		○	
		Gradually increased	○	○	○				
	Non-specified oil is being used		○	○					
Check items	Metal particles are found in oil filter		◎	◎					
	Metal particles are found when oil is drained		◎	◎					
	Oil pressure is low at low idling		○	○					
	Vibration occurs at mid-range speed				○	○			
	Vibration follows engine speed				○	○	○		
	Exhaust smoke is black							◎	○
	Seal on injection pump has come off								◎
Troubleshooting	Remove oil pan and inspect directly		●						
	Remove side cover and inspect directly			●					
	Inspect directly for loose engine mounting bolts, broken cushion				●				
	Inspect inside of output shaft (damper) directly					●			
	Remove front cover and inspect directly						●		
	Remove head cover and inspect directly							●	
	Injection pump test shows that injection amount is incorrect								●
		Remedy	Replace	Replace	Replace	Replace	Correct	Replace	Adjust

TROUBLESHOOTING OF GOVERNOR, PUMP CONTROLLER (PUMP CONTROL SYSTEM) (C MODE)

Points to remember when carrying out troubleshooting of pump controller system 20-153
Action taken by controller and condition of machine when abnormality occurs 20-154
Judgement table for governor, pump controller and hydraulic related parts.. 20-160
Electrical circuit diagram of C mode systems 20-162
C- 1 Abnormality in controller power source (controller LED is OFF) 20-164
C- 2 [E232] Short circuit in pump TVC solenoid system is displayed 20-165
C- 3 [E233] Disconnection pump TVC solenoid system is displayed 20-167
C- 8 [E203] Short circuit in swing holding brake solenoid system is displayed 20-169
C- 9 [E213] Disconnection in swing holding brake solenoid system is displayed 20-171
C-10 [E205] Short circuit in 2-stage relief solenoid system is displayed 20-173
C-11 [E215] Disconnection in 2-stage relief solenoid system is displayed 20-174
C-12 [E206] Short circuit in travel speed solenoid system is displayed 20-175
C-13 [E216] Disconnection in travel speed solenoid system is displayed 20-176
C-14 [E217] Model selection input error is displayed 20-177
C-15 [E222] Short circuit in LS-EPc solenoid system is displayed 20-178
C-16 [E223] Disconnection in LS-EPc solenoid system is displayed 20-179
C-17 [E224] Abnormality in pump pressure sensor system is displayed 20-180
C-19 [E226] Abnormality in pressure sensor power source is displayed 20-181
C-20 [E227] Abnormality in engine speed sensor system is displayed 20-182

POINTS TO REMEMBER WHEN TROUBLESHOOTING PUMP CONTROLLER SYSTEM

1. Points to remember if abnormality returns to normal by itself

In the following two cases, there is a high probability that the same problem will occur again, so it is desirable to follow up this problem carefully.

1) If any abnormality returns to normal by itself, or
2) If the connector is disconnected and the T-adepter is inserted, or if the T-adepter 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 user code from memory.

2. User code memory retention function

When displaying the abnormality code in memory and carrying out troubleshooting, note down the content of the display, then erase the display. After trying to re-enact the problem, carry out troubleshooting according to the failure code that is displayed. (There are cases where mistaken operation or abnormalities that occur when the connector is disconnected and 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 TVC solenoid system	1. Short circuit with ground, short circuit inside pump TVC solenoid 2. Short circuit with power source, short circuit with ground in wiring harness between controller C02 (8) and TVC solenoid C13 (1) ((+) side) 3. Short circuit with power source in wiring harness between controller C02 (18) and TVC solenoid C13 (2) ((-) side) 4. Defective governor, pump controller
	E233	Disconnection in pump TVC solenoid sytem	1. Disconnection, defective contact inside pump TVC solenoid 2. Disconnection, defective contact in wiring harness between controller C02 (8) and TVC solenoid C13 (1) ((+) side) 3. Disconnection, defective contact, short circuit with ground in wiring harness between controllerC02 (18) and TVC solenoidC13 (2) ((-) side) 4. Defective governor, pump controller
E03	E203	Short circuit in swing holding brake solenoid system	1. Short circuit with ground, short circuit inside swing holding brake solenoid 2. Short circuit with ground in wiring harness between controller C01 (3) and solenoid V04 (2) ((+) side) 3. Defective governor, pump controller
	E213	Disconnection in swing holding brake solenoid system	1. Disconnection, defective contact inside swing holding brake solenoid 2. Disconnection, defective contact, short circuit with power source in wiring harness between controller C01 (3) and solenoid V04 (2) ((+) side) 3. Disconnection, defective contact in wiring harness between solenoid V04 (1) and chassis ground ((-) side) 4. Defective governor, pump controller

Condition when normal (voltage, current, resistance)	Action by controller when abnormality is detected	Problem that appears on machine when there is abnormality
• Resistance of solenoid: 10 - 22Ω	1. Make output to TVC solenoid 0. 2. Displays user code E02 on monitor panel. ★ If the abnormality is restored by the vibration of the machine, it resets the power source to restore to the proper condition. (However, the service code display does not go out.)	1. No current flows to the pump TVC solenoid. Therefore, when the load is large, there is a big drop in the engin speed which may result in the engine stalling. 2. The swing acceleration is poor
• Resistance of solenoid: 10 - 22Ω • Current: 1000 mA (H/O mode, auto-deceleration ON, levers at neutral, fuel control dial at MAX.)	1. The current stops flowing to the TVC solenoid, so no particular action is taken. 2. If there is a short circuit with the ground at the (-) end, the current (min. 1A) continues to flow to the TVC solenoid. 3. It displayes user code E02 on the monitor panel. ★ If the abnormality is restored by the vibration of the machine, it resets the power source to restore to the proper condition. (However, the service code display does not go out.)	1. In the case of 1, it is the same as E232. 2. In the case of 2, the current (min. 1A) continues to flow to the pump TVC solenoid, so the output of the pump TVC valve increases and the overall speed becomes slower.
• Resistance of solenoid: 20 - 60Ω	1. Makes output to TVC solenoid 0. 2. displays user code E03 on monitor panel. ★ If the abnormality is restored by the vibration of the machine, it resets the power source to restore to the proper condition. (However, the service code display does not go out.)	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, it resets the power source to restore to the proper condition. (However, the service code display does not go out.)	Same as display for E203

User code	Service code	Abnormal system	Nature of abnormality
-	E205	Short circuit in 2-stage relief solenoid system	1. Short circuit with ground, short circuit inside 2-stage relief solenoid 2. Short circuit with ground in wiring harness between controller c01 (10) and solenoid V05 (2) ((+) side) 3. Defective governor, pump controller
-	E206	Short circuit in travel speed solenoid system	1. Short circuit with ground, short circuit inside travel speed solenoid 2. Short circuit with ground in wiring harness between controller C01 (9) and solenoid V06 (2) ((+) side) 3. Defective governor, pump controller
-	E215	Disconnection in 2-stage relief solenoid system	1. Disconnection, defective contact inside 2-stage relief solenoid 2. Disconnection, defective contact, short circuit with power source in wiring harness between controller C01 (10) and solenoid V05 (2) ((+) side) 3. Disconnection, defective contact in wiring harness between solenoid V05 (1) and chassis ground ((-) side) 4. Defective governor, pump controller
-	E216	Disconnection in travel speed solenoid system	1. Disconnection, defective contact inside travel speed solenoid 2. Disconnection, defective contact, short circuit with power source in wiring harness between controller C01 (9) and solenoid V06 (2) ((+) side) 3. Disconnection, defective contact in wiring harness between solenoid V06 -(1) and chassis ground ((-) side) 4. Defective governor, pump controller
-	E217	Model selection input error	1. Disconnection, defective contact, short circuit with ground in model selection wiring harness C17 (5) (6) (7) (13) (14) 2. Defective governor, pump controller

Condition when normal (voltage, current, resistance)	Action by controller when abnormality is detected	Problem that appears on machine when there is abnormality
• Resistance of solenoid: 20 - 60 Ω	1. Makes output to solenoid O. ★ If the abnormality is restored by the vibration of the machine, it resets the power source to restore to the proper condition. (However, the service code display does not go out.)	1. In the L/O and F/O modes, the work equipment and swing speeds become faster. 2. The steering is difficult to turn.l
• Resistance of solenoid: 20 - 60Ω	1. Makes output to solenoid O. ★ If the abnormality is restored by the vibration of the machine, it resets the power source to restore to the proper condition. (However, the service code display does not go out.)	Even if the travel speed is switched, the travel speed does not change (remains at Lo)
• Resistance of solenoid: 20 - 60Ω	1. The current stops flowing to the solenoid, so no particular action is taken. ★ If the abnormality is restored by the vibration of the machine, it resets the power source to restore to the proper condition. (However, the service code display does not go out.)	Check main relief pressure using monitor code 11. Work equipment relief pressure does not change when P-max button pressed.
• Resistance of solenoid: 20 - 60 Ω	1. The current stops flowing to the solenoid, so no particular action is taken. ★ If the abnormality is restored by the vibration of the machine, it resets the power source to restore to the proper condition. (However, the service code display does not go out.)	Same content as display for E205
• Resistance of solenoid: 20 - 60 Ω	1. The current stops flowing to the solenoid, so no particular action is taken. ★ If the abnormality is restored by the vibration of the machine, it resets the power source to restore to the proper condition. (However, the service code display does not go out.)	Same content as display for E206
• Between C17 (13) and chassis: Max. 1 Ω Between C17 (5), (7), (14) (6) and chassis: Min. 1 MX	Detect abnormality in input 1) Retains data when starting switch is ON	1. Engine stalls, or 2. Work equipment, swing, travel speeds are all slow, and there is no power

User code	Service code	Abnormal system	Nature of abnormality
-	E218	Network response overtime error	1. Disconnection, short circuit, short circuit with ground in network wiring harness 2. Abnormality in governor, pump controller 3. Abnormality in monitor
-	E222	Short circuit in LS-EPC solenoid system	1. Short circuit with ground, short circuit inside LS-EPC solenoid 2. Short circuit with power source, short circuit with ground in wiring harness between controller C02 (7) and solenoid C10 (1) ((+) side) 3. Short circuit with power source in wiring harness between controller C02 (17) and solenoid C10 (2) ((-) side) 4. Defective governor, pump controller
-	E223	Disconnection in LS-EPC solenoid system	1. Disconnection, defective contact inside LS-EPC sollenoid 2. Disconnection, defective contact in wiring harness between controller C02 (7) and solenoid C10 (1) ((+) side) 3. Disconnection, defective contact, short circuit with ground in wiring harness between controller C02 (17) and solenoid C10 (2) ((-) side) 4. Defective governor, pump controller
-	E224	Abnormality in pump pressure sensor system	1. Disconnection, defective contact, short circuit, short circuit with ground inside pump pressure sensor 2. Disconnection, defective contact, short circuit in wiring harness between controller C03 (6) and pressure sensor C08 (2) ((+) side) and between C03 (16) and C08 (1) ((-) side) 3. Disconnection, defective contact, short circuit with power source, short circuit with ground in wiring harness between controller C03 (3) and pressure sensor C08 (3) (SIG side) 4. Defective governor, pump controller
-	E226	Abnormality in pressure sensor power source system	1. Short circuit, short circuit with ground inside pump pressure sensor 2. Short circuit, short circuit with ground in wiring harness between controller C03 (6) and pressure sensor C08 (2) 3. Defective governor, pump controller
-	E227	Abnormality in speed sensor system	1. Disconnection defective contact, short circuit inside engine speed sensor 2. Disconnection, defective contact, short circuit with ground in wiring harness between controller C16 (1) and speed sensor E07 (2) ((-) side) and between C16 (2) and E07 (1) (SIG side) 3. Defective governor, pump controller

Condition when normal (voltage, current, resistance)	Action by controller when abnormality is detected	Problem that appears on machine when there is abnormality
	1. When communications are impossible with the monitor, control is carried out with the following settings. ① Working mode: G/O ② Travel speed: Lo ③ Auto-deceleration: ON ④ Power max. : ON (others are as usual)	1. ① Even when travel is operated, the power max. function does not work ② The swift speed-down function does not wor ③ The auto-deceleration cannot be canceled ④ The travel speed does not increase ⑤ The automatic mode has no effect
• Resistance of solenoid: 7 - 14 Ω	1. Makes output to LS-EPC solenoid O. ★ If the abnormality is restored by the vibration of the machine, it resets the power source to restore to the proper condition. (However, the service code display does not go out.)	1. In L/O and F/O modes, the work equipment speed is too fast. 2. When the engine is running at low idling, the swing speed is too fast.
• Current: Approx. 705 mA (Levers at neutral, low idling)	1. The current stops flowing to the LS-EPC solenoid, so no particular action is taken. 2. If there is a short circuit with the ground at the (-) end, the current (min. 1A) continues to flow to the LS-EPC solenoid. ★ If the abnormality is restored by the vibration of the machine, it resets the power source to restore to the proper condition. (However, the service code display does not go out.)	1. In the case of 1, it is the same as E222 2. In the case of 2, electric current (min. 1A) continues to flow to the LS-EPC solenoid, so the work equipment, travel, and swing speeds are slow
• Between C03 (3) and (16): 0.5 - 4.5 V • Between C03 (6) and (16): 18 - 28 V • Between C03 (female) (3) and (16), (3) and chassis • Resistance: Min. 1 MΩ (Disconnect connectors C03 and C08.)	1. Takes pump pressure as O MPa (0 kg/cm^2)when actuating. * If the abnormality is restored by the vibration of the machine, it resets the power source to restore to the proper condition. (However, the service code display does not go out.)	1. The travel speed does not automatically shift (it does not change from Hi to Lo). ★ If the button is operated manually, the panel display is switched.
• Voltage between C03 (6) and (16): 18 - 28 V	1. Takes front pump and rear pump pressure as O MPa (0 kg/cm^2) when actuating. 2. When 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 dos not automatically shift (it does not change form Hi to Lo). ★ If the button is operated manually, the panel display is switched.
• Resistance: 500 - 1000 Ω • Voltage (AC range) : 0.5 - 3.0 V (engine started)	1. It functions in the equivalent of the G/O mode (the speed rises)	It operated about the same as G/O mode (prolix) (the power is slightly lower)

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

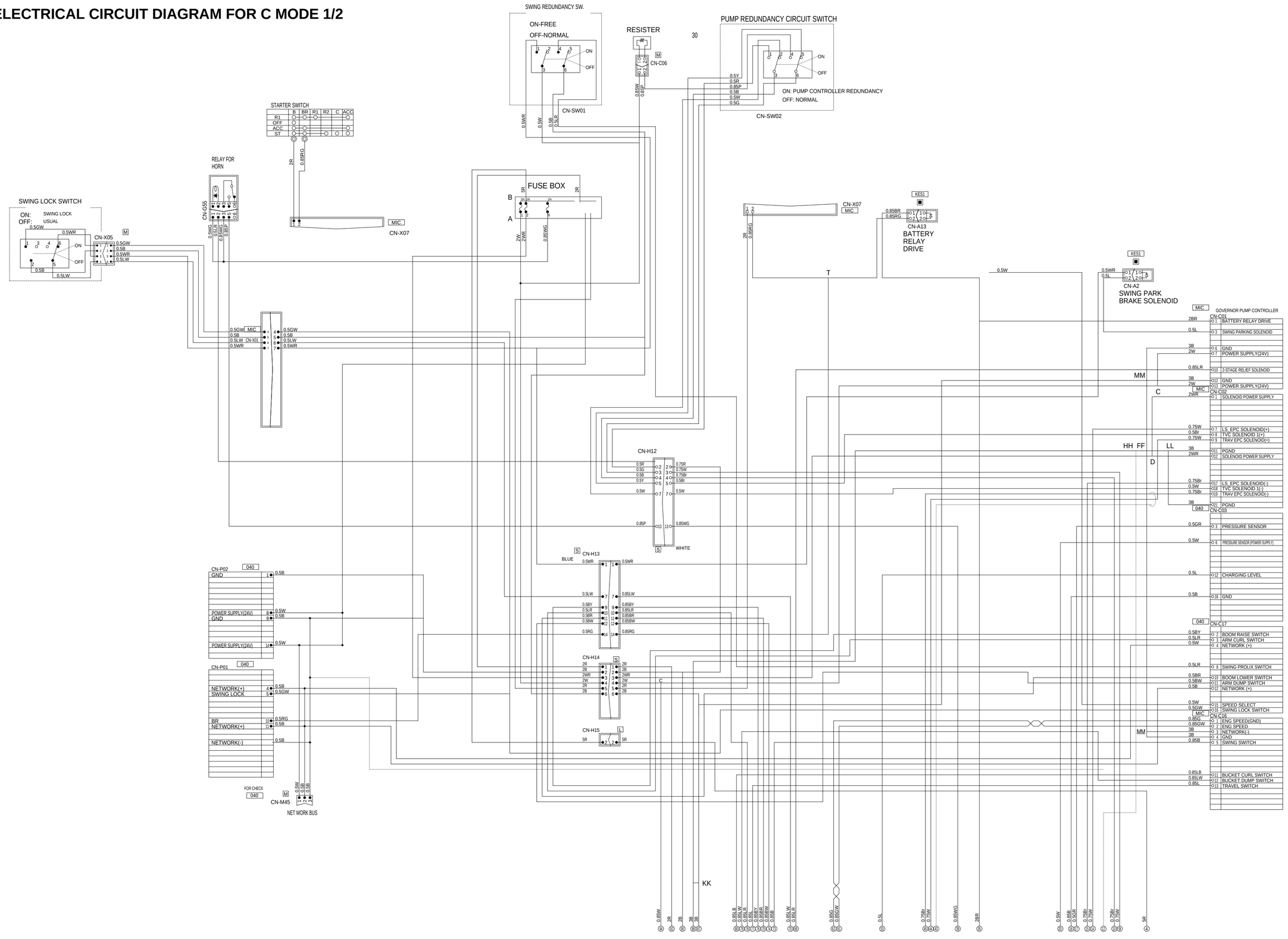
Failure mode			Governor, pump controller (E2:XX system)														
			Self-diagnostic display														
			Abnormality in controller power source	Short circuit in pump TVC solenoid system	Disconnection in pump TVC solenoid system			Short circuit in swing holding brake solenoid system	Disconnection 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 selector solenoid system	Disconnection in travel speed selector solenoid system	Model selection input error	Short circuit in Ls-EPC solenoid system	Disconnection in LS-EPC solenoid system
		User code	LED	E02				E03						-			
		Service code	OFF	232	233			203	213	205	215	206	216	217	222	223
All work equipment travel, swing	Speeds of all work equipment, swing, travel are slow or lack power			•	•									•		•
	There is excessive drop in engine speed, or engine stalls			•	•									•		
	No work equipment, travel, swing move															
	Abnormal noise generated (around pump)															
	Auto-deceleration does not work		•													
	Fine control ability is poor or response is poor															
Work equipment	Boom is slow or lacks power															
	Arm is slow or lacks power															
	Bucket is slow or lacks power															
	Boom does not move															
	Arm does not move															
	Bucket does not move															
	Excessive hydraulic drift															
	Excessive time lag (engine at low idling)															•
	Other equipment moves when single circuit is relieved									•	•					
	In L/O, F/O modes, work equipment speed is faster than specified speed														•	•
	Lack of power when pressure rises															•
Compound operations	In compound operations, work equipment with larger load is slow														•	•
	In swing + boom (RAISE), boom 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 slow	Both left and right														
		One direction only														
	Excessive overrun when stopping swing	Both left and right														
		One direction only														
	Excessive shock when stopping swing (one direction only)															
	Excessive abnormal noise when stopping swing															
	Excessive hydraulic drift of swing	When holding brake is released														
		When holding brake is applied														
	Swing speed is faster than specified swing speed														•	•
	Troubleshooting code when service code is displayed		C-1	C-2	C-3			C-8	C-9	C-10	C-11	C-12	C-13	C-14	C-15	C-16
	Troubleshooting code when there is abnormality in monitoring check		-	-	-			-	-	-	-	-	-	-	-	-

● :This shows applicable item for service code
❋ :This shows item that needs only checking with monitoring
○ : This shows item to check with monitoring or machine monitor

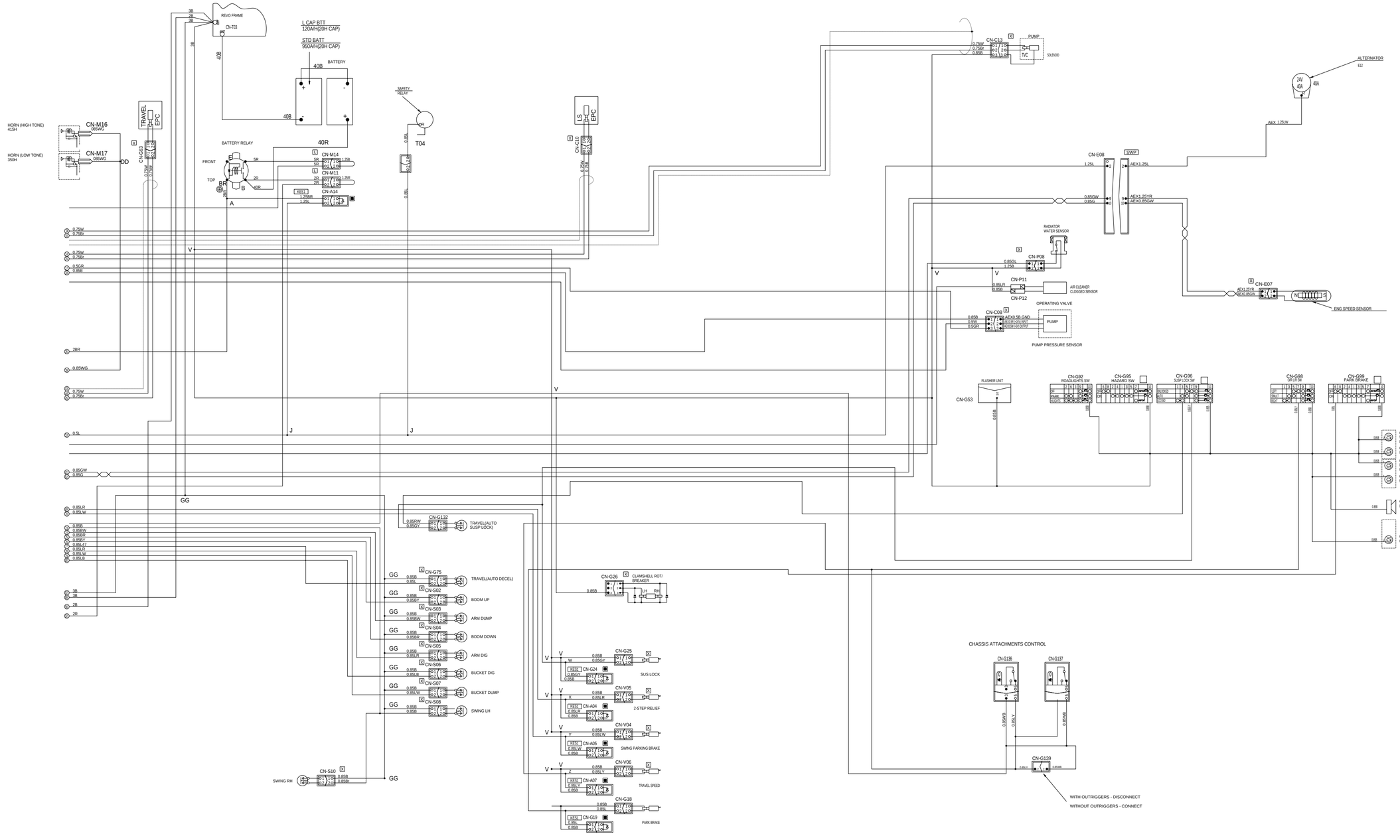
★ If service code E218 (abnormality in network system) is displayed, go to troubleshooting for N mode.

Governor, pump controller (E2:XX system)			Check items in monitoring mode																					
Self-diagnostic display				Pressure switch										Actuation of solennoid										
Abnormality in pump pressure sensor system	Abnormality in pressure sensor power source system	Abnormality in engine speed sensor system	Swing	Travel	Boom LOWER	Boom RAISE	Arm IN	Arm OUT	Bucket CURL	Bucket DUMP	Swing lock switch	Kerosene mode	Knob switch	Swing holding brake	2-stage relief	Travel speed	Model code	Engine speed input	Pump discharge pressure input	Pump TVC current output	LS-EPC current output	Troubleshooting code if no service code is displayed
			Bit pattern														Monitoring code					
224	226	227	20						21			22		23			02	10	11	13	15	
		•										○						※	※	※	※	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 C-21
																						H-16
																						H-17
				○																		H-21
•	•			○											※			※	※		※	H-23
			○								○			※					※			H-25
														※					※			H-26
																			※			
																						H-27
																						H-28
																						H-29
																						H-30
																					※	H-31
C-17	C-19	C-20	-	-	-	-	-	-	-	-	-	-	-	-	※	-	-	-	-	-	※	
-	-	-	F-1	F-2	F-3	F-4	F-5	F-6	F-7	F-8	F-9	F-10	F-11	-	-	-	-	-	-	-	-	

ELECTRICAL CIRCUIT DIAGRAM FOR C MODE 1/2

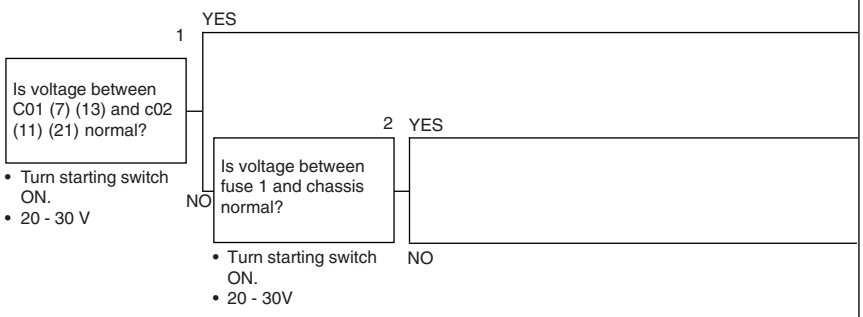


ELECTRICAL CIRCUIT DIAGRAM FOR C MODE 2/2



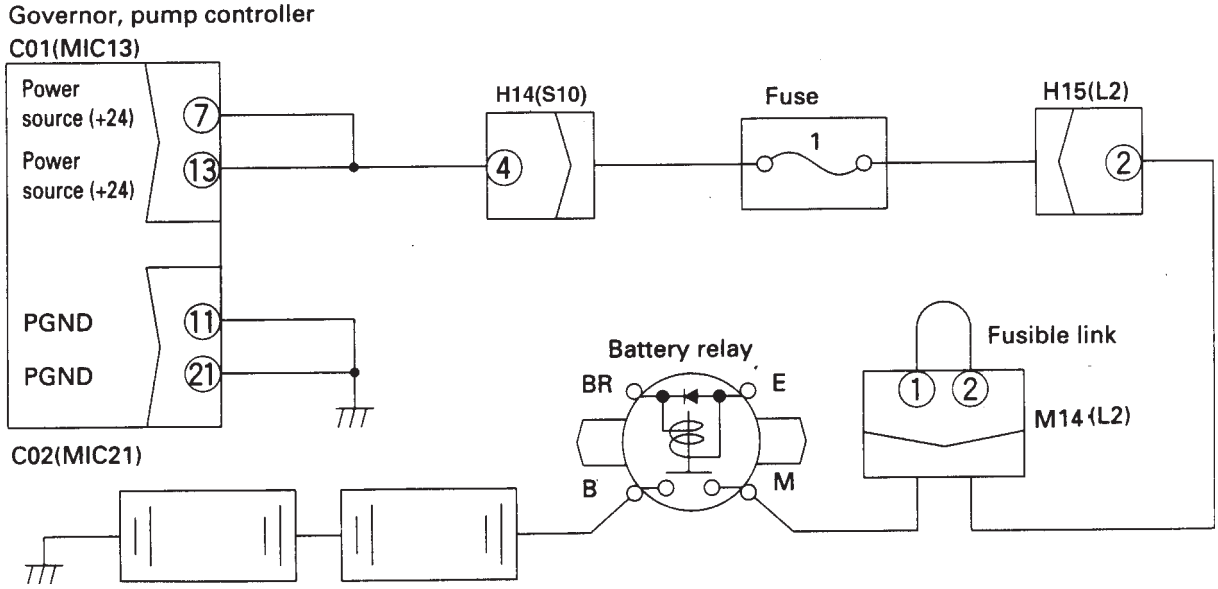
C-1 Abnormality in controller power source system (controller LED is OFF)

★ **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 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 TVC solenoid system is displayed

★ **This troubleshooting is carried out when there is still an abnormality, so when disconnecting the connector and inserting the T-adapter, or when removing the T-adapter and returning the connector to its original position, if an E service code is not displayed, the problem has been removed.**
★ If the starting switch is turned OFF after an abnormality occurs, turn the starting switch ON and check if an E service code is displayed. (If it is not displayed, the problem has been removed.)
★ Always turn the TVC prolix switch OFF.
★ Before carrying out troubleshooting, check that all the related connectors are properly inserted.
★ Always connect any disconnected connectors before going on the next step.

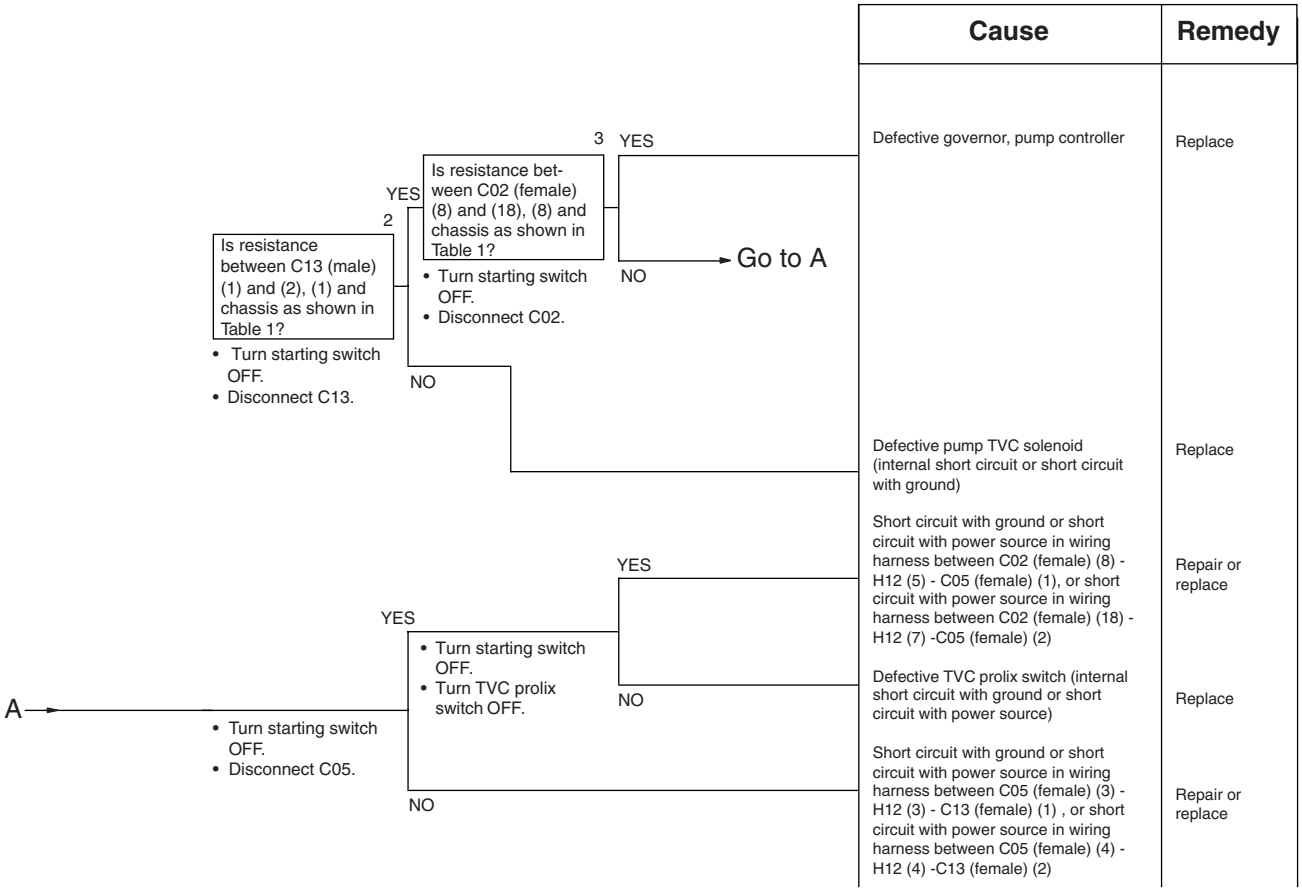
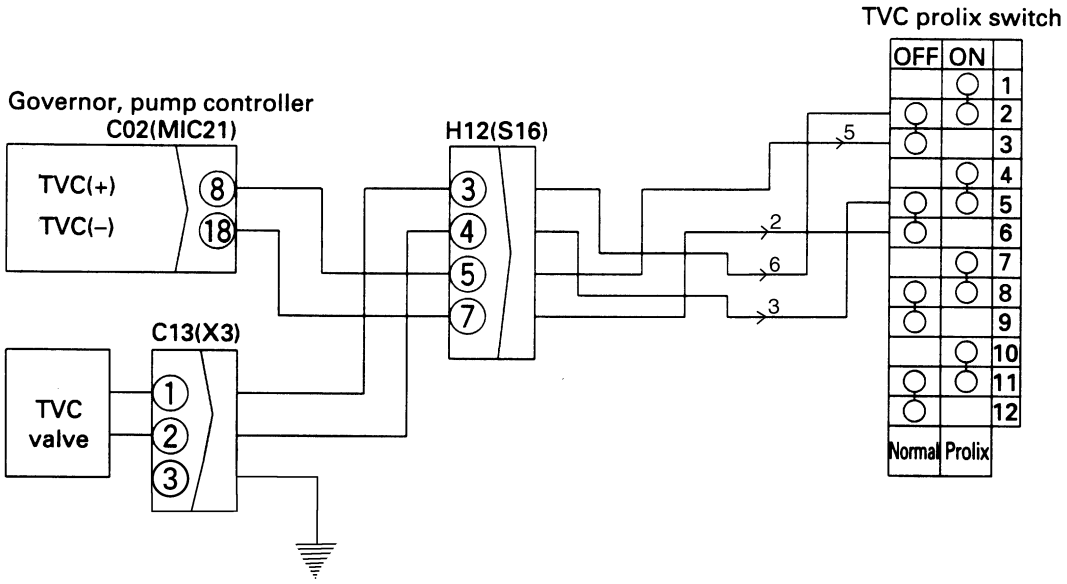


Table 1

Troubleshooting No.2	Troubleshooting No. 3	Resistance value
Between C13 (male) (1) - (2)	Between C02 (female) (8) - (18)	10 - 22 Ω
Between C13 (male) (1) - chassis	Between C02 (female) (8) - chassis	Min. 1 MΩ

C-2 Related electric circuit diagram



C-3 [E233] Disconnection in pump TVC solenoid system is displayed

★ **This troubleshooting is carried out when there is still an abnormality, so when disconnecting the connector and inserting the T-adapter, or when removing the T-adapter and returning the connector to its original position, if an E service code is not displayed, the problem has been removed.**
★ If the starting switch is turned OFF after an abnormality occurs, turn the starting switch On and check if an E service code is displayed. (If it is not displayed, the problem has been removed.)
★ If there is a disconnection in the solenoid or wiring harness, no current flows to the solenoid. If the No. 2 pin of the solenoid is short circuiting with the ground, the current (approx. 1 A) continues to flow to the solenoid.
★ Always turn the TVC prolix switch OFF.
★ Before carrying out troubleshooting, check that all the related connectors are properly inserted.
★ Always connect any disconnected connectors before going on the next step.

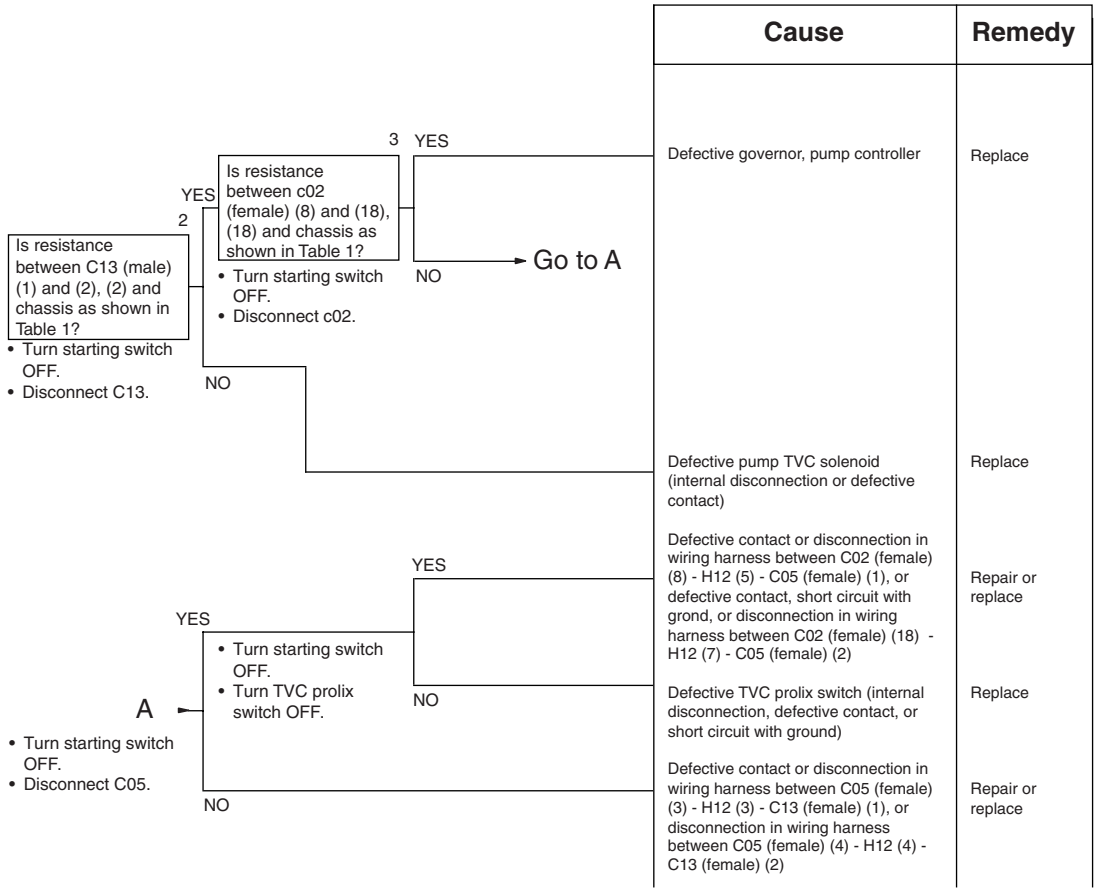
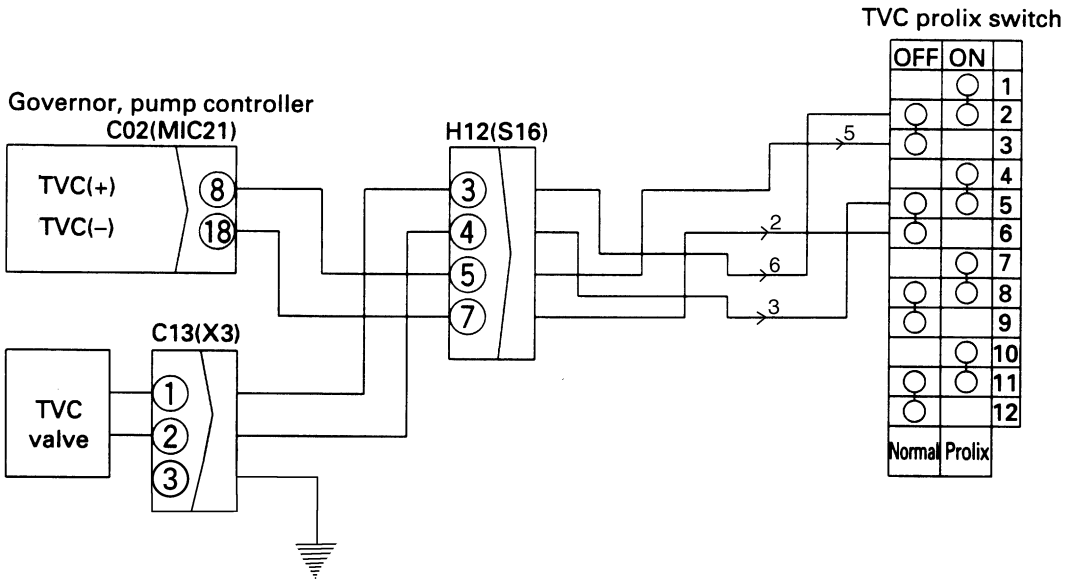


Table 1

Troubleshooting No.2	Troubleshooting No. 3	Resistance value
Between C13 (male) (1) - (2)	Between C02 (female) (8) - (18)	10 - 22 Ω
Between C13 (male) (2) - chassis	Between C02 (female) (18) - chassis	Min. 1 MΩ

C-3 Related electric circuit diagram



C-8 [E203] Short circuit in swing brake solenoid system is displayed

★ **This troubleshooting is carried out when there is still an abnormality, so when disconnecting the connector and inserting the T-adapter, or when removing the T-adapter and returning the connector to its original position, if an E service code is not displayed, the problem has been removed.**
★ If the starting switch is turned OFF after an abnormality occurs, turn the starting switch ON and check if an E service code is displayed. (If it is not displayed, the probem has been removed.)
★ Before carrying out troubleshooting, check that all the related connectors are properly inserted.
★ Always connect any disconnected connectors before going on the next step.
★ Always turn the swing lock prolix switch OFF, then turn the swing lock switch OFF before checking.

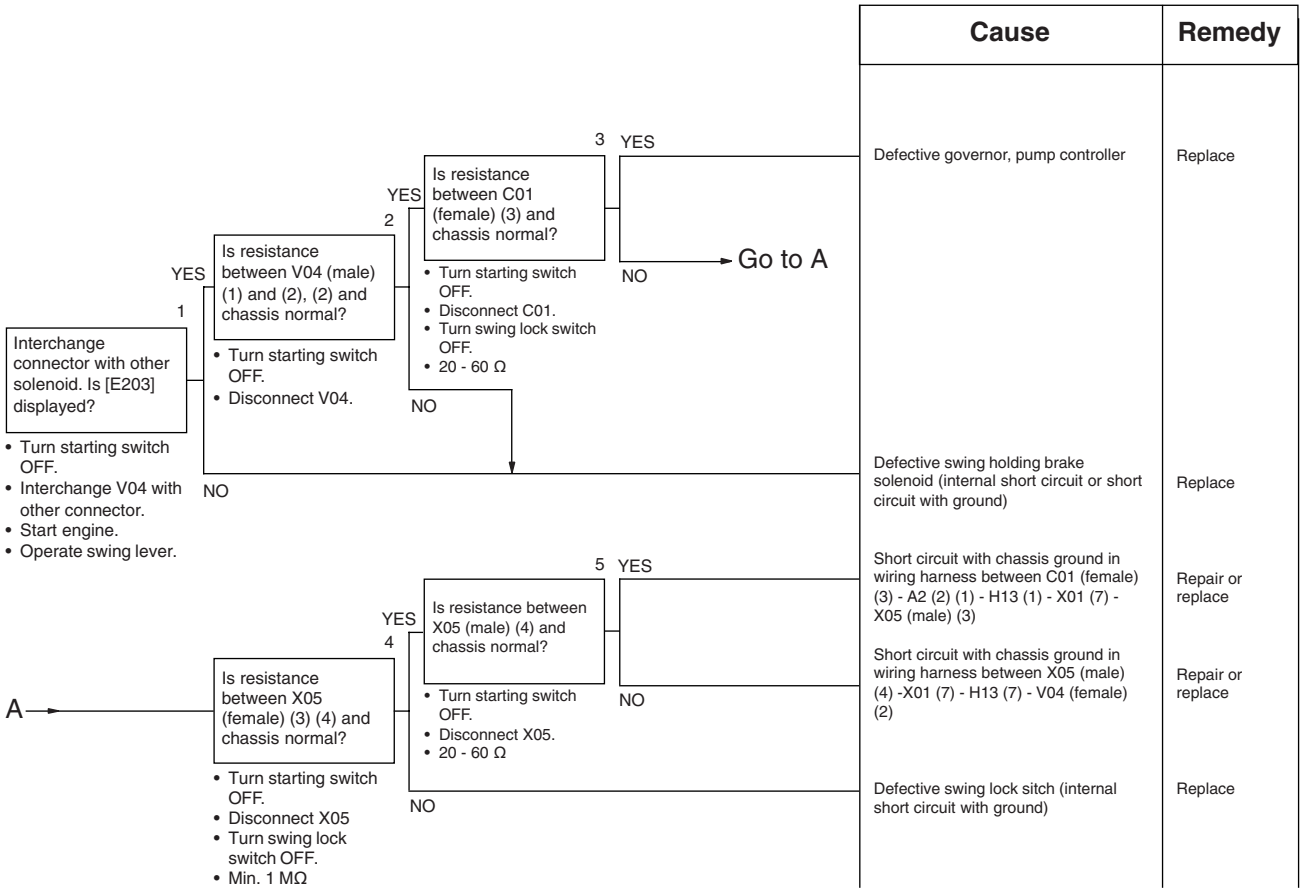
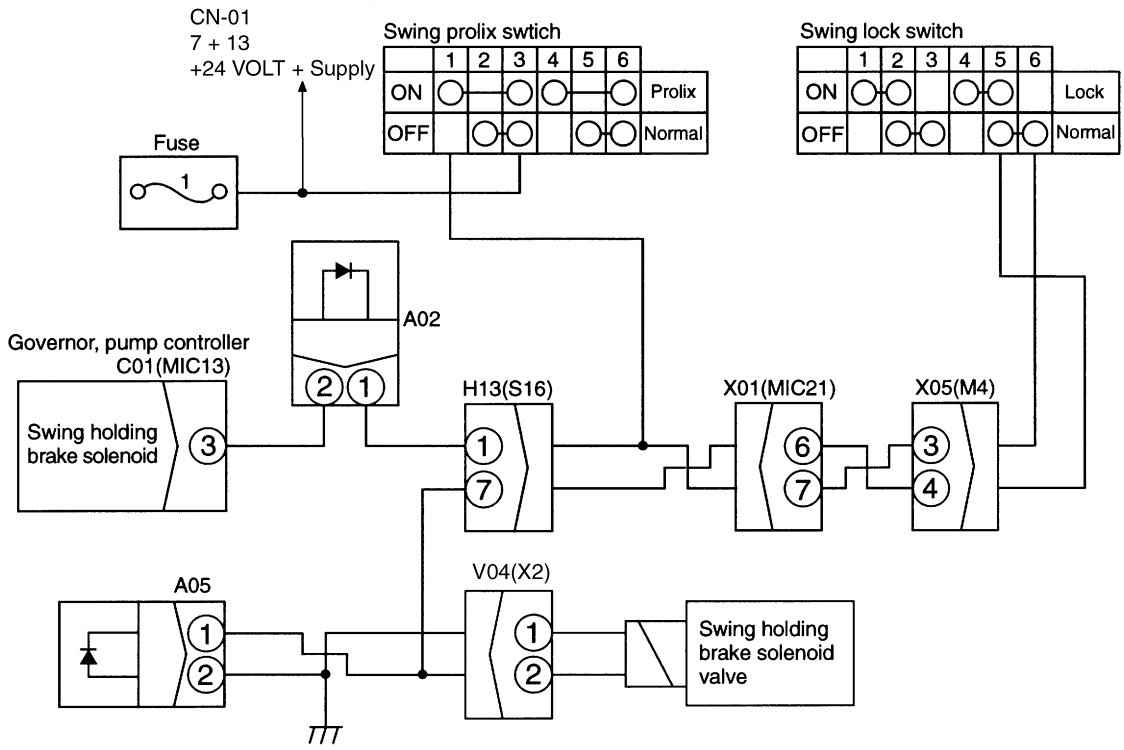


Table 1

Between V04 (male) (1) - 92)	20 - 60 Ω
Between V04 (male) (2) - chassis	Min. 1 MΩ

C-8 Related electric circuit diagram



C-9 [E213] Disconnection in swing brake solenoid system is displayed

★ **This troubleshooting is carried out when there is still an abnormality, so when disconnecting the connector and inserting the T-adapter, or when removing the T-adapter and returning the connector to its orginal position, if an E service code is not displayed, the problem has been removed.**
★ If the starting switch is turned OFF after an abnormality occurs, turn the starting switch ON and check if an E service code is displayed. (If it is not displayed, the problem has been removed.)
★ Always turn the swing lock prolix switch OFF, then turn the swing lock switch OFF before checking.
★ Before carrying out troubleshooting, check that all the related connectors are properly inserted.
★ Always connect any disconnected connectors before going on the next step.

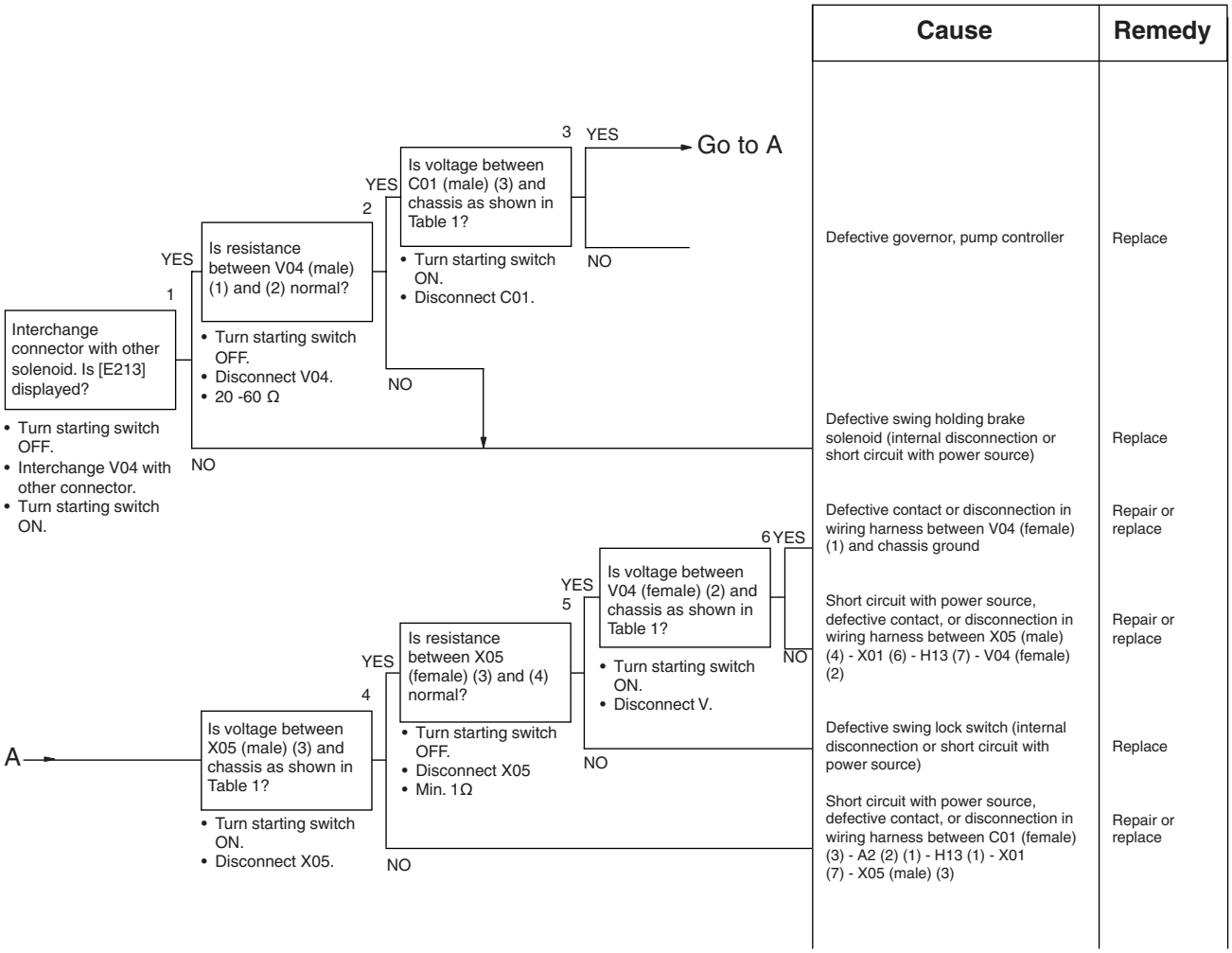
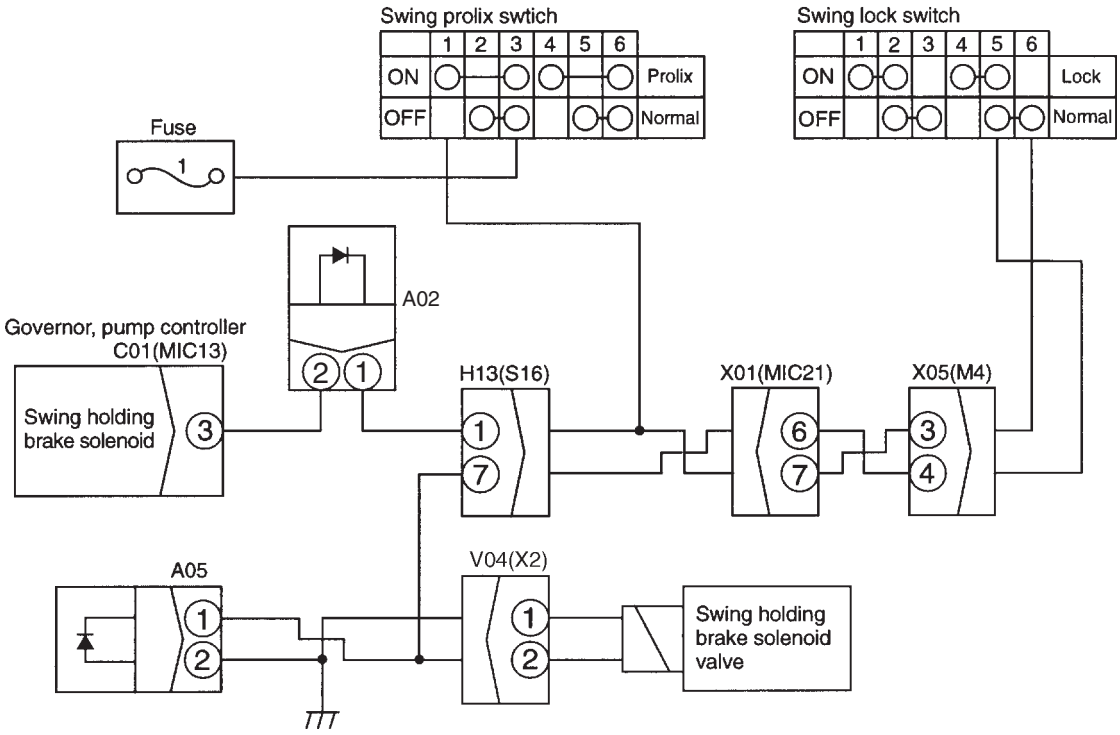


Table 1

Troubleshooting No. 3	Troubleshooting No. 4	Troubleshooting No. 6	Voltage	Measurement condition
Between C01 (male) (3) - chassis	Between X05 (male) (3) - chassis	Between V04 (male) (2) - chassis	0 - 3V	5 seconds after all levers are returned to neutral
			20 - 30V	Swing lever operated

C-9 Related electric circuit diagram



C-10 [E205] Short circuit in 2-stage relief solenoid system is displayed

★ **This troubleshooting is caried out when there is still an abnormality, so when disconnecting the connector and inserting the T-adapter, or when removing the T-adapter and returning the connector to its original position, if an E service code is not displayed, the problem has been removed.**
★ If the starting switch is turned OFF after an abnormality occurs, turn the starting switch ON and check if an E service code is displayed. (If it is not displyed, the problem has been removed.)
★ Before carrying out troubleshooting, check that all the related connectors are properly inserted.
★ Always connect any disconnected connectors before going on the next step.

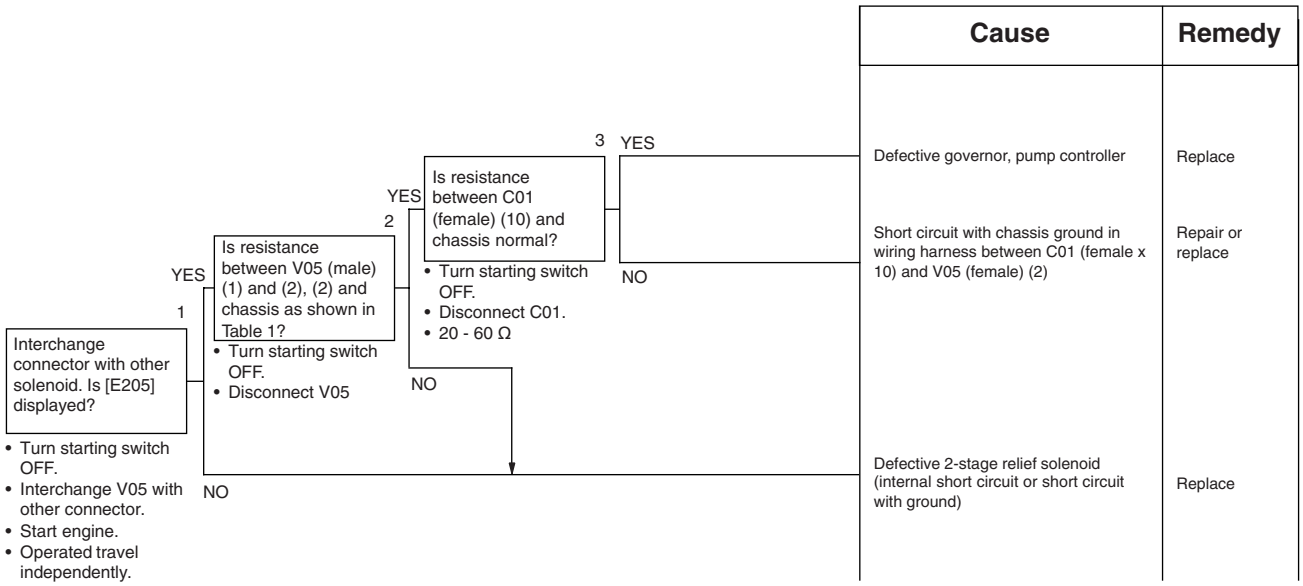
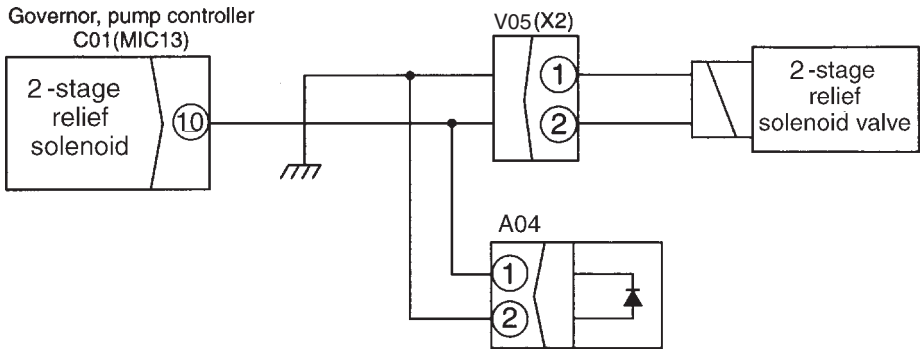


Table 1

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

C-10 Related electric circuit diagram



C-11 [E215] Disconnection in 2-stage relief solenoid system is displayed

★ **This troubleshooting is carried out when there is still an abnormlaity, 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 displyed, the problem has been removed.**
★ If the starting switch is turned OFF after an abnormality occurs, turn the starting switch ON and check if an E service code is displayed. (If it is not displayed, the problem has been removed.)
★ Before carrying out troubleshooting, check that all the related connectors are properly inserted.
★ Always connect any disconnected connectors before going on the next step.

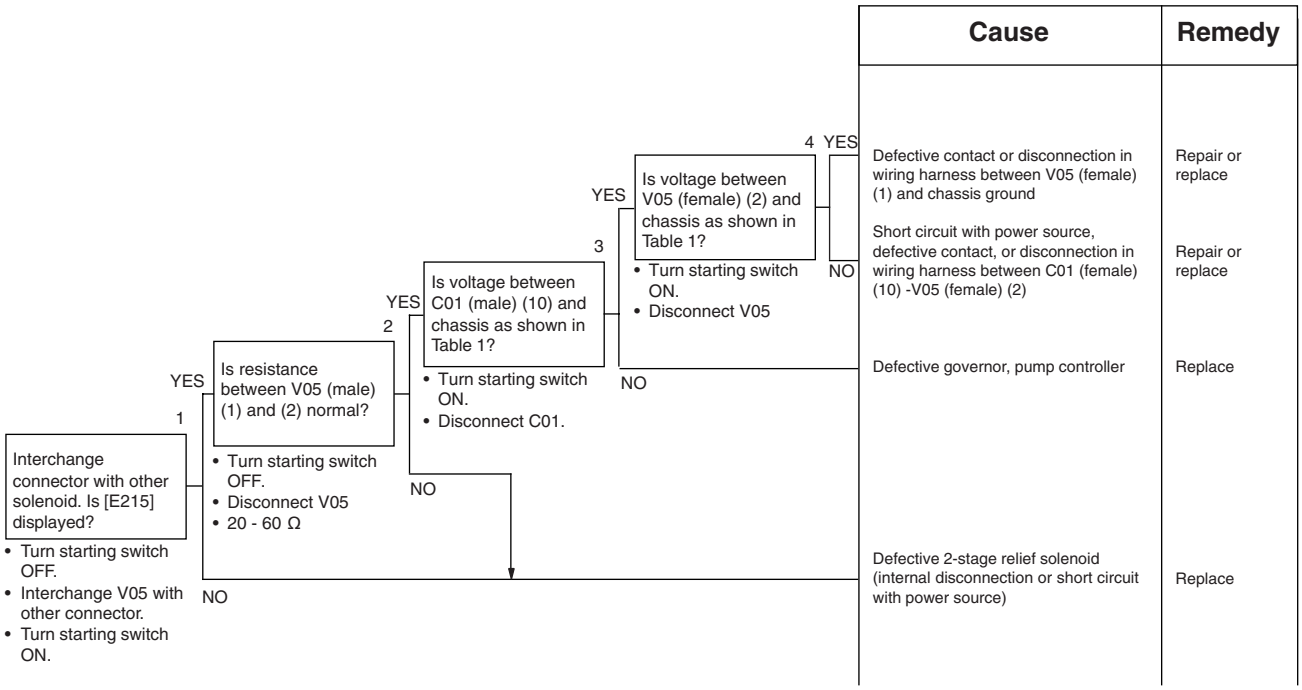
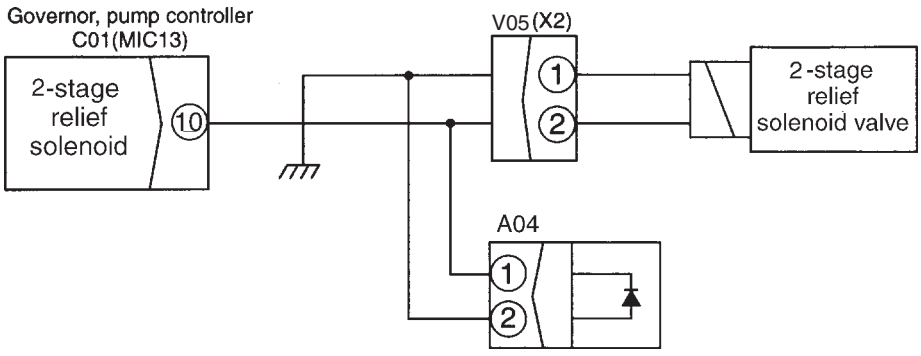


Table 1

Troubleshooting No. 3	Troubleshooting No. 4	Voltage	Measurement condition
Between C01 (male) (10) - chassis	Between V05 (female) (2) - chassis	0 - 3V	All levers at neutral
		20 - 30V	Travel operated independently

C-11 Related electric circuit diagram



C-12 [E206] Short circuit in travel speed solenoid system is displayed

★ **This troubleshooting is carried out when there is still an abnormality, so when disconnecting the connector and inserting the T-adapter, or when removing the T-adapter and returning the connector to its original position, if an E service code is not displayed, the problem has been removed.**
★ If the starting switch is turned OFF after an abnormality occurs, turn the starting switch ON and check if an E service code is displayed. (If it is not displayed, the problem has been removed.)
★ Before carrying out troubleshooting, check that all the related connectors are properly inserted.
★ Always connect any disconnected connectors before going on the next step.

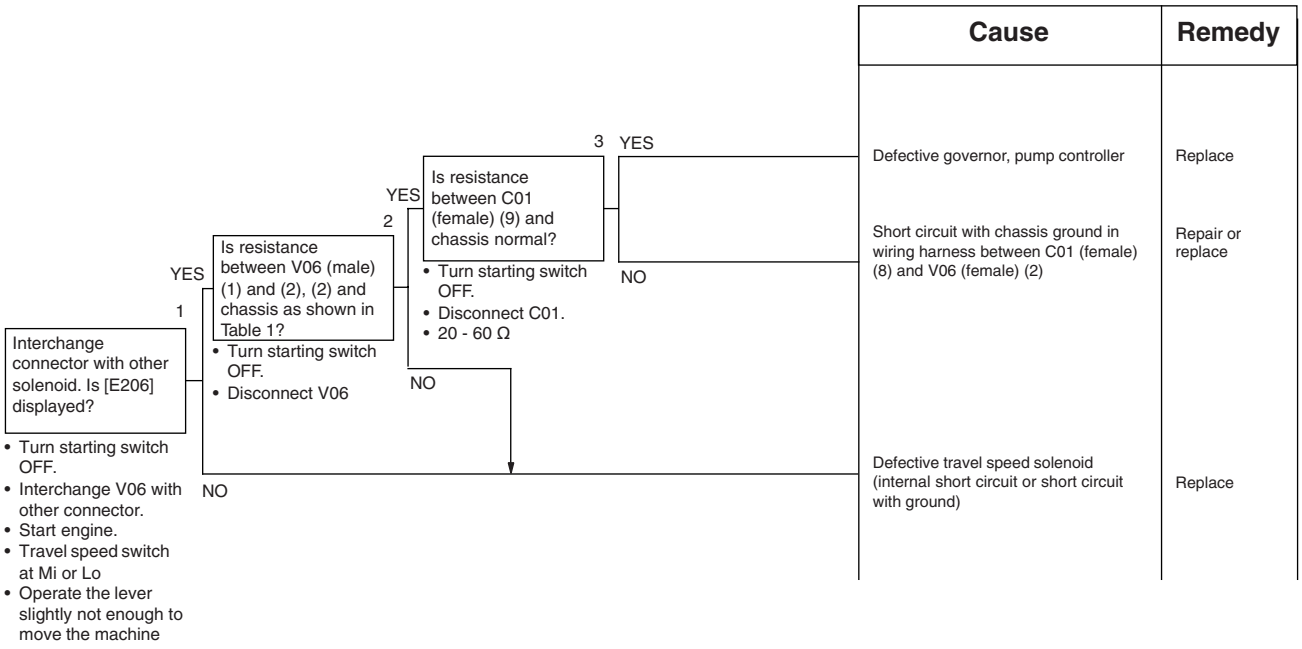
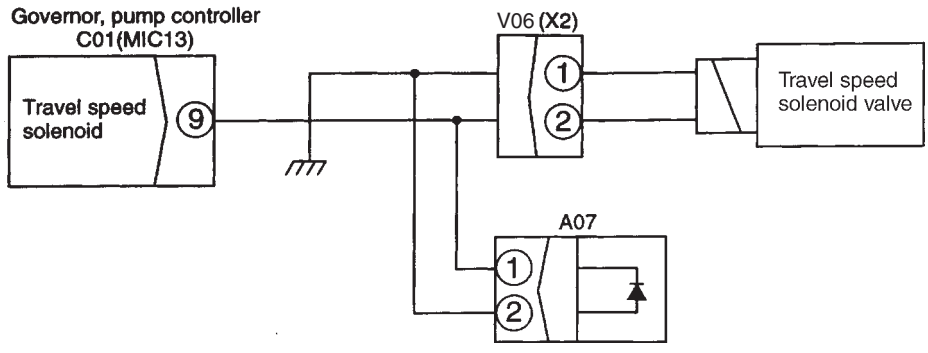


Table 1

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

C-12 Related electric circuit diagram



C-13 [E216] Disconnection in travel speed selector solenoid system is displayed

★ **This troubleshooting is carried out when there is still an abnormality, so when disconnecting the connector and inserting the T-adapter, or when removing the T-adapter and returning the connector to its original position, if an E service code is not displayed, the problem has been removed.**
★ If the starting switch is turned OFF after an abnormality occurs, turn the starting switch ON and check if an E service code is displayed. (If it is not displayed, the problem has been removed.)
★ Before carryuing out troubleshooting, check that all the related connectors are properly inserted.
★ Always connect any disconnected connectors before going on the next step.

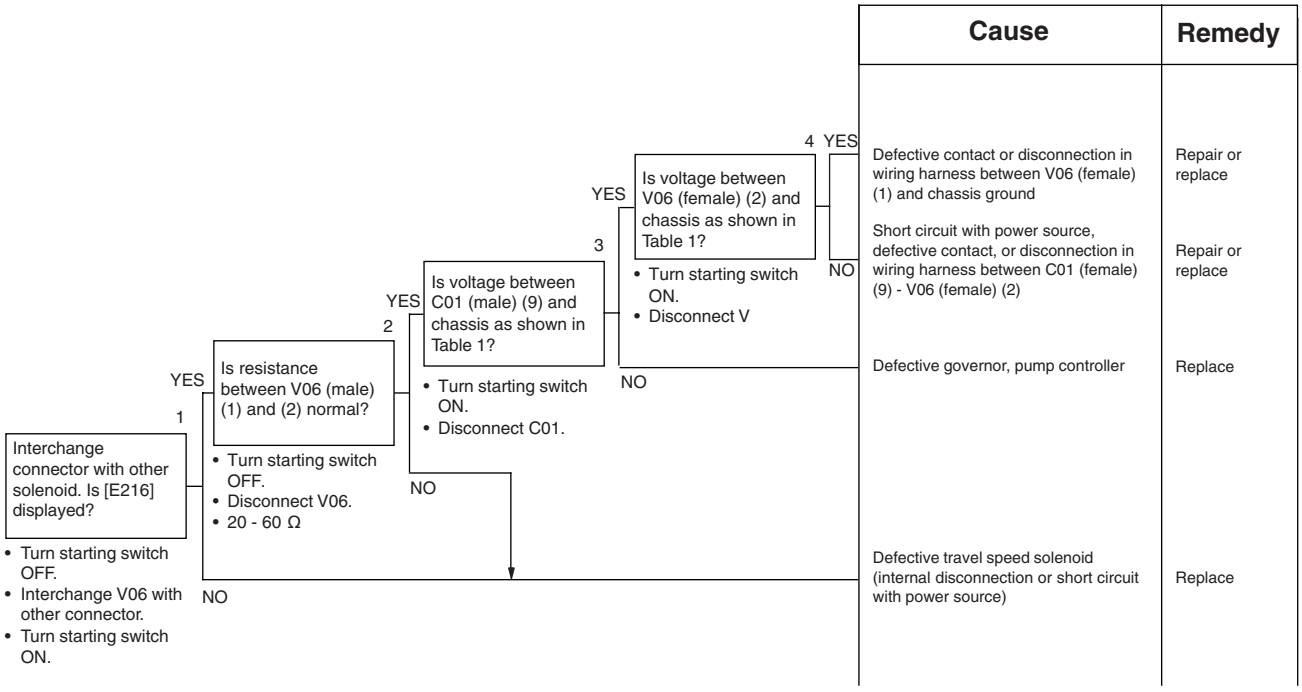
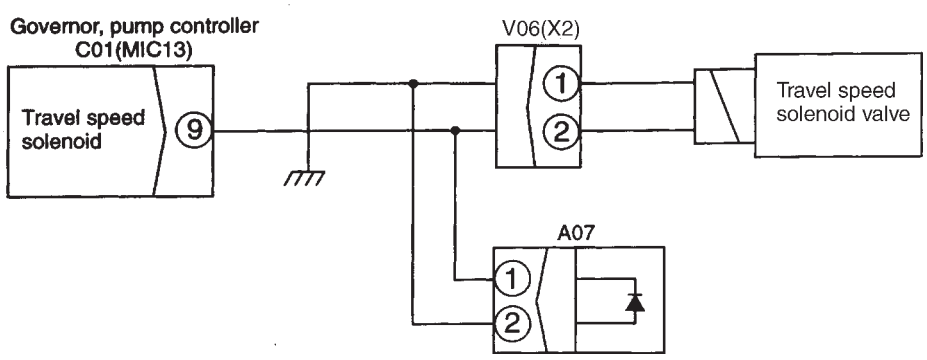


Table 1

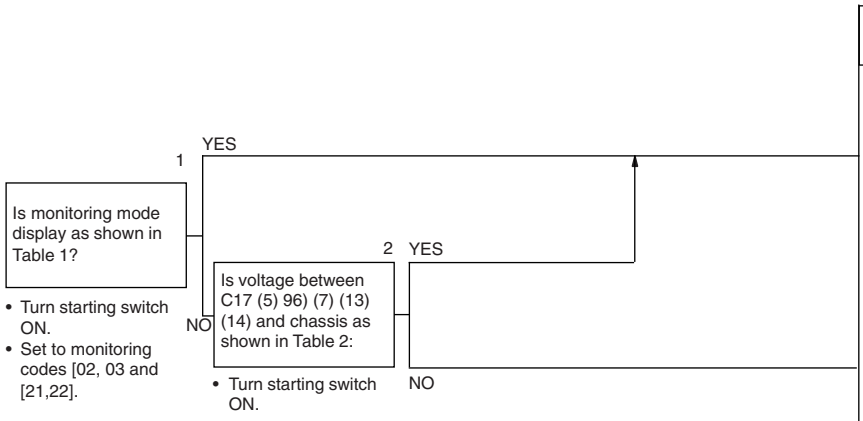
Troubleshooting No. 3	Troubleshooting No. 4	Voltage	Measurement condition
Between C01 (male) (10) - chassis	Between V06 (female) (2) - chassis	0 - 3V	Travel speed switch at Hi
		20 - 30V	Travel speed switch at Mi or Lo
			Operate the lever slightly not enough to move the machine

C-13 Related electric circuit diagram



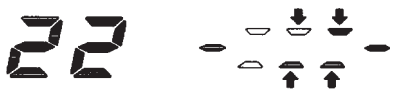
C-14 [E217] Model selection input error is displayed

★ **This stroubleshooting is carried out when there is still an abnormality, so when disconnecting the connector and inserting the T-adapter, or when removing the T-adapter and returning the connector to its original position, if an E service code is not displayed, the problem has been removed.**
★ If the starting switch is turned OFF after an abnormality occurs, turn the starting switch ON and check if an E service code is displayed. (If it is not displayed, the problem has been removed.)
★ Before carrying out troubleshooting, check that all the related connectors are properly inserted.
★ Always connect any disconnected connectors before going on the next step.



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
	 BKP00194	 BKP00198

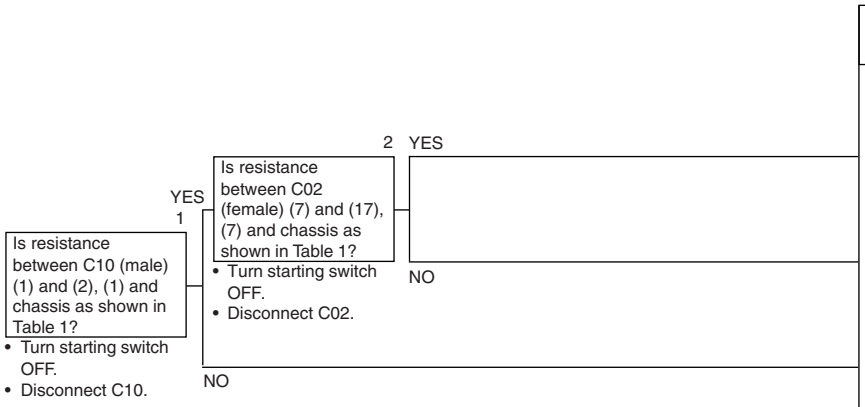
★ The diagram shows monitoring code 02.
★ Check the bit pattern display marked with ←.

Table 2 Voltage of wiring harness

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

C-15 [E222] Short circuit in LS-EPC solenoid system is displayed

★ **This troubleshooting is carried out when there is still an abnormality, so when disconnecting the connector and inserting the T-adapter, or when removing the T-adapter and returning the connector to its original position, if an E service code is not displayed, the problem has been removed.**
★ If the starting switch is turned OFF after an abnormality occurs, turn the starting switch ON and check if an E service code is displayed. (If it is not displayed, the problem has been removed.)
★ Before carrying out troubleshooting, check that all the related connectors are properly inserted.
★ Always connect any disconnected connectors before going on the next step.

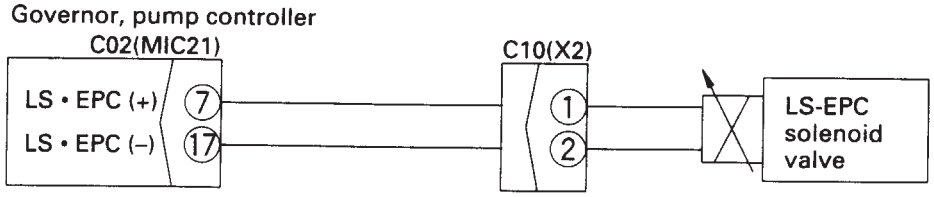


Cause	Remedy
Defective governor, pump controller	Replace
Short circuit with ground or short circuit with power source in wiring harness between C02 (female) (7) - C10 (female) (1), or short circuit with power source in wiring harness between C02 (female) (17) - C10 (female) (2)	Repair or replace
Defective LS-EPC solenoid (internal short circuit with ground or short circuit with power source)	Replace

Table 1

Troubleshooting No. 1	Troubleshooting No. 2	Resistance value
Between C10 (male) (1) - (2)	Between C02 (female) (7) - (17)	7 - 14 Ω
Between C10 (male) (1) - chassis	Between C02 (female) (7) - chassis	Min. 1 MΩ

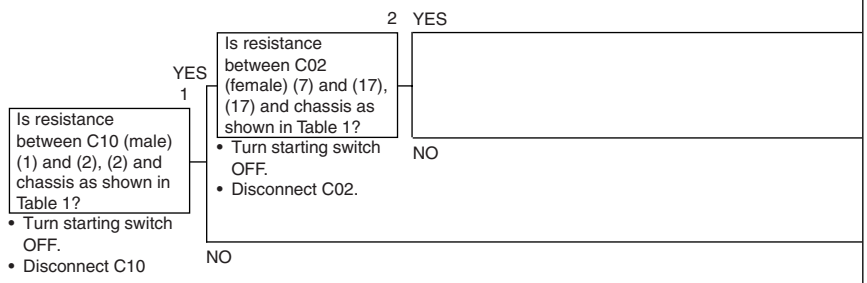
C-15 Related electric circuit diagram



BKP00251

C-16 [E223] Disconnection in LS-EPC solenoid system displays

★ **This troubleshooting is carried out when there is still an abnormality, so when disconnecting the connector and inserting the T-adapter, or when removing the T-adapter and returning the connector to its original position, if an E service code is not displayed, the problem has been removed.**
★ If the starting switch is turned OFF after an abnormality occurs, turn the starting switch ON and check if an E service code is displayed. (If it is not displayed, the problem has been removed.)
★ Before carrying out troubleshooting,check that all the related connectors are properly inserted.
★ Always connect any disconnected connectors before going on the next step.

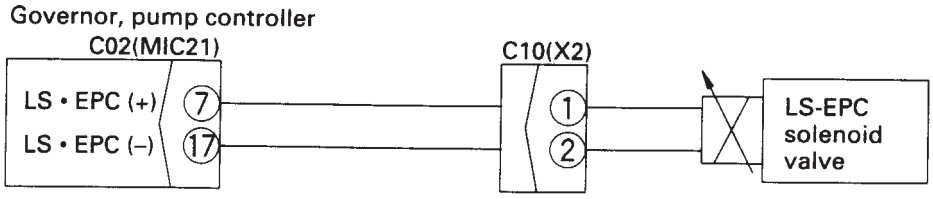


Cause	Remedy
Defective governor, pump controller	Replace
Defect contact or short circuit with chassis ground in wiring harness between C02 (female) (7) and C10 (female) (1), or defective contact, short circuit with ground, or disconnection in wiring harness between C02 (female) (17) - C10 (female) (2)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

Table 1

Troubleshooting No. 1	Troubleshooting No. 2	Resistance value
Between C10 (male) (1) - (2)	Between C02 (female) (7) - (17)	7 - 14 Ω
Between C10 (male) (1) - chassis	Between C02 (female) (7) - chassis	Min. 1 MΩ

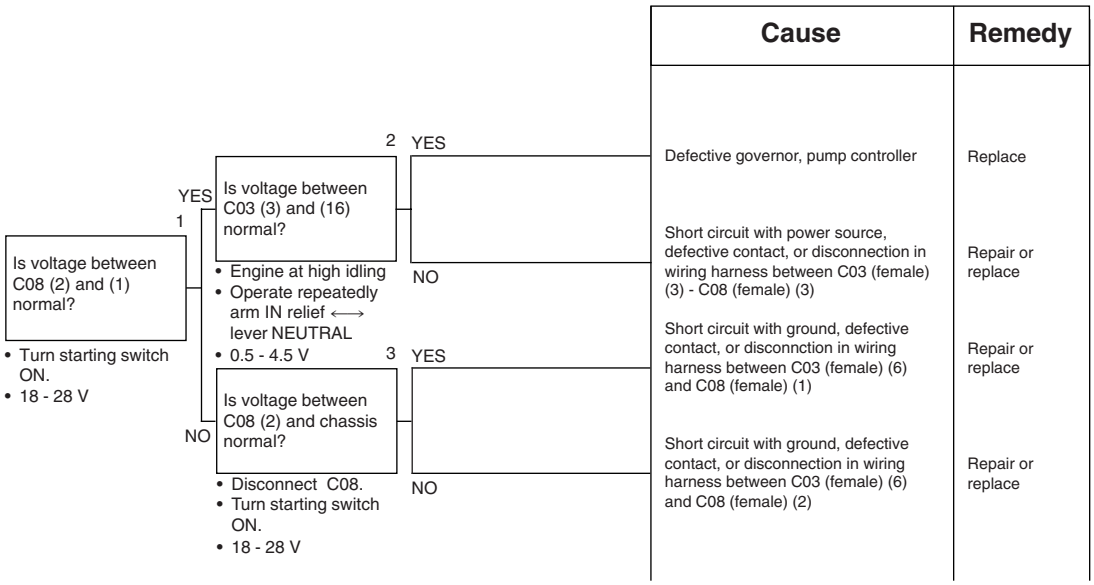
C-16 Related electric circuit diagram



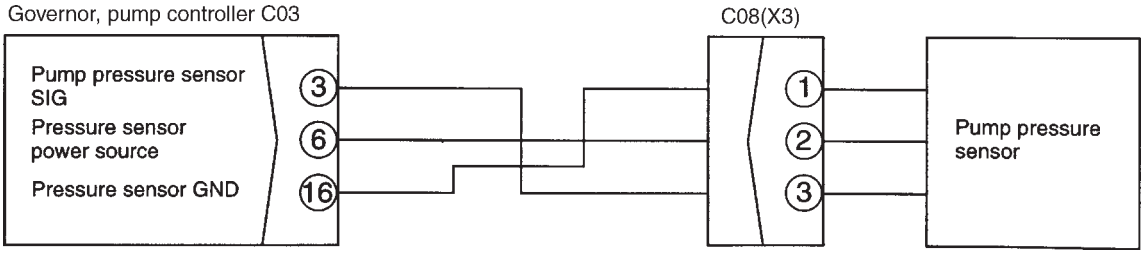
BKP00251

C-17 [E224] Abnormality in pump pressure sensor system is displayed

★ **This troubleshooting is carried out when there is still an abnormality, so when disconnecting the connector and inserting the T-adapter, or when removing the T-adapter and returning the connector to its original position, if an E service code is not displayed, the problem has been removed.**
★ If the starting switch is turned OFF after an abnormality occurs, turn the starting switch ON and check if an E service code is displayed. (If it is not displayed, the problem hs been removed.)
★ Before carrying out troubleshooting, check that all the related connecotrds are properly inserted.
★ Always connect any disconnected connectors before going on the next step.

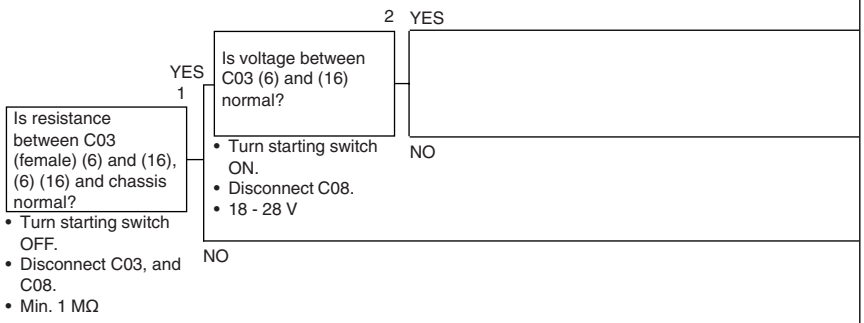


C-17 Related electric circuit diagram



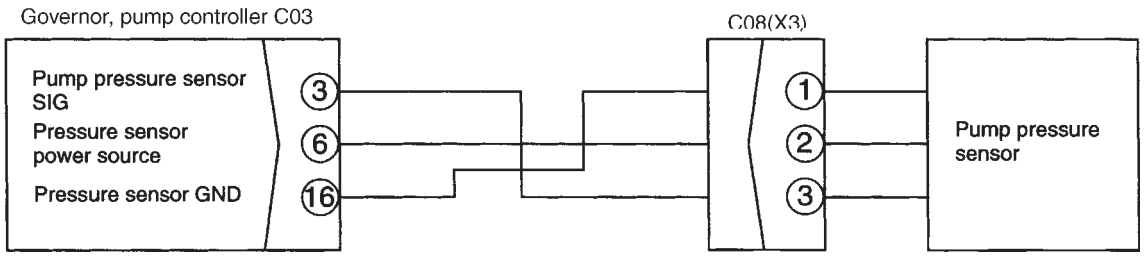
C-19 [E226] Abnormality in pressure sensor power source system is displayed

★ **This troubleshooting is carried out when there is still an abnormality, so when disconnecting the connector and inserting the T-adapter, or when removing the T-adapter and returning the connector to its original position, if an E service code is not displayed, the problem has been removed.**
★ If the starting switch is turned OFF after an abnormaltiy occurs, turn the starting switch ON and check if an E service code is displayed. (If it is not displayed, the problem has been removed.)
★ Before carrying out troubleshooting, check that all the related connectors are properly inserted.
★ Always connect any disconnected connectors before going on the next step.



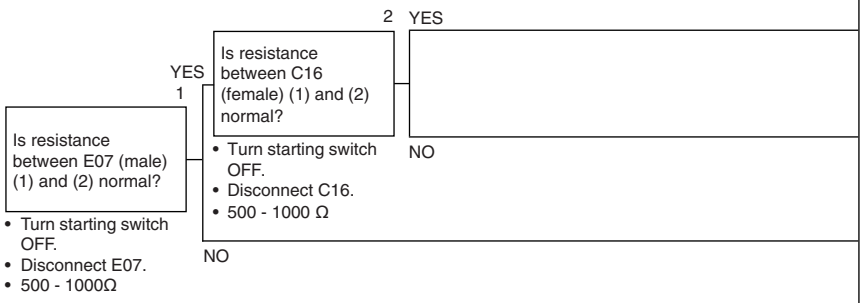
Cause	Remedy
Defective front pump pressure sensor (internal short circuit or short circuit with ground)	Replace
Defective governor, pump controller	Replace
Short circuit or short circuit with ground in wiring harness of system where resistance value is defective	Repair or replace

C-19 Related electric circuit diagram



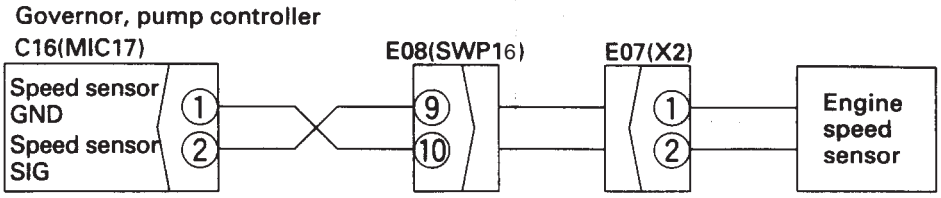
C-20 [E227] Abnormality in engine speed sensor system is displayed

★ **This troubleshooting is carried out when there is still an abnormality, so when disconnecting the connector and inserting the T-adapter, or when removing the T-adapter and returning the connector to its original position, if an E service code is not displayed, the problem has been removed.**
★ If the starting switch is turned OFF after an abnormality occurs, turn the starting switch ON and check if an E service code is displayed. (If it is not displayed, the problem has been removed.)
★ Before carrying out troubleshooting, check that all the related connectors are properly inserted.
★ always connect any disconnected connectors before going on the next step.



Cause	Remedy
Defective govenror, pump controller	Replace
Short circuit with ground, defective contact, or disconnection in wiring harness between C16 (female) (1) - E08 (10) - E07 (female) (2), or between C16 (female) (2) - E08 (9) - E07 (female) (1)	Repair or replace
Defective engine speed sensor (internal disconnection, defective contact, or short circuit with ground)	Replace

C-20 Related electric circuit diagram

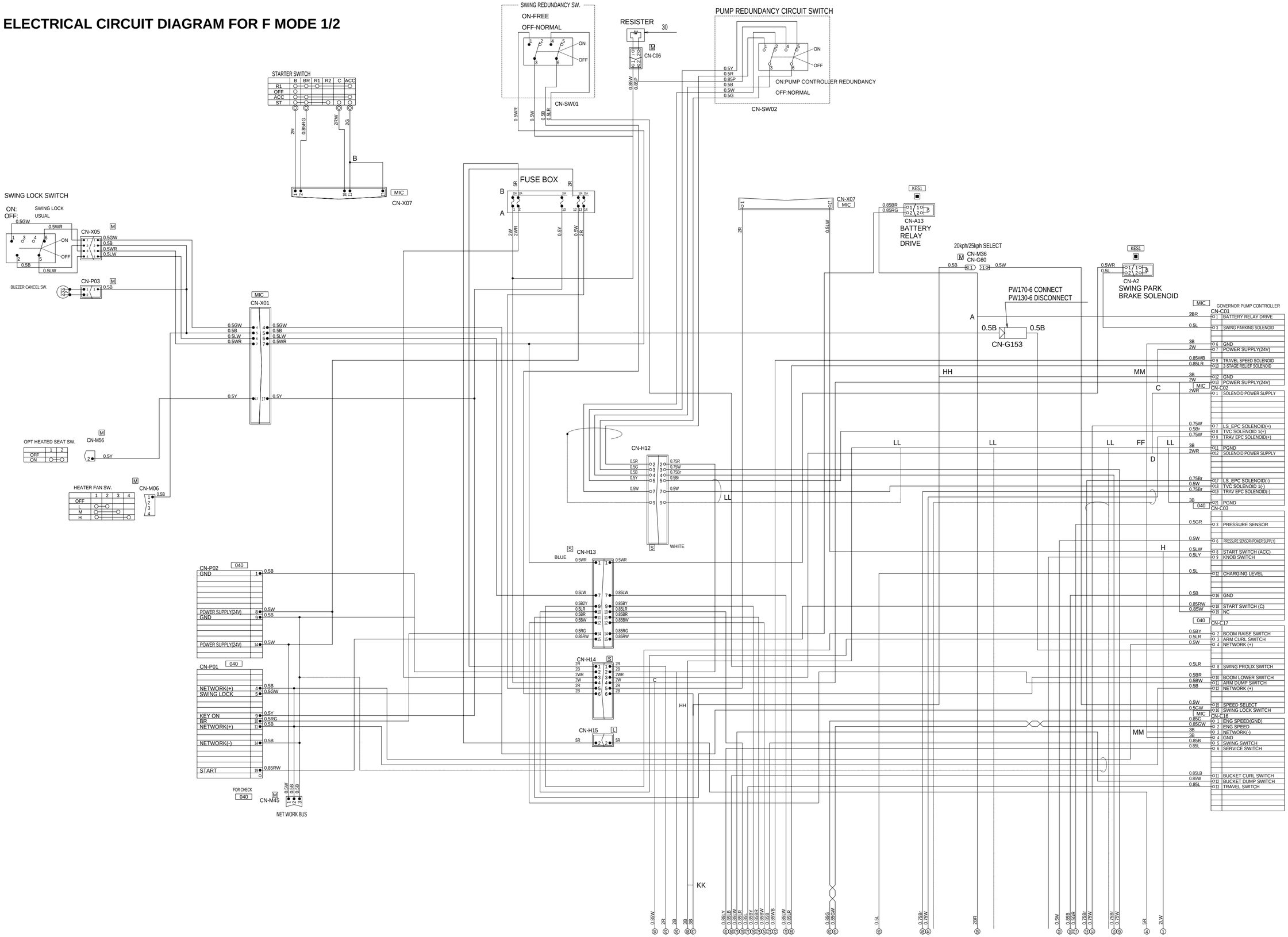


BKP00255

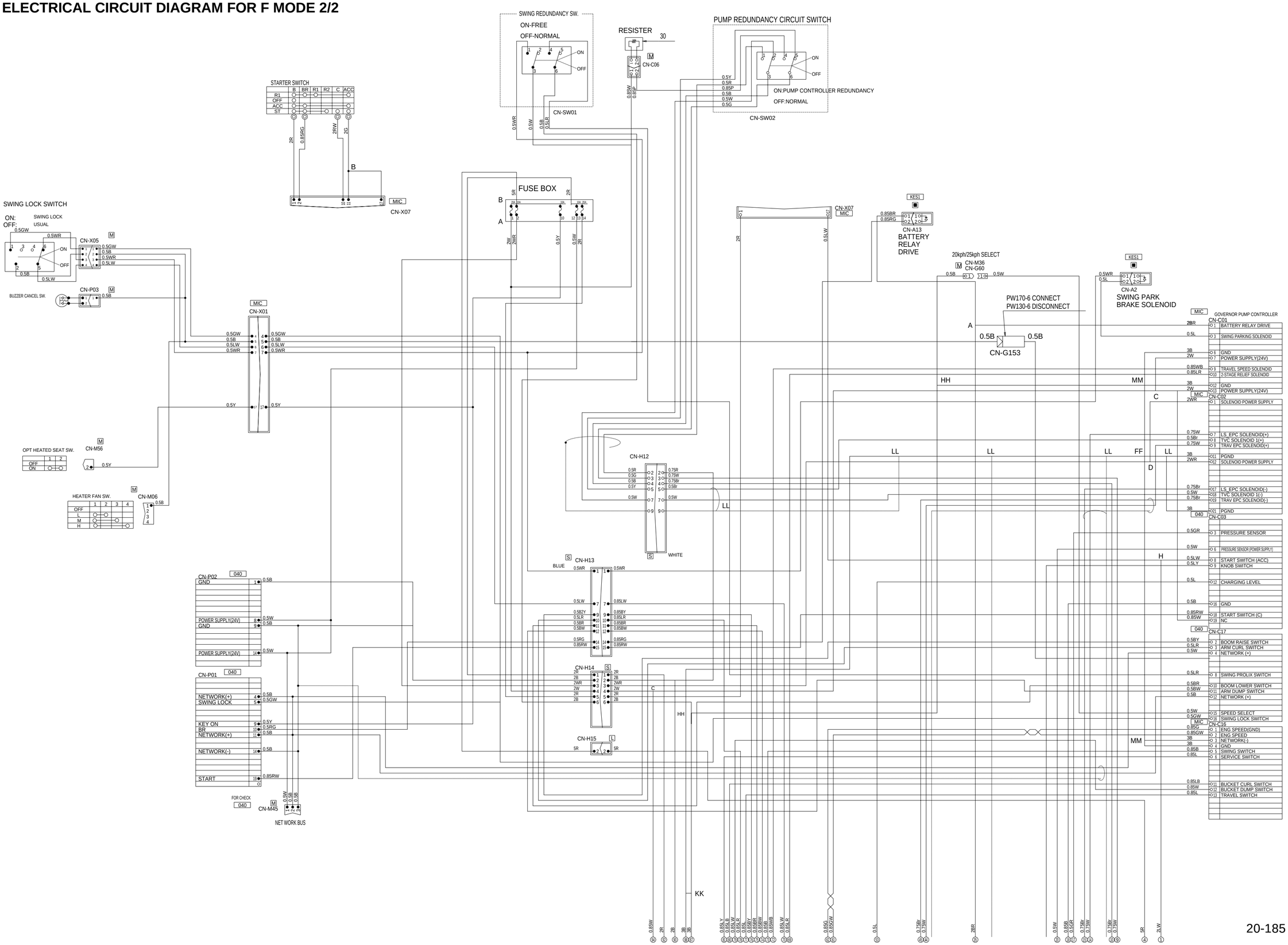
TROUBLESHOOTING OF GOVERNOR, PUMP CONTROLLER (INPUT SIGNAL SYSTEM) (F MODE)

Electrical circuit diagram for F mode... 20-184
F- 1 Bit pattern 20-(1) Swing oil pressure switch does not light up... 20-186
F- 2 Bit pattern 20-(2) Travel oil pressure switch does not light up... 20-187
F- 3 Bit pattern 20-(3) Boom LOWER oil pressure switch does not light up... 20-188
F- 4 Bit pattern 20-(4) Boom RAISE oil pressure switch does not light up... 20-189
F- 5 Bit pattern 20-(5) Arm IN oil pressure switch does not light up... 20-190
F- 6 Bit pattern 20-(6) Arm OUT oil pressure switch does not light up... 20-191
F- 7 Bit pattern 21-(1) Bucket CURL oil pressure switch does not light up... 20-192
F- 8 Bit pattern 21-(2) Bucket DUMP oil pressure switch does not light up... 20-193
F- 9 Bit pattern 21-(3) Swing lock switch does not light up... 20-194
F- 11 Bit pattern 22-(6) L.H. knob switch does not light up... 20-195

ELECTRICAL CIRCUIT DIAGRAM FOR F MODE 1/2



ELECTRICAL CIRCUIT DIAGRAM FOR F MODE 2/2



F-1 Bit pattern 20-(1) Swing oil pressure switch does not light up

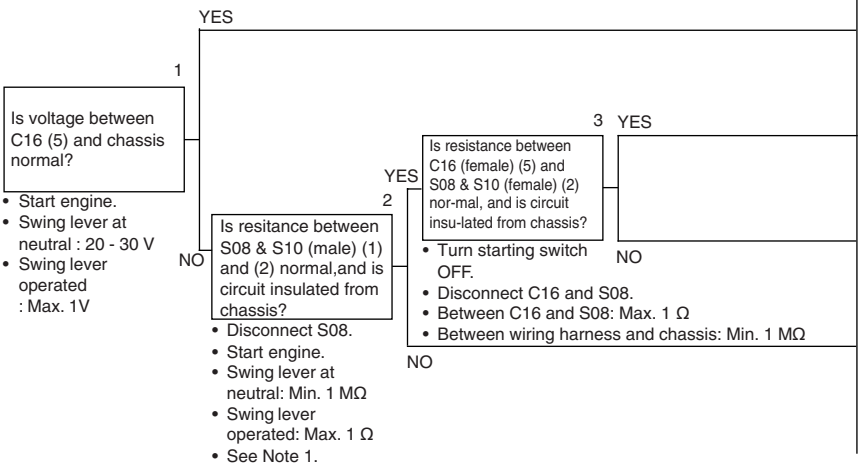
★ **This troubleshooting is carried out when there is still an abnormality, so when disconnecting the connector and inserting the T-adapter, or when removing the T-adapter and returning the connector to its original position, if the monitor code display returns to normal, the problem has been removed.**

⚠ Turn the swing lock switch ON before operating the swing lever.

★ If there is no display when the lever is operated on one side, the PPC valve is defective. (See H-5)

★ Before carrying out troubleshooting, check that all the related connectors are properly inserted.

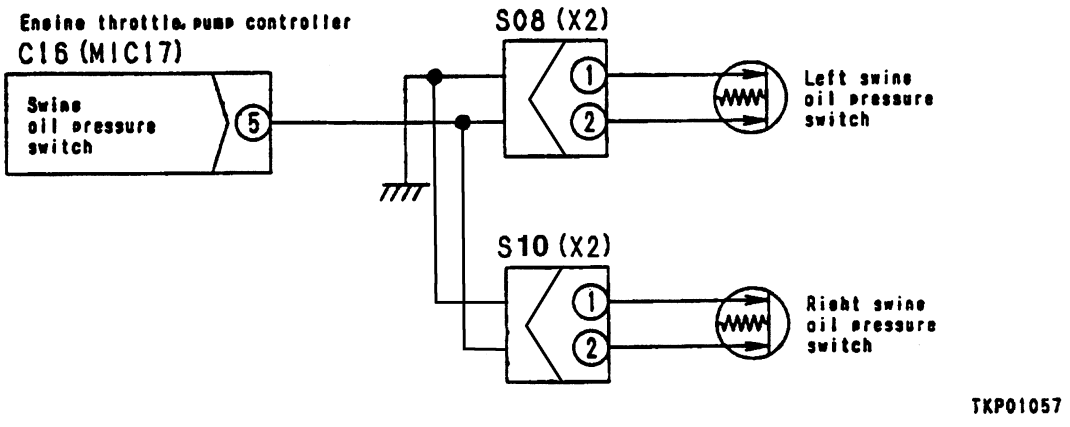
★ Always connect any disconnected connectors before going on the next step.
(When measuring with the engine stopped, charge the accumulator first.)



Cause	Remedy
Defective governor, pump controller	Replace
Defective contact or disconnection in wiring harness between S08 (female) (1) and chassis ground	Repair or replace
Defective contact, short circuit with ground, or disconnection in wiring harness between C16 (female) (5) and S08 (female) (2)	Repair or replace
	Replace

Note 1: It is also possible to fit a short connector and judge the condition. In this case, check the voltage between C16 (5) and the chassis.
- If it is 20 - 30 V: Go to Yes
- If it is less than 1 V: Go to No

F-1 Related electric circuit diagram



F-2 Bit pattern 20-(2) Travel oil pressure switch does not light up

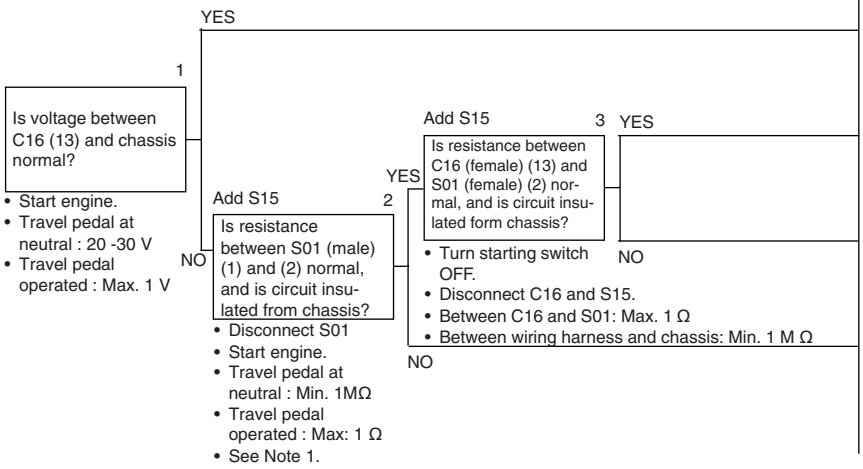
★ **This troubleshooting is carried out when there is still an abnormality, so when the connector and inserting the T-adapter, or when removing the T-adapter and returning the connector to its original position, if the monitor code display returns to normal, the problem has been removed.**

⚠ Before operating the travel lever, check that the surrounding area is safe.

★ If there is no display when the travel lever is operated on one side, the PPC shuttle valve is defective. (See H-5)

★ Before carrying out troubleshooting, check that all the related connectors are properly inserted.

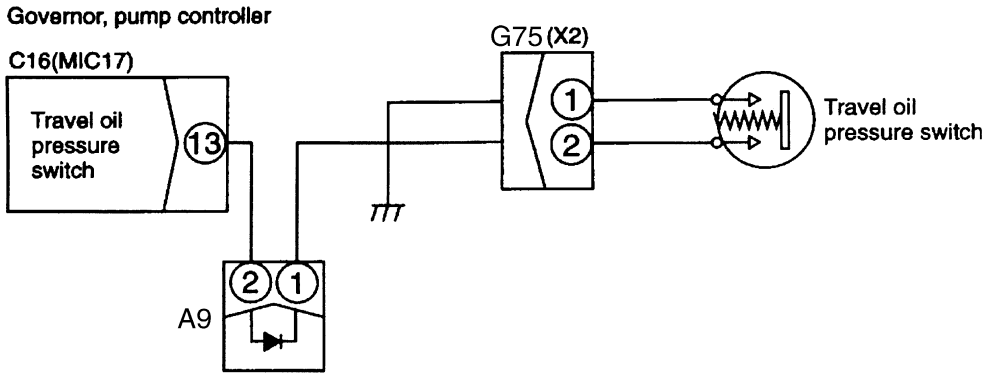
★ Always connect any disconnected connectors before going on the next step.



Cause	Remedy
Defective governor, pump controller	Replace
Defective contact, or disconnection in wiring harness between S15 (female) (1) and chassis ground	Repair or replace
Defective contact, short circuit with ground, or disconnection in wiring harness between C16 (female) (13) S15 (female) (2) and A9 (1) (2)	Repair or replace
	Replace

Note 1: It is also possible to fit a short connector and judge the condition. In this case, check the voltage between C16 (13) and the chassis.
- If it is 20 - 30 V: Go to YES
- If it is less than 1 V: Go to NO

F-2 Related electric circuit diagram



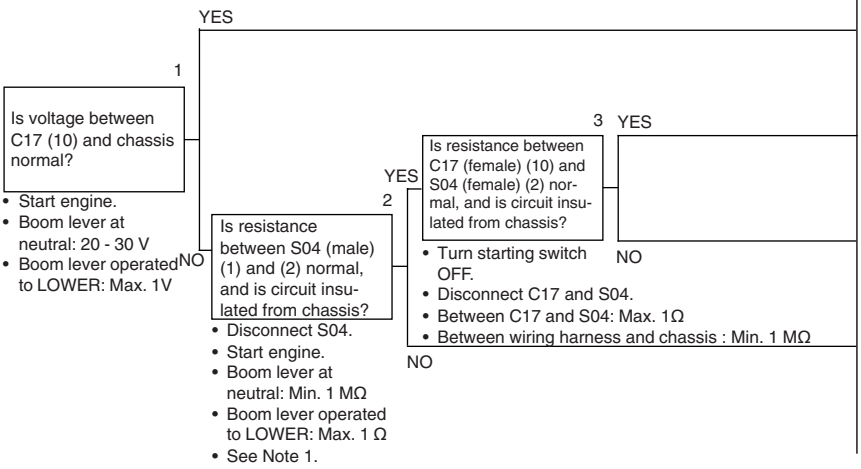
F-3 Bit pattern 20-(3) Boom LOWER oil pressure switch does not light up

★ **This troubleshooting is carried out when there is still an abnormality, so when disconnecting the connector and inserting the T-adpate, or when removing the T-adapter and returning the connector to its original position, if the monitor code display returns to normal, the problem has been removed.**

⚠ When measuring with the engine running, operate the lever slightly and make sure that the work equipment does not move.

★ Before carrying out troubelshooting, check that all the related connectors are properly inserted.

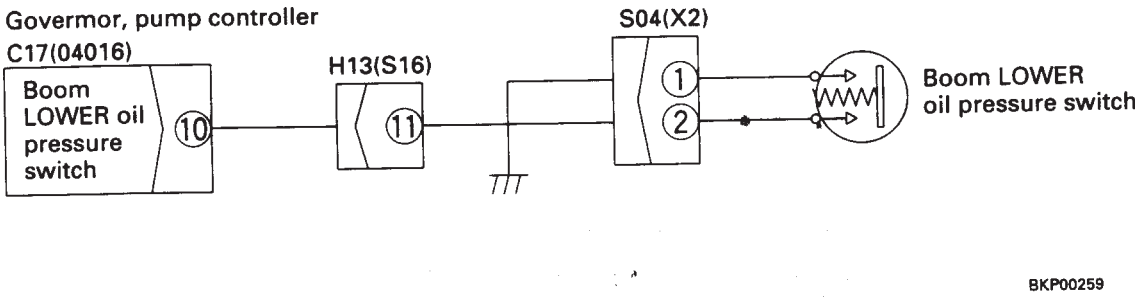
★ Always connect any disconnected connectors before going on the next step.
(When measuring with the engine stopped, charge the accumulator first.)



Cause	Remedy
Defective governor, pump controller	Replace
Defective contact, or disconnection in wiring harness between S04 (female) (1) and chassis ground	Repair or replace
Defective contact, short circuit with ground, or disconnection in wiring harness between C17 (female) (10) - H13 (11) - S04 (female) (2)	Repair or replace
Defective boom LOWER oil pressure switch (if the conditiion does not return to normal even when the switch is replaced, go to H-5.)	Replace

Note 1: It is also possible to fit a short connector and judge the condition. In this case, check the voltage between C17 (10) and the chassis.
- If it is 20 - 30 V: Go to YES
- If it is less than 1 V: Go to NO

F-3 Related electric circuit diagram



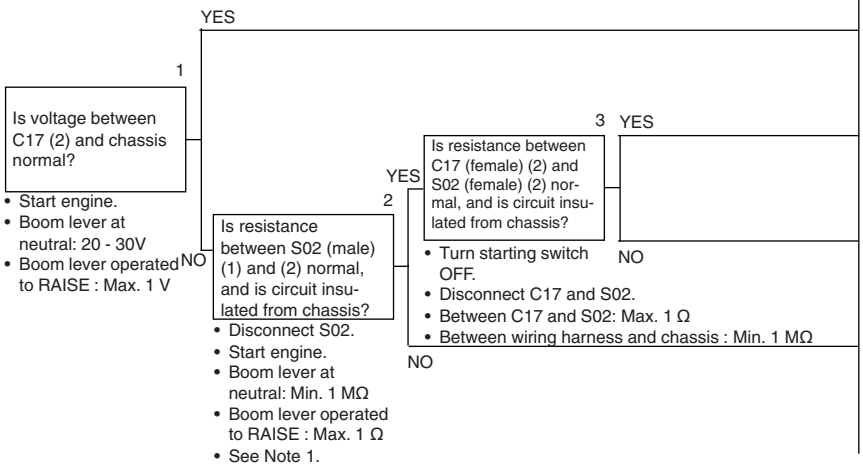
F-4 Bit pattern 20-(4) Boom RAISE oil pressure switch does not light up

★ **This troubleshooting is carried out when there is still an abnormality, so when disconnecting the connector and inserting the T-adapter, or when removing the T-adapter and returning the connector to its original position, if the monitor code display returns to normal, the problem has been removed.**

⚠ When measuring with the engine running, operate the lever slightly and make sure that the work equipment does not move.

★ Before carrying out troubleshooting, check that all the related connectors are properly inserted.

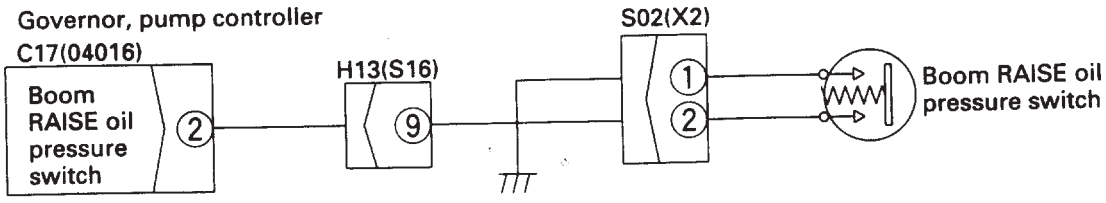
★ Always connect any disconnected connectors before going on the next step.
(When measuring with the engine stopped, charge the accumulator first.)



Cause	Remedy
Defective governor, pump controller	Replace
Defective contact, or disconnection in wiring harness between S02 (female) (1) and chassis ground	Repair or replace
Defective contact, short circuit with ground, or disconnection in wiring harness between C17 (female) (2) - H13 (9) - S02 (female) (2)	Repair or replace
Defective boom RAISE oil pressure switch	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 electric circuit diagram



BKP00260

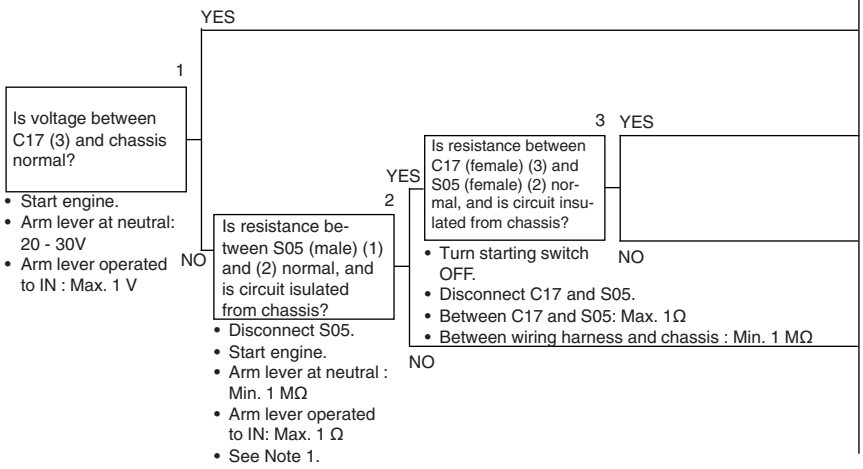
F-5 Bit pattern 20-(5) Arm IN oil pressure switch does not light up

★ **This troubleshooting is carried out when there is still an abnormality, so when disconnecting the connector and inserting the T-adapter, or when removing the T-adapter and returning the connector to its original position, if the monitor code display returns to normal, the problem has been removed.**

⚠ When measuring with the engine running, operate the lever slightly and make sure that the work equipment does not move.

★ Before carrying out troubleshooting, check that all the related connectors are properly inserted.

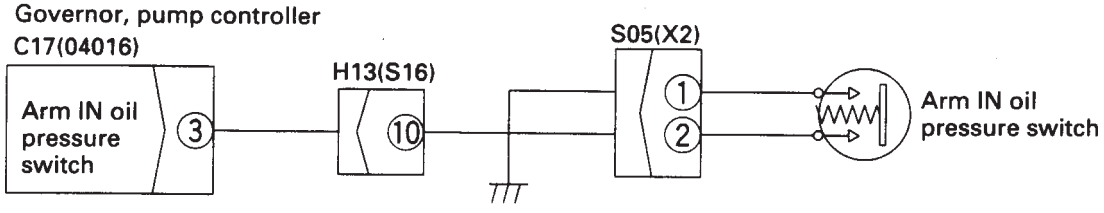
★ Always connect any disconnected connectors before going on the next step.
(When measuring with the engine stopped, charge the accumulator first.)



Cause	Remedy
Defective governor, pump controller	Replace
Defective contact, or disconnection in wiring harness between S05 (female) (1) and chassis ground	Repair or replace
Defective contact, short circuit with ground, or disconnection in wiring harness between C17 (female) (3) - H13 (10) - S05 (female) (2)	Repair or replace
Defective arm IN oil pressure switch	Replace

Note 1: It is also possible to fit a short connecotr 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 electric circuit diagram



BKP00261

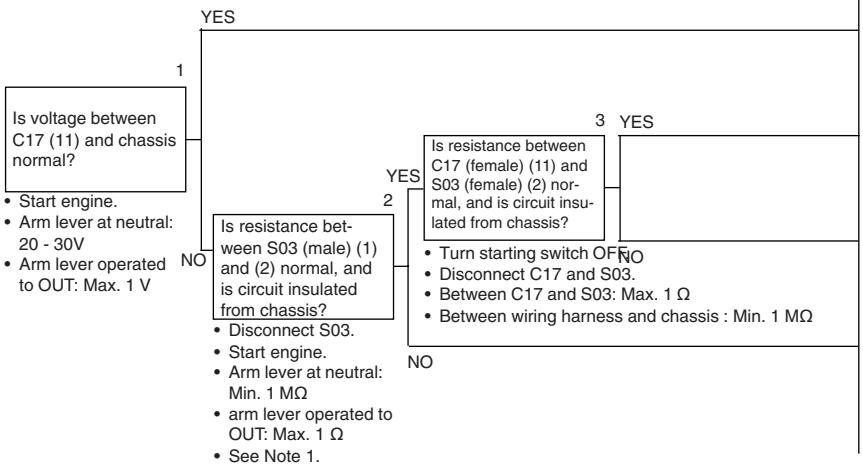
F-6 Bit pattern 20-(6) Arm Out oil pressure switch does not light up

★ **This troubleshooting is carried out when there is still an abnormality, so when disconnecting the connector and inserting the T-adapter, or when removing the T-adapter and returning the connector to its original position, if the monitor code display returns to normal, the problem has been removed.**

⚠ When measuring with the engine running, operate the lever slightly and make sure that the work equipment does not move.

★ Before carrying out troubleshooting, check that all the related connectors are properly inserted.

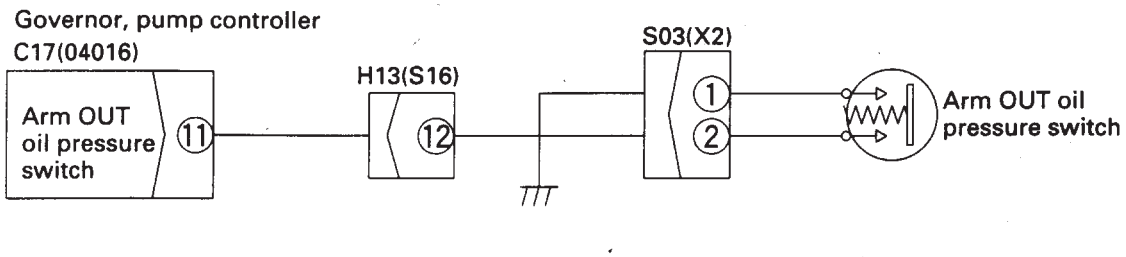
★ Always connect any disconnected connectors before going on the next step.
(When measuring with the engine stopped, charge the accumulator first.)



Cause	Remedy
Defective governor, pump controller	Replace
Defective contact, or disconnection in wiring harness between S03 (female) (1) and chassis ground	Repair or replace
Defective contact, short circuit with ground. or disconnection in wiring harness between C17 (female) (11) - H13 (12) - S03 (female) (2)	Repair or replace
Defective arm OUT oil pressure switch	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 electric circuit diagram



BKP00262

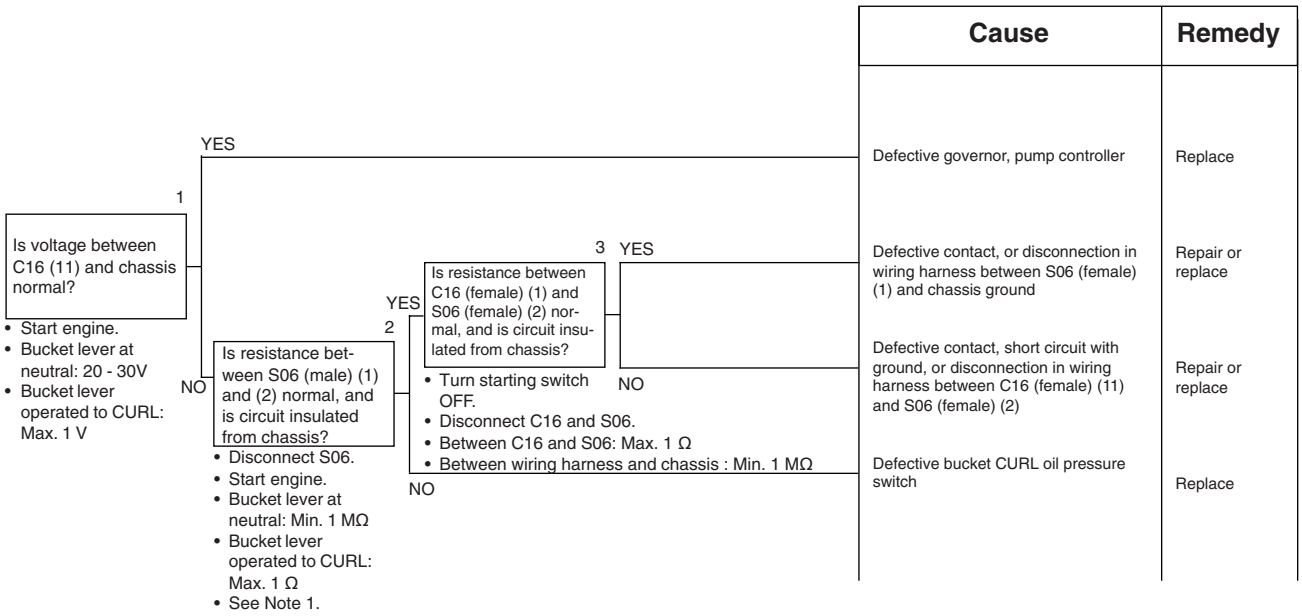
F-7 Bit pattern 21-(1) Bucket CURL oil pressure switch does not light up

★ **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 monitor code display returns to normal, the problem has been removed.**

When measuring with the engine running, operate the lever slightly and make sure that the work equipment does not move.

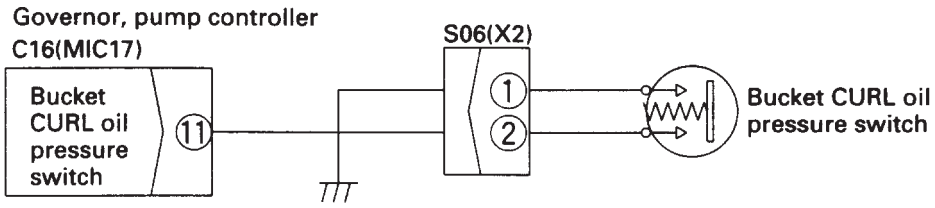
★ Before carrying out troubleshooting, check that all the related connectors are properly inserted.

★ Always connect any disconnected connectors before going on the next step.
(When measuring with the engine stopped, charge the accumulator first.)



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 electric circuit diagram



BKP00263

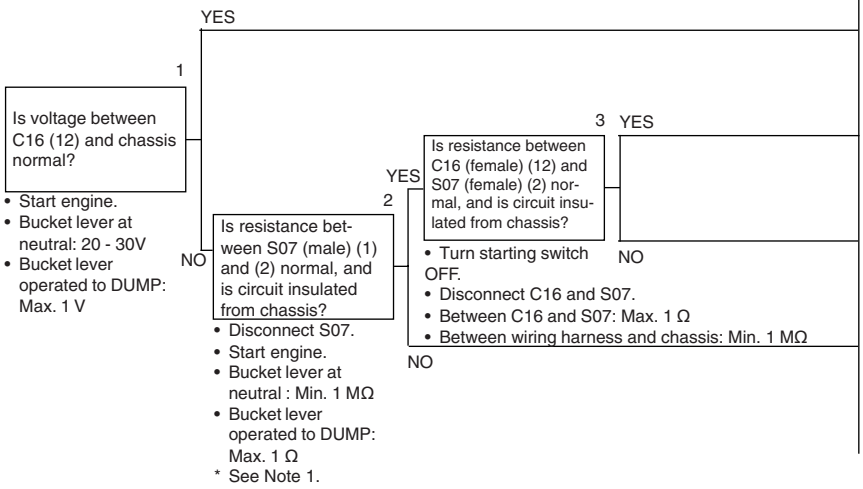
F-8 Bit pattern 21-(2) Bucket DUMP oil pressure switch does not light up

★ **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 monitor code display returns to normal, the problem has been removed.**

When measuring with the engine running, operate the lever slightly and make sure that the work equipment does not move.

★ Before carrying out troubleshooting, check that all the related connectors are properly inserted.

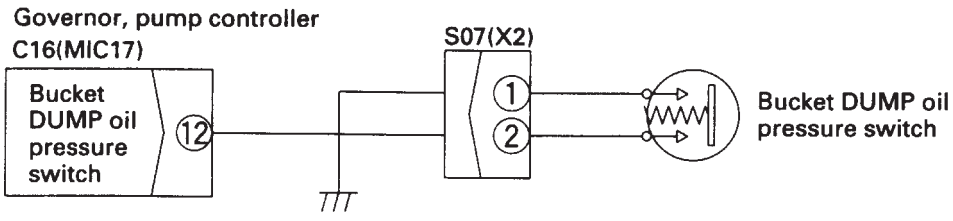
★ Always connect any disconnected connectors before going on the next step.
(When measuring with the engine stopped, charge the accumulator first.)



Cause	Remedy
Defective governor, pump controller	Replace
Defective contact or disconnection in wiring harness between S07 (female) (2) and chassis ground	Repair or replace
Defective contact, short circuit with ground, or disconnection in wiring harness between C16 (female) (12) and S07 (female) (2)	Repair or replace
Defective bucket DUMP oil pressure switch	Replace

Note 1: It is also possible to fit a short connector and judge the condition. In this case, check the voltage between C16 (12) and the chassis.
- If it is 20 - 30V: Go to YES
- If it is less than 1V: Go to NO

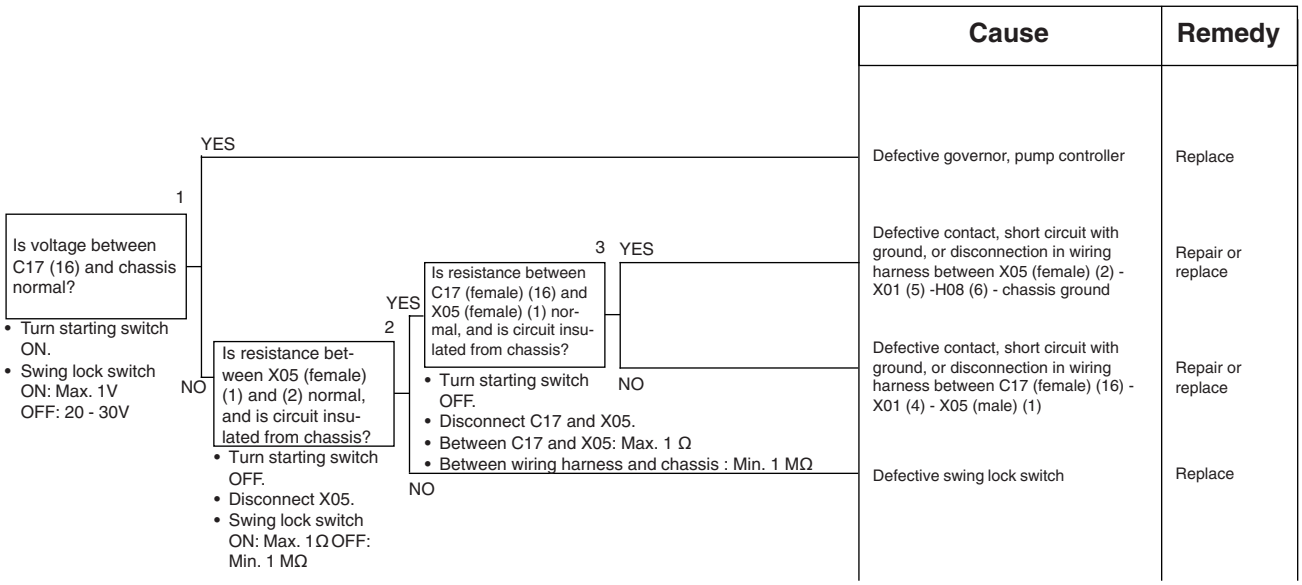
F-8 Related electric circuit digram



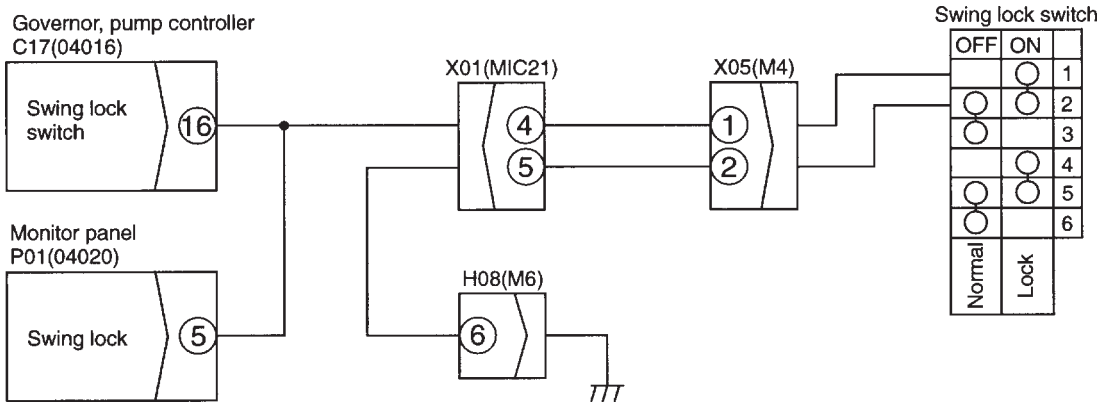
BKP00264

F-9 Bit pattern 21-(3) Swing lock switch does not light up

★ **This troubleshooting is carried out when there is still an abnormality, so when disconnecting the connector and inserting the T-adapter, or when removing the T-adapter and returning the connector to its original position, if the monitor code display returns to normal, the problem has been removed.**
★ If the panel display is normal. (If the 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.

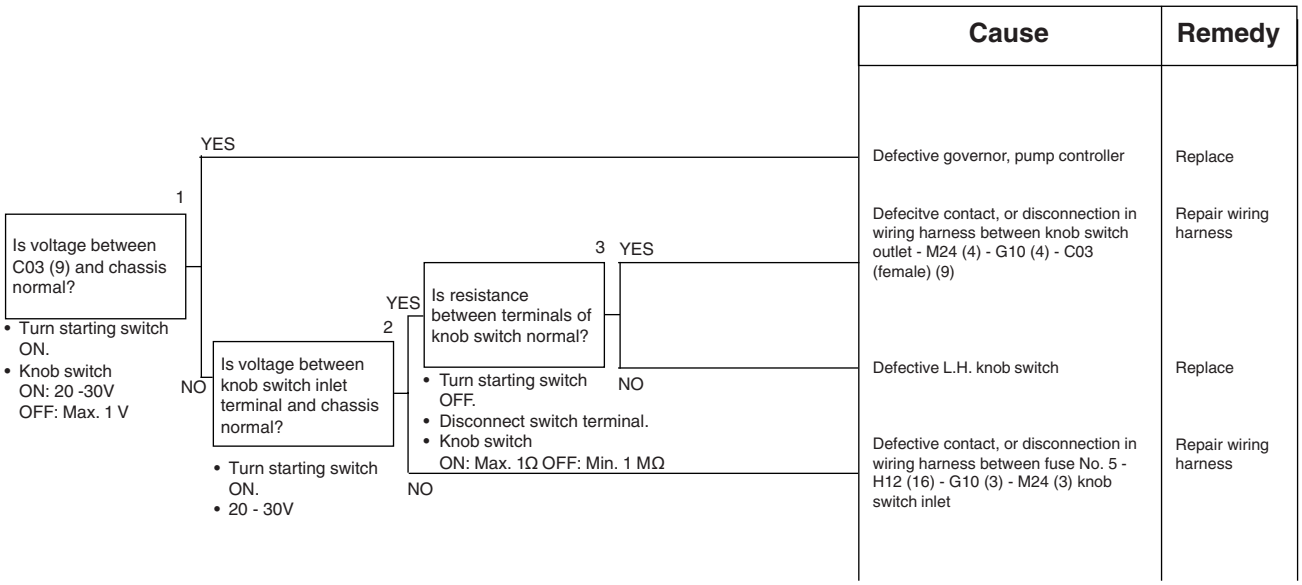


F-9 Related electric circuit diagram

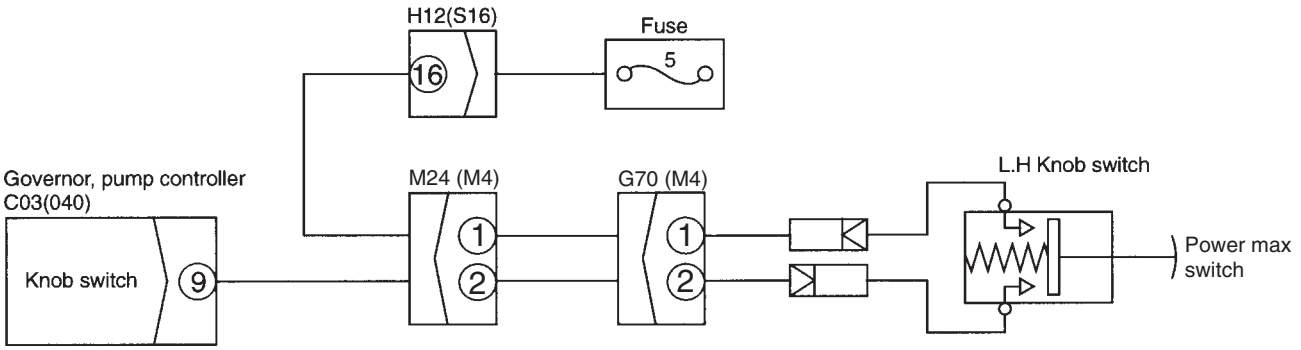


F-11 Bit pattern 22-(6) L.H. knob switch does not light up

★ **This troubleshooting is carried out when there is still an abnormality, so when disconnecting the connector and inserting the T-adapter, or when removing the T-adapter and returning the connector to its original position, if the monitor code display returns to normal, the problem has been removed.**
★ When fuse No. 5 is not blown.
★ Before carrying out troubleshooting, check that all the related connectors are properly inserted.
★ Always connect any disconnected connectors before going on the next step.



F-11 Related electric circuit diagram



TROUBLESHOOTING OF HYDRAULIC, MECHANICAL SYSTEM (H MODE)

Tabel of failure modes and causes.. 20-198
All work equipment, travel, swing
H- 1 Speeds of all work equipment, swing, travel are slow or lack power.. 20-202
H- 2 There is excessive drop in engine speed, or engine stalls.. 20-204
H- 3 No work equipment, travel, swing move.. 20-205
H- 4 Abnormal noise generated (around pump).. 20-205
H- 5 Auto-deceleration does not work.. 20-206
H- 6 Fine control ability is poor or response is poor.. 20-206
Work equipment
H- 7 Boom is slow or lacks power.. 20-208
H- 8 Arm is slow or lacks power.. 20-210
H- 9 Bucket is slow or lacks power.. 20-212
H- 10 Work equipment (boom, arm, bucket) does not move.. 20-213
H- 11 Excessive hydraulic drift (boom, arm bucket).. 20-213
H- 12 Excessive time lag (engine at low idling).. 20-214
H- 13 Other equipment moves when single circuit is relieved.. 20-214
H- 14 In F/O modes, work equipment speed is faster than set speed.. 20-215
H- 15 Lack of power when pressure rises.. 20-215
Compound operations
H- 16 In compound operations, work equipment with larger load is slow.. 20-215
H- 17 In swing + boom RAISE, boom RAISE is slow.. 20-216
Travel system
H- 21 Travel speed is slow.. 20-218
H- 23 Travel speed does not switch or is faster than set speed.. 20-220
Swing system
H- 25 Does not swing (both left and right, one direction only).. 20-221
H- 26 Swing acceleration is poor or swing speed is slow (both left and right, one direction only).. 20-222
H- 27 Excessive overrun when stopping swing (both left and right, one direction only).. 20-224
H- 28 Excessive shock when stopping swing (one direction only).. 20-225
H- 29 Excessive abnormal noise when stopping swing.. 20-225
H- 30 Excessive hydraulic drift of swing (when brake is ON, when brake is OFF).. 20-226
H- 31 Swing speed is faster than specified speed.. 20-227

TABLE OF FAILURE MODES AND CAUSES (1/2)

Failure mode \ Parts causing failure			Piston pump							Control valve
			TVC valve	LS valve	Servo piston	Pump proper		Strainer	Damper	Spool
All work equipment, travel, swing	Speeds of all work equipment, swing, travel are slow or lack power		○	○		○				
	There is excessive drop in engine speed, or engine stalls		○		○					
	No work equipment, travel, swing move					○			○	
	Abnormal noise generated (around pump)					○		○		
	Auto-deceleration does not work									
	Fine control ability is poor or response is poor			○	○	○				
Work equipment	Boom is slow or lacks power									○
	Arm is slow or lacks power									○
	Bucket is slow or lacks power									○
	Boom does not move									○
	Arm does not move									○
	Bucket does not move									○
	Excessive hydraulic drift									
	Escessive time lag (engine at low idling)									
	Other equipment moves when single circuit is relieved									
	In F/O modes, work equipment speed is faster than specified speed			○						
	Lack of power when pressure rises									
Compound operations	In compound operations, work equipment with larger load is slow									
	In swing + boom (RAISE), boom 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 pour or swing speed is slow	Both left and right								
		One direction only								○
	Excessive overrun when stopping swing	Both left and right								
		One direction only								○
	Excessive shock when stopping swing(one direction only)									
	Excessive abnormal noise when stopping swing									
	Exessive hydraulic drift of swing	When brake ON								
		When brake OFF								○
	Swing speed is faster than specified swing speed			○						

★ In the failure modes, modes for compound operations are used when inde

Control valve																			
									Regeneration valve										
Main relief valve	Unload valve	Pressure compensation valve	LS circuit check valve	LS shuttle valve	LS select valve	LS circuit throttle		Boom	Arm	Safety-suction valve	Suction valve	PPC valve			Swing PPC slow return valve	Swivel joint	Engine system	Troubleshooting code
○	○																	H-1
																	○	H-2
																		H-3
																		H-4
																		H-5
						○												H-6
		○		○				○			○	○						H-7
		○		○					○	○		○						H-8
		○								○		○						H-9
												○						H-10
												○						
												○						
		○								○								H-11
		○						○	○	○								H-12
		○																H-13
																		H-14
○																		H-15
																		H-16
					○													H-17
		○		○							○	○						H-21
											○							H-23
																		H-25
												○						
				○														H-26
		○								○		○						
																		H-27
												○			○			
												○			○			H-28
																		H-29
																		H-30
		○																
																		H-31

TABLE OF FAILURE MODES AND CAUSES (2/2)

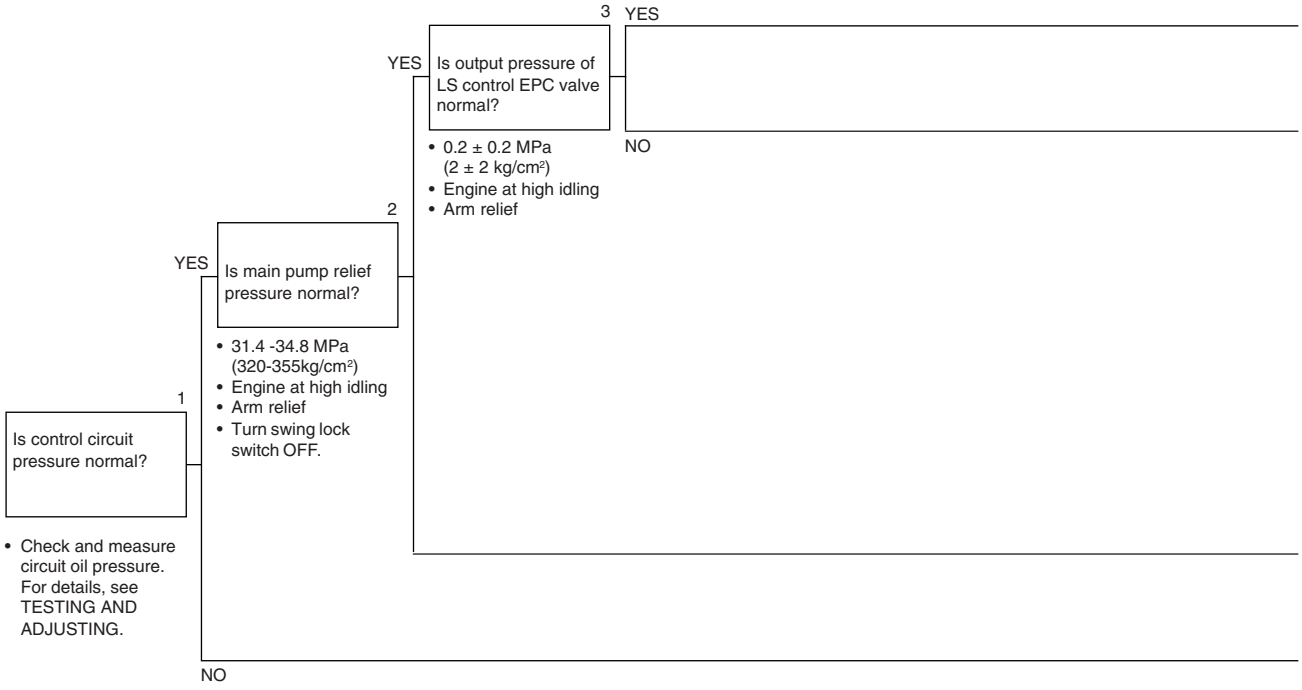
Failure mode \ Parts causing failure			Solenoid valve				Swing motor	
			LS-EPC	2-stage relief	Swing holding brake	Travel speed selector	Safety-suction valve	Leakage, breakage inside body
All work equipment, travel, swing	Speeds of all work equipment, swing, travel are slow or lack power		○	○				
	There is excessive drop in engine speed, or engine stalls							
	No work equipment, travel, swing move							
	Abnormal noise generated (around pump)							
	Auto-deceleration does not work							
	Fine control ability is poor or response is poor							
Work equipment	Boom is slow or lacks power							
	Arm is slow or lacks power							
	Bucket is slow or lacks power							
	Boom does not move							
	Arm does not move							
	Bucket does not move							
	Excessive hydraulic drift							
	Escessive time lag (engine at low idling)		○					
	Other equipment moves when single circuit is relieved							
	In F/O modes, work equipment speed is faster than specified speed		○					
	Lack of power when pressure rises				○			
Compound operations	In compound operations, work equipment with larger load is slow							
	In swing + boom (RAISE), boom is slow							
	In swing + travel. Travel speed drops excessively							
	IIn work equipment boom raise + travel, travel speed drops excessively							
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 slow	Both left and right						○
		One direction only					○	
	Excessive overrun when stopping swing	Both left and right						○
		One direction only					○	
	Excessive shock when stopping swing(one direction only)							
	Excessive abnormal noise when stopping swing						○	
	Exessive hydraulic drift of swing	When brake ON			○			
		When brake OFF					○	○
	Swing speed is faster than specified swing speed		○					

★ In the failure modes, modes for compound operations are used when independ

Travel motor												Pressure switch									Troubleshooting code
												Boom		Arm		Bucket					
Safety valve	Counterbalance valve	Check valve	Travel speed selector servo piston	Leakage, breakage inside body	Swing machinery	Final drive	Hydraulic cylinder	Boom lock valve	Back pressure valve (Lift check valve)		Holding brake (Swing machinery)	RAISE	LOWER	IN	OUT	CURL	DUMP	Swing LH & RH	Travel FWD + REVERSE	Pump pressure sensor	
																					H-1
																					H-2
																					H-3
																					H-4
												○	○	○	○	○	○	○	○		H-5
																					H-6
							○	○				○	○								H-7
							○							○	○						H-8
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																					H-31

H-1 Speeds of all work equipment, swing, travel are slow or lack power

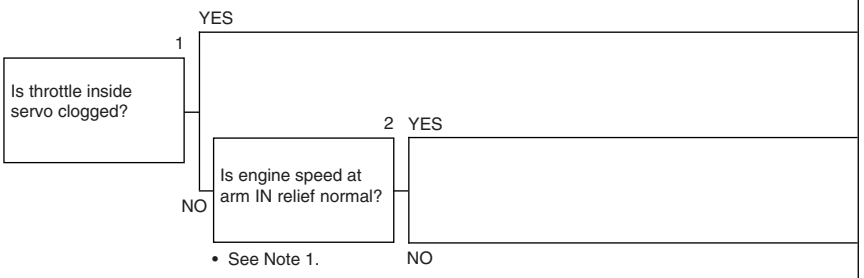
★ Carry out troubleshooting in the H/O mode.
★ Check that no abnormal noise is being generated from the main pump before carrying out troubleshooting. (If there is any abnormal noise, carry out troubleshooting for H-4.)



	Cause	Remedy
	Defective piston pump assy	Replace
	Defective operation os LS control EPC solenoid valve	Replace
	Defective operation of unload valve	Repair or 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 H/O mode.
★ Check that the main relief pressure is normal.



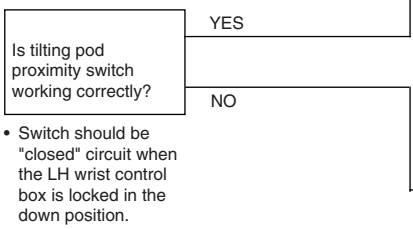
Cause	Remedy
Clogged throttle inside servo	Clean
Defective piston pump Assy	Replace
See troubleshooting for engine (S mode)	-

Note 1:

* Engine speed (reference) at arm IN relief when engine and pump are normal

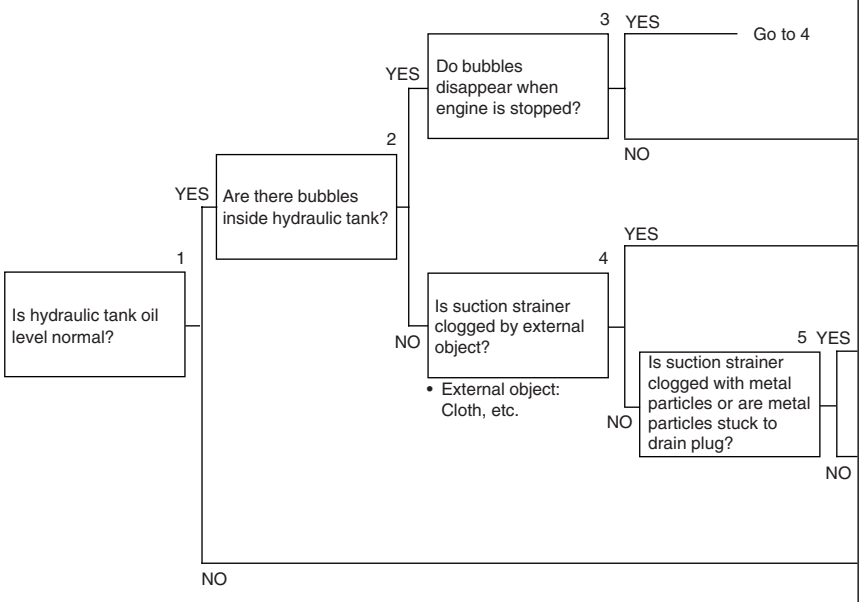
Engine speed at arm IN relief	Conditions
2.310 ± 70 rpm	• Engine at high idling • Power max.mode • Swing lock switch ON • Measure the speed at the point where the drop in engine speed is greatest when the arm cylinder is at the end of stroke and the lever is operated slowly to the full position.

H-3 No movement of work equipment, travel and swing systems



Cause	Remedy
Fault caussed by defect in the hydraulic circuit for the ppc delivery lines	
Check the correct operation of the following: (i) Brake valve ppc delivery port	Replace
(ii) Correct setting of ppc pressure reducing valve	Adjust
Proximity switch is malfuncrioning Check circuit	If circuit OK, then replace proximity switch

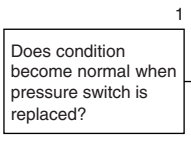
H-4 Abnormal noise generated (around pump)



Cause	Remedy
Improper hydraulic oil	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

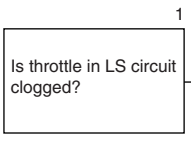
H-5 Auto-deceleration does not work (when PPC valve is cause)

★ The control pressure for the travel and swing passes through the PPC valve and is supplied to the pressure switch.



Cause	Remedy
Defective pressure switch	Replace
Defective operation of PPC shuttle valve in applicable system (swing or travel)	Repair or replace

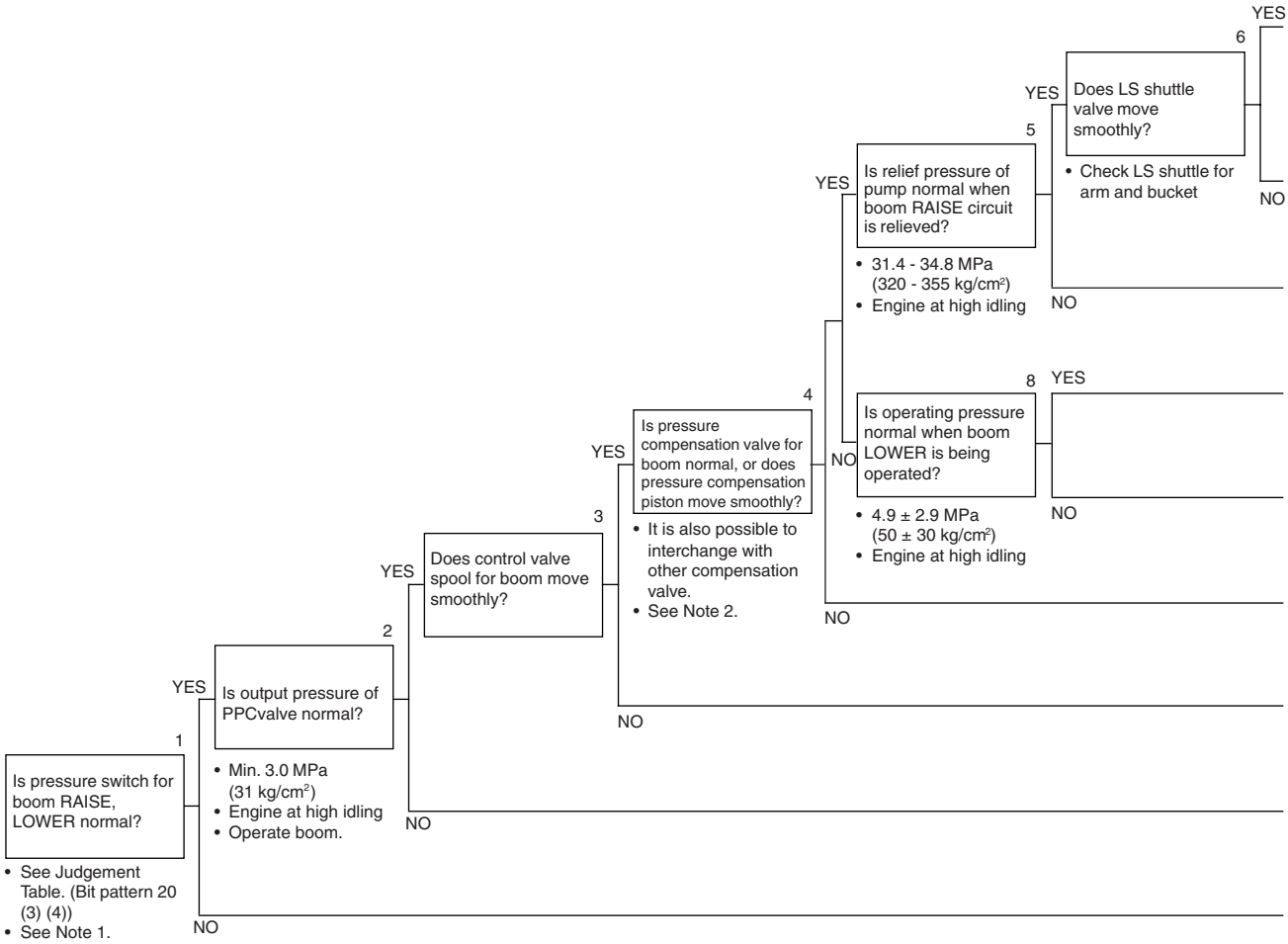
H-6 Fine control ability is poor or response is poor



Cause	Remedy
Clogged throttle in LS circuit	Clean
Defective servo valve assembly (LS valve), or defective servo piston	Replace

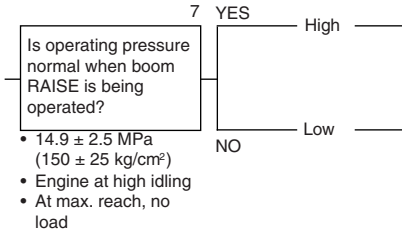
H-7 Boom is slow or lacks power

★ When travel and swing speeds are normal.
★ Carry out troubleshooting in the H/O mode.



Note 1: If auto-deceleration is canceled when boom RAISE or boom LOWER is operated, system is normal.

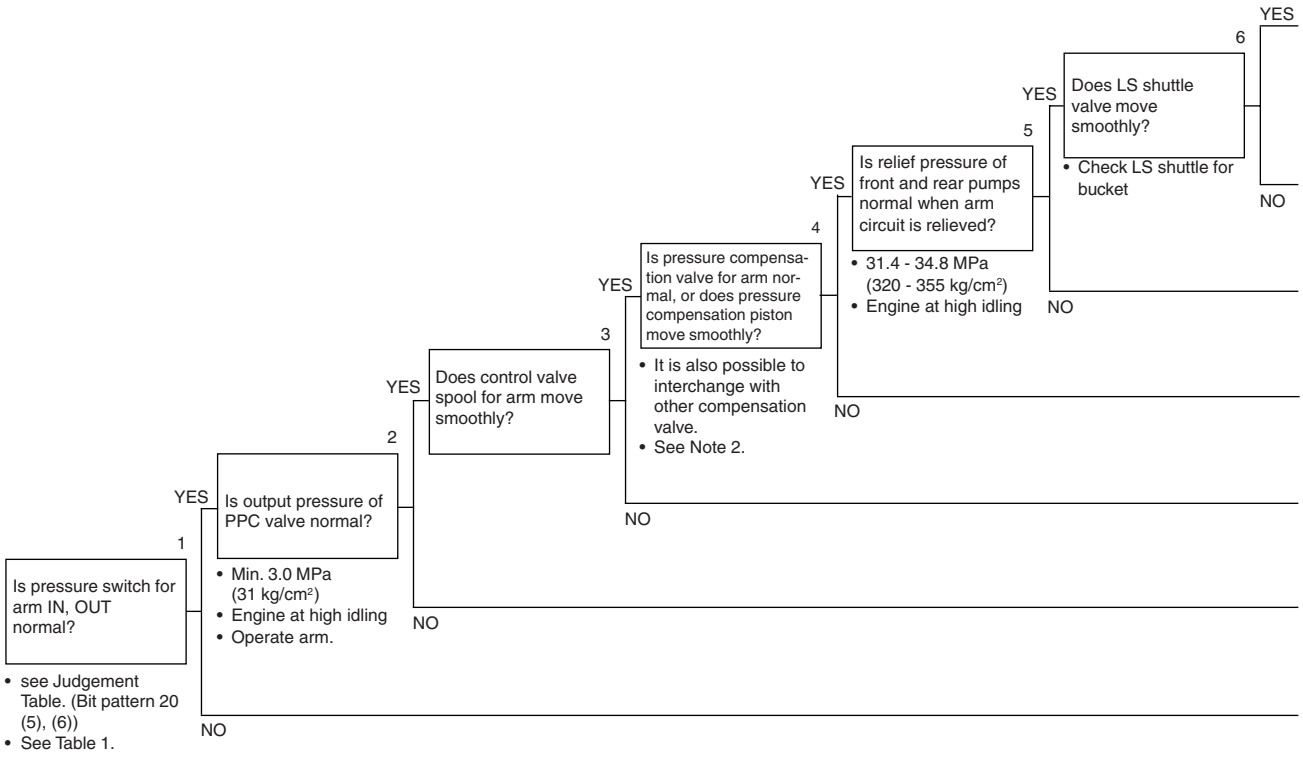
Note 2: After inspection, do not forget to return the interchanged valves to the original position.



Cause	Remedy
Defective operation of boom lock valve	Correct or replace
Defective boom cylinder piston packing	Correct or replace
Defective operation of LS shuttle valve (LS shuttle for arm or bucket)	Correct or replace
Defective boom lock valve or suction valve for boom in control valve	Replace
Defective operation of boom lock valve	Correct or replace
Defective operation of boom regeneration valve	Correct or replace
Defective operation of boom pressure compensation valve or pressure compensation piston (for boom RAISE end)	Correct or replace
Defective operation of control valve spool (for boom RAISE end)	Correct or replace
Defective PPC valve	Replace
Defective boom RAISE or boom LOWER pressure switch	Replace

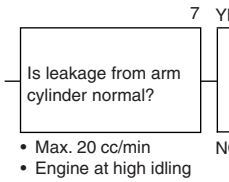
H-8 Arm is slow or lacks power

★ When travel and swing speeds are normal.
★ Carry out troubleshooting in the H/O mode.



Note 1: If the auto-decleration is canceled when arm IN or arm OUT is operated, the system is normal.

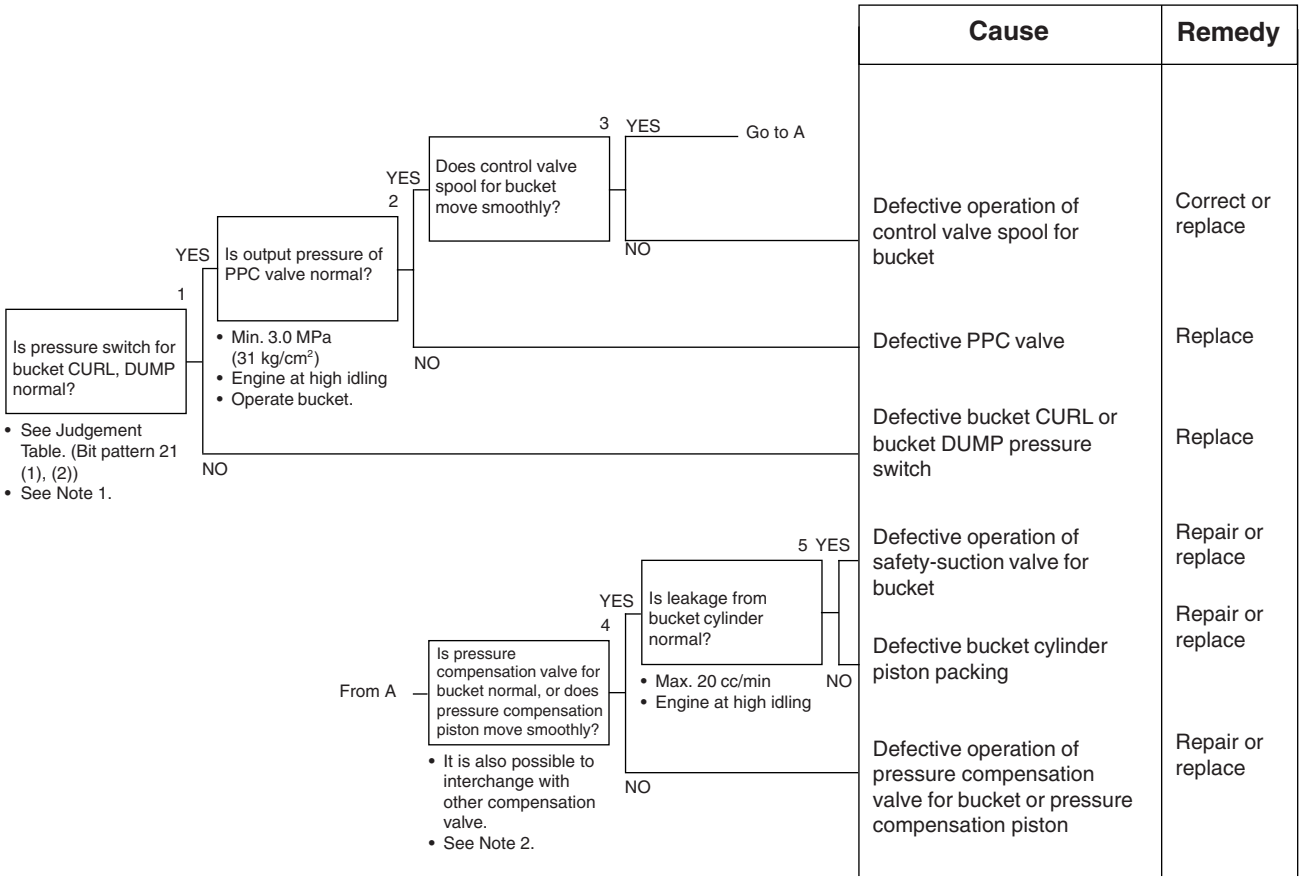
Note 2: After inspection, do not forget to return the interchanged valves to the original position.



Cause	Remedy
Defective operation of arm regeneration valve or arm counterbalance valve.	Correct or replace
Defective arm cylinder piston packing	Correct or replace
Defective operation of LS shuttle valve (LS shuttle for bucket)	Correct or replace
Defective safety-suction valve for arm	Replace
Defective operation of arm pressure compensation valve or pressure compensation piston	Corrrect 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.



Note 1: If the auto-deceleration is canceled when bucket CURL or bucket DUMP is operated, the system is normal.

Note 2: After inspection, do not forget to return the interchanged valves to the original position.

H-10 Work equipment (boom, arm, bucket) does not move (but travel and swing are normal)

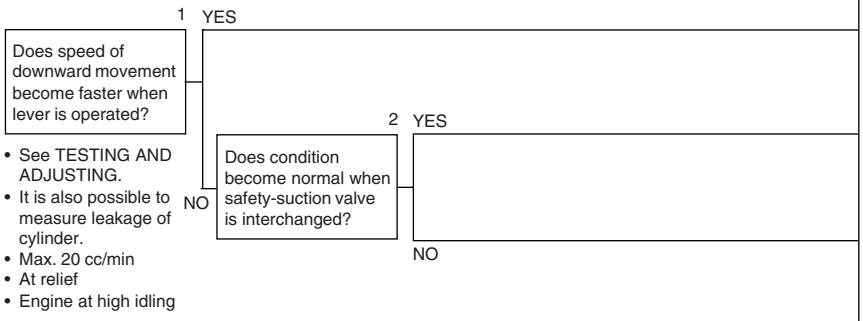
★ When boom, arm, and bucket are each operated independently.



Cause	Remedy
Defective control valve spool	Correct or replace
Defective PPC valve	Replace

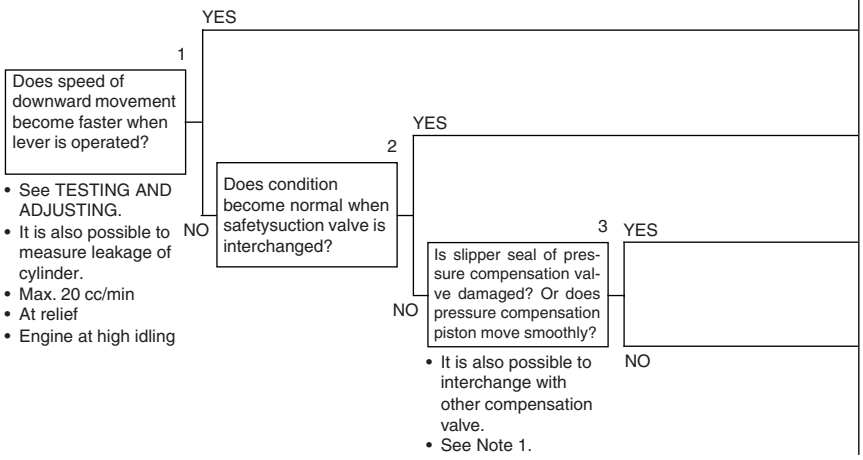
H-11 Excessive hydraulic drift (boom, arm, bucket)

1) Excessive hydraulic drift of boom



Cause	Remedy
Defective hydraulic cylinder piston packing	Replace
Defective operation of satety-suction valve	Replace
Defective operation of boom lock valve	Correct or replace

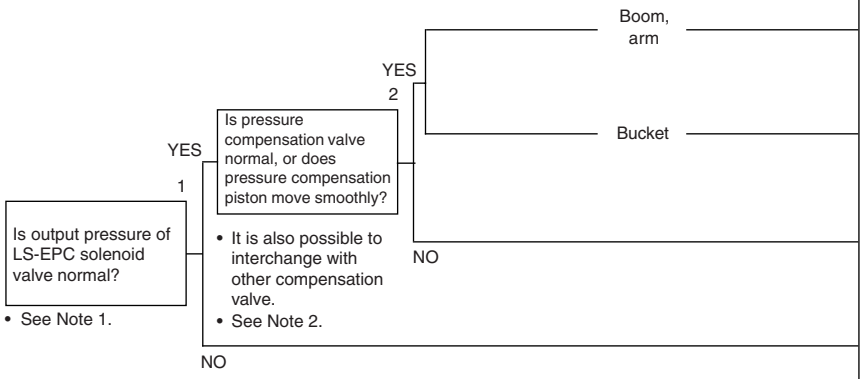
2) Excessive hydraulic drift of arm or bucket



Cause	Remedy
Defective hydraulic cylinder piston packing	Replace
Defective operation of safety-suction valve	Replace
Defective control valve spool	Replace
Damaged slipper seal of pressure compensation valve, or defective operation of pressure compensation piston	Correct or replace

Note 1: After inspection, do not forget to return the interchanged valves to the original position.

H-12 Excessive time lag (engine at low idling)

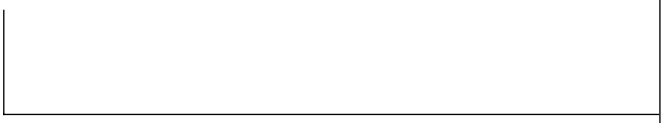


Cause	Remedy
Defective safety-suction valve, or defective regeneration valve	Replace
Defective safety-suction valve	Replace
Defective operation of pressure compensation valve or pressure compensation piston	Correct or replace
Defective operation of LS-EPC sloenoid valve	Correct or replace

Note 1: Output pressure of LS-EPC solenoid
- Approx 2.5 MPa (Approx 26 kg/cm^2) is output from the LS-EPC solenoid when the engine is at low idling (approx. 1100 rpm or below) regardless of the working mode.

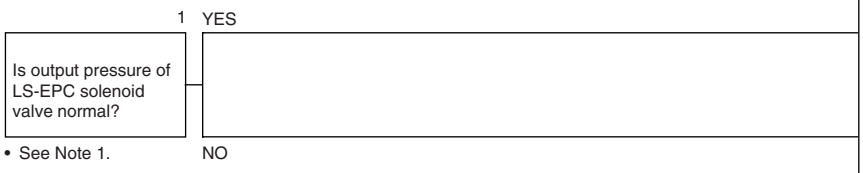
Note 2: After inspection, do not forget to return the interchanged valves to the original postition.

H-13 Other equipment moves when single circuit is relieved



Cause	Remedy
Defective operation of pressure compensation valve slipper seal (The slipper seal in the pressure compensation valve of the circuit that moved is defective.)	Replace

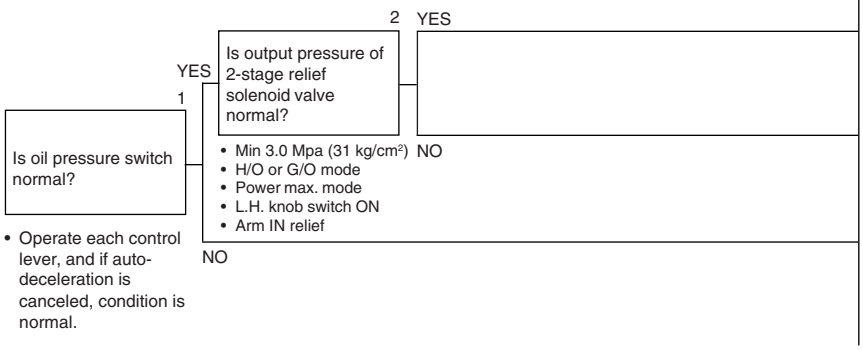
H-14 In F/O modes, work equipment speed is faster than specified speed



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 1.76 MPa (Approx 18 kg/cm^2) is output from the LS control EPC solenoid when the engine speed is approx. 1100 rmp or less and the pump delivery pressure is greater than 19.6 MPa (200 kg/cm^2) in F/O mode. (In F/O mode, the engine speed is set at 2100 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

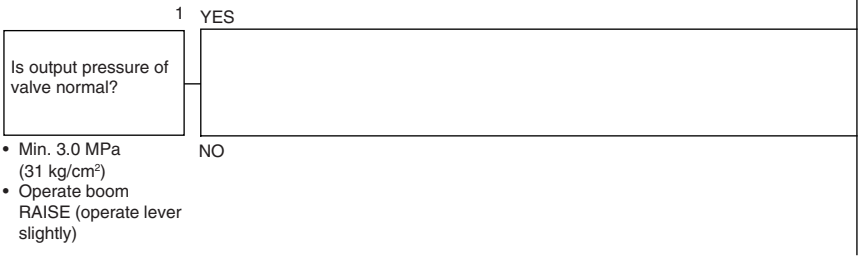
H-16 In compound operations, work equipment with larger load is slow

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 In swing + boom RAISE, boom RAISE is slow

★ If swing and boom RAISE work normally when operated independently.



Cause	Remedy
Defective operation of LS select valve	Correct or replace
Defective operation of PPC valve for LS select circuit	Correct or replace

H-21 TRAVEL SPEED IS ABNORMALLY SLOW

★ When work equipment speed is normal.
★ Check operating condition of oil pressure switch with monitoring code before carrying out troubleshooting.
★ Carry out troubleshooting in H/O mode.

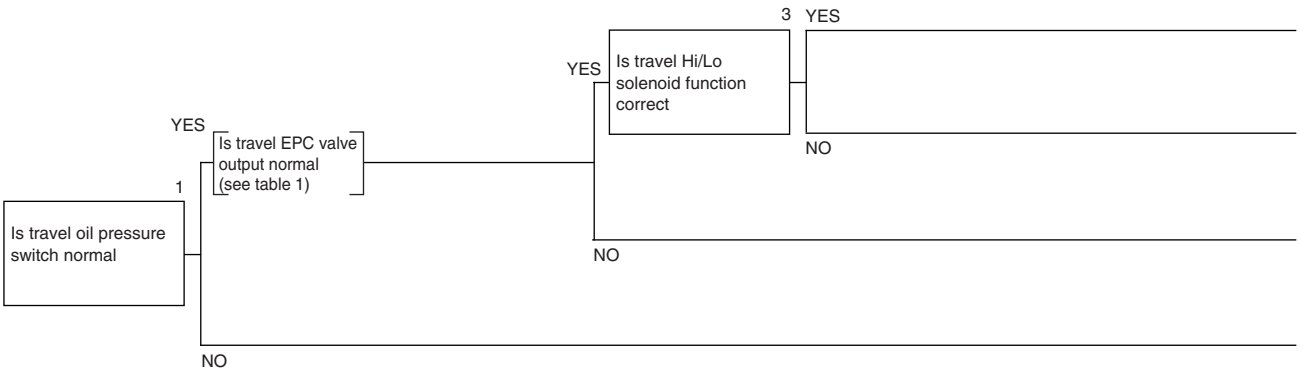


Table 1 Travel EPC valve current map (mA)

Travel speed		20				30			
Travel		OFF		ON		OFF		ON	
Service		OFF	ON	OFF	ON	OFF	ON	OFF	ON
Work mode	Travel speed								
Breaker	HI	400	1000	1000	1000	400	1000	1000	1000
	MI	400	1000	1000	1000	400	1000	1000	1000
	LO	400	1000	525	525	400	1000	525	525
Without breaker	HI	400	490	1000	1000	400	490	1000	1000
	MI	400	490	1000	1000	400	490	1000	1000
	LO	400	490	525	525	400	490	525	525

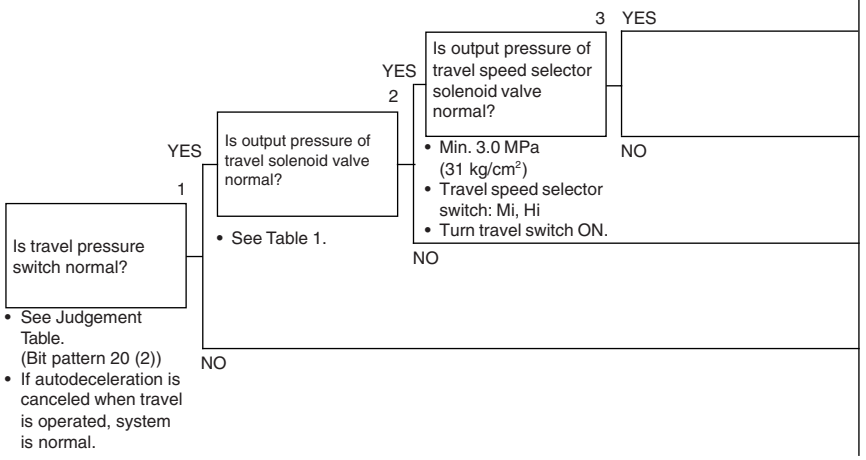
Note:

Travel EPC current	Travel EPC output pressure
1000 mA	2.94 MPa (30 kg/cm^2)
525 mA	1.94 MPa (19 kg/cm^2)
490 mA	1.63 MPa (16 kg/cm^2)
400 mA	0.87 MPa (8.5 kg/cm^2)

	Cause	Remedy
	Defective operation of travel motor displacement control circuit	Repair or replace
	Defective travel Hi/Lo solenoid	Replace
	Defective operation of travel EPC valve	Replace
	Defective oil pressure switch	Replace

H-23 Travel speed does not switch or is faster than specified speed

★ Carry out troubleshooting in the H/O mode.

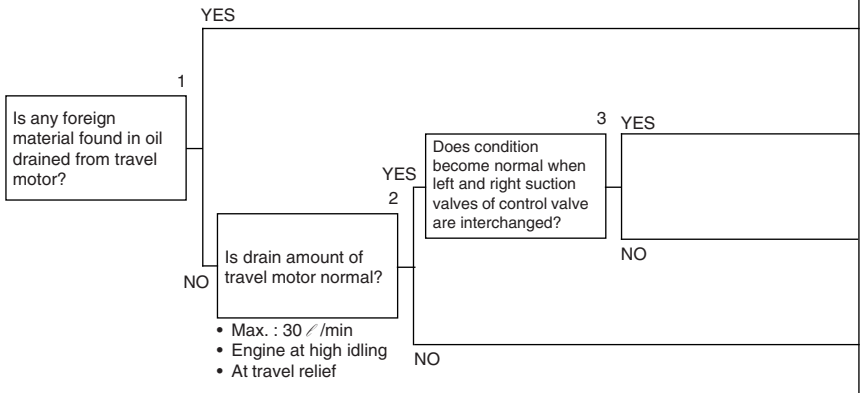


Cause	Remedy
Defective operation of travel speed selector servo piston in travel motor	Replace
Defective operation of travel speed selector solenoid valve	Correct or replace
Defective operation of travel solenoid valve	Correct or replace
Defective travel pressure switch	Replace

Table 1. Operation of travel EPC solenoid

Travel speed		20				30			
Travel		OFF		ON		OFF		ON	
Service		OFF	ON	OFF	ON	OFF	ON	OFF	ON
Work mode	Travel speed								
Breaker	HI	400	1000	1000	1000	400	1000	1000	1000
	MI	400	1000	1000	1000	400	1000	1000	1000
	LO	400	1000	525	525	400	1000	525	525
Without breaker	HI	400	490	1000	1000	400	490	1000	1000
	MI	400	490	1000	1000	400	490	1000	1000
	LO	400	490	525	525	400	490	525	525

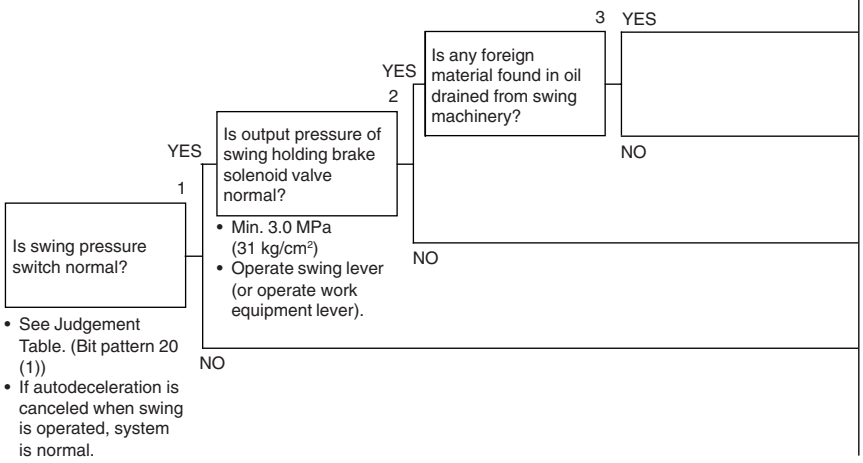
H-24 Travel does not move (one side only)



Cause	Remedy
Defective travel motor	Repair or replace
Defective operation of suction valve of control valve	Replace
Defective operation of counterbalance valve or travel motor safety valve	Replace
Defective travel motor	Replace

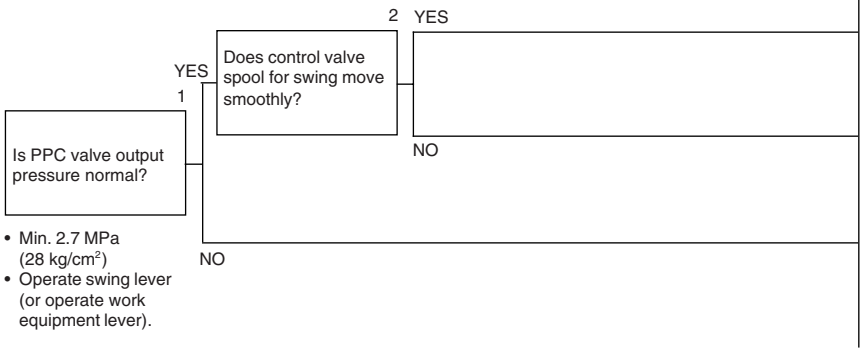
H-25 Does not swing

a) Does not swing to either left or right



Cause	Remedy
Defective swing machinery	Repair or replace
Defective swing holding brake or swing motor	Repair or replace
Defective operation of holding brake solenoid valve	Correct or replace
Defective swing pressure switch	Replace

b) Does not swing in one direction

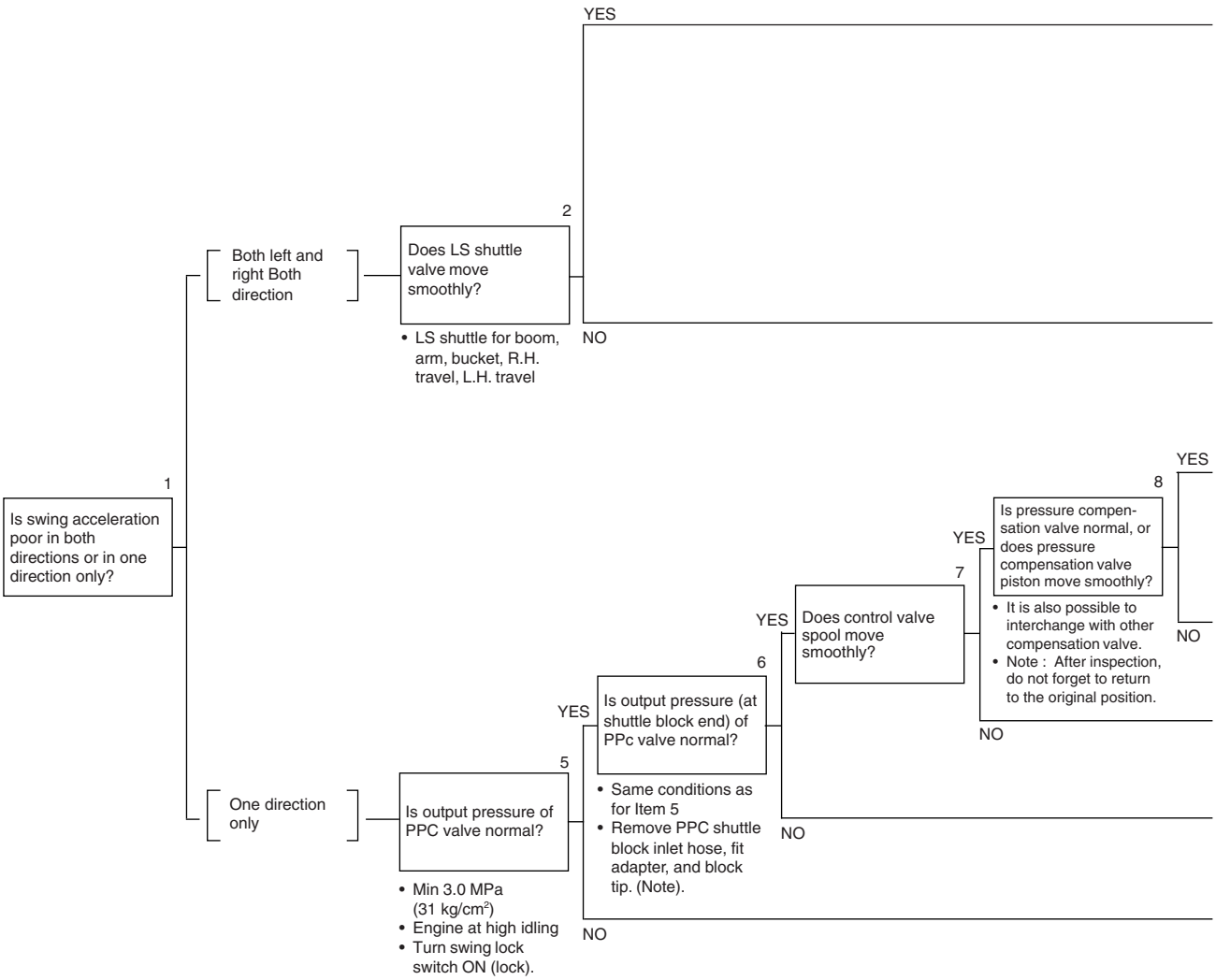


Cause	Remedy
Defective swing motor safety valve or suction valve	Replace
Defective operation of control valve spool for swing	Correct or replace
Defective PPC valve	Replace

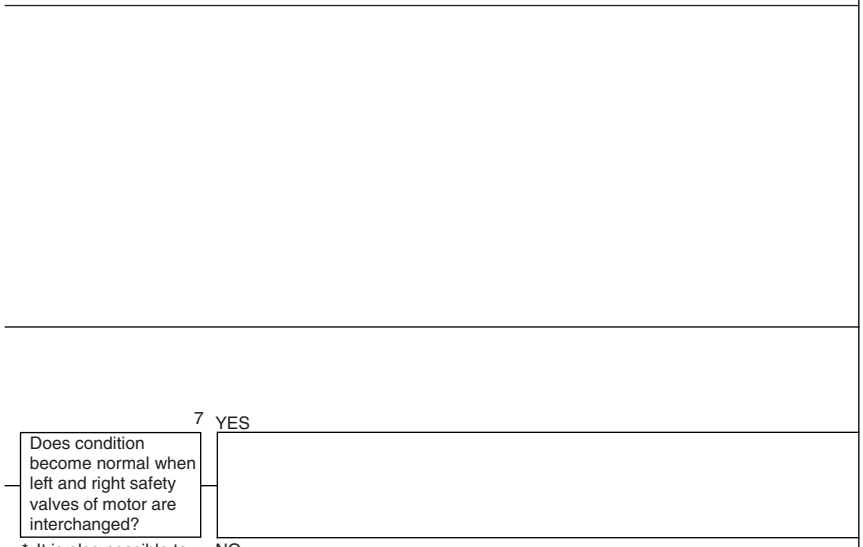
H-26 Swing acceleration is poor or swing speed is slow

★ Carry out troubleshooting in the H/O mode.
★ If condition is normal when work equipment is operated independently.

a) Swing acceleration is poor



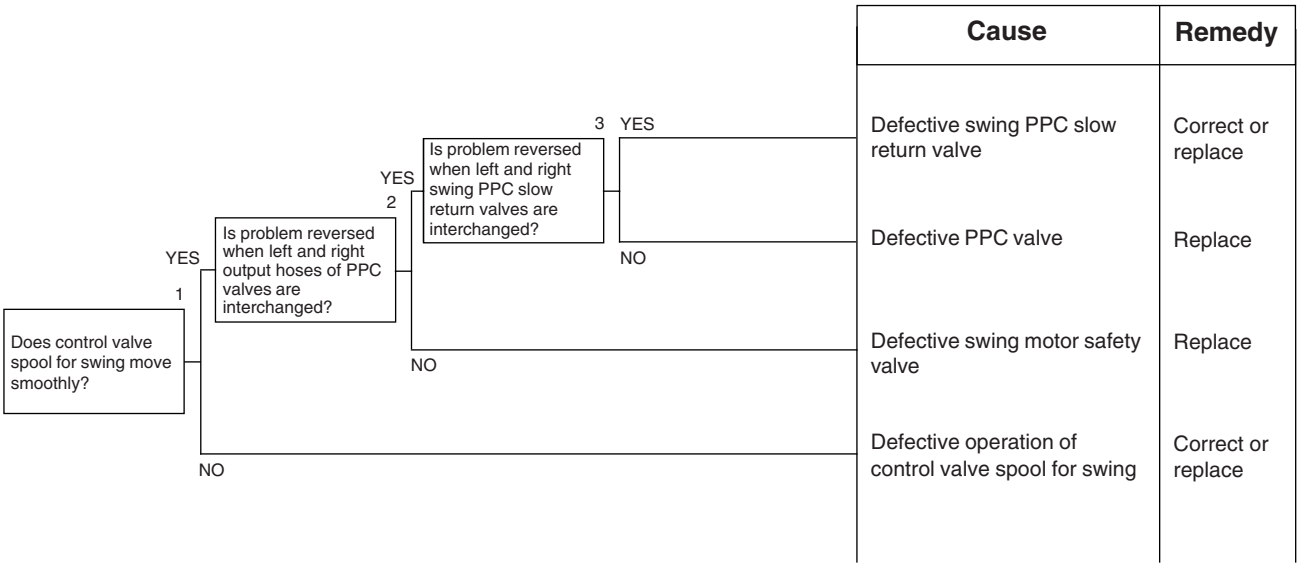
Note: If the adapter for blocking the circuit is not available, interchange PPC hose of swing with one of bucket (CURL, DUMP), boom (LOWER), or arm (IN).



Cause	Remedy
Defective swing motor assembly	Repair or replace
Defective operation of LS shuttle valve (all LS shuttles)	Repair or replace
Defective swing motor safety valve	Replace
Defective swing motor suction valve	Replace
Defective operation of pressure compensation valve or compensation valve piston	Repair or replace
Defective operation of control valve spool	Repair or replace
Defective operation of PPC shuttle valve (for swing)	Repair or replace
Defective PPC valve	Replace

H-27 Excessive overrun when stopping swing

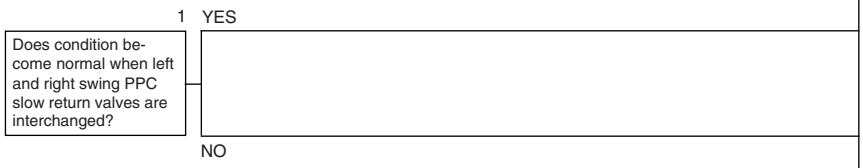
a) One direction only



b) Both directions

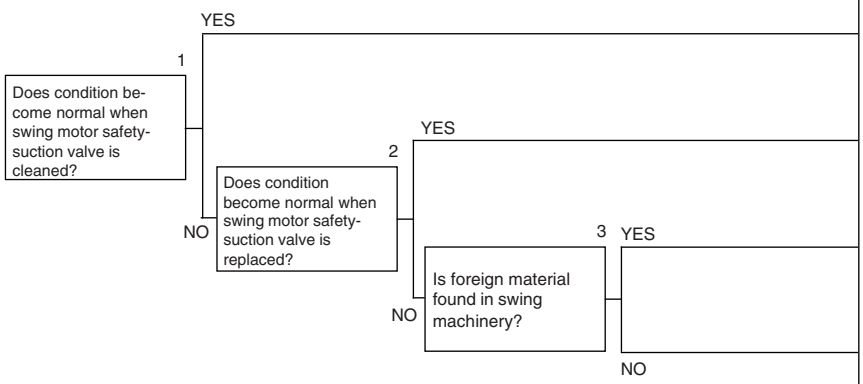
Cause	Remedy
Defective swing motor	Repair or replace

H-28 Excessive shock when stopping swing (one direction only)



Cause	Remedy
Defective swing PPC slow return valve (check valve)	Correct or replace
Defective PPC valve	Replace

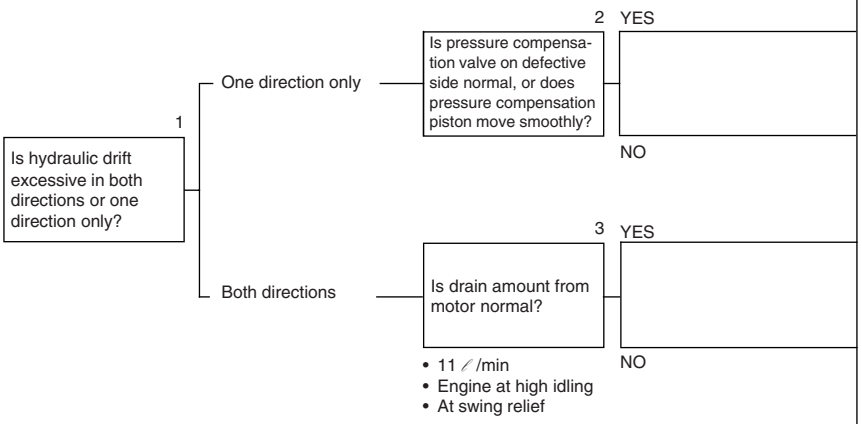
H-29 Excessive abnormal noise when stopping swing



Cause	Remedy
Defective operation of swing motor safety-suction valve	Clean
Defective swing motor safety-suction valve	Replace
Defective swing machinery	Repair or replace
Defective back pressure valve	Correct or replace

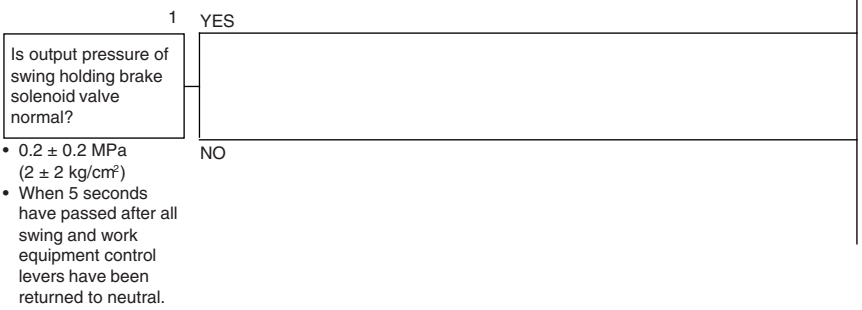
H-30 Excessive hydraulic drift of swing

a) When swing holding brake is released



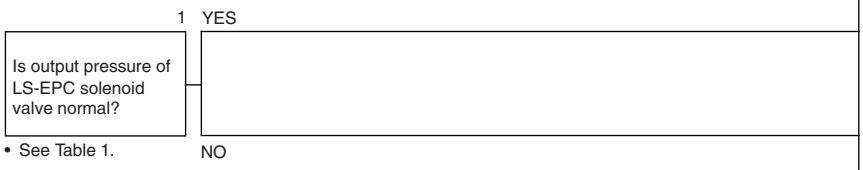
Cause	Remedy
Defective swing motor safety-suction valve	Correct or replace
Defective pressure compensation valve for swing, or defective operation of pressure compensation piston	Correct or replace
Defective control valve spool for swing	Replace
Defective swing motor	Repair or replace

b) When swing holding brake is applied



Cause	Remedy
Defective operation of swing holding brake	Repair or replace
Defective operation of swing holding brake solenoid valve	Correct or replace

H-31 Swing speed is faster than specified swing speed



Cause	Remedy
Defective operation of LS valve	Replace servo assembly
Defective LS-EPC solenoid	Correct or replace

Table 1. Output pressure of LS-EPC solenoid valve

unit: MPa (kg/cm^2)

H/O mode	G/O mode	F/O mode	L/O mode
0 (0)	0 (0)	1.2 ± 0.2 (12 ± 2.0)	0 (0)
• Engine at high idling • Travel OFF • Swing lock switch OFF			

TROUBLESHOOTING OF MACHINE MONITOR SYSTEM (M MODE)

Action taken by panel and condition of machine when abnormality occurs... 20-230
Electrical circuit diagram for monitor system 20-232
M- 1 [E101] Abnormality in error data is displayed [E102] Error in clock data is displayed 20-234
M- 2 [E103] Short circuit in buzzer output or contact of 24 V wiring harness with buzzer drive harness is displayed 20-235
M- 3 [E104] Air cleaner clogging detected is displayed 20-236
M- 4 [E106] Drop in engine oil pressure Hi detected is displayed 20-236
M- 5 [E108] Engine water temperature 105°C detected is displayed 20-237
M- 6 When starting switch is turned ON, none of lamps on monitor panel light up for three seconds 20-238
M- 7 When starting switch is turned ON, monitor panel lamps all stay lighted up and do not go out 20-240
M- 8 When starting switch is turned ON, items lighted up on monitor panel are different from actual machine (model) 20-240
M- 9 When starting switch is turned ON (engine stopped), basic check items flash 20-241
M- 10 Preheating is not being used but preheating monitor lights up 20-243
M- 11 When starting switch is turned ON and engine is started, basic check items flash 20-244
M- 12 When starting switch is turned ON (engine stopped), caution items, emergency stop items flash 20-246
M- 13 When starting switch is turned ON and engine is started, caution items, emergency stop items flash 20-248
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 20-251
M- 15 No abnormality is displayed on monitor but buzzer sounds... 20-251
M- 16 Night lighting on monitor panel does not light up (liquid crystal display is normal 20-252
M- 17 Coolant temperature gauge does not rise 20-253
M- 18 Coolant temperature gauge does not give any display 20-253
M- 19 Fuel level gauge always displays FULL 20-254
M- 20 Fuel level gauge does not give any display 20-254
M- 21 Swing lock switch is turned ON (LOCK) but swing lock monitor does not light up 20-255
M- 22 Swing prolix switch is turned ON (prolix), but swing lock monitor does not flash 20-255
M- 23 Service meter does not advance while engine is running 20-256
M- 24 When starting switch is at OFF and time switch is pressed, time and service meter are not displayed 20-256
M- 25 Defective fuel level sensor system 20-257
M- 26 Defective coolant temperature sensor system 20-258
M- 27 Defective engine oil level sensor system 20-259
M- 28 Defective coolant level sensor system 20-260
M- 30 Wiper does not work or switch is not being used but wiper is actuated 20-261

ACTION TAKEN BY MONITOR PANEL WHEN ABNORMALITY OCCURS AND PROBLEMS ON MACHINE

User code	Service code	Abnormal system	Nature of abnormality
-	E101	Abnormality in error data	1. Abnormality in internal memory 2. Excess voltage (more than 36V) has occurred 3. Low voltage (less than 12V) has occurred 4. Connector has separated
-	E102	Abnormality in clock data	1. Abnormality in internal clock function 2. Excess voltage (more than 36V) has occurred 3. Low voltage (less than 12V) has occurred 4. Connector has separated
-	E103	Short circuit in buzzer output system	1. Short circuit inside buzzer 2. Power line in contact with wiring harness between monitor (P01 (7) pin) and buzzer 3. Abnormality in monitor panel
-	E104	Air cleaner clogging detected is displayed	1. Air cleaner clogging sensor has detected clogging
-	E106	Drop in engine oil Hi pressure detected is displayed	1. Engine oil pressure Hi sensor has detected drop in oil pressure
-	E108	Engine water temperature 105°C detected is displayed	1. Coolant temperature gauge has detected water temperature of 105°C

Condition when normal (voltage, current, resistance)	Action by controller when abnormality is detected	Problem that appears on machine when there is abnormality
• When starting switch is turned ON, keep time switch pressed for 5 seconds to actuated clear function	-	1. Service code cannot be cleared 2. Time becomes 00:00
	-	1. Service code cannot be cleared 2. Time becomes 00:00 3. Clock does not advance.
• Voltage between P01 (7) - chassis Buzzer On: Max. 1V Buzzer OFF: 20 - 30V ★ When there is a disconnection, E103 is not displayed and the buzzer does not sound	-	1. Buzzer does not sound
• Resistance between P11 (male) - P12 (male): Min 1Ω (engine started)	-	1. If abnormality detection continues, air cleaner clogging caution lamp flashes and buzzer sounds
• Resistance between sensor terminal and chassis: Min. 1 MΩ (engine at mid-range speed or above)	-	1. If abnormality detection continues, engine oil pressure caution lamp flashes and buzzer sounds
• Resistance between P07 (1) - (2): Min. 3.156 Ω (engine started)	-	1. If abnormality detection continues, coolant temperature caution lamp flashes and buzzer sounds 2. If abnormality detection continues, engine speed is reduced to low idling

PW170ES-6K
Serial number K32001 and up

M_MODE1.eps

FUSE BOX CONNECTION TABLE.

FUSE NO.	CONNECTION TABLE
1	GOVERNOR & PUMP CONTOLLER + BREAKER SWITCH
2	SOLENOID VALVE
3	AIR CON
4	LIGHT(REAR,BOOM RIGHT)
5	CIGAR LIGHTER,SAFETY LOCK SOL. HEATER,WINDOW WASHER,LEFT KNOB SWITCH. STOP LIGHTS
6	HORN
7	WIPER MOTOR CONTROLLER
8	LIGHT(CAB X2), BEACON, OPT
9	LOWER WIPER,REFUELING PUMP
10	KEY ON SIG,HEATED SEAT,INDICATORS
11	ROADLIGHTS
12	HEADLIGHTS,ENGINE ROOM,HAZARD
13	ALARM BUZZER, MONITOR
14	STARTER SWITCH
15	ROOM LAMP, ADDITIONAL POWER SUPPLY

1.SYMBOLS IN THE DRAWING SHOW FOLLOWING CONNECTORS.

S
YAZAKI "S" TYPE.
D08056-XXXXX

M
YAZAKI "M" TYPE.
D08056-XXXXX

L
YAZAKI "L" TYPE.
D08056-XXXXX

X
YAZAKI "X" TYPE.
D08055-XXXXX

SWP
YAZAKI "SWP" TYPE.
D08055-XXXXX

KES0 KES D08027-0XXXX

KES1 KES D08027-1XXXX

250 AMP 250 TYPE

040 AMP 040 TYPE

070 AMP 070 TYPE

MIC MIC TYPE

SHINAGAWA JIDOSHA DENSEN"SR-5P" TYPE.
22W-06-13460

PA YAZAKI "PA" TYPE.
20Y-06-13590

2.INDICATES SHIELDED WIRE.

3.INDICATES TWISTED WIRE.

4.CN-XXX IN THE DRAWING SHOWS CONNECTOR NO. IN ACTUAL MACHINE "CN-" IS OMITTED, ONLY "XXX" IS INDICATED.

SWING REDUNDANCY SW.
ON-FREE
OFF-NORMAL
CN-SW01

RESISTER
CN-C06

PUMP REDUNDANCY CIRCUIT SWITCH
ON PUMP CONTROLLER REDUNDANCY
OFF-NORMAL
CN-SW02

FUEL DIAL
CN-E06

STARTER SWITCH
B BR R1 R2 C ACC
R1
OFF
ACC
ST

ADDITIONAL POWER SUPPLY

CIGAR LIGHTER

RELAY FOR LOWER WIPER
RELAY FOR HEADLIGHTS
RELAY FOR LIGHT
RELAY FOR OPT LIGHT
RELAY FOR HORN
CN-G36
CN-G35
CN-R04
CN-R05
CN-G05

FUSE BOX
CN-X07
MIC

CN-G69
TO LOWER WIPER

CN-X01
TO (2/2)

CN-M46
FOR CHECK

WIPER MOTOR
CN-W04

HEATED SEAT ASSY
2.5A
CN-G33
KES1

MONITOR
CN-P02 040
GND
POWER SUPPLY(24V)
GND
POWER SUPPLY(24V)

CN-P01 040
NETWORK(+)
SWING LOCK
BUZZER CANCEL
BUZZER DRIVE
LIGHT
KEY ON
BR
NETWORK(+)
NETWORK(-)
PRE-HEATING
START

WIPER MOTOR CONTROLLER
070
CN-W08
GND(POWER)
REAR LIMIT SW.SIG.
VB
WIPER MOTOR +24V(STD)
WIPER MOTOR (REVERSAL)
GND(SIG)
WIPER MOTER SIG-W,P-COMMON
WIPER MOTOR SIG (W)
WIPER MOTOR SIG (P)
WIPER SW.COMON
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

TOKAIRIKA BASE ASSY
ROOM LAMP
CN-M71
CAB GND
PANEL GND

ALARM BUZZER
CN-P04
CN-A11 KES1
CN-M39
OPT2

CN-H12
CN-H13
CN-H14
CN-H15
BLUE
WHITE

CN-X07 MIC
CN-A13 BATTERY RELAY DRIVE
KES1

MODEL SELECT
CN-G153
NOT USED
CN-G60

CN-A2 SWING PARK BRAKE SOLENOID
KES1

MIC GOVERNOR PUMP CONTROLLER
CN-C01
1 BATTERY RELAY DRIVE
3 SWING PARKING SOLENOID
6 GND
7 POWER SUPPLY(24V)
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(-)
7 LS_EPC SOLENOID(+)
8 TVC SOLENOID 1(+)
9 TRAV EPC SOLENOID(+)
11 PGND
12 SOLENOID POWER SUPPLY
17 LS_EPC SOLENOID(-)
18 TVC SOLENOID 1(-)
19 TRAV EPC SOLENOID(-)
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)
12 CHARGING LEVEL
14 FEEDBACK SIGNAL
16 GND
17 GND
18 START SWITCH (C)

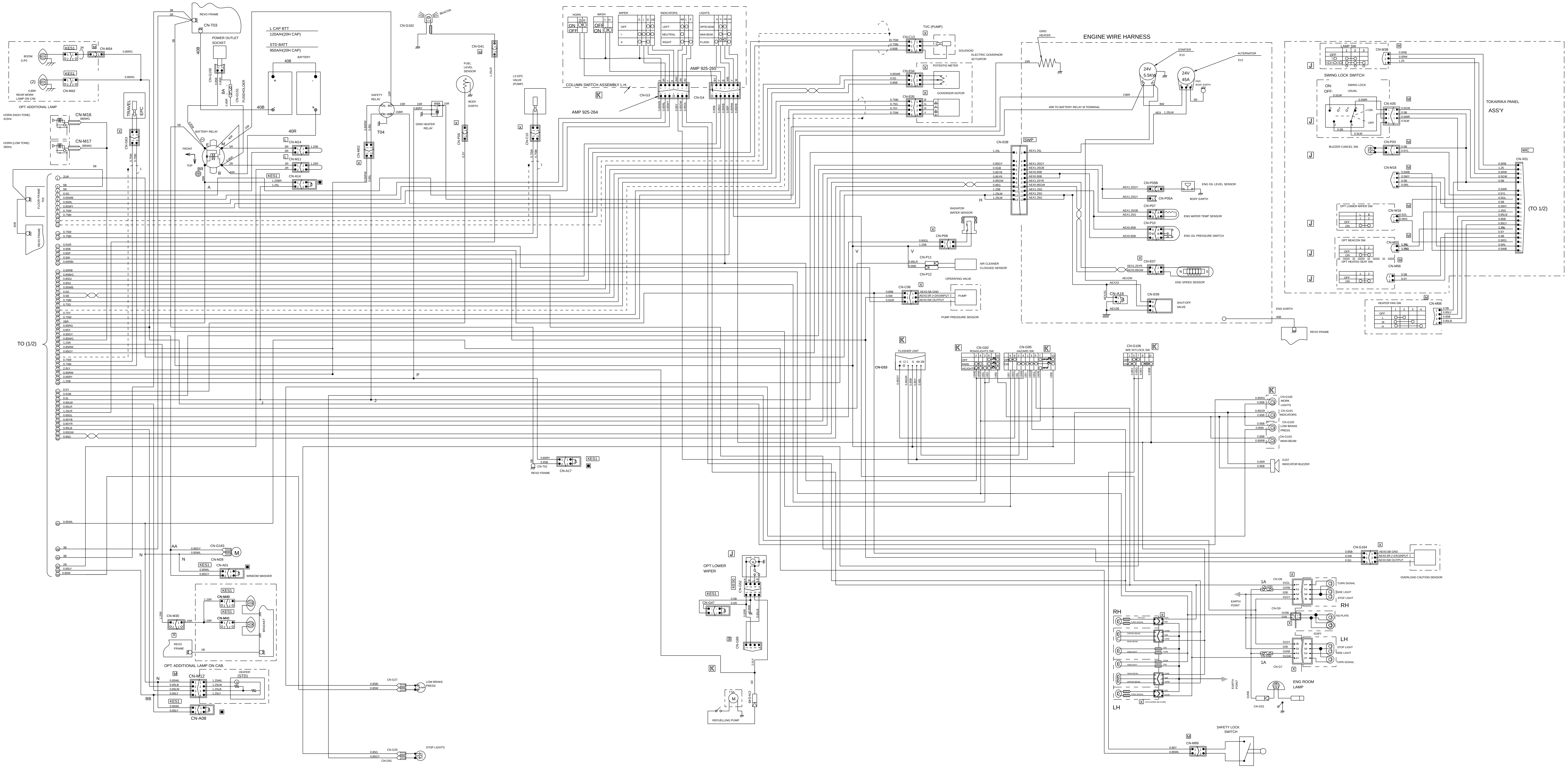
040
CN-C17
4 NETWORK (+)
5 MACHINE SELECT 1
6 MACHINE SELECT 3
7 MACHINE SELECT 5
8 SWING PROLIX SWITCH
9 NC
12 NETWORK (+)
13 MACHINE SELECT 2
14 MACHINE SELECT 4
15 SPEED SELECT
16 SWING LOCK SWITCH

MIC
CN-C18
1 ENG.SPEED(GND)
2 ENG SPEED
3 NETWORK(-)
4 GND
7 ENG. OIL PRESS (HIGH)
8 COOLANT LEVEL
15 ENG. OIL PRESS (LOW)
16 ENG. OIL LEVEL
17 AIR CLEANER

TO (2/2)

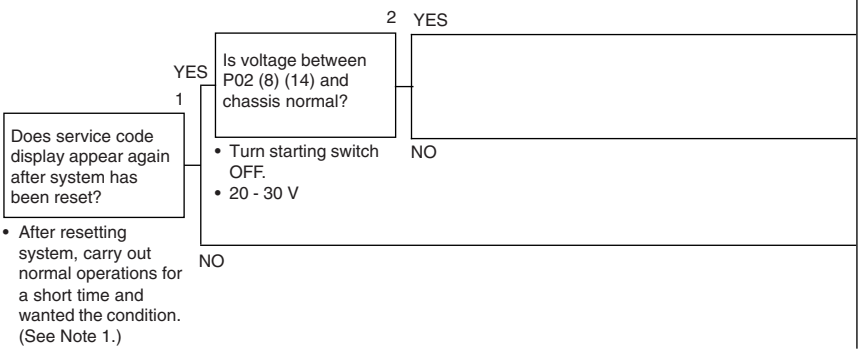
PW170ES-6K
Serial number K32001 and up

M_MODE2.eps



M-1 [E101] Abnormality in error data is displayed [E102] Error in clock data is displayed

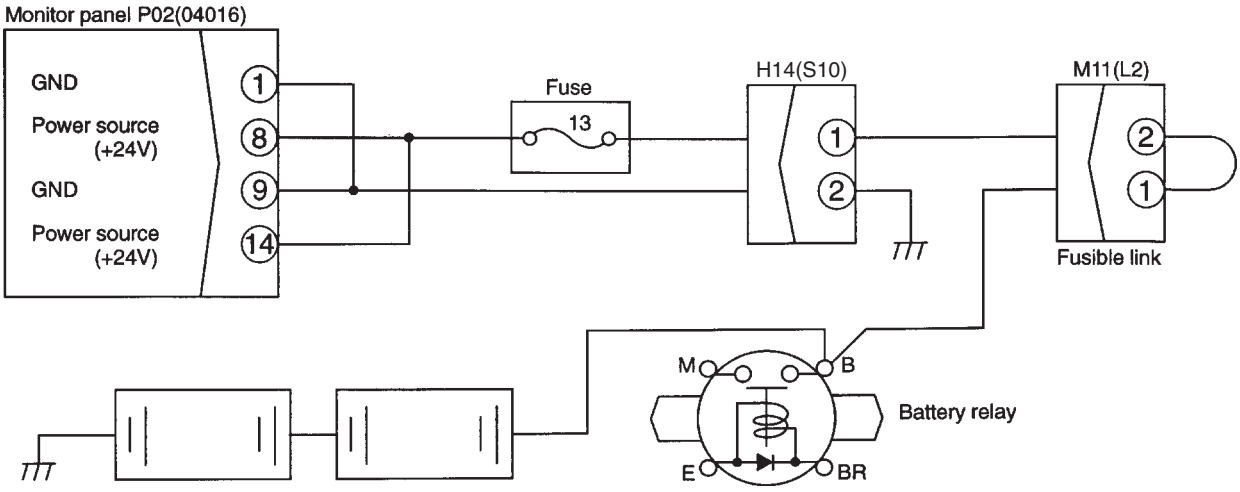
★ This is not an abnormality. It occurs during troubleshooting when disconnecting and connecting connector P02 (for the monitor panel electrical system), fuse No. 13, connector H14, connector M11, battery relay treminal B, or the battery terminal.
(When the monitor panel power source circuit is shut 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
Disconnecton, defective contact, short circuit with ground in wiring harness between battery - battery relay B - M11 (1) (2) - H14 (1) - fuse No. 13 - P02 (female) (8) (14)	Repair or replace
Normal	-

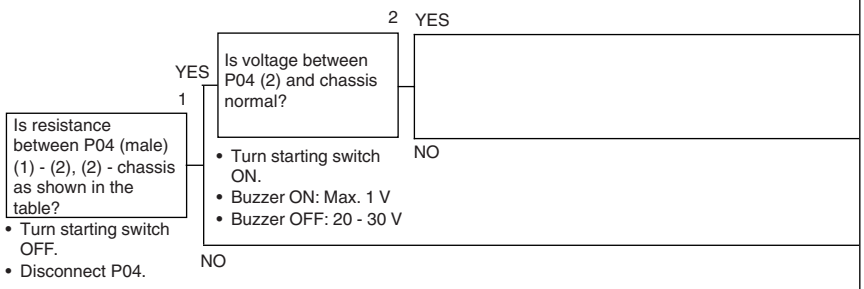
Note 1: Resetting operation:
Turn the starting switch OFF. Then keep the time switch at the back of the monitor panel depressed, switch the starting switch ON again, and keep the time switch depressed for 5 seconds to return the system to normal.
(With this operation, all the service codes in the internal memory are erased.)

M-1 Related electric circuit diagram



M-2 [E103] Short circuit in buzzer output or contact of 24 V 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 sytem has been reset.)
★ Before carrying out troubleshooting, check that all the related connectors are properly inserted.
★ Always connect any disconnected connectors before going on the next step.

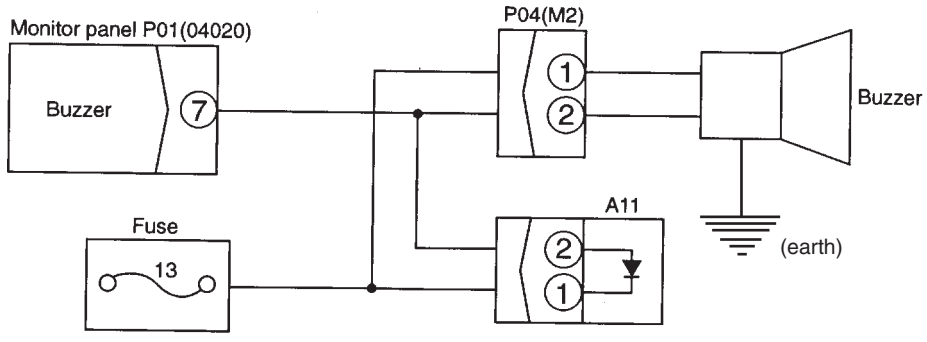


Cause	Remedy
Defective monitor panel	Replace
Short circuit with power source in wiring harness between P01 (female) (7) and P04 (female) (2) or short circuit in wiring harness between P04 (1) and (2)	Repair or replace
Defective buzzer	Replace

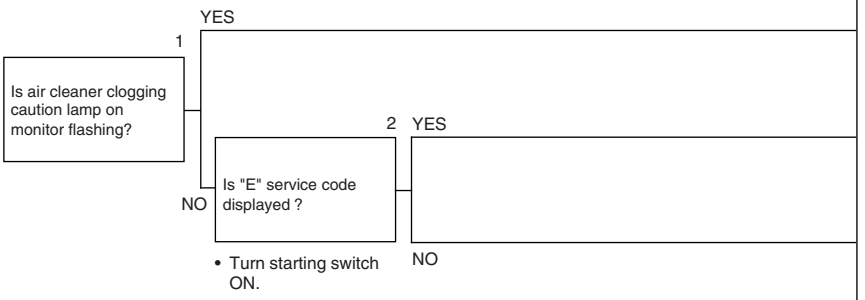
Table

P04 (male)	Resistance value
Between (1) and (2)	200 - 300 Ω
Between (2) and chassis	Min. 1 M Ω

M-2 Related electric circuit diagram



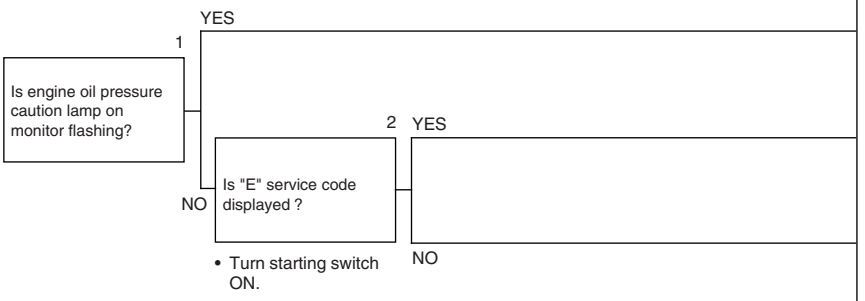
M-3 [E104] Air clogging detected is displayed



Cause	Remedy
(See M-13 f)	-
Defective monitor panel	Replace
Failure in engine system (See Note 1)	-

Note 1: The monitor panel display has returned to normal, but the air cleaner clogging sensor has detected symptoms of clogging in the past, so carry out troubleshooting of the engine to remove the problem

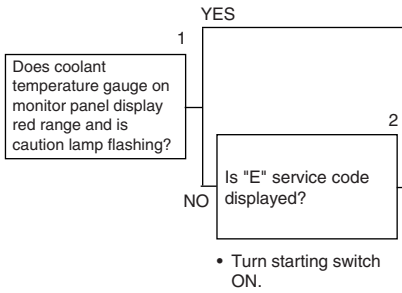
M-4 [E106] Drop in engine oil pressure detected is displayed



Cause	Remedy
(See M-13 a)	-
Defective monitor panel	Replace
Failure in engine system (See Note 1)	-

Note 1: The monitor panel display has returned to normal, but the engine oil pressure sensor has detected symptoms of a drop in the oil pressure in the past, so carry out troubleshooting of the engine to remove the problem.

M-5 [E108] Engine water temperature 105°C detected is displayed



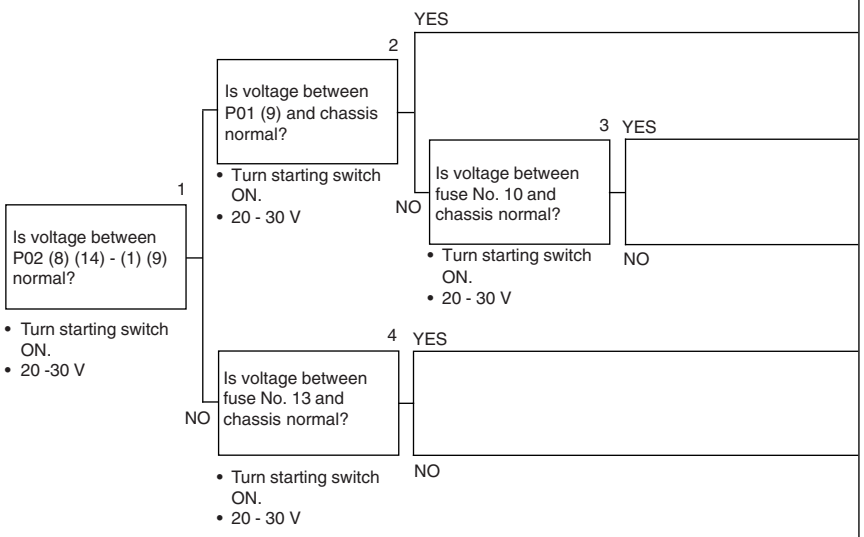
Cause	Remedy
(See M-13 d)	-
Defective monitor panel	Replace
Failure in engine system (See Note 1)	-

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 on monitor panel light up



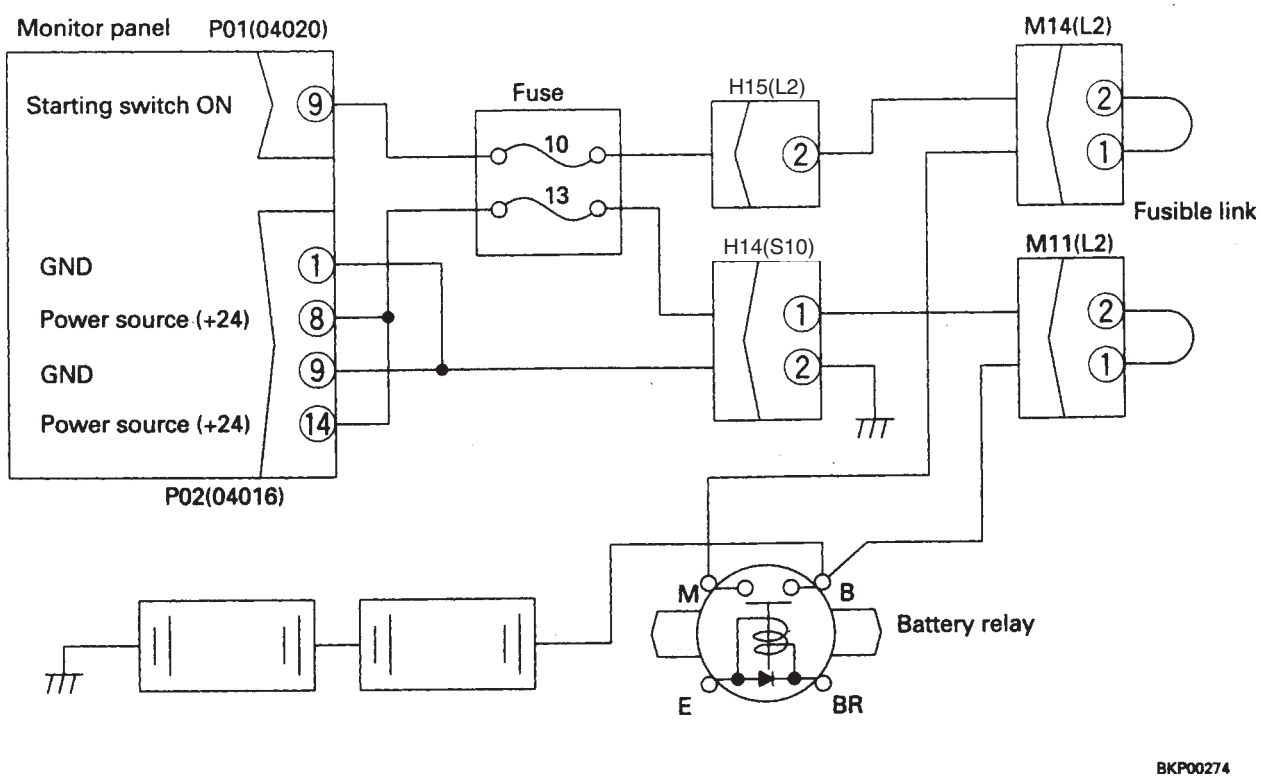
Cause	Remedy
Defective monitor panel	Replace
Disconnetion, defective contact, short circuit with ground in wiring harness between P01 (female) (9) and fuse No. 10	Repair or replace
Disconnection, defeictive contact, short circuit with ground in wiring harness between fuse No. 10 - H05 (2) - M14 (2) (1) - battery relay M	Repair or replace
Disconnection, defective contact, short circuit with ground in wiring harness between P02 (female) (8) (14) and fuse No. 13	Repair or replace
Disconnection, defective contact, short circuit with ground in wiring harness between fuse No. 13 - H14 (2) - M11 (2) (1) - battery relay B	Repair or replace

b) Some of lamps on monitor panel do not light up



Cause	Remedy
Defective monitor panel	Replace

M-6 a) Related electric circuit diagram



M-7 When starting switch is turned ON, monitor panel lamps all stay 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)	-

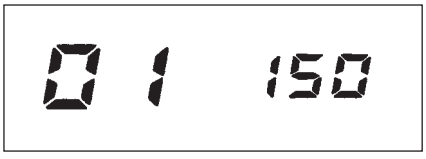
1 Is display of monitoring code 01 as shown in table?

YES

NO

- Turn starting switch ON.
- Set to monitoring code 01.

Table



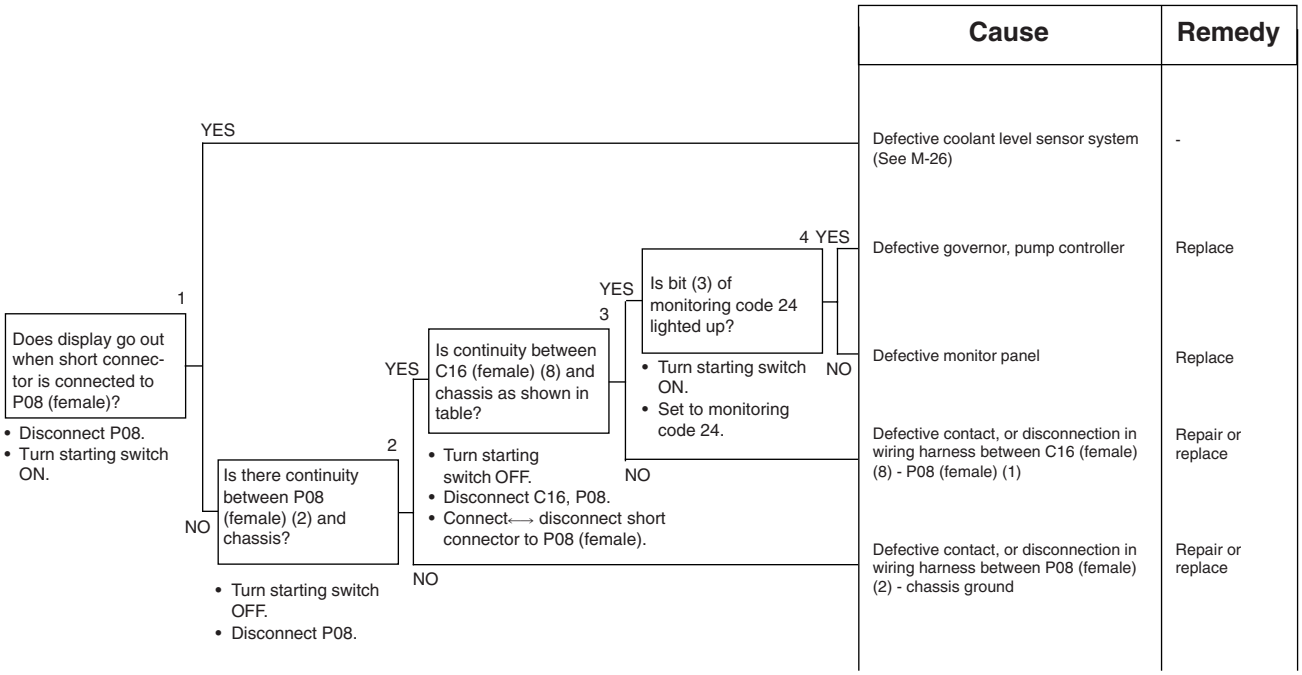
M-9 When starting switch is turned ON (engine stopped), basic check items flashes

★ Before carrying out troubleshoting, check that all the related connectors are properly inserted.
★ Always connect any disconnected connectors before going on the next step.

a) (coolant level) flashes

SAP00519

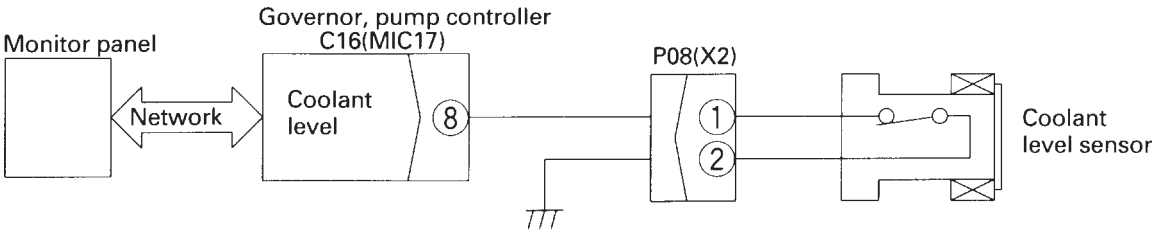
★ Check that the coolant is at the specified level before carrying out troubleshooting.



Table

Short connector	Continuity
Connected	Yes
Disconnected	No

M-9 a) Related electric circuit diagram

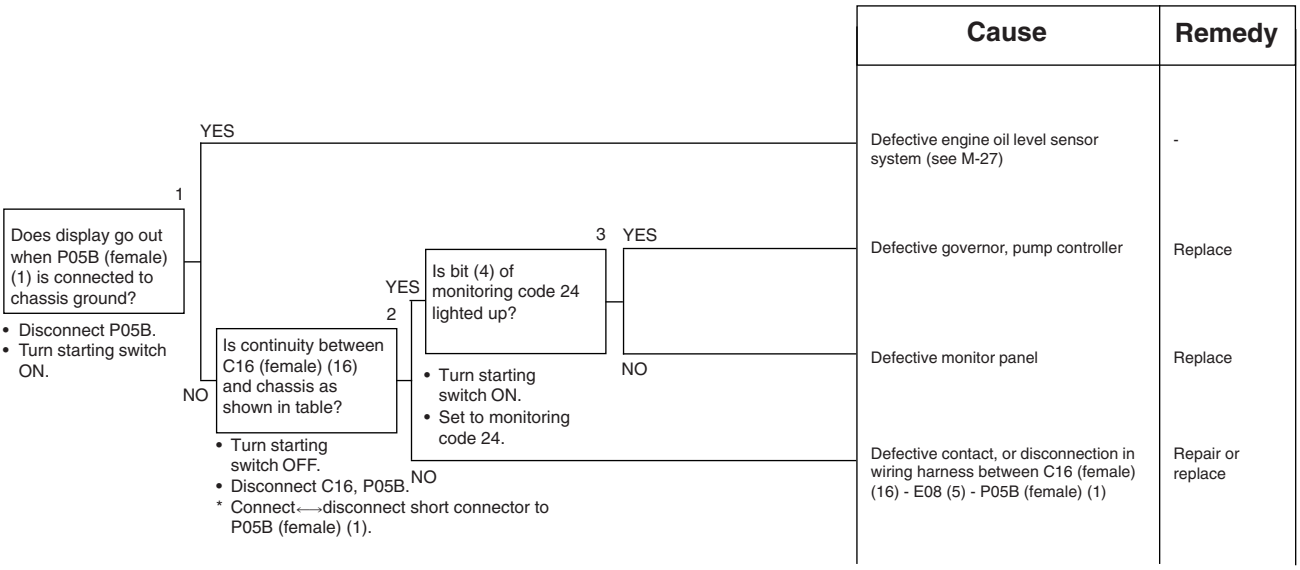


BKP00277

b) (coolant level) flashes

SAP00523

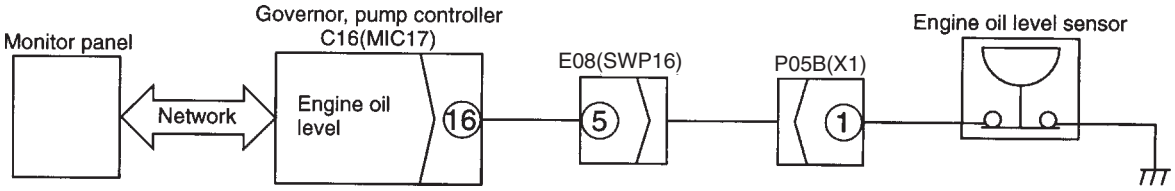
★ Chek that the engine oil is at the specified level before carrying out troubleshooting.



Table

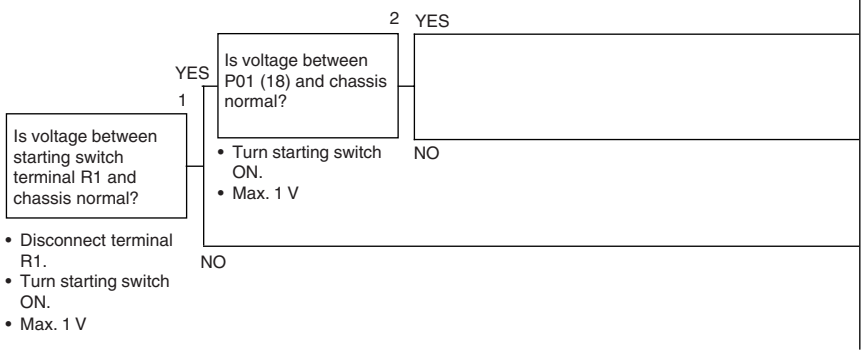
Chassis ground	Continuity
Connected	Yes
Disconnected	No

M-9 b) Related electric circuit diagram



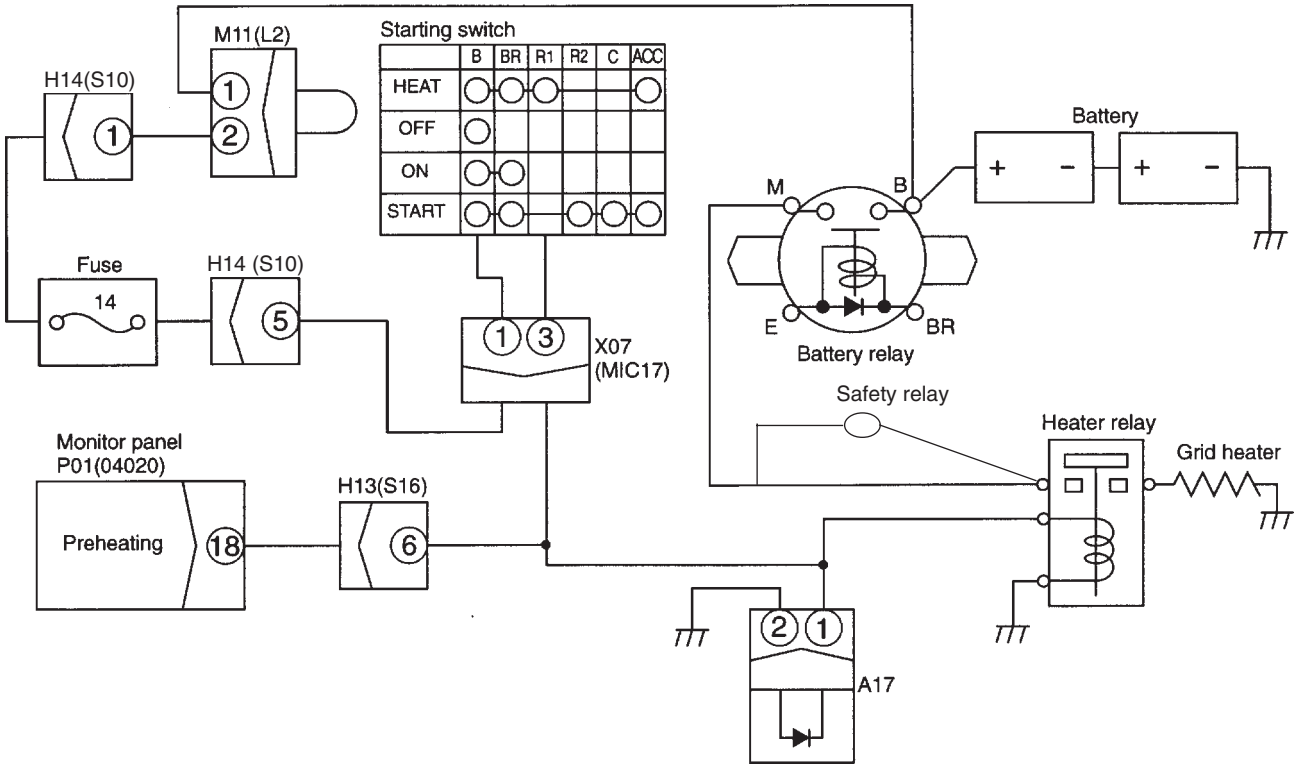
M-10 Preheating is not being used but (preheating monitor) lights up

★ 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 monitor panel	Replace
Short circuit with power source in wiring harness between starting switch R1 - X07 (3) - H13 (6) - P01 (female) (18) or heater relay- H13 (female) (6)	Repair or replace
Defective starting switch	Replace

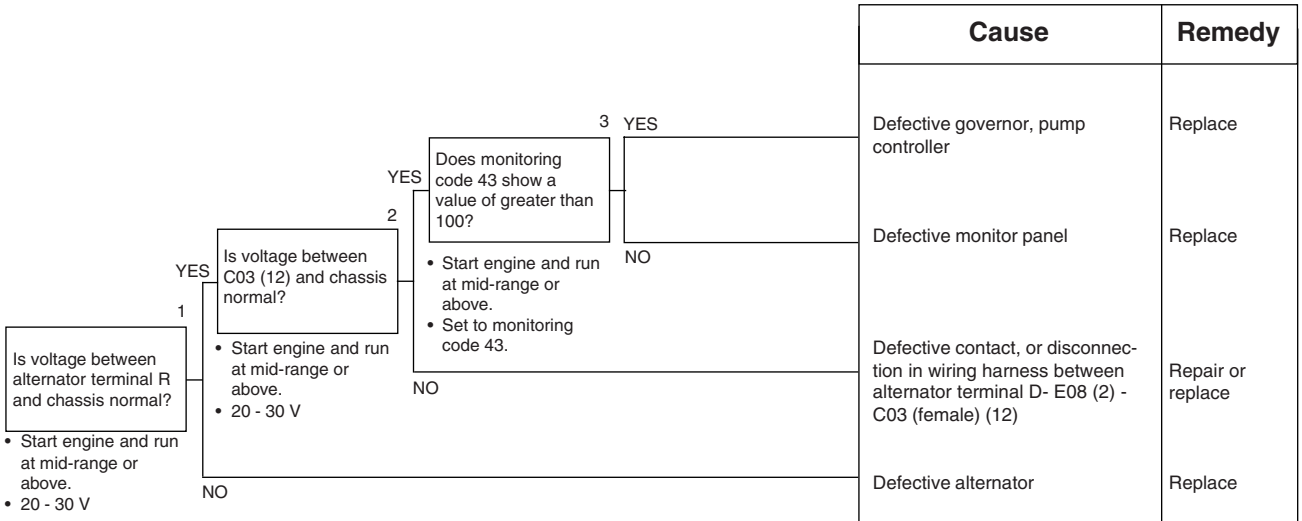
M-10 Related electric circuit diagram



M-11 When starting switch is turned ON and engine is started, basic check items flash

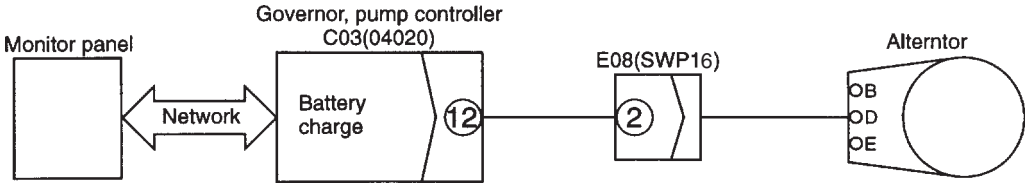
★ Before carrying out troubleshooting, check that all the related connectors sare properly inserted.
★ Always connect any disconnected connectors before going on the next step.
★ Check both the alternator system and the engine oil pressure system.

a) Alternator system



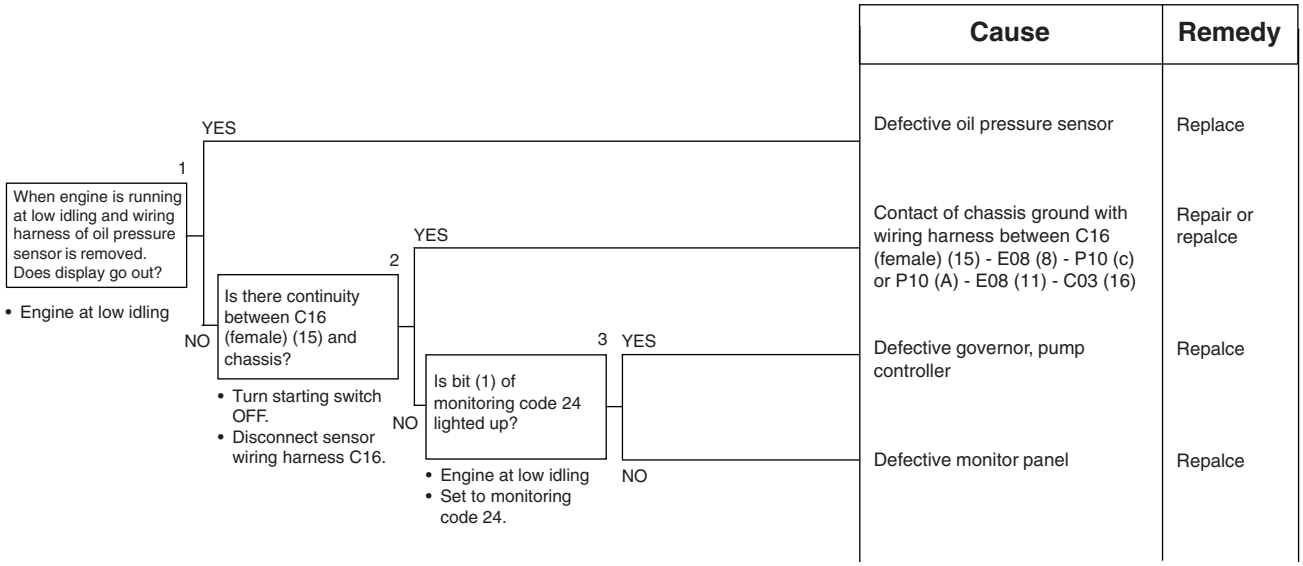
Cause	Remedy
Defective governor, pump controller	Replace
Defective monitor panel	Replace
Defective contact, or disconnection in wiring harness between alternator terminal D- E08 (2) - C03 (female) (12)	Repair or replace
Defective alternator	Replace

M-11a) Related electric circuit diagram



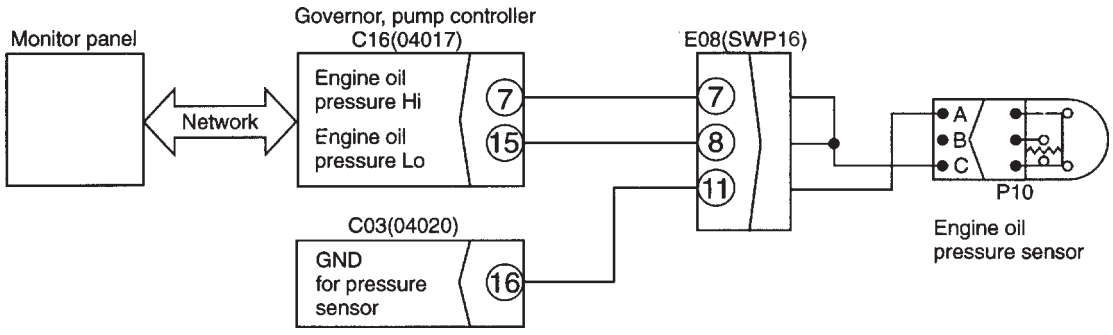
b) Engine oil pressure system

★ 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 repalce
Defective governor, pump controller	Repalce
Defective monitor panel	Repalce

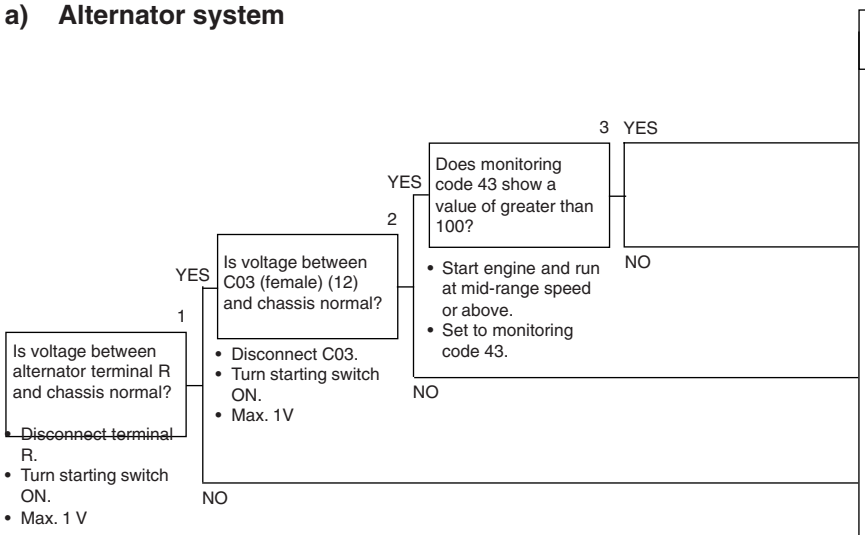
M-11b) Related electric circuit diagram



M-12 When starting switch is turned ON (engine stopped), caution items, emergency items flash (battery, engine oil pressure lamps do not light up)

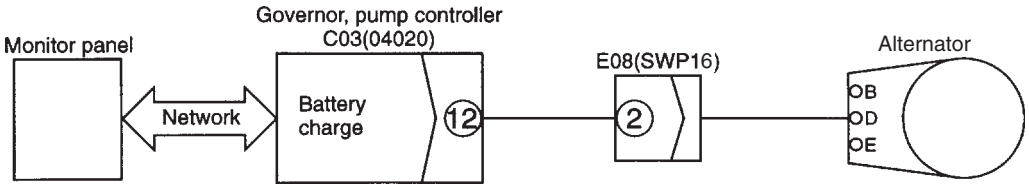
★ Before carrying out troubleshooting, check that all the related connectors are properly inserted.
★ Always connect any disconnected connectors before going on the next step.
★ Check both the alternator system and the engine oil pressure system.

a) Alternator system



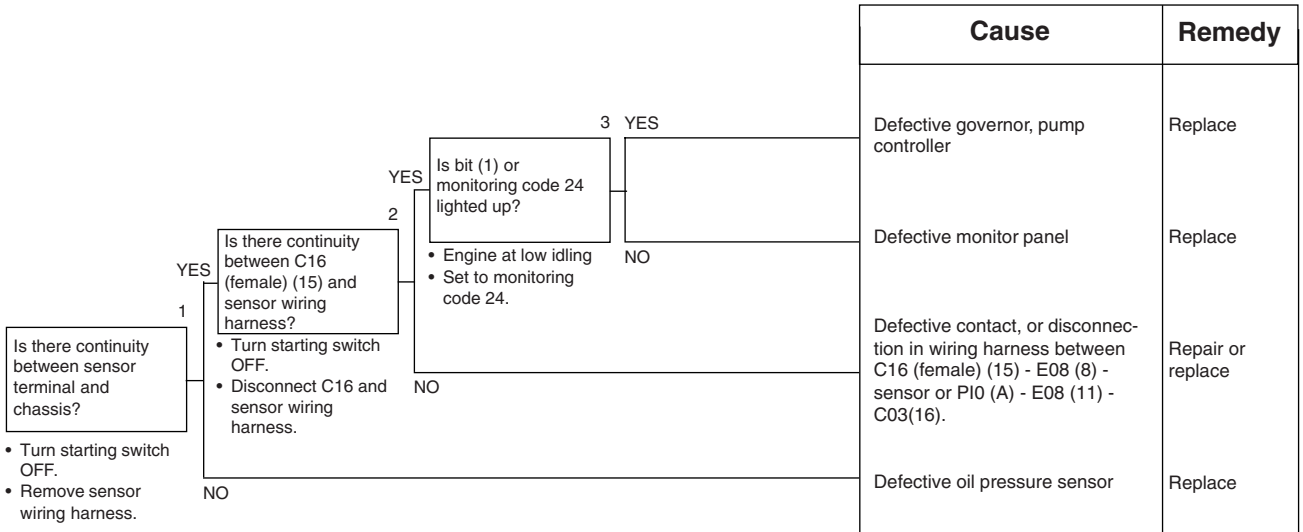
Cause	Remedy
Defective governor, pump controller	Replace
Defective monitor panel	Repalce
Short circuit with power source in wiring harness between C03 (female) (12) - E08 (2) - alternator D	Repair or replace
Defective alternator	Replace

M-12 a) Related electric circuit diagram

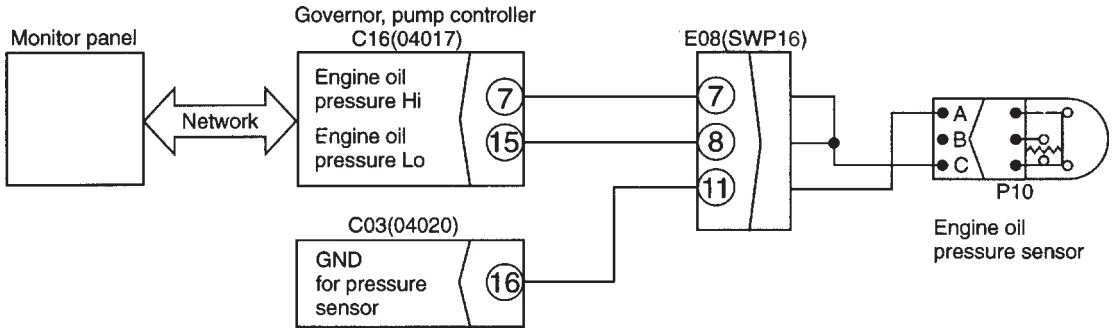


b) Engine oil pressure sensor system

★ When engine oil pressure is normal.



M-12b) 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)  SAP00520 **(engine oil pressure) flashes**

★ Check that the engine oil pressure is normal before carrying out troubleshooting.

Cause	Remedy
See M-11 b)	-

b)  SAP00519 **(coolant level) flashes**

★ Check that the coolant level is normal before carrying out troubleshooting.

Cause	Remedy
See M-9 a)	-

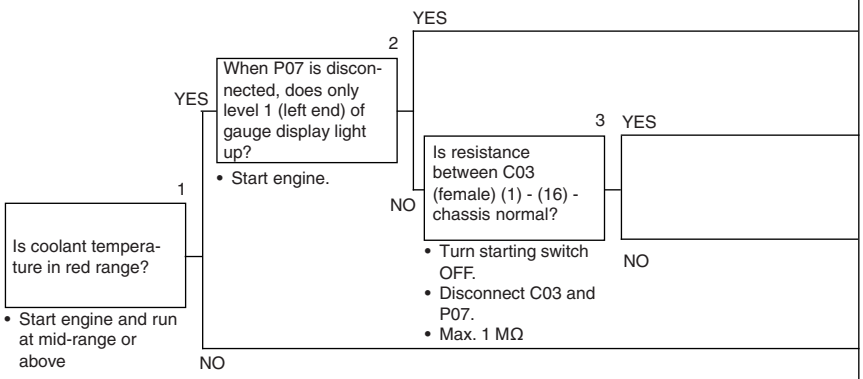
c)  SAP00522 **(battery charge) flashes**

Cause	Remedy
See M-11 a)	-

d)  (coolant temperature) flashes

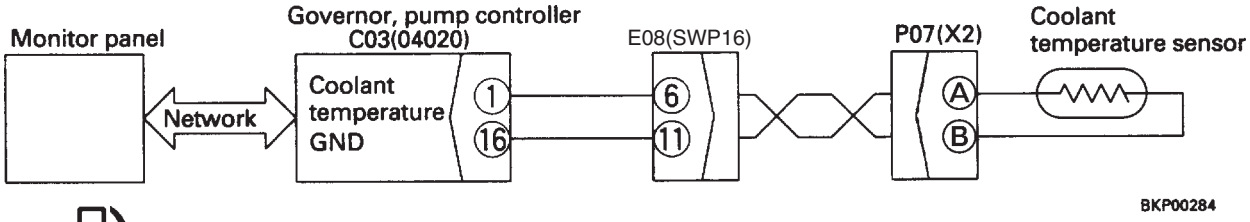
SAP00527

★ 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) - P07 (female) (1) and wiring harness between C03 (female) (16) - E08 (11) - P07 (female) (B)	Repair or replace
Defective monitor panel	Replace

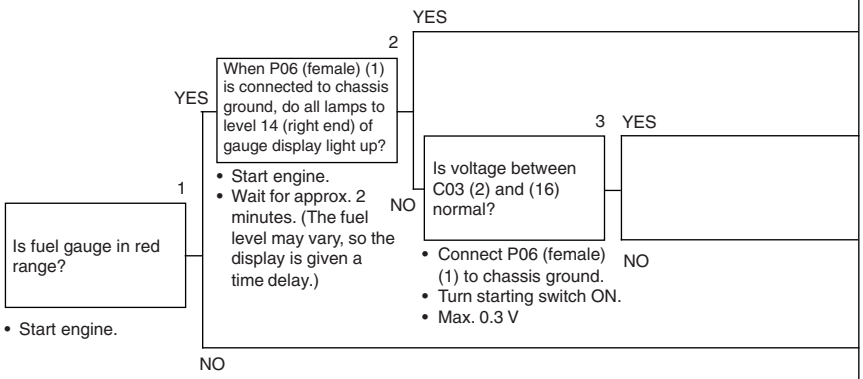
M-13 d) Related electric circuit diagram



e)  (fuel level) flashes

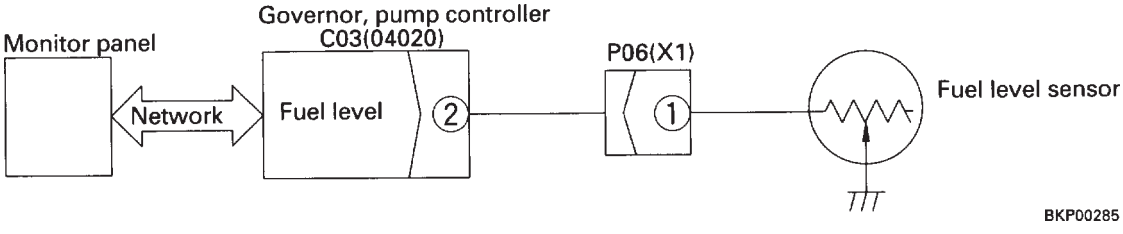
SAP00528

★ 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 (feamle) (1)	Repair or replace
Defective monitor panel	Replace

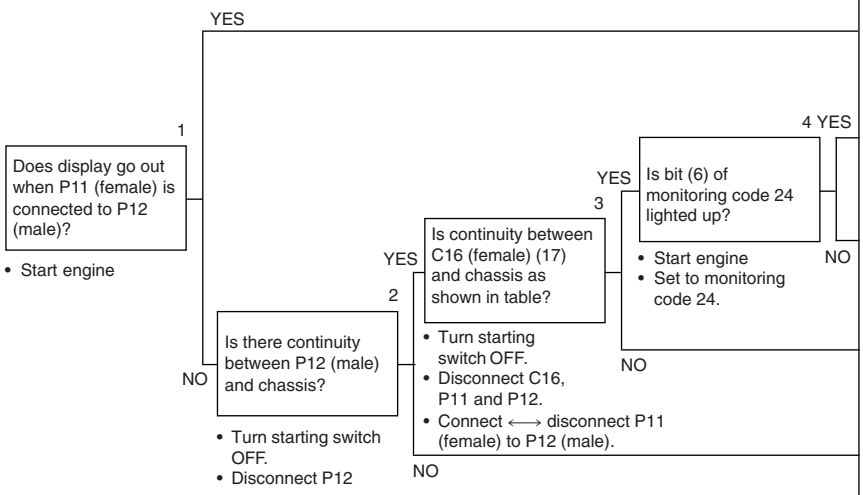
M-13 e) Related electric circuit diagram



f)  (air cleaner clogging) flashes

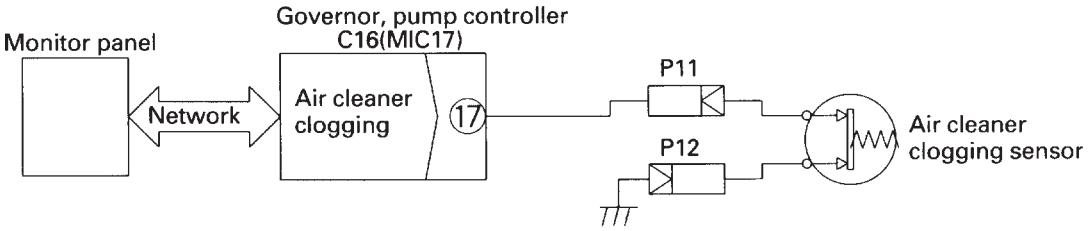
SAP00521

★ Check that the air cleaner is not clogged before carrying out troubleshooting



Cause	Remedy
Defective air cleaner clogging sensor	Replace
Defective governor, pump controller	Replace
Defective monitor panel	Replace
Defective contact or disconnection in wiring harness between C16 (female) (17) and P11 (female)	Repair or replace
Defective contact or disconnectrion in wiring harness between P12 (male) and chassis ground	Repair or replace

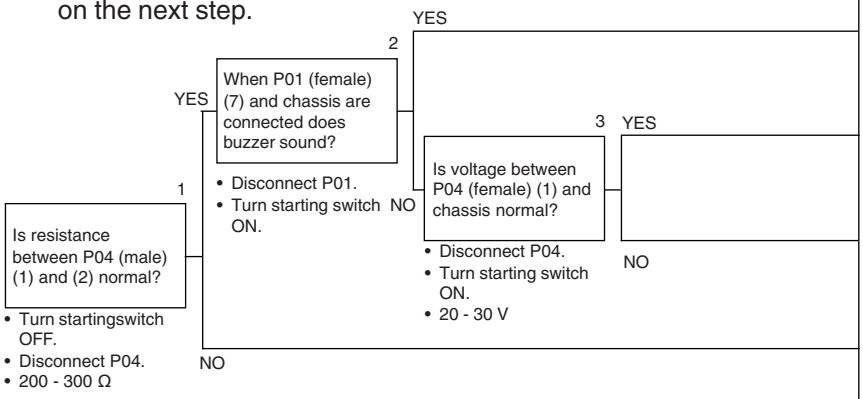
M-13 f) Related electric circuit diagram



BKP00286

M-14 When starting switch is turned ON (engine stopped), buzzer does not sound for 1 second Caution item flashes but buzzer does not sound

★ Of the caution items, the buzzer will not sound even if there is an abnormality in the battery charge or fuel level.
★ Before carrying out troubleshooting, check that all the related connectors are properly inserted.
★ Always connect any disconnected connectors before going on the next step.



Cause	Remedy
Defective monitor 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	Repalce

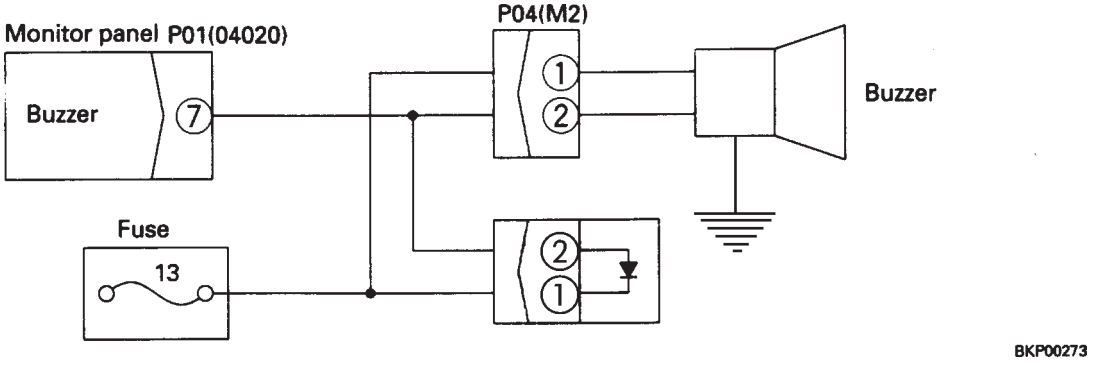
M-15 No abnormality is displayed on monitor but buzzer sounds

★ 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.



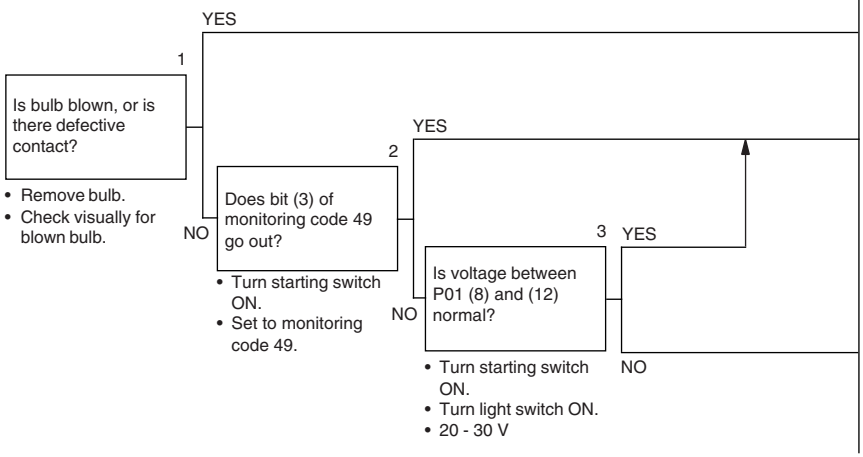
Cause	Remedy
Contact of chassis ground with wiring harness between P01 (female) (7) and P04 (female) (2), or defective buzzer	Repair or replace
Defective monitor panel	Replace

M-14, 15 Related electric circuit diagram



M-16 Night lighting on monitor panel does not light up (liquid crystal display is normal)

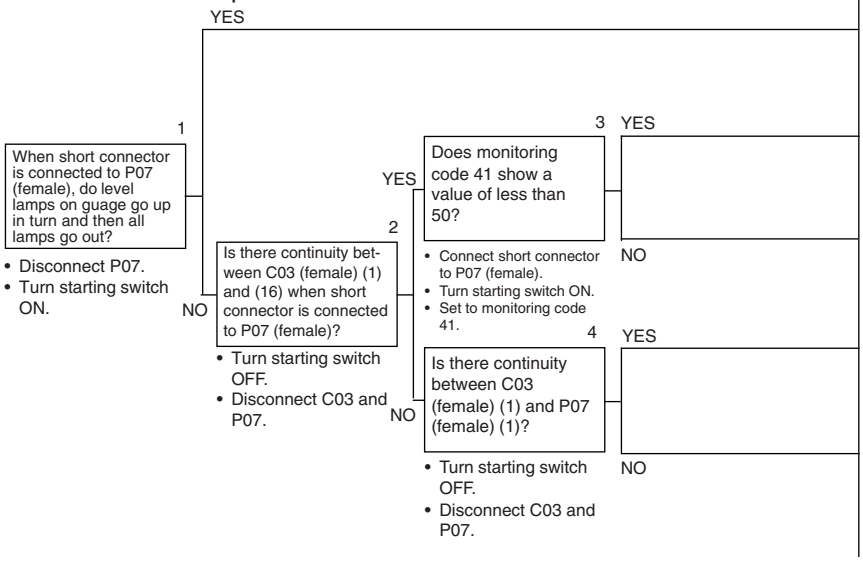
★ When the front lamp and working lamp light up normally.



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 hanress between P01 (female) (8) - X01 (1) - M38 (female) (1)	Repair or replace

M-17 Coolant temperature gauge does not rise

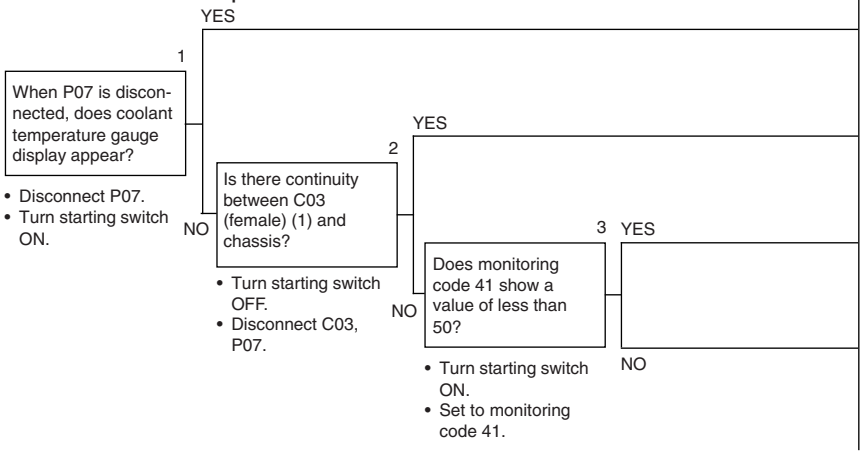
★ If the coolant temperature actually does not rise, check the engine system.
★ Before carrying out troubleshooting, check that all the related connectors are properly inserted.
★ Always connect any disconnected connectors before going on the next step.



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

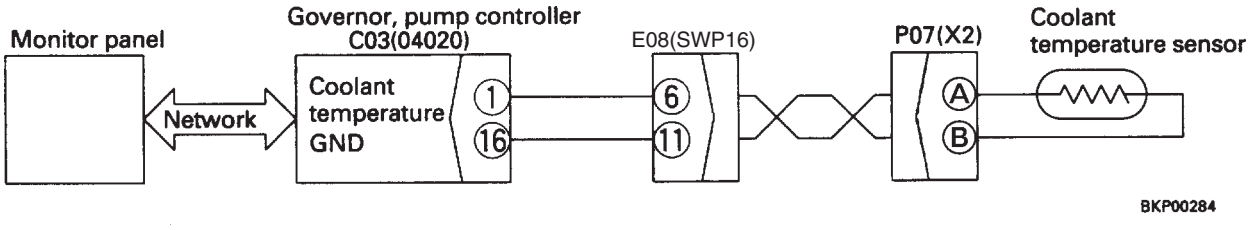
M-18 Coolant temperature gauge does not give any display (none of gauge lamps light up during operation)

★ Before carrying out troubleshooting, check that all the related connectors are properly inserted.
★ Always connect any disconnected connectors before going on the next step.



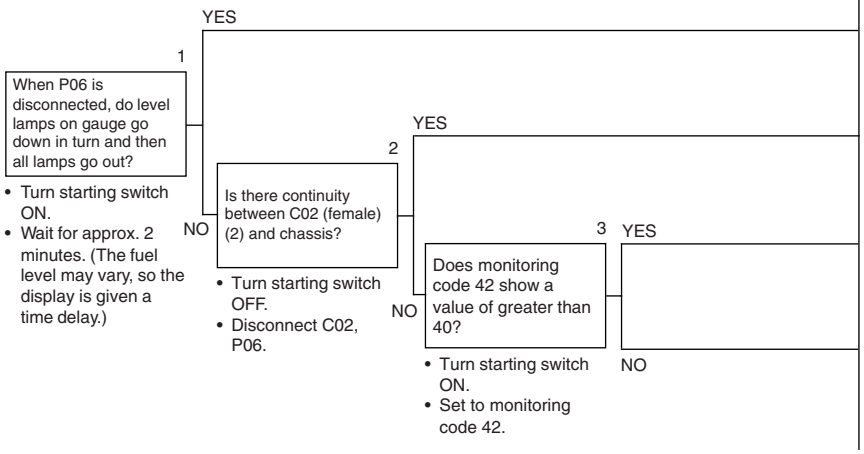
Cause	Remedy
Defective coolant temperature sensor system (see M-26)	-
Contact of chassis ground with wiring harness between C03 (female) (1) - E08 (6) - P07 (female) (A)	Repair or replace
Defective governor, pump controller	Replace
Defective monitor panel	Replace

M-17, 18 Related electric circuit diagram



M-19 Fuel level gauge always displays FULL

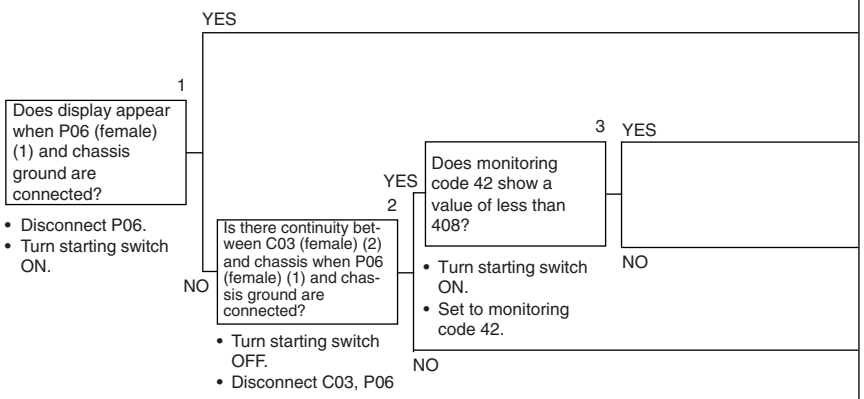
★ Check if the taqnk is actually full before carrying out troubleshooting.
★ Before carrying out troubleshooting, check that all the related connectors are properly inserted.
★ Always connect any disconnected connectors before going on the next step.



Cause	Remedy
Defective fuel level senor system (see M-25)	-
Contact of chassis ground with wiring harness between C03 (female) (2) and P06 (female) (1)	Repair or replace
Defective monitor panel	Replace
Defective governor, pump controller	Replace

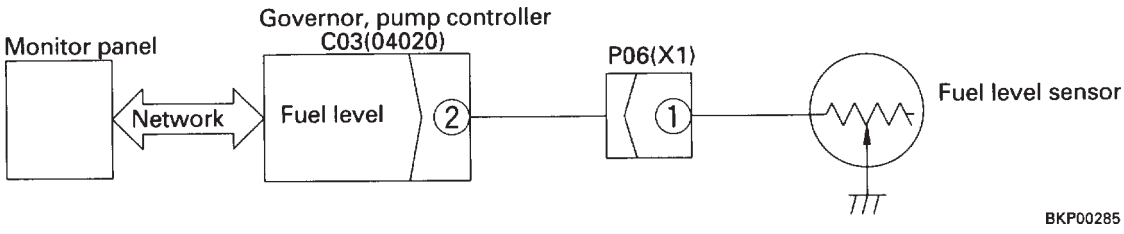
M-20 Fuel level gauge does not give display

★ Check that there is actually no fuel before carrying out troubleshooting.
★ Before carrying out troubleshooting, check that all the related connectors are properly inserted.
★ Always connect any disconnected connectors before going on the next step.



Cause	Remedy
Defective fuel level sensor system (see M-25)	-
Defective governor, pump controller	Replace
Defective monitor panel	Replace
Defective contact, or disconnection in wiring harness between C03 (female) (2) and P06 (female) (1)	Repair or replace

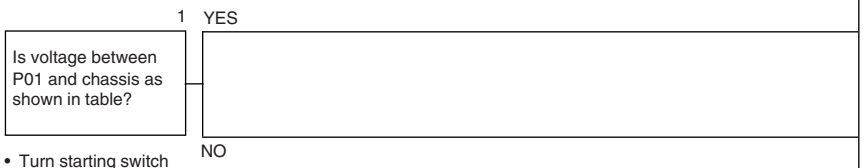
M-19, 20 Related electric circuit diagram



M-21 Swing lock switch is turned ON (LOCK) but (swing lock monitor) does not light up

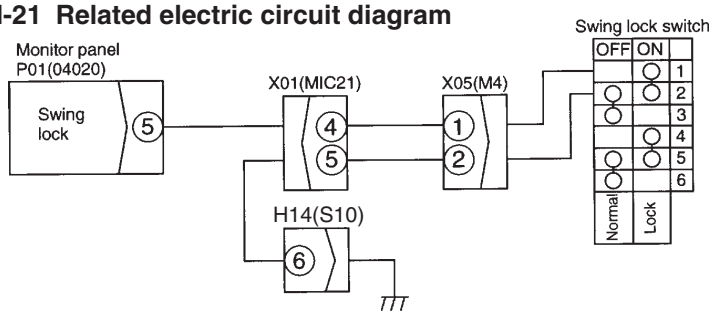


★ Carry out this troubleshooting only if the swing lock is actually being actuated.
★ Before carrying out troubleshooting, check that all the related connectors are properly inserted.
★ Always connect any disconnected connectors before going on the next step.



Cause	Remedy
Defective monitor panel	Replace
Defective contact or disconnection in wiring harness between P01 (female) (5) - X01 (4) - X05 (male)	Repair or replace

M-21 Related electric circuit diagram



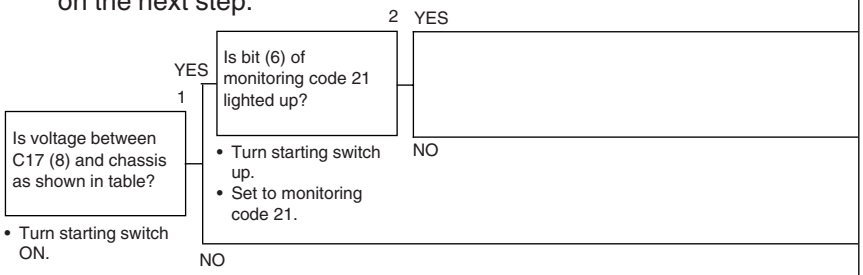
Table

Swing lock switch ON	Max. 1 V
Swing lock switch OFF	20 - 30 V

M-22 Swing prolix switch is turned ON (prolix), but (swing lock monitor) does not flash

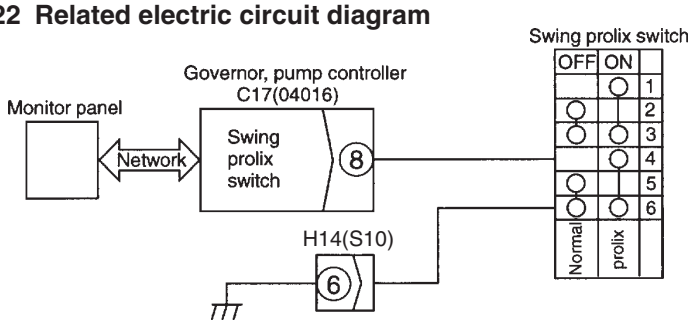


★ Carry out this troubleshooting only if the swing prolix is actually being actuated.
★ Before carrying out troubleshooting, check that all the related connectors are properly inserted.
★ Always connect any disconnected connectors before going on the next step.



Cause	Remedy
Defective monitor panel	Replace
Defective governor, pump controller	Replace
Defective contact or disconnection in wiring harness between C17 (female) (8) and prolix switch (4)	Repair or replace

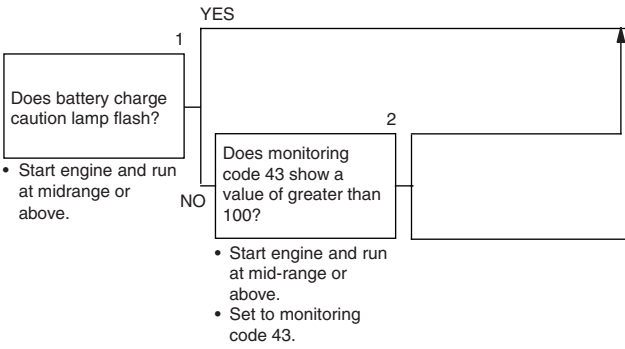
M-22 Related electric circuit diagram



Table

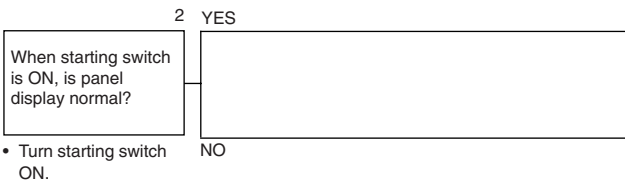
Swing prolix switch ON	Max. 1 V
Swing prolix switch OFF	20 - 30 V

M-23 Service meter does not advance while engine is running



Cause	Remedy
See M-13 d)	-
Defective monitor panel	Replace
Defective governor, pump controller	Replace

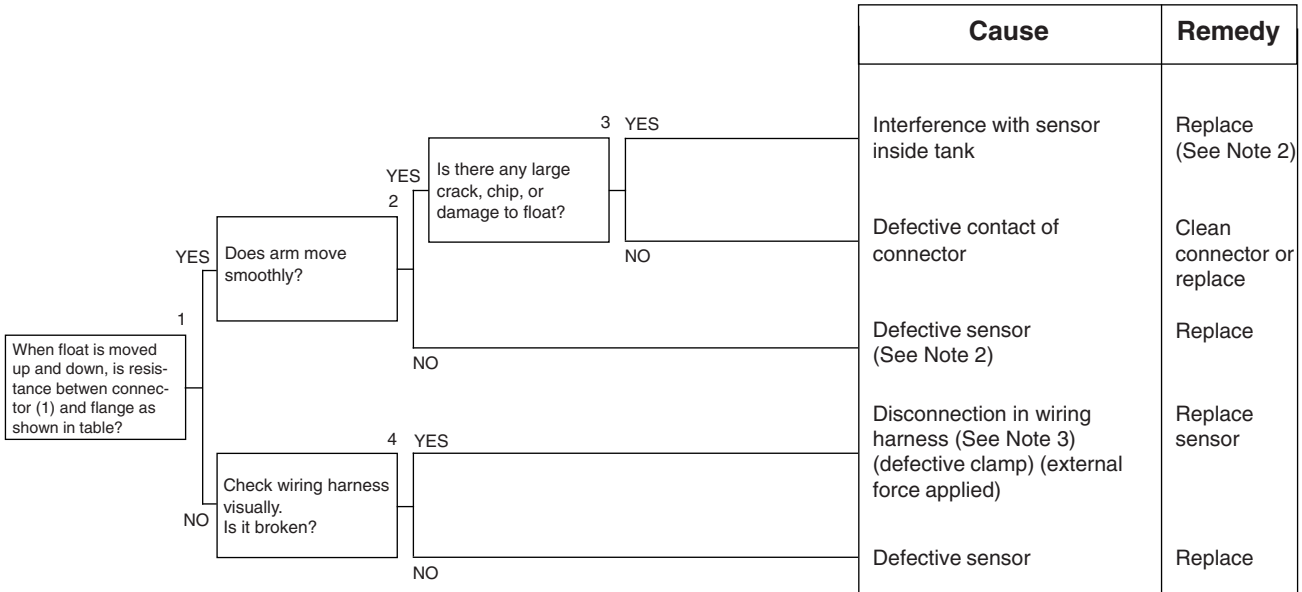
M-24 When starting switch is at OFF and time switch is pressed, time and service meter are not displayed



Cause	Remedy
Defective monitor panel	Replace
See M-6	-

M-25 Defective fuel level sensor system

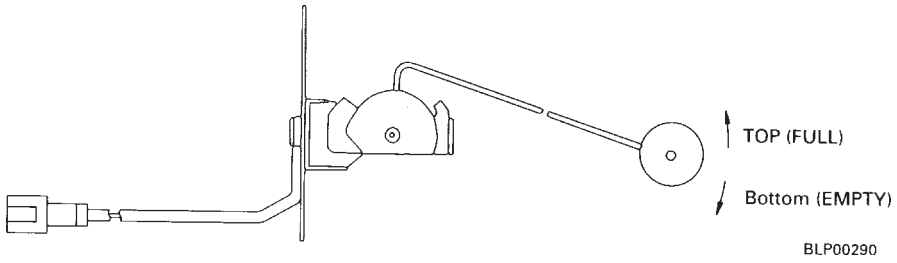
★ Remove the fuel level sensor when carrying out thetroubleshooting



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 postion	Approx. 12Ω or below
Bottom (EMPTY) stopper position	Approx. 85 - 110 Ω

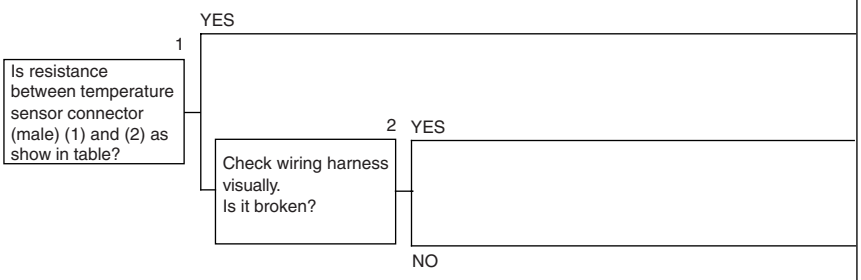


Note 1: Difference between fuel level an gauge display. For gaugedisplay position 14 (FULL), the amount of fuel is 78-100%; and for display position 1 (EMPTY) it is below 14,5%. If the chassis is at an angle, the displayed amount of fuel will be different from the actual amount. Therefore when checking, stop the machine at a horizontal place and wait for at least 2 minutes before checking the gauge. (The display is given a time delay so that the gauge can deal with 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 carefyul when installing

Note 3: Check for vibration at the connector mount. If there is excessive vibration, take the appropriate action.

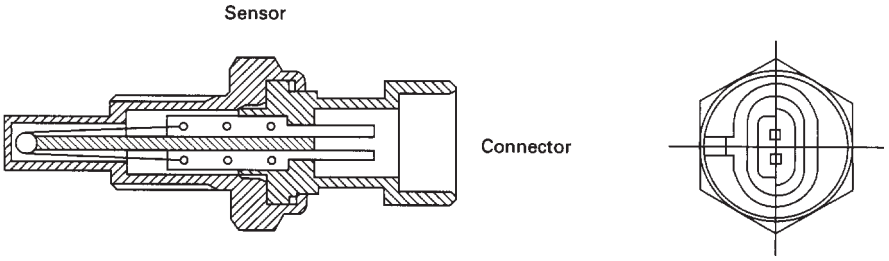
M-26 Defective coolant temperature sensor system



Cause	Remedy
Defective contact of connector (See Note 1)	Clean connector or replace sensor
Disconnection in wiring harness (See Note 2) (defective clamp) (external force applied)	Replace sensor
Defective sensor	Replace

Table

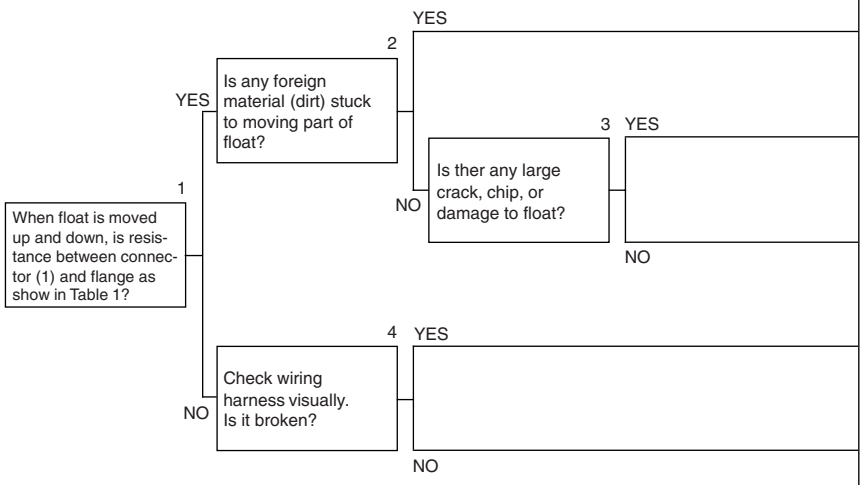
Normal temperature (20°C)	Approx. 70 ~ 78 kΩ
100°C	Approx. 3Ω



Note 1: If the problem occurs again, the connector (female) at the chassis end is probably defective, so check the connector and wiring harness at the chassis end.
Note 2: Check for vibration at the connector mount. If there is excessive vibration, take the appropriate action.

M-27 Defective engine oil level sensor system

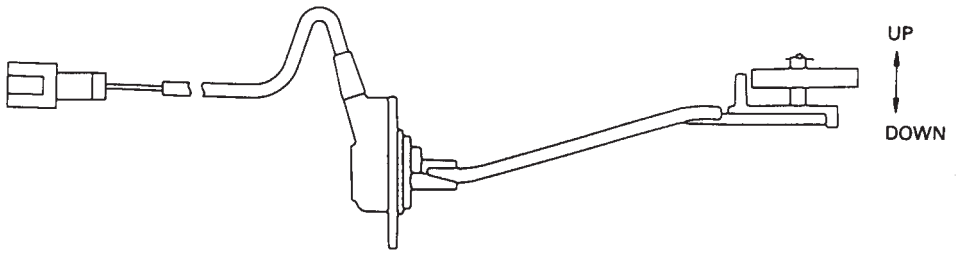
★ Remove the engine oil level sensor when carrying out troubleshooting



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. 1 Ω
Float DOWN	Min. 1 MΩ

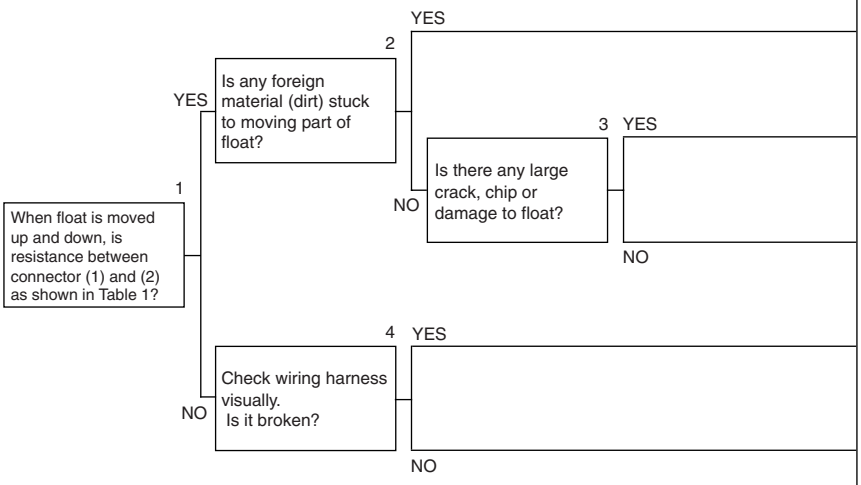


BLP00292

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 at a horizontal place.
Note 2: If the problem occurs again, the connector (female) at the chassis end is probably defective, so check the connector and wiring harness at the chassis end.
Note 3: Check for vibration at the connector mount. If there is excessive vibration, take the appropriate action.
Note 4: Defective installation is a possible cause, so be careful when installing. If the problem occurs again, check for vibration at the connector mount, and if there is excessive vibration, take the appropriate action.

M-28 Defective coolant level sensor system

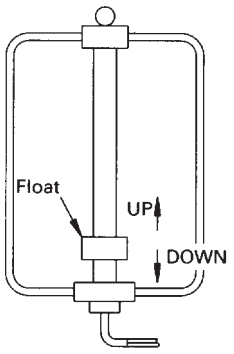
★ Remove the coolant level sensor when carrying out troubleshooting.



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 (Se Note 3) (defective clamp) (external force applied)	Replace sensor
Defective sensor	Replace

Table

Float UP	Max. 1 Ω
Float DOWN	Min. 1 MΩ



BLP00293

Note 1: Variations in coolant level. The coolant level may change according to the angle of the machine, or the swaying of the machine, so if there is any display, check the coolant level again with the machine at a horizontal place.
Note 2: If the problem occurs again, the connector (female) at the chassis end is probably defective, so check the connector and wiring harness at the chassis end.
Note 3: Check for vibration at the connector mount. If there is excessive vibration, take the appropriate action.
Note 4: Defective installation is a possible cause, so be careful when installing. If the problem occurs again, check for vibration at the connector 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.

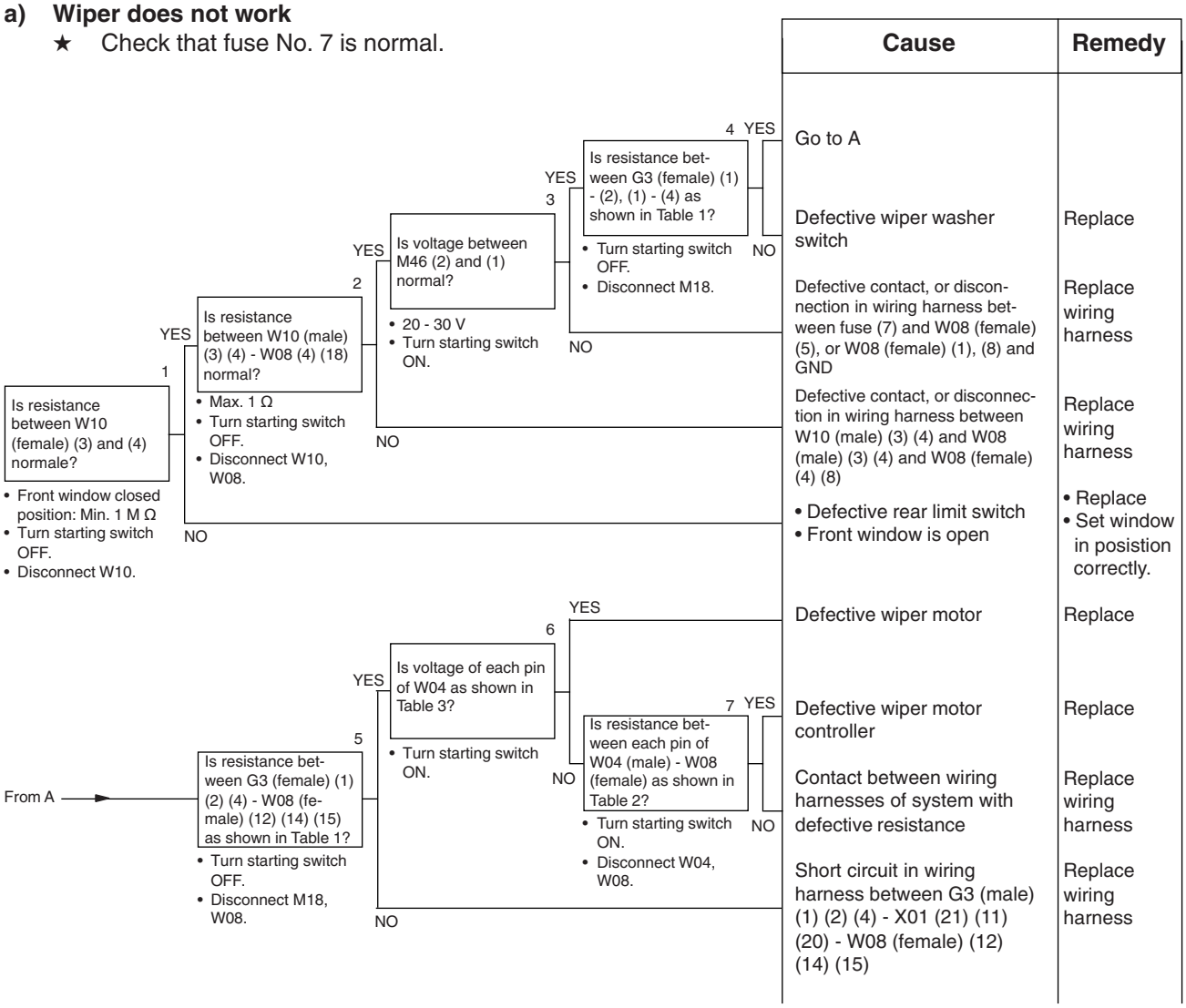


Table 1

Actuation mode	G3 (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

30 DISASSEMBLY AND ASSEMBLY

METHOD OF USING MANUAL 30-3
PRECAUTIONS WHEN CARRYING OUT OPERATION 30-5
SPECIAL TOOL LIST 30-7
GOVERNOR MOTOR ASSEMBLY
Removal and Installation 30-10
HYDRAULIC COOLER ASSEMBLY
Removal 30-11
RADIATOR, HYDRAULIC COOLER ASSEMBLY
Removal 30-12
Installation 30-13
ENGINE, MAIN PUMP ASSEMBLY
Removal 30-14
Installation 30-17
DAMPER ASSEMBLY
Removal and Installation 30-18
FUEL TANK / HYDRAULIC TANK ASSEMBLY
Removal and Installation 30-19
CENTER SWIVEL JOINT ASSEMBLY
Removal and Installation 30-20
Disassembly and Assembly 30-21
SWING MOTOR ASSEMBLY
Removal and Installation 30-21
SWING MACHINERY ASSEMBLY
Removal and Installation 30-22
SWING MOTOR
Disassembly and Assembly 30-24
REVOLVING FRAME ASSEMBLY
Removal 30-31
Installation 30-33
SWING CIRCLE ASSEMBLY
Removal and Installation 30-34
MAIN PUMP ASSEMBLY
Removal 30-38
Installation 30-39
CONTROL VALVE ASSEMBLY
Removal 30-40
Installation 30-41
Disassembly and Assembly 30-42
LS SELECT VALVE ASSEMBLY
Disassembly and Assembly 30-46
LS SHUTTLE VALVE
Disassembly and Assembly 30-47
PRESSURE COMPENSATION VALVE ASSEMBLY
Disassembly and Assembly 30-48
MAIN RELIEF VALVE ASSEMBLY
Disassembly 30-50
Assembly 30-51

LS CONTROL EPC VALVE ASSEMBLY
Removal and installation 30-52
EPC SOLENOID VALVE ASSEMBLY
Removal and Installation 30-53
PPC SHUTTLE VALVE ASSEMBLY
Removal 30-54
Installation 30-55
Disassembly 30-56
Assembly 30-57
WORK EQUIPMENT PPC VALVE ASSEMBLY
Removal and Installation 30-58
TRAVEL PPC VALVE ASSEMBLY
Removal and Installation 30-59
Disassembly 30-59
Assembly 30-59
BOOM CYLINDER ASSEMBLY
Removal 30-60
Installation 30-61
ARM CYLINDER ASSEMBLY
Removal 30-62
Installtion 30-63
BUCKET CYLINDER ASSEMBLY
Removal 30-64
Installation 30-65
HYDRAULIC CYLINDER ASSEMBLY
Disassembly 30-66
Assembly 30-68
WORK EQUIPMENT ASSEMBLY
Removal 30-71
Installation 30-72
BUCKET ASSEMBLY
Removal 30-73
Installation 30-73
ARM ASSEMBLY
Removal 30-73
Installation 30-73
BUCKET, ARM ASSEMBLY
Removal 30-75
Installation 30-75
BOOM ASSEMBLY
Removal 30-77
Installation 30-78
OPERATOR'S CAB ASSEMBLY
Removal 30-79
Installation 30-81
COUNTERWEIGHT ASSEMBLY
Removal and Installation 30-82
GOVERNOR, PUMP CONTROLLER ASSEMBLY
Removal and Installation 30-83
MONITOR PANEL ASSEMBLY
Removal and Installation 30-84
SWING MACHINERY ASSEMBLY
Disassembly 30-85
Assembly 30-101
(Special tools) 30-121
TRANSMISSION 30-123
FRONT TRAVEL MOTOR 30-123
REAR TRAVEL MOTOR 30-123
FRONT AXLE 30-130
REAR AXLE 30-148
BUCKET ADAPTOR
Welding instructions 30-162
OUTRIGGER + BLADE
Cyl 30-165

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. XXXX(1) ..... Step in operation
   ★ ..... Technique or important point to remember when removing XXXX (1).
2. Δ Δ Δ Δ (2): ..... [※1] Indicates that a technique is listed for use during installation
3. □ □ □ □ assembly (3)

 ..... Quantity of oil or water drained

INSTALLATION OF ○○○○ ASSEMBLY ..... Title of operation

- Carry out installation in the reverse order to removal.

[※1] ..... Technique used during installation

★ ..... Technique or important point to remember when installing Δ Δ Δ Δ (2).

- Adding water, oil ..... Step in operation

★ ..... Point to remember when adding water or oil

 ..... Quantity when filling with oil and water

2. General precautions when carrying out installation or removal (disassembly or assembly) of units are given together as PRECAUTIONS WHEN CARRYING OUT OPERATION, so be sure to follow these precautions when carrying out the operation.

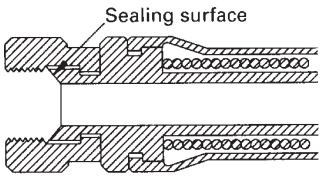
3. Listing of special tools

① For details of the description, part number, and quantity of any tols (**A1**, etc.) that appear in the operation procedure, see the SPECIAL TOOLS LIST given in this manual.

4. General tightening torque table (when using torque wrench)

★ In the case of metric nuts and bolts for which there is no special instruction, tighten to the torque given in the table below.

Thread diameter	Width across flats	 SAD00481	 SAD00482
mm	mm	kgm	Nm
6	10	1.35 ± 0.15	13.2 ± 1.4
8	13	3.2 ± 0.3	31.4 ± 2.9
10	17	6.7 ± 0.7	65.7 ± 6.8
12	19	11.5 ± 1.0	112 ± 9.8
14	22	18.0 ± 2.0	177 ± 19
16	24	28.5 ± 3	279 ± 29
18	27	39 ± 4	383 ± 39
20	30	56 ± 6	549 ± 58
22	32	76 ± 8	745 ± 78
24	36	94.5 ± 10	927 ± 98
27	41	135 ± 15	1320 ± 140
30	46	175 ± 20	1720 ± 190
33	50	225 ± 25	2210 ± 240
36	55	280 ± 30	2750 ± 290
39	60	335 ± 35	3280 ± 340



SAD00483

5. Table of tightening torques for flared nuts

★ In the case of flared nuts for which there is no special instruction, tighten to the torque given in the table below.

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

6. Table of tightening torques for split flange bolts

★ In the case of split flange bolts for which there is no special instruction, tighten to the torque given in the table below.

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

PRECAUTIONS WHEN CARRYING OUT OPERATION

[When carrying out removal or installation (disassembly or assembly) of units, be sure to follow the 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 match marks in the necessary places before removal to prevent any mistake when assembling.
- To prevent any excessive force from being applied to the wiring, always hold the connectors when disconnecting the connectors. Do not pull the wires.
- Fit wires and hoses with tags to show their installation 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 uniformly in turn.
- 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 disassembly
Fit the following blind plugs into the piping after disconnecting it during disassembly operations.

1) Hoses and tubes using sleeve nuts

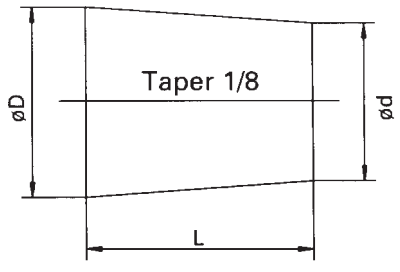
Nominal number	Plug (nut end)	Sleeve nut (elbow end) Use the two items below as a set
02	07376-50210	07221-20210 (Nut), 07222-00210 (Plug)
03	07376-50315	07221-20315 (Nut), 07222-00312 (Plug)
04	07376-50422	07221-20422 (Nut), 07222-00414 (Plug)
05	07376-50522	07221-20522 (Nut), 07222-00515 (Plug)
06	07376-50628	07221-20628 (Nut), 07222-00616 (Plug)
10	07376-51034	07221-21034 (Nut), 07222-01018 (Plug)
12	07376-51234	07221-21234 (Nut), 07222-01219 (Plug)

2) Split flange type hoses and tubes

Nominal number	Flange (hose end)	Sleeve head (tube end)	Split flange
04	07379-00400	07378-10400	07371-30400
05	07379-00500	07378-10500	07371-30500

3) If the part is not under hydraulic pressure, the following corks can be used.

Nominal number	Part Number	Dimensions		
		D	d	L
06	07049-00608	6	5	8
08	07049-00811	8	6.5	11
10	07049-01012	10	8.5	12
12	07049-01215	12	10	15
14	07049-01418	14	11.5	18
16	07049-01620	16	13.5	20
18	07049-01822	18	15	22
20	07049-02025	20	17	25
22	07049-02228	22	18.5	28
24	07049-02430	24	20	30
27	07049-02734	27	22.5	34



DEW00401

2. Precautions when carrying out installation work

- Tighten all bolts and nuts (sleeve nuts) to the specified (KES) torque.
- Install the hoses without twisting or interference.
- Replace all gaskets, O-rings, cotter pins, and lock plated with new parts.
- Bend the cotter pins and lock plates 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 caoting 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 anti-friction compound (LM-P).
- After fitting snap rings, check that the snap ring is fitted securely in the ring groove.
- When connecting wiring connectors, clean the connector to remove all oil, dirt, or water, then connect securely.
- When using eyebolts, check that there is no deformation or deterioration, screw them in fully, and align the direction of the hook.
- When tightening split flanges, tighten uniformly in turn to prevent excessive tighenting on one side.

★ When operating the hydraulic cylinders for the first time after reassembling cylinders, pumps and other hydraulic equipment removed for repair, always bleed the air as follows:

1. Start the engine and run at low idling.
2. Operate the work equipment control lever to operate the hydraulic cylinder 4 - 5 times, stopping the cylinder 100 mm form the end of its stroke.
3. Next, operate the hydraulic cylinder 3 - 4 times to the end of its stroke.
4. After doing this, run the engine at normal speed.

★ When using the machine for the first time after repair or long storage, follow the same procedure.

3 Precautions when completing the operation

- If the coolant has been drained, tighten the drain valve, and add water to the specified level. Run the engine to circulate the water through the system. Then check the water level again.
- If the hydraulic equipment has been removed and installed again, add engine oil to the specified level. Run the engine to circulate the oil through the system. Then check the oil level again.
- If the piping or hydraulic equipment have been removed, always bleed the air from the system after reassembling the parts.

  ★ For details, see TESTING AND ADJUSTING, Bleeding air.
- Add the specified amount of grease (molybdenum disulphide grease) to the work equipment parts.

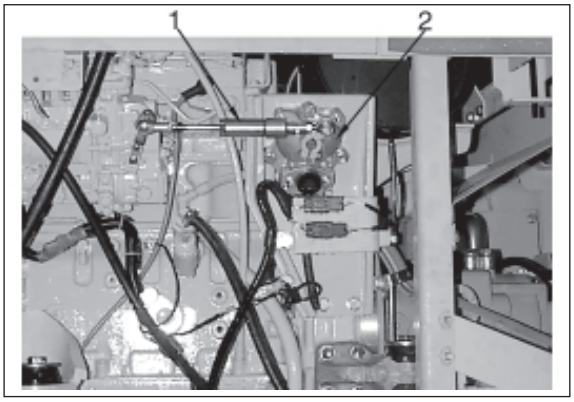
SPECIAL TOOL LIST

Nature of work	Symbol	Part No.	Part Name	Q'ty	Remarks
• Engine • hydraulic pump assembly	B	796-460-1210	Oil stopper	1	
• Radiator • hydraulic oil cooler assembly					
• Control pump assembly					
• Hydraulic pump assembly					
• Removal, installation of TVC • LS valve assembly					
• Revolving frame					
Disassembly of center swivel joint assembly	D	790-101-2501	Push-puller	1	
Removal installation of swing circle	E	790-331-1110	Wrench	1	Tightening of circle bolt

Nature of work	Symbol		Part No.	Part Name	Q'ty	Remarks
Disassembly, assembly of hydraulic cylinder	O	1	790-502-1003	Cylinder repair stand	1	
			790-101-1102	Pump	1	
		2	790-102-1330	Socket (wdth across flats: 75 mm)	1	
			790-302-1430	Socket (width across flats: 85 mm)	1	
		3	790-720-1000	Expander	1	Expansion of piston ring
		4	796-720-1670	Ring	1	
			07281-01279	Clamp	1	
			796-720-1660	Ring	1	
			07281-01159	Clamp	1	

Nature of work	Symbol	Part No.	Part Name	Q'ty	Remarks
• Removal, installation of work equipment assembly • Boom assembly	P	792-785-1100	Remover	1	Removal of boom foot pin
		790-101-3800	Puller (50 ton long)	1	
		790-101-1102	Pump (30 ton)	1	

REMOVAL OF GOVERNOR MOTOR ASSEMBLY



⚠ Disconnect the cable from 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 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. 120 ℓ

1. Remove battery and set oil container under chassis.

2. Disconnect hoses (4) and (5) at cooler end.
   ★ Put blind plugs in the places that have been disconnected.

3. Remove mounting bolts (6) at side of hydraulic oil cooler assembly.

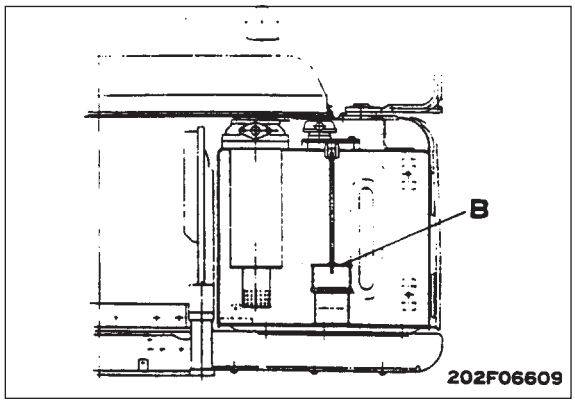
4. Sling hydraulic oil cooler assembly (7), remove 2 mounting bolts each on left and right, then lift off hydraulic oil cooler assembly (7).

   kg Hydraulic oil cooler assembly: 60 kg

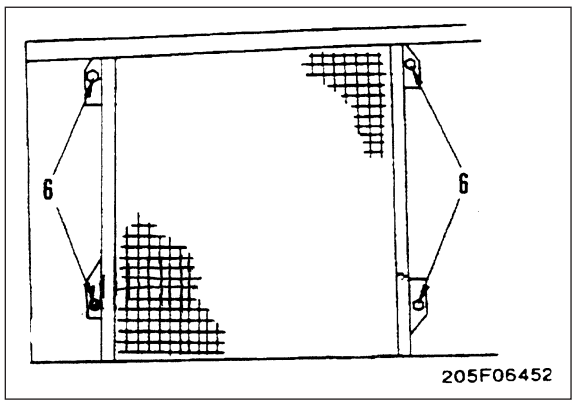
INSTALLATION OF HYDRAULIC OIL COOLER ASSEMBLY

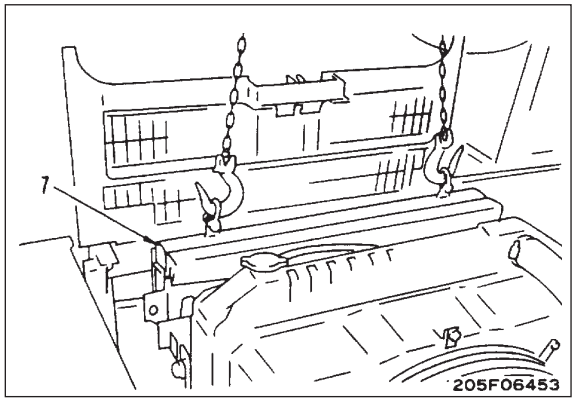
- Carry out installation in the reverse order to removal.

- Refilling with oil (hydraulic tank)
  ★ Add oil through the oil filler to the specified level. Run the engine to circulate the oil through the system. Then check the oil level again.

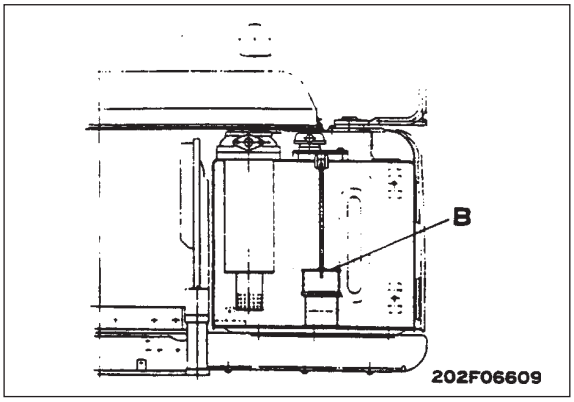








REMOVAL OF RADIATOR • HYDRAULIC OIL COOLER ASSEMBLY



⚠ 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. 120 ℓ
- Drain engine coolant.

1. Remove undercover under radiator.

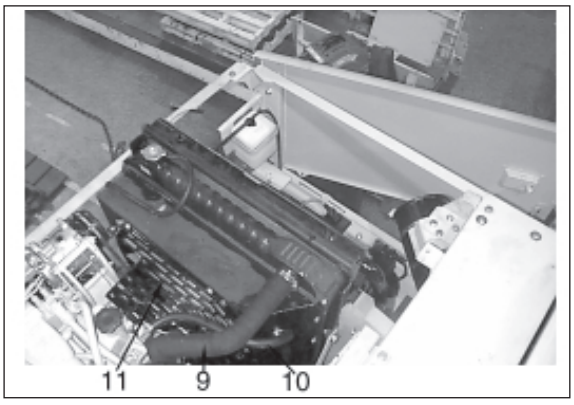
2. Disconnect small diameter from radiator (near cap) to reservoir tank.

3. Disconnect cooler hoses (4) and (5).

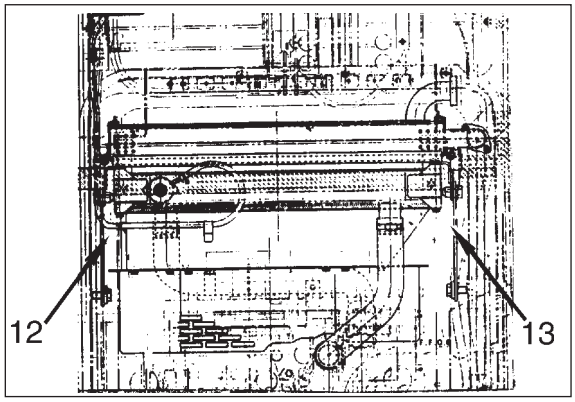


4. Disconnect radiator upper hose (9), and remove clamps of heater hose (10) from right side of radiator assembly.

5. Remove fan guard (11).



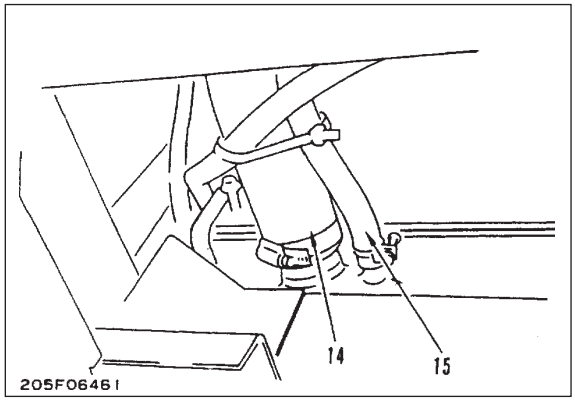
6. Disconnect radiator support rods (12) and (13).
   ★ Loosen the mounting bolts, then remove the top mounting bolts and move the rods towards the rear of the engine.



7. Disconnect radiator lower hose (14) and heater hose (15).
   ★ The radiator lower hose is fixed by a clamp to the radiator, so always disonnect the clamp.

8. Sling radiator and hydraulic oil cooler assembly, remove 4 bottom mounting bolts, then lift off radiator and hydraulic oil cooler assembly.
   ★ When raising the radiator and hydraulic oil cooler assembly, check the position carefully and do not let it hit the fan when removing it.

   kg Radiator • hydraulic oil cooler assembly : 115 kg



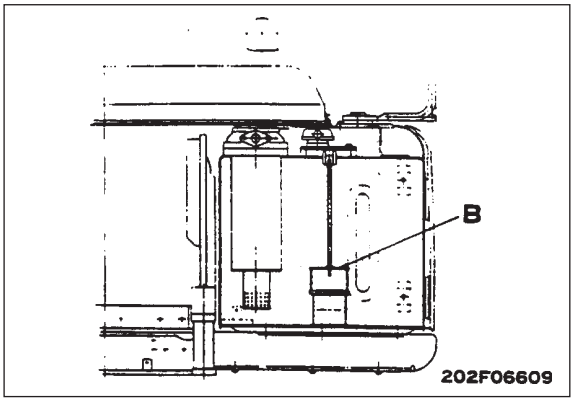
INSTALLATION OF RADIATOR • HYDRAULIC OIL COOLER ASSEMBLY

- Carry out installation in the reverse order to removal.

- Refilling with water
  ★ Add water through the water filler to the specified level. Run the engine to circulate the water through the system. Then check the water level again.

- Refilling with oil (hydraulic tank)
  ★ Add oil through the oil filler to the specified level. Run the engine to circulate the oil through the system. Then check the oil level again.

REMOVAL OF ENGINE • HYDRAULIC 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.

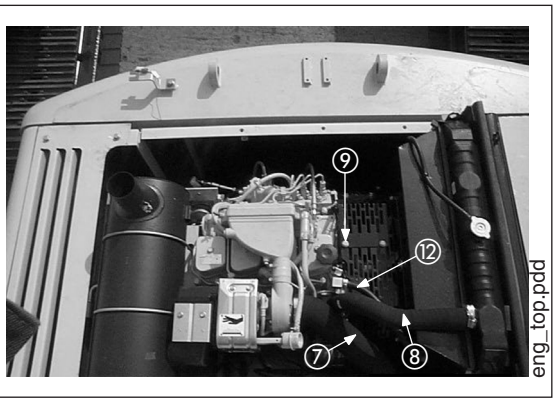
- Remove the hydraulic tank strainer, and using tool **B**, stop the oil.
  - when not using tool **B**, remove the drain plug, and drain the oil from the hydraulic tank and inside the system.

    Hydraulic tank: Approx. 120 ℓ



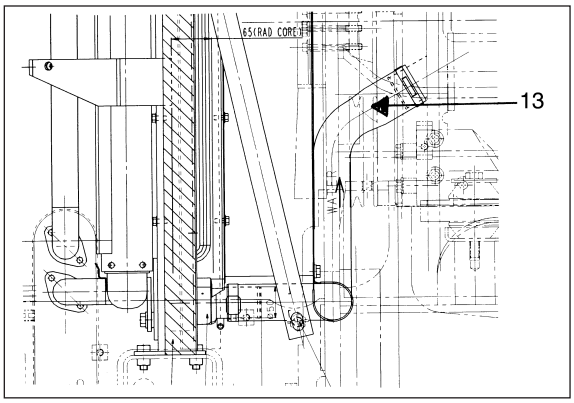
- Drain engine coolant.

1. Remove pump bottom cover and engine bottom cover.
2. Remove engine hood and remove pump top cover.
3. Remove control valve top cover, partition, and exhaust muffler cover .
4. Disconnect alternator wiring (5).
   ★ Mark the wiring with tags to show the connection position.
5. Disconnect engine oil pressure sensor wiring.
6. Disconnect intake hose (7).
7. Remove radiator inlet hose (8).
8. Remove fan guard (9) and belt guards.
9. Loosen fan belt, remove connecting bolt at pulley and spacer, then remove fan.

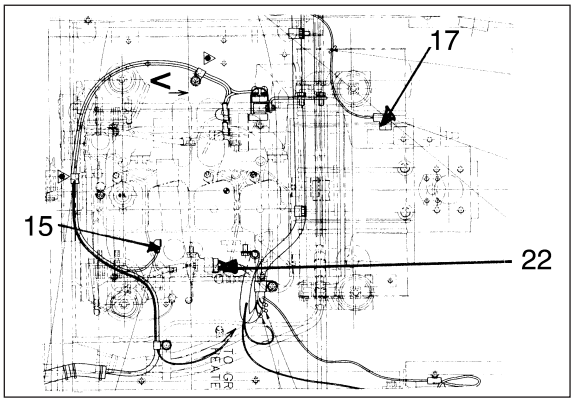


※ 1

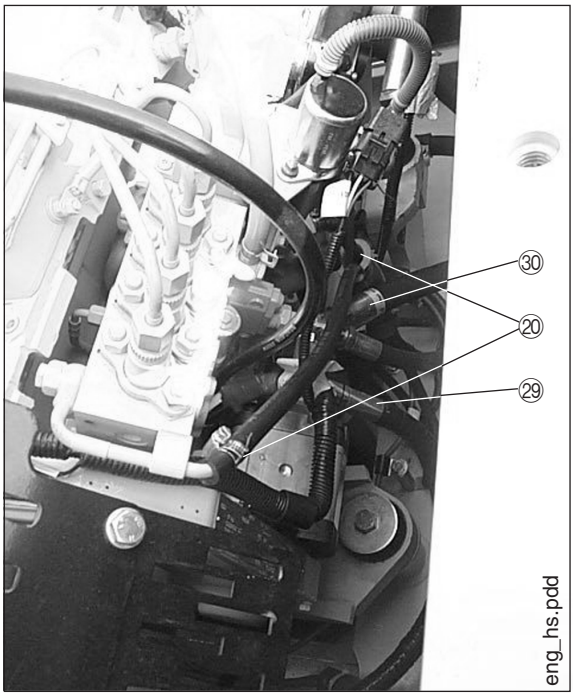
10. Disconnect heater hose (12).
11. Disconnect water pump inlet hose (13).

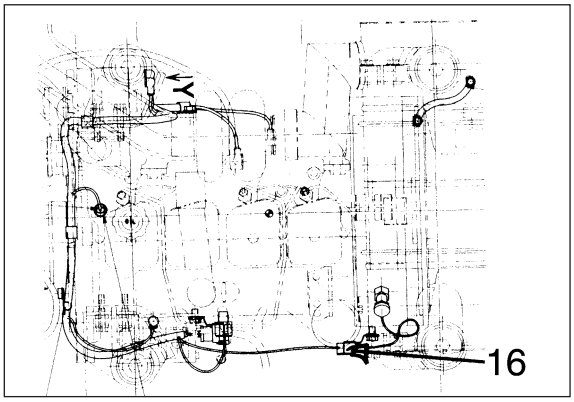


12. Disconnect electrical intake air heater wiring (15).
13. Disconnect governor motor wiring connector (16)
14. Disconnect TVC • LS valve wiring connector (17).

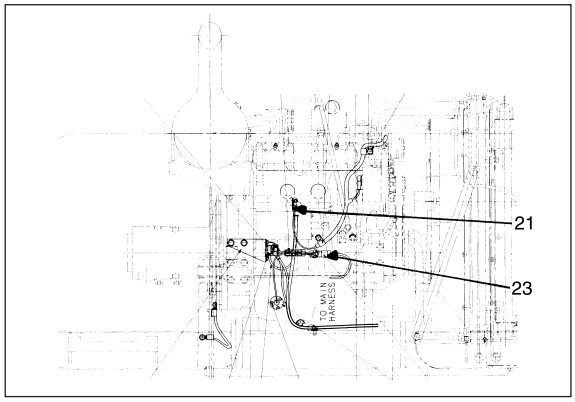


15. Disconnect fuel hoses (20)
    ★ When the hose is disconnected, fuel will flow out, so insert a wooden plug into the hose to prevent the fuel from leaking out.
16. Disconnect brake steel pump suction hose (29) and delivery hose (30).
17. Disconnect starter motor wiring (21).

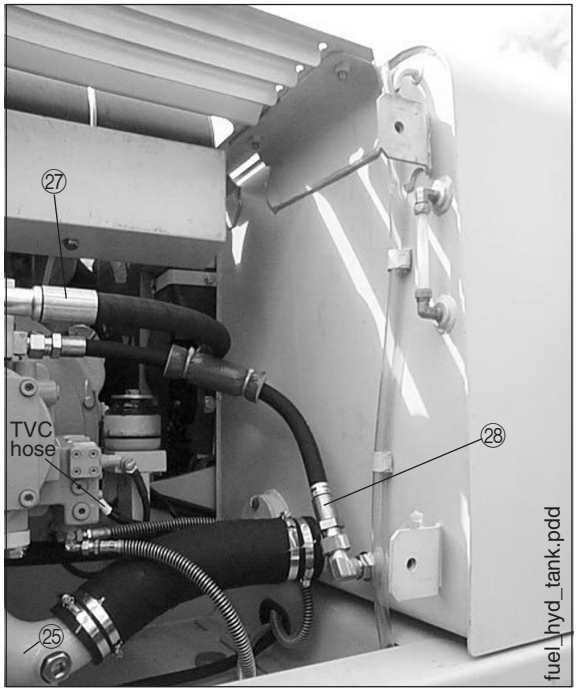




18. Disconnect engine main harness wiring connector (22).
19. Disconnect starting motor wiring connector (23).



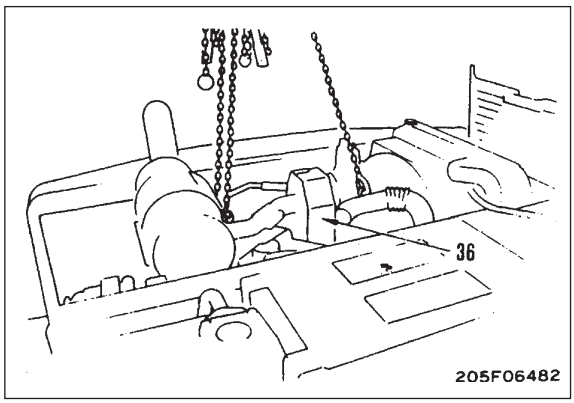
20. Disconnect main pump suction tube (25).
21. Disconnect main pump outlet hose (27).
22. Disconnect main pump drain hose (28).
23. Disconnect TVC • LS valve inlet hoses at side of main pump.



24. Disconnect engine speed wiring connector.
25. Disconnect earth wiring.

26. Remove mount bolt, then lift off engine and hydraulic pump assembly (36) slowly. ❋ 3
    ★ When removing the engine and hydraulic pump asembly, check that all wiring and piping has been disconnected, and be careful not to hit any part when removing.

kg Engine • hydraulic pump assembly: 600 kg



INSTALLATION OF ENGINE • HYDRAULIC PUMP ASSEMBLY

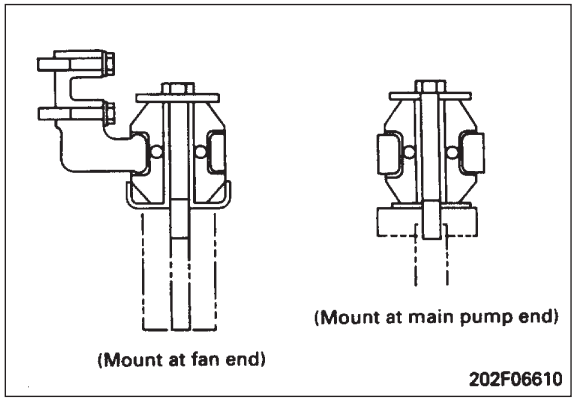
- Carry out installation in the reverse order to removal.

※ 1
★ Adjust the fan belt tension.
For details, see TESTING AND ADJUSTING, Testing and adjusting fan belt tension.

※ 2
★ Check that the O-ring is not damaged or deteriorated, then connect the hoses.

※ 3
★ Set the engine mount rubber as shown in the diagram, then install the engine and hydraulic pump assembly.

kgm Engine mount mounting bolt:
276.9 ± 31.9 Nm(28.25 ± 3.25 kgm)



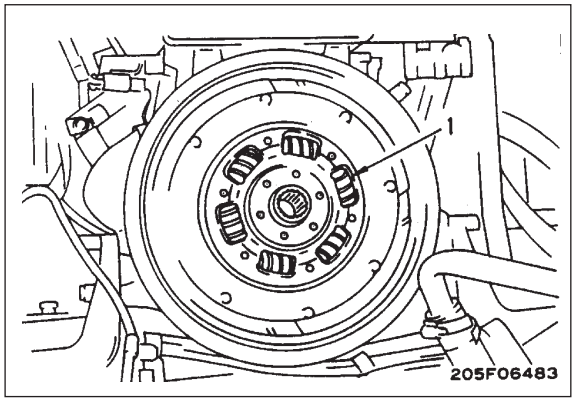
- Refilling with water
  ★ Add water through the water filler to the specified level.
  Run the engine to circulate the water through the system. Then check the water level again.

- Refilling with oil (hydraulic tank)
  ★ Add oil throught 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 hydraulic pump.
  For details, see TESTING AND ADJUSTING, Bleeding air.

- Fill with refrigerant (R-134a).

REMOVAL OF DAMPER ASSEMBLY



1. Remove main pump assembly. For details, see REMOVAL OF MAIN PUMP ASSEMBLY.
2. Remove damper assembly (1).

※ 1

INSTALLATION OF DAMPER ASSEMBLY

- Carry out installation in the reverse order to removal.

※ 1

kgm Damper mounting bolt;
171.05 ± 7.35 Nm (7.25 ± 0.75 kgm)

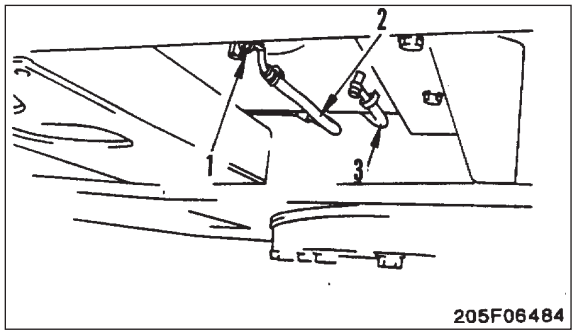
Thread of Damper mounting bolt;
Thread tightener (LT-2)

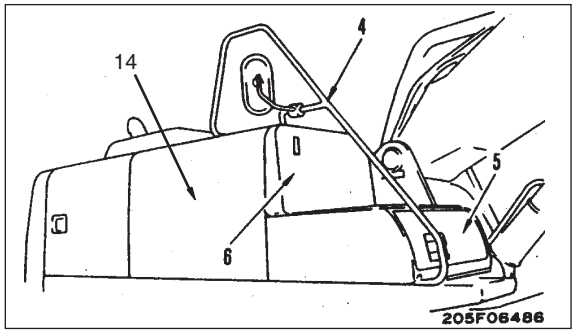
REMOVAL OF FUEL / HYDRAULIC TANK ASSEMBLY

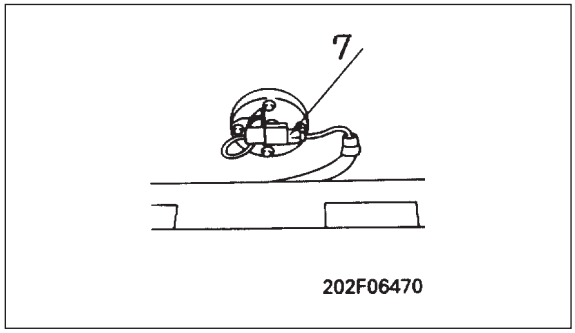
⚠ Disconnect the cable from the negative (-) terminal of the battery.

1. Loosen drain valve (1) of fuel tank and drain fuel.
   Drain oil from hydraulic tank
   Fuel tank: Approx. 250 ℓ (when tank is full)
   Hydraulic tank: Approx 120 ℓ
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 refueling pump is fitted disconnect hose from tank tube.
6. Remove engine hood assembly pump top cover and C/V top cover.
7. Remove suction hose (8)
8. Remove steerpump hose (9) and brake hose (10)
9. Remove drain hoses (11) (12) & (13)
10. Remove mounting bolts, and lift off fuel tank assembly (14). ※ 1

   kg Fuel tank assembly: 180 kg





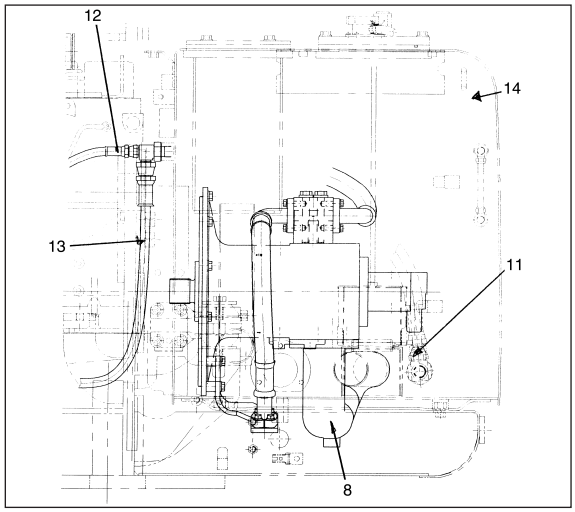


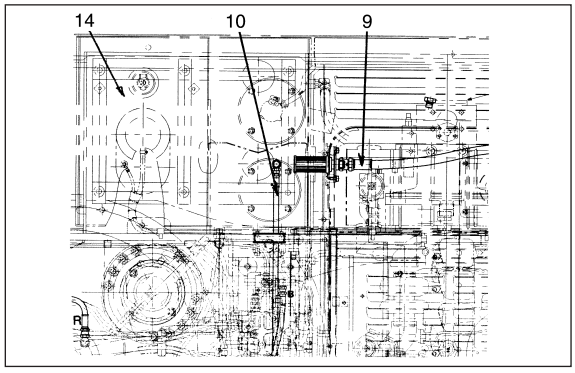
INSTALLATION OF FUEL / HYDRAULIC TANK ASSEMBLY

- 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.
- Refilling with oil (fuel tank)
  Add fuel.
- Bleeding air
  ★ Bleed the air.
  For details, see TESTING AND ADJUSTING, Bleeding air.





REMOVAL OF CENTER SWIVEL JOINT ASSEMBLY

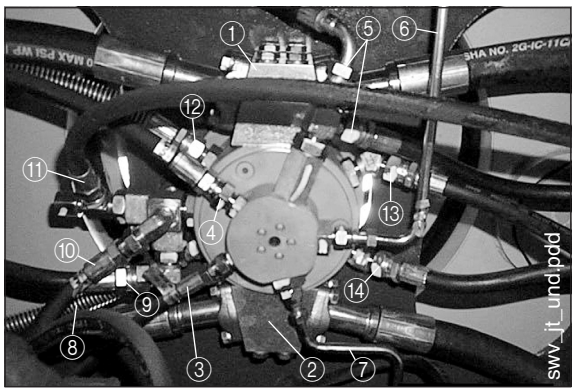
⚠ Lower the work equipment completely to the ground and stop the engine. Then loosen the oil filter cap slowly to release the pressure inside the hydraulic tank.

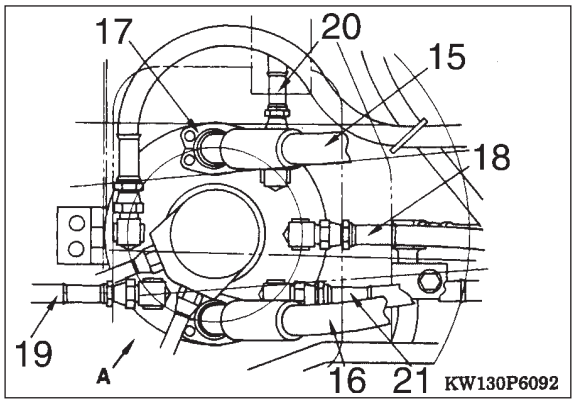
✶ Mark all the piping with tags to prevent mistakes in the mounting position when installing.

1. Disconnect blocks (1) and (2) between travel motor swivel joint.
2. Disconnect pilot hoses (3), (4) and (5) and brake pipes (6) and (7).
3. Disconnect drain and steering hoses (8) (9) (10) (11) (12) (13) (14)

4. Disconnect hoses (15) (16) (17) & (18) between control valve and swivel joint.
5. Disconnect steering hoses (19) and (20) and drain hose (21).
6. Disconnect brake hoses (22) (23) and (24).
7. Disconnect travel speed selector hose (25) and suspension lock hose (26).
8. Remove center swivel joint assembly (27). ❄ 1

kg Center swivel joint assembly: 83 kg





INSTALLATION OF CENTER SWIVEL JOINT ASSEMBLY

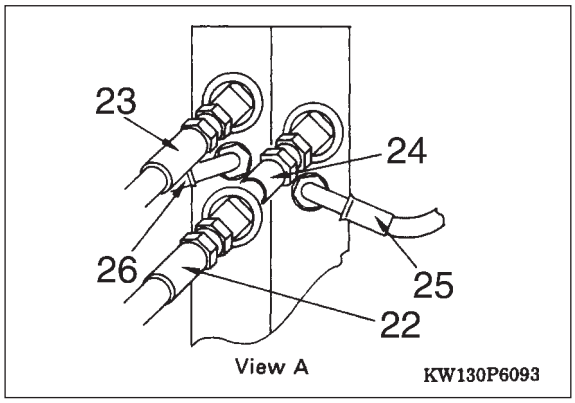
- Carry out installation in the reverse order to removal.

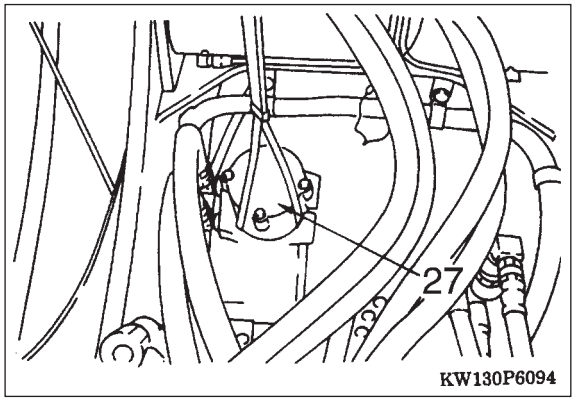
❄ 1 Tread of swivel joint mounting bolt:
Tread tightener (LT-2)

kgm Swivel joint mounting bolt:
277±32 Nm (28.25±3.25 kgm)

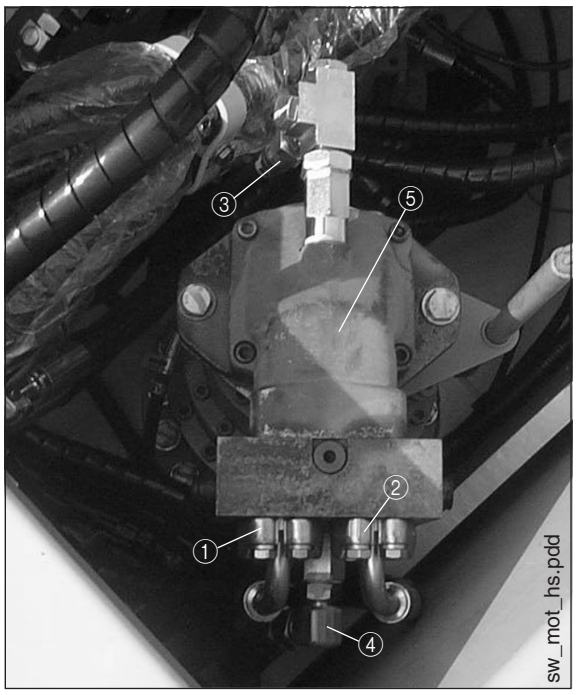
- Refilling with oil (hydraulic tank)
  - ✶ Add oil through the oil filter to the specified level. Run the engine to circulate the oil through the system. Then check the oil level again.

- Bleeding air
  - ✶ Bleed the air from the travel motor. For details, see TESTING AND ADJUSTING, Bleeding air.





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.

3. Disconnect swing motor inlet and outlet hoses (1) and (2).

4. Disconnect drain hose (3).

5. Disconnect suction hose (4).

6. Remove swing motor assembly (5). ❄ 1

kg Swing motor assembly 30 kg

INSTALLATION OF SWING MOTOR ASSEMBLY

- Carry out installation in the reverse order to removal.

- Refilling with oil (hydraulic tank)
  - ★ Add oil through the oil filler to the specified level. Run the engine to circulate the oil through the system. Then check the oil level again.

★ Bleeding air
  - ★ Bleed the air from the swing motor. For details, see TESTING AND ADJUSTING, Bleeding air.

❄ 1 Swing motor mounting bolt:
kgm 277 ± 32 Nm (28.3 ± 3.3 kgm)

REMOVAL OF SWING MACHINERY ASSEMBLY

1. Remove swing motor assembly. For details, see REMOVAL OF SWING MOTOR ASSEMBLY.

2. Using eyebolts ①, remove swing machinery assembly (1). ※ 1
   ★ When removing the swing machinery assembly, lift off slowly and be careful not to damage the hoses.

   kg Swing machinery assembly: 120 kg

INSTALLATION OF SWING MACHINERY ASSEMBLY

- Carry out installation in the reverse order to removal.

※ 1

kgm Swing machinery mounting bolt:
548.8 ± 49 Nm (56 ± 5 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.

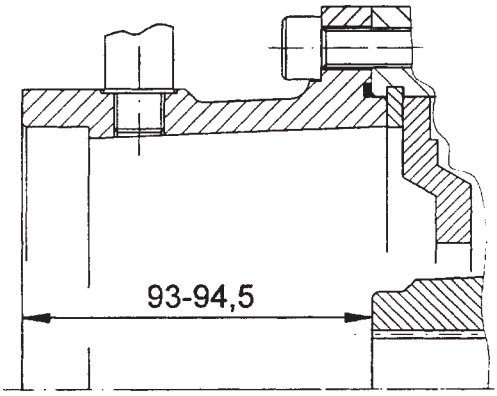
- Bleeding air
  ★ Bleed the air from the swing motor. For details, see TESTING AND ADJUSTING, Bleeding air.

FITTING OF THE HYDRAULIC MOTOR

Clean the mating area and the pilot diameter of the gearbox where the motor is to be mounted.
After mounting the motor, verify, through of a depth slide gauge, the axial dimension of the gearbox measured from input side of the motor adaptor flange to the brake shaft:

Axial dimension = 93 - 94,5 mm.

Place the hydraulic motor and tighten the 2 hexagonal head screws M16 x 40, grade 8.8, by a torque wrench at a torque of 21,5 daNm.

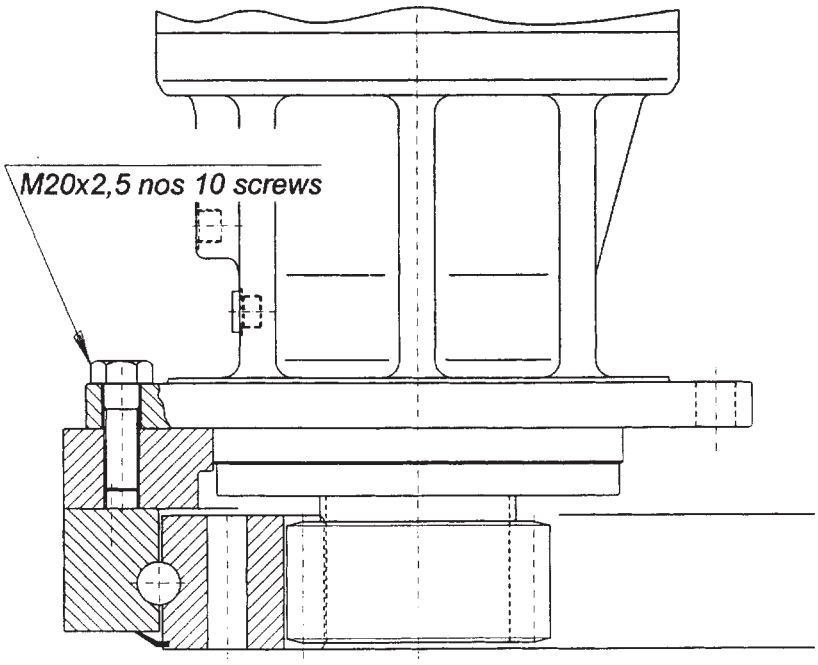


Dwg. Verify the axial dimension of the gearbox

INSTALLATION OF THE SLEW DRIVE TO THE MACHINE

a) Clean the mating surfaces from oils or paint and fit the gearbox to the undercarriage.

b) Fix the slew drive to the frame with 10 screws M20 minimum grade 8.8, tightened by a torque wrench at a torque of 41,5 daNm.

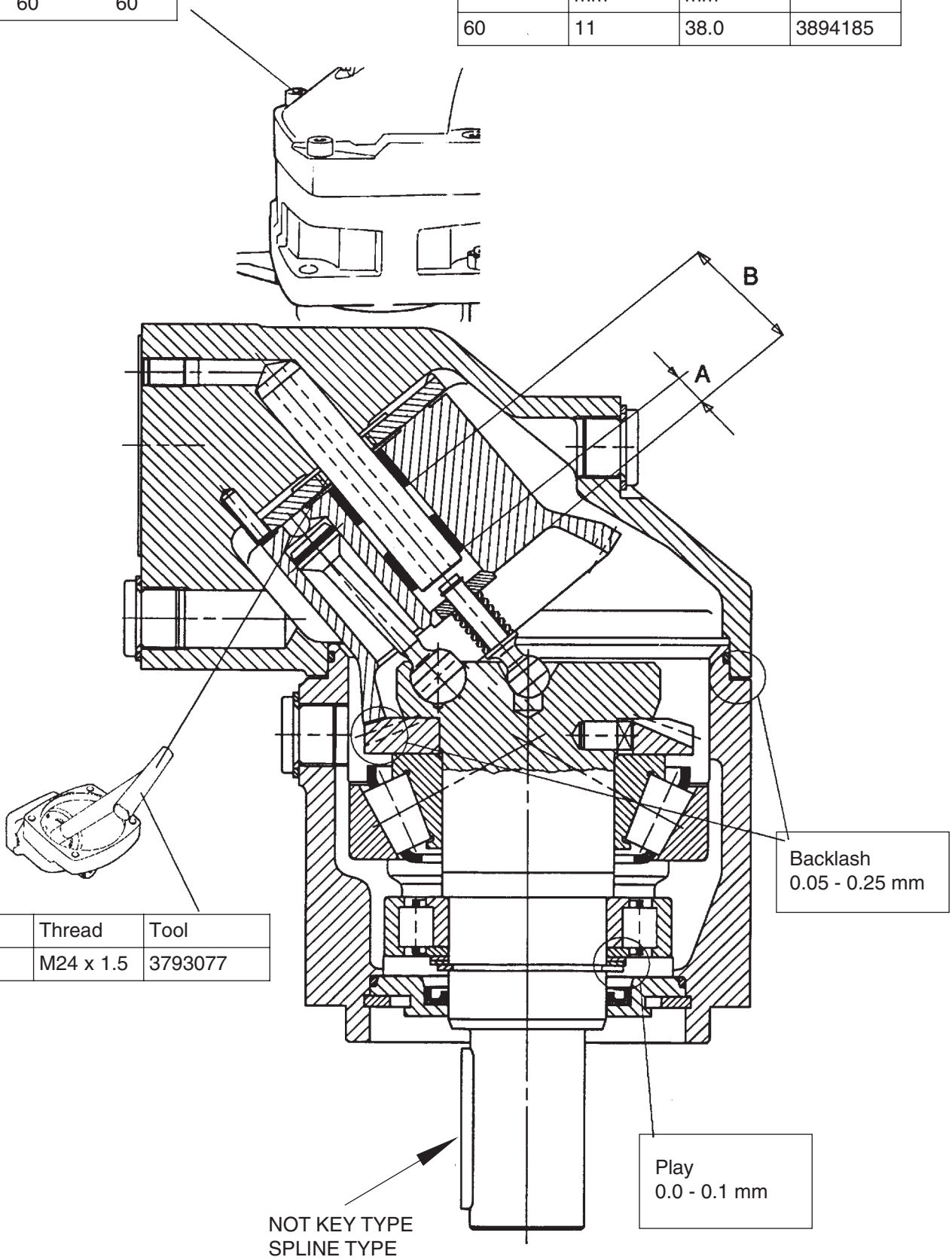


Dwg. - Gearbox installation scheme

DISASSEMBLY AND ASSEMBLY OF SWING MOTOR

F12	Nm ± 10
60	60

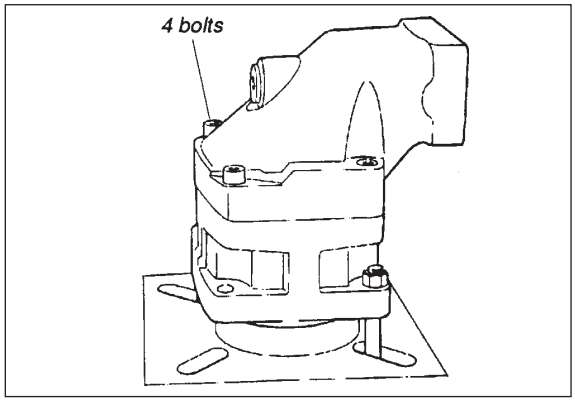
F12	A±0.25 mm	B±0.25 mm	Tool
60	11	38.0	3894185



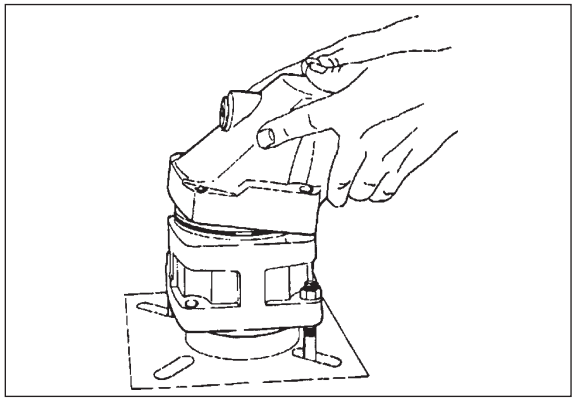
F12	Thread	Tool
60	M24 x 1.5	3793077

Dissasembly

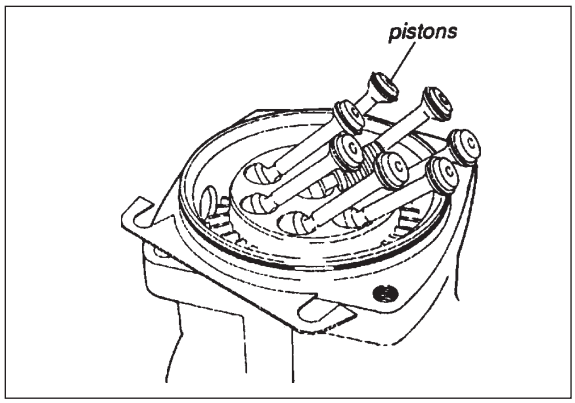
Put the unit in a bench with a hole or place it on a fixture for assembly Loosen the 4 bolts.



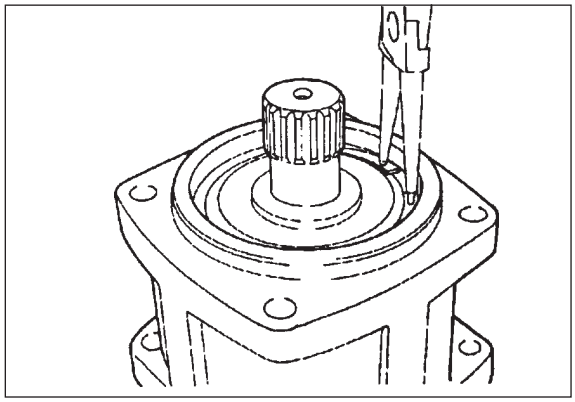
Lift off the housing



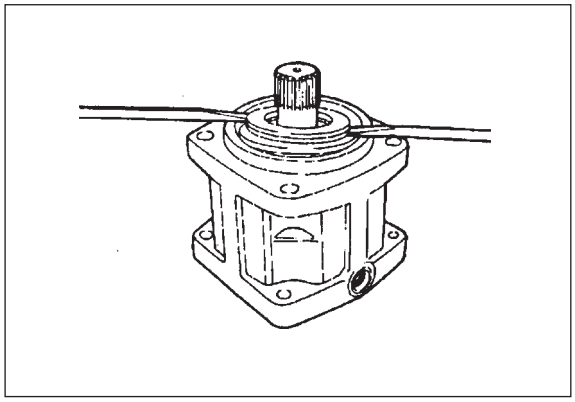
Lift out the pistons



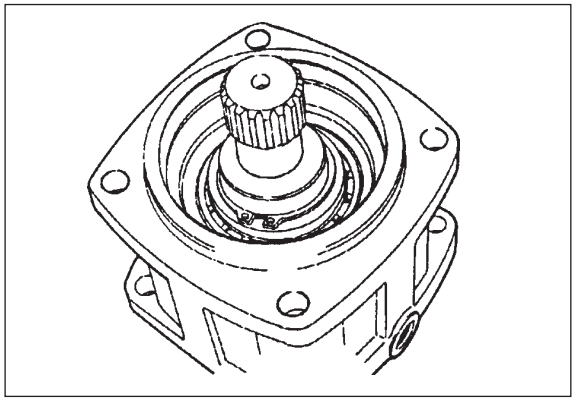
Turn the bearing housing upside down and loosen the retaining ring holding the seal ring carrier.



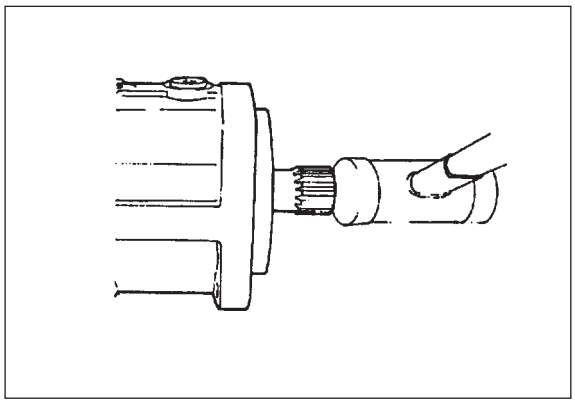
Loosen the seal carrier using two screwdrivers.



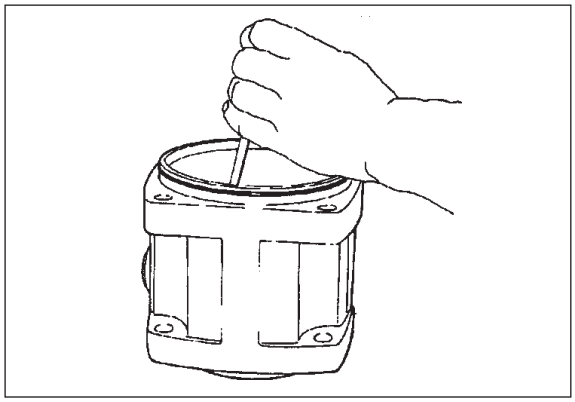
Loosen the retaining ring holding the bearing and bearing play adjustment washers.



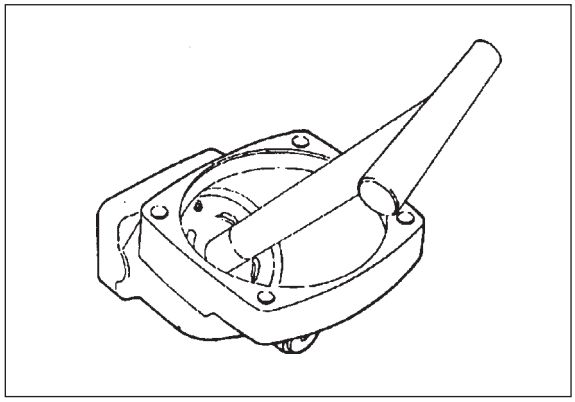
Push out the shaft with a press or a plastic mallet.



If it is necessary to remove the bearing races, use a drift or a press.



For disassembly the valve plate has got a thread in the centre. Use the special tool to pull it out.

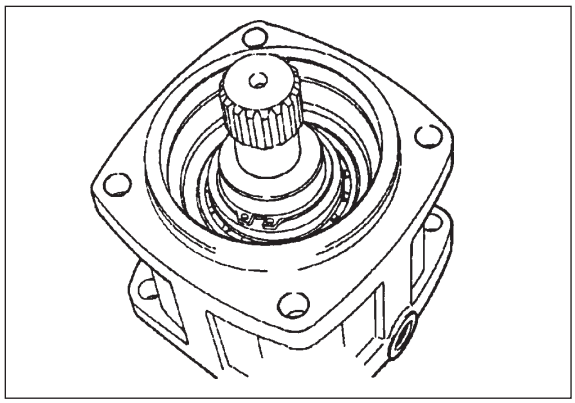


Thread specification:

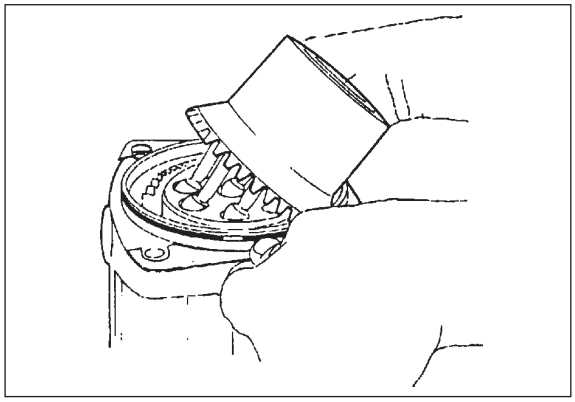
F12	Thread	Tool
60	M24x1.5	3793077

Assembly

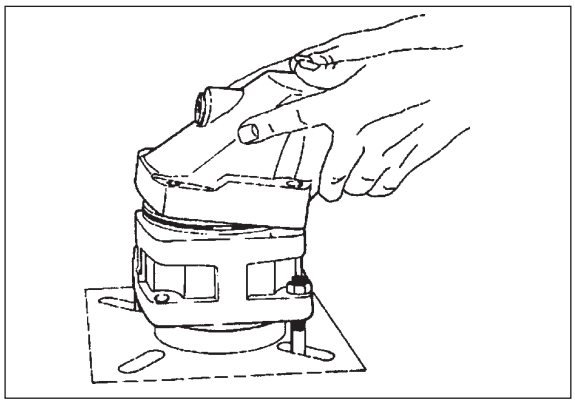
Push the shaft into the bearings in the housing. Use as many washers as needed to just allow the retaining ring on the shaft to enter into its groove.



Install pistons, cylinder barrel support and cylinder barrel.
Note: The shaft has got one tooth marked with a punchmark and the barrel has got one space marked.
It is absolutely necessary that these are mating to ensure correct alignment for the pistons in the cylinders. Also choose correct adjustment shim to ensure correct back-lash.



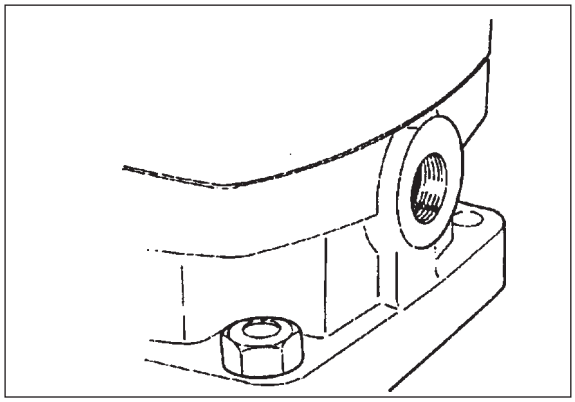
Install the barrel housing and tighten the screws.



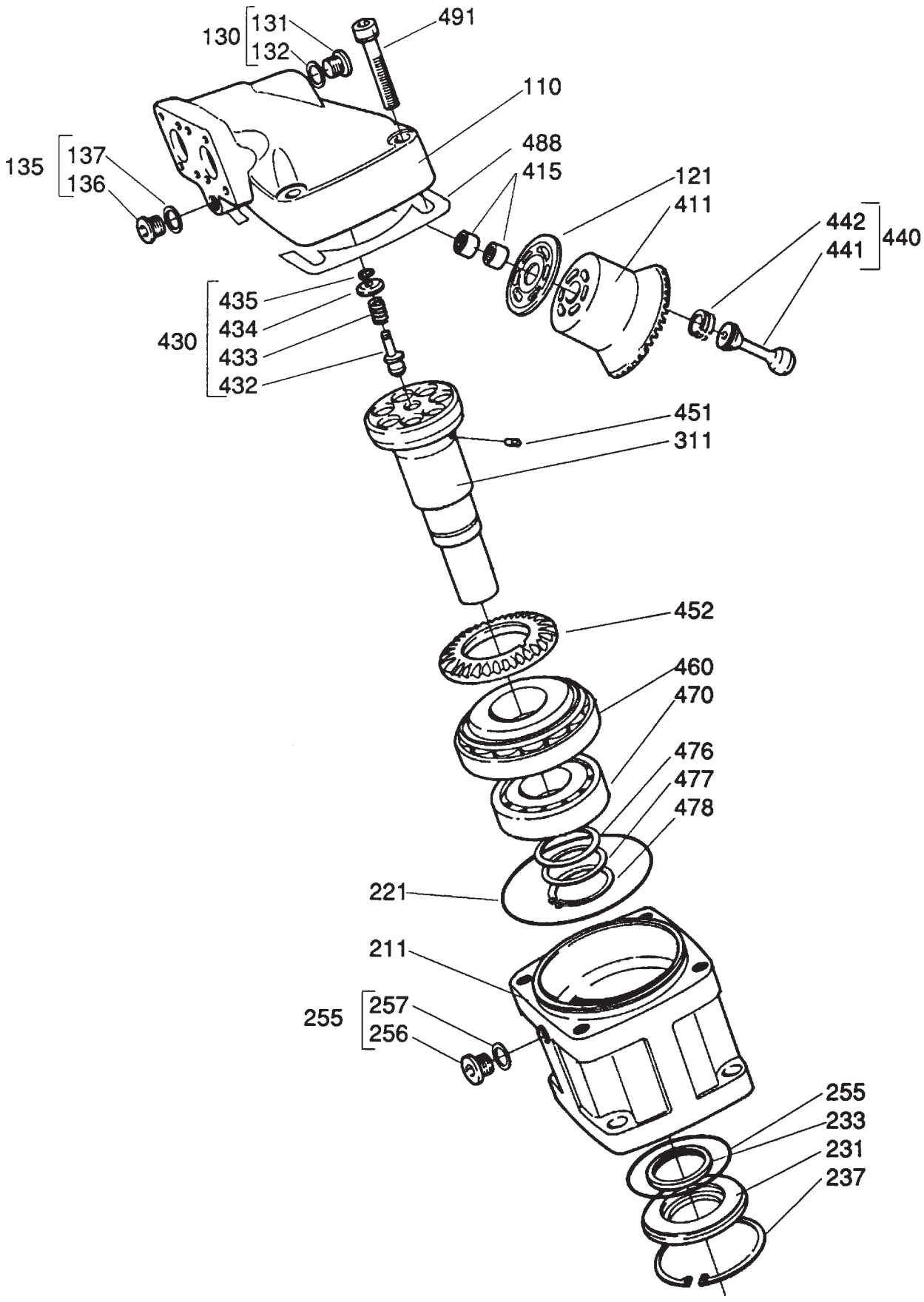
Backlash and correct timing can be checked through the drainhole.

Correct tightening torque is:

F12 Nm ± 10	
60	60



Item	*Title*
110	BARREL HOUSING ASSY
121	VALVE PLATE
131	BLEEDER PLUG
132	SEAL WASHER
211	BEARING HOUSING
221	O-RING
225	O-RING
229	O-RING
231	SEAL CARRIER
233	SHAFT SEAL
237	RETAINING RING
256	PLUG
257	SEAL WASHER
311	SHAFT TYPE
411	CYLINDER BARREL
415	NEEDLE BEARING
430	BARREL SUPPORT
440	PISTON ASSY
442	PISTON RING
451	GUIDE PIN
452	RING GEAR
460	TAP ROL BEARING
470	CYL BEARING
476	SPACER WASHER
478	RETAINING RING
488	SHIM
491	HEX SOCKET SCREW


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121
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137
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460
470
476
477
478
221
211
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257
256
255
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237

REMOVAL OF REVOLVING FRAME 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 filter cap slowly to relaese 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. 120 ℓ

2. Remove 2 boom cylinder assemblies.
   For details, see REMOVAL OF BOOM CYLINDER ASSEMBLY.

3. Remove work equipment assembly.
   For details, see REMOVAL OF WORK EQUIPMENT ASSEMBLY.

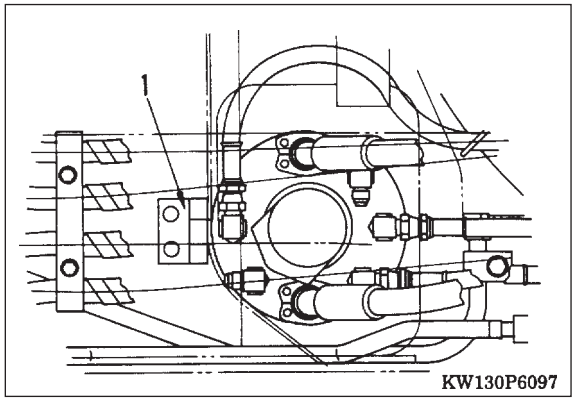
4. Remove counterweight assembly.
   For details, see REMOVAL OF COUNTERWEIGHT ASSEMBLY.

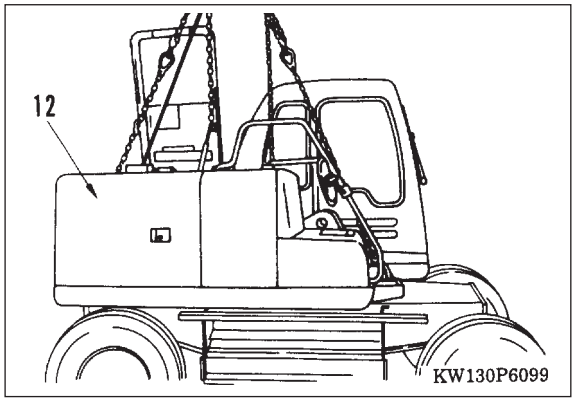
5. Disconnect top mounting hoses of swivel joint assembly. For details, see REMOVAL OF SWIVEL JOINT ASSEMBLY. Remove torque arm (1).

6. Remove mounting bolts, then lift off revolving frame assembly (12). ※ 1
   ✶ Leave 2 bolts ① 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:
   7100 kg (without work equipment)




12
KW130P6099

INSTALLATION OF REVOLVING FRAME ASSEMBLY

- Carry out installation in the reverse order to removal.

※ 1

Mating surface of swing circle:
Gasket sealant (LG-1)

Thread of revolving frame mounting bolt:
Thread tightener (LT-2)

kgm Revolving frame mounting bolt:

Item / Model	Mounting bolt		Mounting bolt tightening torque
	Size	Q'ty	Nm (kgm)
PW170-6	20-105	26	549 ± 59 (56 ± 6)

- 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 SWING CIRCLE ASSEMBLY

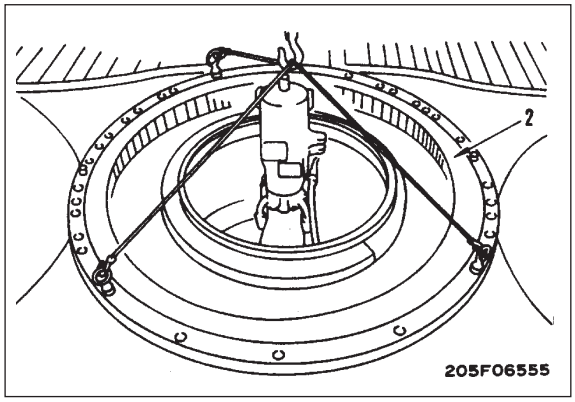
1. Remove revolving frame assembly. For details, see REMOVAL OF REVOLVING FRAME ASSEMBLY.

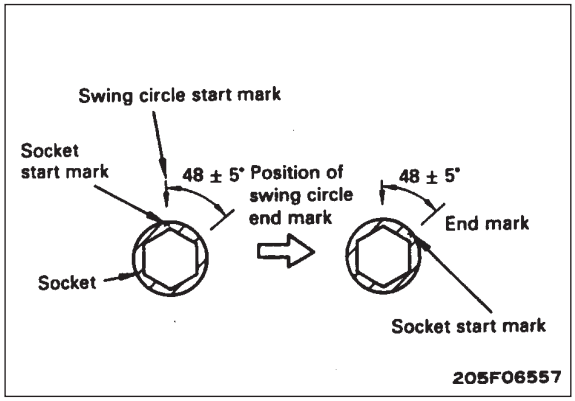
2. Remove swing circle mounting bolts (1), leaving 1 bolt each in front and rear direction. ※ 1
   ★ Swing circle assembly mounting bolts: 30

3. Sling swing circle assembly (2) at three points, then remove remaining mounting bolts.

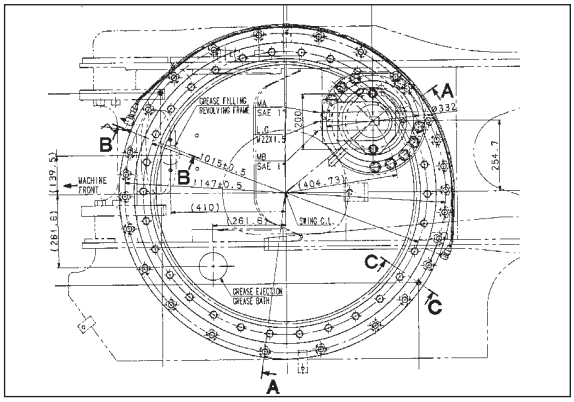
4. Lift off swing circle assembly (2). ※ 2

   kg Swing circle assembly 240 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)

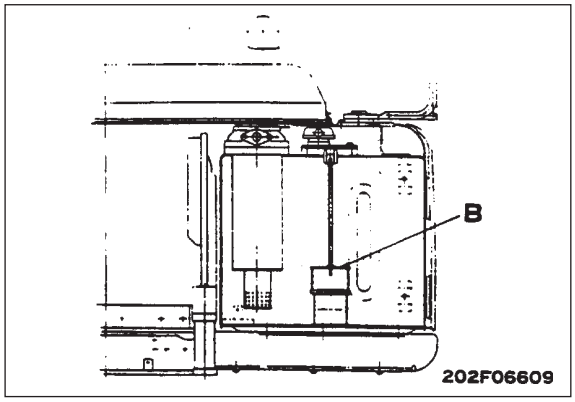
kgm Swing circle mounting bolt:
549 ± 49Nm (56 ± 6 kgm)

※ 2

★ Set the soft zone **S** mark on the inside ring of the inner race facing the right side as shown in the diagram, then install to the track frame.

Swing circle: Grease (G2-LI) 8ℓ

REMOVAL OF MAIN PUMP ASSEMBLY



⚠ Disconnect he 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. 120 ℓ

2. Remove engine hood, and remove main pump top cover, then remove exhaust muffler covers (1) and (2).

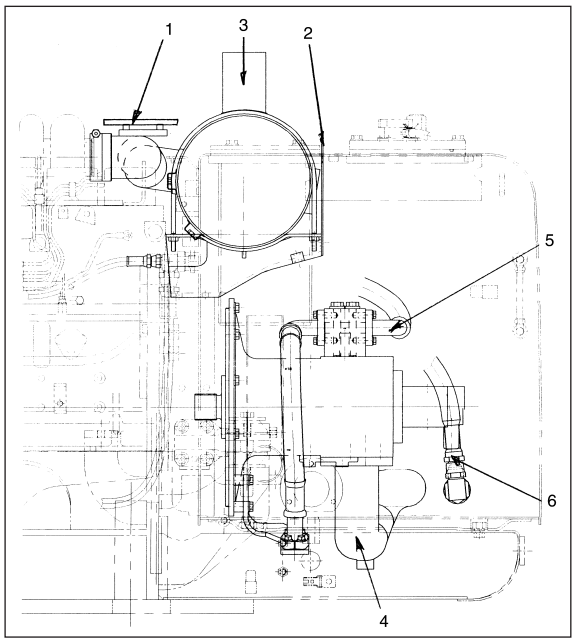
3. Disconnect connecting pipe portion at turbocharger end, and remove exhaust muffler (3) together with bracket.

4. Disconnect main pump suction tube (4).

5. Disconnect main pump outlet hose (5)

6. Disconnect main pump drain hose (6).

7. Disconnect TVC • LS valve inlet hoses (7) & (8).



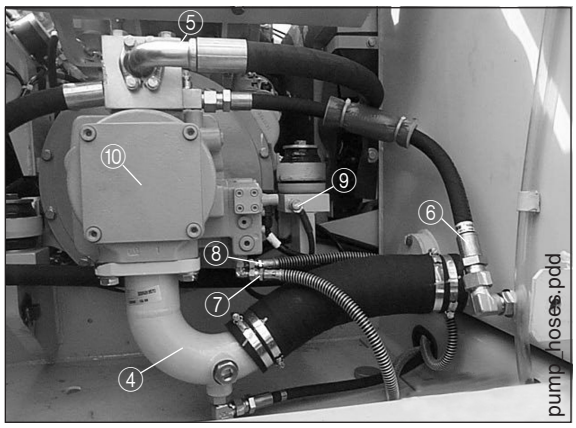
8. Disconnect TVC solenoid wiring plug.

9. Disconnect ground connection (9).

10. Sling main pump assembly (10), remove mounting bolts, then use forcing screws ⑨ to remove.

※ 1

kg Main pump assembly: 100 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)

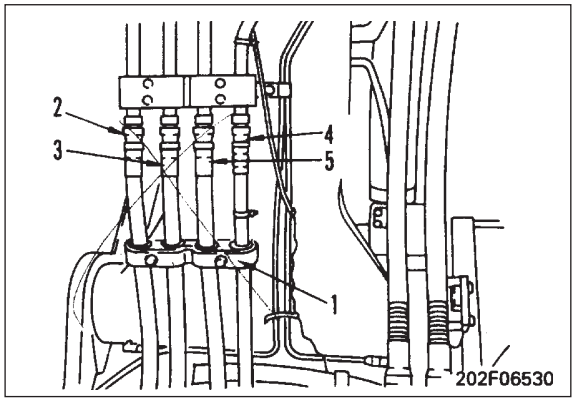
- Refilling with oil (hydraulic tank)
  ★ Add oil throught the oil filler to the specified level.
  Run the engine to circulate the oil through the system. Then check the oil level again.

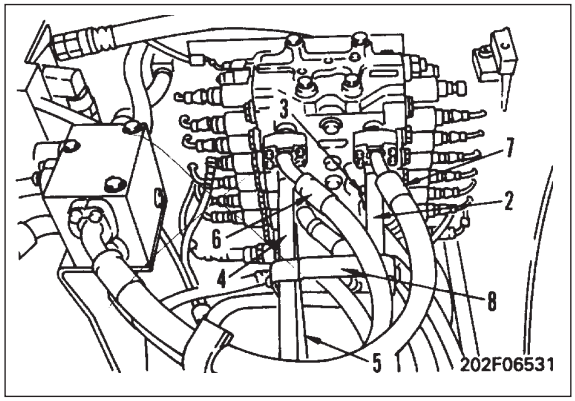
- Bleeding air
  ★ Bleed the air from main pump.
  For details, see TESTING AND ADJUSTING, Bleeding air.

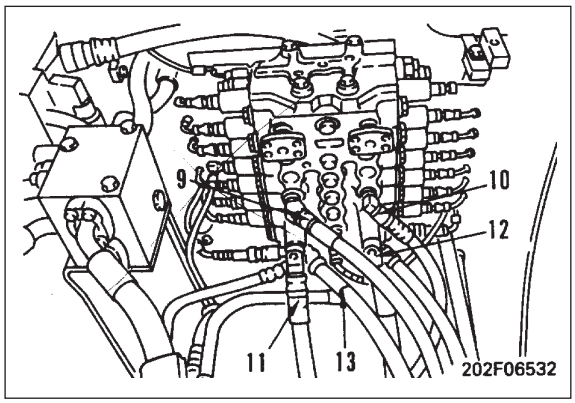
REMOVAL OF CONTROL VALVE ASSEMBLY

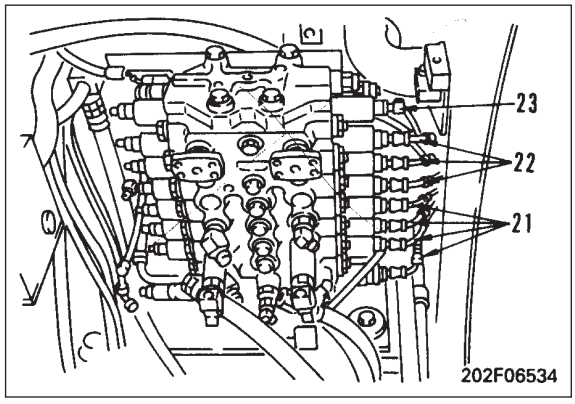
⚠ Release the remaiing pressure in the hydraulic circuit.
For details, see TESTING AND ADJUSTING, Releasing pressure in hydraulic circuit.

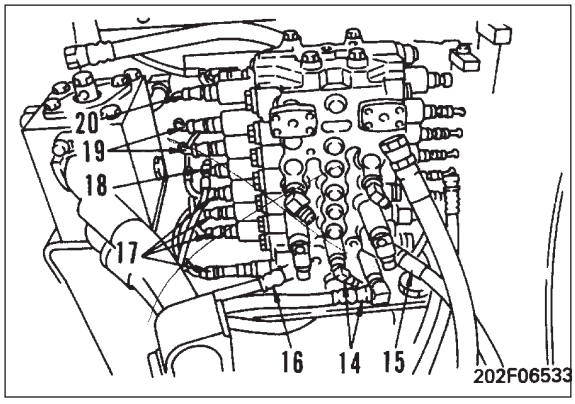
1. Remove engine room partition plate and chassis bodywork cover above control valve assembly.
2. Remove clamp (1), then disconnect hoses (2), (3), (4), and (5).
3. Disconnect hoses (6) and (7).
4. Remove clamp (8), then remove hoses (2), (3), (4), and (5).
5. Disconnect hoses (9), (10), (11), (12), 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).









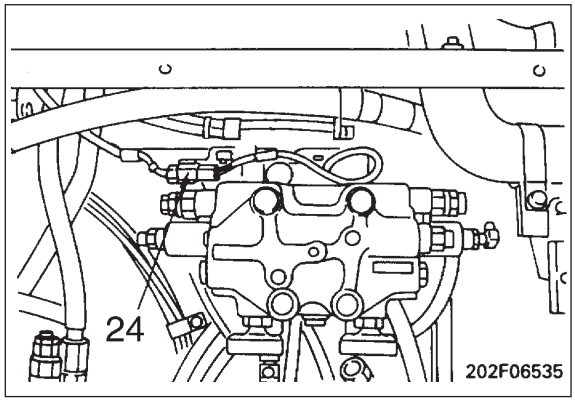


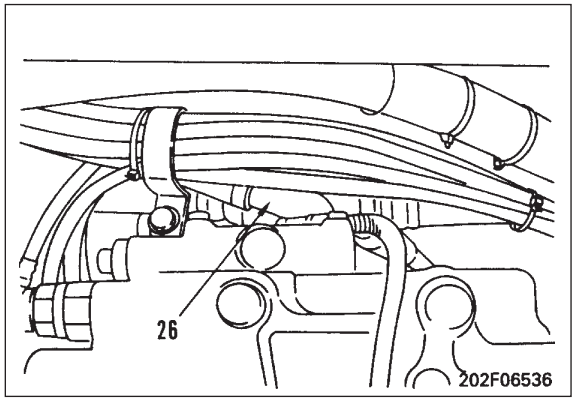
9. Remove connector (24) from clip, then disconnect it.
   ★ Disconnect the wiring harness form the harness clamps (3 places)

10. Disconnect hose (26).

11. Remove mounting bolts, and lift off control valve assembly (27).

    kg Control valve assembly : 70 kg



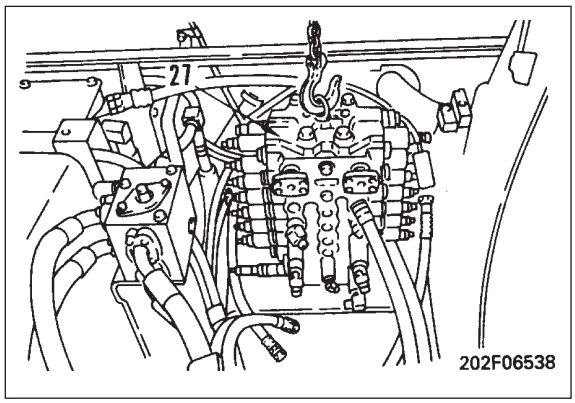


INSTALLATION OF CONTROL VALVE ASSEMBLY

- 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 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).

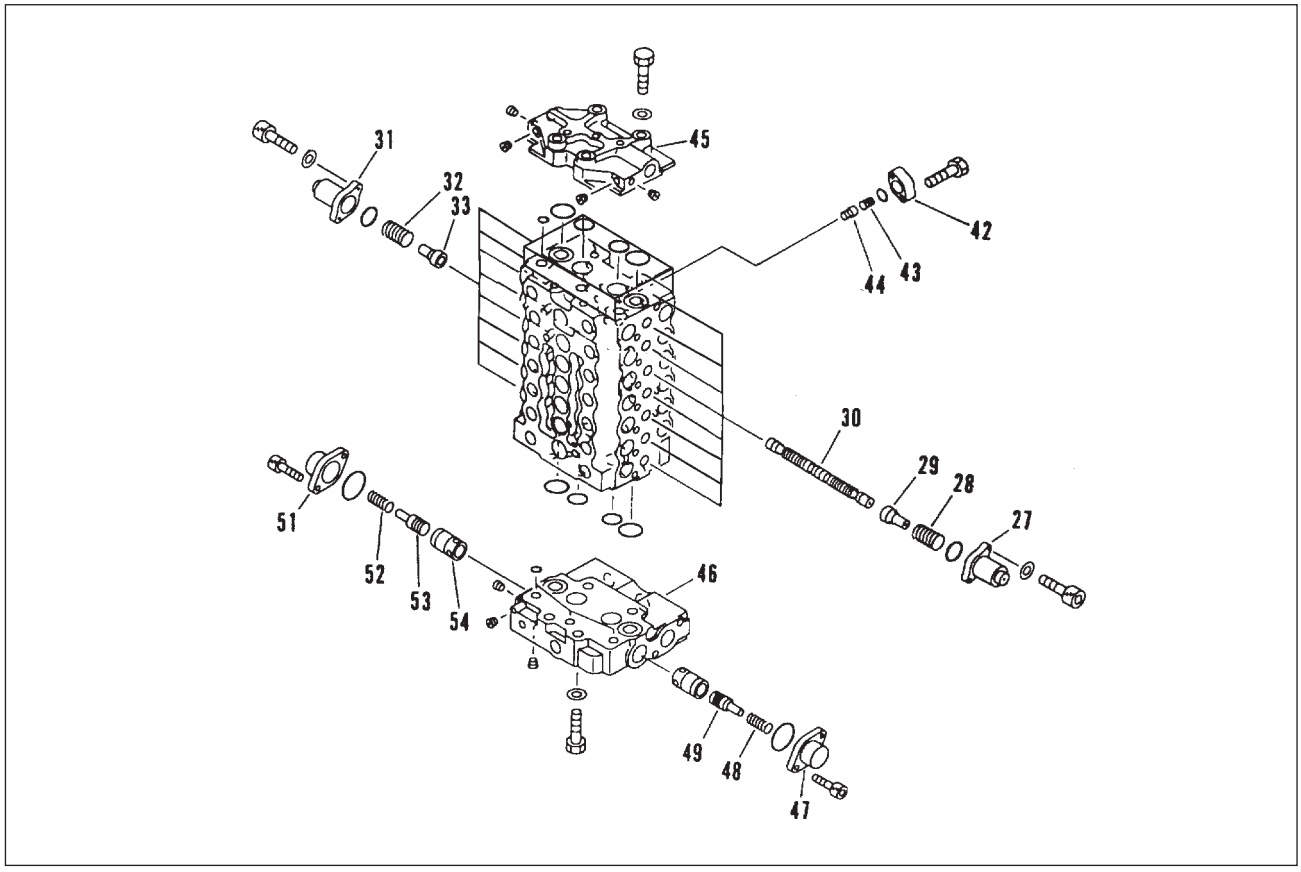
3. Pressure compensation valves
★ Before removing any pressure compensation valve, check and mark its mounting position.
1) Remove bucket CURL pressure compensation valve (11), arm IN pressure compensation valve (11), boom LOWER pressure compensation valve (11) + 2nd boom IN valve, travel + stabiliser travel pressure compensation valve (12), Stabilizer pressure compensation valve (12), and swing RIGHT pressure compensation valve (13) and service valve pressure compensation valve (14).
★ 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 + 2nd boom OUT valve compensation valve (19), boom RAISE pressure compensation valve (19), travel pressure compensation valve (20), Stabilizer pressure compensation valve (20), and swing LEFT pressure compensation valve (21), and service valve pressure compensation valve (22).
★ After removing the pressure compensation valves, remove check valve (24) from each pressure compensation valve mount.

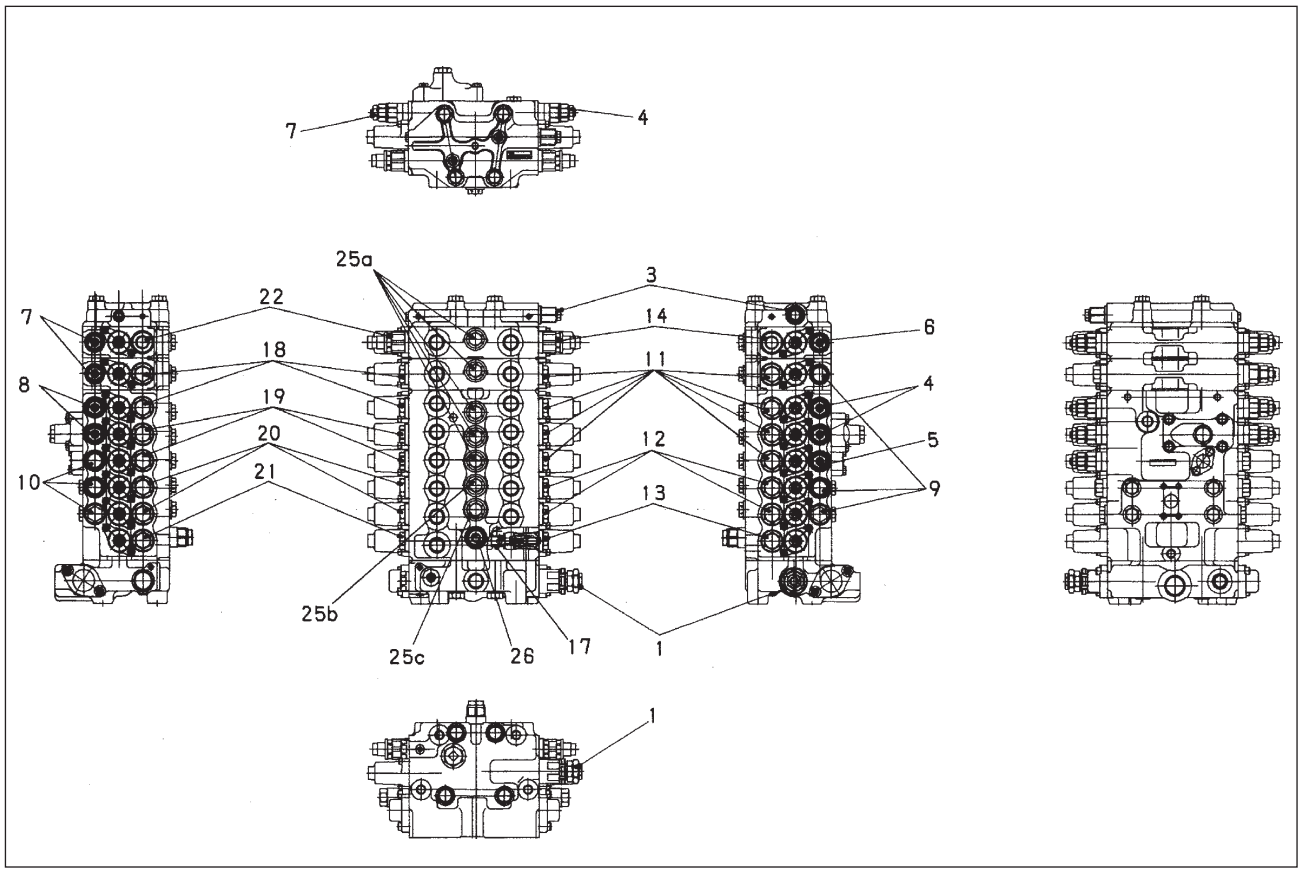
4. LS shuttle, LS select valve
Remove LS shuttle valves (25a) and (25b), and LS select valve (26).
★ Mark the mounting positions of LS shuttle valves (25a), and (25b), and be careful not to make any mistake when installing.

5. 2nd boom control valve, stabilizer control valve, bucket control valve, arm control valve, boom control valve, swing control valve, service 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. Lift check valve
Remove case (47), then remove spring (48), piston (49), and sleeve (50).

7. Cooler bypass valve
Remove case (51), then remove spring (52), piston (53), and sleeve (54).


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25b
25c
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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
1) Fit O-rings and install cover (46) and (45).

kgm Mounting bolt of cover (46):
277.1 ± 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. 2nd boom control valve stabilizer control valve, service control valve, 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)

5. 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.

6. 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 (21) Right and Left, travel pressure compensation valve and stabilizer valve (20), boom RAISE pressure compensation valve (19), arm OUT pressure compensation valve (19), and bucket DUMP pressure compensation valve (18)
3) Fit O-ring, then install swing RIGHT pressure compensation valve (13), Right and Left travel REVERSE pressure compensation valve (12), boom LOWER pressure compensation valve (11), arm IN pressure compensation valve (11), and bucket CURL pressure compensation valve (11).

kgm Pressure compensation valve:
225.5±19.5 Nm (23±2 kgm)

7. Suction valves, safety-suction valves, unload valve
1) Fit O-rings and install suction valves (10) and (9).

kgm Suction valve:
147.1±9.8 Nm (15±1 kgm)

2) Fit O-rings and install safety-suction valves (8), (7), (6), (5) and (4).

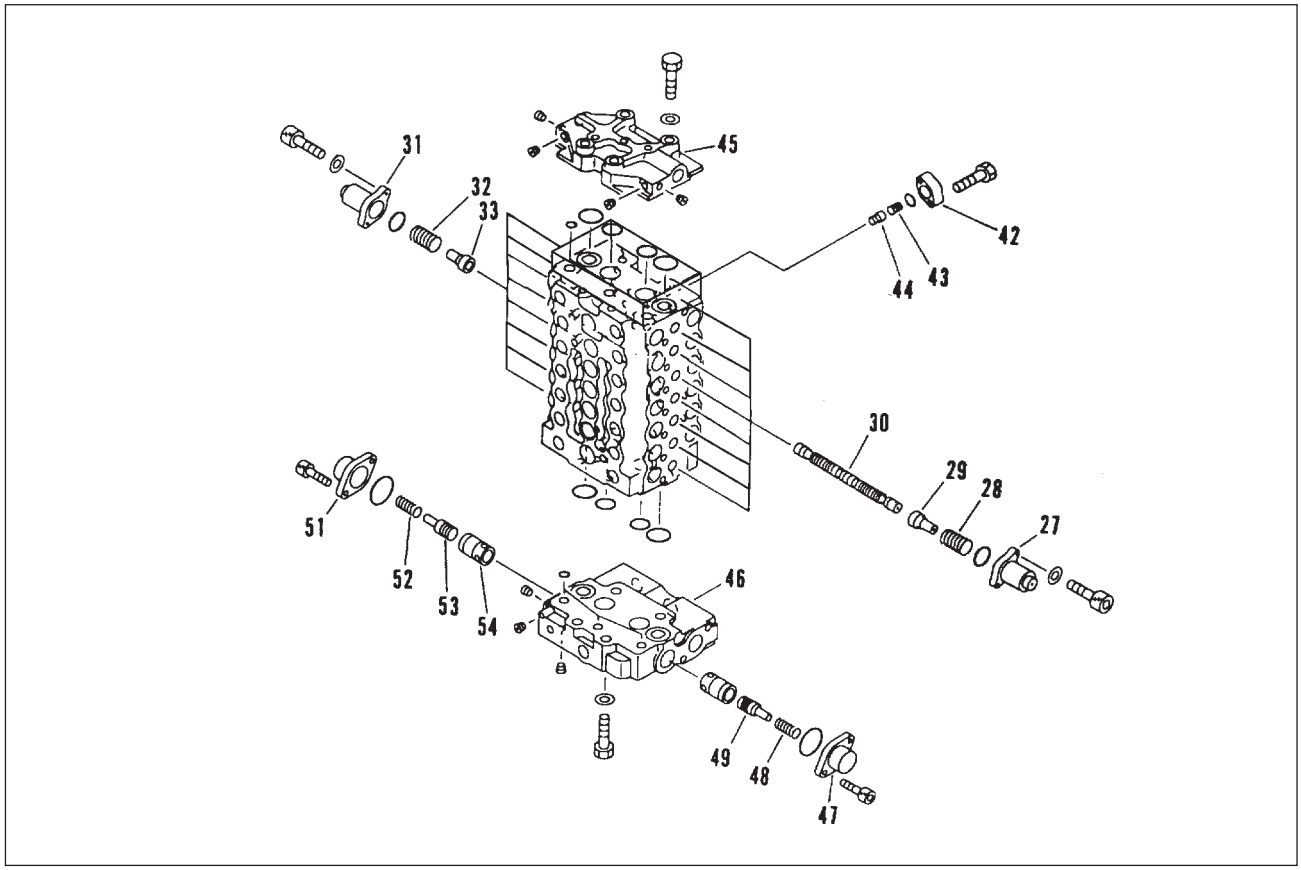
kgm Safety-suction valve:
147.1 ± 9.8 Nm (15±1 kgm)

3) Fit O-ring and install unload valve (3).

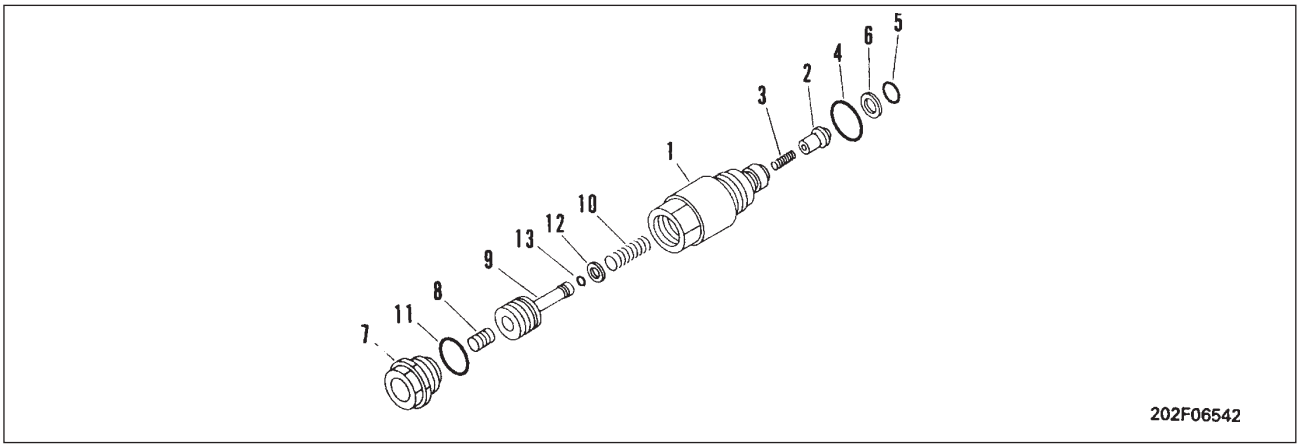
kgm Unload valve :
166.7±19.7 Nm (17±2 kgm)

8. 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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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

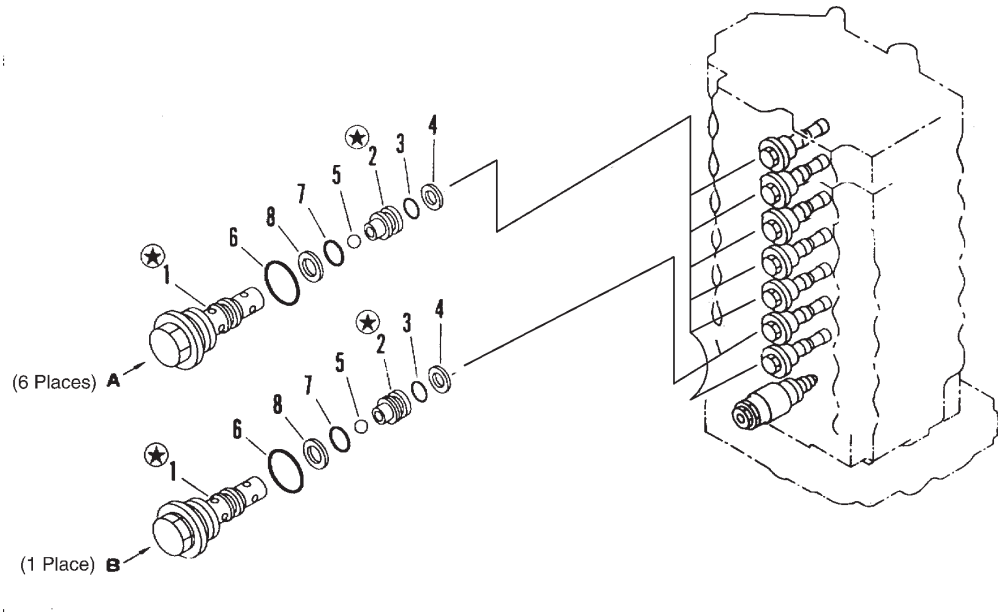
- Before assembling coat the sliding surface with engine oil.

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

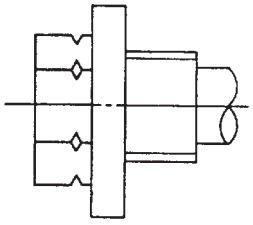
A: LS shuttle valve for work equipment (bucket, arm, boom, 2nd boom, stabiliser).
B: LS shuttle valve for travel.
★: The structure of the parts is the same, but the parts number for the assembly is different, so be careful when assembling.



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.

Type A



ASSEMBLY OF LS SHUTTLE VALVE

- Before assembling coat the sliding surface with engine oil.

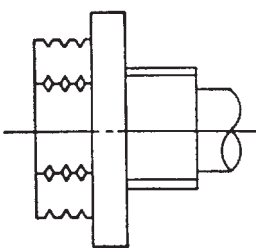
1. Install ring (8) and O-rings (7) and (6) to plug (1).

2. Fit ring (4) and O-ring (3) to seat (2), then assemble ball (5) to plug (1), and install seat (2).

INDENTIFICATION OF LS SHUTTLE VALVE

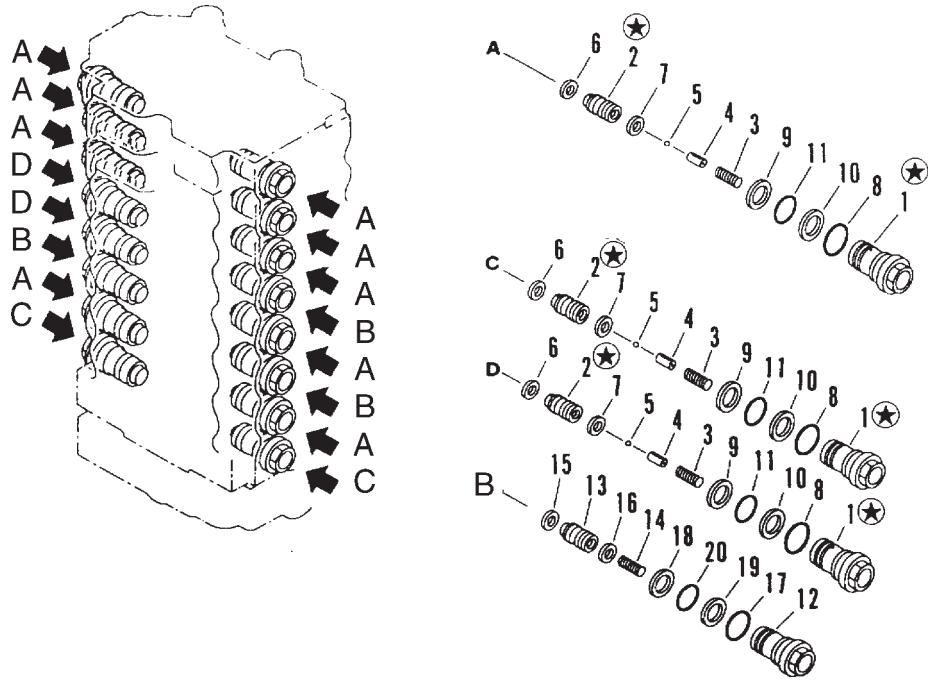
Shuttle valves are identified by markings on the valve assembly.
Type A - 1 mark
Type B - 3 marks

Type B



DISASSEMBLY OF PRESSURE COMPENSATION VALVE ASSEMBLY

Pressure compensation valves
A: For bucket CURL/DUMP, boom Lower arm IN, stabiliser
C: For swing LEFT/RIGHT
D: For arm OUT, boom RAISE
B: For travel



- **Disassembly of pressure compensation valves A,C,D**
- The structure of the parts for pressure compensation valves A, C en 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) form 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 B**

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).

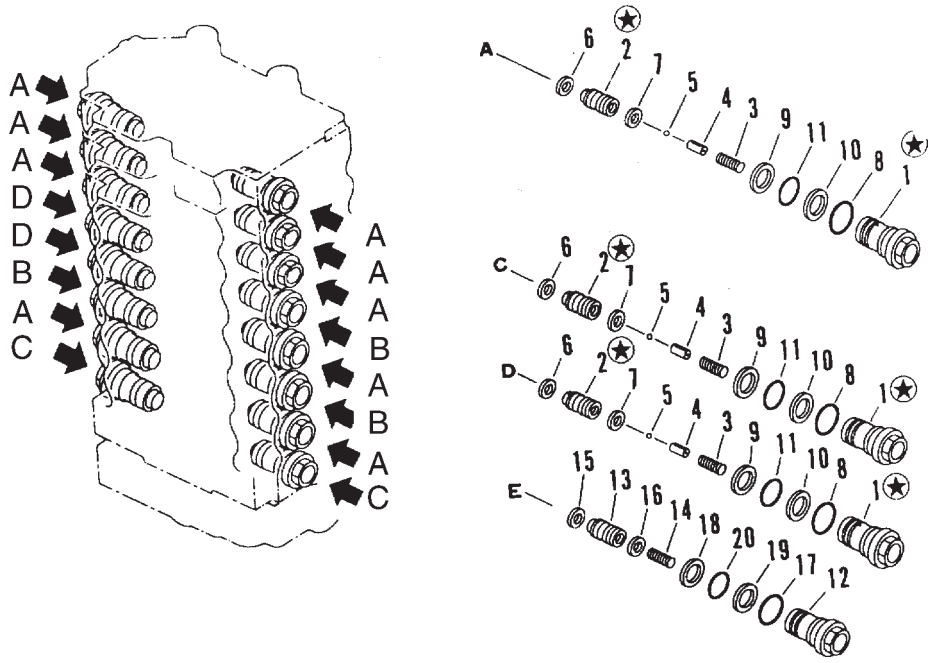
* After disassembling, if there is any abnormality in sleeve (12), piston (13), or seals (15) and (16), replace the whole pressure compensation valve assembly.

IDENTIFICATION OF PRESSURE COMPENSATION VALVE ASSEMBLY

Valves are identified by markings on the valve assembly.
Type A - 1 mark.
Type C - 3 marks.
Type D - 4 marks.
Type B - 2 marks.

ASSEMBLY OF PRESSURE COMPENSATION VALVE ASSEMBLY

Pressure compensation valves
A: For bucket CURL/DUMP, boom Lower, arm IN.
C: For swing LEFT/RIGHT
D: For arm OUT, boom RAISE
B: For travel



- Before assembling coat the sliding surface with engine oil.

- **Assembly of pressure compensation valve B**

1. Install O-rings (17) and (20), and seals (19) and (18) to sleeve (12).

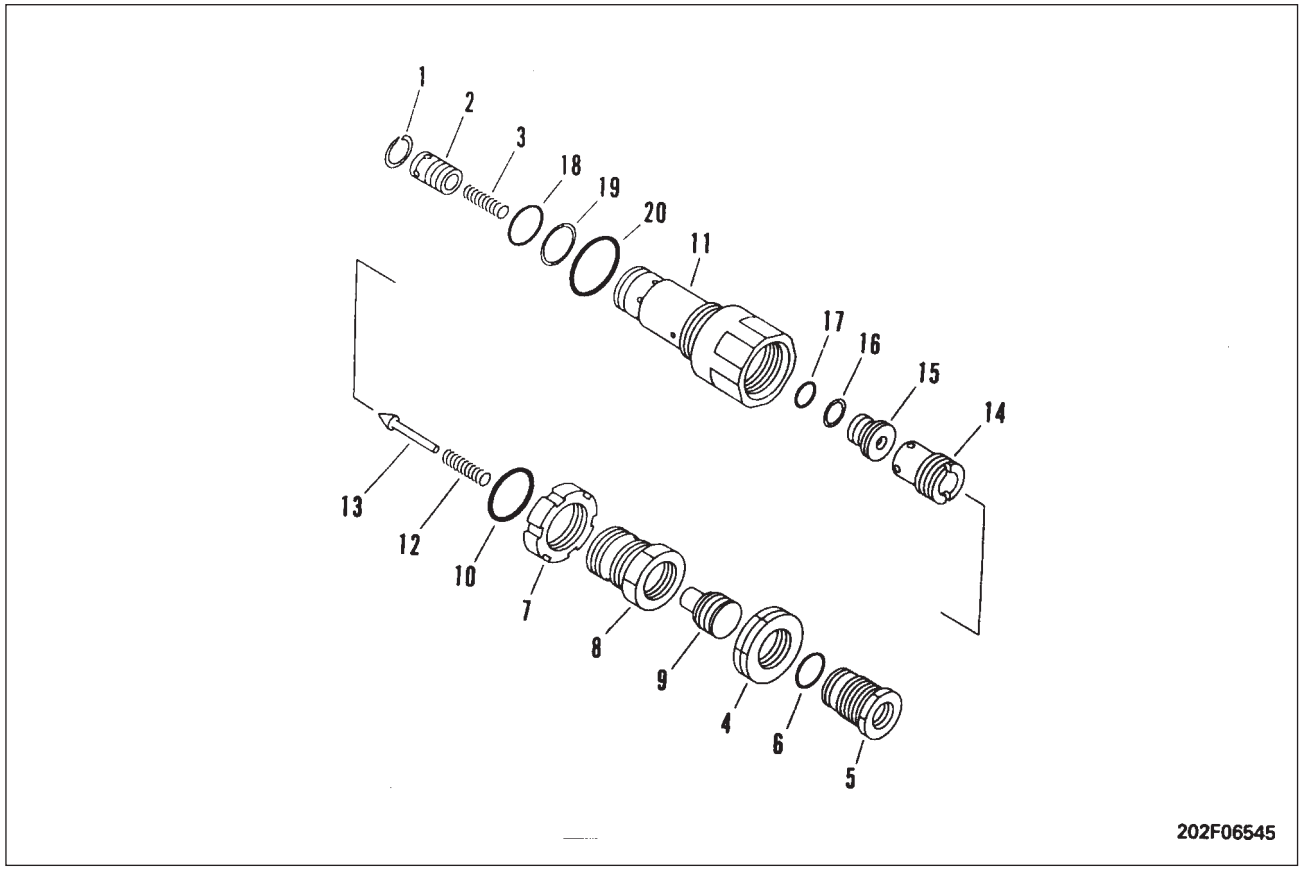
2. Fit seals (16) and (15) to piston (13), then assemble spring (14) and install to sleeve (12).

- **Assembly of pressure compensation valves A, 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 insall to sleeve (1).

DISASSEMBLY OF MAIN RELIEF VALVE ASSEMBLY



1. Remove ring (1), then remove valve (2) and spring (3).

2. Loosen nut (4) and remove plug (5), then remove O-ring (6) and nut (4) from plug (5).

3. Loosen nut (7) and remove holder (8), then remove retainer (9), O-ring (10), and nut (7) from holder (8).

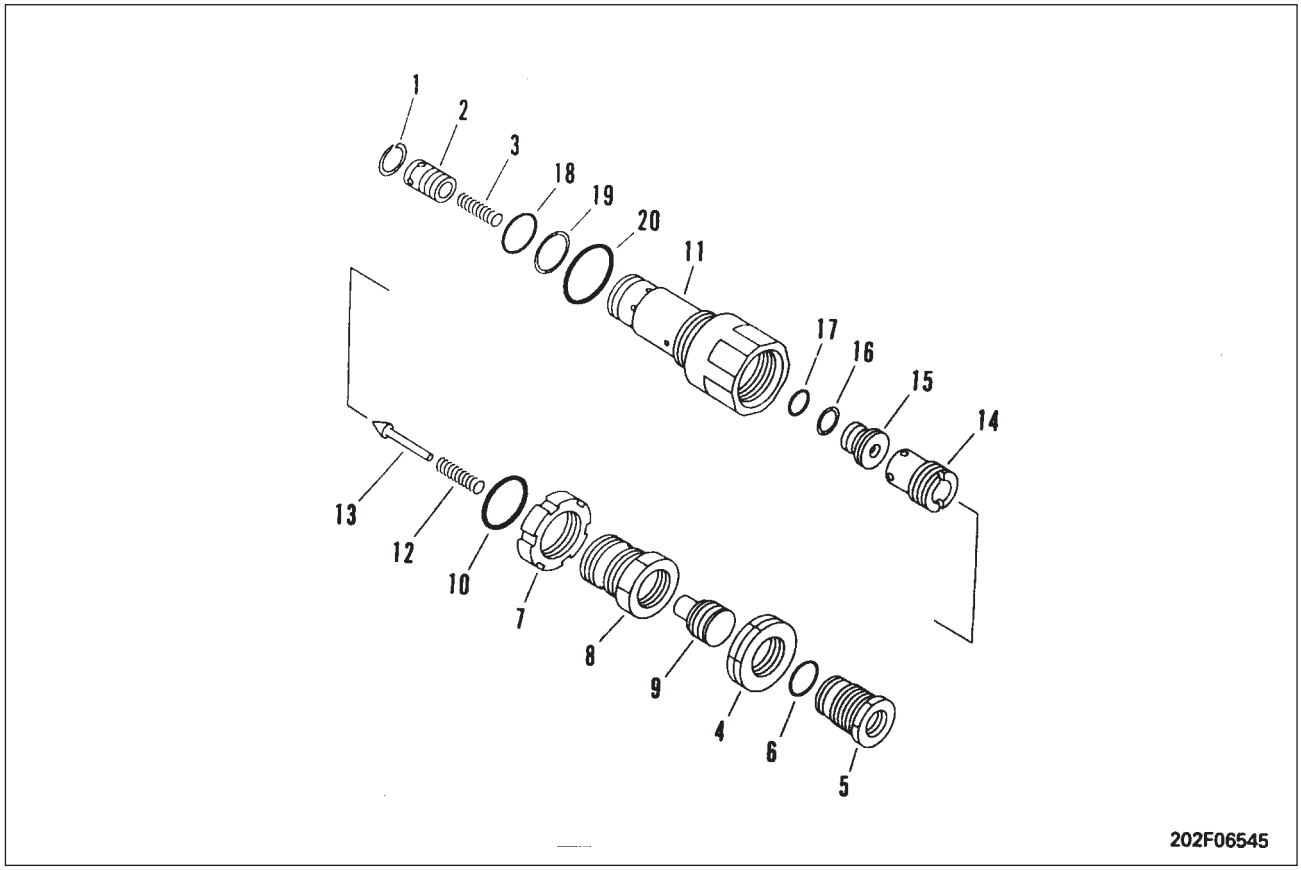
4. Remove spring (12) and poppet (13) from sleeve (11), then remove sleeve (14) and seat (15).

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.

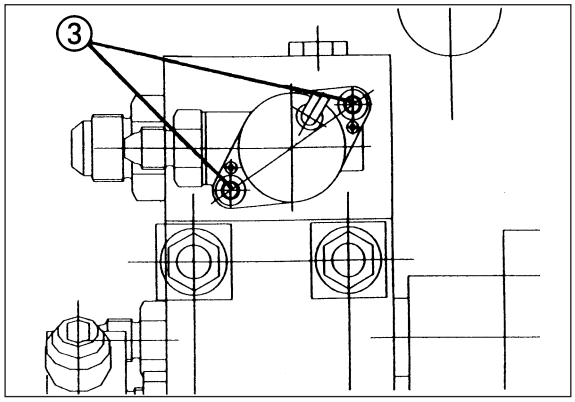
kgm Nut: 58.8±4.9 Nm (6±0.5 kgm)

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 LS CONTROL EPC VALVE ASSEMBLY



1. Remove cover.
2. Disconnect wiring connector (1).
3. Disconnect hose (2).
4. Remove mounting bolts (3). ※ 1

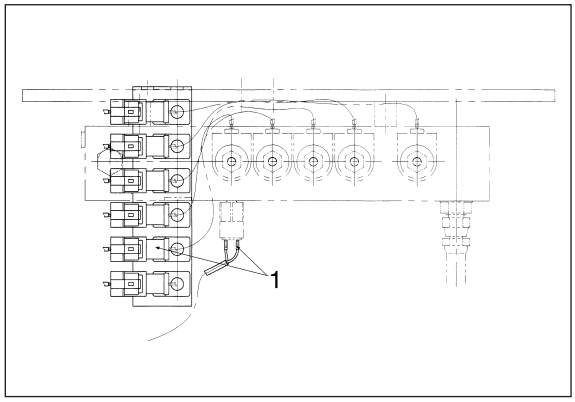
INSTALLATION OF LS CONTROL EPC VALVE ASSEMBLY

- Carry out installation in the reverse order to removal.

※ 1

kgm LS control EPC valve mounting bolt:
11.3±1.5 Nm(1.15±0.15 kgm)

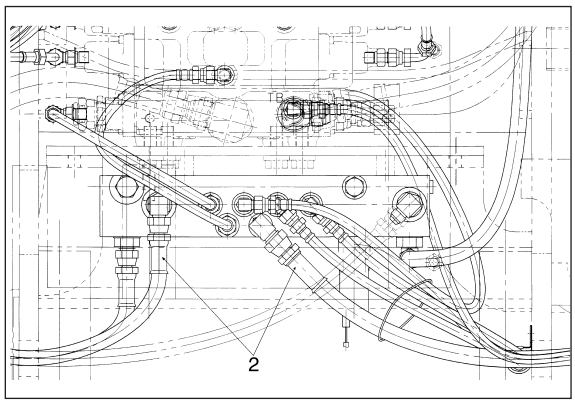
REMOVAL OF SOLENOID VALVE ASSEMBLY



⚠ Disconnect the cable from the negative (-) terminal of the battery.

1. Remove undercarriage steps

2. Slew machine 90° to give access from below to main C/V area

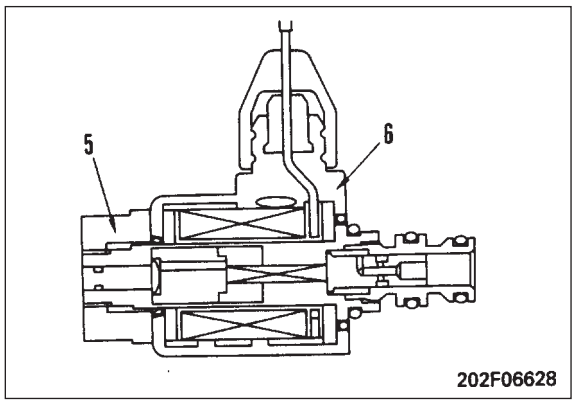


3. Remove 5 solenoid wiring and 1 Epc wiring connectors (1) from clips then disconnect + sus pressure connector
   ★ Mark the male and female ends of each connector with tags to prevent mistakes when connecting.

4. Disconnect 10 hoses (2).
   ★ Fit tags on the hoses.

5. Remove mounting bolts, then remove solenoid valve assembly (4).

- When removing solenoid valve as an individual part Remove mounting nut (5), then remove solenoid valve (6). ※ 1



INSTALLATION OF SOLENOID VALVE ASSEMBLY

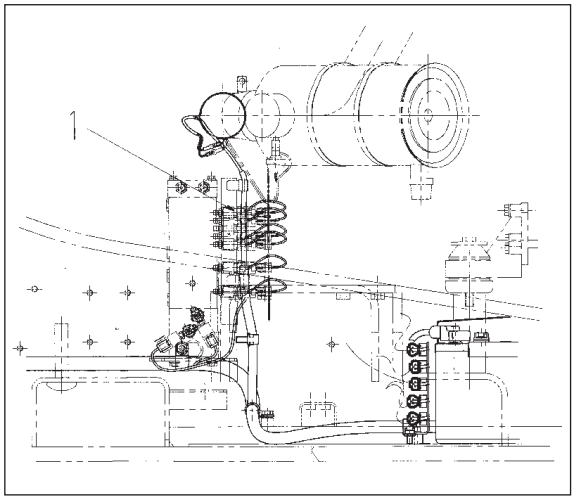
- Carry out installation in the reverse order to removal.

※ 1

kgm Mounting nut (5):
4.9±0.98 Nm (0.5±0.1 kgm)

kgm Solenoid valve (6) (individual part):
39.2±9.8 Nm (4±1 kgm)

REMOVAL OF PRESSURE SWITCH VALVE ASSEMBLY



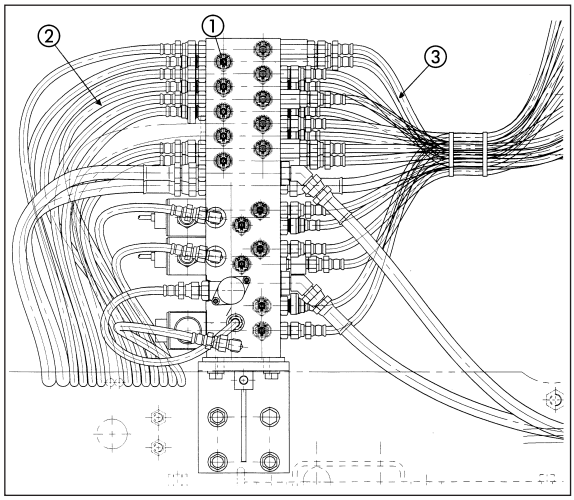
⚠ Lower the work equipment completely to the ground and stop the engine. Then loosen the oil filler cap slowly to release the pressure inside the hydraulic tank.

1 Disconnect the cable from the negative (-) terminal of the battery.
- ★ Make match marks at the male and female ends of the oil pressure switch connectors.
- ★ Before disconnecting any hoses, check the distinguishing tape stuck to the hose, or make match marks.

1. Disconnect 16 oil pressure switch connectors (1).

2. Disconnect PPC hoses (2). ❄ 1

2.5 Remove hoses from additional block.



3. Disconnect control valve hoses (3) (quick joint connection). ❄ 1

3.5 Remove epc valve hose connection.

4. Disconnect hoses from EPC valve/clamshell 50.l valve block.

5. Remove mounting bolts, then remove pressure switch block valve assembly (6).

INSTALLATION OF PRESSURE SWITCH VALVE ASSEMBLY

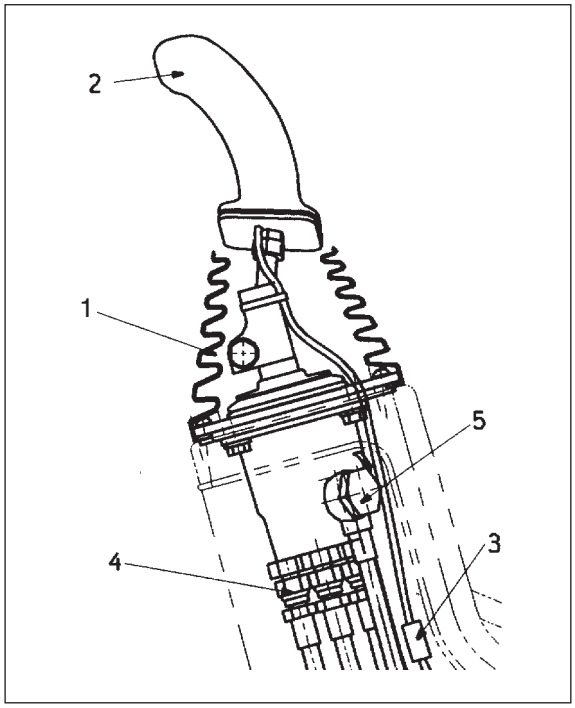
- Carry out installation in the reverse order to removal.

※ 1

- Check that the quick joint does not come out when the hose is pulled.

- **Refilling with oil (hydraulic tank)**
  ★ Add oil through the oil filler to the specified level. Run the engine to circulate the oil through the system. Then check the oil level again.

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 solwly 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 + remove valve ass'y.

★ 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

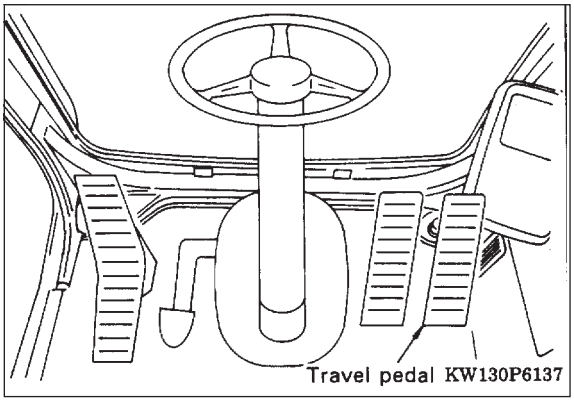
kgm Hose mounting joint bolt:
29.4±4.9 Nm (3.0±0.5 kgm)

※ 2

kgm Hose mounting joint bolt:
39.2±4.9 Nm (4.0±0.5 kgm)

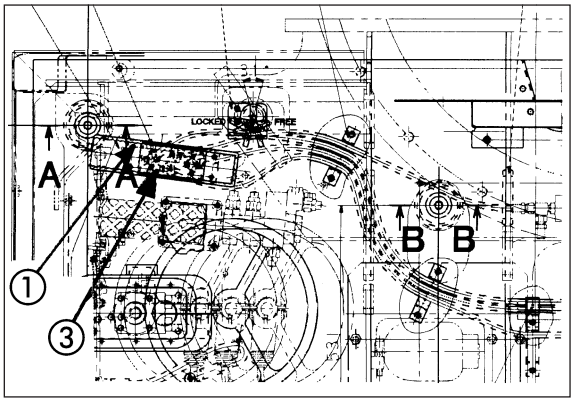
★ If there is excessive play in the control levers, adjust the PPC valve. for details, see TESTING AND ADJUSTING, Adjusting PPC valve.

REMOVAL OF TRAVEL PPC PEDAL ASSEMBLY

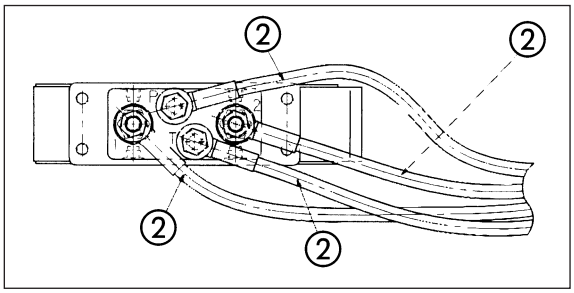


Lower the work equipment completely to the ground and stop the engine. Loosen the oil filter cap slowly to release the pressure inside the hydraulic tank. Then lift the PPC lock wrist control box to the lock position.

1. Remove floor mat.
2. Remove under cover (Front).
3. Remove screws (1) ※ 1
4. Disconnect 4 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±4.9 Nm (3.0±0.5 kgm)

REMOVAL OF BOOM CYLINDER ASSEMBLY

⚠ Extend the arm and bucket fully, lower the work equipment completely to the ground

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.

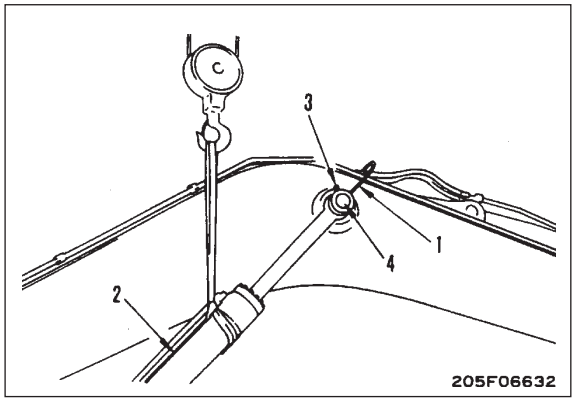
4. Start engine, and retract piston rod, then tie piston rod with wire to prevent it from coming out.
   ★ Set stand ① under the cylinder assembly, and adjust the positon for slinging.
   ⚠ Release the remaining pressure in the hydraulic circuit. For details, see TESTING AND ADJUSTING, Releasing remaining pressure in hydraulic circuit.

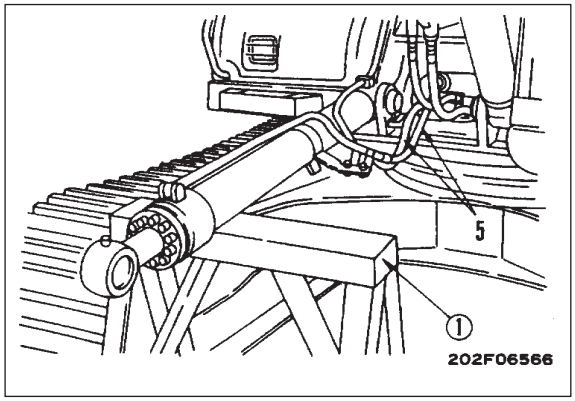
5. Disconnect hoses (5).

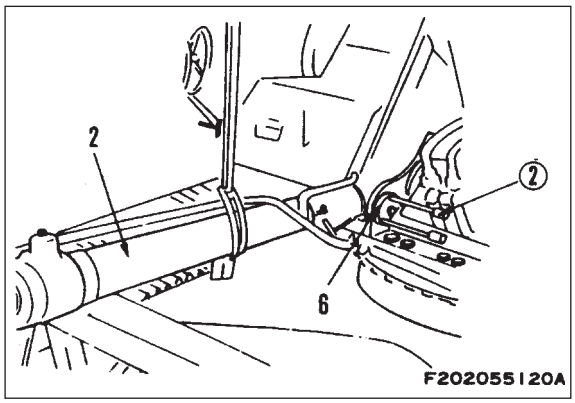
5.5 Disconnect safety valve hoses

6. Remove plate, then using forcing screws ②, 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 135 kg





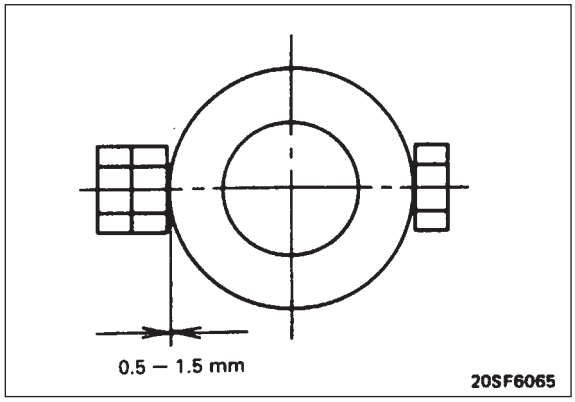


INSTALLATION OF BOOM CYLINDER ASSEMBLY

- Carry out installation in the reverse order to removal.

※ 1

★ When tightening the locknut, tighten so that the clearance between the plate and nut is 0.5 - 1.5 mm.



※ 2

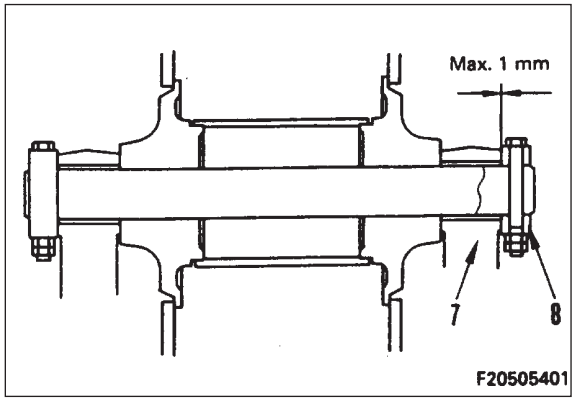
Inside surface of bushing when assembling pin: Anti-friction compound (LM-P)

Greasing after assembling pin: Grease (LM-G)

⚠ When aligning the position of the pin hole, never insert your fingers in the pin hole.

★ Adjust the shim thickness so that the clearance between cylinder rod (7) and plate (8) is below 1 mm.

★ Standard shim thickness: 0.5 mm, 1.0 mm



※ 3

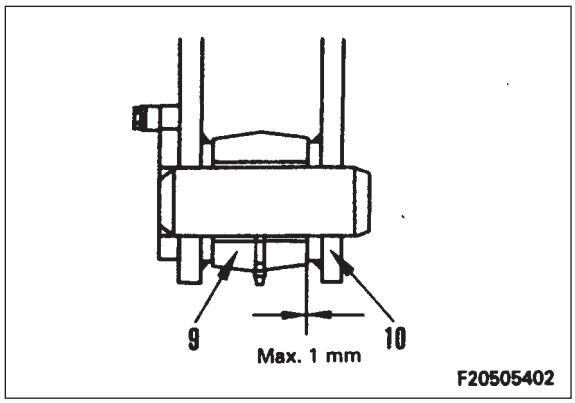
Inside surface of bushing when assembling pin: Anti-friction compound (LM-P)

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 (10) is below 1 mm.

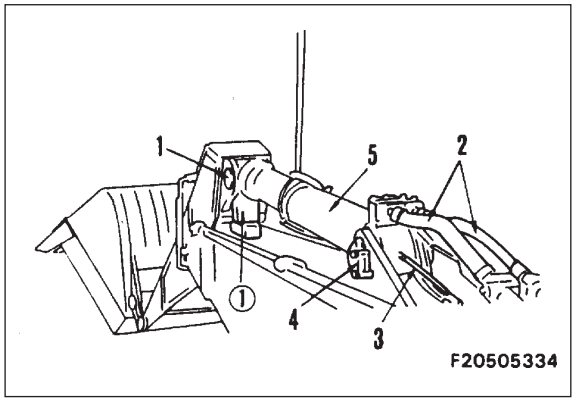
★ Standard shim thickness: 0.8 mm, 1.5 mm



- 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.

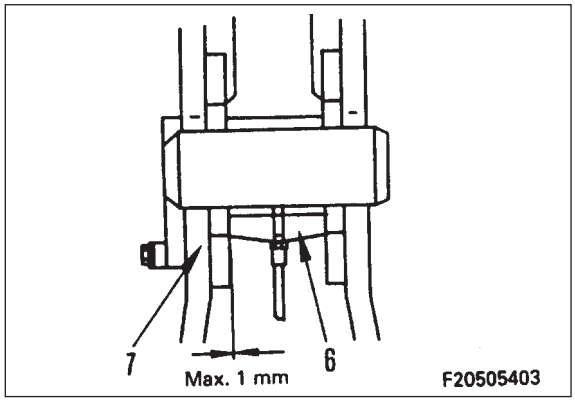
1. Set block ① between arm cylinder and boom.
2. Remove plate, then remove head pin (1). ❄ 1
3. Start engine, and retract piston rod, then tie piston rod with wire to prevent it from coming out.
   ⚠ Release the remaining pressure in the hydraulic circuit. For details, see TESTING AND ADJUSTING, Releasing remaining pressure in hydraulic circuit.
4. Disconnect hoses (2).

4.5 Disconnect safety valve hoses (if applicable)

5. Disconnect grease hose (3).
6. Raise 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 200 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.

※ 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 (6) and bracket (7) is below 1 mm.
  ★ Standard shim thickness: 0.8 mm, 1.5 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.

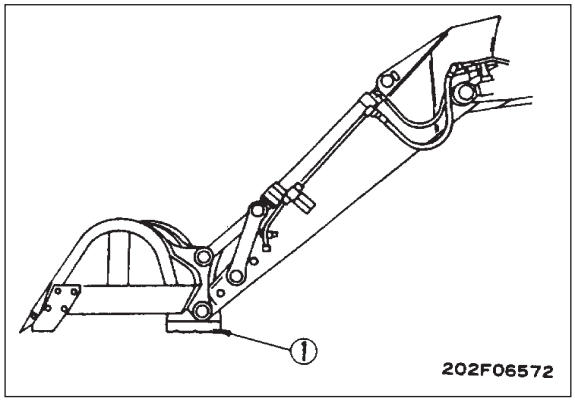
- Bleeding air
  ★ Bleed the air from the cylinder. For details, see TESTING AND ADJUSTING, Bleeding air from hydraulic cylinder.

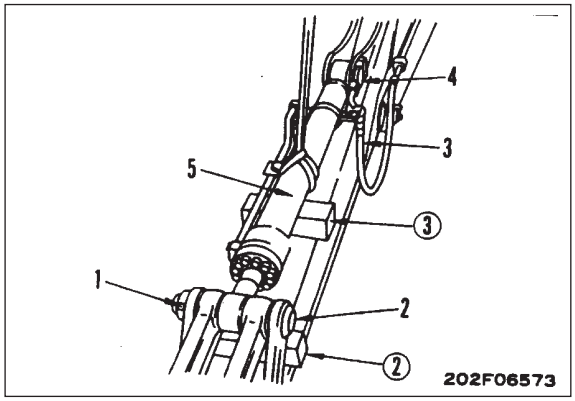
REMOVAL OF BUCKET CYLINDER ASSEMBLY

⚠ Extend the bucket cylinder piston rod approx. 200 mm, lower the work equipment completely to the ground.

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. Raise 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: 130 kg



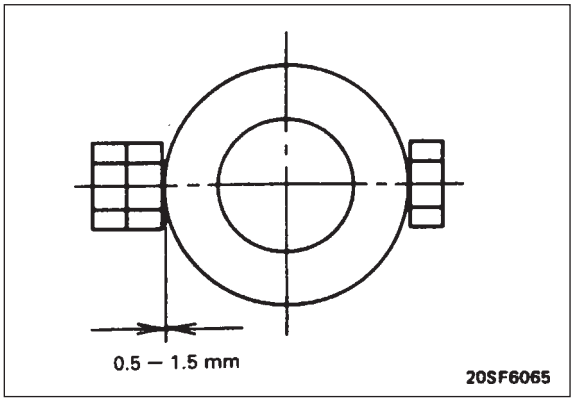


INSTALLATION OF BUCKET CYLINDER ASSEMBLY

- 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)

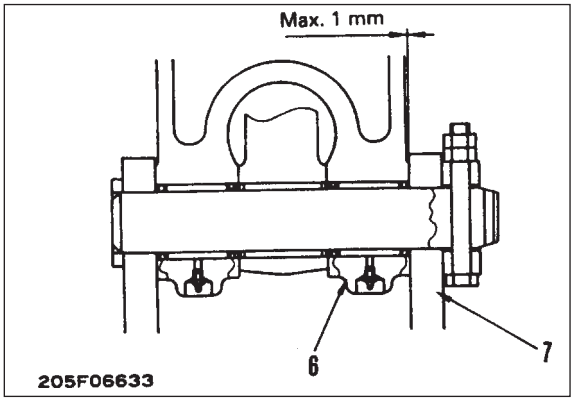
Grease after assembling pin: Grease (LM-G)

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 link (6) and link (7) is below 1 mm.

※ 3

★ Standard shim thickness: 0.8 mm, 1.5 mm



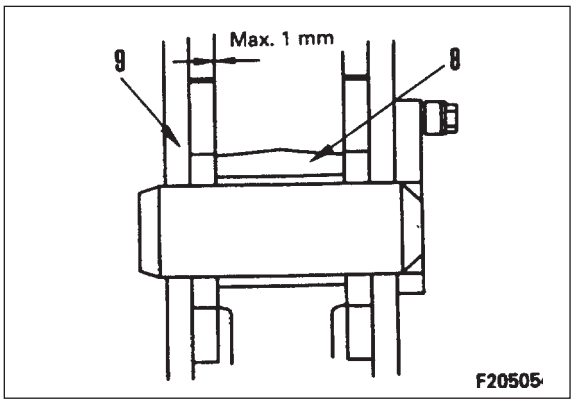
Inside surface of bushing when assembling pin: Anti-friction compound (LM-P)

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: 0.8 mm, 1.5 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.

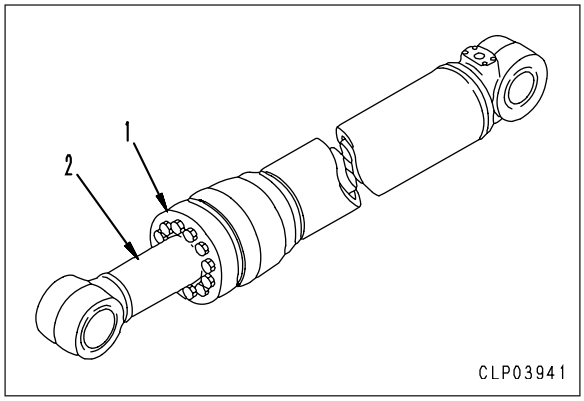
- Bleeding air
  - ★ Bleed the air from the cylinder. For details, see TESTING AND ADJUSTING, Bleeding air from hydraulic cylinder.

HYDRAULIC CYLINDER

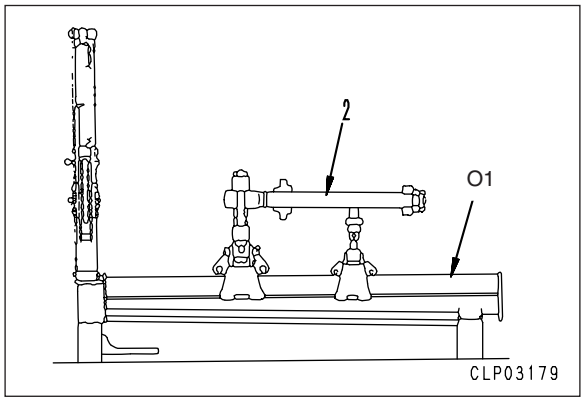
Disassembly

1. Piston rod assembly

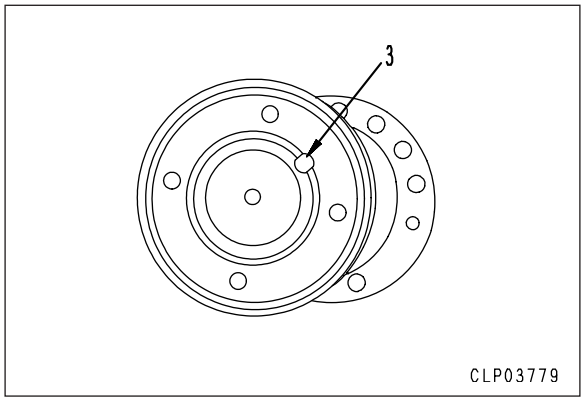
1) Remove piping from cylinder assembly.
2) Remove mounting bolts, and disconnect head assembly (1).
3) Pull out piston rod assembly (2).
   ★ Place a container under the cylinder to catch the oil.



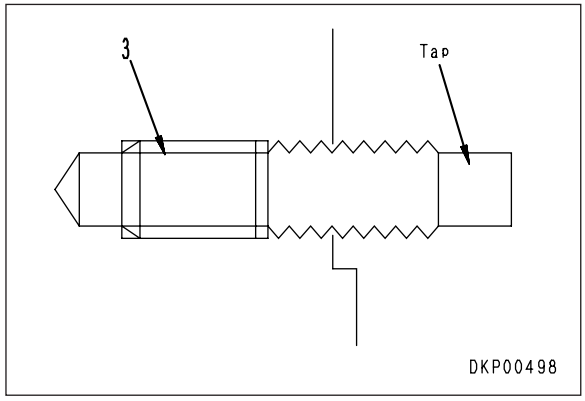
4) Disassemble piston rod assembly as follows.
   i) Set piston rod assembly (2) to tool **O1**.



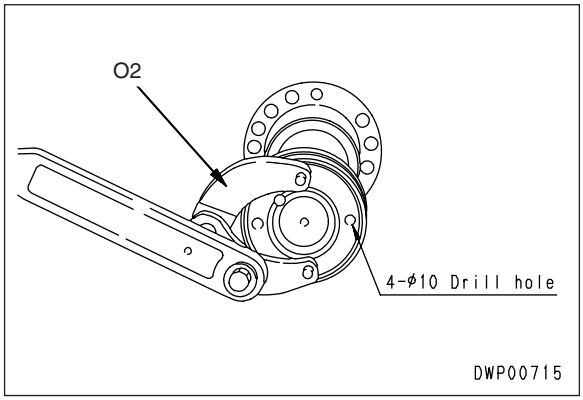
   ii) Remove stopper screw (3) of piston assembly.
   ★ Common screw size for boom, arm, and bucket cylinder:
   M12 x pitch 1.75



   ★ If the caulking of screw (3) is too strong and it cannot be removed, tighten the screw fully, then fit a tap to the thread and remove the screw.



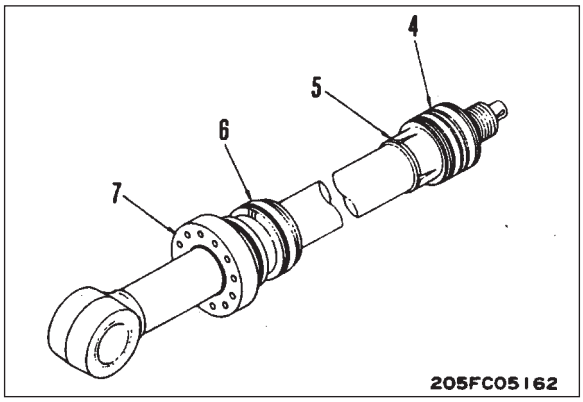
iii) Using tool **O2**, remove piston assembly (4).
- When not using tool **O2**, use the drill holes (ϕ10: 4 places) and loosen the piston assembly.



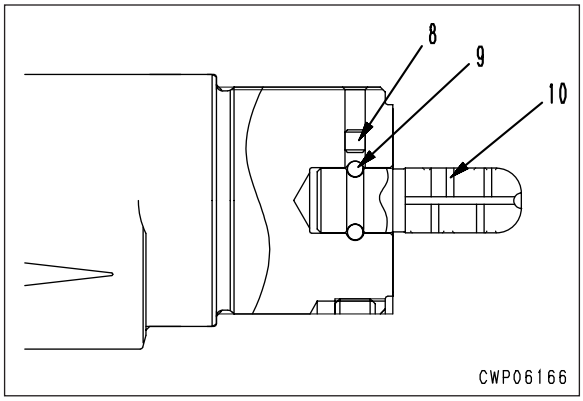
iv) Remove plunger (5).
- Arm and boom cylinder only

v) Remove collar (6).
- Arm and boom cylinder only

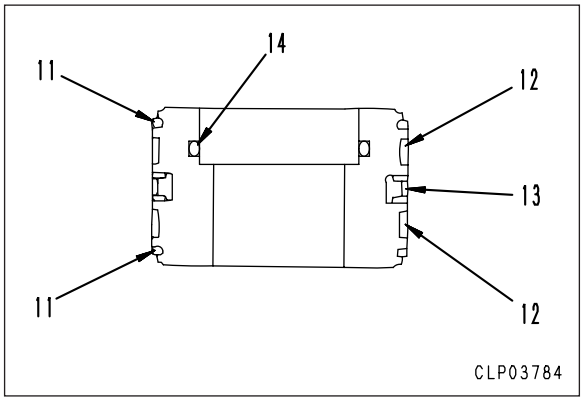
vi) Remove head assembly (7).



vii) Remove cap (8), and pull out 12 balls (9), then remove cushion plunger (10).
- Boom and arm cylinder only

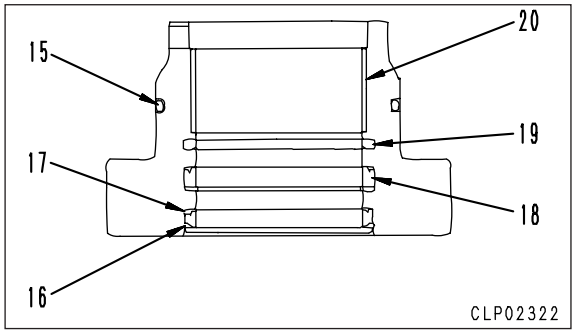


2. Disassembly of piston assembly
1) Remove ring (11).
2) Remove wear ring (12).
3) Remove piston ring (13).
4) Remove O-ring and backup ring (14).



3. Disassembly of cylinder head assembly

a) Remove O-ring and backup ring (15).
b) Remove snap ring (16), then remove dust seal (17).
c) Remove rod packing (18).
d) Remove buffer ring (19).
e) Remove bushing (20).

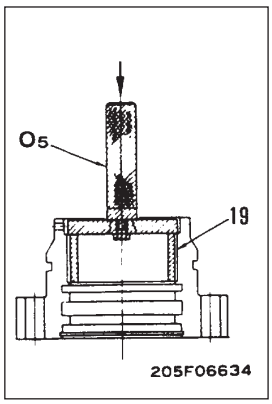


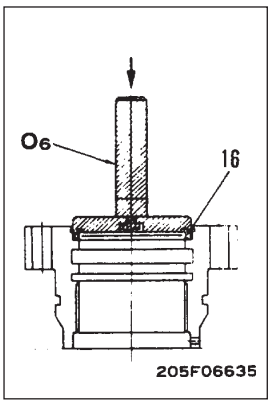
ASSEMBLY

★ Be careful not to damage the packings, dust seals, and O-rings.
★ Do not try to force the backup ring into position. Warm it in warm water (50 - 60°C) before fitting it.

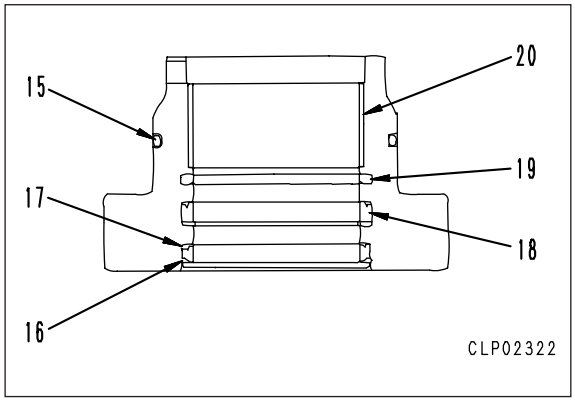
1. Assembly of cylinder head assembly

a) Using tool **O5**, press fit bushing (20).
b) Assemble buffer ring (19).
c) Assemble rod packing (18).
d) Using tool **O6**, install dust seal (17), and secure with snap ring (16).



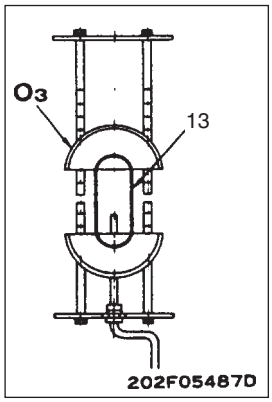


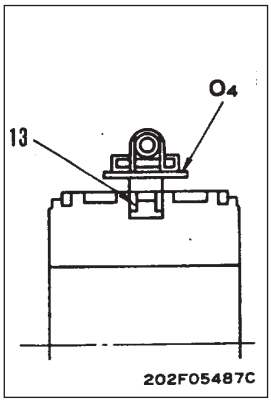
e) Install backup ring and O-ring (15).



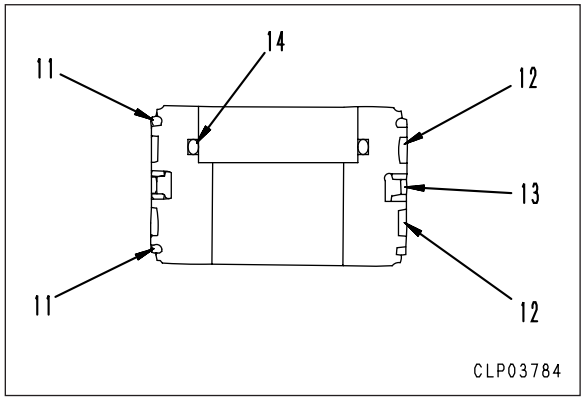
2. Assembly of piston assembly

1) Using tool **O3**, expand piston ring (13).
   ★ Set the piston ring on the tool **O3**, and turn the handle 8 - 10 times to compress the ring.
2) Set tool **O4** in position, and retract piston ring (13).

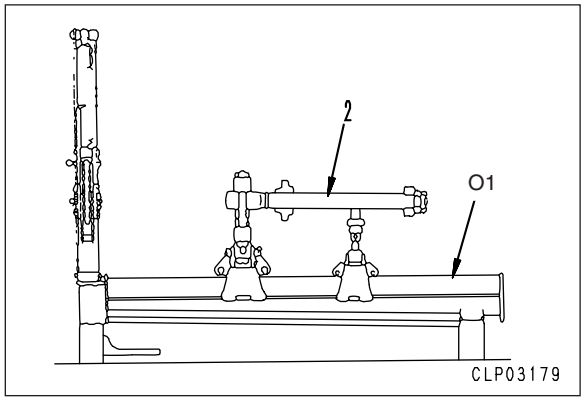




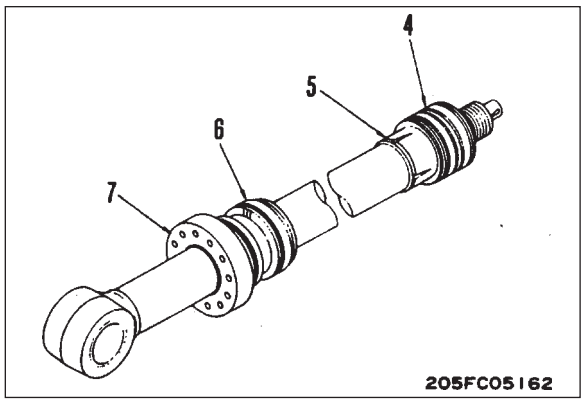
c) Install backup ring and O-ring (14).
d) Assemble wear ring (12).
e) Assemble ring (11).
★ Be careful not to open the end gap of the ring too wide.
Ring groove : **Grease (G2-LI)**



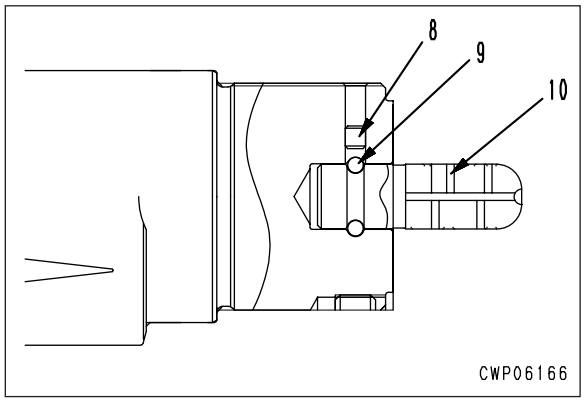
3. Piston rod assembly
a) Set piston rod assembly (2) to tool **O1**.



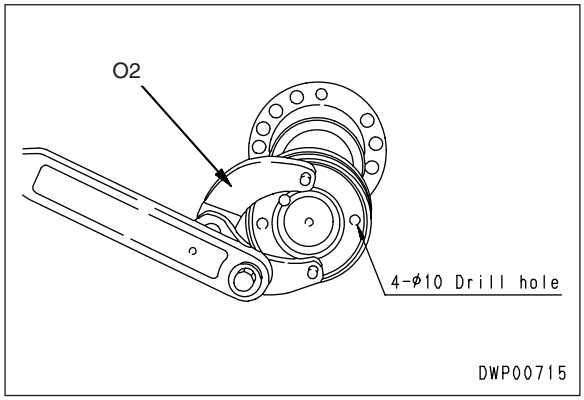
b) Assemble head assembly (7).
c) Fit O-ring and backup ring to collar (6), then assemble.
• Boom and arm cylinder only
d) Assemble plunger (5).
• Boom and arm cylinder only
★ Check that there is a small amount of play at the tip of the plunger (arm cylinder only).

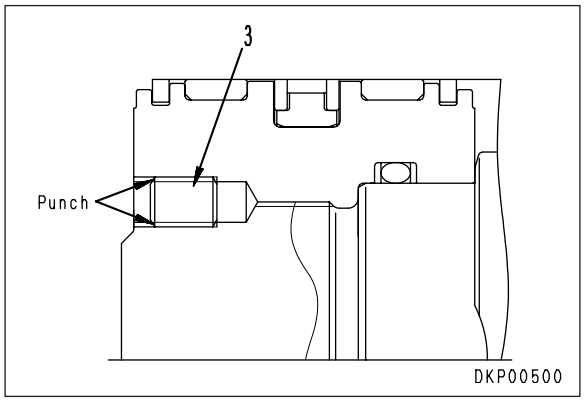


e) Set cushion plunger (10) to piston rod, then assemble 12 balls (9), and secure with cap (8).
• Arm cylinder only



f) Assemble piston assembly (4) as follows.
- When using rod and piston again
  - ★ Wash thoroughly and remove all metal particles and dirt.
  - i) Screw in piston assembly (4), then use tool **O2** to tighten piston assembly (2) so that position of screw thread hole matches.
    - ★ Remove all burrs and flashes with a file.
  - ii) Tighten screw (3).
    kgm Screw (3):
    66.2 ± 7.35 Nm {6.75 ± 0.75 kgm}
  - iii) Caulk thread at 2 places with punch.

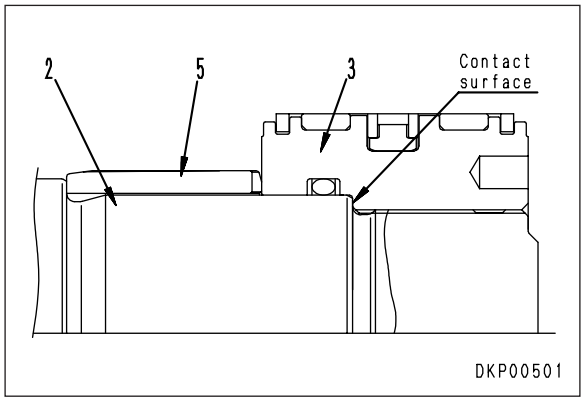


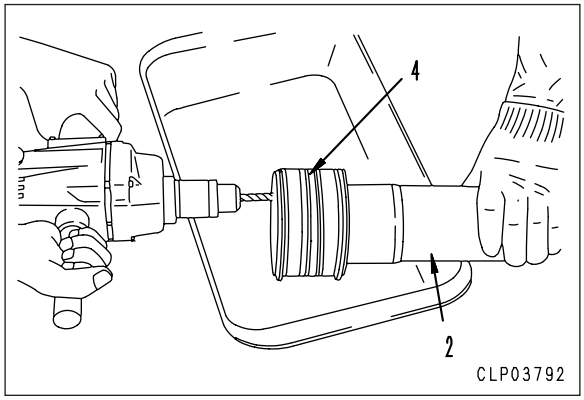


g) When using a new part for either or both of rod or piston assembly (2)
- ★ For the rod with bottom cushion, mark the cushion plug position on the end face of the rod (arm cylinder only).
- i) Screw in until piston assembly (4) contacts end face of rod, then use tool **O2** to tighten.
  kgm Piston 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 hole used to install screw (3).
  - ★ Align a drill horizontal with the V-groove of the thread of rod (2) and piston (4), then carry out machining.
  - ★ For the cylinder with bottom cushion (arm cylinder), avoid the cushion plug position when machining.
  - Screw machining dimension (mm)

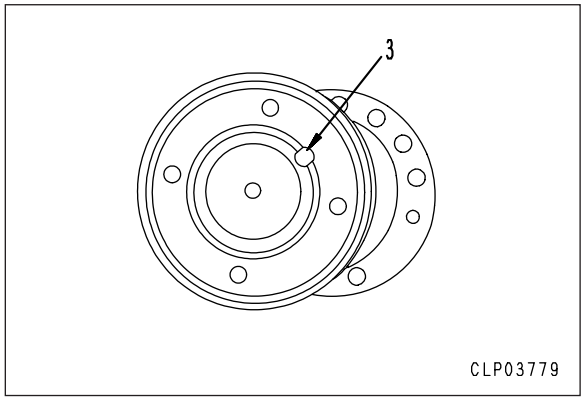
Drill diameter	Bottom hole depth	Tap used	Tap depth
10.3	27	12×1.75	20

- iii) After machining, wash thoroughly to remove all metal particles and dust.

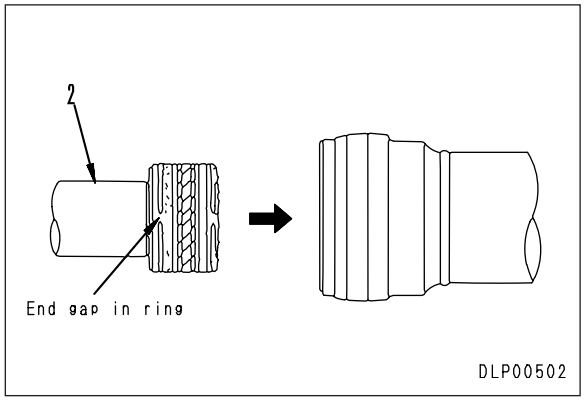




iv) Tighten screw (3).
kgm Screw (3):
66.2 ± 7.35 Nm {6.75 ± 0.75 kgm}
v) Caulk thread at 2 places with punch.

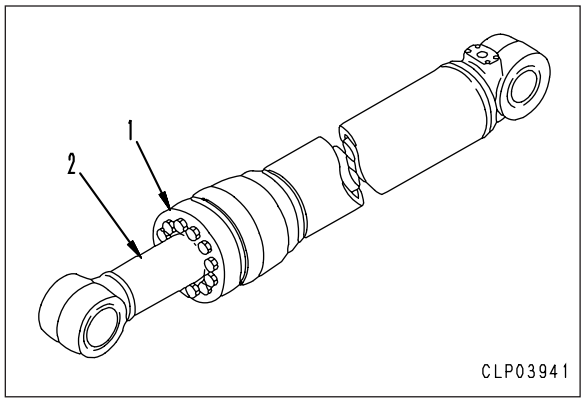


h) Assemble piston rod assembly (2).
Seal portion: **Grease (G2-LI)**
★ Set the end gap of the ring at the horizontal (side) position, align the axial center of shaft and cylinder tube, then insert.
★ After inserting, check that the ring is not broken and has not come out, then push in fully.



i) Tighten head assembly (1) with mounting bolts.
kgm Mounting bolt :

Cylinder	Tightening torque
Bucket	**270 ± 39.0 Nm {27.5 ± 4.0 kgm}**
Arm	**270 ± 39.0 Nm {27.5 ± 4.0 kgm}**
Boom	**270 ± 39.0 Nm {27.5 ± 4.0 kgm}**



j) Install piping.

REMOVAL OF WORK EQUIPMENT ASSEMBLY

⚠ Extend the arm and the bucket fully and lower the work equipment completely to the ground, then operate the control levers 2 to 3 times.

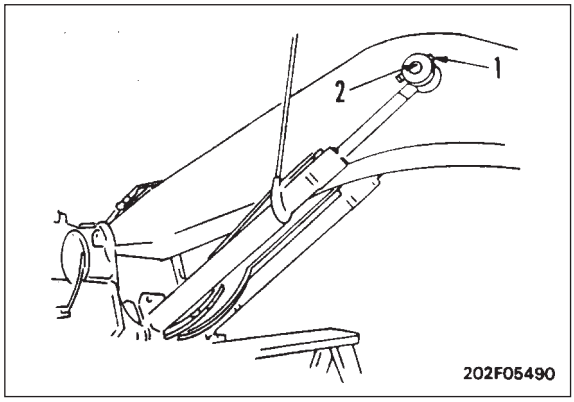
1. Remove lock bolt (1). (See F) ❄ 1
2. Remove pin (2). (See F1) ❄ 2
   ★ Sling the boom cylinder assembly and remove the pin.

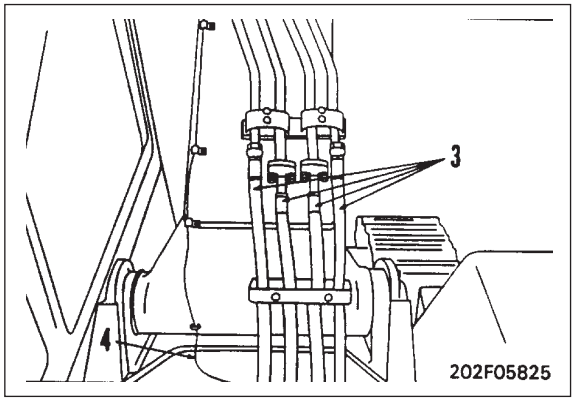
   ⚠ Start the engine and retract the boom cylinder rod, then tie the rod with wire to prevent it from coming out, and lower it onto the block.

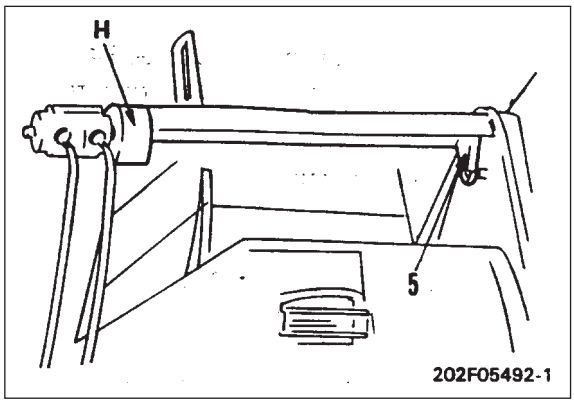
   ★ Disconnect the boom cylinder on the opposite side in the same way.

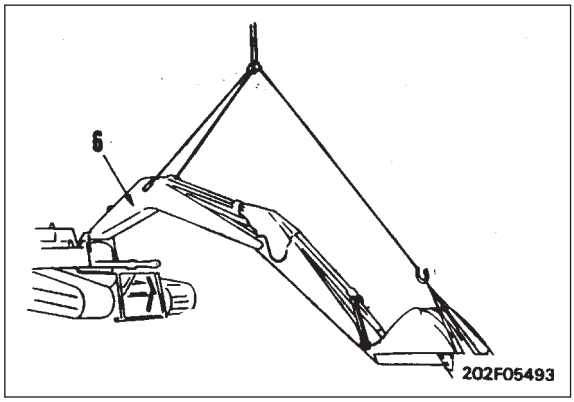
   ⚠ Release the remaining pressure in the circuit. For details, see TESTING AND ADJUSTING, Releasing pressure in hydraulic circuit for machines with PPC valve.
3. Disconnect hoses (3). (See F2)
4. Disconnect wiring (4). (See F2)
5. Remove pin (5). (See F3)
   ★ Sling work equipment assembly (6), then using tool **H**, remove the pin.
6. Remove work equipment assembly (6). (See F4)

   kg 600kg







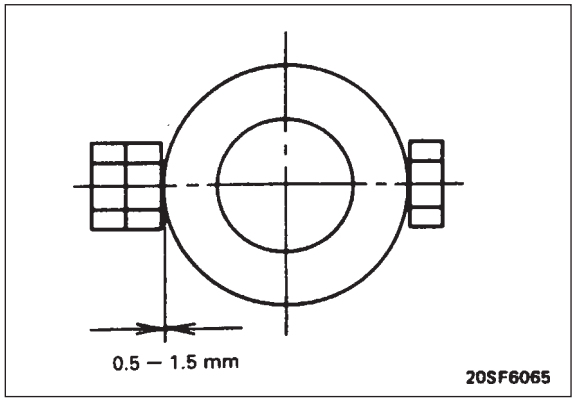


INSTALLATION OF WORK EQUIPMENT ASSEMBLY

- 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

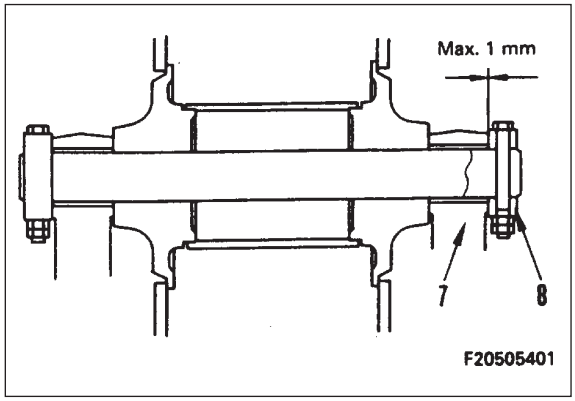
Inside surface of bushing when assembling pin: Anti-friction compound (LM-P)

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 (10) and plate (11) is below 1 mm.

★ Standard shim thickness: 0.8 mm, 1.5 mm



※ 3

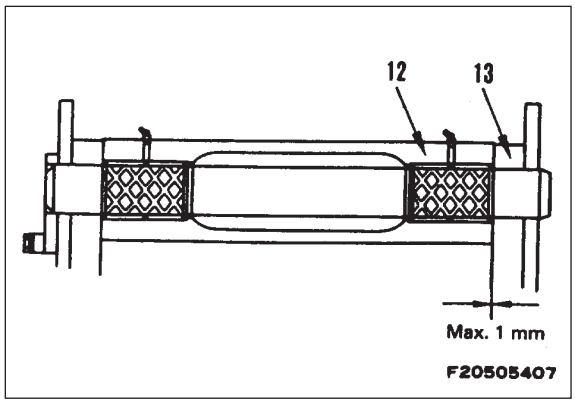
Inside surface of bushing when assembling pin: Anti-friction compound (LM-P)

Grease after assembling pin: Grease (LM-G)

When aligning the position of the pin hole, never insert your fingers in the pin hole.

★ Adjust the shim thickness so that the clearance between boom (12) and bracket (13) is below 1 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 ASSEMBLY

⚠ Set the back of the bucket facing down, lower the work equipment completeley to the ground, and operate the control levers 2 of 3 times.

1. Remove lock bolt (1). (See F1) ※ 1
2. Remove plate (2). (See F1) ※ 2
3. Remove pin (3). (See F1) ※ 3
4. Remove lock bolt (4). (See F1) ※ 4
5. Remove pin (5). (See F1)
6. Remove bucket assembly (6). (See F1)
   ★ Raise the work equipment and disconnect the arm from the bucket.

kg 600 kg

INSTALLATION OF BUCKET ASSEMBLY

- Carry out installation in the reverse order to removal.

※ 1 ※ 4
★ Tighten with the locknut so that the clearance between the bucket boss and nut is 0.5 - 1.5mm. (See F2)

※ 2
★ Adjust the shim thickness so that the clearance between bucket boss (7) and spacer (8) is 2mm. (See F3)

※ 3
★ When aligning the position of the pin hole, run the engine at low idling, and align slowly.
Never insert your fingers in the pin hole.

REMOVAL OF ARM ASSEMBLY

1. Bucket assembly
   For details, see REMOVAL OF BUCKET ASSEMBLY.

2. Set work equipment
   ★ Secure the bucket cylinder assembly to the arm, then pull in the arm, and lower it onto block ①.

3. Remove pin (1). (See F4) ※ 1
   ★ Sling the arm cylinder assembly, and remove the pin.

⚠ Start the engine, and retract the arm cylinder rod, then tie the rod with wire to prevent it from coming out.

↘ ⚠ ↙ ↑ Release the remaining pressure in the circuit. For details, see TESTING AND ADJUSTING, Releasing pressure in hydraulic circuit for machines with PPC valve.

4. Disconnect hoses (2). (See F4)

5. Remove pin (3). (See F4)

6. Remove arm assembly (4). (See F4)
   ★ Raise the boom and disconnect the boom from the arm.

kg See Weight Table.

INSTALLATION OF ARM ASSEMBLY

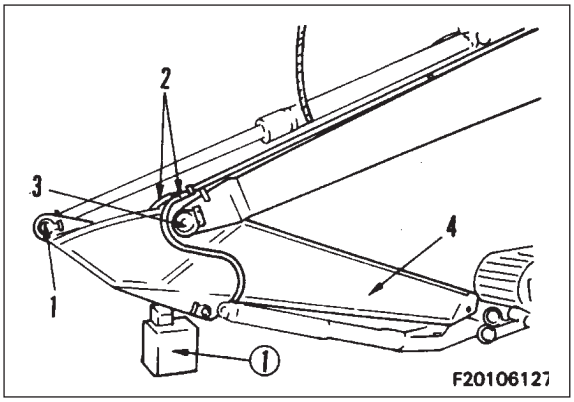
- Carry out installation in the reverse order to removal.

※ 1

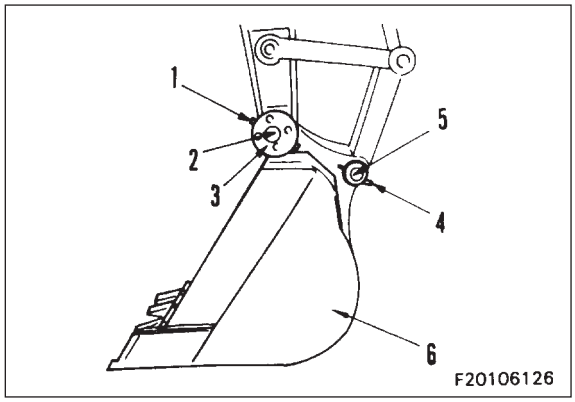
⚠ When aligning the position of the pin hole, run the engine at low idling, and align slowly.
Never insert your fingers in the pin hole.

- Bleeding air
  ★ Bleed the air from the cylinder.
  For details, see TESTING AND ADJUSTING, Bleeding air from hydraulic cylinder.
  ★ After bleeding the air from the cylinder, check the level of the oil in the hydraulic tank.

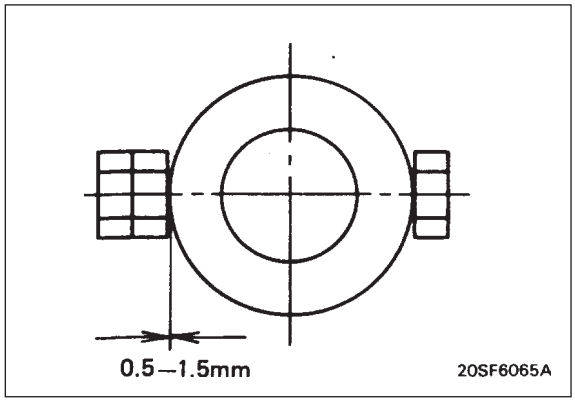
F4



F1



F2



REMOVAL OF ARM, BUCKET ASSEMBLY

Extend the arm and bucket fully, lower the work equipment completely to the ground, and operate the control levers 2 or 3 times.

1. Remove pin (1). (See F1) [※ 1]
   ★ Set block ① between the arm and the boom, then sling the arm cylinder, and remove the pin.

   ⚠ Start the engine, and retract the arm cylinder rod, then tie the rod with wire to prevent it from coming out.

   ⚠ Release the remaining pressure in the circuit. For details, see TESTING AND ADJUSTING, releasing pressure in hydraulic circuit for machines with PPC valve.

2. Disconnect hose (2). (See F2)

3. Remove pin (3). (See F2)
   ★ Sling the arm and bucket assembly, then remove the pin.

4. Remove arm and bucket assembly (4). (See F2)

   kg See Weight Table.

INSTALLATION OF ARM, BUCKET ASSEMBLY

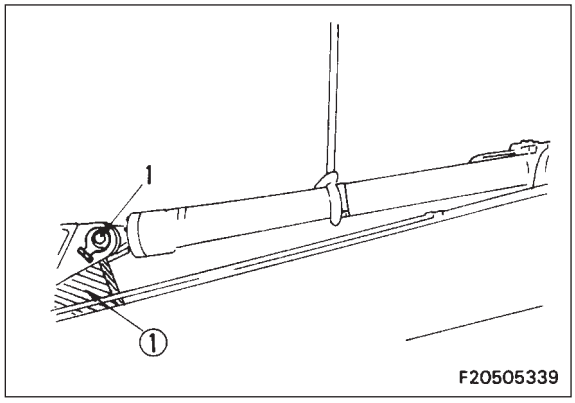
- Carry out installation in the reverse order to removal.

[※ 1]

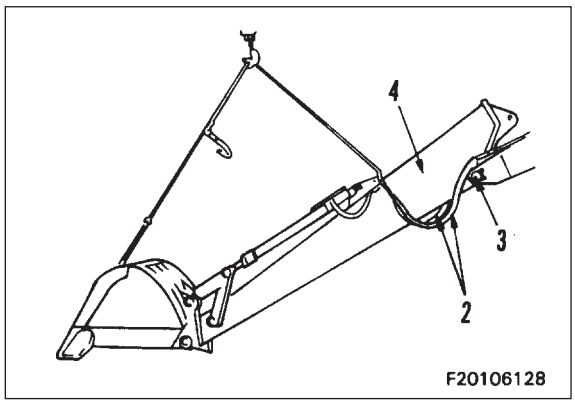
⚠ When aligning the position of the pin hole, run the engine at low idling, and align slowly. Never insert your fingers in the pin hole.

- Bleeding air
  ★ Bleed the air from the cylinder. For details, see TESTING AND ADJUSTING, Bleeding air from hydraulic cylinder.
  ★ After bleeding the air from the cylinder, check the level of the oil in the hydraulic tank.

F1



F2



REMOVAL OF BOOM ASSEMBLY

1. Arm and bucket assembly
   For details, see REMOVAL OF ARM, BUCKET ASSEMBLY.

2. Remove lock bolt (1). (See F1) ※ 1

3. Remove pin (2). (See F1) ※ 2
   ★ Sling the boom cylinder assembly, and remove the pin.

   ⚠ Start the engine, and retract the boom cylinder rod, then tie the rod with wire to prevent it from coming out, and lower it into the block.

   ★ Disconnect the boom cylinder assembly on the opposite side in the same way.

   ↘⚠↙ ↑ Release the remaining pressure in the circuit. For details, see TESTING AND ADJUSTING, Releasing pressure in hydraulic circuit for machines with PPC valve.

4. Disconnect hose (3). (See F1)

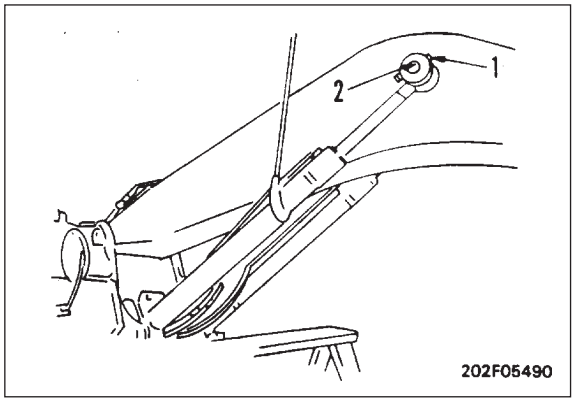
5. Disconnect wiring (4). (See F2)

6. Remove pin (5). (See F3)
   ★ Sling the boom assembly, then use tool **H** to remove the pin.

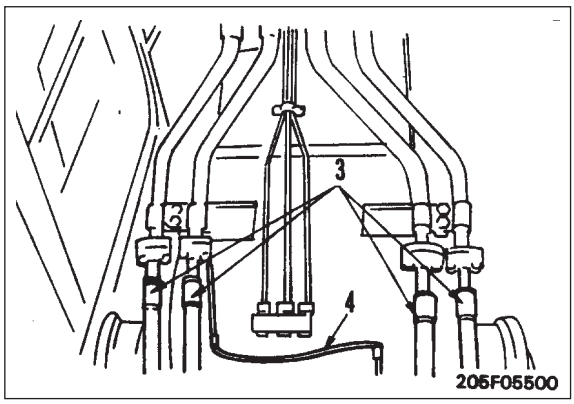
7. Remove boom assembly (6). (See F4)

   kg See Weight Table.

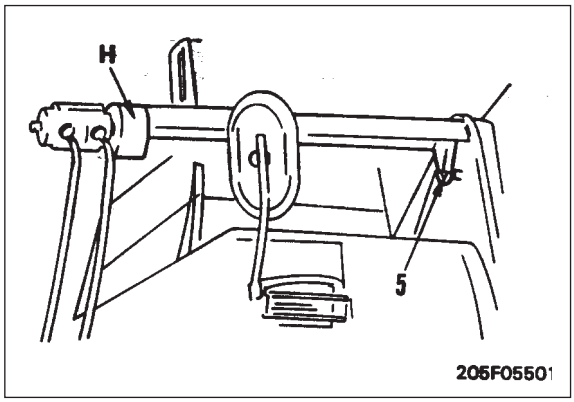
F1



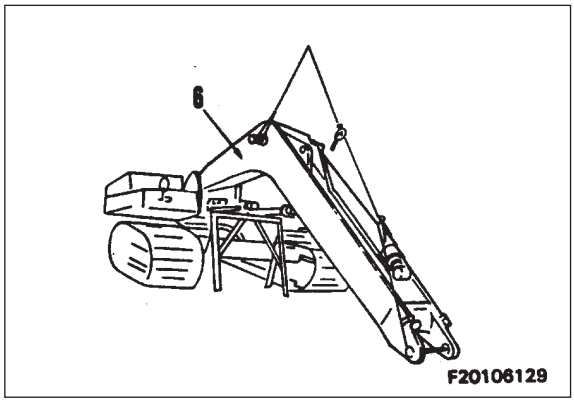
F2



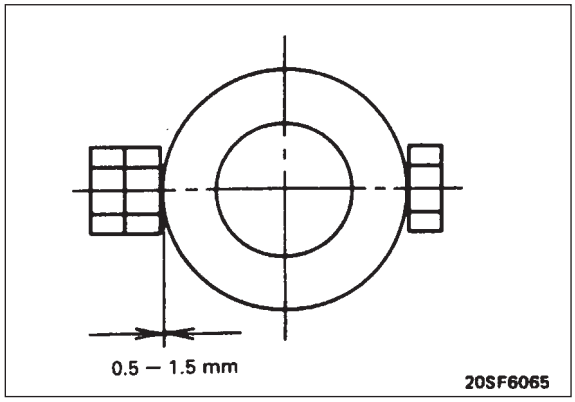
F3



F4



INSTALLATION OF BOOM ASSEMBLY



- Carry out installation in the reverse order to removal.

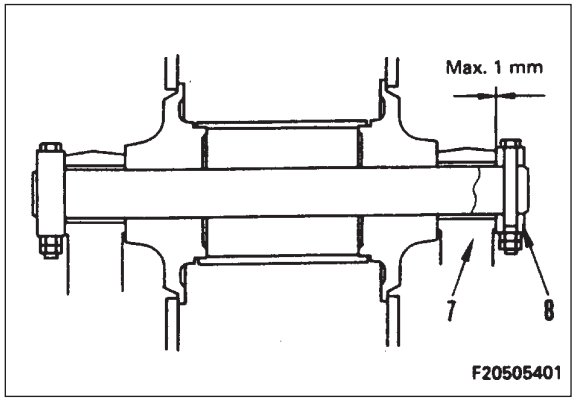
※ 1
★ When tightening the locknut, tighten so that the clearance between the plate and nut is 0.5 - 1.5 mm.

※ 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 (10) and plate (11) is below 1 mm.
★ Standard shim thickness: 0.8 mm, 1.5 mm

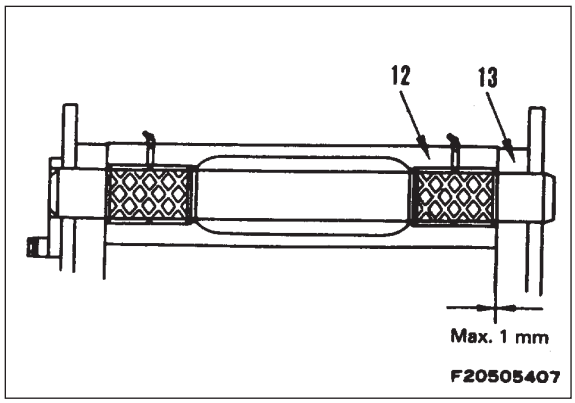


※ 3
Inside surface of bushing when assembling pin: Anti-friction compound (LM-P)

Grease after assembling pin: Grease (LM_G)

⚠ When aligning the position of the pin hole, never insert your fingers in the pin hole.

★ Adjust the shim thickness so that the clearance between boom (12) and bracket (13) is below 1 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 OPERATOR'S CAB ASSEMBLY

⚠ Disconnect the table from the negative (-) terminal of the battery.

1. Remove floor mat (1).

3. Remove knob (3).

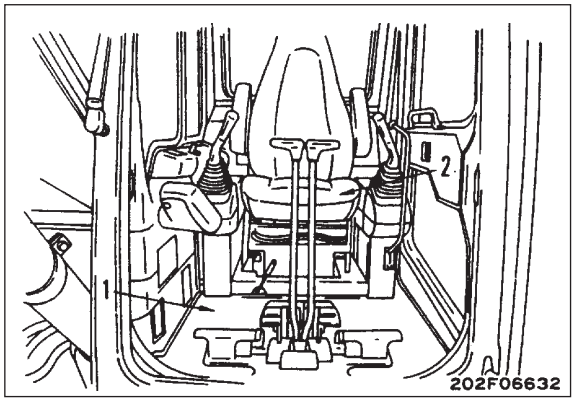
4. Remove 4 caps (4) and clip (5), then remove middle panel (6).

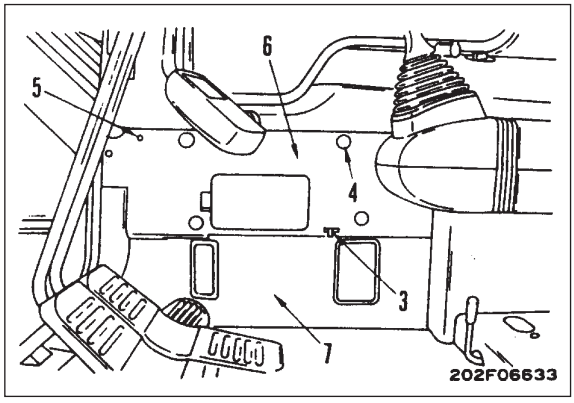
5. Remove bottom panel (7).
   ★ The panel is held by a clip, so remove the clip when removing the panel and be careful not to damage it.

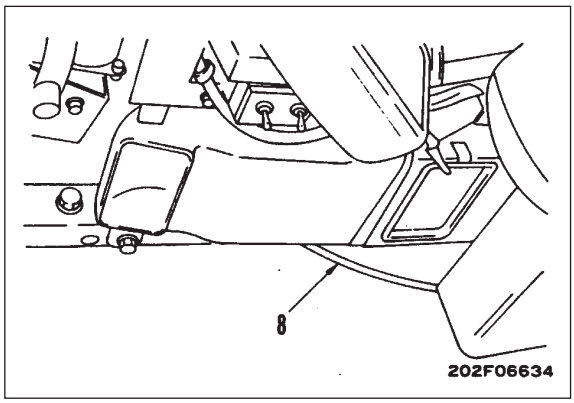
6. Disconnect washer hose (8).

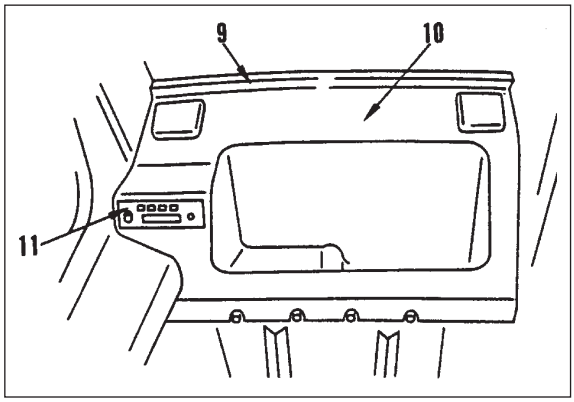
7. Remove radio (11) if fitted (refer to radio operation manual).
   ★ Remove plate (9), then remove cover (10).

8. Lift cover (10) away carefully to locate speaker harness connector. Disconnect and remove panel completely.





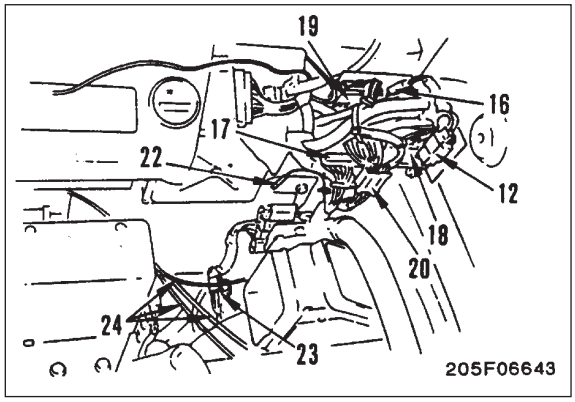


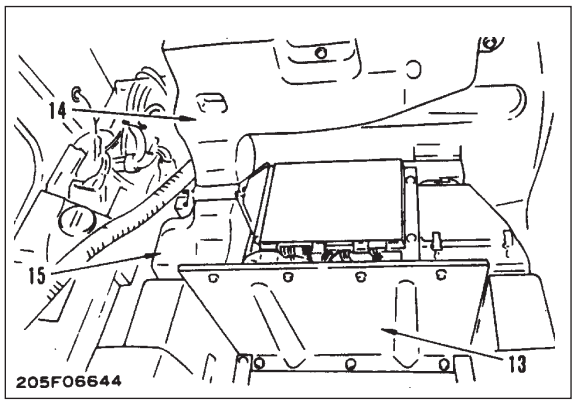


9. Remove divider board (13).

10. Remove heater duct of air conditioner ducts (14) and (15) (if fitted).

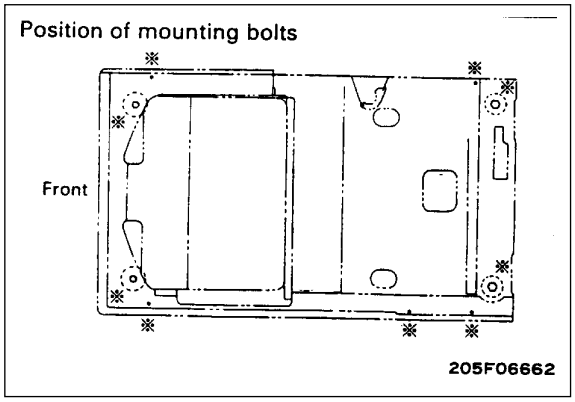
11. Disconnect wiring connectors CN-H01 (16), CN-H02 (17), CN-H03 (18), CN-H04 (19), CN-H05 (20), CN-H06 (21), CN-K01 (22), CN-H07 CN-H08 CN-H09





12. Disconnect heater cables or air conditioner cables (24) (if fitted).

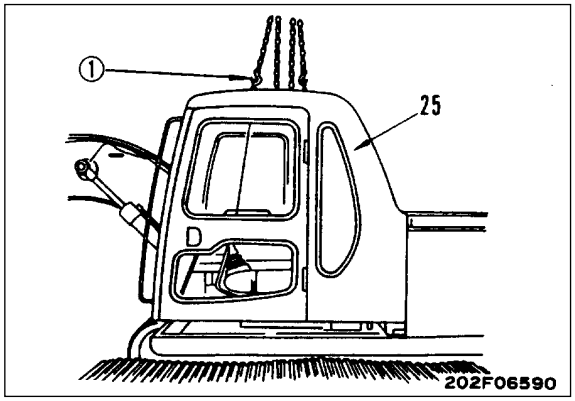
13. Remove 9 cab mounting bolts (marked ※).



14. Using eyebolts ①, remove opeator's cab assembly (25).

kg Operator's cab assembly: 300 kg

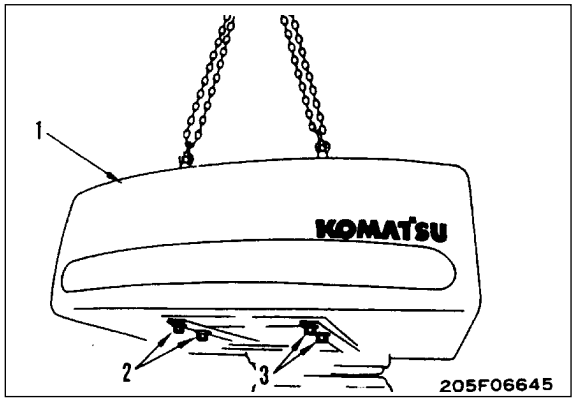
★ When raising the cab assembly, check that all the wiring has been disconnected, then lift off slowly and be careful not to hit any part.



INSTALLATION OF OPERATOR'S CAB ASSEMBLY

- Carry out installation in the reverse order to removal.

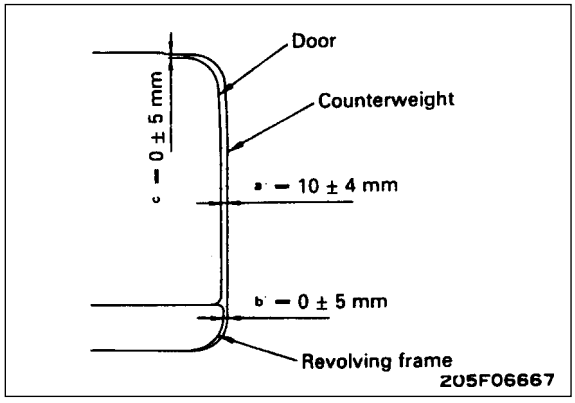
REMOVAL OF COUNTERWEIGHT ASSEMBLY



1. Set lifting hook chains of counterweight assembly in position, and sling.
2. Remove mounting bolts (2) and (3). ※ 1
   ★ Be careful not to lose the shims when removing.
3. Lift off counterweight (1) horizontally with wire or chain block. ※ 2
   ★ Be careful not to hit the engine, radiator and cooler assembly.

kg Counterweight assembly: 2950 kg

INSTALLATION OF COUNTERWEIGHT ASSEMBLY



- Carry out installation in the reverse order to removal.

※ 1

Thread of counterweight mounting bolt: Thread tightener (LT-2)

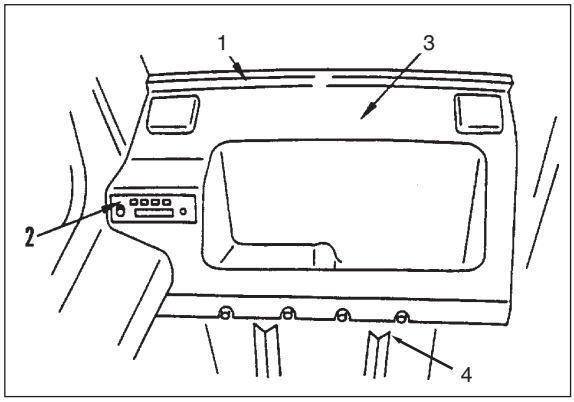
kgm Counterweight mounting bolt: 1,720 ± 190Nm (175±20kgm)

※ 2

★ Installing and adjusting counterweight

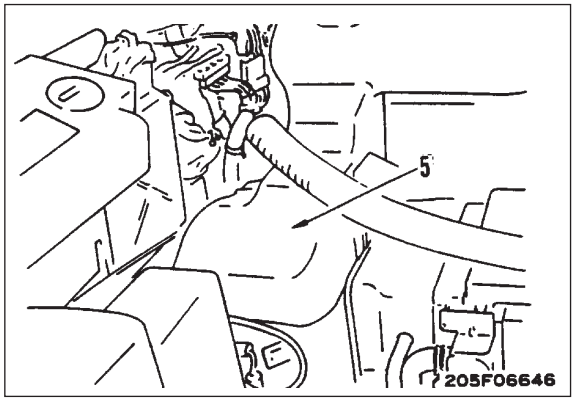
1) Sling counterweight with crane and set in position on frame.
2) Use counterweight pusher bolt ② and align mounting bolts holes. Then install shim and mounting bolts (2) and (3), and adjust to following dimensions.
   - Clearance from revolving frame: 10 ± 5 mm (left and right)
   - Clearance from bodywork door: 10±5 mm (left and right)
   - Stepped difference b from revolving frame in left-to-right direction: Max. 5 mm
   - Stepped difference a from bodywork door in left-to-right direction: 10 ± 4 mm
   - Stepped difference c from bodywork top cover in up-down direction: Max. 5 mm

REMOVAL OF GOVERNOR PUMP CONTROLLER ASSEMBLY

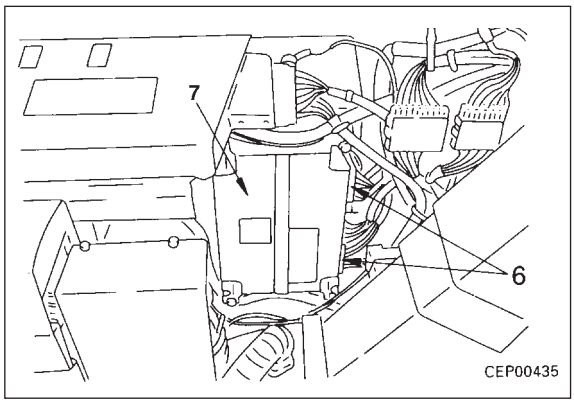


⚠ Disconnect the cable from the negative (-) terminal of the battery.

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 (4).
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

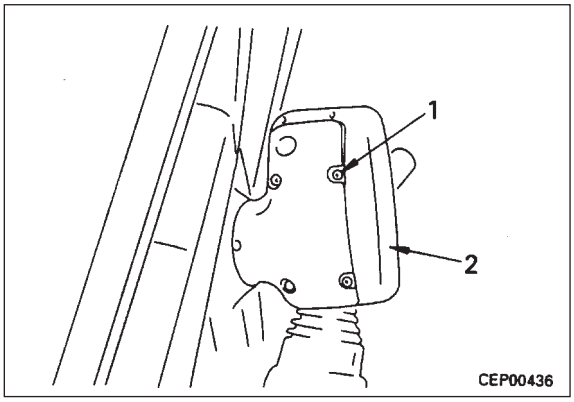


- Carry out installation in the reverse order to removal.

※ 1

- Check the performance of the work equipment, travel, and swing. For details, see TESTING AND ADJUSTING.

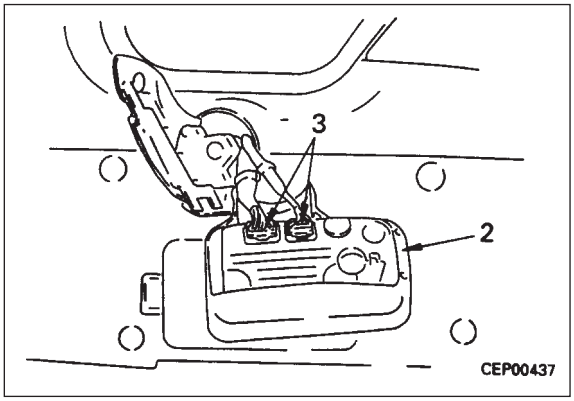
REMOVAL OF MONITOR PANEL ASSEMBLY



⚠ 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.

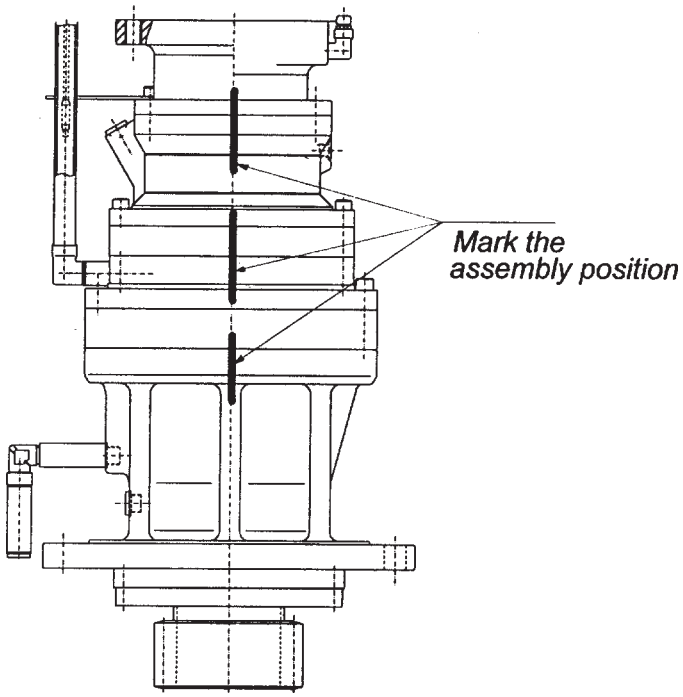
※ 1

- Check the mode setting and display function.
  For details, see TESTING, AND ADJUSTING, AND TROUBLESHOOTING.

DISASSEMBLY OF SWING MACHINERY ASSEMBLY

3. DISASSEMBLING

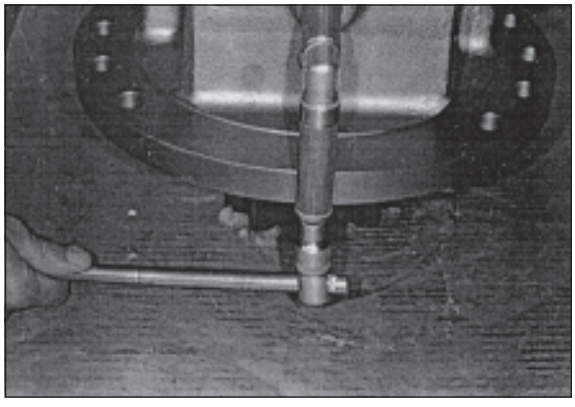
Initial inspection of the gears and the hydraulic motor, can be made without dismantling the slew drive from the machine.



Note

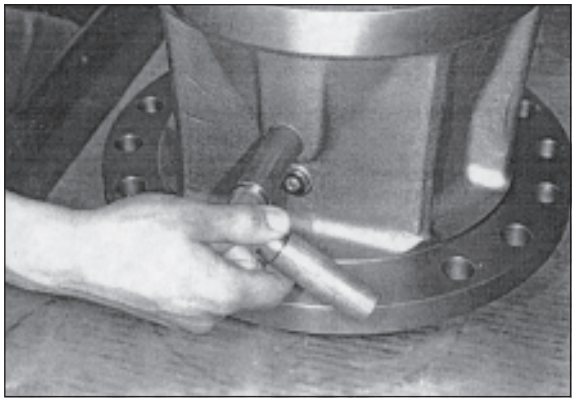
Before starting the gearbox disassembly, it is better to mark the assembly position of: motor adaptor (pos. 50), brake housing (pos. 32), toothed rings (pos. 25-18), cover (pos. 21) and gearbox housing (pos. 7) in order to obtain an exact reference of position at reassembly.
Unscrew and remove the 2 screws M16x40 (pos. 49), grade 8.8, and remove the hydraulic motor and the O-ring (pos. 51).

STEP 1
Unscrew the draining plug M18x1,5 (pos. 9) and its washer (pos. 8) from the gearbox housing (pos. 7) and drain the oil from the gearbox.

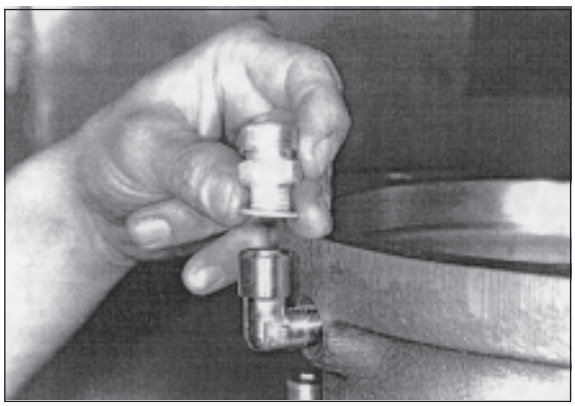


DISASSEMBLING

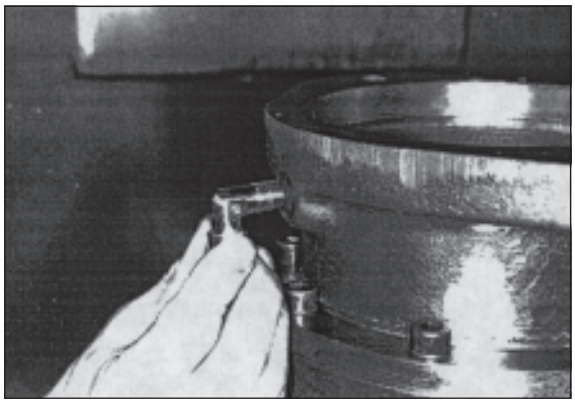
STEP 2
Remove the extensions (pos. 10), the elbow (pos. 11) and the washer (pos. 8) from the gearbox housing (pos. 7).



STEP 3
Unscrew the plug G1/4 (pos. 47) from the motor adaptor (pos. 50)

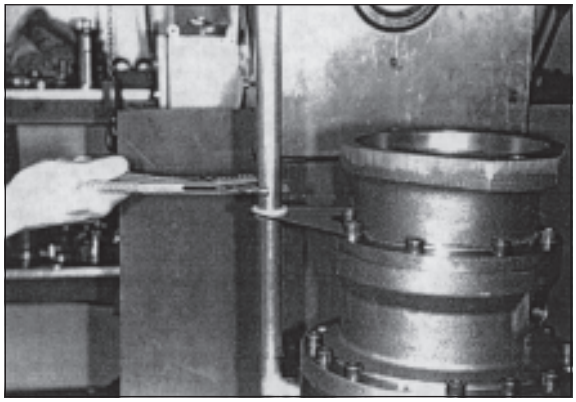


STEP 4
Unscrew the elbow (pos. 46) from the motor adaptor (pos. 50).

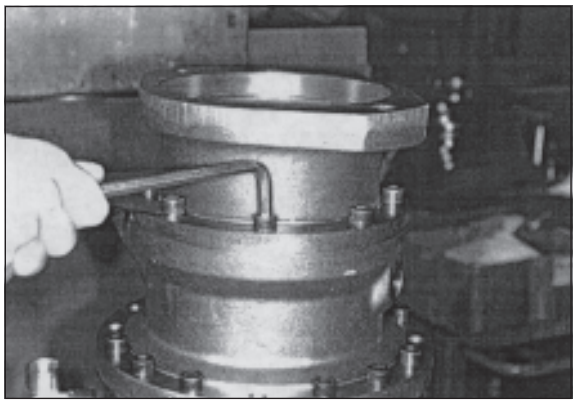


DISASSEMBLING

STEP 5
Unscrew the dipstick for oil filling and level kit (pos. 52).



STEP 6
Unscrew the 8 socket head screws M10x30 (pos. 48) grade 8.8, fixing the motor adaptor (pos. 50) to the brake housing (pos. 32).

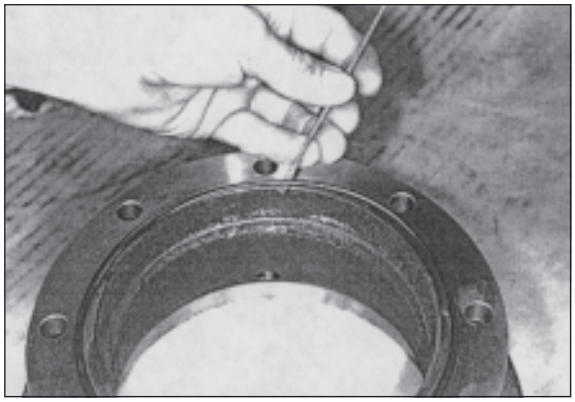


STEP 7
Remove the 8 socket head screws (pos. 48), the bracket of oil filling and level kit (pos. 52) and remove the motor adaptor (pos. 50).

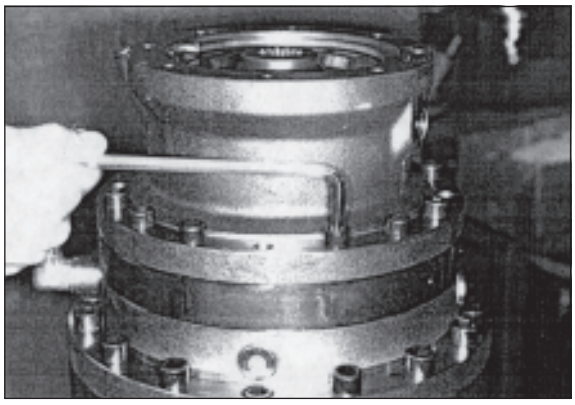


DISASSEMBLING

STEP 8
Remove the O-ring (pos. 44) from its seat in the motor adaptor (pos. 50).



STEP 9
Unscrew the 11 socket head screws M10x70 (pos. 33) grade 8.8 and remove the brake assembly.

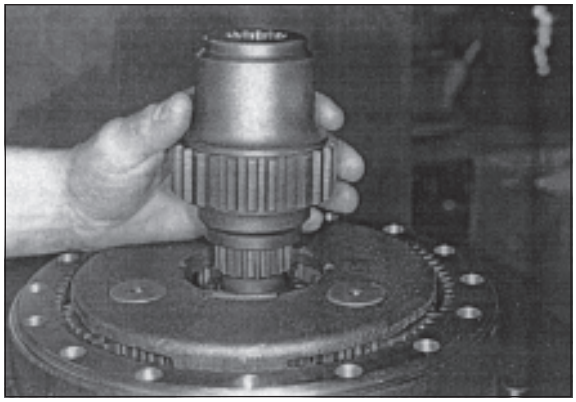


STEP 10
Overturn the brake assembly and remove the O-ring (pos. 24) from its seat in the brake housing (pos. 33).

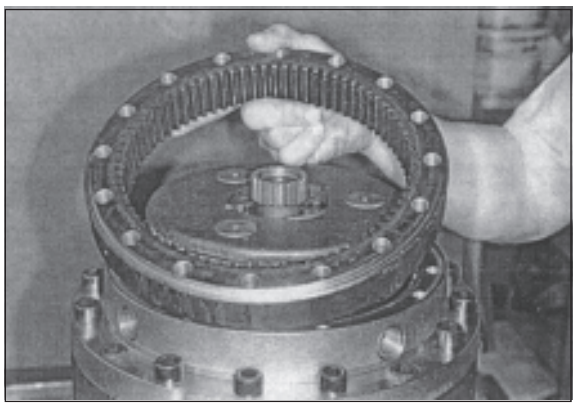


DISASSEMBLING

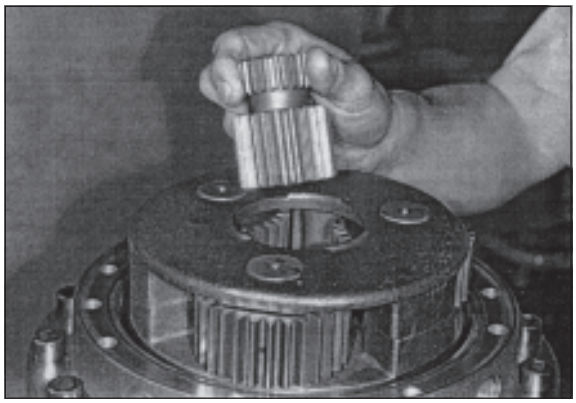
STEP 11
Remove the brake shaft (pos. 35).



STEP 12
Remove the toothed ring (pos. 25).

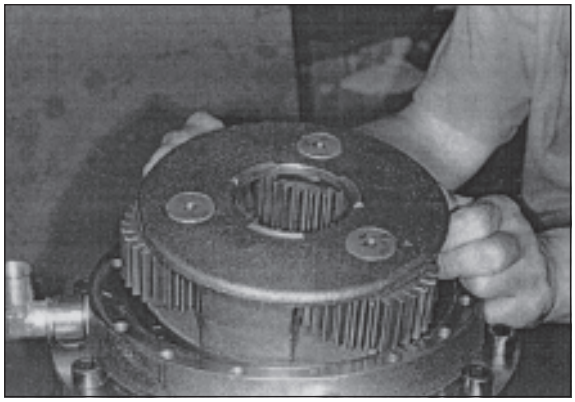


STEP 13
Remove the 1st stage sun gear (pos. 27).

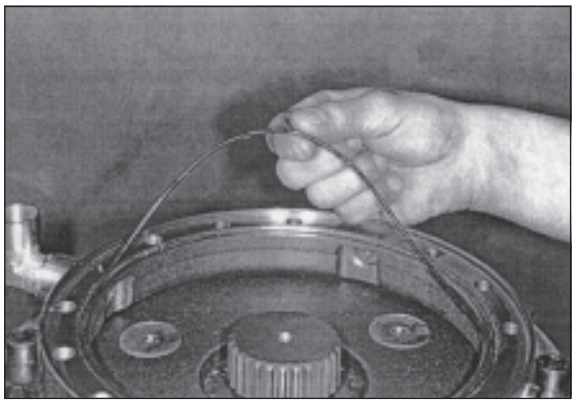


DISASSEMBLING

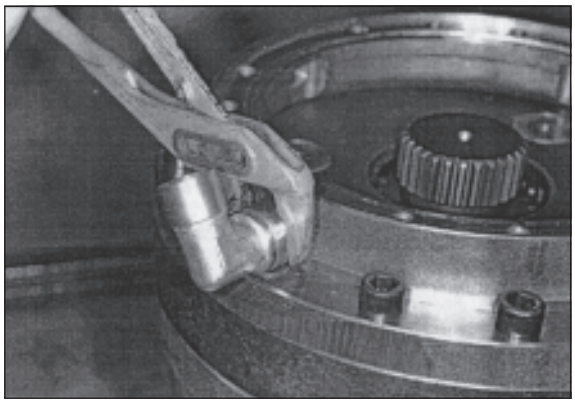
STEP 14
Remove th 1st reduction assembly (pos. 26).



STEP 15
Remove the O-ring (pos. 24) from its seat in the cover (pos. 21).

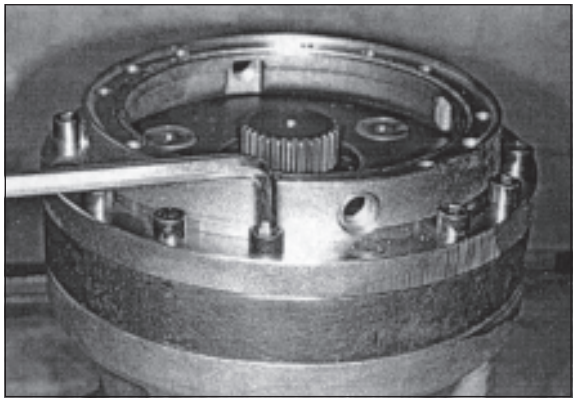


STEP 16
Using pliers remove the elbow and the extension of the oil filling and level kit (pos. 52) from the cover (pos. 21) and all plugs and washers present in the gearbox too.

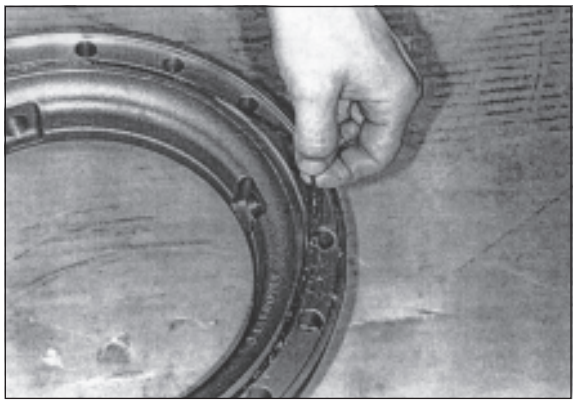


DISASSEMBLING

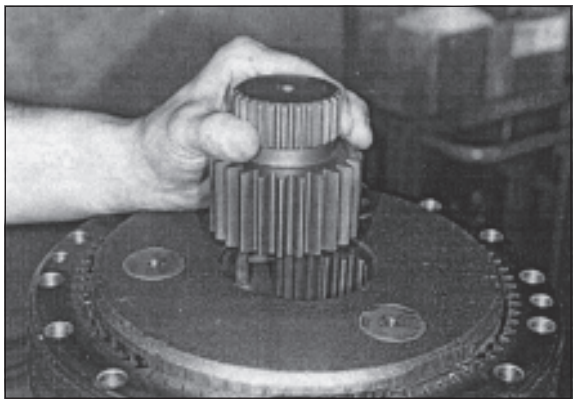
STEP 17
Unscrew the 4 socket head screws M12x80 (pos. 22), grade 12.9, and the 12 socket head screws M12x90 (pos. 23), grade 12.9, and remove the cover (pos. 21).



STEP 18
Remove the O-ring (pos. 12) from its seat in the end cover (pos. 21).

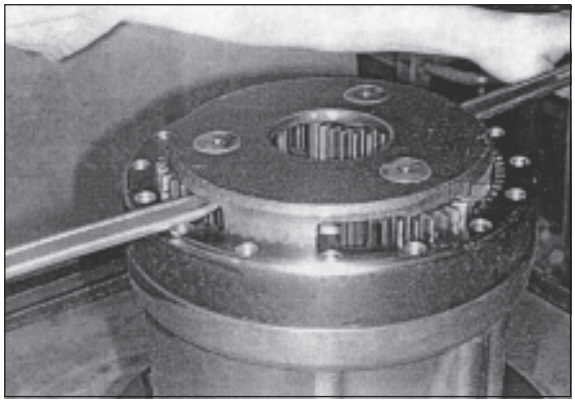


STEP 19
Remove the 2nd stage sun gear (pos. 19).

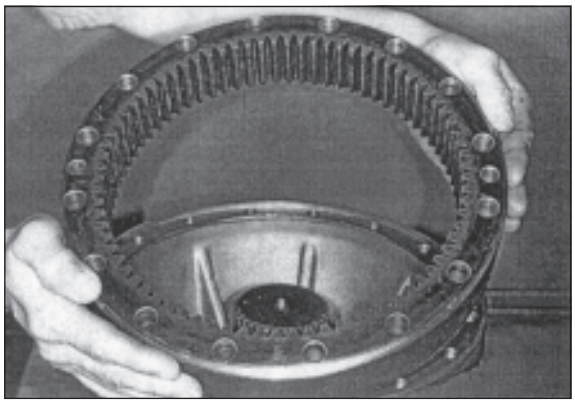


DISASSEMBLING

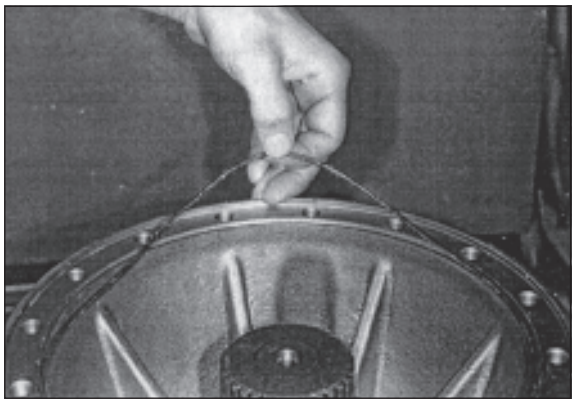
STEP 20
Remove the 2nd reduction assembly (pos. 17).



STEP 21
Remove the toothed ring (pos. 18).

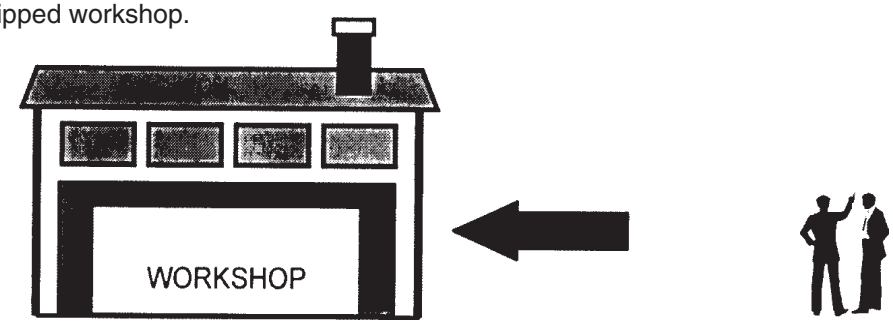


STEP 22
Remove the O-ring (pos. 12) from its seat in the gearbox housing (pos. 7).

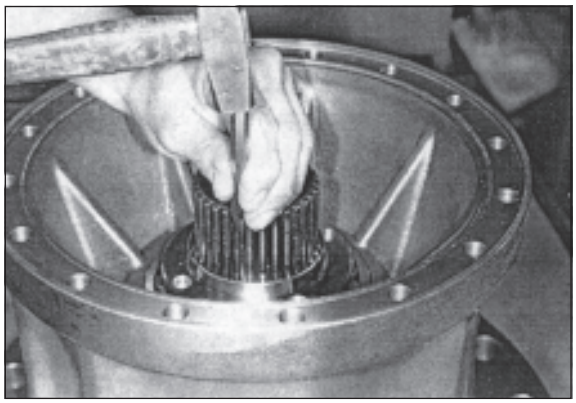


Note

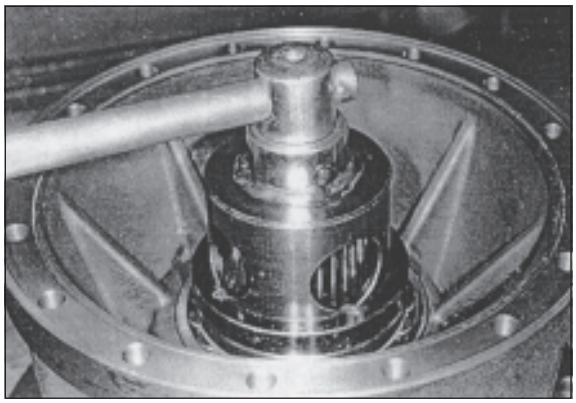
In order to proceed with the slew drive disassembling, it is now necessary to remove it from the machine and bring it to a properly equipped workshop.



STEP 23
By means of a punch, remove the caulking in the edge of the nut (pos. 15).

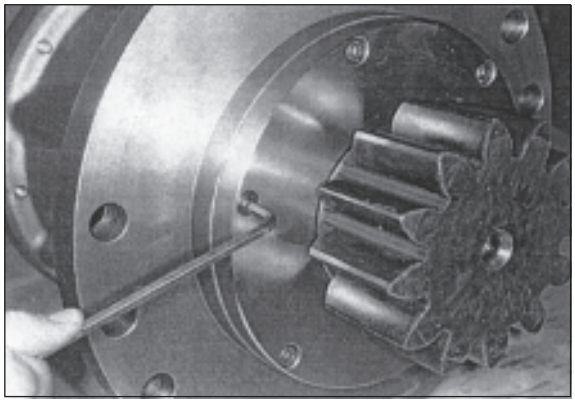


STEP 24
Using the tool AT709C06, unscrew the nut M75x2 (pos. 15).

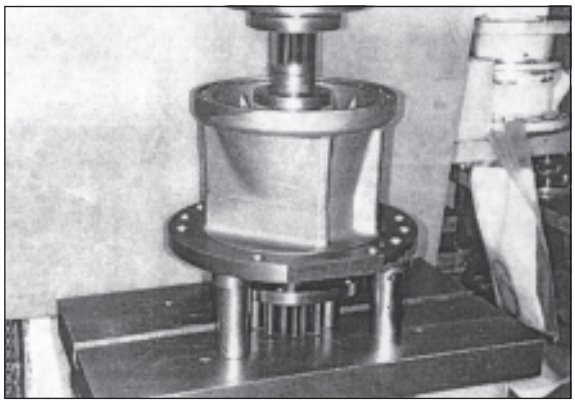


DISASSEMBLING

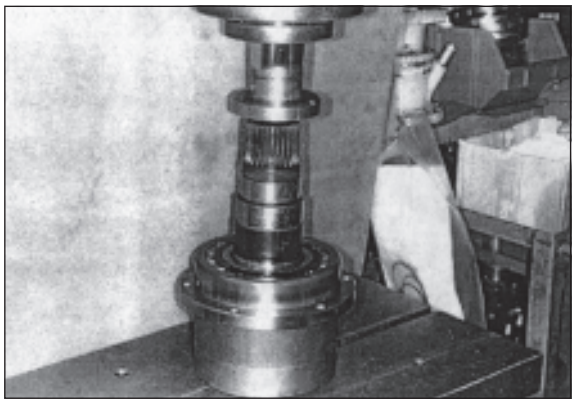
STEP 25
Overturn the output assembly (pos. 16), unscrew and remove the 8 socket head screws M8x20 (pos. 4), grade 8.8, from the front cover (pos. 5)



STEP 26
Place the gearbox housing (pos. 7) on three spacers and through a press push on the pinion shaft (pos. 1) and remove it from the gearbox housing (pos. 7).

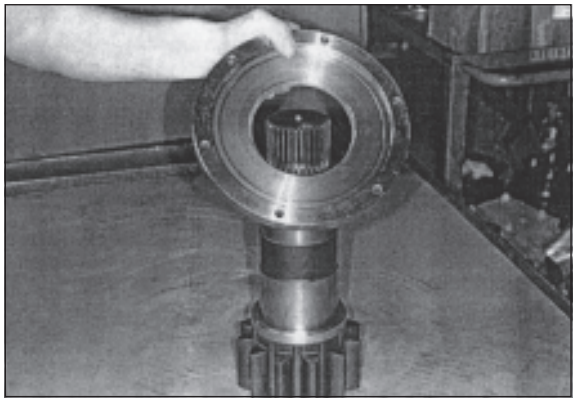


STEP 27
Place the pinion shaft (pos. 1), front cover (pos. 5) and bearing (pos. 6) group on a spacer.
Through a press push on the pinion shaft (pos. 1) and extract the bearing (pos. 6).

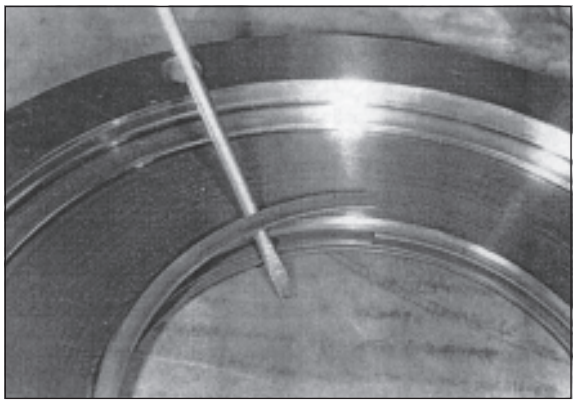


DISASSEMBLING

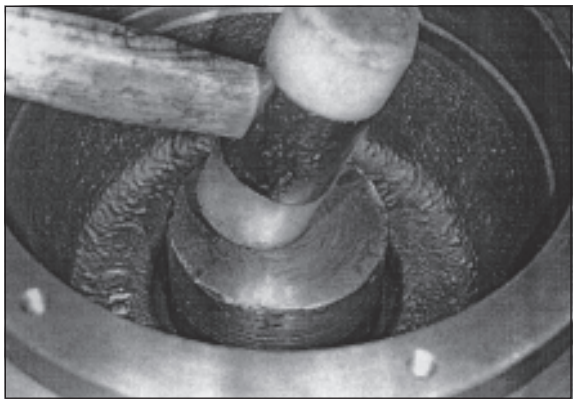
STEP 28
Remove the front cover (pos. 5).



STEP 29
Use a screwdriver to remove the ringseals (pos. 3) from their grove in the front cover (pos. 5)

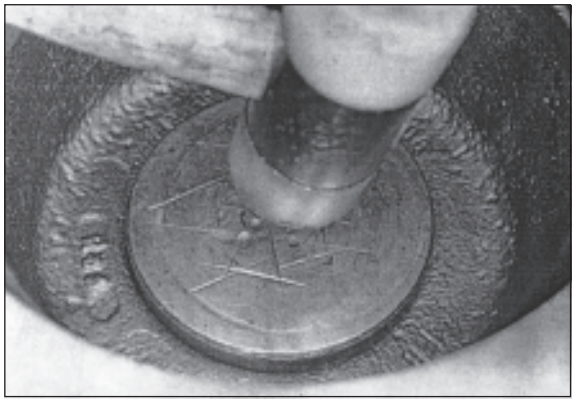


STEP 30
Use a rubber hammer a metal stopper to remove the bearing (pos. 14) from the the gearbox housing (pos. 7).



DISASSEMBLING

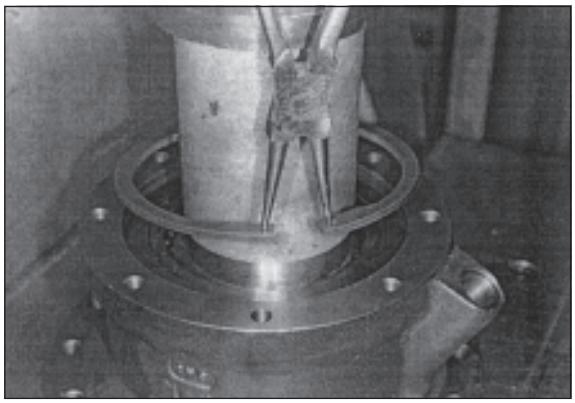
STEP 31
Use a rubber hammer a metal stopper to remove the seal ring (pos. 13). from the the gearbox housing (pos. 7).



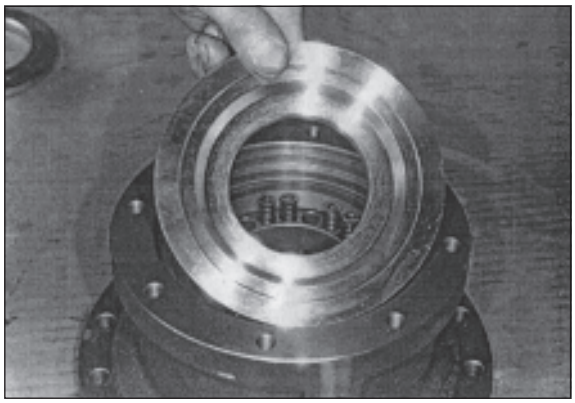
Important

Disassemble the seal ring only in case it has to be replaced.

STEP 32
Through a press and a metal stopper, push on the spring retainer (pos. 42), thus removing the force of the springs (pos. 41) on the circlip (pos. 43) and through pliers remove it.

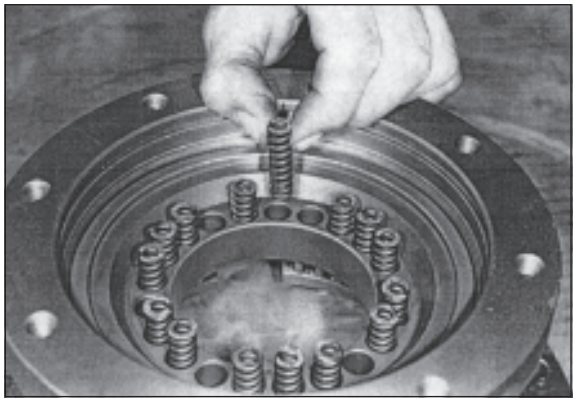


STEP 33
Remove the springs retainer (pos. 42).



DISASSEMBLING

STEP 34
Remove the springs (pos. 41) from their groves in the brake piston (pos. 40).



STEP 35
Remove the brake piston (pos. 40).
To get it easier, pumping compressed air into the brake port hole (max. 0,2 bar), taking care the piston (pos. 40) doesn't jump out the brake housing (pos. 32).

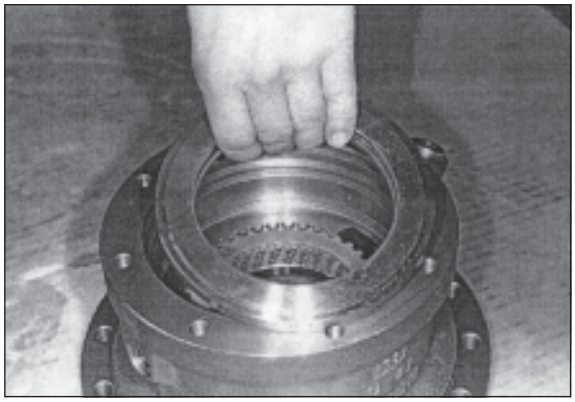


STEP 36
Remove the 1 st O-rings (pos. 34) from its seat in the brake housing (pos. 32).

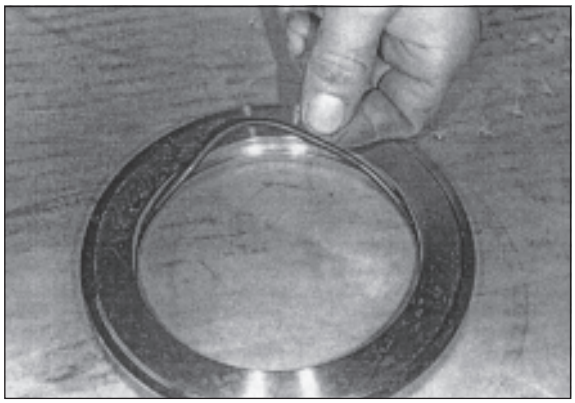


DISASSEMBLING

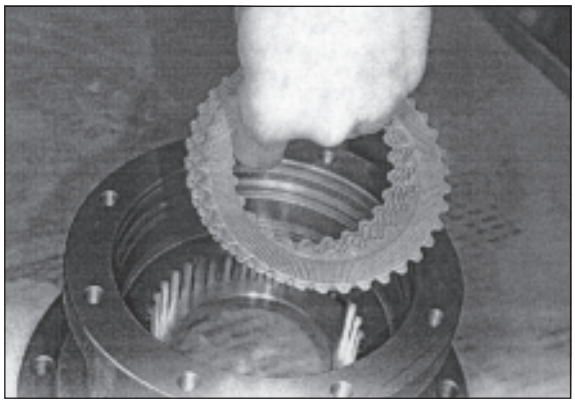
STEP 37
Remove spacer (pos. 38) and remove the 2nd O-rings (pos. 34) from its grove in the brake housing (pos. 32).



STEP 38
Remove the O-ring (pos. 39) from its seat in the spacer (pos. 38).

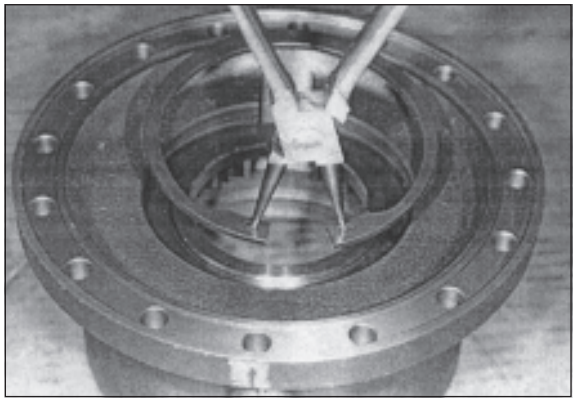


STEP 39
Remove brake discs pack (pos. 36-37).

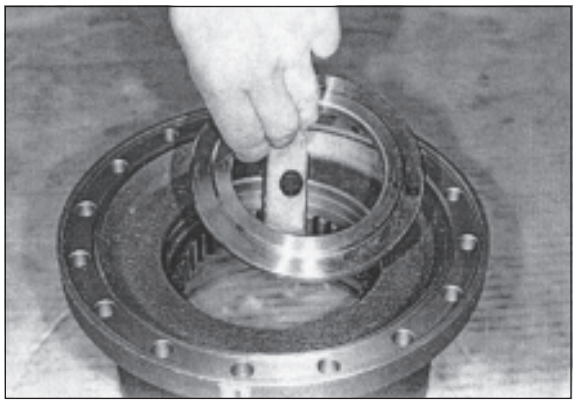


DISASSEMBLING

STEP 40
Through pliers remove the circlip (pos. 29) from its grove in the brake housing (pos. 32).



STEP 41
Remove the discs retainer (pos. 30)



Note
The gearbox disassembling ends with the above operation: all items are now available for the necessary inspections.

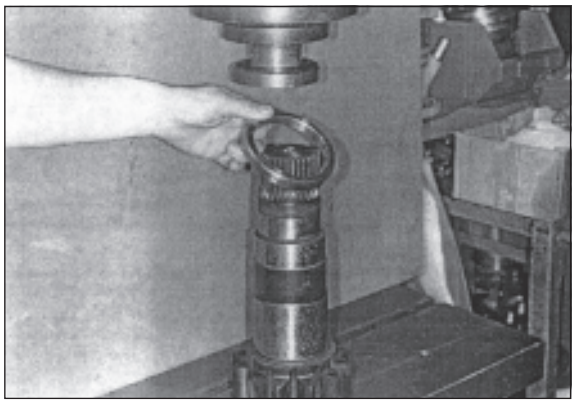
4. ASSEMBLY

4.1 IMPORTANT NOTES BEFORE THE ASSEMBLING

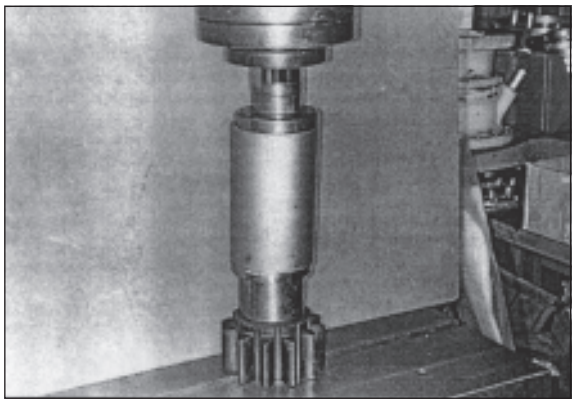
When proceeding with the gearbox re-assembly, it is necessary to follow up the rules listed below:

a) In case of damaged gears, for example a planet, **do not replace the single gear, but the whole reduction stage.**
b) **Always replace the O-rings of the item to be reassembled** after having carefully cleaned the seats and having butterd some grease on the groves themselves and on the O-rings to make easier the reassembly.

STEP 42
Place correctly the spacer (pos. 2) on the pinion shaft (pos. 1).

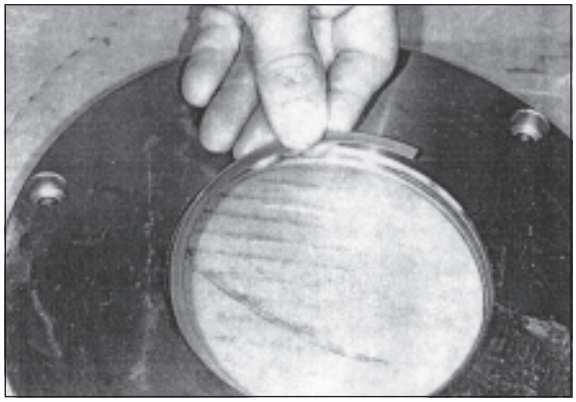


STEP 43
Through a press and a metal stopper push the spacer (pos. 2) against the shoulder on the pinion shaft (pos. 1) untill assembling is complete.

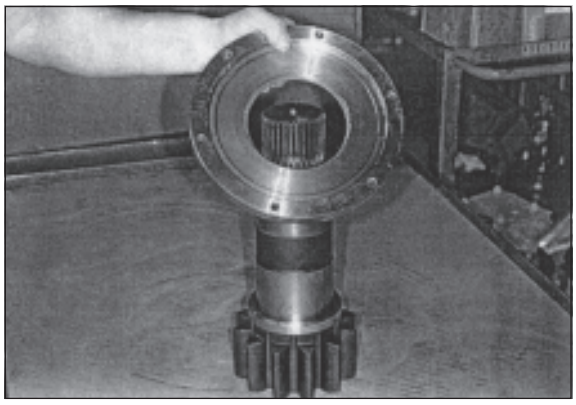


ASSEMBLING

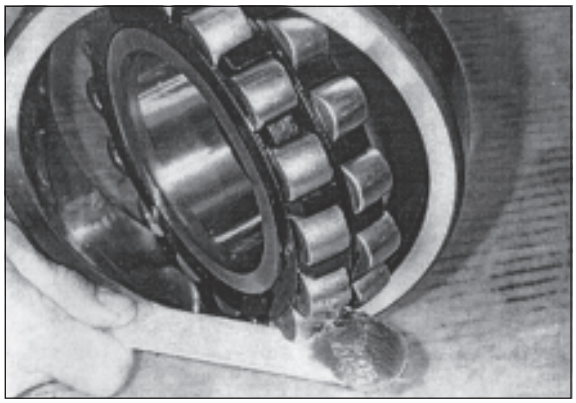
STEP 44
Mount the seal ring (pos. 3) into its grove in the front cover (pos. 5).



STEP 45
Mount the front cover (pos. 5) on the pinion shaft (pos. 1).

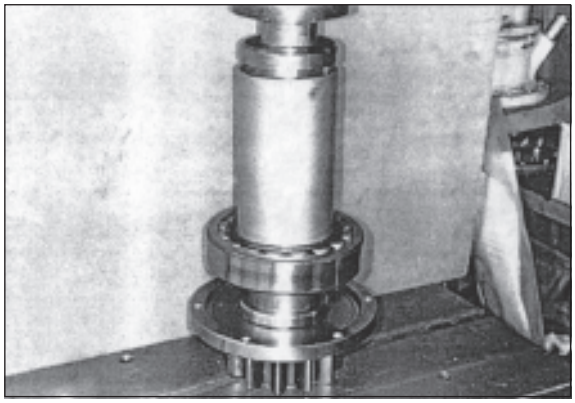


STEP 46
Apply on the bearing (pos. 6) a coat of grease type **NGLI 2 with EP characteristics.**

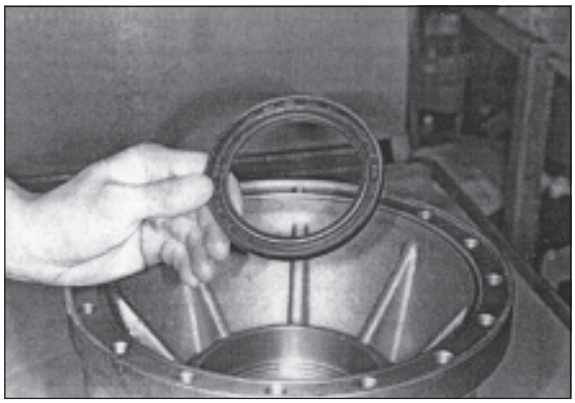


ASSEMBLING

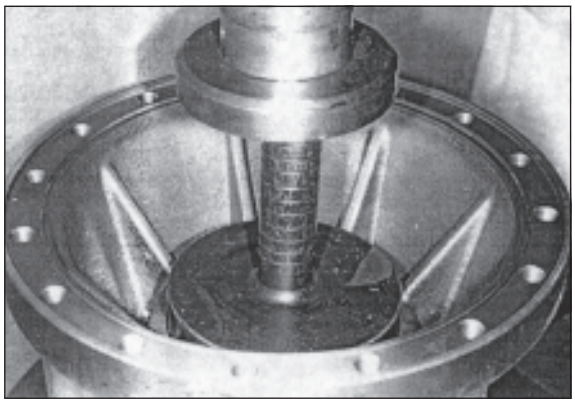
STEP 47
Place the bearing (pos. 6) on the pinion shaft (pos. 1). Through a press and a metal stopper, push the bearing (pos. 6) against the spacer shoulder (pos. 2).



STEP 48
Place the seal ring (pos. 13) inside the gearbox housing (pos. 7).

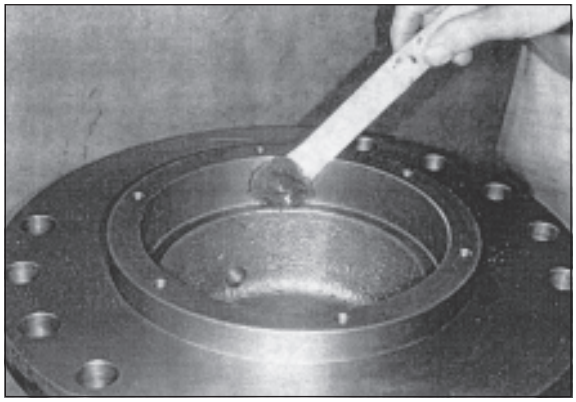


STEP 49
Through a press and the proper metal stopper AT709C14, push the seal ring (pos. 13) against the shoulder on the gearbox housing (pos. 7).

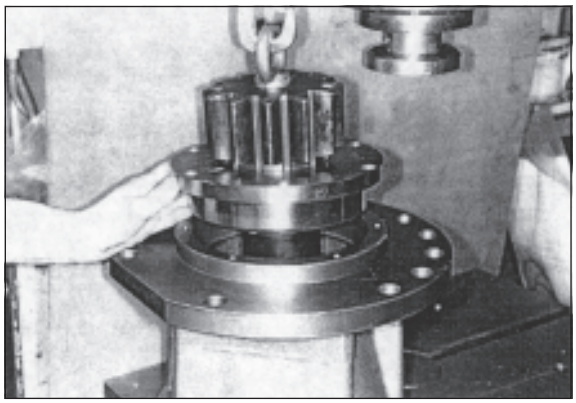


ASSEMBLING

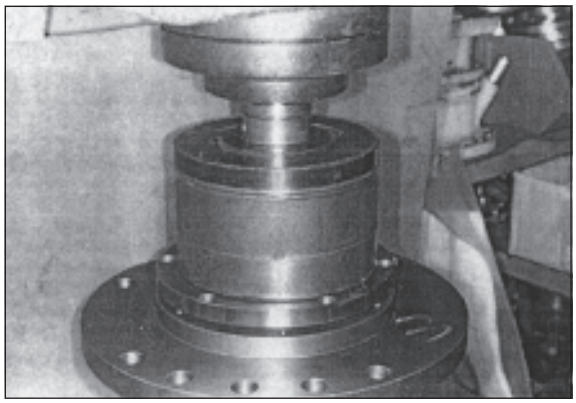
STEP 50
Overturn the gearbox housing (pos. 7) and fill with grease type **NGLI 2 with EP characteristics** the upper chamber placed between the seal ring (pos. 13) and the bearing (pos. 6).



STEP 51
Place the pinion shaft (pos. 1) -spacer (pos. 2) -front cover (pos. 5) -bearing (pos. 6) group in the gearbox housing (pos. 7).

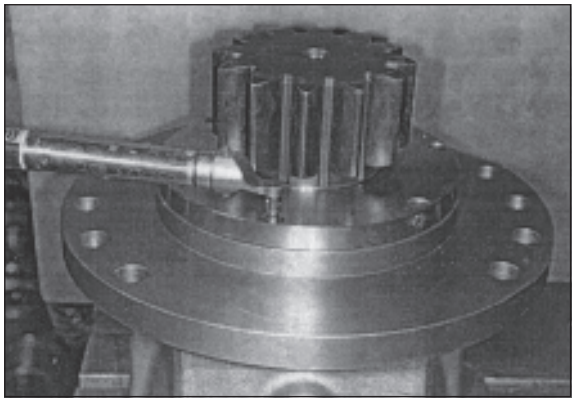


STEP 52
Use a press and a proper metal stopper to push the pinion shaft (pos. 1) against the shoulder on the gearbox housing (pos. 7 until assembling of the unit is complete.

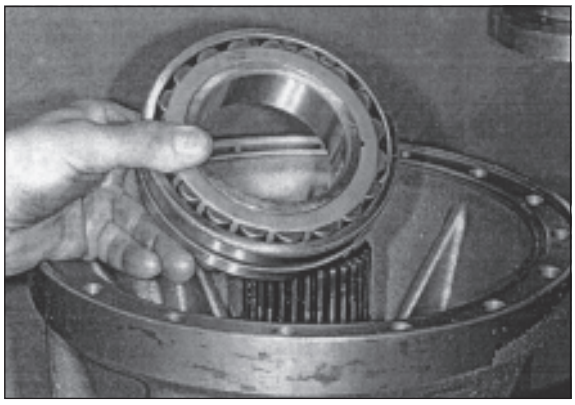


ASSEMBLING

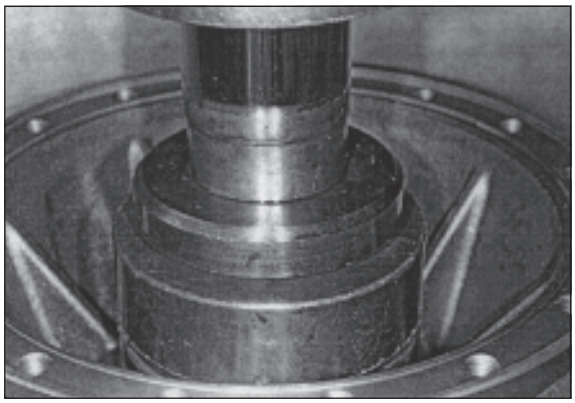
STEP 53
Tighten the 6 socket head screws M8x20 (pos. 4), grade 8.8, by a torque wrench at a torque of 2,5 daNm.



STEP 54
Overturn the gearbox (pos. 7) and place inside it the bearing (pos. 14).

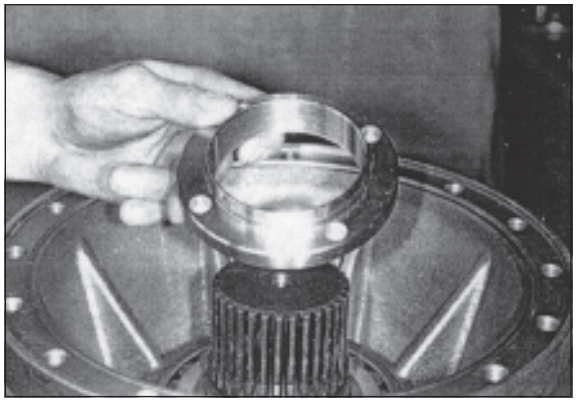


STEP 55
Use a press and the metal stopper to push the bearing (pos. 14) against the shoulder in the gearbox housing (pos. 7).

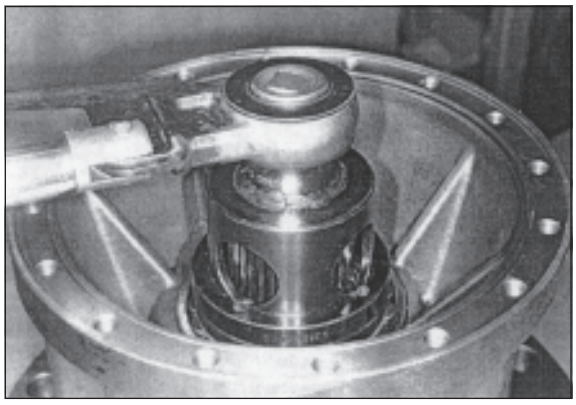


ASSEMBLING

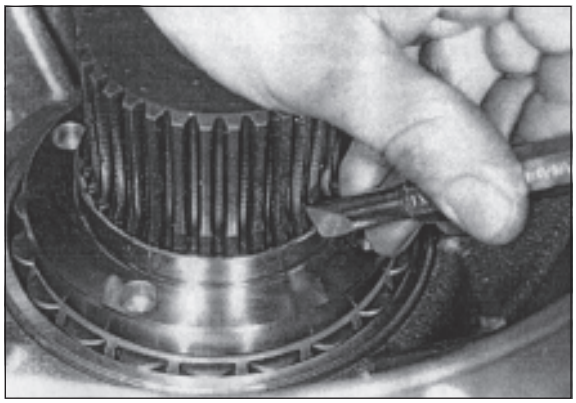
STEP 56
Place a new ring nut (pos. 15) on the pinion shaft (pos. 1). Never use the nut disassembled because already deformed.



STEP 57
Use the tool AT709C06 to tighten the ring nut M75x2 (pos. 15), by a torque wrench, at a torque of 110-120 daNm.

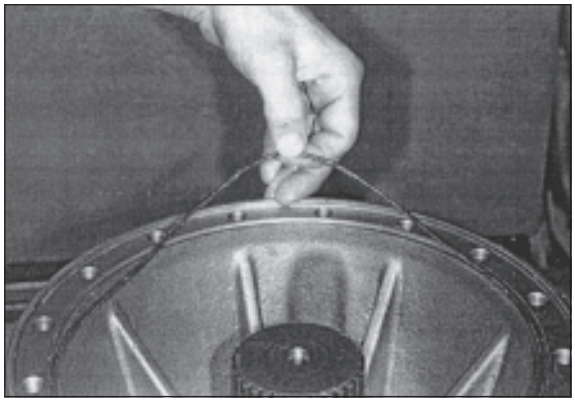


STEP 58
Caulk the ring nut (pos. 13) next to 3 spaces placed at 120° of the pinion shaft spline (pos. 1).

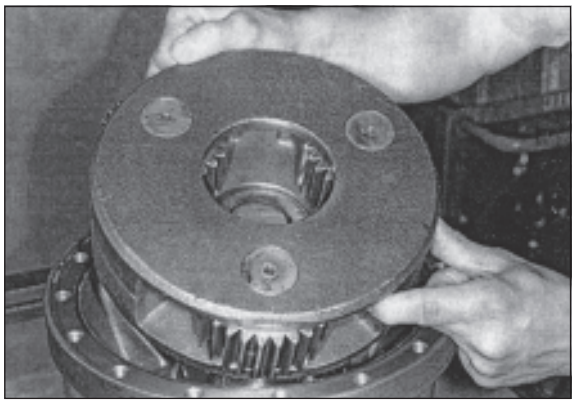


ASSEMBLING

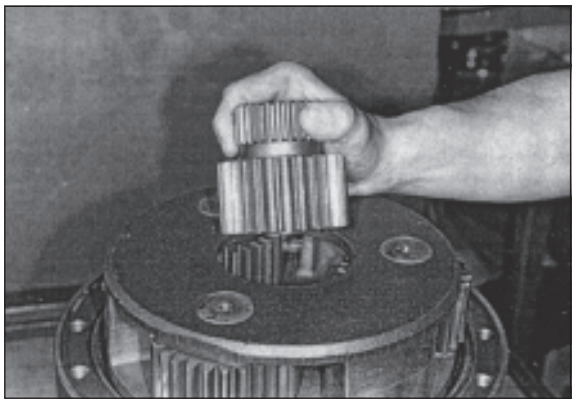
STEP 59
Apply in the O-ring's seat in the gearbox housing (pos. 7) a coat of grease.
Mount the 1st O-ring (pos. 12).



STEP 60
Assemble the 2nd reduction assembly (pos. 17).

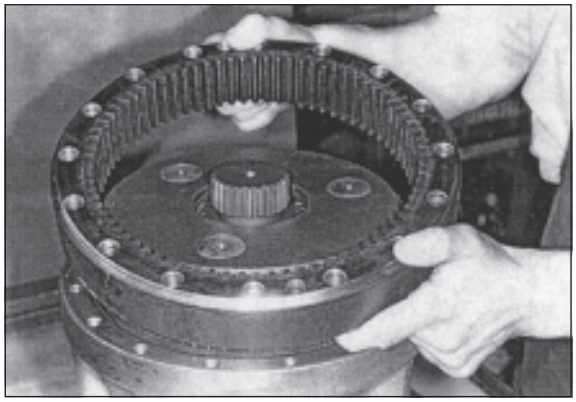


STEP 61
Insert the 2nd stage sun gear (pos. 19).

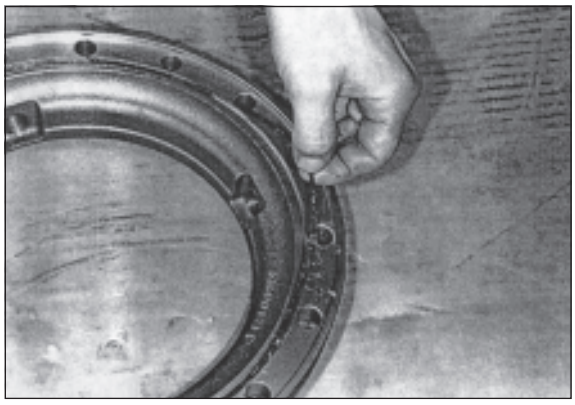


ASSEMBLING

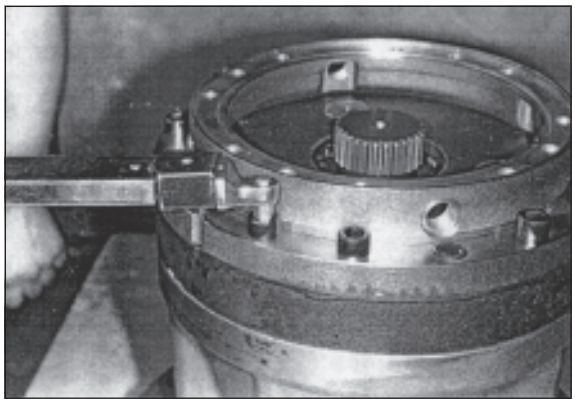
STEP 62
Assemble the toothed ring (pos. 18).



STEP 63
Apply in the O-ring's seat in the cover (pos. 21) a coat of grease.
Mount the 2nd O-ring (pos. 12).

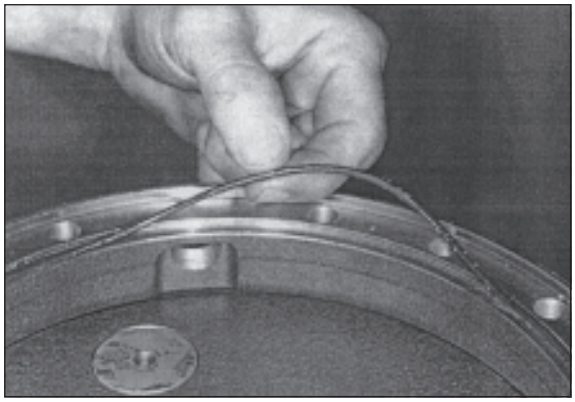


STEP 64
Place the cover (pos. 21) on the toothed ring (pos. 18) and fix it through 4 socket head screws M12x80 (pos. 22), grade 8.8, and through 12 socket head screws M12x90 (pos. 23), grade 8.8, tightened by a torque wrench at 12 daNm torque.

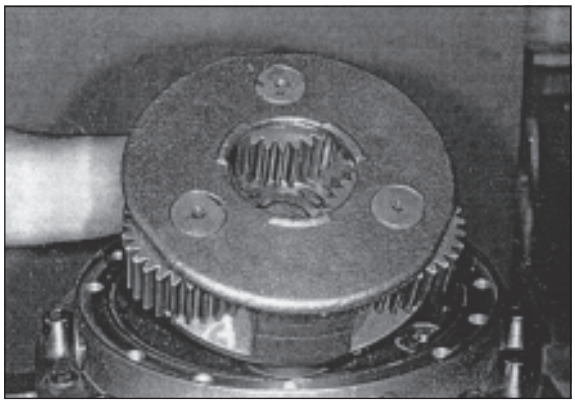


DISASSEMBLING

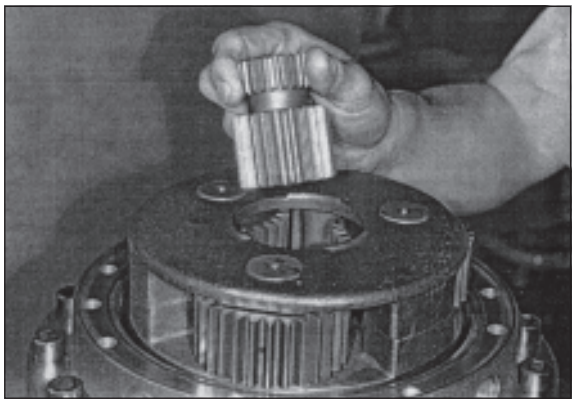
STEP 65
Apply in the O-ring's seat in the cover (pos. 17) a coat of grease.
Mount the 1st O-ring (pos. 24).



STEP 66
Assemble the 1st reduction assembly (pos. 26).

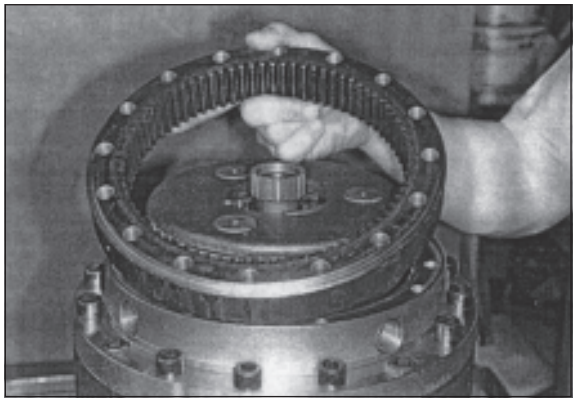


STEP 67
Insert the 1st stage sun gear (pos. 27).

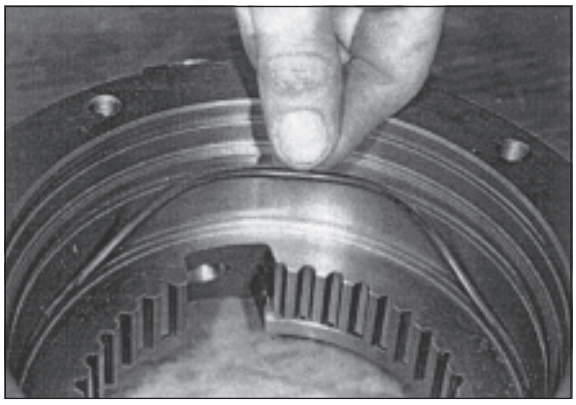


ASSEMBLING

STEP 68
Assemble the toothed ring (pos. 25).



STEP 69
Apply in the internal seal's groves of the brake housing (pos. 32) a coat of grease, and insert the O-rings (pos. 34).

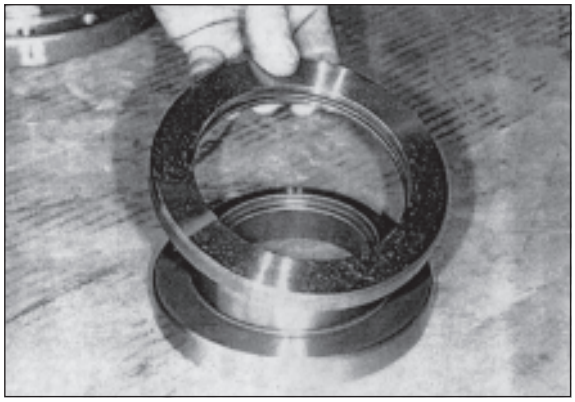


STEP 70
Apply in the inside surface of the spacer (pos. 38) a coat of grease.
Fit the O-ring (pos. 39) into its seat in the spacer (pos. 38).

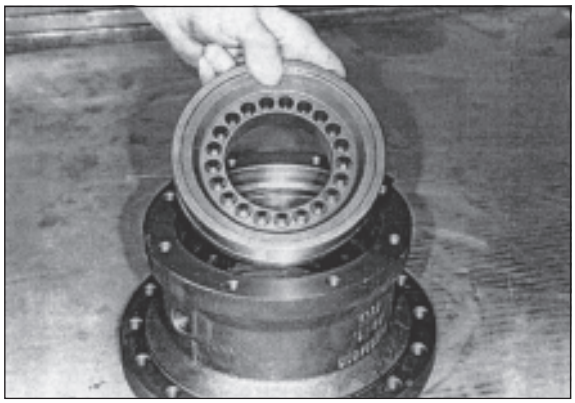


ASSEMBLING

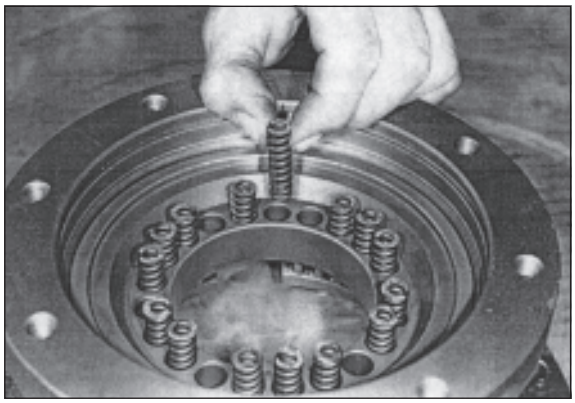
STEP 71
Assemble corectly the spacer (pos. 38) to the brake piston (pos. 40), paying attention not to damage the O-ring (pos. 39) already fitted.



STEP 72
Insert the brake piston-spacer group (pos. 40-38) inside the brake housing (pos. 32), paying attention not to damage the seals already fitted.

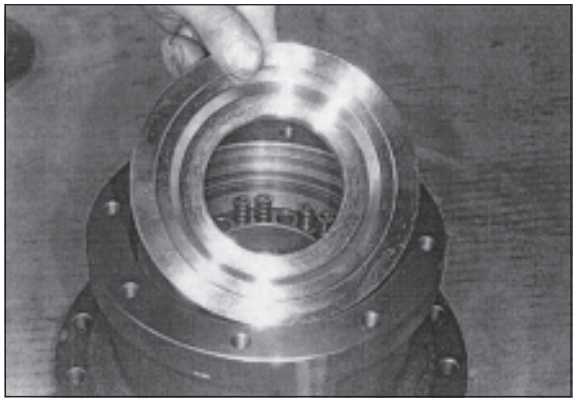


STEP 73
Insert the springs (pos. 41) into the holes in the brake piston (pos. 40), according the picture arangement.

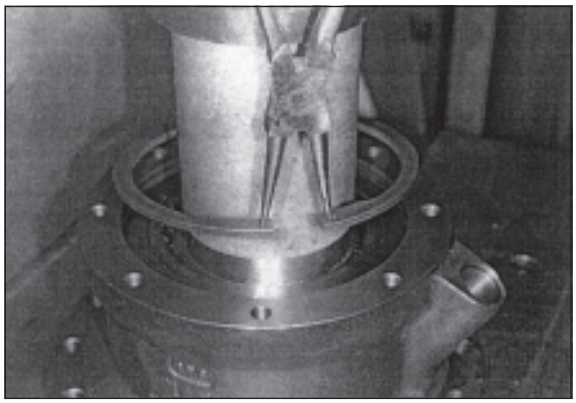


ASSEMBLING

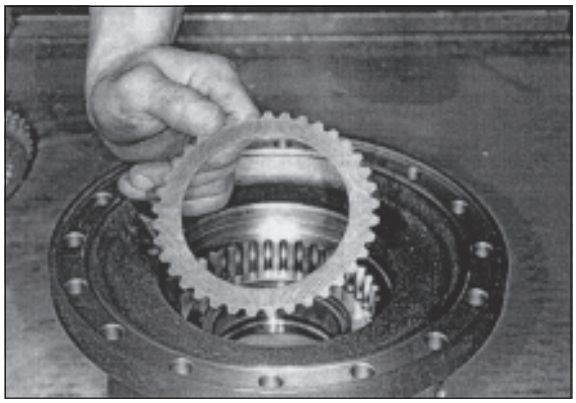
STEP 74
Insert the springs retainer (pos. 42).



STEP 75
Through a press and a metal stopper, push on the springs retainer (pos. 42), in lowering it in order to permit the assembly of the circlip (pos. 43) in its grove in the brake housing (pos. 32).

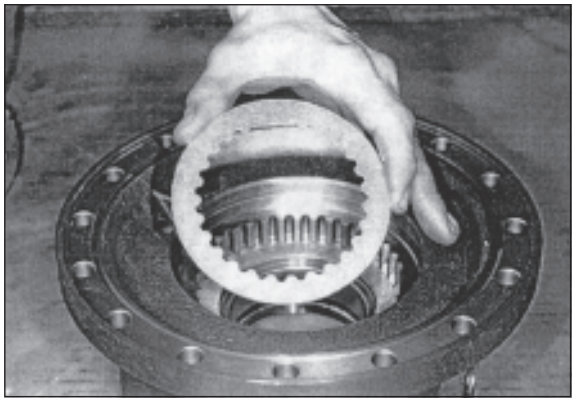


STEP 76
Overturn the brake housing (pos. 32) and assemble the brake discs package according to the following order:
firstly insert an external toothed sintered bronze disc (pos. 37).

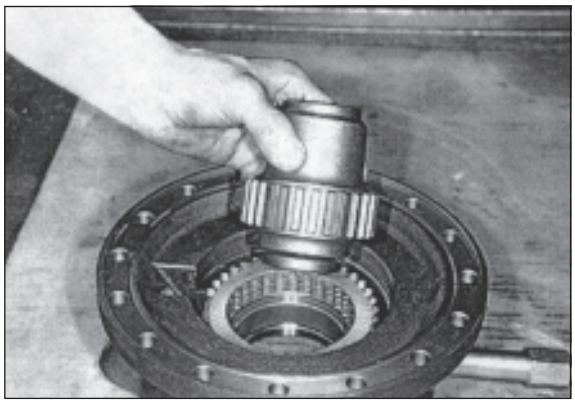


ASSEMBLING

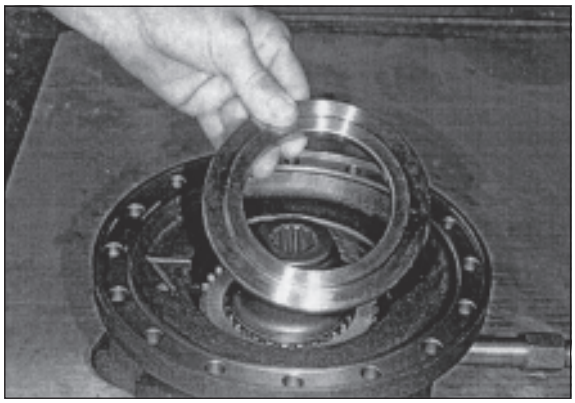
STEP 77
Then insert, an internal toothed steel disc (pos. 36).
Repete the operation untill reaching the number of 6 sintered bronze and 5 stell discs.



STEP 78
Assemble the brake shaft (pos. 35) and insert oil at a pressure of 20 bar from the brake pilot port (see installation drawing ref. 4) in order to permit the assembling of the last sintered bronze disc (pos. 37) and the discs retainer (pos. 30).

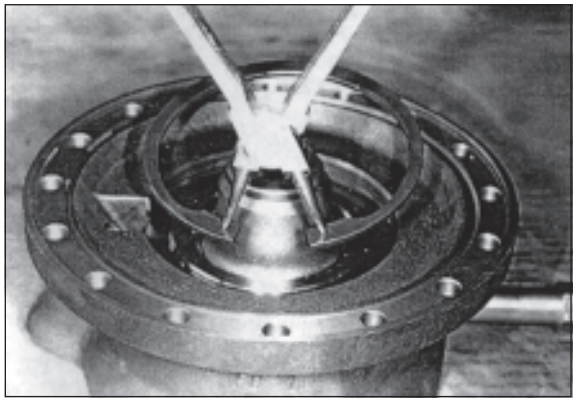


STEP 79
Assemble correctly the discs retainer (pos. 30) in the brake housing (pos. 32).

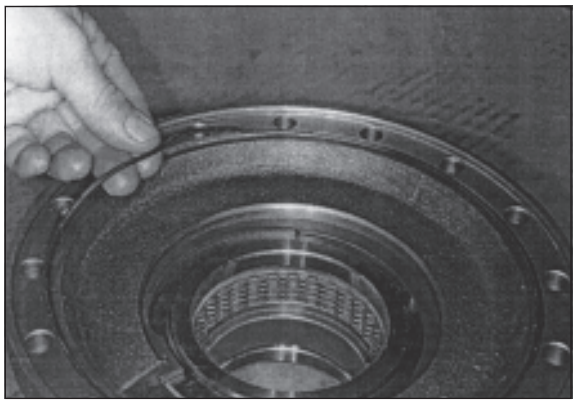


ASSEMBLING

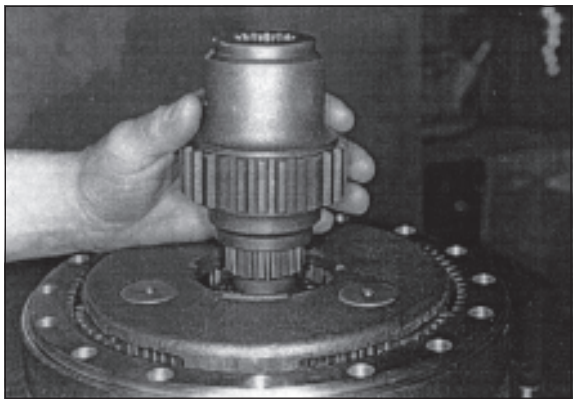
STEP 80
Through pliers, assemble the circlip (pos. 29) into its grove.
Then remove the compressed air from the brake assembly and dismount the brake shaft (pos. 35).



STEP 81
Apply in the O-ring's seat in the brake housing (pos. 32) a coat of grease.
Mount the 2nd O-ring (pos. 24).

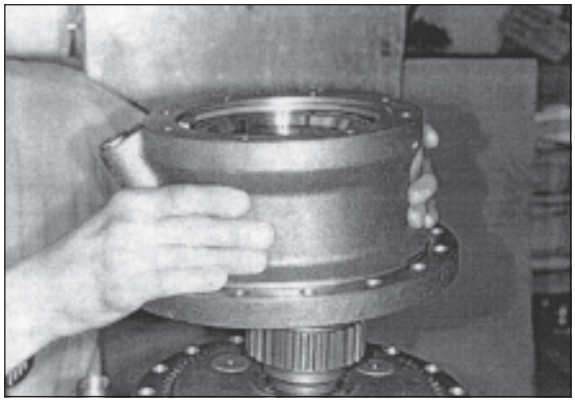


STEP 82
Assemble the brake shaft (pos. 35).

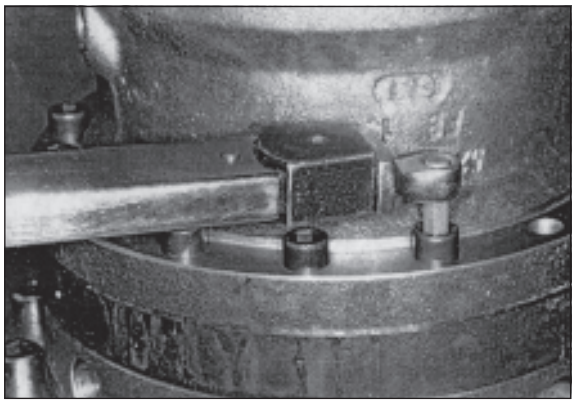


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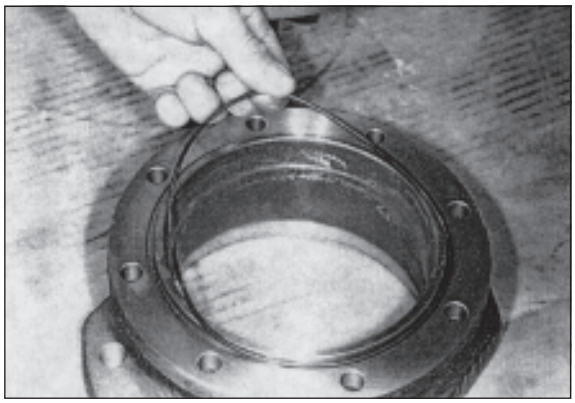
STEP 83
Assemble the brake assembly.



STEP 84
Tighten the 11 socket head screws M10x70 (pos. 33), grade 8.8, by a torque wrench at 5 daNm torque.



STEP 85
Mount the O-ring (pos. 44) into its seat in the motor flange (pos. 50).

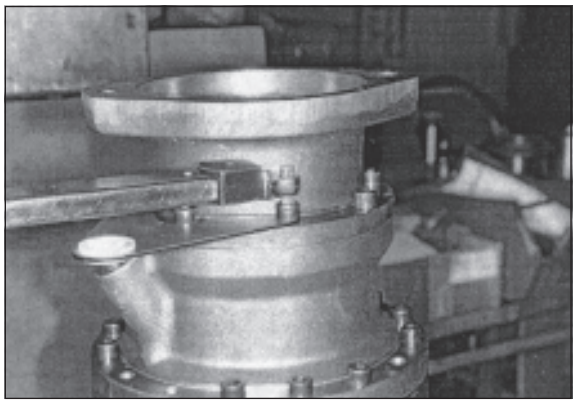


ASSEMBLING

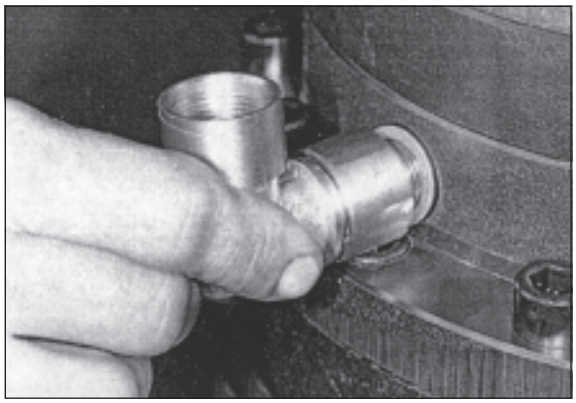
STEP 86
Place the motor flange (pos. 50) on the brake housing (pos. 32) and insert the 8 socket head screws M10x30 (pos. 48) grade 8.8.
Contemporary assemble the flask of the filling and oil level kit (pos. 52).



STEP 87
Tighten the 8 socket head screws M10x30 (pos. 48), grade 8.8, by a torque wrench at 5 daNm torque.

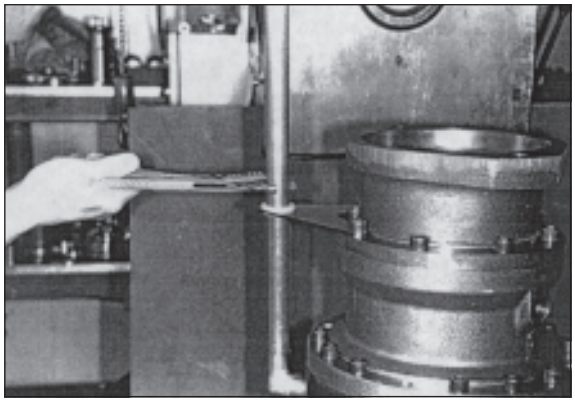


STEP 88
Using pliers, screw the washer (pos. 8), the elbow and the extension of the filling and oil level kit (pos. 52) in the cover (pos. 21).

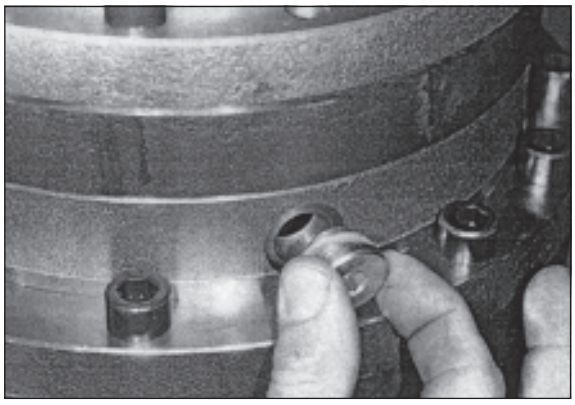


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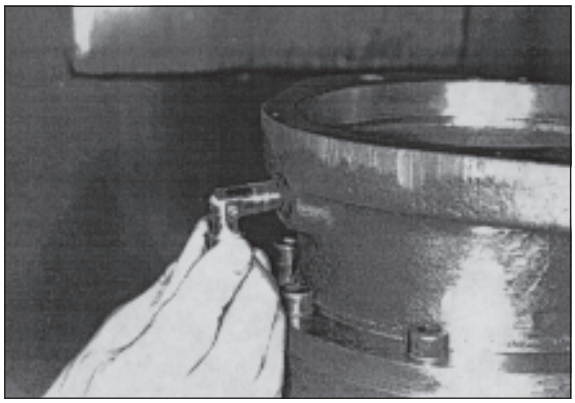
STEP 89
Mount and tighten the dipstick of the filling and oil level kit (pos. 52).



STEP 90
Insert and screw all plugs M18x1,5 (pos. 9) and washers (pos. 8) in the gearbox.

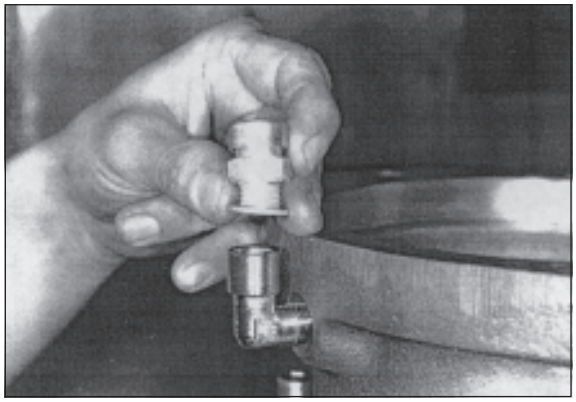


STEP 91
Assemble the angle (pos. 46) in the motor flange (pos. 50).

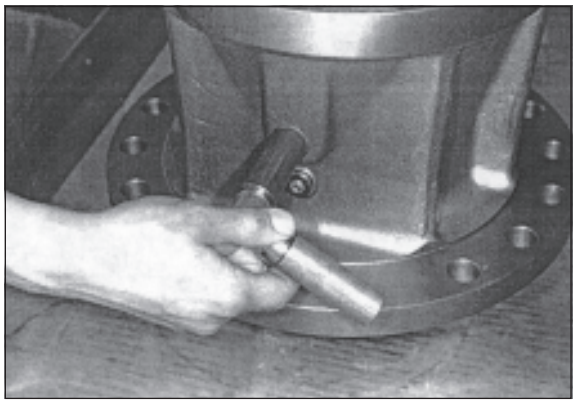


ASSEMBLING

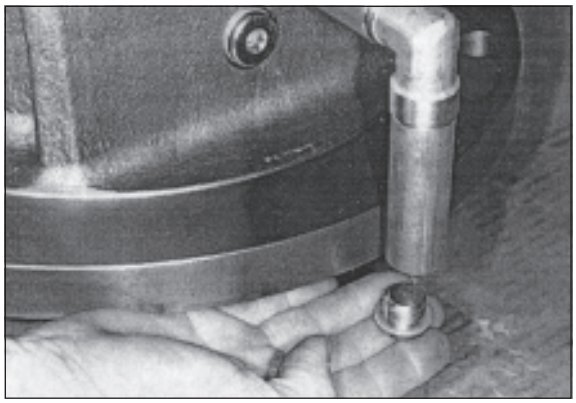
STEP 92
Assemble the breather plug G1/4 (pos. 47).



STEP 93
Asemble the extensions (pos. 10), the angle (pos. 11) and the washer (pos. 8) in the gearbox housing (pos. 7).



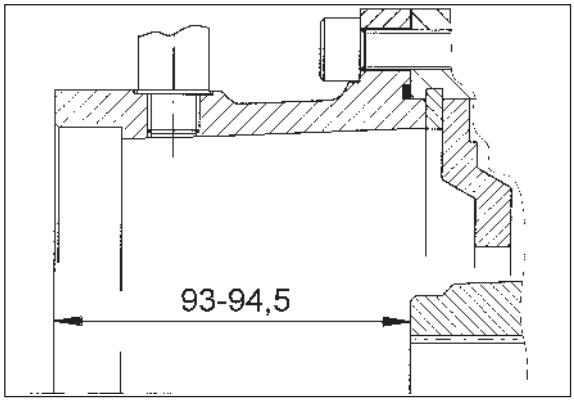
STEP 94
Assemble the plug M18x1,5 (pos. 9).



ASSEMBLING

STEP 95

Important
After mounting the hydraulic motor, verify, through a depth slide gauge, the axial dimension of the gearbox measured by input side of the motor adaptor (pos. 50) to the brake shaft (pos. 35).
Axial dimension = 93-94,5 mm.

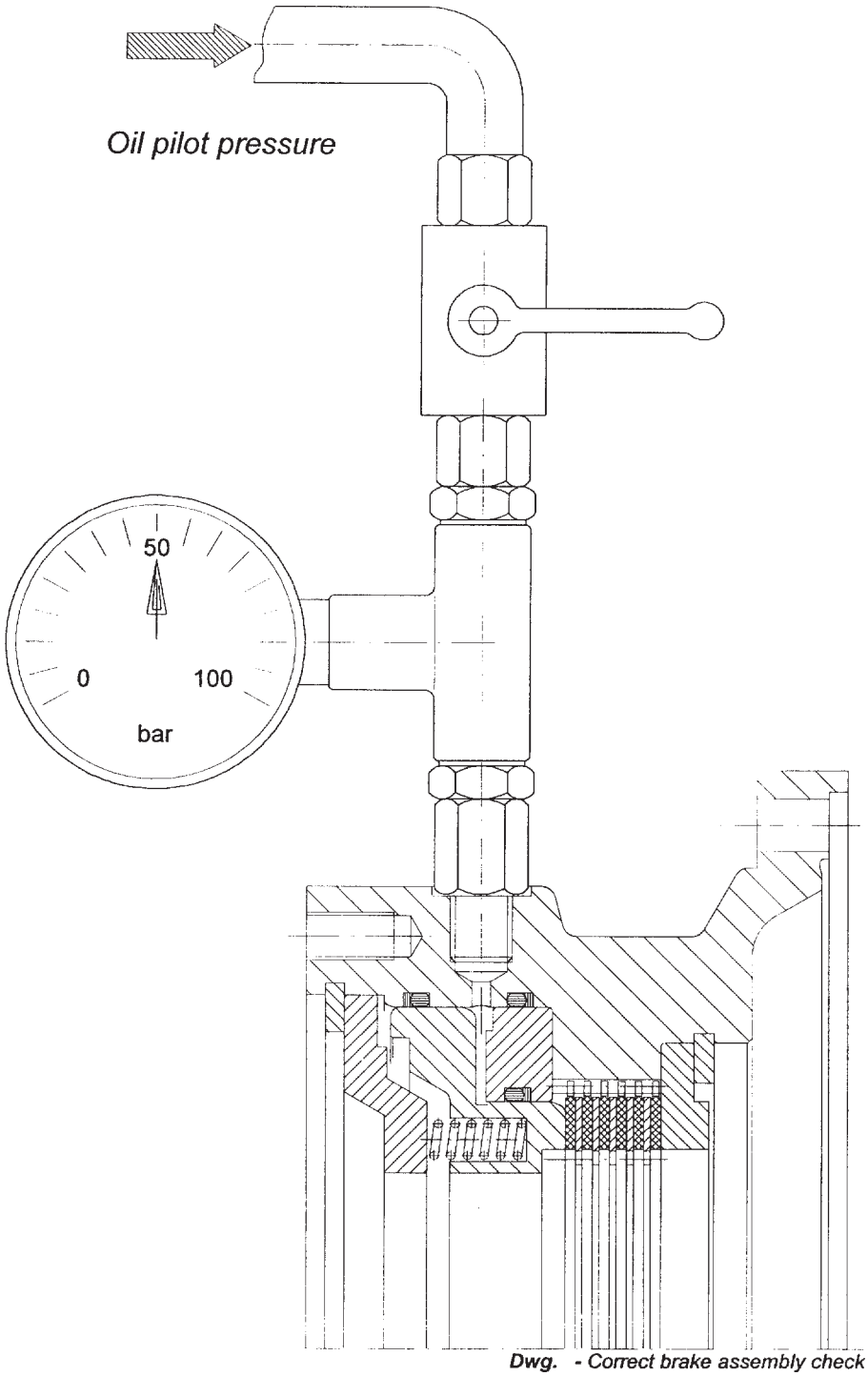


STEP 96
After having re-assembled the gearbox, fit the hydraulic motor (taking care to include the O-ring pos. 51), throurgh 2 fixing screws M16x40 (pos. 49), grade 8.8 tightened at a torque of 21,5 daNm. Fill the gearbox with the lubricant oil as shown in section 4.2.

5. BRAKE CHECK

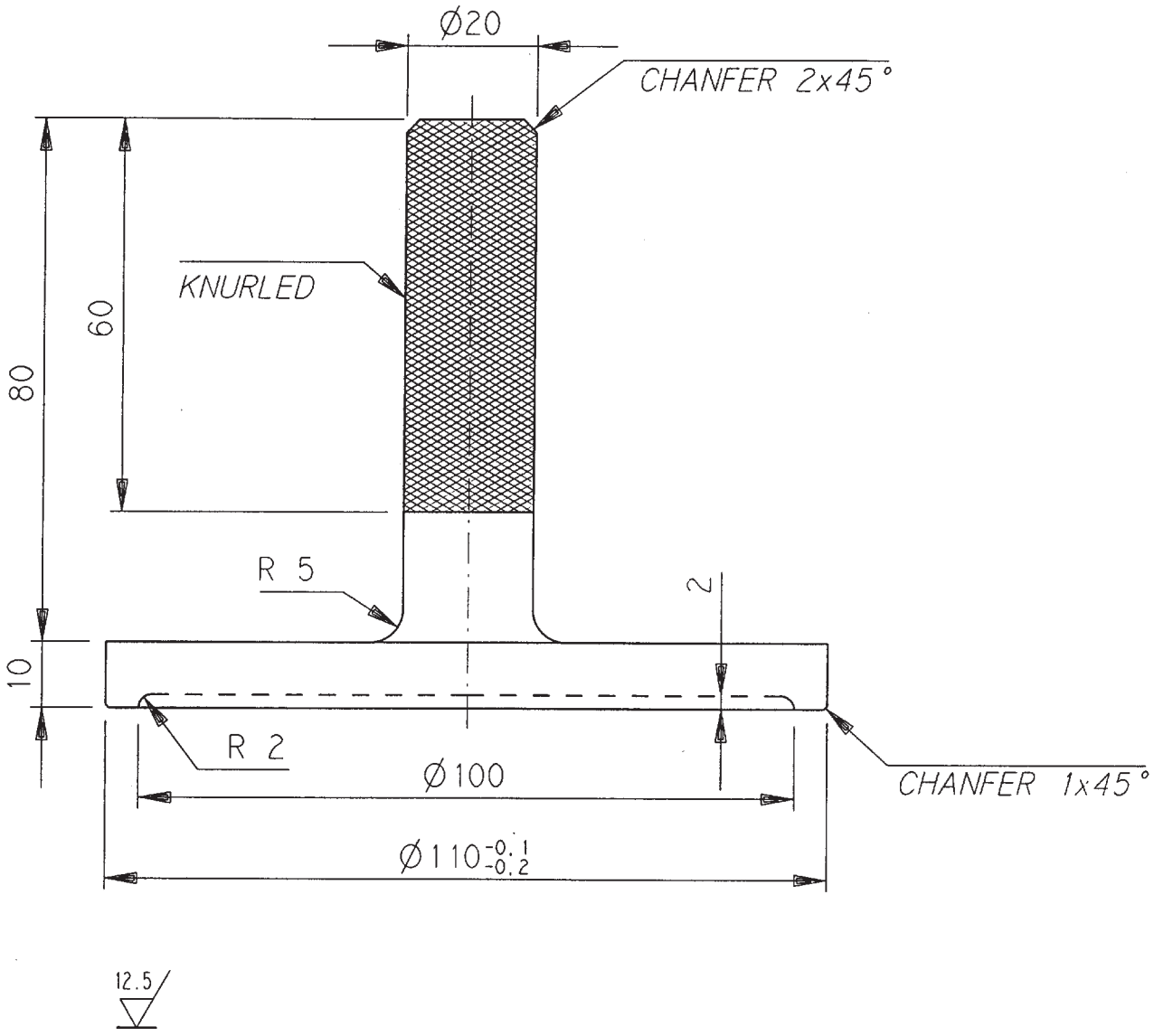
In order to verify the correct assembly of the brake group, it is necessary to carry out a test of the seal rings. Connect the brake port to a pump and release the brake by pumping oil. By means of a pressure gauge verify that the pressure does not decrease (see dwg. 6). Otherwise, the seal rings of the brake leak oil and it is necessary to disassembly the brake and provide for their replacement.

Test data: **Test duration = 3 minutes.**

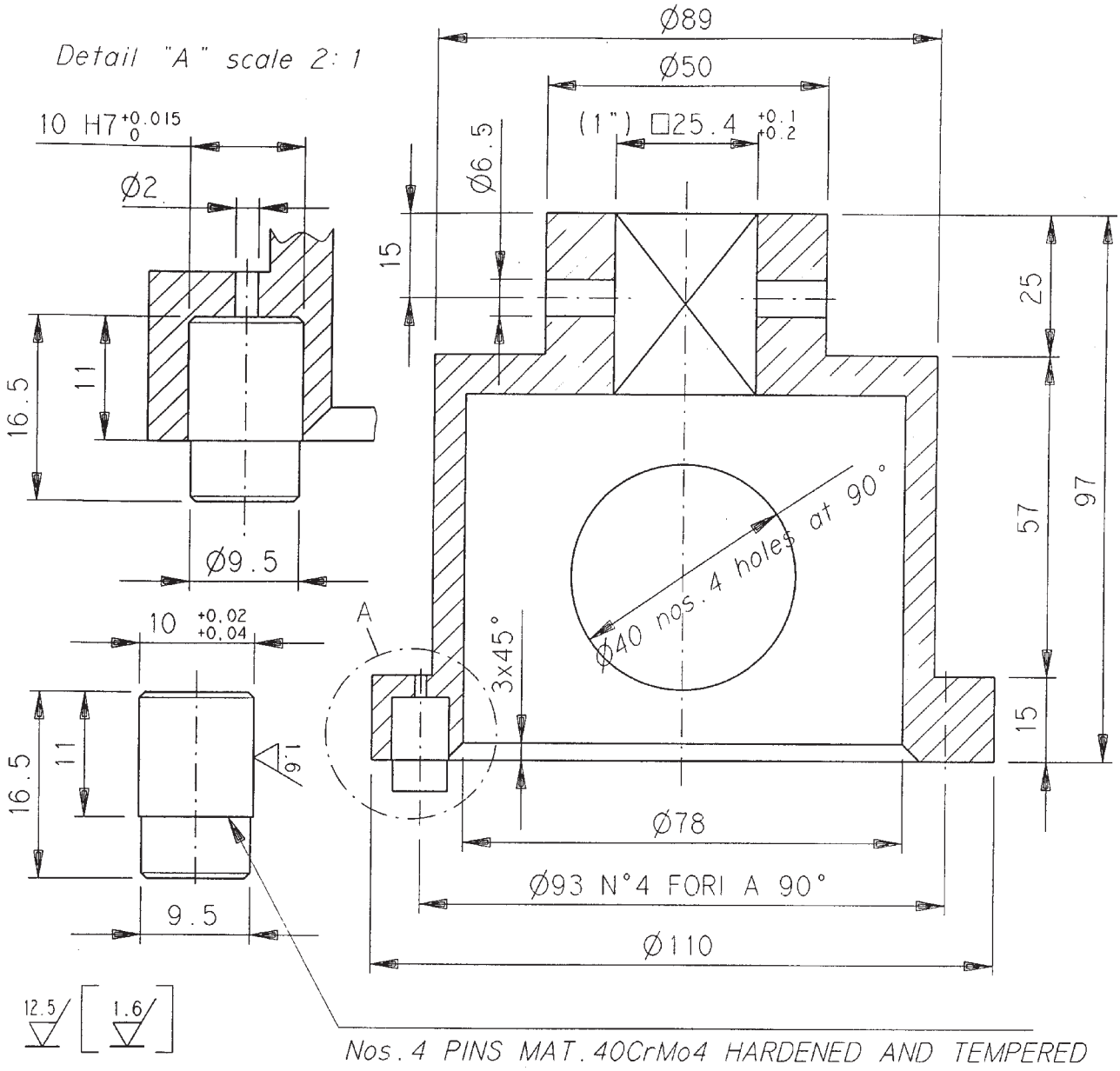


Dwg. - Correct brake assembly check

(SPECIAL TOOLS FOR SWING MACHINERY)



(SPECIAL TOOLS FOR SWING MACHINERY)



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: adequatly 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 measurements or the thickness indicated on the shim.

Bearings
For a correct assembly it is suggested to warm them in a furnace from 80C to 90C before installation in their respective shafts or to cool them before inserting in their respective seats with outer housing.

Sealing
Use LOCTITE 510 or types following the sepcifications. 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

> **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 pipings, then install a protection plug.

Loosen all the remaining connections, then separate the transfer box from the vehicle structure.

Installing the transfer box reverse the order; check for eventual leakages of oil.

Check the oil level and, if necessary, re-fill.

Carry out the braking system bleeding.

EMERGENCY BRAKE

- Unscrew the screw (1), remove the washer (2) and the flange (3).
- Unscrew the screws (7) and remove the brake cylidner (8).

- Keep the brake piston (20) and the seal rings (16-17-18-19); replace if necessary.

- Keep the three trust 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 disorted or scorched; if necessary, replace them.

- Check the friction disks thickness (11) is not lower than the one specified; if necessary, replace them (see 40-32).

- Check the groove condition on output shaft and on brake sleeve (12).

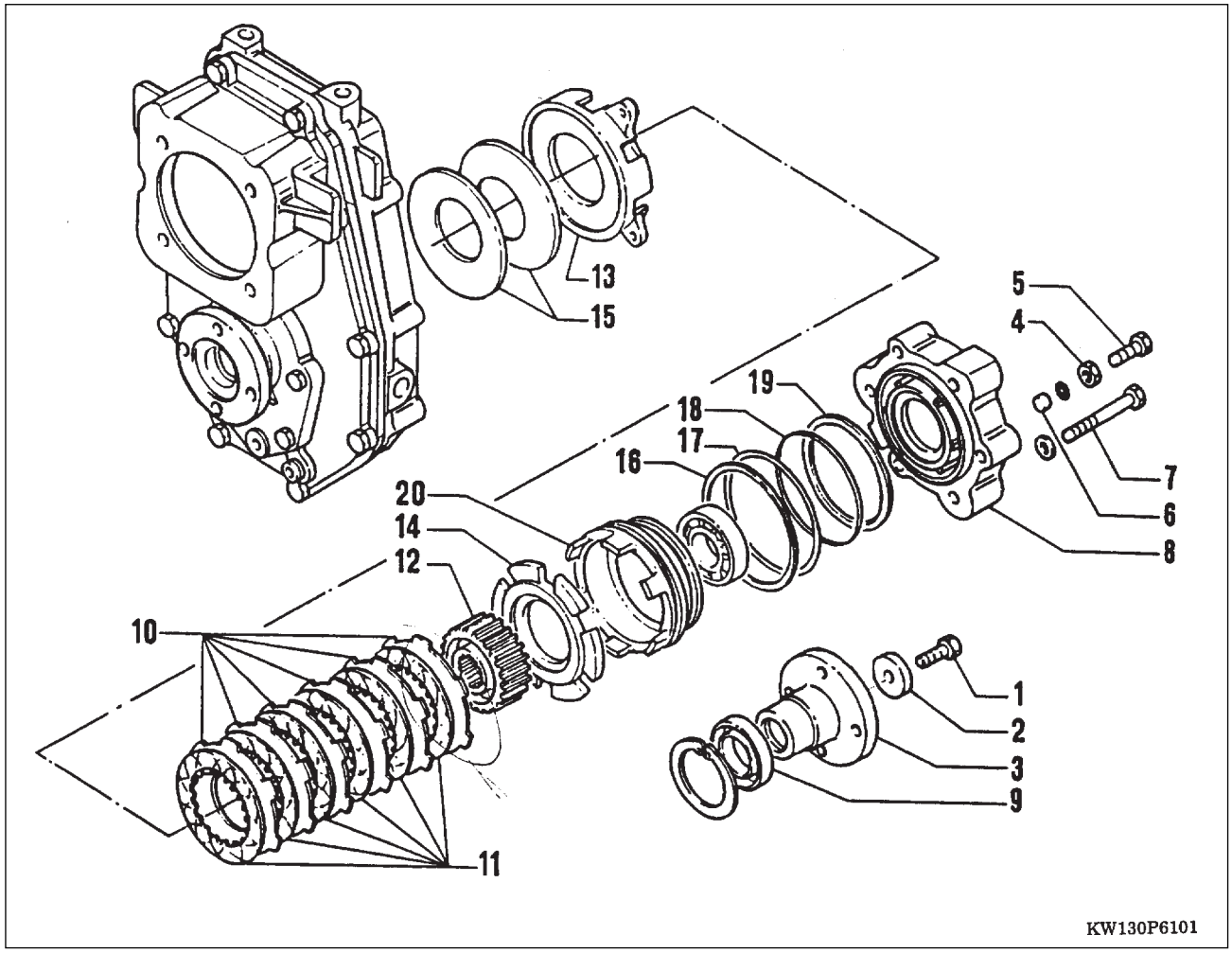
- Check the brake drum (13) and the reaction plate (14) are not worn out.

- 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).

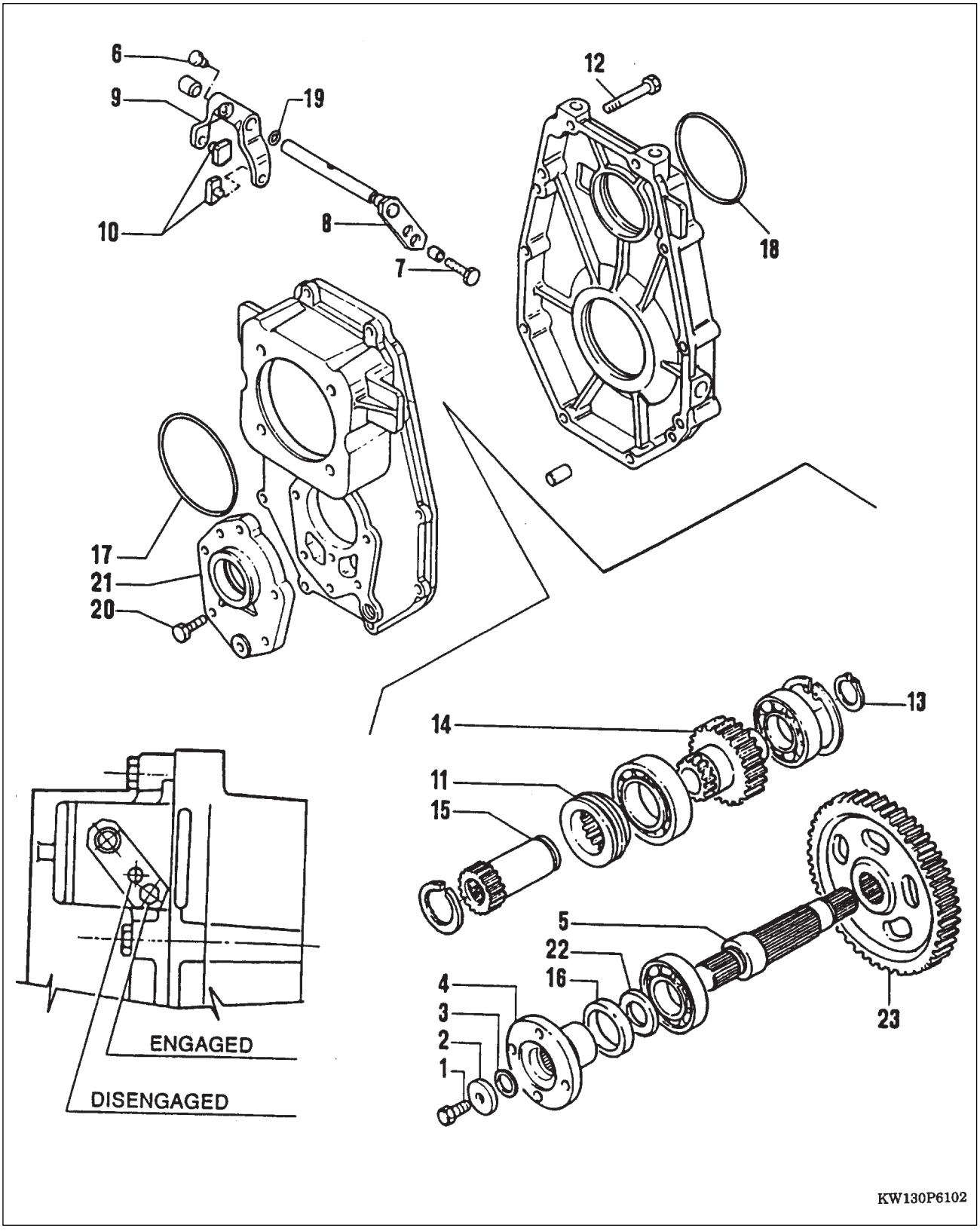
SPECIAL TOOLS

- Driver for oil seal (9): ref. 119038
- Interchangeable handle: ref. 119033


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GEAR AND CONTROL BOX

- 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 axtract the 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-housing and use Loctite 510.
- Check for bearing condition and replace, if necessary.
- Check oil drain condition, clean and replace, if necessary.

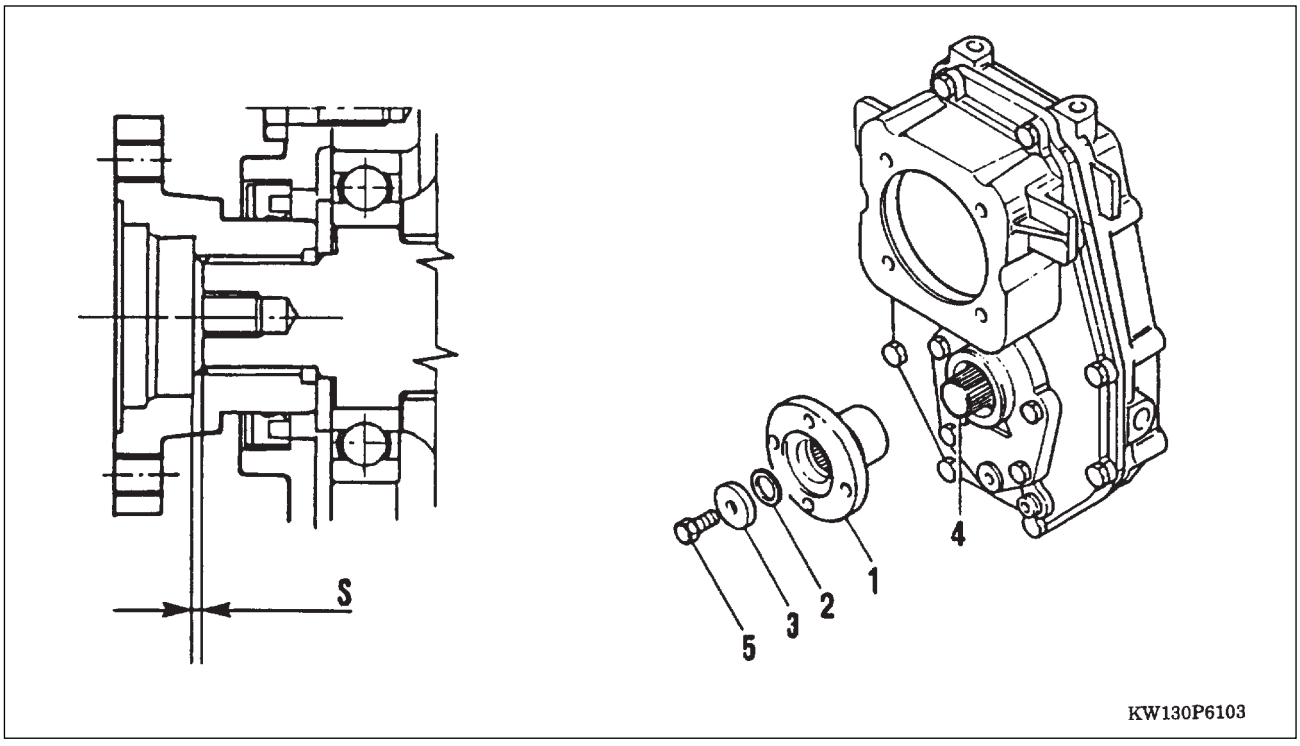

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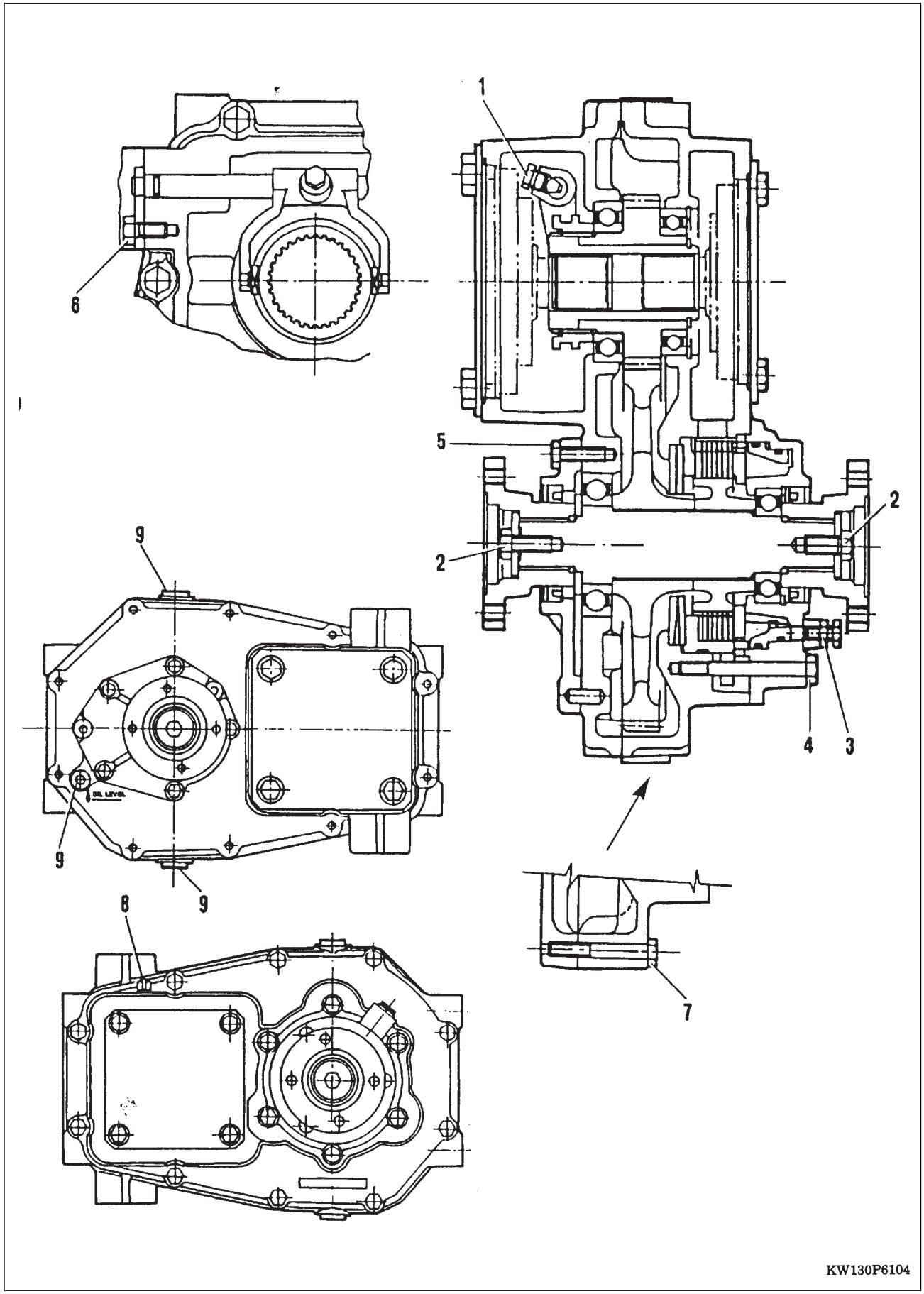
FLANGE POSITIONING

- 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

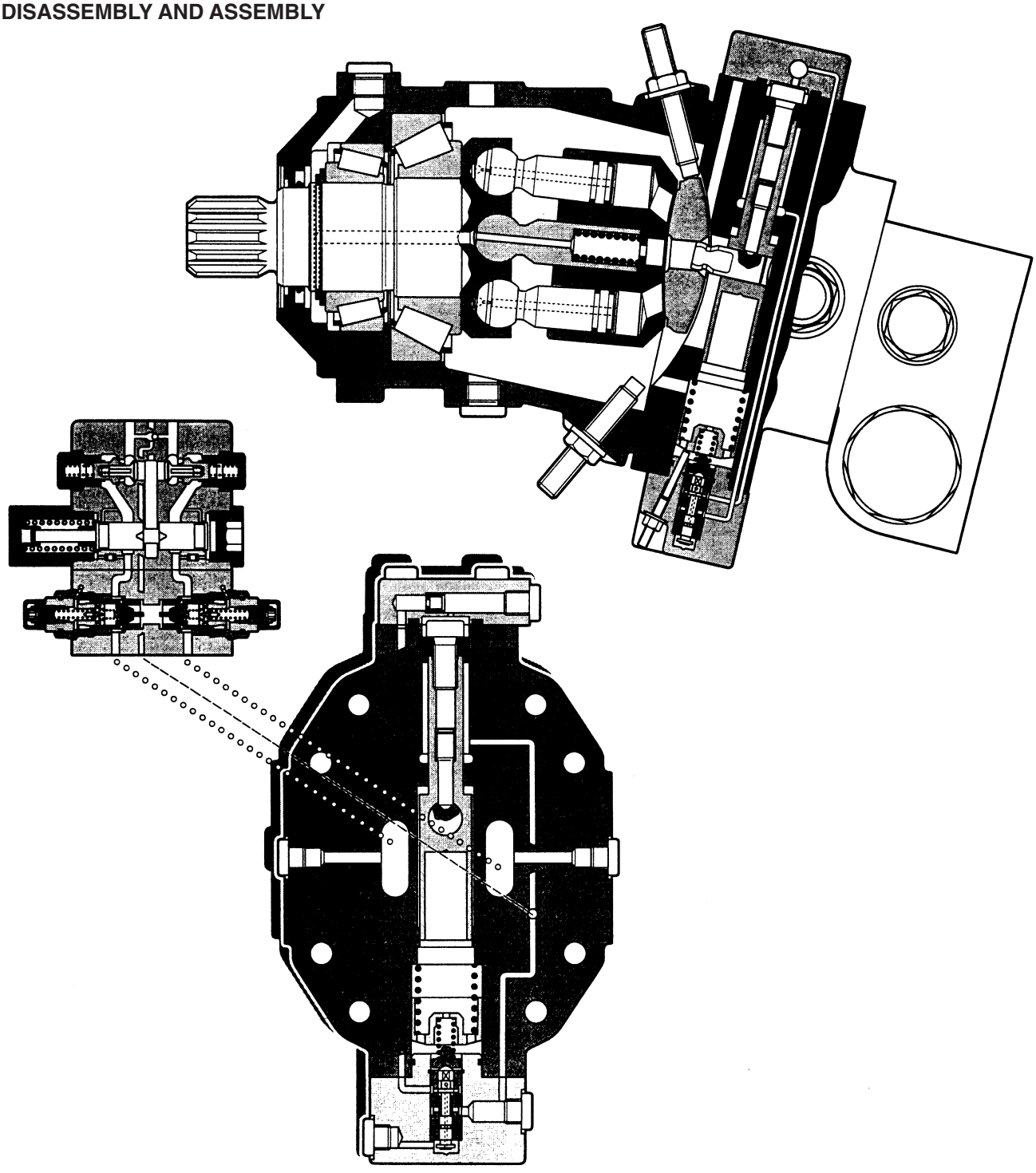
		Thread	Nm
1	Screw-fork to shaft	-	32
2	Screw-output flanges	M12x25	139
3	Brake release nut-screw	M10x20	50
4	Front cover-screw	M10x90	50
5	Rear cover-screw	M10x30	50
6	Fork control screw-lever	M10x20	50
7	Half-housing fastening screw	M10x65	50
8	Breather	M10	10
9	Oil drain, filling and level plug	M22	60




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7
KW130P6104

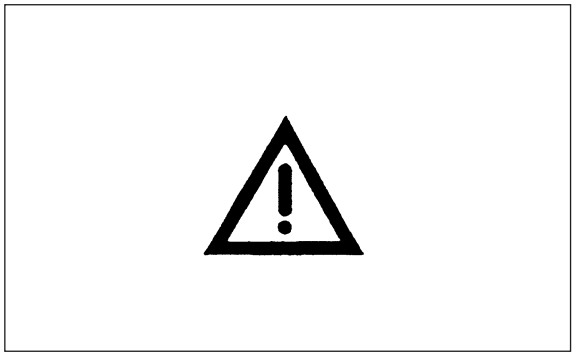
FRONT TRAVEL MOTOR

DISASSEMBLY AND ASSEMBLY

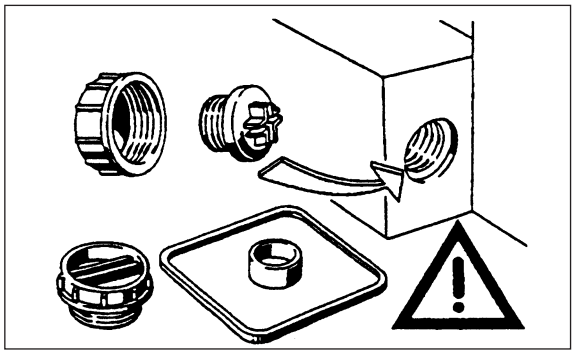


Sectional view

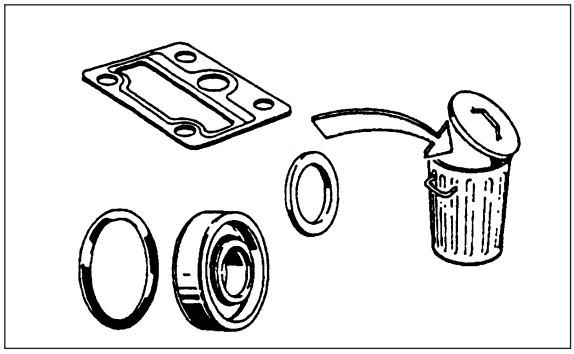
Attention!
Observe the following notices when carrying out repair work at hydraulic aggregates!



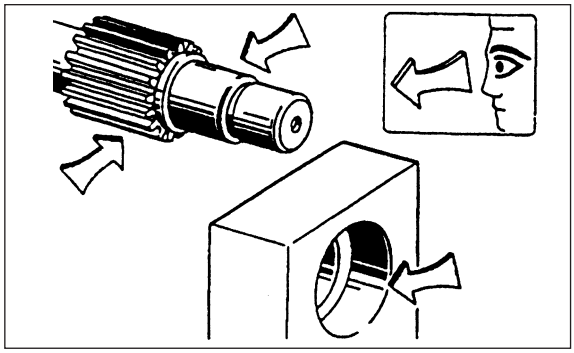
Close all ports of the hydraulic aggregates.



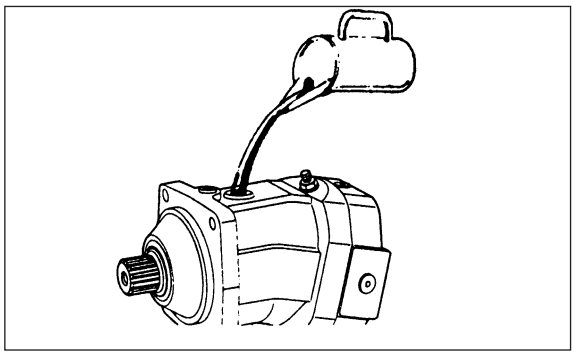
Replace all seals.
Use only original Komatsu spare parts.



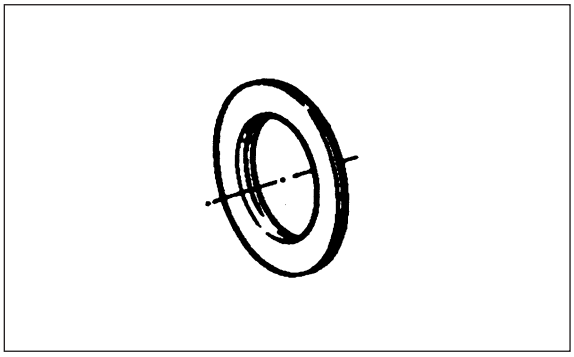
Check all seal and sliding surfaces for wear.
Attention: Rework of sealing area f. ex. with abrasive paper can dammage surface.



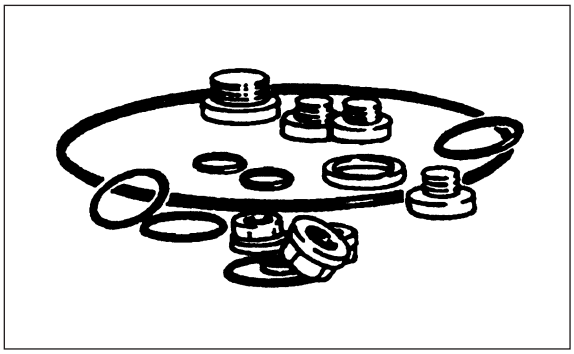
Fill up hydraulic aggregates with hydrulic oil before start-up.



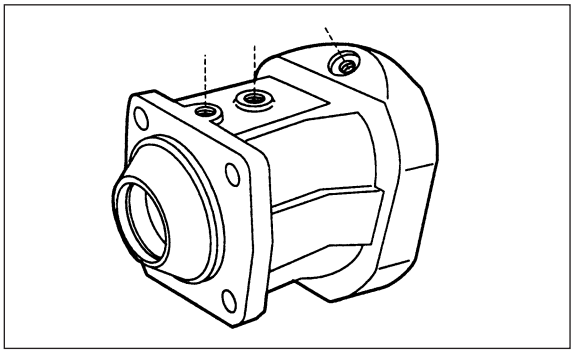
1 Seal kit for drive shaft



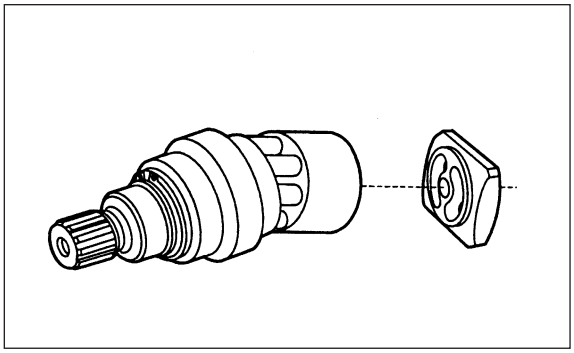
2 External seal kit



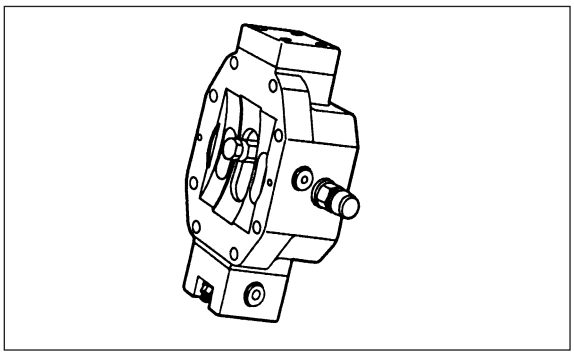
3 Housing



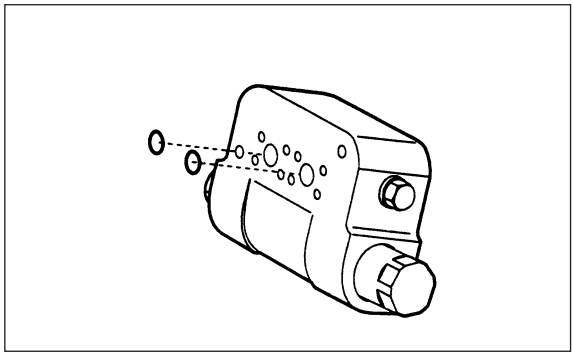
4 Complete rotary group



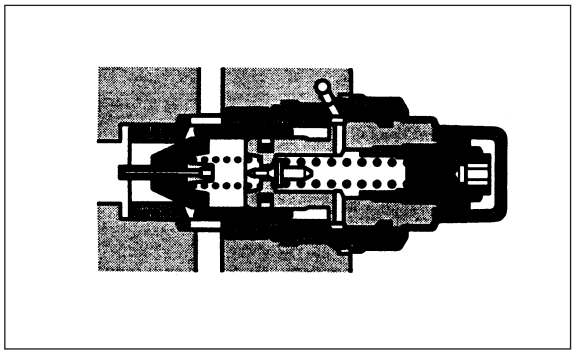
5 Port plate with control piston



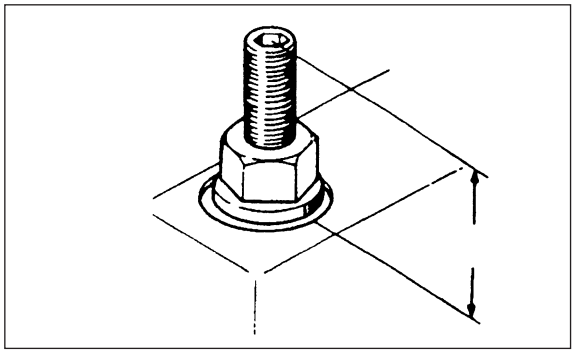
6 Counter-balance valve



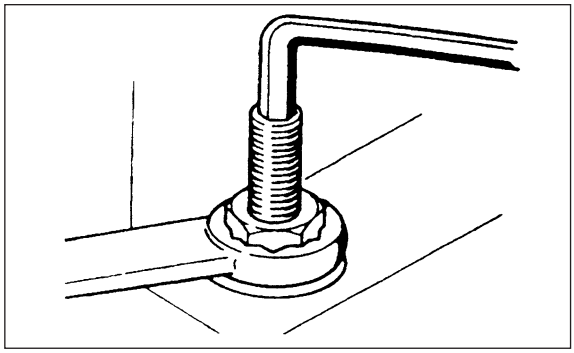
7 Relief valve / Make up check valve

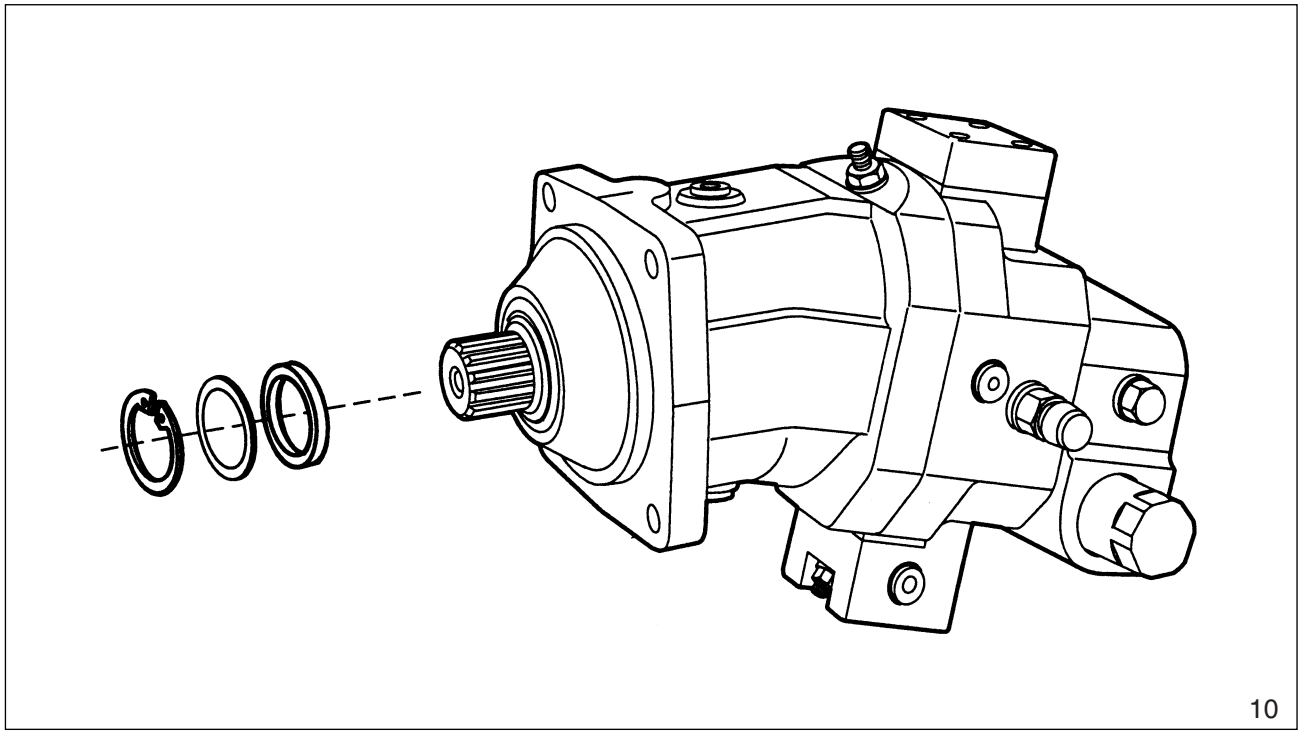


8 Replace seal nut
First measure and record setting height



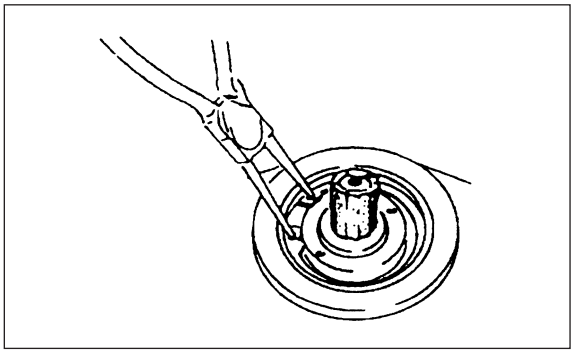
9 When tightening, counterhold setting screw, then check setting height



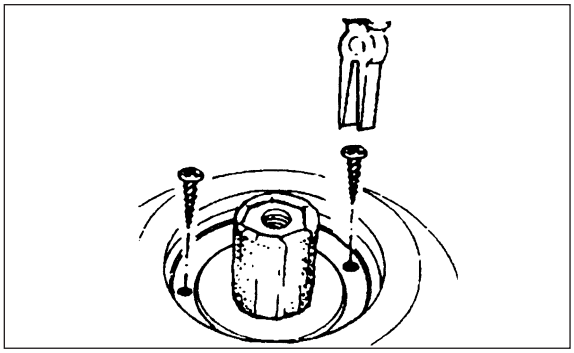


10

11 Protecting the drive shaft
Remove retaining ring and shim

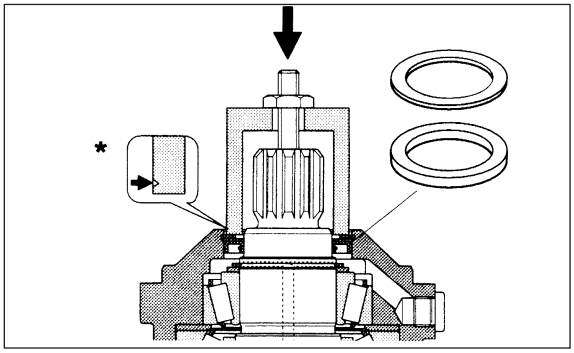


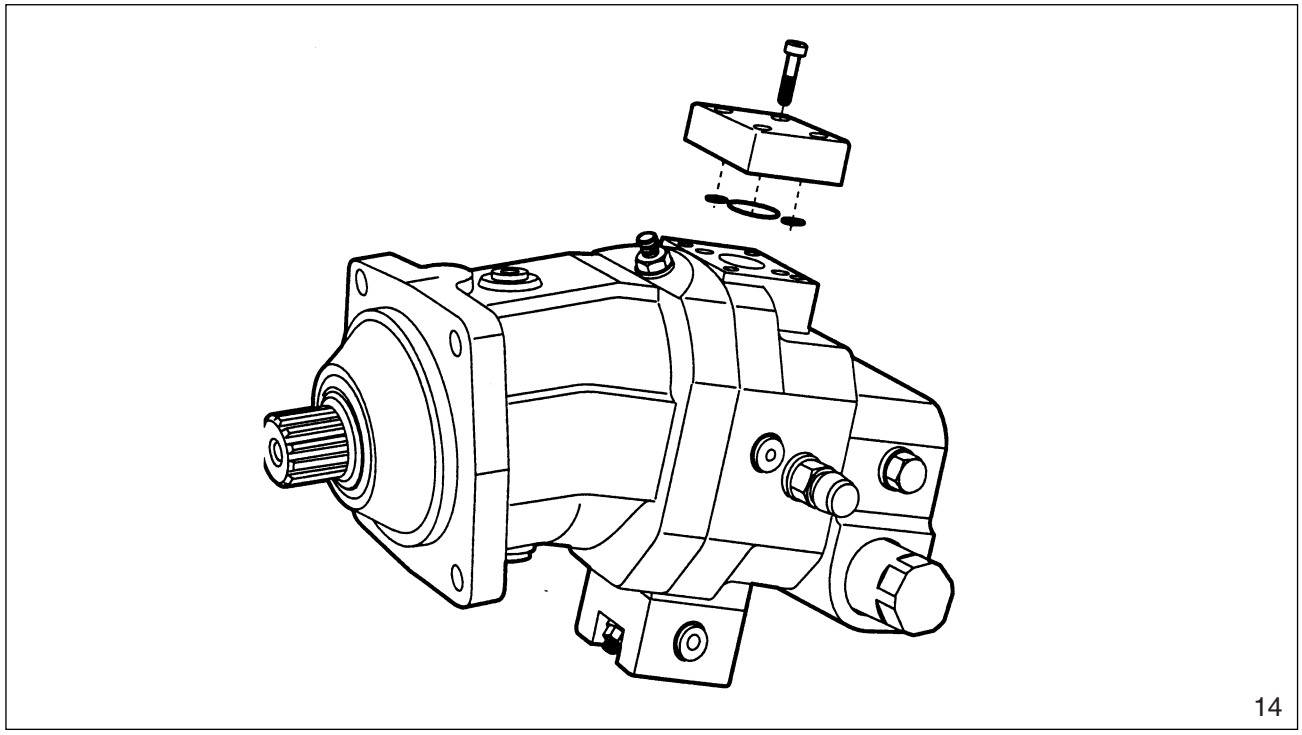
12 Screw in sheet metal screw into the holes fitted with rubber
Pull out seal with pliers



13 Press in shaft seal and shim with bush to stop

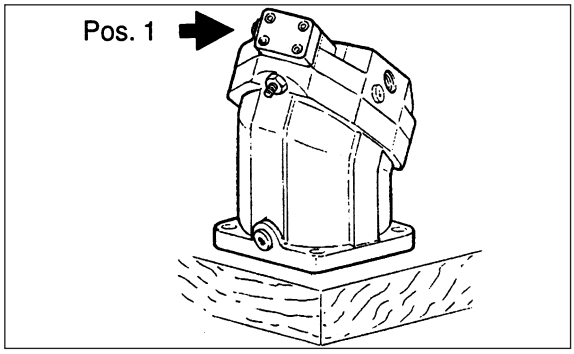
⚠ Pay attention to pressing depth!
* Mark for pressing depth
Assemble retaining ring



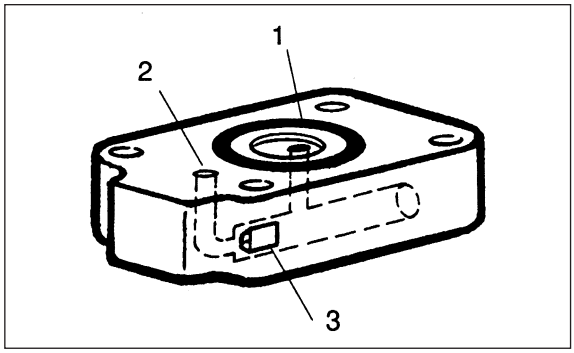


14

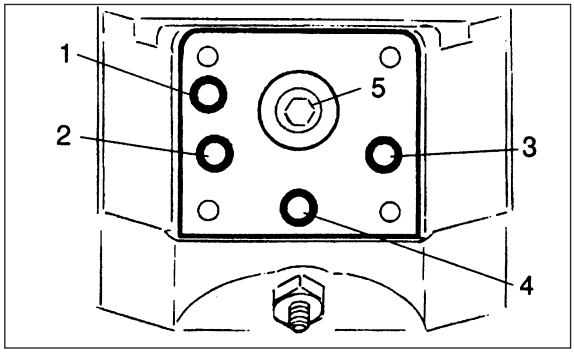
15 Disassembly position:
Remove cover pos. 1

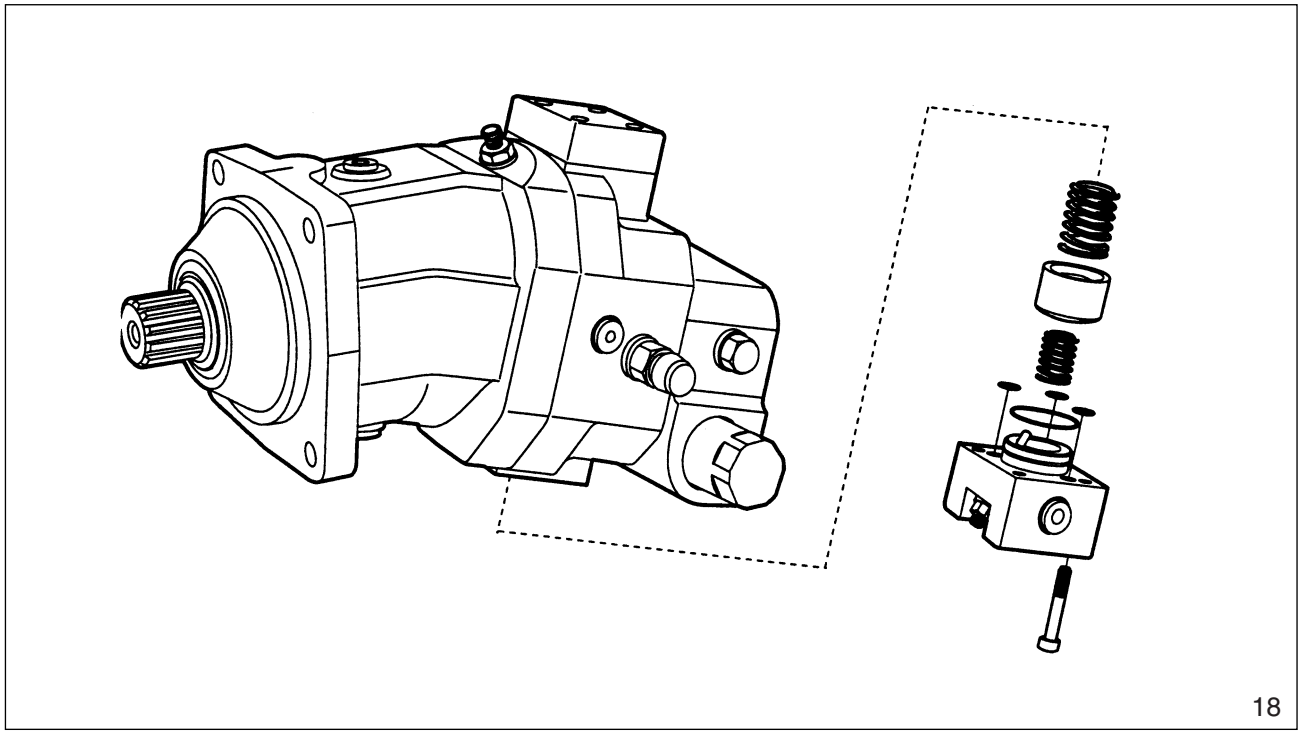


16 (1) O-ring
(2) Input flow of oil control
(3) Throttle pin
⚠ Installation position differs according to the control components



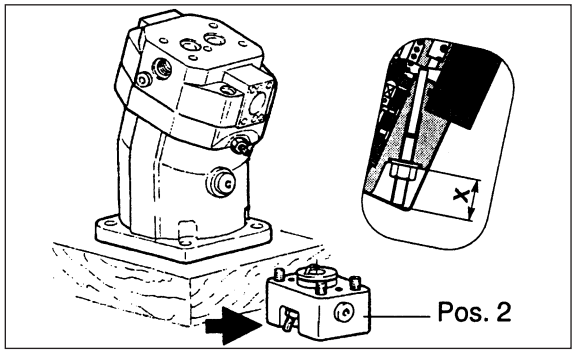
17 (1) Input flow of oil control
(2) High pressure / low pressure
(3) High pressure / low pressure
(4) Leakage oil
(5) Control piston



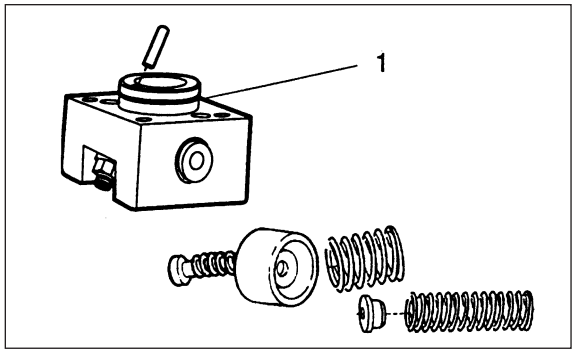


18

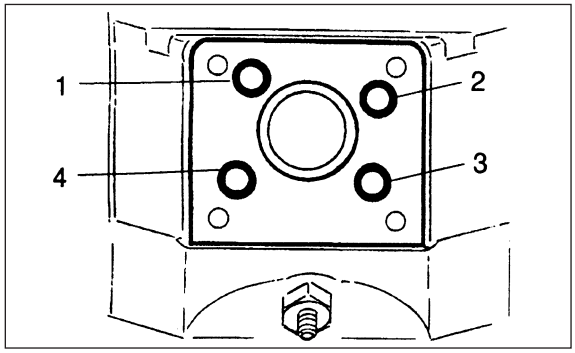
19 Disassembly position: Remove cover pos. 2
Attention! Spring load
⚠ Dimension x: Note dimension
(begin of regulation)



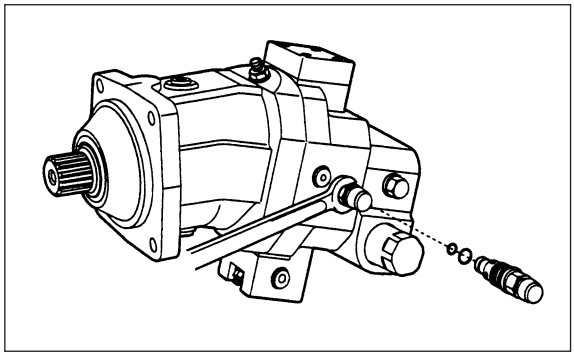
20 (1) Check of O-ring



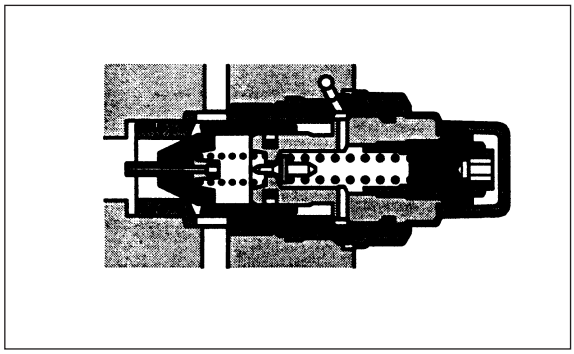
21 (1) O-ring / High pressure - small control piston side
(2) O-ring / Control pressure
(3) O-ring / High pressure - check valve
(4) O-ring / High pressure - check valve



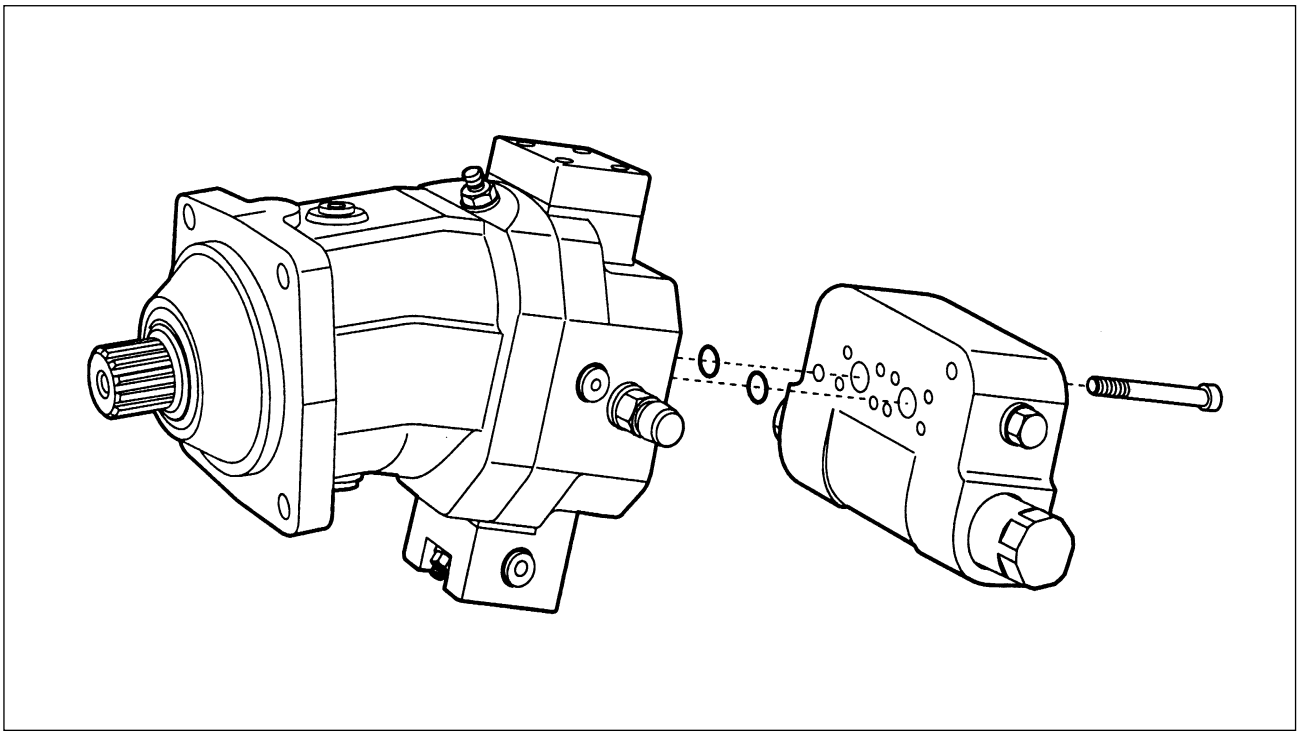
22 Remove relief valve

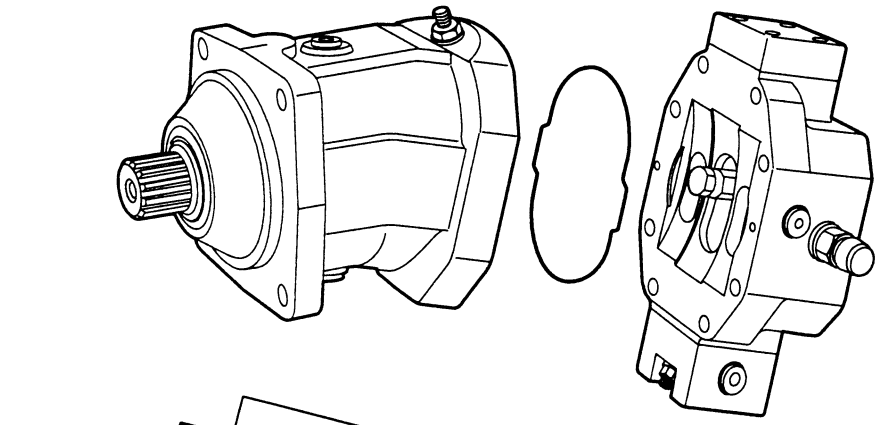


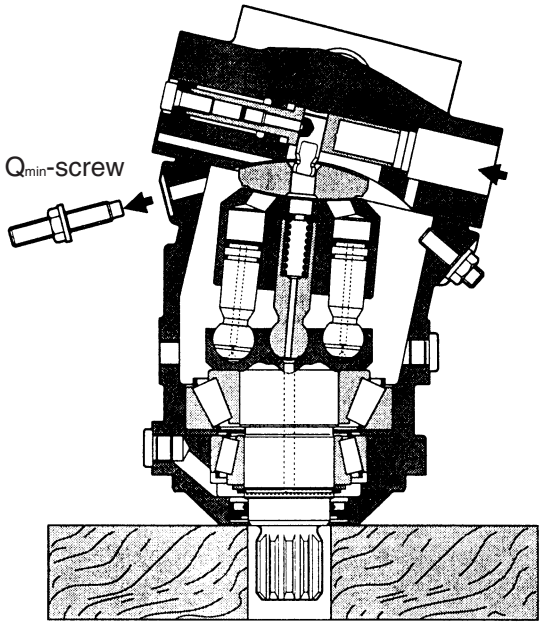
23 Inspect!
O-ring

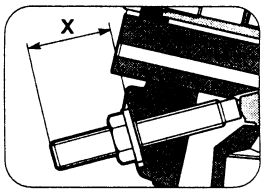


24 Remove countert-balance valve
Inspect!
O-ring







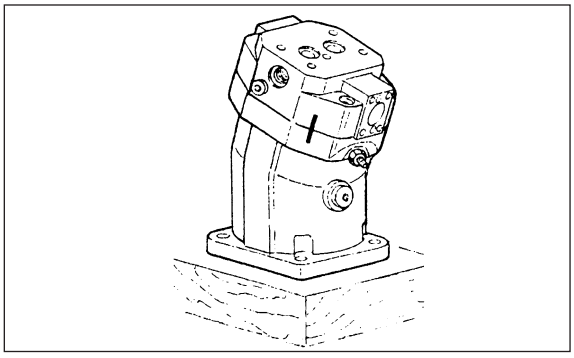


Note dimension x
Remove Q_{min}-screw
Swivel rotary group to zero p

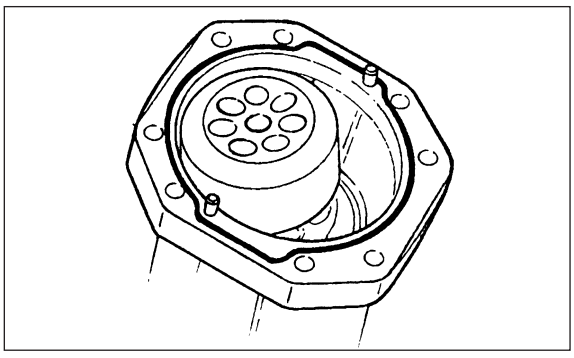
⚠ For disassembly of the port plate, swivel always rotary group to zero position
Piston rings to hang out of the cylinder boring

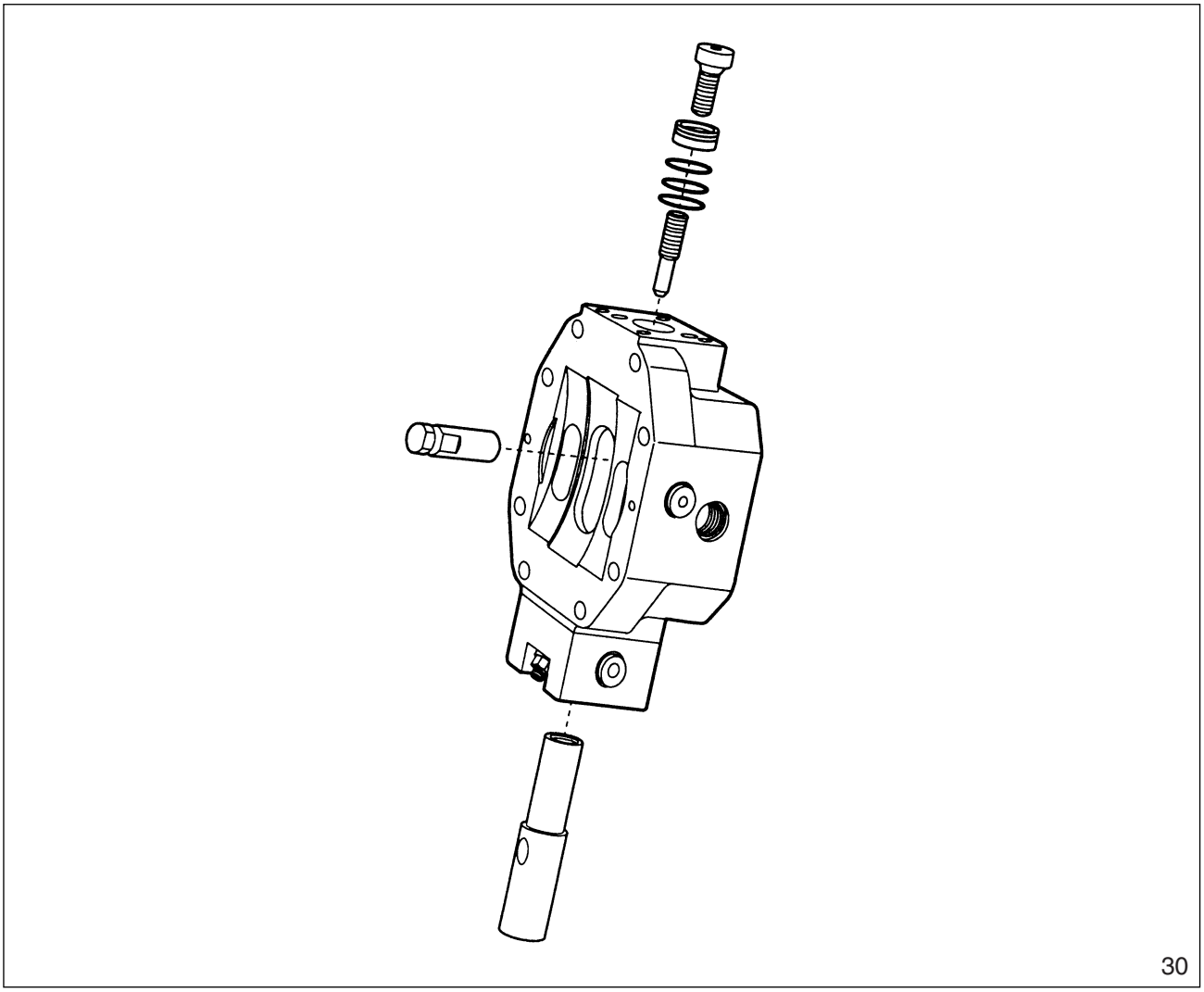
27

28 Port plate
Mark position. Loosen screws
Removal



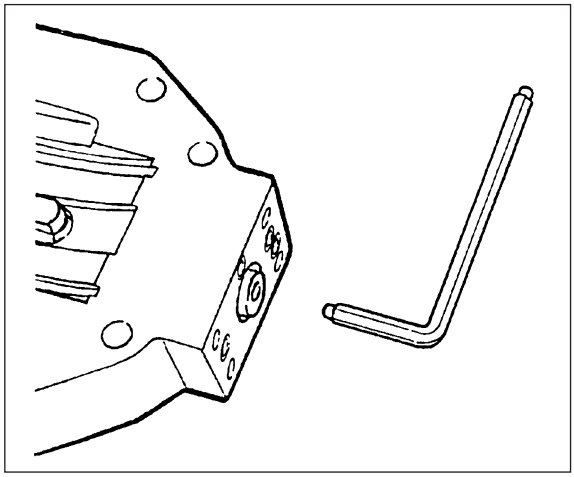
29 Check O-ring
Stick new O-ring with some grease
⚠ Do not swivel rotary group
Piston rings to hang out from the cylinder boring



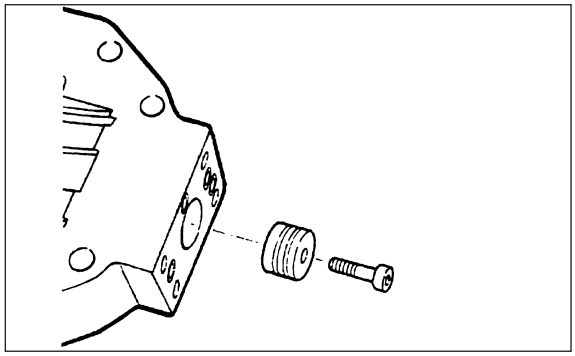


30

31 Loosen fixing screw
Use only socket wrench

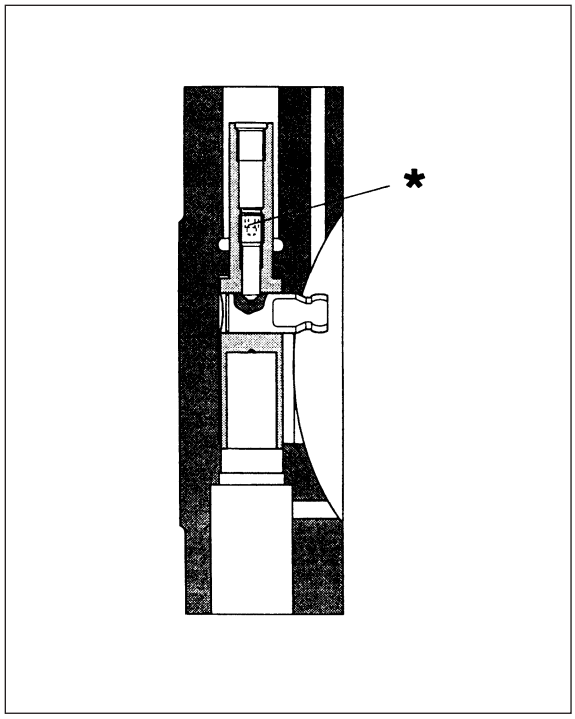


32 Remove piston with piston ring



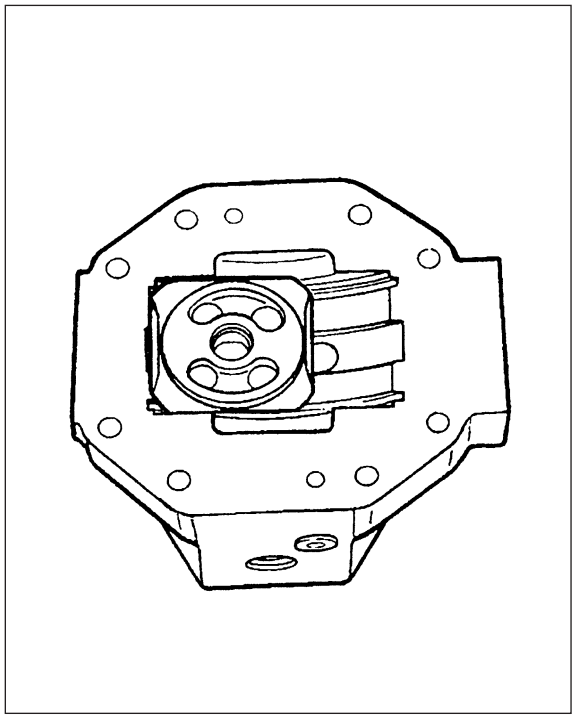
33 Warm up fixation screw * for positioning plug via boring (screw glued - to turn out)

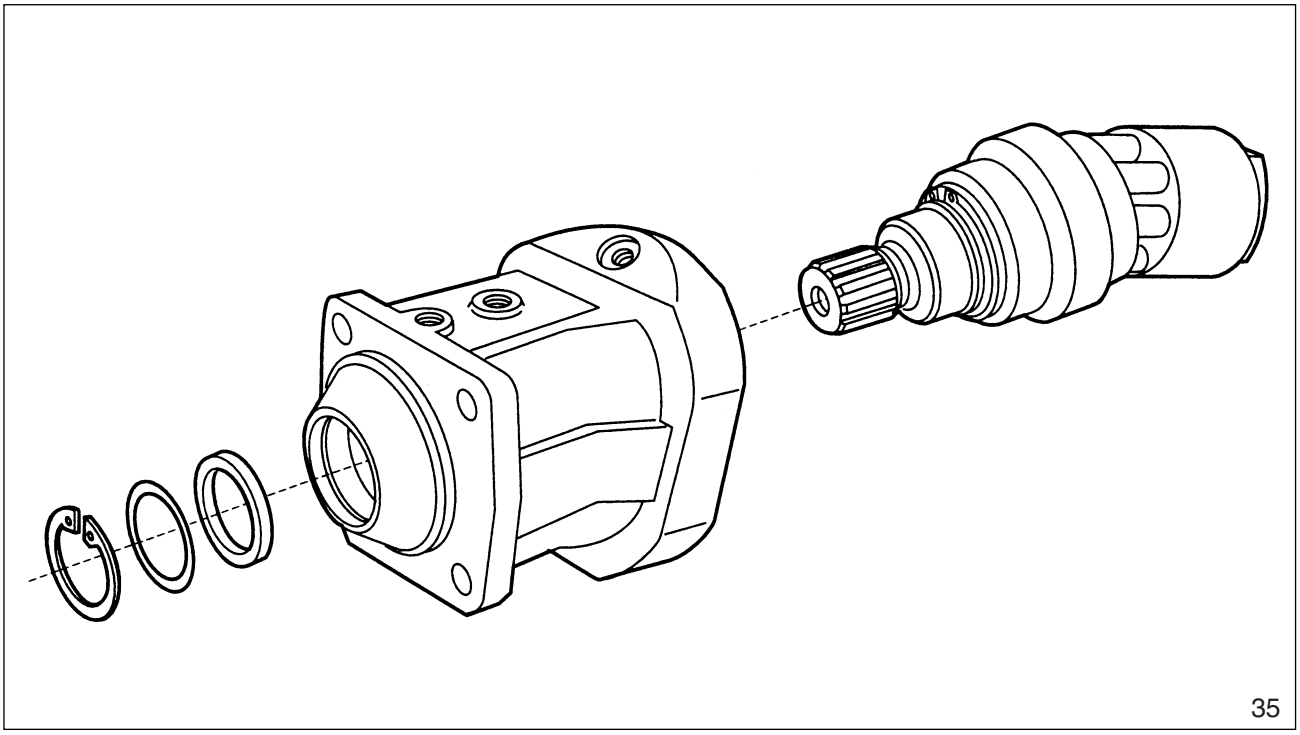
⚠ Use new screw
Precote coating
Note tightening torque!



34 ⚠ Stick control lens in sliding surface with grease
Assemebly in reversal order
Mount port plate

⚠ Rotaty group vertical

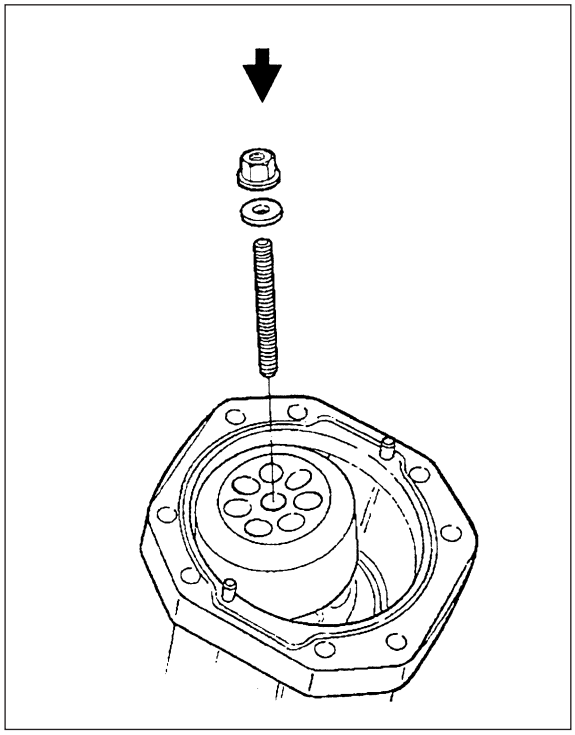




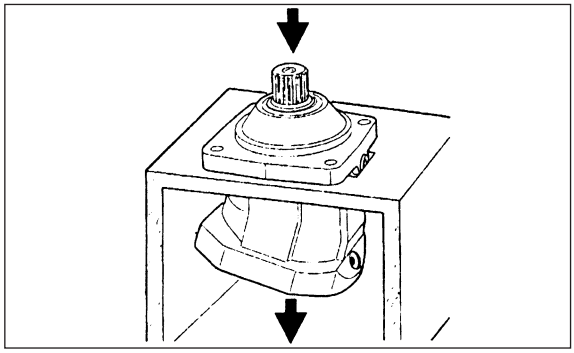
35

36 Screw in threaded pin into center
Fix the cylinder with disc and locknut

Size		
	28	: M4 x 58 mm
	55	: M5 x 71 mm
	80	: M6 x 82 mm
	107	: M6 x 92 mm
	140	: M8 x 105 mm
	160	: M8 x 105 mm
	200	: M8 x 109 mm

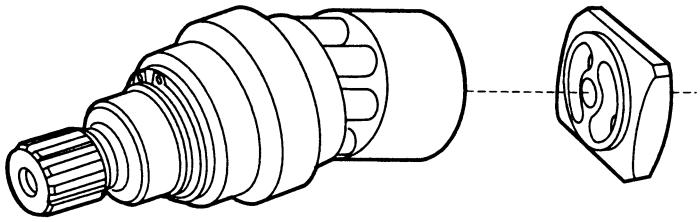


37 Press out rotary group!
⚠ If the bearings are used again do not hit on the drive shaft

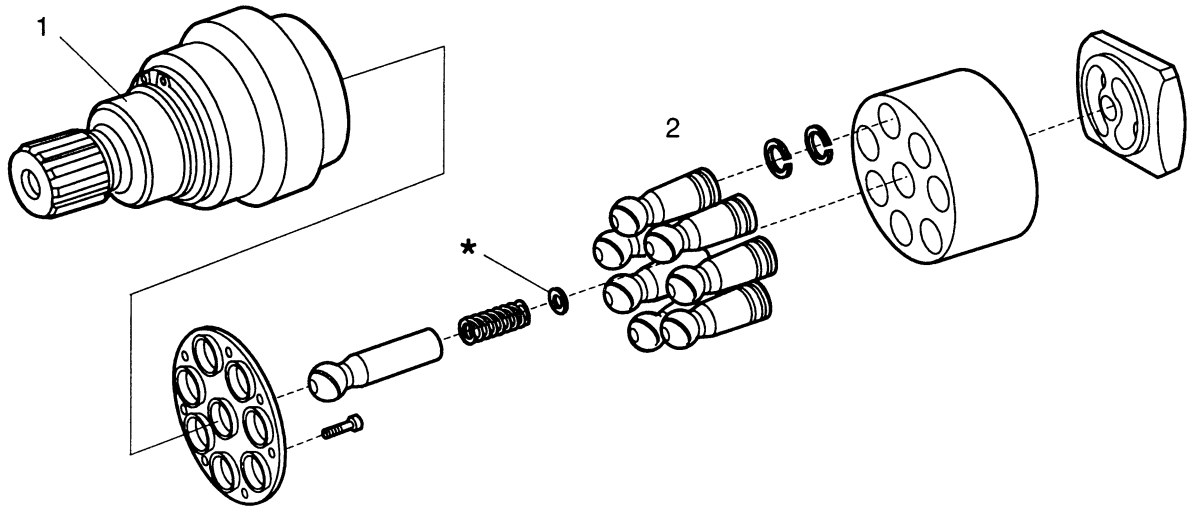


Complete rotary group

⚠ Setting of hydraulic part necessary



38

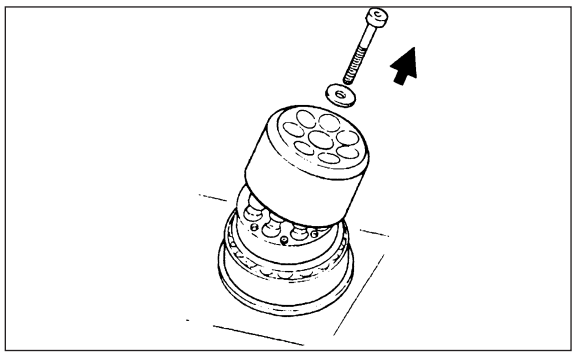


Rotary group

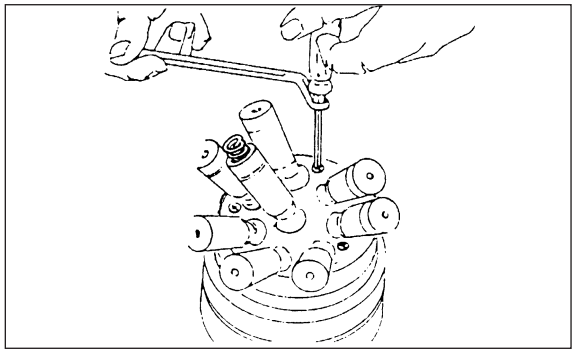
1. Mechanical part: Adjust drive shaft with bearing
2. Hydraulic part: ⚠ Adjustment necessary

39

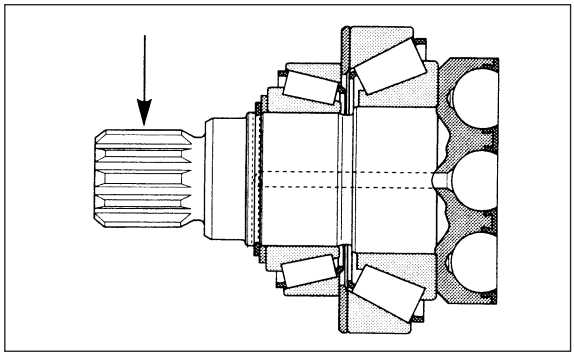
40 Remove fixing screw (cylinder)
Remove cylinder



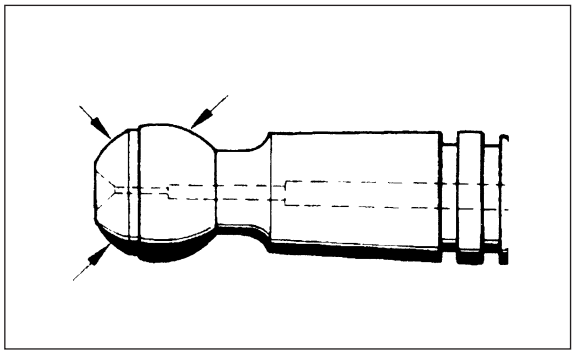
41 Disassemble retaining plate
⚠ Screws are glued
Use Torx-tools



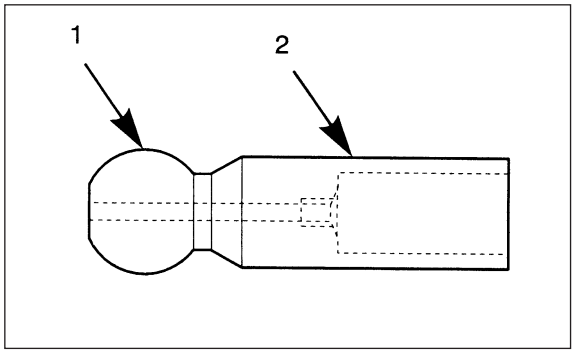
42 Free of corrosion, erosion or fretting; no damage to splines or keyways



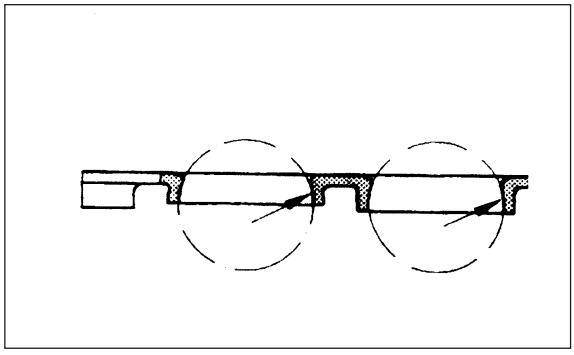
43 Pistons
No scoring and no pittings



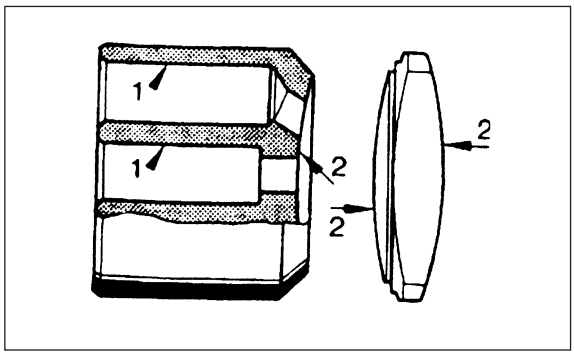
44 Center pin
No scoring and no pittings



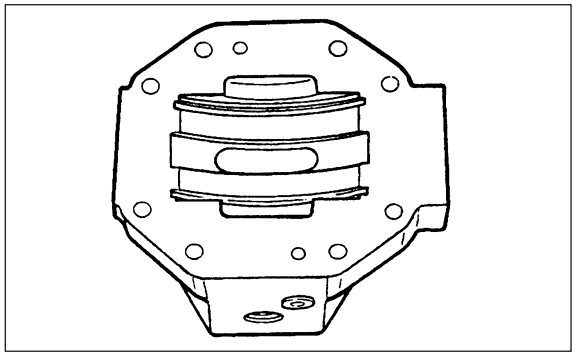
45 Retaining plate
No scoring and no evidence of wear



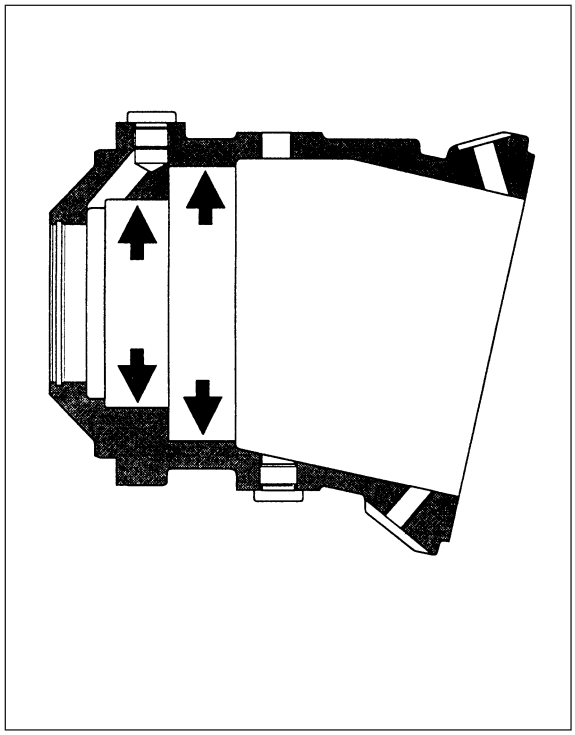
46 Cylinder block / control lens
1. Bores free of scoring, no evidence of wear
2. Faces smooth and even, free of cracks and scoring



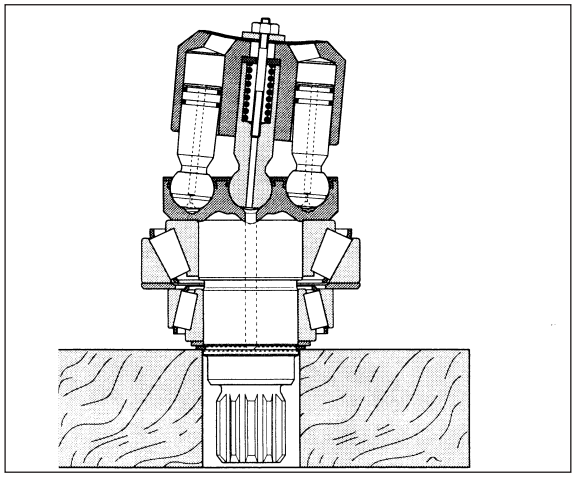
47 Control housing
Sliding surface and side guides free of scoring and no wear



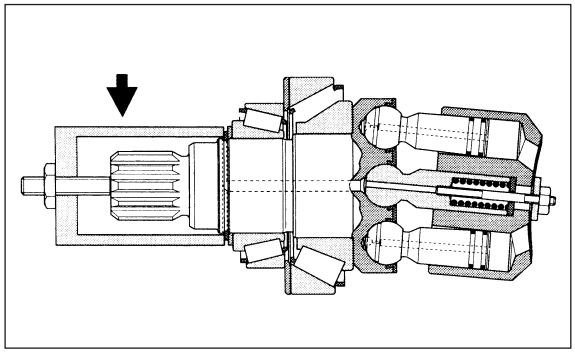
48 Visual check:
Bearing areas free of scoring and no evidence of wear



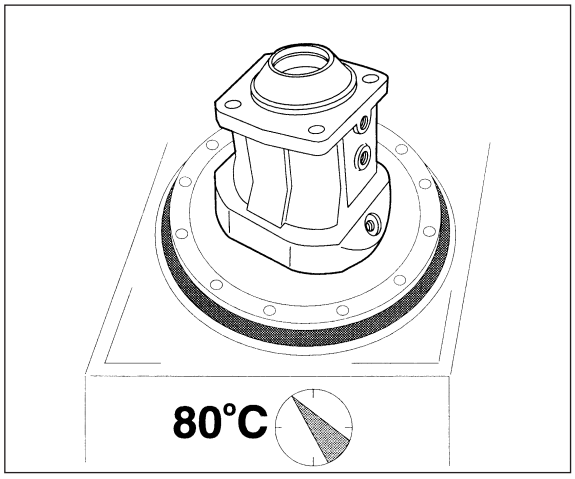
49 Rotary group completely assembled ready for assembly



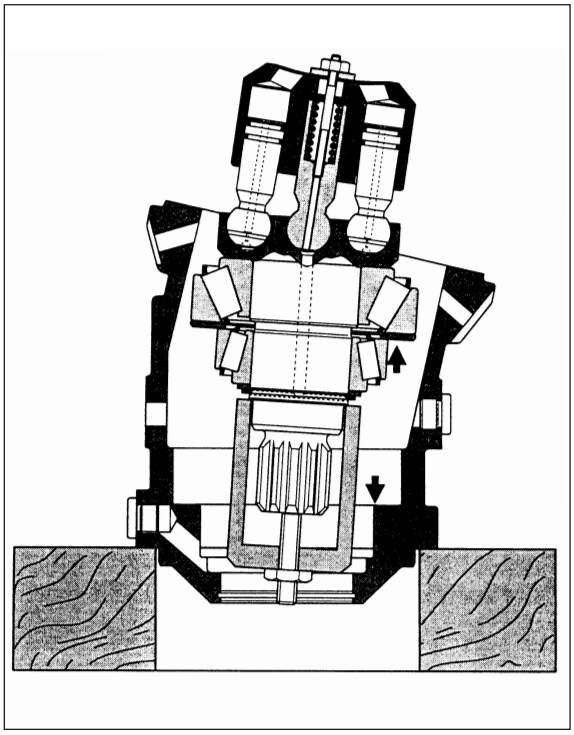
50 Place assembly sleeve



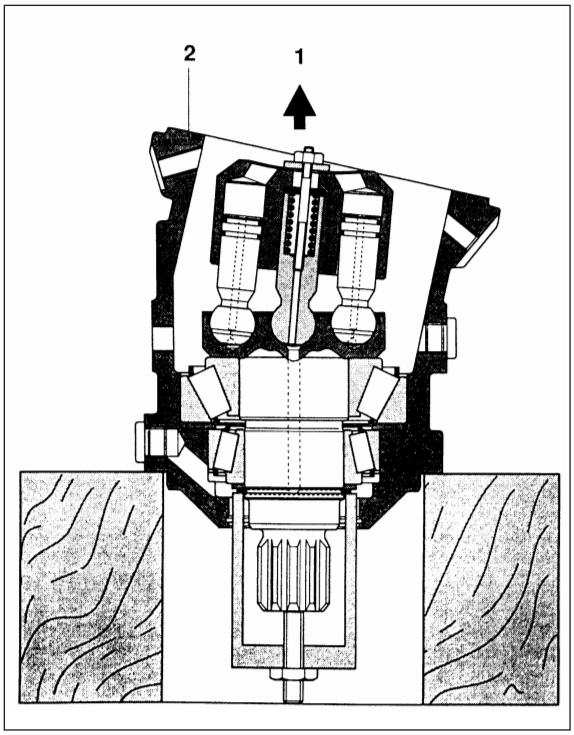
51 Warm up housing to 80°C



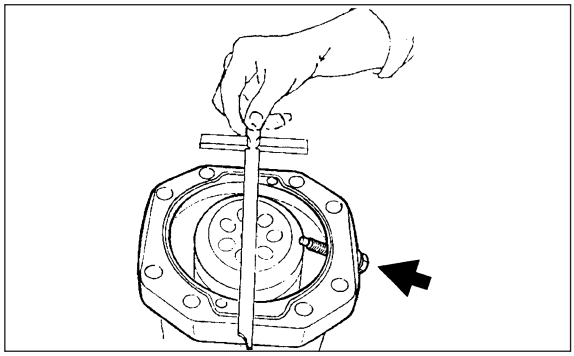
52 Insert rotary group into housing to seat position



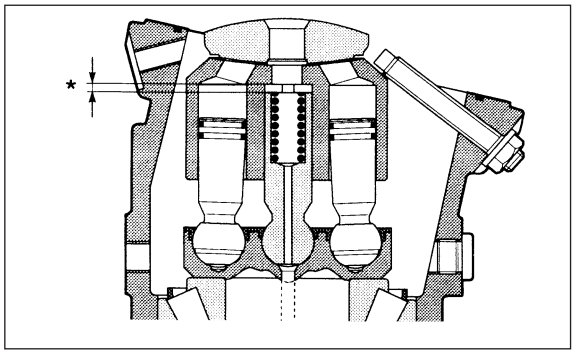
53 Fix zero position of cylinder with Q_{max}-screw
1. Disassemble cylinder fixing screw
2. Insert O-ring



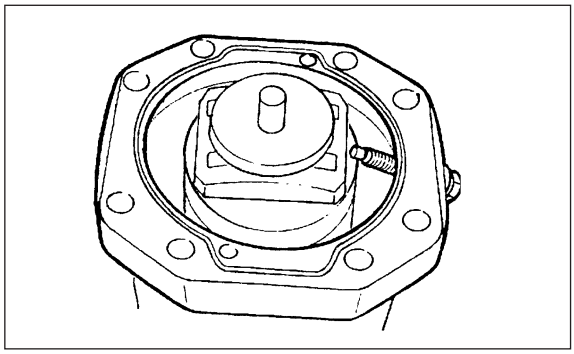
54 Determine cylinder swivel range to max. angle with screw



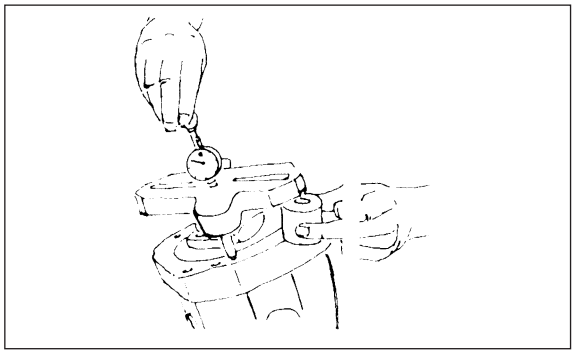
55 * Disc



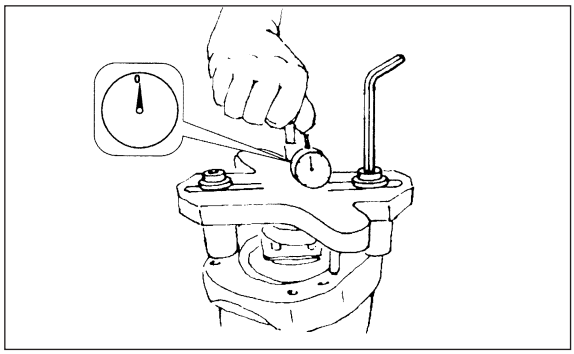
56 Place centering disc



57 Mount measuring device



58 Check dimension X

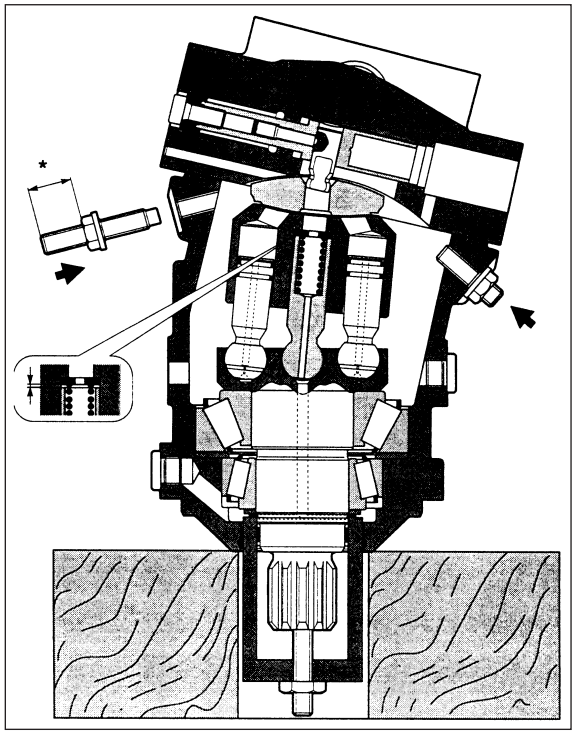


59 (1) Assembly port plate

⚠ Take care of assembly design!

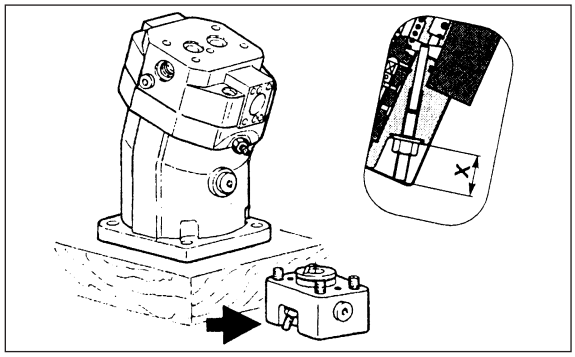
⚠ Tighten fixing screws with torque

(2) Set Q_{min}-screw to dimension*
(3) Assembly plug
(4) Remove assembly sleeve

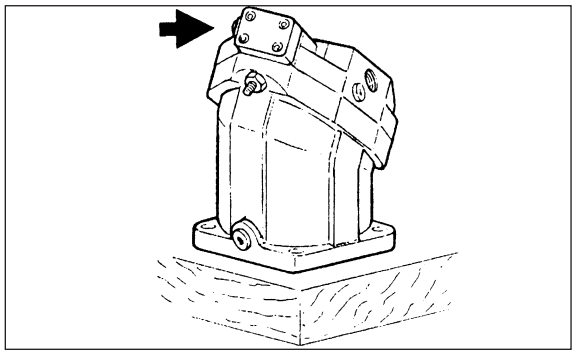


60 Assemble control components.

Assemble cover

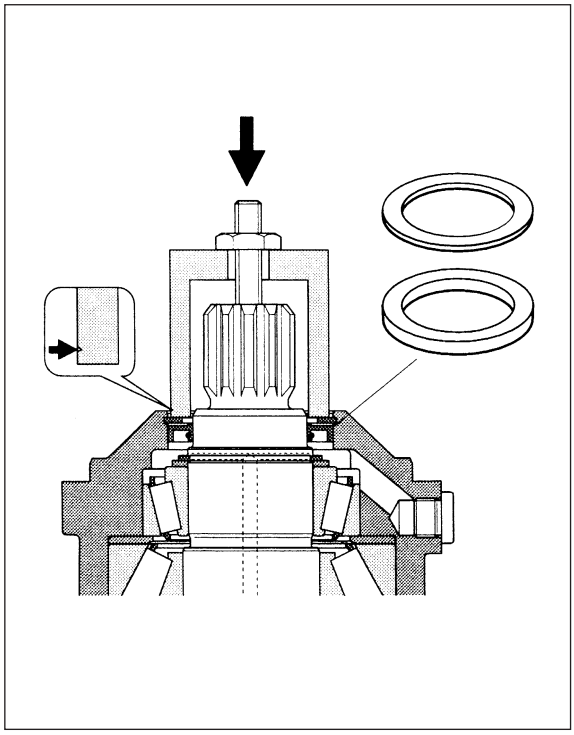


61 Assemble cover

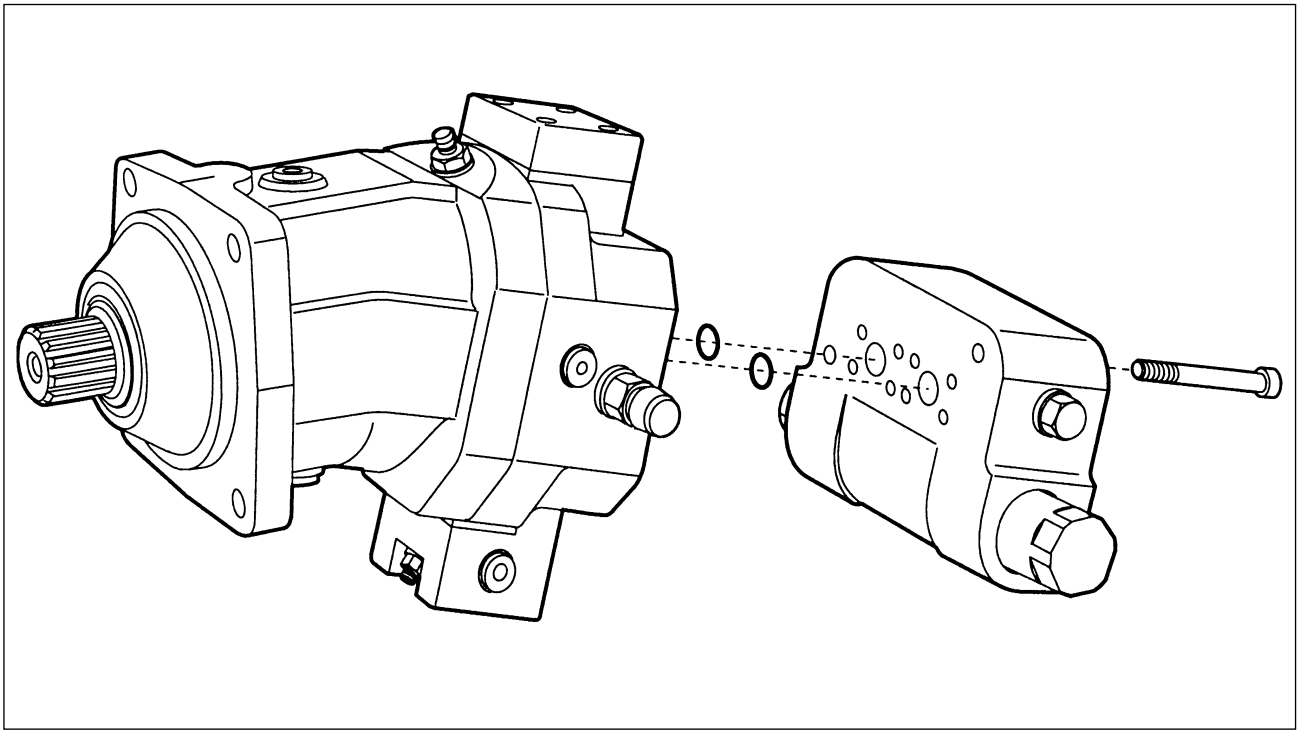


62 Assemble shaft seal, disc and safety ring
Press-in with assembly sleeve

⚠ Take care of press-in depth



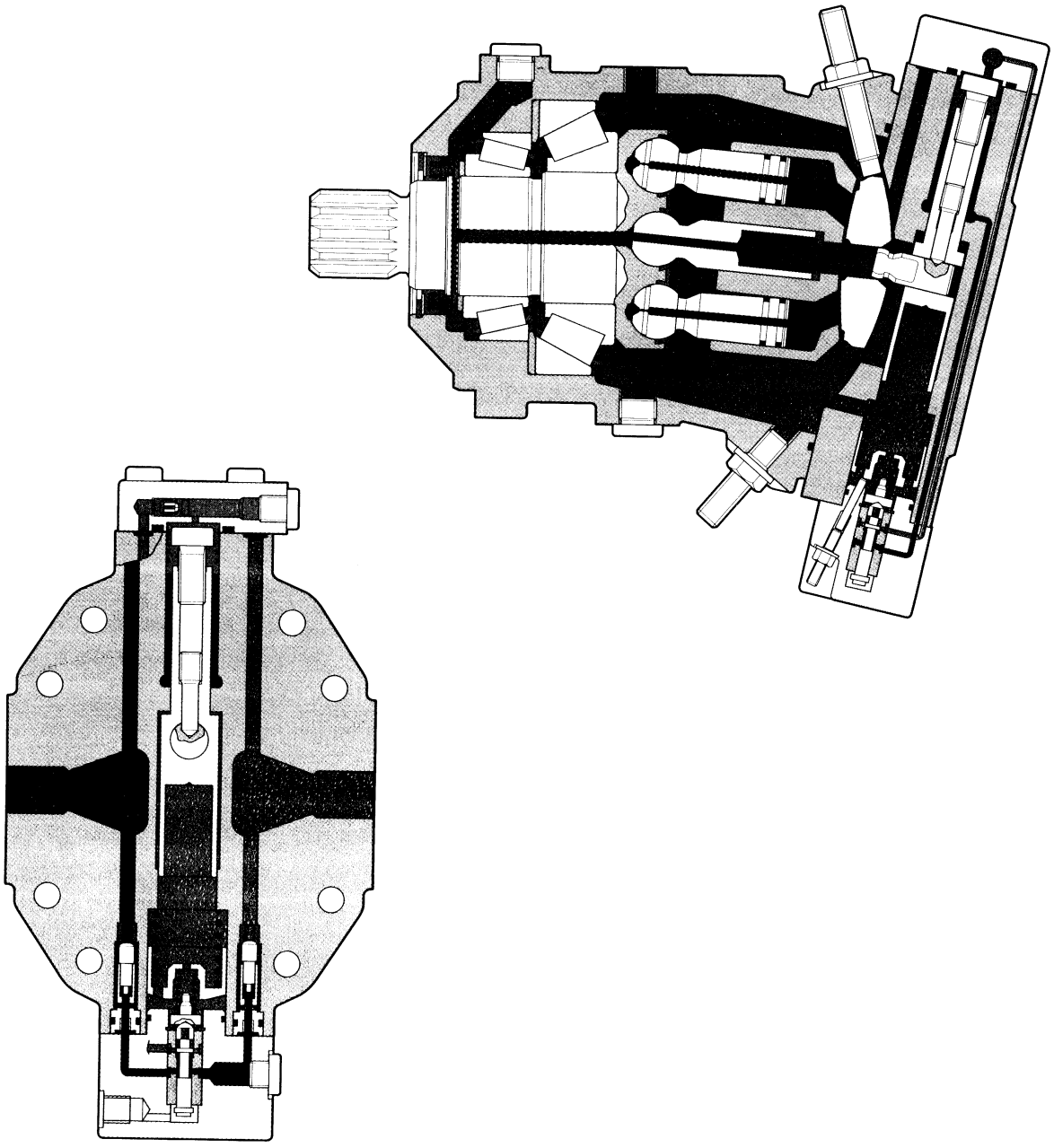
63 Assemble counter-balance valve



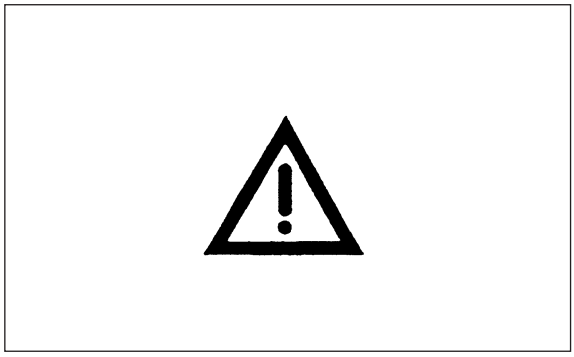
REAR TRAVEL MOTOR

DISASSEMBLY AND ASSEMBLY

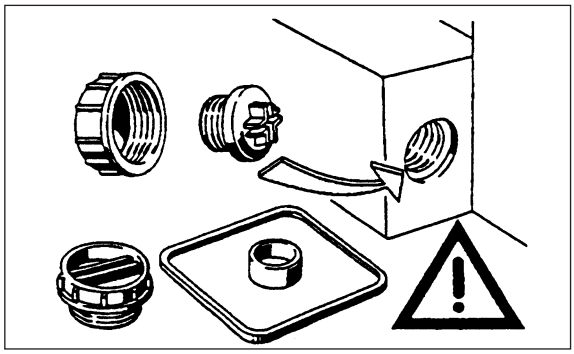
Rear travel motor: Sectional view



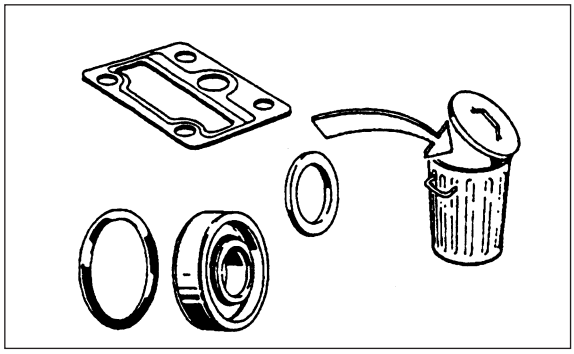
Attention!
Observe the following notices when carrying out repair work at hydraulic aggregates!



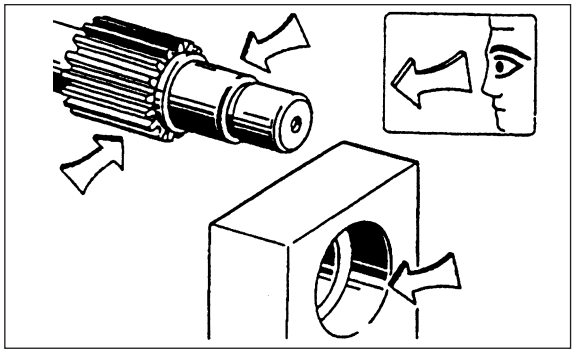
Close all ports of the hydraulic aggregates.



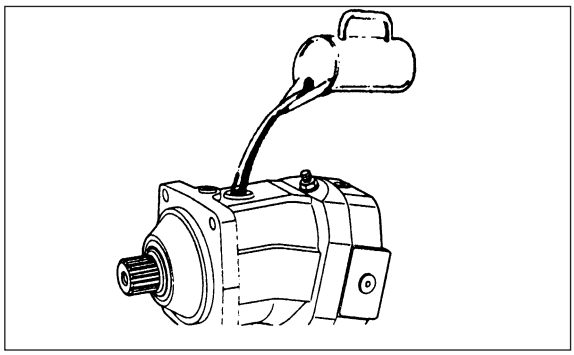
Replace all seals.
Use only original Komatsu spare parts.



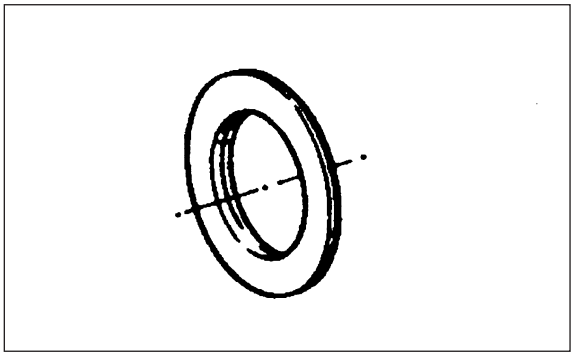
Check all seal and sliding surfaces for wear.
Attention: Rework of sealing area f. ex. with abrasive paper can dammage surface.



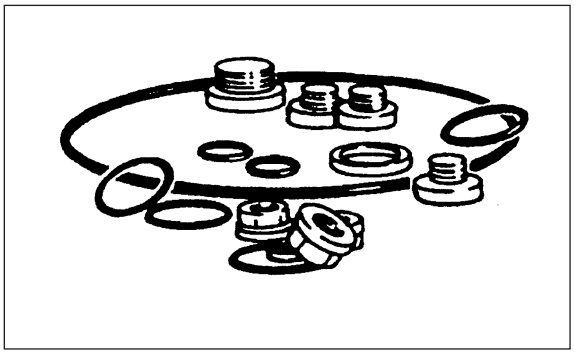
Fill up hydraulic aggregates with hydrulic oil before start-up.



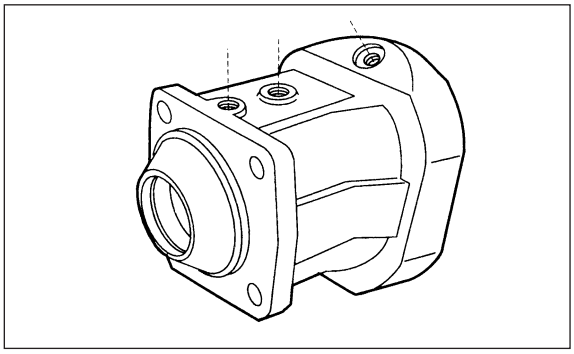
1 Seal kit for drive shaft



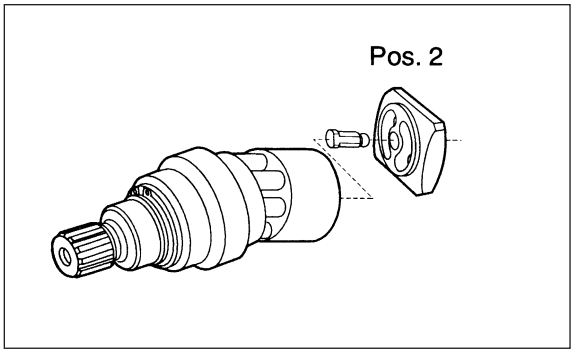
2 External seal kit



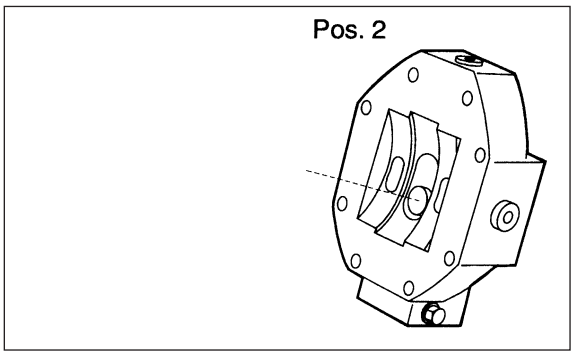
3 Housing



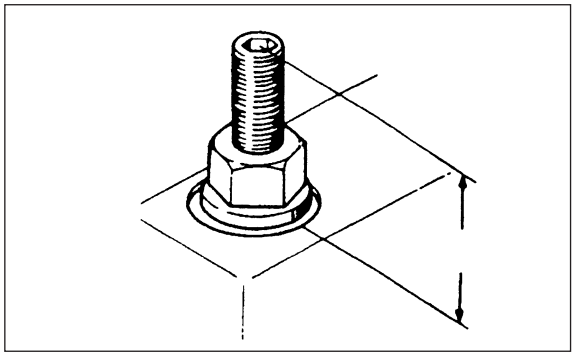
4 Complete rotary group
Note: Pos. 2 - For port plate with synchronizing piston



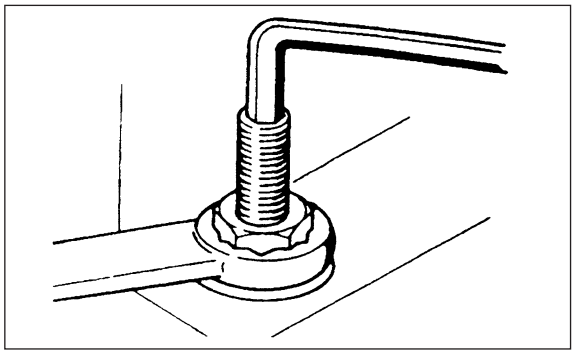
5 Port plate with control piston
Note: Pos. 2 - For port plate with synchronizing piston

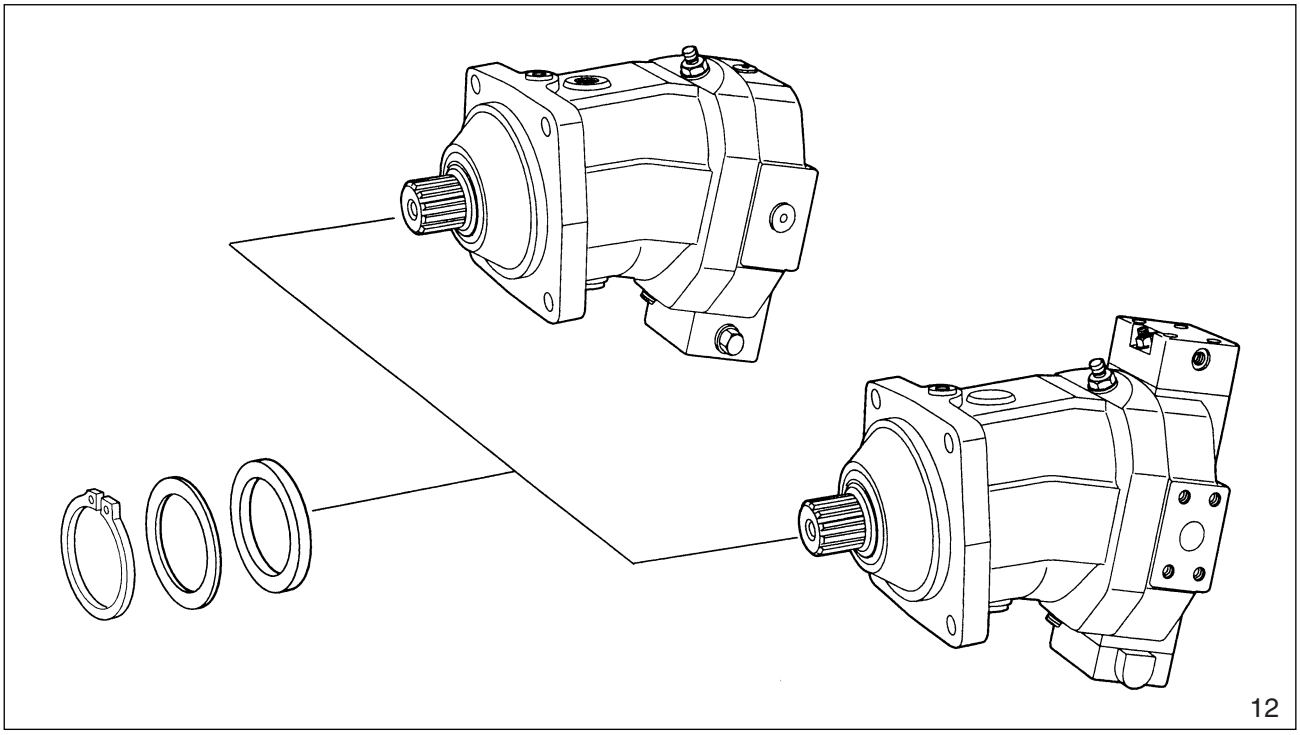


10 Replace seal nut
First measure and record setting height

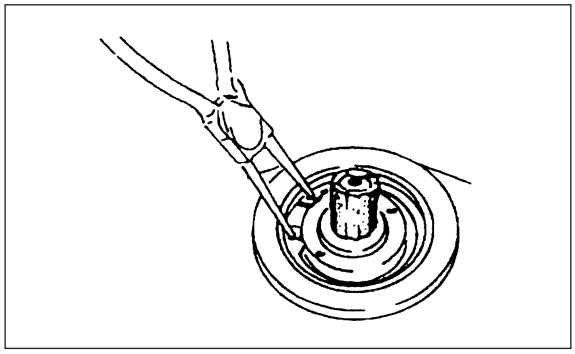


11 When tightening, counterhold setting screw, then check setting height

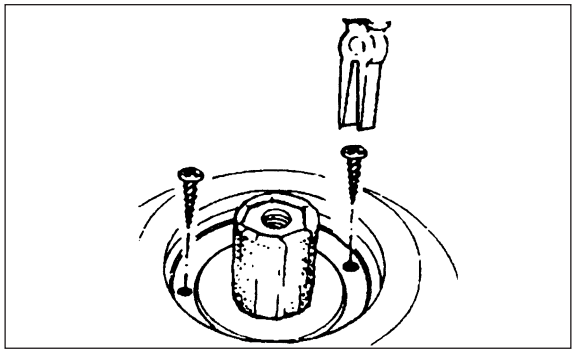



12

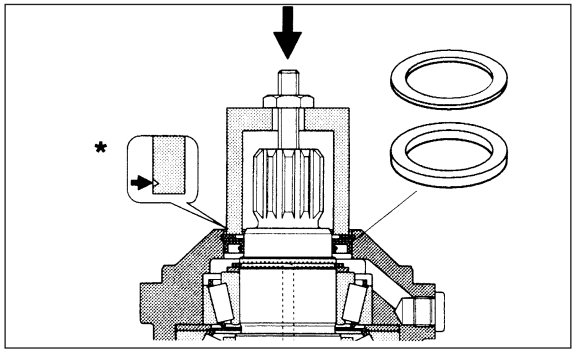
13 Protecting the drive shaft
Remove retaining ring and shim

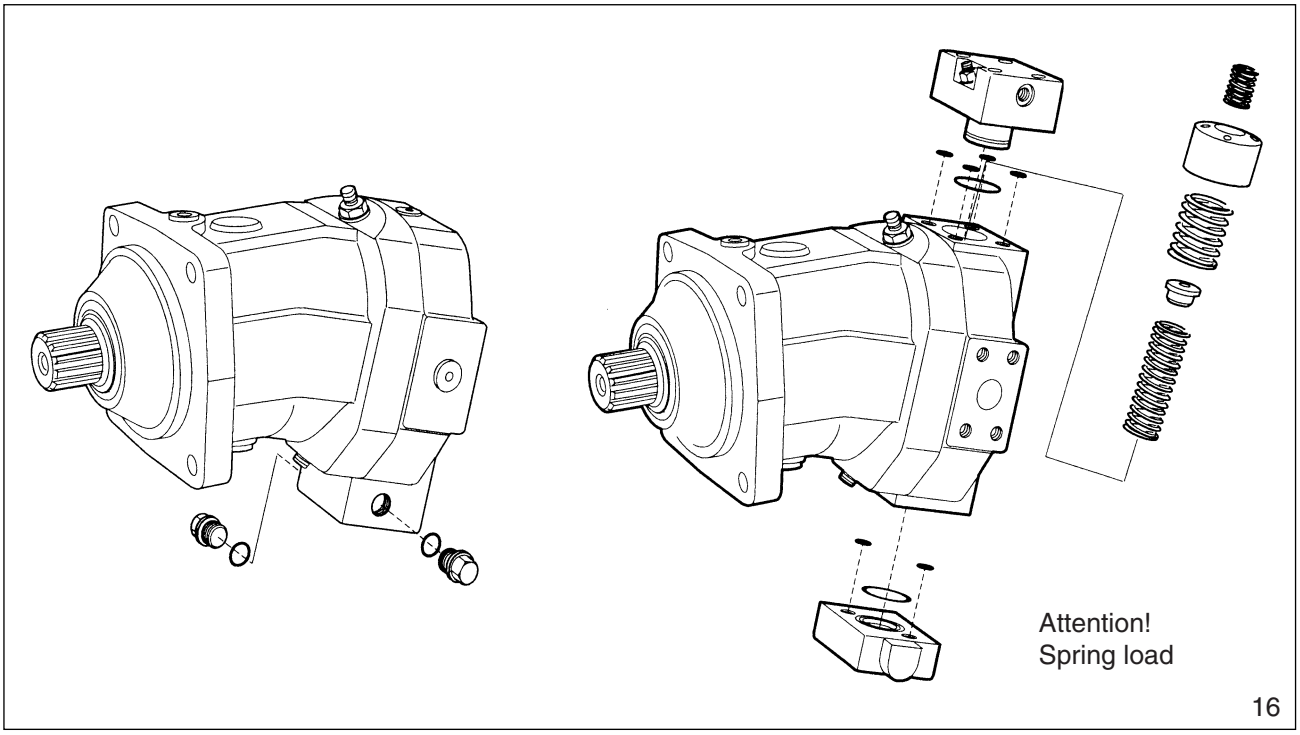


14 Screw in sheet metal screw into the holes fitted with rubber
Pull out seal with pliers



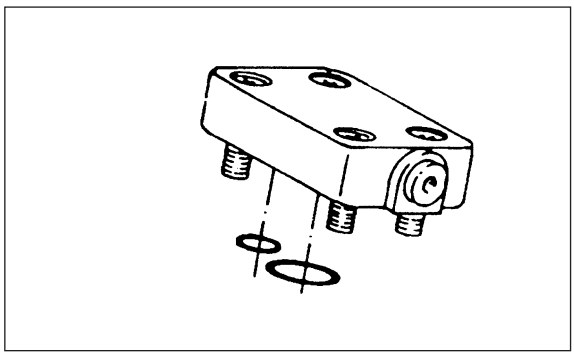
15 Press in shaft seal and shim with bush to stop
⚠ Take note of press-in depth!
Install mark for press-in depth of safety ring



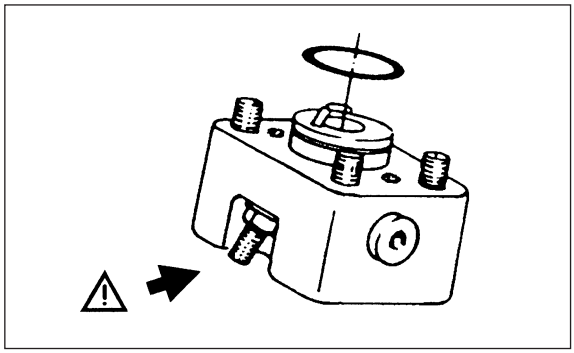


16

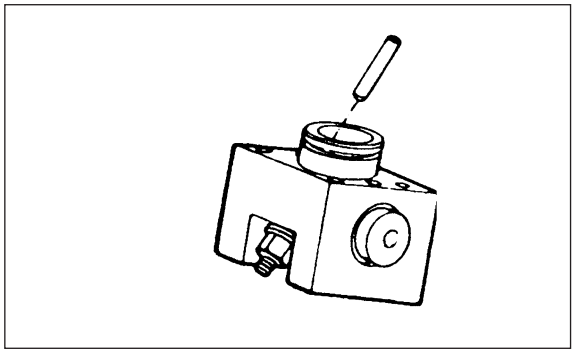
17 Inspect
Drilling in housing, O-ring, groove

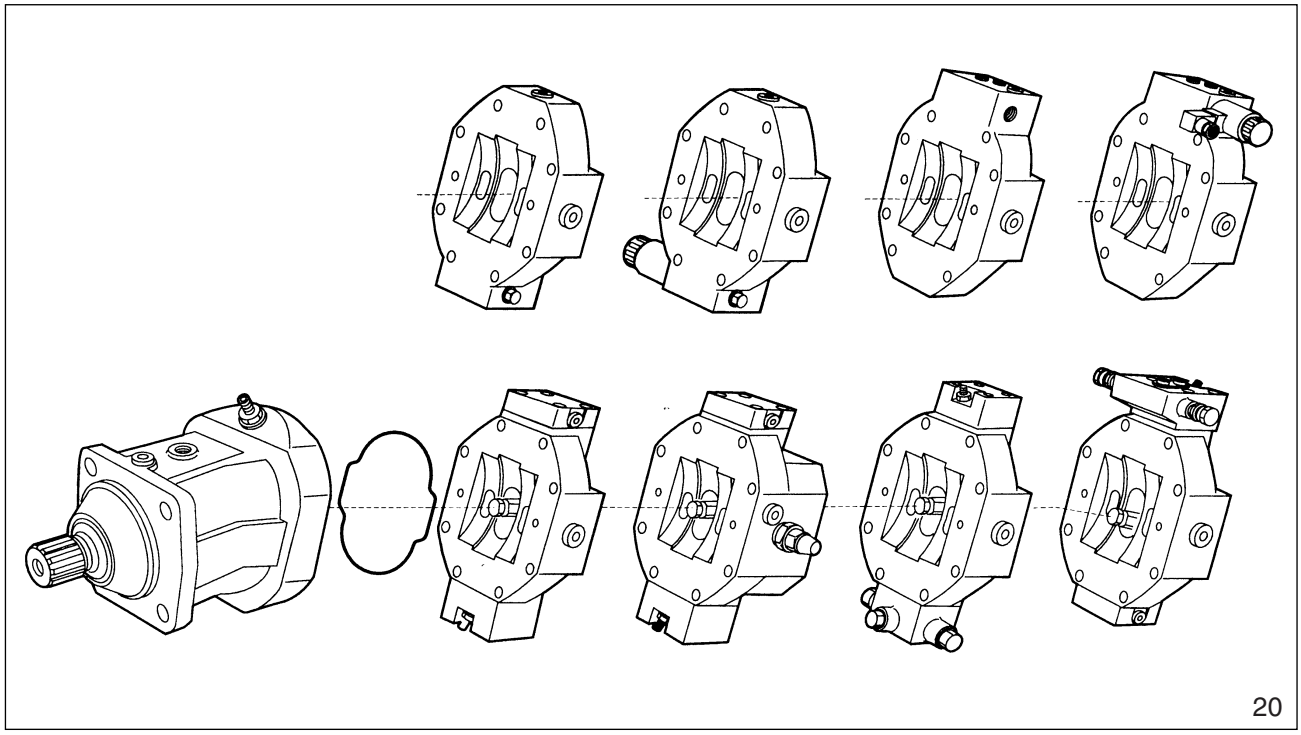


18 ⚠ Do not removeadjustment screw
Inspect
O-ring, O-ring groove, housing



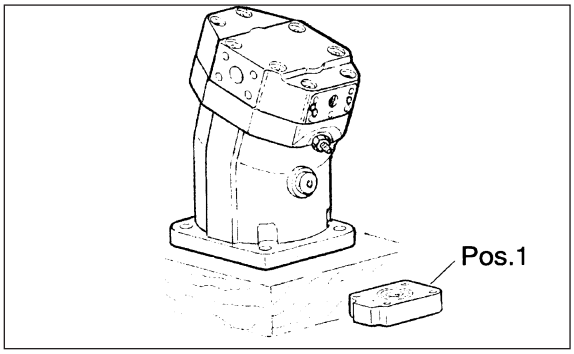
19 Assembly aid
Insert pin with grease



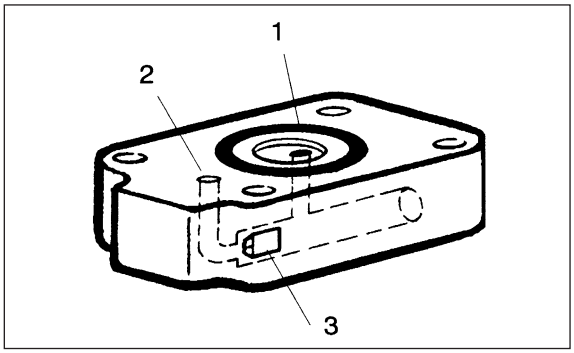


20

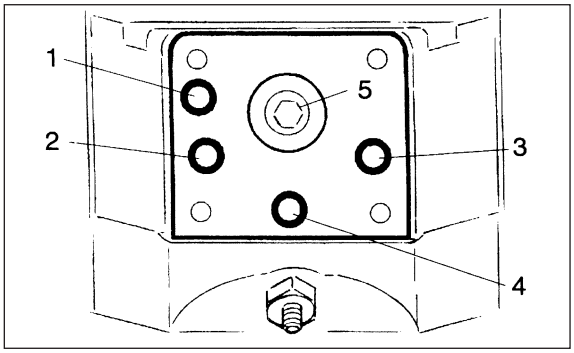
21 Example: A6VM ... HD control
Disassembly position:
Remove cover pos. 1

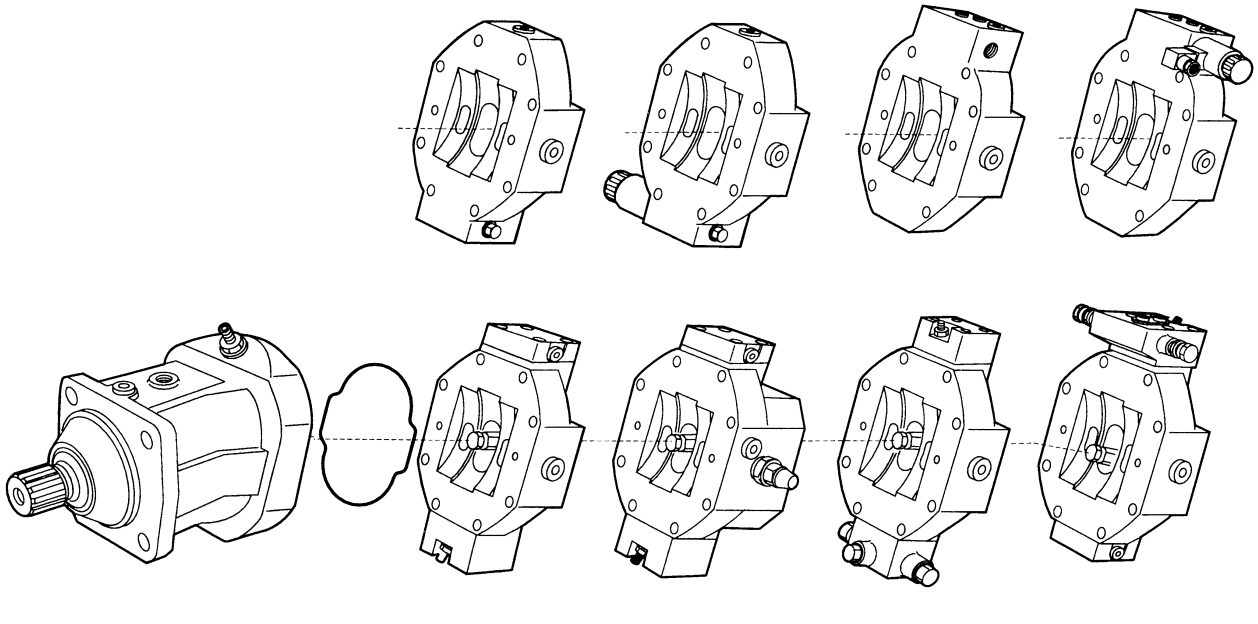


22 (1) O-ring
(2) Input flow of oil control
(3) Throttle pin
⚠ Installation position differs according to the control components



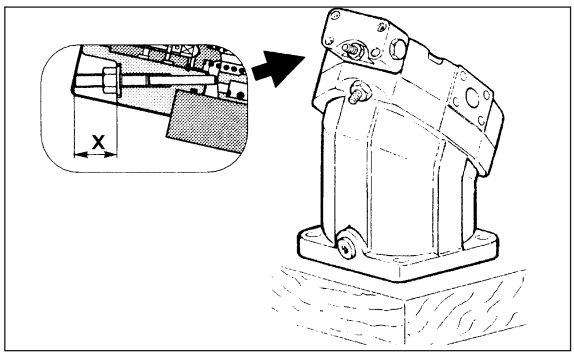
23 (1) Input flow of oil control
(2) High pressure / low pressure
(3) High pressure / low pressure
(4) Leakage oil
(5) Control piston



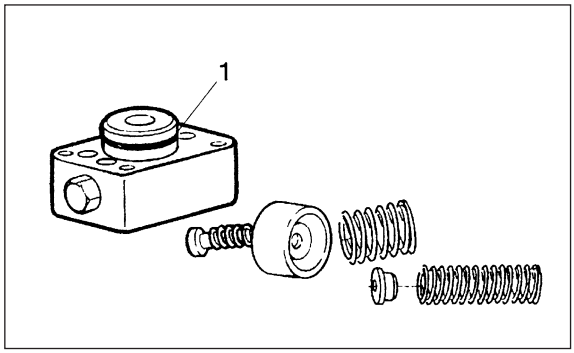


24

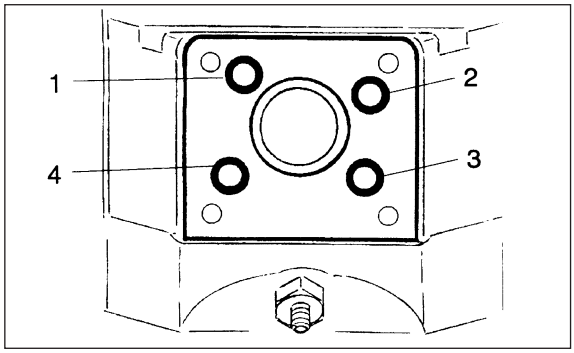
25 Example: A6VM ... control - **differential piston**
Disassembly position: Remove cover pos. 2
Attention! Spring load
Dimension x: Note dimension (begin of regulation)



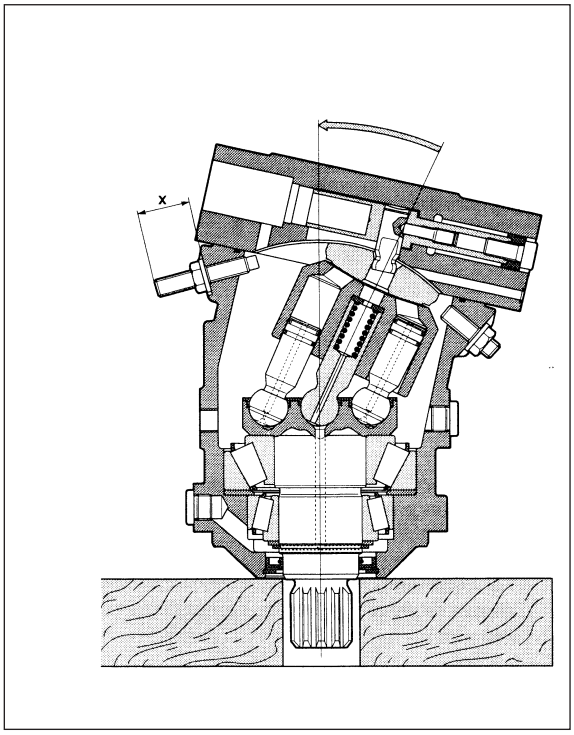
26 (1) Check of O-ring



27 (1) High pressure - small control piston piston side
(2) Control pressure
(3) High pressure - check valve
(4) High pressure - check valve

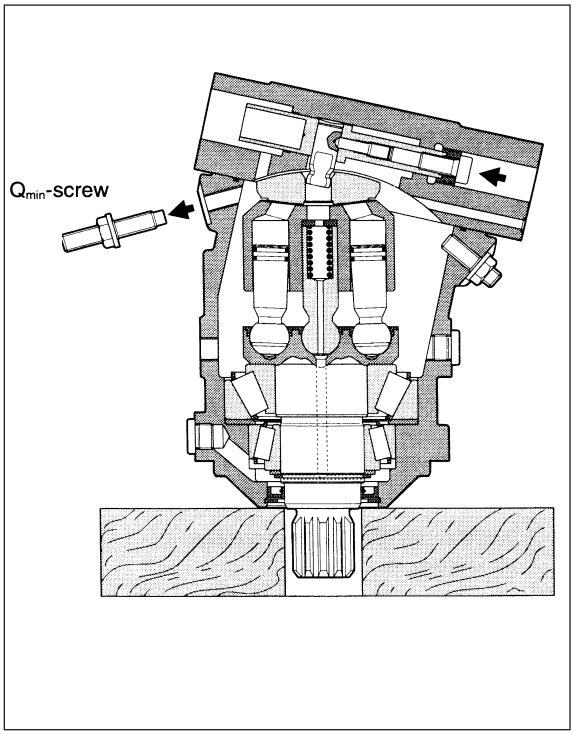


Diferential piston:
Note dimension x

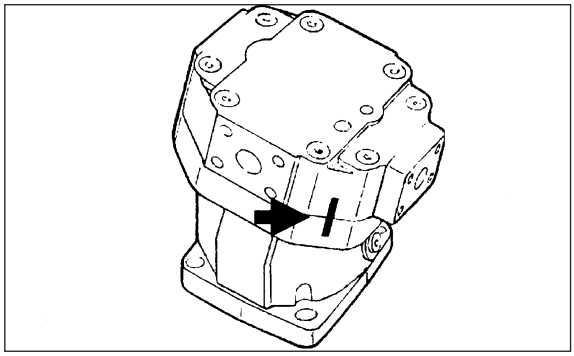


For disassembly of the port plate, swivel always rotary group to zero position
Piston rings to hang out of the cylinder boring

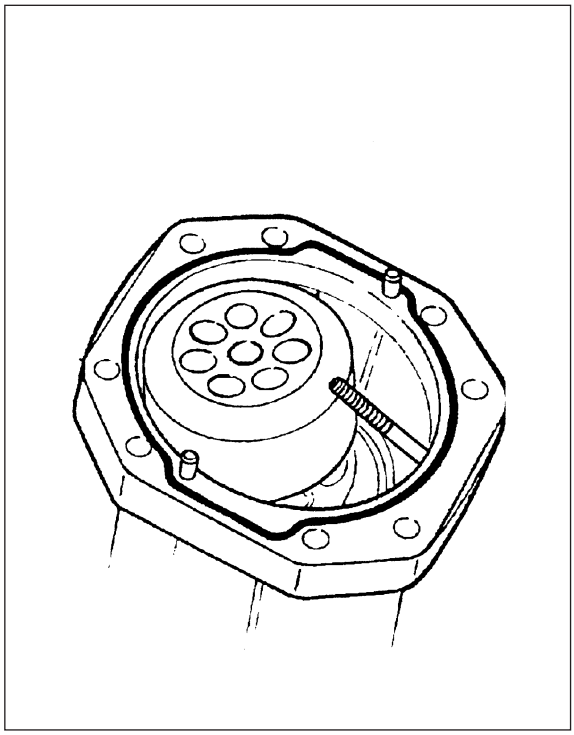
Remove Q_{min}-screw
Swivel rotary group to 0°



28 Port plate
Mark position. Loosen screws
Removal

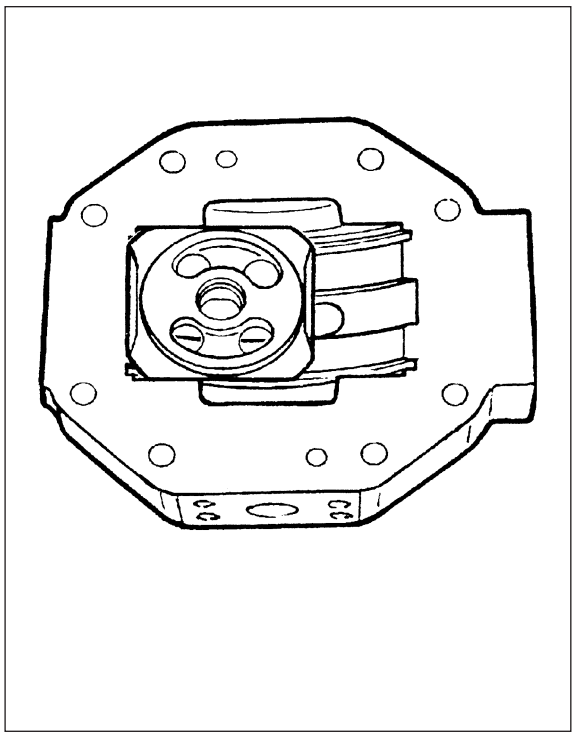


29 Check O-ring
Stick new O-ring with some grease
Do not swivel rotary group
⚠ Piston rings to hang out from the cylinder boring

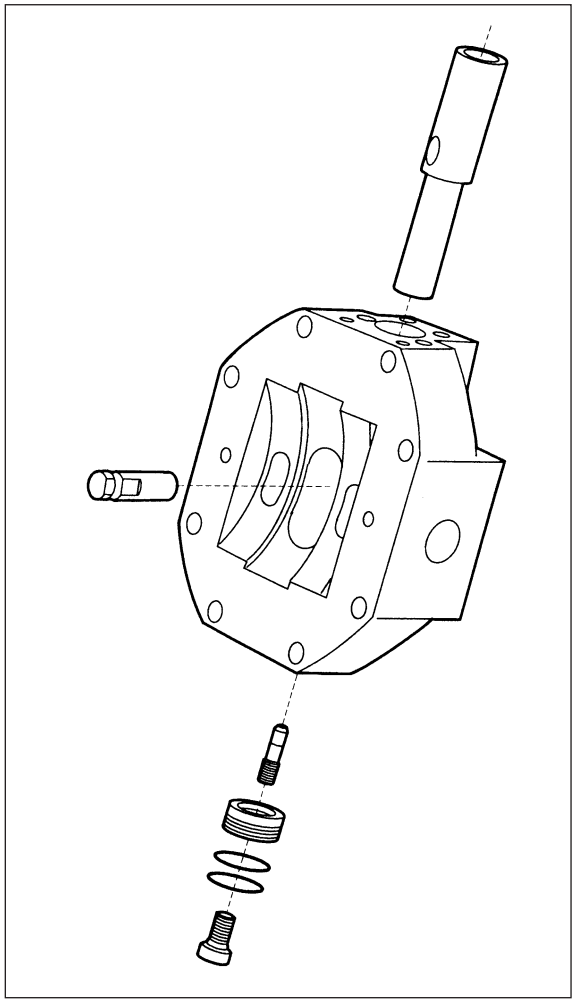


30 ⚠ Stick control lens in sliding surface with grease
Assembly in reversal order
Mount port plate

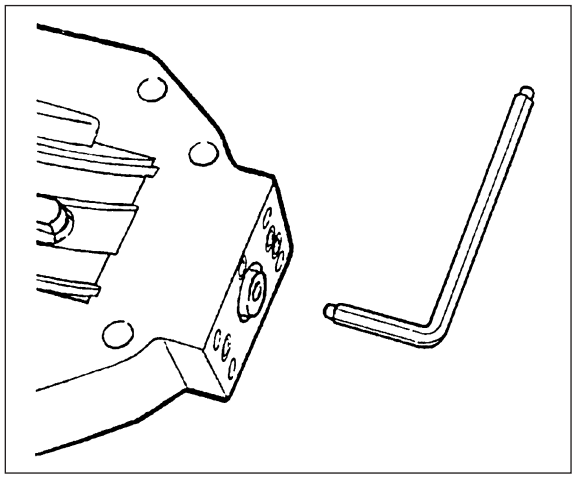
⚠ Rotary group vertical



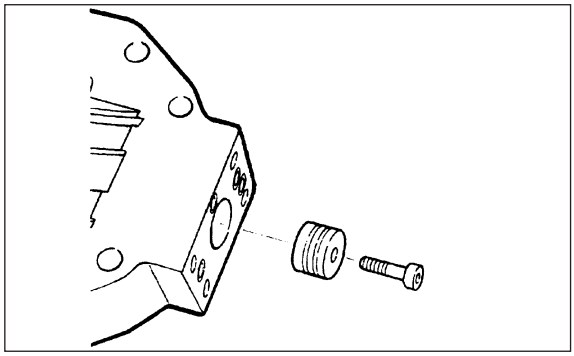
31 **Differential piston**



32 Loosen fixing screw
Use only socket wrench



33 Remove piston with piston ring



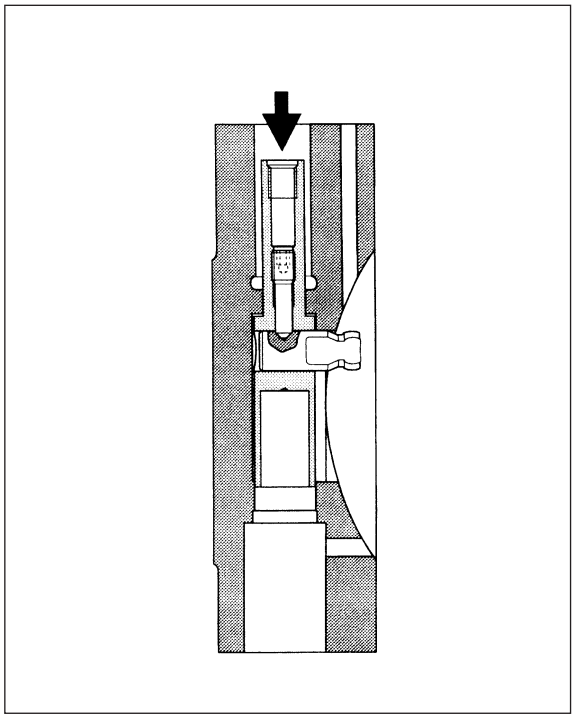
34 **Differential piston**

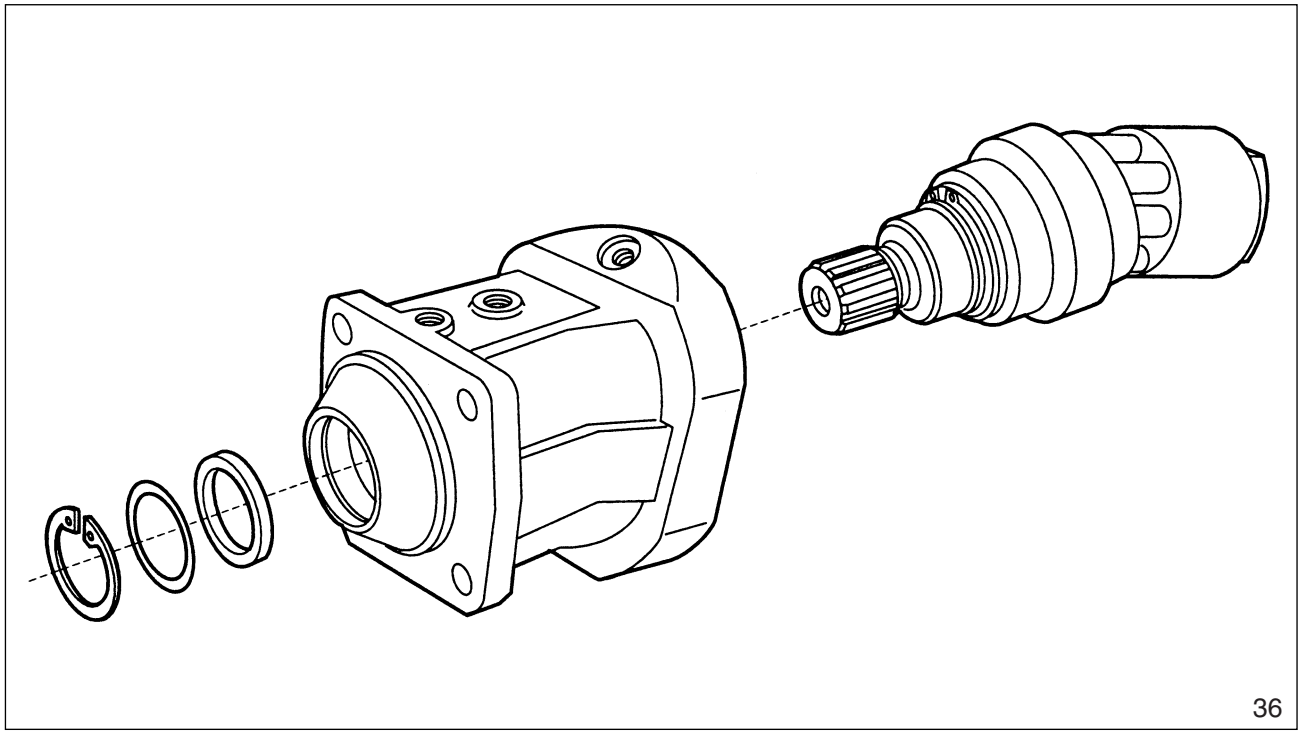
Warm up fixation screw for positioning plug via boring (screw glued - to turn out)

Use new screw

Precote coating

Note tightening torque!

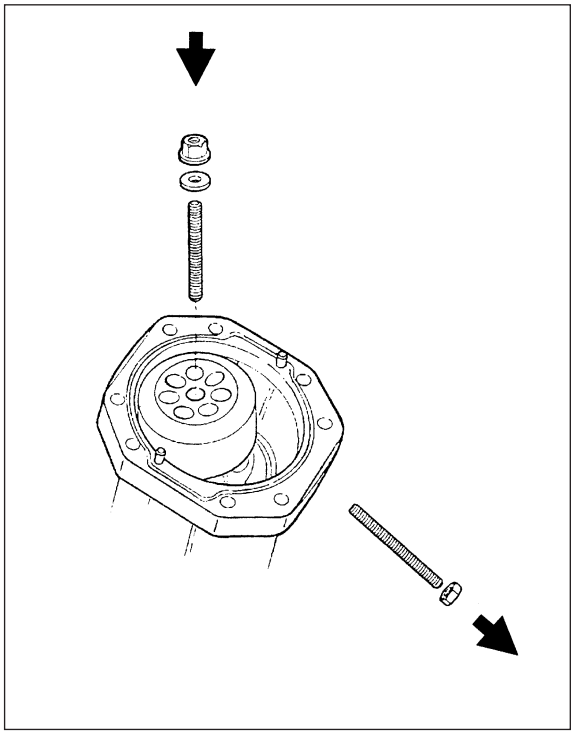




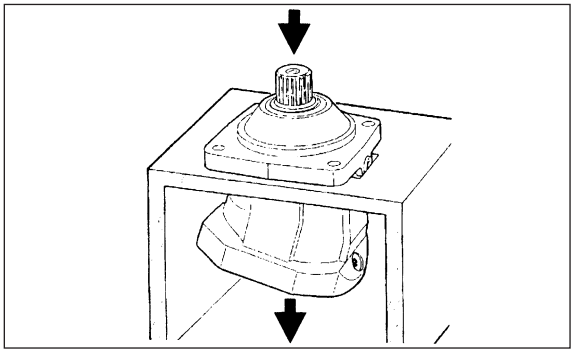
36

37 Screw in threaded pin into center
Fix the cylinder with disc and locknut
Remove Q_{max}-stop screw

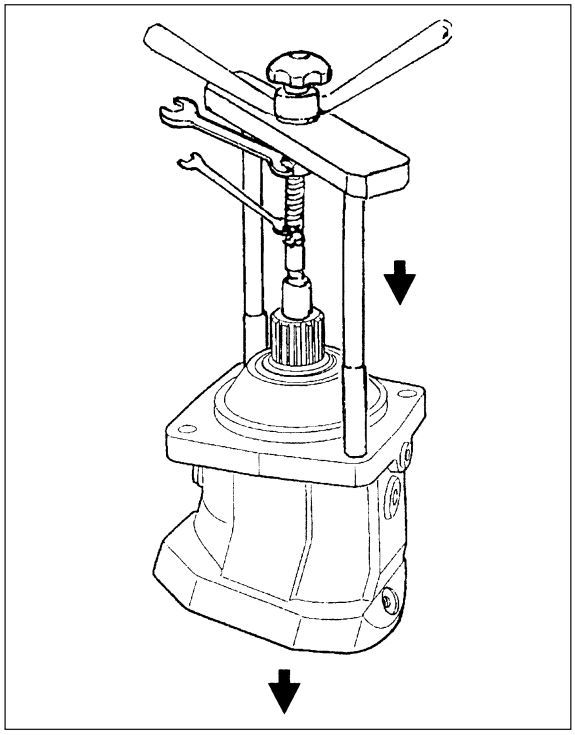
Size	28	: M4 x 58 mm
	55	: M5 x 71 mm
	80	: M6 x 82 mm
	107	: M6 x 92 mm
	140	: M8 x 105 mm
	160	: M8 x 105 mm
	200	: M8 x 109 mm

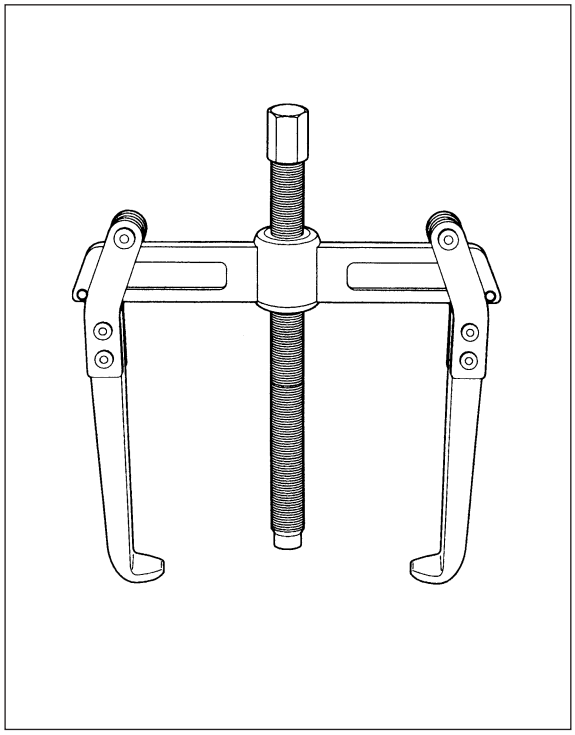


38 Press out rotary group!
⚠ If the bearings are used again do not hit on the drive shaft



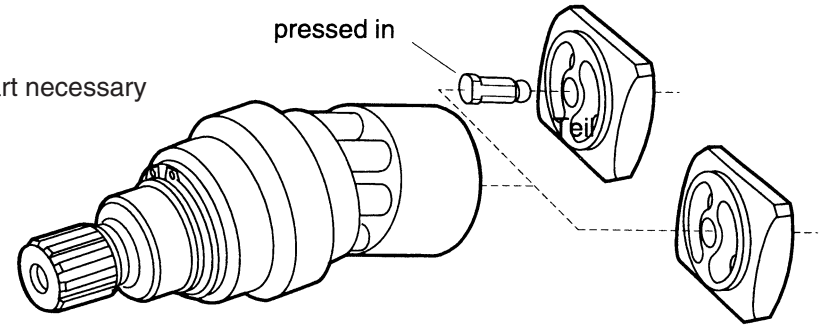
39 Or press-out with extraction device



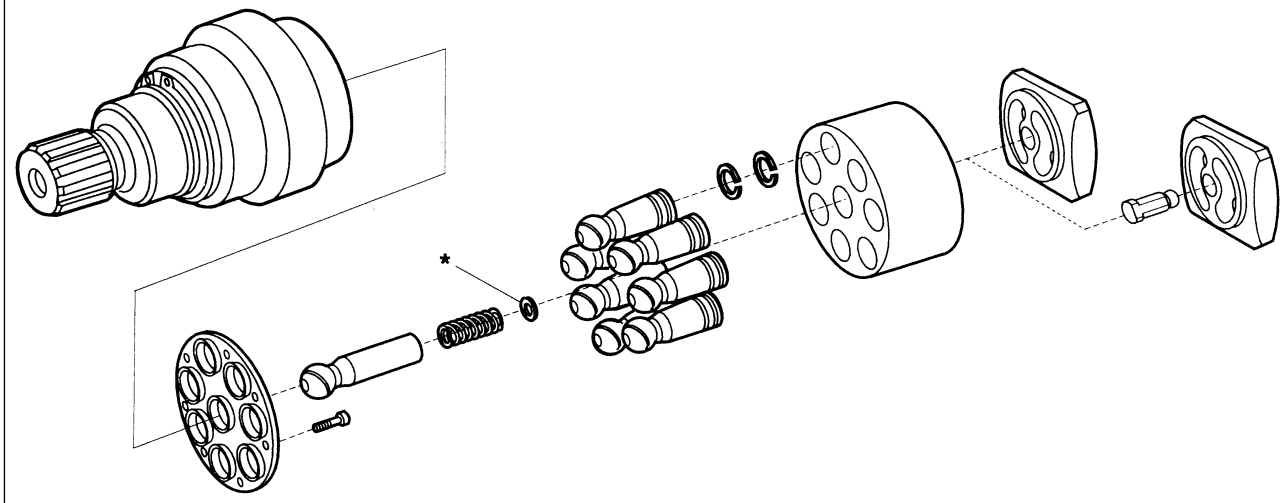


Complete rotary group

⚠ Setting of hydraulic part necessary



40



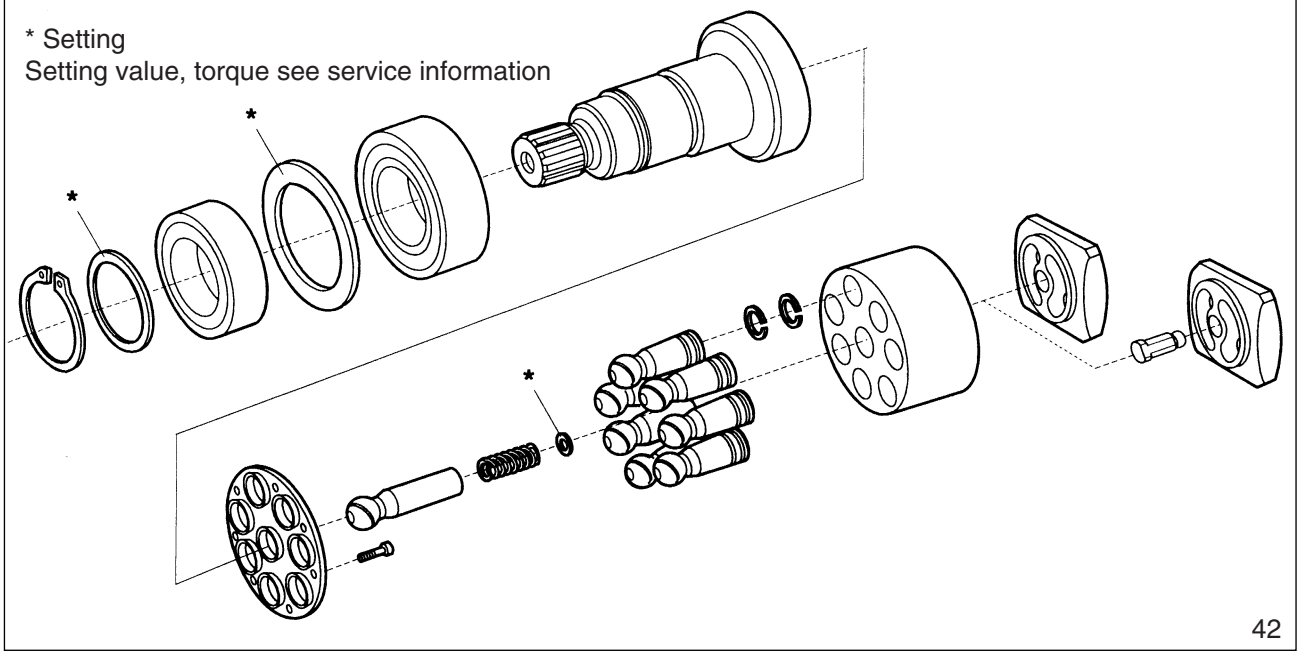
Rotary group

1. Mechanical part: Adjust drive shaft with bearing
2. Hydraulic part: ⚠ Adjustment necessary

41

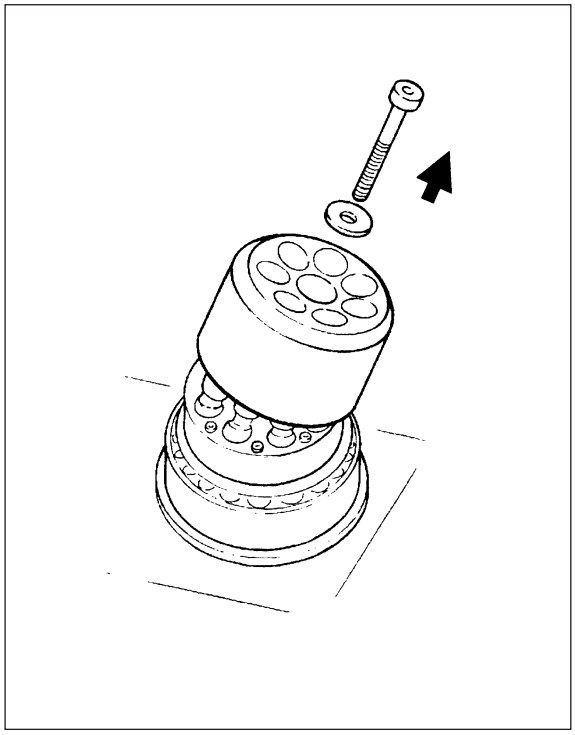
Rotary group: All parts

* Setting
Setting value, torque see service information

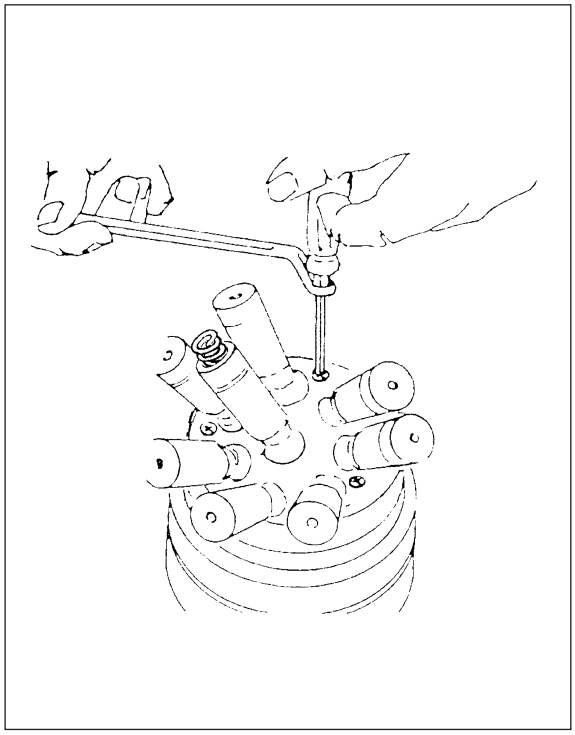


42

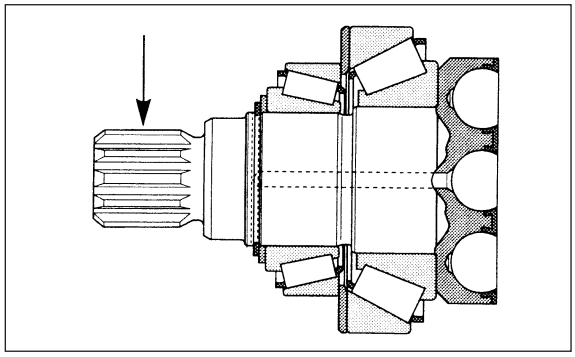
43 Remove fixing screw (cylinder)
Remove cylinder



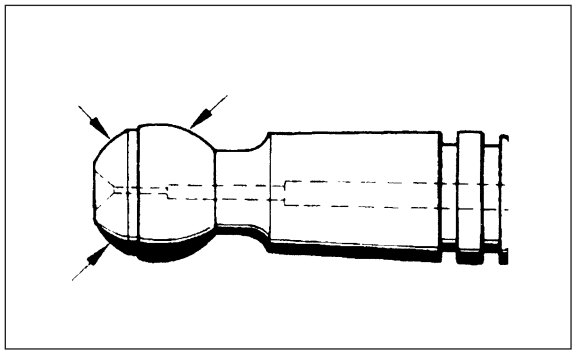
44 Disassemble retaining plate
Screws are glued
⚠ Use Torx-tools



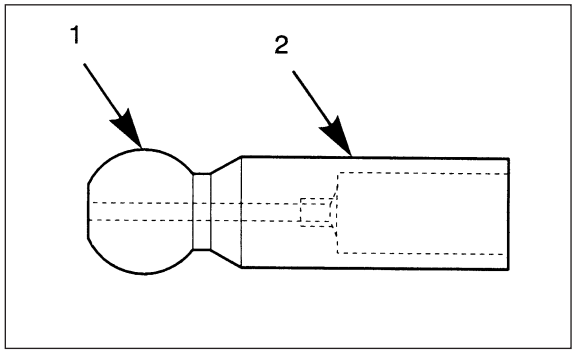
45 Free of corrosion, erosion or fretting; no damage to splines or keyways



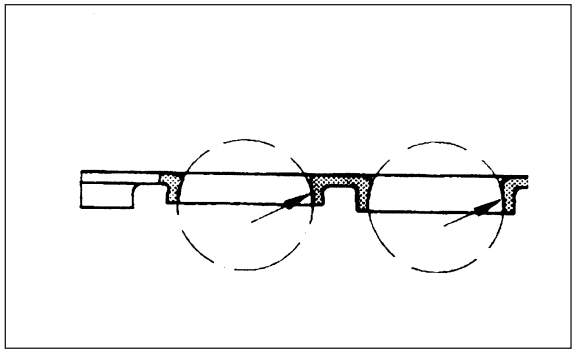
46 Pistons
No scoring and no pittings



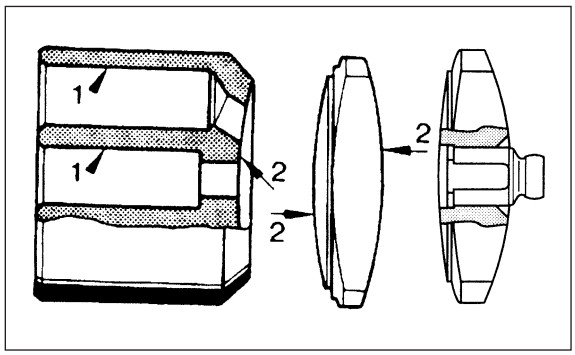
47 Center pin
No scoring and no pittings



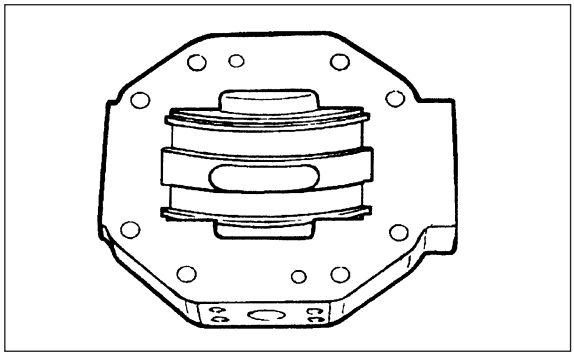
48 Retaining plate
No scoring and no evidence of wear



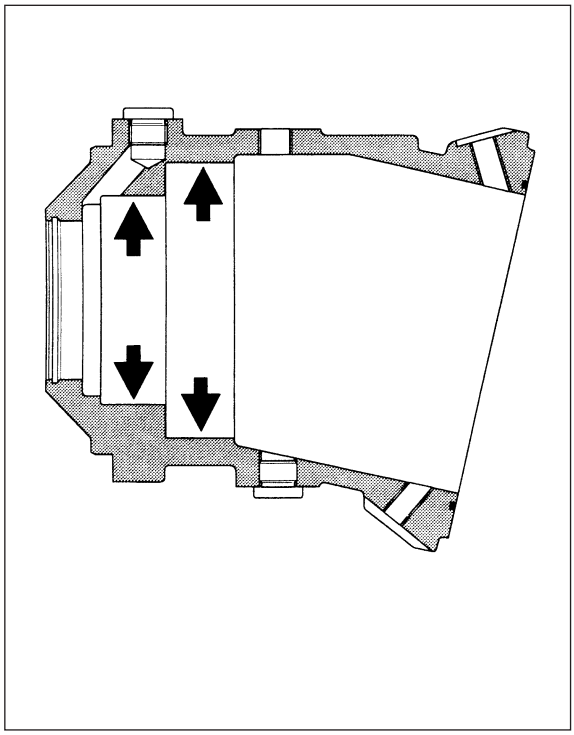
49 Cylinder block / control lens
1. Bores free of scoring, no evidence of wear
2. Faces smooth and even, free of cracks and scoring



50 Control housing
Sliding surface and side guides free of scoring and no wear

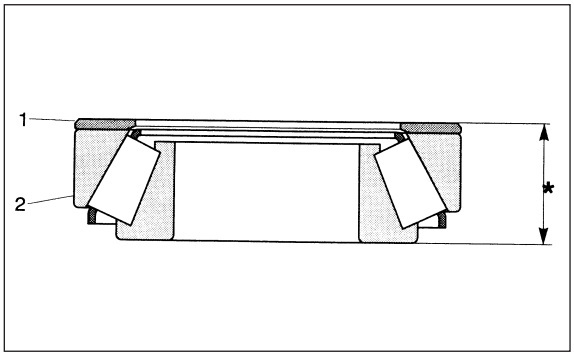


51 Visual check:
Bearing areas free of scoring and no evidence of wear

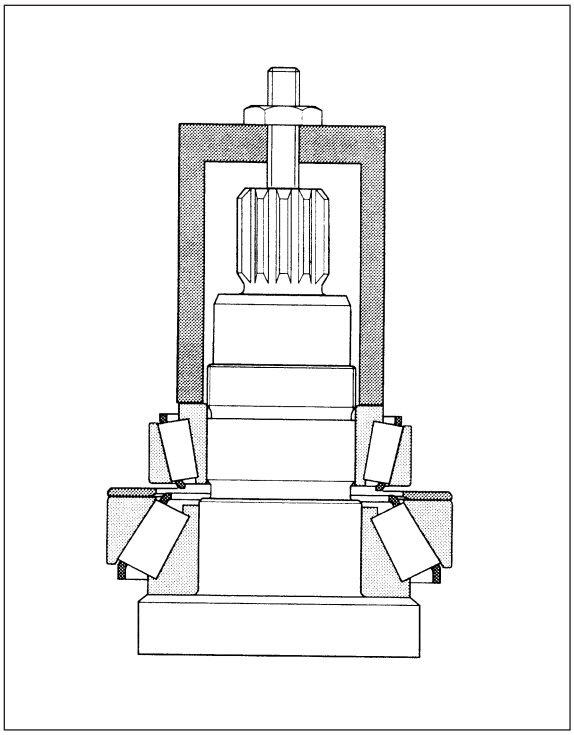


Rotary group: mechanical part

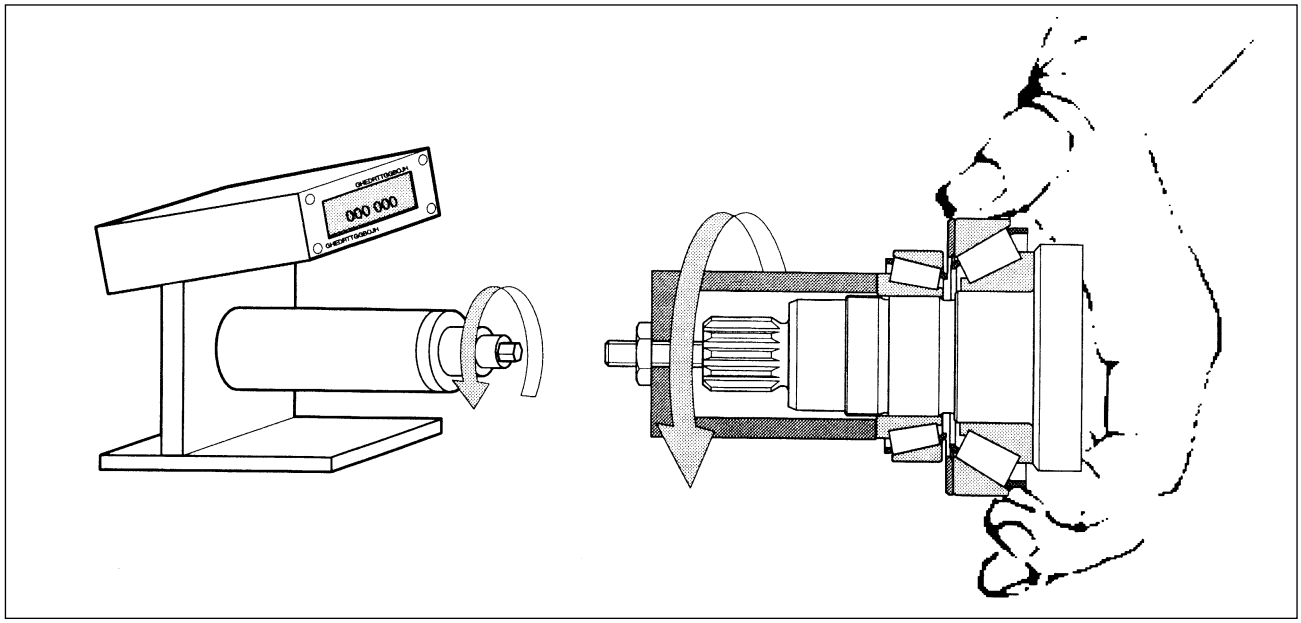
Adjustment dimension * and bearing torque see service information



Press on bearing
Do not exeed bearing torque during press-on

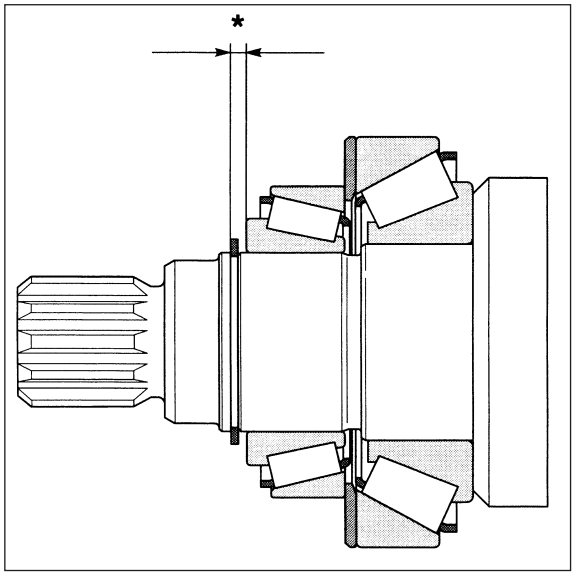


Preload bearing with assembly sleeve and steady control of the torque

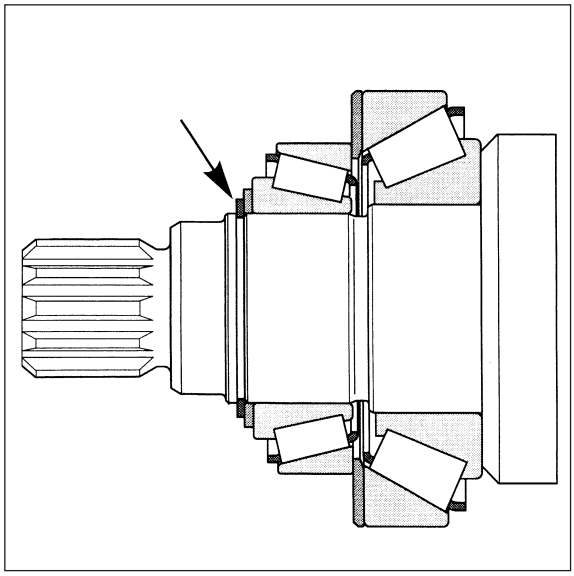


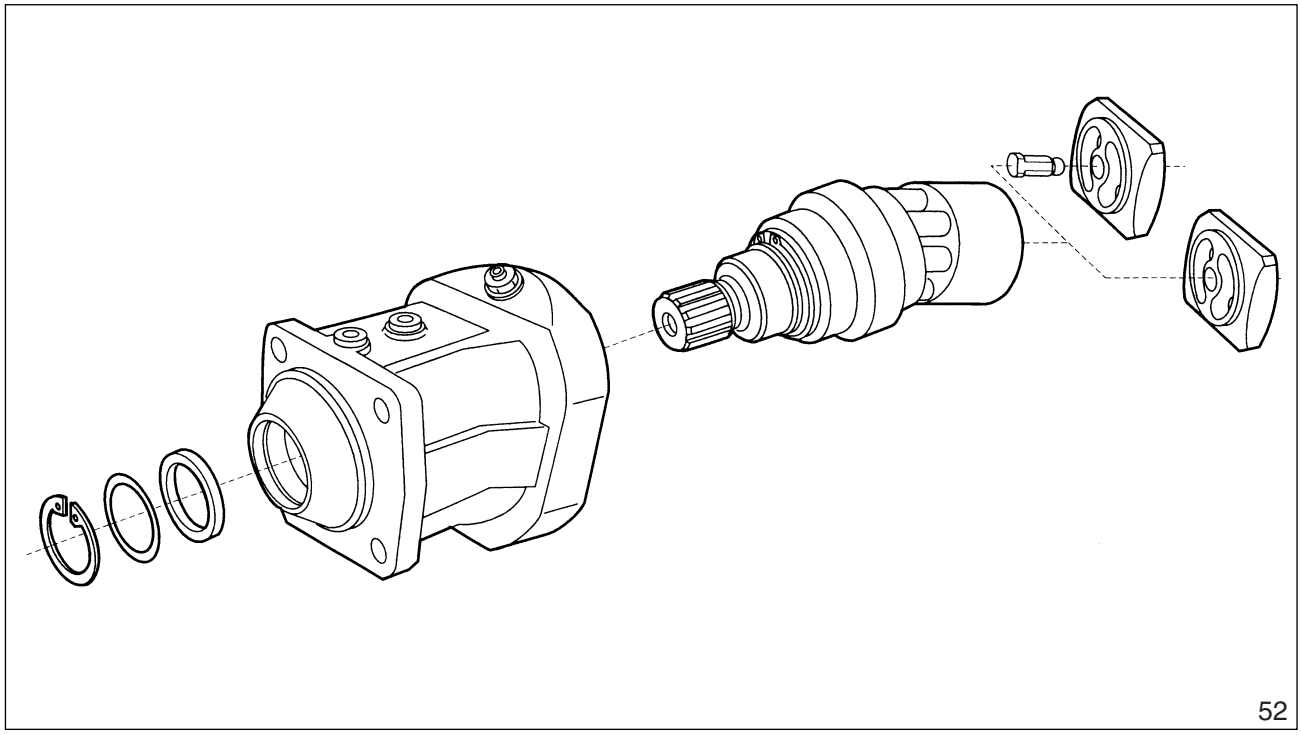
Rotary group: mechanical part

Assemble safety ring
Determine dimension for adjustment disc with final dimensions (crossover)



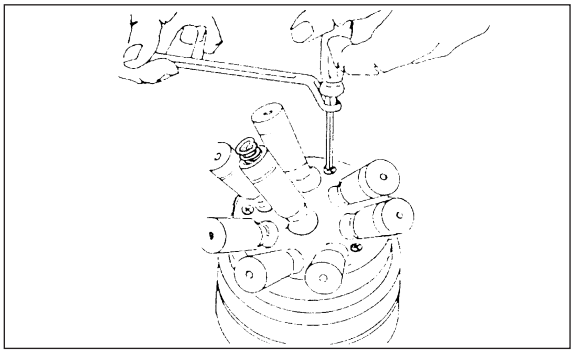
Install adjustment disc
Assemble safety ring
Drive shaft ready for assembly



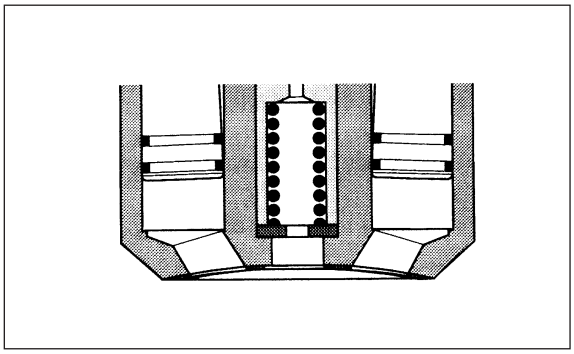


52

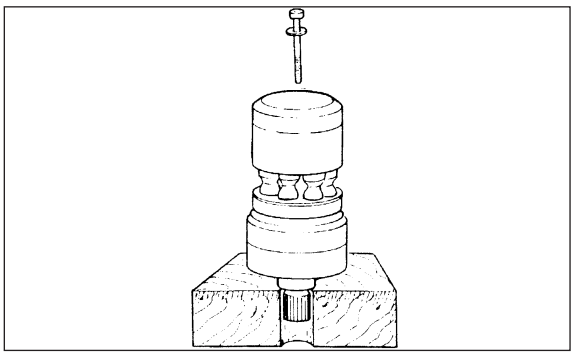
53 Insert retaining plate with piston and center pin
Use screw with Precote-coating



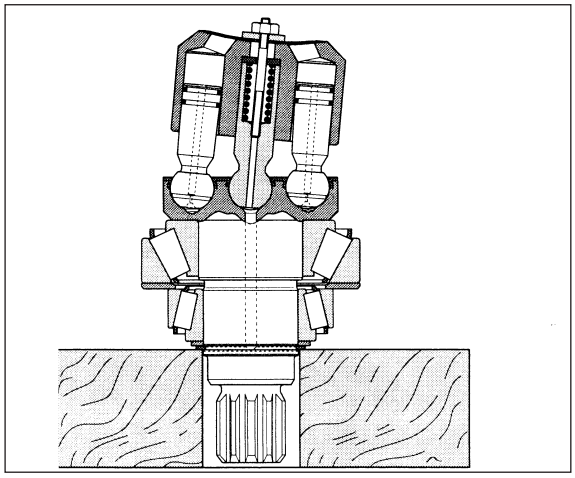
54 Make sure all parts are fitted in correctly



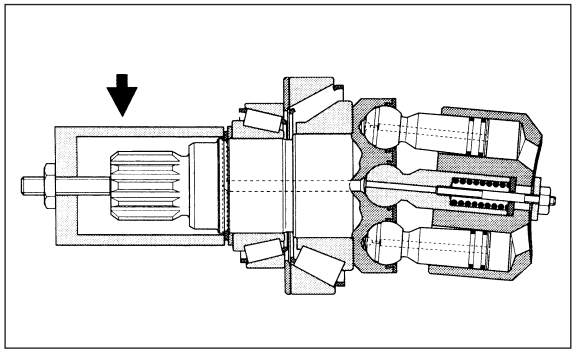
55 Swivel cylinder block to max. and fix the cylinder



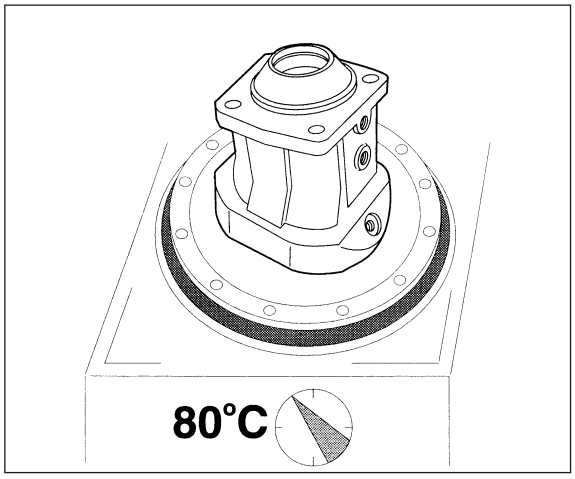
Rotary group completely assembled ready for assembly



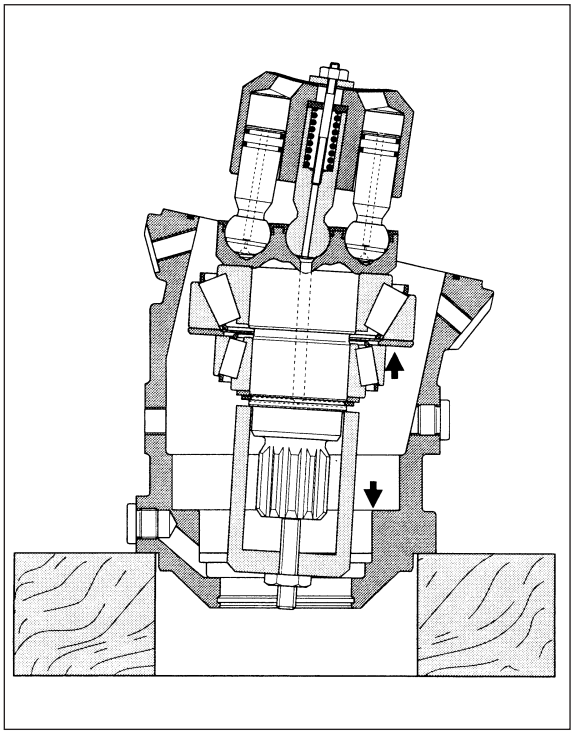
Place assembly sleeve



Warm up housing to 80°C

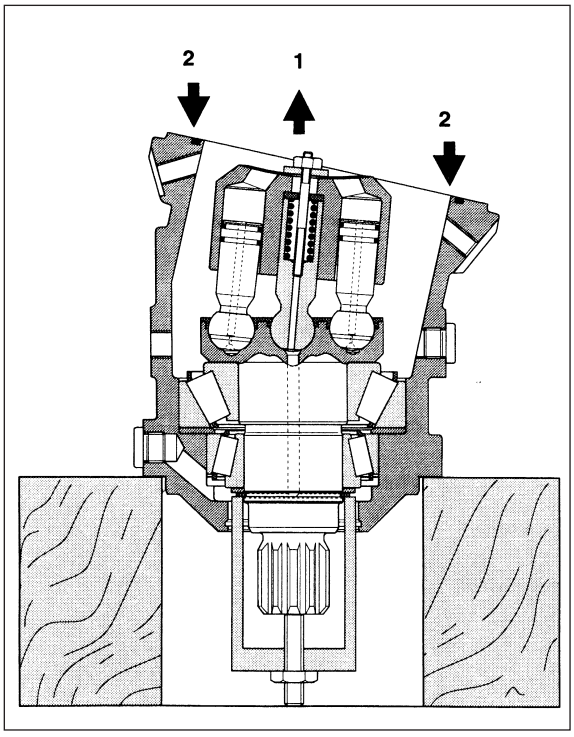


Insert rotary group into housing to seat position

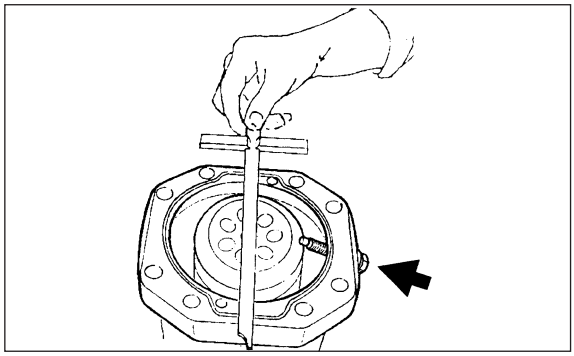


Fix zero position of cylinder with Q_{max}-screw

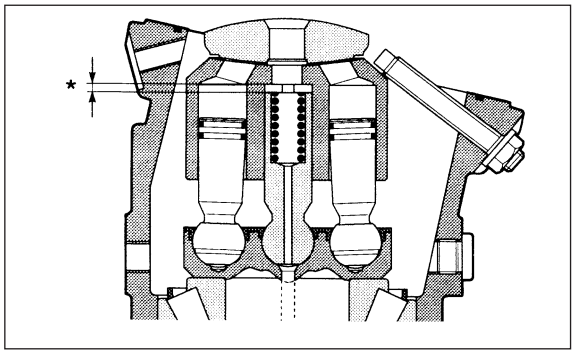
1. Disassemble cylinder fixing screw
2. Insert O-ring



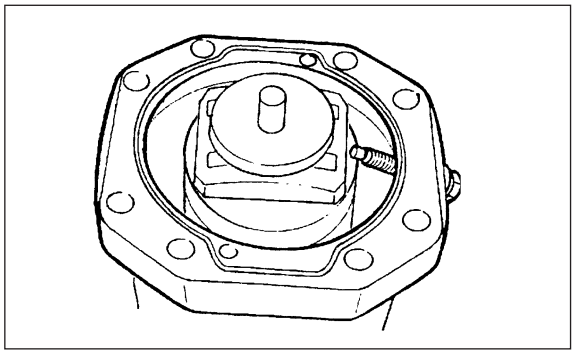
56 Determine cylinder swivel range to max. angle with screw



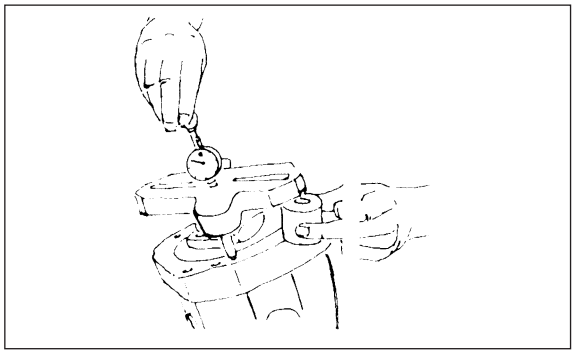
57 * Disc



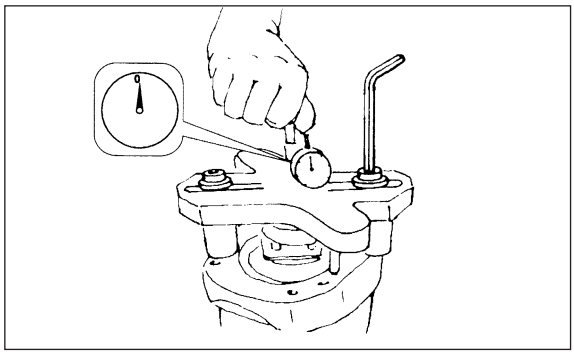
58 Place centering disc



59 Mount measuring device



60 Check dimension X

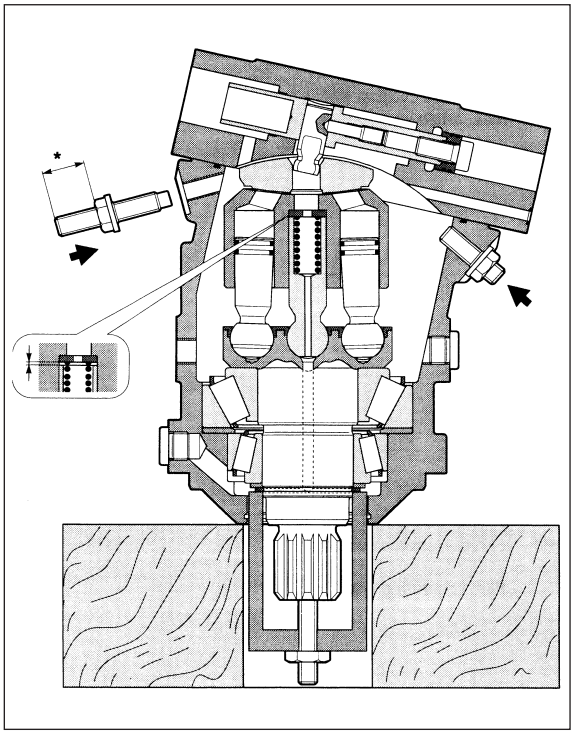


61 (1) Assembly port plate with differential piston

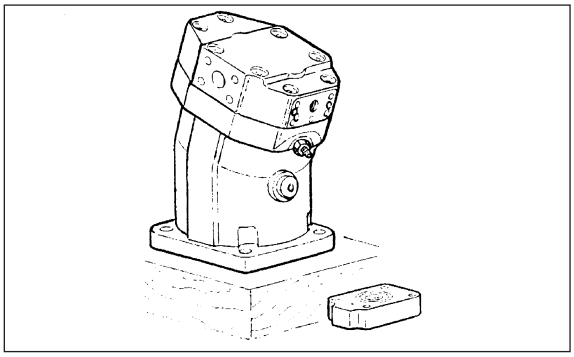
⚠ Take care of assembly design!

⚠ Tighten fixing screws with torque

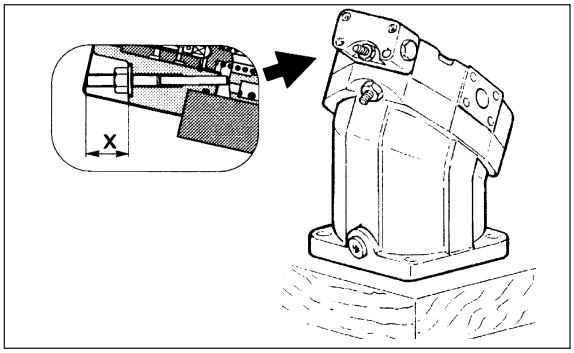
(2) Swivel rotary group to "starting position"
(3) Set Q_{min}-screw to dimension*
(4) Assembly plug
(5) Remove assembly sleeve



62 Assemble cover

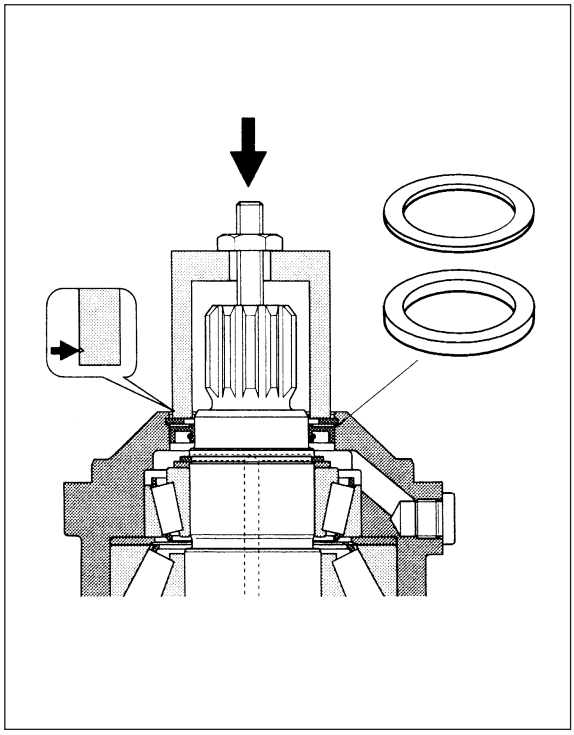


63 Assemble control components



65 Assemble shaft seal, disc and safety ring
Press-in with assembly sleeve

⚠ Take care of press-in depth



FRONT AXLE

DISASSEMBLING, SETTING OPERATIONS AND REASSEMBLING

FOREWARD

Oil seals for rotating shafts
For correct installation of oil seals adhere to the following recommendations:

- Befopre 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, fitter 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.
- Instal 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; adequatly protect the same during shaft assembly procedure.

O-ring
Ensure adequate lubricatoin 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 measurements or the thickness indicated on the shim.

Bearings
For a correct assembly it is suggested to warm them in a furnace from 80C to 90C before installing 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.

> **Warning**: The exhaust oil disposal must be carried out according to the laws in force.

Removal an dinstallation 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 pipings, then install some protection plugs.

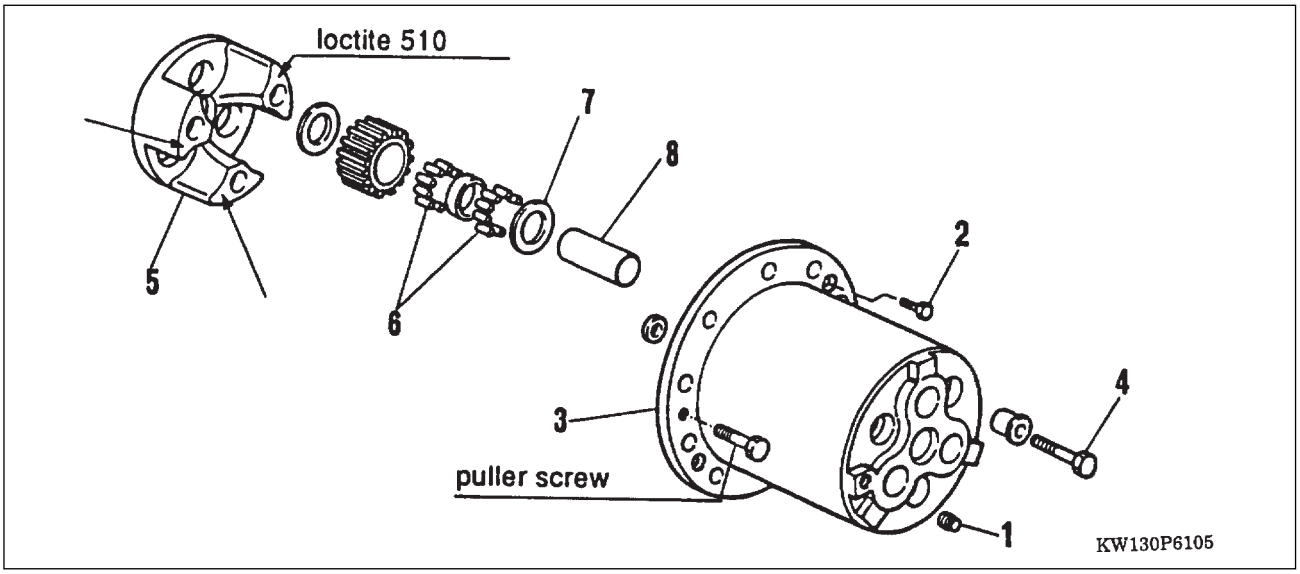
Loosen all lthe remaining connections between frame and axle, then seperate the axle from the frame structure.

Installing the axle reverse the order; check for eventual leakes of oil.

Check the oil level and, if necessary, re-fill.

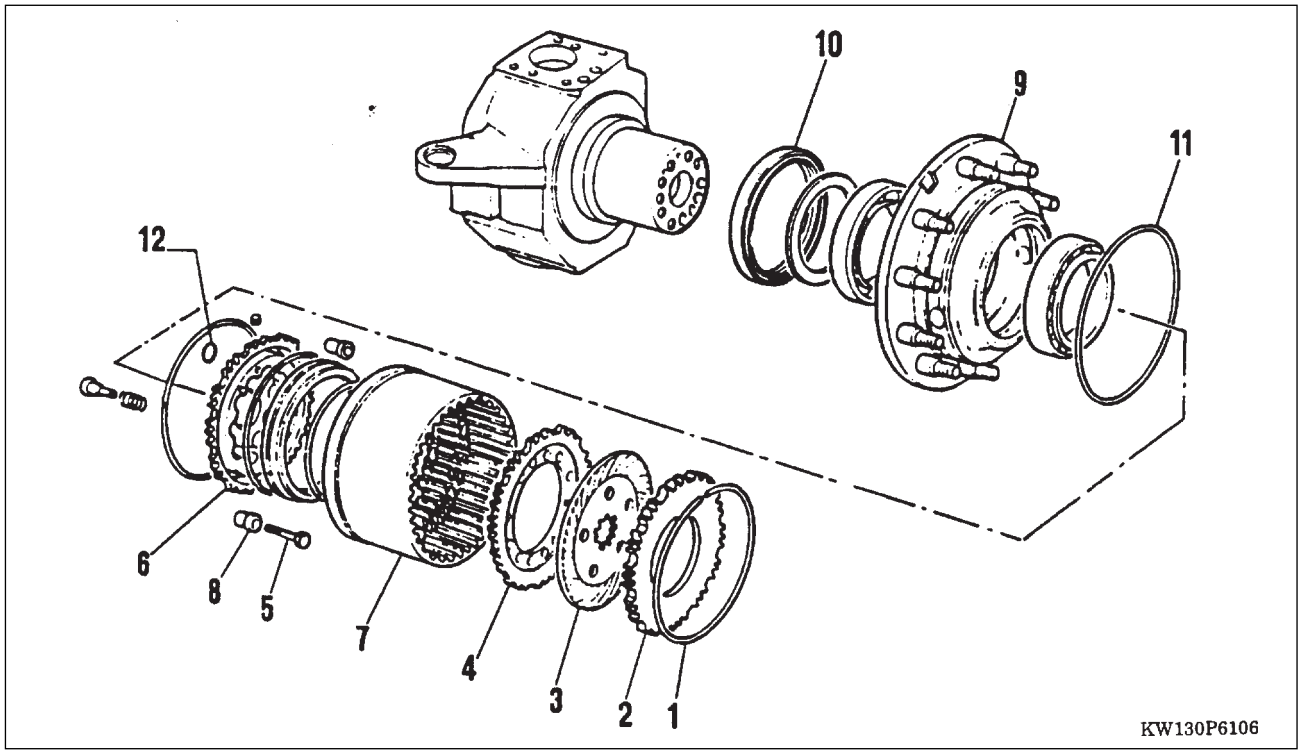
Carry out the braking system bleeding.

FINAL DRIVES



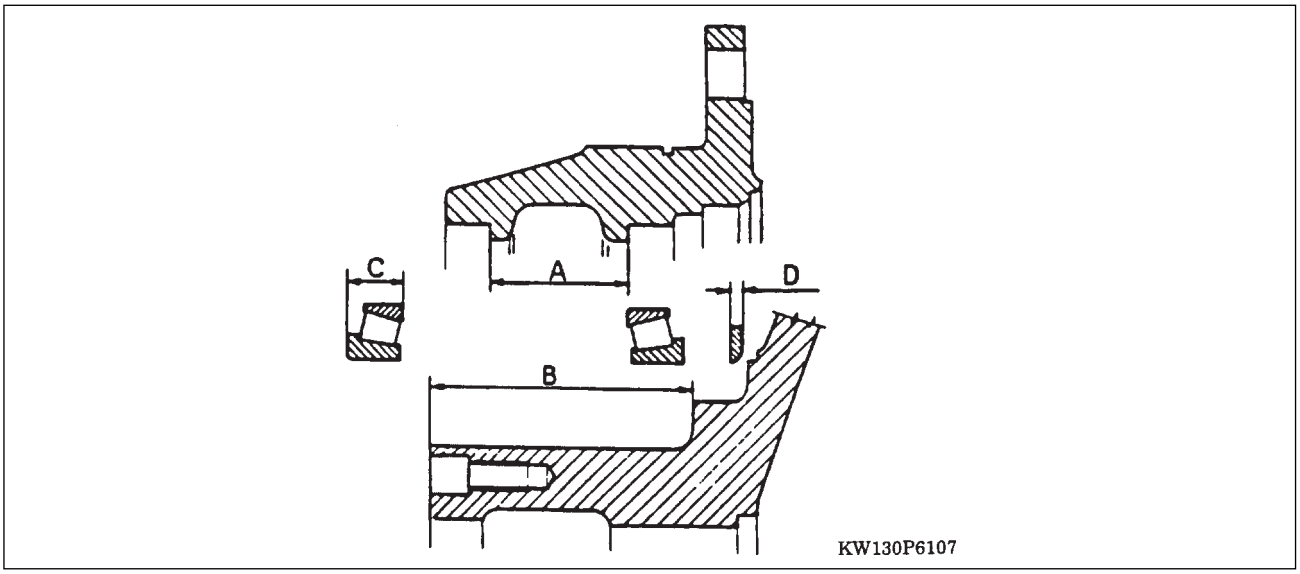
- Unscrew the screws (2) of the carrier assy (3).
- Remove the planetary carrier from the wheel hub, using a puller two screws and operating on the extraction holes.
- Partially unscrew the screws (4) and knock with a plastic hammer to separate the planetary carrier (5). The remove the screws. When reassembling, clean and degrease the planetary carrier (5) union surface to the carrier assy (3) and use Loctite 510.
- Check tje 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 ckeck 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 o grooves exceeding 0.20 mm.

WHEEL HUBS AND BRAKES

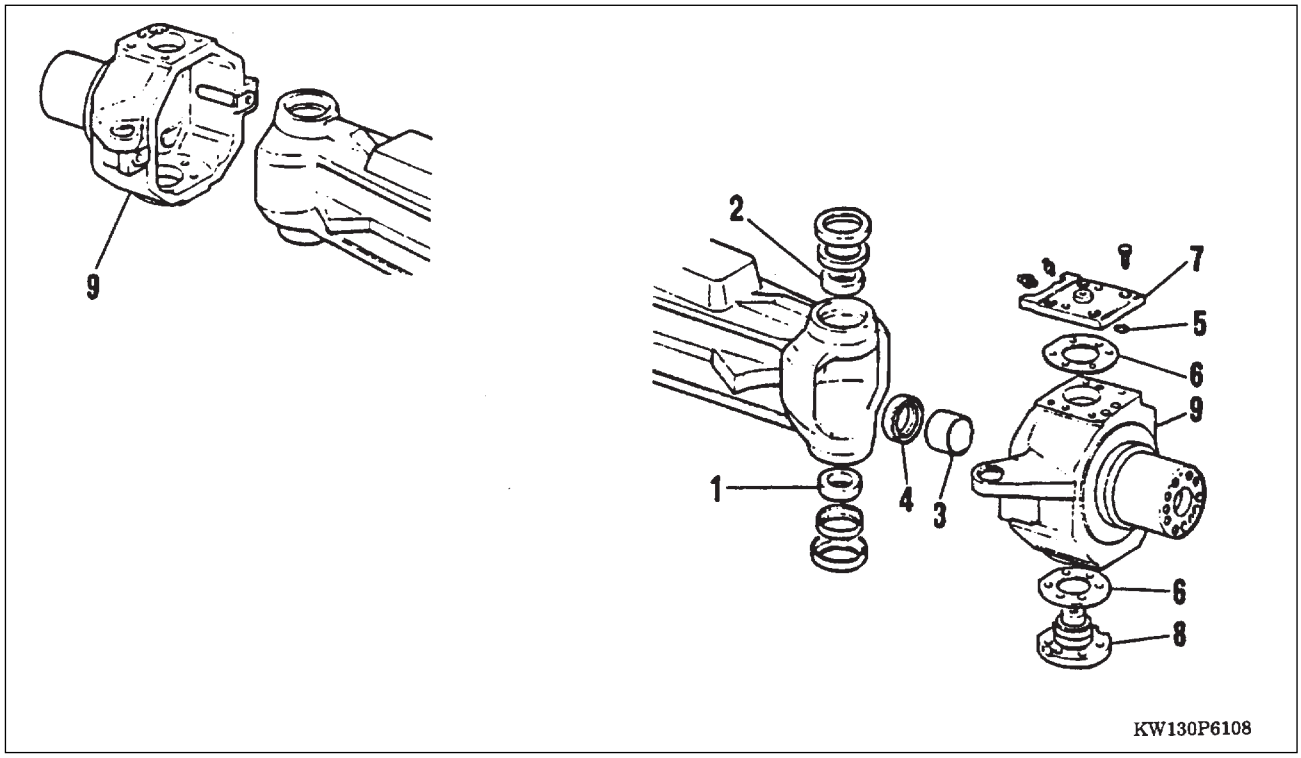


- The special arrangement “Set right” of bearings needs no pre-load or backlash specific rules. However, before reassembling the new spare parts, the following dimensions must be checked:

  A = 51.95 to 52.00
  B = 114.175 to 114.225
  C = 29.00 to 29.15
  D = 3.95 to 4.00

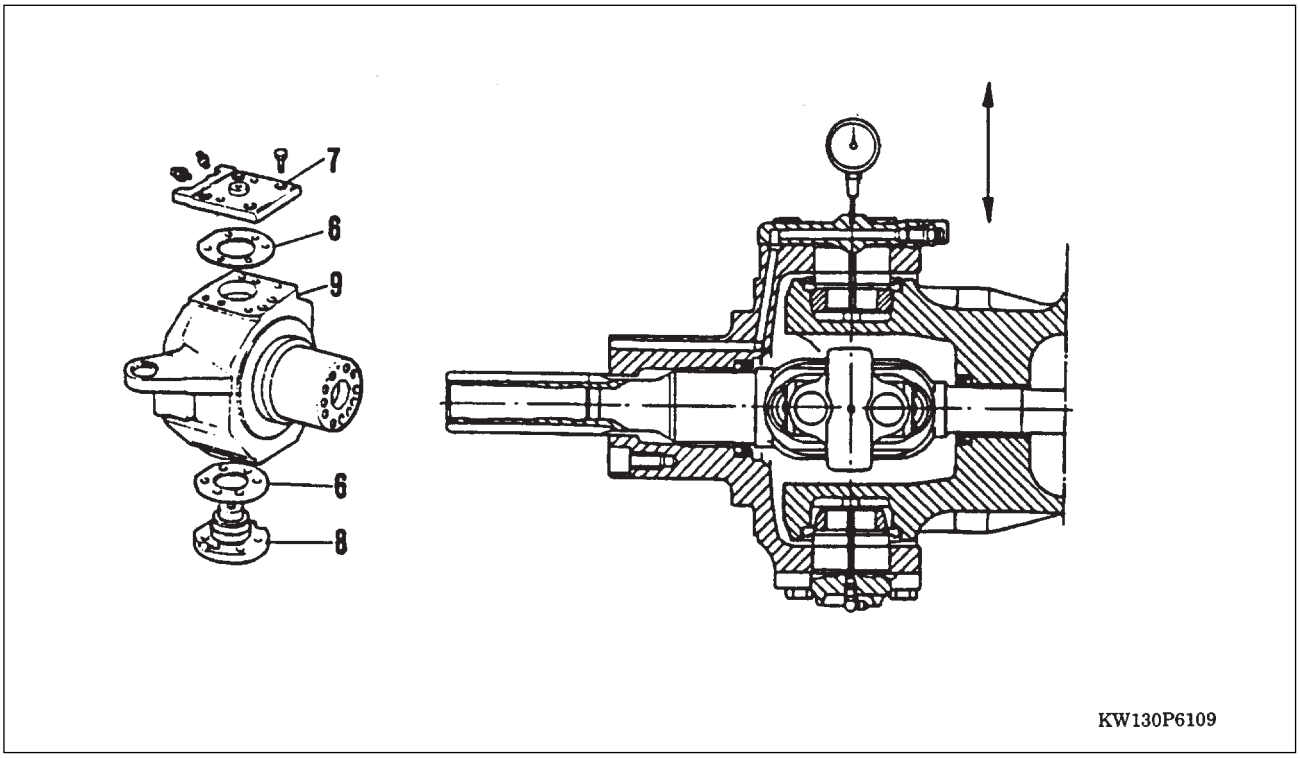
  Change the components out of tolerance.

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.
- Check out the swivel pin bearing clearance record.

SWIVEL PIN BEARING CLEARANCE



The swivel pin bearings are set with 0.00 to .10 mm of clearance. Make this operation adding or subtracting shims (6) between king pins (7) and (8) and the swivel housing (9).

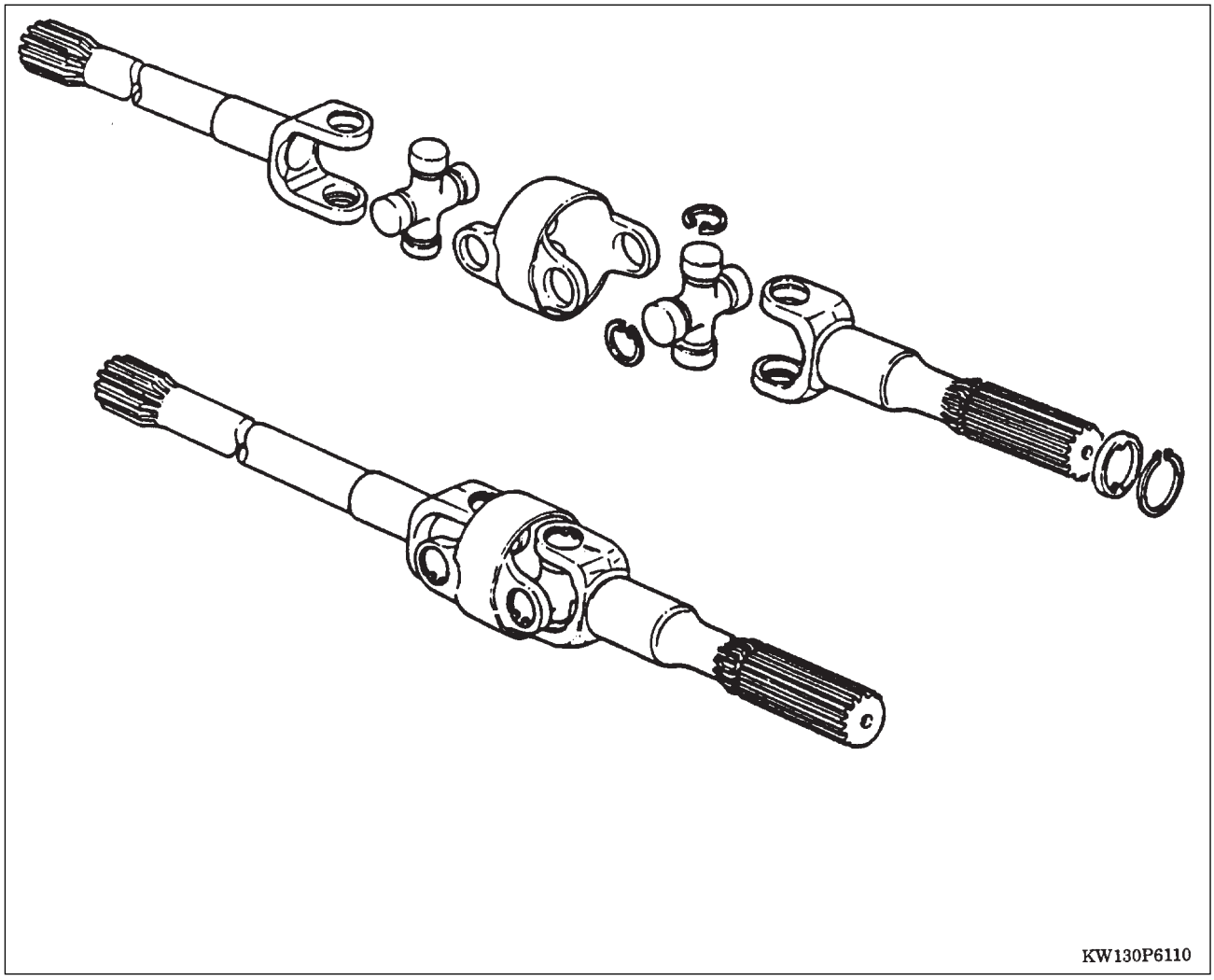
Do the following procedure:

- 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 knucle and cover.
- Operate with a lever between knucle and axle beam (example of measure: 0.50 mm).
- Substract from this value the clearance required for the bearings: 0.50 - (0.00 to 0.10) = 0.50 to 0.40 mm.
- Substract from this value from the employed shims (1.00 mm). Divide by 2 to obtain the shims to employ under each cover:

$$\frac{1.00-(0.50 \text{ to } 0.40)}{2} = 0.25 \text{ to } 0.30 \text{ mm}$$

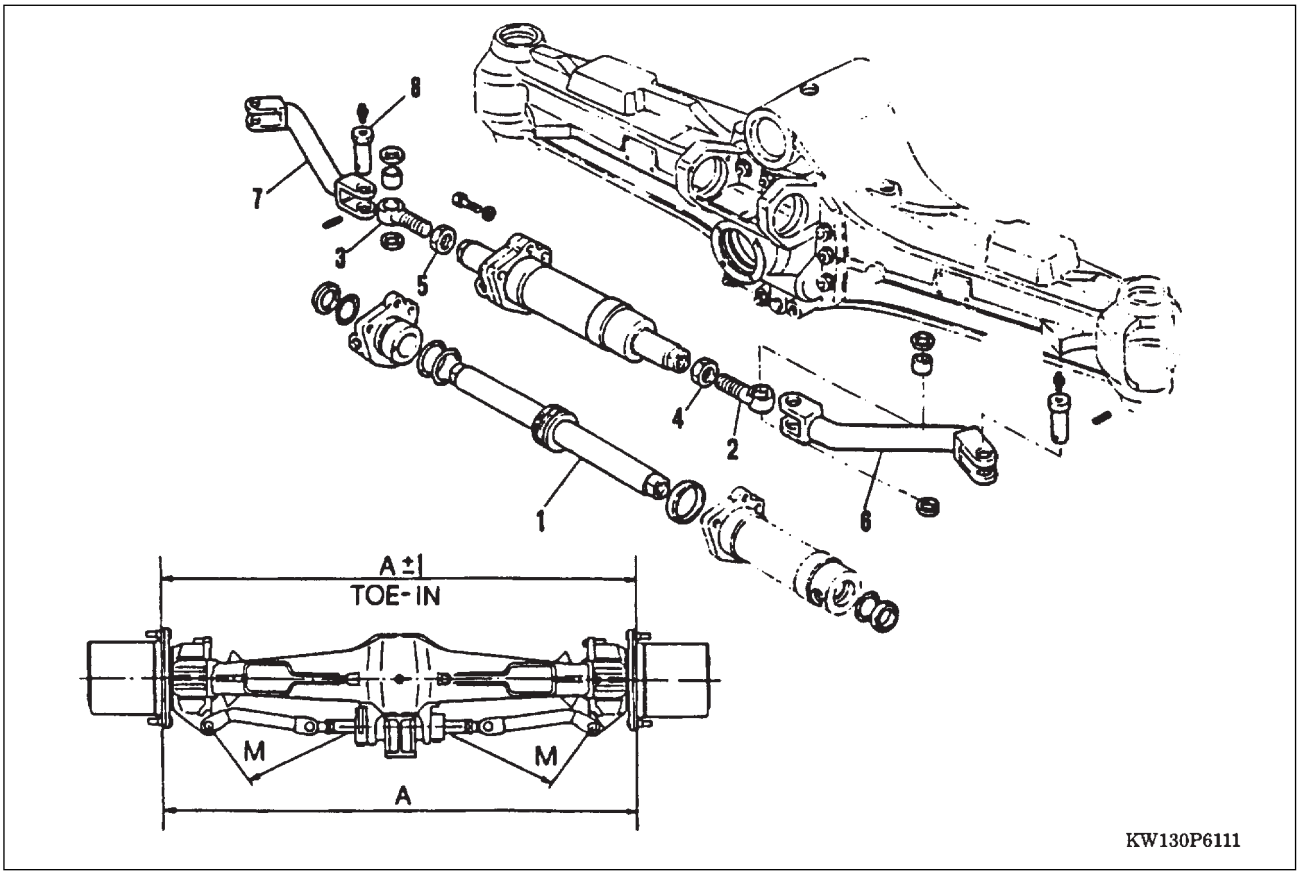
- Remove the covers and install under each of them the shims established before: 0.25 to 0.30 mm.
- Tighten the set screw.

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.

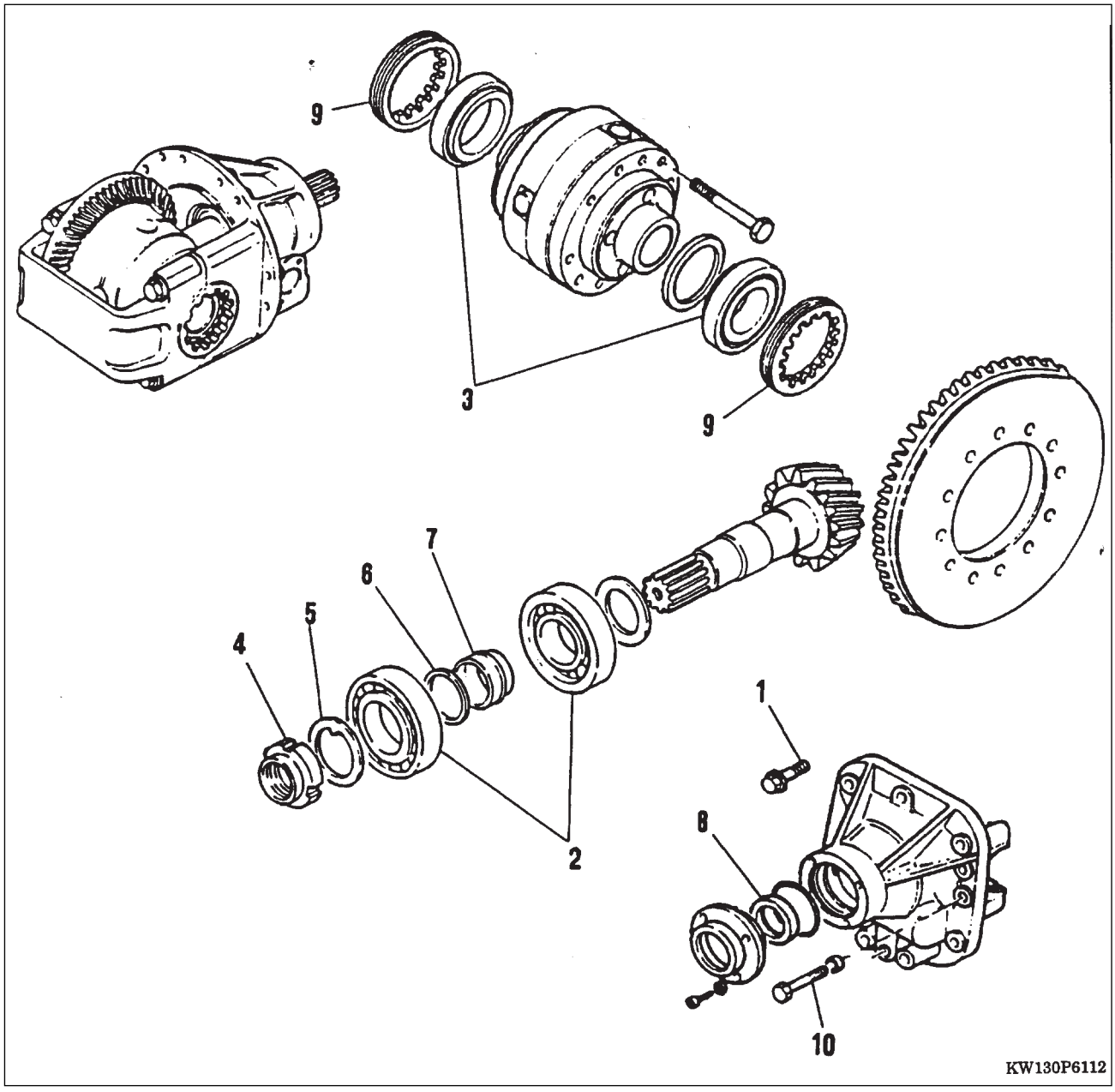
Toe-in

- The toe-in value has to be of +1 to -1 mm.

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) and 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 do it as the shafts (2) and (3) are threaded left and right hand.
- Check for the distance (M) is the same both side.
- When the final adjustment is reached, lock the nuts (4) and (5) to 300 Nm.

BEVEL GEAR AND PINION SET

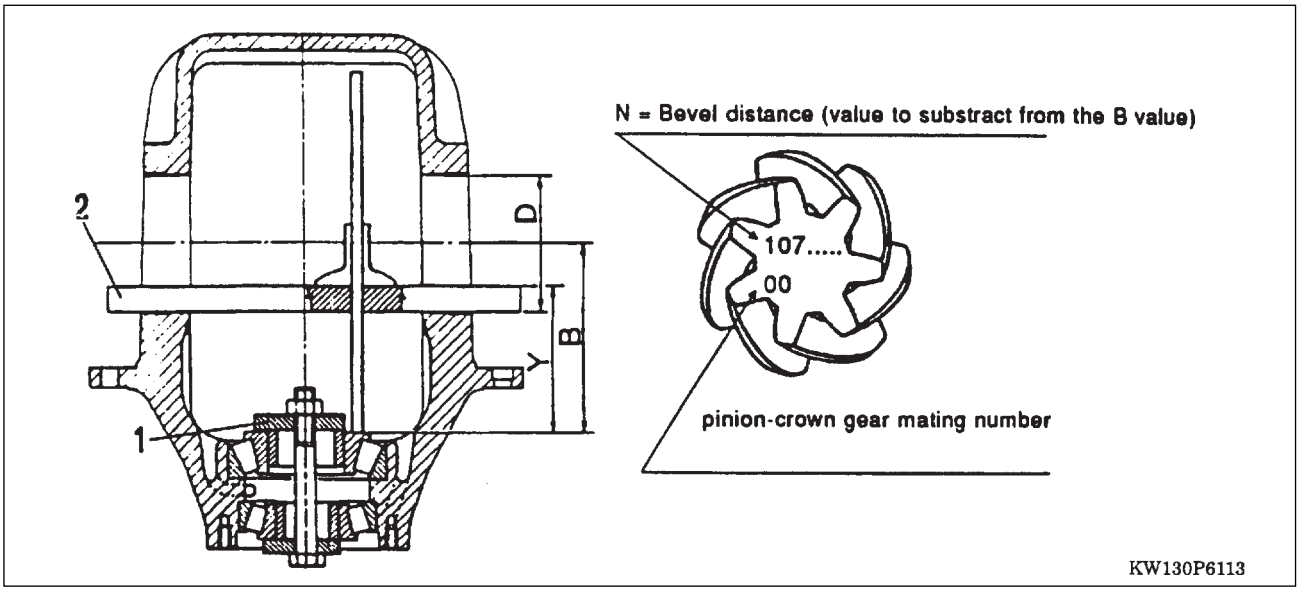


- Unscrew the screw (1) and the bolts (10) to disassemble the complete differential and to be able to work on bench.
- Check the conditions of the bevel pinion bearings (2) and of the differential bearings (3); repplace them, if necessary.
- If you change the bevel gear and the pinion set, you have to 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 FLANGE ON PINION

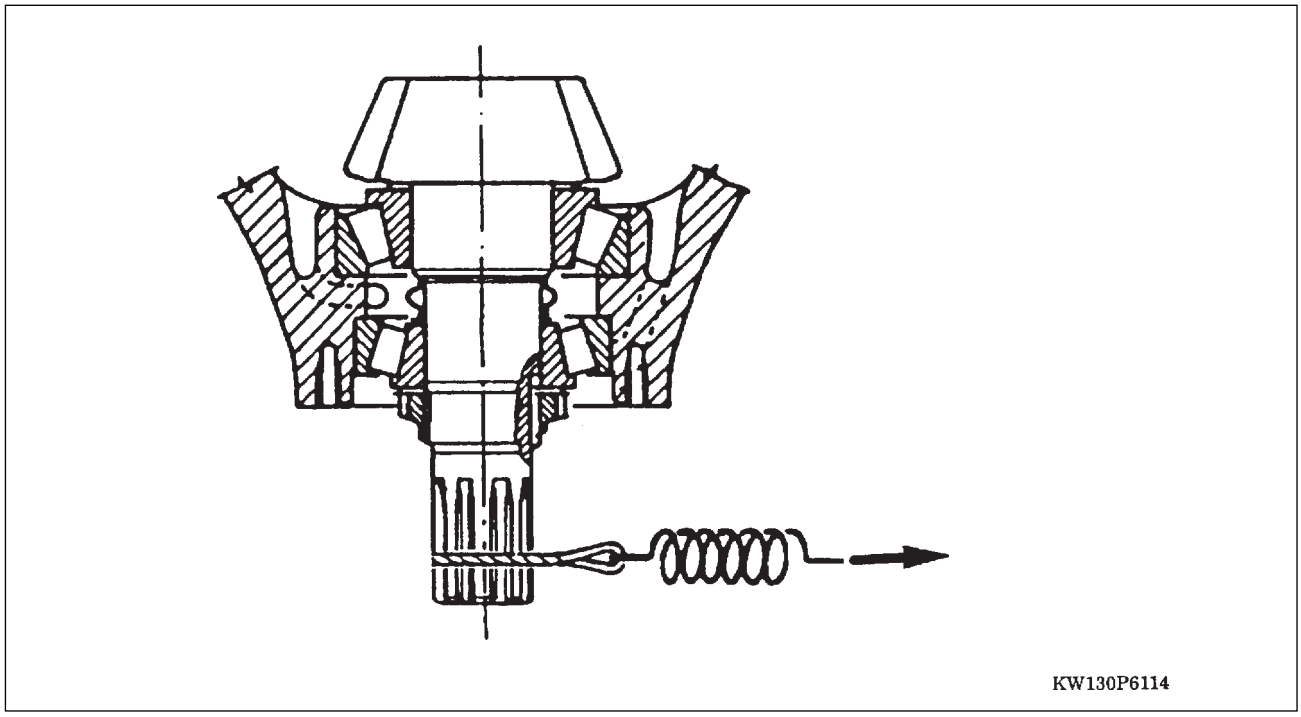
PINION POSITIONING



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 turn the conical bearings by hand, never close tight.
- Assemble the central gear half-cover and fasten it with 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 substract 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



- 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 a contactr 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 plastice hammer in order to eliminate any bearing backlash. You can get such a condition when the ring nut rotation becomes difficult.

- Position the dial gague 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 dynanometer 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.

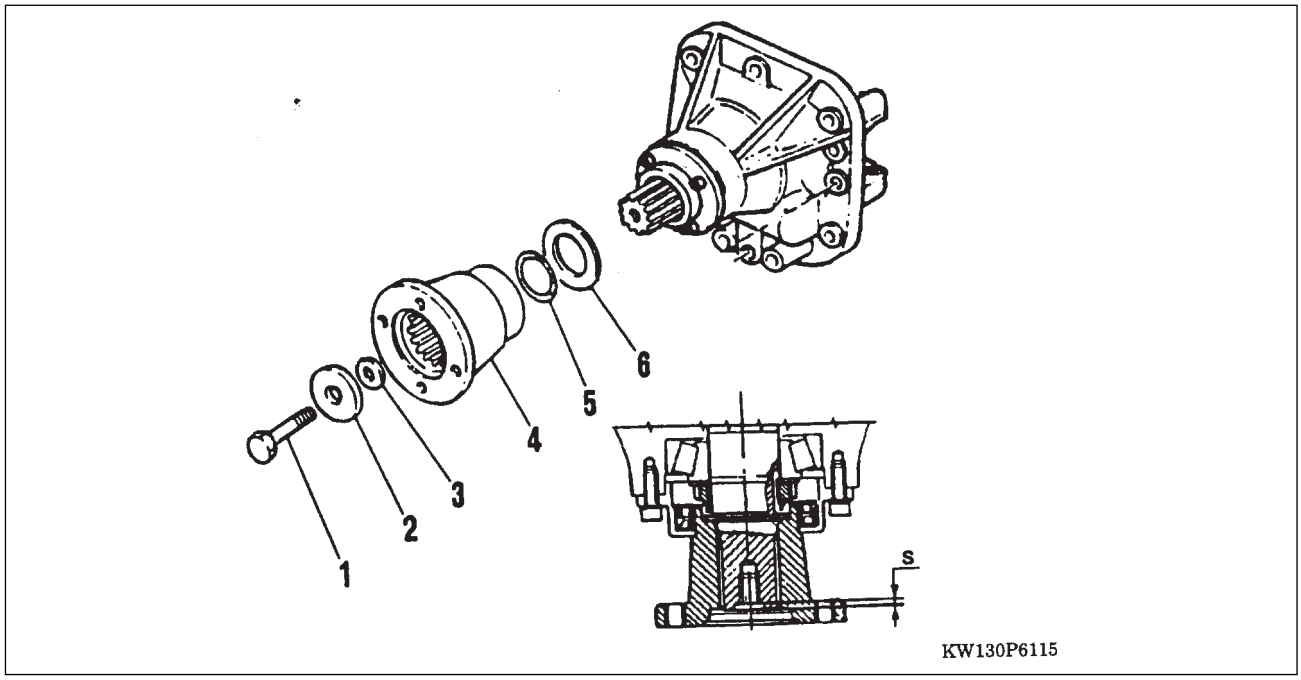
- Turn each ring nut to the same extent (tighten or loosen) in order to maintain the same backlash value.

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

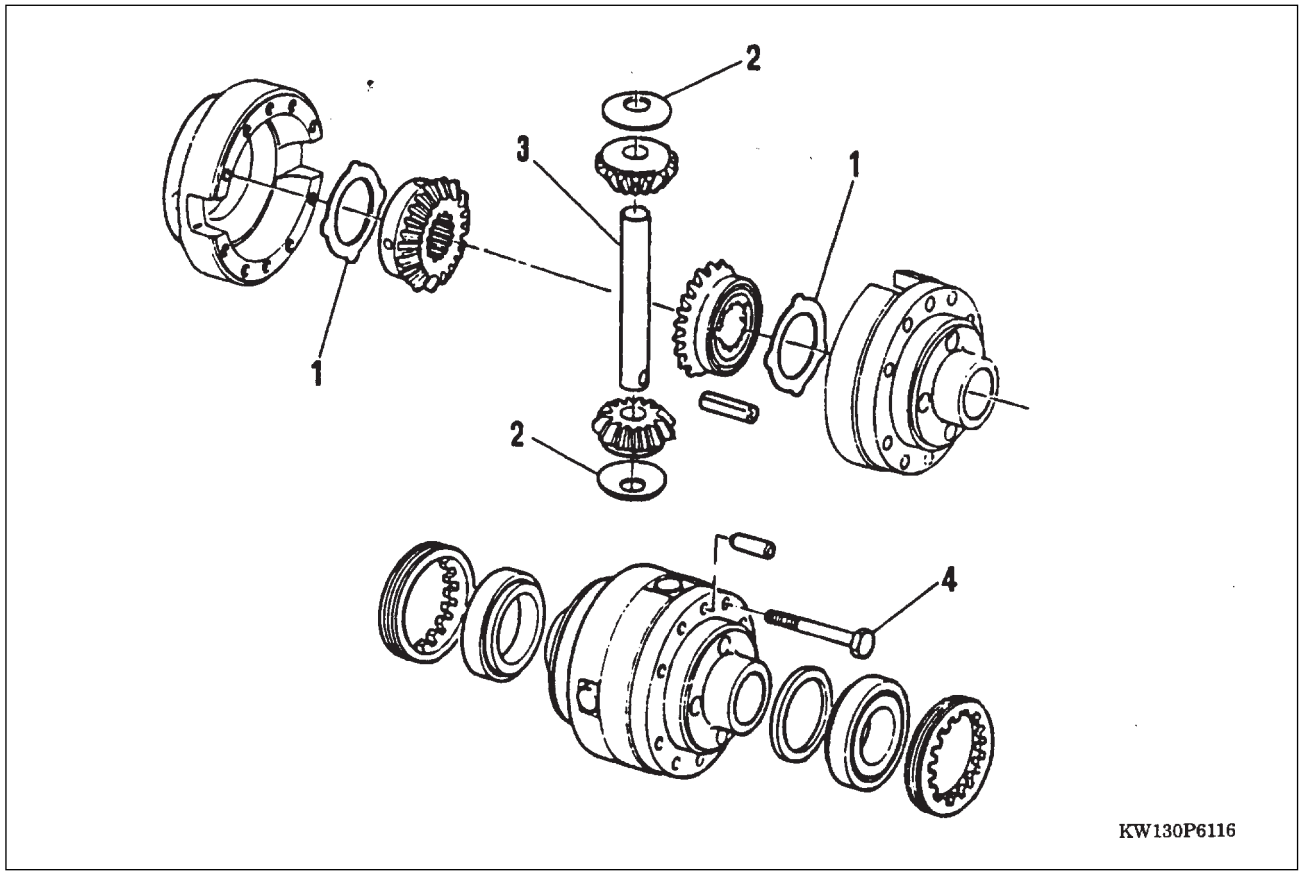
where P is the actual pre-load measured on the pinion.

ADJUSTMENT OF THE FLANGE ON THE PINION



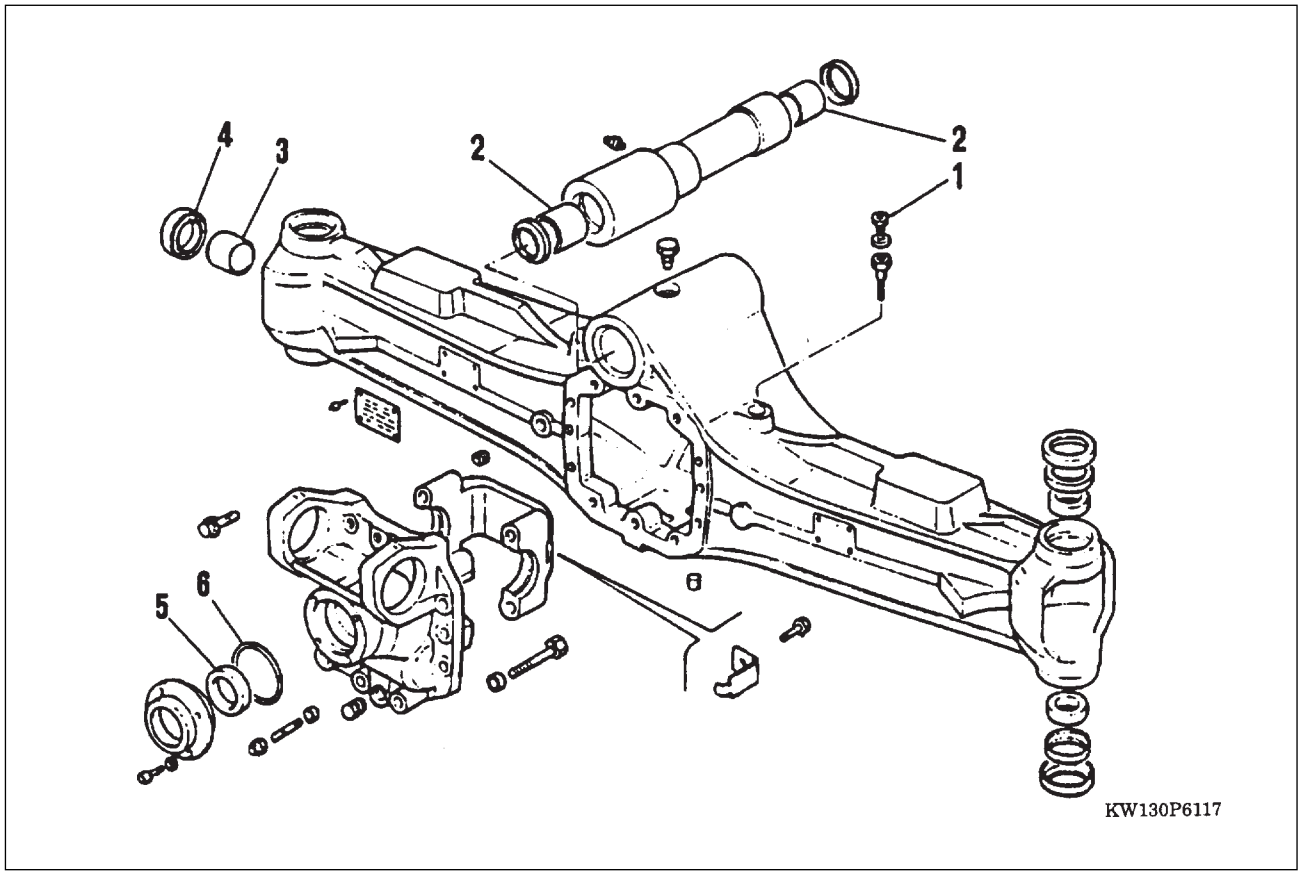
- The motion input flange (4) should be mounted with some adjusting shims (3) between washer (2) and bevel pinion in order to ensure a correct assembling.
- In order to measure the dimension (S) of the shims to be used, it is necessary to mount the washer (6) without O-ring (5), and then the flange (4).
- 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

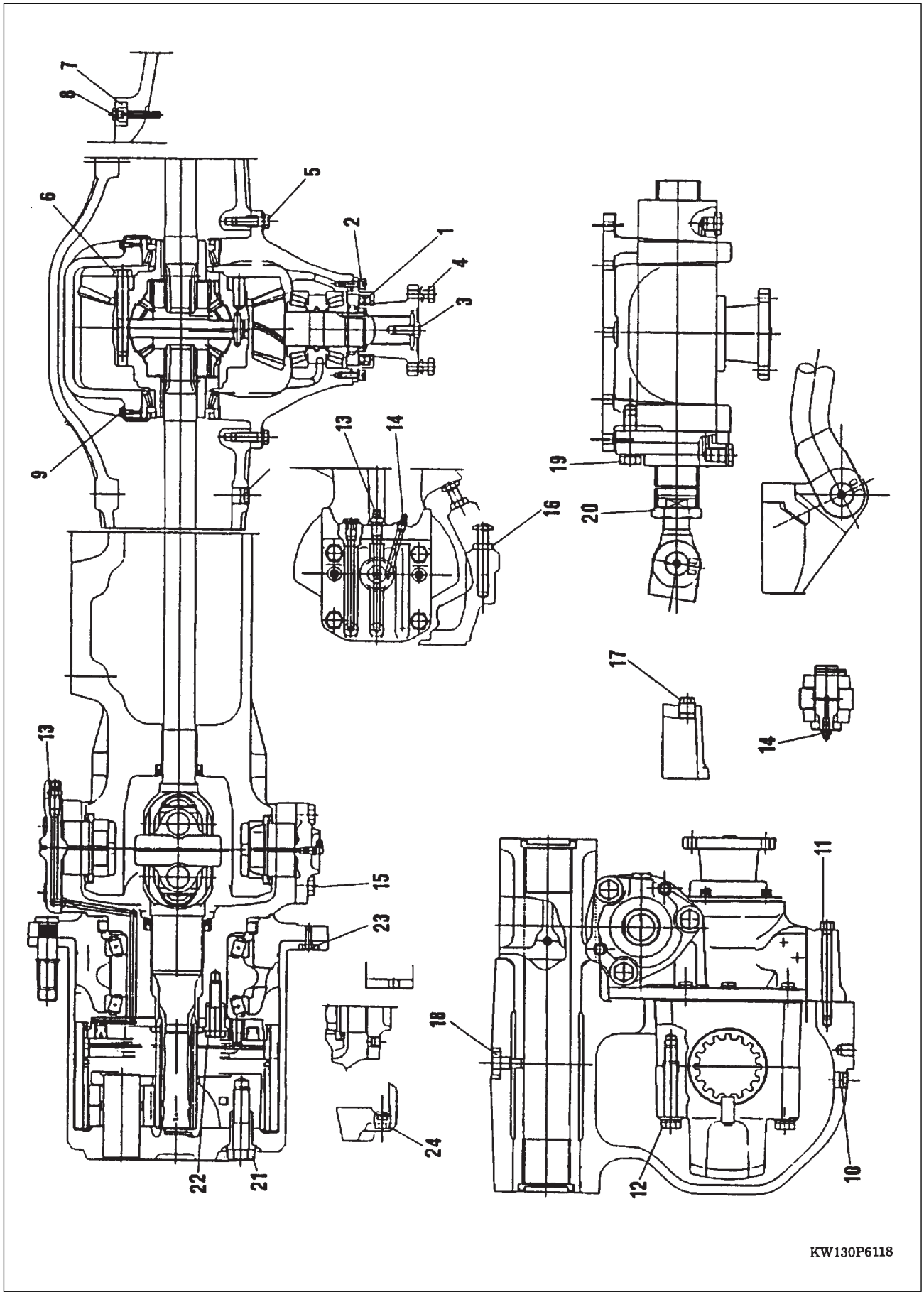


- Check the condition of thrust washers (1) and (2).
- Also check the condition of all other components, particulary of pin (3).
- During reassembly, it is suggested to replace the screws (4) which fasten the bevel gear to the differential case.

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.


KW130P6118

TIGHTENING TORQUES

		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 locite 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 filing level plug	-	60

REAR AXLE

DISASSEMBLING, SETTING OPERATIONS AND REASSEMBLING

FOREWARD

Oils 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 teh 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 saft: 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 tickness indicated on the shim.

Bearings
For a correct assembly it is suggested to warm them in a furnace from 80°C to 90°C before installation in their respective shafts or to cool them before inserting in ther respective seats with outer housing.

Elastic plugs
During the plug assembly and with turbo off ensure that their notch has oriented towards the stress wich is subjecting the trust.

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.

> **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 pipings, then install some protection plugs.

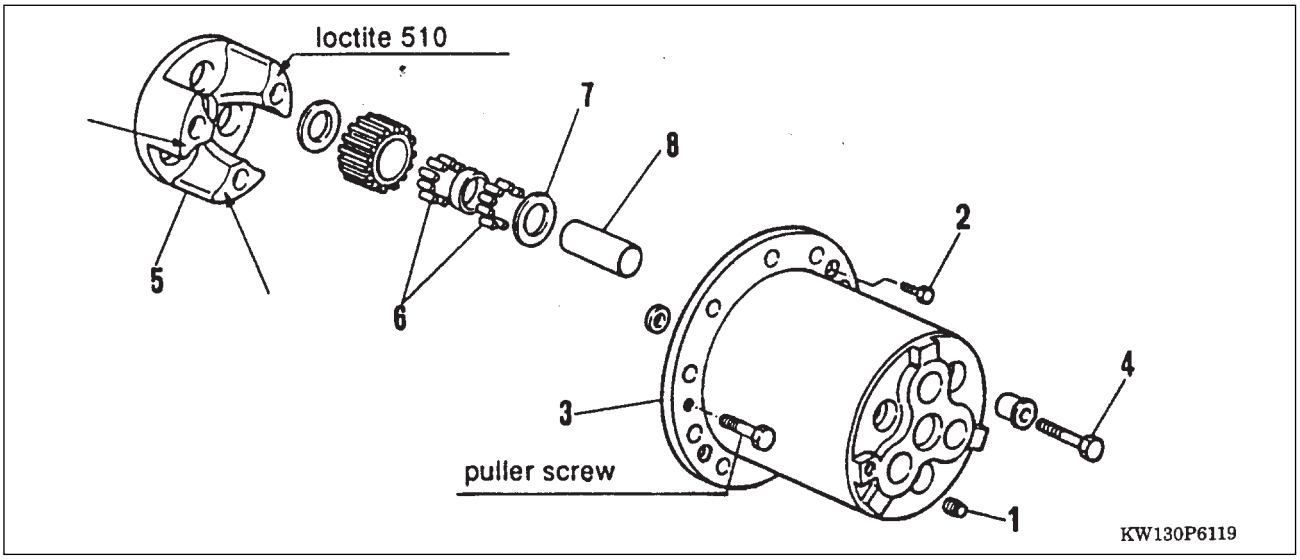
Loosen all the remaining connections between frame and axle, then separate the axle from the frame structure.

Installing the axle reverse the order; check for eventual leakages of oil.

Check the oil level and, if necessary, re-fill.

Carry out the braking system bleeding.

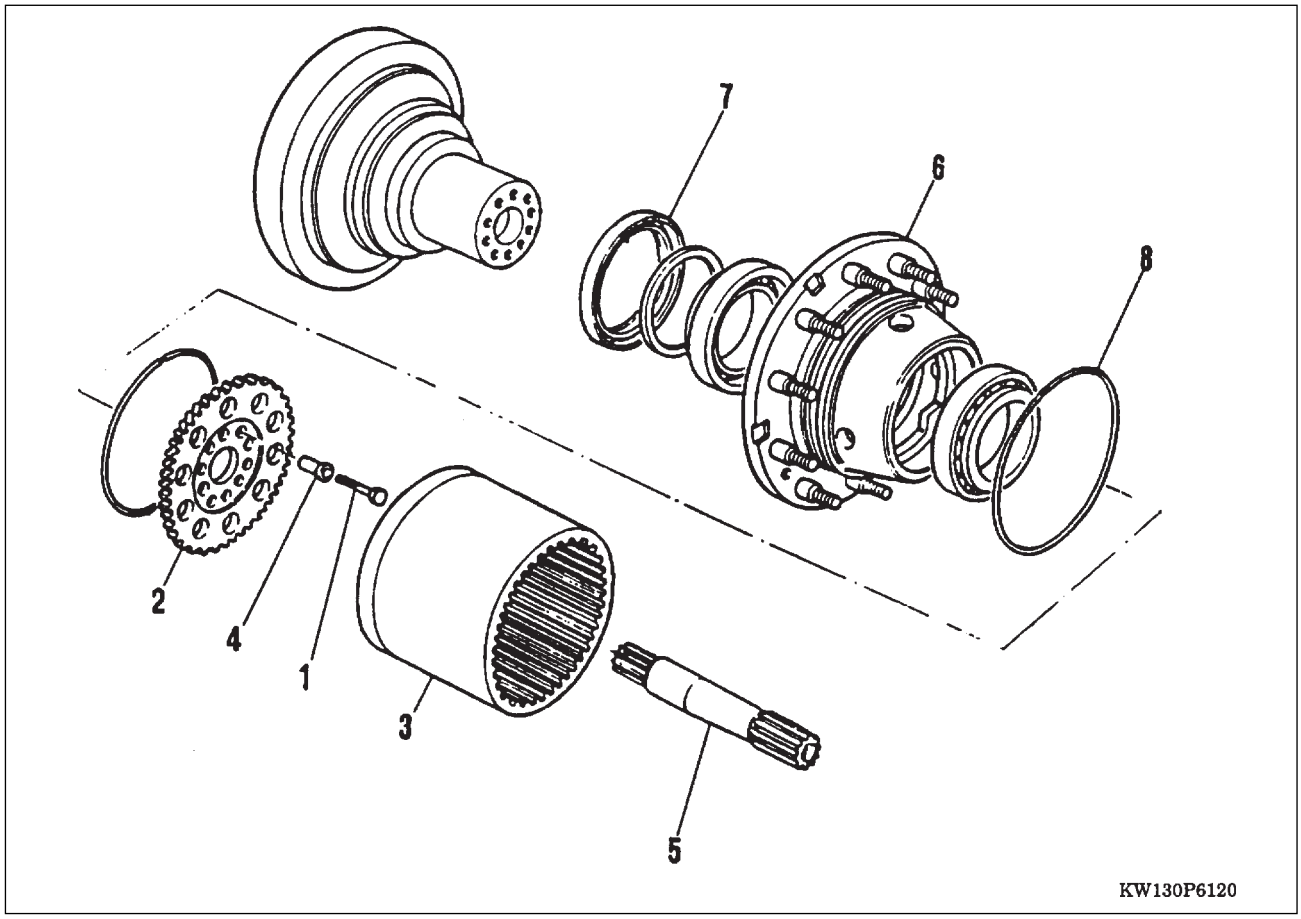
FINAL DRIVES



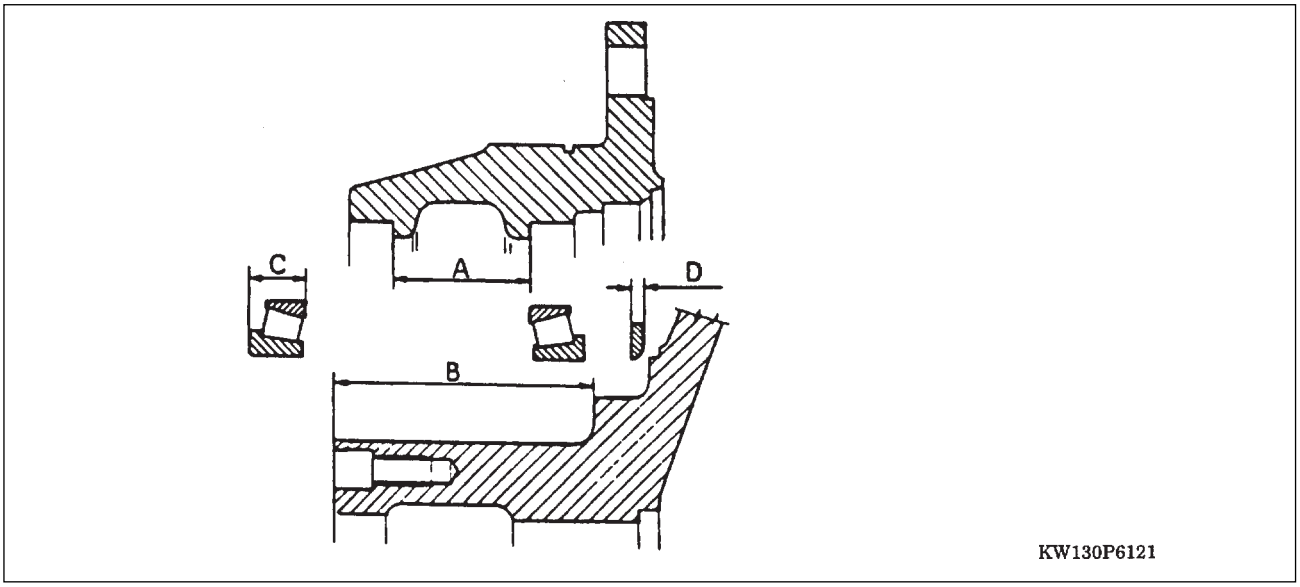
- Unscrew the screws (2) of the carrier assy (3).
- Remove the planetary carrier from the wheel hub, using as a puller two screws and operating on the extraction holes.
- Partially unscrew the screws (4) and knock with a plastic hammer to separate the planetary carrier (5). Then remove the screws. When 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 pins (8) conditions. As they are forced on the planetary carrier (3), replace the whole planetary cariier 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 and use a correct seal driver to avoid damaging it during the assembling.
- Check the conditions of the splines on the halft shaft (5).
- Replace the O-ring (8).

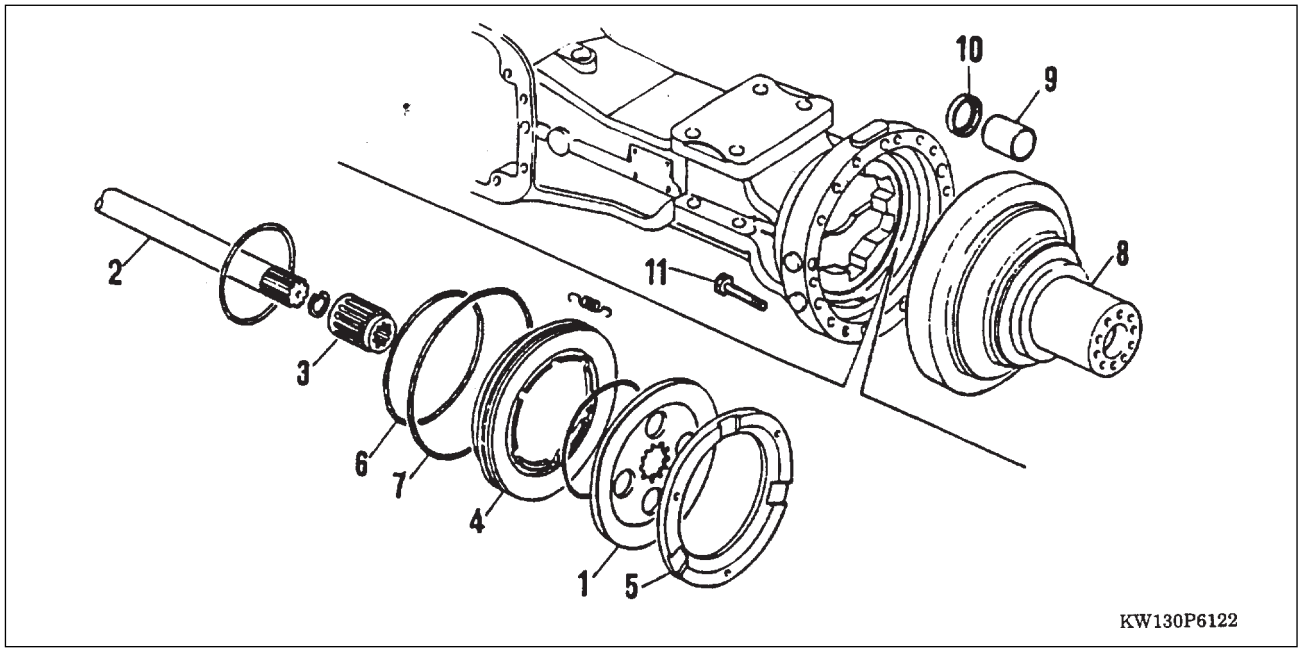


- The special arrangement “Set right” of bearing needs no pre-load or backlash specific rules. However, before reassembling the new spare parts, the following dimensions must be checked:

  A = 68.95 to 69.00
  B = 132.175 to 132.225
  C = 29.00 to 29.15
  D = 4.95 to 5.00

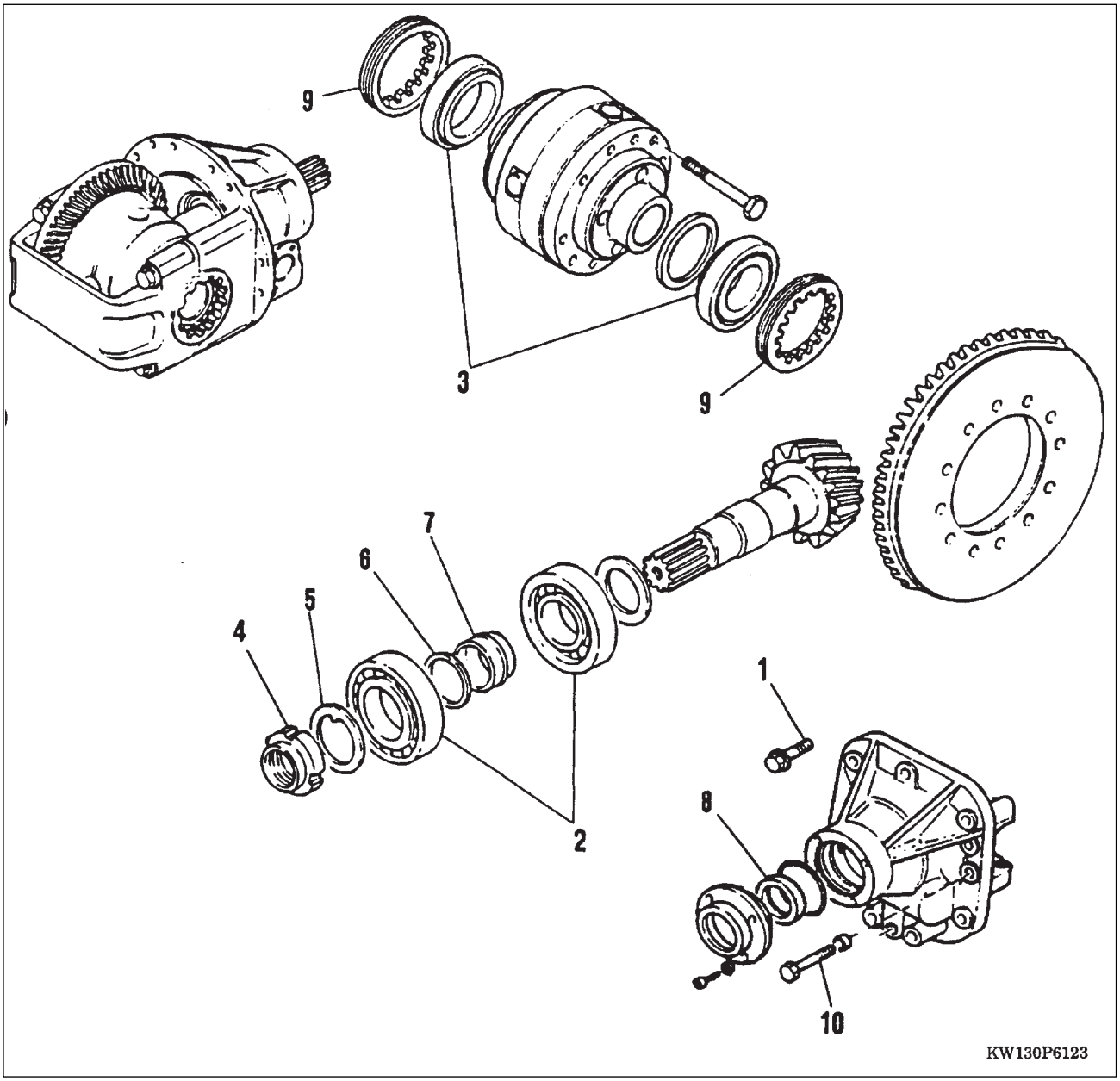
  Change the components out of tolerance.

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 and signs of excessive wear o grooves exceeding 0.20 mm.
- Replace the quadrings (6) and (7).

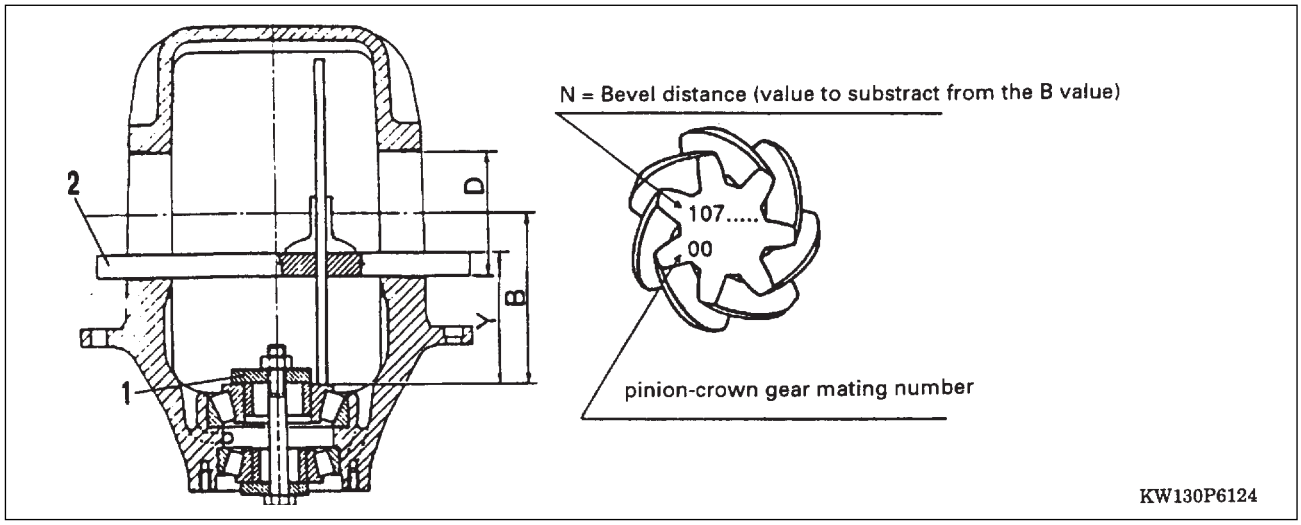
BEVEL GEAR AND PINION SET



- Unscrew the screw (1) and the bolts (10) to disassemble the complete differential and 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 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 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 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).

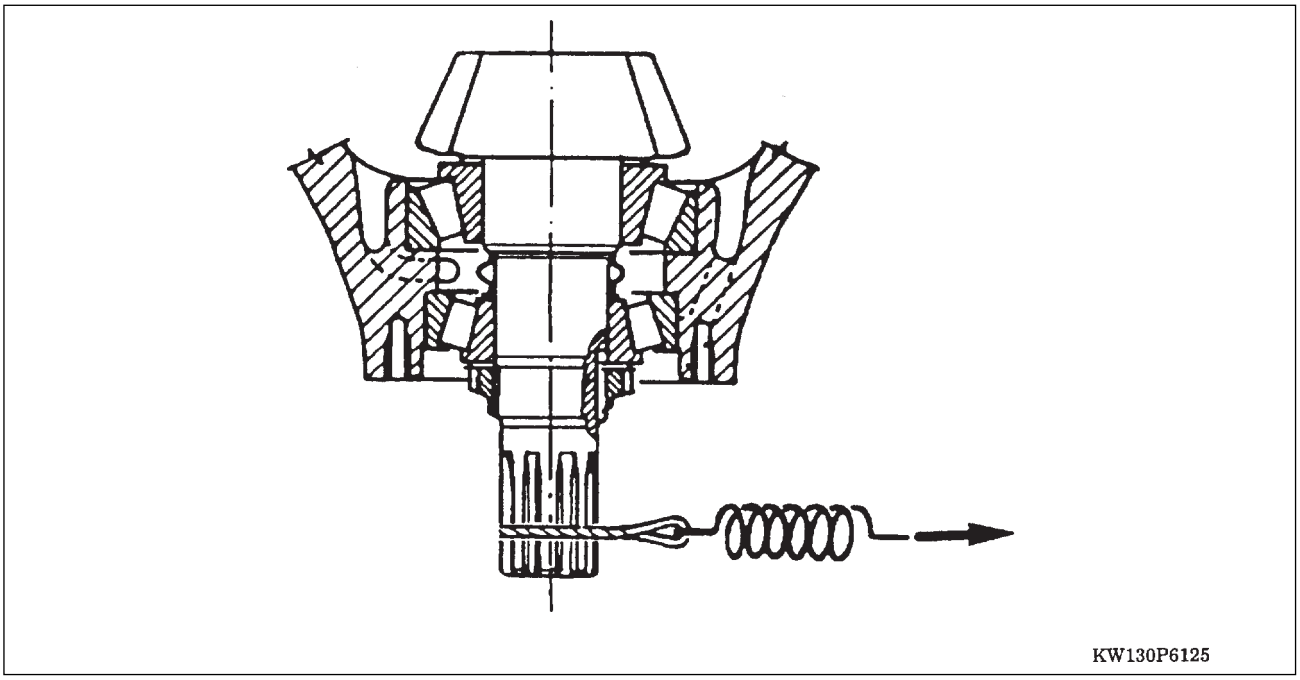
- Carry out the following operation:
  B = Y - 25 (calibrated rod diameter) + D/2.

- In order to determinate the tickness to be inserted between the pinion and the bearing, simply substract from the (B) valve the one stamped on the pinion head.

- Create this thickness by using the range of the rings on hand, and inserting the in the pinion shaft.

- Insert the bearing in the pinion shaft, and ensure that it is completely seated.

PINION BEARINGS PRE-LOAD



- The bearing pre-load must be 84 to 126 N, measured on the queue of the pinion outer diameter.
- Tighten progessively 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 rotating 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 a contact between the crown and th 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.

- Brng 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.

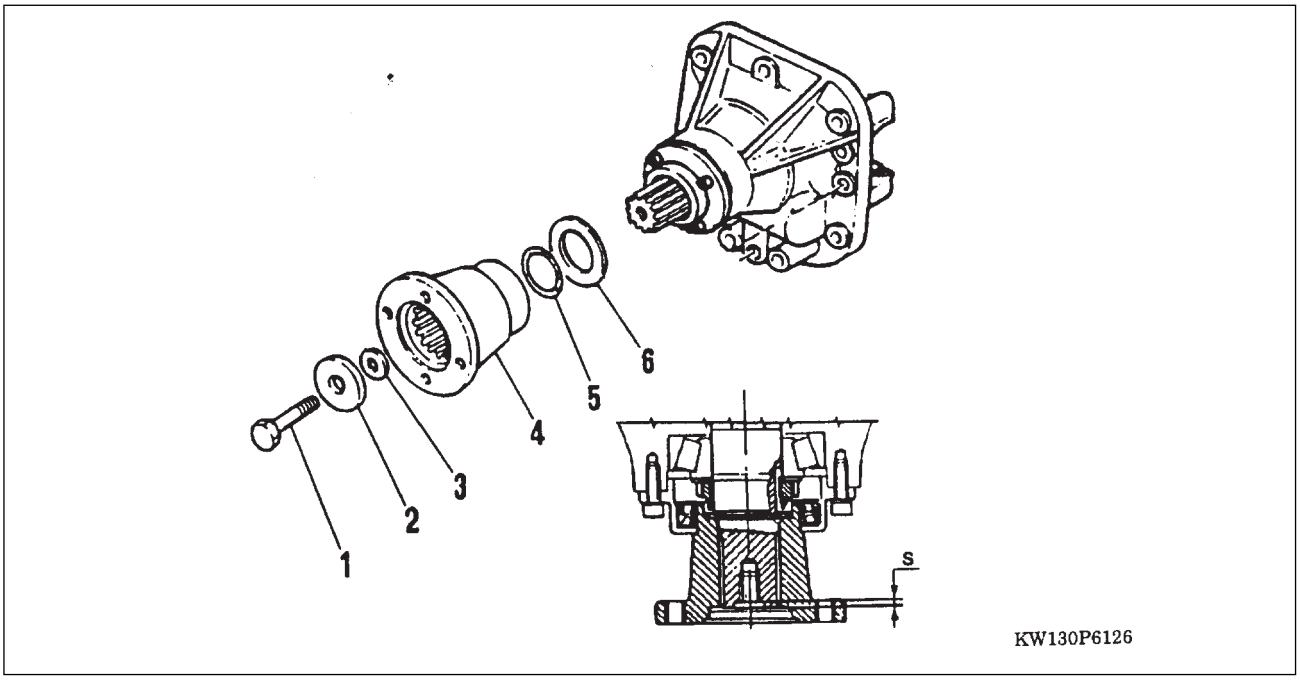
- Turn each ring nut to the same extent (tighten of loosen) in order to maintain the same backlash value.

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

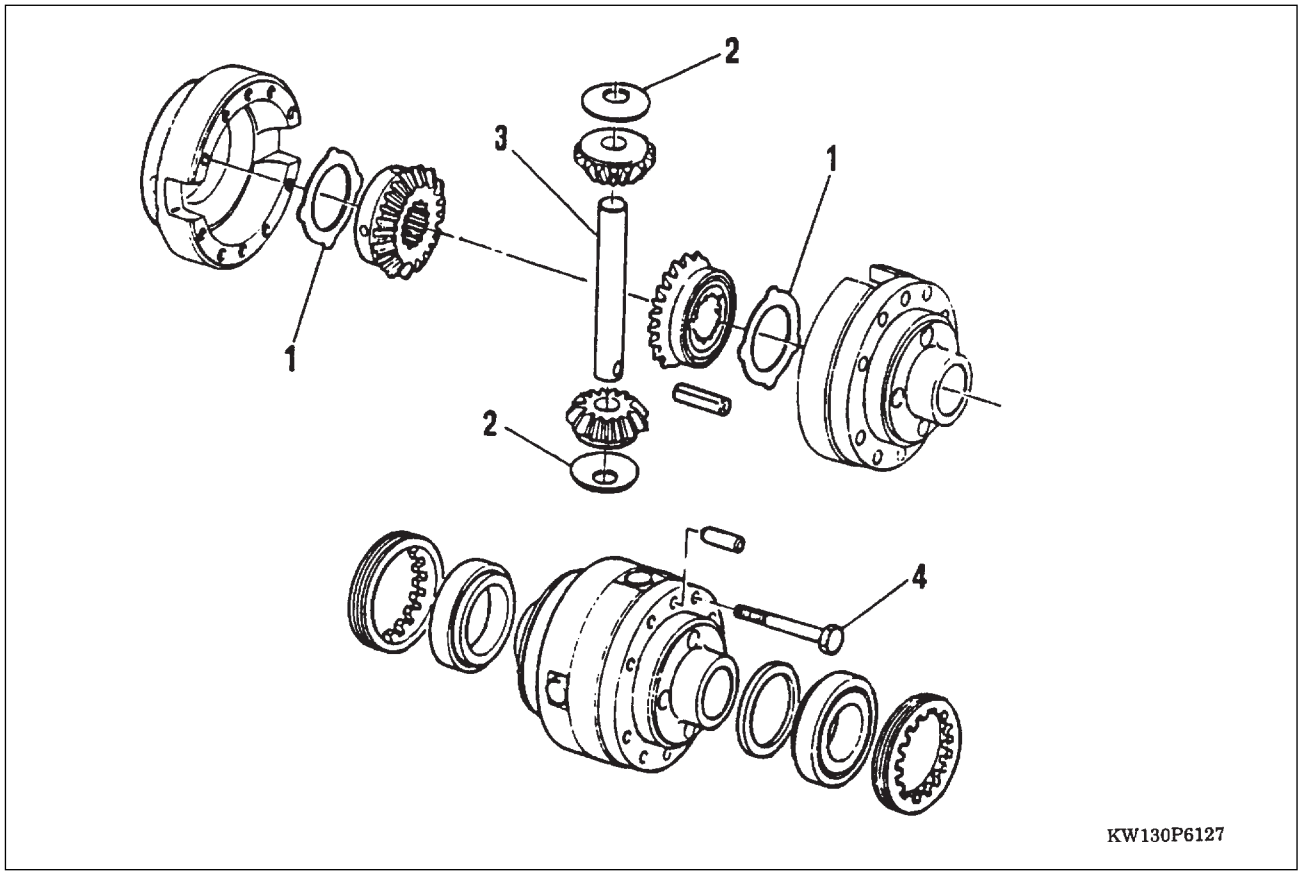
where P is the actual pre-load measured on the pinion.

ADJUSTMENT OF THE FLANGE ON THE PINION



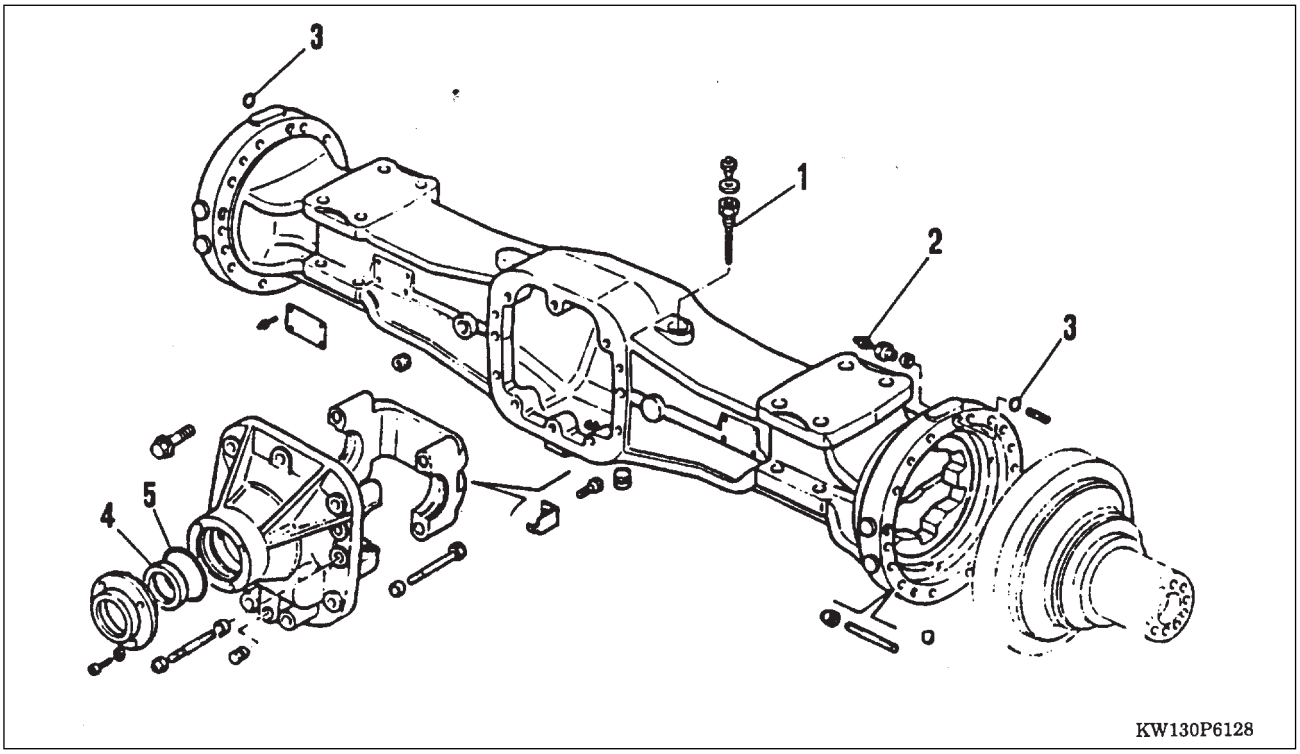
- The motion input flange (4) should be mounted with some adjusting shims (3) between washer (2) and bevel pinion in order to ensure a correct assembling.
- In order to measure the dimension (S) of the shims to be used, it is necessary to mount the washer (6) without O-ring (5), and then the flange (4).
- Measure dimensions (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

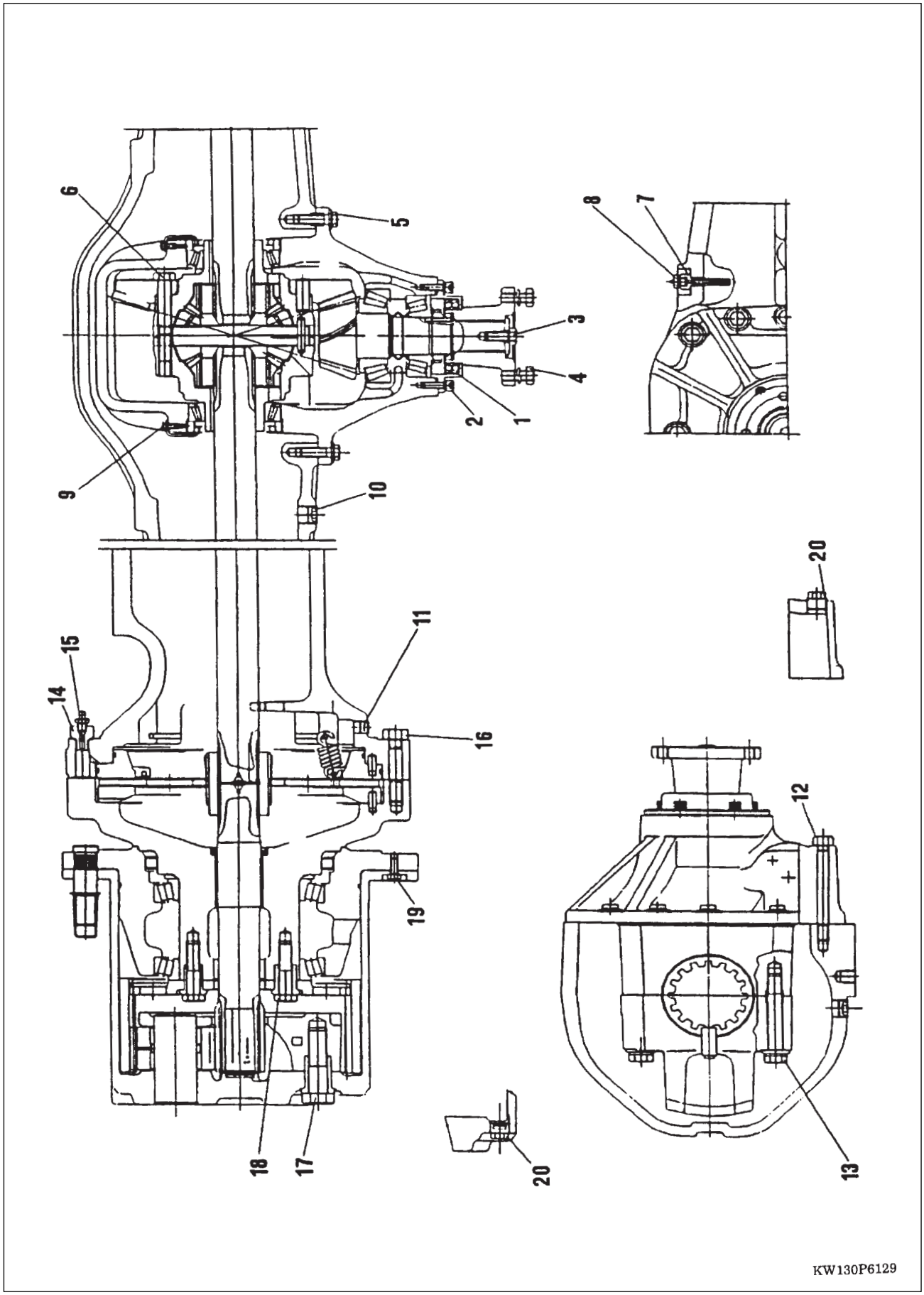


- Check the condition of thrust washers (1) and (2).
- Also check the condition of all other components, particularly of pin (3).
- During reassembly, it is suggested to replace the screws (4) which fasten the bevel gear to the differential case.

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.


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20
KW130P6129

TIGHTENING TORQUES

		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	M6x1.x10	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

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 204°C) if surrounding air temperature is 40°F (5°C) or less. Measure temperature with a Tempilstik®.

Maintain preheat temperature while welding.

Maximum interpass temperature should not exceed 500°F (260°C).

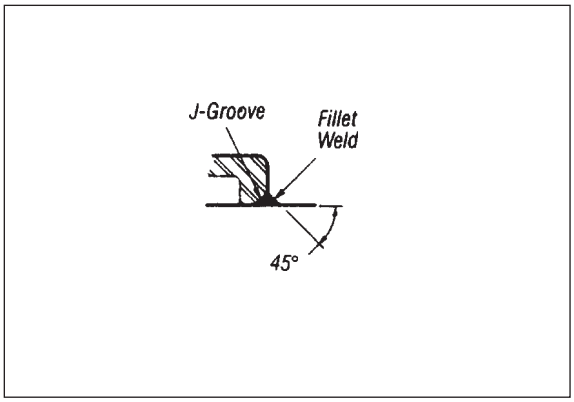
After welding, postheat to 350° to 400°F (117° to 204°C) if surrounding air temperature is 40°F (5°C) or less, then let air-cool. If air temperature is above 40°F, postheating is not necessary.

Welds should fill J-grooves to a 45° angle. If an adapter does not have a J-groove, apply fillet welds according to the following:

Bucket Size (volume)

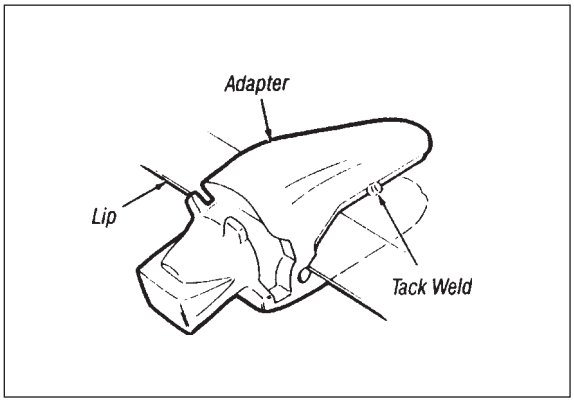
Yards ^{3}	Meter ^{3}	Fillet Size
2	1.8	1/2" (13mm)
2 1/4 - 5	2 - 4.6	5/8" (16mm)
5 1/2 - 12	5 - 11	3/4" (19mm)
above 12	above 11	1" (25mm)

For complete welding information and procedures, refer to ESCO Products Maintenance Manual, Catalog 100-A, "How to weld ESCO alloy 12 series."

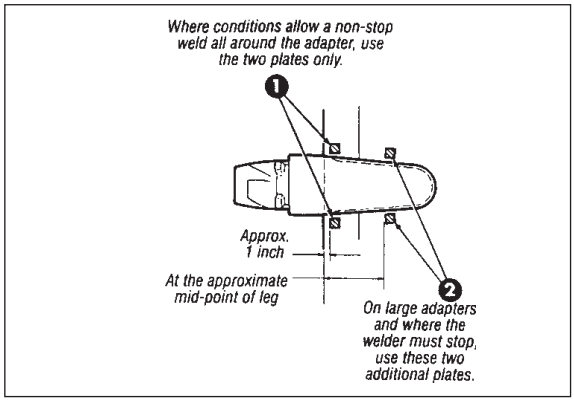


Lip Adapter Installation

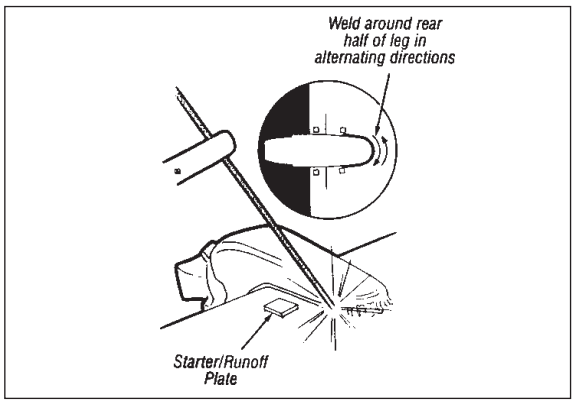
1. Locate the adapters on a clean bucket, then tackweld them in place, followed by a root layer all the way around.



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 1 1/2- and 2-leg adapters.

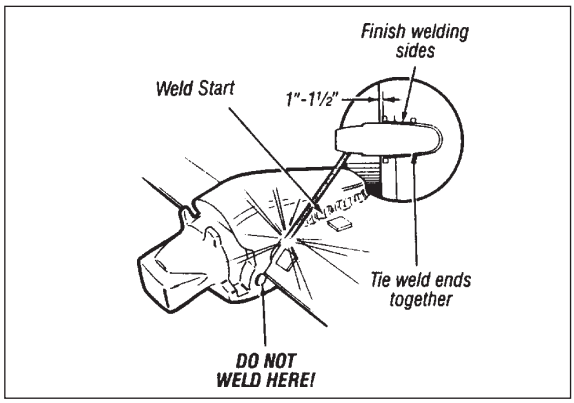


3. If using four starter/runoff plates, weld the rear half of the adapter with alternating clockwise and counter clockwise passes. Build up the weld to a full fillet.
   If using only two starter/runoff plates, use the same technique, welding to the ends of the J-groove, then proceed to step 5. **Do not weld to the lip leading edge!**



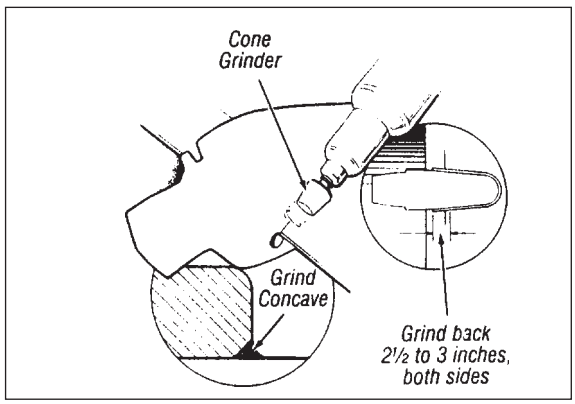
4. If using four plates, continue welding to the ends of the J-groove. **Do not weld to the lip leading edge!** Alternate from side to side until the weld is complete. Maintain a full fillet weld and tie weld ends together.

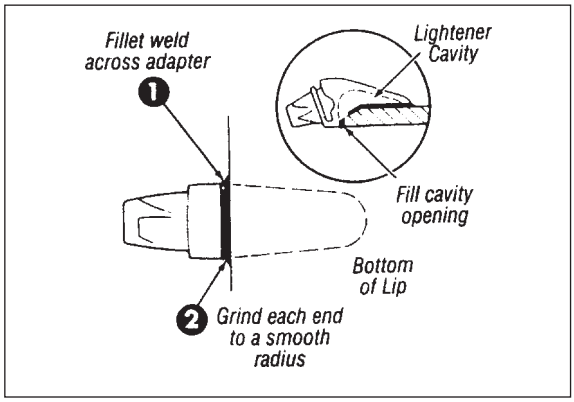
5. Remove the starter/runoff plates, then smooth the forward edge of the welds with a conical grinder.
   Blend the welds concave to remove stress concentrations.



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!**

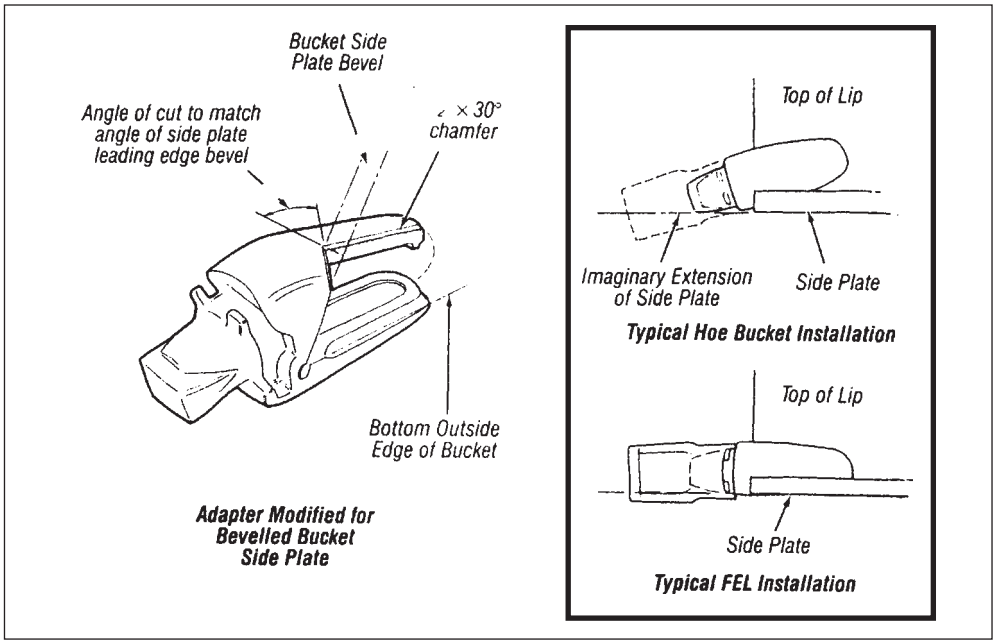
The corner adapter should be positioned so the point cuts clearance for the bucket. The best bucket wear protection is achieved when the adapter is positioned so the nose is flush with an imaginary line extending forward from the outside edge of the bucket side plate.

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 30° for weld preparation.

Following welding procedures descrebed 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.



OUTRIGGER CYLINDER

REMOVAL OF OUTRIGGER CYLINDER

1) Lower the outriggers until they just touch the ground but do not take any of the wight 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.

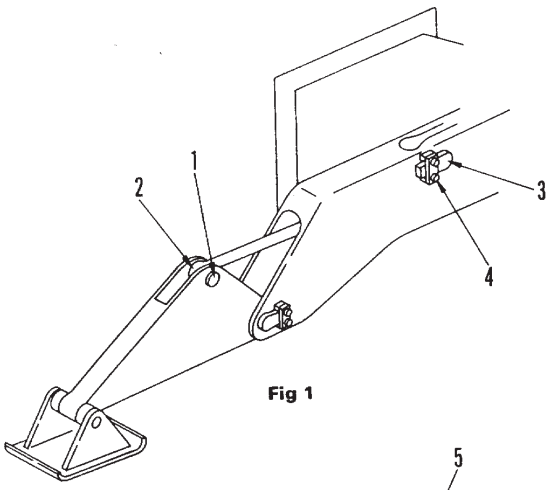


Fig 1

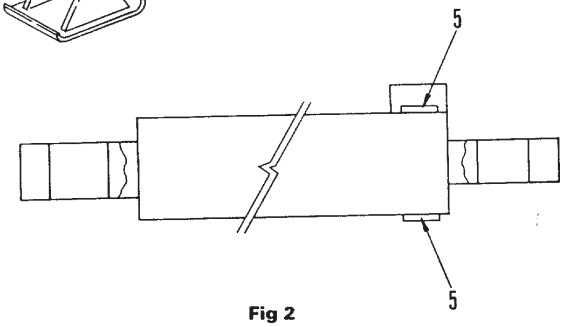


Fig 2

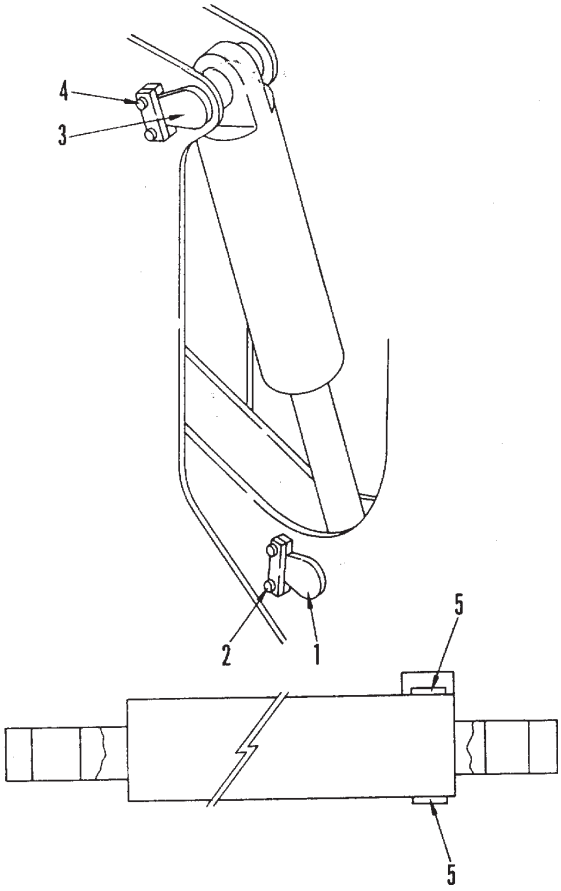
INSTALLATION OF OUTRIGGER CYLINDER

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.

BLADE CYLINDER



REMOVAL OF BLADE CYLINDER

1) Lower the blade until it just touches the ground. Do not take any of the weight of the machine on the blade.

2) Turn off the engine.

3) Depressurize the blade hydraulic cicuit.

3) Disconnect the hydraulic lines from the cylinder.

4) Attach lifting tackle.

5) Remove bolts (2) and pin (1).

6) Remove bolts (4) and pin (3).

7) Remove cylinder.

8) **Important**: Depressurize cylinder before opening it. To depressurize, loosen the plugs (6) by approx. 2 turns using an Allen key and wait until all 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.

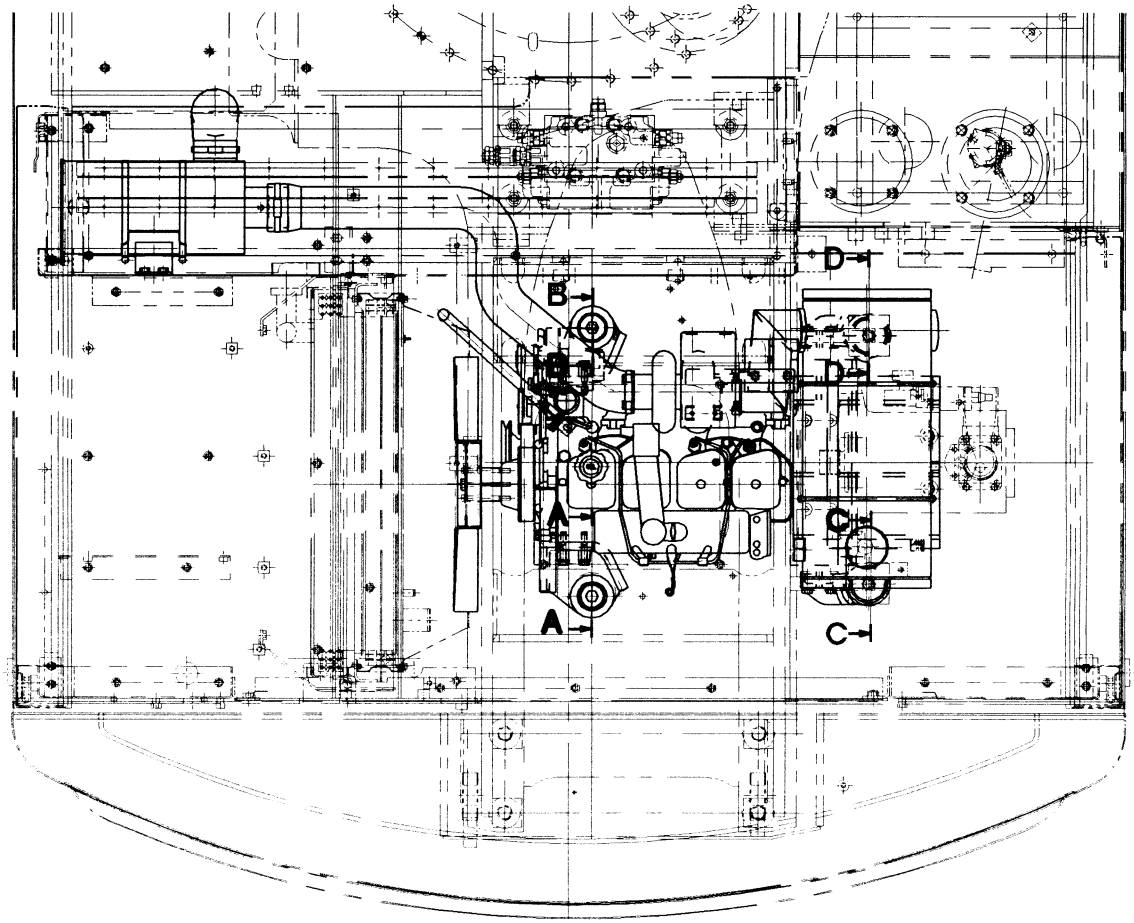
2) Grease pins (1) and (3) before fitting. Grease bearing points after assembly.

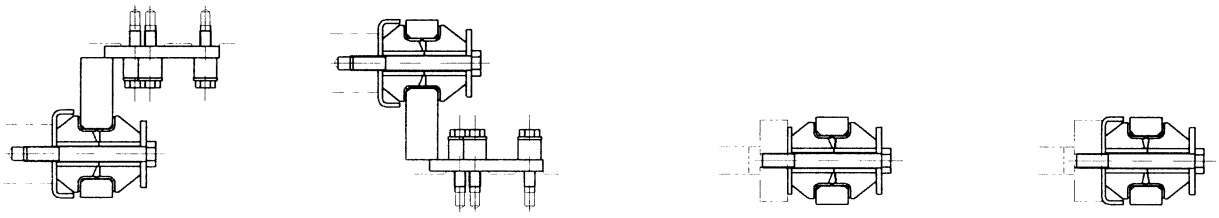
3) Bleed air from cylinders by raising and lowering the blade several times.

40 MAINTENANCE STANDARD

Engine mount 40- 2
Swing machinery 40- 3
Swing circle 40- 5
Control valve 40- 6
Suction-safety valve 40- 14
Swing motor 40- 15
Work equipment, swing PPC valve 40- 16
EPC solenoid valve 40- 17
Center swivel joint 40- 18
Boom safety valve (Arm safety valve) 40- 19
Hydraulic cylinder 40- 20
Work equipment 40- 21
Bucket 40- 27
Dozer blade, outrigger cyl 40- 29
Outrigger bush pins 40- 30
Transmission 40- 31
Front axle 40- 32
Rear axle 40- 33
Arm rotation circle 40- 34

ENGINE MOUNT



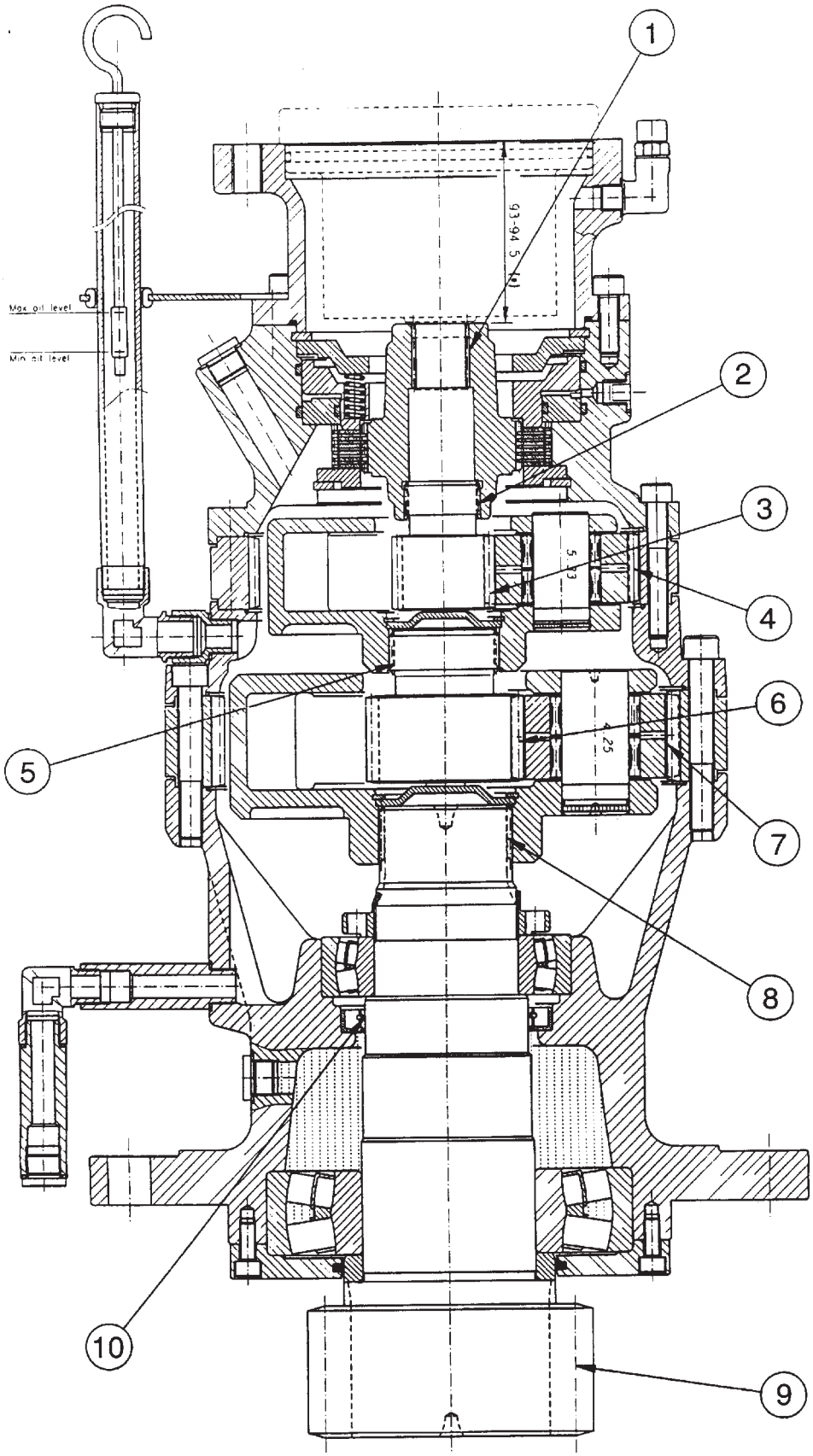


A- A B- B C- C D- D

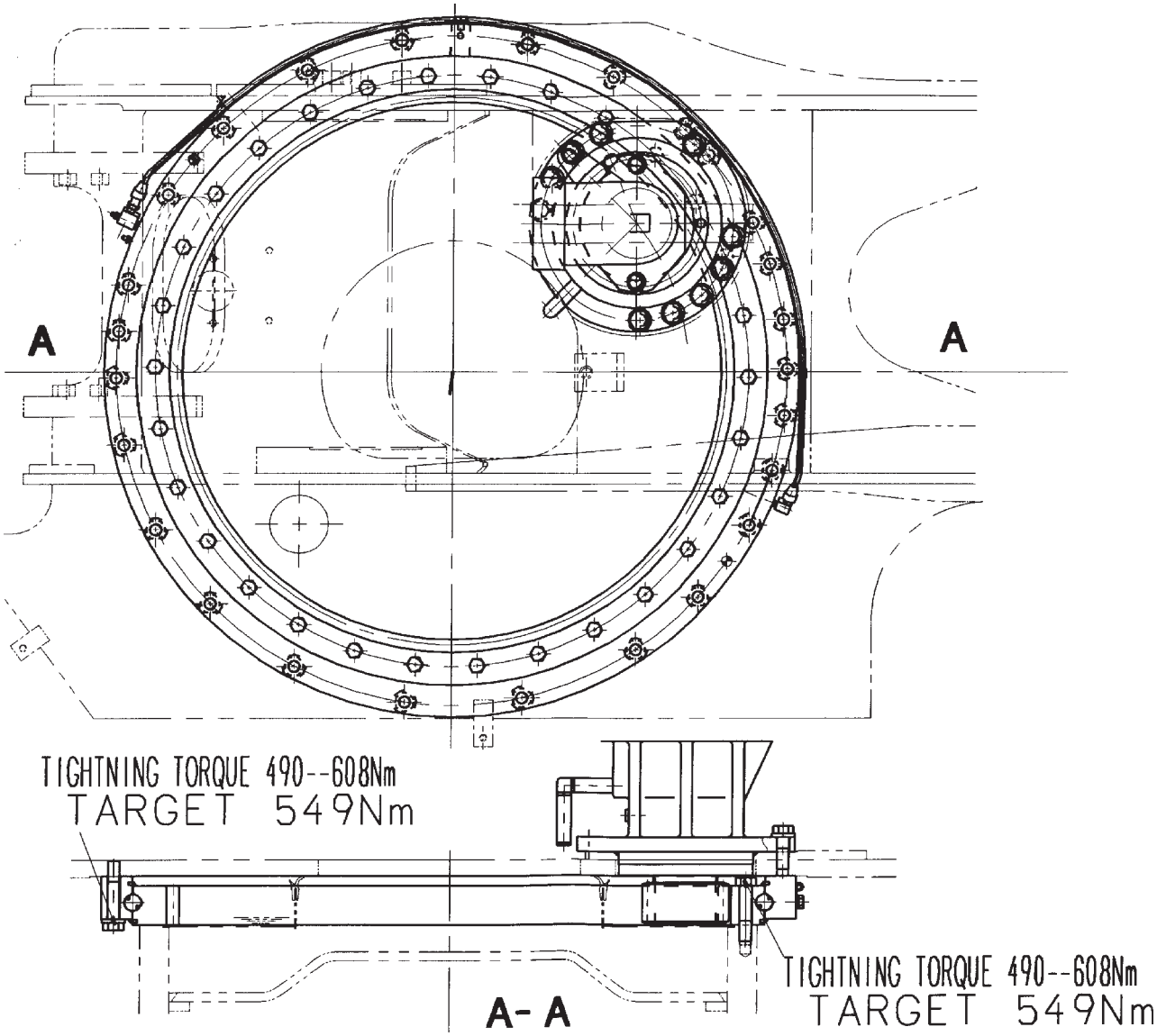
Unit: mm

No.	Check item	Criteria		Remedy
1	Free dia of front mount rubber A & B	Standard size	Repair limit	Replace
		84	-	
2	Free dia of rear mount rubber C & D	84	-	

SWING MACHINERY



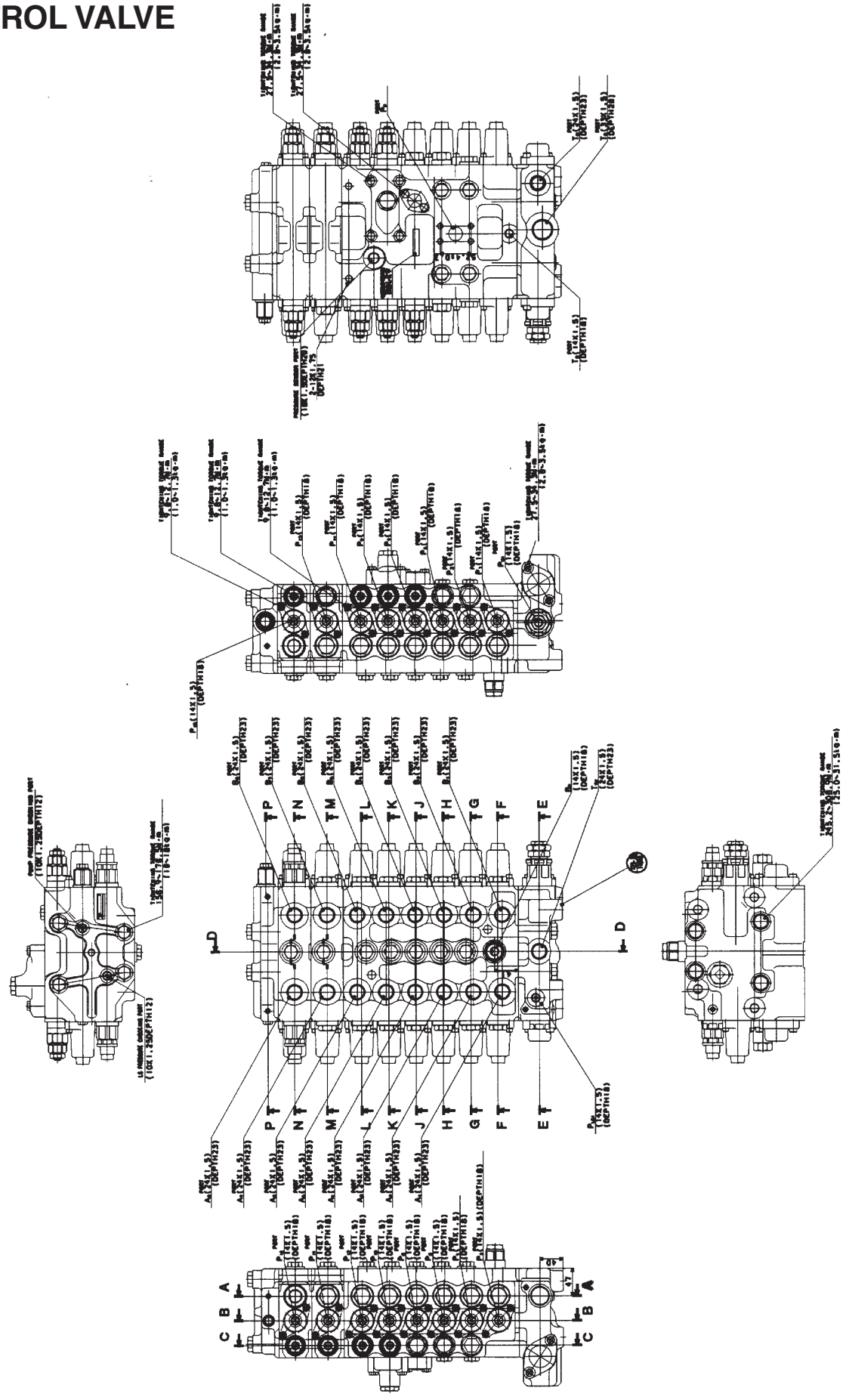
Pos.	Check item	Standard clearance (mm)	Clearance limit (mm)	Component	Check measurement standard (mm)	Check measurement limit (mm)
1	Backlash between motor shaft and brake shaft	0,064- 0,155	0,33	Motor Shaft:	Measurement over pin ø4mm 34,144 -0,054 -0,120	Measurement over pin ø4mm 33,90
				Brake shaft:	Measurement over pin ø3,5mm 22,484 +0,171 +0,063	Measurement over pin ø3,5mm 22,85
2	Backlash between brake shaft and 1st stage sun gear	0,020 - 0,098	0,27	Brake shaft:	Measurement over pin ø3,5mm 32,611 +0,101 +0,001	Measurement over pin ø3,5mm 32,89
				Sun gear:	Measurement over pin ø3,5mm 43,311 -0,030 -0,076	Measurement over pin ø3,5mm 43,10
3	Backlash between 1st stage sun gear and 1st stage planet gear	0,093 - 0,165	0,43	Sun gear:	Span measurement over 4 teeth 27,729 -0,037 -0,080	Span measurement over 4 teeth 27,52
				Planet gear:	Span measurement over 4 teeth 27,531 -0,050 -0,075	Span measurement over 4 teeth 27,33
4	Backlash between 1st stage planet gear and toothed ring	0,133 - 0,213	0,48	Planet gear:	Span measurement over 4 teeth 27,531 -0,050 -0,075	Span measurement over 4 teeth 27,33
				Toothed ring:	Measurement over pin ø4mm 192,072 +0,350 +0,210	Measurement over pin ø4mm 192,77
5	Backlash between 1st stage planet carrier and 2nd stage sun gear	0,020 - 0,098	0,27	Planet carrier:	Measurement over pin ø3,5mm 49,879 +0,088 +0,002	Measurement over pin ø3,5mm 50,12
				Sun gear:	Measurement over pin ø3,5mm 59,847 -0,029 -0,075	Measurement over pin ø3,5mm 59,64
6	Backlash between 2nd stage sun gear and 2nd stage planet gear	0,112 - 0,192	0,51	Sun gear:	Span measurement over 4 teeth 33,511 -0,045 -0,090	Span measurement over 4 teeth 33,27
				Planet gear:	Span measurement over 4 teeth 32,911 -0,060 -0,090	Span measurement over 4 teeth 32,67
7	Backlash between 2nd stage planet gear and toothed ring	0,160 - 0,255	0,58	Planet gear:	Span measurement over 4 teeth 32,911 -0,060 -0,090	Span measurement over 4 teeth 32,67
				Toothed ring:	Measurement over pin ø5mm 299,720 +0,426 +0,256	Measurement over pin ø5mm 230,57
8	Backlash between 2nd stage planet carrier and swing pinion	0,020 - 0,098	0,27	Planet carrier:	Measurement over pin ø4mm 60,579 +0,094 -0,002	Measurement over pin ø4mm 60,84
				Pinion shaft:	Measurement over pin ø4mm 73,232 -0,034 -0,082	Measurement over pin ø4mm 73,01
9	Backlash between swing pinion and swing circle	0,018 - 1,235	2,30	Pinion shaft:	Span measurement over 3 teeth 78,90 -0,050 -0,200	Span measurement over 3 teeth 78,20
				Swing circle:	Measurement over pin ø15mm 924,3 +2,260 +0,470	Measurement over pin ø15mm 927,98
10	Wear of swing pinion oil seal contact surface					ø84,5

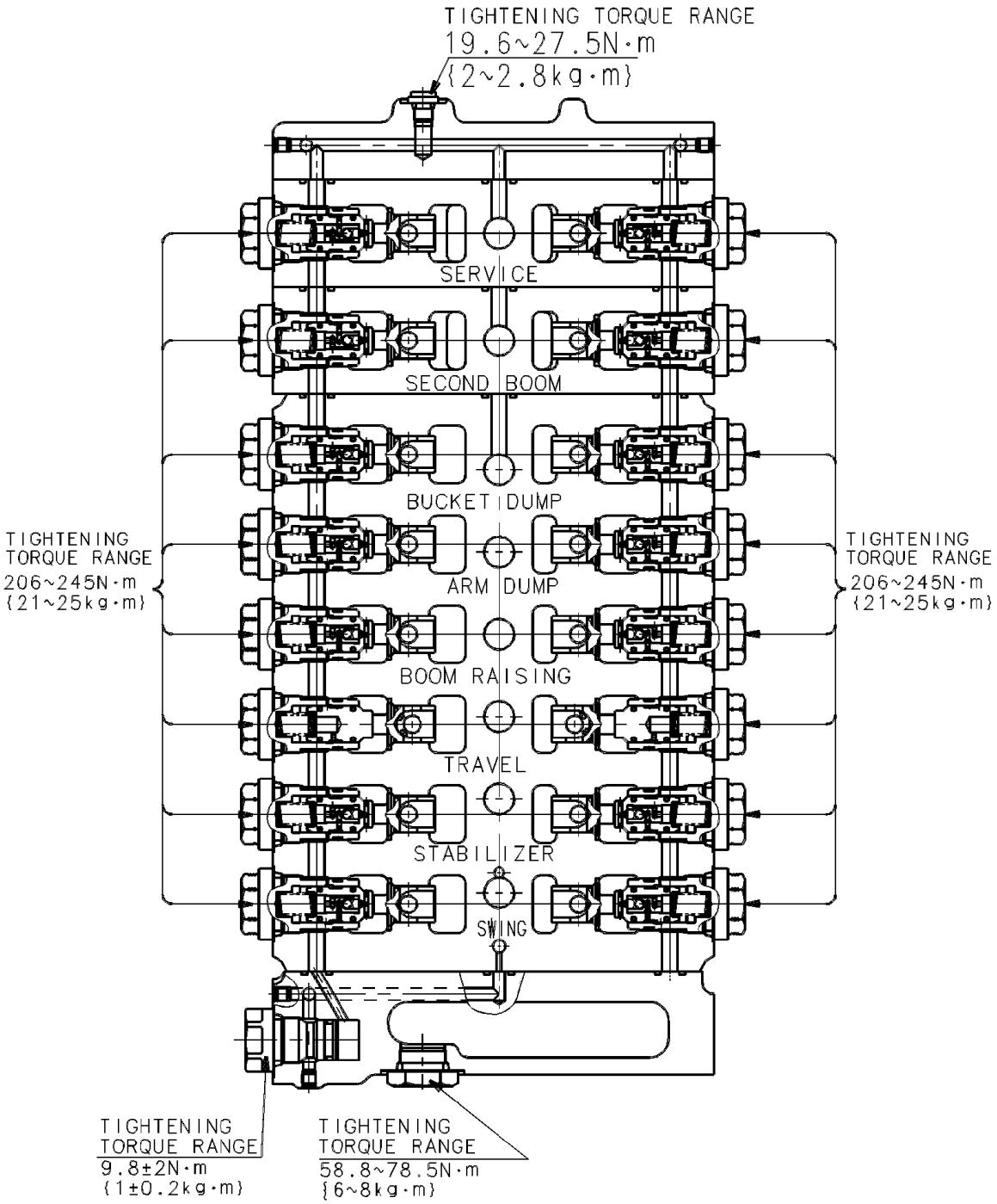


Unit: mm

No.	Check item	Criteria		Remedy
1	Axial clearance of bearing (When mounted on machine)	Standard clearance	Clearance limit	Replace
		0.5 - 1.6	3.2	

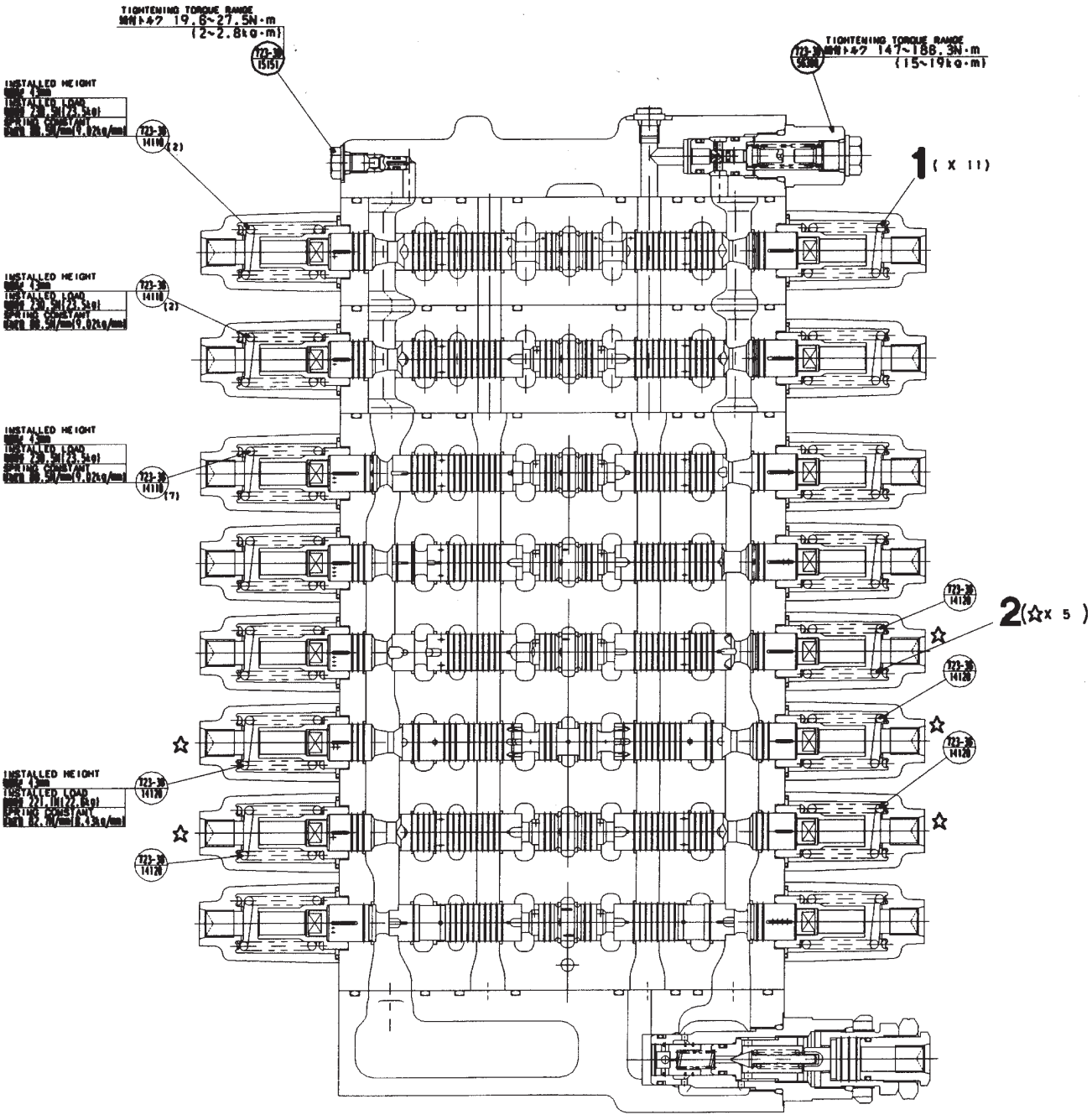
CONTROL VALVE





Unit: mm

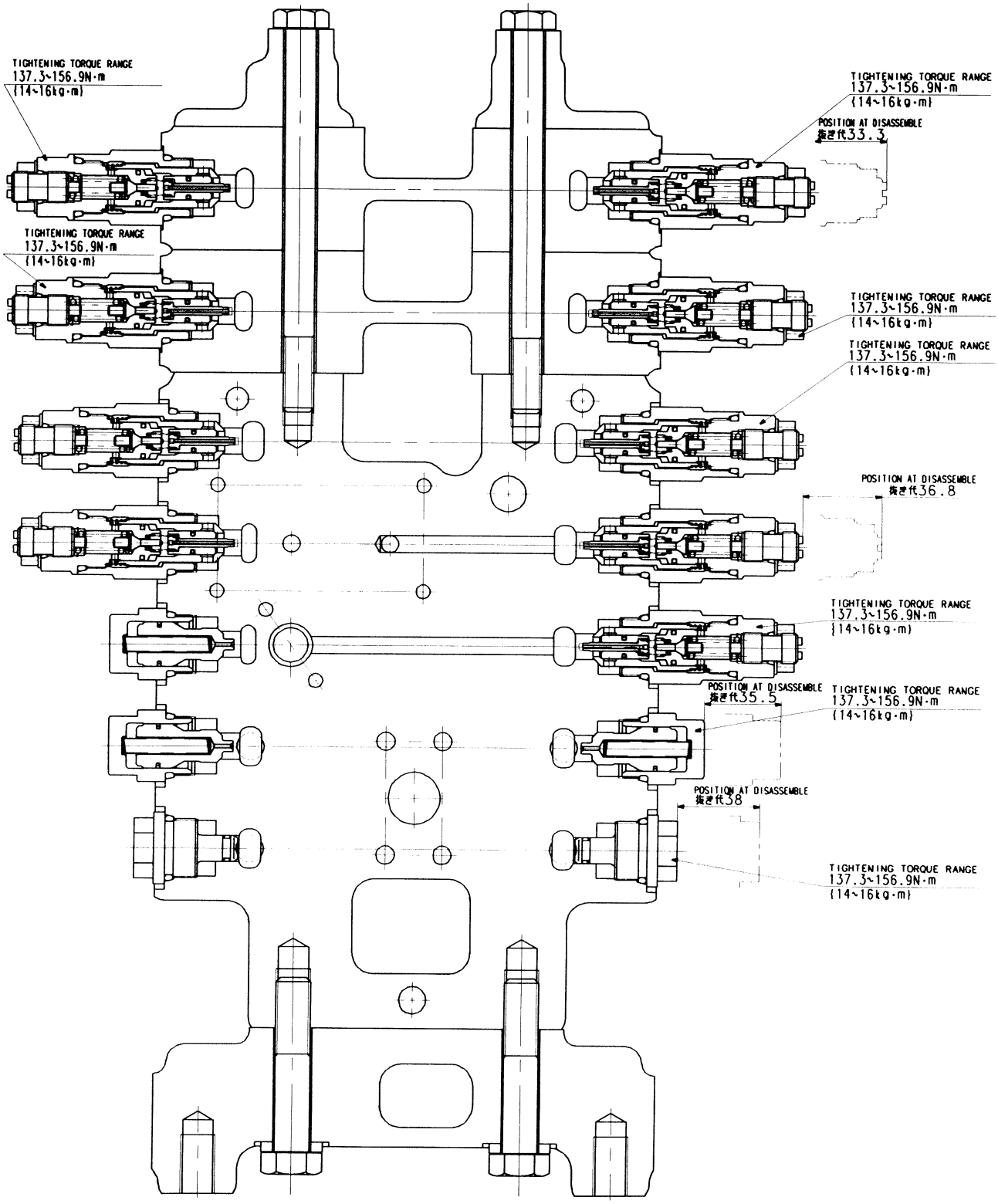
No.	Check item	Criteria					Remedy
		Standard size			Repair limit		
1	Pressure compensation valve spring (work equipment, swing)	Free length X O.D.	Installed length	Installed load	Free length	Installed load	Replace spring if any damages or deformations are found.
		34.4 x 12	20	17.6 ± 1.0 N (1.8 ± 0.1 kg)	-	13.2 N (1.3 kg)	
2	Pressure compensation valve spring (travel)	27.3 x 12	20	25.5 N (2.6 kg)	-	19.6 N (2.0 kg)	



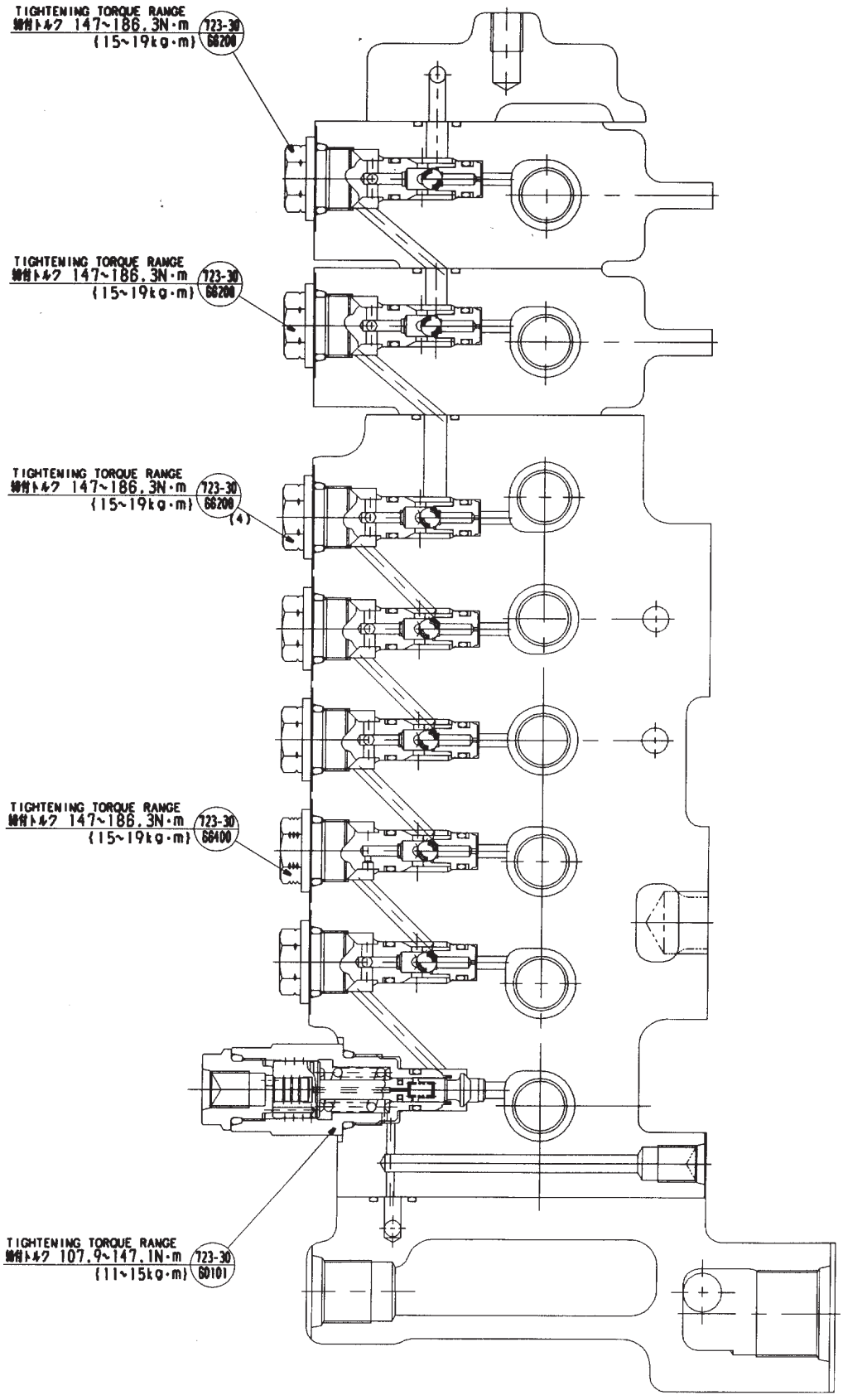
B-B

Unit: mm

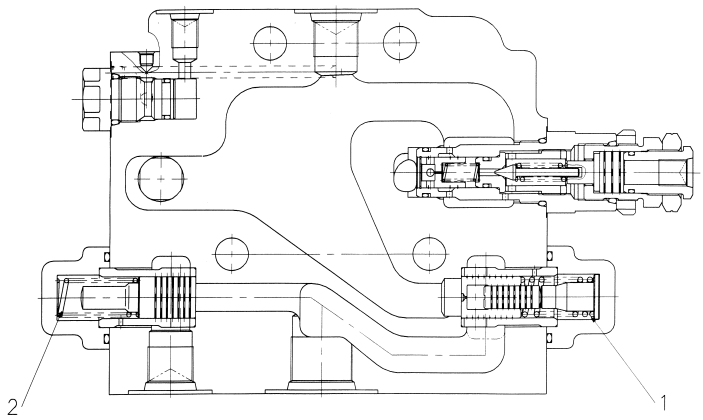
No.	Check item	Criteria					Remedy
		Standard size			Repair limit		
1	Spool return spring	Free length X O.D.	Installed length	Installed load	Free length	Installed load	Replace spring if any damages or deformations are found.
		45.6 x 28	43	230.5 ± 14.7N (23.5 ± 1.5kg)	-	208.7N (21.3kg)	
2	Spool return spring (☆)	45.7 x 28	43	221.1 ± 13.7N (22.6 ± 1.4kg)	-	179.3N (18.3kg)	


TIGHTENING TORQUE RANGE
137.3~156.9N·m
{14~16kg·m}
TIGHTENING TORQUE RANGE
137.3~156.9N·m
{14~16kg·m}
POSITION AT DISASSEMBLE
指寸法33.3
TIGHTENING TORQUE RANGE
137.3~156.9N·m
{14~16kg·m}
TIGHTENING TORQUE RANGE
137.3~156.9N·m
{14~16kg·m}
TIGHTENING TORQUE RANGE
137.3~156.9N·m
{14~16kg·m}
POSITION AT DISASSEMBLE
指寸法36.8
TIGHTENING TORQUE RANGE
137.3~156.9N·m
{14~16kg·m}
POSITION AT DISASSEMBLE
指寸法35.5
TIGHTENING TORQUE RANGE
137.3~156.9N·m
{14~16kg·m}
POSITION AT DISASSEMBLE
指寸法38
TIGHTENING TORQUE RANGE
137.3~156.9N·m
{14~16kg·m}

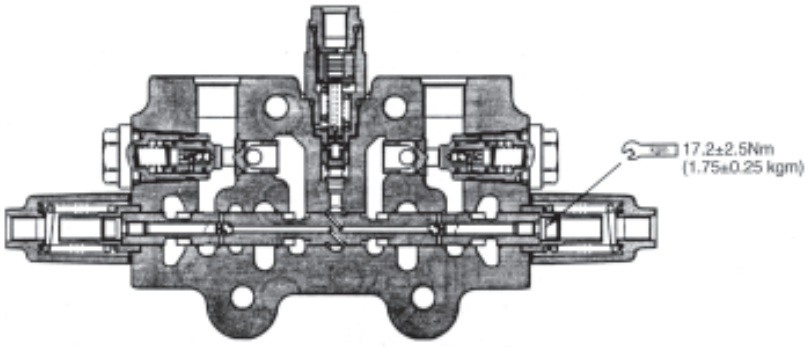
C-C


TIGHTENING TORQUE RANGE
締付トルク 147~186.3N·m
{15~19kg·m}
723-30
66200
TIGHTENING TORQUE RANGE
締付トルク 147~186.3N·m
{15~19kg·m}
723-30
66200
TIGHTENING TORQUE RANGE
締付トルク 147~186.3N·m
{15~19kg·m}
723-30
66200
(4)
TIGHTENING TORQUE RANGE
締付トルク 147~186.3N·m
{15~19kg·m}
723-30
66400
TIGHTENING TORQUE RANGE
締付トルク 107.9~147.1N·m
{11~15kg·m}
723-30
60101

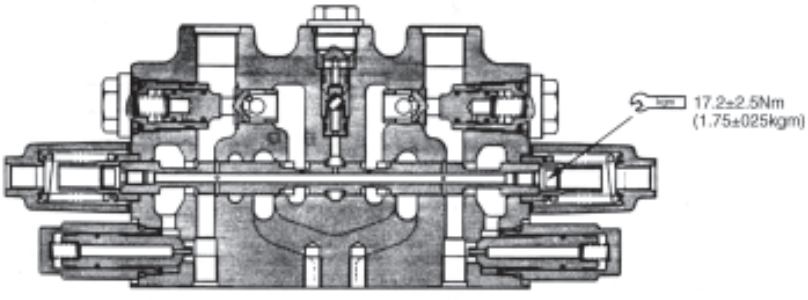
D-D



E-E



F-F

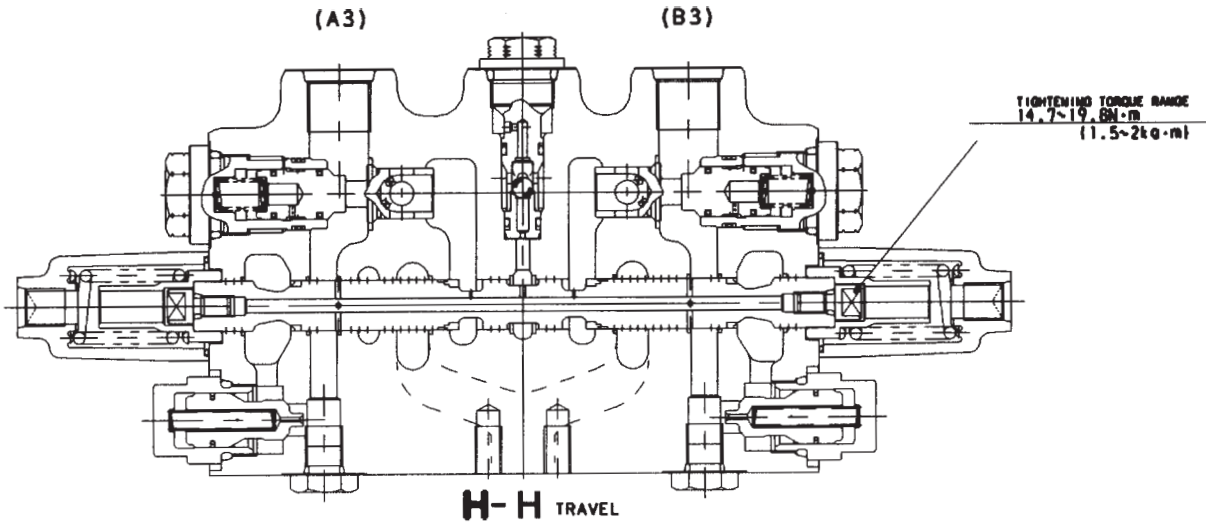


G-G

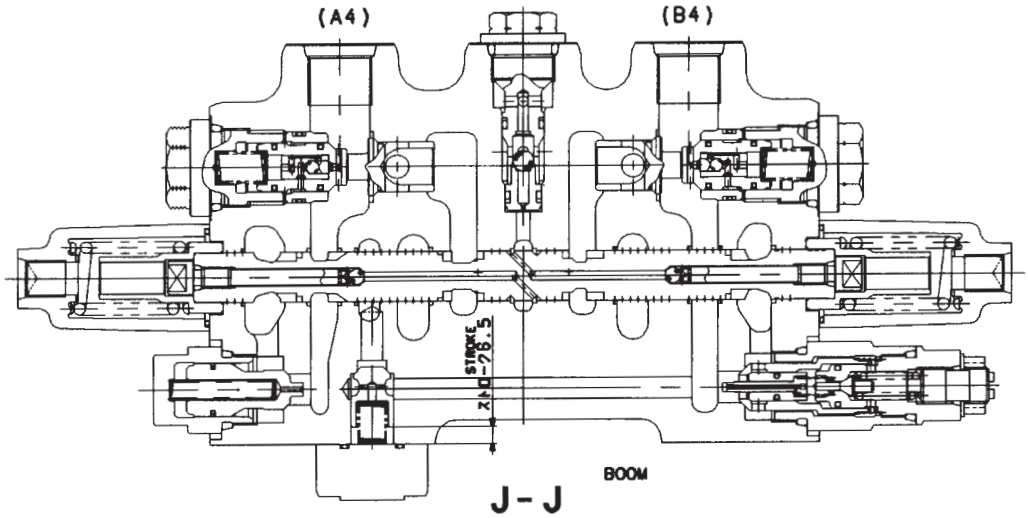
202F06295

Unit: mm

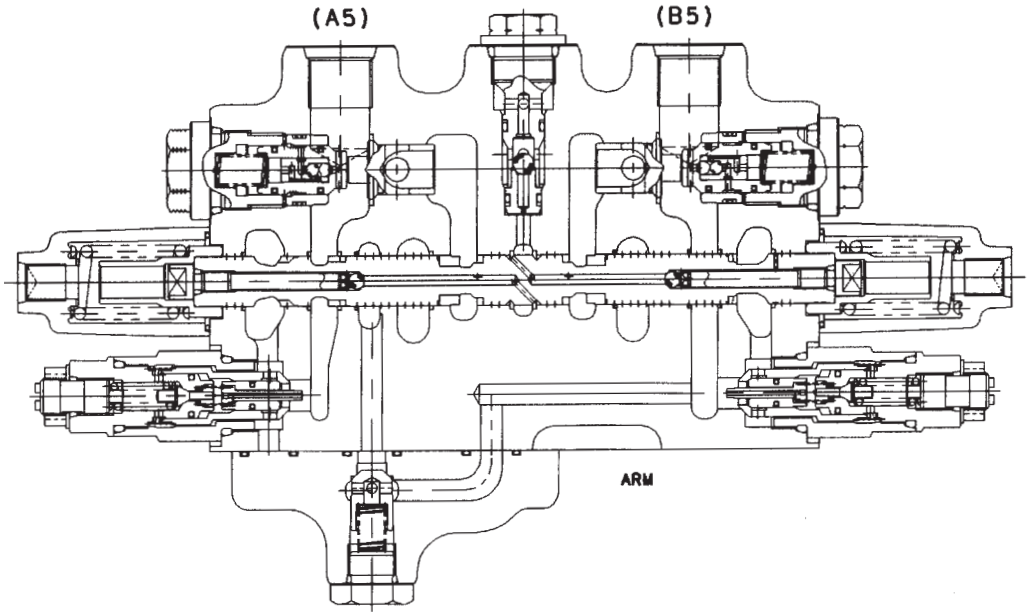
No.	Check item	Criteria					Remedy
		Standard size			Repair limit		
1	Lift check valve spring.	Free length X O.D.	Installed length	Installed load	Free length	Installed load	Replace spring if any damages or deformations are found.
		72.7 x 20.6	42.5	135.2 ± 4.9 N (13.8 ± 0.5 kg)	-	112.7 N (11.5 kg)	
2	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)	



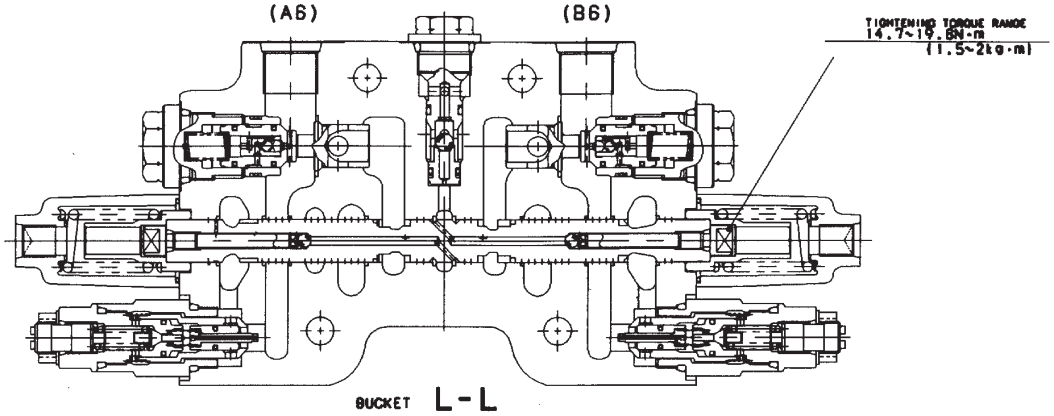
H-H TRAVEL



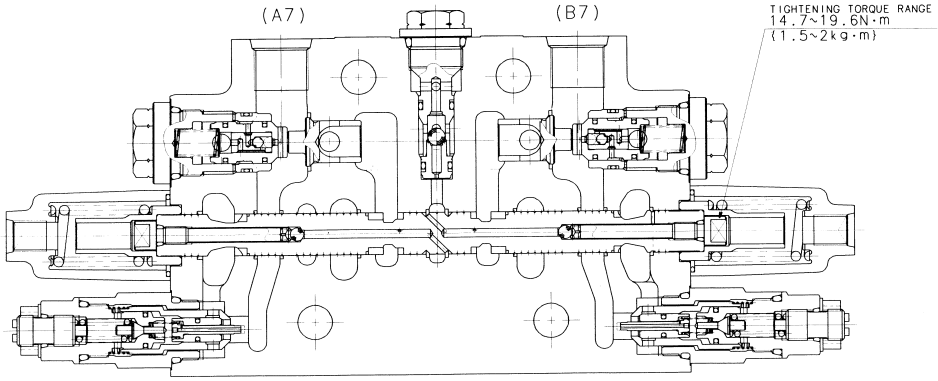
J-J



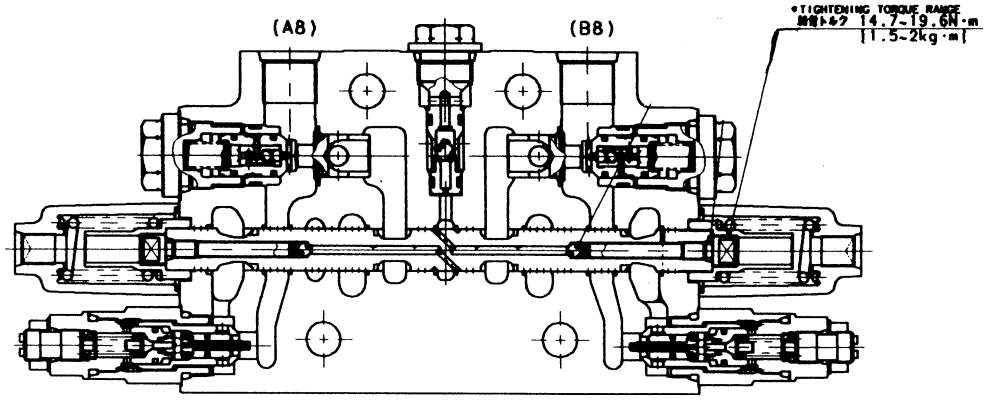
K-K



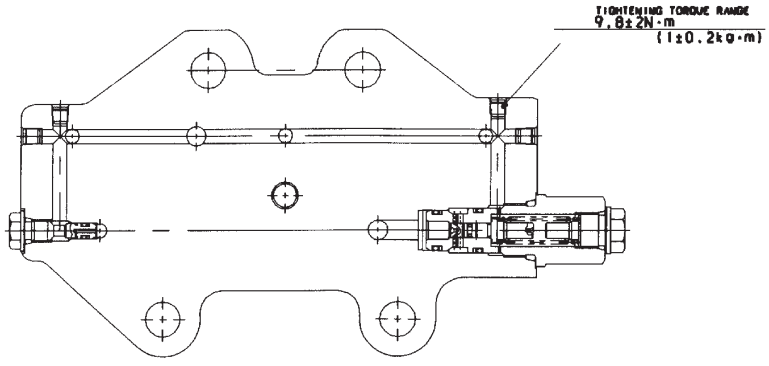
BUCKET L-L



M-M

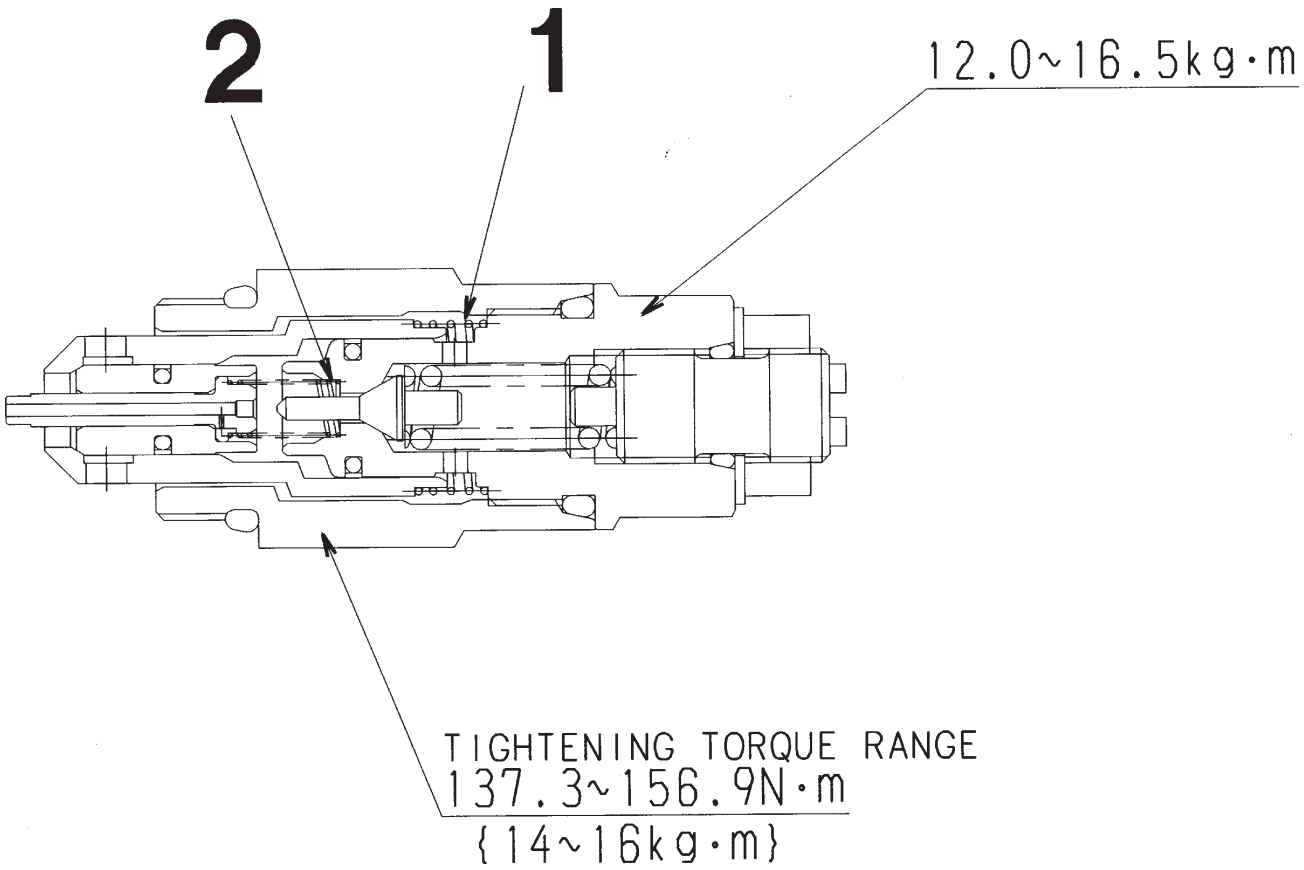


N-N (FROM 1/3) SERVICE サービス



P-P

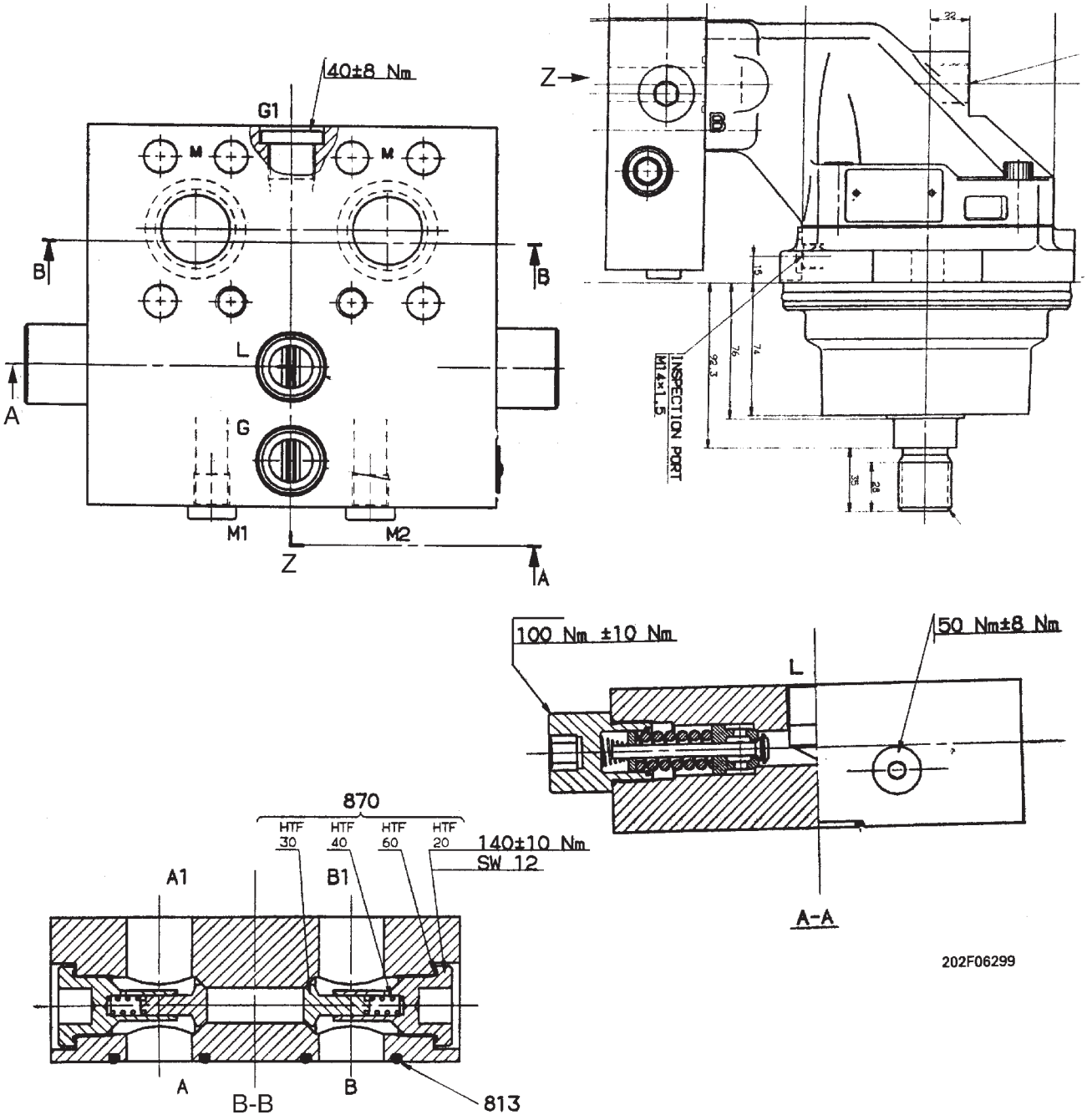
SUCTION-SAFETY VALVE



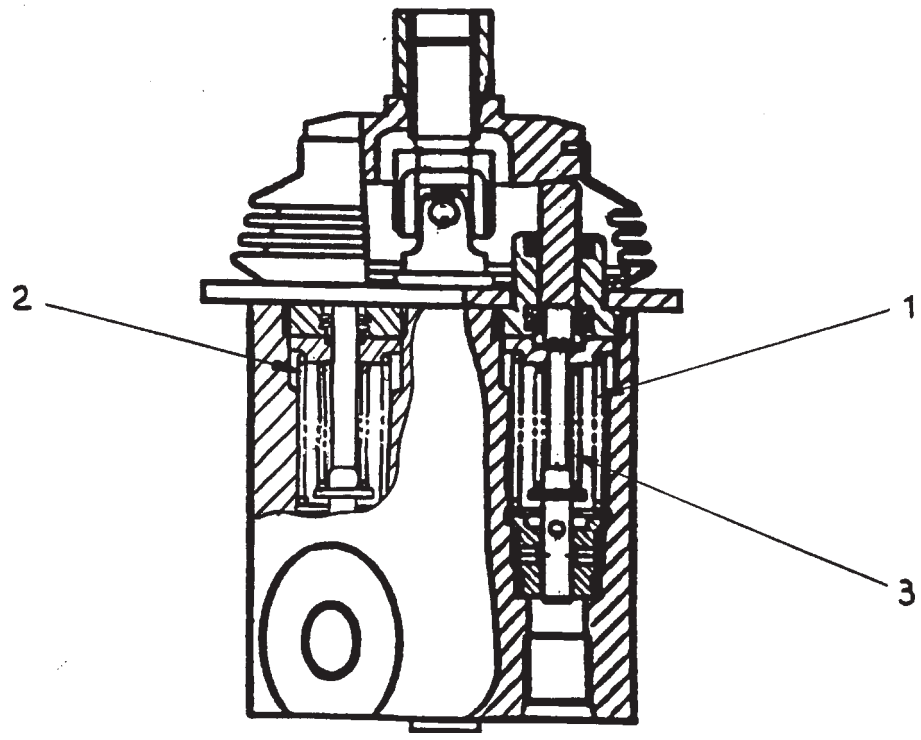
Unit: mm

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 damages or deformations are found.
		16.3 x 21.3	9.0	2.2N (0.22kg)	-	1.6 N (0.16 kg)	
2	Main valve spring	20 x 7	13.7	1.3N (0.13kg)	-	1.6 N (0.16 kg)	

SWING MOTOR


40±8 Nm
G1
M
M
B
B
L
A
G
M1
M2
Z
A
Z
B
22
13
76
74
92.3
INSPECTION PORT
M14x1.5
35
28
100 Nm ±10 Nm
50 Nm±8 Nm
L
A-A
870
HTF 30
HTF 40
HTF 60
HTF 20
140±10 Nm
SW 12
A1
B1
A
B-B
B
813
202F06299

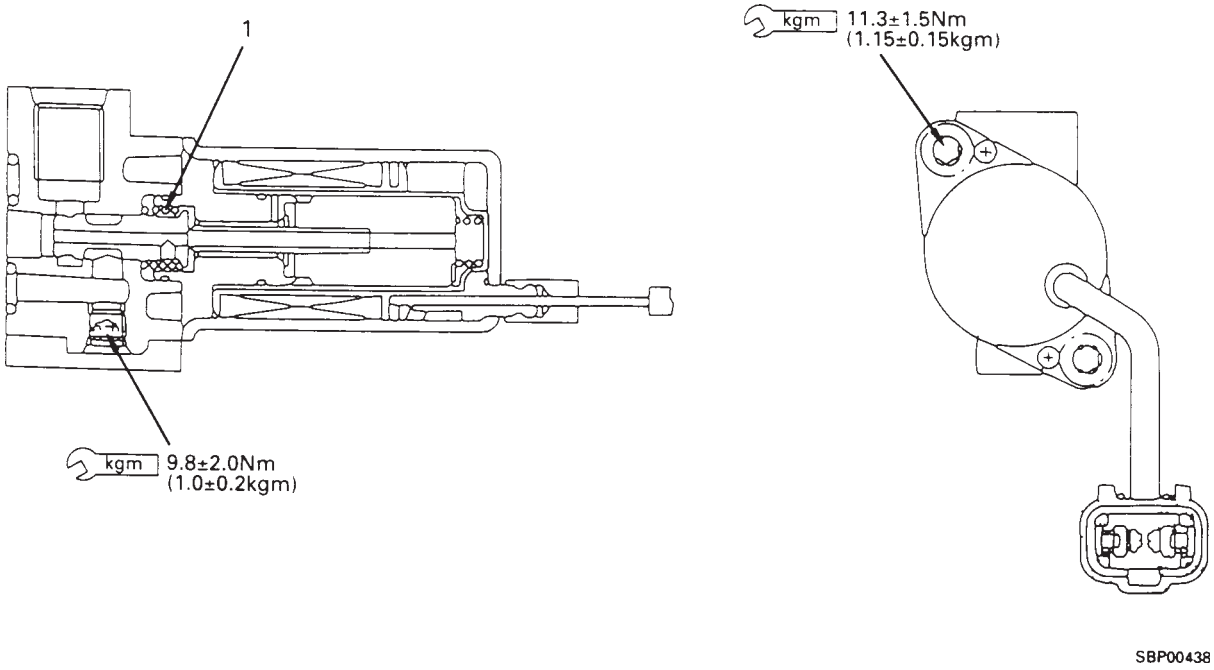
WORK EQUIPMENT, SWING PPC VALVE



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 there is damage or deformation
		43.3 X 19.5	33.5	17.7 N (1.8 kg)	-	13.7 N (1.4 kg)	
2	Centering spring (for P1, P2)	45.5 X 19.6	33.5	29.0 N (3.0 kg)	-	23.2 N (2.4 kg)	
3	Metering spring	27.6 X 9.5	26	16.7 N (1.7 kg)	-	13.7 N (1.4 kg)	

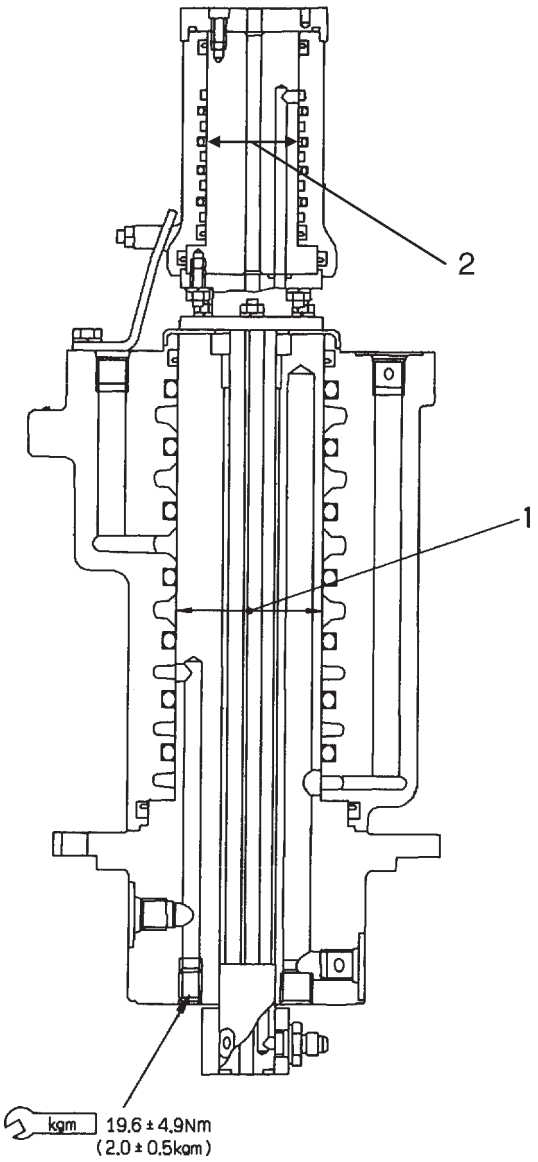
EPC SOLENOID VALVE
FOR LS VALVE + TRAVEL



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 assembly if there is damage or deformation
		9.0 x 11.4	7.9	3.14 N (0.32 kg)	-	-	

CENTER SWIVEL JOINT

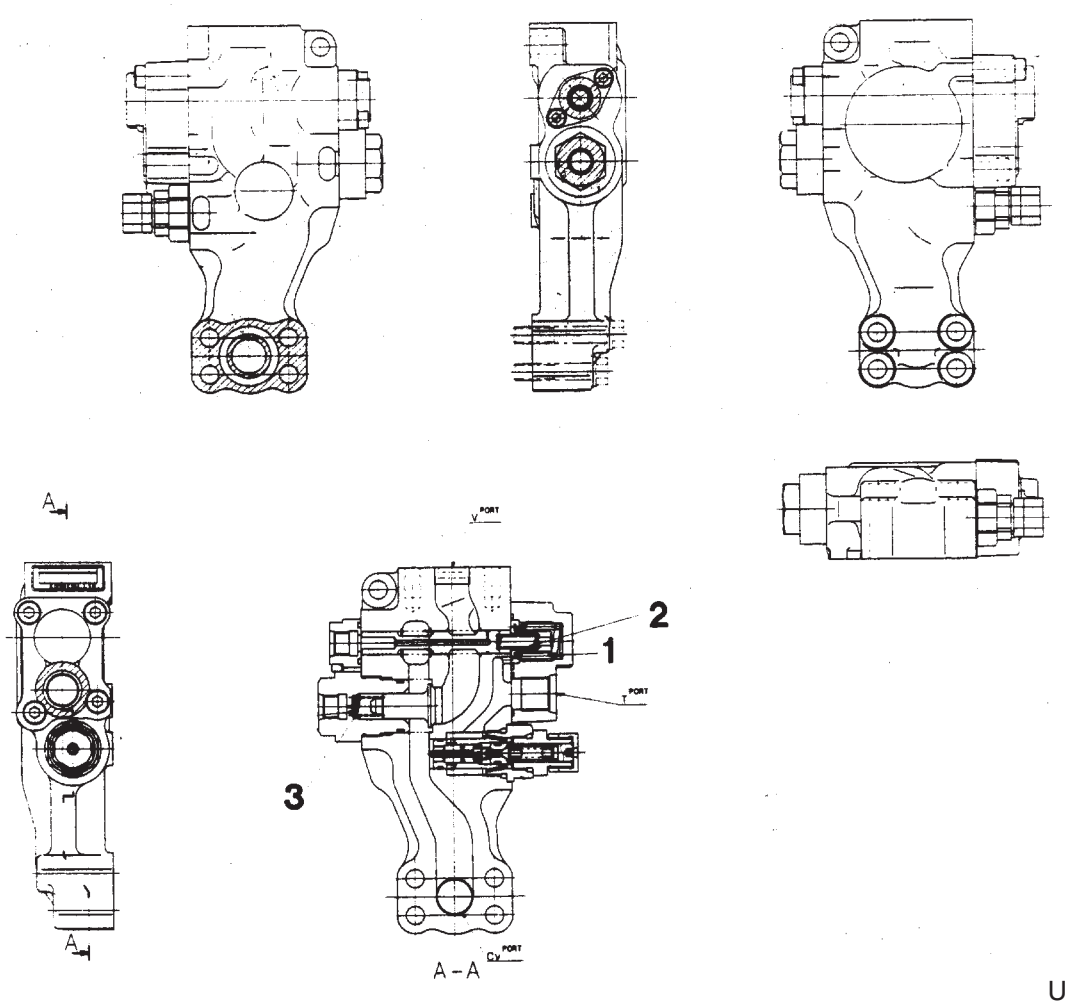


Unit: mm

No.	Check item	Criteria			Remedy
1	Clearance between rotor and shaft	Standard size	Standard clearance	Clearance limit	Replace
		Shaft Ø105 $^{+0.02}_{-0.06}$ Rotor Ø105 $^{+0.16}_{-0.05}$	min - 0.07 max - 0.21	0.28	
2	Clearance between rotor + shaft	Shaft - Ø50 $^{+0.02}_{-0.05}$ Rotor - Ø50 $^{+0.05}_{-0.02}$	min - 0.06 max - 0.17	0.22	Replace

ARM, BOOM SAFETY VALVE

★ For machine equipped with arm safety valve, the Maintenance Standard of arm safety valve is the same as this valve.

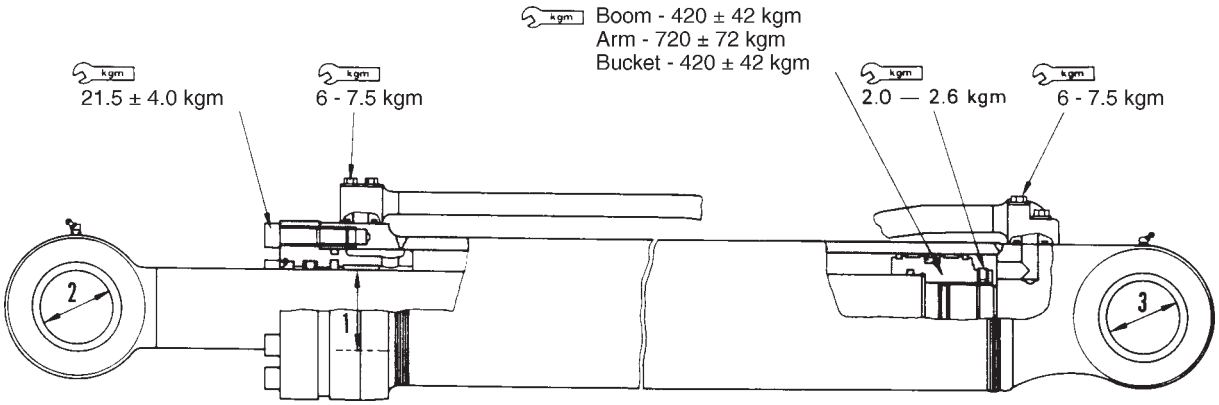


Unit: mm

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 damages or deformations are 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

PW170ES-6K

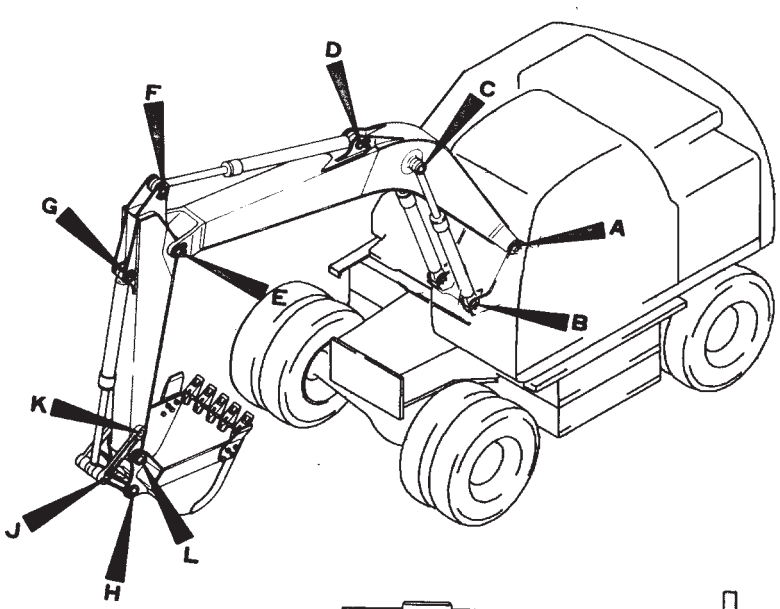


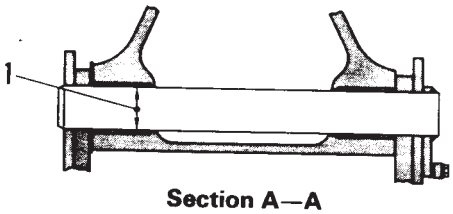
Unit: mm

No.	Check item		Criteria					Remedy
		Name of cylinder	Standard size	Tolerance		Standard clearance	Clearance limit	
				Shaft	Hole			
1	Clearance between piston rod and bushing	Boom	75	-0.030 -0.076	+0.270 +0.065	0.095 - 0.346	0.446	Replace bushing
		Arm	85	-0.036 -0.090	+0.222 +0.047	0.083 - 0.312	0.412	
		Bucket	75	-0.030 -0.076	+0.270 +0.065	0.095 - 0.346	0.446	
2	Clearance between piston rod support and bushing	Boom	70	-0.030 -0.104	+0.198 +0.124	0.154 - 0.302	1.0	Replace pin and bushing
		Arm	80	-0.030 -0.104	+0.211 +0.124	0.154 - 0.315	1.0	
		Bucket	70	-0.030 -0.076	+0.198 +0.124	0.154 - 0.274	1.0	
3	Clearance between cylinder bottom support shaft and bushing	Boom	70	-0.030 -0.100	+0.198 +0.124	0.154 - 0.298	1.0	
		Arm	80	-0.030 -0.104	+0.211 +0.124	0.154 - 0.315	1.0	
		Bucket	70	-0.030 -0.104	+0.198 +0.124	0.154 - 0.315	1.0	

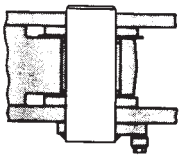
WORK EQUIPMENT

PW170ES-6K

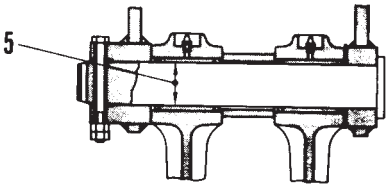




Section A—A



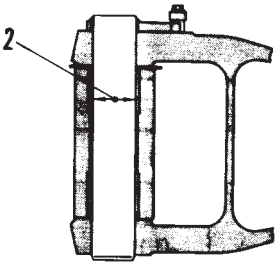
Section D—D



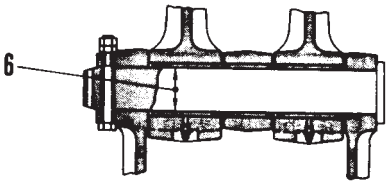
Section H—H



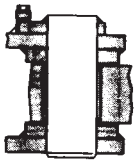
Section B—B



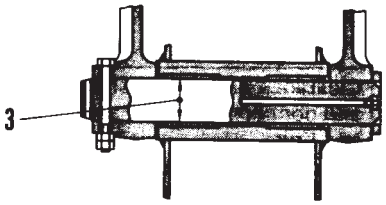
Section E—E



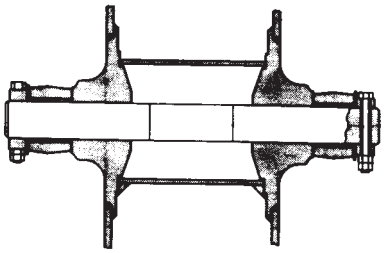
Section J—J



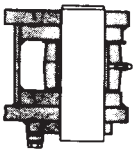
Section F—F



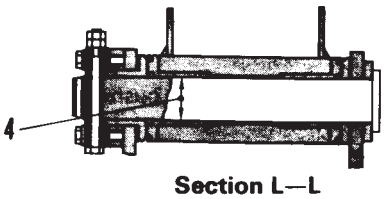
Section K—K



Section C—C



Section G—G

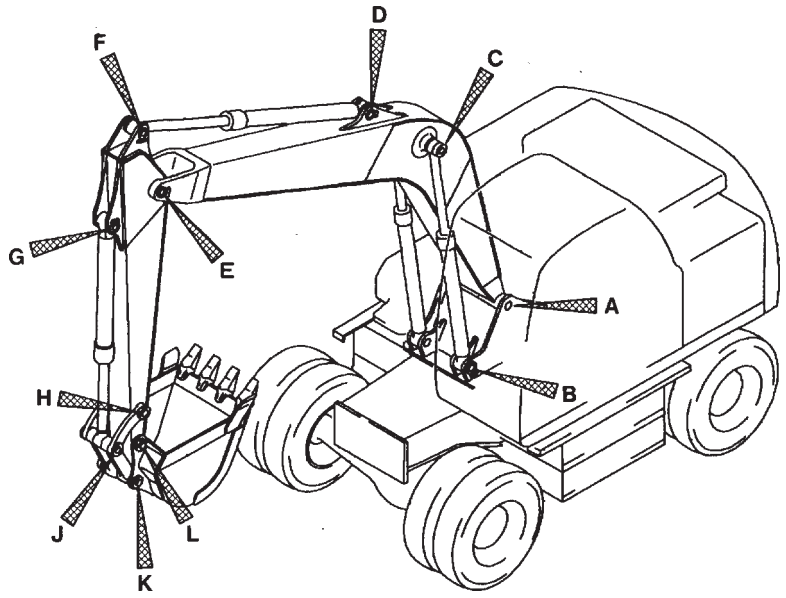


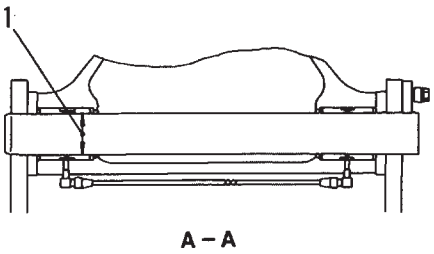
Section L—L

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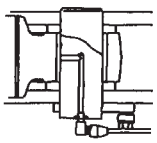
WORK EQUIPMENT - ONE PIECE BOOM

PW170ES-6K

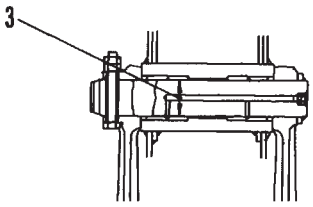




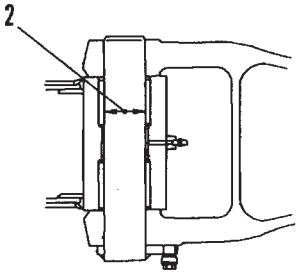
A – A



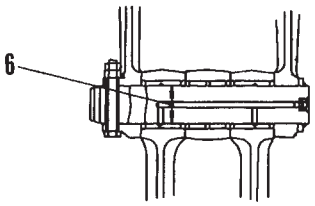
D – D



H – H



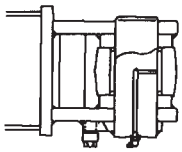
E – E



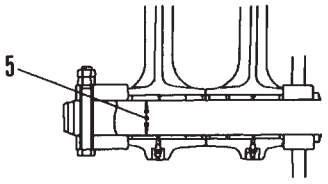
J – J



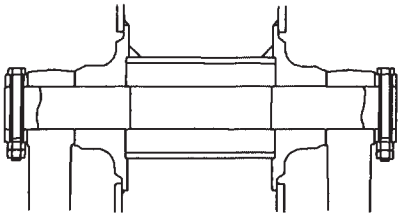
B – B



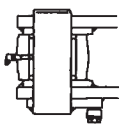
F – F



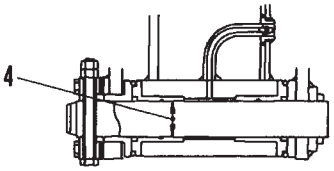
K – K



C – C



G – G

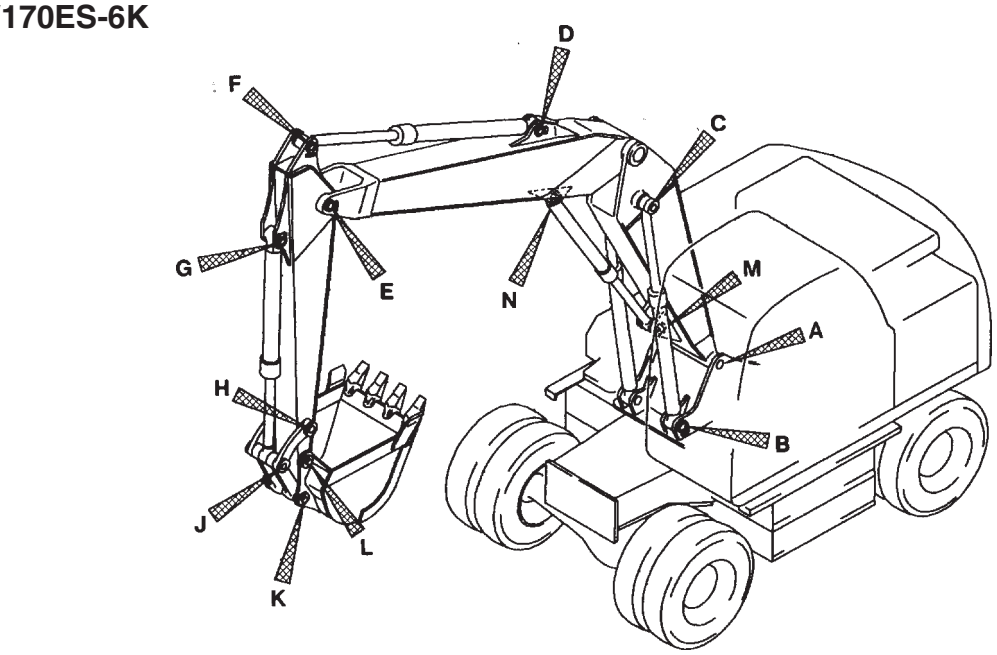


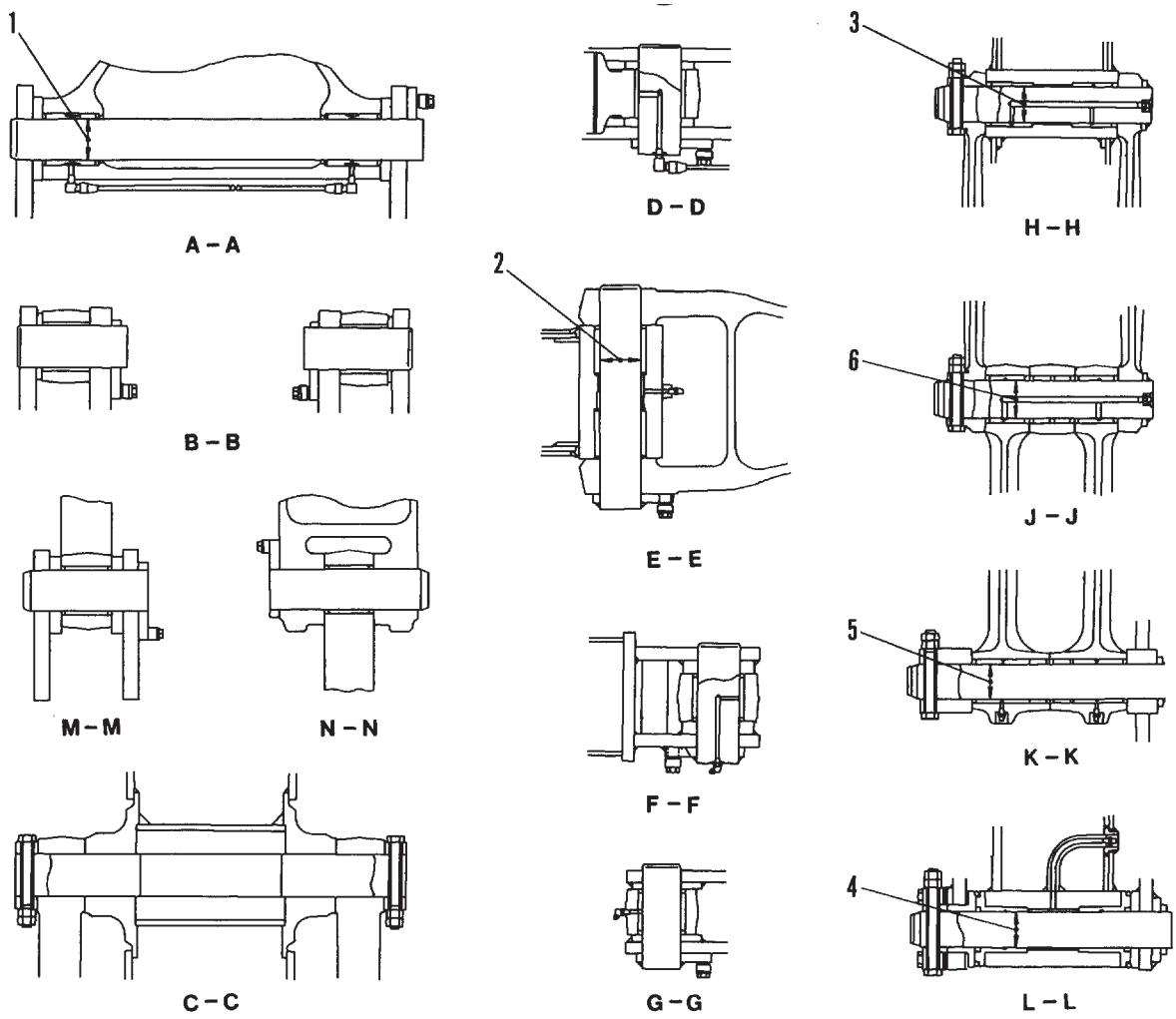
L – L

KW130P6167

WORK EQUIPMENT - TWO PIECE BOOM

PW170ES-6K





KW130P6168

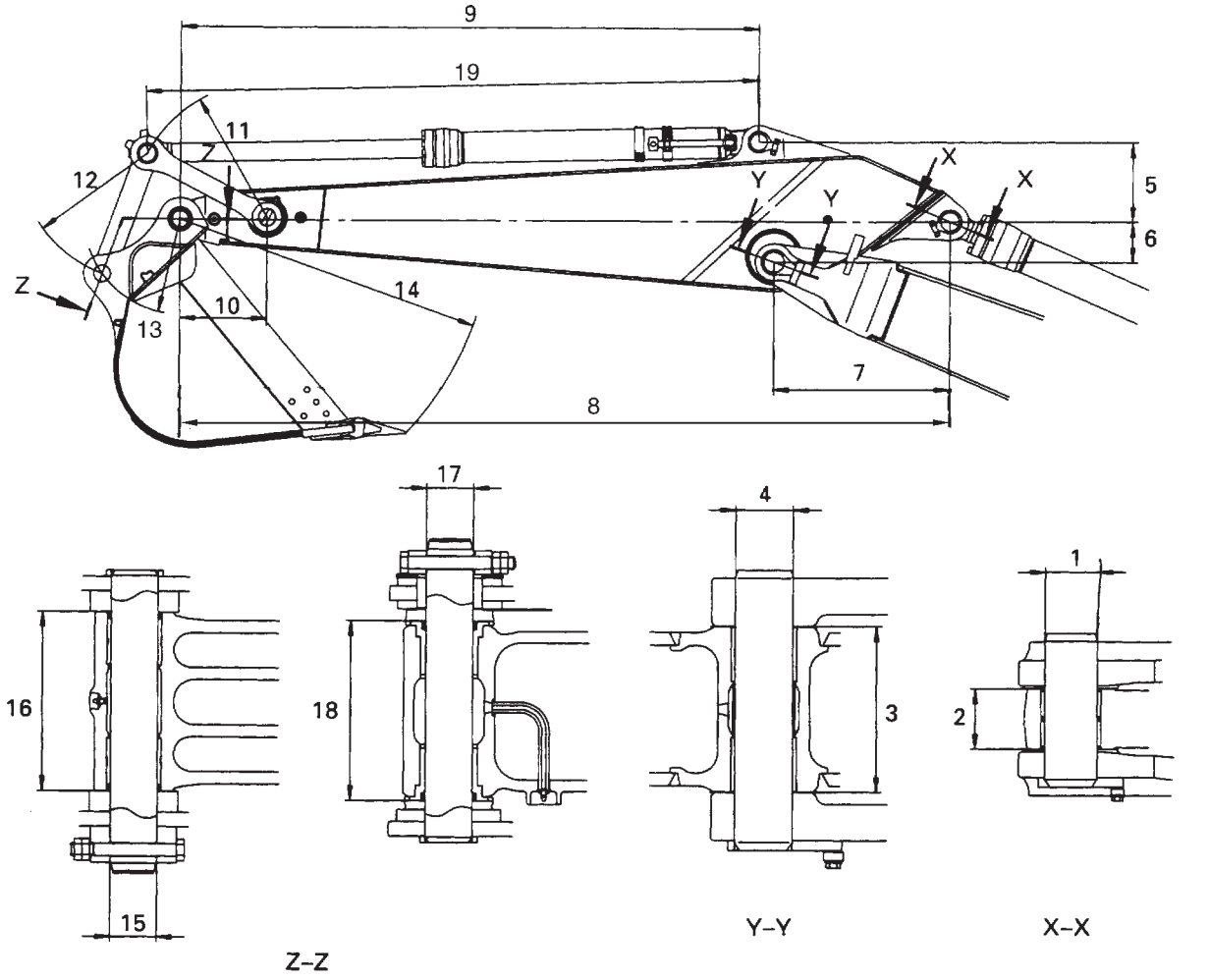
Unit: mm

No.	Check item	Criteria					Remedy
		Standard size	Tolerance		Standard clearance	Clearance limit	
			Shaft	Hole			
1	Clearance between bushing and connecting pin of revolving frame and boom	80	-0.030 -0.060	+0.106 +0.045	0.075 - 0.166	1.0	Replace
2	Clearance between bushing and connecting pin of boom and arm	80	-0.030 -0.104	+0.141 +0.074	0.074 - 0.245	1.0	
3	Clearance between bushing and connecting pin of arm and link	70	-0.030 -0.076	+0.335 +0.275	0.305 - 0.411	1.0	
4	Clearance between bushing and connecting pin of arm and bucket	70	-0.030 -0.076	+0.331 +0.270	0.300 - 0.407	1.0	
5	Clearance between bushing and connecting pin of link and bucket	70	-0.030 -0.076	+0.335 +0.275	0.305 - 0.411	1.0	
6	Clearance between bushing and connecting pin of link and link	70	-0.030 -0.076	+0.335 +0.275	0.305 - 0.411	1.0	

DIMENSIONS OF WORK EQUIPMENT

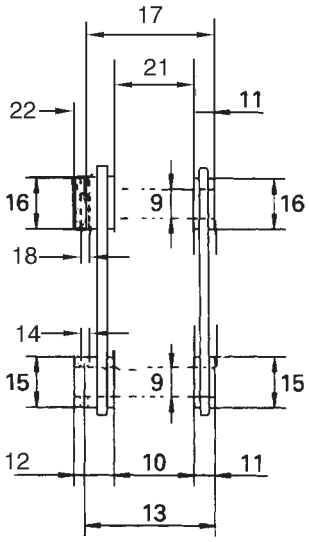
PW170ES-6K

1. ARM

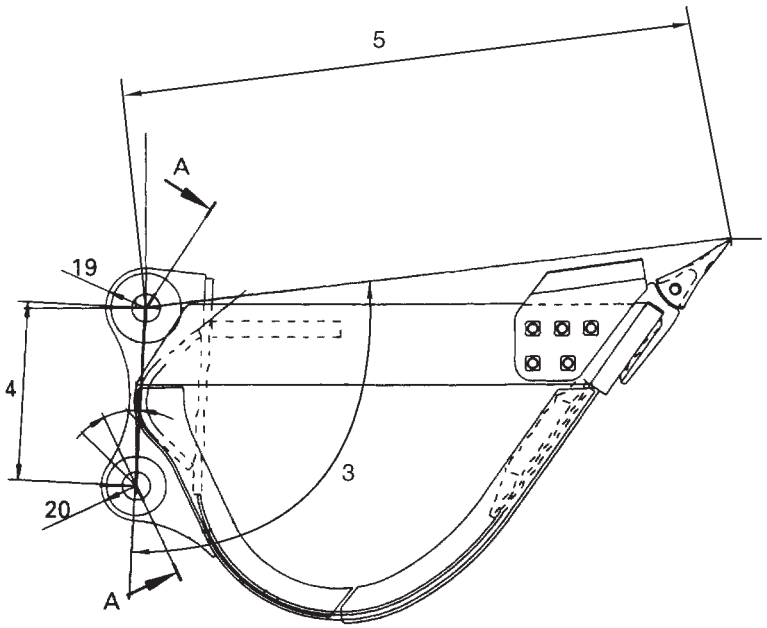


No. \ Model		2.25 m ARM	2.6 m ARM
1		ø80 $^{+0.1}_{0}$ / $^{-0.030}_{-0.104}$	ø80 $^{+0.1}_{0}$ / $^{-0.030}_{-0.104}$
2		98 $^{+1.0}_{0}$ 96 ± 1.2	98 $^{+1.0}_{0}$ 96 ± 1.2
3		284 $^{+0.5}_{0}$ / $^{-0.3}_{-0.8}$	284 $^{+0.5}_{0}$ / $^{-0.3}_{-0.8}$
4		ø80 $^{+0.337}_{+0.273}$ / $^{-0.030}_{-0.104}$	ø80 $^{+0.337}_{+0.273}$ / $^{-0.030}_{-0.104}$
5		395.8 ± 2	399.5 ± 2
6		203.8 ± 1	173.8 ± 1
7		745.3 ± 1	753 ± 1.0
8		2995.3	3357.6 ± 3
9		2377 ± 1.0	2377 ± 1.0
10		330 ± 0.5	330 ± 0.5
11		583 ± 0.5	583 ± 0.5
12		524 ± 0.5	524 ± 0.5
13		400.8	400.8
14		(1348)	(1348)
15		ø70 $^{+0.2}_{0}$ / $^{-0.030}_{-0.076}$	ø70 $^{+0.2}_{0}$ / $^{-0.030}_{-0.076}$
16		311.5 ± 1	311.5 ± 1
17		ø70 $^{+0.2}_{0}$ / $^{-0.030}_{-0.076}$	ø70 $^{+0.2}_{0}$ / $^{-0.030}_{-0.076}$
18	Arm as individual part	276 $^{0}_{-0.5}$	276 $^{0}_{-0.5}$
	When press fitting bushing	310	310
19	Min.	1547	1547
	Max.	2560	2560

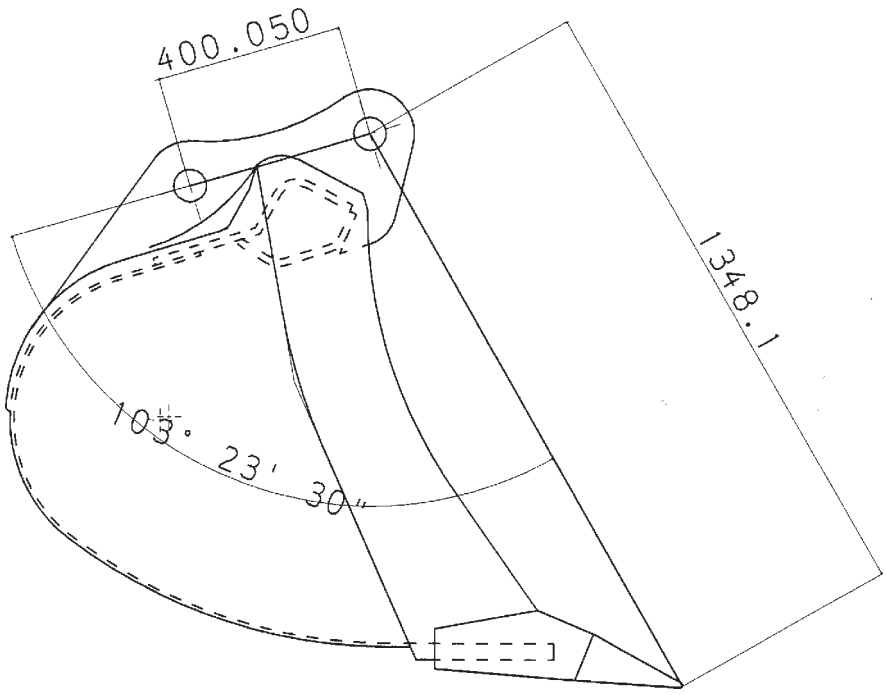
1. BUCKET



A–A

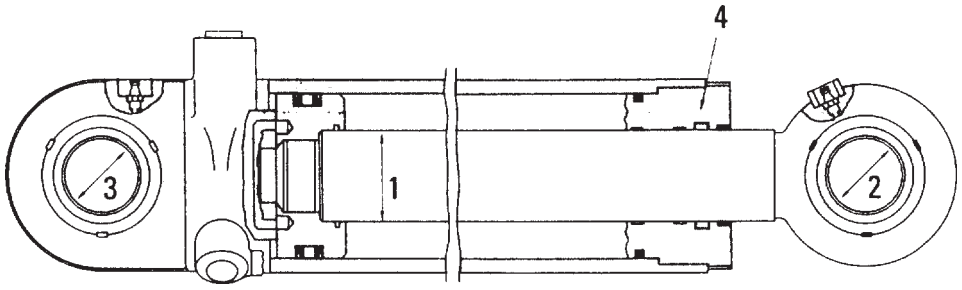


SAP00447



No. \ Model	PW170ES-6k
3	103° 23'
4	400
5	1348
7	-
9	ø70 $^{+0.3}_{+0.2}$
10	311.5 $^{+0.2}_{0}$
11	50
12	96
13	440 $^{+1}_{0}$
14	ø18
15	ø130
16	ø130
17	440 $^{+0.1}_{0}$
18	ø18
19	R95
20	R95
21	311.5 $^{+0.2}_{0}$
22	96

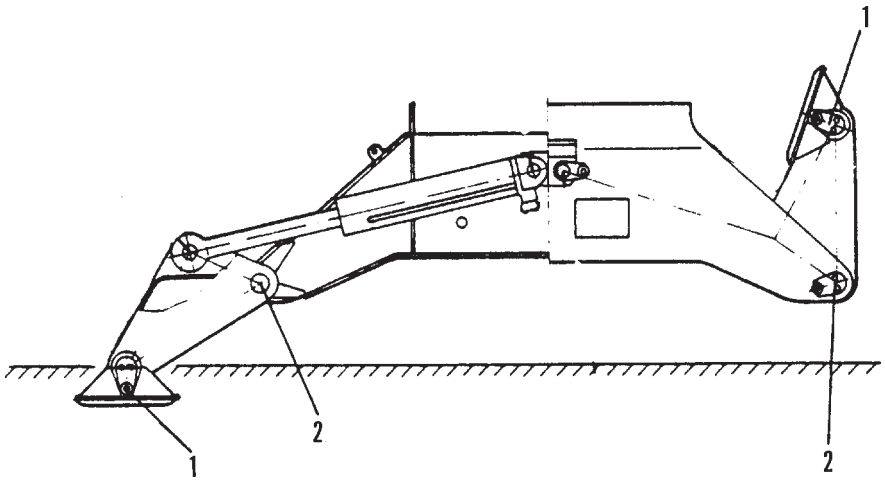
DOZER BLADE AND OUTRIGGERS HYDRAULIC CYLINDERS



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	
		Outrigger					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	
		Outrigger	-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	
		Outrigger	-0.030 -0.100	0 -0.015	0.030 0.115	0.30	60	
4	Cylinder head torque	Blade					800Nm	
		Outrigger					800Nm	

OUTRIGGER BUSH PINS



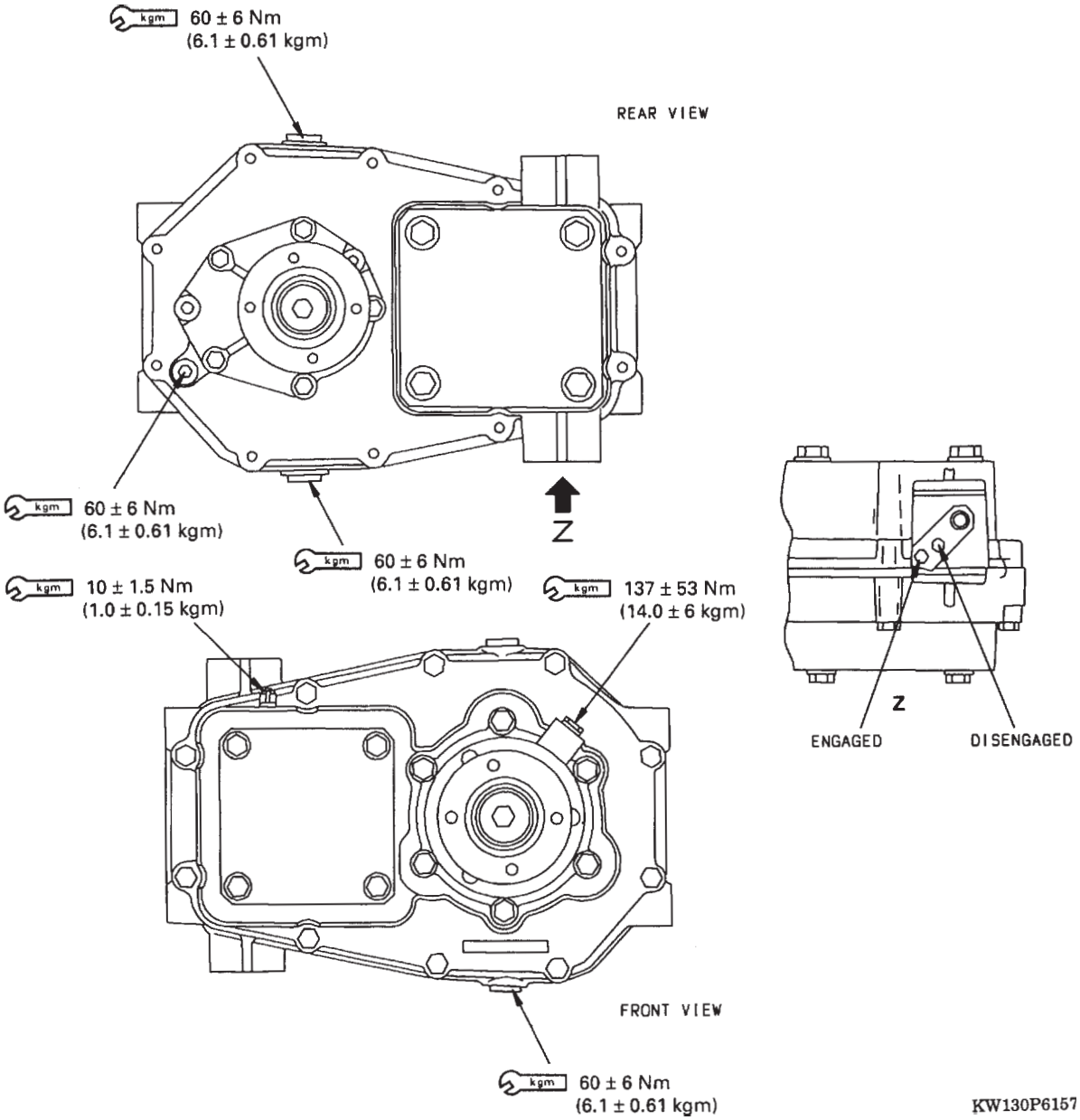
Unit: mm

No.	Check item	Criteria			Remedy
1	Pin	Pin dia	Max. undersize when new	Max. permissible play	
		45	-0.064	0.02	
2	Pin	70	-0.10	0.023	

TRANSMISSION

1. Oil filling kgm 60 ± 6Nm (6.1 ± 0.61 kgm)
2. Oil level kgm 60 ± 6Nm (6.1 ± 0.61 kgm)
3. Oil drain kgm 60 ± 6Nm (6.1 ± 0.61 kgm)
4. Oil brake connection port kgm 137 ± 53Nm (14.0 ± 6 kgm)
5. Oil breather kgm 10 ± 1.5Nm (1.0 ± 0.15 kgm)

Park brake wear limit
Brake disk thickness:
new = 2.38 ~ 2.40 (mm)
repair limit = 1.90 ~ 2.10 (mm)



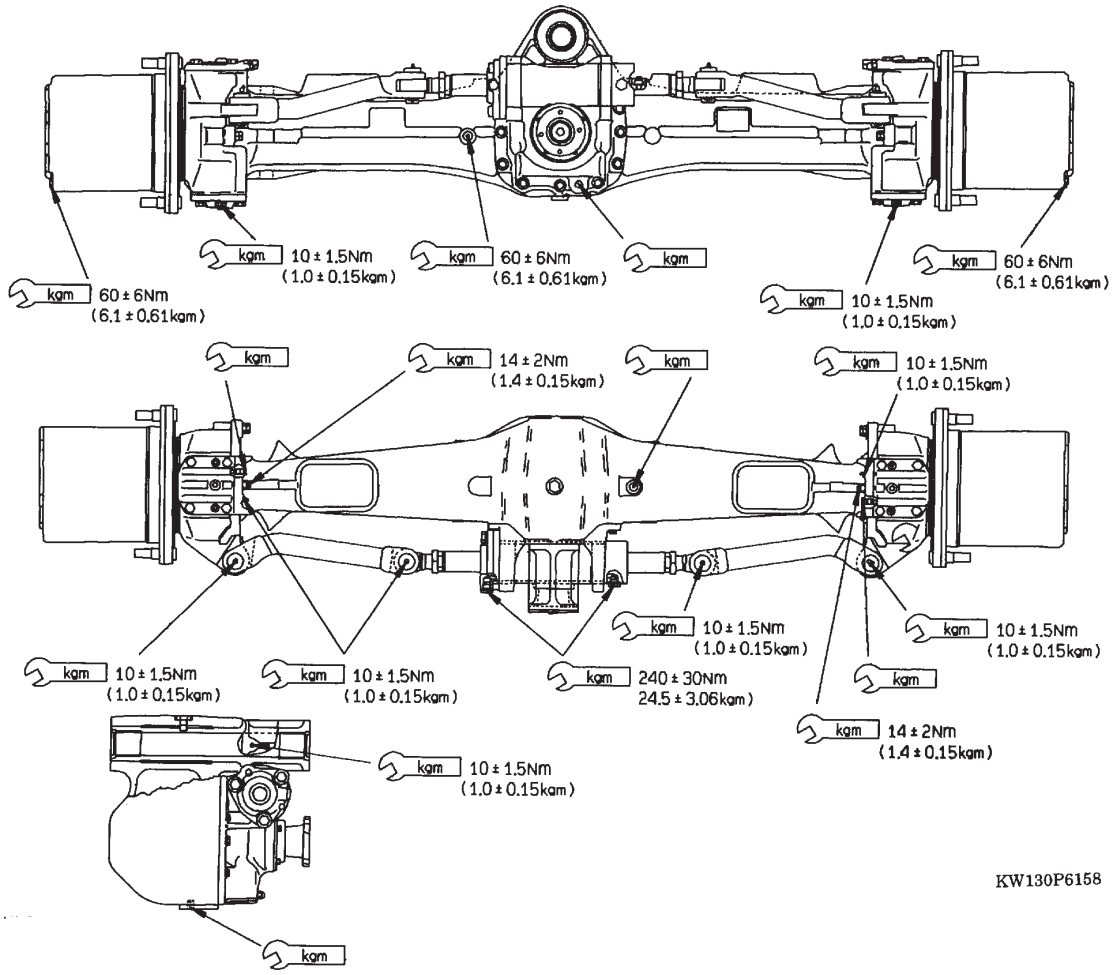
LUBRICATION

Filling: use oil SAE 20W-30 that meets the specification SAE-J306C, API GL4 or GL5

Oil quantity: 1 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 ± 6Nm (6.1 ± 0.61 kgm)
2. Differential oil filling and level plug kgm 60 ± 6Nm (6.1 ± 0.61 kgm)
3. Differential drain plug kgm 60 ± 6Nm (6.1 ± 0.61 kgm)
4. Brake control fluid inlet port kgm 14 ± 2Nm (1.4 ± 0.15 kgm)
5. Brake circuit bleeding kgm 14 ± 2Nm (1.4 ± 0.15 kgm)
6. Axle beam oil breather kgm 5 ± 1Nm (0.51 ± 0.5 kgm)
7. Lubrication point kgm 10 ± 1.5Nm (1.0 ± 0.15 kgm)
8. Steering cylinder feeding kgm 240 ± 30Nm (24.5 ± 3.06 kgm)



LUBRICATION

Filling: use oil SAE 80W-90 that meets the specification SAE-J306C, API GL5

Oil quantity
- differential: 15 litres
- epicyclic reduction (each): 2.5 litres

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 bisuphide
Applications: every 250 hours.

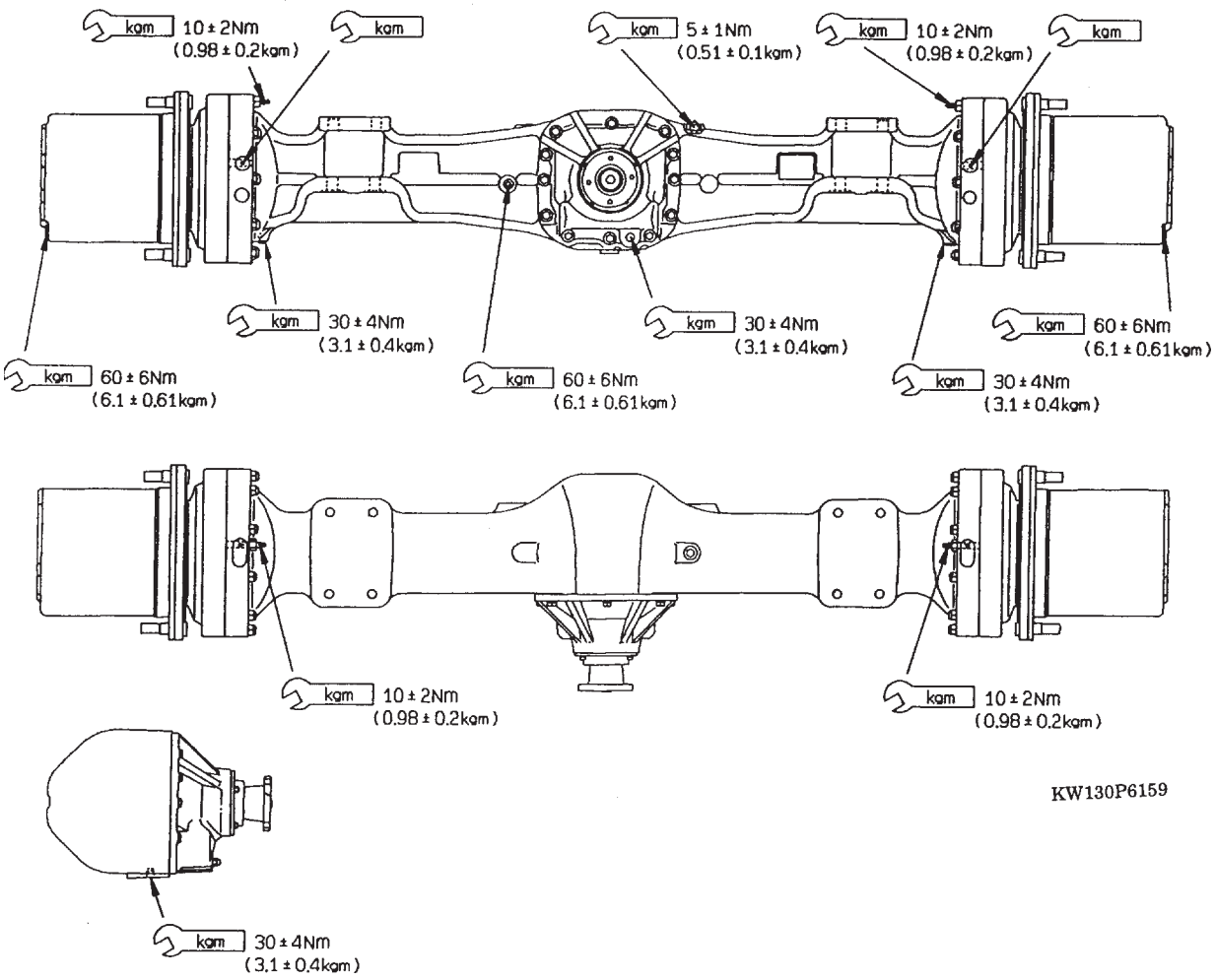
BRAKES CONTROL

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 ± 6Nm (6.1 ± 0.61 kgm)
2. Differential oil filling and level plug kgm 60 ± 6Nm (6.1 ± 0.61 kgm)
3. Differential drain plug kgm 60 ± 6Nm (3.1 ± 0.4 kgm)
4. Brake control liquid inlet port kgm 14 ± 2Nm (1.4 ± 0.15 kgm)
5. Brake circuit bleeding kgm 10 ± 2Nm (0.98 ± 0.2 kgm)
6. Axle beam oil breather kgm 5 ± 1Nm (0.51 ± 0.1 kgm)



LUBRICATION

Filling: use oil SAE 80W-90 that meets the specification SAE-J306C, API GL5

Oil quantity
- differential: 20 litres
- epicyclic reduction (each): 2.7 litres

Oil checking and changes:
- Initial change at 250 hours
- Subsequent changes every 2000 hours
- Inspection of level every 250 hours

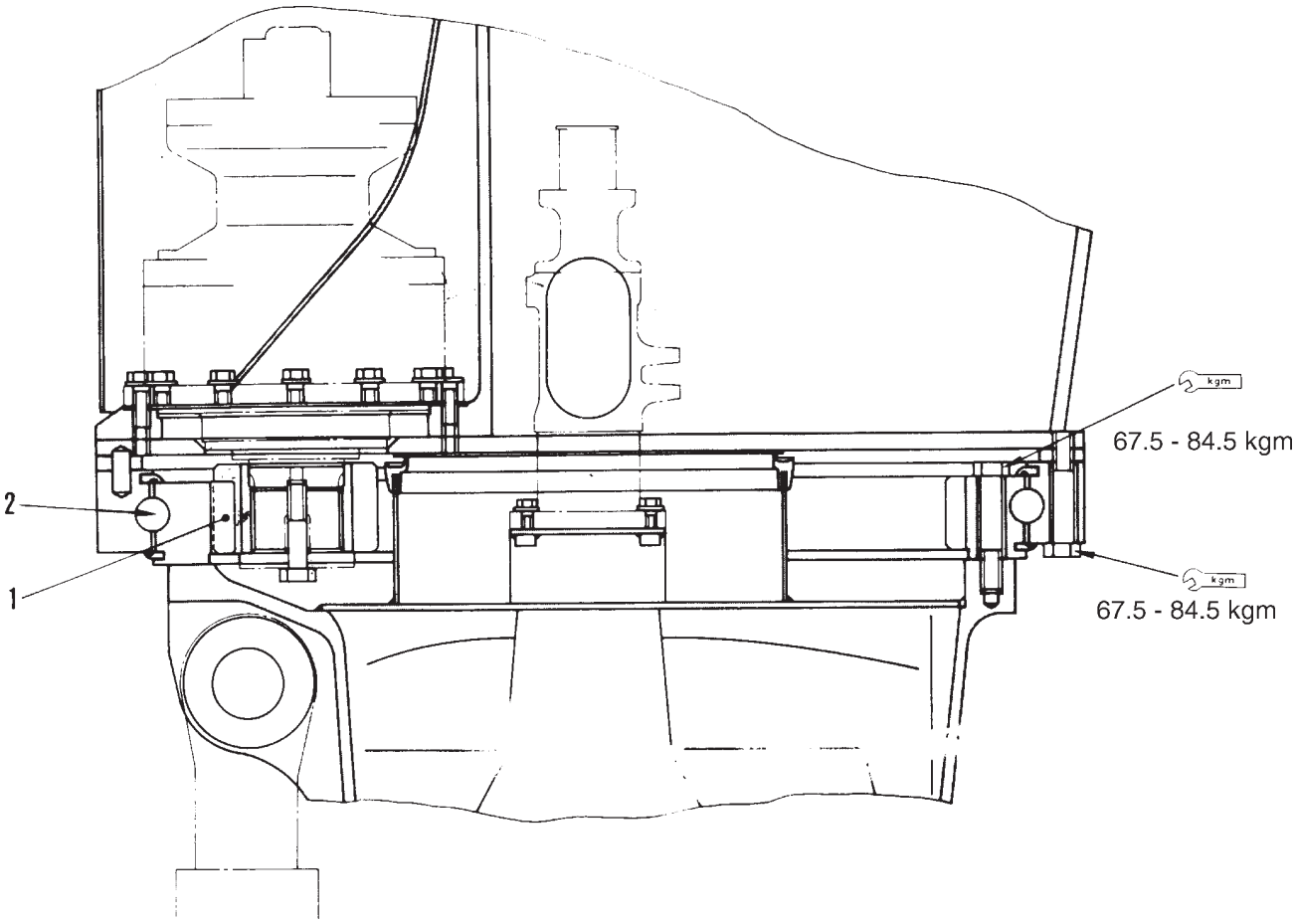
BRAKES CONTROL

Filling: use mineral oil

Oil quantity necessary for activating:
- min 5.23 cm^3 x 2
- max 15.68 cm^3 x 2

ARM ROTATION CIRCLE

PW170ES-6K



Unit: mm

No.	Check item	Criteria		Remedy
1	Backlash between swing pinion and swing circle	Standard clearance	Clearance limit	Replace
		*	*	
2	Clearance in bearing in axial direction	0.08 - 0.25		