

# SHOP MANUAL

## KOMATSU

### D31E, P, PL, PLL-18

### D31P-18A

### D31S, Q-18

### D37E, P-2

MACHINE MODEL	SERIAL No.	MACHINE MODEL	SERIAL No.
D31E-18	40001 and up	D31S-18	40001 and up
D31P-18	40001 and up	D31Q-18	40001 and up
D31P-18A	40001 and up	D37E-2	1501 and up
D31PL-18	40001 and up	D37P-2	1501 and up
D31PLL-18	40001 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.
- D31-18 and D37-2 mount the 6D95L and S6D95L engine. For details of the engine, see the 95 Series Engine Shop Manual.

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## IMPORTANT SAFETY NOTICE

Proper service and repair is extremely important for the safe operation of your machine. The service and repair techniques recommended by Komatsu and described in this manual are both effective and safe methods of operation. Some of these operations require the use of tools specially designed by Komatsu for the purpose.

To prevent injury to workers, the symbols  and  are used to mark safety precautions in this manual. The cautions accompanying 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.



## SAFETY

### GENERAL PRECAUTIONS

Mistakes in operation are extremely dangerous. Read the Operation and Maintenance Manual 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 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 work 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 places 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 filler 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 the correct places. Use a hoist or 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 fuel or oil drips on to 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, use only 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 they will not be damaged by contact with other 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 particularly 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 measuring hydraulic pressure, check that the measuring tool is correctly assembled before 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.

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## FOREWORD

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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 chapters for each main group of components; these chapters are further divided into the following sections.

### **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 each 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 specifications contained in this shop manual are subject to change at any time and without any advance notice. Contact your KOMATSU distributor for the latest information.**

## HOW TO READ THE SHOP MANUAL

### VOLUMES

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

**Chassis volume:** Issued for every machine model

**Engine volume:** Issued for each engine series

**Electrical volume** : } Each issued as one  
**Attachments volume** : } 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 attachment volumes are ready.

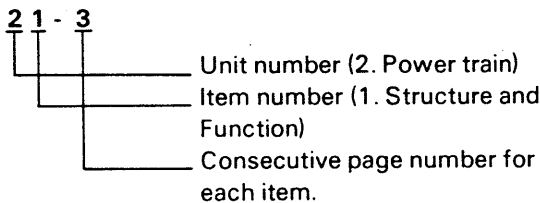
### DISTRIBUTION AND UPDATING

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

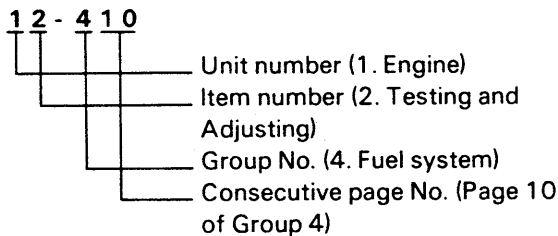
### FILING METHOD

1. See the page number on the bottom of the page. File the pages in correct order.
2. Following examples show how to read the page number.

Example 1 (Chassis volume):



Example 2 (Engine volume):



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

Example:



### REVISED EDITION MARK (① ② ③....)

When a manual is revised, an edition mark is recorded on the bottom outside corner of the pages.

### REVISIONS

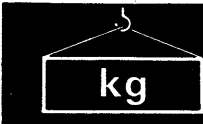
Revised pages are shown at the LIST OF REVISED PAGES on the between the title page and SAFETY page.


### SYMBOLS

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

Symbol	Item	Remarks
	Safety	Special safety precautions are necessary when performing the work.
		Extra special safety precautions are necessary when performing the work because it is under internal pressure.
	Caution	Special technical precautions or other precautions for preserving standards are necessary when performing the work.
	Weight	Weight of parts or systems. Caution necessary when selecting hoisting wire, or when working posture is important, etc.
	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



**⚠** Heavy parts (25 kg or more) must be lifted with a hoist etc. In the **Disassembly and Assembly** section, every part weighing 25 kg or more is indicated clearly with the symbol 

1. If a part cannot be smoothly removed from the machine by hoisting, the following checks should be made:

- Check for removal of all bolts fastening the part to the relative parts.
- Check for existence of another part causing interference with the part to be removed.

## 2. Wire ropes

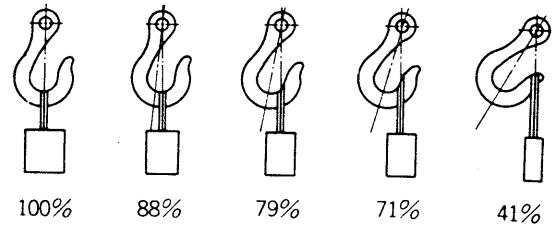
1) Use adequate ropes depending on the weight of parts to be hoisted, referring to the table below:

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 maximum strength at the middle portion.



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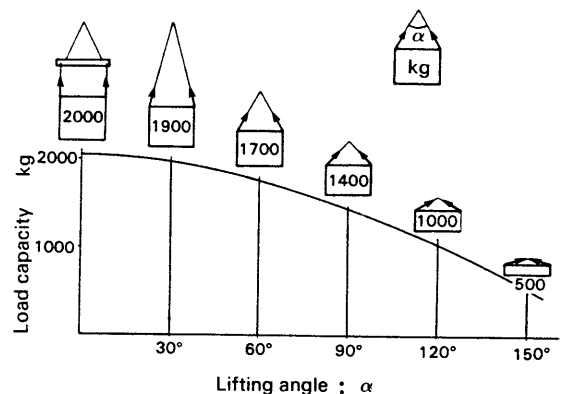
3) Do not sling a heavy load with one rope alone, but sling with two or more ropes symmetrically wound on to the load.

**⚠** 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 hanging 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°.





FS0065



## STANDARD TIGHTENING TORQUE

### 1. STANDARD TIGHTENING TORQUE OF BOLTS AND NUTS

The following charts give the standard tightening torques of bolts and nuts. Exceptions are given in sections of "Disassembly and Assembly".

Thread diameter of bolt (mm)	Width across flat (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

This torque table does not apply to the bolts with which nylon packings or other non-ferrous metal washers are to be used, or which require tightening to otherwise specified torque.

★ Nm (newton meter): 1Nm ≅ 0.1 kgm

### 2. TIGHTENING TORQUE OF SPLIT FLANGE BOLTS

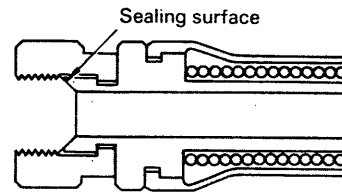
Use these torques for split flange bolts.

Thread diameter of bolt (mm)	Width across flats (mm)	Tightening torque	
		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

## STANDARD TIGHTENING TORQUE

### 3. TIGHTENING TORQUE FOR NUTS OF FLARED

Use these torques for nut part of flared.



FS0068

Thread diameter of nut part (mm)	Width across flats of nut part (mm)	Tightening torque	
		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

## COATING MATERIALS

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

Nomenclature	Komatsu code	Applications
Adhesives	LT-1A	Used to apply rubber pads, rubber gaskets, and cork plugs.
	LT-1B	Used to apply resin, rubber, metallic and non-metallic parts when a fast, strong seal is needed.
	LT-2*	Preventing bolts, nuts and plugs from loosening and leaking oil.
	LT-3	Provides an airtight, electrically insulating seal. Used for aluminum surfaces.
Liquid gasket	LG-1	Used with gaskets and packings to increase sealing effect.
	LG-3	Heat-resistant gasket for precombustion chambers and exhaust piping.
	LG-4	Used by itself on mounting surfaces on the final drive and transmission cases. (Thickness after tightening: 0.07 – 0.08 mm)
	LG-5	Used by itself to seal grease fittings, tapered screw fittings and tapered screw fittings in hydraulic circuits of less than 50 mm in diameter.
Antifriction compound (Lubricant including molybdenum disulfide)	LM-P	Applied to bearings and taper shafts to facilitate press-fitting and to prevent sticking, burning or rusting.
Grease (Lithium grease)	G2-LI	Applied to bearings, sliding parts and oil seals for lubrication, rust prevention and facilitation of assembling work.
Vaseline	—	Used for protecting battery electrode terminals from corrosion.

\*LT-2 is also called LOCTITE in the shop manuals.





## 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: 05WB indicates a cable having a nominal number 05 and white coating with black stripe.

### CLASSIFICATION BY THICKNESS


Nominal number	Copper wire			Cable O.D. (mm)	Current rating (A)	Applicable circuit
	Number strands	Dia. of strands (mm)	Cross section (mm <sup>2</sup> )			
01	11	0.32	0.88	2.4	12	Starting, lighting, signal etc.
02	26	0.32	2.09	3.1	20	Lighting, signal etc.
05	65	0.32	5.23	4.6	37	Charging 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	Circuits		Starting	Charging	Lighting	Signal	Instrument	Other
	Classification							
1	Primary	Code	B	W	R	G	Y	L
		Color	Black	White	Red	Green	Yellow	Blue
2		Code	BW	WR	RW	GW	YR	LW
		Color	Black & White	White & Red	Red & White	Green & White	Yellow & Red	Blue & White
3	Auxiliary	Code	BY	WB	RB	GR	YB	LR
		Color	Black & Yellow	White & Black	Red & Black	Green & Red	Yellow & Black	Blue & Red
4		Code	BR	WL	RY	GY	YG	LY
		Color	Black & Red	White & Blue	Red & Yellow	Green & Yellow	Yellow & Green	Blue & Yellow
5		Code	—	WY	RG	GB	YL	LB
		Color	—	White & Yellow	Red & Green	Green & Black	Yellow & Blue	Blue & Black
6		Code	—	WG	RL	GL	YW	
		Color	—	White & Green	Red & Blue	Green & Blue	Yellow & White	



# WEIGHT TABLE D31E,P,PL-18, D31P-18A

 This weight table is a guide for use when transporting or handling components.

Unit: kg

Machine Model	D31E-18	D31P-18A	D31P-18	D31PL-18	D31PLL-18
Serial No.	40001 and up	40001 and up	40001 and up	40001 and up	40001 and up
Engine and main clutch assembly	450	450	450	450	450
• Engine assembly	420	420	420	420	420
• Main clutch assembly	27	27	27	27	27
Radiator assembly	37	37	37	37	37
Fuel tank assembly (with fuel)	175	175	175	175	175
HYDOROSHIFT transmission assembly	232	232	232	232	232
• Modulating valve assembly	6	6	6	6	6
• Speed and inching valve assembly	8	8	8	8	8
Bevel gear shaft and steering clutch assembly	140	140	140	140	140
• Steering clutch assembly (each side)	48	48	48	48	48
• Brake band assembly (each side)	9	9	9	9	9
• Bevel gear shaft	9	9	9	9	9
• Bevel gear	15	15	15	15	15
Steering control valve assembly	9	9	9	9	9
Final drive case (each side)	45	45	45	69	69
Sprocket (each side)	41	41	41	41	41
Main frame assembly	690	700	700	720	720
• Main frame and steering case	623	624	624	624	624
• Sprocket shaft (each side)	32	37	32	45	45
Track group assembly (each side)	478	523	530	530	665
• Track frame (each side)	106	127	132	132	163
• Idler assembly (each side)	95	95	95	95	95
• Track roller assembly (each)	27	27	27	27	27
• Carrier roller assembly (each)	20	20	20	20	20
Track shoe assembly (each side)	880	1,350	1,350	1,610	1,800
Cross bar	106	128	106	106	106

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Unit: kg

Machine Model	D31E-18	D31P-18A	D31P-18	D31PL-18	D31PLL-18
Serial No.	40001 and up	40001 and up	40001 and up	40001 and up	40001 and up
Hydraulic tank assembly	70	70	70	70	70
Hydraulic control valve assembly	25	25	20	20	20
Blade lift cylinder assembly (each side)	24	24	34	34	34
Blade tilt cylinder assembly	18	18	22	22	22
Blade angle cylinder assembly (each side)	24	24	—	—	—
Power angle and tilt/dozer assembly	726	787			
• Blade	360	412	—	—	—
• U-frame	261	261			
Straight tilt/dozer assembly			678		
• Blade			349		
• Straight frame (each side)	—	—	82		
• Blade tilt cylinder assembly			22		
• Tilt brace			14		
Radiator guard	51	51	152	152	
Engine underguard	42	42	42	42	42
Transmission underguard	36	39	39	39	39
Hood	38	38	39	39	39
Loader frame	116	116	98	98	98
Operator's seat assembly	21	21	21	21	21
Canopy assembly	95	95	95	95	95

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# WEIGHT TABLE D37E, P-2



This weight table is a guide for use when transporting or handling components.

Unit: kg

Machine Model	D37E-2		D37P-2	
	1501 – 2500	2501 and up	1501 – 2000	2001 and up
Engine and damper assembly	450	460	450	460
• Engine assembly	420	430	420	430
• Damper assembly	27	27	27	27
Radiator assembly	37	40	37	40
Fuel tank assembly	175	175	175	175
HYDROSHIFT transmission assembly	232	232	232	232
• Modulating valve assembly	6	6	6	6
• Speed and inching valve assembly	8	8	8	8
Bevel gear shaft and steering clutch assembly	140	140	140	140
• Steering clutch assembly (each side)	48	48	48	48
• Brake band assembly (each side)	9	9	9	9
• Bevel gear shaft	9	9	9	9
• Bevel gear	15	15	15	15
Steering control valve assembly	9	9	9	9
Final drive case (each side)	45	45	53	53
Sprocket assembly (each side)	41	41	41	41
Main frame assembly	660	660	670	670
• Main frame and steering case assembly	596	596	596	596
• Sprocket shaft (each side)	32	32	37	37
Track group assembly (each side)	523	523	523	663
• Track frame (each side)	127	127	127	197
• Idler assembly (each side)	95	95	95	95
• Track roller assembly (each)	27	27	27	27
• Carrier roller assembly (each)	20	20	20	20
Track shoe assembly	980	980	1,350	1,350
Cross bar	106	106	128	128

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Unit: kg

Machine Model	D37E-2		D37P-2	
	1501 – 2500	2501 and up	1501 – 2000	2001 and up
Hydraulic tank assembly	70	70	70	70
Hydraulic control valve assembly	25	25	25	25
Blade lift cylinder assembly (each)	24	24	24	24
Blade tilt cylinder assembly	18	18	18	18
Blade angle cylinder assembly (each)	24	24	24	24
Power angle and tilt dozer assembly	749	749	770	770
• Blade	383	383	424	424
• U-frame	260	260	260	260
Radiator guard	51	51	51	51
Engine underguard	42	42	42	42
Transmission underguard	39	39	39	39
Hood	38	37	38	37
Loader frame	123	124	123	124
Operator's seat assembly	21	21	21	21

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# WEIGHT TABLE D31S,Q-18

 This weight table is a guide for use when transporting or handling components.

Unit: kg

Machine Model	D31S-18	D31Q-18
Serial No.	40001 and up	40001 and up
Engine and damper assembly	450	450
• Engine assembly	420	420
• Damper assembly	27	27
Radiator assembly	37	37
Fuel tank assembly (with fuel)	175	175
HYDROSHIFT transmission assembly	232	232
• Modulating valve assembly	6	6
• Speed and inching valve assembly	8	8
Bevel gear shaft and steering clutch assembly	140	140
• Steering clutch assembly (each side)	48	48
• Brake band assembly (each side)	9	9
• Bevel gear shaft	9	9
• Bevel gear	15	15
Steering control valve assembly	9	9
Final drive case (each side)	45	53
Sprocket (each side)	41	41
Main frame assembly	680	680
• Main frame and steering case	612	612
• Sprocket shaft (each side)	32	37
Track group assembly (each side)	478	478
• Track frame (each side)	106	106
• Idler assembly (each side)	95	95
• Track roller assembly (each)	27	27
• Carrier roller assembly (each)	20	20

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Unit: kg

Machine Model	D31S-18	D31Q-18
Serial No.	40001 and up	40001 and up
Track shoe assembly (each side)	1,000	1,210
Cross bar	106	106
Hydraulic tank assembly	70	70
Hydraulic control valve assembly	20	20
Bucket lift cylinder assembly (each side)	43	43
Bucket dump cylinder assembly (each side)	33	33
Lift arm assembly	487	487
Bucket dump lever (Inside)	23	23
Bucket dump lever (Outside)	26	26
Bucket assembly (with tooth)	357	384
Radiator guard	51	51
Engine underguard	42	42
Transmission underguard	36	36
Hood	38	38
Loader frame	282	282
Operator's seat assembly	21	21
Canopy assembly	95	95

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# FUEL, COOLANT AND LUBRICANTS

## PROPER SELECTION OF FUEL, COOLANT AND LUBRICANTS

RESERVOIR	KIND OF FLUID	AMBIENT TEMPERATURE					CAPACITY (ℓ)	
		14 -10	32 0	50 10	68 20	86° F 30° C	Specified	Refill
Engine oil pan		SAE 30					D31E,P,PL PLL-18 D31P-18A D31S,Q-18 11 D37E,P-2 11.5	9 9.5
		SAE 10W						
		SAE 10-30						
		SAE 15W-40						
Transmission case Transfer case (incl. bevel gear case) Steering clutch case Final drive case (each)	Engine oil						16 17.5	13 17
		SAE 30					30	30
		SAE 10W					D31E,P,S-18 D37E-2: 9.5	9.5
							D31P-18A, D31Q-18, D37P-2: 12 D31PL,PLL -18: 15	12 15
Hydraulic tank		SAE 10W					D31E,P-18 D31P-18A D31S,Q-18 D37E,P-2 49 D31P,PL, PLL-18: 45	33 33
		SAE 10W-30						
		SAE 15W-40						
Idler (each) Track roller (each) Carrier roller (each)		SAE 30					0.15 0.15 0.115	0.15 0.15 0.115
Fuel tank	Diesel fuel	*					118	-
		ASTM D975 No.2						
Cooling system	Water	Add antifreeze					22	-

\* ASTM D975 No.1

### NOTE:

ASTM: American Society of Testing and Material

SAE: Society of Automotive Engineers

API: American Petroleum Institute

Specified capacity: Total amount of oil including oil for components and oil in piping.

Refill capacity: Amount of oil needed to refill system during normal inspection and maintenance.

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

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

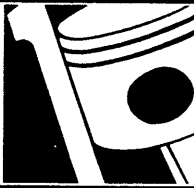
(2) When starting the engine in an atmospheric temperature of lower than 0°C, be sure to use engine oil of SAE10W, SAE10W-30 and SAE15W-40, even though an atmospheric temperature goes up to 10°C more or less in the day time.

(3) Use API classification CD as engine oil and if API classification CC, reduce the engine oil change interval to half.







# ENGINE

## 12 TESTING AND ADJUSTING



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Adjusting fuel control lever .....	12-10

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-  When carrying out testing, adjusting or troubleshooting, stop the machine on level ground, apply the lock levers and block the tracks.
-  When working in groups, use agreed signals and do not allow unauthorized persons near the machine.
-  When checking the water level in the radiator, wait for the water to cool. Do not remove the radiator cap while the water is hot. Boiling water may spurt out.
-  Be careful not to get caught in rotating parts.

# TESTING AND ADJUSTING DATA

D31-18

D37E-2 Serial No. 1501 - 2500

D37P-2 Serial No. 1501 - 2000

Applicable machine model			D31-18, D37-2	
Engine model			6D95L-1, S6D95L-1	
Item	Condition	Unit	Standard value	Permissible value
Engine speed	High idling speed Low idling speed Rated speed	rpm	2600 - 2700 700 - 750 2350	2600 - 2700 700 - 750 2345 - 2355
Exhaust gas color	Quick acceleration At high idling	Bosch scale	Max. 4.0 (*1: 4.5) Max. 3.0 (*1: 2.5)	6.0 (*1: 6.5) 4.0 (*1: 3.5)
Valve clearance	(at cold) Intake valve Exhaust valve	mm	0.35 0.50	- -
Compression pressure	Oil temperature: 40 - 60°C Engine speed: 320 - 360 rpm (SAE30 oil)	kg/cm <sup>2</sup>	Min. 30	21
Blow-by pressure	Water temperature: Inside operating range At rated speed (SAE30 oil)	mmH <sub>2</sub> O	Max. 50	100
Oil pressure	(Water temperature: Inside operating range) At high idling (SAE30) At low idling (SAE30) At high idling (SAE10W) At low idling (SAE10W)	kg/cm <sup>2</sup>	3.0 - 6.0 Min. 1.0 3.0 - 6.0 Min. 0.8	2.5 0.7 2.5 0.7
Oil temperature	All speed (oil in oil pan)	°C	80 - 110	120
Fuel injection timing	B.T.D.C.	degree	16 ± 1 *2: 18 ± 1	16 ± 1 *2: 18 ± 1
Fan belt tension	Deflection when pushed with a force of 6 kg (Alternator side)	mm	10 *2: 8	8 - 12 *2: 6 - 10

\*1: For F37-2

\*2: Only for S6D95L-1

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**D37E-2 Serial No. 2501 and up**  
**D37P-2 Serial No. 2001 and up**

Applicable machine model			D37-2	
Engine model			6D95L-1, S6D95L-1	
Item	Condition	Unit	Standard value	Permissible value
Engine speed	High idling speed Low idling speed Rated speed	rpm	2600 – 2700 700 – 750 2500	2600 – 2700 700 – 750 2500
Exhaust gas color	Quick acceleration At high idling	Bosch scale	Max. 5.0 Max. 2.5	7.0 3.5
Valve clearance	(at cold) Intake valve Exhaust valve	mm	0.35 0.50	— —
Compression pressure	Oil temperature: 40 – 60°C Engine speed: 320 – 360 rpm (SAE30 oil)	kg/cm <sup>2</sup>	Min. 30	21
Blow-by pressure	Water temperature: Inside operating range At rated speed (SAE30 oil)	mmH <sub>2</sub> O	Max. 50	100
Oil pressure	(Water temperature: Inside operating range) At high idling (SAE30) At low idling (SAE30) At high idling (SAE10W) At low idling (SAE10W)	kg/cm <sup>2</sup>	3.5 – 7.0 Min. 1.0 3.0 – 6.5 Min. 0.8	2.5 0.7 2.1 0.7
Oil temperature	All speed (oil in oil pan)	°C	80 – 110	120
Fuel injection timing	B.T.D.C.	degree	16 ± 1	16 ± 1
			※1: 18 ± 1	※1: 18 ± 1
Fan belt tension	Deflection when pushed with a force of 6 kg (Alternator side)	mm	10	8 – 12

※ 1: Only for S6D95L-1

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# TOOL LIST FOR TESTING AND ADJUSTING

No.	Testing and measuring item	Fault finding tool	Part No.	Remarks
1	Engine speed	Multi-tachometer	799-203-8000	Digital reading: 60 – 2,000 rpm (L range) 60 – 20,000 rpm (H range)
2	Water temperature, oil temperature	Digital temperature gauge or thermistor temperature gauge	799-101-6000 790-500-1300	– 50 – 1,200°C
3	Lubrication oil pressure	Hydraulic tester	799-101-5000	0 – 20 kg/cm <sup>2</sup>
4	Compression pressure	Compression gauge	795-502-1590	0 – 70 kg/cm <sup>2</sup>
		Adapter	795-502-1380	
5	Blow-by pressure	Blow-by checker	799-201-1504	0 – 500 mmH <sub>2</sub> O
6	Valve clearance	Feeler gauge	795-125-1370	0.35, 0.50 mm
7	Exhaust gas color	Handy smoke checker	799-201-9000	Dirtiness 0 – 70% with standard color (Dirtiness % x 1/10 = Bosch scale)
		Smoke meter	Commercially available	

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# ADJUSTING VALVE CLEARANCE


★ Adjust clearance between valve stem and rocker arm as follows.

1. Remove muffler (1) and the cylinder head cover.
2. Rotate the crankshaft in the normal direction. While watching the movement of the intake valve of the No. 6 cylinder, bring the No. 1 cylinder into the top dead center position of the compression stroke and align the "1.6 TOP" mark on the crankshaft pulley with pointer (2).
3. When No. 1 cylinder is top dead center of compression stroke, adjust the valve clearance for valves marked ● in the valve arrangement chart. When No. 6 cylinder is top dead center of compression stroke, adjust the valve clearance for valves marked ○ in the valve arrangement chart.

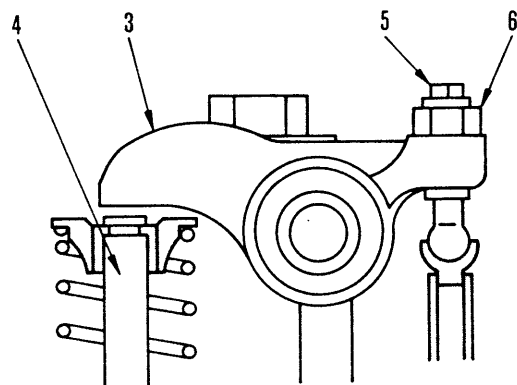
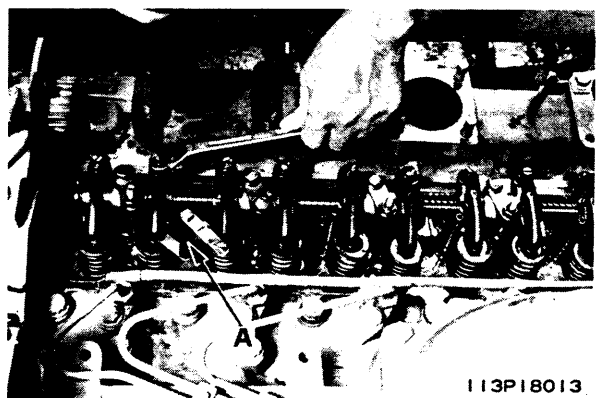
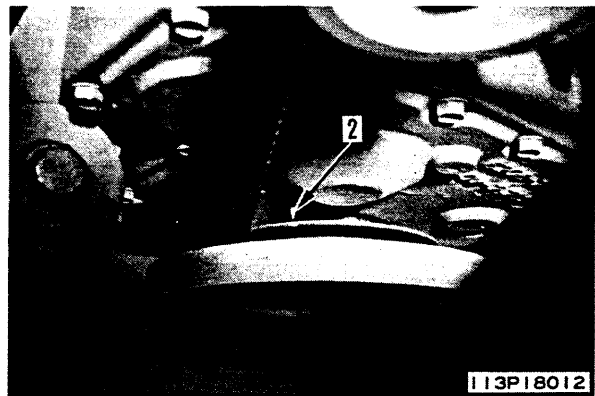
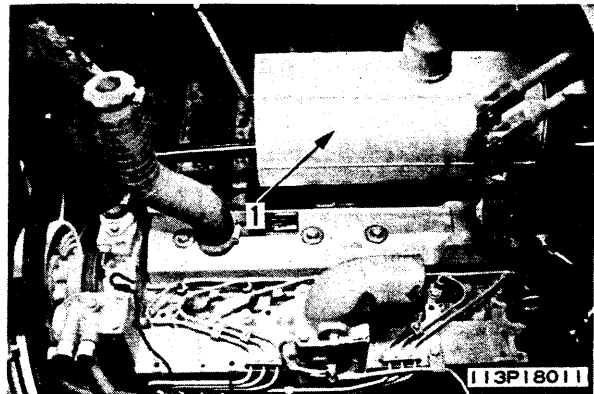
★ Valve arrangement chart

Cylinder No.	1	2	3	4	5	6
Intake valve	●	●	○	●	○	○
Exhaust valve	●	○	●	○	●	○

4. To adjust the valve clearance, loosen locknut (6) on adjustment screw (5), insert feeler gauge A corresponding to the specified clearance between valve stem (4) and rocker arm (3), and adjust the clearance with the adjustment screw until the feeler gauge can slide lightly.
5. Rotate the crankshaft in the normal direction by one revolution and adjust the valve clearance for the remaining valves marked ○.
6. After the clearance is properly adjusted, tighten the locknut to secure the adjustment screw.

 Locknut:  $4.5 \pm 0.5$  kgm

- ★ Intake and exhaust valve clearances may be adjusted for each cylinder in the firing order by rotating the crankshaft  $120^\circ$  at a time in the normal direction.
- ★ Firing order is 1-5-3-6-2-4.
- ★ After tightening locknut, check valve clearance again.



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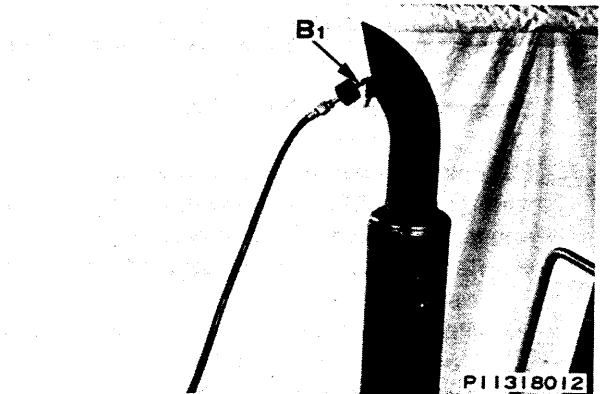
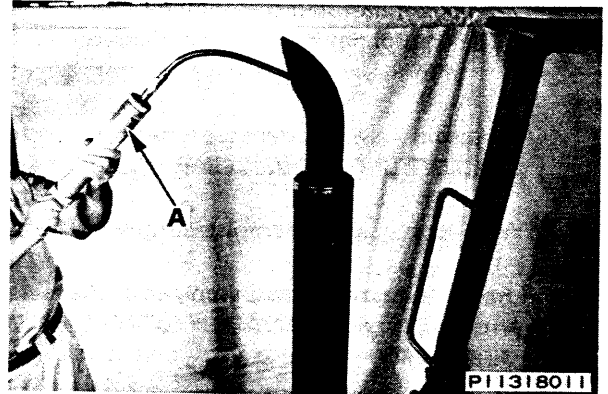
# MEASURING EXHAUST GAS COLOR

**!** When measuring the exhaust gas color, be careful not to touch the exhaust pipe.

- ★ Measure the exhaust gas color while engine is warm.  
(Oil temperature: 40 – 60°C)
- ★ If an exact figure is needed, use tool B.

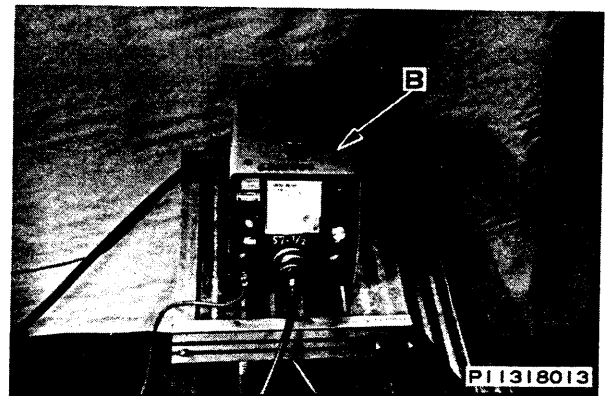
## 1. MEASURING BY HANDY SMOKE METER A

- 1) Loosen cap nut of handy smoke meter A and insert filter paper.
  - ★ Fit the filter paper carefully so that no exhaust gas escapes.
- 2) Insert the exhaust pipe into the exhaust gas suction port, accelerate the engine suddenly, and operate the handle to catch the exhaust gas on the filter paper.
- 3) Remove the filter paper, and compare it with the scale supplied to judge the exhaust gas color.



## 2. MEASURING BY SMOKE METER B

- 1) Insert probe A<sub>1</sub> in outlet of exhaust pipe (1) and secure to exhaust pipe with clip.
- 2) Connect probe hose, connector for accelerator switch and air hose to smoke meter B.
  - ★ The pressure of air supply should be less than 1.5 kg/cm<sup>2</sup>.
- 3) Connect power cable to power source.
  - ★ Check that the power switch is OFF before connecting the code.
- 4) Loosen cap nut of suction pump and insert filter paper.
- 5) Turn power switch ON.
- 6) Accelerate engine suddenly. At the same time, depress accelerator pedal, operate relief valve and catch exhaust gas color on filter paper.
- 7) Lay filter paper used to catch exhaust gas color on top of unused filter papers (10 sheet or more) inside filter paper holder, and read indicated value.



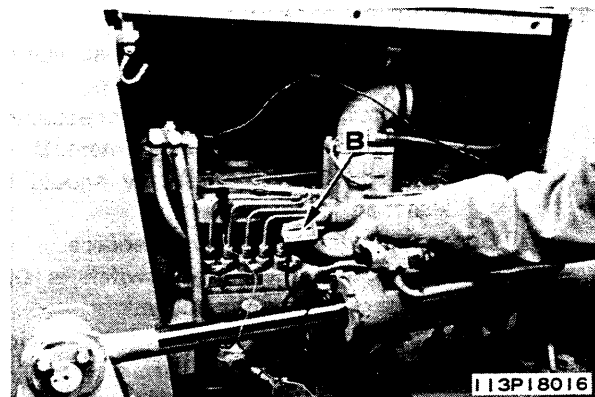
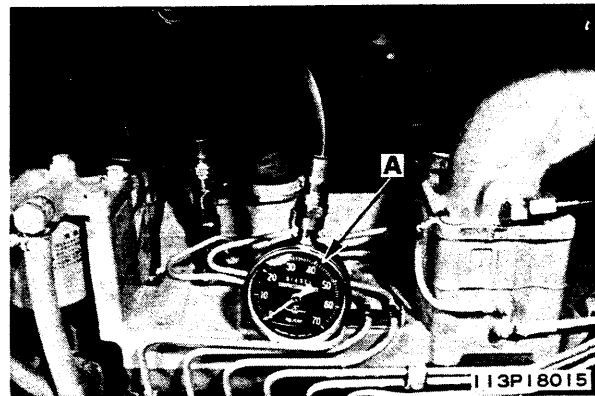
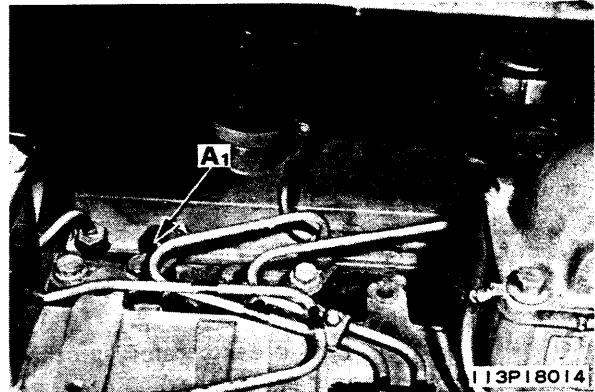
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# MEASURING COMPRESSION PRESSURE



When measuring the compression pressure, be careful not to touch the exhaust manifold or muffler, or to get caught in rotating parts.

1. Adjust the valve clearance properly. For details, see ADJUSTING VALVE CLEARANCE.
  2. Warm up engine. (Oil temperature: 40 – 60°C)
  3. Remove nozzle holder assembly to be measured. For details, see REMOVAL OF NOZZLE HOLDER ASSEMBLY.
  4. Install adapter  $A_1$  to the nozzle holder mount.
  5. Connect compression gauge  $A$  to the adapter  $A_1$ .
  6. Set tachometer  $B$  to fuel injection pipe.
  7. Place the fuel control lever in NO INJECTION position, crank the engine with the starting motor, and measure compression pressure.
    - ★ Read compression gauge when the pointer is stabilized.
    - ★ When measuring the compression pressure, measure the engine speed to confirm that it is within the specified range.
- ★ After measuring the compression pressure, install nozzle holder assembly. For details, see INSTALLATION OF NOZZLE HOLDER ASSEMBLY.

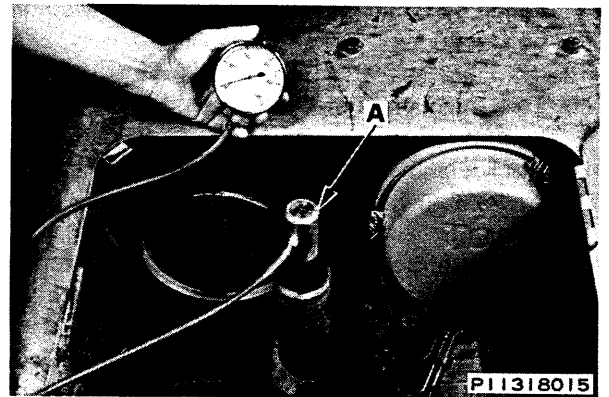
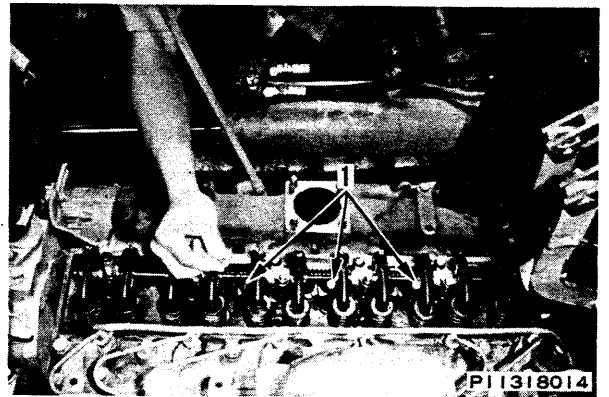


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## MEASURING BLOW-BY PRESSURE

**⚠** When measuring the blow-by pressure, be careful not to touch the exhaust manifold or muffler, or to get caught in rotating parts.

1. Warm up engine. (Water temperature is inside operating range.)
  2. Remove head cover, install plug on blow-by suction tube (1), then install head cover.
  3. Install adapter of blow-by checker A on oil filler.
  4. Connect blow-by checker A to adapter.
  5. Run engine at high idling speed, then measure blow-by pressure.
- ★ After measuring the blow-by pressure, remove plug on blow-by suction tube.

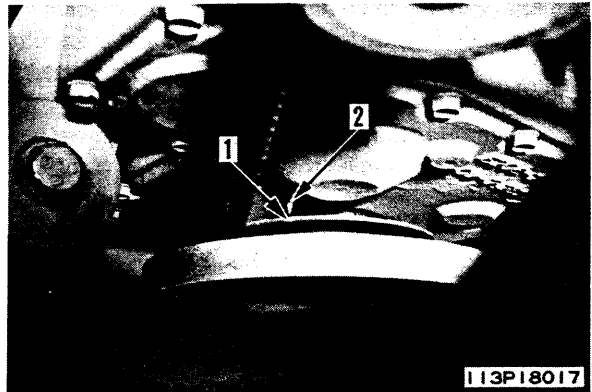


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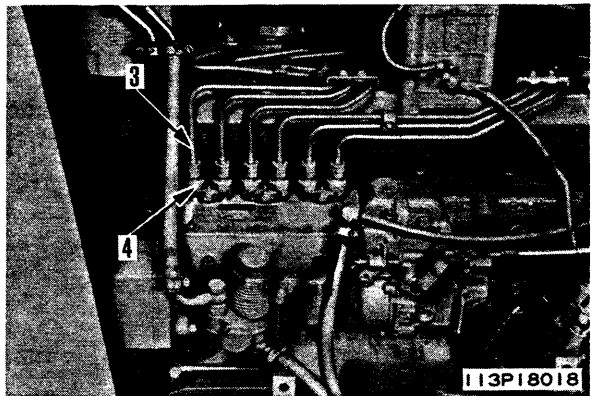
# ADJUSTING FUEL INJECTION TIMING

1. Align the "1.6" injection timing stamp line on crankshaft pulley (1) with pointer (2) by slowly rotating the crankshaft in the normal direction.



2. Disconnect fuel injection pipe (3) for the No. 1 cylinder.

3. Remove delivery valve holder (4), remove spring (6) and delivery valve (5) from delivery valve holder, and reassemble delivery valve holder (4).



4. Place the fuel control lever in FULL position.

5. Loosen nuts (7) on injection pump mounting flange slot, and loosen injection pump mounting bolts (8).

6. Turn injection pump outward, operating priming pump, slowly turn injection pump to cylinder block end, stop injection pump in the position where fuel flow out from delivery valve holder stops.

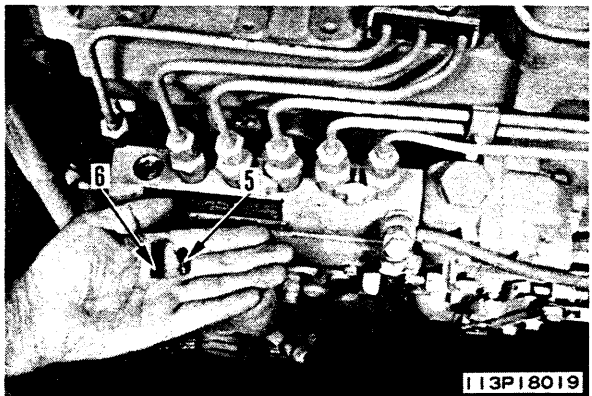
★ If fuel flow out does not stop when turn injection pump either directions, rotate crankshaft one more turn.

★ If turn injection pump outward, injection timing is retard. If turn injection pump cylinder block end, injection timing is advanced.

7. Tighten injection pump mounting bolts (8) in turn.


8. Tighten nuts (7) on injection pump mounting flange slot.

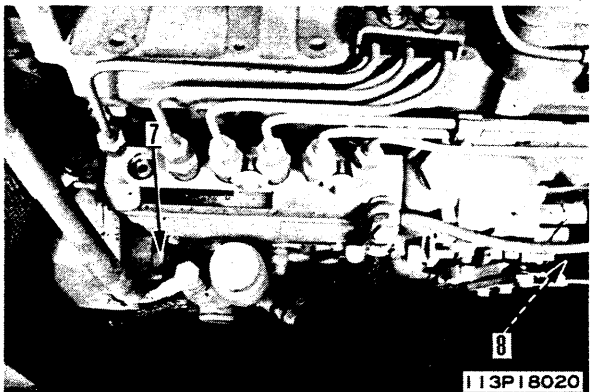
9. Remove delivery valve holder (4), assemble delivery valve (5) and spring (6), install delivery valve holder (4) again.



 Delivery valve holder:  $4.25 \pm 0.25$  kgm

10. Connect fuel injection pipe (3).

 Sleeve nut:  $2.4 \pm 0.1$  kgm

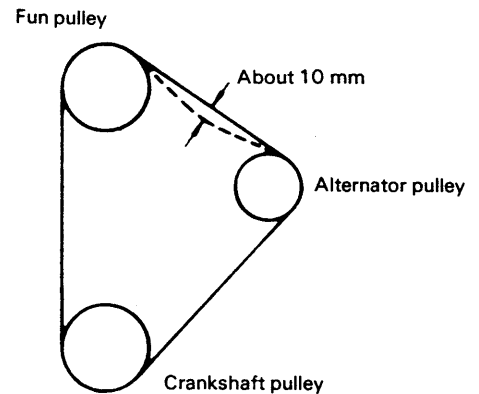


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# TESTING AND ADJUSTING FAN BELT TENSION

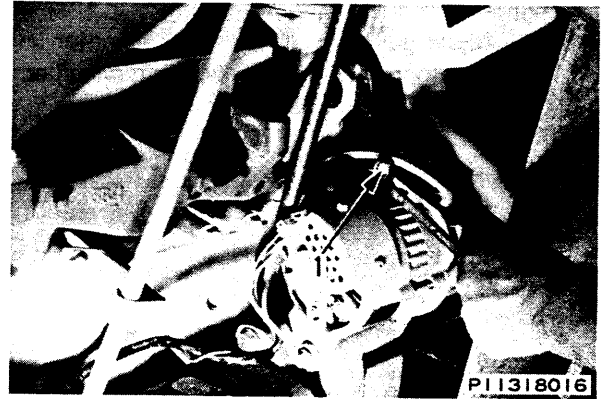
## TESTING FAN BELT TENSION

- Check the amount the fan belt deflects when pushed with a force of 6 kg at a point midway between the fan pulley and the alternator pulley.



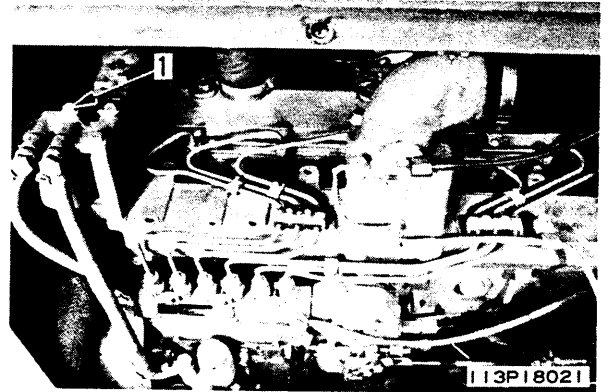
## ADJUSTING FAN BELT TENSION

- 1) Loosen the mounting bolt of the alternator assembly and belt tension adjustment bolt (1).
- 2) Using a bar, raise alternator and adjust fan belt tension.  
Tighten adjustment bolt (1), then tighten the mounting bolt.



## BLEEDING AIR FROM FUEL CIRCUIT

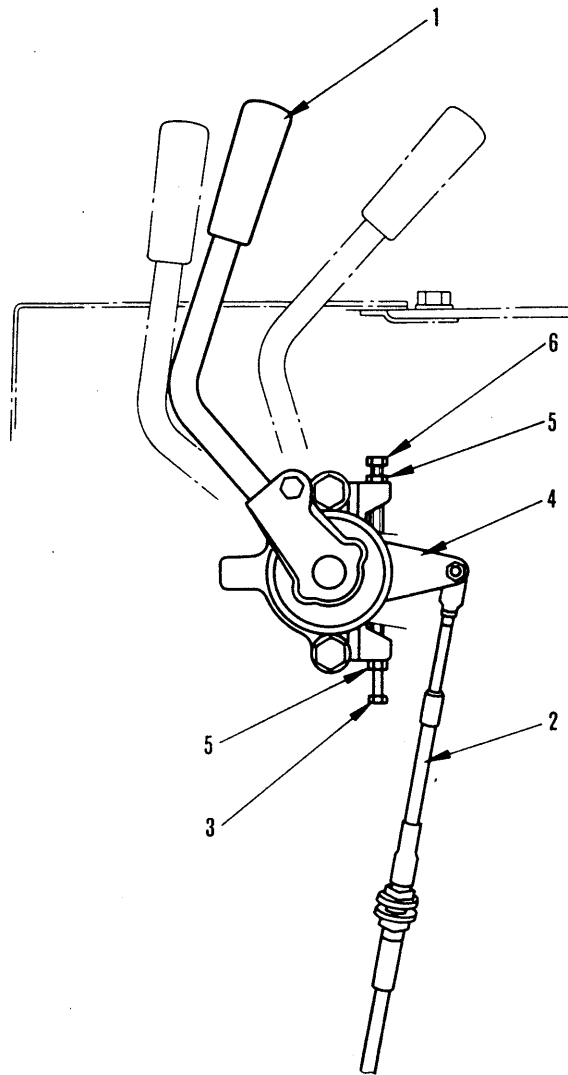
1. Automatic air bleeding  
Turn the starting switch key to the START position and crank the starting motor for 30 – 35 seconds. Repeat this procedure 2 – 3 times.  
★ Do not rotate the starting motor for more than 35 seconds continuously. Wait for 1 – 2 minutes before trying again.
2. Manual air bleeding
  - 1) Loosen plug (1), and operate the feed pump to bleed the air inside the piping.
  - 2) When no more bubbles come out with the fuel, tighten plug (1).



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# ADJUSTING FUEL CONTROL LEVER

1. After setting control lever (1) in notched part, set engine governor lever in idling position, then connect cable (2).
  - ★ Judge the position of the notched part from the clicking sound and difference in operating force.
2. Operate fuel control lever, set engine governor lever in high idling position, then fit stopper bolt (3) and fuel control lever (4), and tighten locknut (5).
3. Set engine governor lever in stop position, then fit stopper bolt (6) and fuel control lever, and tighten lock nut (5).
  - ★ Adjust governor lever to put governor lever and stopper of fuel injection pump in contact at the FULL and STOP position.

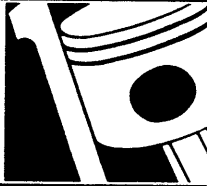


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# ENGINE

## 13 DISASSEMBLY AND ASSEMBLY



STARTING MOTOR	
Removal and Installation .....	13- 2
ALTERNATOR	
Removal and Installation .....	13- 2
WATER PUMP	
Removal and Installation .....	13- 2
FUEL INJECTION PUMP	
Removal and Installation .....	13- 4
NOZZLE HOLDER	
Removal and Installation .....	13- 4
CYLINDER HEAD	
Removal and Installation .....	13- 6
RADIATOR GUARD	
Removal and Installation .....	13- 8
RADIATOR	
Removal and Installation .....	13-10
THERMOSTAT	
Removal and Installation .....	13-10
ENGINE	
Removal .....	13-12
Installation .....	13-14

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## REMOVAL OF STARTING MOTOR ASSEMBLY

**⚠** Disconnect the cable from the negative (–) terminal of the battery.

1. Remove cover of engine left side.
2. Disconnect starting motor wiring (1) and (2).
3. Remove mounting bolt, and remove starting motor assembly (3). (See P1)

## INSTALLATION OF STARTING MOTOR ASSEMBLY

1. Fit O-ring and install starting motor assembly (3). (See P1)
2. Connect starting motor wiring (2) and (1). (See P1)
3. Install cover of engine left side.

## REMOVAL OF ALTERNATOR ASSEMBLY

**⚠** Disconnect the cable from the negative (–) terminal of the battery.

1. Remove cover of engine left side.
2. Disconnect wiring (1) from alternator. (See P2)
3. Remove mounting bolt (2) of adjustment plate, then loosen mounting bolt (3) and nut, and remove fan belt (4). (See P2)
4. Remove mounting bolt and nut, then remove alternator assembly (5). (See P2)

## INSTALLATION OF ALTERNATOR ASSEMBLY

1. Set alternator assembly (5) on bracket, and tighten mounting bolt (3) and nut, and mounting bolt (2) of adjustment plate temporarily, then fit fan belt (4) in pulley groove. (See P2)
  - ★ For details of dimensions and the procedure for adjusting the belt tension, see 12 TESTING AND ADJUSTING.
2. Tighten mounting bolt and nut, and mounting bolt of adjustment plate. (See P2)
3. Connect wiring (1) to alternator. (See P2)
4. Install cover of engine left side.

## REMOVAL OF WATER PUMP ASSEMBLY

1. Loosen radiator drain valve and drain cooling water.
  - ★ If the coolant contains antifreeze, dispose of it correctly.
2. Remove exhaust pipe, then disconnect air cleaner hose (1). (See P3).
3. Using lifting tool ①, remove engine hood together with air cleaner. (See P3)



Engine hood assembly: 50 kg

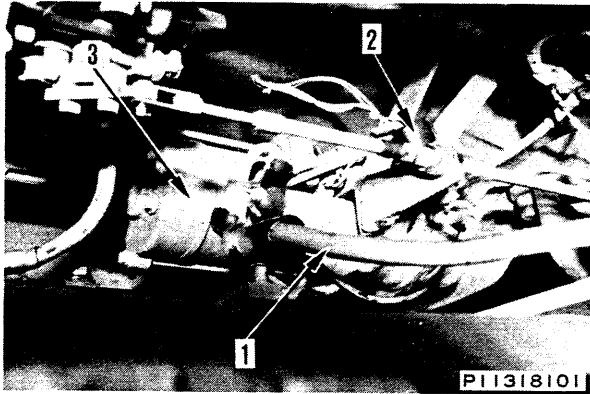
4. Remove fan guard (2) and shroud (3). (See P4)
5. Disconnect radiator hoses (4), (5) and wire (6) of water temperature gauge sensor. (See P5)
6. Loosen mounting bolt of adjustment plate, then mounting bolt and nut, and remove fan belt (8) and fan (7). (See P5)
7. Remove fan pulley (9). (See P6)
8. Remove water pump assembly (10). (See P7)

## INSTALLATION OF WATER PUMP ASSEMBLY

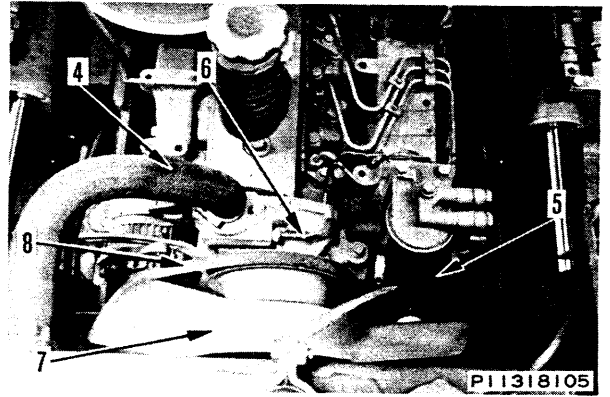
1. Fit gasket and install water pump assembly (10). (See P7)
2. Install fan pulley (9). (See P6)
3. Install fan (7) and fan belt (8), then tighten mounting bolt and nut, and mounting bolt of adjustment plate. (See P5)
  - ★ For details of adjusting the fan belt tension, see 12 TESTING AND ADJUSTING.
4. Connect wire (6) of water temperature gauge sensor and radiator hoses (5), (4). (See P5)
5. Install shroud (3) and fan guard (2). (See P4)
6. Using lifting tool ①, install engine hood together with air cleaner. (See P3)
7. Connect air cleaner hose (1), and install exhaust pipe. (See P3)
8. Tighten drain valve and add water through water filler to the specified level.
  - ★ Run the engine to circulate the water through the system. Then check the water level again.

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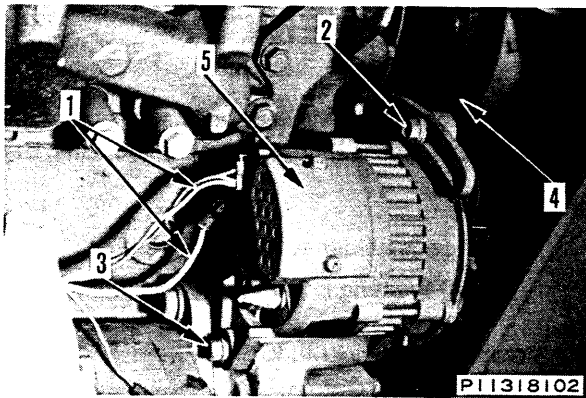
P1



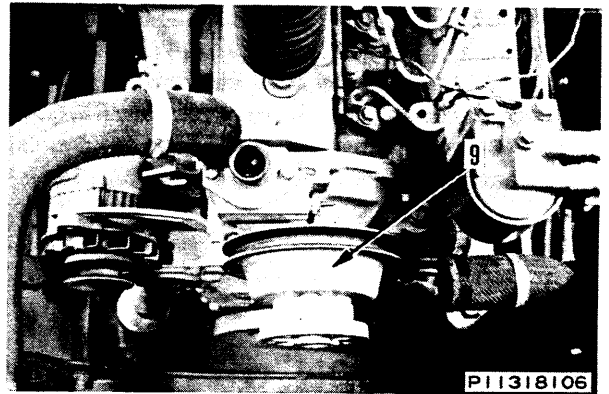
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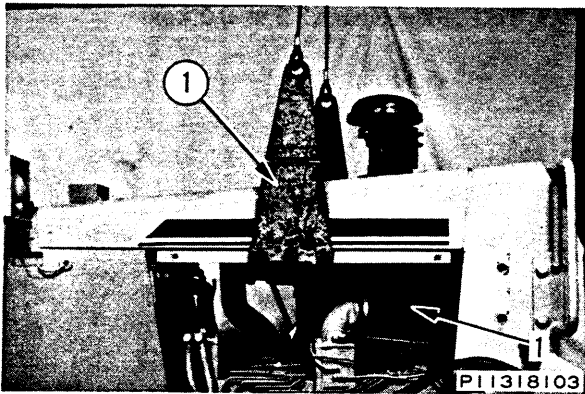
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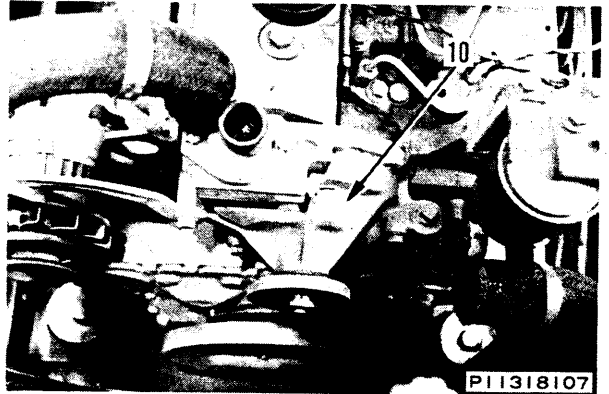
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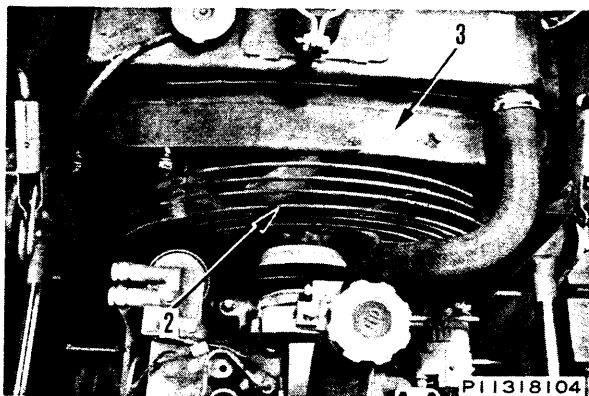
P3



P7



P4



## REMOVAL OF FUEL INJECTION PUMP ASSEMBLY

1. Open engine cover.
2. Disconnect supply hose (1), fuel hoses (2), return hoses (3) and (4). (See P1)
  - ★ Fit a blind plug in supply hose (1) to prevent fuel from leaking out.
3. Remove lubrication tube (5), then disconnect fuel rod (6). (See P1)
4. Disconnect 6 fuel injection tubes (7). (See P1)
5. Remove cover (8), then rotate engine crankshaft until pin ① (Diameter: approx. 4.5 mm, Length = 100 mm) enters drive gear of fuel injection pump through hole in front cover. (See P2, P3)
  - ★ Check that the "1.6T" mark on the crankshaft pulley is aligned with pointer (9). (See P4)
6. Remove bracket (10), then remove fuel injection pump assembly (11). (See P5)



## INSTALLATION OF FUEL INJECTION PUMP ASSEMBLY

1. Using bolt ③ (Thread dia. = 8 mm, Pitch = 1 mm), fix pump drive gear (12) to fuel injection pump (11). (See P6)
2. Insert pin ① through hole in front cover and align positioning hole ② of pump drive gear (12) with pin ① then install fuel injection pump assembly (11). (See P7, P3)
3. Connect 6 fuel injection tubes (7). (See P1)
4. Fit gasket and install lubrication tube (5). (See P1)
5. Connect fuel rod (6). (See P1)
  - ★ Bend the cotter pin securely.
6. Fit gaskets and connect return hoses (4), (3), fuel hoses (2) and supply hose (1). (See P1)
7. Bleed air from fuel circuit.
  - ★ For details, see 12 TESTING AND ADJUSTING, Bleeding air from fuel circuit.
8. Close engine cover.

## REMOVAL OF NOZZLE HOLDER ASSEMBLY

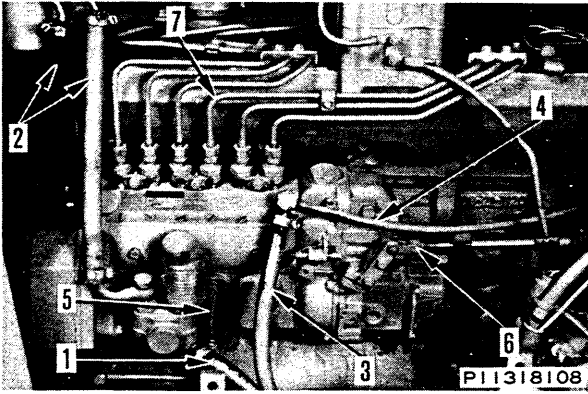
1. Remove clamp (1), then disconnect fuel injection pipe (2). (See P8)
2. Disconnect spill hose (3). (See P9)
3. Remove the bolt, then remove nozzle holder assembly (4). (See P9)
  - ★ When removing the nozzle holder assembly, clean around the nozzle holder assembly and fit a blind plug to prevent dust or dirt from entering.

## INSTALLATION OF NOZZLE HOLDER ASSEMBLY

- ★ When installing the nozzle holder assembly, check the nozzle holder mount, and clean before installing.
1. Install nozzle holder assembly (4). (See P9)
    -  Mounting bolt:  $4.5 \pm 0.5$  kgm
  2. Connect spill hose (3). (See P9)
  3. Connect fuel injection pipe (2) and secure with clamp (1). (See P8)
    -  Sleeve nut:  $2.3 \pm 0.2$  kgm

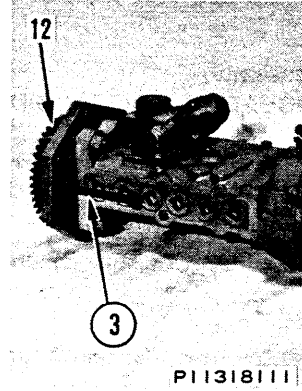


P1



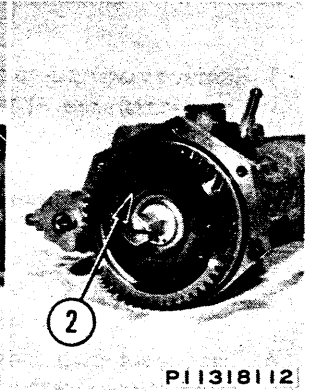
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P6



PI1318111

P7



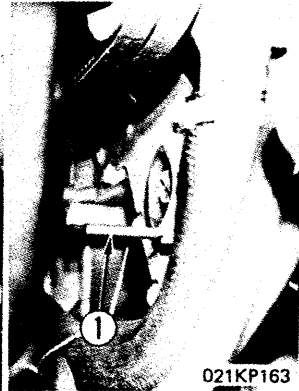
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P2



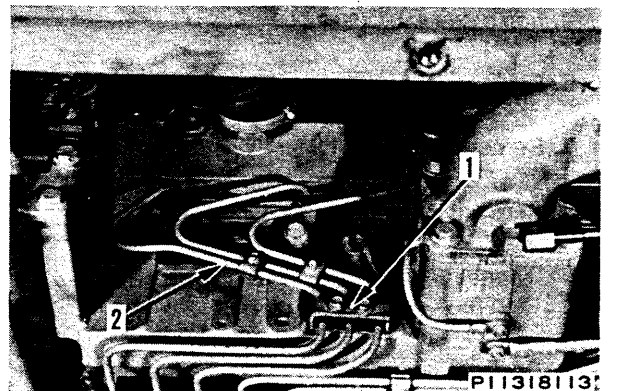
021KP162

P3



021KP163

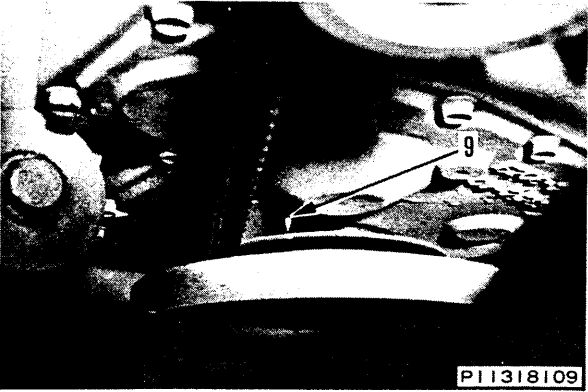
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PI1318113

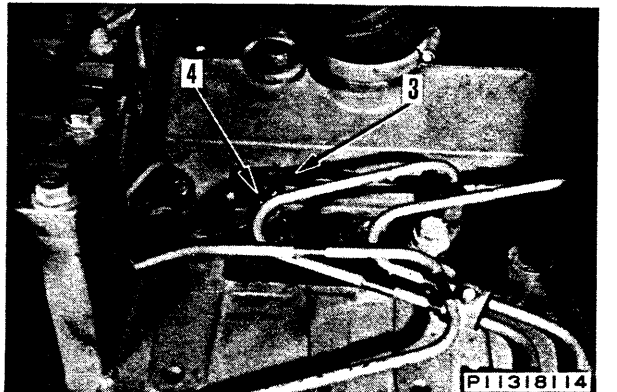
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P4



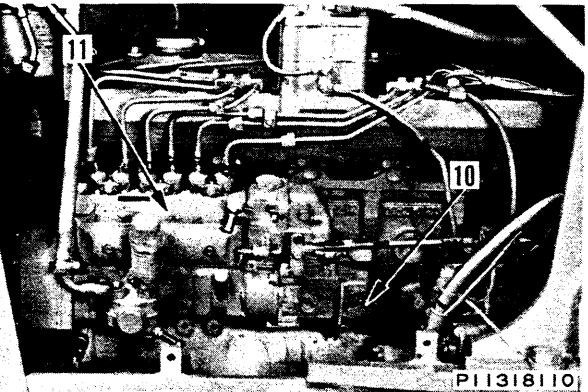
PI1318109

P9



PI1318114

P5



PI1318110



# REMOVAL OF CYLINDER HEAD ASSEMBLY

1. Remove water pump assembly.  
For details, see REMOVAL OF WATER PUMP ASSEMBLY.
2. Remove exhaust muffler (1). (See P1)
3. Remove fuel filter assembly (2) from cylinder head. (See P2)
4. Disconnect dust indicator hose (3) and heater wiring (4). (See P2)
5. Remove clamps (5), then disconnect 6 fuel injection pipes (6). (See P2)
6. Disconnect spill hose (7). (See P3)
7. Remove nozzle holder assembly (8). (See P3)
8. Remove head cover (9). (See P3)
9. Loosen adjustment screw (10) 2 – 3 times, then remove rocker arm assembly (11). (See P4)
10. Remove push rod (12). (See P5)
11. Lift off cylinder head assembly (13). (See P6)

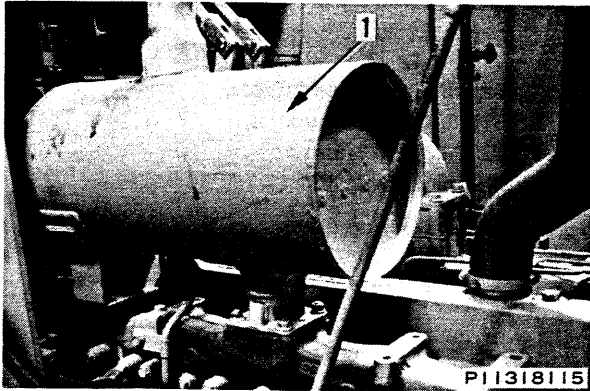


Cylinder head assembly: 76 kg

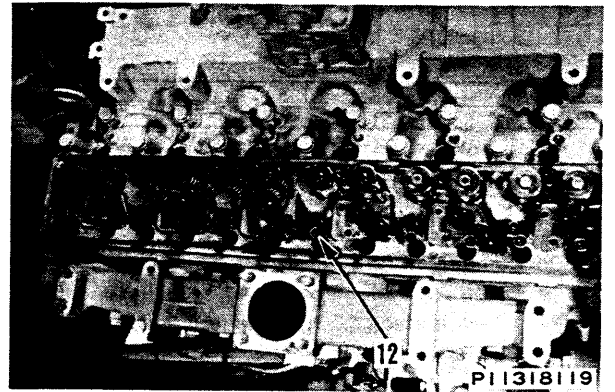
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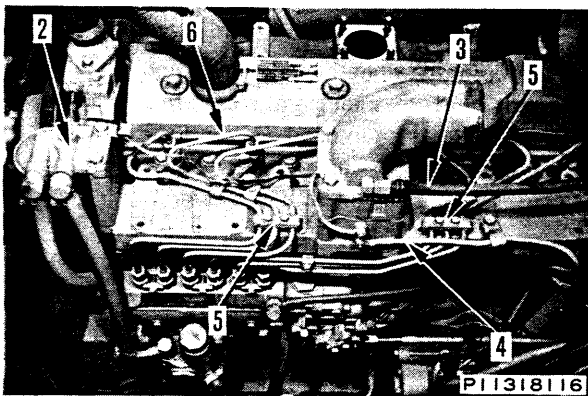
P1



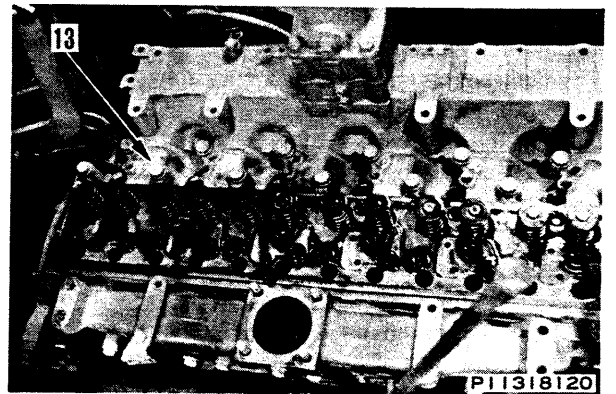
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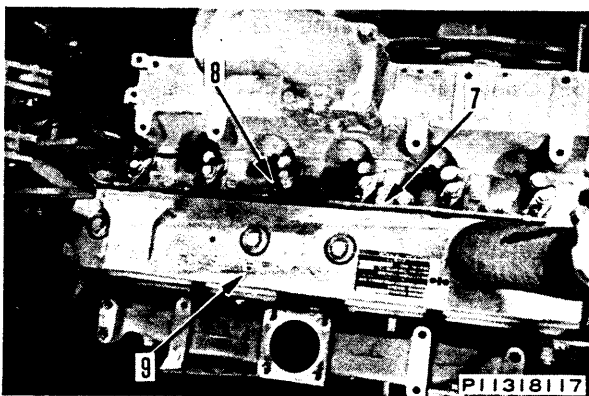
P2



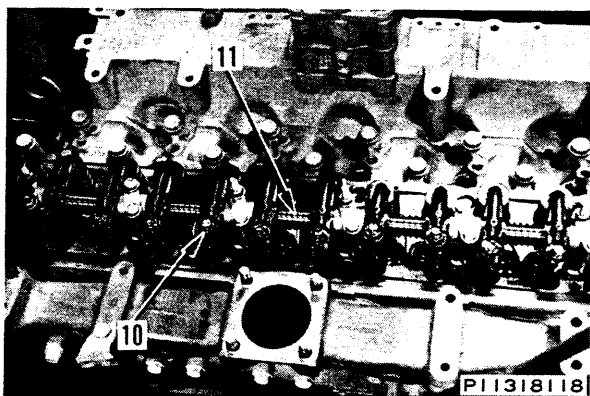
P6



P3



P4



# INSTALLATION OF CYLINDER HEAD ASSEMBLY

## Special tool

	Part No.	Part Name	Q'ty
A	795-125-1370	Filler gauge	1

### 1. Install head gasket.

- ★ Remove all carbon and dirt from the contact surface of the cylinder block and cylinder head. Remove all burrs and damage, and clean out all dirt from inside the cylinder block.

### 2. Raise cylinder head assembly (13), set in position, and tighten head bolts in order shown in diagram on right. (See P1, F1, F2)

- ★ If any rust of more than 5 mm square is found on the shaft or thread of any head bolt, replace the head bolt with a new bolt.
- ★ Check that there is no dirt or dust on the cylinder head mounting surface or inside the cylinder.
- ★ Check that the grommet does not come out when installing the gasket.
- ★ Screw in the cylinder head mounting bolts 2 – 3 turns by hand, then tighten as follows.



Mounting bolt:

Anti-friction compound (LM-P)

- Applicable engine serial No.  
D31-18 10001 – 40631  
D37-2 10001 – 40462  
(Head bolt P/No. 6142-11-1611)



Mounting bolt:

Unit: kgm

Order	Torque
1st step	8.0 ± 1.0
2nd step	12.0 ± 1.0
3rd step	15.0 ± 0.5

- Applicable engine serial No.  
D31-18 40632 and up  
D37-2 40463 and up  
(Head bolt P/No. 6204-13-1610)



Mounting bolt:

Order	Torque
1st step	7 ± 1.0 kgm
2nd step	11 ± 0.5 kgm
3rd step	90° $\begin{matrix} +30^\circ \\ 0 \end{matrix}$

- ★ After tightening, make one punch mark on the bolt head to indicate the number of times that the bolt has been used.
  - If any bolt has 5 punch marks, do not reuse it. Replace it with a new bolt.

### 3. Install push rod (12). (See P2)

### 4. Set rocker arm assembly (11) in position, then tighten mounting bolt. (See P3)

- ★ Check that the ball of the adjustment screw (10) is fitted properly into the socket of the push rod.



Mounting bolt: 2.5 ± 1.0 kgm

### 5. Using tool A, adjust clearance between valve and rocker lever. (See P4)

- ★ Valve clearance

Unit: mm

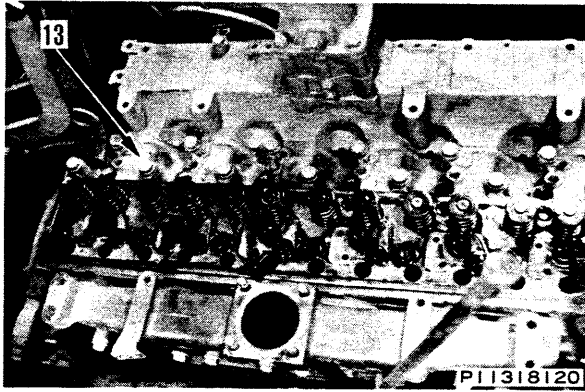
Intake valve	Exhaust valve
0.35	0.50

- ★ For details of the adjustment procedure, see 12 TESTING AND ADJUSTING, Adjusting valve clearance.

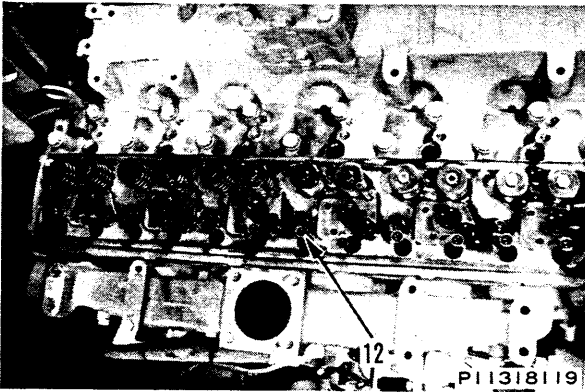
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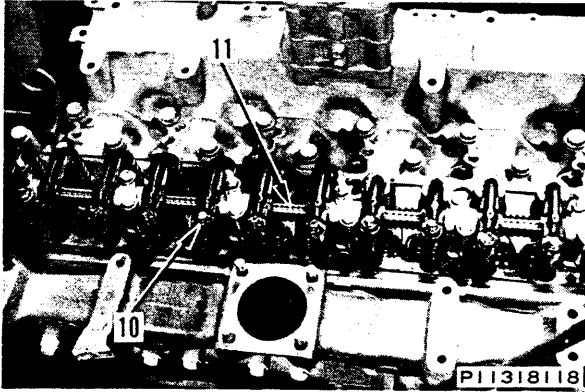
P1



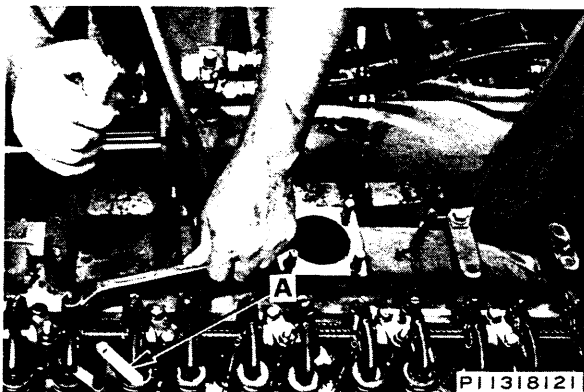
P2



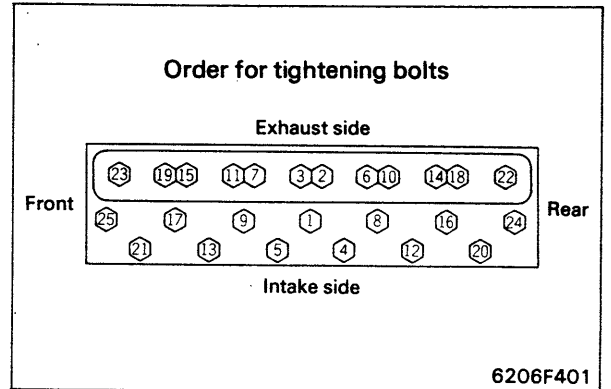
P3



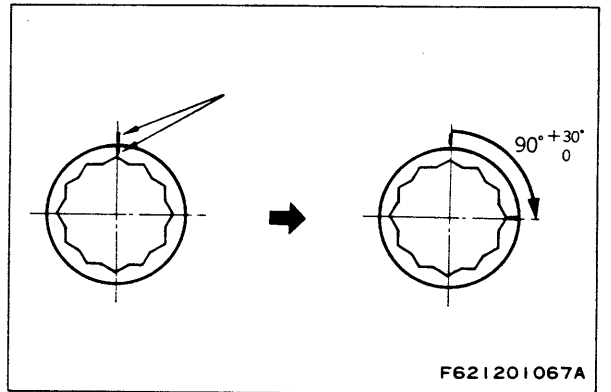
P4




F1




F2



6. Fit O-ring and install head cover (9). (See P1)

 Mounting nut:  $0.9 \pm 0.1$  kgm

7. Install nozzle holder assembly (8). (See P1)

 Mounting bolt:  $4.5 \pm 0.5$  kgm

8. Connect spill hose (7). (See P1)

9. Connect 6 fuel injection pipes (6) and secure with clamp (5). (See P2)

 Sleeve nut:  $2.3 \pm 0.2$  kgm

10. Connect heater wiring (4) and dust indicator hose (3). (See P2)

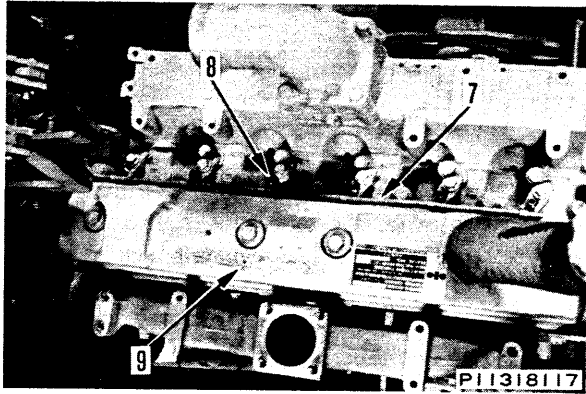
11. Install fuel filter assembly (2) to cylinder head. (See P2)

12. Fit gasket and install exhaust muffler (1). (See P3)

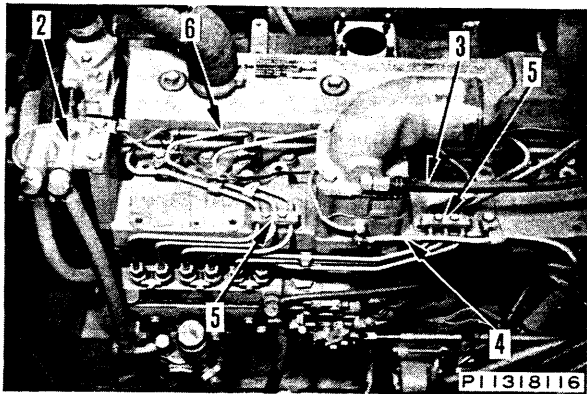
13. Install water pump assembly.  
For details, see INSTALLATION OF WATER PUMP ASSEMBLY.

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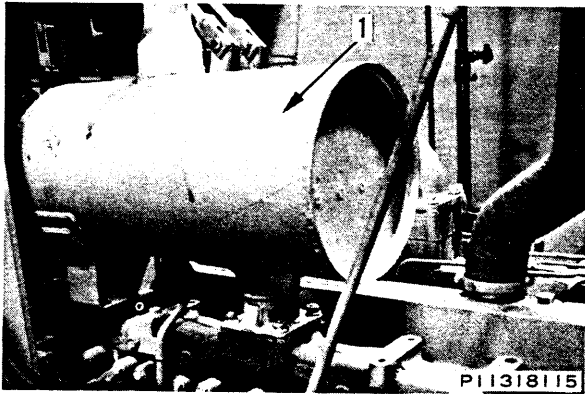
P1



P2



P3



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## REMOVAL OF RADIATOR GUARD ASSEMBLY

★ The steps 1 and 2 show D31P, PL-18.

1. Remove pin (1) and start engine, then retract lift cylinder piston rod fully. (See P1)

★ Stop the engine and operate the work equipment control lever several times to release the pressure inside the piping.

2. Disconnect hoses (2) from lift cylinder. (See P2)

3. Loosen radiator drain valve and drain cooling water.

★ If the coolant contains antifreeze, dispose of it correctly.

4. Remove exhaust pipe, then disconnect air cleaner hose (3). (See P3)

5. Using lifting tool ①, then remove engine hood together with air cleaner. (See P3)



Engine hood assembly: 50 kg

6. Disconnect wiring (4) and radiator hoses (5) and (6), and remove fan guard (7). (See P4)

7. Remove grille (8). (See P5)

8. Remove plate (9), then disconnect oil cooler hoses (10). (See P6)

9. Using eyebolts (Thread dia. = 12 mm, Pitch = 1.75 mm) and lever block, then lift off radiator guard assembly (11). (See P7)



Radiator guard assembly: 175 kg  
(With lift cylinder)

Radiator guard assembly: 105 kg  
(Without lift cylinder)

## INSTALLATION OF RADIATOR GUARD ASSEMBLY

★ The steps 8 and 9 show D31P, PL-18.

1. Using eyebolts (Thread dia. = 12 mm, Pitch = 1.75 mm) and lever block, then raise radiator guard assembly (11) and install. (See P7)

2. Connect oil cooler hose (10), and install plate (9). (See P6)

3. Install grille (8). (See P5)

4. Install fan guard (7), then connect radiator hoses (6) and (5), and wiring (4). (See P4)

5. Using lifting tool ①, then install engine hood together with air cleaner. (See P3)

6. Connect air cleaner hose (3), then install exhaust pipe. (See P3)

7. Tighten radiator drain valve and add water through water filler to the specified level.

★ Run the engine to circulate the water through the system. Then check the water level again.

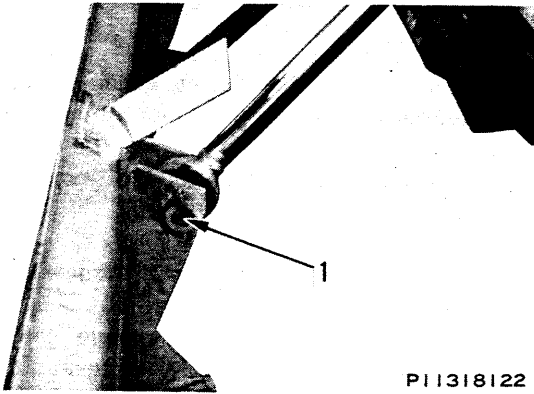
8. Connect hoses (2) to lift cylinder. (See P2)

9. Start engine and extend lift cylinder piston rod, then install pin (1). (See P1)

011418

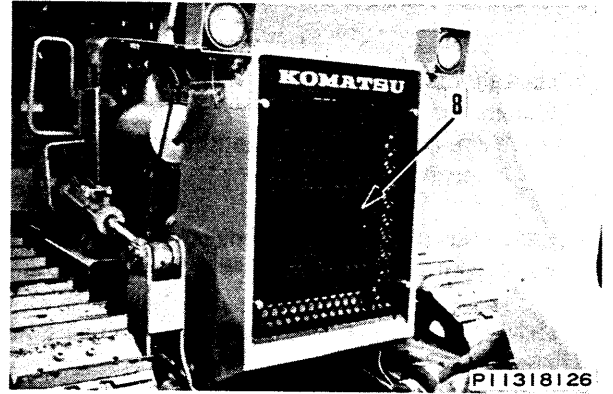
011418

P1



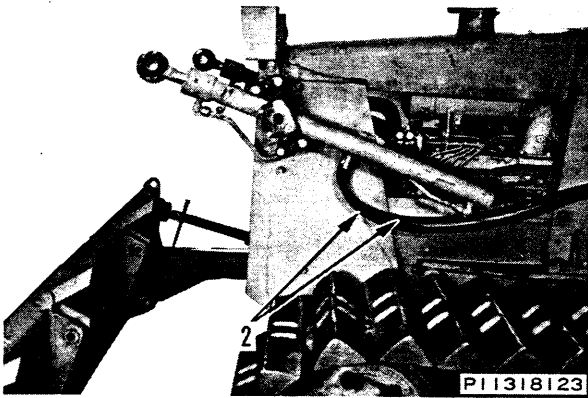
PI1318122

P5



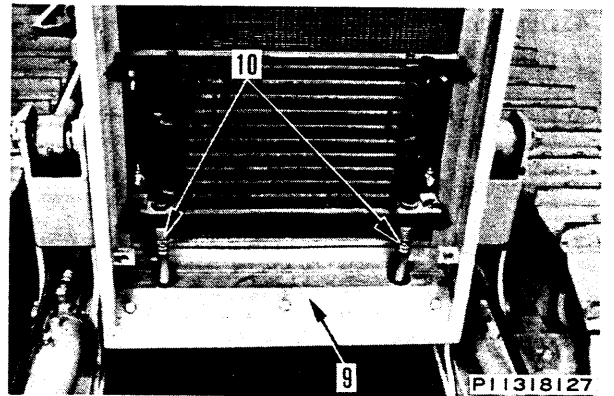
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P2



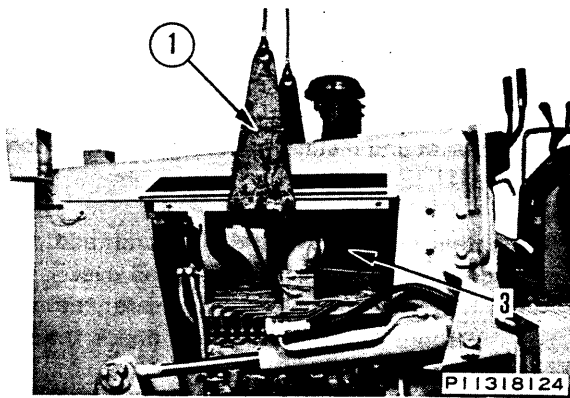
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P6



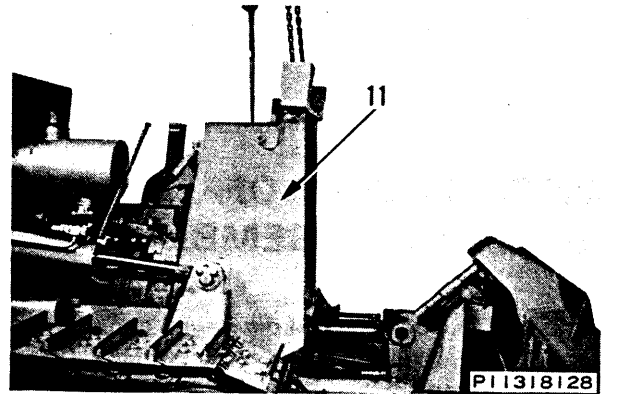
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P3



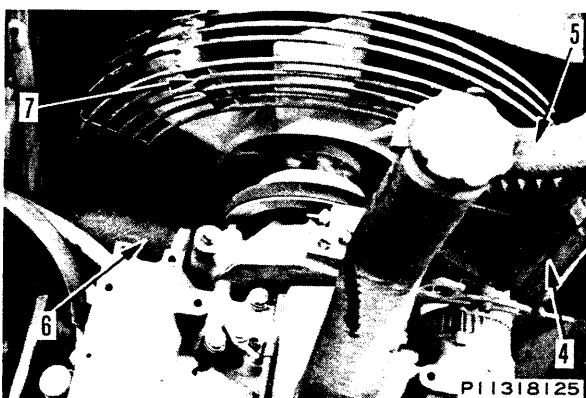
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P7



PI1318128


P4



PI1318125



## REMOVAL OF RADIATOR ASSEMBLY

1. Loosen radiator drain valve and drain cooling water.  
★ If the coolant contains antifreeze, dispose of it correctly.
  2. Remove exhaust pipe, then disconnect air cleaner hose (1). (See P1)
  3. Using lifting tool ①, then remove engine hood together with air cleaner. (See P1)
- 
- Engine hood: 50 kg
4. Disconnect hoses (2) and (3), then remove fan guard (4). (See P2)
  5. Remove shroud (5) of lower end. (See P3)
  6. Remove bracket (6). (See P4)
  7. Remove grille, then remove plate (7). (See P5)
  8. Remove mounting bolts of oil cooler (8), and move towards front. (See P5)
  9. Remove mounting bolt of radiator.
  10. Using eyebolts (Thread dia. = 14 mm, Pitch = 2.0 mm), then lift off radiator assembly (10). (See P6)



Radiator assembly: 40 kg

## INSTALLATION OF RADIATOR ASSEMBLY

1. Using eyebolts (Thread dia. = 14 mm, Pitch = 2.0 mm), then raise radiator assembly (10) and install. (See P6)
2. Tighten mounting bolt.
3. Install oil cooler (8). (See P5)
4. Install plate (7), then install grille. (See P5)
5. Install bracket (6). (See P4)
6. Install shroud (5) of lower end. (See P3)
7. Install fan guard (4), then connect hoses (3) and (2). (See P2)

8. Using lifting tool ①, then install engine hood together with air cleaner. (See P1)
9. Connect air cleaner hose (1), then install exhaust pipe.
10. Tighten radiator drain valve and add water through water filler to the specified level.  
★ Run the engine to circulate the water through the system. Then check the water level again.

## REMOVAL OF THERMOSTAT

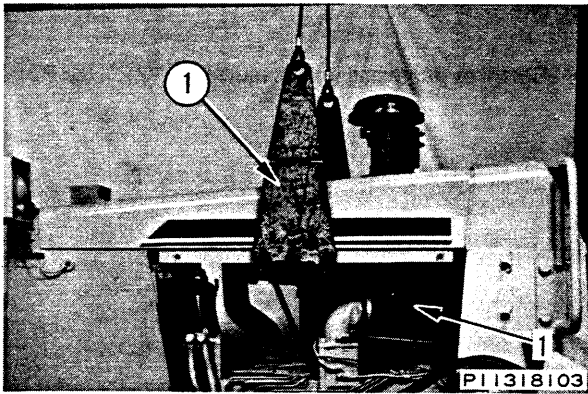
1. Loosen radiator drain valve and drain cooling water.  
★ If the coolant contains antifreeze, dispose of it correctly.
2. Disconnect hose (1), and remove connector (2). (See P7)
3. Remove thermostat (3). (See P8)

## INSTALLATION OF THERMOSTAT

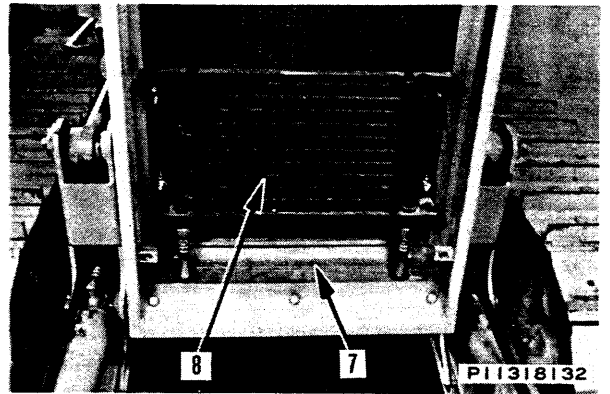
1. Set thermostat (3) in mounting position. (See P8)
2. Fit gasket and install connector (2), then connect hose (1). (See P7)
3. Tighten radiator drain valve and add water through water filler to the specified level.  
★ Run the engine to circulate the water through the system. Then check the water level again.

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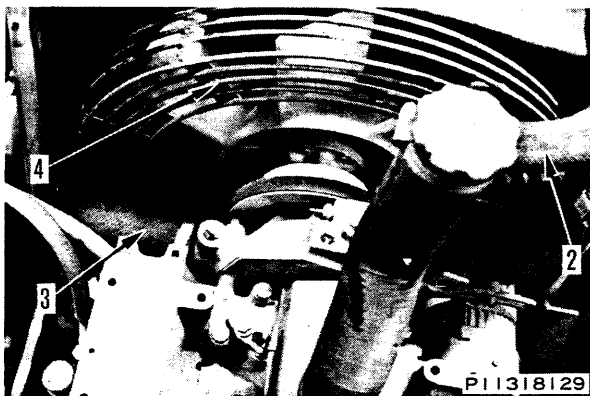
P1



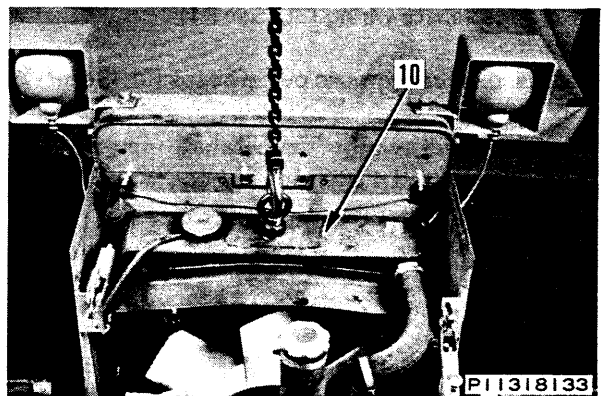
P5



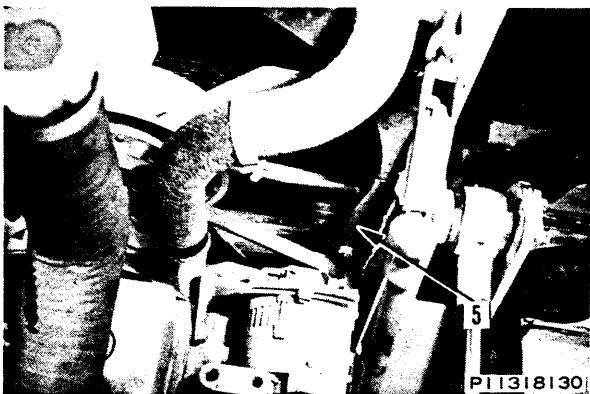
P2



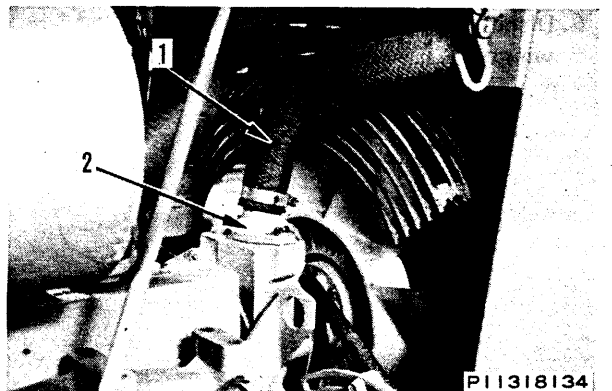
P6



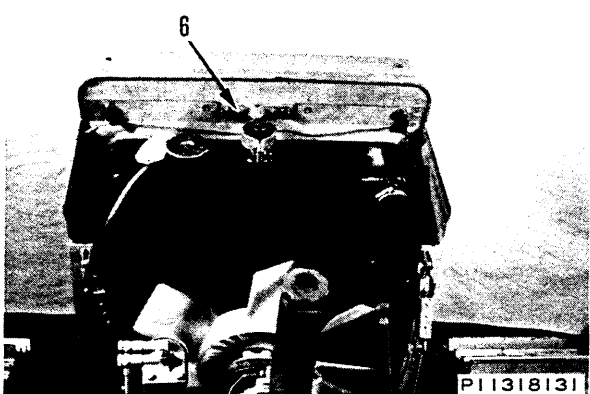
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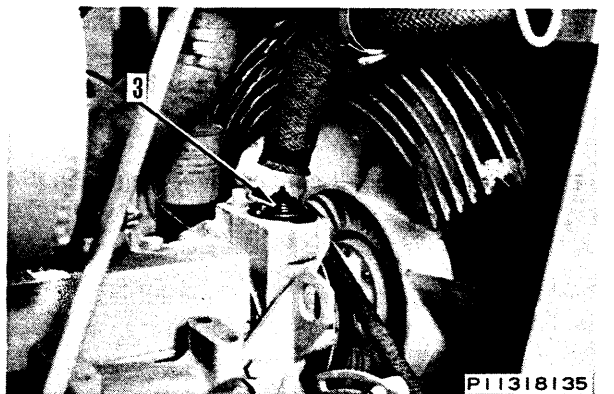
P7




P4



P8



# REMOVAL OF ENGINE ASSEMBLY

 Disconnect the cable from the negative (–) terminal of the battery.

1. Remove the cover, then remove drain plug and drain oil from hydraulic tank.



Hydraulic tank: Approx. 33ℓ

2. Remove the radiator guard assembly.  
For details, see REMOVAL OF RADIATOR GUARD ASSEMBLY.

3. Disconnect alternator wiring (1) and oil pressure gauge sensor wiring (2). (See P1)

4. Disconnect hydraulic pump hoses (3). (See P1)

5. Disconnect water temperature gauge sensor wiring (4) and dust indicator hose (5).

6. Disconnect starting motor wiring (6) and heater wiring (7). (See P3)

7. Disconnect fuel control rod (8), fuel hoses (9) and (10). (See P4)

★ Fuel will come out when the hoses are disconnected, so fit blind plugs.

8. Disconnect ground connection wiring (11). (See P4)

9. Remove universal joint assembly (12). (See P5)

10. Remove mounting bolts, then lift off engine assembly (13). (See P6)

★ When raising the engine assembly, be careful of the position of the center of gravity, and check again that all wiring and piping has been removed.

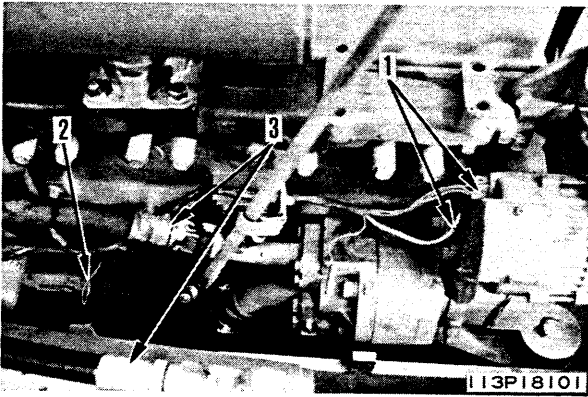


Engine assembly: 450 kg

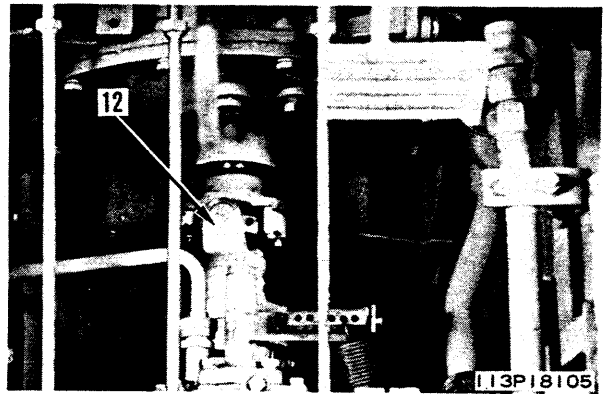
★ Mark the positions of the left, right, front, and rear engine mount cushions.

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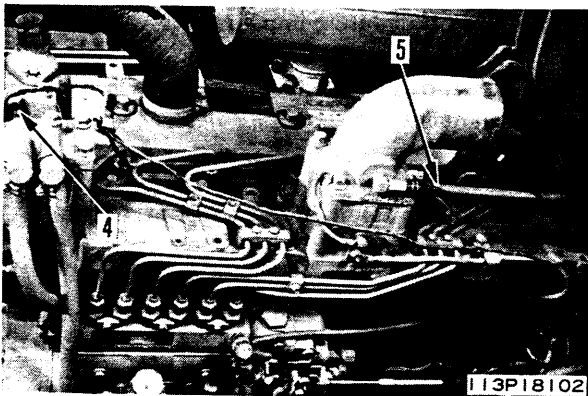
P1



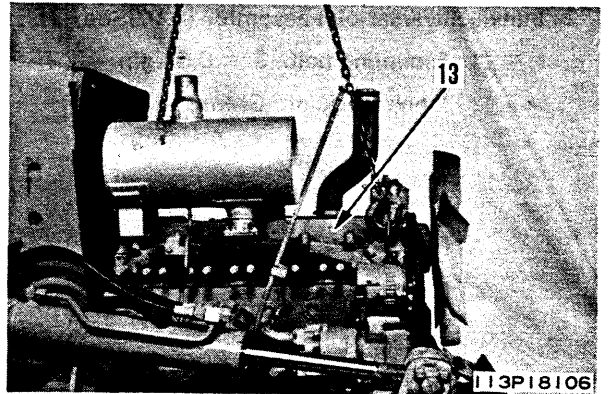
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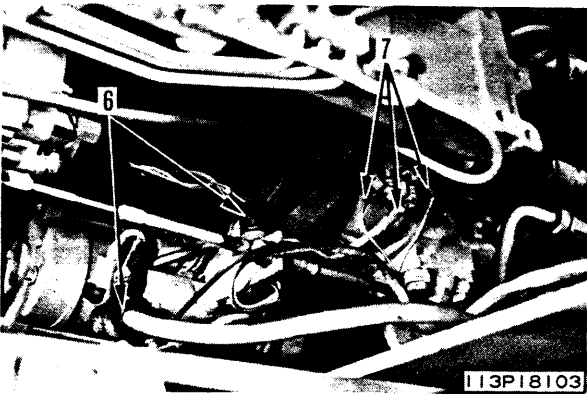
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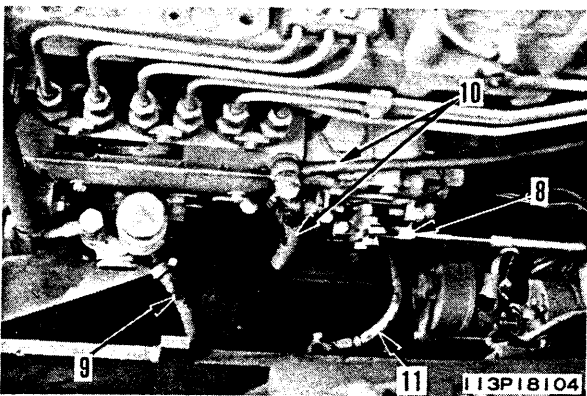
P6



P3



P4




# INSTALLATION OF ENGINE ASSEMBLY

1. Raise engine assembly (13), set in position, fit cushions and align mounting bolts, then lower engine. (See P1)

- ★ The spring coefficient of the front, rear, left, and right mount cushions is different, so be careful to set them correctly in the positions marked when removing.

2. Tighten the mounting bolts.

 Mounting bolt: Thread tightener (LT-2)

3. Install universal joint assembly (12). (See P2)

 Mounting bolt:  $3 \pm 0.5$  kgm

 Universal joint: Grease (G2-LI)

4. Connect ground connection wiring (11). (See P3)

5. Connect fuel hoses (10), (9), and fuel control rod (8). (See P3)

6. Connect heater wiring (7) and starting motor wiring (6). (See P4)

7. Connect dust indicator hose (5) and water temperature gauge sensor wiring (4). (See P5)

8. Connect hydraulic pump hoses (3). (See P6)

9. Connect oil pressure gauge sensor wiring (2) and alternator wiring (1). (See P6)

10. Install radiator guard assembly.  
For details, see INSTALLATION OF RADIATOR GUARD ASSEMBLY.

11. Tighten drain plug of hydraulic tank and add hydraulic oil through oil filler to the specified level.



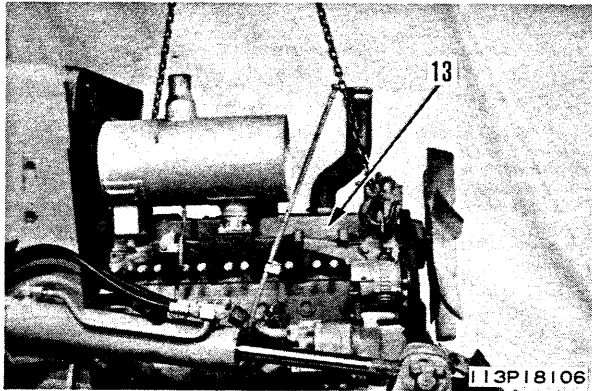
Hydraulic tank: Approx. 33 l

- ★ Run the engine to circulate the oil through the system. Then check the oil level again.

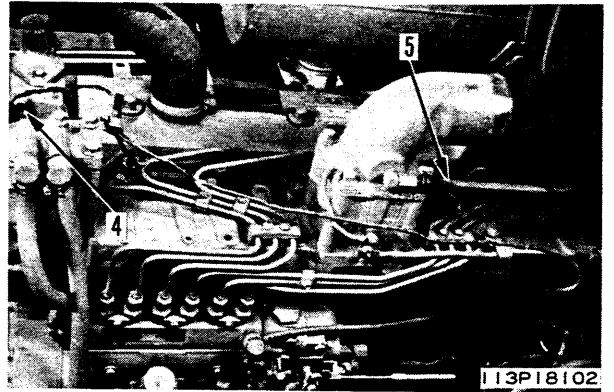
011418

011418

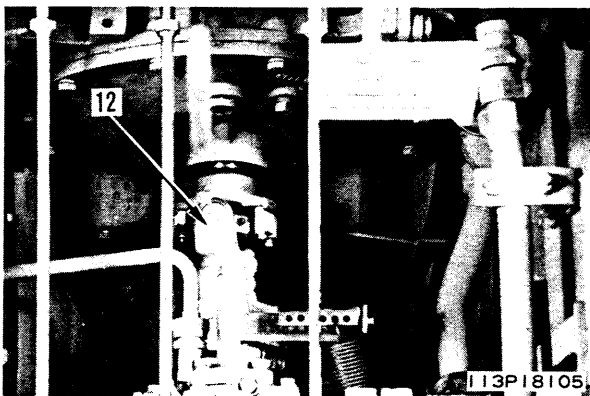
P1



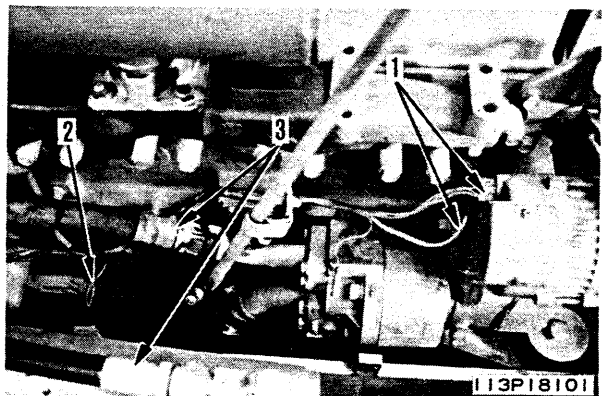
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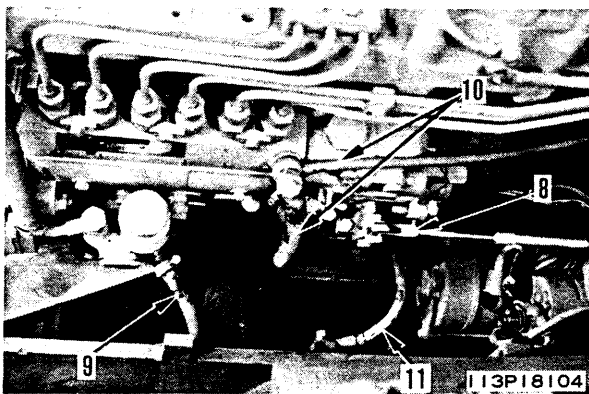
P2



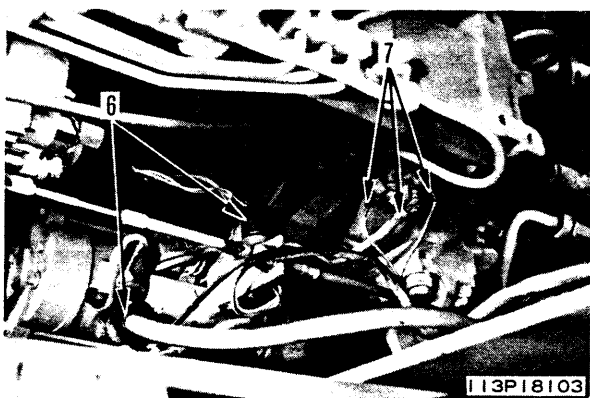
P6



P3



P4



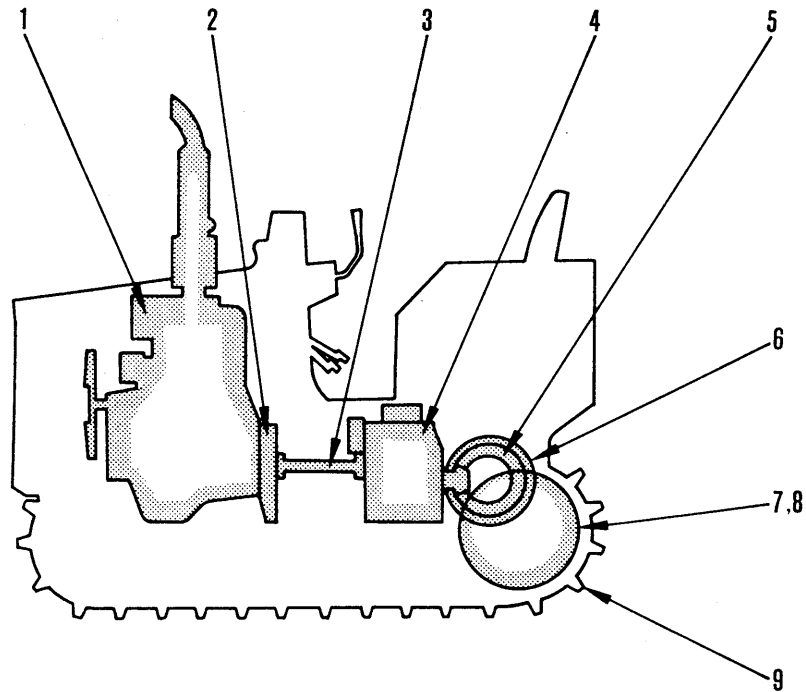
# POWER TRAIN

## 21 STRUCTURE AND FUNCTION



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Steering brake .....	21-44
Final drive .....	21-46

# GENERAL



F 10306002

- |                            |                   |
|----------------------------|-------------------|
| 1. Engine (6D95L-1)        | 6. Steering brake |
| 2. Damper                  | 7. Final drive    |
| 3. Universal joint         | 8. Sprocket       |
| 4. HYDROSHIFT transmission | 9. Track shoe     |
| 5. Steering clutch         |                   |

Motive power generated by diesel engine (1) is transmitted to damper (2) which is fixed on the engine flywheel.

After vibration is absorbed by the damper, the power from the engine passes from the output shaft through universal joint (3) to the input shaft of HYDROSHIFT transmission (4). In accordance with changes in load, transmission control valve which is mounted at the top of the transmission case is operated to select an appropriate speed stage. The power which is selected by the make and break action of the speed change clutch inside the transmission passes through the output gear of transfer to bevel pinion.

The power which is transmitted from the engine → damper → transmission at the rear of the machine is then diverted into the left and right directions by means of the bevel pinion and bevel gear on the bevel gear shaft.

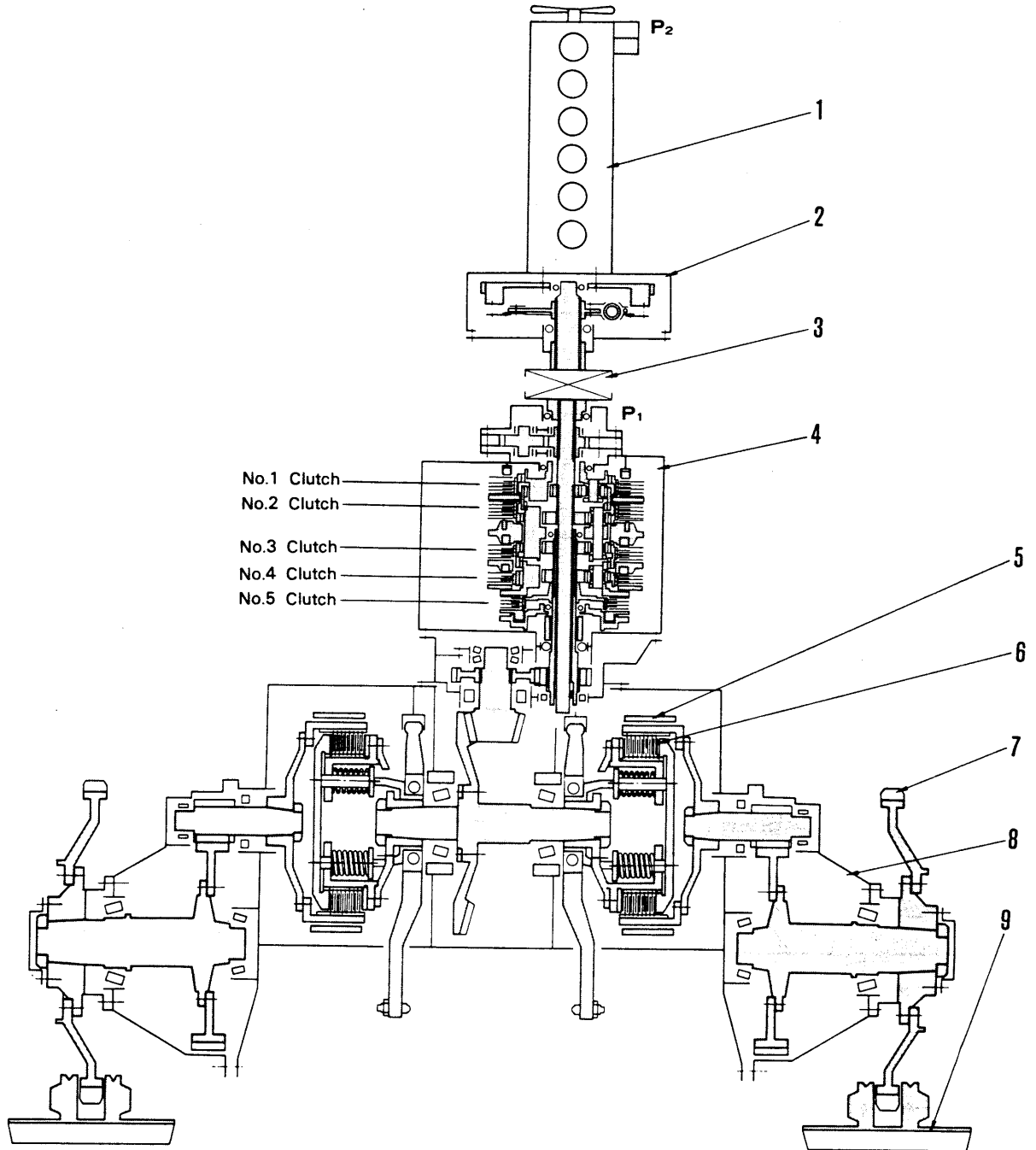
Steering clutches (5) is installed at both ends of the bevel gear shaft make and break the flow of power from the bevel gear shaft to the final drive, and are used to change the direction of the machine.

The direction of the machine is changed by operating the steering control valve mounted at the top of the steering case in order to cut off power from the clutch at the side of the machine to which it is to be steered. The size of the turning radius is varied by means of steering brake (6) which is mounted on the periphery of the brake drum of the steering clutch. Power from the steering clutch is transmitted to the final drive flange where speed reduction takes place through pinion → gear prior to rotating sprocket (8).

The rotation of the sprocket drives track (9) of the undercarriage, causing the machine to travel.



011418



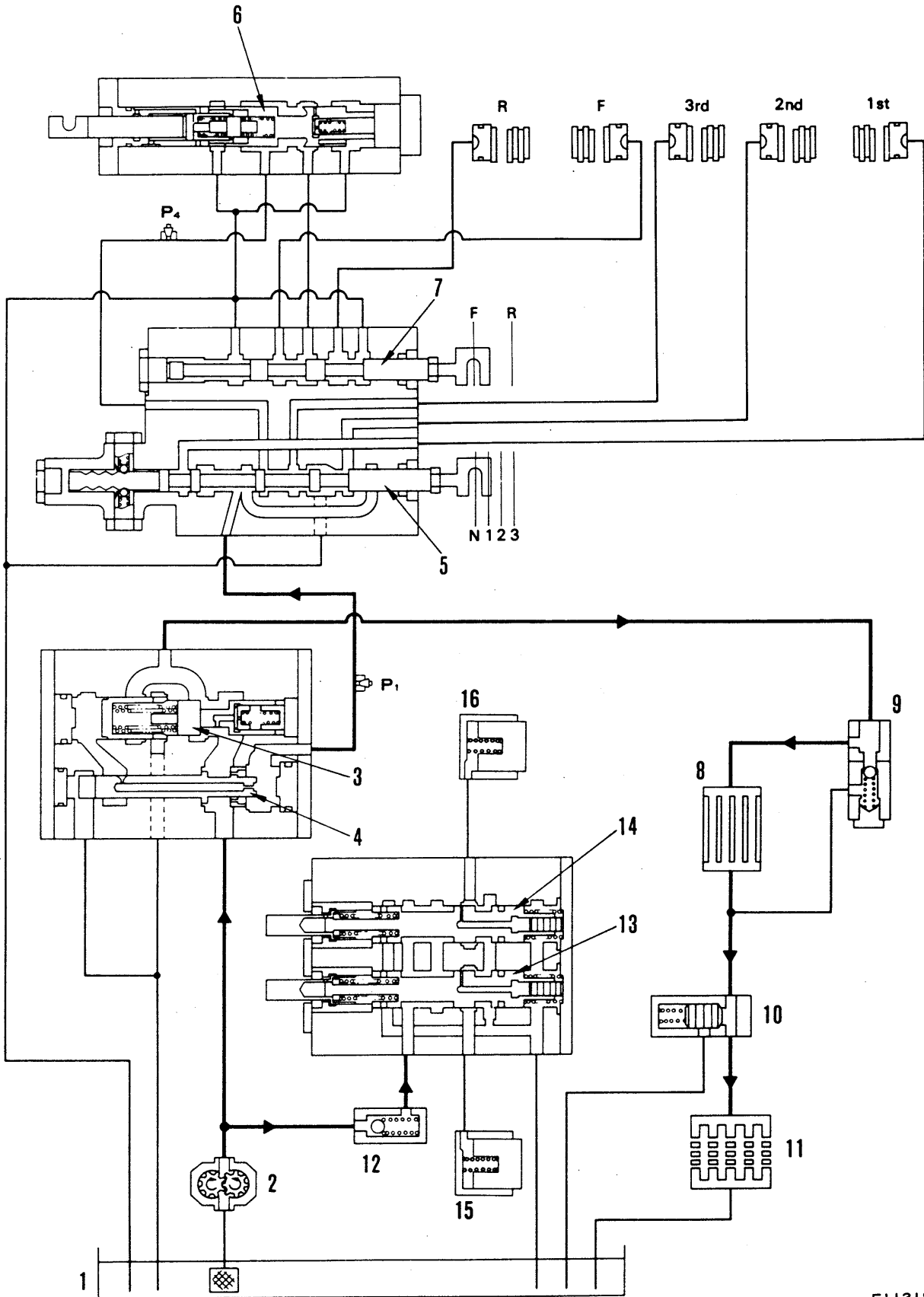
113F18004

- 1. Engine (6D95L-1)
- 2. Damper
- 3. Universal joint
- 4. HYDROSHIFT transmission
- 5. Steering clutch
- 6. Steering brake
- 7. Final drive
- 8. Sprocket
- 9. Track shoe

- P<sub>1</sub>. Transmission Pump
- P<sub>2</sub>. Hydraulic Pump (SAL036)

# POWER TRAIN HYDRAULIC SYSTEM

D31E, P, PL, PLL-18, D31P-18A, D37E, P-2

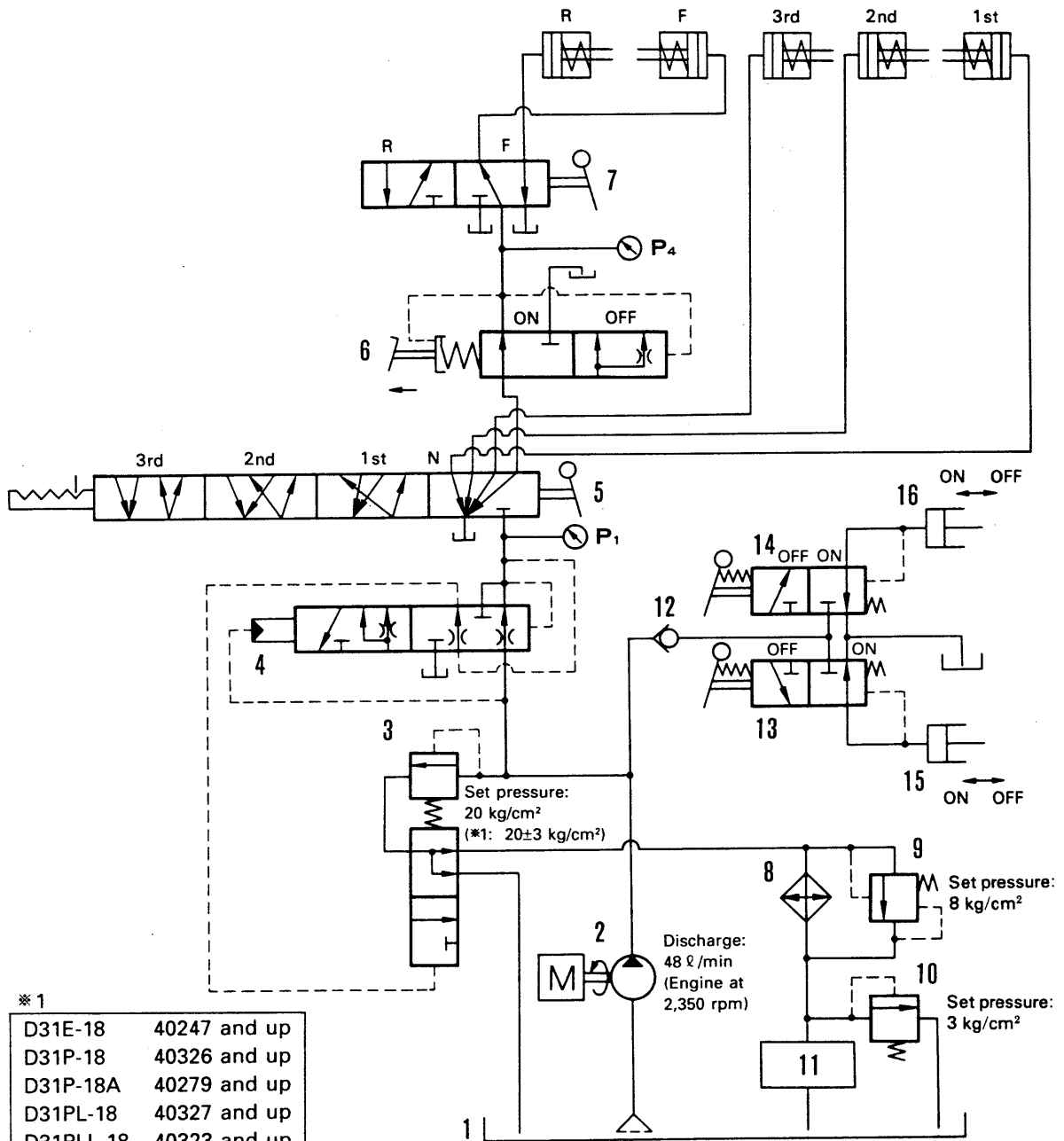


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# POWER TRAIN HYDRAULIC CIRCUIT DIAGRAM

D31E, P, PL, PLL-18, D31P-18A  
 D37E-2 Serial No. 1501-2500  
 D37P-2 Serial No. 1501-2000



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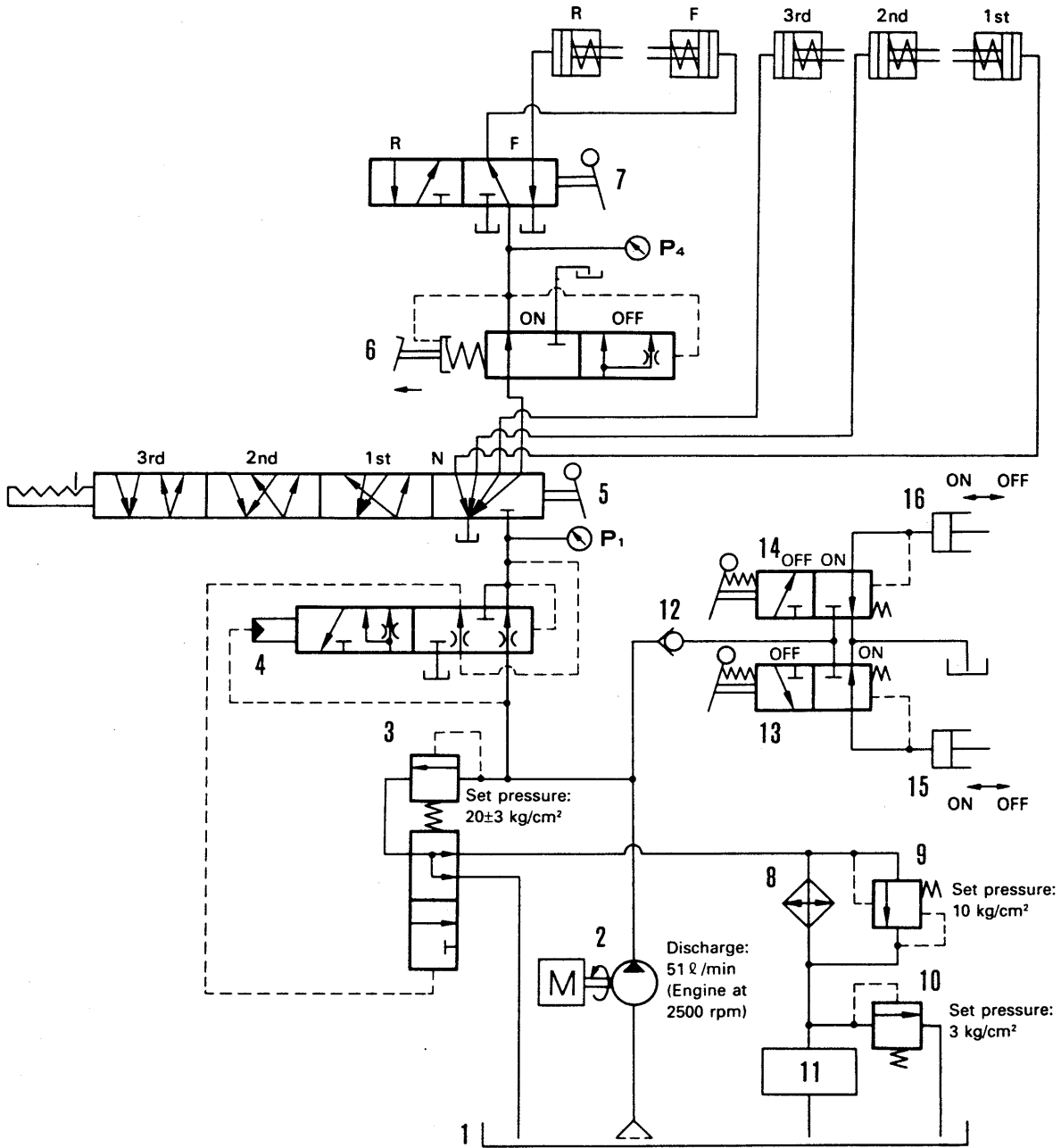
※1

D31E-18	40247 and up
D31P-18	40326 and up
D31P-18A	40279 and up
D31PL-18	40327 and up
D31PLL-18	40323 and up
D37E-2	1702 and up
D37P-2	1549 and up

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- |                            |  |
|----------------------------|--|
| 1. Transmission case       | 10. Transmission lubrication valve               |
| 2. Transmission pump       | 11. Transmission lubrication                     |
| 3. Modulating valve        | 12. Check valve                                  |
| 4. Quick return valve      | 13. L.H. steering valve                          |
| 5. Speed valve             | 14. R.H. steering valve                          |
| 6. Inching valve           | 15. L.H. steering cylinder                       |
| 7. F-R valve               | 16. R.H. steering cylinder                       |
| 8. Oil cooler              | P <sub>1</sub> . Plug for main relief pressure   |
| 9. Oil cooler bypass valve | P <sub>4</sub> . Plug for inching valve pressure |

D37E-2 Serial No. 2501 and up  
 D37P-2 Serial No. 2001 and up

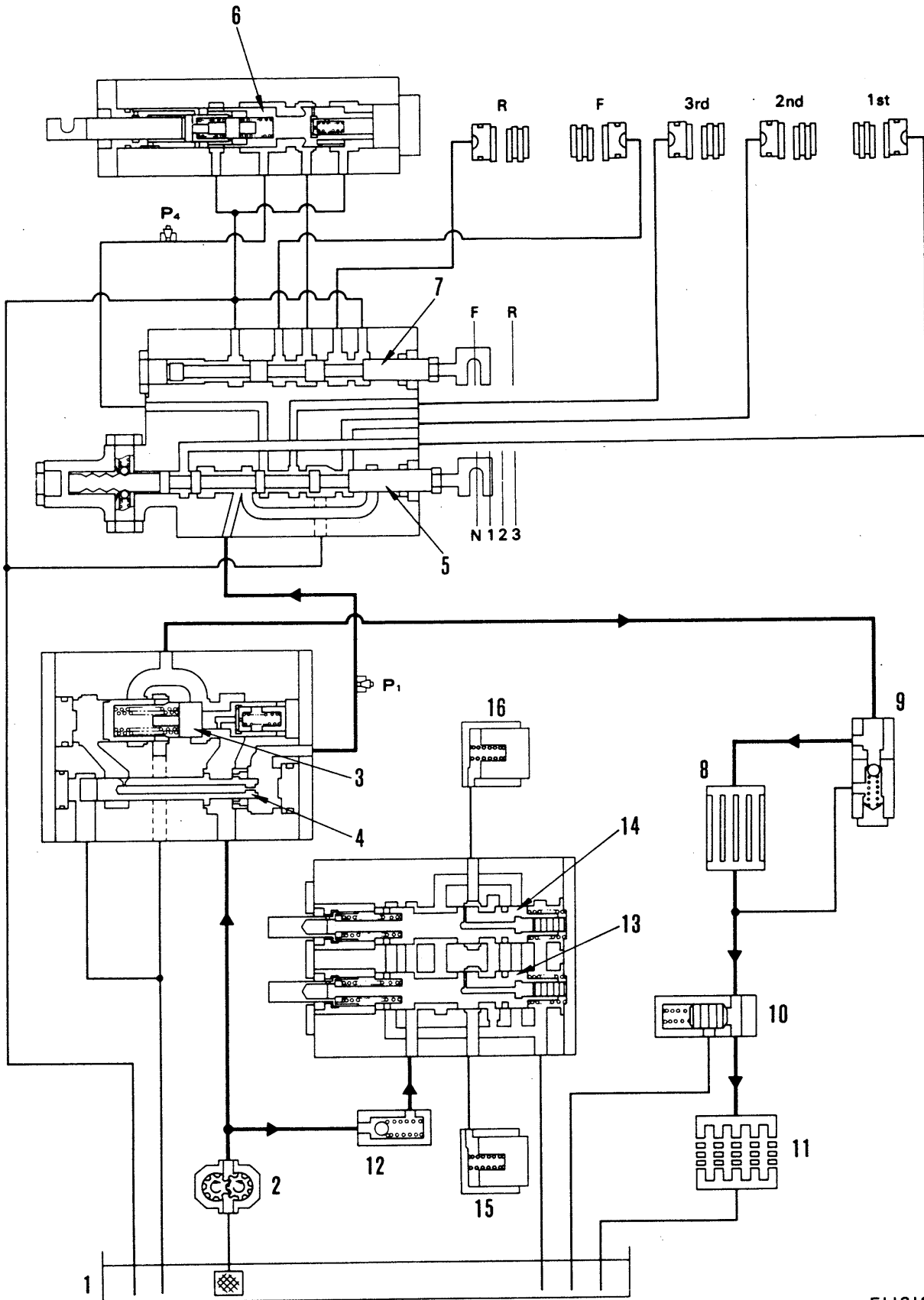


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- |                            |  |
|----------------------------|--|
| 1. Transmission case       | 10. Transmission lubrication valve               |
| 2. Transmission pump       | 11. Transmission lubrication                     |
| 3. Modulating valve        | 12. Check valve                                  |
| 4. Quick return valve      | 13. L.H. steering valve                          |
| 5. Speed valve             | 14. R.H. steering valve                          |
| 6. Inching valve           | 15. L.H. steering cylinder                       |
| 7. F-R valve               | 16. R.H. steering cylinder                       |
| 8. Oil cooler              | P <sub>1</sub> . Plug for main relief pressure   |
| 9. Oil cooler bypass valve | P <sub>4</sub> . Plug for inching valve pressure |

# POWER TRAIN HYDRAULIC SYSTEM

D31S, Q-18

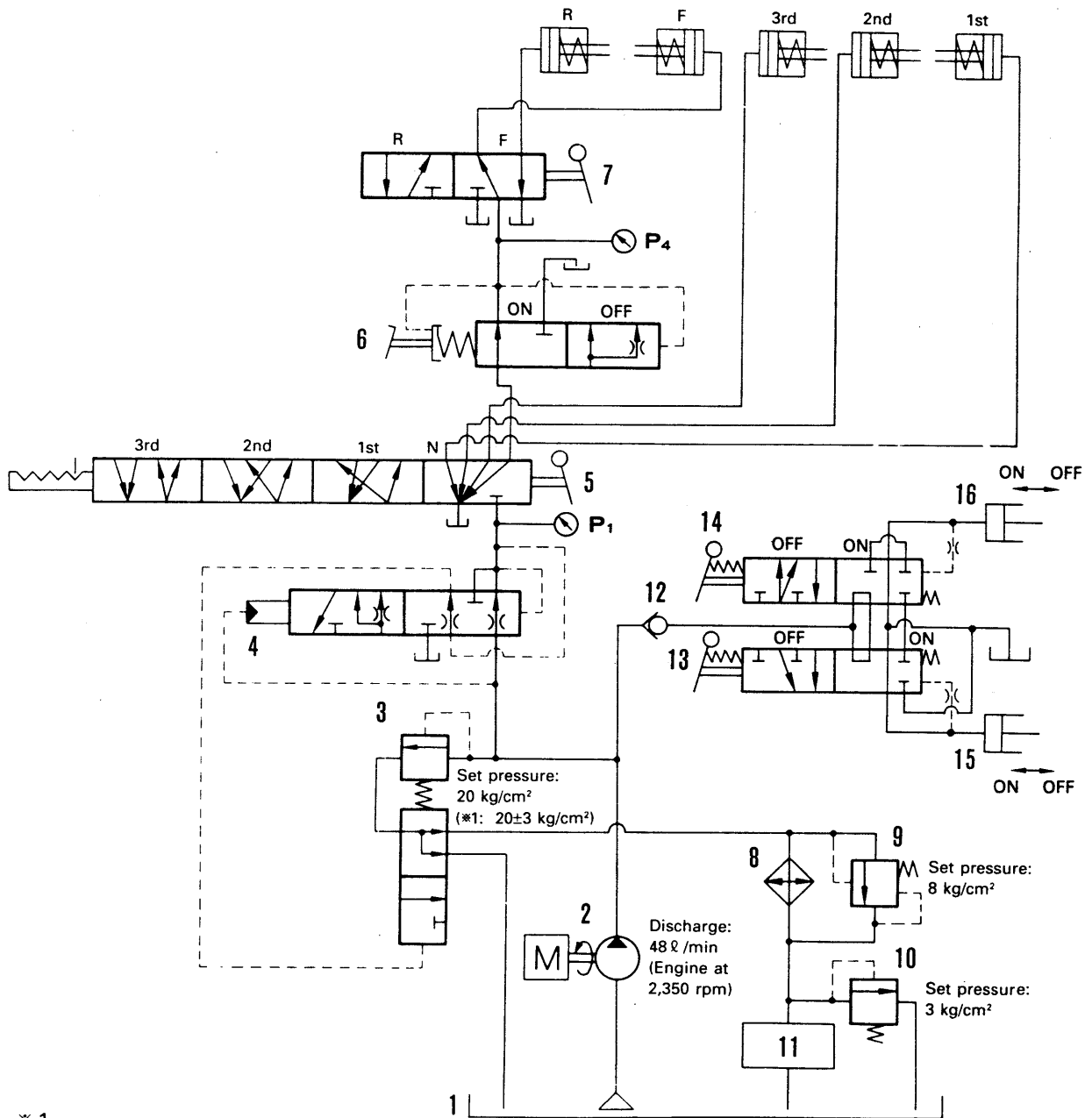


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# POWER TRAIN HYDRAULIC CIRCUIT DIAGRAM

D31S, Q-18



011418

\* 1

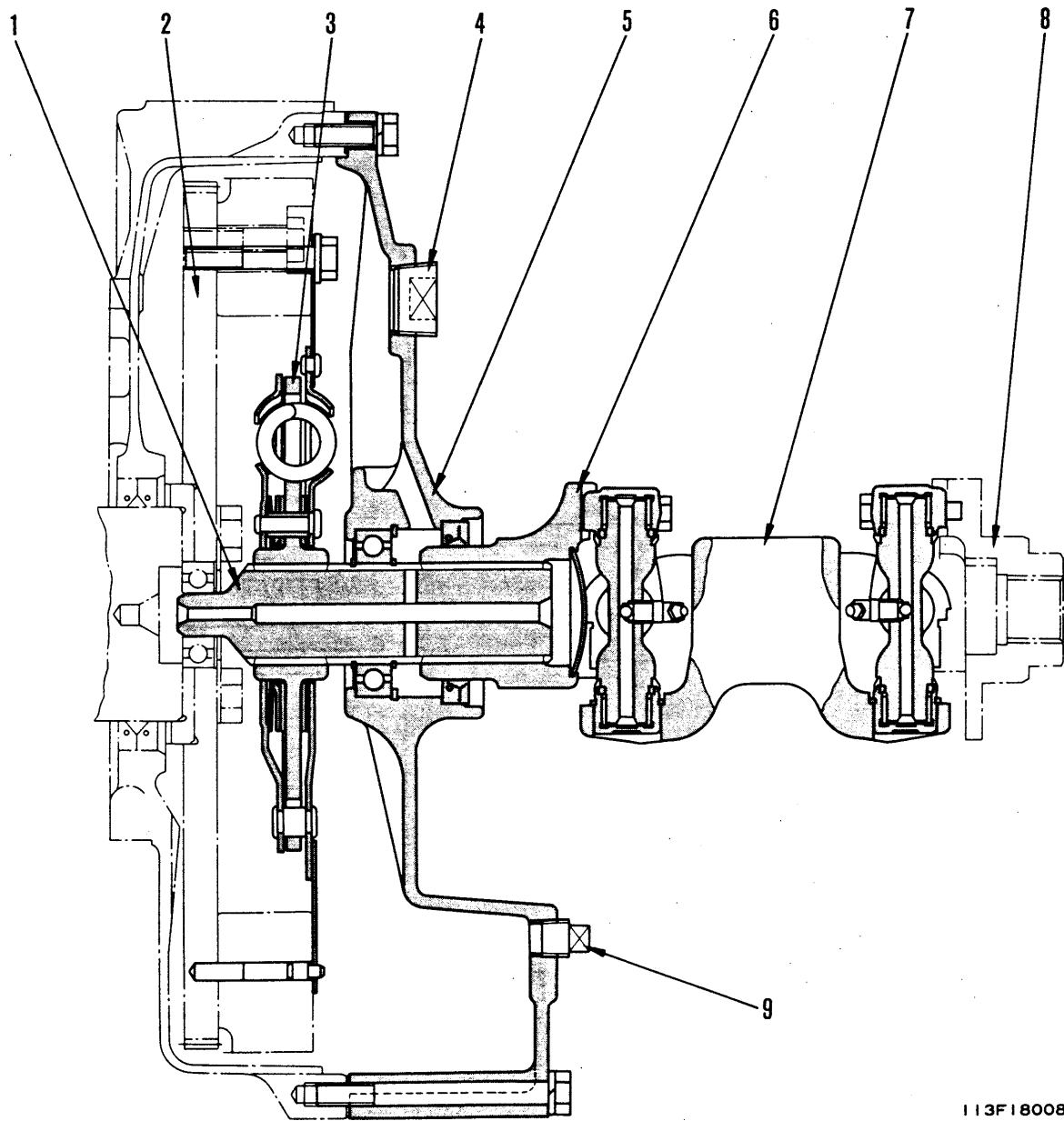
D31S-18	40068 and up
D31Q-18	40068 and up

113F18305

- 1. Transmission case
- 2. Transmission pump
- 3. Modulating valve
- 4. Quick return valve
- 5. Speed valve
- 6. Inching valve
- 7. F-R valve
- 8. Oil cooler
- 9. Oil cooler bypass valve

- 10. Transmission lubrication valve
- 11. Transmission lubrication
- 12. Check valve
- 13. L.H. steering valve
- 14. R.H. steering valve
- 15. L.H. steering cylinder
- 16. R.H. steering cylinder
- P<sub>1</sub>. Plug for main relief pressure
- P<sub>4</sub>. Plug for inching valve pressure

# DAMPER AND UNIVERSAL JOINT



011418

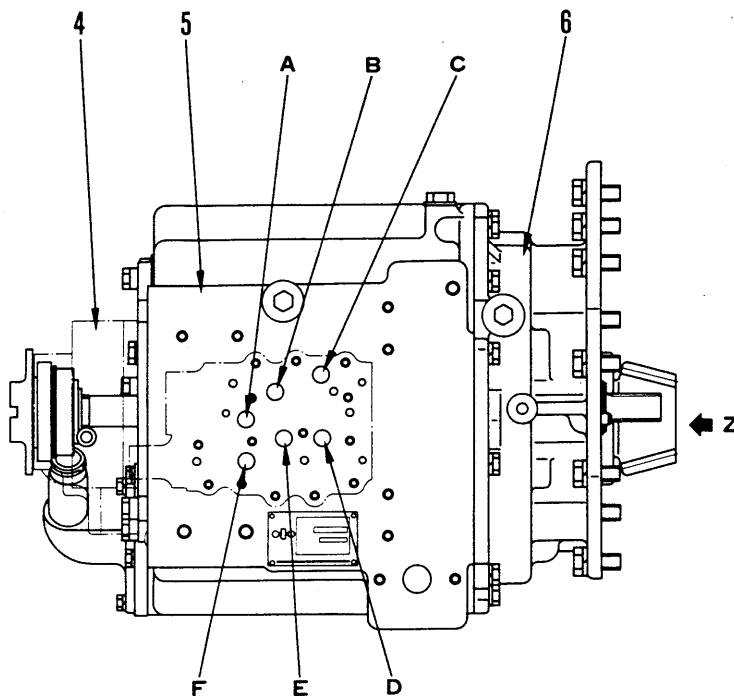
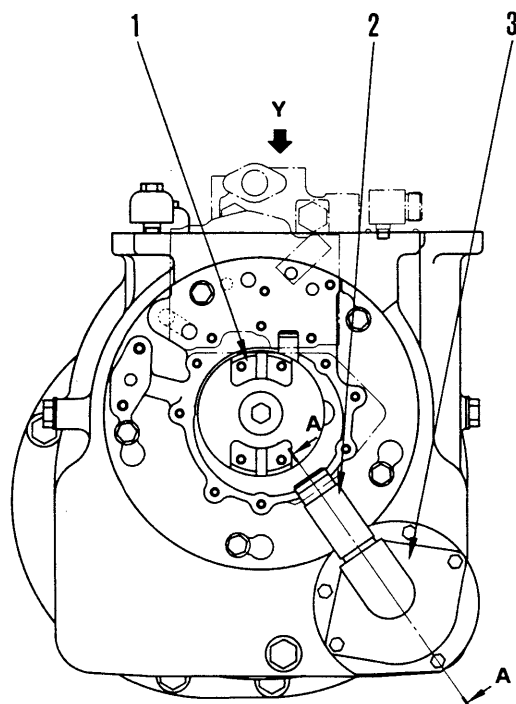
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## OUTLINE

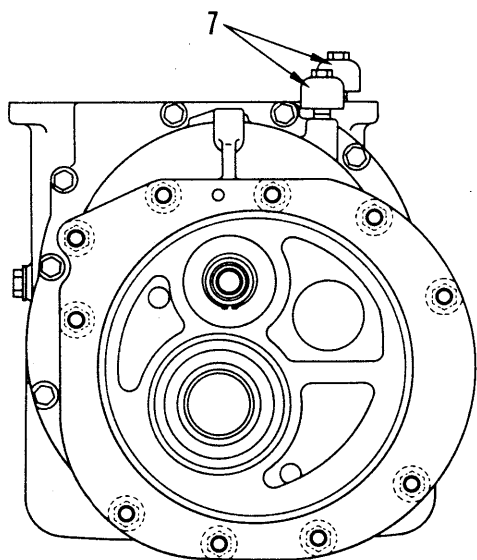
1. Output shaft
2. Flywheel
3. Damper
4. Oil filler plug
5. Cover
6. Output coupling
7. Universal joint
8. Transmission input coupling
9. Oil level plug

- The damper acts as a cushion to prevent the vibration of the engine from being transmitted directly to the transmission.
- The power from the engine is transmitted to damper (3) through flywheel (2). The power is absorbed the engine vibration by damper (3), and is transmitted to shaft (1) and universal joint (7), and then is transmitted to the transmission.

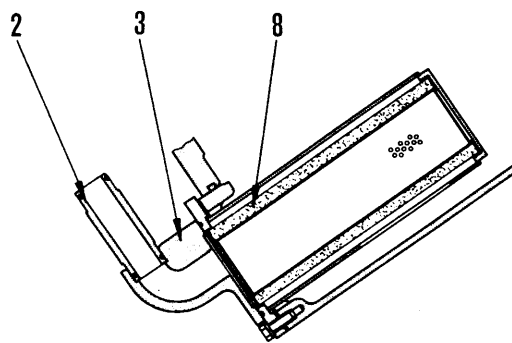
# HYDROSHIFT TRANSMISSION



View Y



View Z



Section A-A

- A. To 1st speed clutch
- B. To forward clutch
- C. To reverse clutch
- D. To 2nd speed clutch
- E. To 3rd speed clutch
- F. From modulation valve

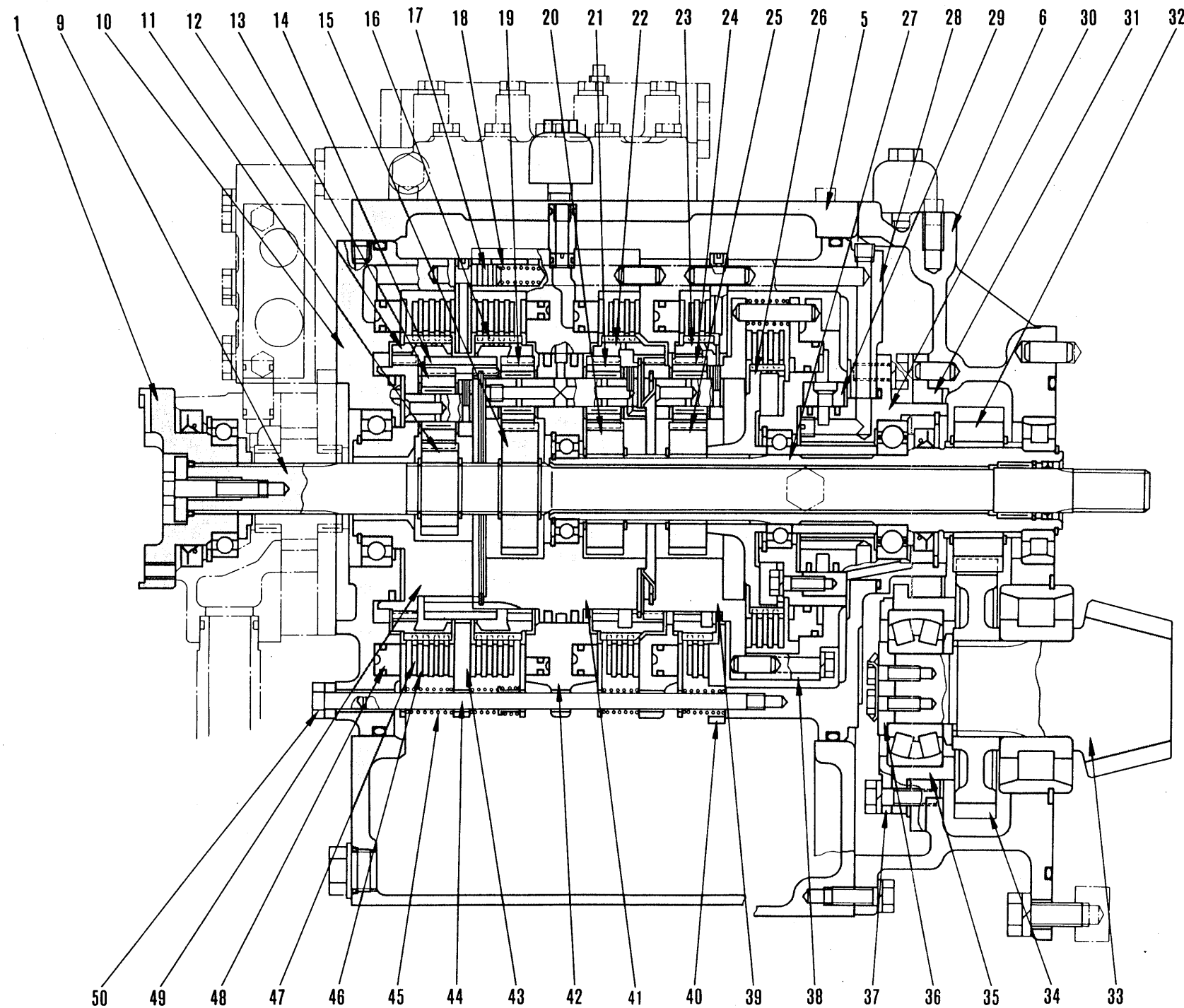
- 1. Input coupling
- 2. Sleeve
- 3. Cover
- 4. Transmission pump
- 5. Transmission case
- 6. Transfer case
- 7. Breather
- 8. Oil strainer

011418

113F1809



011418



- 9. Input shaft
- 10. No.1 clutch housing
- 11. No.1 sun gear (24 teeth)
- 12. No.1 ring gear (72 teeth)
- 13. No.1 planet gear (21 teeth)
- 14. No.1 ring gear (66 teeth)
- 15. No.2 sun gear (36 teeth)
- 16. No.2 ring gear (72 teeth)
- 17. Transmission lubrication valve
- 18. Valve spring
- 19. No.2 planet gear (18 teeth)
- 20. No.3 sun gear (36 teeth)
- 21. No.3 planet gear (18 teeth)
- 22. No.3 ring gear (72 teeth)
- 23. No.4 ring gear (72 teeth)
- 24. No.4 planet gear (18 teeth)
- 25. No.4 sun gear (36 teeth)
- 26. No.5 ring gear
- 27. Output shaft
- 28. No.5 clutch housing
- 29. Seat
- 30. Cage
- 31. Plate
- 32. Transfer drive gear (21 teeth)
- 33. Pinion shaft (13 teeth)
- 34. Transfer driven gear (35 teeth)
- 35. Bearing cage
- 36. Retainer
- 37. Retainer
- 38. No.5 piston housing
- 39. No.4 carrier
- 40. Plate
- 41. No.2 and No.3 carrier
- 42. No.2 and No.3 clutch housing
- 43. Plate
- 44. Tie rod pin
- 45. Clutch spring
- 46. Clutch plate
- 47. Clutch disc
- 48. Clutch piston
- 49. No.1 carrier
- 50. Tie rod bolt

**OUTLINE**

The D31-18 and D37-2 bulldozer is equipped with a planetary type, "3-forward and 3-reverse speed" transmission which is a combined structure of a planetary gear mechanism and disc clutches.

The rotational direction and the revolution of the transmission output shaft is selected by fixing two disc clutches out of five disc clutches by means of control valve operation.

No.1 clutch is fixed in reverse, No.2 clutch in forward, No.3 clutch in third speed, No.4 clutch in second speed, and No.5 clutch in first speed.

Any speed can be selected from three forward speeds and three reverse speeds by fixing either No.1 or No.2 clutch and one clutch among No.3, No.4, and No.5 clutches and by combining two of the above.

**Speeds and operating clutches**

	Speed	Operating clutch
Forward	Neutral	No.5 clutch
	First speed	No.2 and No.5 clutches
	Second speed	No.2 and No.4 clutches
Reverse	Third speed	No.2 and No.3 clutches
	Neutral	No.5 clutch
	First speed	No.1 and No.5 clutches
Reverse	Second speed	No.1 and No.4 clutches
	Third speed	No.1 and No.3 clutches

**Number of discs and plates on each clutch**

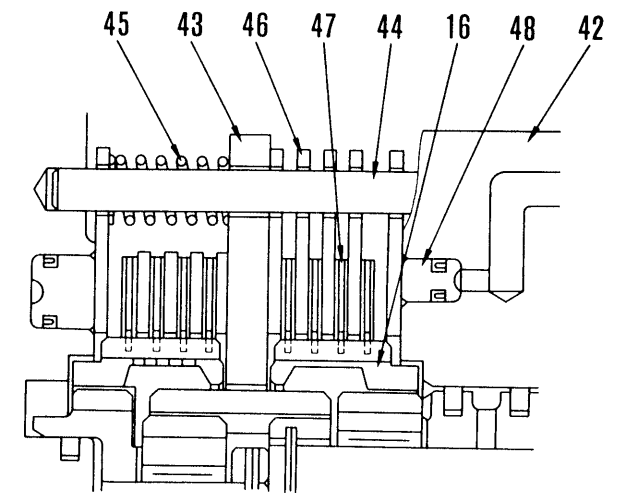
Clutch No.	Number of discs	Number of plates
No.1 clutch	4	4
No.2 clutch	4	4
No.3 clutch	3	3
No.4 clutch	2	2
No.5 clutch	3	4

## ACTING OF PISTON

To lock ring gear (16), the discs (47) and plates (46) are brought into close contact. The clutch consists of a clutch piston (48), clutch plates (46), clutch discs (47), pins (44) and piston return springs (45).

The disc's internal teeth engage with the ring gear's external teeth.

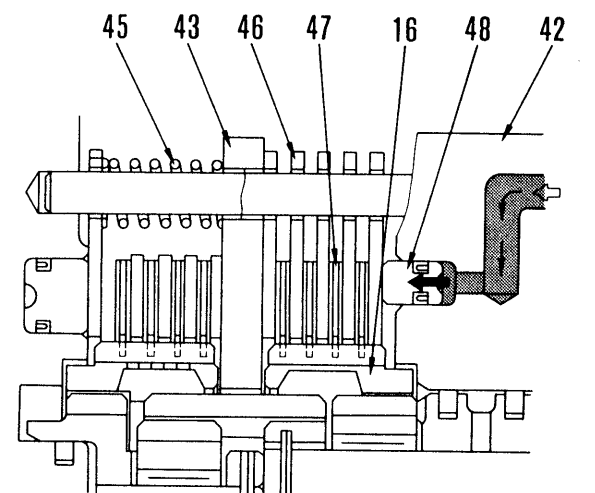
The plates, whose notch on the outside diameter engage with pins (44) on housings (42) and (43), are locked against the rotating direction. Piston (48) also is locked against the rotating direction.



F11318004

- **Clutch engaged (oil pressure is acting)**

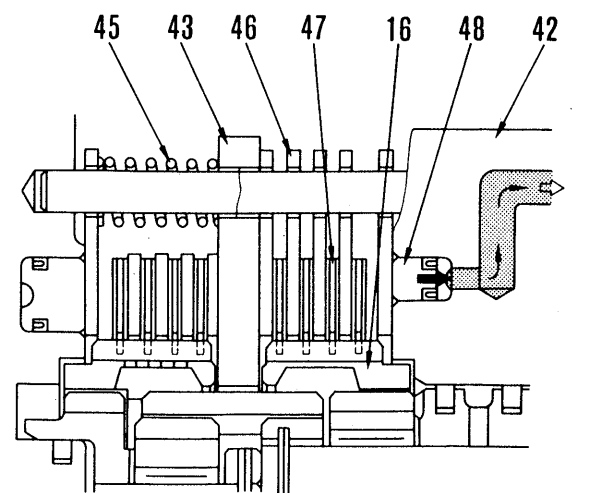
Oil from the control valve flows under pressure through the port in housing (42) to the piston (48). The piston presses clutch plates (46) and clutch discs (47) together, and the frictional force developed stops clutch discs (47) revolution, thus ring gear (16) meshing with the disc's internal teeth is locked.



F11318005

- **Clutch disengaged (oil pressure is not acting)**

When the supply of pressure oil from the control valve is shut off, piston (48) returns to the initial position by the force of piston return spring (45), thus relieving the frictional force between plates (46) and discs (47), making the ring gear (16) free.

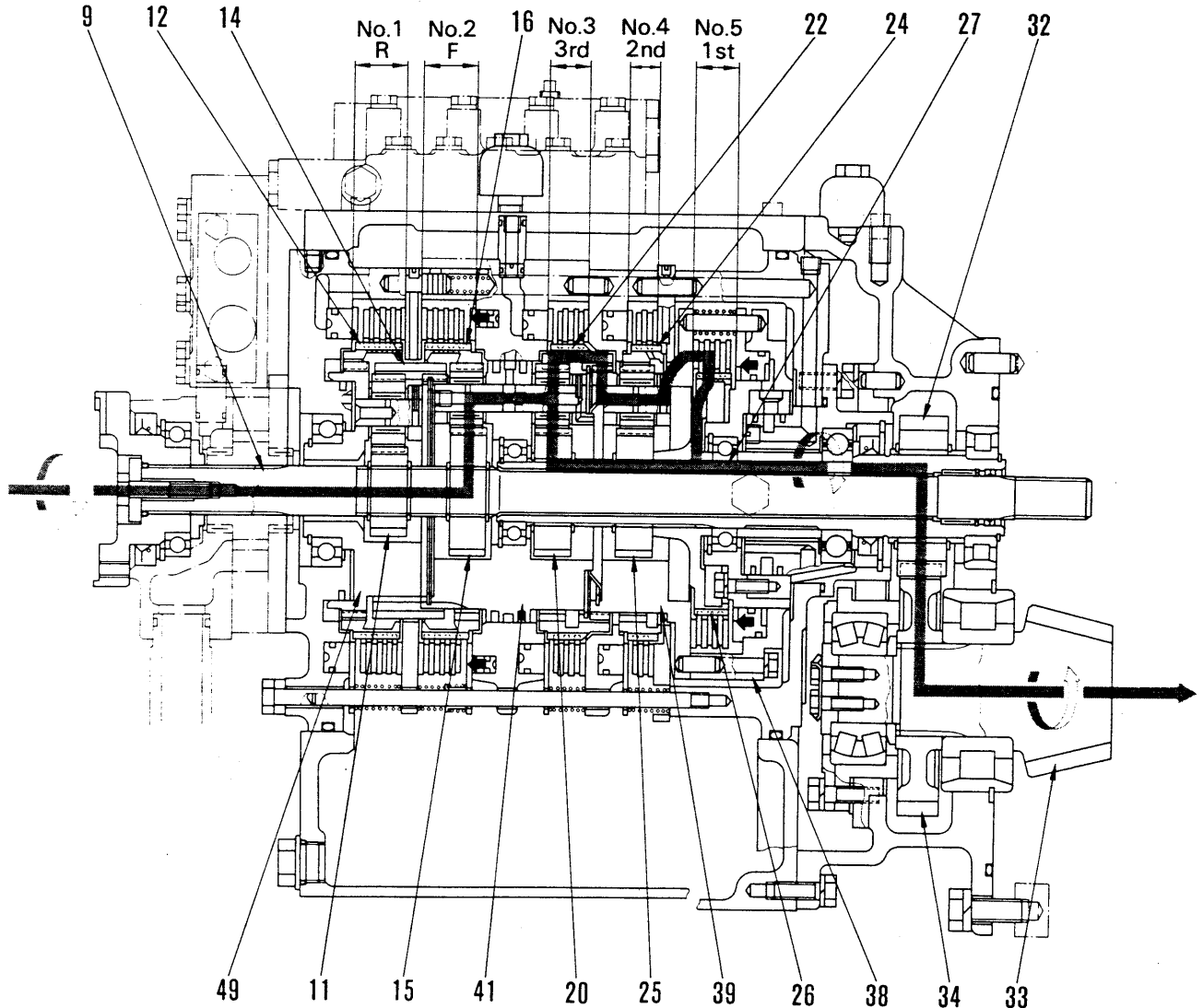


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011418

## POWER TRAIN OF TRANSMISSION

### FIRST FORWARD SPEED



No.2 and No.5 clutches engaged and No.2 ring gear fixed, No.4 carrier and No.5 ring gear are engaged.

With No.2 and No.5 clutches engaged, No.2 ring gear (16) is fixed and No.4 carrier (39) and No.5 ring gear (26) are engaged. When No.2 ring gear (16) is fixed, the rotation of the engine is transmitted to No.2, 3 carrier (41) with reduced turning speed through input shaft (9) and No.2 sun gear (15). No.2, 3 carrier (41), then, rotates in the same direction as input shaft (9).

Since No.4 carrier (39) and No.5 ring gear (26) are engaged, sun gear (20), ring gear (22), No.4 carrier (39), No.5 ring gear (26) and No.5 piston housing (38) are all engaged as a unit.

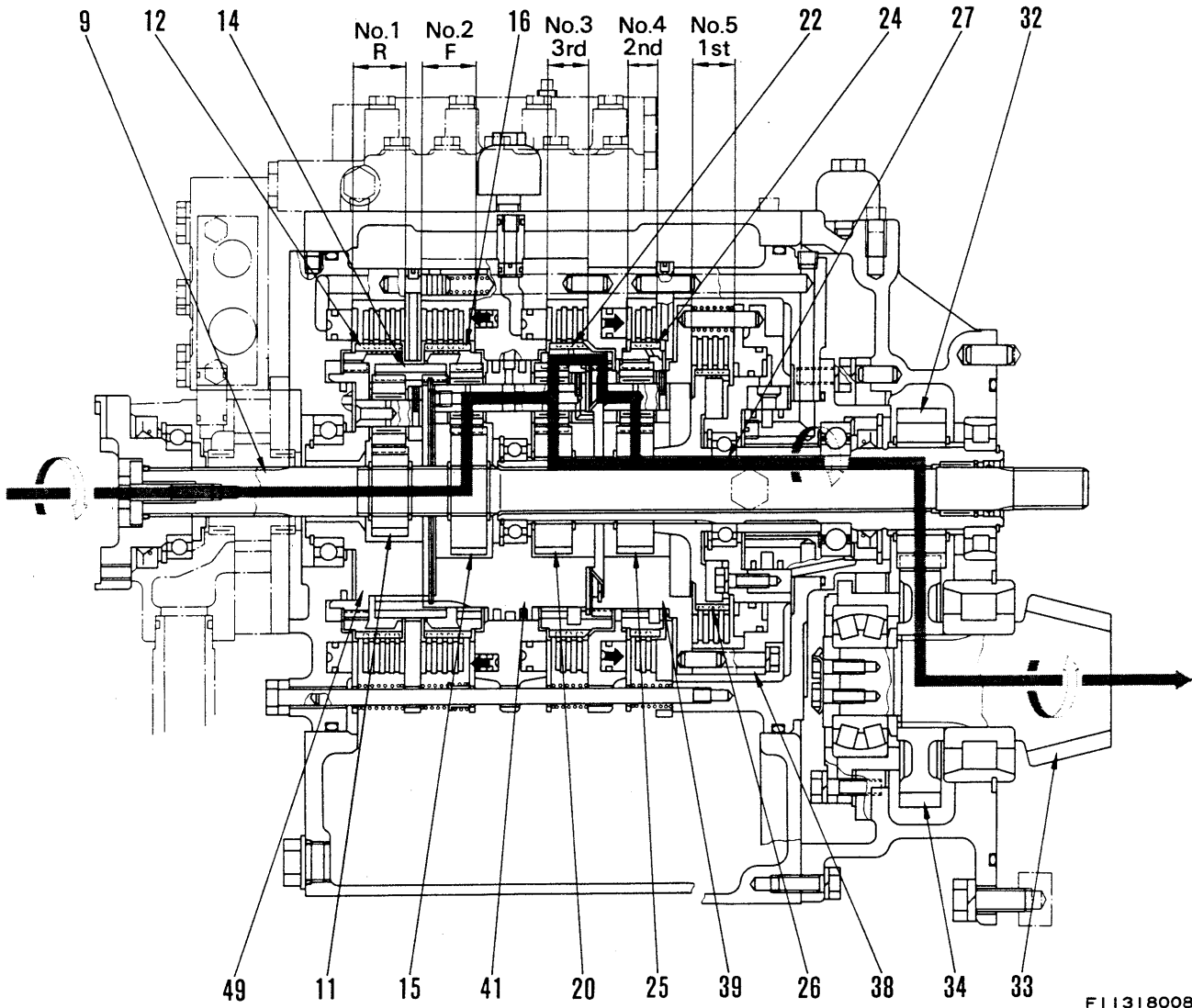
The rotation of No.2, 3 carrier (41) is then transmitted to output shaft (27) in the same direction and at the same speed.

The rotation of output shaft (27) is transmitted to bevel pinion (33) with reduced turning speed through transfer drive gear (32) and transfer driven gear (34).

Bevel pinion (33) then rotates in the opposite direction to output shaft (27).

F11318007

**SECOND FORWARD SPEED**



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No.2 and No.4 clutches engaged and No.2 and No.4 ring gears fixed.

With No.2 and No.4 clutches engaged, No.2 and No.4 ring gears (16) and (24) are fixed. When No.2 ring gear (16) is fixed, the rotation of the engine is transmitted to No.2, 3 carrier (41) with reduced turning speed and in the same direction as in the case of first forward speed.

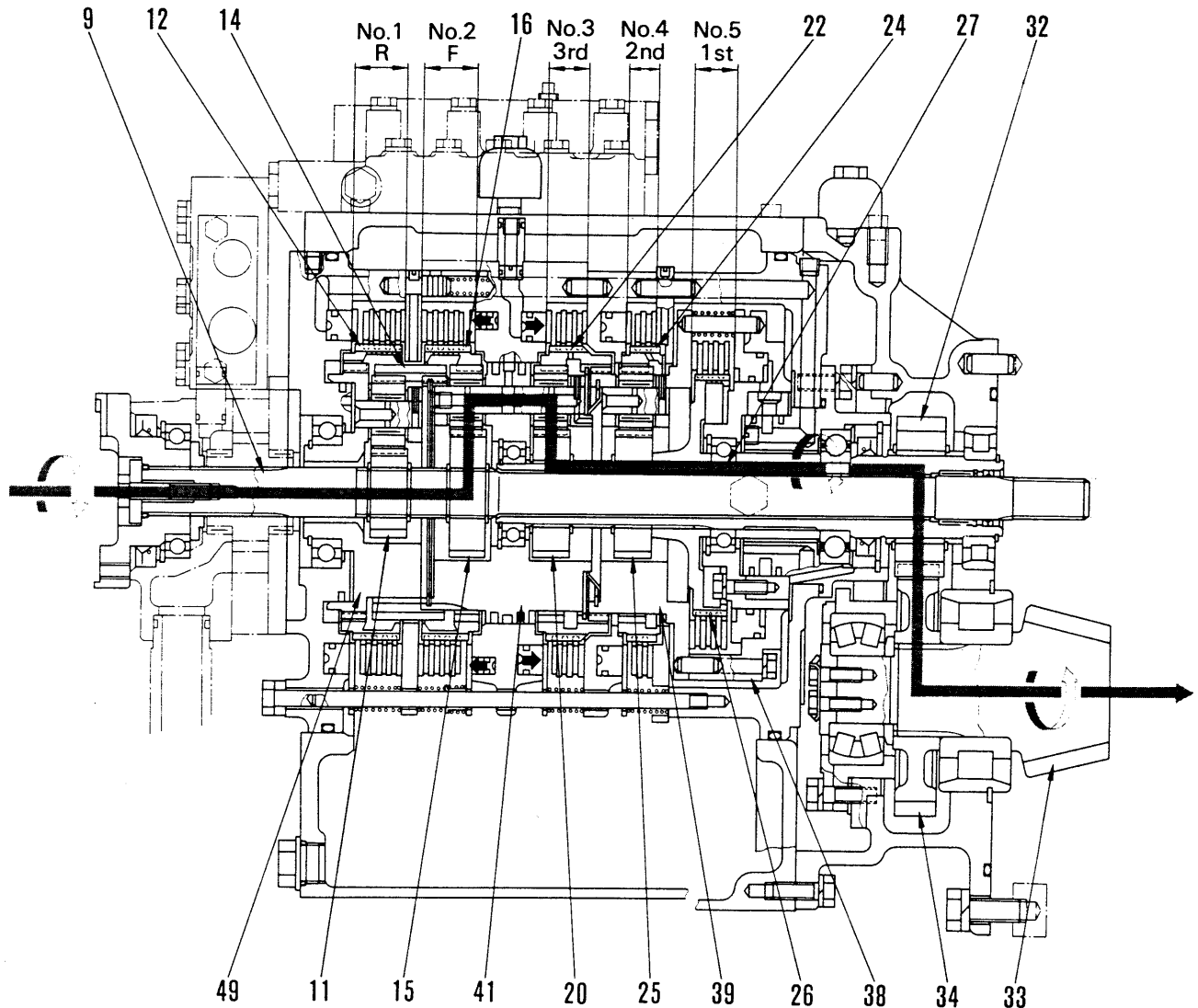
Since No.4 ring gear (24) is fixed, the rotation of No.2, 3 carrier (41) is transmitted to output shaft (27) at an increased turning speed through No.3 ring gear (22) and No.4 carrier (39), and No.4 sun gear (25) in that order.

(Besides, the rotation is transmitted from No.3 sun gear (20) to output shaft (27).)

Output shaft (27) rotates in the same direction as input shaft (9).

The rotation of output shaft (27) is transmitted to bevel pinion (33) with reduced turning speed through transfer drive gear (32) and transfer driven gear (34). Bevel pinion (33) then rotates in the opposite direction to output shaft (27).

**THIRD FORWARD SPEED**



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No.2 and No.3 clutches engaged and No.2 and No.3 ring gears fixed.

With No.2 and No.3 clutches engaged, No.2 and No.3 ring gears (16) and (22) are fixed.

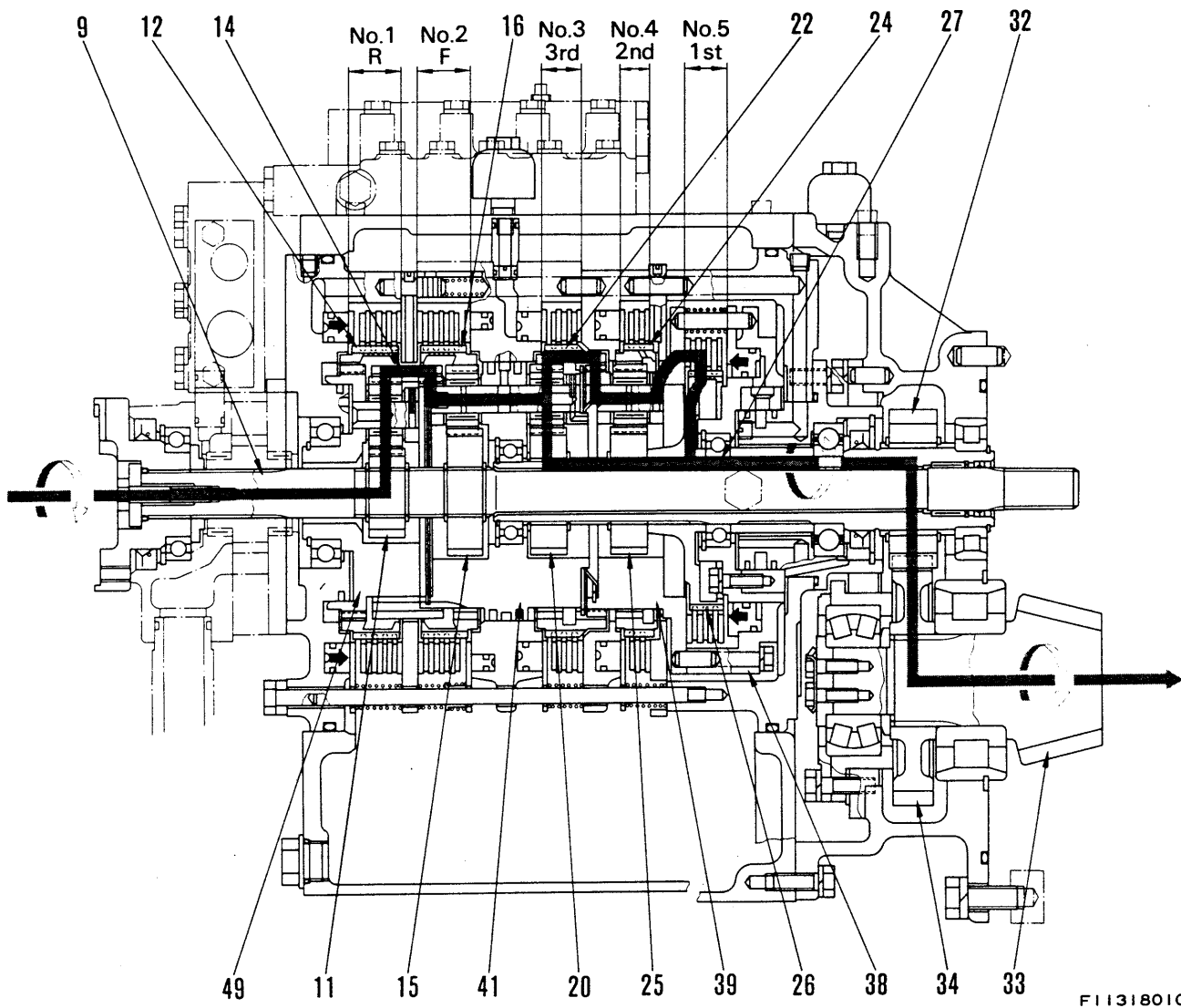
When No.2 ring gear (16) is fixed, the rotation of the engine is transmitted to No.2, 3 carrier (41) with reduced turning speed and in the same direction as in the case of first forward speed.

Since No.3 ring gear (22) is fixed, the rotation of No.2, 3 carrier (41) is transmitted to output shaft (27) at an increased turning speed through No.3 sun gear (20) in that order.

Output shaft (27) rotates in the same direction as input shaft (9).

The rotation of output shaft (27) is transmitted to bevel pinion (33) with reduced turning speed through transfer drive gear (32) and transfer driven gear (34). Bevel pinion (33) then rotates in the opposite direction to output shaft (27).

**FIRST REVERSE SPEED**



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No.1 and No.5 clutches engaged and No.1 ring gear fixed, No.4 carrier and No.5 ring gear are engaged.

With No.1 and No.5 clutches engaged, No.1 ring gear (12) is fixed and No.4 carrier (39) and No.5 ring gear (26) are engaged. When No.1 ring gear (12) is fixed, No.1 carrier (49) meshed with No.1 ring gear (12) is also fixed.

The rotation of the engine is transmitted to ring gear (14) through input shaft (9) and No.1 sun gear (11) in the opposite direction and at a reduced turning speed.

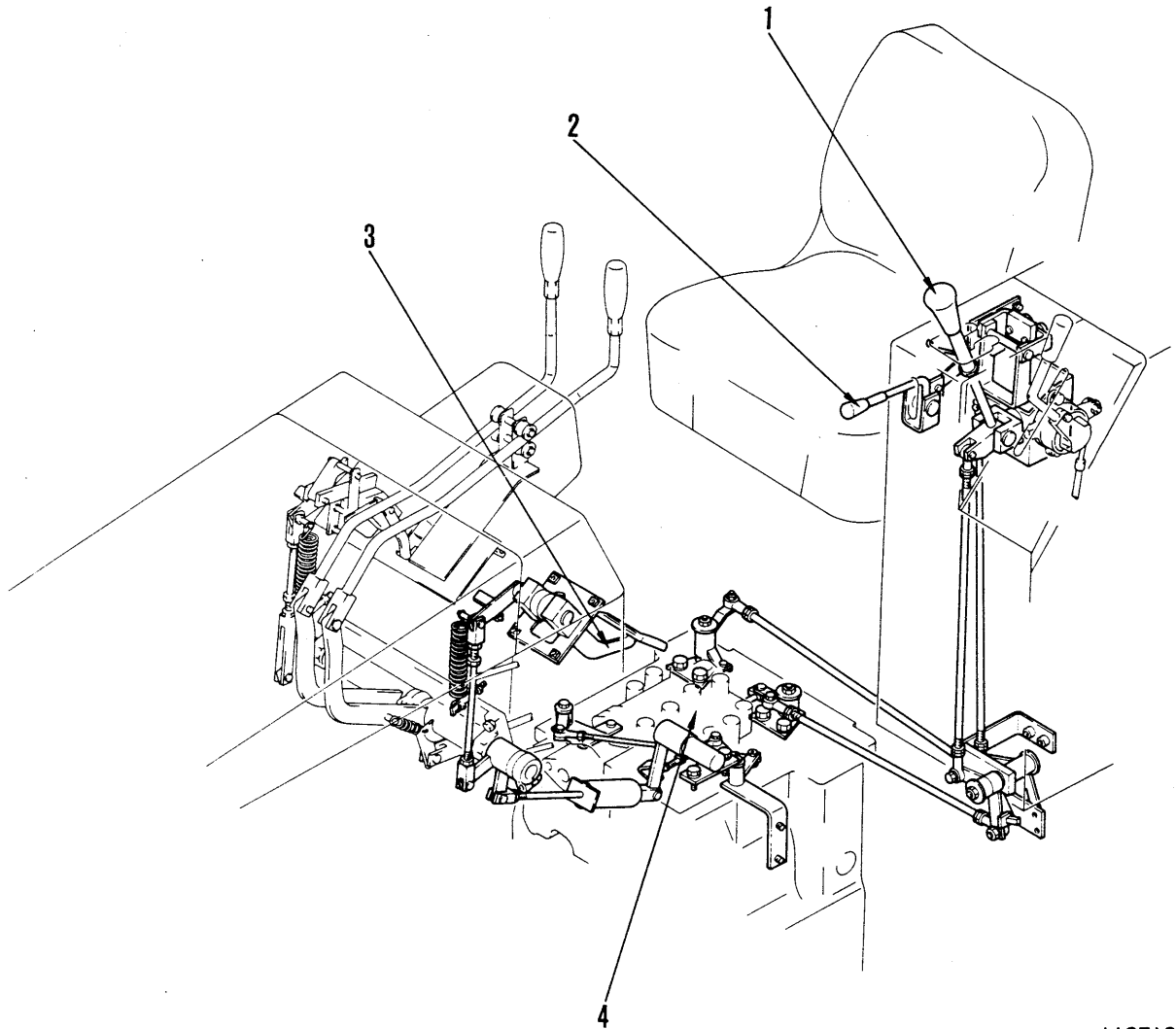
Since ring gear (11) is meshed with No.2, 3 carrier (41), the rotation is transmitted to No.2, 3 carrier (41).

The rotation of No.2, 3 carrier (41) is transmitted to output shaft (27) in the same way as in first forward speed.

Output shaft (27) rotates in the opposite direction to input shaft (9).

The rotation of output shaft (27) is transmitted to bevel pinion (33) with reduced turning speed through transfer drive gear (32) and transfer driven gear (34). Bevel pinion (33) then rotates in the opposite direction to output shaft (27).

# TRANSMISSION CONTROL



011418

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1. Gear shift lever
2. Lock lever
3. Inching pedal
4. Speed, F-R and inching valve assembly

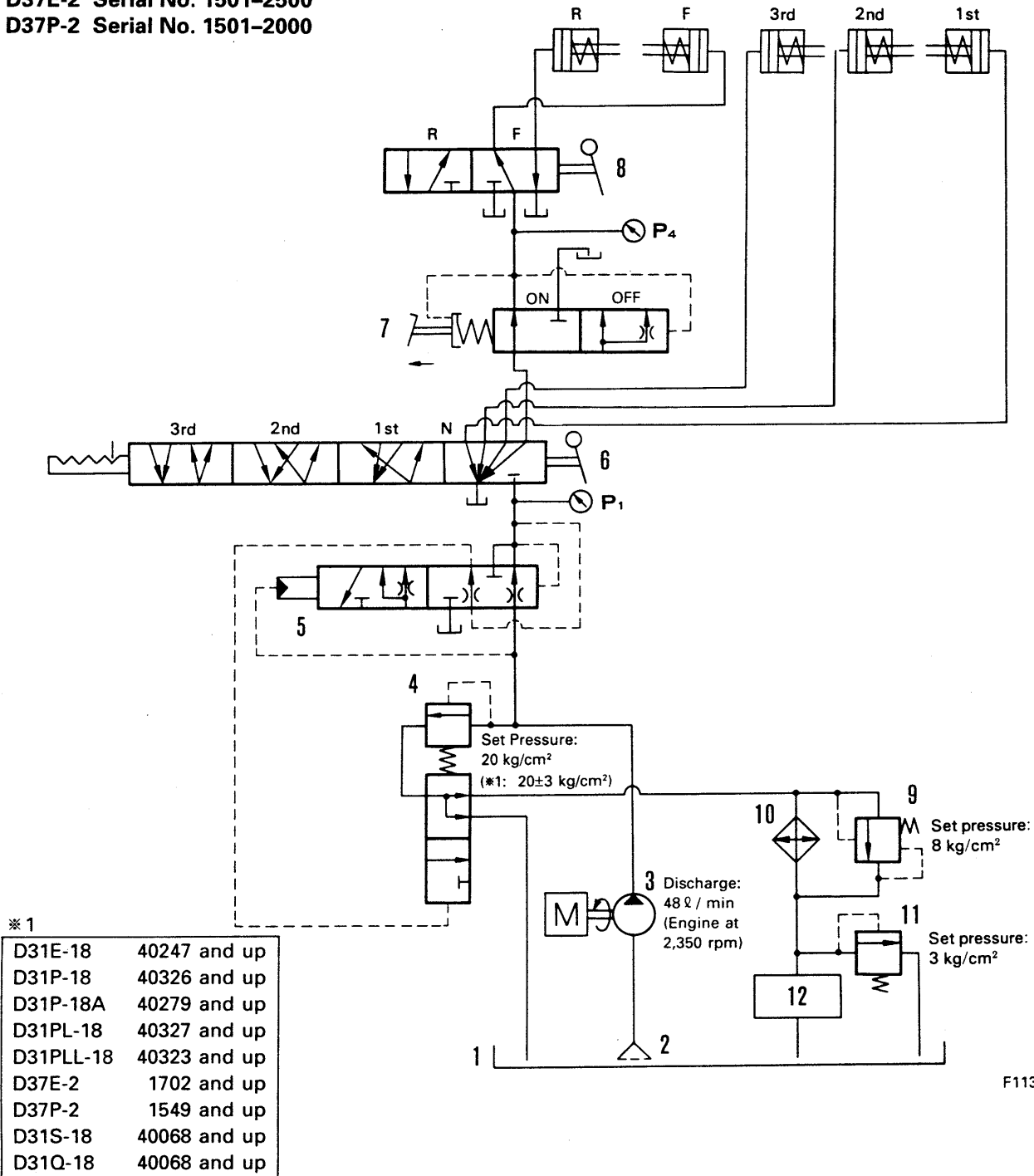
- Gear shift lever (1) inside the operator's compartment is connected to the spool of the speed, F-R, and inching valve assembly (4) on top of the transmission case.  
Inching pedal (3) is connected to the inching valve spool in the same way.  
When gear shift lever (1) is operated, the speed valve spool and F-R valve spool are actuated at the same time.  
The two clutches inside the transmission are engaged, and the machine travels.

When inching pedal (3) is operated, the inching valve spool is actuated, and the FORWARD or REVERSE clutch inside the transmission is partially disengaged, or is completely disengaged. This gives fine control of the machine travel speed, or stops the machine.

The inching pedal is also interconnected with the brake. When the clutch is disengaged, the brake is interconnected at the same time and the machine can be kept stopped.

# HYDROSHIFT TRANSMISSION HYDRAULIC CIRCUIT DIAGRAM

D31E, P, PL, PLL-18, D31P-18A, D31S, Q-18  
 D37E-2 Serial No. 1501-2500  
 D37P-2 Serial No. 1501-2000

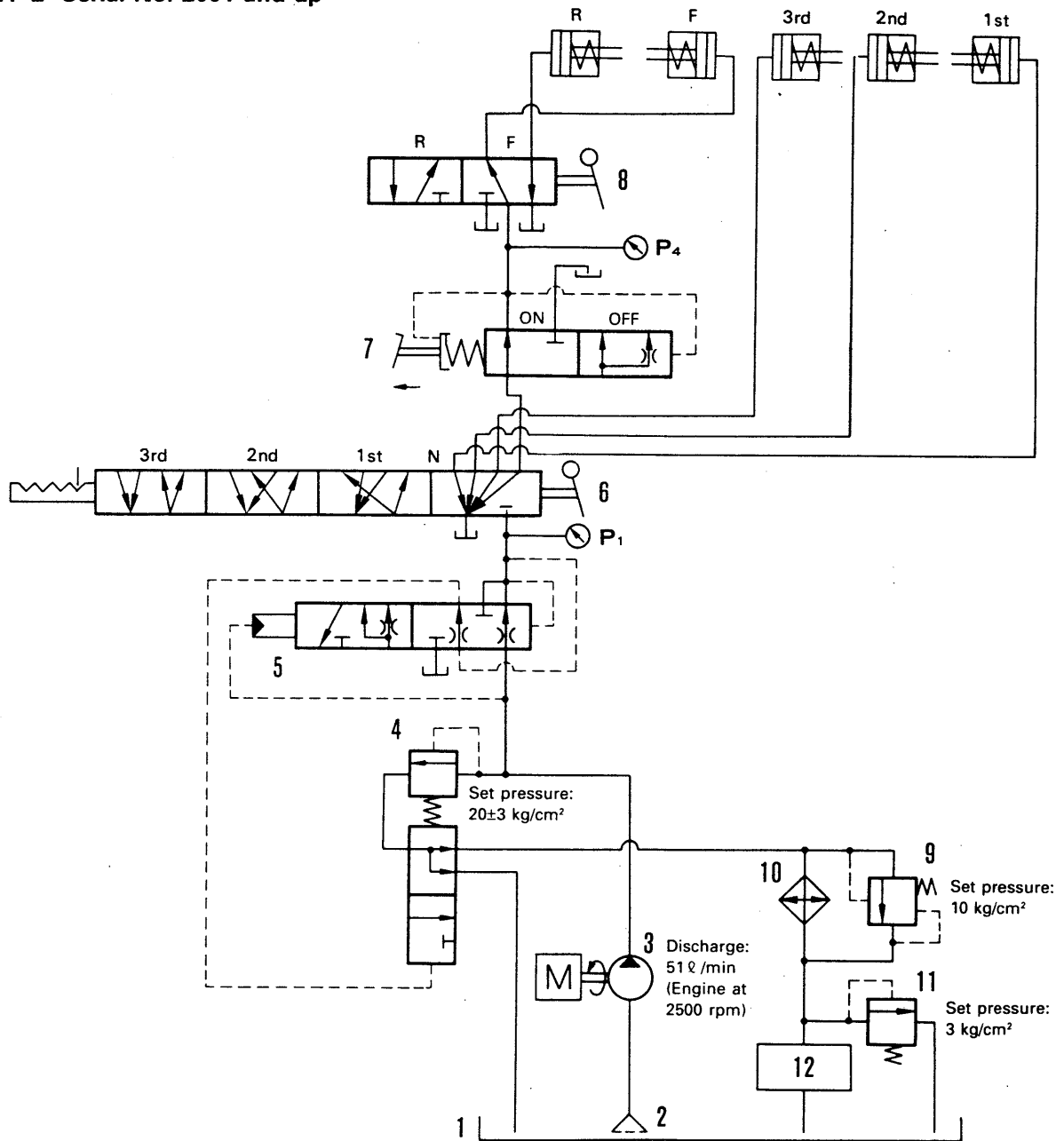


## OUTLINE

- The oil in transmission case (1) is sucked by transmission pump (3) through strainer (2), and is sent to modulating valve (4) and quick return valve (5).
- The modulating valve and quick return valve act together, and regulates the oil pressure in the circuit at 20 kg/cm<sup>2</sup> (\*1: 20±3 kg/cm<sup>2</sup>). The oil flows through to the oil cooler and transmission case.
- The oil flowing to the quick return valve enters speed valve (6), inching valve (7) and F-R valve (8).
- The oil cooler bypass valve (9) is installed on transmission case.
- The transmission lubrication relief valve (11) is built into the transmission.



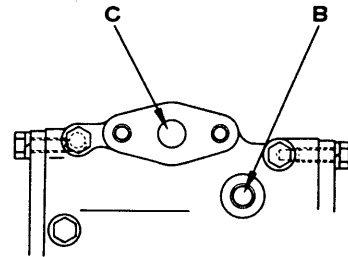
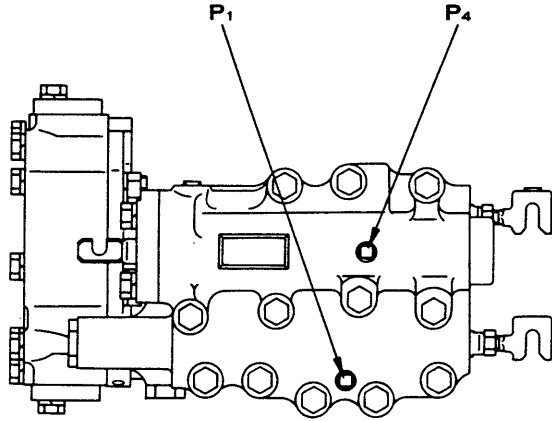
D37E-2 Serial No. 2501 and up  
 D37P-2 Serial No. 2001 and up



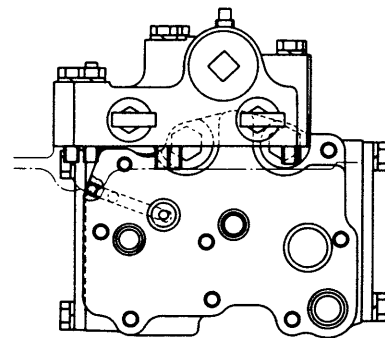
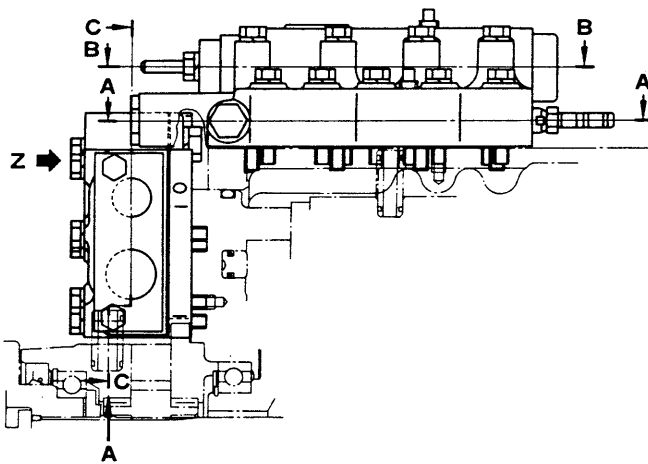
F11318011

- The oil in transmission case (1) is sucked by transmission pump (3) through strainer (2), and is sent to modulating valve (4) and quick return valve (5).
- The modulating valve and quick return valve act together, and regulates the oil pressure in the circuit at  $20 \pm 3 \text{ kg/cm}^2$ . The oil flows through to the oil cooler and transmission case.
- The oil flowing to the quick return valve enters speed valve (6), inching valve (7) and F-R valve (8).
- The oil cooler bypass valve (9) is installed on transmission case.
- The transmission lubrication relief valve (11) is built into the transmission.

# TRANSMISSION CONTROL VALVE



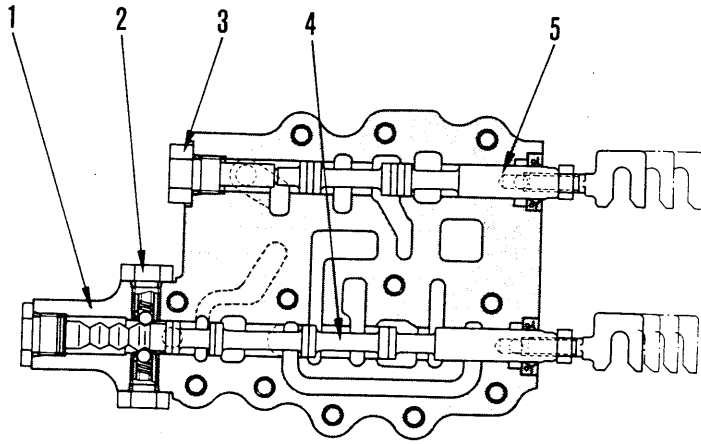
View Z



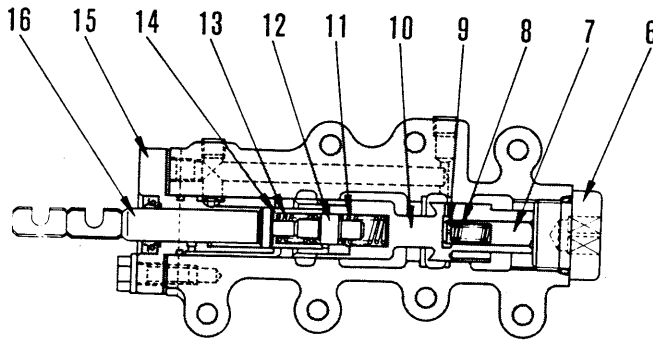
113F18011

- A. From transmission pump
- B. To steering circuit
- C. To oil cooler
- P<sub>1</sub> Plug for main relief pressure
- P<sub>4</sub> Plug for inching valve pressure

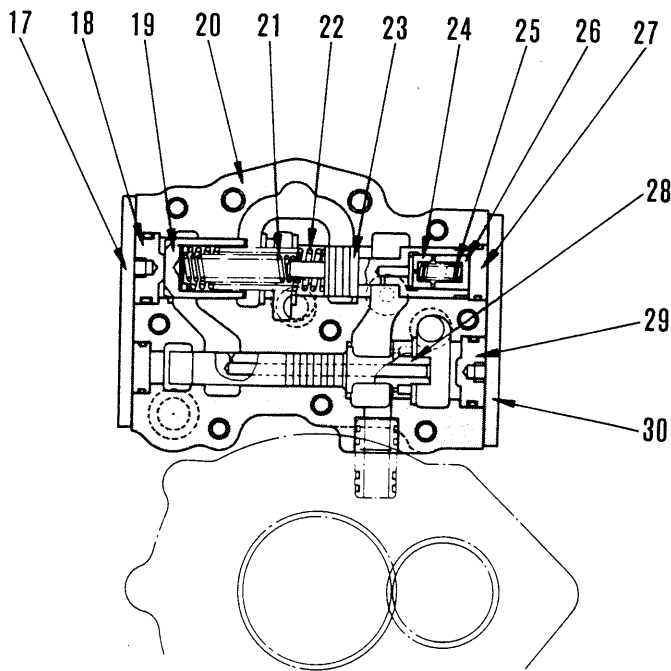
011418



Section A - A



Section B - B



Section C - C

F10406015

1. Valve body
  2. Detent
  3. Plug
  4. Speed spool
  5. F-R spool
  6. Plug
  7. Piston
  8. Spring
  9. Piston
  10. Inching valve
  11. Spring
  12. Piston
  13. Spring
  14. Sleeve
  15. Sleeve
  16. Inching valve spool
  17. Cover
  18. Stopper
  19. Load piston
  20. Valve body
  21. Spring
  22. Spring
  23. Modulating valve
  24. Piston
  25. Spring
  26. Piston
  27. Stopper
  28. Quick return valve
  29. Stopper
  30. Cover
- A. From transmission pump

011418

## MODULATING VALVE

### OUTLINE

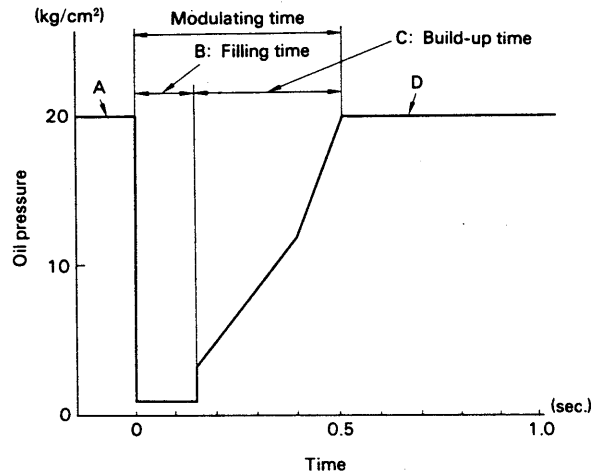
- The modulating valve consists of a modulating relief valve and a quick return valve, and acts to modulates the pressure.
- When the gear shift lever is operated to shift gear, the clutch is pushed into close contact by the piston. However, if high pressure is suddenly applied, the piston will suddenly engage the clutch. This will make the machine suddenly start, and it will receive an excessive shock. To prevent this, the modulating valve is installed. When the gear shift lever is operated to shift gear, the pressure on the piston gradually rises to the set pressure and the clutch is engaged smoothly. This allows the machine to start without any shock, thereby improving the durability of the power train and at the same time providing a comfortable ride for the operator.
- The figure on the right shows the relationship between the time and the increase in the hydraulic pressure of the modulating valve.

For example, when the gear is shifted from F1 to F2, the oil from the pump passes through the speed valve spool, flows to the second clutch and fills the circuit up to the clutch piston port.

The time taken for the circuit to be filled up to the clutch piston port is called the "filling time", and the oil pressure during this time is 0 kg/cm<sup>2</sup>.

When the circuit up to the clutch piston port is filled with oil, the oil pressure starts to rise. The time taken for the pressure to rise to the set pressure is called the "build-up time". The filling time and build-up time together are called the "modulating time".

### • Modulating graph



F10406016

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**OPERATION**

**1. While traveling**

(Range A and D in Fig. F10406016.)

The oil from the transmission pump enters port **A** and chamber **B**.

The oil passes through orifice **b** and goes from chamber **F** through the speed valve and F-R valve to fill the two sets of clutch piston ports.

The pressure in this circuit is always set by the action of modulating valve (23) to 20 kg/cm<sup>2</sup>. (\*1: 20±3 kg/cm<sup>2</sup>)

\*1: Applicable Serial No.

D31E-18	40247 and up
D31P-18	40326 and up
D31P-18A	40279 and up
D31PL-18	40327 and up
D31PLL-18	40323 and up
D31S-18	40068 and up
D31Q-18	40068 and up
D37E-2	1702 and up
D37P-2	1549 and up

When the pressure inside the circuit becomes higher, the modulating valve moves to the left. It opens the passage between chambers **B** and **E**, so the oil from the pump is relieved to chamber **E**. If the pressure inside the circuit drops because of leakage of oil from the clutch piston or valve, the modulating valve moves to the right. This closes the passage between chambers **B** and **E**, so the oil from the pump all flows from port **A** into the circuit to the clutch piston port.

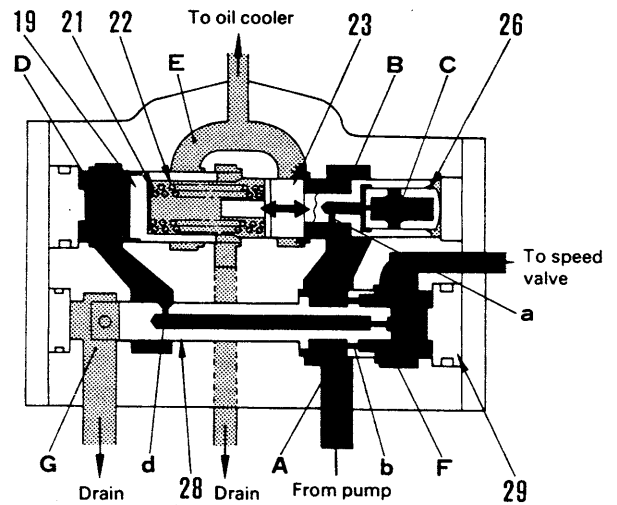
**2. Immediately after shifting gear shift lever**

(Range B in Fig. F10406016)

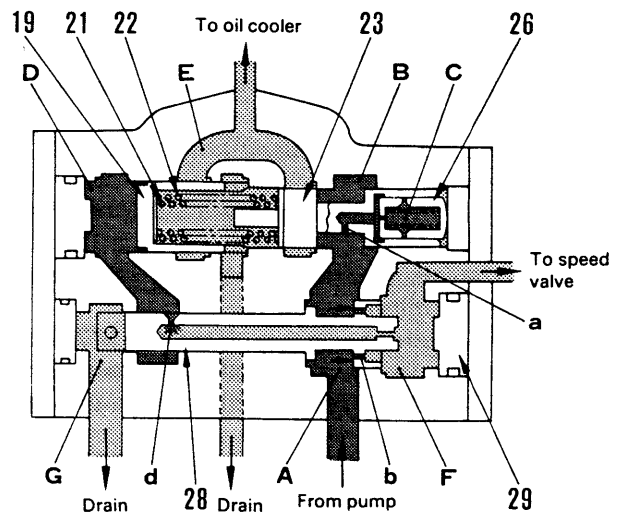
When the gear shift lever is moved, the circuit from the transmission pump to the piston port of the clutch after gear shifting is opened and oil flows to the clutch piston port.

When this happens, a difference in pressure is generated between port **A** and chamber **F** because the oil is restricted by orifice **b**. Because of the pressure at port **A**, quick return valve (28) moves to the right. This connects chamber **D** and drain port **G** and relieves the back pressure on load piston (9).

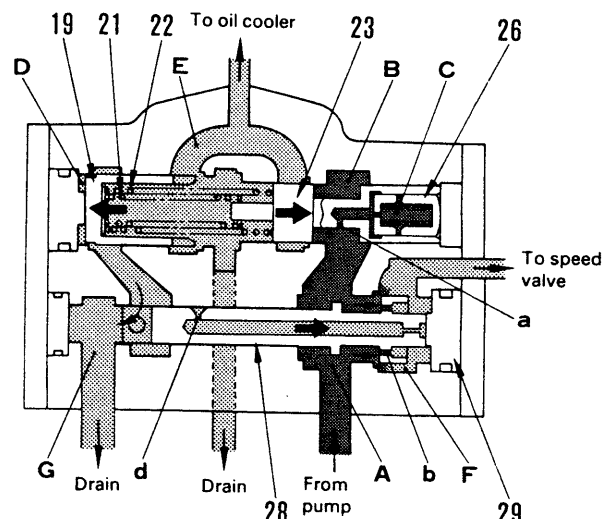
When this happens, modulating valve (23) is moved to the right by the tension of springs (21) and (22), and load piston (19) is returned to the left.



F10306027



F10306028



F10306029

**3. While clutch pressure is rising**

(Range C in Fig. F10406016)

When the oil sent under pressure from the pump fills the circuit from port A to the clutch piston port, the oil pressure starts to rise.

When this happens, the difference in pressure on both sides of orifice b is removed. Quick return valve (28) moves to the left and the passage between chamber D and drain port G is closed.

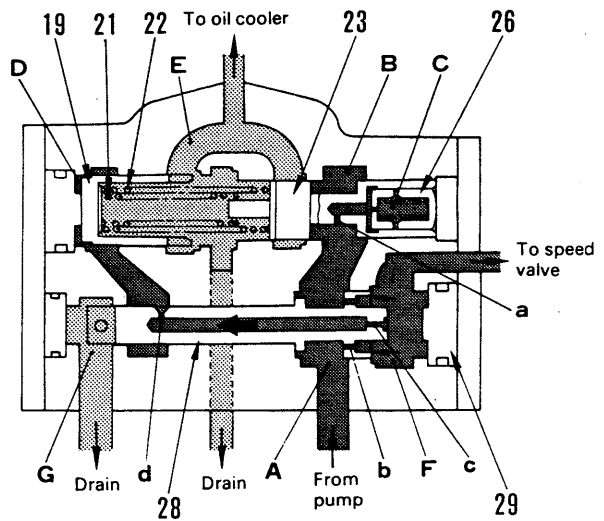
The oil flows through orifice a to chamber C and pushes piston (26). The reaction to this makes modulating valve (23) compress springs (21) and (22) and move to the left. This opens the passage from chamber B to chamber E.

At the same time, the oil passing from orifice c through the chamber in the center of quick return valve (28) then passes through orifice d and enters chamber D. The oil becomes the back pressure of load piston (19), compresses springs (21) and (22) and move the load piston to the right to the passage between close chambers B and E.

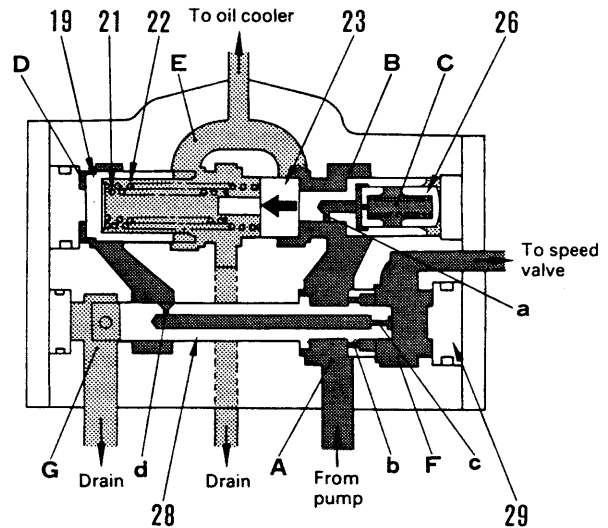
This operation is repeated continuously to increase the load on springs (21) and (22). In this way, the hydraulic pressure inside the circuit gradually rises and finally load piston (19) comes into contact with the valve body and cannot move any further.

When this happens, modulating valve (23) stops in a position where the passage between chambers B and E is open, and the rise in pressure is completed.

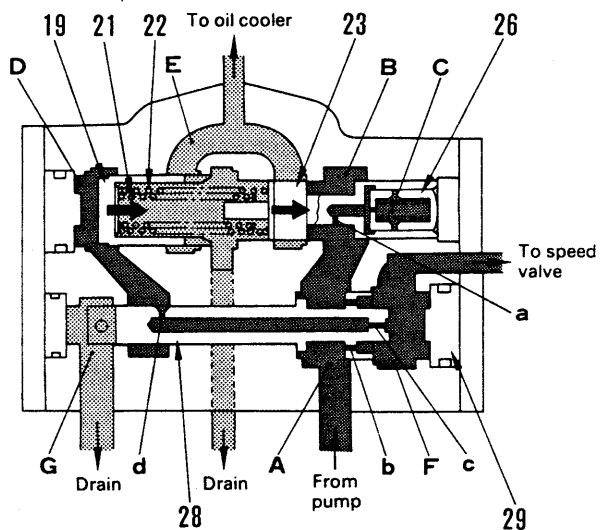
The hydraulic pressure at this point is 20 kg/cm<sup>2</sup>. The oil relieved from chamber B to chamber E flows from chamber E into the oil cooler circuit.



F10306030



F10306031



F10306032

011418

## INCHING VALVE

### OUTLINE

- The inching valve is in the circuit between the speed valve and F-R valve. The amount that the inching pedal is operated adjusts the amount of oil (oil pressure) sent from the speed valve to the F-R valve. This changes the contact force of the FORWARD or REVERSE clutches to partially disengage the clutches and allow fine control of the travel speed; or it completely disengages the clutches to make it possible to stop the machine.

### OPERATION

#### 1. Inching pedal not operated

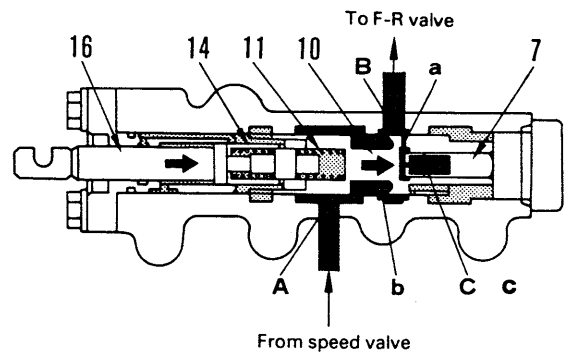
Spool (16) is interconnected with the inching pedal, so when the inching pedal is not being operated, it is at the end of its stroke on the right. As a result, valve (10) is pushed to the right by sleeve (14) together with the spool.

The oil sent under pressure from the pump passes through the modulating valve and speed valve and enters ports A and B. It then passes through the F-R valve and flows to the FORWARD or REVERSE clutch piston port.

The oil passing through orifice a and entering chamber C becomes the force trying to move valve (10) to the left because of the reaction pushing piston (7).

However, valve (10) is in contact with sleeve (14), so it cannot move to the left. Therefore, passage b between port A and B is kept fully open.

As a result, the oil from the speed valve gradually increases in pressure because of the action of the modulating valve. It enters clutch piston port and fully engages the clutch.



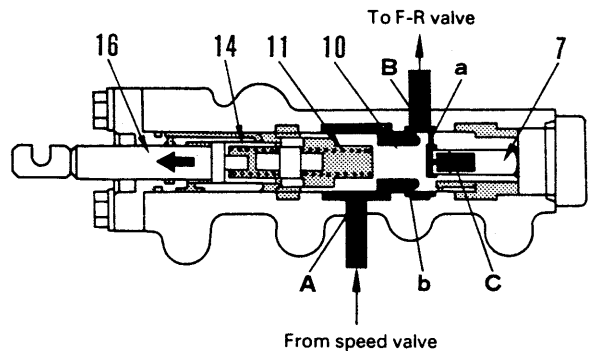
F 1 0306033

**2. Fine operation of inching pedal**

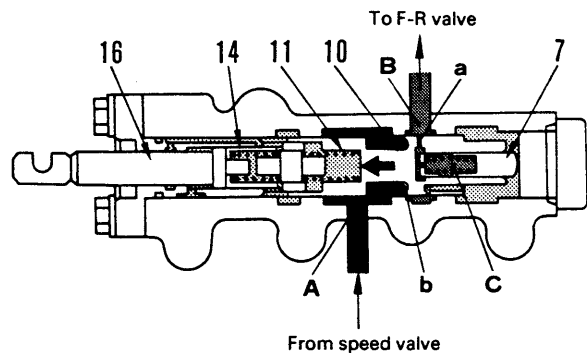
When the inching pedal is partially depressed, spool (16) moves to the left by an amount which corresponds to the amount the pedal is depressed. When this happens, sleeve (14) moves out of contact with valve (10) and determines the tension of spring (11). In this case, if the oil from the speed valve fills the circuit to the clutch piston port, the oil pressure gradually rises.

When this happens, the oil pressure in chamber C gradually moves valve (10) to the left to a position where it is in balance with the tension of spring (11). Passage b is restricted, so the pressure in the circuit from port D to the clutch port does not rise any more.

As a result, the clutch is partially disengaged and the machine travel speed drops.



F 10306034



F 10306035

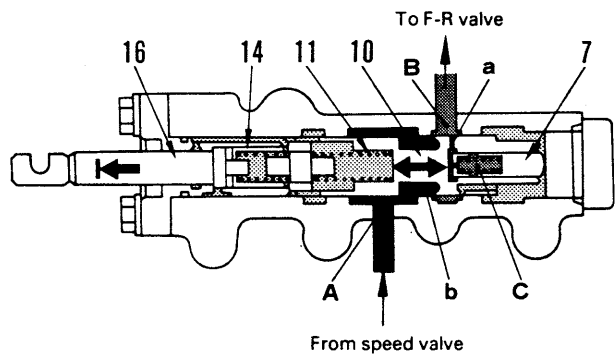
**3. Inching pedal fully depressed**

When the inching pedal is fully depressed, spool (16) moves to the left from the condition in Step 2, and the tension of spring (11) becomes the minimum.

In this condition, the oil pressure in the circuit from port B to the clutch piston port rises slightly, and valve (10) is moved by the oil pressure in chamber C to close passage b.

Therefore, the clutch is disengaged and the machine stops. If the oil pressure in the circuit beyond B drops because of oil leakage in the circuit beyond port B, the balance between the hydraulic pressure in chamber C and the tension of spring (11) is lost. The tension of spring (11) then moves valve (10) back to the right to open passage b and supply oil.

This operation is repeated to maintain the hydraulic pressure in the circuit beyond port B to a fixed level.



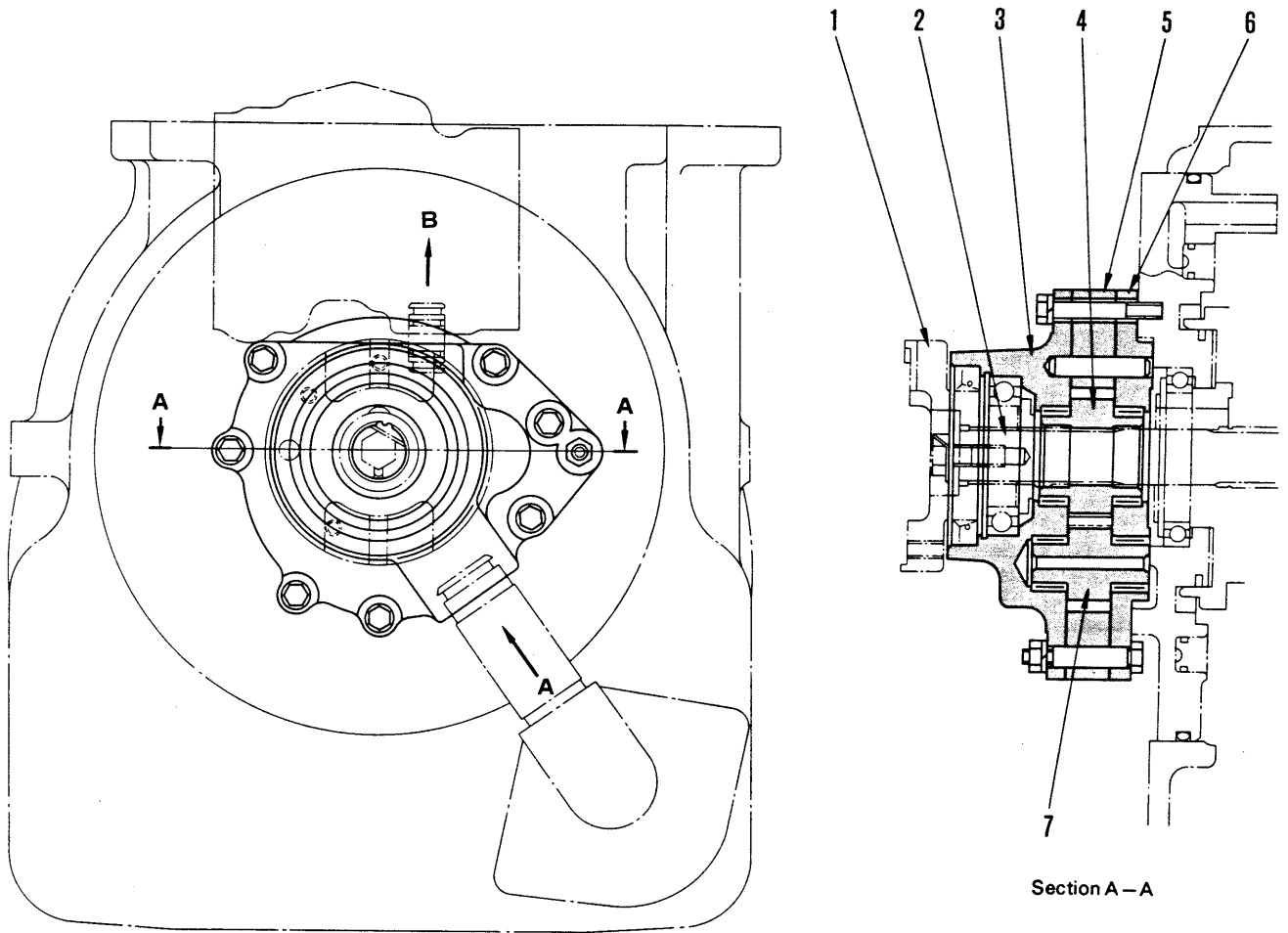
F 10306036

011418



# TRANSMISSION PUMP

011418



113F18012

1. Transmission input coupling
2. Transmission input shaft
3. Cover
4. Drive gear
5. Gear case
6. Bracket
7. Driven gear
- A. From transmission case
- B. To transmission control valve

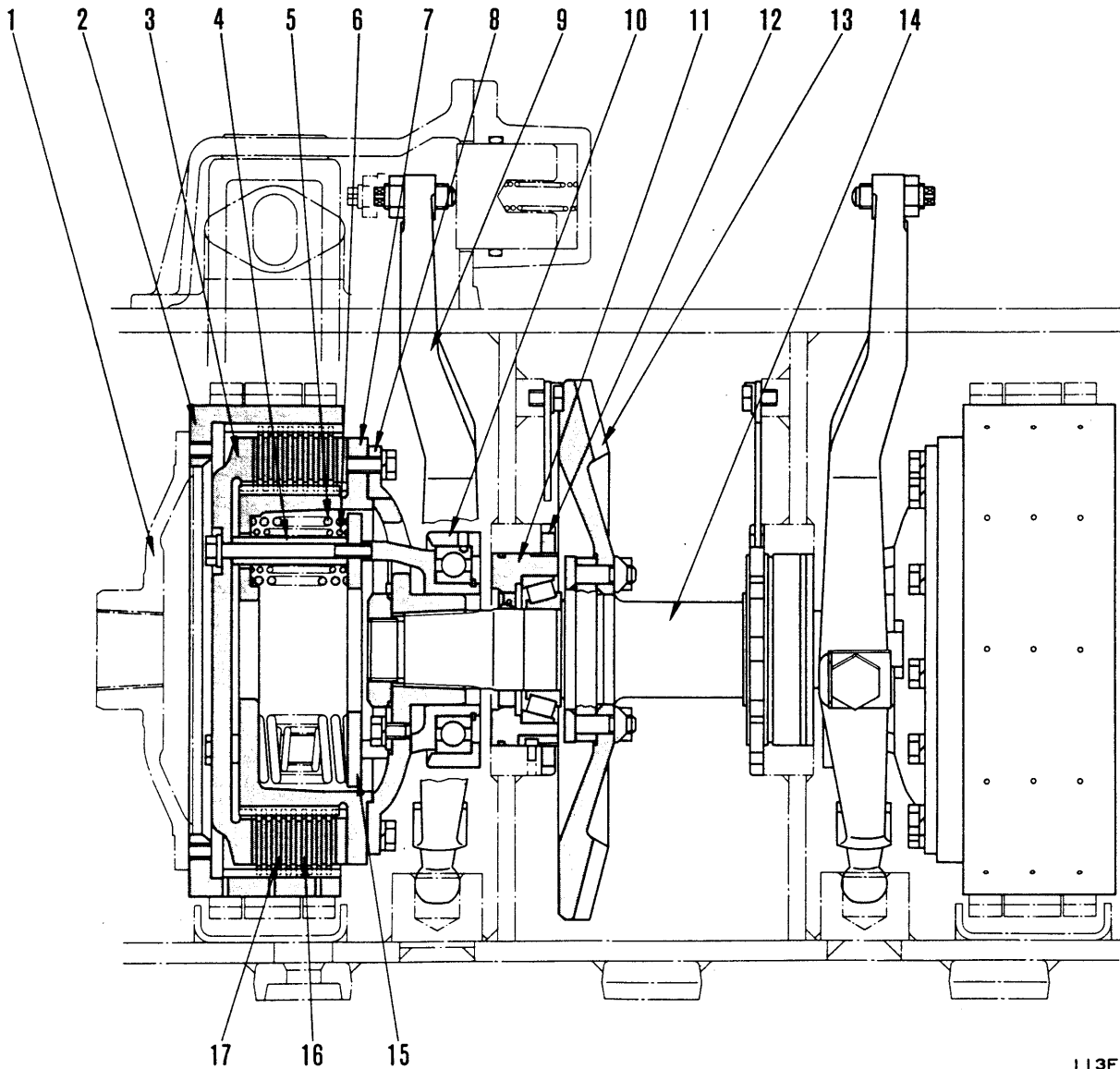
## OUTLINE

- The transmission pump is assembled to the transmission input shaft.
- The oil in the transmission case passes through the strainer, is sucked in at port A and discharged from port B.

It then flows to the transmission control valve and the steering control valve.

Item	
Discharge	48ℓ/min
Setting pressure	20 kg/cm <sup>2</sup>
Engine revolution	2,350 rpm

# BEVEL GEAR SHAFT AND STEERING CLUTCH



1. Final drive flange
2. Outer drum (Brake drum)
3. Pressure plate
4. Collar
5. Clutch spring
6. Clutch spring
7. Inner drum
8. Bevel gear shaft hub
9. Release yoke
10. Bearing cage
11. Bearing cage
12. Adjustment nut
13. Bevel gear
14. Bevel gear shaft
15. Retainer
16. Clutch disc
17. Clutch plate

## OUTLINE

- The steering clutch is a wet type, multiple disc, spring-boosted clutch.
- There are steering clutches installed on the left and right at both ends of the bevel gear shaft, between the bevel gear shaft and the final drive. The steering clutches transmit or cut the transmission of motive force from the bevel gear shaft to the final drive to change the direction of the machine.

113F18014

011418

## OPERATION

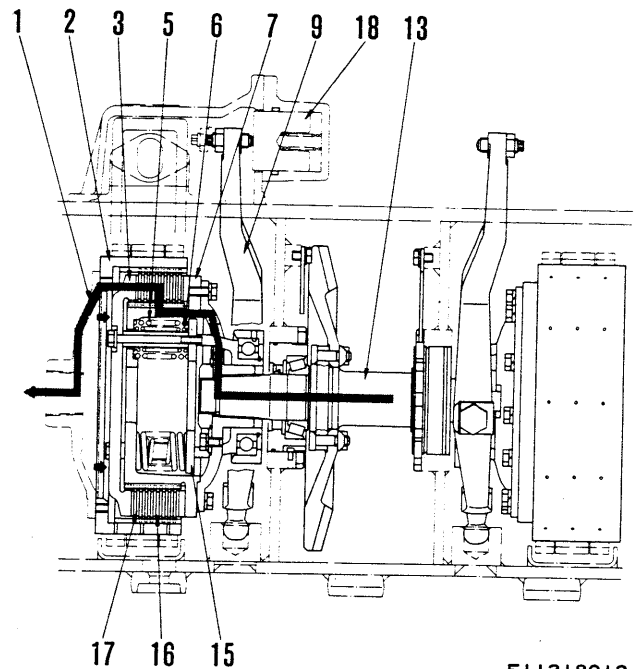
### 1. L.H. steering clutch ENGAGED

When the left steering lever is not being pulled, no oil enters steering booster cylinder (18) from the steering control valve.

As a result, release yoke (9) is not actuated, and the tension of clutch springs (5) and (6) makes pressure plate (3) push clutch disc (16) and clutch plate (17) into close contact with inner drum (7).

In this condition, the motive force from bevel gear shaft (13) is transmitted from inner drum (7) through the clutch disc and clutch plate to outer drum (2). It is then transmitted to final drive from flange (1), which forms one unit with the outer drum.

Therefore, if the right steering clutch is also engaged, the machine will travel in a straight line.



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### 2. L.H. steering DISENGAGED

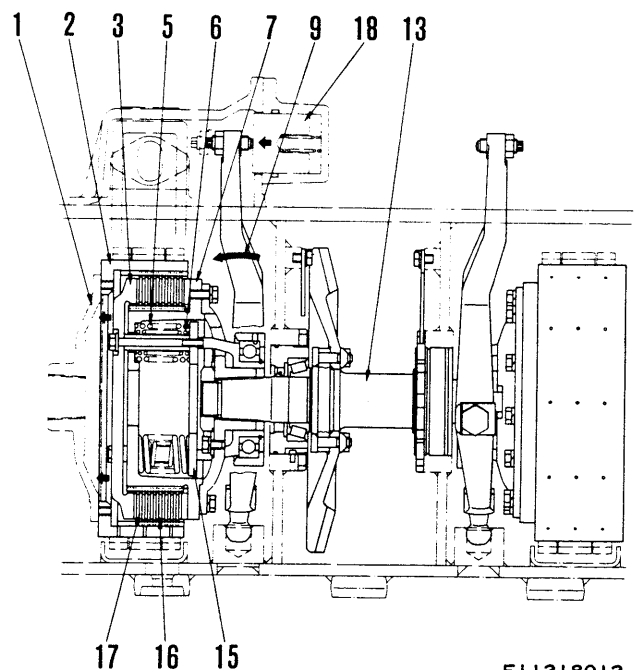
When the left steering lever is pulled, the steering control valve is actuated and oil enters steering booster cylinder (18).

As a result, release yoke (9) is pushed to the left, and retainer (15) and pressure plate (3) move to the left as one unit.

When this happens, the close contact between clutch disc (16) and clutch plate (17), and inner drum (7) is released.

In this condition, the motive force from bevel gear shaft (13) is transmitted only as far as inner drum (7). It is not transmitted to outer drum (2).

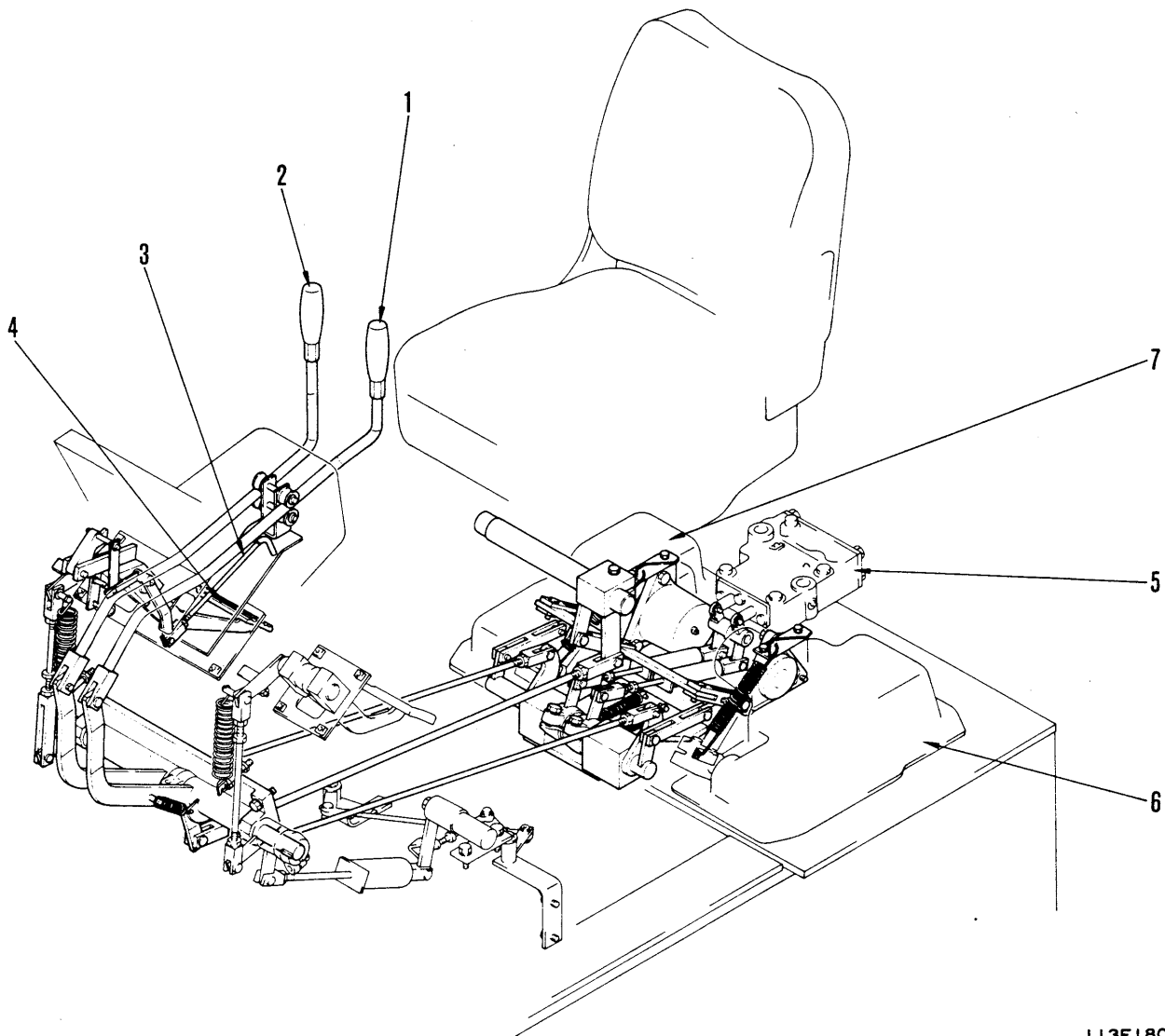
Therefore, if the right steering clutch is engaged, the machine will turn to the left.



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# STEERING CONTROL

D31E, P, PL, PLL-18, D31P-18A, D37E, P-2



1. L.H. steering lever
2. R.H. steering lever
3. Brake lock lever
4. Brake pedal
5. Steering control valve
6. L.H. steering brake
7. R.H. steering brake

## OUTLINE

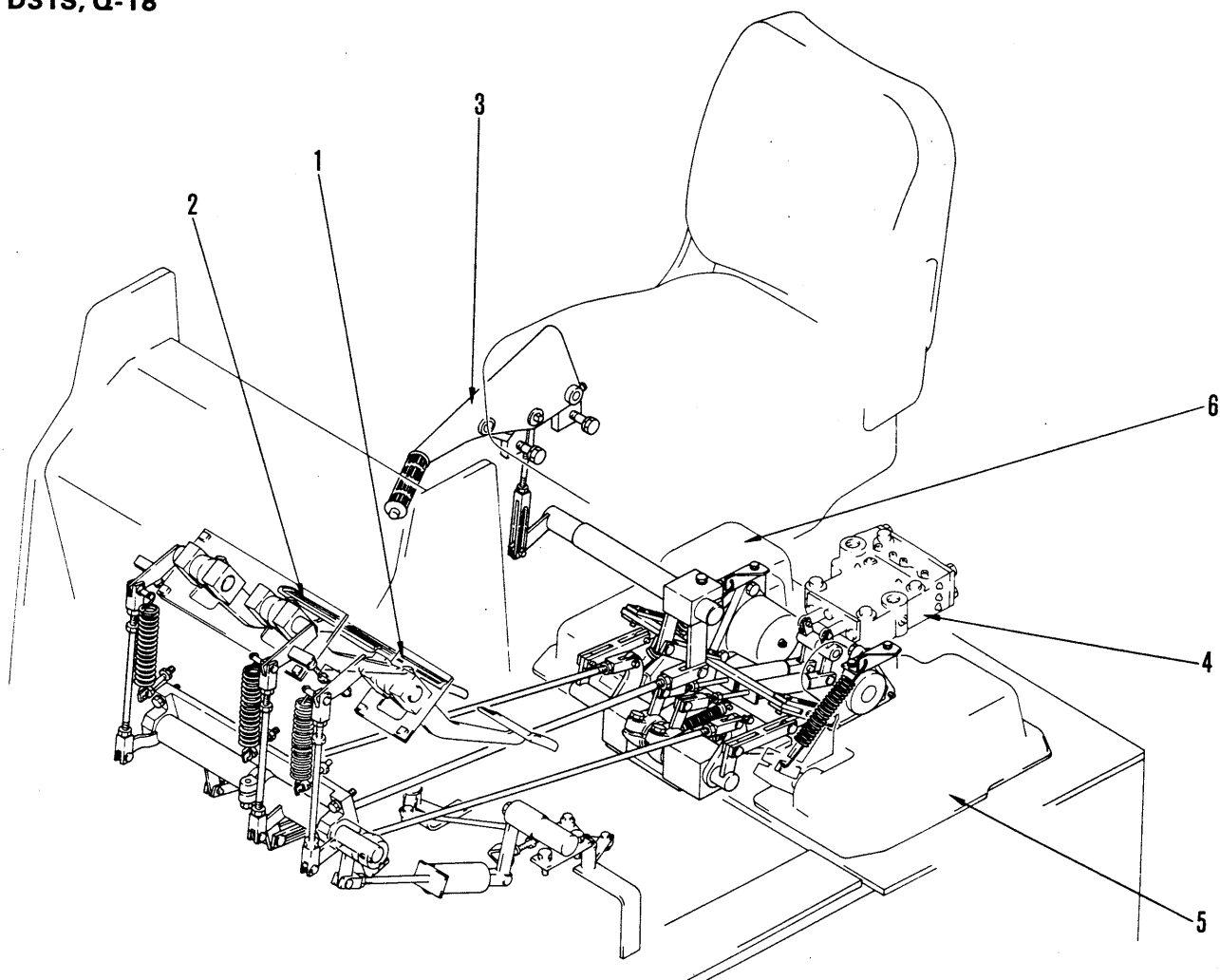
- The two steering levers (1) and (2) in the operator's compartment are a full console type. They are interconnected with the brake levers and the spools of steering control valve (5) on top of the steering case. Brake pedal (4) is only connected to the brake levers.

If left steering lever (1) is pulled slightly, the spool of the steering control valve is actuated. The left steering clutch is disengaged and the machine turns slowly to the left.

If the left steering lever is pulled fully, the left steering clutch is completely disengaged, and in addition, the left steering brake (6) is also applied, so the machine turns sharply to the left.

# STEERING CONTROL

D31S, Q-18



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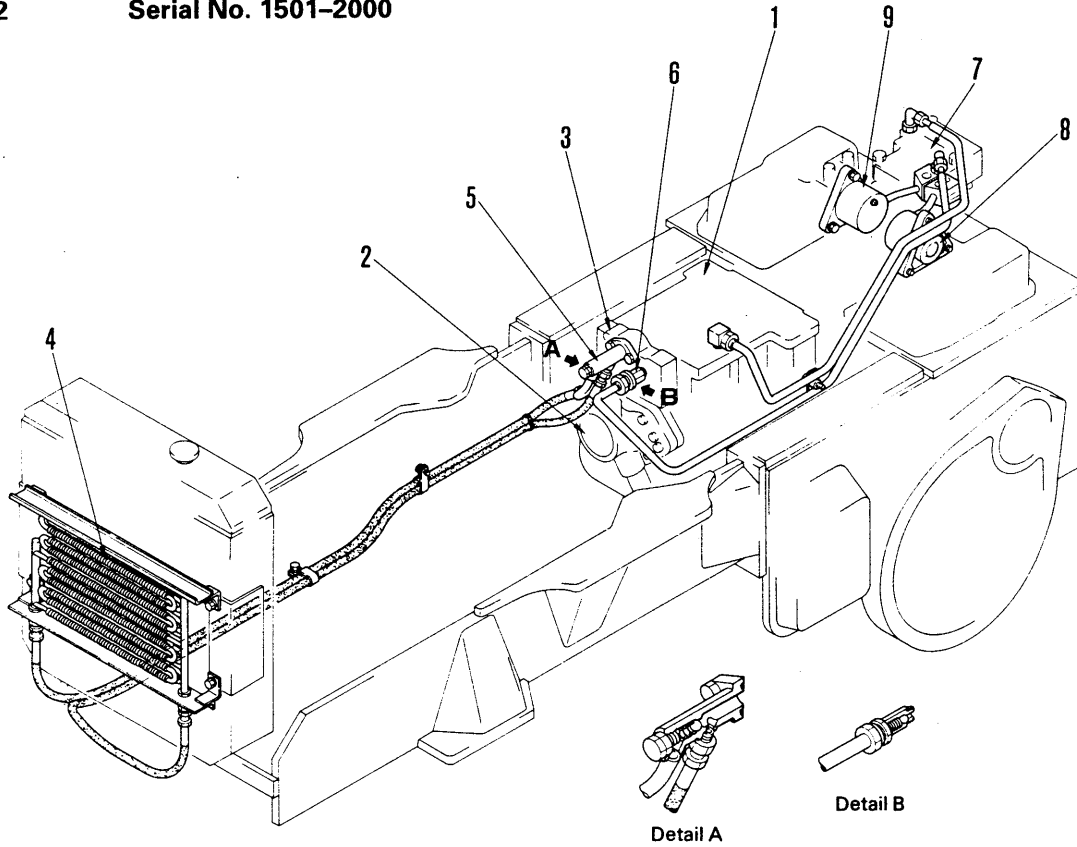
1. L.H. steering pedal
2. R.H. steering pedal
3. Brake lock lever
4. Steering control valve
5. L.H. steering brake
6. R.H. steering brake

## OUTLINE

- The two steering pedals (1) and (2) in the operator's compartment are interconnected with left and right steering brakes (5) and (6), and steering control valve (4) on the steering case. When left steering pedal (1) is slightly depressed, the spool of the left steering control valve is actuated, and the left steering clutch is disengaged to turn the machine gradually to the left. When the left steering pedal is fully depressed, the steering clutch is completely disengaged. In addition, left steering brake (5) is engaged, so the machine turns sharply to the left. When the left and right steering pedals are both depressed at the same time, the left and right steering clutches are not disengaged. They remain engaged just as when the pedals are not depressed. However, the left and right steering brakes are engaged at the same time and this allows the machine to be stopped.

# STEERING HYDRAULIC PIPING

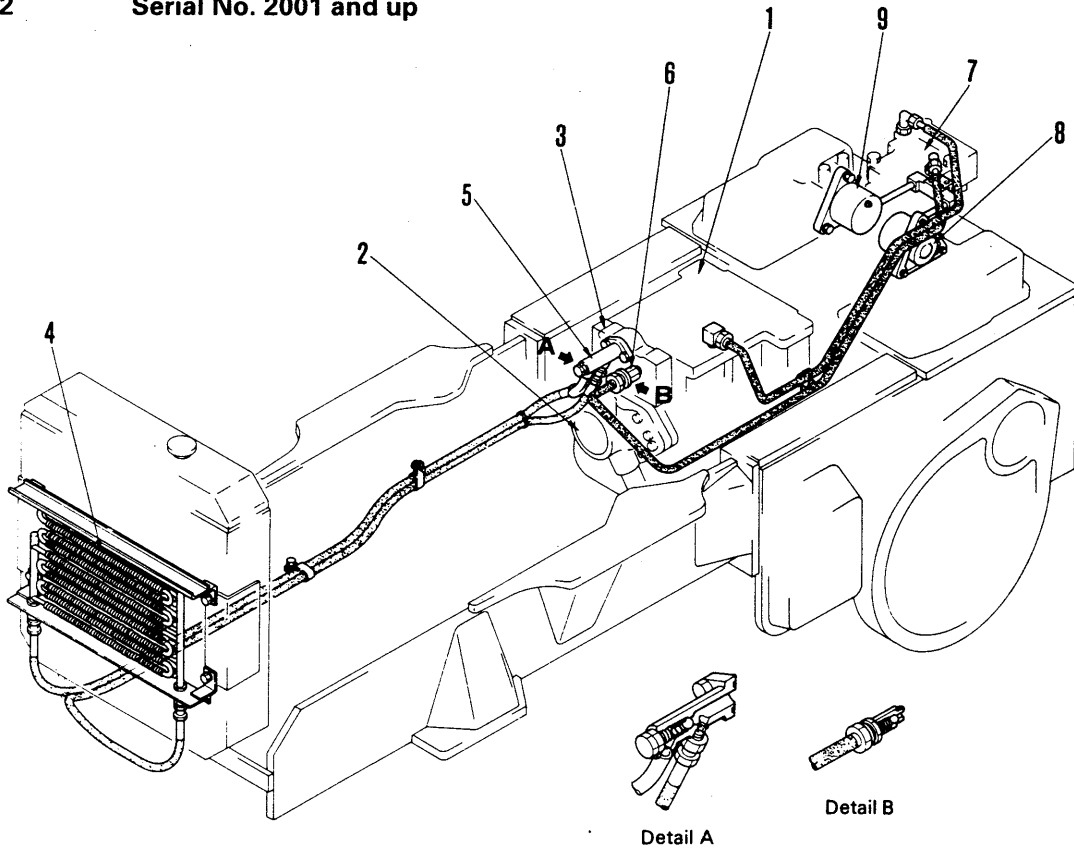
D31E-18	Serial No. 40001-40445
D31P-18	Serial No. 40001-40745
D31P-18A	Serial No. 40001-40684
D31PL, PLL-18	Serial No. 40001-40743
D31S-18	Serial No. 40001-41114
D31Q-18	Serial No. 40001-41111
D37E-2	Serial No. 1501-2500
D37P-2	Serial No. 1501-2000



113F18005

- |                                  |                            |                           |
|----------------------------------|----------------------------|---------------------------|
| 1. Transmission case             | 4. Oil cooler              | 7. Steering control valve |
| 2. Transmission pump             | 5. Oil cooler bypass valve | 8. L.H. steering cylinder |
| 3. Transmission modulating valve | 6. Check valve             | 9. R.H. steering cylinder |

**D31E-18**            **Serial No. 40446 and up**  
**D31P-18**            **Serial No. 40746 and up**  
**D31P-18A**          **Serial No. 40685 and up**  
**D31PL, PLL-18**    **Serial No. 40744 and up**  
**D31S-18**            **Serial No. 41115 and up**  
**D31Q-18**            **Serial No. 41112 and up**  
**D37E-2**             **Serial No. 2501 and up**  
**D37P-2**             **Serial No. 2001 and up**



011418

113F18303

- |                                  |                            |                           |
|----------------------------------|----------------------------|---------------------------|
| 1. Transmission case             | 4. Oil cooler              | 7. Steering control valve |
| 2. Transmission pump             | 5. Oil cooler bypass valve | 8. L.H. steering cylinder |
| 3. Transmission modulating valve | 6. Check valve             | 9. R.H. steering cylinder |

## OUTLINE

- Oil in transmission case (1) is sucked up by pump (2) installed to the transmission. It passes through modulating valve (3), pushes open check valve (6), and is sent to steering control valve (7).
- The steering control valve switches the flow of the oil according to the operation of the left and right steering levers or pedals, and sends it to one or both of left and right cylinders (8) and (9) to disengage the steering clutch.
- The modulating valve sets the pressure in the circuit to 20 kg/cm<sup>2</sup> (\*1: 20±3 kg/cm<sup>2</sup>). Oil relieved by the main relief valve passes through bypass valve (5), and is then sent to oil cooler (4), where it is cooled before being sent to lubricate the transmission.

\*1: Applicable Serial No.

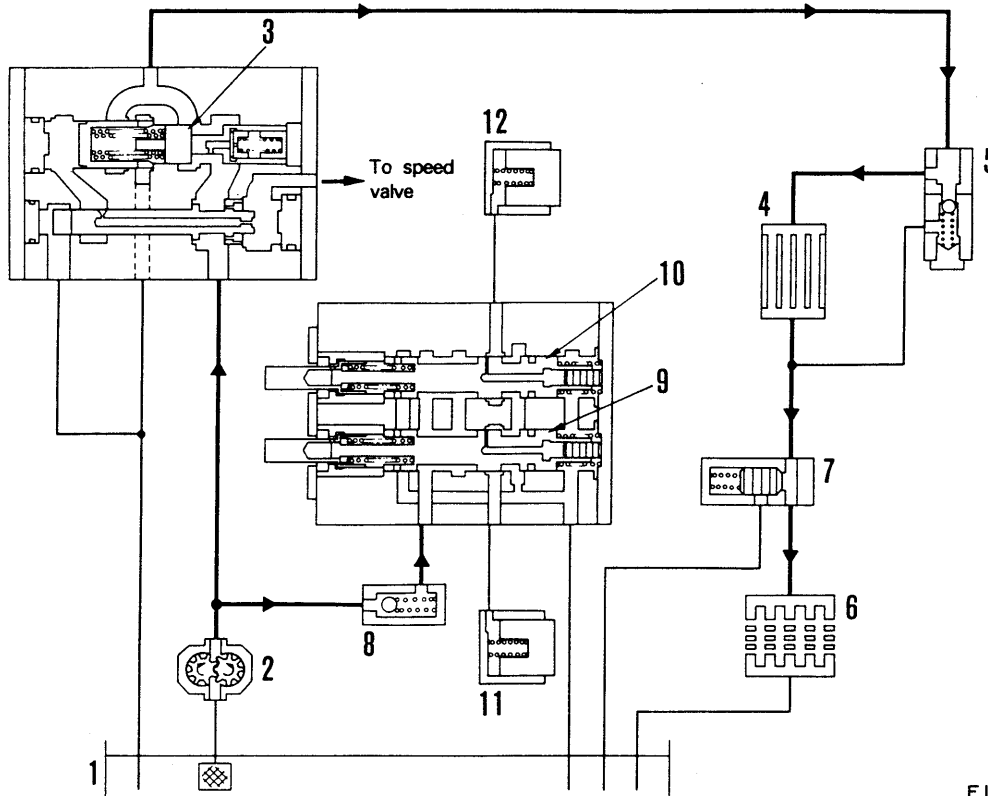
D31E-18	40247 and up
D31P-18	40326 and up
D31P-18A	40279 and up
D31PL-18	40327 and up
D31PLL-18	40323 and up
D31S-18	40068 and up
D31Q-18	40068 and up
D37E-2	1702 and up
D37P-2	1549 and up

- The oil cooler bypass valve acts to protect the oil cooler from damage. It sends the oil directly from the modulating valve to the transmission lubrication circuit when clogging of the oil cooler circuit causes the pressure to go above 8 kg/cm<sup>2</sup> (10 kg/cm<sup>2</sup> for D37E-2 Serial No. 2501 and up, D37P-2 Serial No. 2001 and up.)
- The check valve is in the circuit between the transmission hydraulic circuit and the steering hydraulic circuit. It prevents the oil in the transmission hydraulic circuit from flowing back.  
In other words, if the gear is shifted when the steering clutch is disengaged, the modulating valve acts to make the pressure in the circuit 0 kg/cm<sup>2</sup>, so it becomes impossible to disengage the clutch.  
When this happens, the check valve shuts off the two circuits and keeps the pressure in the steering circuit high, so it remains possible to disengage the steering clutch.



# STEERING HYDRAULIC SYSTEM

D31E, P, PL, PLL-18, D31P-18A  
 D37E-2 Serial No. 1501-2500  
 D37P-2 Serial No. 1501-2000

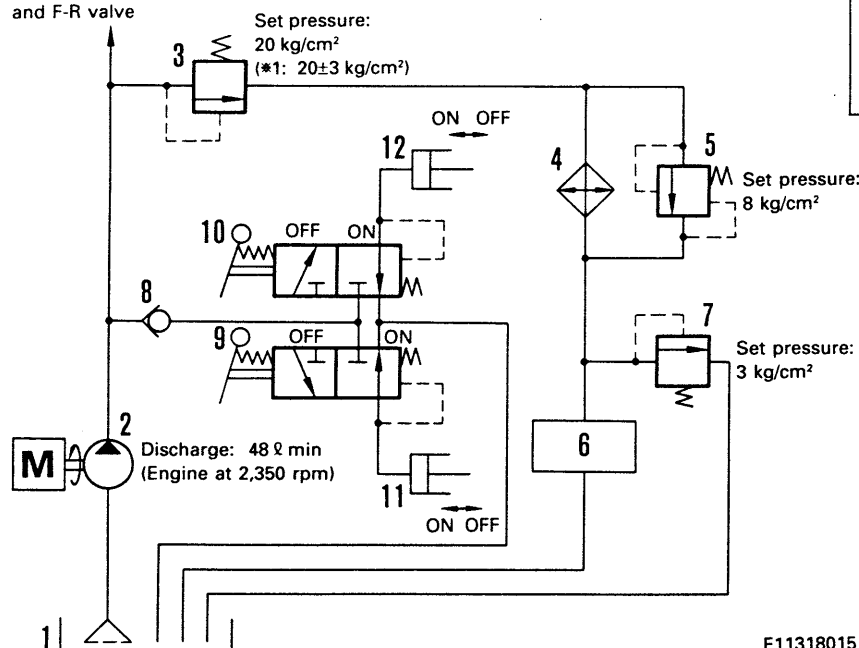


F11318014

# STEERING HYDRAULIC CIRCUIT DIAGRAM

D31E, P, PL, PLL-18, D31P-18A  
 D37E-2 Serial No. 1501-2500  
 D37P-2 Serial No. 1501-2000

To transmission speed  
 and F-R valve



※1

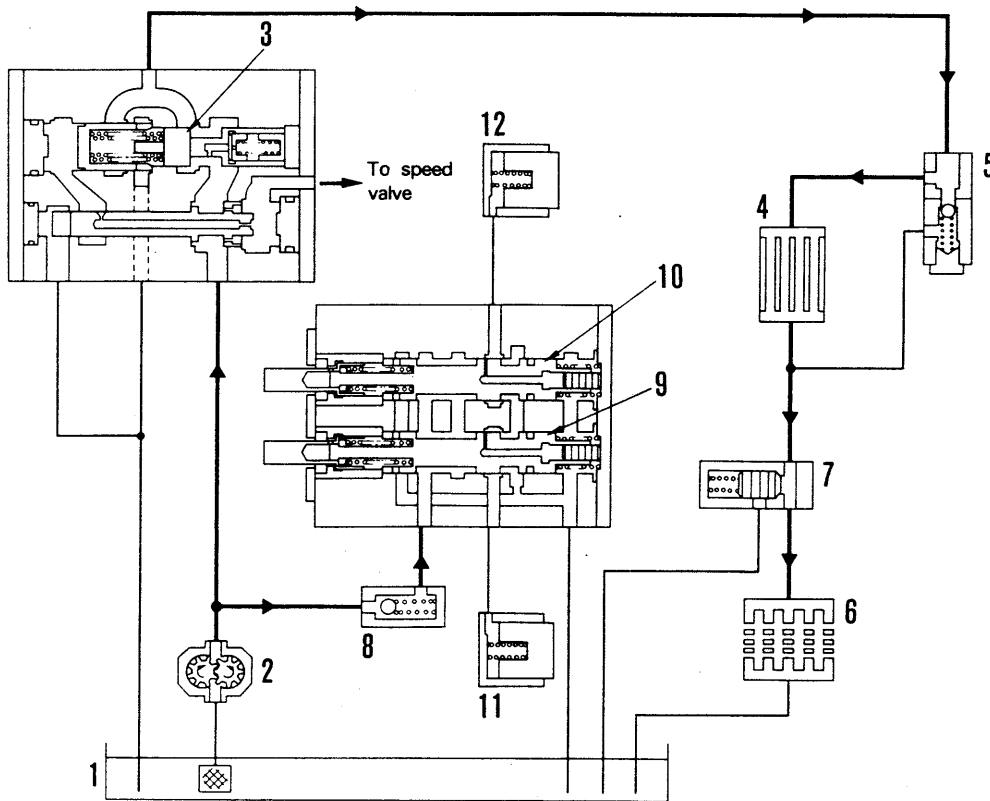
D31E-18	40247 and up
D31P-18	40326 and up
D31P-18A	40279 and up
D31PL-18	40327 and up
D31PLL-18	40323 and up
D37E-2	1702 and up
D37P-2	1549 and up

1. Transmission case
2. Transmission pump
3. Transmission modulation valve
4. Oil cooler
5. Oil cooler bypass valve
6. Transmission lubrication
7. Transmission lubrication valve
8. Check valve
9. L.H. steering control valve
10. R.H. steering control valve
11. L.H. steering cylinder
12. R.H. steering cylinder

F11318015

# STEERING HYDRAULIC SYSTEM

D37E-2 Serial No. 2501 and up  
D37P-2 Serial No. 2001 and up



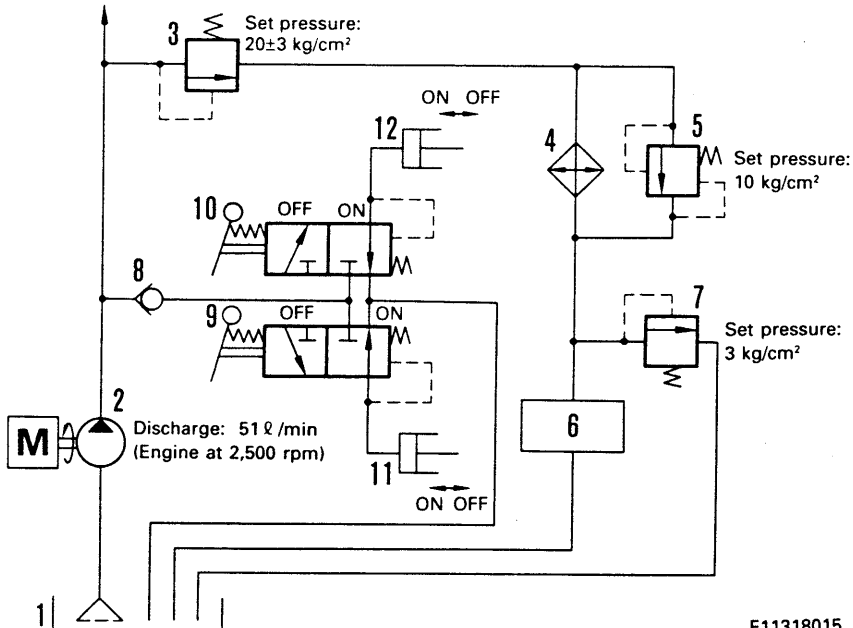
011418

F11318014

# STEERING HYDRAULIC CIRCUIT DIAGRAM

D37E-2 Serial No. 2501 and up  
D37P-2 Serial No. 2001 and up

To transmission speed  
and F-R valve

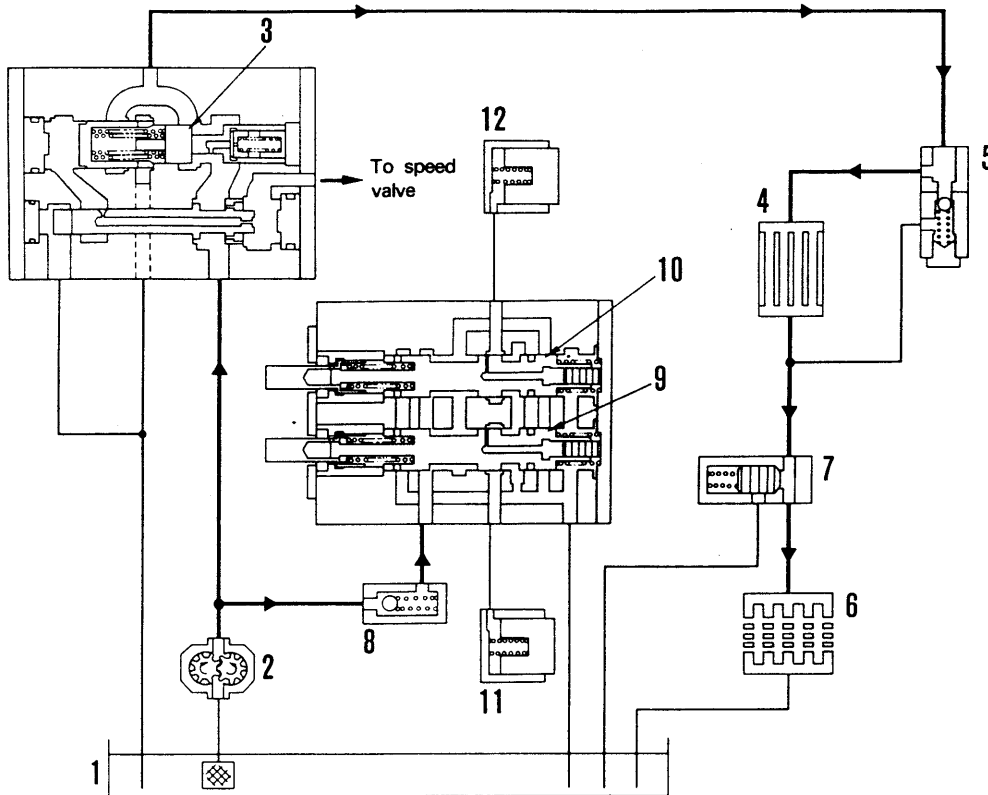


1. Transmission case
2. Transmission pump
3. Transmissin modulation valve
4. Oil cooler
5. Oil cooler bypass valve
6. Transmission lubrication
7. Transmission lubrication valve
8. Check valve
9. L.H. steering control valve
10. R.H. steering contr l valve
11. L.H. steering cylinder
12. R.H. steering cylinder

F11318015

# STEERING HYDRAULIC SYSTEM

D31S, Q-18

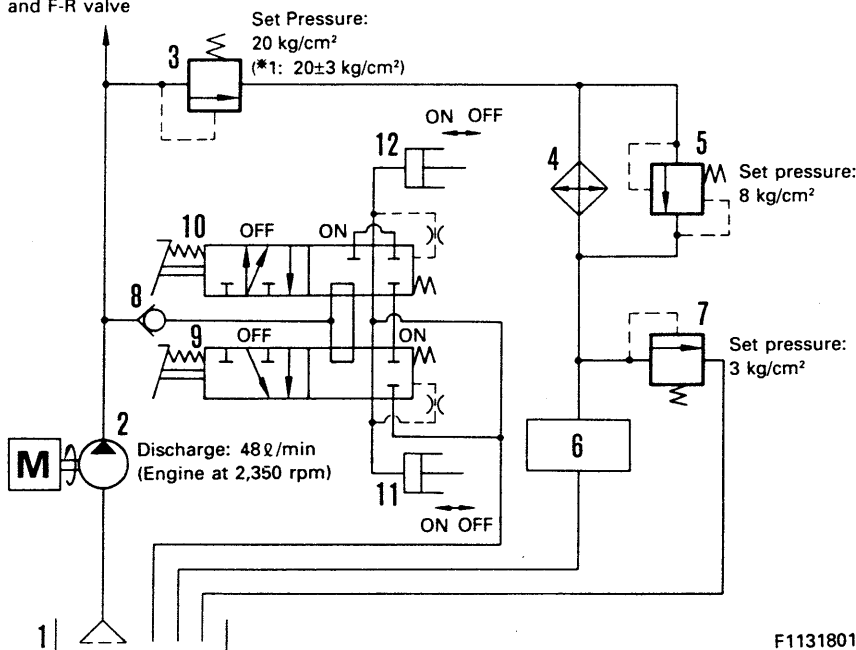


F11318016

# STEERING HYDRAULIC CIRCUIT DIAGRAM

D31S, Q-18

To transmission speed and F-R valve



※1

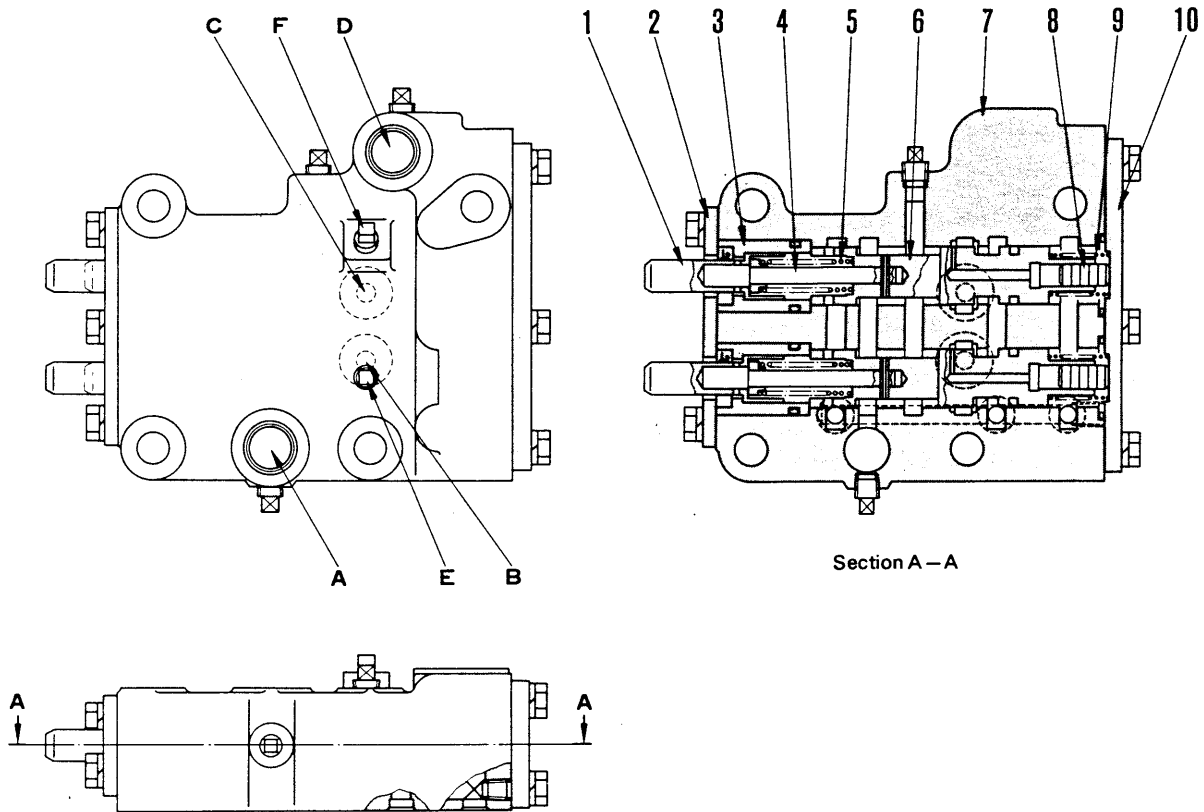
D31S-18 40068 and up  
D31Q-18 40068 and up

1. Transmission case
2. Transmission pump
3. Transmission modulation valve
4. Oil cooler
5. Oil cooler bypass valve
6. Transmission lubrication
7. Transmission lubrication valve
8. Check valve
9. L.H. steering control valve
10. R.H. steering control valve
11. L.H. steering cylinder
12. R.H. steering cylinder

F11318017

# STEERING CONTROL VALVE

D31E, P, PL, PLL-18, D31P-18A, D37E, P-2



1. Valve stem
  2. Cover
  3. Sleeve
  4. Shaft
  5. Spring
  6. Spool
  7. Valve body
  8. Piston
  9. Spring
  10. Cover
- A. From pump  
 B. To L.H. steering cylinder  
 C. To R.H. steering cylinder  
 D. Drain  
 E. Plug for L.H. steering pressure  
 F. Plug for R.H. steering pressure

## OUTLINE

- The steering control valve includes a modulation mechanism to allow the hydraulic pressure to rise gradually within a range of 9.5–16.8 kg/cm<sup>2</sup>. When the modulation is completed, the pressure rises to the specified pressure (20 kg/cm<sup>2</sup>, \*1: 20±3 kg/cm<sup>2</sup>) of the transmission modulating valve.

\*1: Applicable Serial No.

D31E-18	40247 and up
D31P-18	40326 and up
D31P-18A	40279 and up
D31PL-18	40327 and up
D31PLL-18	40323 and up
D37E-2	1702 and up
D37P-2	1549 and up

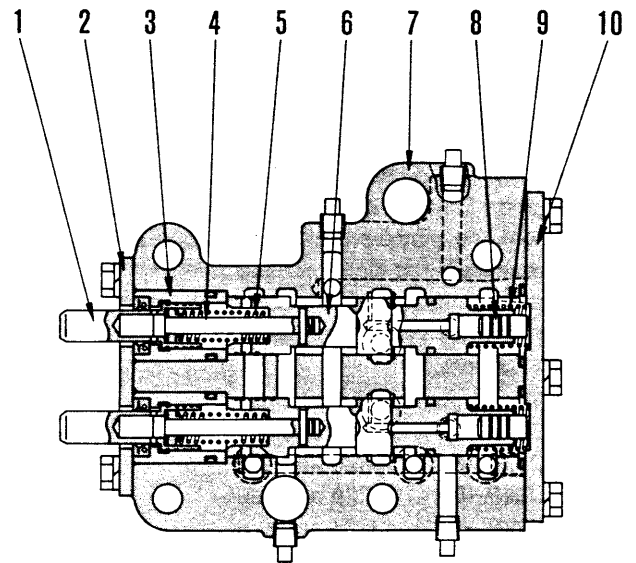
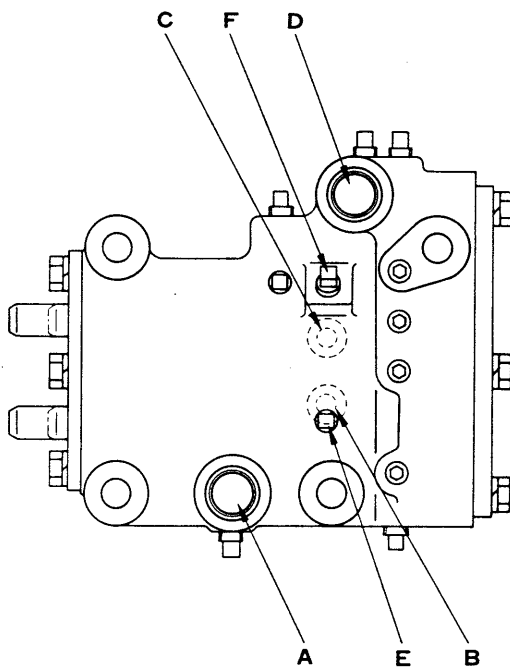
If either the left or right steering levers are pulled, the left or right steering clutch is disengaged. If both left and right levers are pulled together, both the left and right steering clutches are disengaged at the same time.

011418

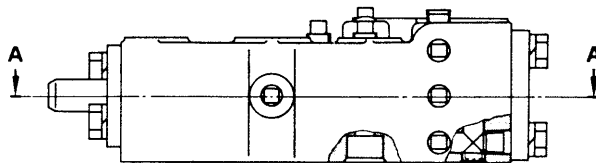
103F06034

# STEERING CONTROL VALVE

D31S, Q-18



Section A-A



011418

113F18015

1. Valve stem
  2. Cover
  3. Sleeve
  4. Shaft
  5. Spring
  6. Spool
  7. Valve body
  8. Piston
  9. Spring
  10. Cover
- A. From pump
  - B. To L.H. steering cylinder
  - C. To R.H. steering cylinder
  - D. Drain
  - E. Plug for L.H. steering pressure
  - F. Plug for R.H. steering pressure

## OUTLINE

- The steering control valve includes a modulation mechanism to allow the hydraulic pressure to rise gradually within a range of 9.5 – 16.8 kg/cm<sup>2</sup>. When the modulation is completed, the pressure rises to the specified pressure (20 kg/cm<sup>2</sup>, \*1: 20±3 kg/cm<sup>2</sup>) of the transmission modulating valve.

\*1: Applicable Serial No.

D31S-18 40068 and up

D31Q-18 40068 and up

If either the left or right steering pedals are depressed, the left or right steering clutch is disengaged. If both left and right pedals are depressed together, both the left and right steering clutches are not disengaged, but remain engaged.

**D31E, P, PL, PLL-18, D31P-18A, D37E, P-2**

**OPERATION**

**1. Left and right steering levers not operated**  
(Left and right steering clutches engaged)

The oil from the pump enters ports **A** and **B**. However, steering valves (6L) and (6R) are not being operated, so the passage to chamber **B** and ports **C** and **D** does not open. Therefore, the oil from the pump enters ports **A** and **B** and the oil pressure in the circuit rises.

The oil pressure is relieved from the transmission modulating valve (set pressure: 20 kg/cm<sup>2</sup>, \*1: 20±3 kg/cm<sup>2</sup>).

\*1: Applicable Serial No.

D31E-18	40247 and up
D31P-18	40326 and up
D31P-18A	40279 and up
D31PL-18	40327 and up
D31PLL-18	40323 and up
D37E-2	1702 and up
D37P-2	1549 and up

**2. Left steering lever partially operated**

(Left clutch partially engaged, right clutch engaged)

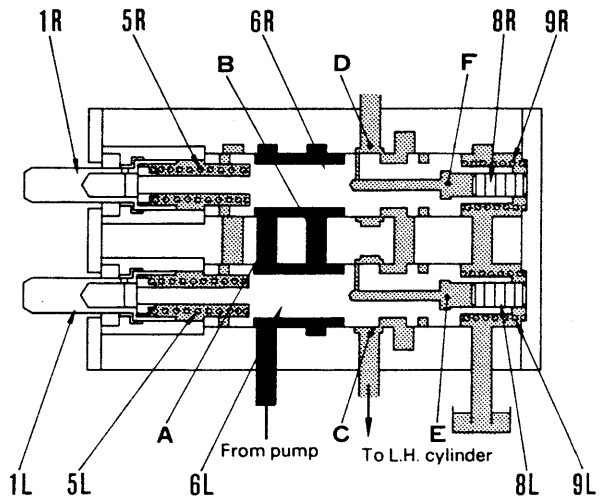
When the left steering lever is pulled slightly, stem (1L) moves to the right and compresses spring (5L).

Compressed spring (5L) uses this tension to move spool (6L) to the right.

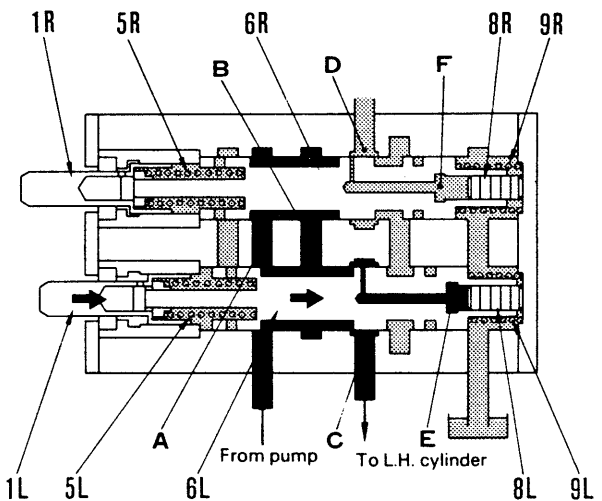
When this happens, the passage between chamber **B** and port **C** opens and the oil from the pump passes through the passage inside the spool and left cylinder port, and enters chamber **E**.

When the flow of oil from the pump increases and the pressure rises, the total of the pressure of the oil entering chamber **E** and the tension of spring (9L) becomes larger than the tension of spring (5L) set by the stroke of the stem. When it becomes larger than the tension of spring (5L), it moves spool (6L) to the left. When this happens, the passage between chamber **B** and port **C** closes, and the pressure beyond port **C** does not rise any further. This action is repeated continuously until the movement of the steering lever is stopped. During this period, the oil pressure gradually rises.

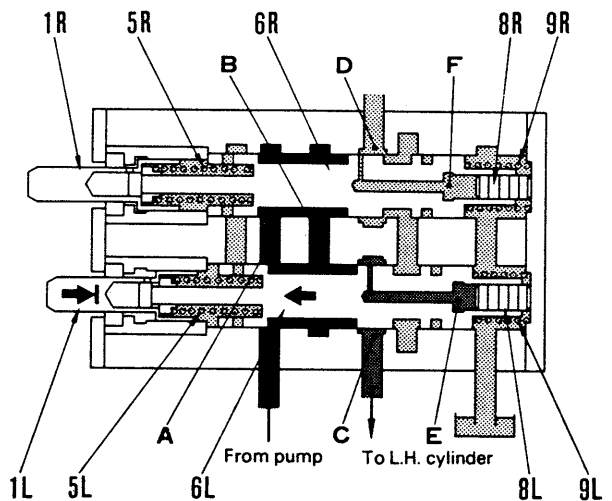
The contact of the steering clutch is decided by the level of the pressure beyond port **C** (that is, by the amount that the steering lever is operated), and the radius of the turn is varied accordingly.



F10306043



F10306044



F10306045

011418

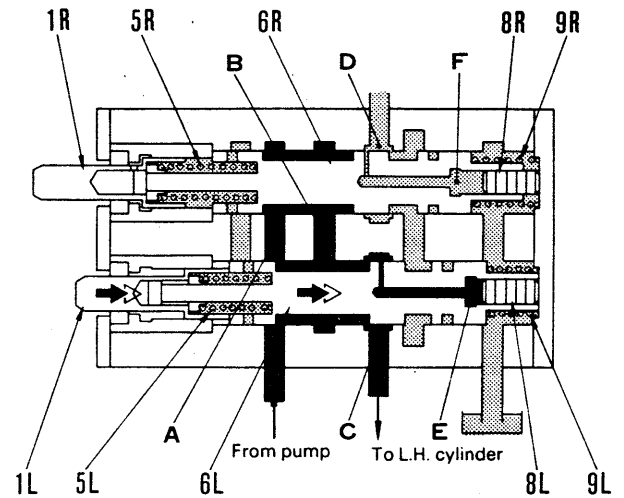
**3. Left steering lever fully operated**

(Left clutch disengaged, right clutch engaged)

When the left steering lever is pulled fully, stem (1L) moves to the right from the position in Step 2. It then pushes spool (6L) directly and reaches the end of its stroke.

As a result, the oil pressure does not rise gradually as in Step 2. It increases in an almost direct line until it reaches the set pressure of the main relief valve.

Therefore, the steering clutch is completely disengaged and the machine turns sharply.

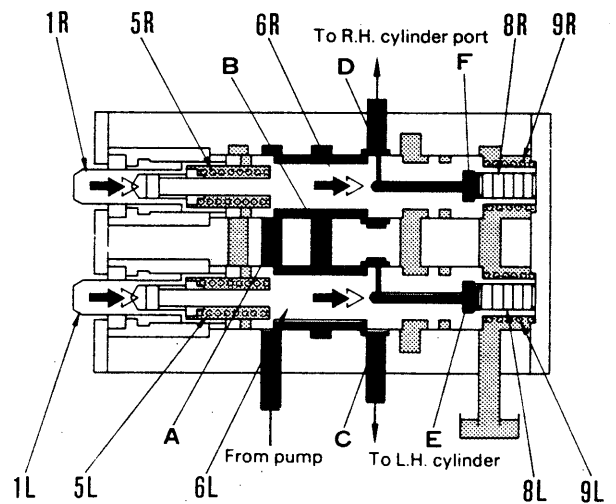


F10306046

**4. Left and right steering levers operated**

(Left and right clutches disengaged)

When both the left and right steering levers are operated, the steering valve operates in the same way as Step 2 or Step 3, and the left and right steering clutches are partially disengaged or completely disengaged.



F10306047

011418

# D31S, Q-18

## OPERATION

### 1. Left and right steering pedals not operated (Left and right steering clutches engaged)

The oil from the pump enters chambers B and C from port A. However, steering valves (6L) and (6R) are not being actuated, so the passages from chamber B to port D, and from chamber C to port E are not open.

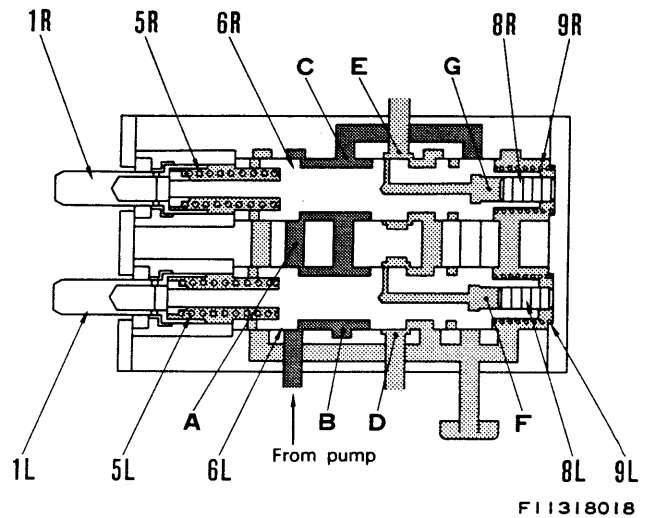
Therefore, the oil from the pump enters chambers B and C from port A and the pressure in the circuit rises.

The rise in the oil pressure is relieved through the transmission modulating valve (set pressure: 20 kg/cm<sup>2</sup>, \*1: 20±3 kg/cm<sup>2</sup>).

\*1: Applicable Serial No.

D31S-18 40068 and up

D31Q-18 40068 and up



### 2. Left steering pedal partially operated (Left steering clutch partially engaged, right steering clutch engaged)

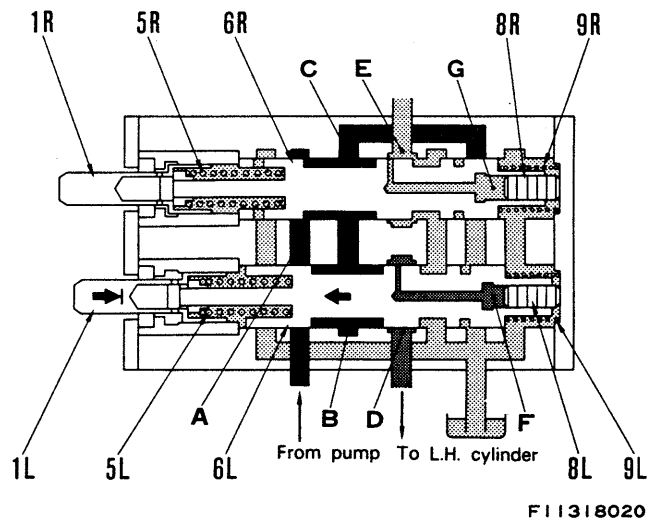
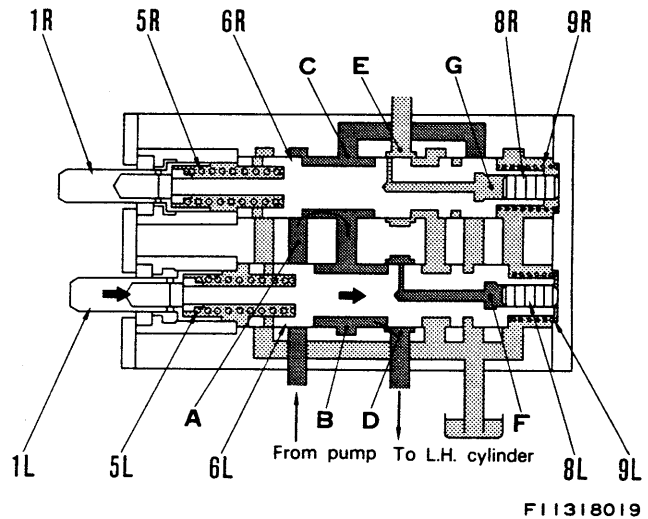
When the left steering pedal is partially depressed, stem (1L) moves to the right and compresses spring (5L). The tension of compressed spring (5L) moves left steering valve (6L) to the right. When this happens, the passage between chamber B and port D is opened, and at the same time, the passage between port A and chamber B is closed. However, the oil from the pump passes from port A through chamber C of right steering valve (6R), which is not being actuated. It then enters chamber B and passes through the left cylinder port and the passage inside the spool, and enters chamber F.

When the amount of oil flowing from the pump increases and the pressure rises, the total of the pressure of the oil entering chamber F and the tension of spring (9L) becomes greater than the tension of spring (5L), which is set by the stroke of stem (1L), and it moves spool (6L) to the left.

When this happens, the passage between chamber B and port D is closed, so the pressure beyond port D does not rise any further.

This operation is repeated, and continues until the steering pedal stops. During this time, the hydraulic pressure rises gradually.

The level of the hydraulic pressure beyond port D at this point, that is the travel of the steering pedal, determines the compression force of the steering clutch and the turning radius of the machine can be changed.

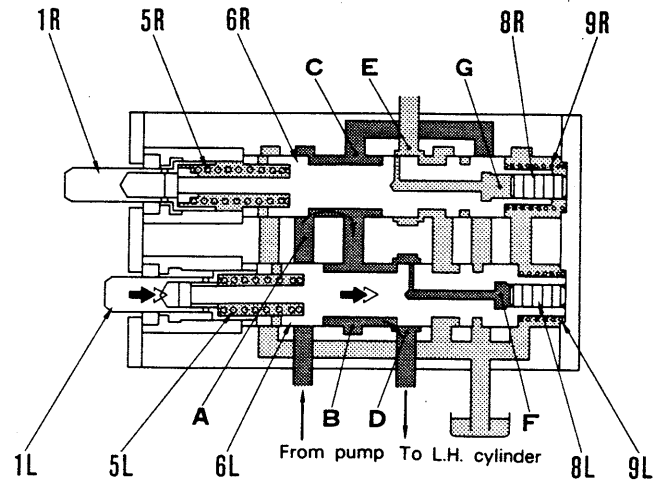


011418

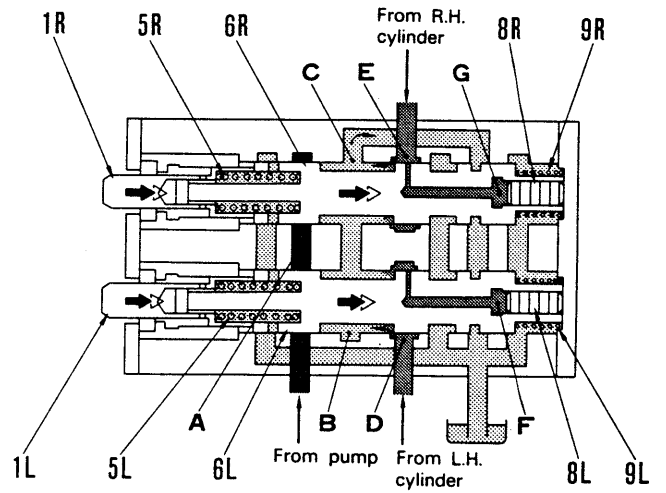


**3. Left steering pedal fully operated**  
 (Left steering clutch disengaged, right steering clutch engaged)  
 When the left steering pedal is fully depressed, stem (1L) moves further to the right than in Step 2. It pushes spool (6L) directly and moves to the end of its stroke. As a result, the pressure does not rise gradually as in Step 2. It rises in almost a straight line until it reaches the set pressure of the main relief valve. Therefore, the left steering clutch is completely disengaged and the machine turns sharply.

**4. Left and right steering pedals operated**  
 (Left and right steering clutches engaged)  
 When the left and right steering pedals are both operated at the same time, stems (1L) and (1R), and spools (6L) and (6R) move to the right, and the passage between port A and chamber B and chamber C is closed. As a result, the oil from the pump enters port A but goes no further. It does not flow to the left and right cylinder ports. Therefore, the left and right steering clutches remain engaged, just in the same way as when the steering pedals are not operated. However, the steering pedals are interconnected with the steering brakes, so when this happens, the steering brakes are actuated to stop the machine.



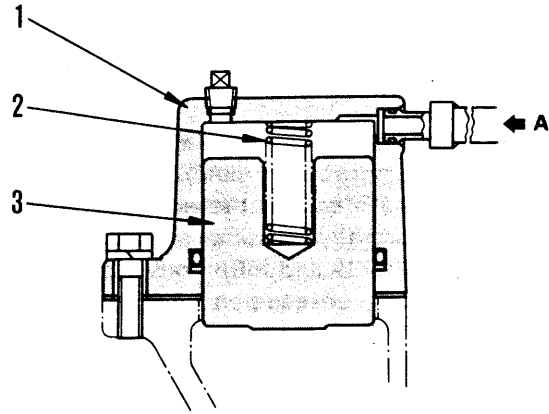
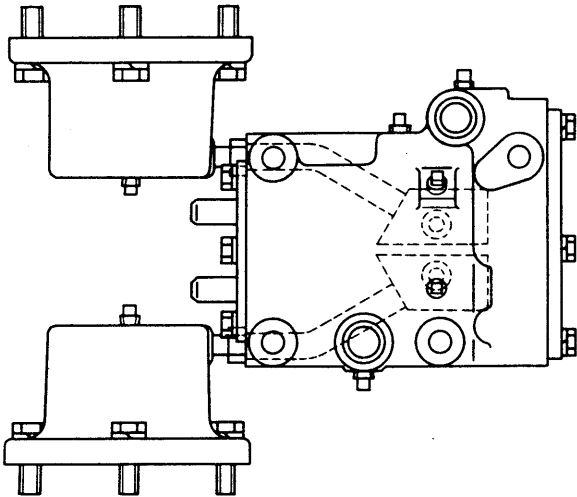
F11318021



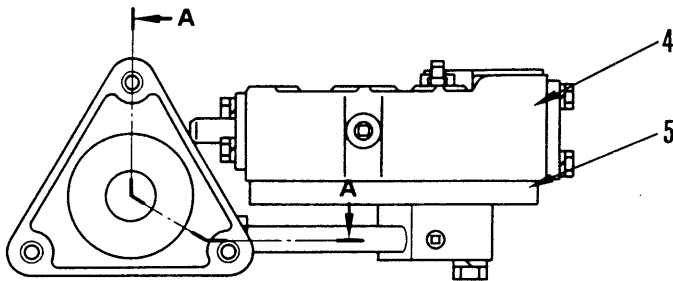
F11318022

# STEERING BOOSTER CYLINDER

D31E-18	Serial No. 40001-40445
D31P-18	Serial No. 40001-40745
D31P-18A	Serial No. 40001-40684
D31PL, PLL-18	Serial No. 40001-40743
D31S-18	Serial No. 40001-41114
D31Q-18	Serial No. 40001-41111
D37E-2	Serial No. 1501-2500
D37P-2	Serial No. 1501-2000



Section A - A



1. Steering booster cylinder
2. Spring
3. Piston
4. Steering control valve
5. Plate
- A. From steering control valve

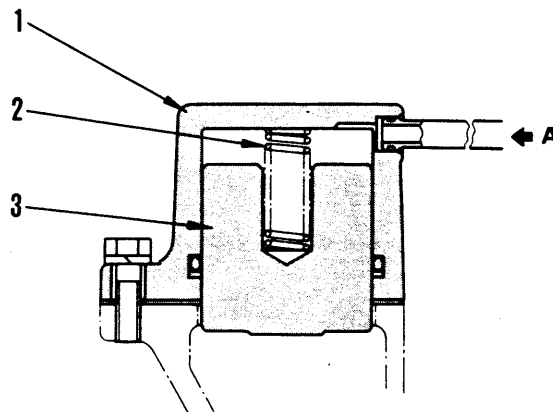
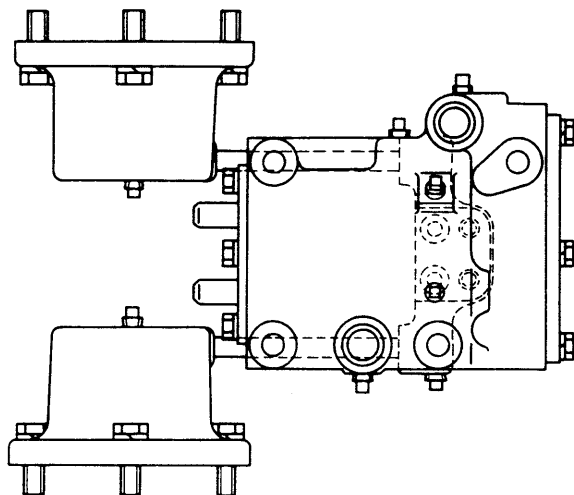
## OUTLINE

- The steering booster cylinder is installed on the steering case. It is actuated by the oil pressure from the steering control valve and operates the release yoke of the steering clutch.

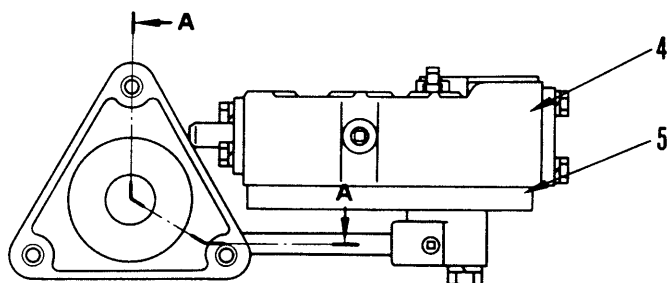
011418

113F18016

**D31E-18**      **Serial No. 40446 and up**  
**D31P-18**      **Serial No. 40746 and up**  
**D31P-18A**     **Serial No. 40685 and up**  
**D31PL, PLL-18** **Serial No. 40744 and up**  
**D31S-18**      **Serial No. 41115 and up**  
**D31Q-18**      **Serial No. 41112 and up**  
**D37E-2**       **Serial No. 2501 and up**  
**D37P-2**       **Serial No. 2001 and up**



Section A-A



- 1. Steering booster cylinder
- 2. Spring
- 3. Piston
- 4. Steering control valve
- 5. Plate
- A. From steering control valve

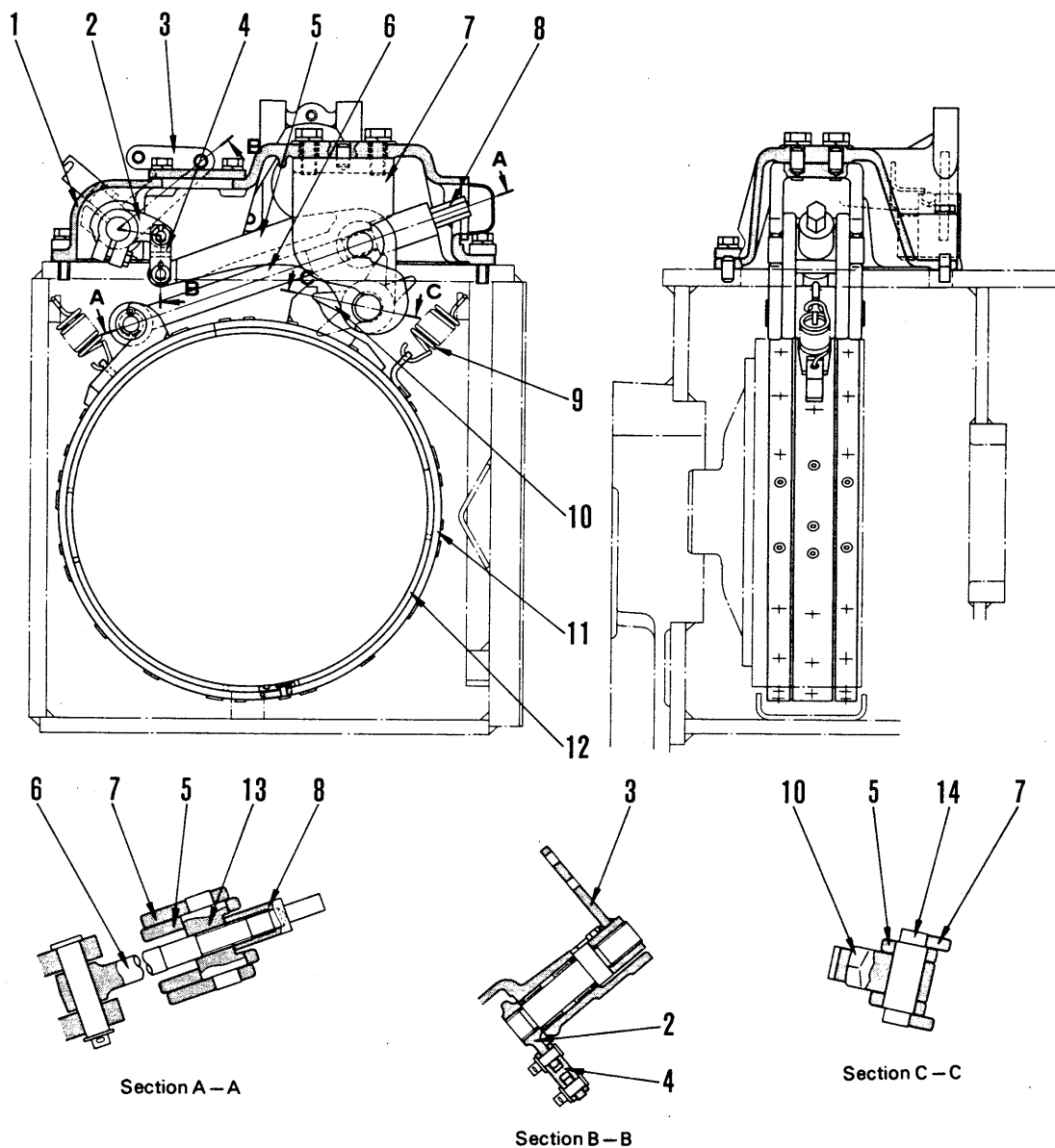
**OUTLINE**

- The steering booster cylinder is installed on the steering case. It is actuated by the oil pressure from the steering control valve and operates the release yoke of the steering clutch.

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# STEERING BRAKE



1. Steering case cover
2. Lever
3. Lever
4. Yoke
5. Lever
6. Rod
7. Anchor
8. Adjustment nut
9. Spring
10. End
11. Brake band
12. Lining
13. Pin
14. Pin

## OUTLINE

- The steering brake is an anchor type contracting band brake which is tightened on the outside circumference of the brake drum (steering clutch outer drum).
- The steering brake has two functions: sharp turning and stopping. It is used to stop the machine when the brake pedal is depressed, and to steer the machine when the steering lever is pulled to move lever (3).  
When parking the machine, depress the brake pedal and apply the brake lock lever to hold the pedal in position.

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## OPERATION

- When steering to the left, pull the left steering lever and the left steering clutch is disengaged; when steering to the right, pull the right steering lever and the right steering clutch is disengaged. However, the motive force passing through the steering clutch is not completely cut, so there is dragging for a short time and the machine turns in a wide circle.

To adjust the radius of the turn, depress the brake pedal on the side to which the machine is turning. This will tighten the brake band on the outer drum (brake drum) and prevent the dragging.

### 1. Operation of brake when traveling forward

When the brake pedal is depressed, lever (2) moves up and pulls up lever (5) to contract both ends of the brake band to the inside.

When this happens, the outer drum is rotating forward (clockwise in the diagram), so the brake band is pulled in the direction of rotation. This tension is borne by end (10) installed by a pin to lever (5), but actually, it is borne by point A at the mount of the lever and end.

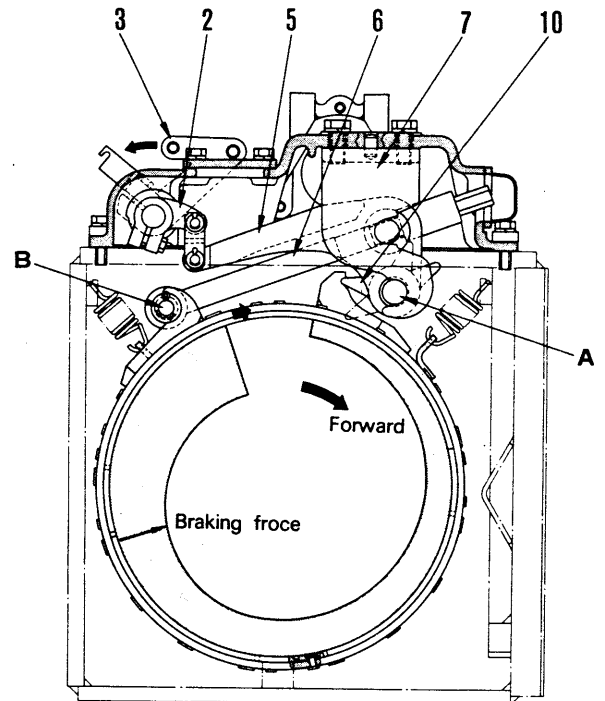
Therefore, the brake band restricts the brake drum with the fulcrum at point A, and pushes out point B on the other side to the right.

### 2. Operation of brake when traveling in reverse

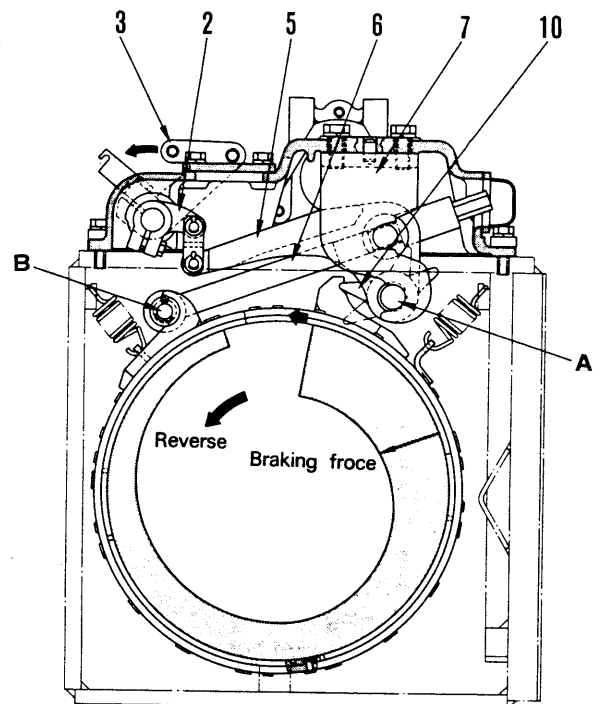
In the same ways as when traveling forward, when the brake pedal is depressed, both ends of the brake band are contracted to the inside.

When this happens, the outer drum is rotating in reverse (counterclockwise in the diagram), so the brake band is pulled in the direction of rotation. This tension is borne by mount B of rod (6) and the brake band.

Therefore, the brake band restricts the brake drum with the fulcrum at point B, and pushes out point A on the other side to the left.



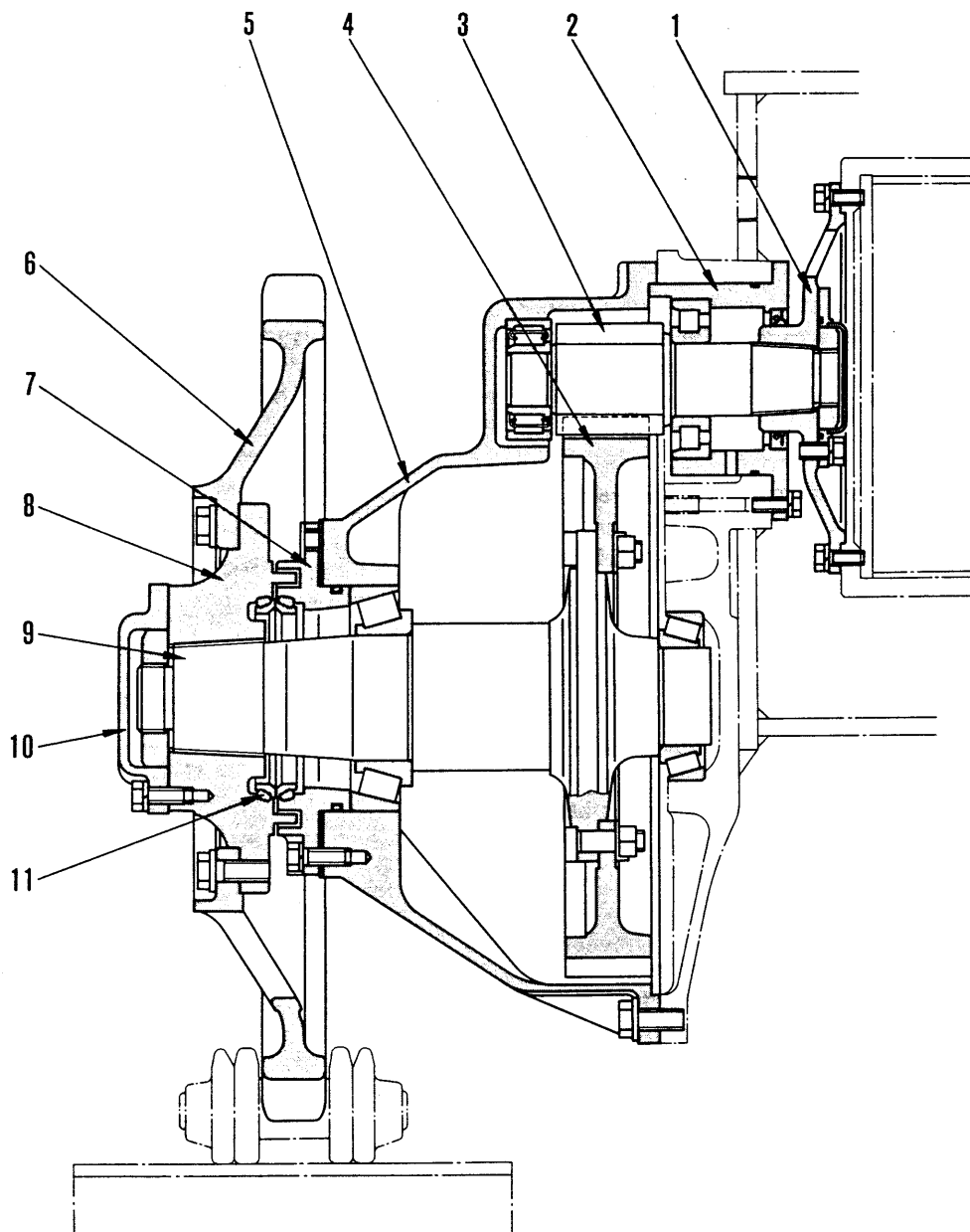
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# FINAL DRIVE

★ The diagram shows the D31E, P, S-18.



1. Final drive flange
2. Cage
3. Pinion shaft (10 teeth)
4. Gear (63 teeth)
5. Final drive case
6. Sprocket
7. Ring
8. Sprocket boss
9. Sprocket shaft
10. Cover
11. Floating seal

## OUTLINE

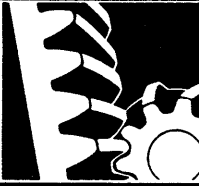
- The final drive is a spur gear, one stage reduction, splash lubrication type.

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# POWER TRAIN

## 22 TESTING AND ADJUSTING



Standard for testing and adjusting .....	22- 2
Testing and adjusting tool list .....	22- 3
Measuring oil temperature .....	22- 4
Measuring oil pressure .....	22- 5
Adjusting gear shift lever control linkage ....	22- 7
Adjusting inching control linkage .....	22- 8
Adjusting steering control linkage .....	22- 9
Adjusting clearance of brake lining .....	22-12
Troubleshooting .....	22-13

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-  When carrying out testing, adjusting or troubleshooting, stop the machine on level ground, install the safety pins and block the tracks.
-  When working in groups, use agreed signals and do not allow unauthorized persons near the machine.
-  When checking the water level in the radiator, wait for the water to cool. Do not remove the radiator cap while the water is hot. Boiling water may spurt out.
-  Be careful not to get caught in rotating parts.

# STANDARD FOR TESTING AND ADJUSTING

	Check item	Conditions	Unit	Standard value	Permissible value
Travel of control levers	Fuel control lever	<ul style="list-style-type: none"> <li>Center of lever knob</li> <li>Engine stopped</li> </ul>	Engine: low idling — full throttle	78 — 108	78 — 108
			Engine: low idling — stop	61 — 91	61 — 91
	Gear shift lever	<ul style="list-style-type: none"> <li>Center of lever knob</li> <li>Engine stopped</li> </ul>	Between each speed range	31 — 46	31 — 46
	Inching pedal	<ul style="list-style-type: none"> <li>Center of pedal</li> <li>Engine stopped</li> </ul>	To stroke end	103 — 113	103 — 113
	Steering lever	<ul style="list-style-type: none"> <li>Center of lever</li> <li>Engine stopped</li> </ul>	To stroke end	180 — 220	290
	Brake pedal	<ul style="list-style-type: none"> <li>Center of pedal</li> <li>Engine stopped</li> </ul>	With operating force 15 kg (Clearance between lining and drum is 0.3 mm)	103 — 113	162
Operating force of control levers	Fuel control lever	<ul style="list-style-type: none"> <li>Center of lever knob</li> <li>Engine stopped</li> </ul>	Engine: low idling — full throttle	6.8 — 8.0	6.8 — 8.0
			Engine: low idling — stop	6.0 — 10.0	6.0 — 10.0
	Gear shift lever	<ul style="list-style-type: none"> <li>Center of lever knob</li> <li>Engine stopped</li> </ul>	Between each speed range	2.5 — 3.5	2.5 — 3.5
			F ↔ R	0.5 — 1.5	0.5 — 1.5
	Inching pedal	<ul style="list-style-type: none"> <li>Center of pedal</li> <li>Engine low idling</li> </ul>	To stroke end	7.5 — 10.5	7.5 — 10.5
	Steering lever	<ul style="list-style-type: none"> <li>Center of lever</li> <li>Engine stopped</li> </ul>	To stroke end	6.5 — 7.5	6.5 — 7.5
Brake pedal	<ul style="list-style-type: none"> <li>Center of lever</li> <li>Engine low idling</li> </ul>	To stroke end	7.0 — 9.0	7.0 — 9.0	
Hydraulic pressure	Transmission main relief pressure	<ul style="list-style-type: none"> <li>Oil temperature in transmission: 40 — 60°C</li> <li>Gear shift lever in neutral position</li> </ul>	Engine low idling	18 — 20	18 — 20
			※1: 19 — 21	※1: 19 — 21	
	Steering main relief pressure	<ul style="list-style-type: none"> <li>Oil temperature in transmission: 40 — 60°C</li> <li>Gear shift lever in neutral position</li> <li>Steering lever operated</li> </ul>	Engine low idling	18 — 20	18 — 20
			Engine full throttle	20 — 23	20 — 23
			Engine full throttle	※1: 21 — 24	※1: 21 — 24
Travel	Travel speed	<ul style="list-style-type: none"> <li>Engine full throttle</li> <li>Engine water temperature: within operating range</li> <li>Machine is on level ground</li> <li>Measure time taken to travel for 10 — 30 m after traveling 20 m as an approach travel</li> </ul>	First forward speed	2.2	2.2
			※2: 2.3	※2: 2.3	
			Second forward speed	3.9	3.9
			※2: 4.1	※2: 4.1	
			Third forward speed	6.5	6.5
			※2: 6.9	※2: 6.9	
			First reverse speed	2.4	2.4
			※2: 2.5	※2: 2.5	
			Second reverse speed	4.3	4.3
※2: 4.5	※2: 4.5				
			Third reverse speed	7.1	7.1
			※2: 7.5	※2: 7.5	

※1: Applicable serial No.

※2: Applicable serial No.

D31E-18 40247 and up  
D31P-18 40326 and up  
D31P-18A 40279 and up  
D31PL-18 40327 and up  
D31PLL-18 40323 and up  
D31S-18 40068 and up  
D31Q-18 40068 and up  
D37E-2 1702 and up  
D37P-2 1549 and up

D37E-2 2501 and up  
D37P-2 2001 and up

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## TESTING AND ADJUSTING TOOL LIST

No.	Check item	Tool	Part No.	Remarks
1	Oil temperature	Thermistor kit	799-101-6000	-50 - 1,200°C
2	Hydraulic pressure	Hydraulic tester D	799-101-5000	Pressure gauge: 25, 60, 400, 600 kg/cm <sup>2</sup>
3	Engine speed	Multi-tachometer	799-203-8000	Digital display L: 60 - 2,000 rpm H: 60 - 19,999 rpm
4	Operating force	Push-pull scale	Commercially available	-
5	Travel	Scale	-	-

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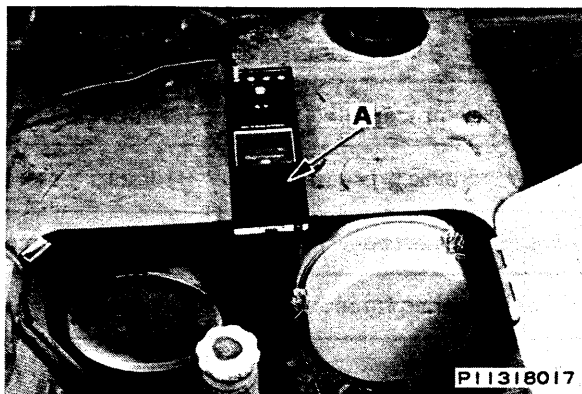
# MEASURING OIL TEMPERATURE



Stop the machine on level ground and lower the work equipment to the ground.

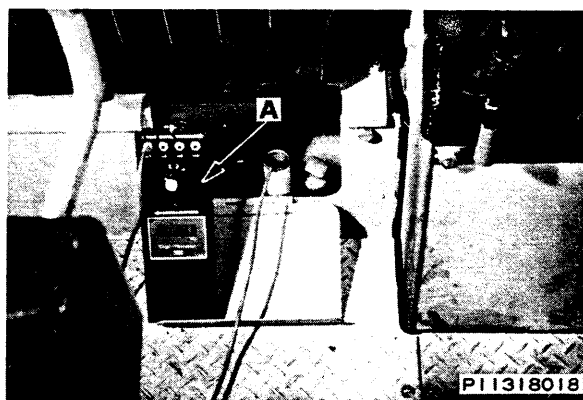
## 1. Measuring engine oil temperature

- 1) Remove oil level gauge.
- 2) Using thermistor A, measure temperature of oil in engine oil pan.



## 2. Measuring transmission oil temperature

- 1) Remove oil level gauge.
- 2) Using thermistor A, measure temperature of oil in transmission case.



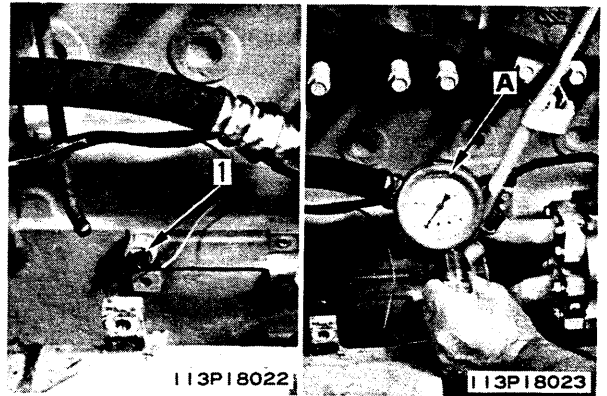
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# MEASURING OIL PRESSURE

- ⚠ Stop the machine on level ground and lower the work equipment to the ground.
- ⚠ Always remove and install plugs and pressure gauge with the engine stopped.
- ★ When measuring the oil pressure, remove all dirt and dust from around the nipple and plug.

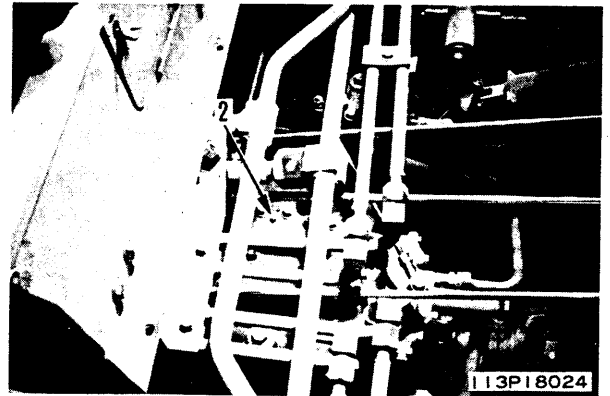
## 1. Measuring engine oil pressure

- 1) Remove sensor (1) of oil pressure.
- 2) Install hydraulic tester A (25 kg/cm<sup>2</sup>).
- 3) Start engine and measure oil pressure.

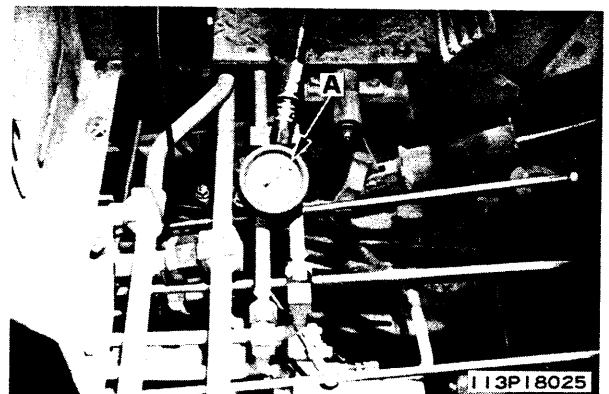


## 2. Measuring transmission main relief pressure

- 1) Remove plug (2) of transmission control valve.
- 2) Install hydraulic tester A (60 kg/cm<sup>2</sup>).



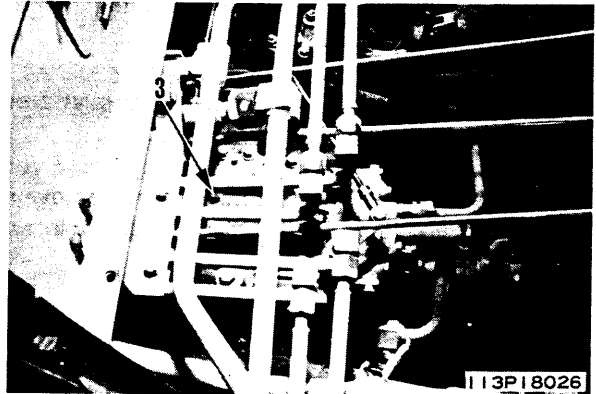
- 3) Start engine and measure oil pressure.



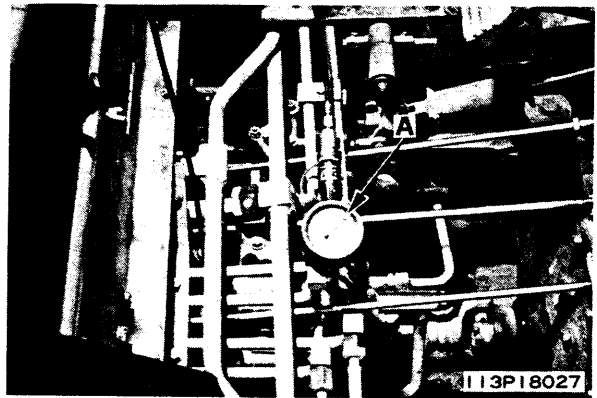
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**3. Measuring inching valve oil pressure**

- 1) Remove plug (3) of transmission control valve.
- 2) Install hydraulic tester A (60 kg/cm<sup>2</sup>).

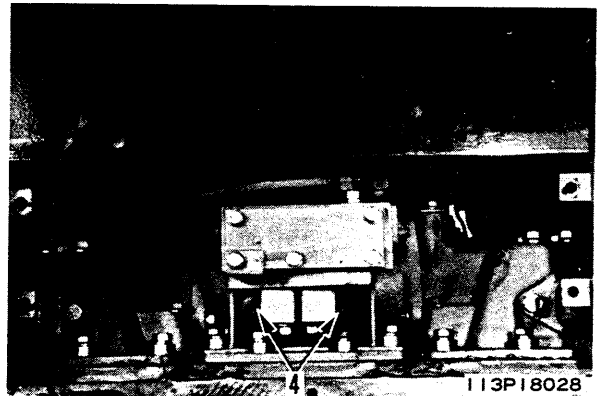


- 3) Start engine, check that the oil pressure is about 0 kg/cm<sup>2</sup> when the inching pedal is fully depressed.  
★ Measure with the gear shift lever at the F1 position.

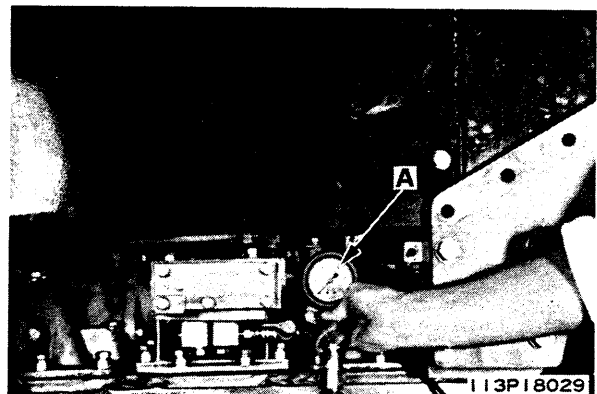


**4. Measuring steering booster cylinder oil pressure**

- 1) Remove plug (4) of steering control valve.
- 2) Install hydraulic tester A (60 kg/cm<sup>2</sup>).



- 3) Start engine and measure the oil pressure, when the steering lever is pulled.  
★ Measure with the gear shift lever at the N position.



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# ADJUSTING LINKAGE

## ADJUSTING GAR SHIFT LEVER CONTROL LINKAGE

1. Set speed valve spool in the N position, adjust the length of rods (1) and (2), and install.

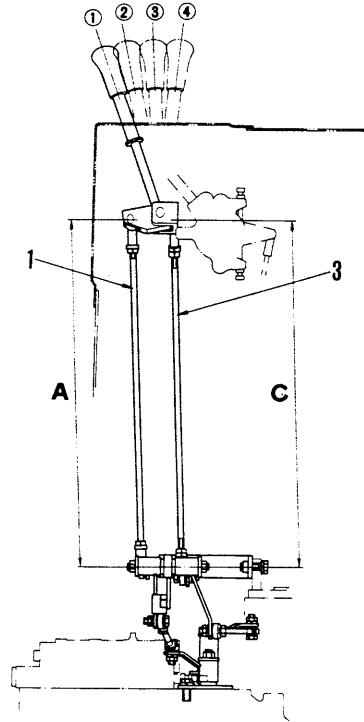
★ Standard length  
 Dimension A: 500 mm  
 Dimension B: 366 mm

2. Set F-R valve spool in the F or R position, and adjust the length of rods (3) and (4), and install.

★ Standard length  
 Dimension C: 498 mm  
 Dimension D: 538 mm

- ~~3. After connecting all the parts of the linkage, adjust the length of rods (2) and (4) finely if lever (5) is in contact with guide (6).~~

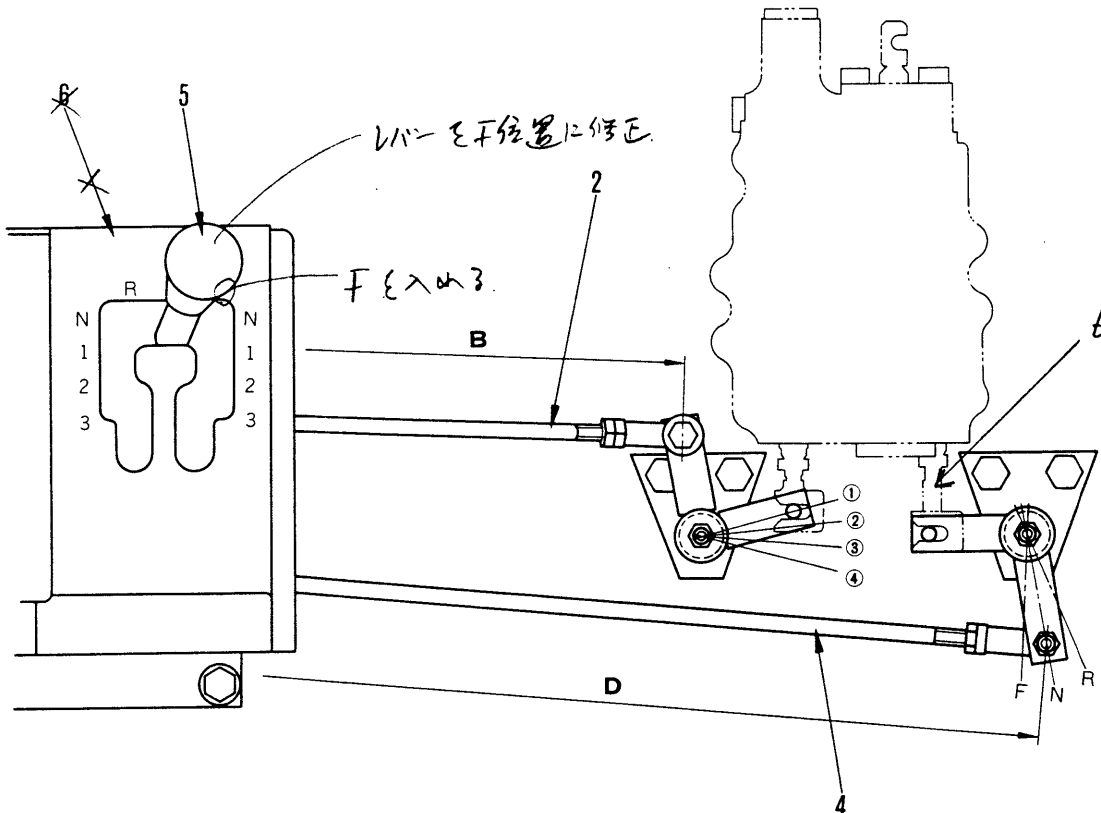
シフトバルブのF-Rスプール(6)を押し込んだ状態(Fポジション)で速達バー(5)がF位置になるようにロッド(3),(4)を調整する



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Lever position

- ①: Neutral
- ②: 1st
- ③: 2nd
- ④: 3rd

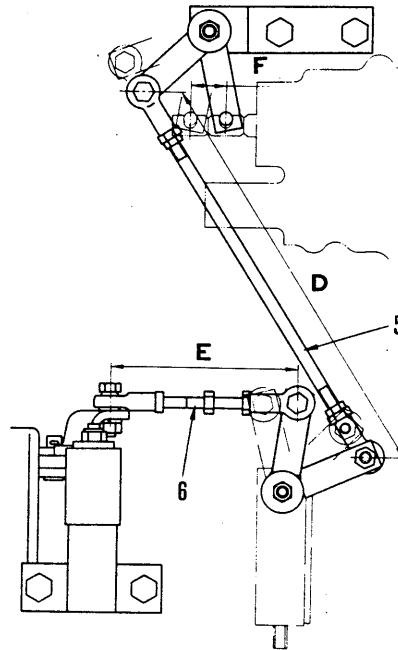


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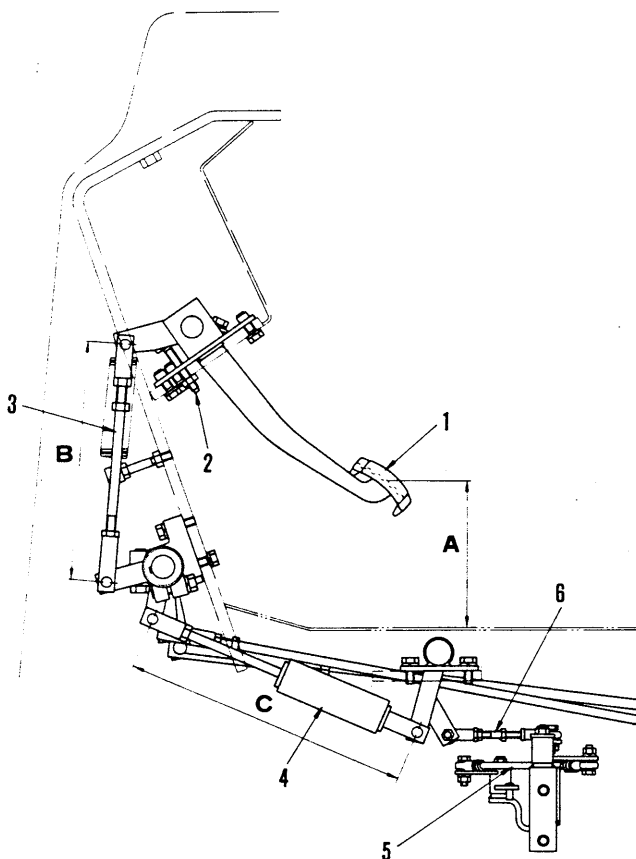
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## ADJUSTING INCHING CONTROL LINKAGE

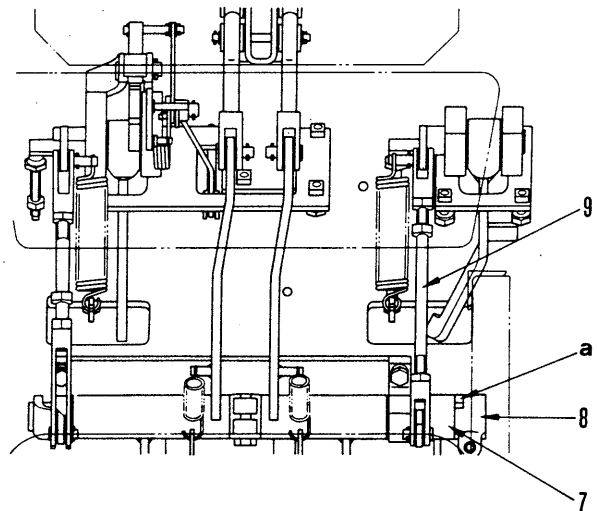
1. Adjust the height of stopper bolt (2) so that dimension **A** of inching pedal (1) is 178 mm from the upper face of the floor plate.
2. Adjust the length of rods (3), (4), (5) and (6), and install.
  - ★ Standard length
  - Dimension **B**: 286.6 mm
  - Dimension **C**: 343.6 mm
  - Dimension **D**: 287.1 mm
  - Dimension **E**: 125.0 mm
3. Depress the inching pedal fully, and check the travel of inching valve spool **F** is 23.5 mm.
4. Adjust the clearance **a** by rod (9) so that clearance between lever (7) and boss (8) is 0 mm.



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## ADJUSTING STEERING CONTROL LINKAGE

### 1. ADJUSTING STEERING LEVER LINKAGE D31E, P, PL, PLL-18 D31P-18A, D37E-2, D37P-2

★ Bend the cotter pin securely.

1) Adjust the length of stopper bolt (1) so that dimension **A** of steering lever is 295 mm from the point **a** on the dashboard.

2) Adjust the length of rods (2) and (3) between the steering lever and the case and install.

★ Standard length

Dimension **B**: 854 mm

Dimension **C**: 285 mm

★ Pull the steering lever fully, check the travel of steering valve spool **D** is 17 mm.

3) Adjust clearance of the brake lining.

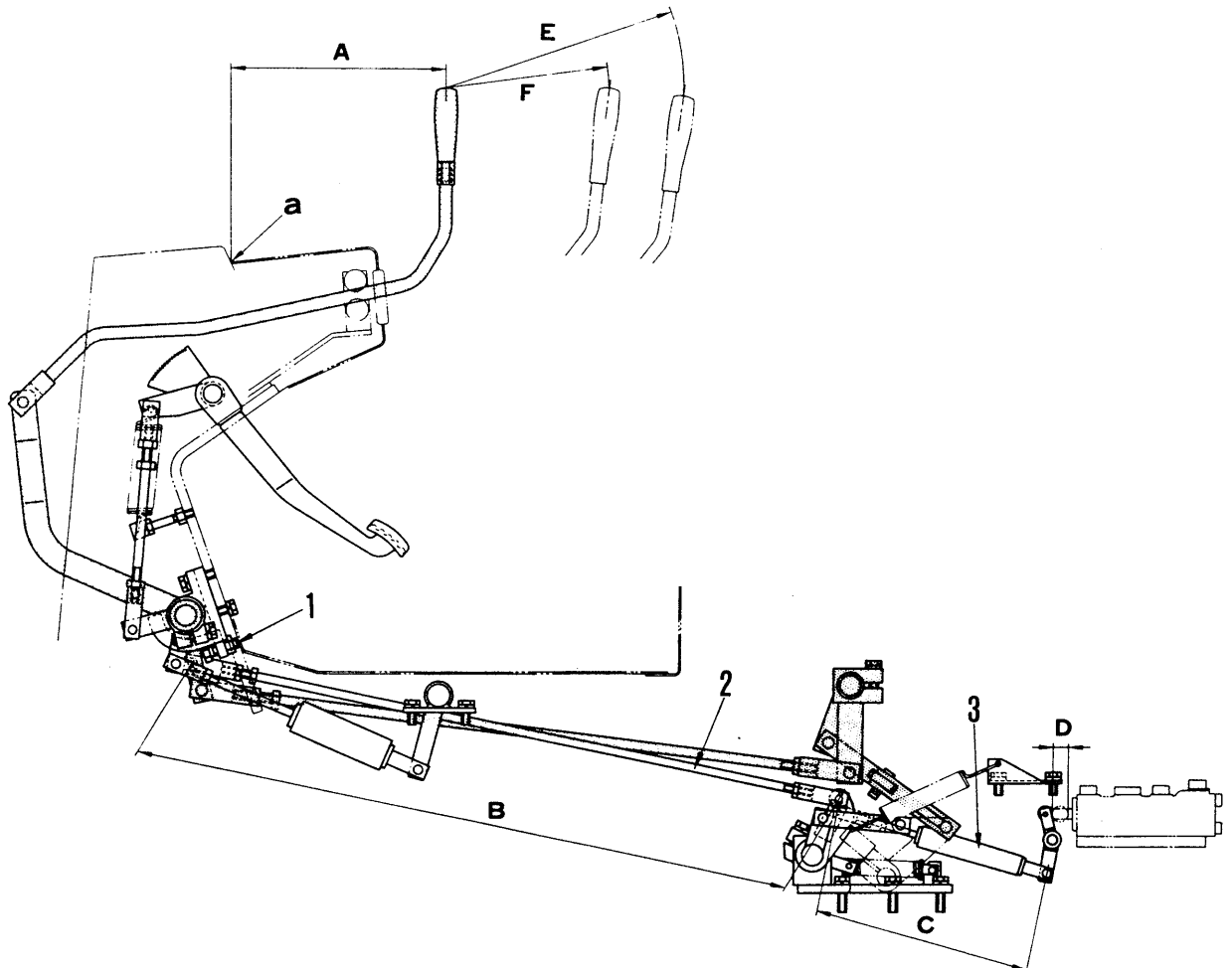
★ For details, see ADJUSTING CLEARANCE OF BRAKE LINING.

4) Check the travel of the steering lever.

★ Standard travel

Travel **E** (at band clearance 0.45 mm):  
290 mm

Travel **F** (at band clearance 0.30 mm):  
200 mm



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## 2. ADJUSTING BRAKE PEDAL LINKAGE

D31E, P, PL, PLL-18

D31P-18A, D37E-2, D37P-2

★ Bend the cotter pin securely.

1) Adjust dimension **A** of rod (4).

★ Standard length

Dimension **A**: 286.6 mm

2) Adjust the height of stopper bolt (6) so that dimension **B** of brake pedal (5) is 178 mm from the upper face of floor plate.

★ Standard travel

Travel **C** (at band clearance 0.45 mm):

161.7 mm

Travel **D** (at band clearance 0.30 mm):

107.7 mm

3) Adjust dimension **E** of rod (7).

★ Standard length

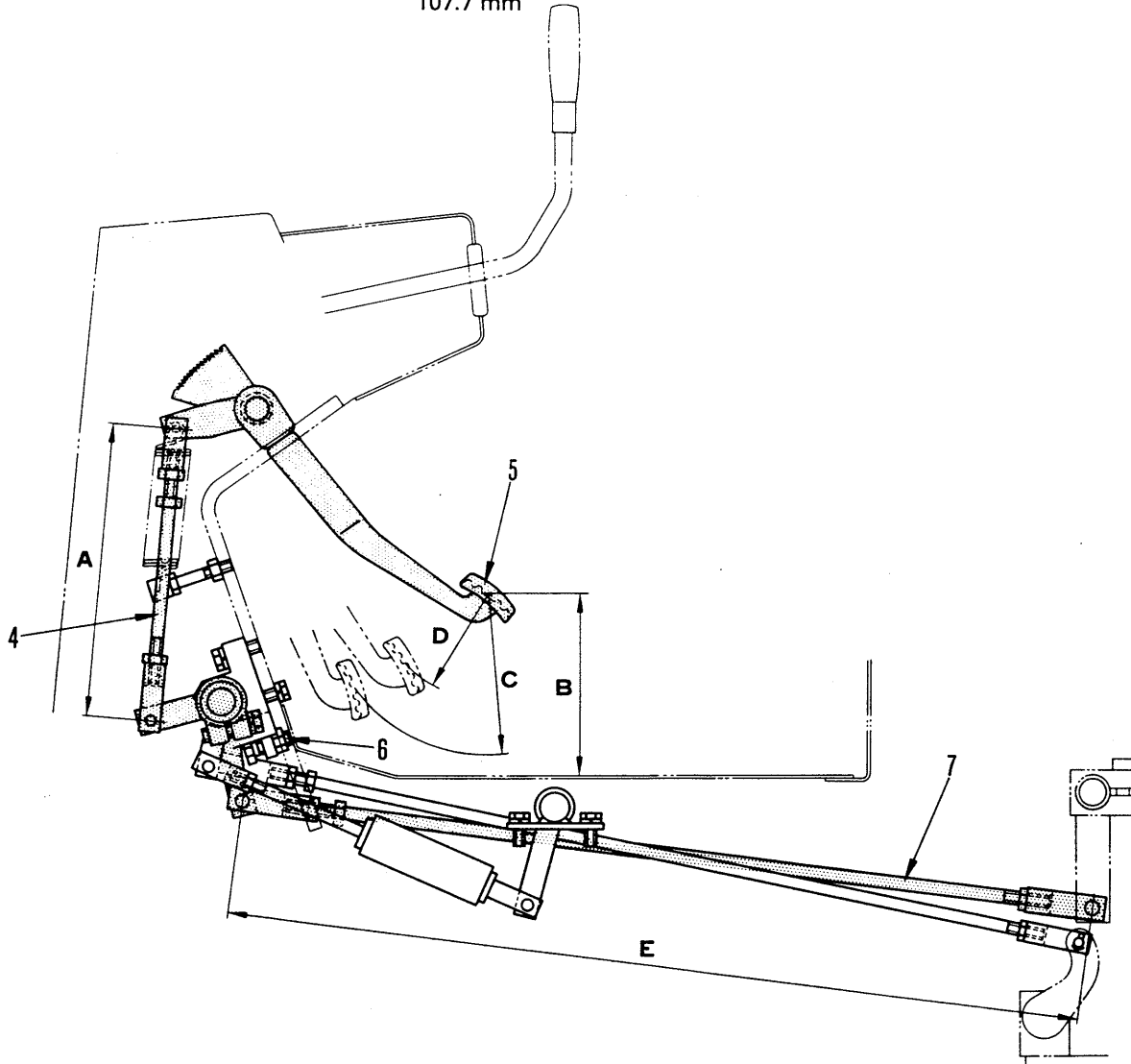
Dimension **E**: 846 mm

4) Adjust the clearance of the brake lining.

★ For details, see ADJUSTING CLEARANCE OF BRAKE LINING.

5) Check the travel of brake pedal.

★ Travel: 110 – 126 mm



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### 3. ADJUSTING STEERING PEDAL LINKAGE D31S, Q-18

★ Bend the cotter pin securely.

1) Adjust dimension **A** of rod (4).

★ Standard length

Dimension **A**: 286.6 mm

2) Adjust the height of stopper bolt (6) so that dimension **B** of brake pedal (5) is 178 mm from the upper face of floor plate.

★ Standard travel

Travel **C** (at band clearance 0.45 mm):

161.7 mm

Travel **D** (at band clearance 0.30 mm):

107.7 mm

3) Adjust dimension **E** of rod (7).

★ Standard length

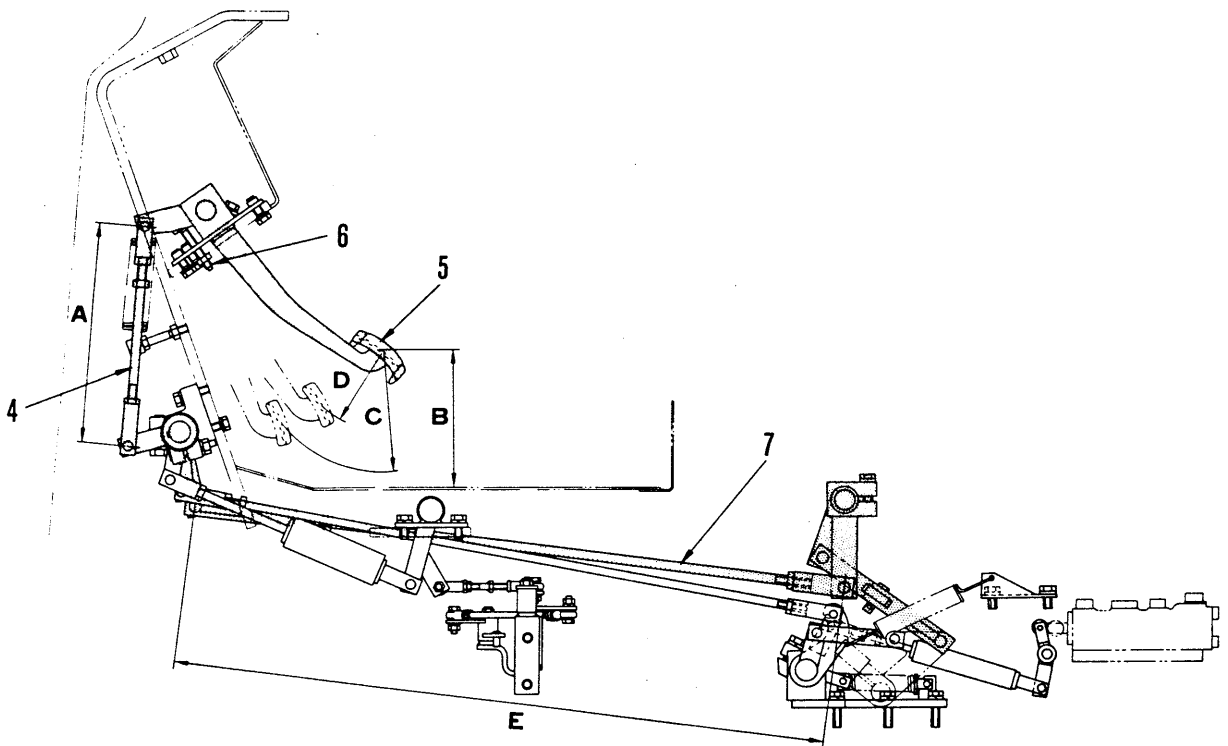
Dimension **E**: 846 mm

4) Adjust the clearance of the brake lining.

★ For details, see ADJUSTING CLEARANCE OF BRAKE LINING.

5) Check the travel of brake pedal.

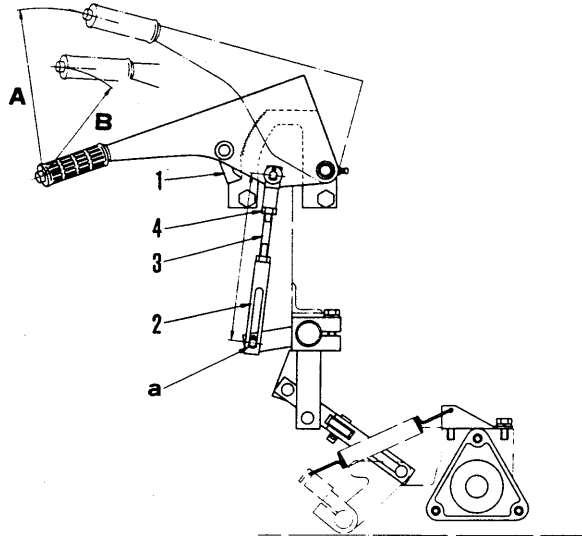
★ Travel: 110 – 126 mm



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
**4. ADJUSTING PARKING BRAKE  
D31S, Q-18**

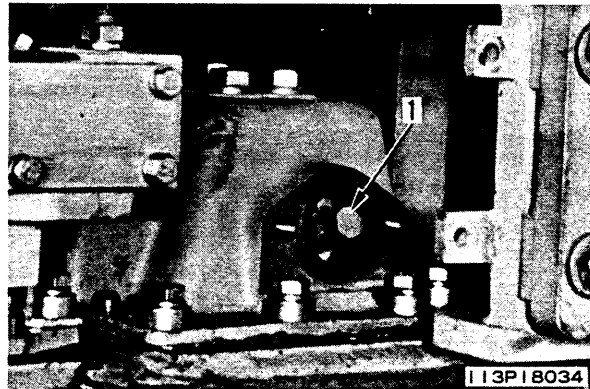
- 1) Put tooth (1) of the parking brake lever in contact with the stopper.
  - ★ Put it in contact with the stopper so that there is no clearance.
- 2) Adjust rod (3) so that the pin contacts the end of hole "a" of yoke (2) with no clearance, then secure with locknut (4).
  - ★ Bend the cotter pin securely.
  - ★ Standard travel
    - Travel A (at band clearance 0.45 mm):  
223.2 mm
    - Travel B (at band clearance 0.30 mm):  
148 mm



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**5. ADJUSTING CLEARANCE OF BRAKE LINING**

- ★ Adjust the clearance between the lining and brake drum when the brake pedal and the steering lever travels are not within the standard value, or disassemble steering clutch and brake.
- 1) Tighten adjustment nut (1) and bring the lining and brake drum into close contact.
    -  Adjustment nut: 4 kgm
  - 2) Loosen adjustment nut (1) 2.5 turns, and adjust the clearance between the lining and brake drum to 0.3 mm.



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## TROUBLESHOOTING

1. Machine does not move off ..... 22-14
2. Drawbar-pull is small or travel speed is low ..... 22-15
3. Time lag is excessive when moving off or gearshifting ..... 22-16
4. When engine is started, machine moves ..... 22-17
5. Machine shock is large when moving off and gearshifting ..... 22-17
6. Oil quantity in transmission and bevel gear case fluctuates ..... 22-17

011418

# 1. Machine does not move off.

## Ask the operator the following questions.

- Did the machine suddenly stop moving?  
→ Seizure or damage to internal parts.
- Was unusual noise heard from the machine?  
→ Damaged parts.

## Check before troubleshooting

- Is oil quantity of transmission case and/or bevel gear case correct?
- Is the travel of the transmission control valve spool normal?
- Is the universal joint damaged?
- Is the steering brake locked?

No.	Problems	Remedy	Cause												
			Case to pump				Transmission control valve			Transmission					
			a	b	c	d	e	f	g	h	i	j	k	l	m
			C	Δ	X	Δ	Δ	C	Δ	X	X	X	X	Δ	X
1	Unusual noise is heard from transmission pump when oil temperature is low.		○												
2	Machine does not move off in any speed position.		○	○	○	○	○	○						○	
3	Machine moves off normally in a certain speed position.								○	○				○	
4	When gear shift lever is placed in position, universal joint does not rotate but engine does not stop.														○
5	Engine stops when gear shift lever is placed in position.									○				○	
6	Machine does not move off when oil temperature is high.			○					○		○				
7	The transmission modulating relief pressure does not rise for any speed position.		○	○		○	○								
8	The transmission modulating relief pressure is only normal when placing the gear shift lever in a certain speed position.								○						
9	The transmission modulating relief pressure is not stable.		○												
10	No oil comes out when the pressure take-off plug is removed, and the engine is cranked.				○										

- ★ If the other possible causes have been eliminated, the slip of steering clutch maybe considered at the cause of trouble.
- ★ If the other possible causes been eliminated in spite of lowering transmission modulating relief pressure, the crack of transmission and valve maybe considered at the cause of trouble.

Troubleshooting tools	Hydraulic tester	
	Thermistor temperature gauge	

The following symbols are used to indicate the action to be taken when a cause of failure is located.

X: Replace                      Δ: Repair  
A: Adjust                        C: Clean

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**2. Drawbar-pull is small or travel speed is low.  
(Normal power cannot be obtained and travel speed does not increase)**

Ask the operator the following questions.

- Did you operate this machine from ago?
- Why were you aware of the insufficient performance?
  - As compared with before
    - The machine is considered improper
  - As compared with other model (large model)
    - The machine is considered normal

**Check before troubleshooting**

- Is oil quantity of transmission case and/or bevel gear case normal?
- Does the oil leak from piping and from between case and valve?
- Is the steering brake locked?
- Is the tension of track normal?

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No.	Problems	Remedy	Cause									
			Case to pump			Transmission control valve		Transmission				Other unit
			a	b	c	d	e	f	g	h	i	
			Transmission strainer clogged Transmission pump sucking air Transmission pump defective Transmission modulating relief valve and spool defective Seal ring of clutch and ring groove defective Seizure of clutch Rotating clutch defective Seal ring on rotating clutch (oil leakage) Engine defective									
			C	Δ	X	Δ	X	X	X	X		
1	Unusual noise is heard from transmission pump when oil temperature is low.		○									
2	The drawbar pull and travel speed becomes normal when the gear shift lever is operated to a certain speed position.					○	○	○				
3	The transmission modulating relief pressure does not rise for any speed position.		○	○	○							
4	The transmission modulating relief pressure is only normal when placing the gear shift lever in a certain speed position.					○		○				
5	The transmission modulating relief pressure is not stable.		○									
6	Engine rotation speed is low.									○		

- ★ If engine is defective, check the cause using the ENGINE TROUBLESHOOTING TABLE.
- ★ If all other possible causes have been eliminated, a possible cause is damage of the brake and steering clutch.

Troubleshooting tools	Thermistor temperature gauge	Hydraulic tester
	Tachometer	

The following symbols are used to indicate the action to be taken when a cause of failure is located.

X: Replace                      Δ: Repair  
 A: Adjust                      C: Clean

### 3. Time lag is excessive when moving off or gearshifting

#### Check before troubleshooting

- Is oil quantity of transmission case and/or steering case correct?
- Does the oil leakage from piping and between case and valve?

No.	Problems	Remedy	Cause								
			Tank (case) to pump			Transmission control valve			Transmission		
			a	b	c	d	e	f	g	h	i
			C	Δ X	X	Δ X	C	Δ X	X	X	X
1	Unusual noise is heard from transmission pump when oil temperature is low.		○								
2	Time lag is excessive when operating the gear shift lever to any speed position.		○	○	○	○	○				
3	Time lag is normal when operating the gear shift lever to a certain speed position.							○	○		
4	Time lag is excessive when operating the gear shift lever to 1st speed position.								○		
5	The transmission modulating relief pressure does not rise for any speed position.		○	○	○	○					
6	The transmission modulating relief pressure is not stable.		○								

★ If all other possible causes have been eliminated, a possible cause is damage of the brake and steering clutch.

Troubleshooting tools	Hydraulic tester	
	Thermistor temperature gauge	

The following symbols are used to indicate the action to be taken when a cause of failure is located.

X: Replace                      Δ: Repair  
A: Adjust                        C: Clean

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**4. When engine is started, machine moves.**

- |  |   |   |
|--|---|---|
| 1. Engine cranks when the gear shift lever is placed in a certain speed position.                              | → | Transmission safety switch defective                |
| 2. When engine is started with placing the gear shift lever in NEUTRAL position, machine moves.                | → | Seizure of transmission.                            |
| 3. In case of items 1 and 2, after engine is warmed up for 10 to 15 minutes, the machine becomes normal again. | → | In correct oil being used. (Viscosity is too high.) |

**5. Machine shock is excessive when moving off or gearshifting.**

**Fault check**

Because it is difficult to determine whether machine shock is large or not, judge machine shock as large in the following case.

- It is clear that machine shock has suddenly become larger than any shock has occurred so far.
- Machine shock is large compared to that occurring on other machines of the same type.

**Cause**

- Blocked orifice on modulating relief valve, operation defective →
- Blocked orifice on quick return valve, operation defective →

**Remedy**

- C. Δ. X
- C. Δ. X

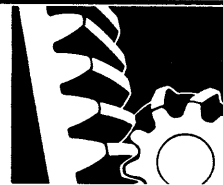
**6. Oil quantity in transmission and bevel gear case fluctuates.**

- |   |  |   |
|---|--|---|
| Oil quantity in transmission case decreases and that in bevel gear case increases → | Oil seal or O-ring on transmission output shaft defective. → | X |
|---|--|---|

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# POWER TRAIN

## 23 DISASSEMBLY AND ASSEMBLY




DAMPER	
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
## REMOVAL OF DAMPER ASSEMBLY

 Jack up the machine, insert blocks (height: approx. 300 mm) under the tracks, then apply the parking brake securely.

1. Using transmission jack , remove underguard (1). (See P1)



Underguard: 35 kg

2. Remove universal joint assembly (2). (See P2)
3. Using forcing screws  (Thread dia. = 10 mm, Pitch = 1.5 mm), remove cover (3). (See P3)

★ Oil will come out, so catch it with a pad.



Damper case: Approx. 0.8 ℓ

4. Remove damper assembly (4). (See P4)

## INSTALLATION OF DAMPER ASSEMBLY

1. Install damper assembly (4). (See P4)



Mounting bolt:  $7 \pm 0.5$  kgm

★ Bend the lock plate securely.

2. Fit gasket, and install cover (3). (See P3)



Gasket: Gasket sealant (LG-1)

★ Tighten the bolts as follows. (See F1)

- i) Tighten 4 bolts marked ★ in turn on opposite sides temporarily.
- ii) Tighten bolts fully in order 1 – 12.
- iii) Tap portion A 4 – 5 times with a plastic hammer to take the force in the thrust direction and make the rotation smooth.

3. Install universal joint assembly (2). (See P2)



Mounting bolt:  $3.0 \pm 0.5$  kgm



Universal joint: Grease (G2-LI)

4. Using transmission jack , install underguard (1). (See P1)

5. Remove plug, and add engine oil to the specified level.



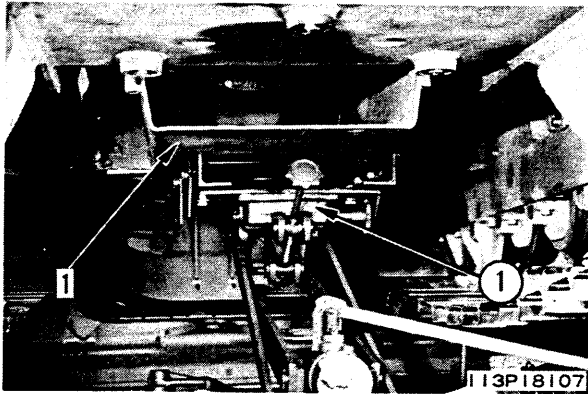
Damper case: Approx. 0.8 ℓ

Remove the blocks from under the tracks, then lower the machine to the ground.

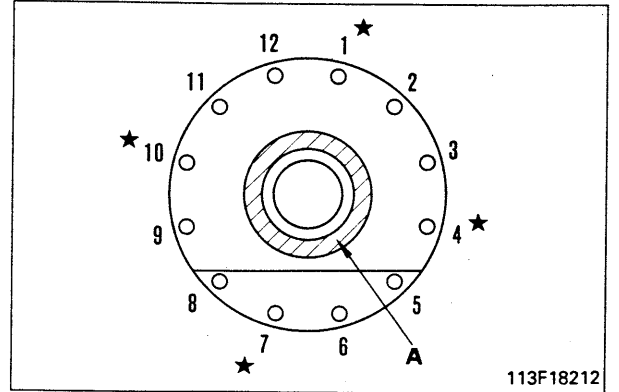
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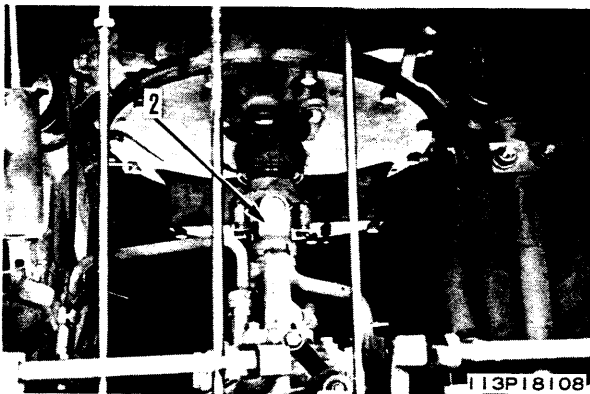
P1



F1



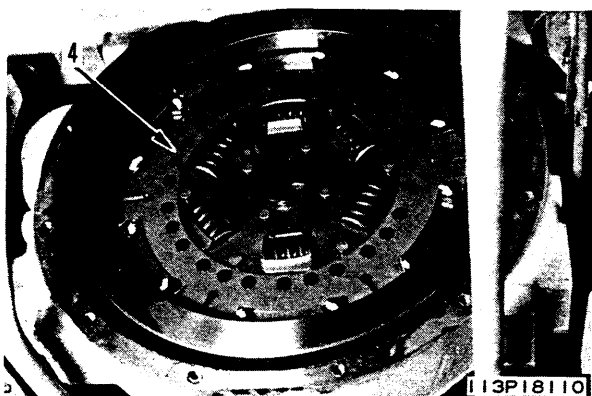
P2



P3




P4



# REMOVAL OF HYDROSHIFT TRANSMISSION ASSEMBLY

## Preparatory work

- Jack up the machine, and insert blocks (height: approx. 300 mm) under the tracks.

 After setting the machine on the blocks, apply the parking brake securely.

1. Using transmission jack ①, remove underguard (1). (See P1)



Underguard: 35 kg

2. Remove drain plug and drain oil from transmission case and bevel gear case.



Transmission case: Approx. 13 ℓ



Bevel gear case: Approx. 17 ℓ

3. Remove floor plate, then remove operator's seat assembly (2) and cover (3). (See P2)

4. Disconnect rods (4) and (5). (See P3)

5. Disconnect battery cable (6) and wiring (7). (See P4)

6. Remove operator's seat frame assembly (8) together with battery.



Operator's seat frame assembly:  
50 kg (With 2 batteries)

7. Remove oil filler (9). (See P5)

8. Remove spring (10). (See P6)

9. Remove rods (11), (12) and (13). (See P6)

10. Remove universal joint assembly (14). (See P7)

11. Disconnect control rods (15). (See P8)

12. Disconnect tube (16). (See P8)

13. Disconnect hose (17). (See P8)

14. Using eyebolts (Thread dia. = 10 mm, Pitch = 1.5 mm) x 2, sling transmission assembly (18) temporary. (See P9)



Transmission assembly: 220 kg

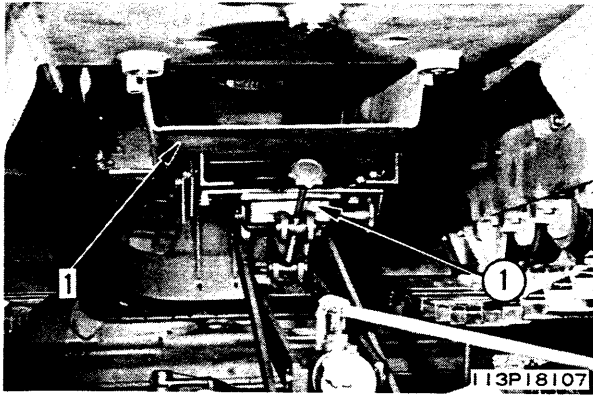
15. Remove mounting bolts, then lower transmission assembly. (See P9)

16. Put transmission assembly on lift truck ②, and pull out to remove. (See P10)

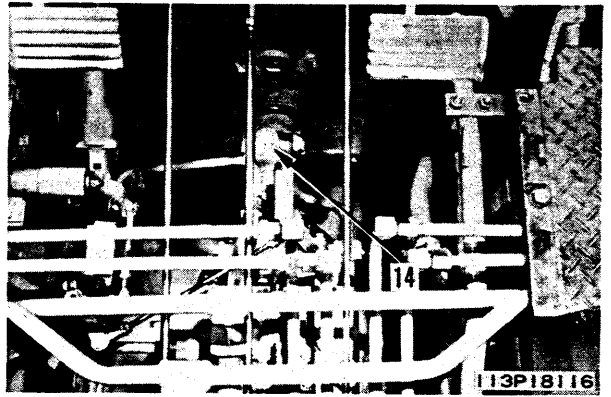
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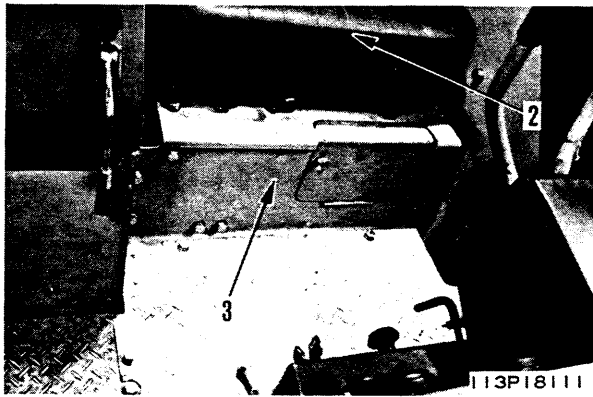
P1



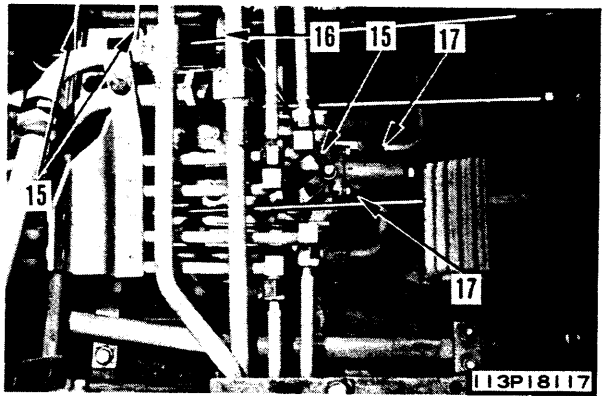
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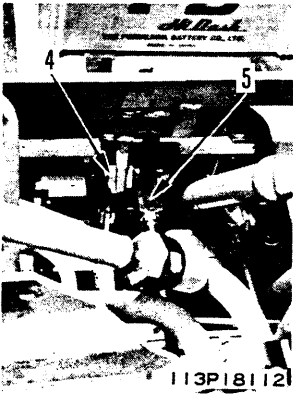
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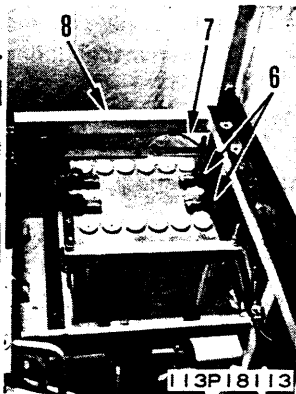
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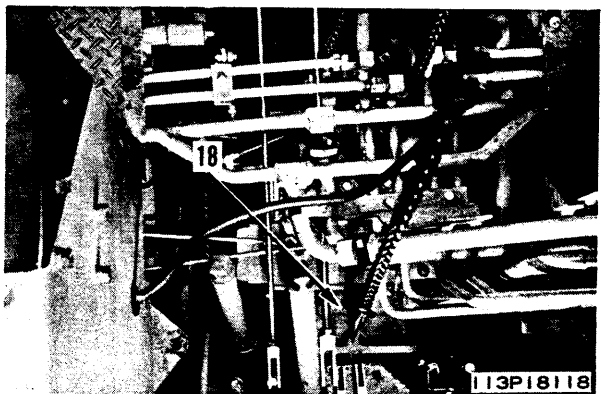
P3



P4



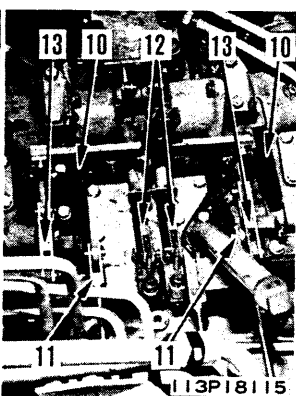
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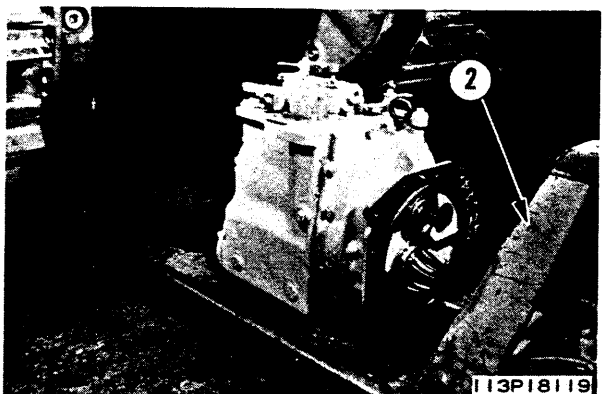
P5









P6



P10



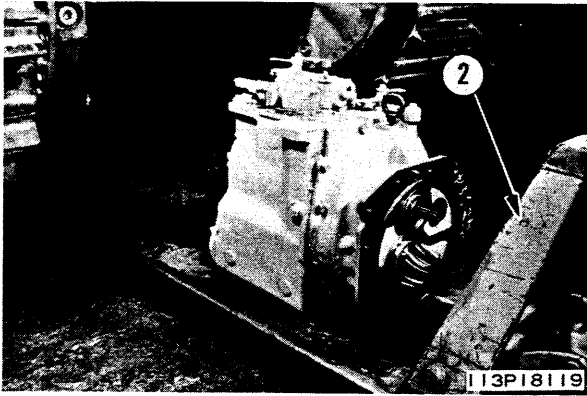
# INSTALLATION OF HYDROSHIFT TRANSMISSION ASSEMBLY

1. Fit O-ring, put transmission assembly (18) on lift truck ②, then push under machine. (See P1)
  2. Install eyebolts (Thread dia. = 10 mm, Pitch = 1.5 mm) x 2, raise slowly and set transmission assembly (18) in position on steering case. (See P2)
  3. Knock in dowel pin, and tighten mounting bolts, then install transmission assembly. (See P2)
  4. Connect hose (17). (See P3)
  5. Connect tube (16). (See P3)
  6. Connect control rods (15). (See P3)
  7. Install universal joint assembly (14). (See P4)
    -  Mounting bolt: 3.0 ± 0.5 kgm
    -  Universal joint: Grease (G2-LI)
  8. Connect rods (13), (12) and (11). (See P5)
  9. Install spring (10). (See P5)
  10. Fit gasket and install oil filler (9). (See P6)
  11. Raise and install operator's seat frame assembly (8) together with battery. (See P7)
  12. Connect battery wiring (7) and cable (6). (See P7)
  13. Connect rods (5) and (4). (See P8)
  14. Install cover (3) and operator's seat assembly (2), then install floor plate. (See P9)
  15. Tighten drain plugs of transmission case and bevel gear case, then add oil through oil filler to the specified level.
    -  Transmission case: Approx. 13 ℓ
    -  Bevel gear case: Approx. 17 ℓ
  - ★ Run the engine to circulate the oil through the system. Then check the oil level again.
  16. Put underguard (1) on transmission jack ①, push under machine, and install. (See P10)
    -  Mounting bolt: Thread tightener (LT-2)
-  Remove the blocks from under the tracks, then lower the machine to the ground.

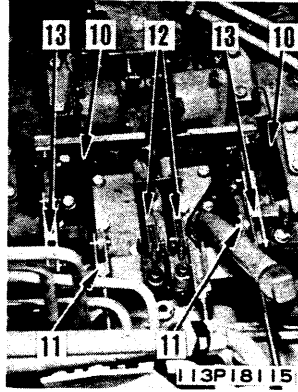
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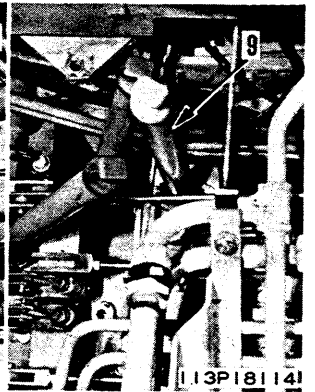
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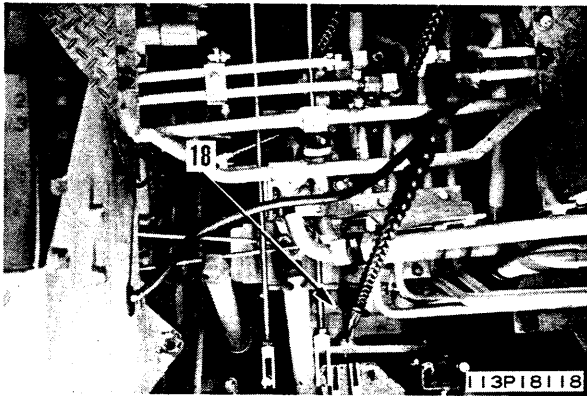
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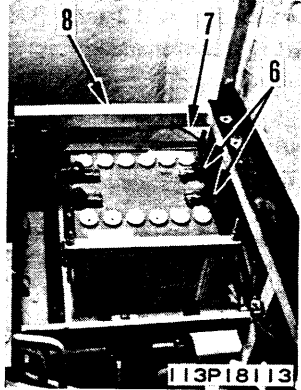
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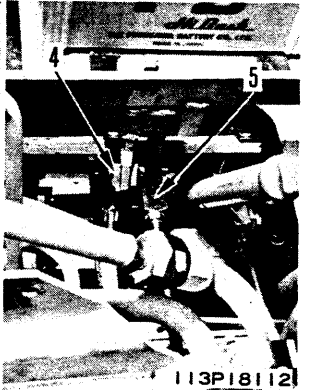
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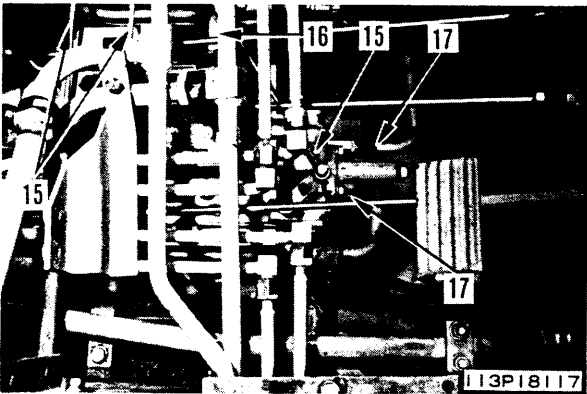
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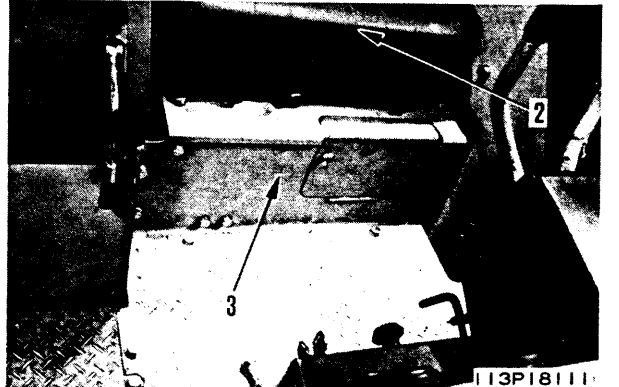
P8



P3



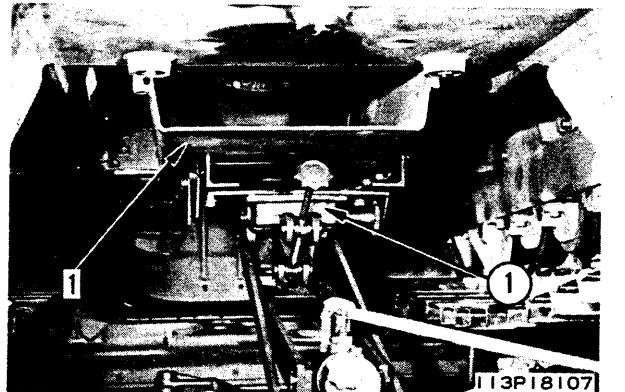
P9



P4



P10



# DISASSEMBLY OF HYDROSHIFT TRANSMISSION ASSEMBLY

## Special tool

	Part No.	Part Name	Q'ty
A	799-301-1300	Air checker	1

## GENERAL DISASSEMBLY

1. Remove brackets (1), (2) and (3) together with levers. (See P1)
2. Remove selector and inching valve assembly (4).
3. Screw in eyebolts (Thread dia. = 12 mm, Pitch = 1.75 mm), and lift off transfer assembly (5). (See P2)



Transfer assembly: 40 kg

6. Remove left and right lock bolts (12), then remove transmission case (13). (See P5, P6)



Transmission case: 50 kg

7. Using tool A, check the operating condition and stroke of each piston. (See P7)

★ Air check pressure: 3 – 5 kg/cm<sup>2</sup>

4. Removal of modulating valve assembly. (See P3)
  - 1) Remove cover (6) together with sleeve.
  - 2) Remove holder (7), then remove coupling (8).
  - 3) Remove tube (9).
  - 4) Remove modulating valve and transmission pump assembly (10).

8. Remove 5 tie bolts (14). (See P8)

9. Remove No. 1 housing and carrier assembly (15). (See P9)

5. Using forcing screw (Thread dia. = 10 mm, Pitch = 1.5 mm), remove sleeve (11). (See P4)

10. Remove No. 1, 2 sun gears and input shaft assembly (16). (See P10)

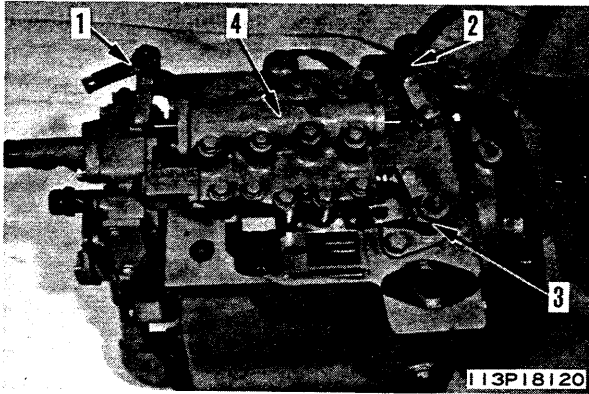
11. Remove springs (17), plates (18), (19) and discs (20). (See P10)

★ Keep the plates and discs stored in a vertical or horizontal position to prevent any deformation.

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P1



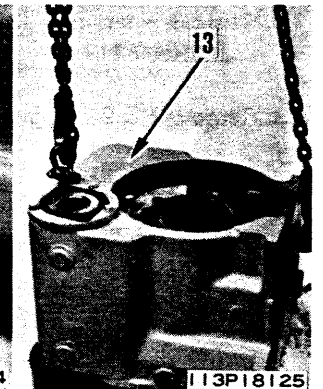
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P5



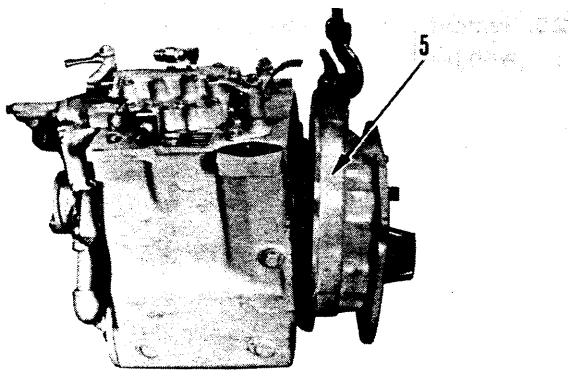
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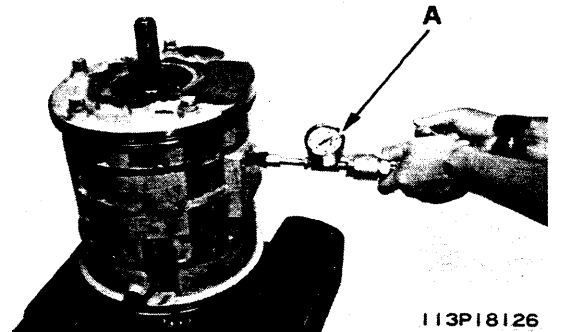
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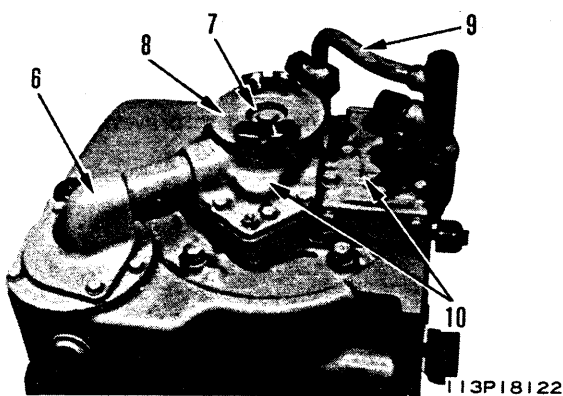
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P7



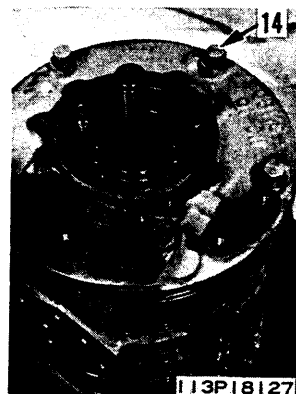
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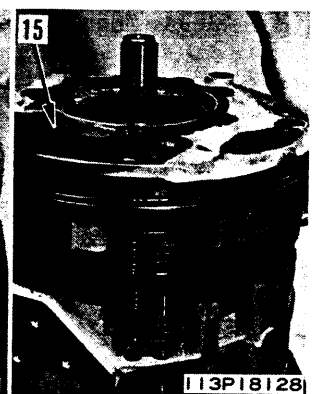
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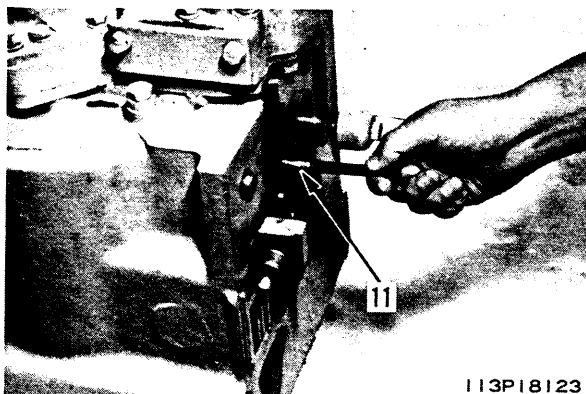
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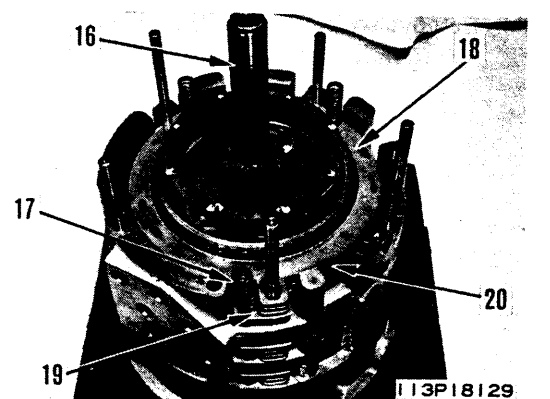
113P18128

P4



113P18123

P10



113P18129



12. Remove snap ring (21), then remove ring gear (22). (See P1)

13. Remove No. 2 ring gear (23). (See P1)

14. Remove No. 2, 3 housing assembly (24) and plate (25) together with No.3 clutch piston. (See P2)

15. Remove guide pins (26). (See P3)

16. Remove springs (27), plates (29) and discs (28). (See P3)

★ Keep the plates and discs stored in a vertical or horizontal position to prevent any deformation.

17. Remove snap ring (30). (See P4)

★ Remove from bearing inner race side.

18. Remove No. 2, 3 carrier assembly (31). (See P5)

19. Remove No. 3 ring gear (32). (See P5)

20. Remove No. 4 housing assembly (33) together with plate (34). (See P6)

21. Remove springs (35), discs (36) and plates (37). (See P7)

★ Keep the plates and discs stored in a vertical or horizontal position to prevent any deformation.

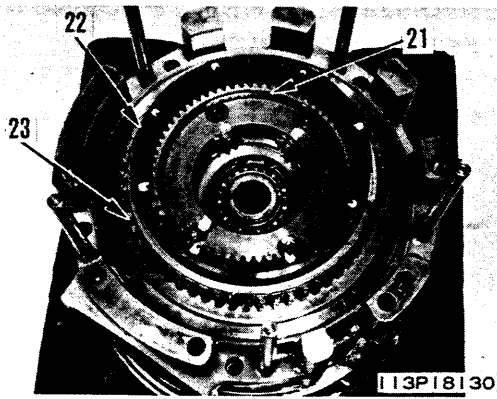
22. Remove No. 4 ring gear (38). (See P8)

23. Remove snap ring (40), then remove No. 3 sun gear (41). (See P8)

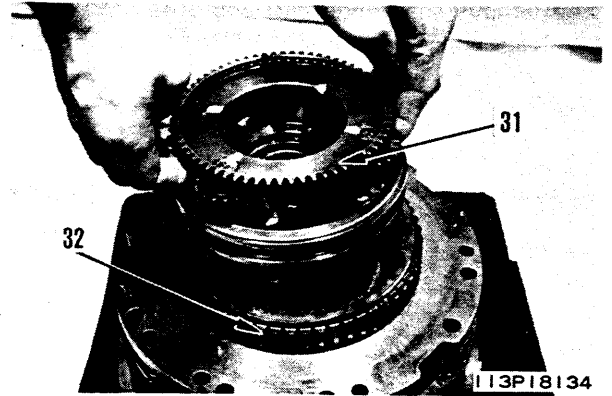
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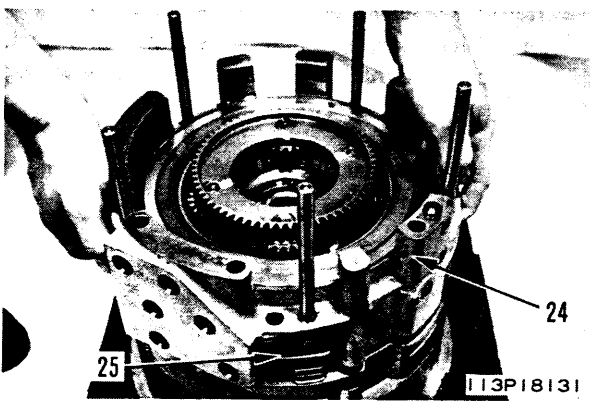
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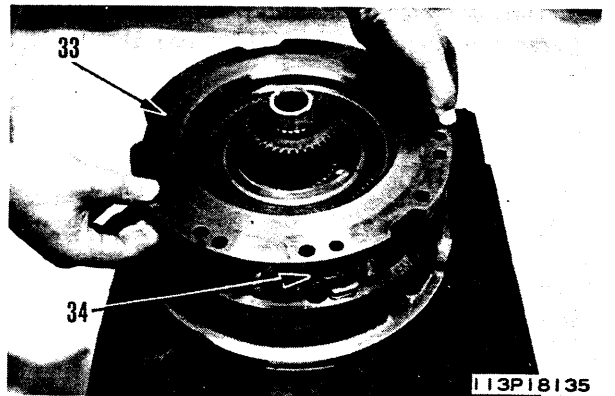
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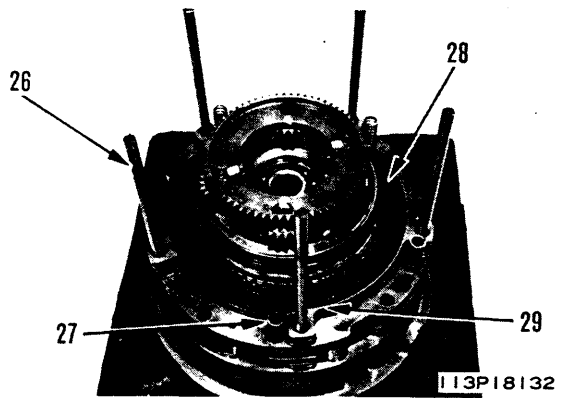
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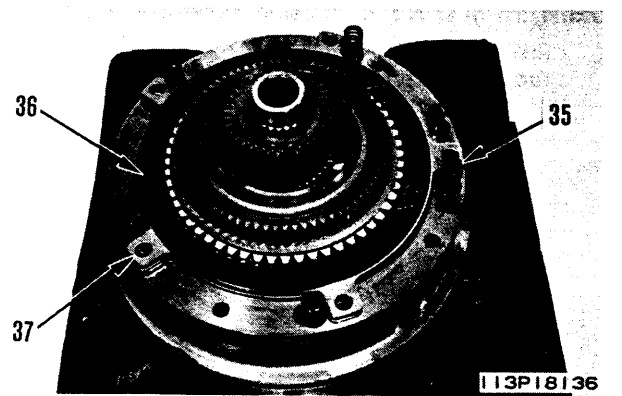
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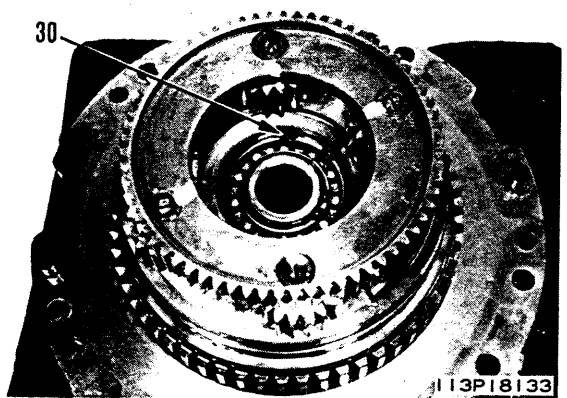
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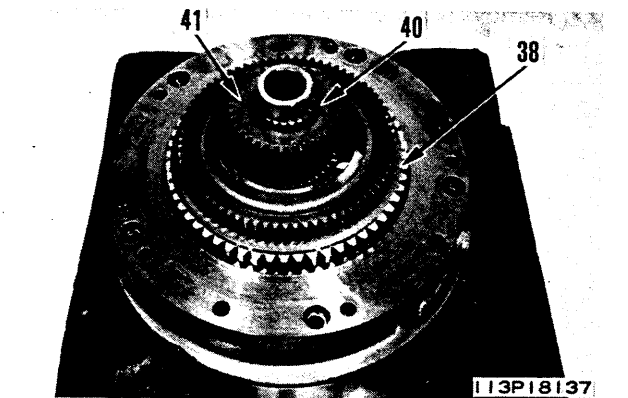
P7



P4



P8



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24. Remove snap rings (42) and (43), then remove No. 4 sun gear (44). (See P1)

25. Turn over No. 5 housing assembly (45), then remove mounting bolts (46). (See P2)

26. Turn over No. 5 housing assembly again, then put copper rod in contact with end of shaft, and tap shaft assembly (47) out. (See P3)

27. Remove No. 5 clutch assembly (48). (See P4)

## DISASSEMBLY OF No. 1 HOUSING AND CARRIER ASSEMBLY

1. Remove plate (1), then remove spring (2). (See F1)

2. Remove discs (3) and plates (4). (See P5)

★ Keep the plates and discs stored in a vertical or horizontal position to prevent any deformation.

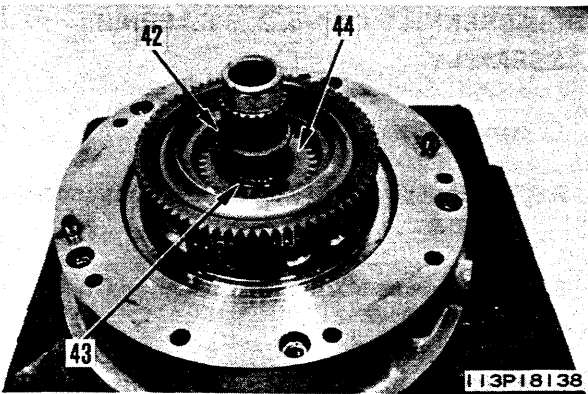
3. Remove ring gear (5) and piston (6). (See P6)

4. Remove snap ring (7), then tap out No. 1 carrier assembly (8). (See P7, P8, F2)

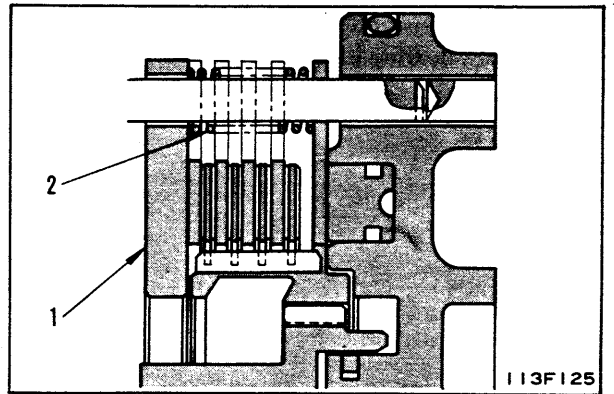
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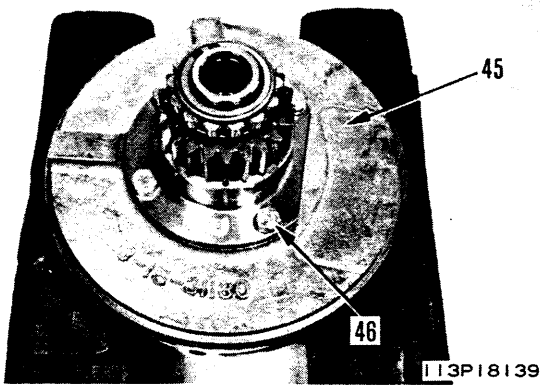
P1



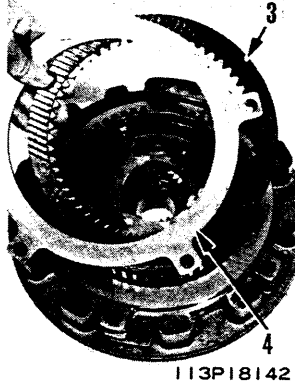
F1



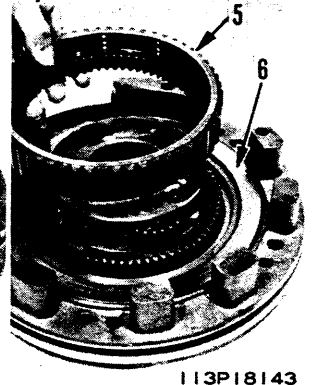
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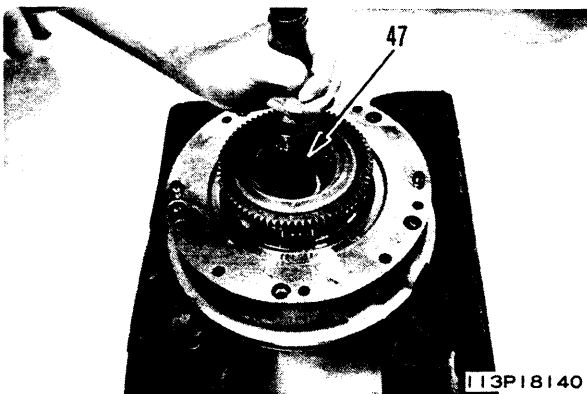
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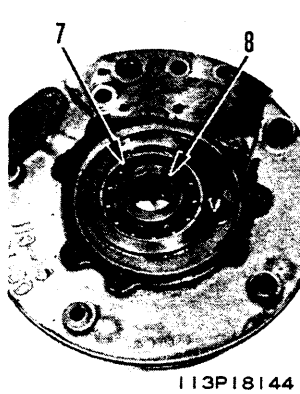
P6



P3



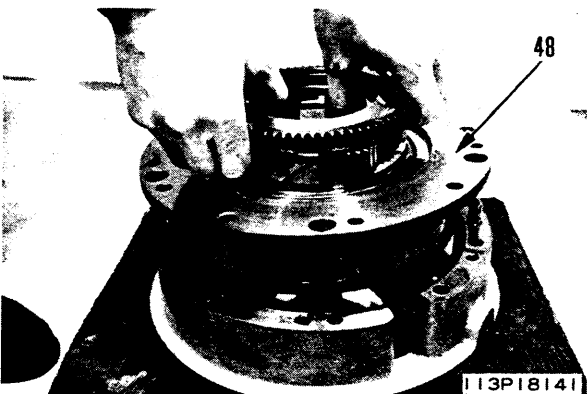
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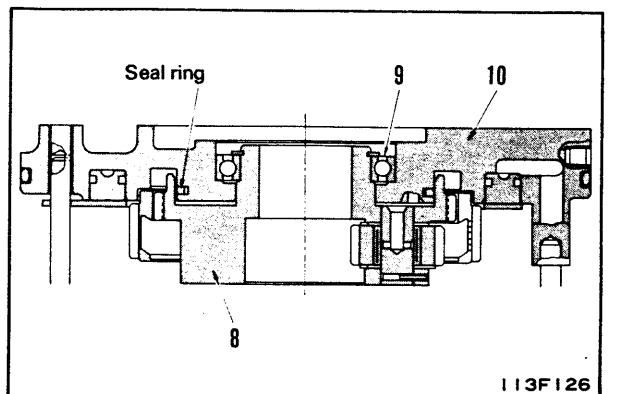
P8



P4



F2



5. Using push tool ① (outside diameter: 70 mm), remove bearing (9) from housing (10). (See P1)

**6. Disassembly of No. 1 carrier assembly.**

- 1) Tap in roll pin (11) to shaft, then tap out shaft (12). (See P2)
  - ★ Remove roll pin from shaft.

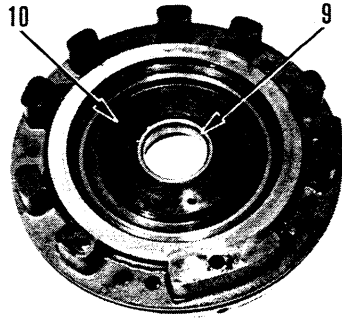
- 2) Remove washer (13) and gear (14). (See P3)
- 3) Remove bearing (15) from gear. (See P3)

**DISASSEMBLY OF No. 2, 3 CARRIER ASSEMBLY**

1. Remove seal ring (1). (See F1)
2. Tap in roll pin (2) to shaft, then tap out shaft (3). (See F2)
3. Remove gears (4), (5) and washer (6) from carrier (7). (See F2)
4. Remove snap ring (8), then remove bearing (9) from carrier (7). (See F1)

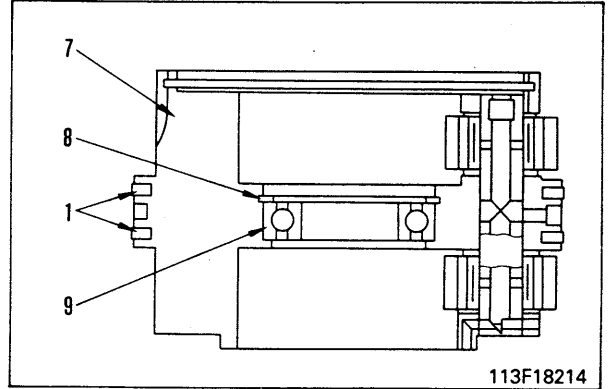
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P1



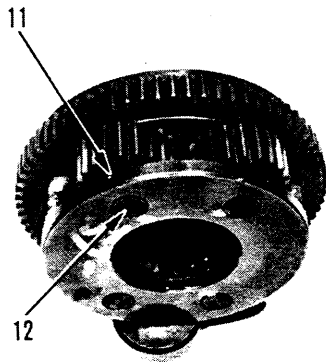
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F1



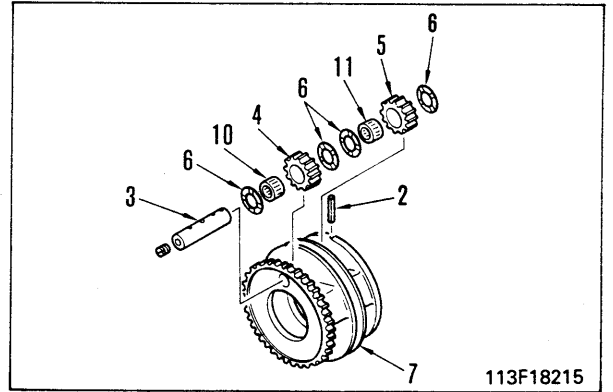
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P2



113P18147

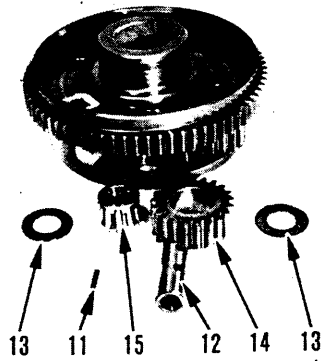
F2



113F18215

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P3



113P18148

## DISASSEMBLY OF BEARING CAGE AND OUTPUT SHAFT ASSEMBLY

9. Pull out bearing (11) from shaft (10), remove collar (12), then remove oil seal from collar. (See P7)

1. Remove seal ring (1) from cage (2). (See P1)

2. Remove spacer (3). (See P1)

3. Remove snap ring (4). (See P2)

4. Using puller ①, pull out bearing (5). (See P3)

5. Remove snap ring (6). (See P4)

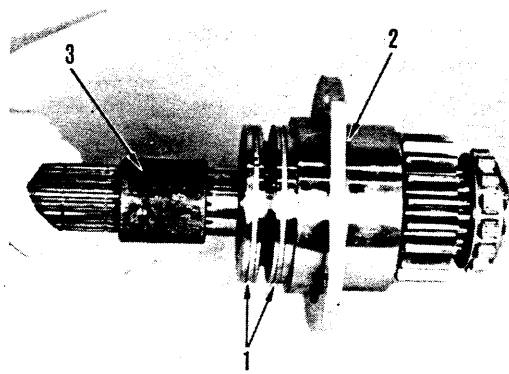
6. Remove gear (7). (See P4)

7. Remove snap ring (8). (See P5)

8. Support cage (9) end, and push shaft (10) to remove. (See P6)

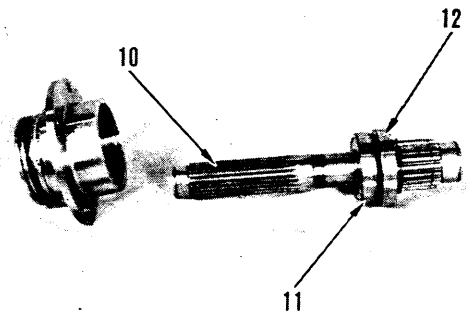
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P1



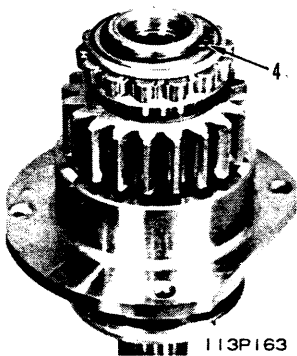
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P7



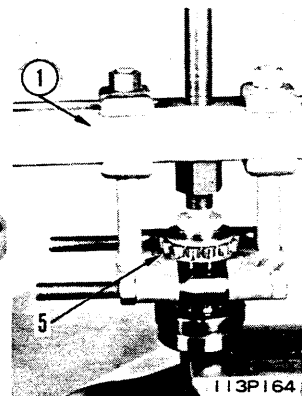
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113P163

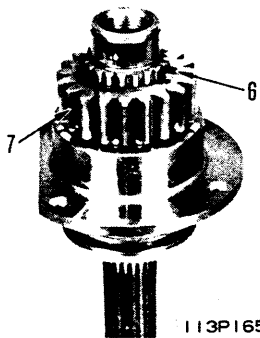
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113P164

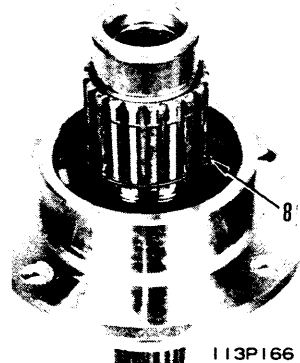
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P4



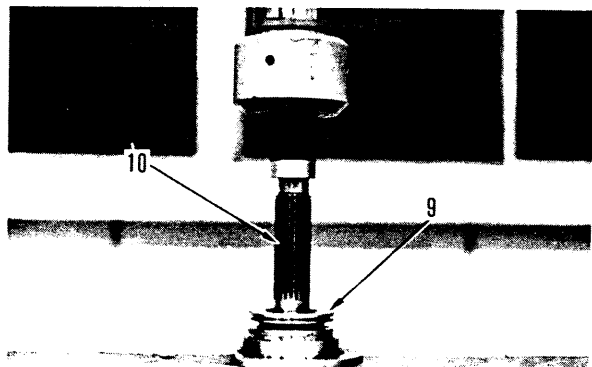
113P165

P5



113P166

P6



113P167

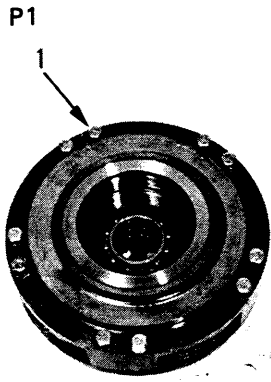


## **DIASSEMBLY OF No. 5 CLUTCH HOUSING ASSEMBLY**

1. Remove mounting bolts (1), then remove housing (2) together with clutch piston (3). (See P1, P2)
  
2. Remove springs (4), plates (5), discs (6) and pins (7). (See P3)
  - ★ Keep the plates and discs stored in a vertical or horizontal position to prevent any deformation.
  
3. Remove gear (8). (See P4)
  
4. Remove snap ring (9), then remove cover (10). (See P5)
  
5. Disassembly of carrier assembly.
  - 1) Tap in roll pin (12) to shaft, then tap out shaft (13). (See P6)
    - ★ Remove roll pin from shaft.
  
- 2) Remove washer (14), gear (15) and bearing (16). (See P7)
  
6. Disassembly of housing assembly.
  - 1) Remove snap ring (17). (See P8)
  - 2) Using push tool ① (outside diameter = 62 mm), remove bearing (18). (See P8, P9)
  
  - 3) Using push tool ② (outside diameter = 80 mm), remove cage (19).

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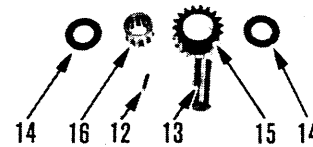
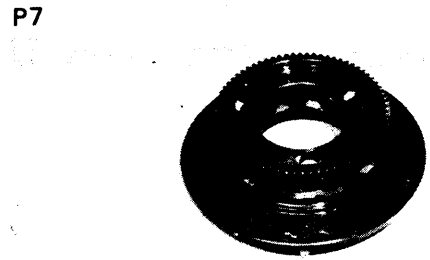
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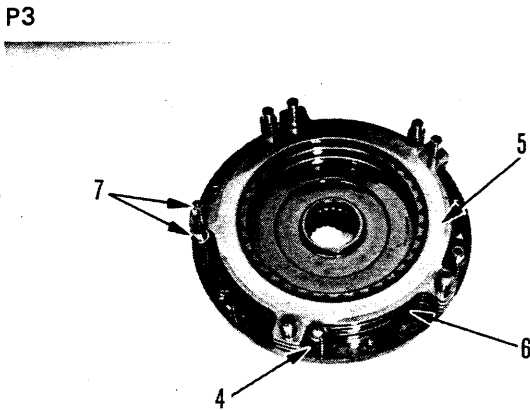
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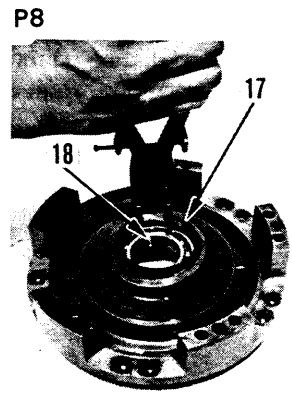
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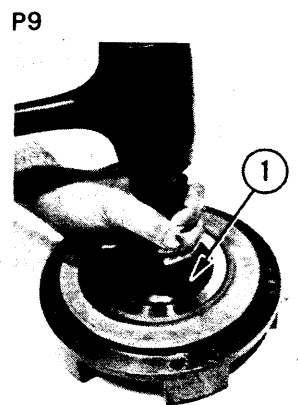
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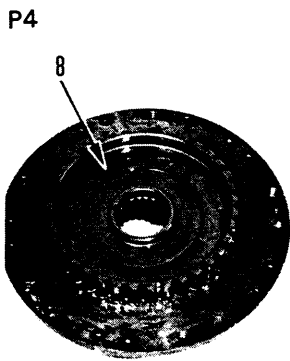
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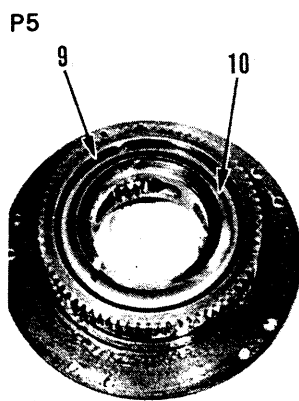
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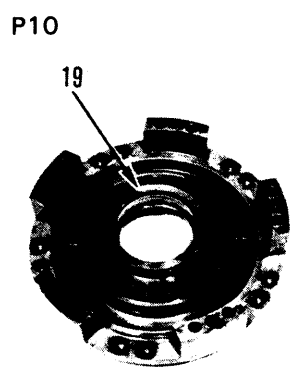
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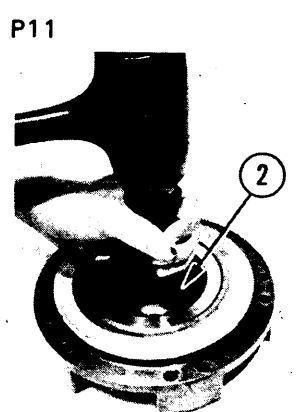
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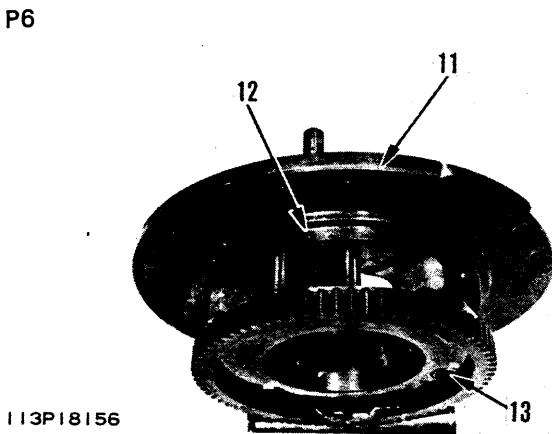
113P18155



113P18160



113P18161



113P18156

## DISASSEMBLY OF TRANSFER ASSEMBLY

5. Remove gear (7) from case (8). (See P6)

1. Remove cover (1) and holder (2). (See P1)

2. Using forcing screws ① (Thread dia. = 10 mm, Pitch = 1.5 mm, Length = 100 mm), remove cage (3). (See P2)

★ Check the number of shims, and keep in a safe place.

6. Using push tool ① (outside diameter = 115 mm), pull out outer race (9). (See P7, P8)

3. Remove collar (4), and tap out shaft (5). (See P3, P4)

7. Using push tool ② (outside diameter = 75 mm), pull out outer race (10). (See P9, P10)

4. Using forcing screws ② (Thread dia. = 14 mm, Pitch = 2.0 mm), remove cover (6). (See P5)

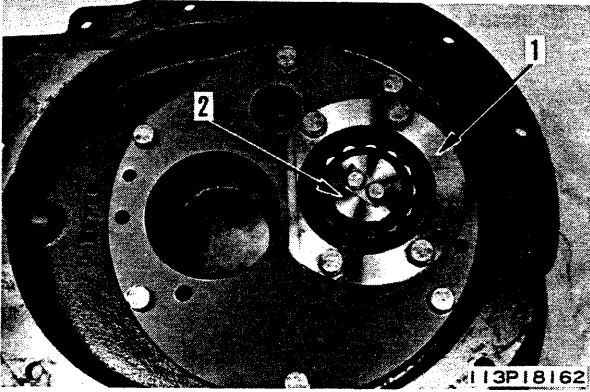
8. Using push tool ③ (outside diameter = 75 mm), pull out bearing (11). (See P11)

9. Using puller ④, pull out bearing (12). (See P12)

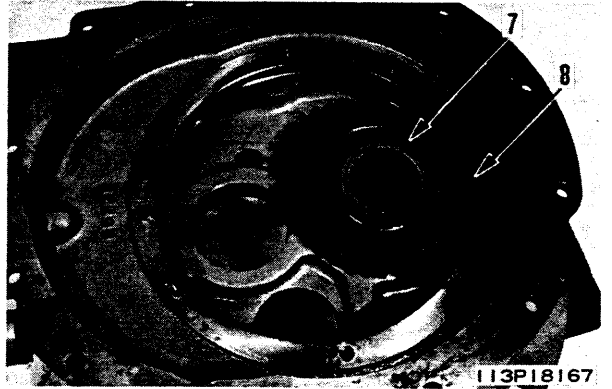
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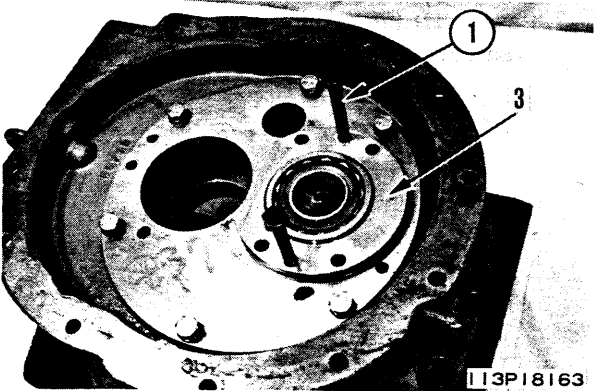
P1



P6



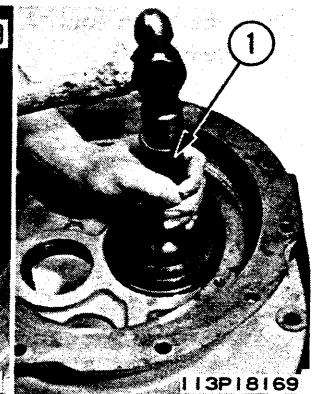
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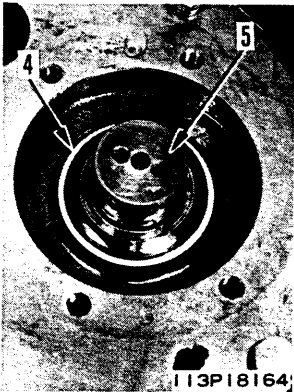
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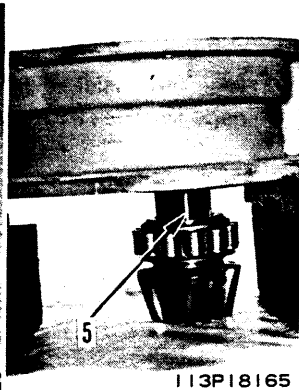
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P3



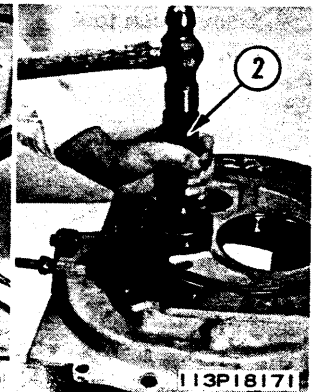
P4



P9



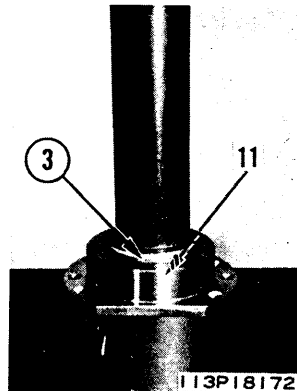
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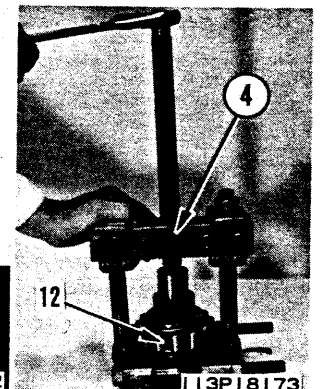
P5



P11



P12



# ASSEMBLY OF HYDROSHIFT TRANSMISSION ASSEMBLY

## Special tool

	Part No.	Part Name	Q'ty
A	799-301-1300	Air checker	1

## ASSEMBLY OF TRANSFER ASSEMBLY

1. Using push tool ⑤ (inside diameter: 55 mm), press fit bearing (12). (See P1)
2. Using push tool ⑥ (outside diameter: 90 mm), press fit bearing (11). (See P2)
3. Using push tool ②, press fit outer race (10). (See P3, P4)

4. Using push tool ①, press fit outer race (9). (See P5, P6)

5. Set gear (7) in case (8). (See P7)

6. Install cover (6). (See P8)

7. Pass shaft (5) through gear (7) and install, then install collar (4). (See F1)

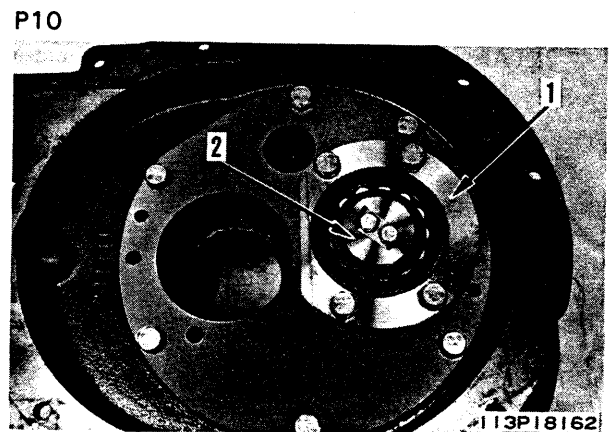
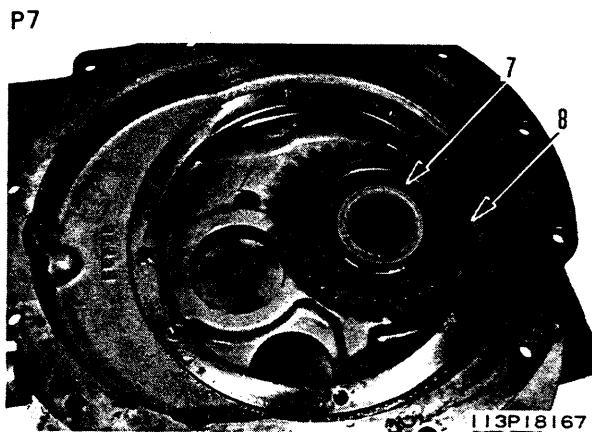
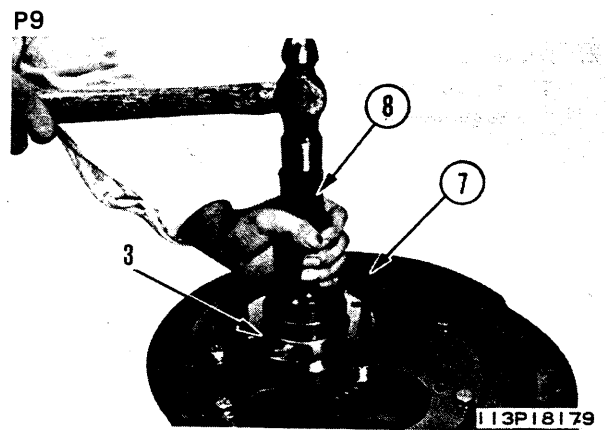
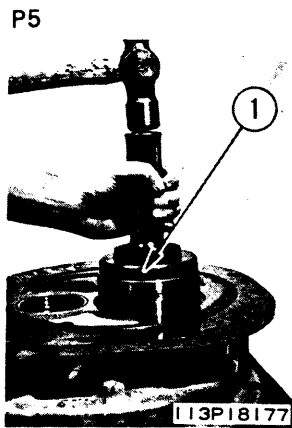
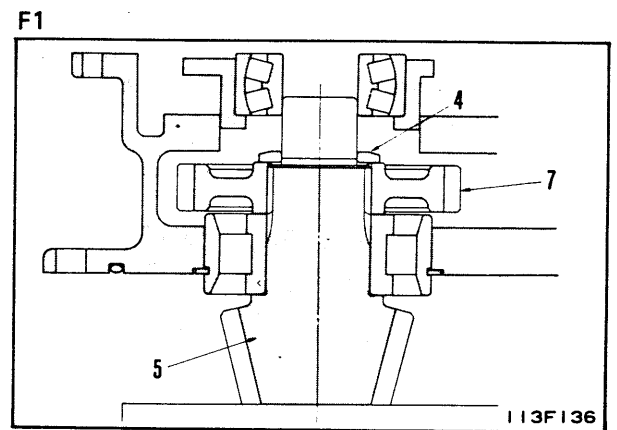
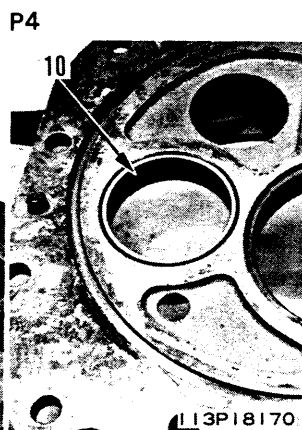
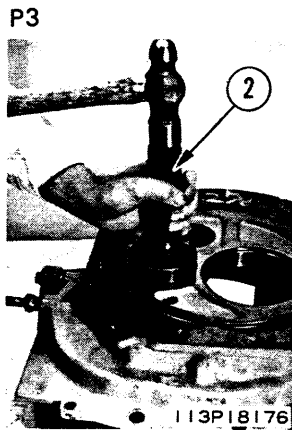
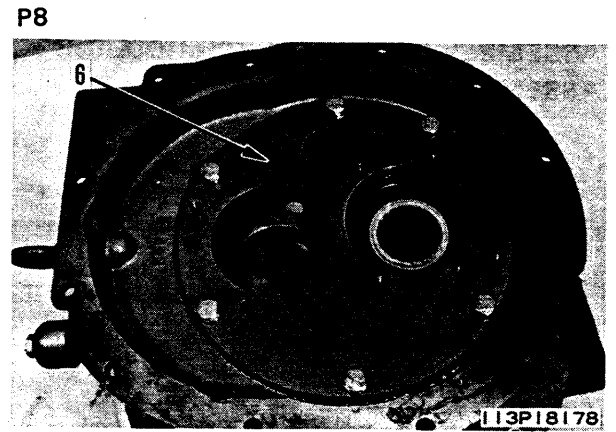
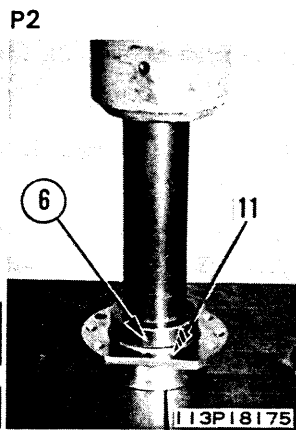
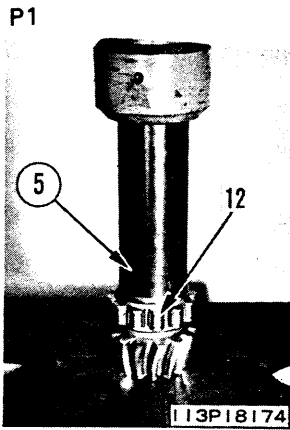
8. Using guide bolts ⑦ (Thread dia. = 10 mm, Pitch = 1.5 mm, Length = 100 mm) and push tool ⑧ (inside diameter = 40 mm), press fit cage (3). (See P9)

9. Install holder (2). (See P10)  
★ Bend lock plate securely.

10. Install cover (1). (See P10)

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## ASSEMBLY OF No. 5 CLUTCH HOUSING ASSEMBLY

### 1. Assembly of housing assembly.

- 1) Using push tool ② (outside diameter = 80 mm), press fit cage (19). (See P1)



Mounting bolt:

Thread tightener (LT-2)



Mounting bolt:  $3 \pm 0.5$  kgm

- 2) Using push tool ③ (outside diameter = 68 mm), press fit bearing (18). (See P2, P3)

- 3) Install snap ring (17). (See P3)

### 2. Assembly of carrier assembly.

- 1) Assemble bearing (16) in gear (15), fit washer (14), then set in position. (See P4)

- 2) Align shaft (13) with roll pin hole of carrier (11), then knock in roll pin (12), and lock. (See P5)

3. Install cover (10), then install snap ring (9). (See P6)

4. Turn over carrier assembly, then install gear (8). (See P7)

5. Install pins (7), discs (6), plates (5) and springs (4). (See P8)

★ Plates: 4

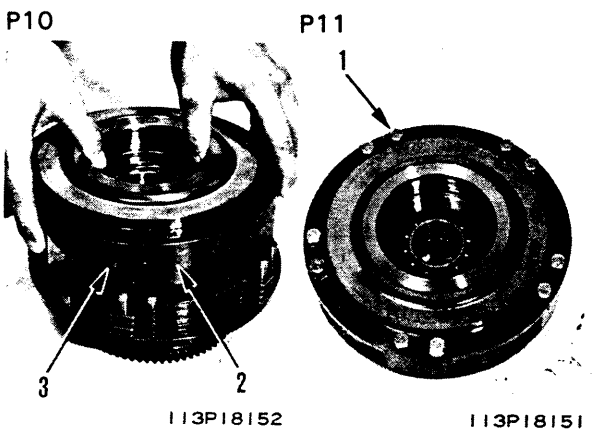
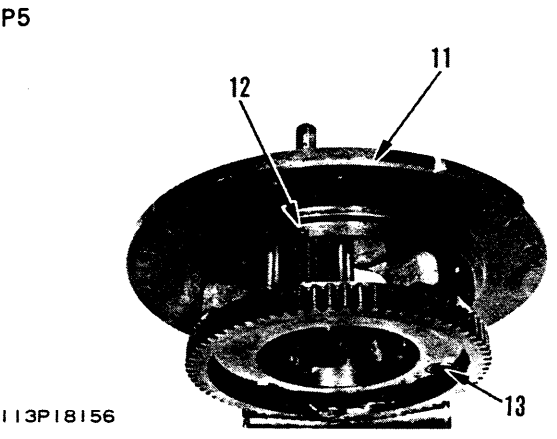
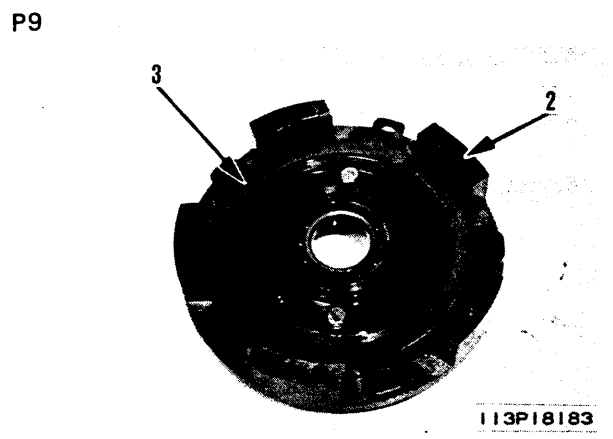
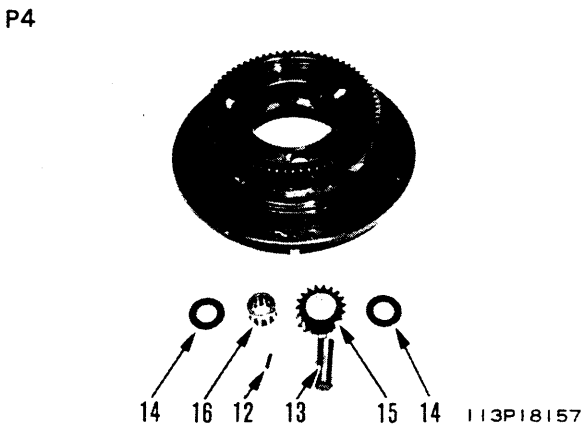
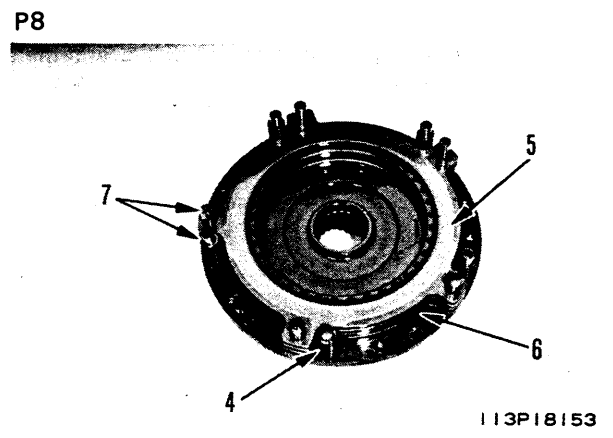
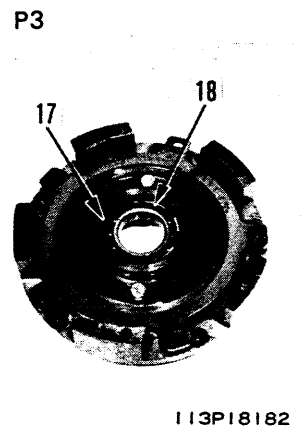
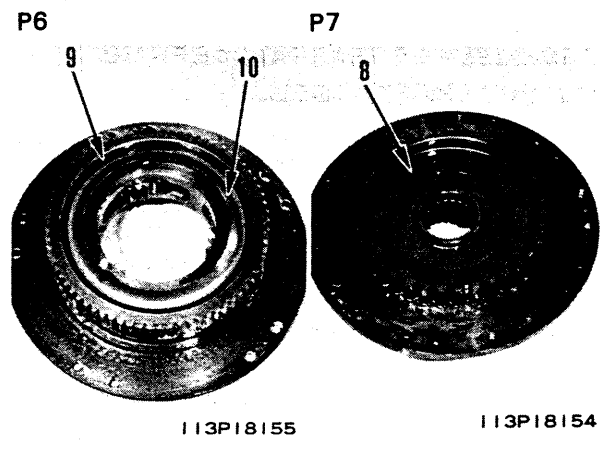
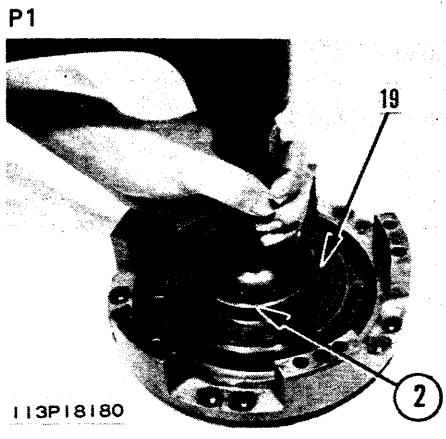
Discs: 3

6. Fit seal ring, install piston assembly (3) in housing (2). (See P9)

7. Turn over housing assembly, and set in carrier assembly, then tighten mounting bolts (1).

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## ASSEMBLY OF BEARING CAGE AND OUTPUT SHAFT ASSEMBLY

1. Press fit oil seal (13) to collar (12). (See F1)

 Lip of oil seal: Grease (G2-LI)

2. Install collar (12) to shaft (10), then press fit bearing (11). (See P1)

★ Inside diameter of bearing: 45 mm

3. Support cage, push outside of collar, and install output shaft assembly (10) to cage. (See P2)

4. Install snap ring (8). (See P3)

5. Install gear (7). (See P4)

6. Install snap ring (6). (See P4)

7. Press fit bearing (5) to shaft (10). (See P5)

★ Inside diameter of bearing: 40 mm

8. Install snap ring (4). (See P6)

9. Install spacer (3). (See P7)

10. Install seal ring (1) to cage (2). (See P7)

## ASSEMBLY OF No. 2, 3 CARRIER ASSEMBLY

1. Using push tool (outside diameter = 85 mm), press fit bearing (9) in carrier (7). (See F2)

2. Install snap ring (8). (See F2)

3. Assemble needle bearings (10) and (11) in pinion gears (5) and (4). (See F3)

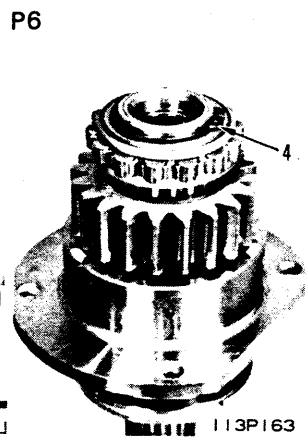
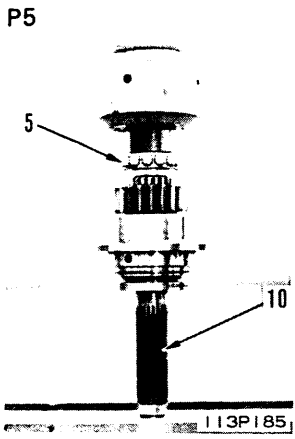
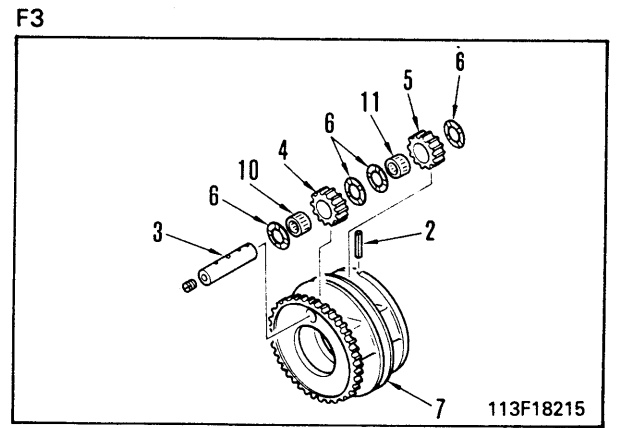
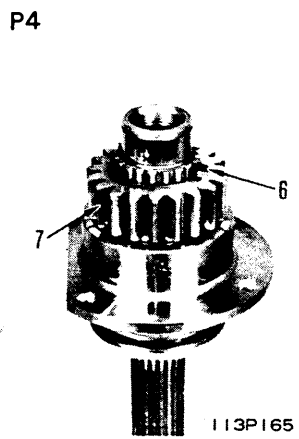
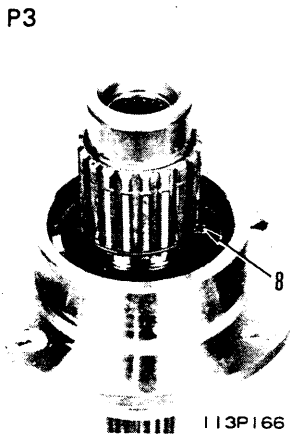
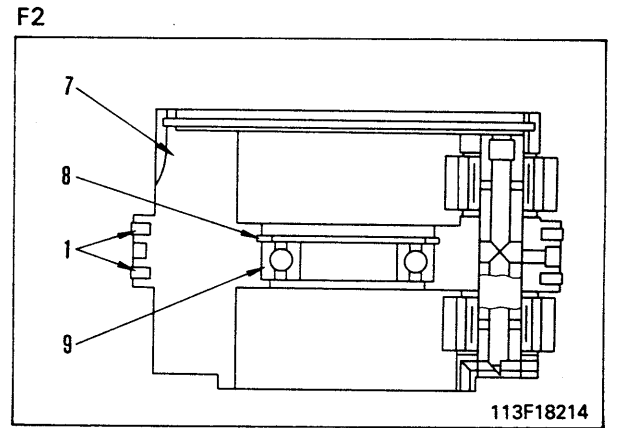
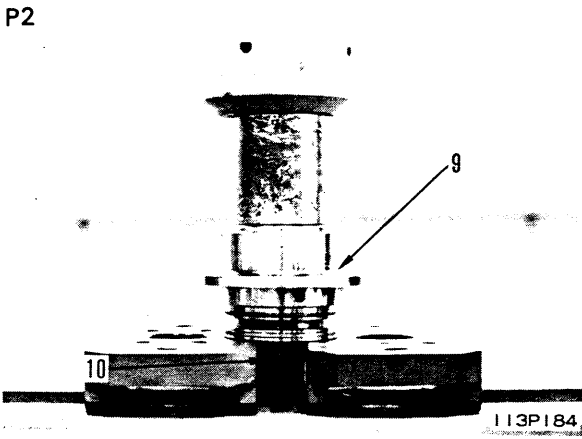
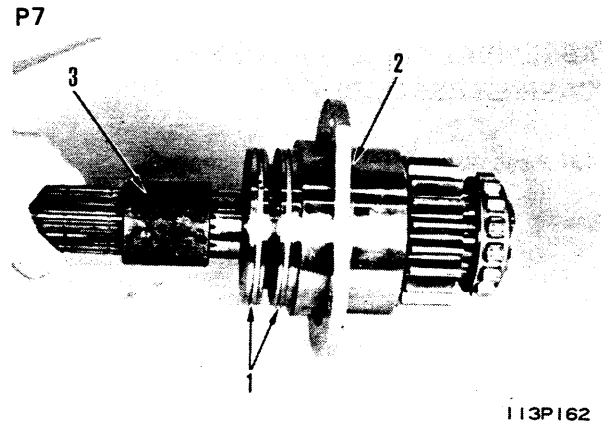
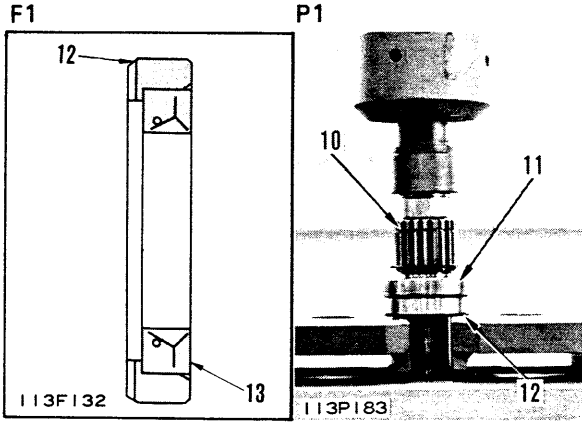
4. Assemble thrust washers (6) and pinion gears as one unit in carrier (7). (See F3)

5. Align shaft (3) with roll pin hole of carrier, and knock in shaft with a plastic hammer. (See F3)  
★ Rotate the pinion gear when knocking in the shaft.

6. Knock in roll pin (2). (See F3)

7. Assemble seal ring (1). (See F2)

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## ASSEMBLY OF No. 1 HOUSING AND CARRIER ASSEMBLY

### 1. Assembly of No. 1 carrier assembly

- 1) Assemble needle bearing (15) in pinion gear (14). (See P1)
- 2) Assemble thrust washers (13) and pinion gear (14) as one unit in carrier. (See P1)

3) Align shaft (12) with roll pin hole of carrier, and knock in shaft with a plastic hammer. (See P2)

- ★ Rotate the pinion gear when knocking in the shaft.

4) Knock in roll pin (11). (See P2)

2. Using push tool ① (outside diameter: 90 mm), press fit bearing (9) in housing (10). (See P3, P4)

3. Put No. 1 housing (10) on No. 1 carrier assembly (8), and assemble with bearing (11). (See F1, P5)

- ★ Assemble seal ring on housing.
- ★ Bearing (11) inside diameter: 65 mm  
outside diameter: 90 mm

4. Install snap ring (7). (See P6)

5. Assemble seal ring, and install piston (6). (See P7)

6. Install ring gear (5). (See P7)

7. Install plates (4) and discs (3) in turn. (See P8)

- ★ Plates: 4
- Discs: 3

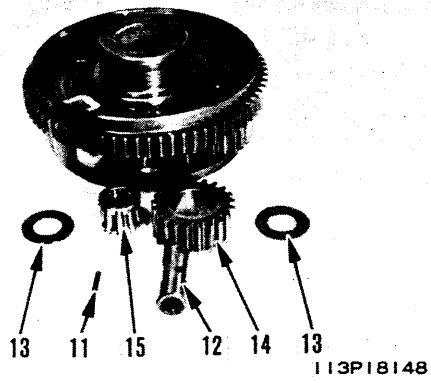
8. Install springs (2). (See F2)

9. Align plate (1) with dowel pin, and knock in plate. (See F2)

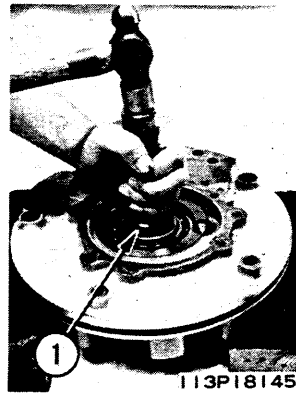
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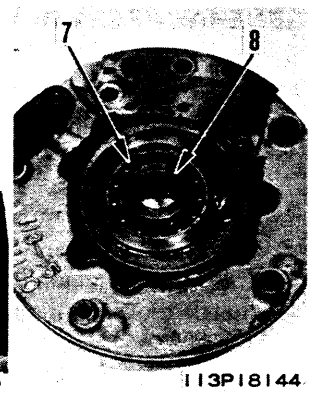
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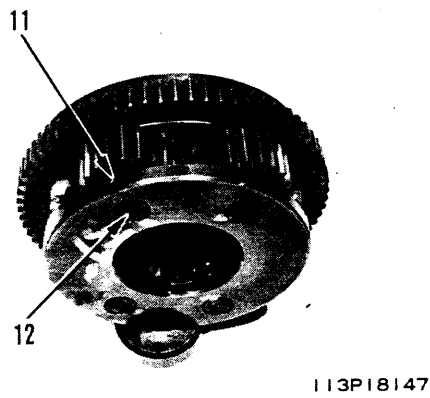
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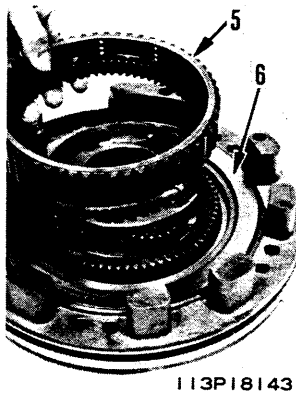
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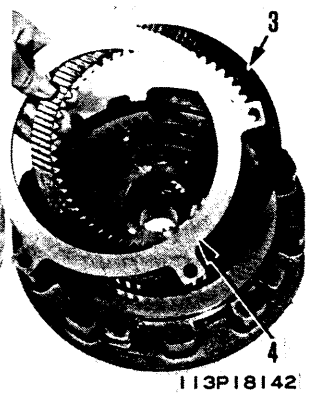
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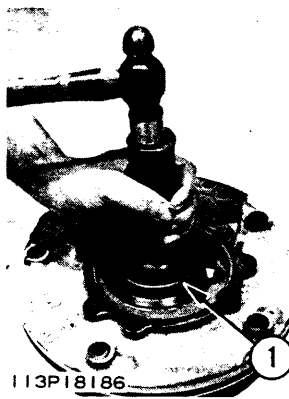
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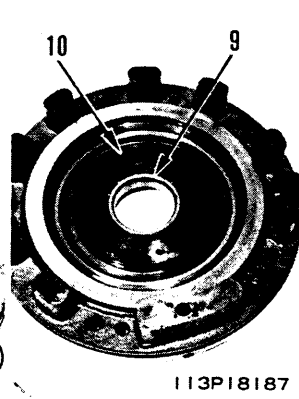
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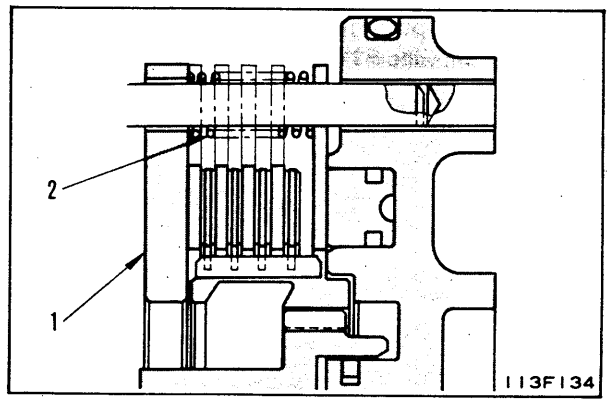
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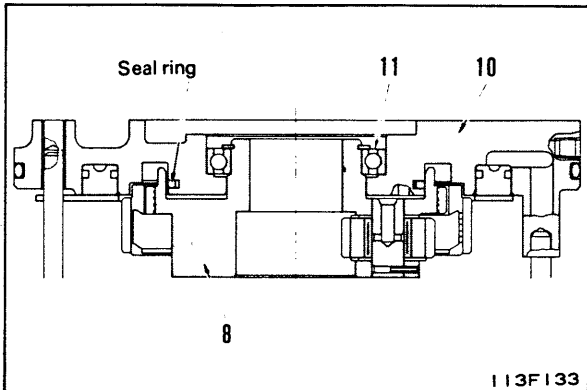
P4



F2



F1



## GENERAL ASSEMBLY

- ★ Clean all parts, and check for dirt or damage. Coat the sliding surfaces of the bearings, shafts, plates, discs and other parts with engine oil before installing.
- ★ The piston ring must be installed facing in the correct direction. Install with the side receiving the pressure facing the housing. (See F1)
- ★ Install the snap ring as shown in the diagram. (See F2)
- ★ Coat the seal ring with grease (G2-LI) before assembling.

5. Assemble No. 4 sun gear (44), and install snap rings (43) and (42). (See P3)

6. Assemble No. 3 sun gear (41), and install snap ring (40). (See P4)

7. Assemble No. 4 ring gear (38). (See P4)

1. Set No. 5 housing (45) on block (height: approx. 200 mm). (See P1)

2. Install output shaft assembly (47). (See P1)

3. Turn over No. 5 housing. (See P2)

4. Install No. 5 clutch assembly (48). (See P2)

8. Install plates (37) and discs (36) in turn, then springs (35).

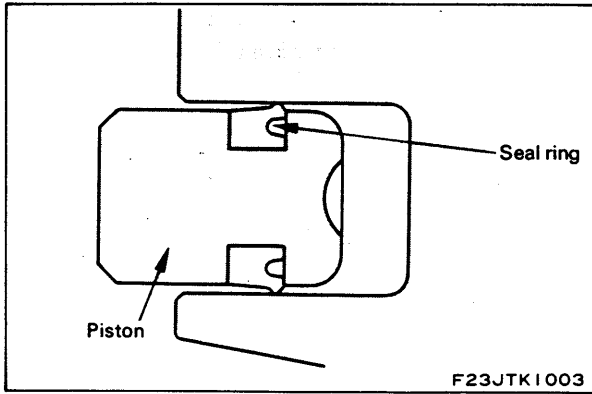
★ Plates: 2

★ Discs: 2

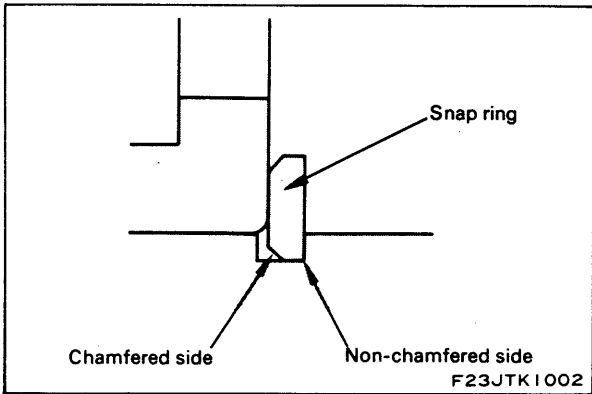
9. Assemble piston, and install No. 4 housing (33) together with plate (34). (See P6)

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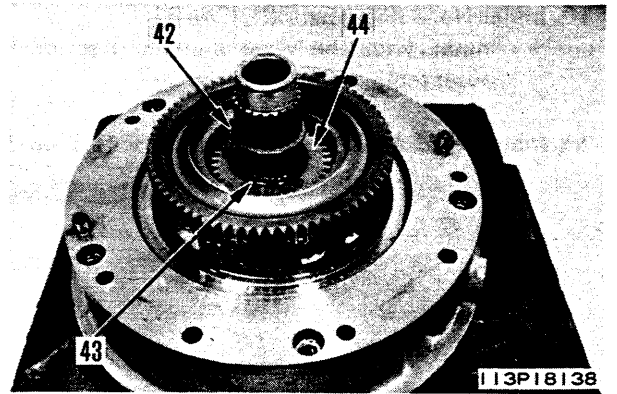
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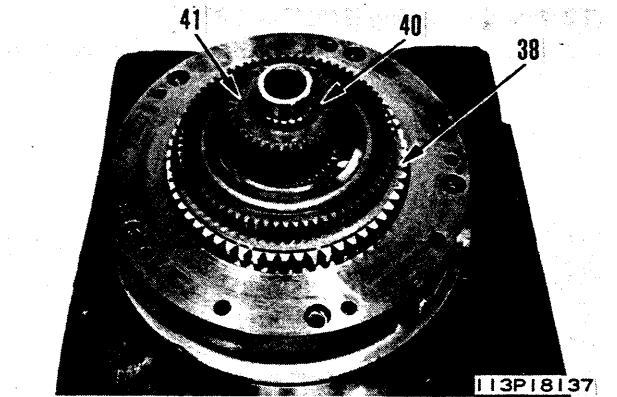
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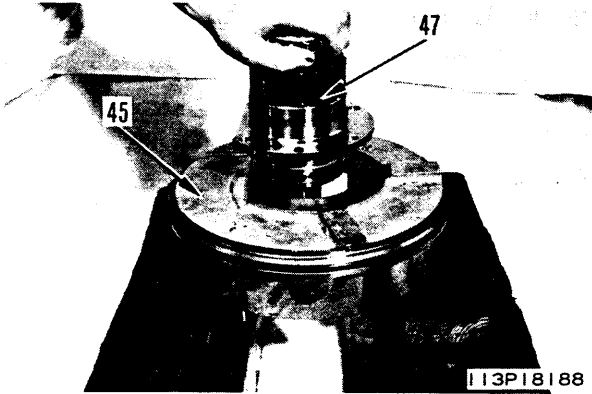
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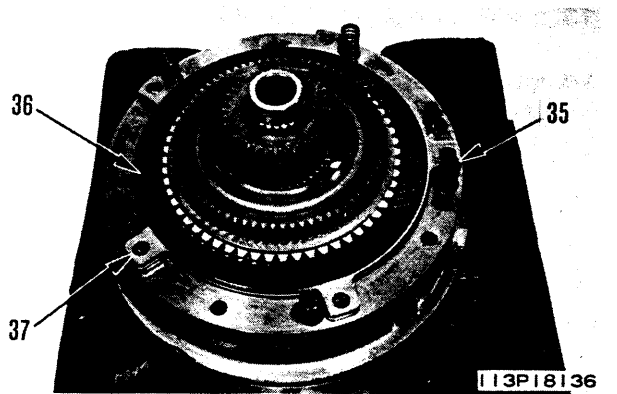
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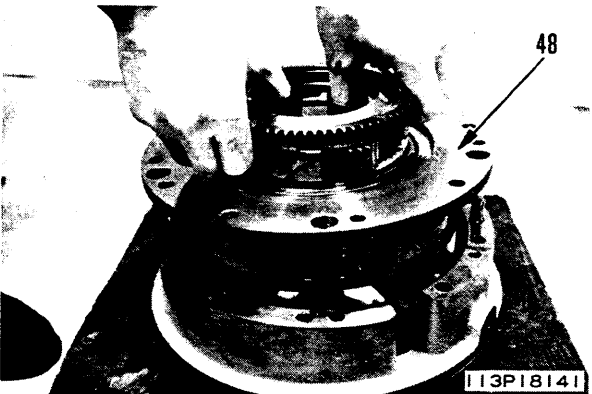
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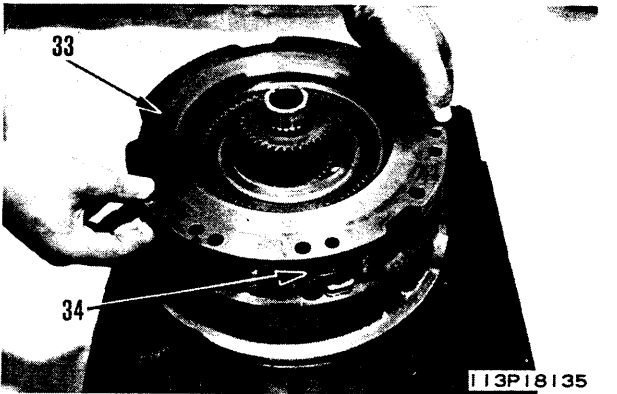
P5



P2



P6



10. Install No. 3 ring gear (32). (See P1)

- ★ Install with the wide stepped part of the outer teeth at the bottom.

11. Install No. 2 and 3 carrier assembly (31). (See P1)

12. Install snap ring (30). (See P2)

- ★ Secure the inner race of the bearing to the shaft.

13. Install guide pin (26). (See P3)

14. Install plates (29) and discs (28) in turn, then install springs (27). (See P3)

- ★ Plates: 3
- Discs: 3

15. Assemble piston ring on piston, and install to No. 2, 3 housing assembly (24) together with plate (25). (See P4)

16. Assemble spring (47) and transmission lubrication valve (48) in housing (24). (See F1)

17. Mesh with pinion gear, and install No. 2 ring gear (23). (See P5)

- ★ The wider stepped part of the external teeth is at the bottom.

18. Install ring gear (22). (See P5)

19. Install snap ring (21). (See P5)

- ★ The snap ring fits into the gear of the No. 2, 3 carrier. Lift up the ring gear by hand and check that the ring gear does not come up. (If the ring gear comes up, the snap ring is not properly fitted.)

20. Install plates (18) and (19), discs (20) in turn, then install springs (17). (See P6)


- ★ Plates: 4
- Discs: 4

21. Install No. 1 sun gear and input shaft assembly (16). (See P6)

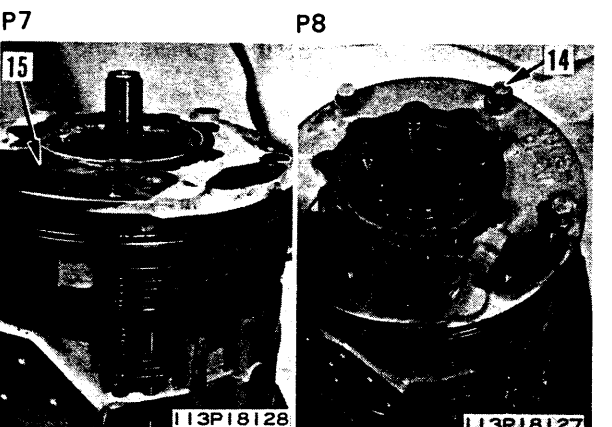
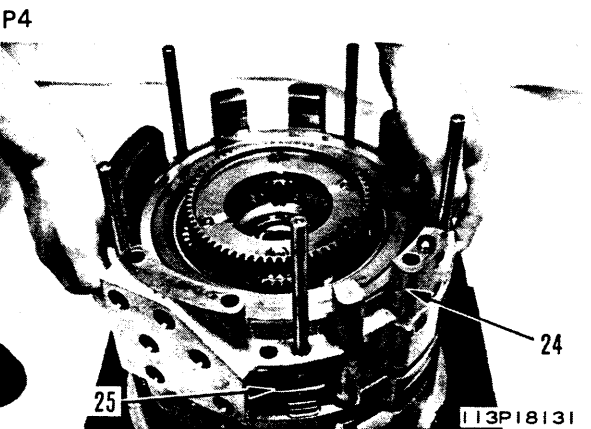
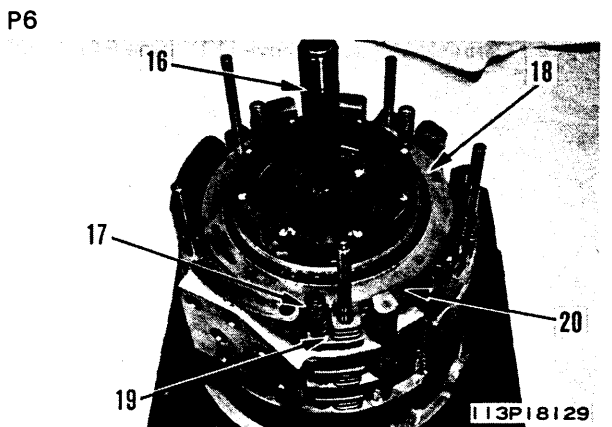
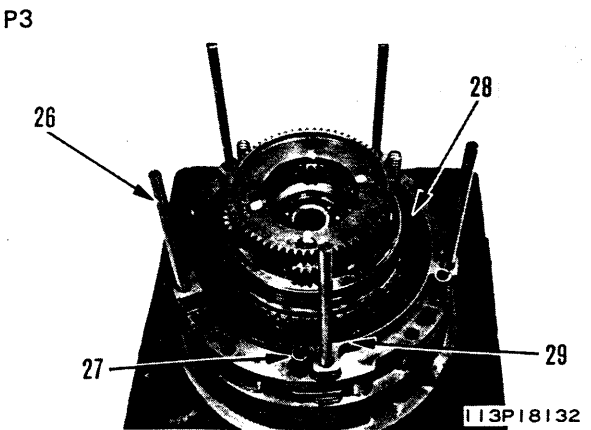
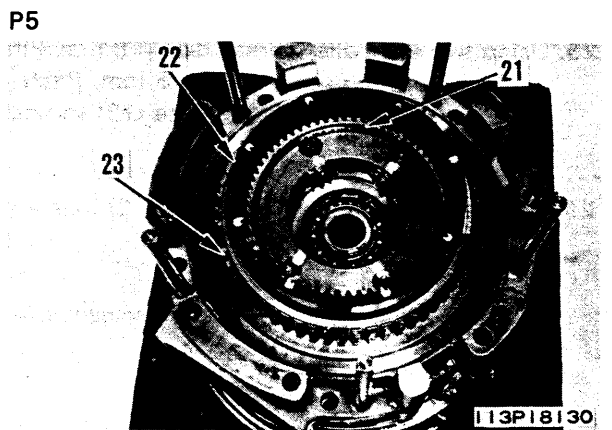
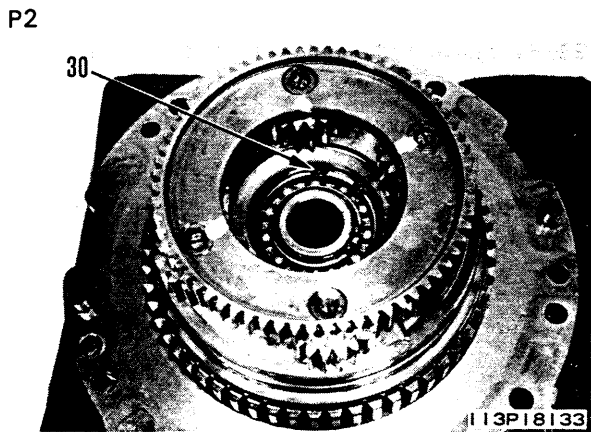
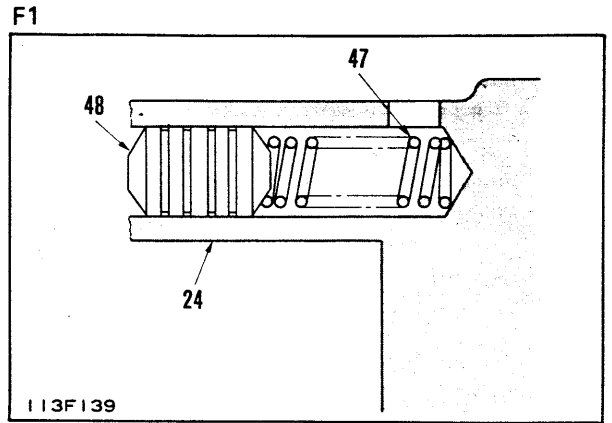
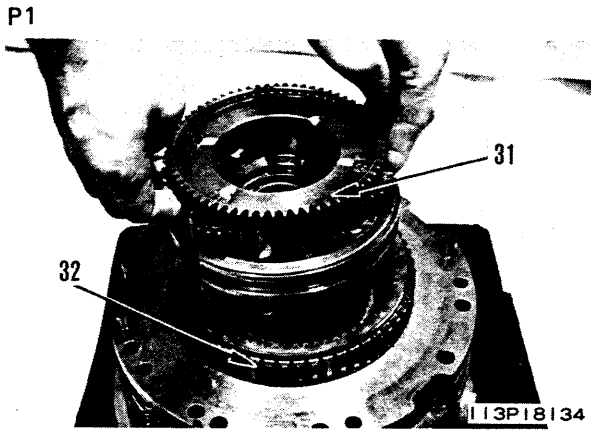
22. Align planet gear with No. 1 sun gear and install No. 1 housing and carrier assembly (15). (See P7)

23. Tighten five tie bolts (14). (See P8)

- ★ Assemble O-ring under spacer.
- ★ One of the bolts at the mounting surface of the modulating relief valve is 5 mm shorter than the other four.

 Tie bolt:  $6.5 \pm 0.5$  kgm

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24. Using tool A, check that pistons of each clutch function correctly.

★ Air pressure when checking: 3 – 5 kg/cm<sup>2</sup>

25. Using two eye bolts (Thread dia. = 8 mm, Pitch = 1.25 mm; Thread dia. = 12 mm, Pitch = 1.75 mm) raise transmission case (13) vertically and install. (See P2)

26. Fit washers and install lock bolts (12) (one each on both sides). (See P3)



Both faces of washer:

Gasket sealant (LG-1)

27. Fit O-ring and install sleeve (11). (See P4)

28. Installation of modulating valve and pump assembly.

- 1) Fit O-ring to sleeve and put modulating valve and pump assembly together. (See P5)
- 2) Fit gasket and install modulating valve and pump assembly (10). (See P5)

 Mounting bolt: 3.2 ± 0.3 kgm

3) Fit O-ring and install suction tube (9). (See P6)

4) Assemble coupling (8), fit O-ring, and install holder (7). (See P6)

 Mounting bolt: 6.5 ± 0.7 kgm

★ Bend lock washer securely.

5) Fit O-ring, and install cover (6) together with sleeve. (See P6)

29. Fit gasket and install transfer assembly (5). (See P7)



Gasket: Gasket sealant (LG-1)

30. Fit gasket and install selector and inching valve assembly (4). (See P8)



Mounting bolt: Gasket sealant (LG-1)

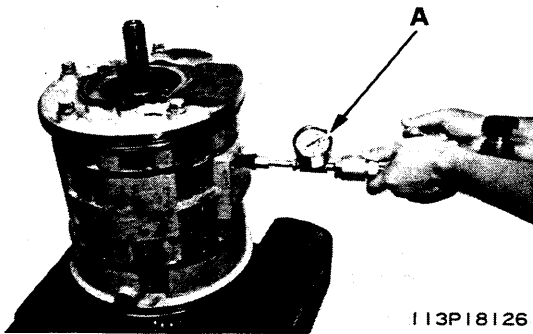


Mounting bolt: 3.2 ± 0.3 kgm

31. Align lever with yoke and install brackets (3), (2) and (1). (See P8)

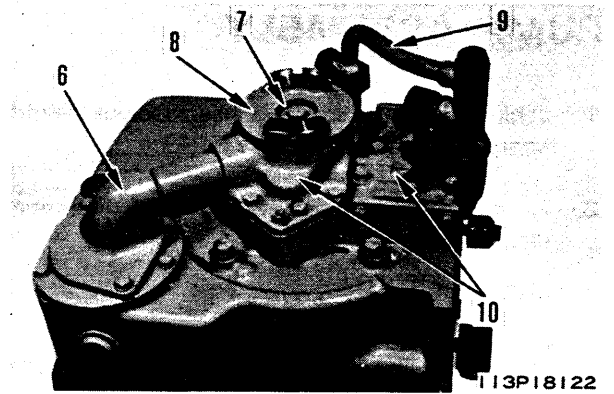
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P1



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P6



113P18122

P2



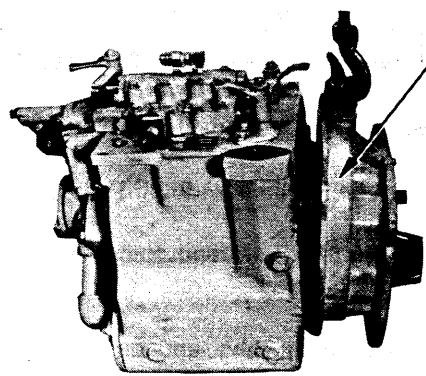
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P3



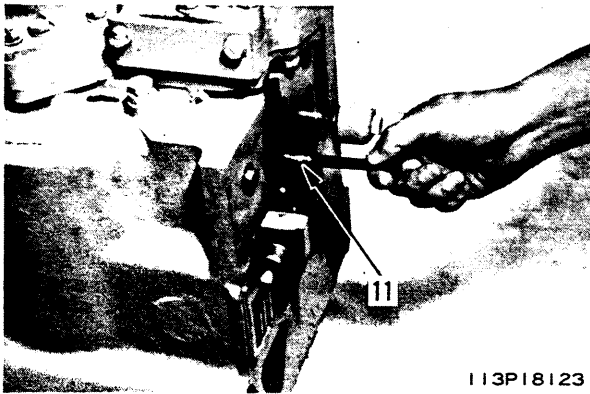
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P7



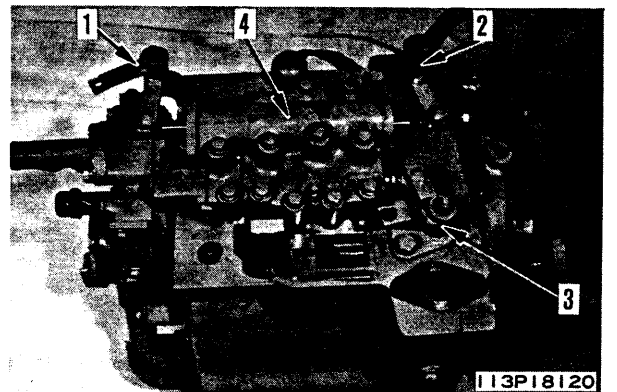
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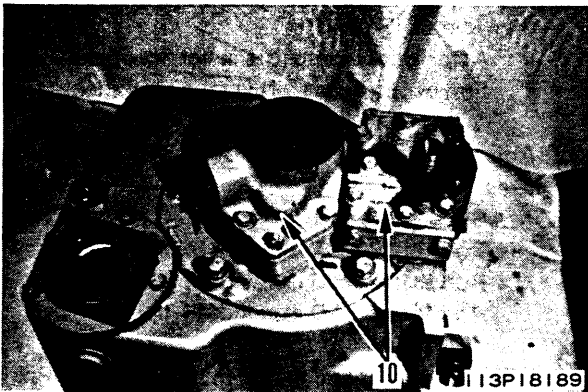
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P8



113P18120

P5



113P18189

## REMOVAL OF MODULATING VALVE AND PUMP ASSEMBLY

1. Jack up the machine, and insert blocks (height: approx. 300 mm) under the tracks.
2. Using transmission jack ①, remove underguard (1). (See P1)



Underguard: 35 kg

3. Remove drain plug and drain oil from transmission case.



Transmission case: Approx. 13 ℓ

4. Remove universal joint assembly (2). (See P2)
5. Disconnect hose (3) and tube (4). (See P3)
6. Disconnect tube (5) and rod (6). (See P3)
7. Remove suction tube (7) and coupling (8). (See P4)
8. Remove modulating valve and pump assembly (9). (See P5)

## INSTALLATION OF MODULATING VALVE AND PUMP ASSEMBLY

1. Fit gasket and install modulating valve and pump assembly (9). (See P5)



Gasket: Gasket sealant (LG-1)



Mounting bolt:  $3 \pm 0.5$  kgm

2. Install coupling (8), then fit O-ring and install holder. (See P4)



Mounting bolt:  $7 \pm 0.5$  kgm

3. Fit O-ring and install suction tube (7). (See P4)
4. Connect rod (6) and tube (5). (See P3)
5. Fit O-ring and connect tube (4), then connect hose (3). (See P3)
6. Install universal joint assembly (2). (See P2)



Mounting bolt:  $3 \pm 0.5$  kgm



Universal joint assembly: Grease (G2-LI)

7. Put underguard (1) on transmission jack ①, push under machine, and install. (See P1)



Mounting bolt: Thread tightener (LT-2)

8. Tighten drain plug and add engine oil through oil filler to the specified level.



Transmission case: Approx. 13 ℓ

- ★ After lowering the machine to the ground, run the engine to circulate the oil through the system. Then check the oil level again.

9. Remove blocks from under tracks, then lower machine to ground.

## REMOVAL OF SELECTOR AND INCHING VALVE ASSEMBLY

1. Remove floor plate and remove cover (1). (See P6)
2. Disconnect rods (2), (3) and (4). (See P7)
3. Remove levers (5), (6) and (7). (See P8)
4. Remove selector and inching valve assembly (8). (See P9)

## INSTALLATION OF SELECTOR AND INCHING VALVE ASSEMBLY

1. Fit gasket and install selector and inching valve assembly (8). (See P9)



Bolt: Gasket sealant (LG-5)



Mounting bolt:  $3.2 \pm 0.3$  kgm

2. Connect levers (7), (6) and (5) to each spool, then install. (See P8)

- ★ After connecting the lever, check the position of the gear shift lever and guide.

3. Adjust length of rods (4), (3) and (2) and connect. (See P7)

- ★ Standard length

Rod (2): 287.1 mm (For inching)

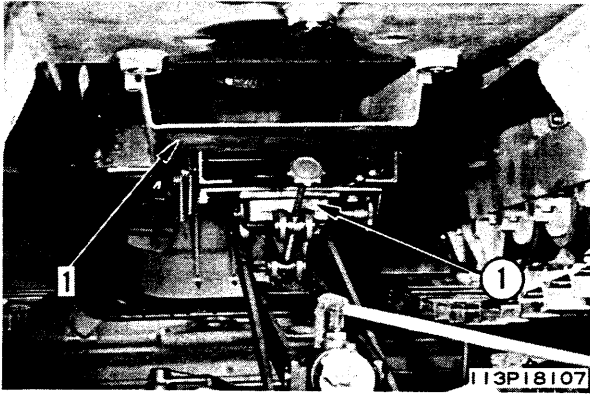
Rod (3): 266.0 mm (For selector)

Rod (4): 538.0 mm (For F-R)

4. Install cover (1) and install floor plate. (See P6)

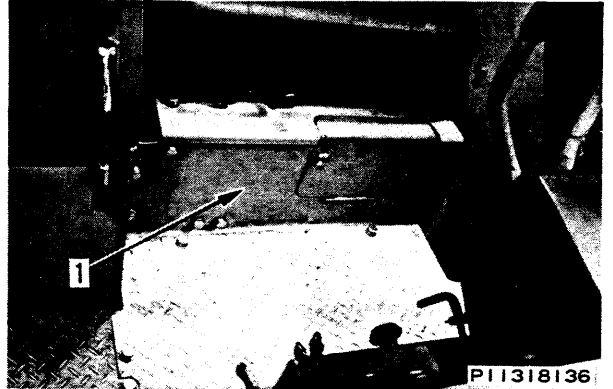
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P1



113P18107

P6



P11318136

P2

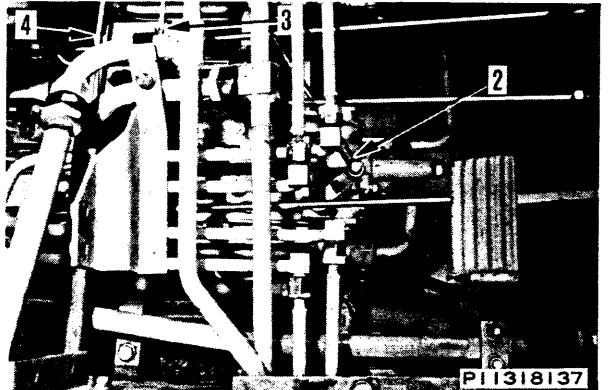


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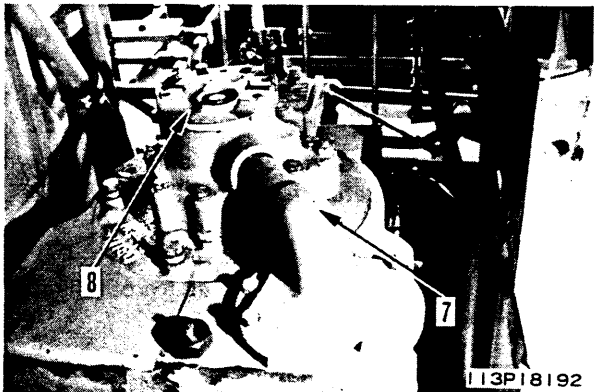
P3

P7



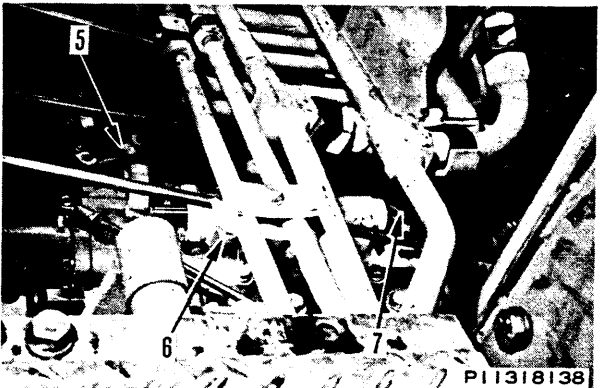
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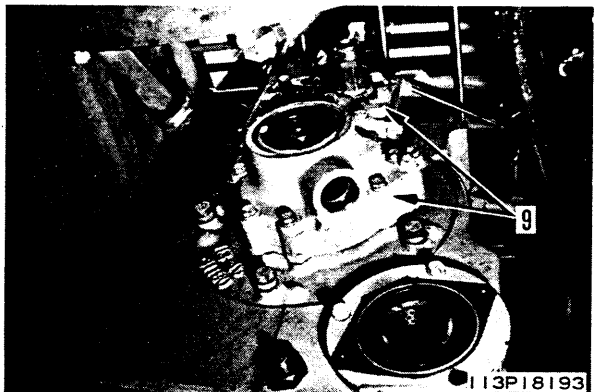
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P8



P11318138

P5



113P18193

P9



P11318139

## DISASSEMBLY OF MODULATING VALVE ASSEMBLY

1. Remove 2 mounting bolts (1) and 2 mounting bolts (2), then remove seat (3). (See P1, F1)

### DISASSEMBLY OF QUICK RETURN VALVE SPOOL

2. Remove plates (4) and (5) from body (6). (See P1, F1)
3. Remove stopper (7). (See F1)
4. Pull out quick return spool (8). (See F1)
5. Remove stopper (9). (See F1)

### DISASSEMBLY OF MODULATING VALVE

6. Remove plates (4) and (5) from body (6). (See P1, F1)
7. Remove stopper (10). (See F1)
8. Remove valve (11) and spring (12), and pull out modulating spool (13) together with valve (14). (See F1)
9. Remove stopper (15). (See F1)
10. Pull out valve (16) and shim (17) as one unit, and remove springs (18) and (19). (See F1)

## ASSEMBLY OF MODULATING VALVE ASSEMBLY


### ASSEMBLY OF MODULATING VALVE


1. Assemble shim (17), and springs (18) and (19) in valve (16), then assemble in body (6). (See F1)
  - ★ Standard shim thickness: 1.0 mm
  - ★ Types of shim:  $t = 0.5$  mm,  $t = 0.2$  mm
  - ★ Coat the sliding surface of the spool with engine oil before assembling.
2. Fit O-ring and install stopper (15). (See F1, F2)
  - ★ Install the stopper with the protruding part on the inside as shown in Fig. F2.
3. Assemble valve (14) in modulating spool (13), then assemble in body, and install spring (12) and valve (11). (See F1)
  - ★ Coat the sliding surface of the spool with engine oil before assembling.
  - ★ Be careful to assemble valves (14) and (11) in the direction shown in Fig. F2.

4. Fit O-ring and install stopper (10). (See F1)
5. Install plates (4) and (5). (See P1, F1)

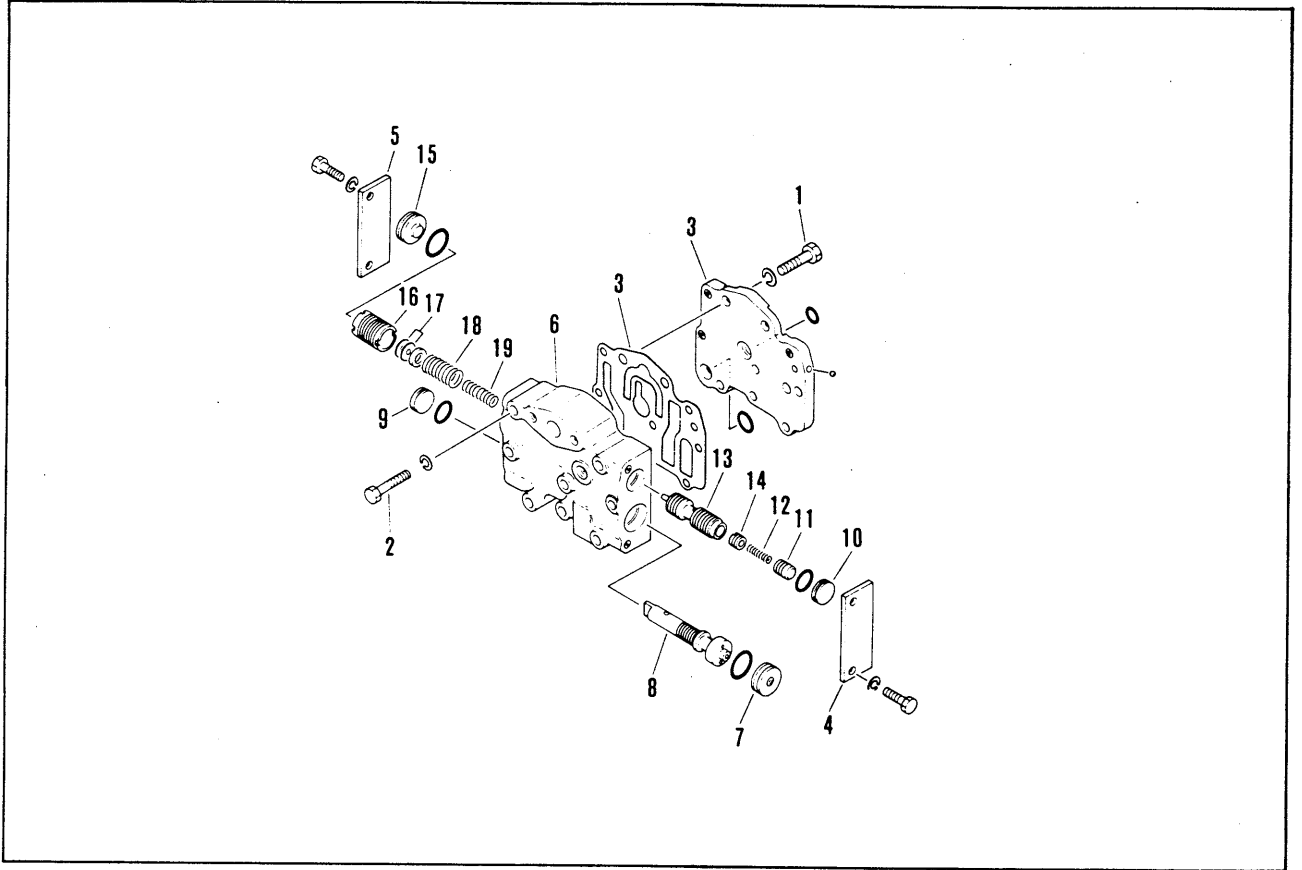
### ASSEMBLY OF QUICK RETURN VALVE

6. Fit O-ring and install stopper (9). (See F1)
7. Assemble quick return spool (8) in body (6). (See F1)
  - ★ Coat the sliding surface of the spool with engine oil before assembling.
8. Fit O-ring and install stopper (7). (See P1, F2)
  - ★ Install the stopper with the protruding part on the inside as shown in Fig. F2.
9. Install plates (4) and (5). (See P1, F1)
10. Fit gasket and install seat (3), then tighten bolts (2) and (1). (See P1, F1)

 Mounting bolt (2) (8 mm):  
3.2 ± 0.3 kgm

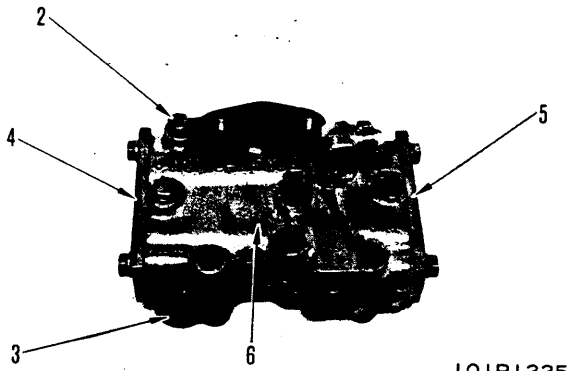
 Mounting bolts (1) (10 mm):  
6.8 ± 0.7 kgm

F1



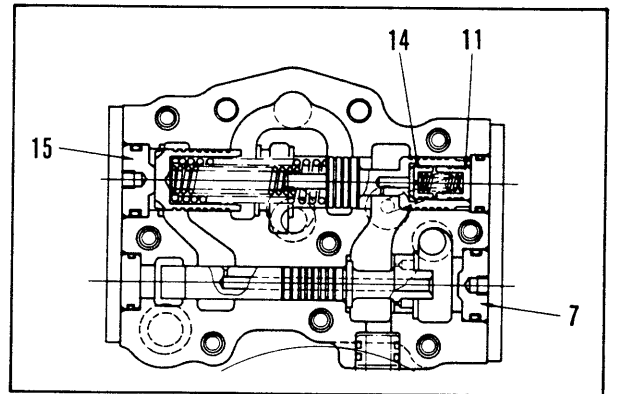
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P1

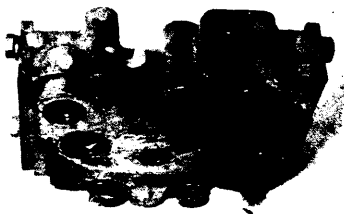


10IP1225

F2



P2



10IP1226

# DISASSEMBLY OF SELECTOR AND INCHING VALVE ASSEMBLY

## DISASSEMBLY OF INCHING VALVE

1. Remove cover (1) and shims (2). (See P1, F1)
2. Pull out inching valve spool (3) from body (4), then remove stoppers (5) and (7), springs (6) and (8). (See P1, F1)
3. Remove plug (10) and pull out valve (11). (See P1, F1)
4. Remove valve (12), spring (13) and valve (14) from valve (11) in order. (See P1, F1)
5. Pull out oil seal (15) from cover. (P1, F1)

## DISASSEMBLY OF F-R VALVE

6. Pull out F-R spool from body (4). (See P2, F1)
7. Loosen nut (17) and remove yoke (18) from F-R spool. (See P2, F1)
8. Remove plug (19) and oil seal (20) from body. (See P2, F1)


## DISASSEMBLY OF SPEED VALVE



9. Remove retainer (21) and remove spring (22) and ball (23). (See P3, F1)
10. Pull out speed spool (24) from body. (See P3, F1)
11. Loosen nut (25), then remove yoke (26) from speed spool. (See P3, F1)
12. Remove plug (27) and oil seal (28). (See P3, F1)

# ASSEMBLY OF SELECTOR AND INCHING VALVE ASSEMBLY



- ★ Clean all parts, and check for dirt and damage. Coat the sliding surfaces of all parts with engine oil before installing.

## ASSEMBLY OF SPEED VALVE



1. Fit O-ring and install plug (27) to body (4). (See P3, F1)  
 Plug:  $4 \pm 0.5$  kgm

2. Press fit oil seal (28) to body. (See P3, F1)
3. Install yoke (26) to speed spool (24). (See P3, F1)
  - ★ Installed dimension a of yoke: 27 mm (See F2)
4. Tighten locknut (25) securely. (See P3, F1)  
 Locknut:  $0.8 \pm 0.2$  kgm
5. Assemble speed spool (24) in body. (See P3, F1)
6. Assemble ball (23) and spring (22) in body. (See P3, F1)
7. Fit O-ring and install retainer (21). (See P3, F1)  
 Retainer:  $1.5 \pm 0.5$  kgm
8. Check operating force of speed spool. (See P3, F1)
  - ★ Operating force: 9.5 kg

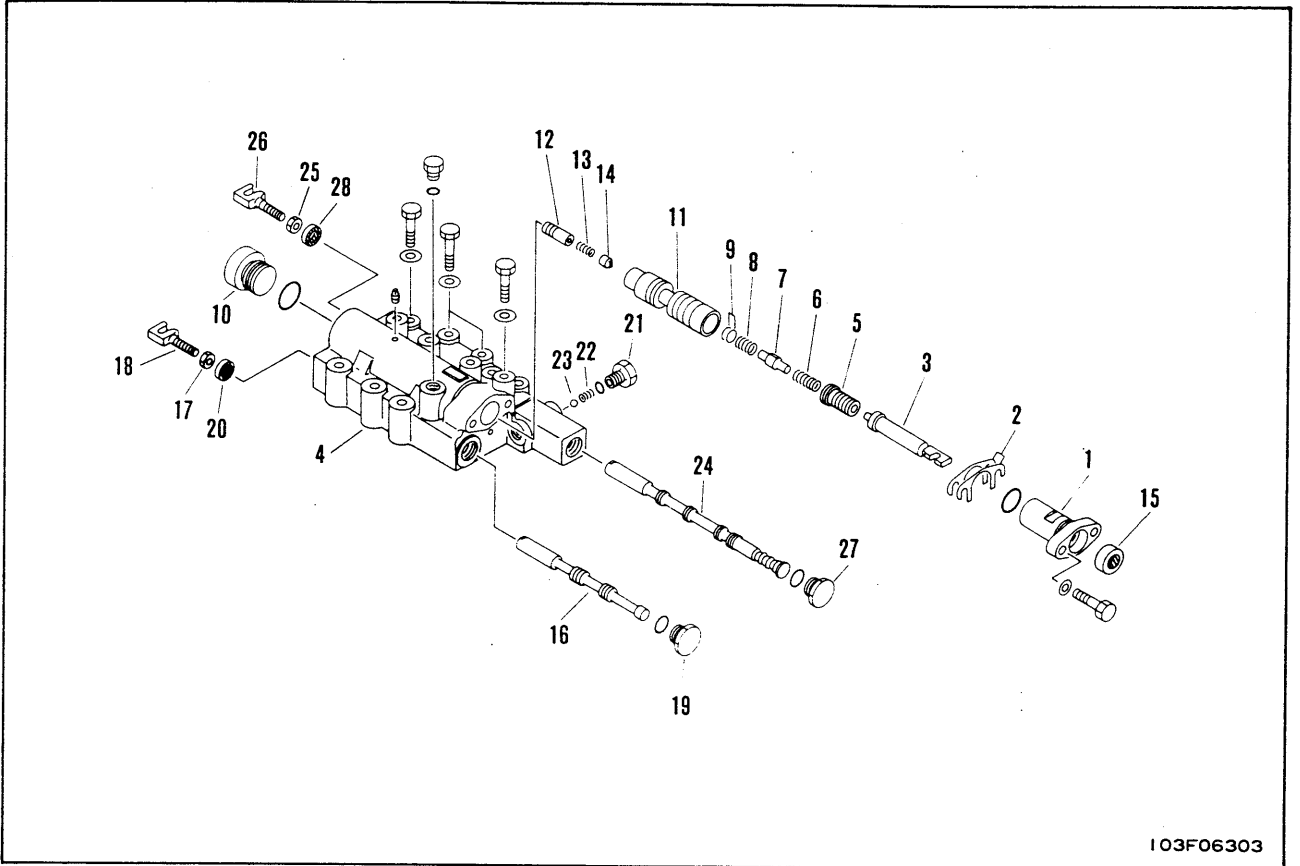
## ASSEMBLY OF F-R VALVE

9. Fit O-ring and install plug (19) to body. (See P2, F1)  
 Plug:  $4 \pm 0.5$  kgm
10. Press fit oil seal (20) to body. (See P2, F1)
11. Install yoke (18) to F-R spool. (See P2, F1)
  - ★ Installed dimension b of yoke: 28 mm (See F2)
12. Tighten locknut (17) securely. (See P2, F1)  
 Locknut:  $0.8 \pm 0.2$  kgm
13. Assemble F-R spool (16) in body. (See P2, F1)

## ASSEMBLY OF INCHING VALVE

14. Assemble valve (14), spring (13) and valve (12) in order, and assemble to body, then fit O-ring and install plug. (See P1, F1)  
 Plug:  $11 \pm 1.5$  kgm
15. Assemble shims (9), springs (8) and (6), stoppers (7) and (5) to valve and body (4), then install inching spool to body. (See P1, F1)
  - ★ Standard thickness of shim (9): 2.0 mm
16. Press fit oil seal (15) to cover (1). (See P1, F1)  
 Oil seal: Grease (G2-LI)
17. Fit O-ring and shim (2), and install cover (1) to body. (See P1, F1)
  - ★ Standard thickness of shim (2): 2.0 mm

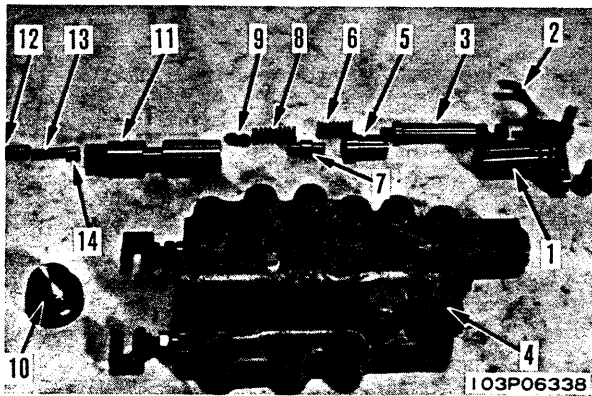
F1



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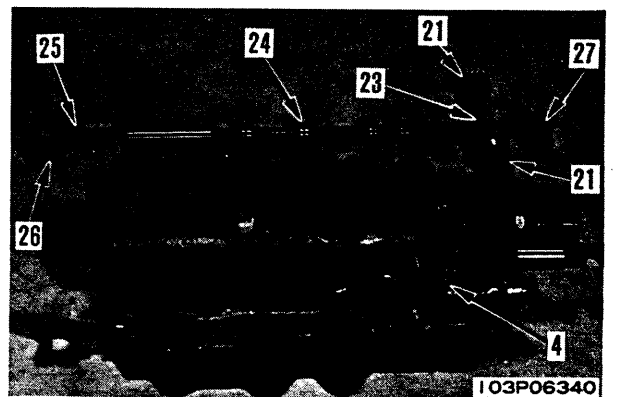
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P1



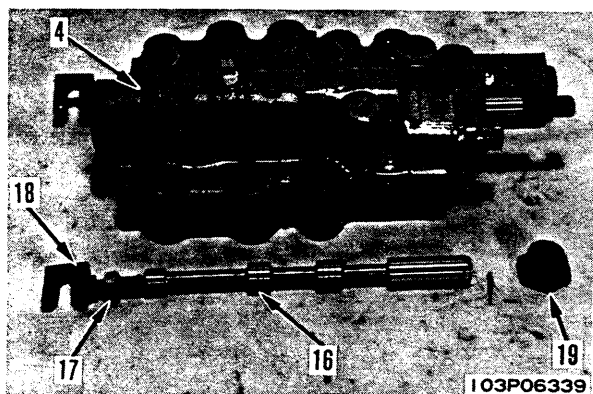
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P3



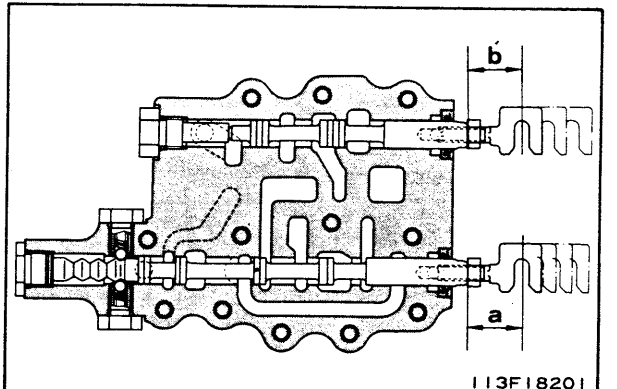
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P2



103P06339

F2



113F18201



## REMOVAL OF STEERING VALVE ASSEMBLY

1. Remove floor plate, then remove machine rear cover.
2. Remove operator's seat (1) and cover (2). (See P1)
3. Disconnect 2 rods (3). (See P2)
4. Disconnect battery cable (4) and wiring (5). (See P3)
5. Remove seat frame assembly (6) together with battery. (See P3)
6. Disconnect tubes (7), then remove steering valve assembly (8). (See P4)

## INSTALLATION OF STEERING VALVE ASSEMBLY

1. Set steering valve assembly (8) on bracket, and tighten mounting bolts. (See P4)
  - ★ When installing the steering valve, coat the O-ring of the sleeve assembled inside tube with grease (G2-LI) to prevent the O-ring from being damaged when installing.
2. Connect tube between cylinder and steering valve. (See P4)
3. Connect tube (7) between transmission and steering valve. (See P4)
4. Install seat frame assembly (6) together with battery. (See P3)
5. Connect wiring (5) and battery cable (4). (See P3)
6. Connect 2 rods (3). (See P2)
7. Install cover (2) and operator's seat (1). (See P1)
8. Fit machine rear cover, and install floor plate.

## DISASSEMBLY OF STEERING VALVE ASSEMBLY

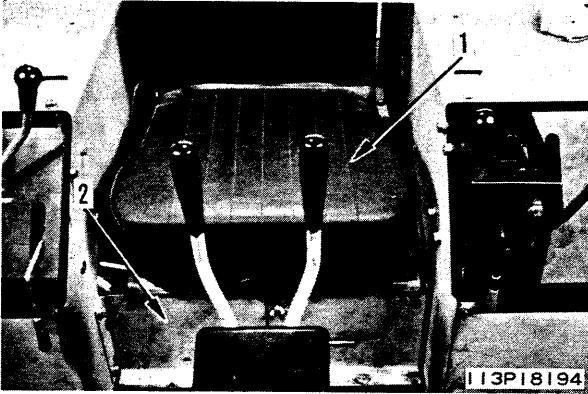
1. Remove cover (1), then remove spring (2), piston (3), and spool assembly (4). (See F1)
2. Remove cover (5), then remove collar (6) and stem (7). (See F1)
3. Remove spring pin (8), then remove shaft (9), guide (10), and spring (11). (See F1)

## ASSEMBLY OF STEERING VALVE ASSEMBLY

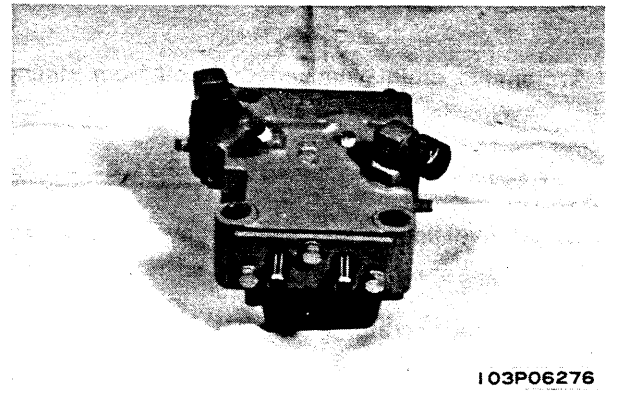
1. Assemble guide (10) and spring (11) to shaft (9), set in spool (4), then install with spring pin (8). (See F1)
2. Assemble spool assembly (4) in body (12), assemble piston (3) and spring, then install cover (1). (See F1)
3. Fit oil seal (13) to collar (6), assemble stem (7), set in body (12), then install cover (5). (See F1)

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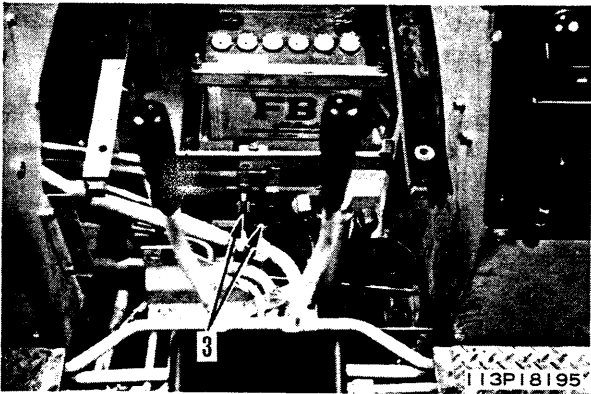
P1



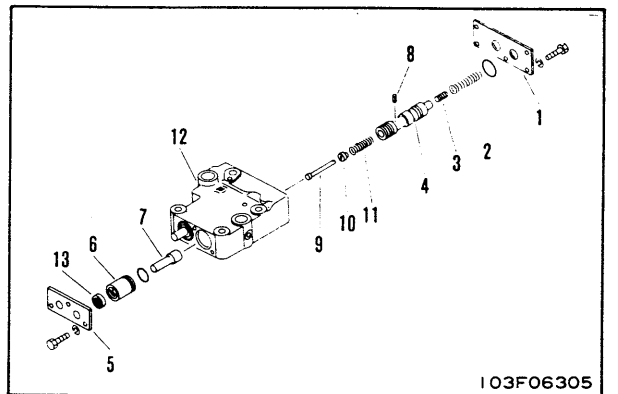
P5



P2

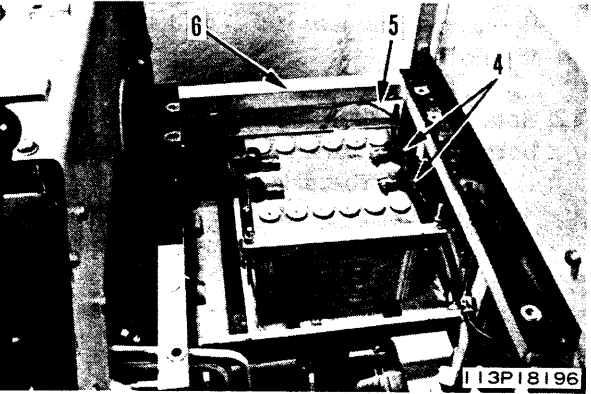


F1

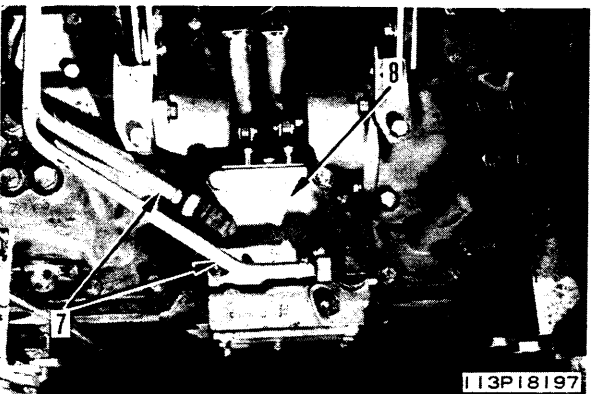


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P3



P4



# REMOVAL OF STEERING CLUTCH ASSEMBLY

1. Remove drain plug and drain oil from steering case.



Steering case: Approx. 30 l

2. Remove floor plate, then remove machine rear cover.
3. Remove operator's seat (1) and cover (2). (See P1)

4. Disconnect 2 rods (3). (See P2)

5. Disconnect battery cable (4) and wiring (5). (See P3)

6. Remove seat frame assembly (6) together with battery. (See P3)

7. Disconnect tubes (7), then remove steering valve assembly (8). (See P4)

8. Disconnect brake rods (9) and (10), and remove rod (11) and tubes (12). (See P5)

9. Remove cover (13), then remove brake adjustment screw. (See P6)

10. Using 2 eyebolts (Thread dia. = 10 mm, Pitch = 1.5 mm), then remove brake cover assembly (14). (See P7)

11. Remove adjustment rod (15) and springs (16). (See P8)

12. Rotate track with jack, and remove mounting bolts (18) of steering clutch assembly and bolts (17) of brake drum side. (See P9)

★ To remove outer mounting bolts (17), remove the plug from the frame and insert a wrench through the hole.

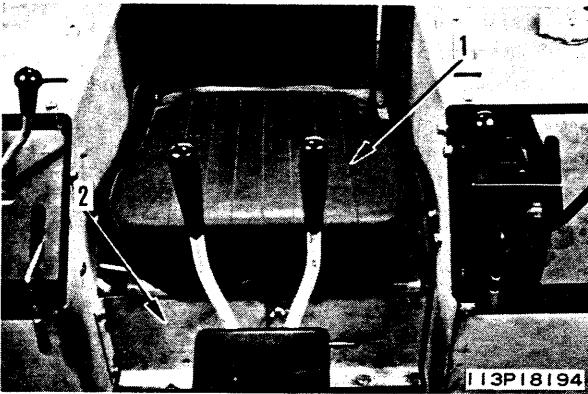
★ Outer mounting bolts (17) are 5 mm longer.

13. Sling brake band (20) and lift off steering clutch assembly (19). (See P10)

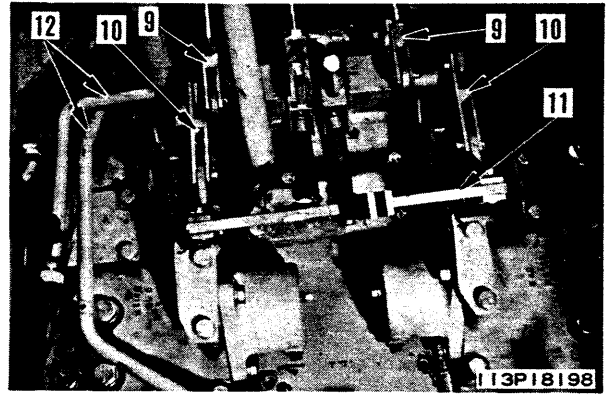
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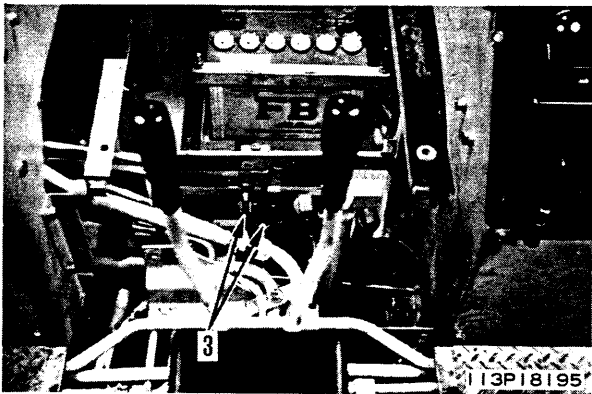
P1



P5



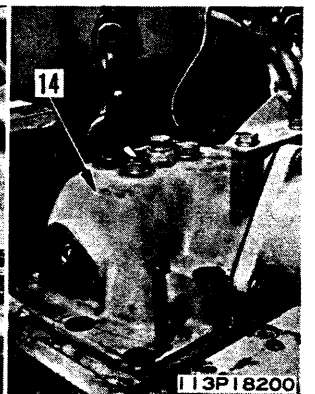
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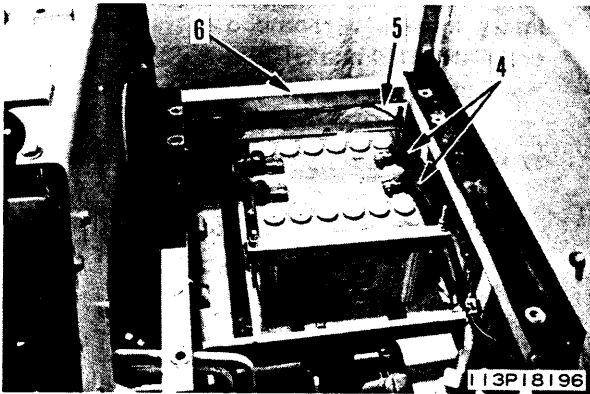
P6



P7



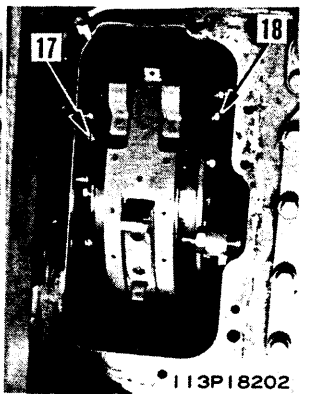
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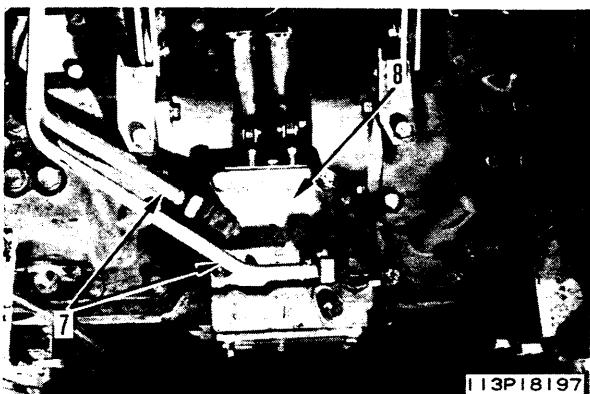
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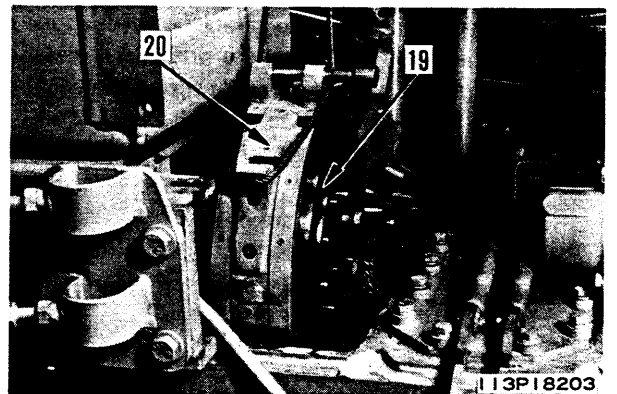
P9



P4



P10



# INSTALLATION OF STEERING CLUTCH ASSEMBLY


1. Assemble brake band and sling steering clutch assembly (19), then set inside clutch case. (See P1)

★ Be careful to install the brake band facing in the correct direction.

2. Align bolt holes and install bolts. (See P2)

★ Move brake assembly carefully to bring drum and flange into close contact, then tighten bolts fully.

3. Rotate track with jack, and tighten all mounting bolts (17) and (18). (See P2)

 Mounting bolt:  $7 \pm 0.5$  kgm

4. Adjust adjustment screw of yoke assembly (21) as follows. (See P3, P4)

- 1) Draw center line *d* of machine on cover (22). (See P3)

★ The center line between right and left mounting bolts (23) of the cover is the center line of the machine.

- 2) Make a perpendicular line with a square or other tool, and measure horizontal distance *e* from here to adjustment screw. (See P4)


★ Distance *e*: 135 mm

- 3) Loosen nut (25) and turn screw (24) to adjust. (See P4)

5. Install springs (16) and set adjustment rod (15) in position. (See P5)

★ Add engine oil before installing the cover.

6. Fit gasket and install brake cover assembly (14). (See P6)

 Mounting bolt: Thread tightener (LT-2)

 Gasket: Gasket sealant (G2-LI)

★ Pass the brake adjustment rod through the lever of the cover, and screw in the adjustment screw.

7. Adjust brake adjustment screw, then fit gasket and install cover (13). (See P7)

8. Install tubes (12) and rod (11), then connect brake rods (10) and (9). (See P8)

★ Bend cotter pin securely.

9. Set steering valve assembly (8) on bracket, and tighten mounting bolts. (See P9)

★ When installing the steering valve, coat the O-ring of the sleeve assembled inside tube with grease (G2-LI) to prevent the O-ring from being damaged when installing.

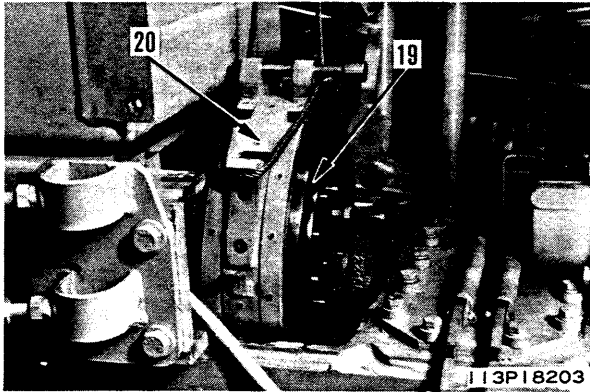
10. Connect tube between cylinder and steering valve. (See P9)

11. Connect tube (7) between transmission and steering valve. (See P9)

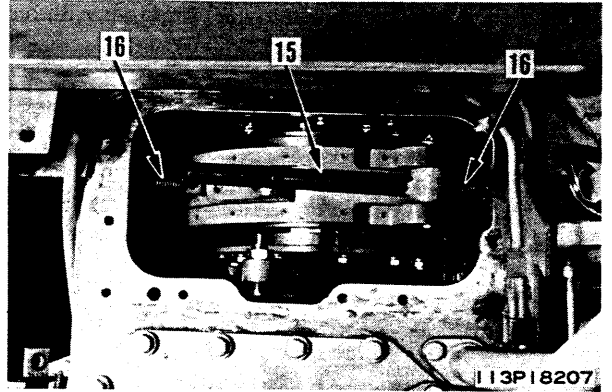
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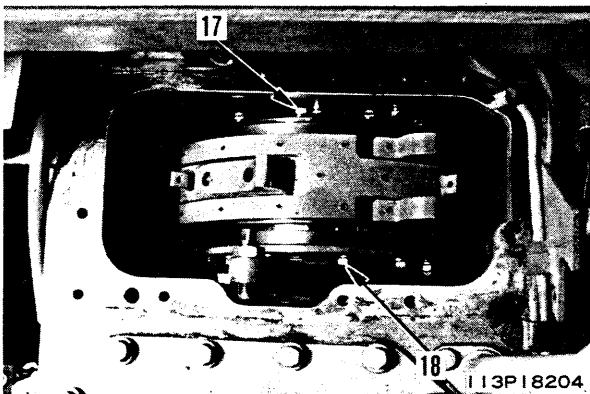
P1



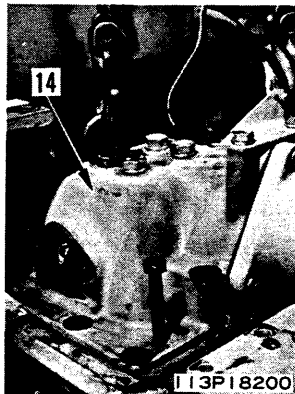
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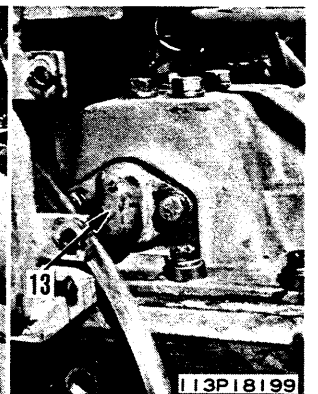
P2



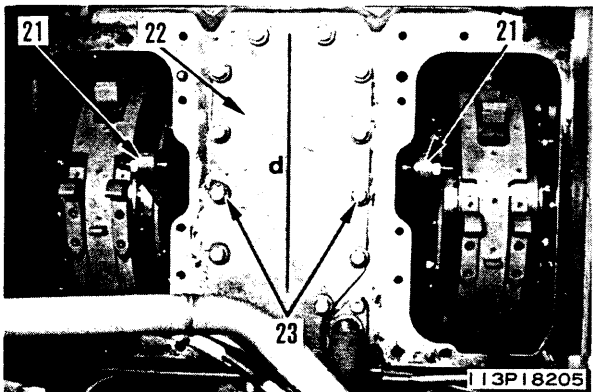
P6



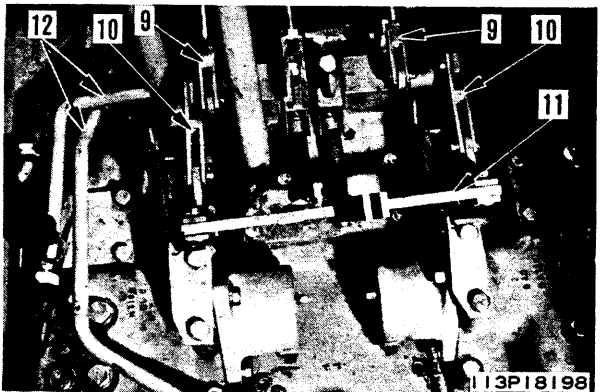
P7



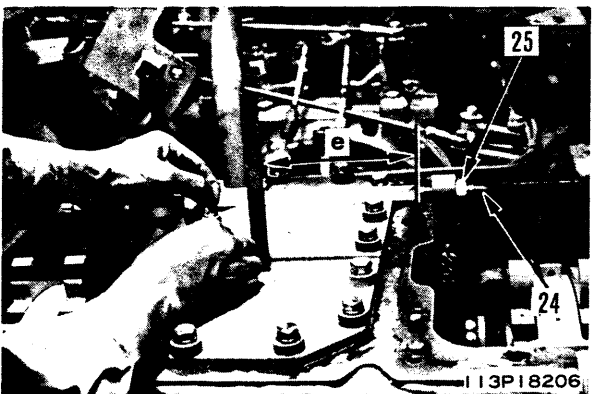
P3



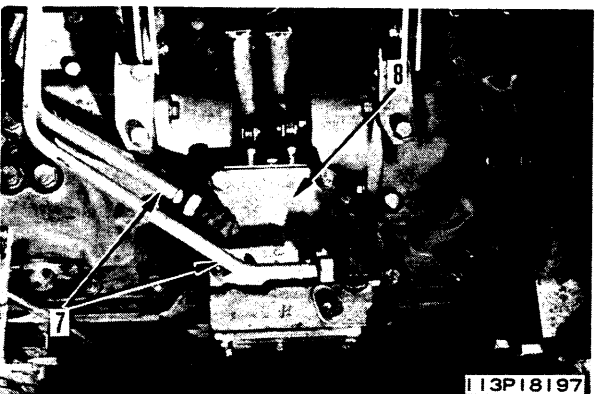
P8



P4



P9



**12. Install seat frame assembly (6) together with battery. (See P1)**

**13. Connect wiring (5) and battery cable (4). (See P1)**

**14. Connect 2 rods (3). (See P2)**

**15. Install cover (2) and operator's seat (1). (See P3)**

**16. Fit machine rear cover, and install floor plate.**

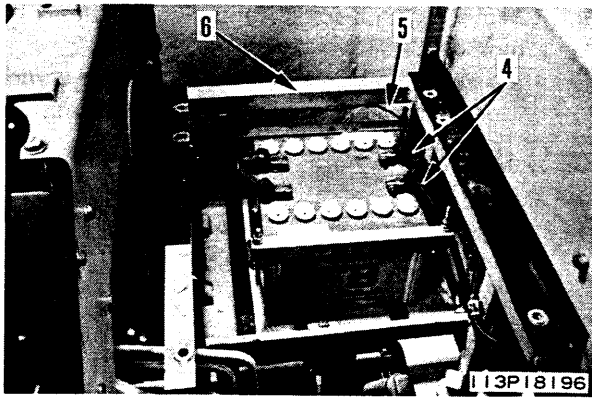
**17. Tighten drain plug and add engine oil through oil filler to the specified level.**



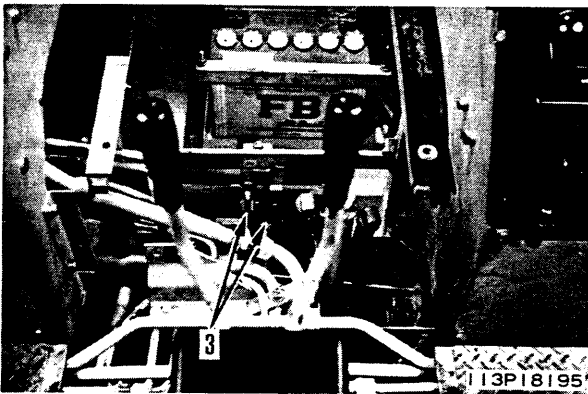
**Steering case: Approx. 30 ℓ**

**★ Run the engine to circulate the oil through the system. Then check the oil level again.**

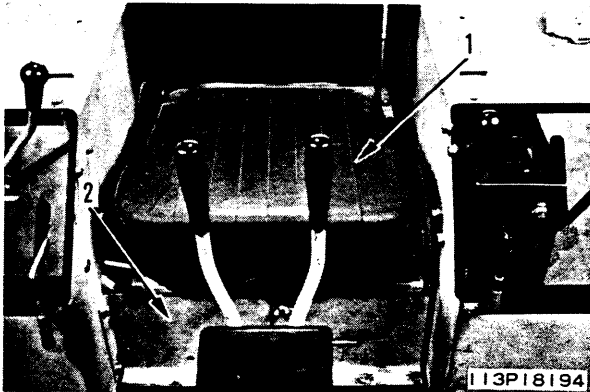
P1



P2



P3



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# DISASSEMBLY OF STEERING CLUTCH ASSEMBLY

## Special tool

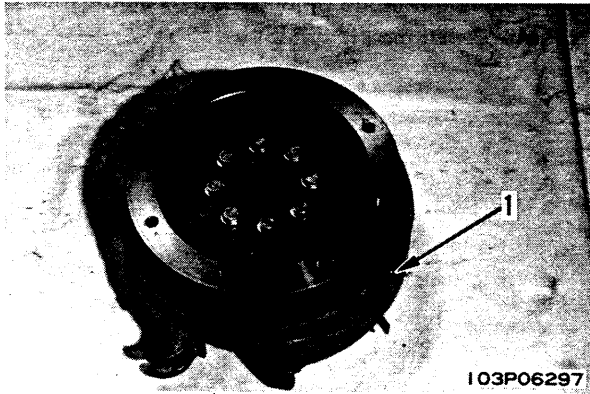
	Part No.	Part Name	Q'ty
A	791-417-5000	Compressor	1

1. Remove brake band (1). (See P1)
2. Set steering clutch assembly in tool A, and screw in nut (2) to compress clutch spring. (See P2)
3. Remove brake drum (3). (See P2)
  - ★ Tighten the nut of tool A so that its head protrudes the same amount as the head of the bolt tightening the clutch spring.
4. Remove bolt (4), and loosen nut slowly to remove clutch spring tension, then remove plate of tool A. (See P3, P4)
5. Remove pressure plate (5). (See P5)
6. Remove clutch discs (6) and clutch plates (7) in turn. (See P6)
  - ★ Keep the plates and discs stored in a vertical or horizontal position to prevent any deformation.
7. Lift clutch drum (8) upward and remove. (See P7)
8. Remove springs (9) and pipes (10). (See P8)
9. Remove retainer (11). (See P8)

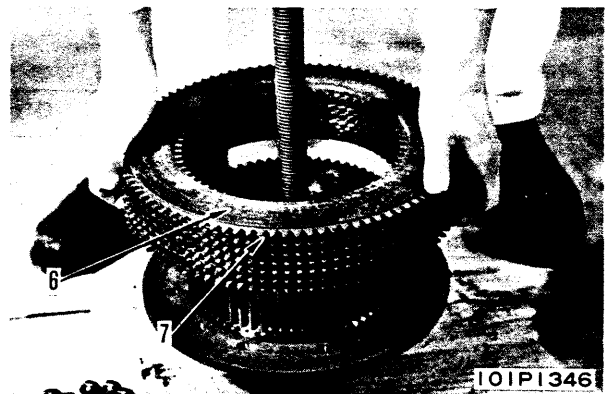
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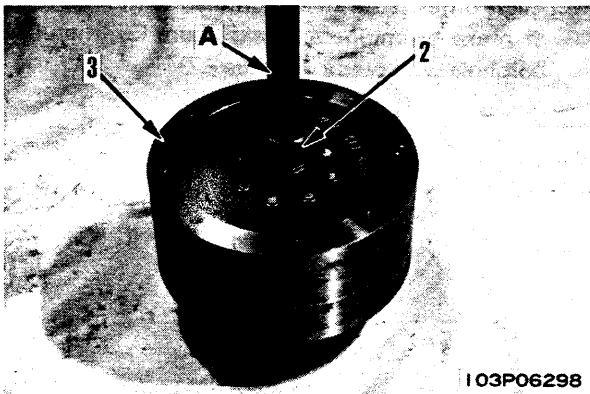
P1



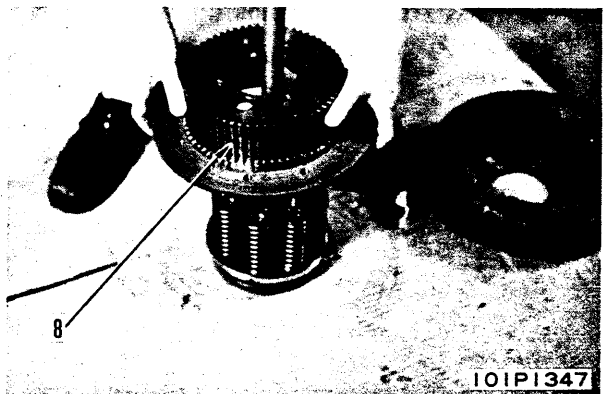
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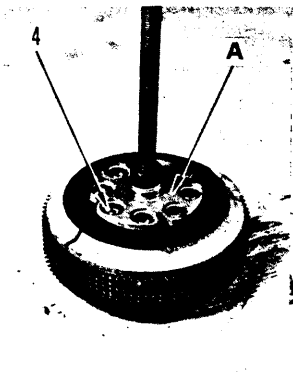
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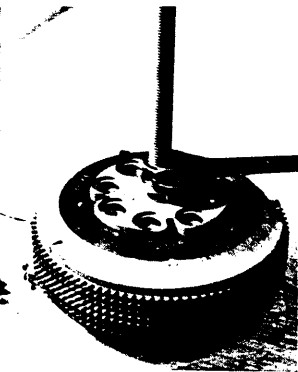
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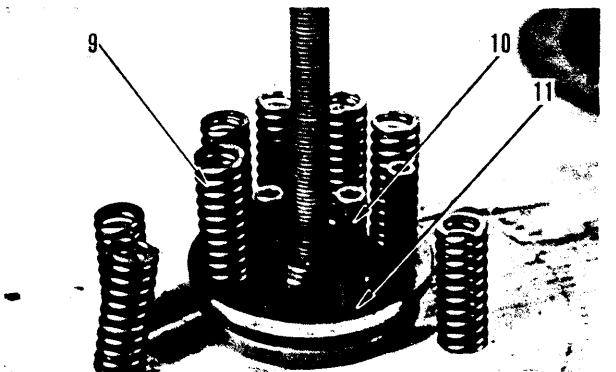
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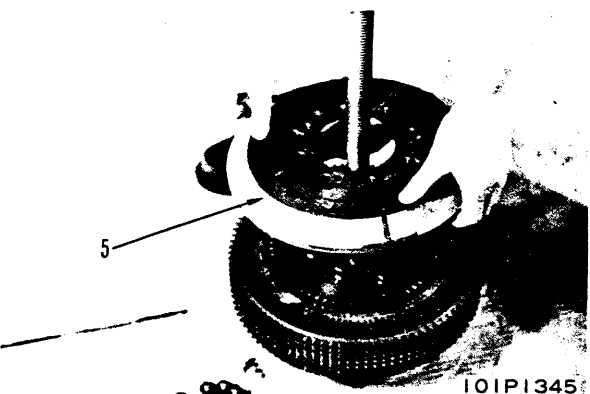
P4



P8



P5



# ASSEMBLY OF STEERING CLUTCH ASSEMBLY

## Special tool

	Part No.	Part Name	Q'ty
A	791-417-5000	Compressor	1

1. Set retainer (11) in tool A. (See P1)

2. Set pipes (10) and springs (9) in retainer (11). (See P2)

★ Free height of spring: 68.6 mm

3. Install clutch drum (8). (See P8)

★ After installing the clutch drum, screw in pressure plate mounting bolts (4) and align the bolt holes.

4. Align clutch discs (6) and clutch plates (7) in turn with inside teeth of clutch drum, and assemble. (See P5)

★ Clutch plates: 7  
Clutch discs: 6

5. Remove mounting bolts used as a guide, then install pressure plate (5). (See P6)

6. Align outer teeth of clutch disc with inner teeth of brake drum, install brake drum (3), then align bolt hole with guide ①. (See P7)

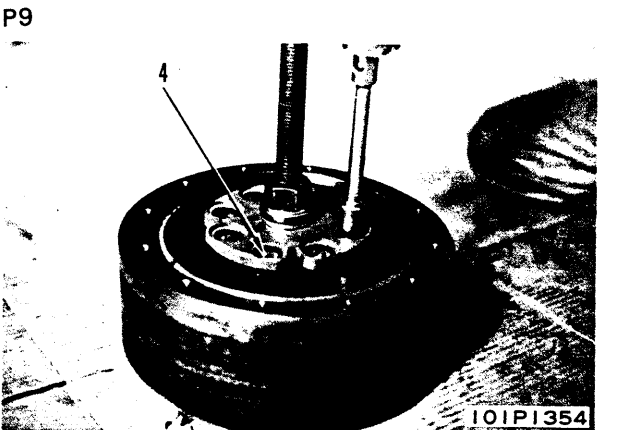
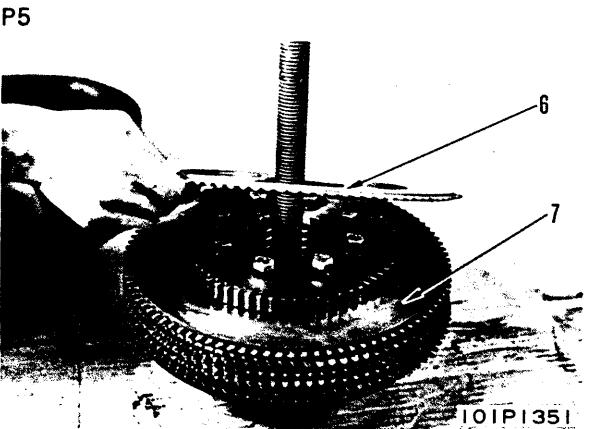
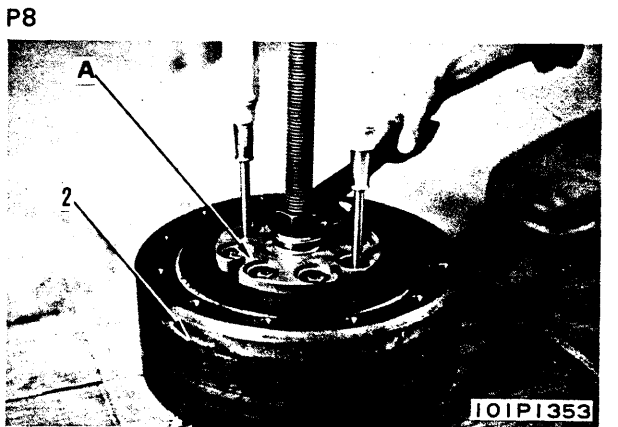
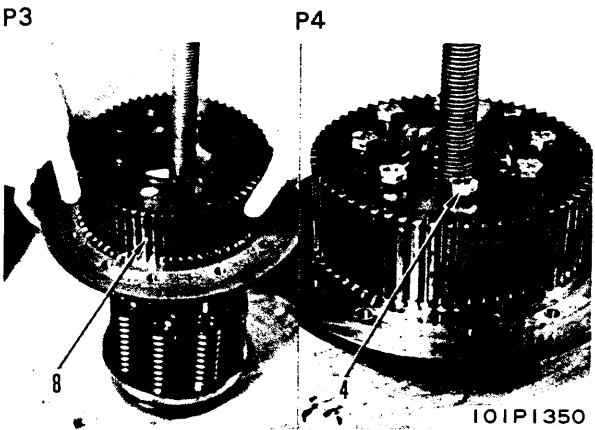
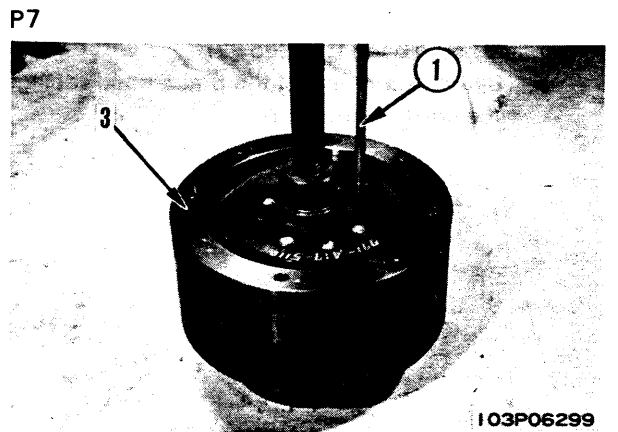
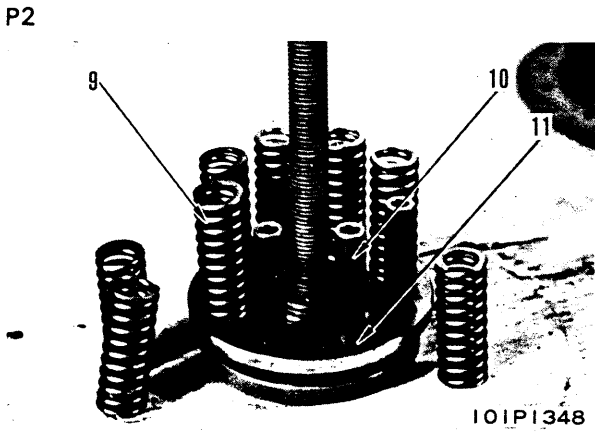
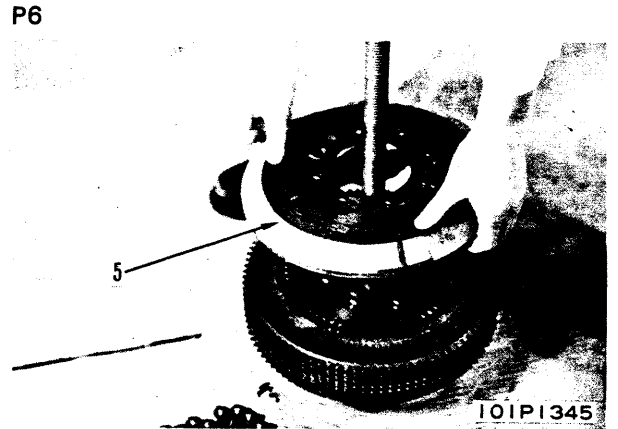
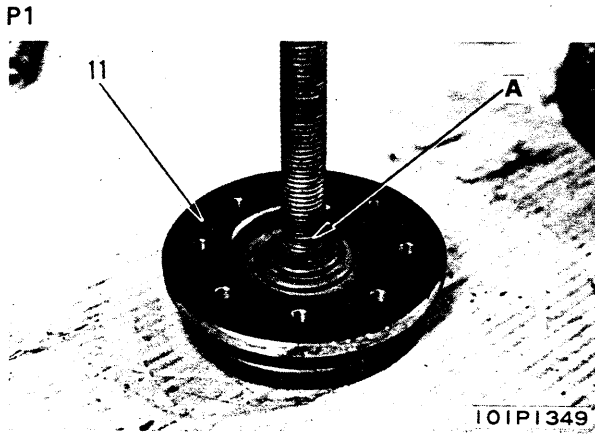
7. Set tool A in position, and tighten nut to compress clutch spring. (See P8)

★ When the nut is tightened, the mounting holes move out of position, so keep the mounting hole aligned with a screwdriver.

8. Tighten bolts (4). (See P9)

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**9. Loosen nut (2), and remove tool A. (See P1)**

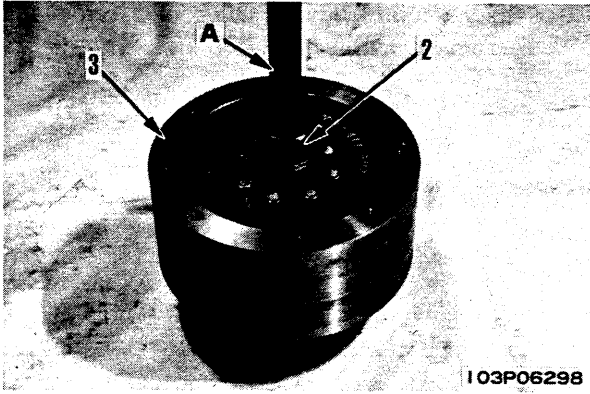
- ★ Move the brake drum (3) up and down and check that it moves smoothly.

**10. Install brake band (1). (See P2)**

- ★ Be careful to install the brake band facing in the correct direction.

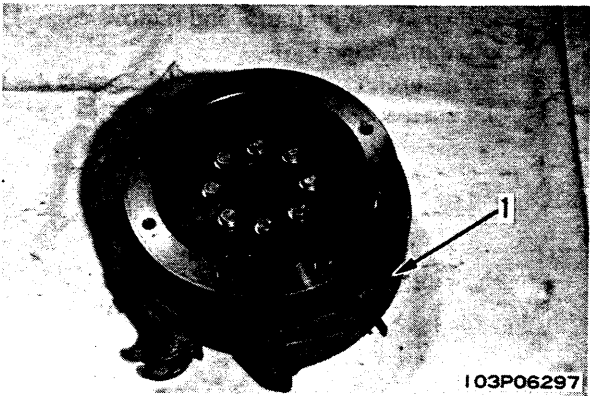
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P1



103P06298

P2




103P06297

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# REMOVAL OF BEVEL GEAR SHAFT AND BEVEL GEAR ASSEMBLY

## Special tools

	Part No.	Part Name	Q'ty
A	791-422-6000	Wrench	1
B	791-422-2001	Remover B	1
C	791-423-1500	Remover	1
C <sub>1</sub>	790-101-3200	Bearing puller	1
D	791-422-1300	Wrench	1
E	791-423-1800	Centering tool	1

1. Remove steering clutch assembly.  
For details, see 23 REMOVAL OF STEERING CLUTCH ASSEMBLY.
2. Remove drain plug and drain oil from bevel gear case.  
 Bevel gear case: Approx. 17 ℓ
3. Remove steering valve control link assembly (1), then remove cover (2). (See P1)
4. Remove lock (3), then using tool A, remove nut (4). (See P2, F1)  
★ Lock the flange to stop rotation.
5. Using tool B, remove flange (5). (See P3)  
★ Lock the flange to stop rotation.
6. Remove yoke assembly (6). (See P4)

7. Remove eight mounting nuts (7). (See P5)  
★ Install the flange temporarily to stop rotation.

8. Remove lock (8), then using tool D, remove nut (9) from cage. (See P6, P7)

9. Raise gear (10) with tool E and remove cage (11) of right end. (See P.8)

- ★ Be careful not to damage the oil seal if it is to be used again.

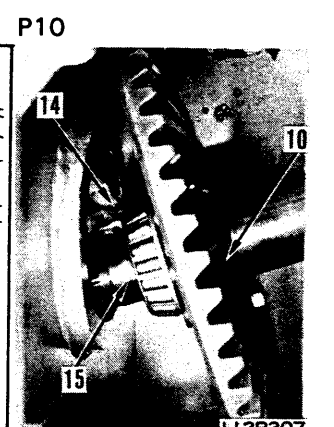
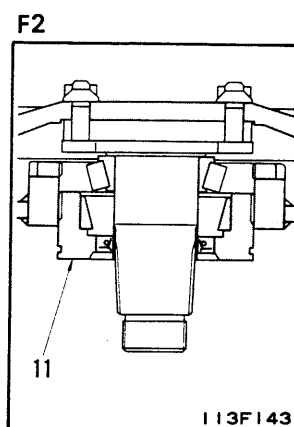
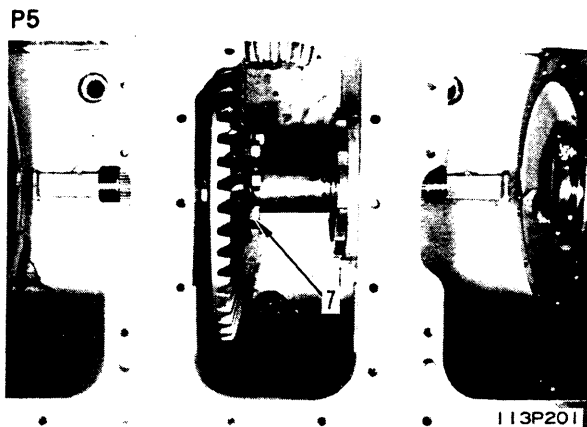
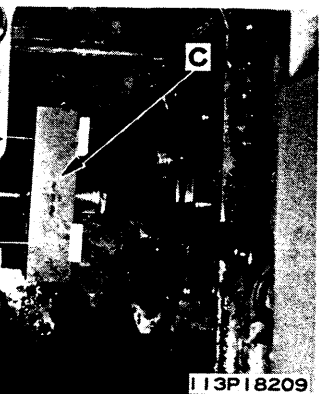
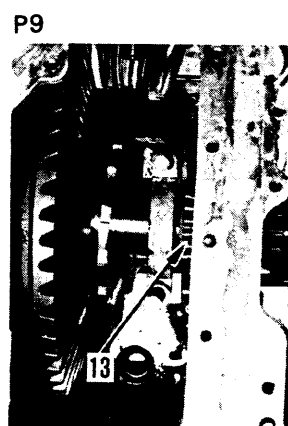
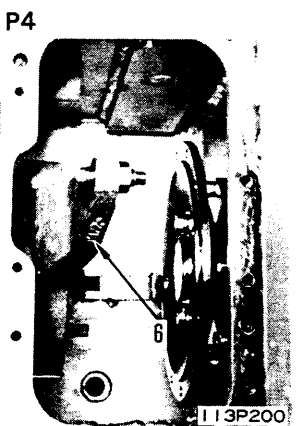
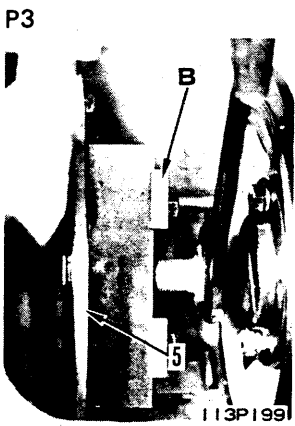
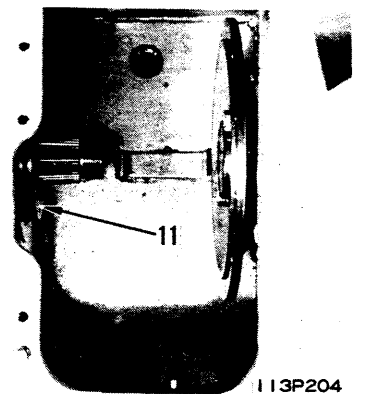
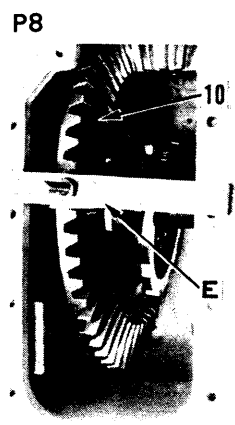
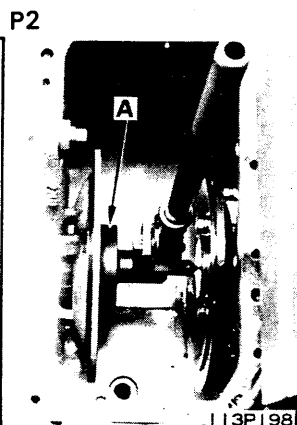
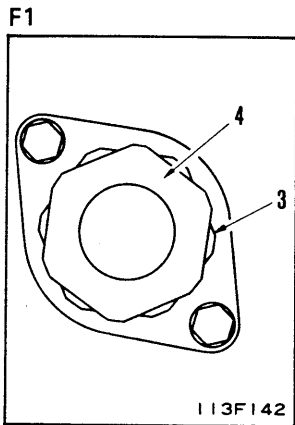
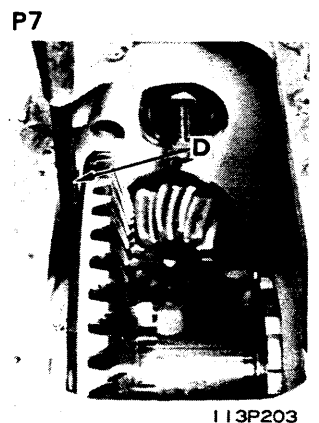
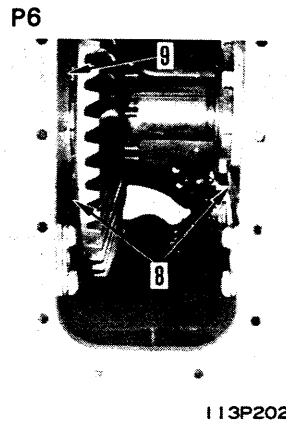
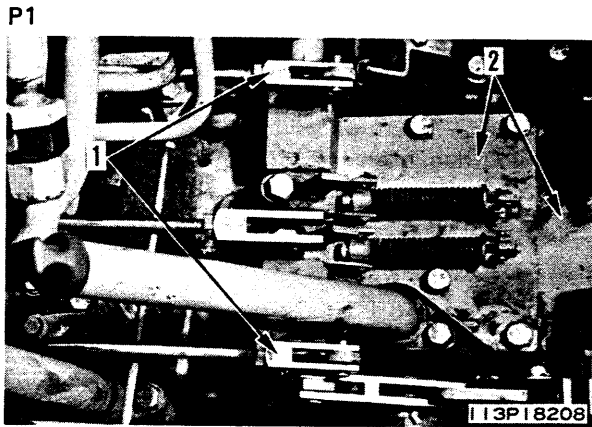
10. Using tool C, pull out bearing (13). (See P9).

11. Push out cage (11) of left end with shaft and remove. (See F2)

- ★ Be careful not to damage the oil seal if it is to be used again.

12. Remove dowel (14) on left side of case, then disconnect gear (10) from shaft (15) and remove. (See P10)

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# INSTALLATION OF BEVEL GEAR SHAFT AND BEVEL GEAR ASSEMBLY

## Special tools

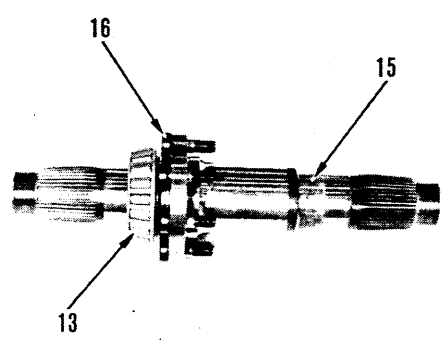
	Part No.	Part Name	Q'ty
A	791-422-6000	Remover and installer	1
B	791-440-4000	Installer B	1
B <sub>1</sub>	790-101-1102	Pump	1
B <sub>2</sub>	790-101-4200	Puller (30t)	1
C	791-422-1600	Seal guide	1
D	791-422-1300	Wrench	1
E	791-423-1800	Centering tool	1

1. Assemble eight bolts (16) in shaft (15) and shrink fit bearing (13). (See P1)
  - ★ Shrink-fitting temperature: 100°C for 30 minutes
2. Insert bevel gear (10) and nut (9) in case. Assemble nut (9) of right end while installing shaft (15). (See P2, P3)
3. Assemble dowel (14) for left end case, install all bevel gear mounting nuts (7) temporarily, then raise with tool E. (See P4, P5)
4. Shrink fit bearing (13) of right end. (See P6)
  - ★ Shrink-fitting temperature: 100°C for 30 minutes
5. Install oil seal (12) in cage (11). (See P7)
  - ★ Outside dia.: 78 mm
6. Fit O-ring, align with dowel and install cage (11) in case. (See P8)
  - ★ Fit tool C on shaft side, guide oil seal and install.
7. Screw nut (9) into cage. (See P9)
  - ★ On the left side, push the bevel gear fully to the pinion side and leave a large clearance from the case when installing.
8. Tighten mounting nuts (7) of bevel gear. (See P9)
  - ★ Bend lock plate securely.
9. Adjust backlash and tooth contact of bevel gear.
  - 1) Using tool D, rotate gear while watching backlash, and tighten nuts (9). (See P10)
    - ★ Backlash: 0.18 – 0.23 mm
    - ★ Rotating torque of bevel gear shaft: 0.14 – 0.24 kgm  
(However, it should be about 14 kg at the top of the bevel gear tooth when the transmission is engaged.)  
In this case, tighten adjustment nut at 45 ± 5 kgm
    - ★ To measure the backlash, put a fuse wire between the gears. Rotate the gears and measure the thickness of the crushed fuse wire with a micrometer.
    - ★ Tighten nut (9) so that the lock groove is in the correct position.
  - 2) Check tooth contact.
  - 3) After adjusting backlash and tooth contact, install lock (8). (See P11)
    - ★ Bend lock plate securely.

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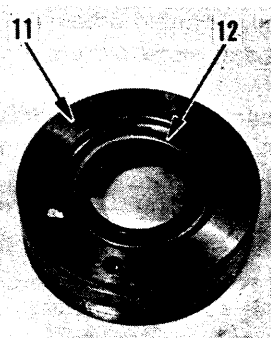
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P1



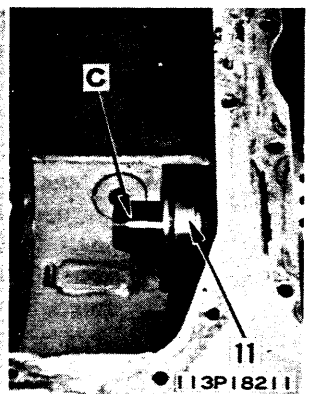
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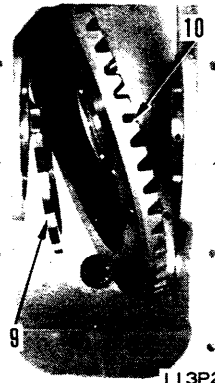
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P8



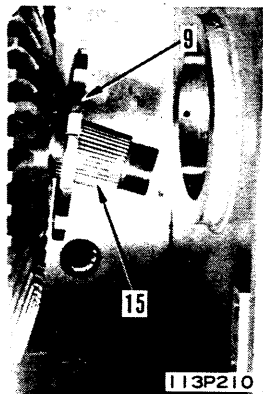
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P2



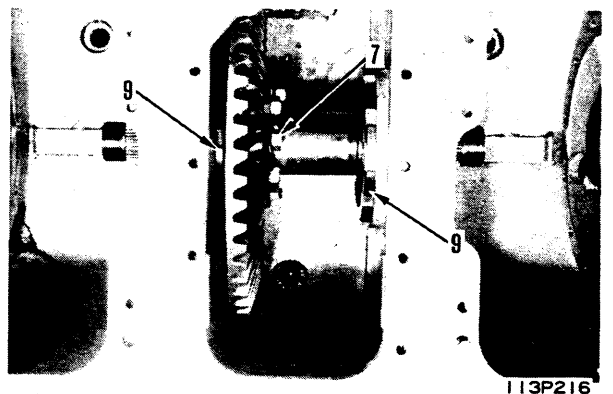
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P3



113P210

P9



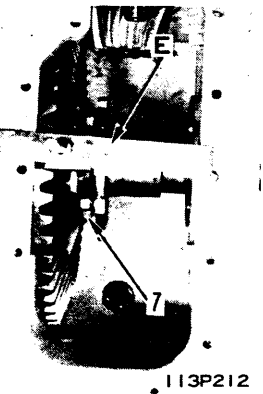
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P4



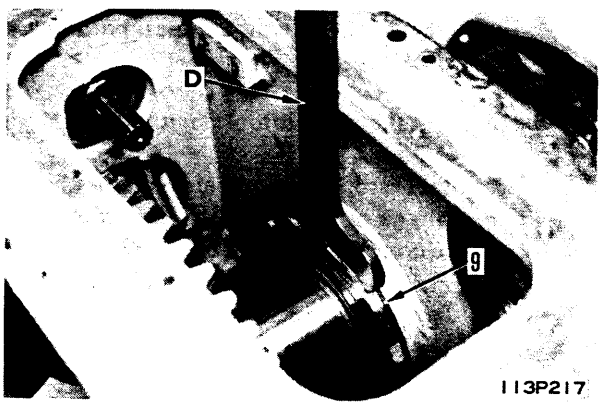
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P5



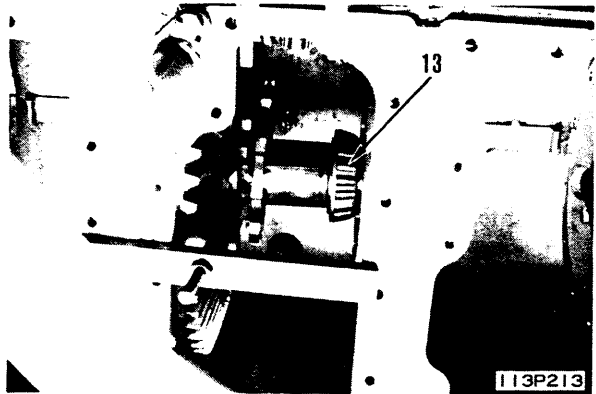
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P10



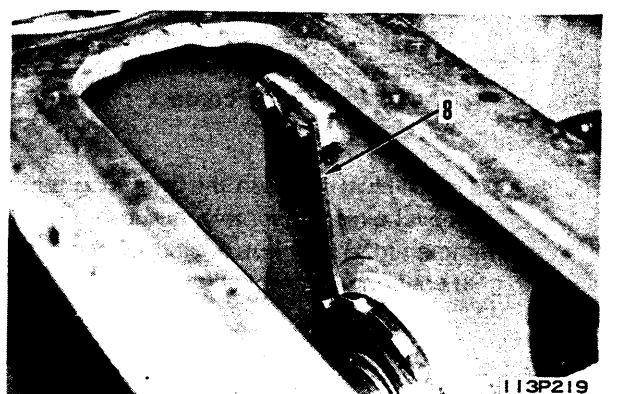
113P217

P6



113P213

P11



113P219

- **Adjusting tooth contact**

Coat the tooth face of the bevel pinion lightly with red lead (minimum). Rotate the bevel gear forward and backward and inspect the pattern left on the teeth.

- ★ Tooth contact should be checked with no load on the bevel pinion. The tooth contact pattern should cover about 30% of the length of the tooth, and should start near the small end. It should be in the center of the tooth height. (See P1)

If the gears are adjusted to this pattern, the tooth contact will be correct when load is applied.

- If the result of the inspection shows that the correct tooth contact is not being obtained, adjust again as follows.

1) If bevel pinion is too far from center line of bevel gear.

Contact is at the small end of the convex tooth face of the bevel gear and at the big end of the concave tooth face. (See P2)

- ★ Procedure for adjustment (See F1)

Reduce the thickness of the shims at the mounting face of the bevel pinion assembly cage and steering case to move the pinion shaft in direction **A**, nearer to the bevel gear. Using the adjustment nut, move the bevel gear in direction **B** by the same amount that the bevel pinion has moved in direction **A**.

Check the tooth contact pattern and backlash.

2) If bevel pinion is too close to center line of bevel gear.

Contact is at the small end of the concave tooth face of the bevel gear and the big end of the convex tooth face. (See P2)

- ★ Procedure for adjustment (See F2)

Increase the thickness of the shims at the mounting face of the bevel pinion assembly cage and steering case to move the pinion shaft in direction **A**, away from the bevel gear. Using the adjustment nut, move the bevel gear in direction **B**, by the same amount that the bevel pinion has moved in direction **A**.

Check the tooth contact pattern and backlash.

- ★ To insert shims, loosen the mounting bolt of the bevel pinion assembly, and use a plastic hammer to knock out the tip of the pinion gear enough to extract shims.

- ★ When adjusting the bevel gear, do not change the preload of the bearing. Always turn the adjustment nuts at both ends the same amount in the same direction.

- ★ Count the movement of the notches to check the amount of adjustment by the adjustment nut.

10. Fit gasket and install cover (2) and link assembly (1). (See P4)

- ★ Do not install the front four mounting bolts.



Gasket: Gasket sealant (LG-1)



Mounting bolt: Thread tightener (LT-2)

11. Install yoke assembly (6). (See P5)

- ★ Be careful to install facing in right direction.

12. Align with tabs of collar and install flange (5). (See P5)

- ★ Only one place can be aligned.



Serrated portion:

Anti-friction compound (LM-P)

13. Using tool **B**, press fit flange (5). (See P5)

14. After press fitting flange, measure distance **a** from end face of shaft to end face of flange. (See F3)

- ★ Distance **a**:  $8 \pm 0.7$  mm

- ★ When no measuring tool is available, measure distance **b** of the shaft before press fitting the flange. (See F3)

After press fitting the flange, measure distance **c**.

$$b - c = a$$

15. Using tool **A**, tighten nut (4). (See P6, F4)



Nut thread: Anti-friction compound (LM-P)



Nut:  $35 \pm 5$  kgm

- ★ After tightening to about 30 kgm, check the position of the mounting hole of lock plate (3).

If it is not in the correct position, tighten the nut until it reaches the correct position.

16. Tighten lock plate. (See F4)

17. Install steering clutch assembly.

For details, see 23 INSTALLATION OF STEERING CLUTCH ASSEMBLY.

18. Tighten drain plug and add engine oil through oil filler to the specified level.

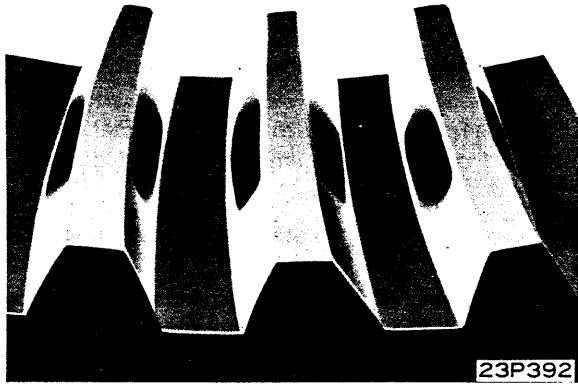


Steering case: Approx. 17 l

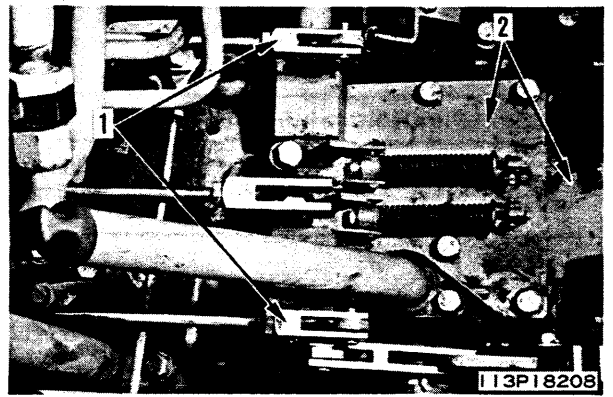
- ★ Run the engine to circulate the oil through the system. Then check the oil level again.

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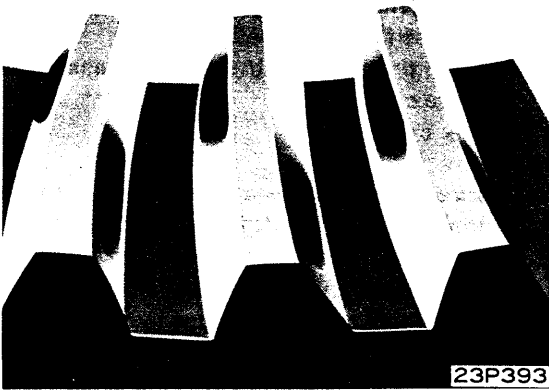
P1



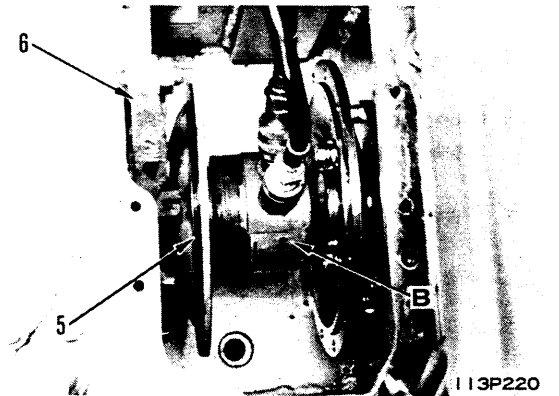
P4



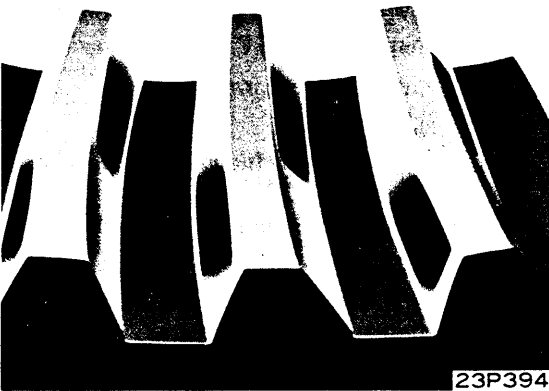
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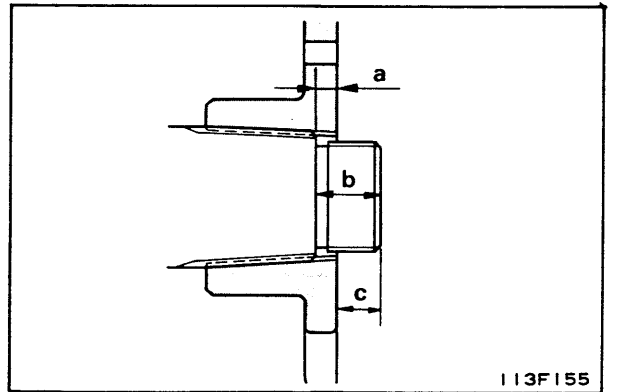
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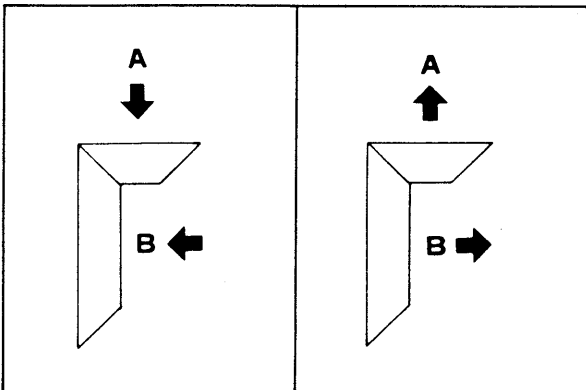
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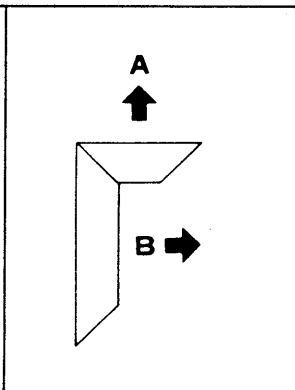
F3



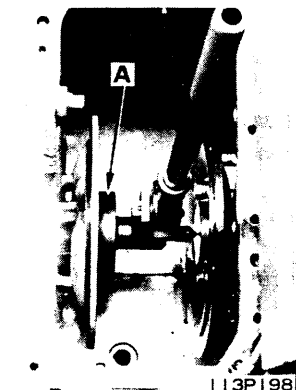
F1



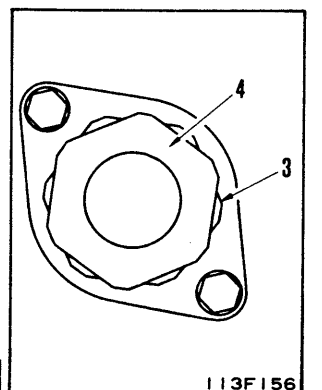
F2



P6



F4



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# REMOVAL OF FINAL DRIVE FIRST PINION ASSEMBLY

## Special tools


	Part No.	Part Name	Q'ty
A	791-422-6000	Remover and installer	1
B	791-422-2001	Remover	1





1. Remove steering clutch assembly.  
For details, see 23 REMOVAL OF STEERING CLUTCH ASSEMBLY.
2. Remove cover (1), then using tool A, remove nut (2). (See P1, P2, P3)
3. Using tool B, remove flange (3). (See P4)
4. Using forcing screws ① (Thread dia. = 10 mm, Pitch = 1.5 mm), remove retainer (4). (See P5)
5. Remove first pinion assembly (5). (See P6)

# INSTALLATION OF FINAL DRIVE FIRST PINION ASSEMBLY

## Special tools

	Part No.	Part Name	Q'ty
A	791-422-6000	Remove and installer	1
B	791-440-4000	Installer B	1
B <sub>1</sub>	791-101-1102	Pump	1
B <sub>2</sub>	790-101-4200	Puller (30 ton)	1

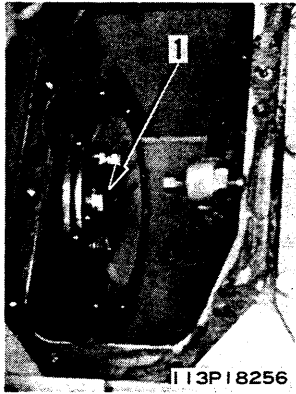
1. Press fit bearing (7) and inner races (8) to pinion gear (6). (See F1)
  - ★ Inside diameter of bearing (7): 60 mm
  - ★ Inside diameter of inner race (8): 40 mm
2. Press fit oil seal (9) and inner races (10) to retainer (4). (See F2)
  - ★ Outside diameter of inner races: 120 mm
  - ★ Outside diameter of oil seal: 105 mm Lip of oil seal: Grease (G2-LI)

3. Install first pinion assembly (5).
4. Fit O-ring and install retainer assembly (4).
5. Press fit flange (3) with tool B. (See P7)
  - ★ Flange press-fitting force: 4 – 12 tons
  -  Serration:  
Anti-friction compound (LM-P)
6. After press fitting flange, measure dimension a from end face of shaft to end face of flange. (See F3)
  - ★ Dimension a:  $3 \pm 0.7$  mm
  - ★ When no measuring tool is available, measure distance b of the shaft before press fitting the flange. (See F3)  
After press fitting the flange, measure distance c.  
 $b - c = a$
7. Measure face runout and radial runout of flange (3) from bevel gear shaft flange end. (See F4, F5)
  - ★ Set dial gauge in position, rotate the bevel gear shaft flange end, and measure the movement of the dial gauge indicator.
  - ★ Face runout: 0.3 mm (reading of dial gauge)
  - ★ Radial runout: 0.4 mm (reading of dial gauge)
8. Using tool A, align nut (2) with bolt hole of cover (1), then install. (See P2, P3)
  -  Nut:  $35 \pm 5$  kgm
  -  Nut thread:  
Anti-friction compound (LM-P)
9. Fit O-ring and install cover (1). (See P1)
  -  Gasket: Gasket sealant (LG-1)
10. Install steering clutch assembly.  
For details, see 23 INSTALLATION OF STEERING CLUTCH ASSEMBLY.

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P1



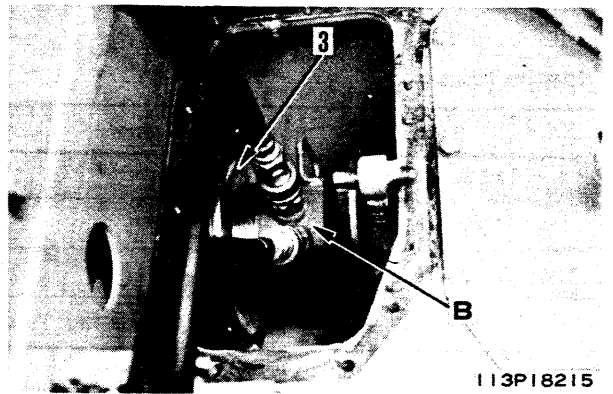
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P2



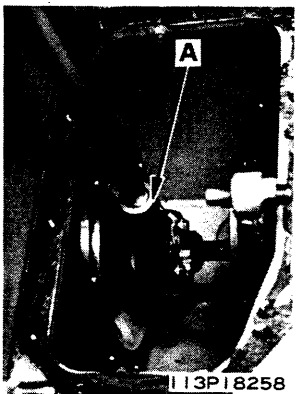
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P7



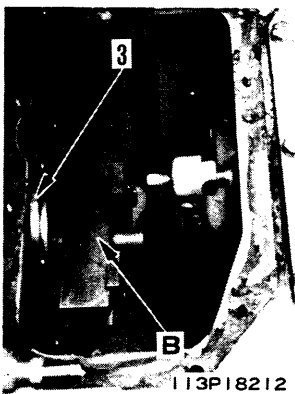
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P3



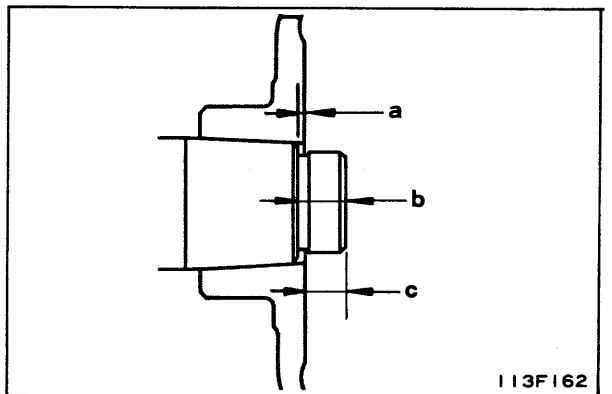
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P4



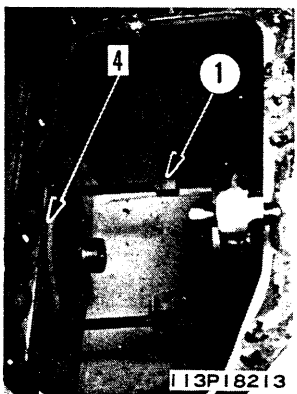
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F3



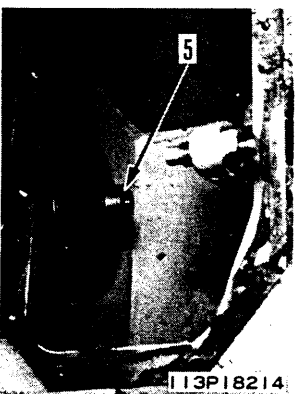
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P5



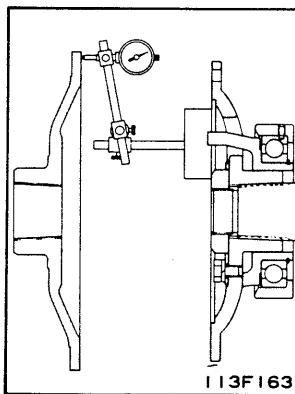
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P6



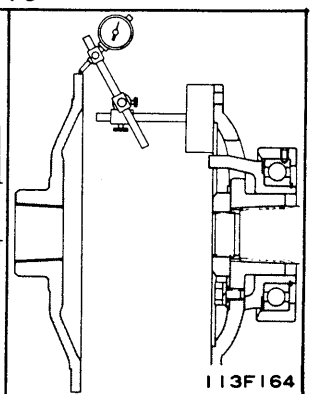
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F4



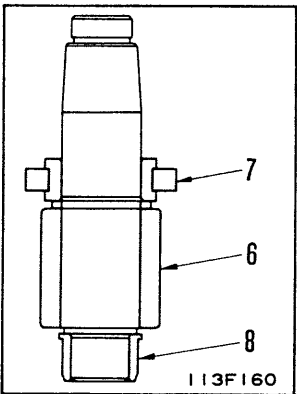
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F5



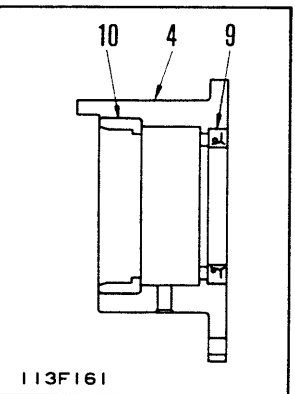
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F1



113F160

F2



113F161

# DISASSEMBLY OF FINAL DRIVE ASSEMBLY

## Special tools

	Part No.	Part Name	Q'ty
A	791-522-7110	Socket	1
B	791-521-1002	Remover	1
B <sub>1</sub>	790-101-1102	Pump	1
B <sub>2</sub>	790-101-1600	Cylinder (70 ton)	1

1. Remove track shoe assembly.  
For details, see 33 REMOVAL OF TRACK SHOE ASSEMBLY.
2. Jack up machine and put stands ① under steering case and equalizer bar. (See P1)
3. Remove drain plug and drain oil from final drive case.



Final drive case:

Approx. 9.5 ℓ (D31E, P, S-18, D37E-2)

Approx. 12 ℓ (D31P-18A, D31Q-18, D37P-2)

Approx. 15 ℓ (D31PL, PLL-18)

4. Remove bracket (1). (See P2)
5. Remove lock cover (2) of nut. (See P2)
6. Using tool A, remove nut (3). (See P3,P4)  
★ Width across flats: 95 mm

7. Using tool B, B<sub>1</sub> and B<sub>2</sub>, pull out sprocket and hub assembly (4). (See P5)



When removing the sprocket and hub assembly, there is danger that it may fly out, so temporarily fit a nut.

8. Leaving 2 or 3 mounting bolts in position, sling sprocket and final drive assembly, then remove remaining mounting bolts, and lift off sprocket and final drive assembly (5) as one unit. (See P6)

★ When removing the final drive assembly, the shaft assembly will come out of the final drive case, so leave sprocket hub assembly (4) and nut (3) fitted together temporarily.

9. Remove nuts (3), then remove sprocket (6) (See P7)



Sprocket: 45 kg

10. Remove hub (7) (See P8)

11. Remove floating seals (8) and (9). (See P9, P10)

12. Remove mounting bolts, then remove cover (10) and shims (11). (See P11).

★ Check the number and thickness of the shims, and keep in a safe place.

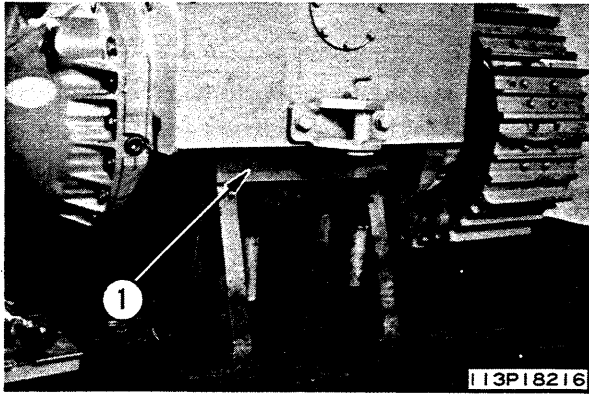
13. Using eyebolts ① (Thread dia. = 12 mm, Pitch = 1.75 mm), remove case (12). (See P12)



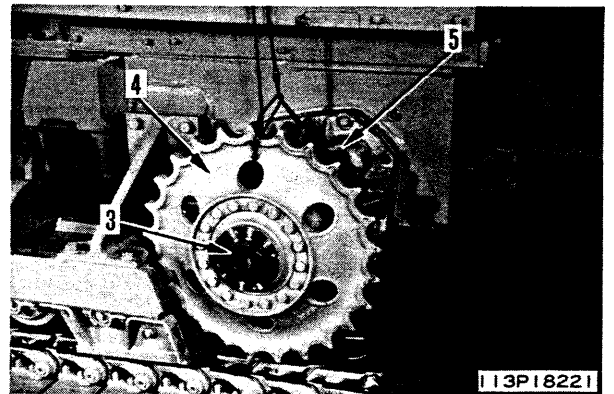
Case: 40 kg

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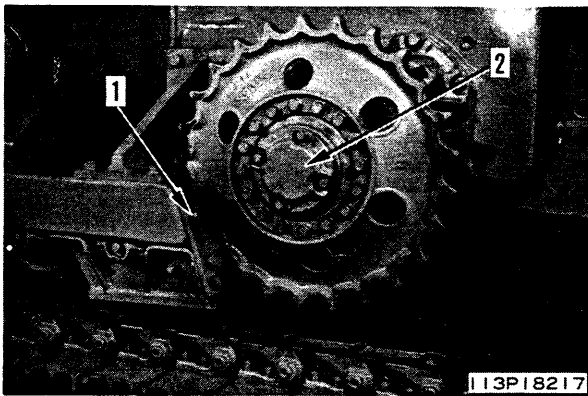
P1



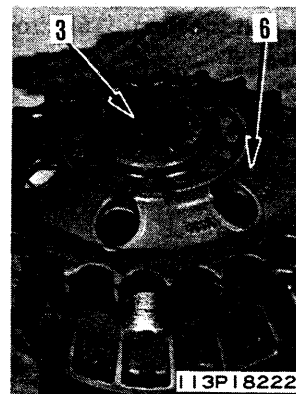
P6



P2



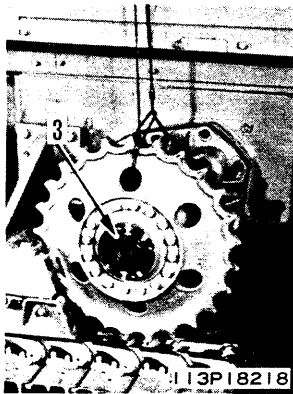
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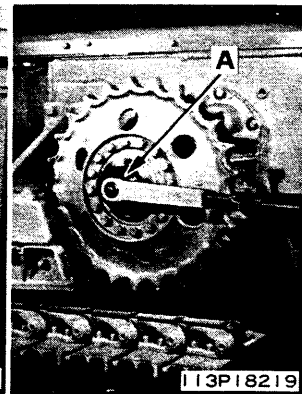
P8



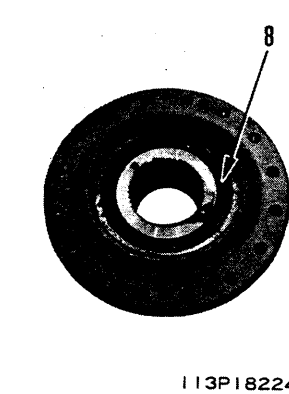
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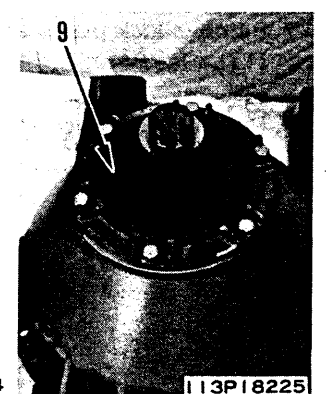
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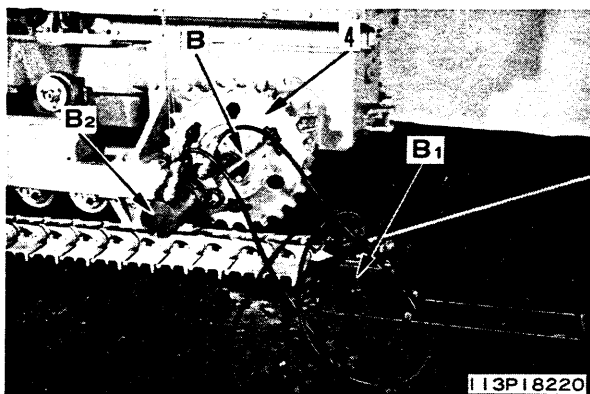
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P10



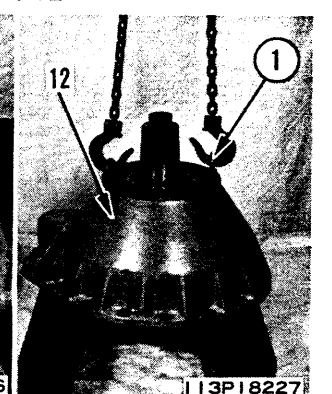
P5



P11



P12



011418



**14.** Pull out bearing (13) and outer race (14) from final drive case. (See P1)

**15.** Using puller ②, pull out bearing (15) from sprocket shaft. (See P2)

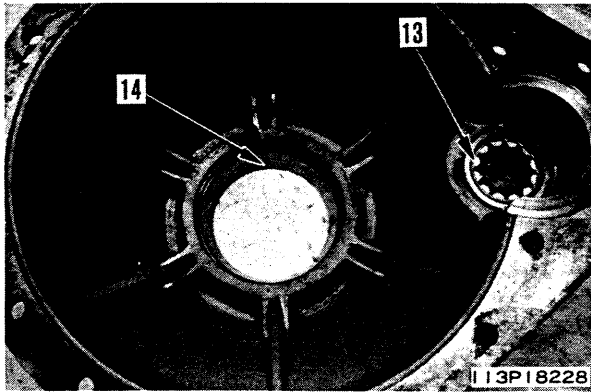
**16.** Using puller ③, pull out bearing (16) from sprocket shaft. (See P3)

**17.** Remove lock plates and nuts, then remove gear (17). (See P4)

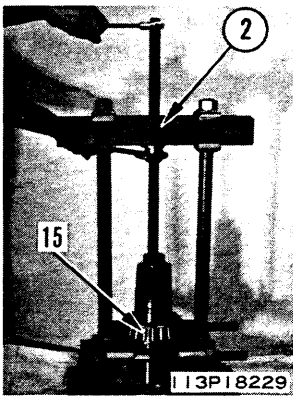
**18.** Pull out outer race (18) from steering case end. (See P5)

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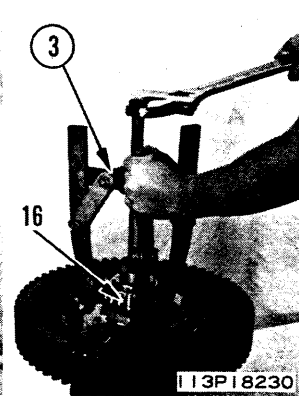
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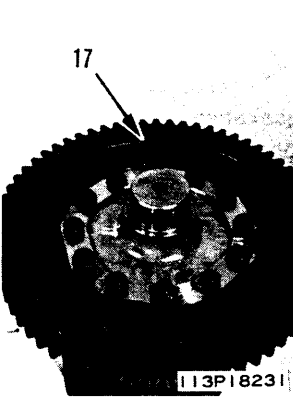
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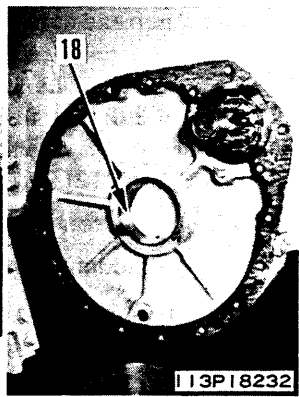
P3



P4



P5



011418

# ASSEMBLY OF FINAL DRIVE ASSEMBLY

## Special tools

	Part No.	Part Name	Q'ty
A	791-442-1500	Socket	1
C	791-521-2001	Installer	1
C <sub>1</sub>	790-101-1102	Pump	1
C <sub>2</sub>	790-101-1600	Cylinder (70 ton)	1
D	791-560-1520	Installer	1

★ Clean all parts, and check for dirt or damage. Coat the sliding surfaces of all parts with engine oil before installing.

1. Using push tool ④ (outside diameter: 130 mm), press fit outer race (18) to steering case. (See P1, P2)

2. Install driven gear (17) to shaft, and fit lock plate, then tighten nut. (See P3)

★ Bend the lock plate securely.

3. Using push tool ⑤ (inside diameter: 80 mm), press fit bearing (16) to shaft. (See P4)

4. Using push tool ⑥ (inside diameter: 100 mm), press fit bearing (15) to shaft. (See P5)

5. Using push tool ⑦ (outside diameter: 170 mm), press fit outer race (14) to case (See P6, P7)

6. Using push tool ⑧ (outside diameter: 85 mm), press fit bearing (13) to case. (See P8, P9)


7. Using eyebolts ① (Thread dia. = 12 mm, Pitch = 1.75 mm), install case (12). (See P10)

8. Assemble shim (11) temporarily, and fit cover (10) temporarily. (See P11)

9. Install hub and nuts temporarily.

10. Using guide bolts ⑨ (Thread dia. = 16 mm, Pitch = 2.0 mm), fit gasket and set final drive assembly (5) in position, then tighten mounting bolts. (See P12)

 Gasket: Gasket sealant (LG-1)

 Mounting bolt: Thread tightener (LT-2)

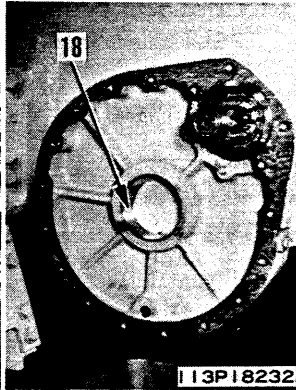
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P1



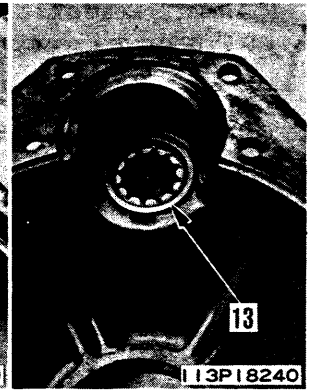
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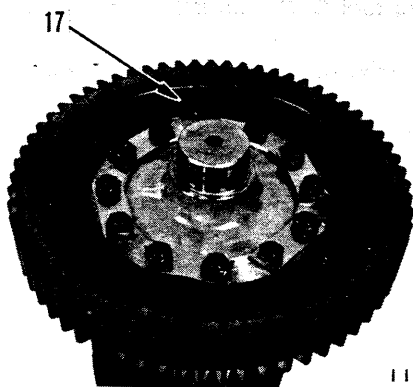
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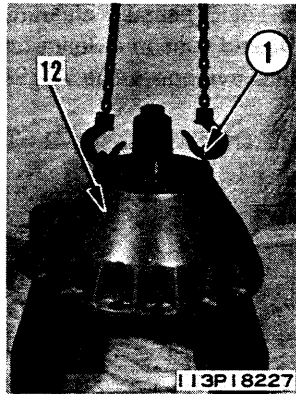
P9



P3



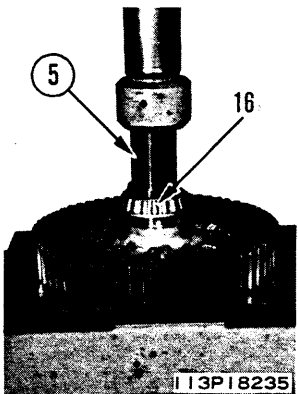
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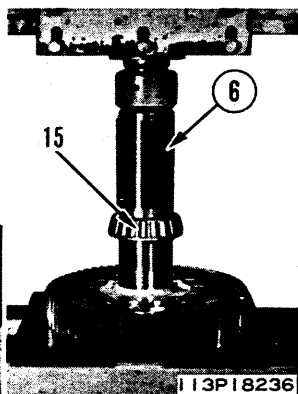
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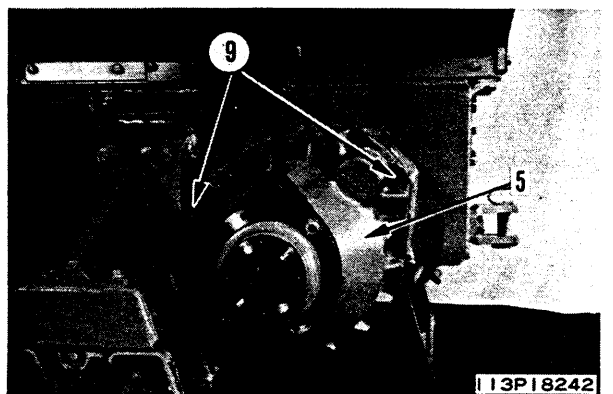
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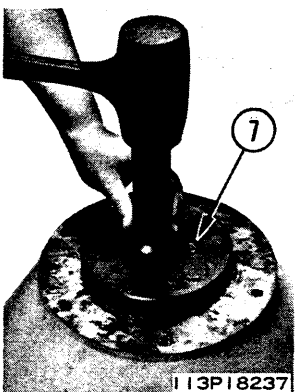
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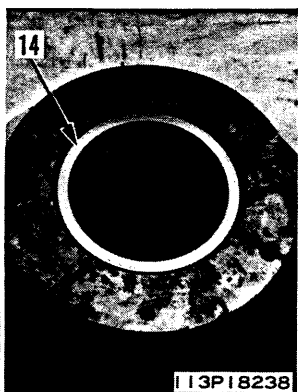
P12



P6



P7



11. Adjust preload of bearing.

- 1) Remove temporarily installed nut and sprocket hub.
- 2) Remove shim (11), then tighten mounting bolts marked ※ (4 places) of cover (10) uniform to tightening torque of 1 – 1.5 kgm. (See P1, F1)
- ★ Rotate the track on the other side with a jack to rotate shaft 4 – 5 times to settle in the roller of the bearing, then tighten the mounting bolts evenly to a torque of 1 – 1.5 kgm.

- 3) Using feeler gauge ⑩, measure clearance between cover (10) and case in at least four places, and calculate average value A. (See P2, F2)
- 4) Decide thickness of shim (11) as  $A + 0.3$  mm and install. (See F2)

13. Using tool D, install floating seals (8). (See P5, P6)

14. Using tool C, C<sub>1</sub> and C2, press fit hub (7). (See P7)

- ★ Press-fitting force: 15 – 45 tons



Serrated portion:

Anti-friction compound (LM-P)

15. After press fitting, use gauge (11) to measure distance b from end face of shaft to end face of sprocket hub (See P8, F3)

- ★ Distance b:  $1.5 \begin{matrix} +0.3 \\ -0.1 \end{matrix}$  mm

- ★ If the value is too large, press fit again at the maximum press-fitting force within the permitted range.

If the value is too small, replace the hub.

12. Using tool D, install floating seals (9). (See P3, P4)

16. Using tool A, tighten nut (3). (See P9, P10)



Nut: Anti-friction compound (LM-P)

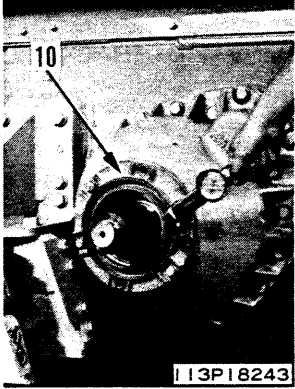


Nut:  $118 \pm 8$  kgm

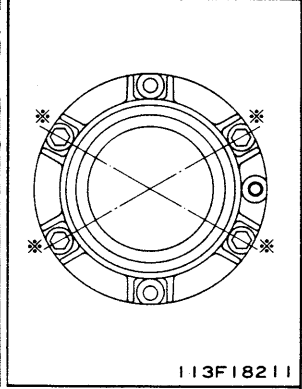
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P1



F1



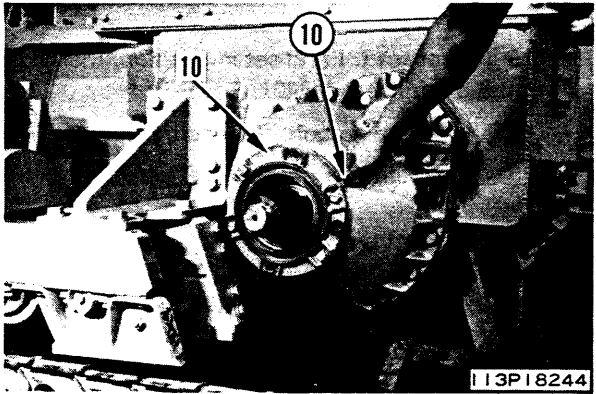
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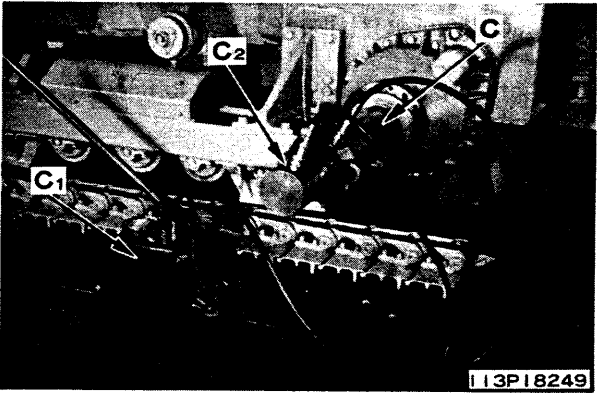
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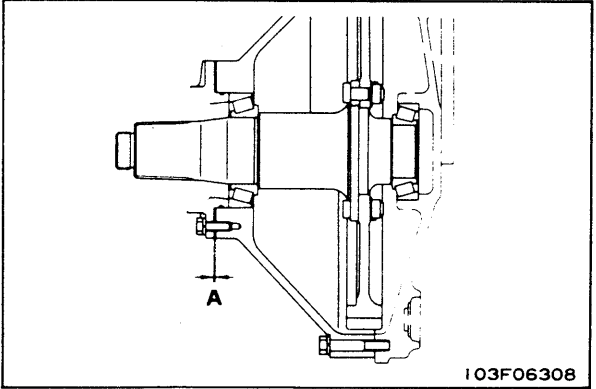
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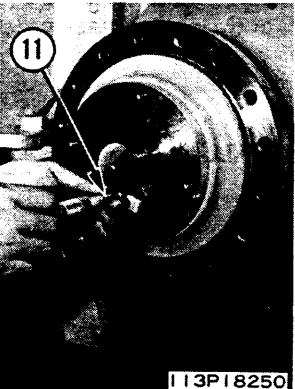
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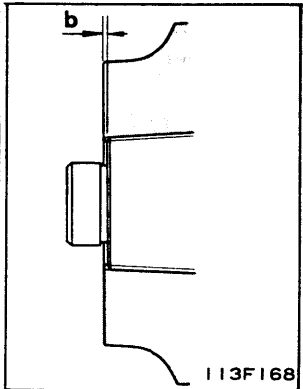
F2



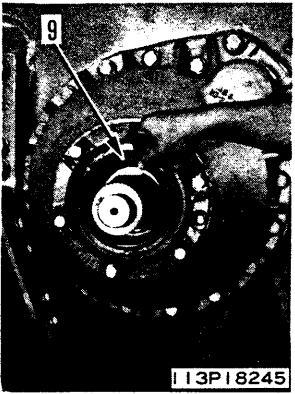
P8



F3



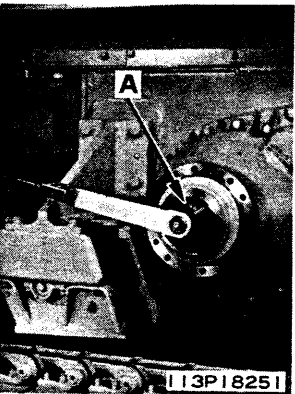
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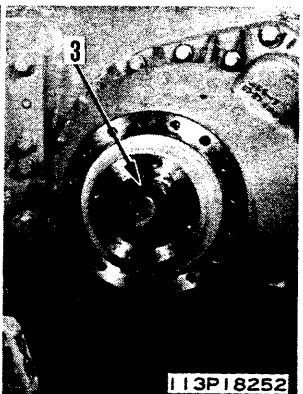
P4



P9



P10



17. Fit gasket and install cap (2). (See P1)



Gasket: Gasket sealant (LG-1)

18. Install sprocket (6). (See P1)



Mounting bolt: Thread tightener (LT-2)



Mounting bolt:  $28 \pm 3$  kgm

19. Install bracket (1). (See P2)

20. Tighten drain plug and add oil to final drive case to the specified level.



Final drive case:

Approx. 9.5ℓ (D31E, P, S-18, D37E-2)

Approx. 12ℓ (D31P-18A, D31Q-18,  
D37P-2)

Approx. 15ℓ (D31PL, PLL-18)

21. Remove stands ①, and lower machine to ground. (See P3)

22. Install track shoe assembly.

For details, see 33 INSTALLATION OF TRACK SHOE ASSEMBLY.

## REMOVAL OF SPROCKET

1. Remove track shoe assembly.

For details, see 33 REMOVAL OF TRACK SHOE ASSEMBLY.

2. Remove bracket (1). (See P4)

3. Remove 16 mounting bolts (2), then lift off sprocket (3). (See P5)



Sprocket: 45 kg

## INSTALLATION OF SPROCKET

1. Sling sprocket (3) and set in position, then tighten 16 mounting bolts (2). (See P5)



Mounting bolt: Thread tightener (LT-2)



Mounting bolt:  $28 \pm 3$  kgm

2. Install bracket (1). (See P4)

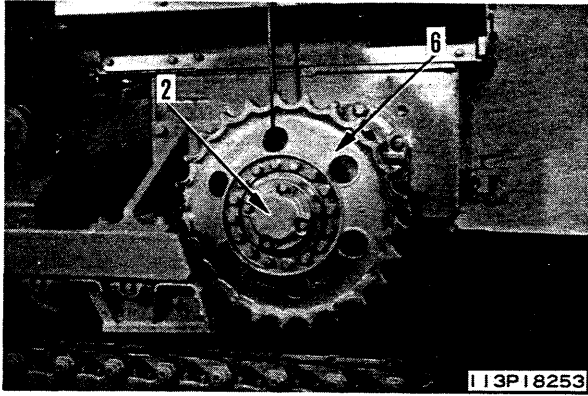
3. Install track shoe assembly.

For details, see 33 INSTALLATION OF TRACK SHOE ASSEMBLY.

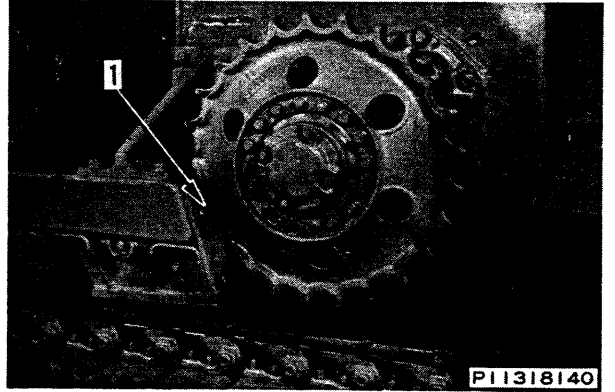
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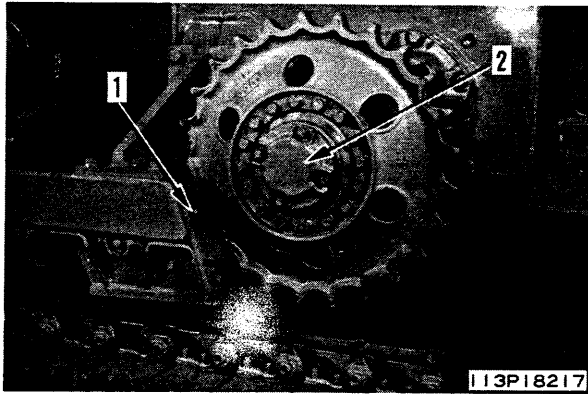
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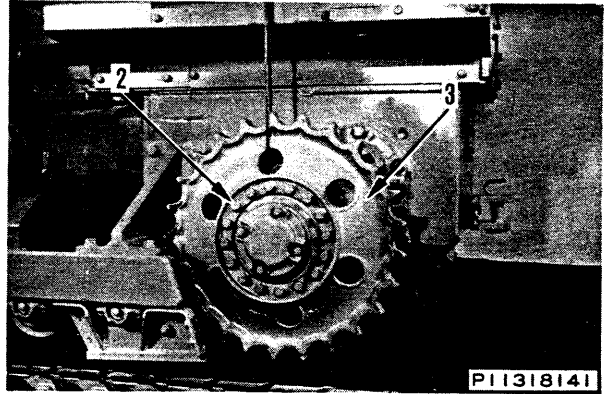
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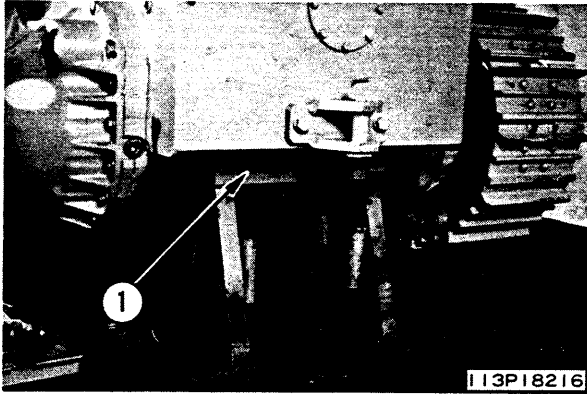
P2



P5



P3



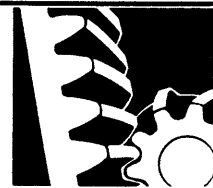


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# POWER TRAIN

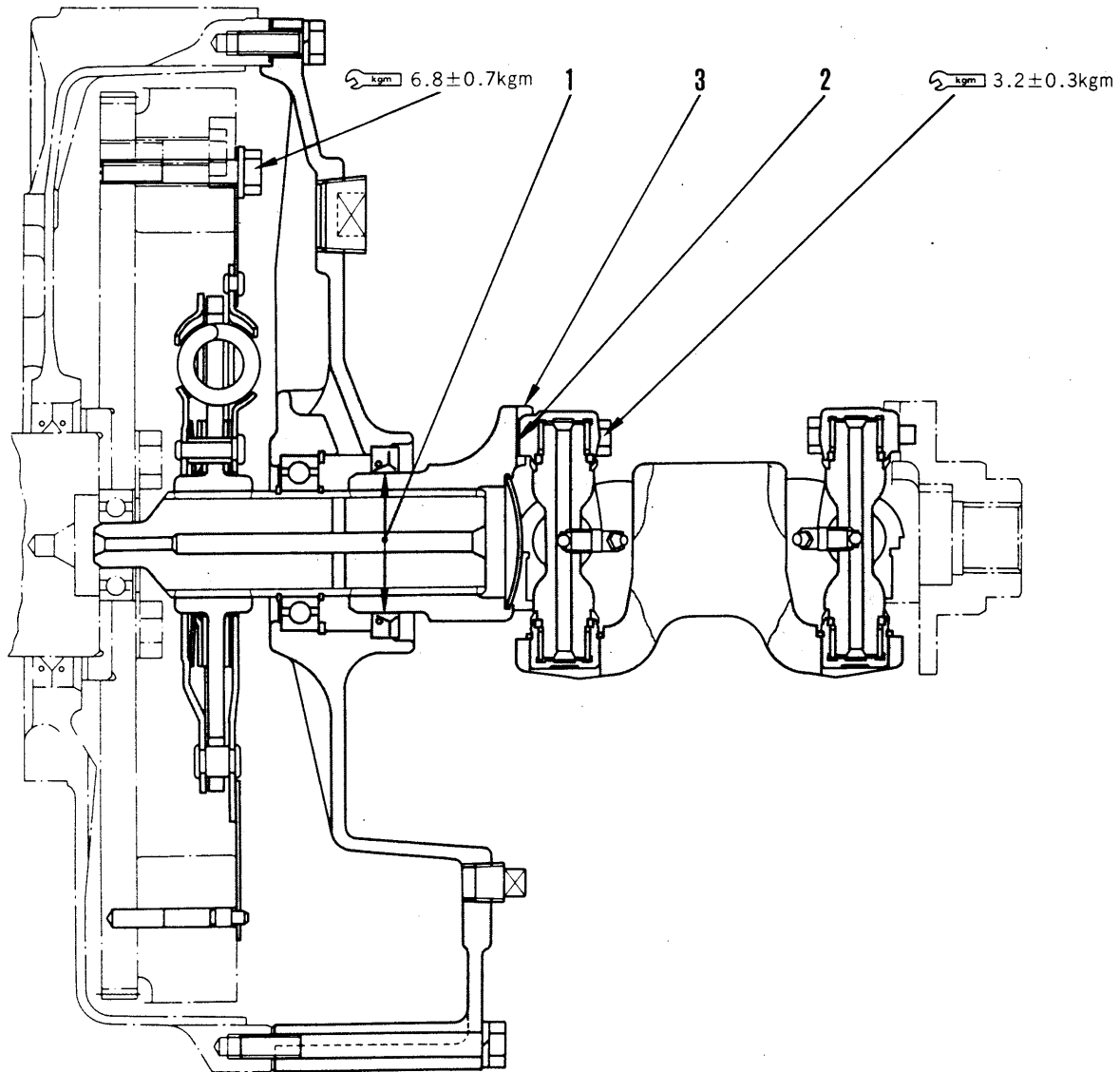
## 24 MAINTENANCE STANDARD

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Damper and universal joint .....	24- 2
Transmission and steering pump .....	24- 3
HYDROSHIFT transmission .....	24- 4
Transmission control valve .....	24- 6
Bevel gear shaft .....	24- 8
Steering clutch .....	24-10
Steering control valve (D31E, P, PL-18, D31P-18A, D37A, E-2) .....	24-12
Steering control valve (D31S, Q-18) .....	24-13
Steering booster cylinder .....	24-14
Steering brake .....	24-15
Final drive .....	24-16

# DAMPER AND UNIVERSAL JOINT



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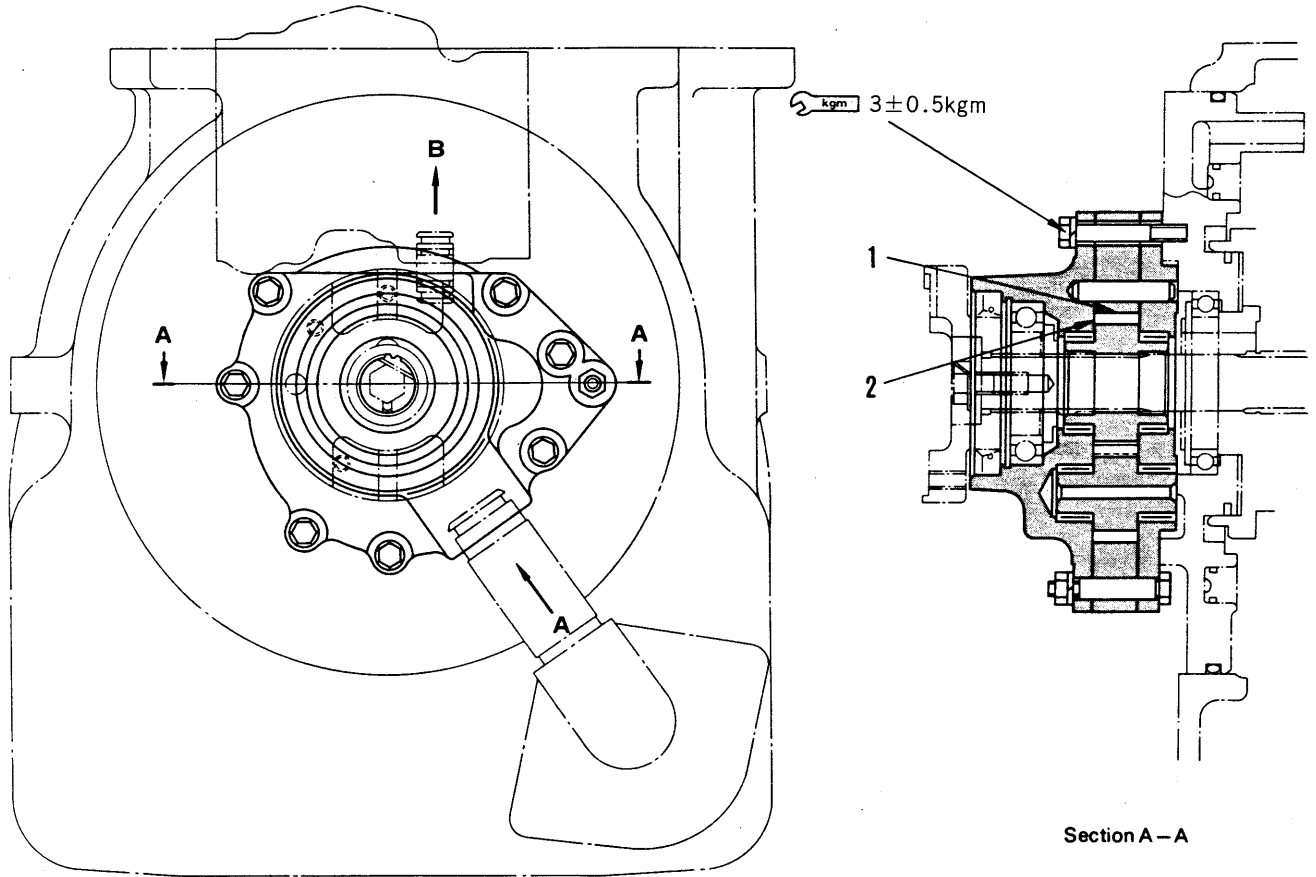
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Unit: mm

No.	Check item	Criteria			Remedy
		Standard size	Tolerance	Repair limit	
1	Outside diameter of oil seal contact surface on coupling	60	0 -0.074	59.9	Replace
2	Face runout of output coupling	Max. 1.0 (Take coupling at transmission end as fulcrum and measure surface of coupling at damper end)			Adjust
3	Radial runout of output coupling	Max. 3.0 (Take coupling at transmission end as fulcrum and measure surface of coupling at damper end)			

# TRANSMISSION AND STEERING PUMP

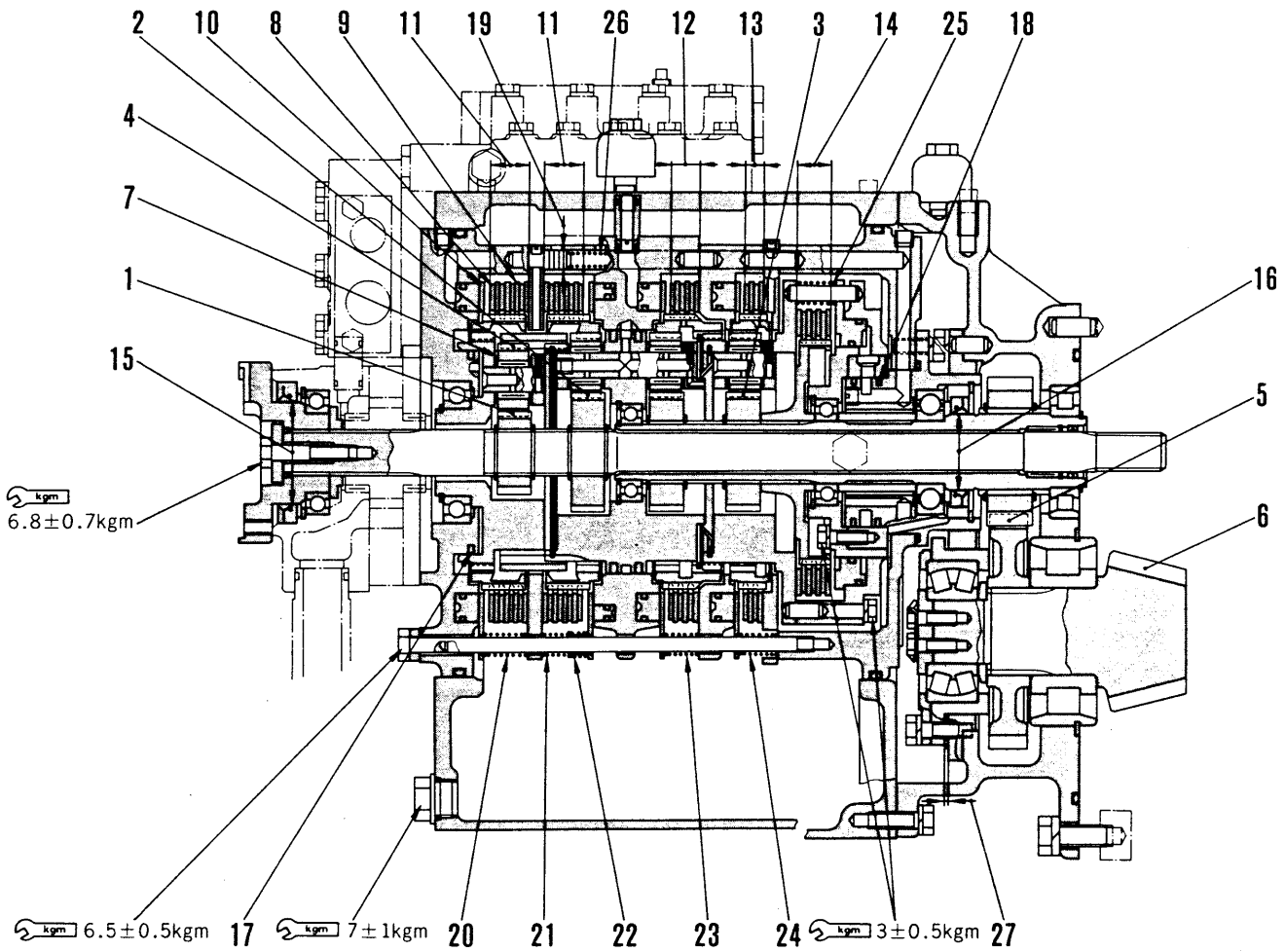
011418



113F18053

Unit: mm						
No.	Check item	Criteria				Remedy
1	Top clearance between gear case and gear	Standard clearance		Clearance limit		Repalce
		0.140 – 0.170		0.2		
2	Side clearance between gear case and gear	0.060 – 0.070		0.1		
3	Discharge (Class-CD SAE 10W, 45 – 55°C)	Revolution (rpm)	Pressure (kg/cm <sup>2</sup> )	Standard discharge (ℓ/min)	Repair limit discharge (ℓ/min)	-
		2,700	20	54.9	45.8	

# HYDROSHIFT TRANSMISSION



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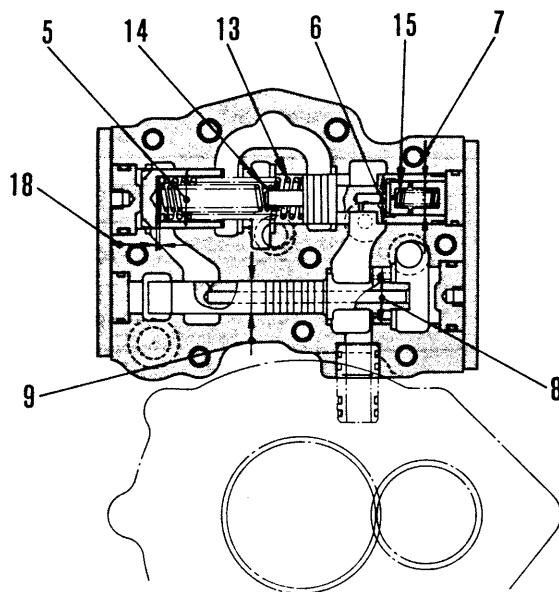
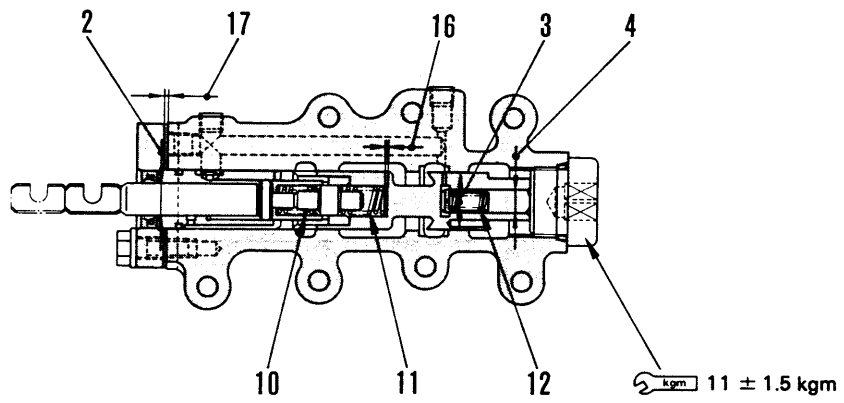
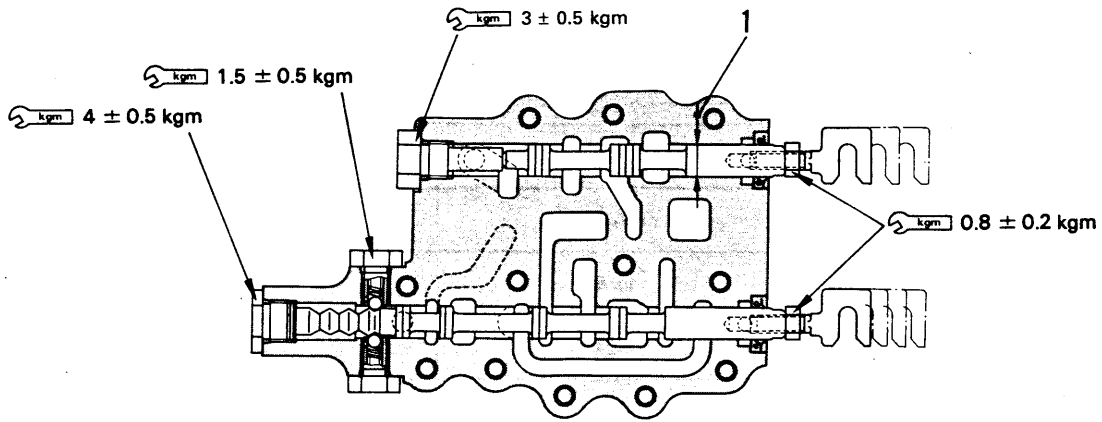
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Unit: mm

No.	Check item	Criteria		Remedy
		Standard size	Repair limit	
1	Backlash between No.1 sun gear and planetary gear	Standard size	Repair limit	Replace
		0.12 – 0.22	–	
2	Backlash between No.2 sun gear and planetary gear	0.14 – 0.24	–	
3	Backlash between No.3, 4 sun gear and planetary gear	0.13 – 0.23	–	
4	Backlash between each planetary gear and ring gear	0.15 – 0.27	–	
5	Backlash between transfer drive gear and driven gear	0.18 – 0.33	–	
6	Backlash between bevel pinion and bevel gear	0.18 – 0.23	–	
7	Clearance between each planetary gear and thrust bearing		–	

No.	Check item	Criteria				Remedy	
		Standard size		Repair limit			
8	Thickness of a disc	Standard size		Repair limit		Replce	
		3.0		2.7			
9	Thickness of a plate	3.2		2.9			
10	Thickness of a pressure plate	3.2		3.05			
11	Overall thickness of four discs and four plates for No.1 and No.2 clutches	24.8					
12	Overall thickness of three discs and three plates for No.3 clutch	18.6		16.8			
13	Overall thickness of two discs and two plates for No.4 clutch	12.4		11.2			
14	Overall thickness of three discs and four plates for No.5 clutch	21.8					
15	Outside diameter of oil seal contact surface on input coupling	Standard size	Tolerance		Repair limit	Repair or replace	
		65.0	0	-0.074	64.9		
16	Outside diameter of oil seal contact surface on output shaft	48.0	0	-0.062	47.9		
17	Wear of seal ring on No.1 carrier	Width	4.0	-0.01 -0.03	3.76		
		Thickness	4.9	± 0.12	4.70		
18	Wear of seal ring on No.4 carrier	Width	3.0	-0.01 -0.03	2.82		
		Thickness	3.8	± 0.12	3.65		
19	Clearance between lubrication valve spool and clutch housing	Standard size	Tolerance		Standard clearance	Clearance limit	
			Shaft	Hole			
		12.0	-0.020 -0.030	+0.027 0	0.020 - 0.057	0.08	
20	No.1 clutch spring	Standard size			Repair limit		Replace
		Free length	Installation length	Installation load	Free length	Installation load	
		29.13	27.8	8.69 kg	27.4	7.4 kg	
21	No.2 clutch spring	18.65	16.5	7.88 kg	17.5	6.7 kg	
22	No.2 clutch spring	22.93	10.3	7.88 kg	21.6	6.7 kg	
23	No.3 clutch spring	29.0	20.8	12.33 kg	27.3	10.5 kg	
24	No.4 clutch spring	37.5	24.8	12.14 kg	35.3	10.3 kg	
25	No.5 clutch spring	29.0	25.0	6.02 kg	27.3	5.1 kg	
26	Lubrication valve spring	25.4	23.6	1.93 kg	23.9	1.65 kg	
27	Thickness of shim for bevel pinion bearing cage	2.0				Adjust	

# TRANSMISSION CONTROL VALVE



011418

F10406019B

※1: Applicable Serial No.

※2: Applicable Serial No.

D31E-18	40771 and up
D31P-18	41408 and up
D31P-18A	41337 and up
D31PL-18	41402 and up
D31PLL-18	41406 and up
D31S-18	40255 and up
D31Q-18	40239 and up
D37E-2	2104 and up
D37P-2	1711 and up

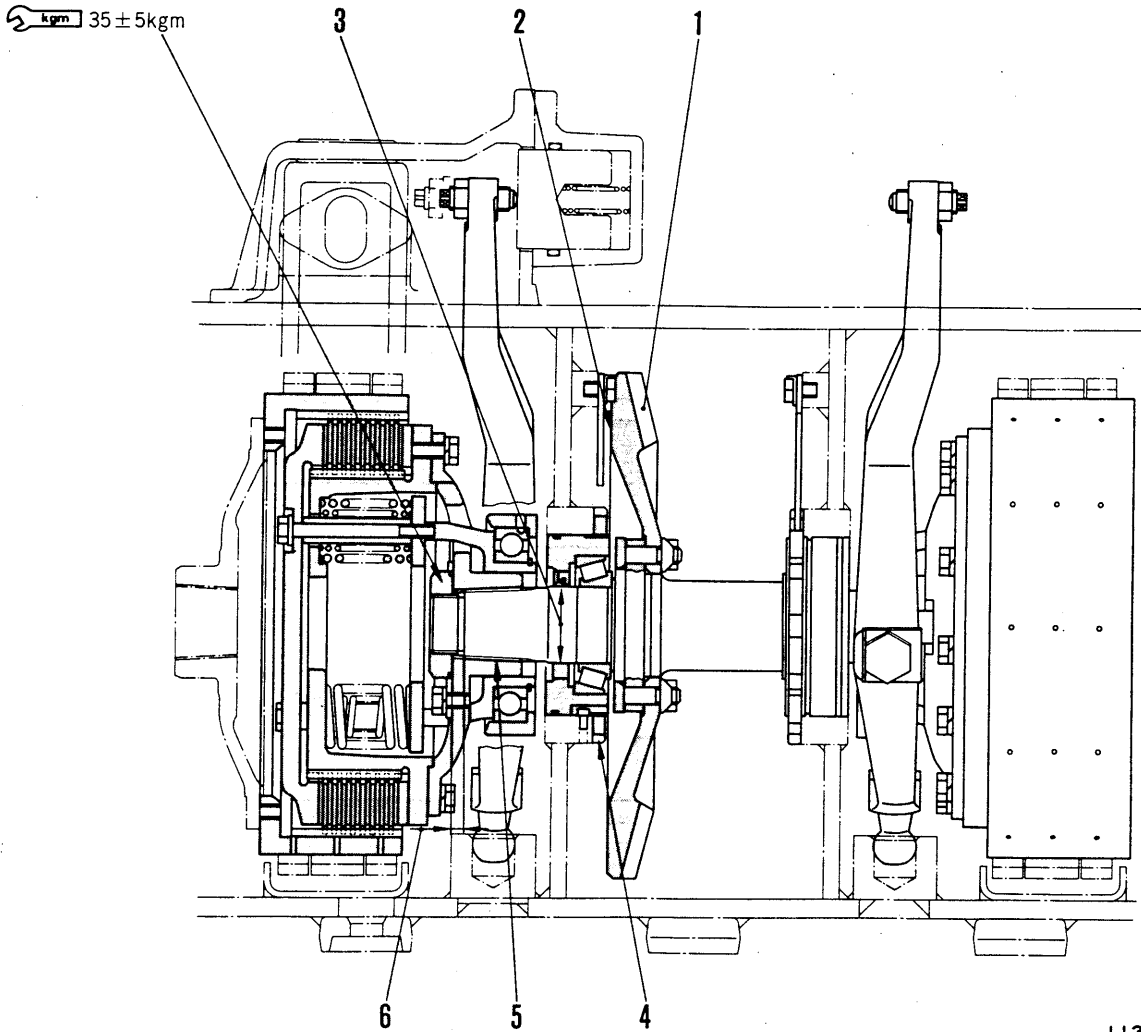
D31E-18	40247 and up
D31P-18	40326 and up
D31P-18A	40279 and up
D31PL-18	40327 and up
D31PLL-18	40323 and up
D31S-18	40068 and up
D31Q-18	40239 and up
D37E-2	1702 and up
D37P-2	1549 and up

Unit: mm

No.	Check item	Criteria					Remedy	
		Standard size	Tolerance		Standard clearance	Clearance limit		
Shaft	Hole							
1	Clearance between F-R and speed valve spool and body	14.0	-0.020 -0.030	+0.011 0	0.020 - 0.041	0.08	Replace	
2	Clearance between inching spool and sleeve	14.0	0 -0.027	+0.027 0	0 - 0.054	0.08		
3	Clearance between inching valve spool and body	25.0	-0.035 -0.045	+0.013 0	0.035 - 0.058	0.08		
4	Clearance between inching valve spool and piston	10.0	-0.020 -0.030	+0.015 0	0.020 - 0.045	0.08		
5	Clearance between modulating load piston and body	26.0	-0.035 -0.045	+0.013 0	0.035 - 0.058	0.08		
6	Clearance between modulating valve spool and body	22.0	-0.035 -0.045	+0.013 0	0.035 - 0.058	0.08		
7	Clearance between modulating valve spool and piston	15.0	-0.020 -0.030	+0.018 0	0.020 - 0.048	0.08		
8	Clearance between quick return valve spool and body	25.0	-0.100 -0.200	+0.033 0	0.100 - 0.233	0.26		
9	Clearance between quick return valve spool and body	14.0	-0.035 -0.045	+0.011 0	0.035 - 0.056	0.08		
10	Inching valve spring	Standard size			Repair limit			
		Free length	Installation length	Installation load	Free length	Installation load		
		27.0	18.0	2.115 kg	26.2	2.0 kg		
11	Inching valve spring		34.30	20.0	4.73 kg	33.3	4.5 kg	
		※1	34.19	20.0	5.68 kg	33.2	5.4 kg	
12	Piston spring	26.0	21.0	0.415 kg	25.2	0.39 kg		
13	Modulating valve spring (Large)	62.0	37.0	22.8 kg	60.1	21.7 kg		
14	Modulating valve spring (Small)		52.4	40.0	12.8 kg	50.8	12.2 kg	
		※2	53.9	39.88	14.5 kg	51.2	13.05 kg	
15	Piston spring	26.0	21.0	0.42 kg	25.2	0.4 kg		
16	Thickness of shim for inching valve	1.0 (One shim of 0.5 mm will charge the pressure by 0.25 kg/cm <sup>2</sup> )					Adjustment	
17	Thickness of shim for inching valve sleeve	1.0 (One shim of 0.5 mm will charge the pressure by 0.09 kg/cm <sup>2</sup> )						
18	Thickness of shim for modulating valve	1.0 (One shim of 0.5 mm will charge the pressure by 0.55 kg/cm <sup>2</sup> )						

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# BEVEL GEAR SHAFT



I 13F18054

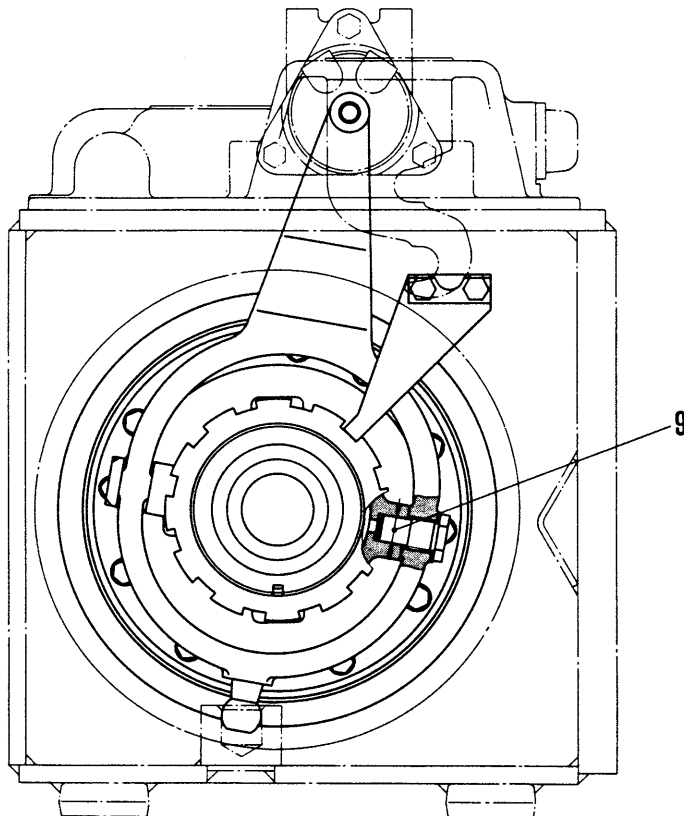
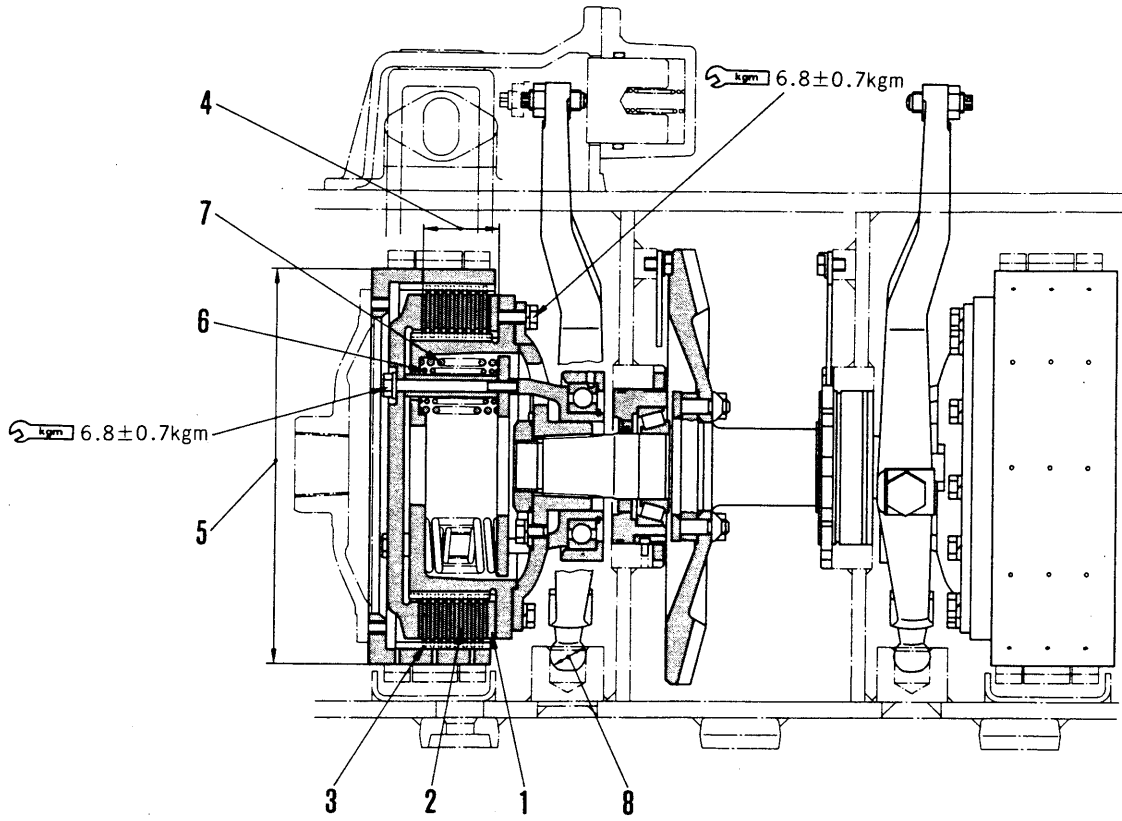
Unit: mm

No.	Check item	Criteria			Remedy
		Standard clearance	Clearance limit		
1	Backlash between bevel gear and pinion	0.18 – 0.23	–		Adjust
2	Face runout of back of bevel gear	Max. 0.1			
3	Outside diameter of oil seal contact surface on bevel gear shaft	Standard size	Tolerance	Repair limit	Repair or replace
		55	0 –0.074	54.9	
4	Preload of tapered roller bearing on bevel gear shaft	0.14 – 0.24 kgm (Rotating torque of bevel gear shaft) (For details, see 23 INSTALLATION OF BEVEL GEAR SHAFT AND BEVEL GEAR ASSEMBLY.)			Adjust
5	Fitting pressure of hub of bevel gear shaft	4 – 12 ton			
6	Clearance between bevel gear shaft and hub	8 ± 0.7			

011418



# STEERING CLUTCH



011418

113F18055

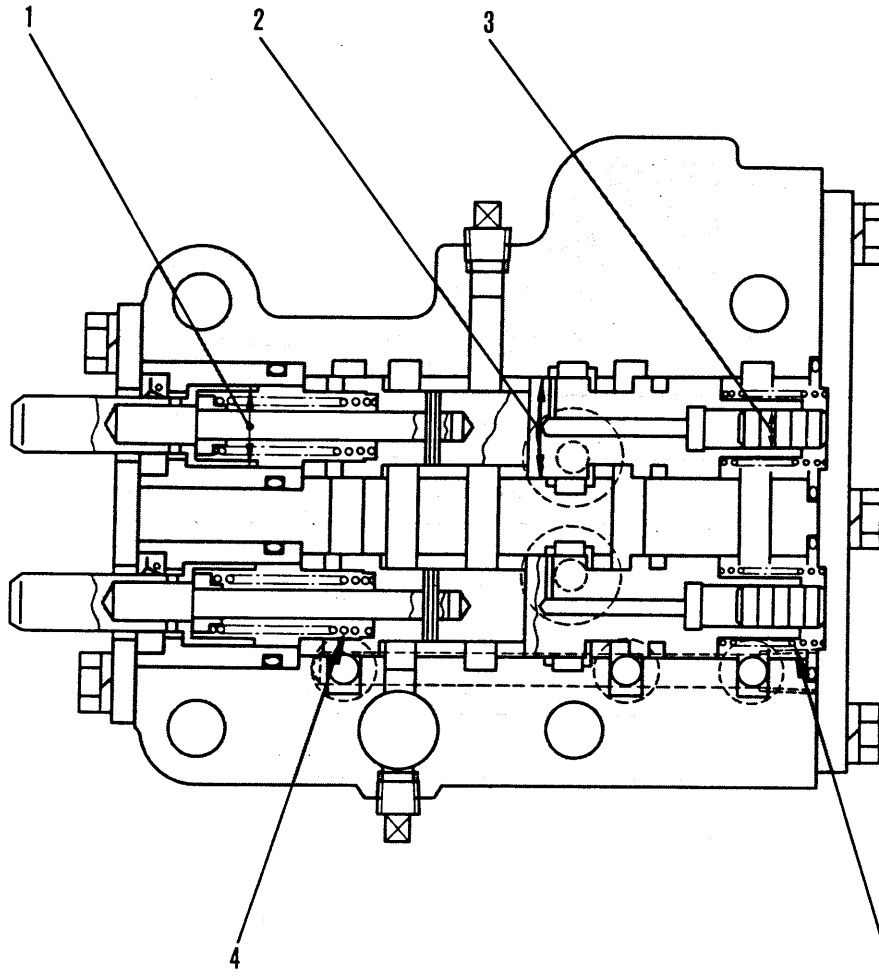
Unit: mm

No.	Check item	Criteria				Remedy	
1	Thickness of clutch plate	Standard size		Repair limit		Replace	
		6.8		5.3			
2	Thickness of clutch plate	2.6		2.4		Repair or replace	
	Strain of clutch plate	Tolerance		Repair limit			
3	Thickness of clutch disc	Standard size		Repair limit		Replace	
		4.2		3.6			
4	Strain of clutch disc	Tolerance		Repair limit		Repair or replace	
		0.2		0.2			
5	Thickness of clutch disc assembly	Standard size		Repair limit		Replace	
		63.8		61.8			
6	Wear of brake drum of outside diameter	330.0		329.0		Replace	
7	Clutch spring	Standard size			Repair limit		Replace
		Free length	Installation length	Installation load	Free length	Installation load	
		100.3	65.0	140.7 kg	—	132.0 kg	
8	Clutch spring	94.0	65.0	70.0 kg	—	66.0 kg	
9	Clearance between release yoke ball and bushing	Standard size	Tolerance		Standard clearance	Clearance limit	
			Shaft	Hole			
		30	-0.100 -0.200	+0.200 0	0.100 - 0.400	1.0	
10	Clearance between pin for release yoke and bearing cage	20	-0.050 -0.070	+0.021 0	0.050 - 0.091	0.2	

011418

# STEERING CONTROL VALVE

D31E, P, PL, PLL-18, D31P-18A, D37E, P-2



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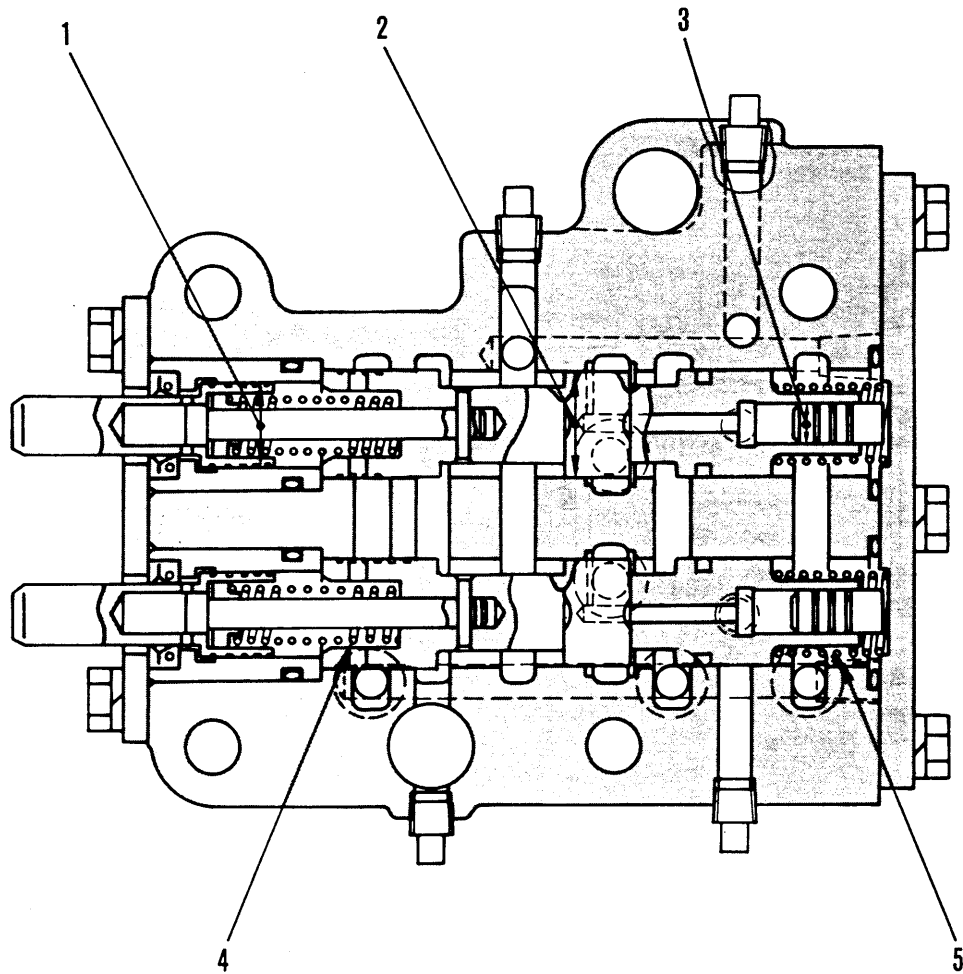
011418

Unit: mm

No.	Check item	Criteria				Remedy
		Standard size	Tolerance		Standard clearance	
Shaft	Hole					
1	Clearance between valve stem and sleeve	20	-0.035 -0.045	+0.013 0	0.035 - 0.058	0.08
2	Clearance between valve spool and body	25	-0.035 -0.045	+0.013 0	0.035 - 0.058	0.08
3	Clearance between valve spool and piston	10	-0.030 -0.040	+0.015 0	0.030 - 0.055	0.08
4	Modulating valve spring	Standard size			Repair limit	
		Free length	Installation length	Installation load	Free length	Installation load
		62.5	40.0	11.77 kg	60.6	11.1 kg
5	Spool return spring	87.0	25.0	4.04 kg	84.4	3.8 kg

# STEERING CONTROL VALVE

D31S, Q-18



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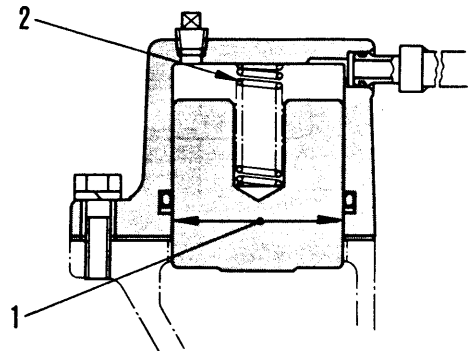
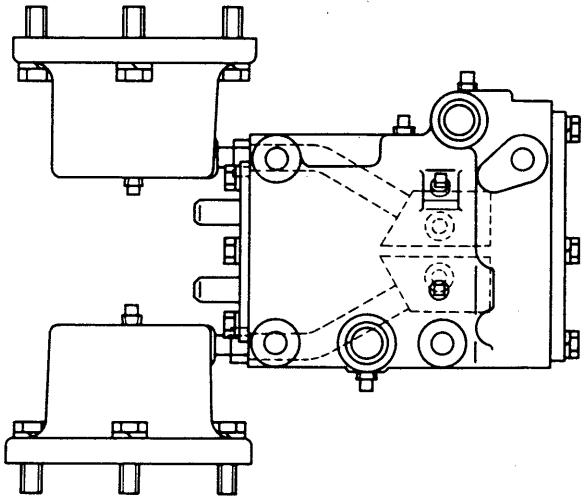
113F18081

Unit: mm

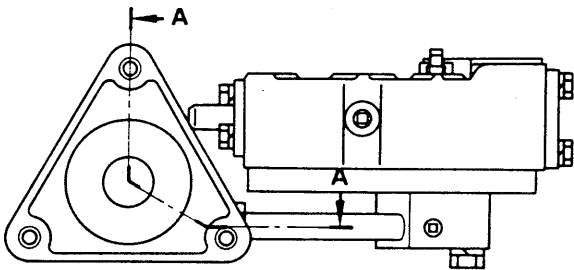
No.	Check item	Criteria				Remedy	
		Standard size	Tolerance		Standard clearance		Clearance limit
Shaft	Hole						
1	Clearance between valve stem and sleeve	20	-0.035 -0.045	+0.013 0	0.035 - 0.058	0.08	
2	Clearance between valve spool and body	25	-0.035 -0.045	+0.013 0	0.035 - 0.058	0.08	
3	Clearance between valve spool and piston	10	-0.030 -0.040	+0.015 0	0.030 - 0.055	0.08	Replace
4	Modulating valve spring	Standard size			Repair limit		
		Free length	Installation length	Installation load	Free length	Installation load	
		62.5	40.0	11.77 kg	60.6	11.1 kg	
5	Spool return spring	87.0	25.0	4.04 kg	84.4	3.8 kg	

# STEERING BOOSTER CYLINDER

- D31E-18      Serial No. 40001 - 40445
- D31P-18      Serial No. 40001 - 40745
- D31P-18A    Serial No. 40001 - 40684
- D31PL, PLL-18   Serial No. 40001 - 40743
- D31S-18      Serial No. 40001 - 41114
- D31Q-18      Serial No. 40001 - 41111
- D37E-2        Serial No. 1501 - 2500
- D37P-2        Serial No. 1501 - 2000



Section A - A



011418

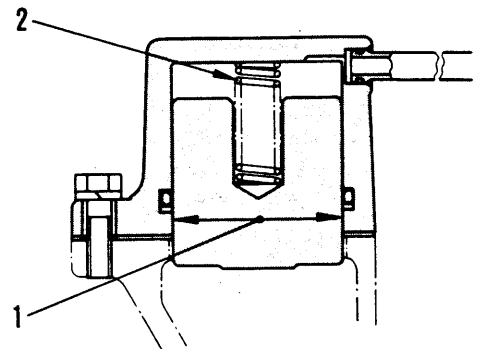
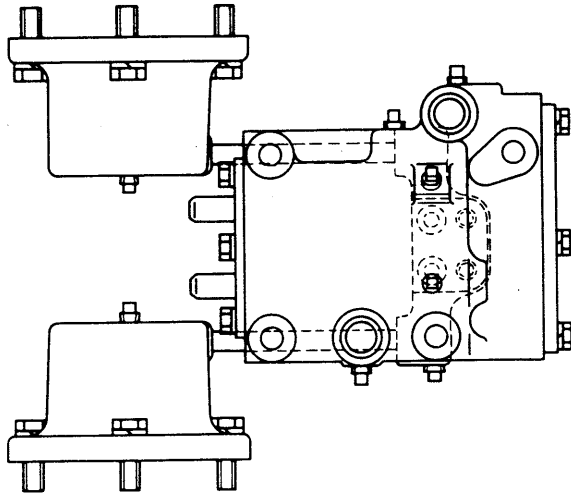
I 13F 18056

Unit: mm

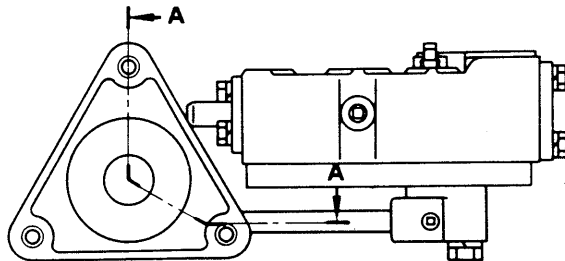
No.	Check item	Criteria				Remedy
		Standard size	Tolerance		Standard clearance	
	Shaft		Hole			
1	Clearance between cylinder and piston	70	-0.030 -0.060	+0.030 0	0.030 - 0.090	Replace
2	Piston spring	Standard size		Repair limit		
		Free length	Installation length	Installation load	Free length	Installation load
		52.0	49.0	5.1 kg		

# STEERING BOOSTER CYLINDER

- D31E-18      Serial No. 40446 and up
- D31P-18      Serial No. 40746 and up
- D31P-18A     Serial No. 40685 and up
- D31PL, PLL-18   Serial No. 40744 and up
- D31S-18      Serial No. 41115 and up
- D31Q-18      Serial No. 41112 and up
- D37E-2        Serial No. 2501 and up
- D37P-2        Serial No. 2001 and up



Section A - A



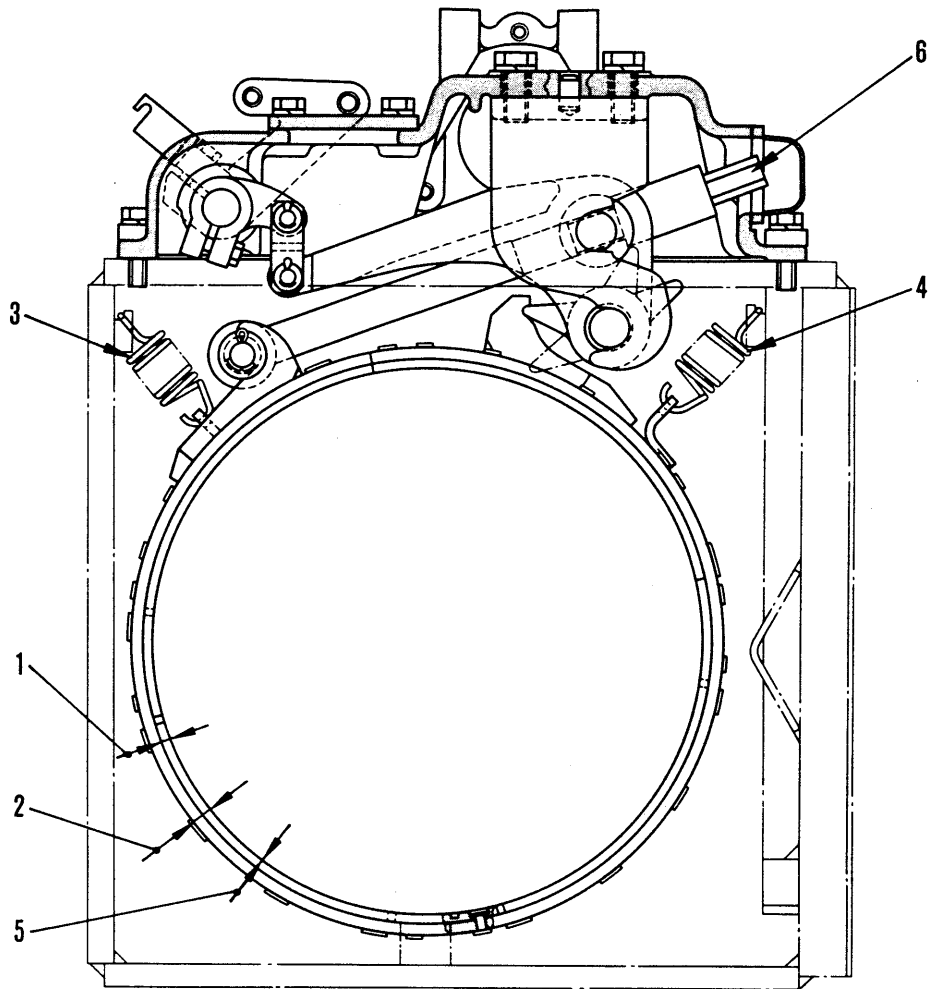
011418

113F18315

Unit: mm

No.	Check item	Criteria				Remedy
		Standard size	Tolerance		Standard clearance	
	Shaft		Hole			
1	Clearance between cylinder and piston	70	-0.030 -0.060	+0.030 0	0.030 - 0.090	0.1
2	Piston spring	Standard size			Repair limit	
		Free length	Installation length	Installation load	Free length	Installation load
		52.0	49.0	5.1 kg		

# STEERING BRAKE



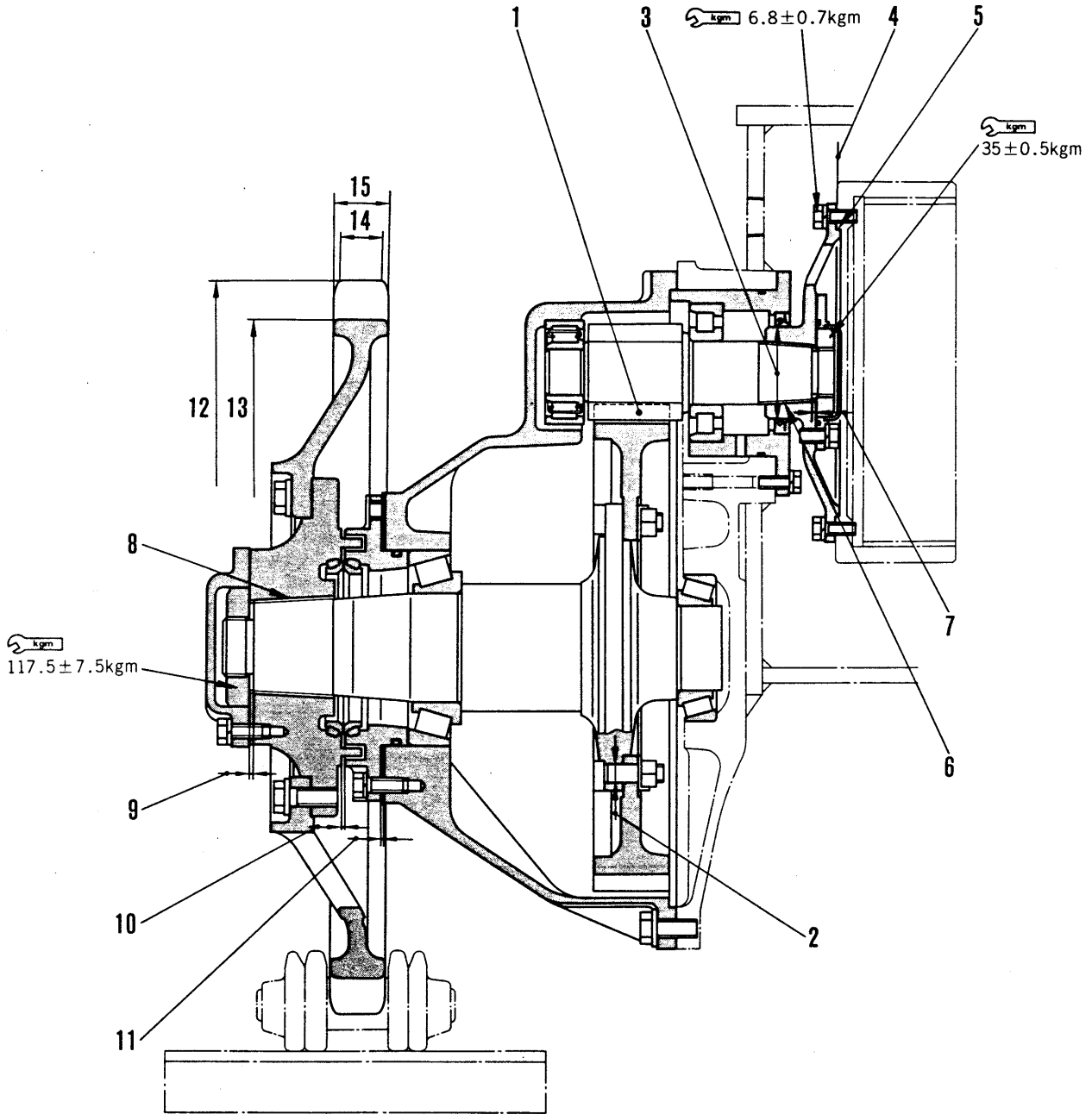
011418

113F18057

Unit: mm

No.	Check item	Criteria					Remedy
		Standard size			Repair limit		
1	Thickness of brake lining	6.0			4.3		Replace
2	Thickness of lining and brake band assembly	14.0			12.3		
3	Brake band spring for rearward	Standard size			Repair limit		
		Free length	Installation length	Installation load	Free length	Installation load	
		72.0	76.5	8.2 kg	—	—	
4	Brake band spring for forward	72.0	77.0	8.7 kg	—	—	
5	Clearance between brake drum and lining	0.3					Adjust
6	Brake lining adjustment nut	Tighten adjustment nut to 4 kgm and turn back 2.5 rotation					

# FINAL DRIVE



113F18058

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Unit: mm

No.	Check item	Criteria				Remedy		
1	Backlash between pinion and gear	Tolerance		Repair limit				
		0.18 – 0.53		–				
2	Interference between boss of sprocket shaft and reamer bolt	Standard size	Tolerance		Standard interference	Interference limit	Replace	
			Shaft	Hole				
		16	0 –0.015	+0.027 0	0 – 0.042	–		
3	Outside diameter of oil seal contact surface on final drive flange	Standard size		Tolerance		Repair limit		Repair or replace
		80		0 –0.074		79.9		
4	Face runout of final drive flange	0.3 (Datum point: Center of bevel gear shaft (at $\phi$ 172))						
5	Radial runout of final drive flange	0.4 (Datum point: Center of bevel gear shaft)						
6	Fitting pressure of final drive flange	4 – 12 ton						Adjust
7	Clearance between final drive flange and pinion shaft	3 $\pm$ 0.7						
8	Fitting pressure of sprocket shaft	15 – 45 ton						
9	Clearance between sprocket shaft and sprocket boss	1.5 $\begin{matrix} +0.5 \\ -0.1 \end{matrix}$						
10	Clearance between sprocket boss and ring	2.5						
11	Thickness of shim for ring	1.5 (For details, see 23 ASSEMBLY OF FINAL DRIVE ASSEMBLY.)						
12	Wear of tips of sprocket teeth	Standard size		Repair limit				Repair or replace
		636.4		624.5				
13	Wear of roots of sprocket teeth	571.9		560.0				
14	Wear of teeth crest width of sprocket teeth	38.0		32.0				
15	Wear of bottom land width of sprocket teeth	47.5		42.0				

011418

# UNDERCARRIAGE

## 31 STRUCTURE AND FUNCTION



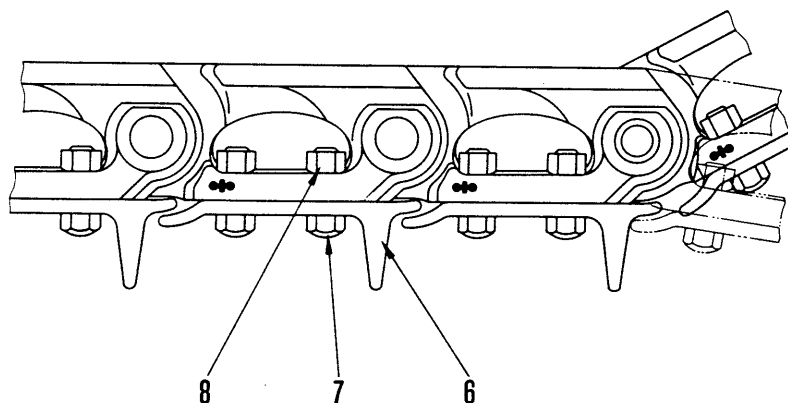
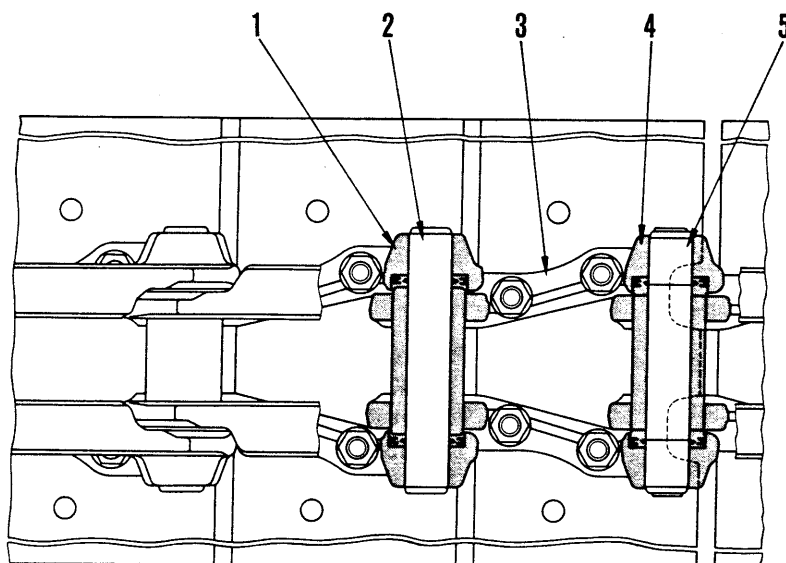
Track (dry type track link) (D31E, P, PL, PLL-18, D31P-18A, D37E, P-2) .....	31- 2
Track (lubricated track link) (D31E, P, PL, PLL-18, D31P-18A, D37E, P-2) .....	31- 3
Track (dry type track link) (D31S, Q-18) .....	31- 4
Track (lubricated track link) (D31S, Q-18) .....	31- 5
Track group .....	31- 6
Idler .....	31- 9
Idler cushion .....	31-10
Track roller .....	31-12
Carrier roller .....	31-12
Main frame and suspension .....	31-13

011418

# TRACK (DRY TYPE TRACK LINK)

D31E, P, PL, PLL-18, D31P-18A, D37E, P-2

★ The diagram shows the D31E-18 track.



1. Regular bushing
2. Regular pin
3. Link
4. Master bushing
5. Master pin
6. Track shoe
7. Shoe bolt
8. Shoe nut

## OUTLINE

- Track shoe (6) for the D31E-18 and D37E-2 is a single grouser type.
- Track shoe (6) for the D31P, PL, PLL-18, D37P-2 and D31P-18A is a swamp type.

	Number of shoes (each side)	Shoe width (Standard)
D31E-18	37	330 mm
D31P-18A	41	600
D31P-18	41	600
D31PL-18	41	1,050
D31PLL-18	46	1,050
D37E-2	47	330
D37P-2	41	600

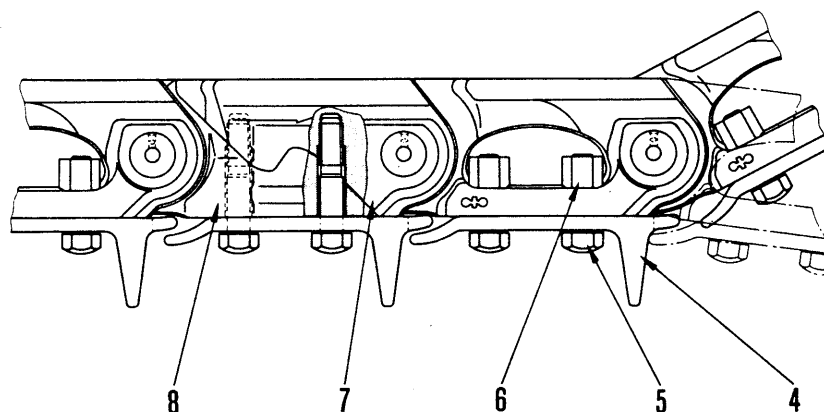
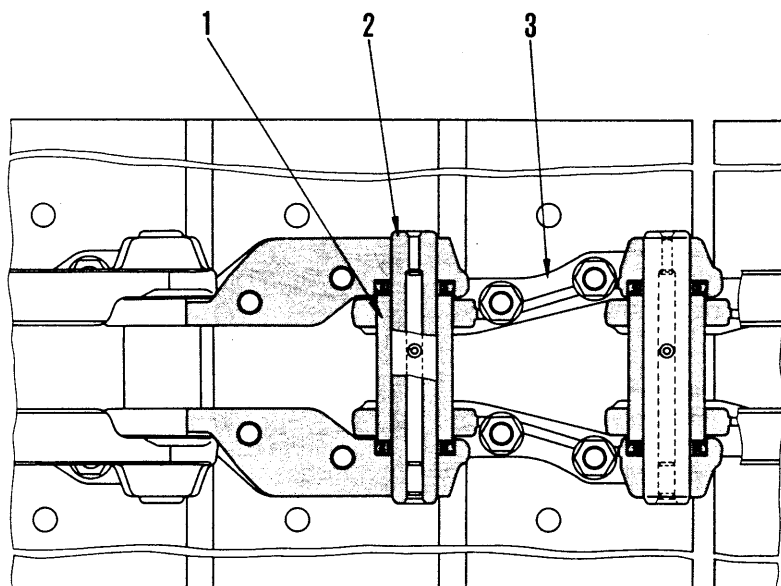
011418

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# TRACK (LUBRICATED TRACK LINK)

D31E, P, PL, PLL-18, D31P-18A, D37E, P-2

★ The diagram shows the D31E-18 track.



F11318026

1. Bushing
2. Pin
3. Regular link
4. Track shoe
5. Shoe bolt
6. Shoe nut
7. Master link (pin side)
8. Master link (shoe side)

## OUTLINE

- Track shoe (6) for the D31E-18 and D37E-2 is a single grouser type.
- Track shoe (6) for the D31P, PL, PLL-18, D37P-2 and D31P-18A is a swamp type.

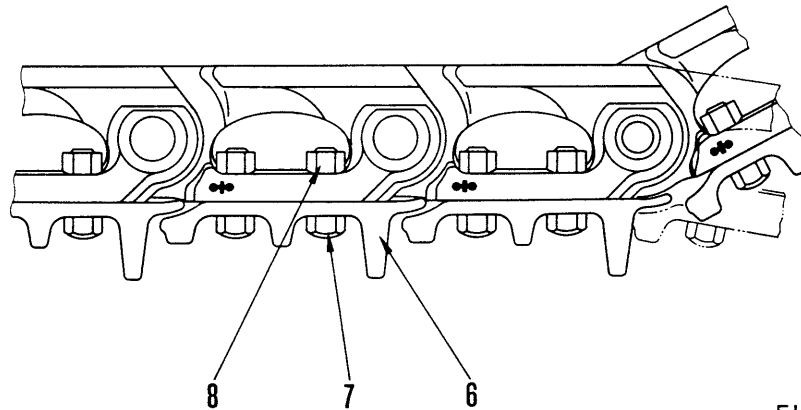
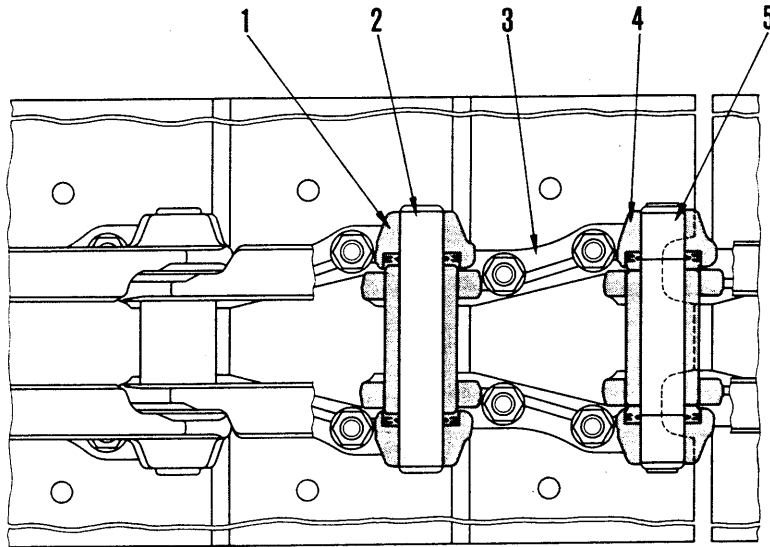
	Number of shoes (each side)	Shoe width (Standard)
D31E-18	37	330 mm
D31P-18A	41	600
D31P-18	41	600
D31PL-18	41	1,050
D31PLL-18	46	1,050
D37E-2	47	330
D37P-2	41	600

011418

# TRACK (DRY TYPE TRACK LINK)

D31S, Q-18

★ The diagram shows the D31S-18 track.



F11318027

1. Regular bushing
2. Regular pin
3. Link
4. Master bushing
5. Master pin
6. Track shoe
7. Shoe bolt
8. Shoe nut

## OUTLINE

- Track shoe (6) for the D31S-18 is a semidouble grouser type.
- Track shoe (6) for the D31Q-18 is a swamp type.

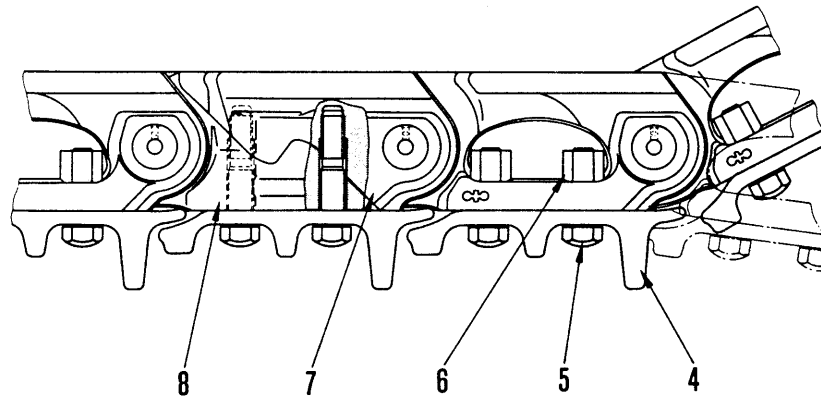
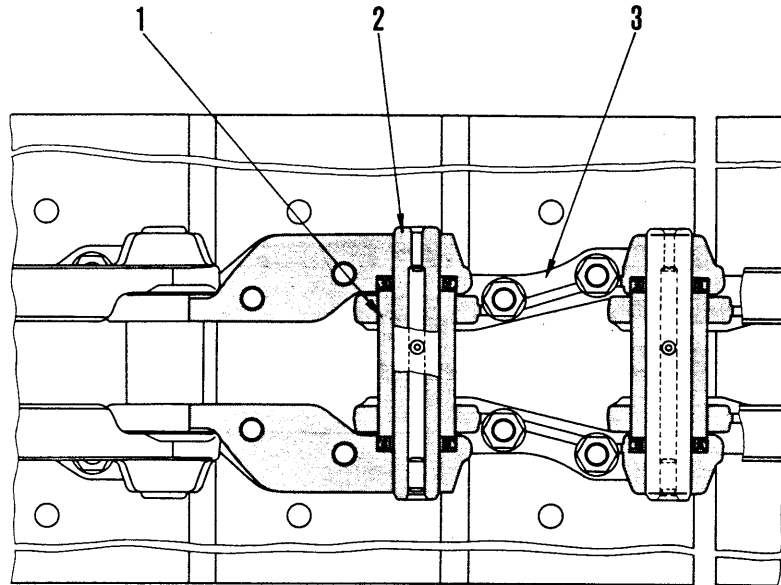
	Number of shoes (each side)	Shoe width (Standard)
D31S-18	37	330 mm
D31Q-18	37	600

011418

# TRACK (LUBRICATED TRACK LINK)

D31S, Q-18

★ The diagram shows the D31S-18 track.



011418

F11318028

1. Bushing
2. Pin
3. Regular link
4. Track shoe
5. Shoe bolt
6. Shoe nut
7. Master link (pin side)
8. Master link (shoe side)

## OUTLINE

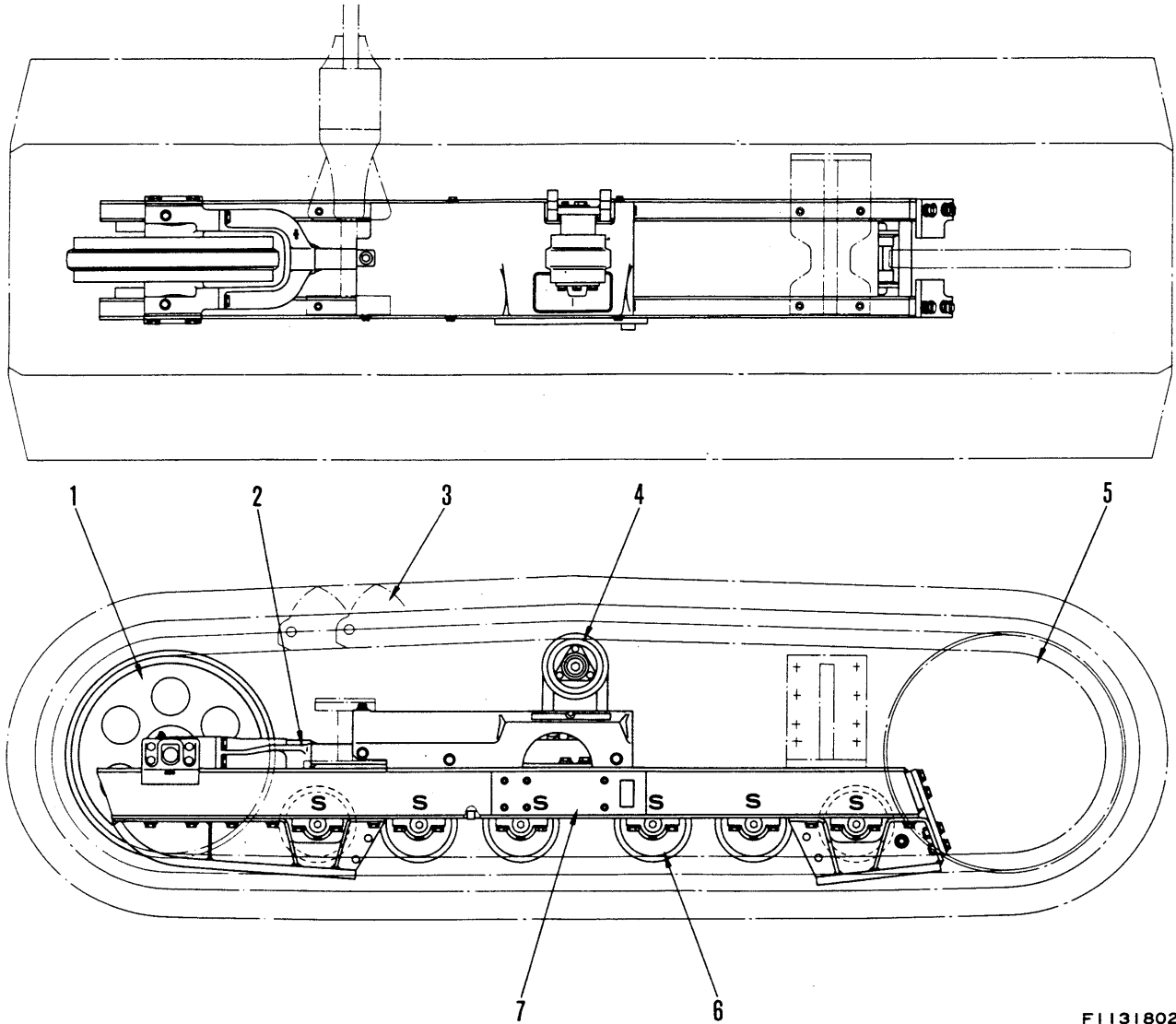
- Track shoe (6) for the D31S-18 is a semidouble grouser type.
- Track shoe (6) for the D31Q-18 is a swamp type.

	Number of shoes (each side)	Shoe width (Standard)
D31S-18	37	330 mm
D31Q-18	37	600

# TRACK GROUP

D31E, P, PL, PLL-18  
 D37E-2 Serial No. 1501-2500  
 D37P-2 Serial No. 1501-2000

★ The diagram shows the D31E-18



- 1. Idler
- 2. Idler cushion
- 3. Track
- 4. Carrier roller
- 5. Sprocket
- 6. Track roller
- 7. Track frame

### OUTLINE

- The track group supports the whole machine weight, and moves the machine by driving track (3) using the motive force of the power train transmitted from sprocket (5).

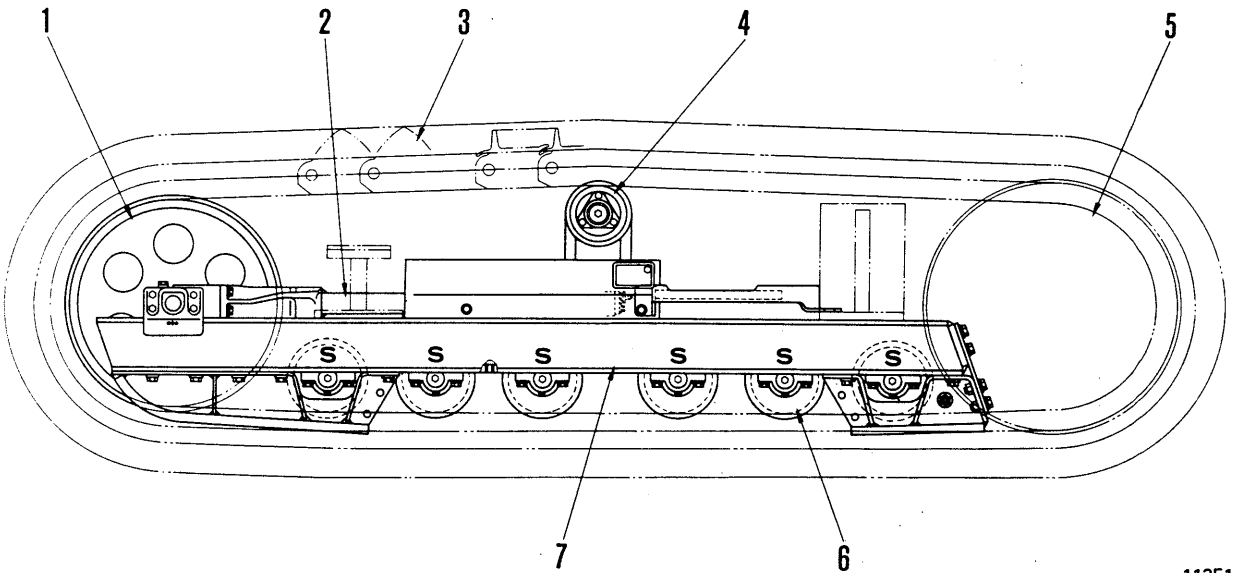
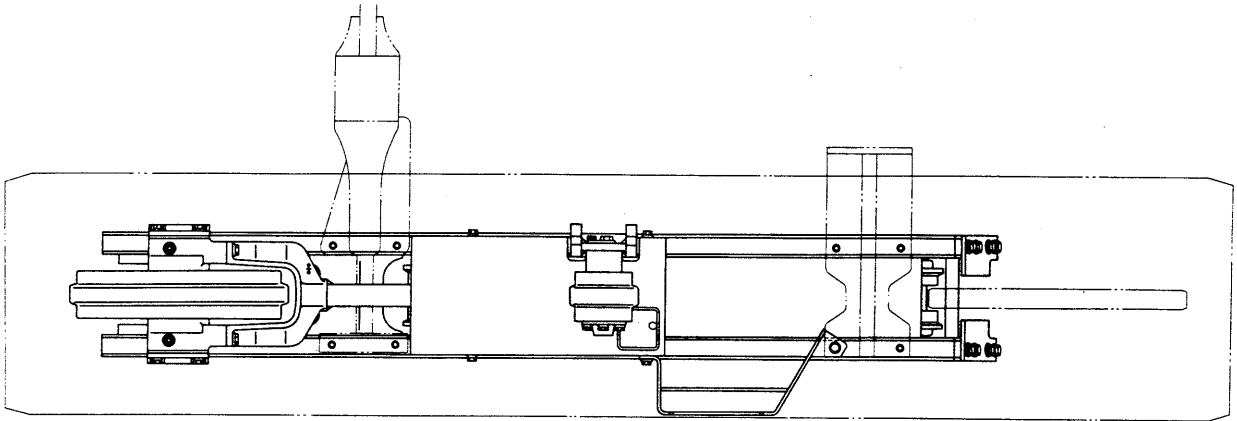
- Number of rollers

Model	Number of Carrier roller (each side)	Number of track roller (each side)
D31E,P,PL-18	1	6
D31PLL-18	2	8

011418

F11318029

D31P-18A Serial No. 40001 and up  
 D37E-2 Serial No. 2501 and up  
 D37P-2 Serial No. 2001 and up



011418

113F18307

1. Idler
2. Idler cushion
3. Track
4. Carrier roller
5. Sprocket
6. Track roller
7. Track frame

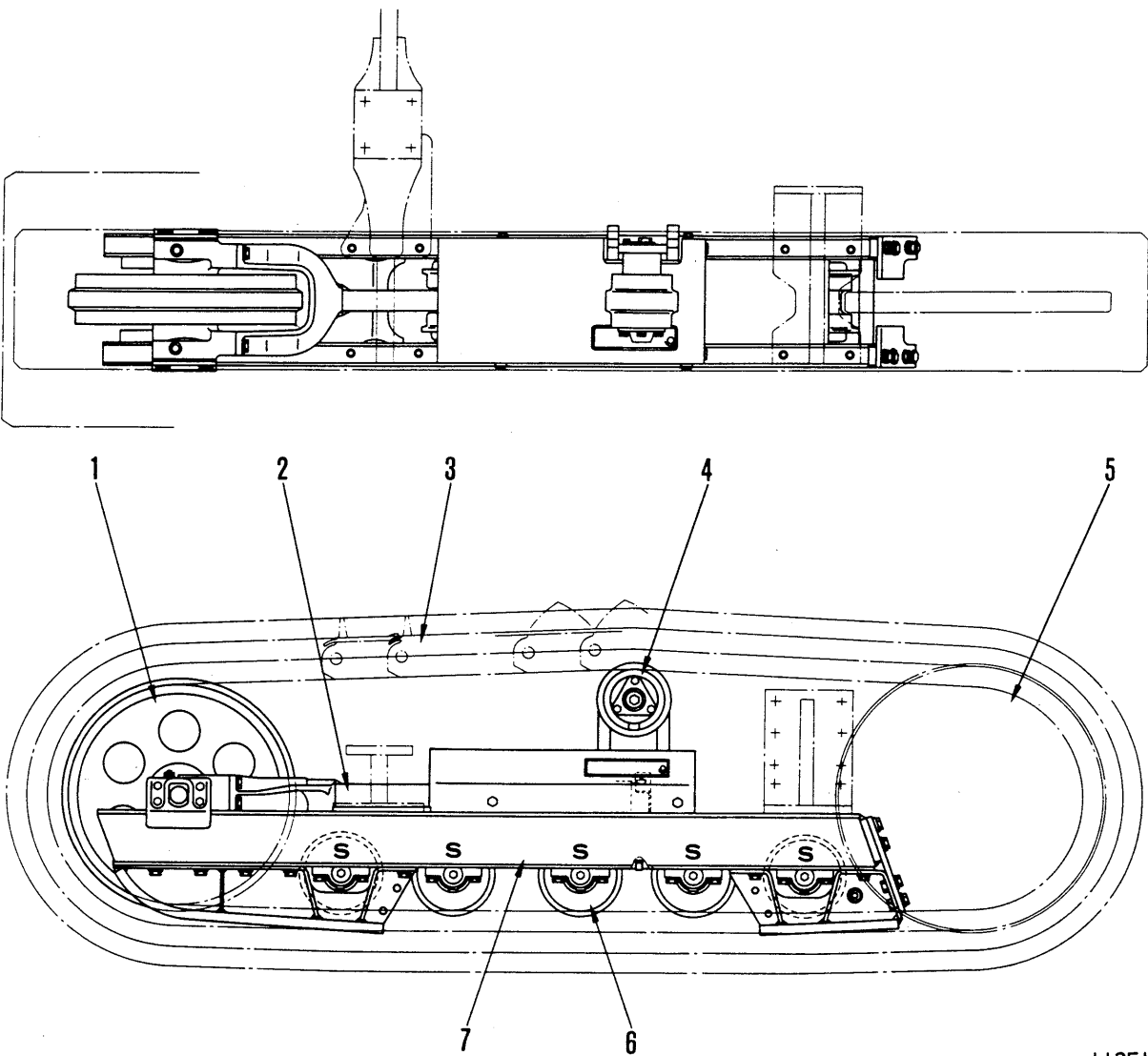
**OUTLINE**

- The track group supports the whole machine weight, and moves the machine by driving track (3) using the motive force of the power train transmitted from sprocket (5).

- Number of rollers

Model	Number of Carrier roller (each side)	Number of track roller (each side)
D31P-18A D37E, P-2	1	6





113F18021

1. Idler
2. Idler cushion
3. Track
4. Carrier roller
5. Sprocket
6. Track roller
7. Track frame

**OUTLINE**

- The track group supports the whole machine weight, and moves the machine by driving track (3) using the motive force of the power train transmitted from sprocket (5).

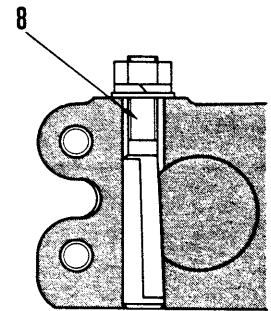
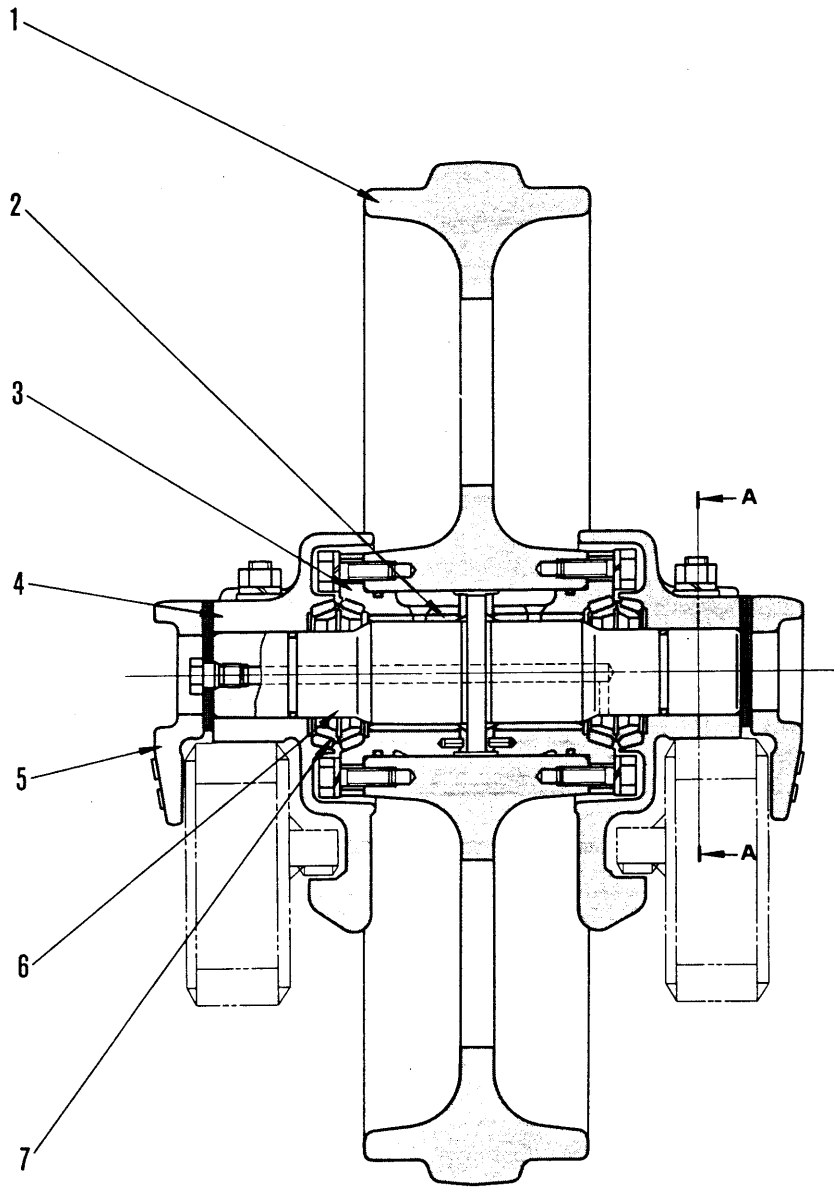
• Number of rollers

Model	Number of Carrier roller (each side)	Number of track roller (each side)
D31S, Q-18	1	5

011418

# IDLER

011418



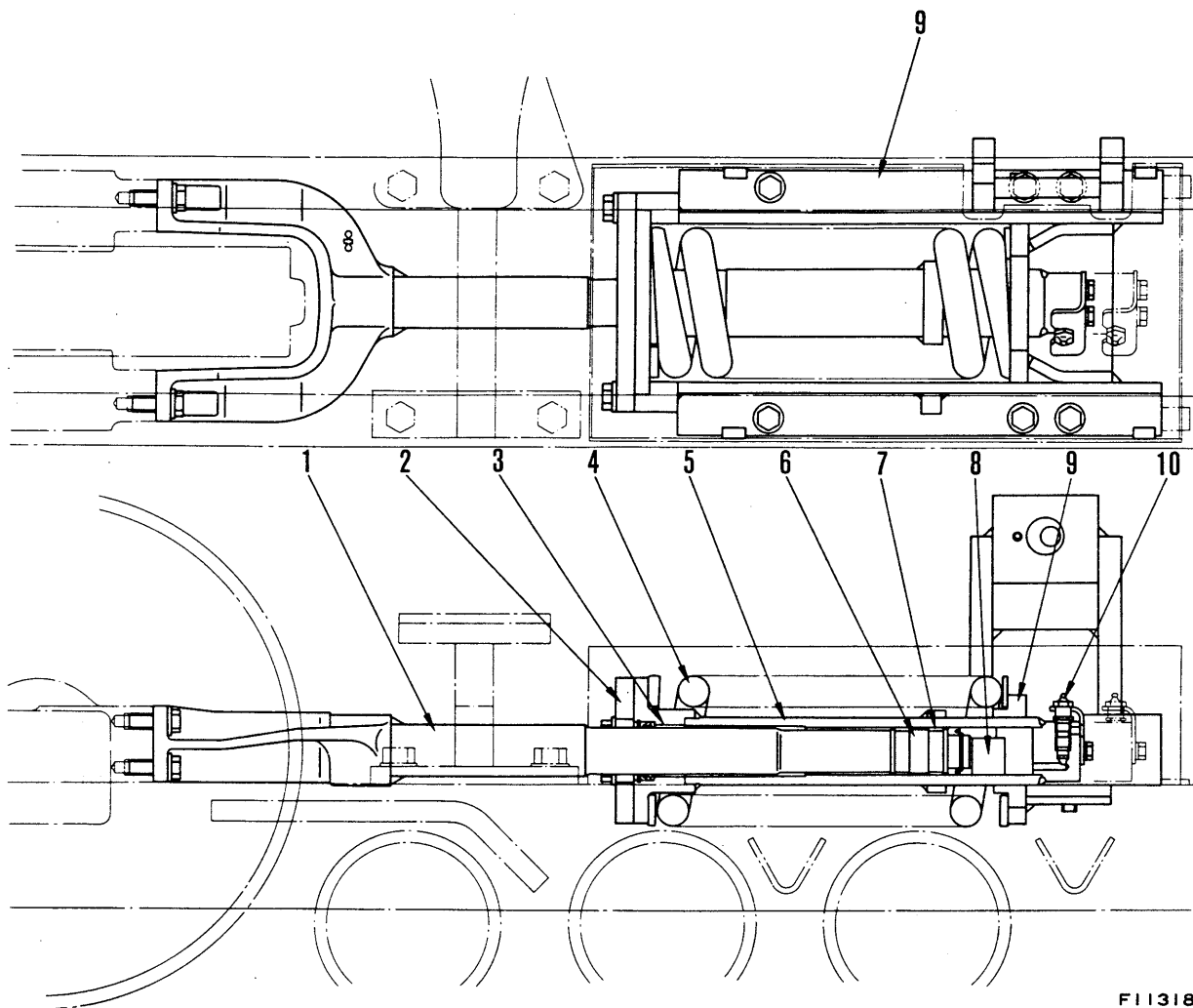
Section A-A

F11318030

- 1. Idler
- 2. Bushing
- 3. Bushing
- 4. Bracket
- 5. Cover
- 6. Shaft
- 7. Floating seal
- 8. Bolt

# IDLER CUSHION

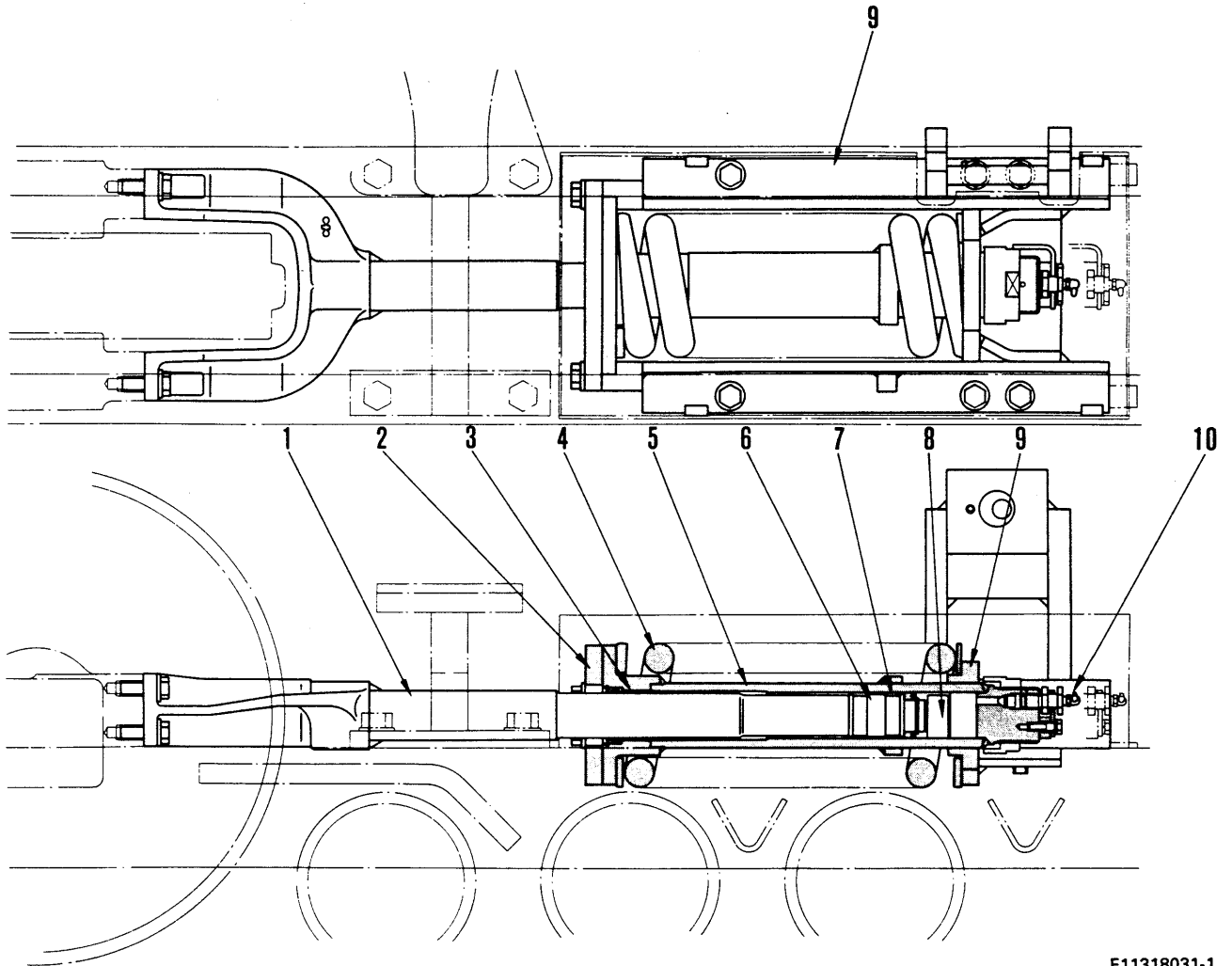
D31E, P, PL, PLL-18, D31S, Q-18  
D37E-2 Serial No. 1501-2500  
D37P-2 Serial No. 1501-2000



F11318031

- 1. Yoke
- 2. Cover
- 3. Bushing
- 4. Recoil spring
- 5. Cylinder
- 6. Piston
- 7. Wear ring
- 8. Pin
- 9. Bracket
- 10. Valve

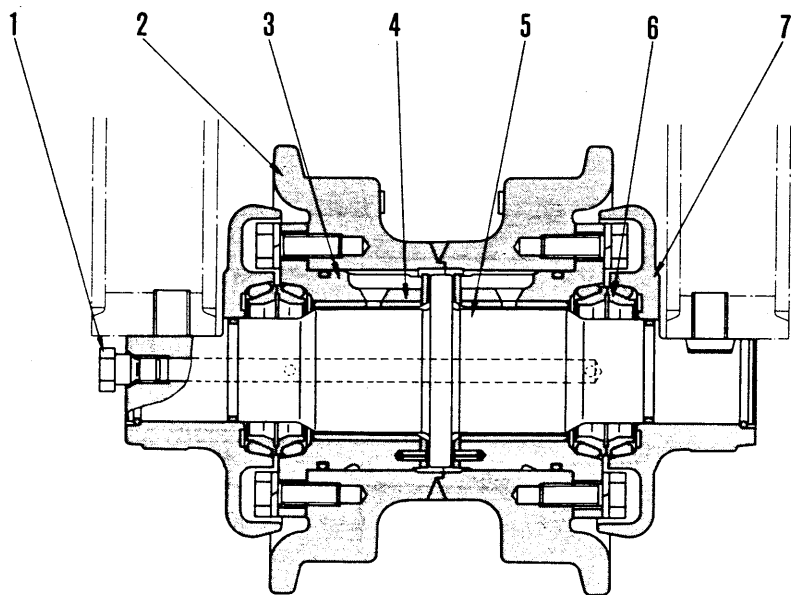
D31P-18A Serial No. 40001 and up  
 D37E-2 Serial No. 2501 and up  
 D37P-2 Serial No. 2001 and up



1. Yoke
2. Cover
3. Bushing
4. Recoil spring
5. Cylinder
6. Piston
7. Wear ring
8. Pin
9. Bracket
10. Valve

F11318031-1

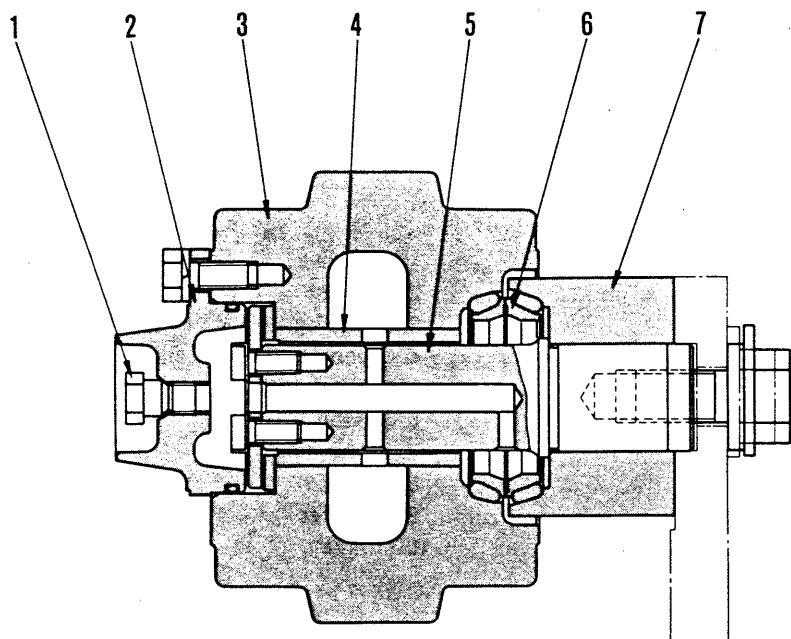
# TRACK ROLLER



- 1. Plug
- 2. Track roller
- 3. Bushing
- 4. Bushing
- 5. Shaft
- 6. Floating seal
- 7. Collar

F11318032

# CARRIER ROLLER



- 1. Plug
- 2. Cover
- 3. Carrier roller
- 4. Bushing
- 5. Shaft
- 6. Floating seal
- 7. Bracket

F11318033

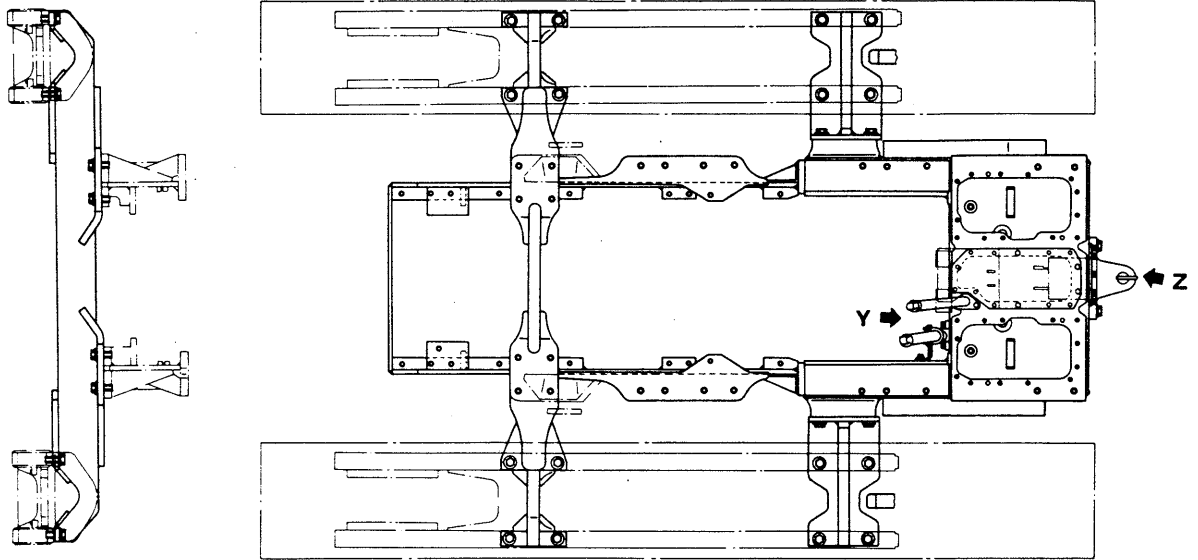
011418

# MAIN FRAME AND SUSPENSION

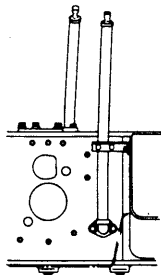
D31E, P, PL, PLL-18, D31P-18A, D31S, Q-18

D37E-2 Serial No. 1501 - 2500

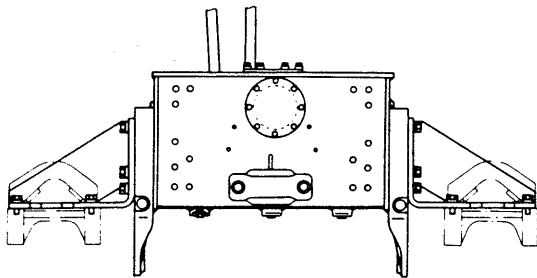
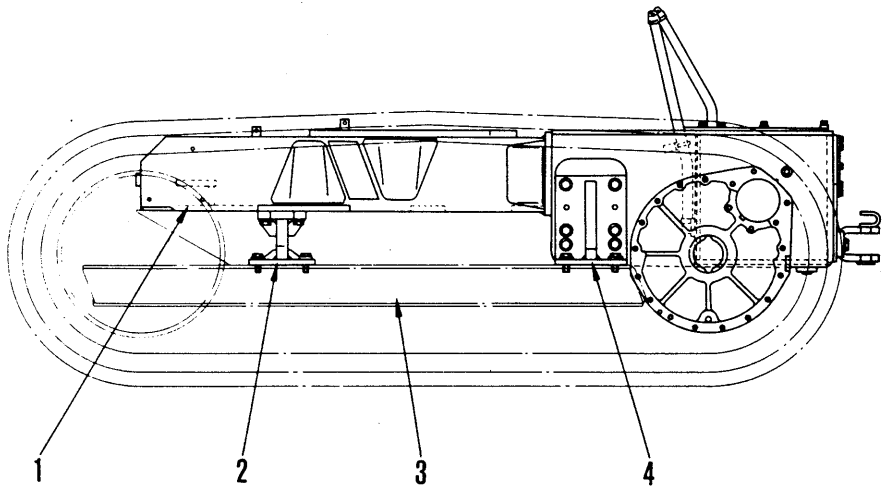
D37P-2 Serial No. 1501 - 2000



011418



View Y



View Z

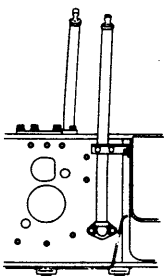
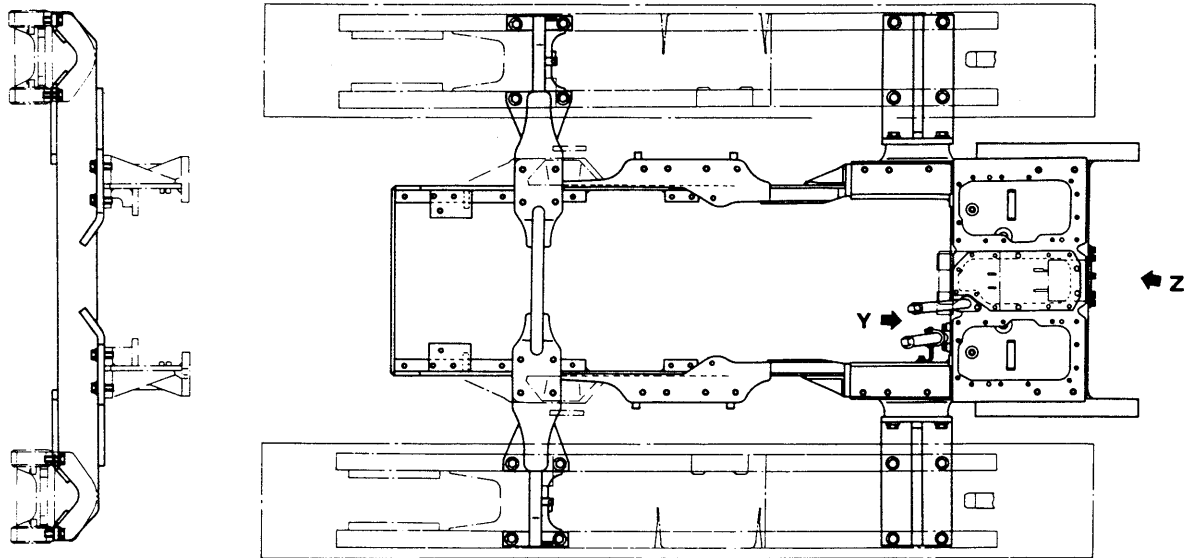
113F18022

1. Main frame
2. Cross-bar
3. Track frame
4. Bracket

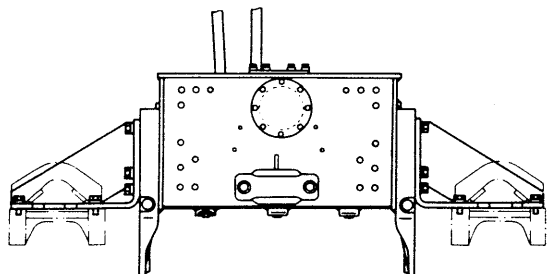
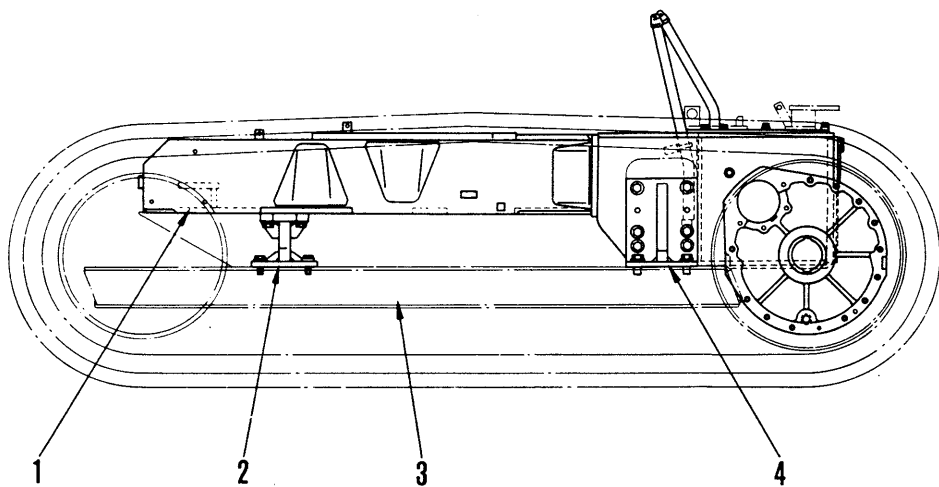
## OUTLINE

- The suspension consists of left and right brackets (4) and cross bar (2) installed to the main frame. It is a fixed type connecting the main frame and track frame.

D37E-2 Serial No. 2501 and up  
 D37P-2 Serial No. 2001 and up



View Y



View Z

1. Main frame
2. Cross-bar
3. Track frame
4. Bracket

**OUTLINE**

- The suspension consists of left and right brackets (4) and cross bar (2) installed to the main frame. It is a fixed type connecting the main frame and track frame.

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# UNDERCARRIAGE

## 33 DISASSEMBLY AND ASSEMBLY



TRACK FRAME	
Removal and Installation .....	33- 2
RECOIL SPRING	
Removal and Installation .....	33- 2
Disassembly and Assembly .....	33- 4
IDLER	
Removal and Installation .....	33- 5-1
CARRIER ROLLER	
Removal and Installation .....	33- 5-1
TRACK ROLLER	
Removal and Installation .....	33- 6
TRACK SHOE	
Removal and Installation .....	33- 6

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## REMOVAL OF TRACK FRAME ASSEMBLY

1. Remove work equipment assembly. (For D31P, PL-18)
  - ★ For details, see 73 REMOVAL OF WORK EQUIPMENT ASSEMBLY.
2. Remove track shoe assembly.
  - ★ For details, see REMOVAL OF TRACK SHOE ASSEMBLY.
3. Jack up machine and put stand under steering case and under equalizer bar.
4. Sling track frame assembly and remove mounting bolts (1) (four each at front and rear). (See P1)
5. Lift off track frame assembly (2). (See P2)



Track frame assembly (each side):

D31E, S, Q-18	: 480 kg
D31P-18A	: 540 kg
D31P-18	: 530 kg
D31PL-18	: 540 kg
D37E, P-2	: 530 kg
D37E-2	
Serial No. 2501 and up:	540 kg
D37P-2	
Serial No. 2001 and up:	670 kg

## INSTALLATION OF TRACK FRAME ASSEMBLY

1. Raise track frame assembly (2), set in position and tighten mounting bolts (1) (four each at front and rear). (See P2)
2. Remove stand from under steering case and equalizer bar and lower machine. (See P1)
3. Install track shoe assembly.
  - ★ For details, see INSTALLATION OF TRACK SHOE ASSEMBLY.
4. Install work equipment assembly (For D31P, PL-18)
  - ★ For details, see 73 INSTALLATION OF WORK EQUIPMENT ASSEMBLY.

## REMOVAL OF RECOIL SPRING ASSEMBLY

1. Remove track shoe assembly.
  - ★ For details, see 33 REMOVAL OF TRACK SHOE ASSEMBLY.
2. Remove cover (1). (See P3)
3. Remove lubricator (2) and pull out rod (3) and idler to front as one unit. (See P4)
4. Lift off recoil spring assembly (4). (See P5)



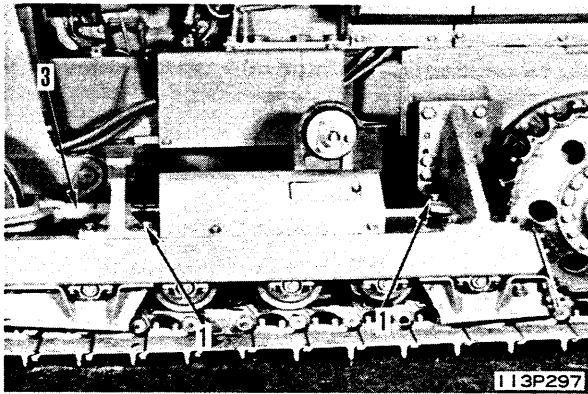
Recoil spring assembly: 90 kg

## INSTALLATION OF RECOIL SPRING ASSEMBLY

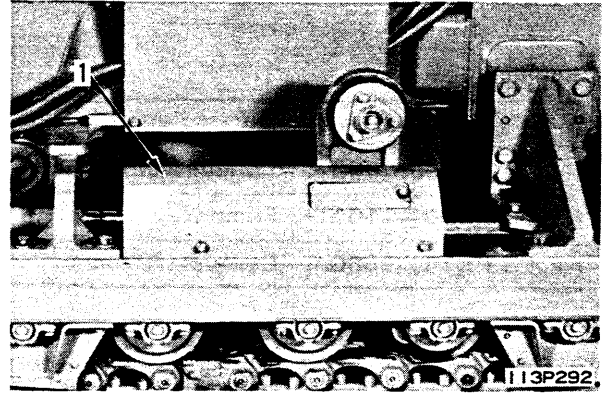
1. Raise recoil spring assembly (4) and install. (See P5)
2. Push in rod (3) taking care not to damage packing of cylinder. (See P4)
3. Install lubricator (2). (See P4)
4. Install cover (1). (See P3)
5. Install track shoe assembly.
  - ★ For details, see 33 INSTALLATION OF TRACK SHOE ASSEMBLY.

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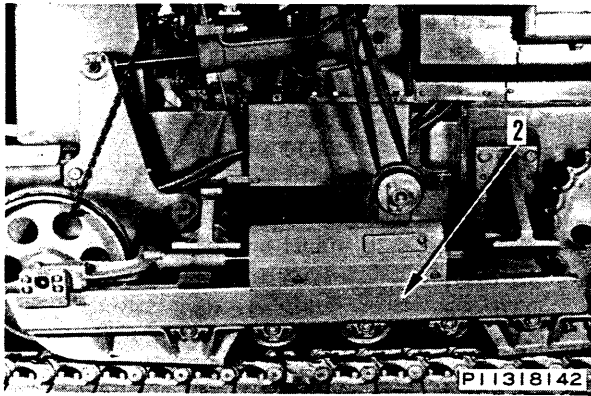
P1



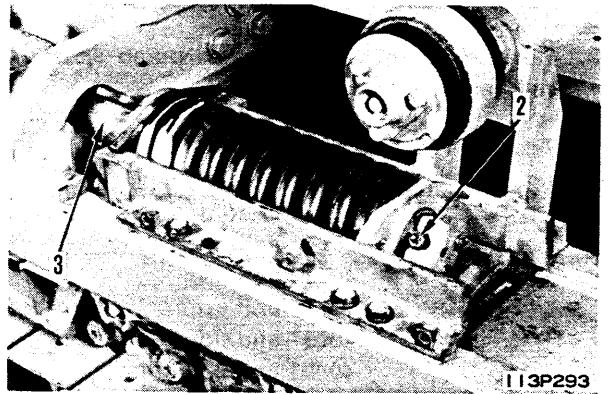
P3



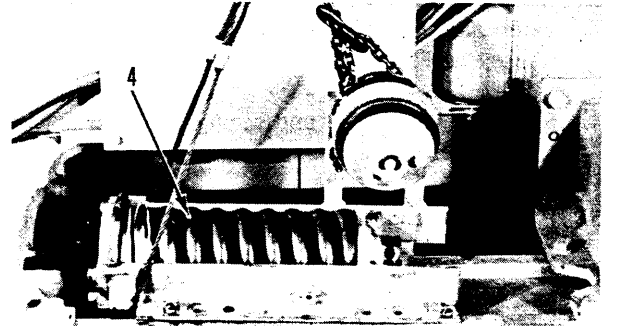
P2



P4



P5



I13P294

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## DISASSEMBLY OF RECOIL SPRING ASSEMBLY

### Special tools

	Part No.	Part Name	Q'ty
A	791-685-8002	Compressor	1
A1	790-101-1101	Pump	1
A2	790-101-1600	Cylinder (70 ton)	1

1. Set recoil spring assembly (1) in tool A. (See P1)
  2. Operate pump slowly to compress spring then remove plate (2). (See P1)
  3. Release hydraulic pressure in pump slowly to relieve spring tension. (See P1)
- ★ Applicable Serial No.
- |           |              |
|-----------|--------------|
| D31E-18   | 40390 and up |
| D31P-18   | 40529 and up |
| D31P-18A  | 40551 and up |
| D31PL-18  | 40519 and up |
| D31PLL-18 | 40521 and up |
| D31S-18   | 40097 and up |
| D31Q-18   | 40091 and up |
| D37E-2    | 1794 and up  |
| D37P-2    | 1592 and up  |
3. Release pressure in pump slowly, then gradually extend spring and turn nut (14) to extend spring fully. (See F1)
  4. Remove cylinder (4) and spring (5) from bracket (3). (See P2)
  5. Remove piston (6) from cylinder (4). (See P2)

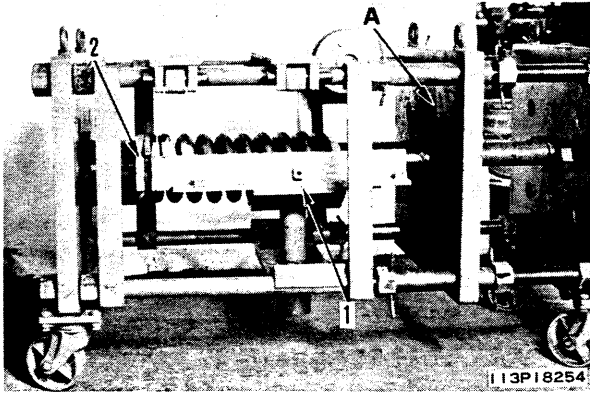
## ASSEMBLY OF RECOIL SPRING ASSEMBLY

1. Fit packing (7) on piston (6), then install snap ring (8) and ring (9). (See F2)
2. Insert bar (10) in cylinder (4), then install piston (6). (See P2, F3)
  - ★ Push in from packing side.
3. Fit seal (11) and spacer (12) in cylinder (4), then install snap ring (13). (See P2, F3)
5. Operate pump of tool A to compress spring, then install plate (2). (See P1)
  - ★ Applicable Serial No.
 

D31E-18	40390 and up
D31P-18	40529 and up
D31P-18A	40551 and up
D31PL-18	40519 and up
D31PLL-18	40521 and up
D31S-18	40097 and up
D31Q-18	40091 and up
D37E-2	1794 and up
D37P-2	1592 and up
5. Operate pump of tool A, then compress spring and tighten nut (14), and install plate (2) when spring is compressed fully. (See P1, F1)
  - ★ Using guide bolt, align mounting holes of plate.
6. Release hydraulic pressure in pump and remove recoil spring assembly (1) from tool A. (See P1)

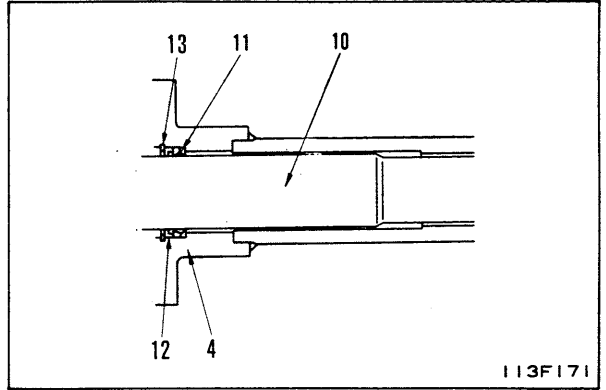
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P1



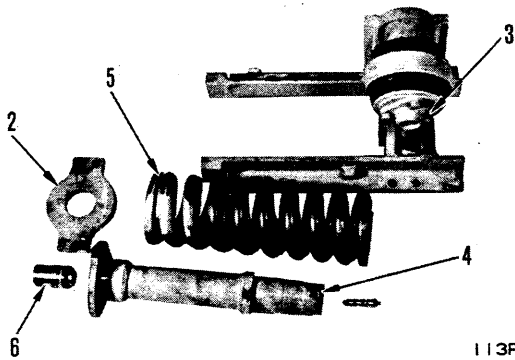
113P18254

F3



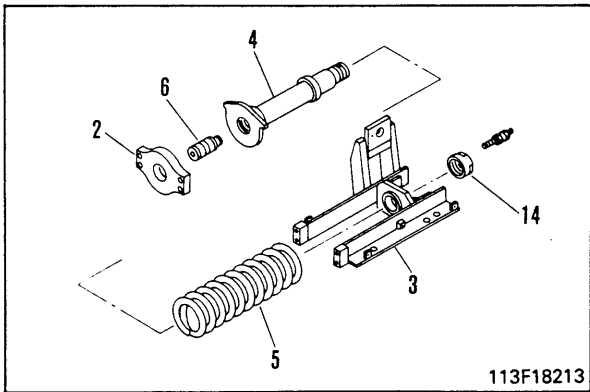
113F171

P2



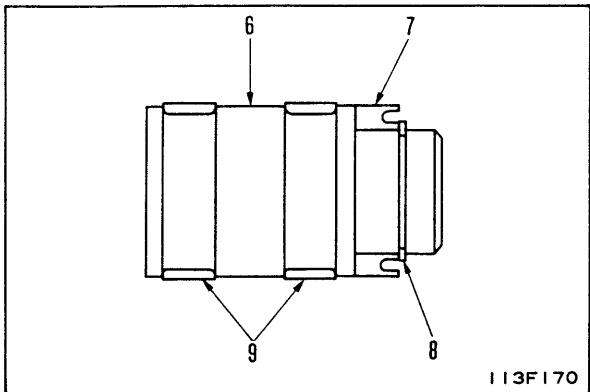
113P296

F1



113F18213

F2



113F170

011418

## REMOVAL OF IDLER ASSEMBLY

1. Remove track shoe assembly.
  - ★ For details, see REMOVAL OF TRACK SHOE ASSEMBLY.
2. Remove four bracket mounting bolts (1). (See P1)
3. Raise idler assembly (2) and pull forward to remove. (See P2)



Idler assembly: 95 kg

## INSTALLATION OF IDLER ASSEMBLY

1. Raise idler assembly (2) and install on track frame. (See P2)
2. Tighten bracket mounting bolts (1). (See P1)
3. Install track shoe assembly.
  - ★ For details, see INSTALLATION OF TRACK SHOE ASSEMBLY.

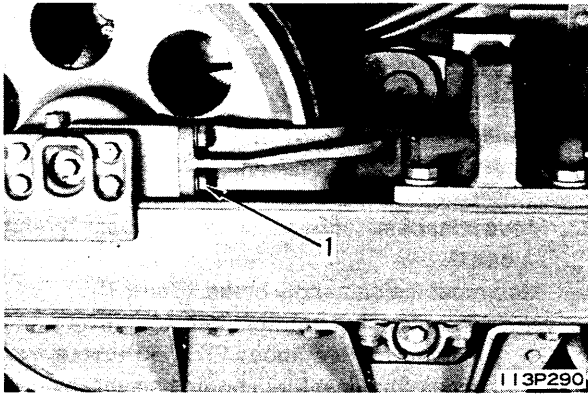
## REMOVAL OF CARRIER ROLLER ASSEMBLY

1. Raise track shoe assembly using hydraulic jack ①. (See P3)
2. Remove mounting bolt from inside, then remove carrier roller assembly (1). (See P3)

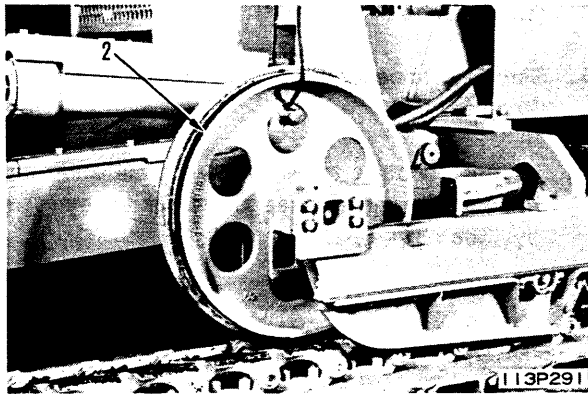
## INSTALLATION OF CARRIER ROLLER ASSEMBLY

1. Install carrier roller assembly (1), then tighten mounting bolt (2) from inside. (See P3, F1)
  - ★ Align the bolt hole of lock (3) before tightening bolt (2).
2. Release hydraulic jack ① and remove from track shoe assembly (1). (See P3)

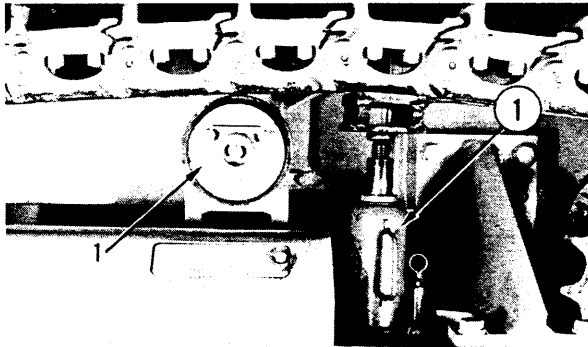
P1



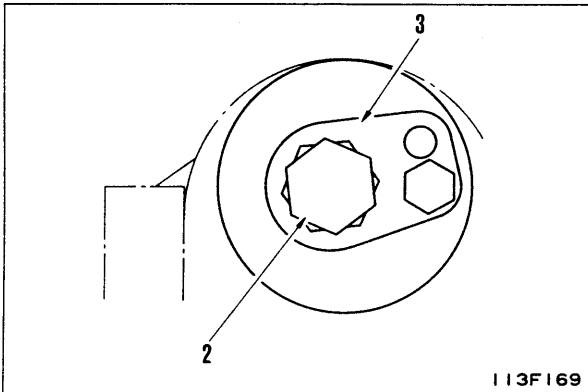
P2



P3



F1




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## REMOVAL OF TRACK ROLLER ASSEMBLY

1. Loosen lubricator (1) one turn to relieve track tension. (See P1)
  - ★ If the track tension is not relieved, move the machine backwards and forwards.
2. Remove roller guards (2) and (3). (See P2, P3)
3. Remove track roller mounting bolts (4). (See P4)
4. Using work equipment at front and hydraulic jack at rear, raise machine and remove track roller assembly (5). (See P5)



## INSTALLATION OF TRACK ROLLER ASSEMBLY

1. Set track roller assembly (5) on track link. (See P5)
2. Lower machine carefully to ground and temporarily tighten track roller mounting bolts (4). (See P4)
  -  Mounting bolt: Thread tightener (LT-2)
3. Lower machine completely to ground and tighten track roller mounting bolts fully.
4. Instal roller guards (3) and (2). (See P3, P2)
5. Tighten lubricator (1), then pump in grease (G2-LI) to adjust track tension. (See P1)

## REMOVAL OF TRACK SHOE ASSEMBLY

1. Loosen lubricator (1) one turn to relieve track tension. (See P6)
  - ★ If the track tension is not relieved, move the machine backwards and forwards.
2. Move machine forward so that grouser mounts block ①.  
Stop machine and apply brake. (See P7)
  - ★ When laying out the track to the rear, the machine moves about 2 m in reverse, so a space of at least 3 m should be available.
3. Remove shoe bolt (3) of master link (2), then remove shoe (4). (See P7)
4. Screw in shoe bolt (3) again and separate link (2). (See P8)
5. Support front of track shoe with bar and move machine inreverse to separate track shoe assembly. (See P9)

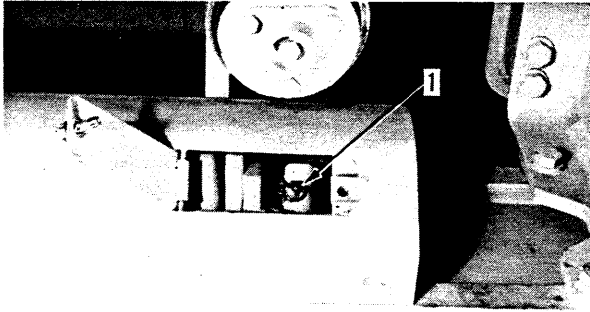
## INSTALLATION OF TRACK SHOE ASSEMBLY

1. Fit link on sprocket and move machine forward slowly to wind on track shoe assembly. (See P9)
2. Connect master link (2), and tighten together with shoe (4) using shoe bolt (3). (See P10, P8, P7)
  -  Master link bolt:  
Initial tightening:  $15 \pm 2$  kgm  
Additional tightening angle:  $180^\circ \pm 10^\circ$
  -  Shoe bolt:  
Initial tightening:  $15 \pm 2$  kgm  
Additional tightening angle:  $60^\circ \pm 10^\circ$
3. Tighten lubricator (1), then pump in grease (G2-LI) to adjust track tension.
  - ★ Move the machine slowly backwards and forwards while pumping in grease. Finally, drive forward, stop the machine without using the brake, and check the track tension.

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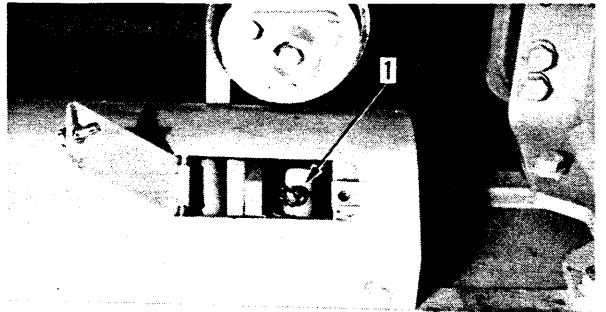
011418

P1



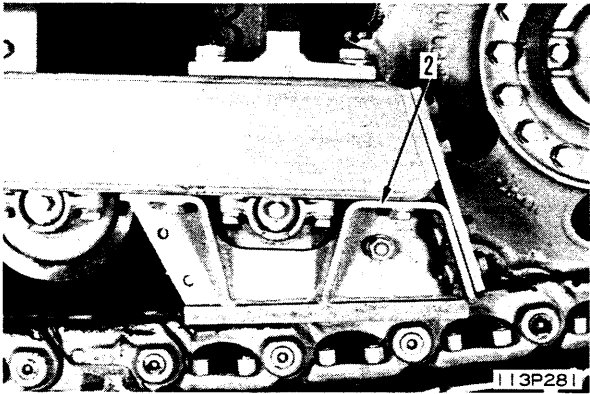
113P280

P6



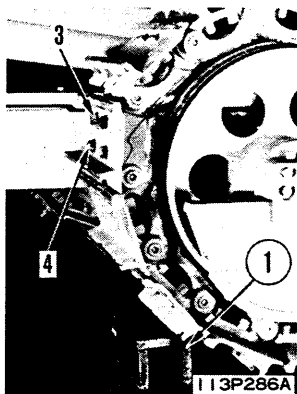
113P285

P2



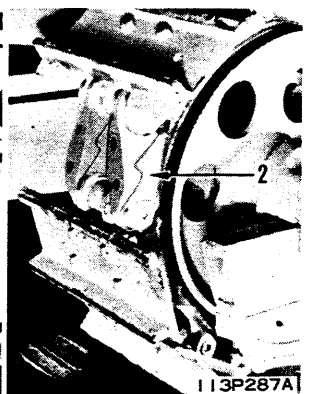
113P281

P7



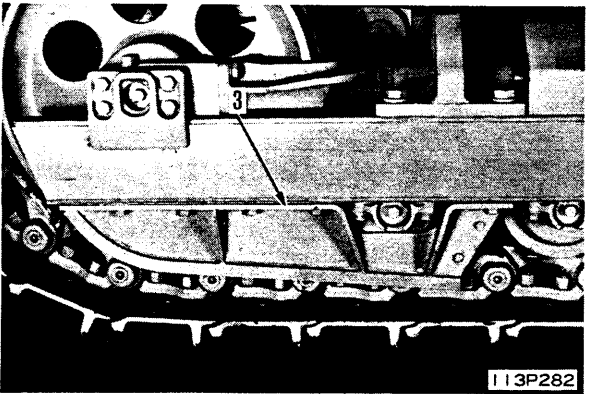
113P286A

P8



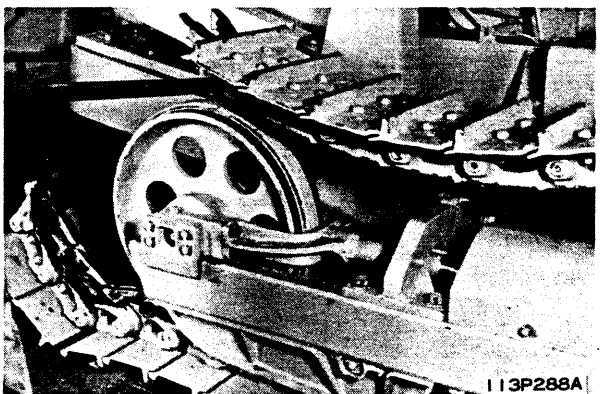
113P287A

P3



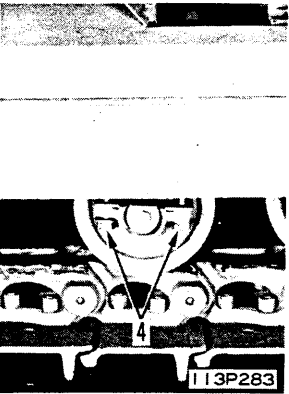
113P282

P9



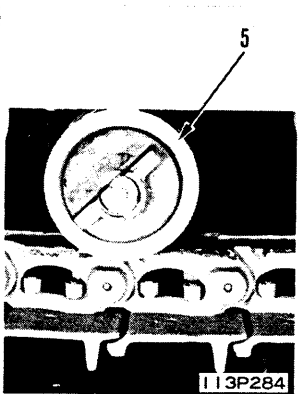
113P288A

P4



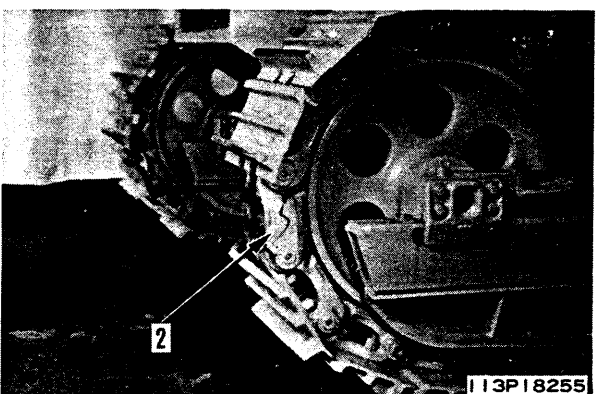
113P283

P5



113P284

P10



113P18255



# UNDERCARRIAGE

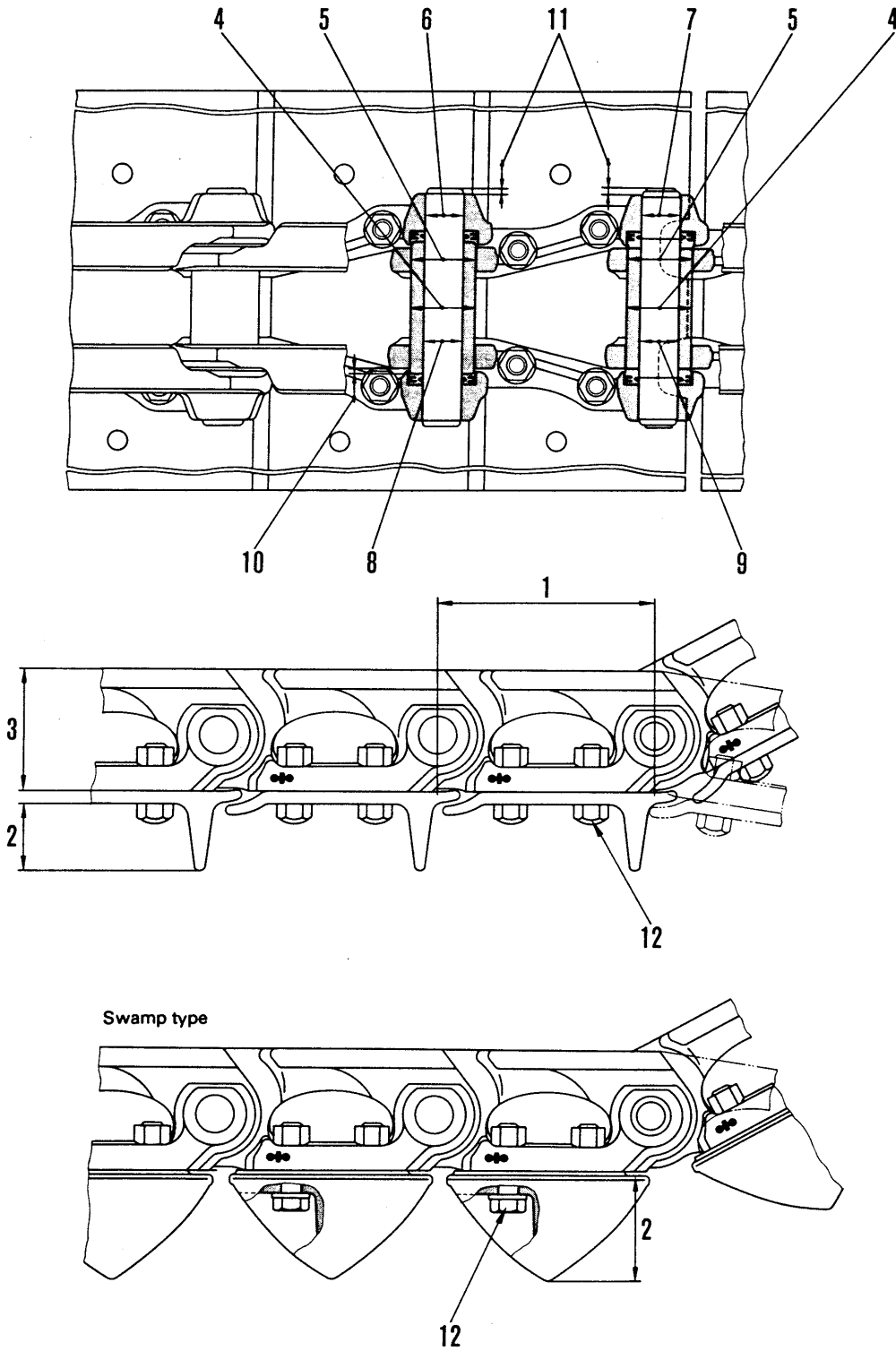
## 34 MAINTENANCE STANDARD



Track (dry type track link) (D31E, P, PL, PLL-18, D31P-18A, D37E, P-2) .....	34- 2
Track (lubricated track link) (D31E, P, PL, PLL-18, D31P-18A, D37E, P-2) .....	34- 4
Track (dry type track link) (D31S, Q-18) .....	34- 6
Track (lubricated track link) (D31S, Q-18) .....	34- 8
Track frame .....	34-10
Idler cushion .....	34-11
Idler .....	34-12
Track roller .....	34-14
Carrier roller .....	34-15

# TRACK (DRY TYPE TRACK LINK)

D31E, P, PL, PLL-18, D31P-18A, D37E, P-2



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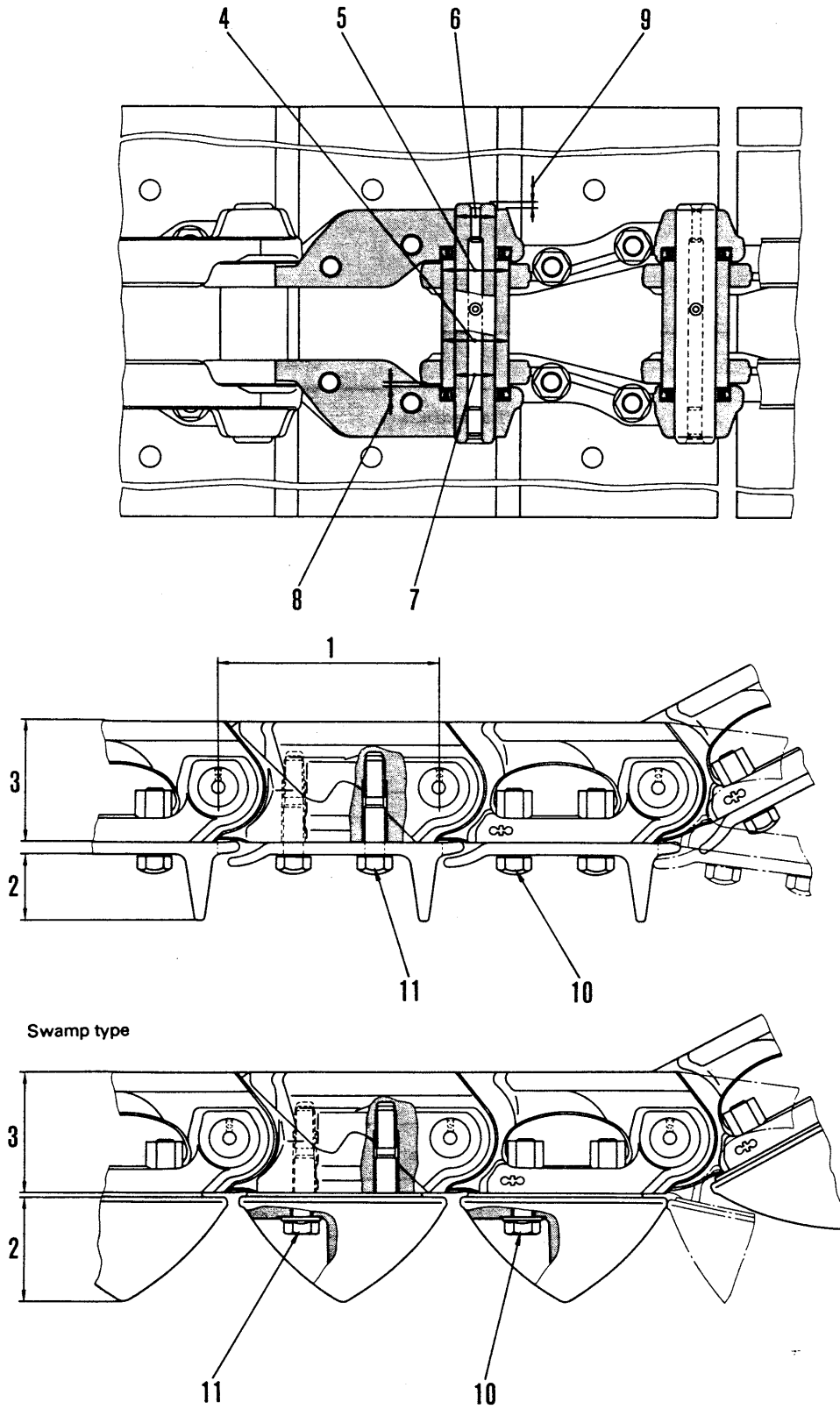
011418

Unit: mm

No.	Check item	Criteria				Remedy	
		Standard size	Tolerance		Repair limit		
1	Link pitch	Standard size		Repair limit		Turn or replace	
		154.25		157.25			
2	Height of grouser	Single type D31E-18, D37E-2	47.0		20.0		Lug weld, repair by build-up welding, or replace
		Swamp type D31P, PL, PLL-18 D31P-18A, D37P-2	74.5		67.5		
3	Link height	87.0		80.0		Repair by build-up welding or replace	
4	Outside diameter of bushing	47.0		42.2 (Normal loading) 44.2 (Hard loading)		Turn or replace	
5	Interference between link and bushing	Standard size	Tolerance		Standard interference	Interference limit	
			Shaft	Hole			
		47	+0.287 +0.247	+0.062 0	-0.185 - -0.287	0.1	
6	Interference between link and regular pin	28	+0.100 0	-0.148 -0.200	0.148 - 0.300	0.14	
7	Interference between link and master pin	28	-0.030 -0.070	-0.148 -0.200	0.078 - 0.170	0.078	
8	Clearance between bushing and regular pin	Standard size	Tolerance		Standard clearance	Clearance limit	
			Shaft	Hole			
		28	+0.830 +0.330	-0.200 -0.400	0.530 - 1.230	-	
9	Clearance between bushing and master pin	28	+0.630 +0.230	-0.200 -0.400	0.430 - 1.030	-	
10	Protrusion of bushing	3.75				Adjust	
11	Protrusion of pin	4.0					
12	Tightening torque for shoe bolts	Initial tightening		Additional tightening angle		Retighten	
		15 ± 2 kgm		60 ± 10°			

# TRACK (LUBRICATED TRACK LINK)

D31E, P, PL, PLL-18, D31P-18A, D37E, P-2



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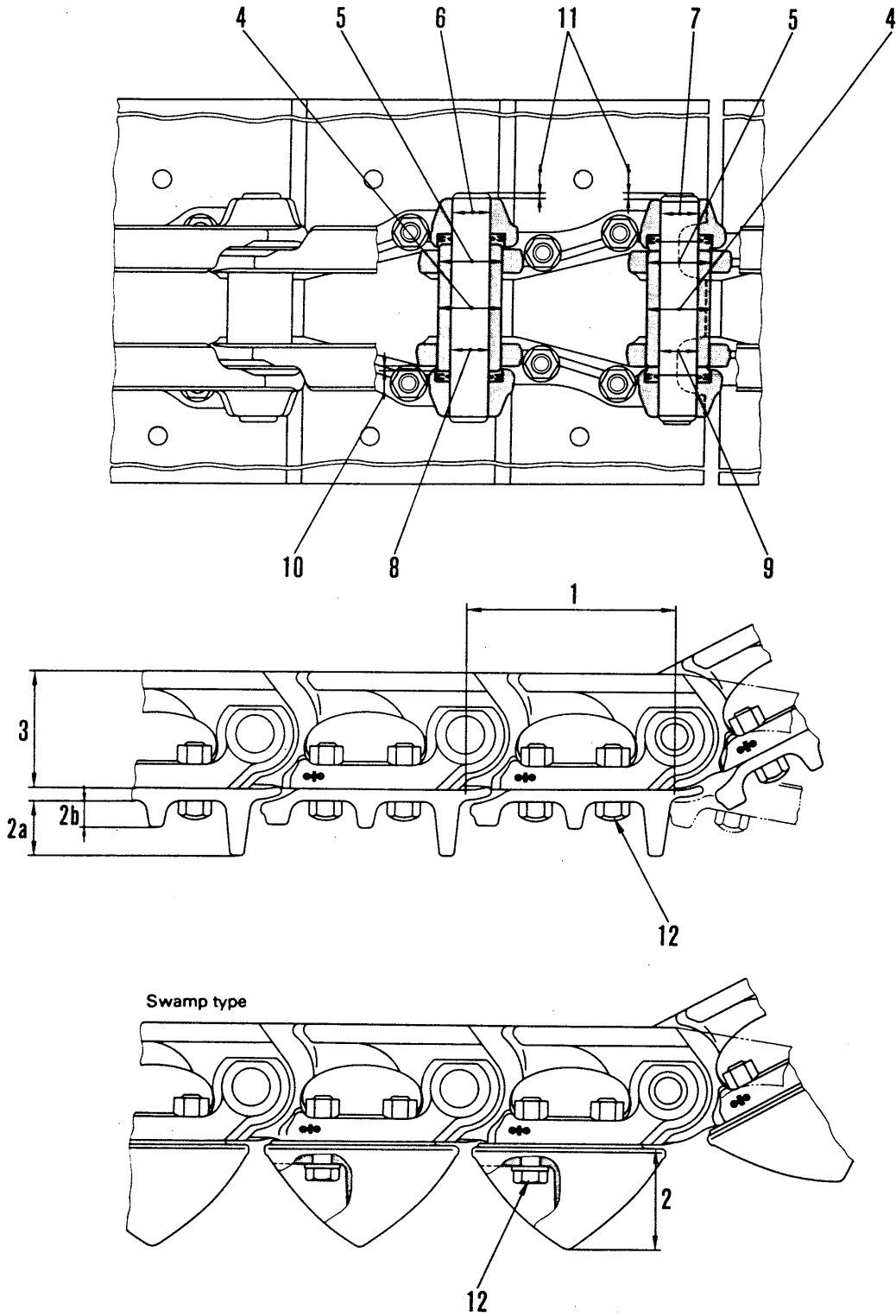
Unit: mm

No.	Check item	Criteria				Remedy	
		Standard size		Repair limit			
1	Link pitch	154.25		-		Turn or replace	
2	Height of grouser	Single type D31E-18, D37E-2		47.0		20.0	Lug weld, repair by build-up welding, or replace
		Swamp type D31P, PL, PLL-18 D31P-18A, D37P-2		74.5		67.5	
3	Link height	87.0		80.0		Repair by build-up welding or replace	
4	Outside diameter of bushing	47.0		42.2 (Normal loading) 44.2 (Hard loading)		Turn or replace	
5	Interference between link and bushing	Standard size	Tolerance		Standard interference	Interference limit	
			Shaft	Hole			
		47	+0.287 +0.247	+0.062 0	-0.185 - -0.287	0.1	
6	Interference between link and pin	28	+0.100 0	-0.148 -0.200	0.148 - 0.300	0.14	Replace
7	Clearance between bushing and pin	Standard size	Tolerance		Standard clearance	Clearance limit	
			Shaft	Hole			
		28	+0.100 0	+0.785 +0.285	0.185 - 0.785	-	
8	Protrusion of bushing	2.75				Adjust	
9	Protrusion of pin	4.0					
10	Tightening torque for shoe bolts	Initial tightening		Additional tightening angle		Retighten	
		15 ± 2 kgm		60 ± 10°			
11	Tightening torque for master link connecting bolts	15 ± 2 kgm		180° ± 10°			

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# TRACK (DRY TYPE TRACK LINK)

D31S, Q-18



011418

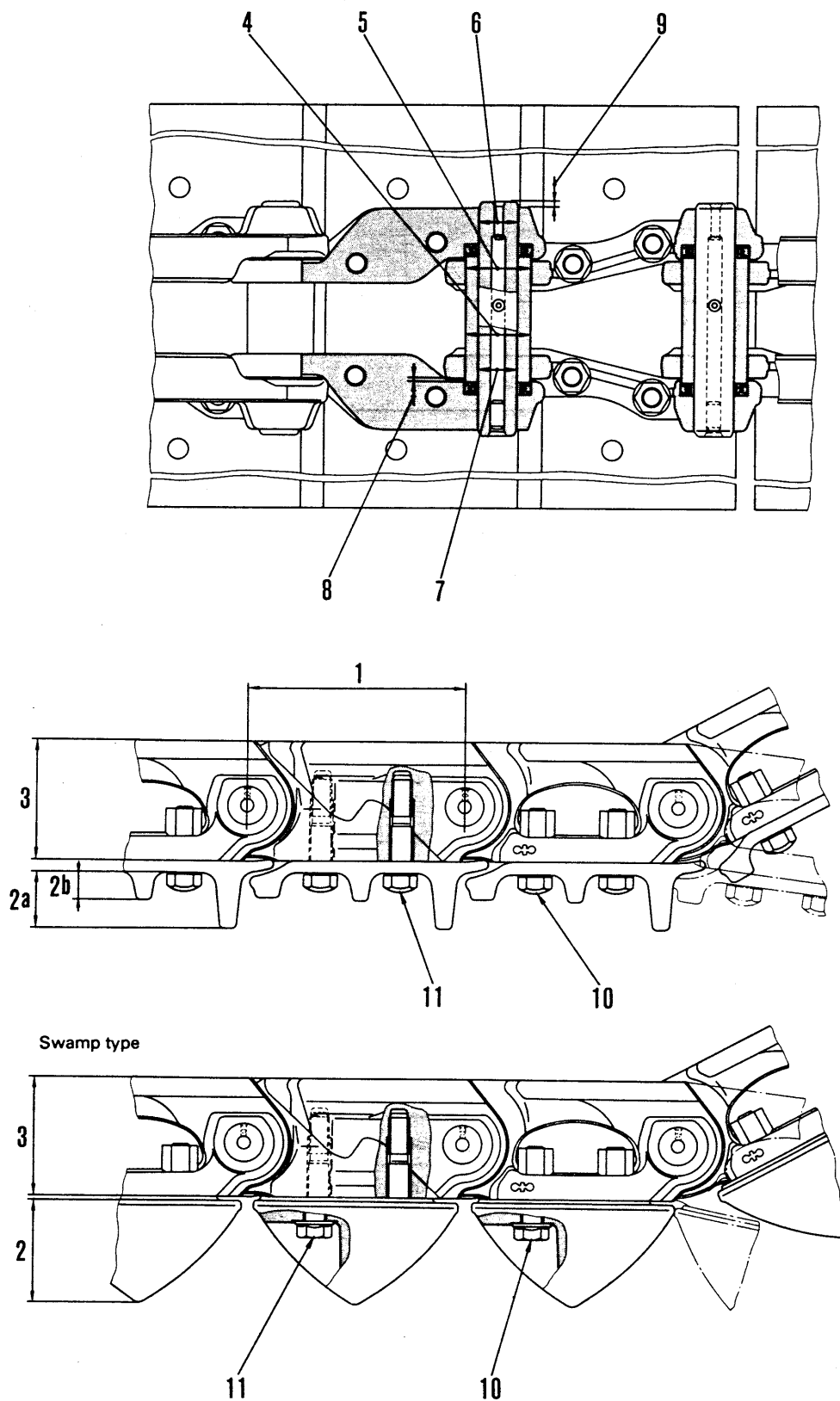
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011418

							Unit: mm
No.	Check item		Criteria				Remedy
1	Link pitch	Standard size		Repair limit			Turn or replace
		154.25		157.25			
2	Height of grouser	Semi double type D31S-18	a	40.0	20.0		Lug weld, repair by build-up welding, or replace
			b	20.0	-		
		Swamp type D31Q-18	74.5	67.5			
3	Link height	87.0		80.0			Repair by build-up welding or replace
4	Outside diameter of bushing	47.0		42.2 (Normal loading) 44.2 (Hard loading)			Turn or replace
5	Interference between link and bushing	Standard size	Tolerance		Standard interference	Interference limit	Replace
			Shaft	Hole			
47	+0.287 +0.247	+0.062 0	-0.185 - -0.287	0.1			
6	Interference between link and regular pin	28	+0.100 0	-0.148 -0.200	0.148 - 0.300	0.14	
7	Interference between link and master pin	28	-0.030 -0.070	-0.148 -0.200	0.078 - 0.170	0.078	
8	Clearance between bushing and regular pin	Standard size	Tolerance		Standard clearance	Clearance limit	
			Shaft	Hole			
28	+0.830 +0.330	-0.200 -0.400	0.530 - 1.230	-			
9	Clearance between bushing and master pin	28	+0.630 +0.230	-0.200 -0.400	0.430 - 1.030	-	
10	Protrusion of bushing	3.75				Adjust	
11	Protrusion of pin	4.0					
12	Tightening torque for shoe bolts	Initial tightening		Additional tightening angle			Retighten
		15 ± 2 kgm		60 ± 10°			

# TRACK (LUBRICATED TRACK LINK)

D31S, Q-18



011418

113F18067



011418

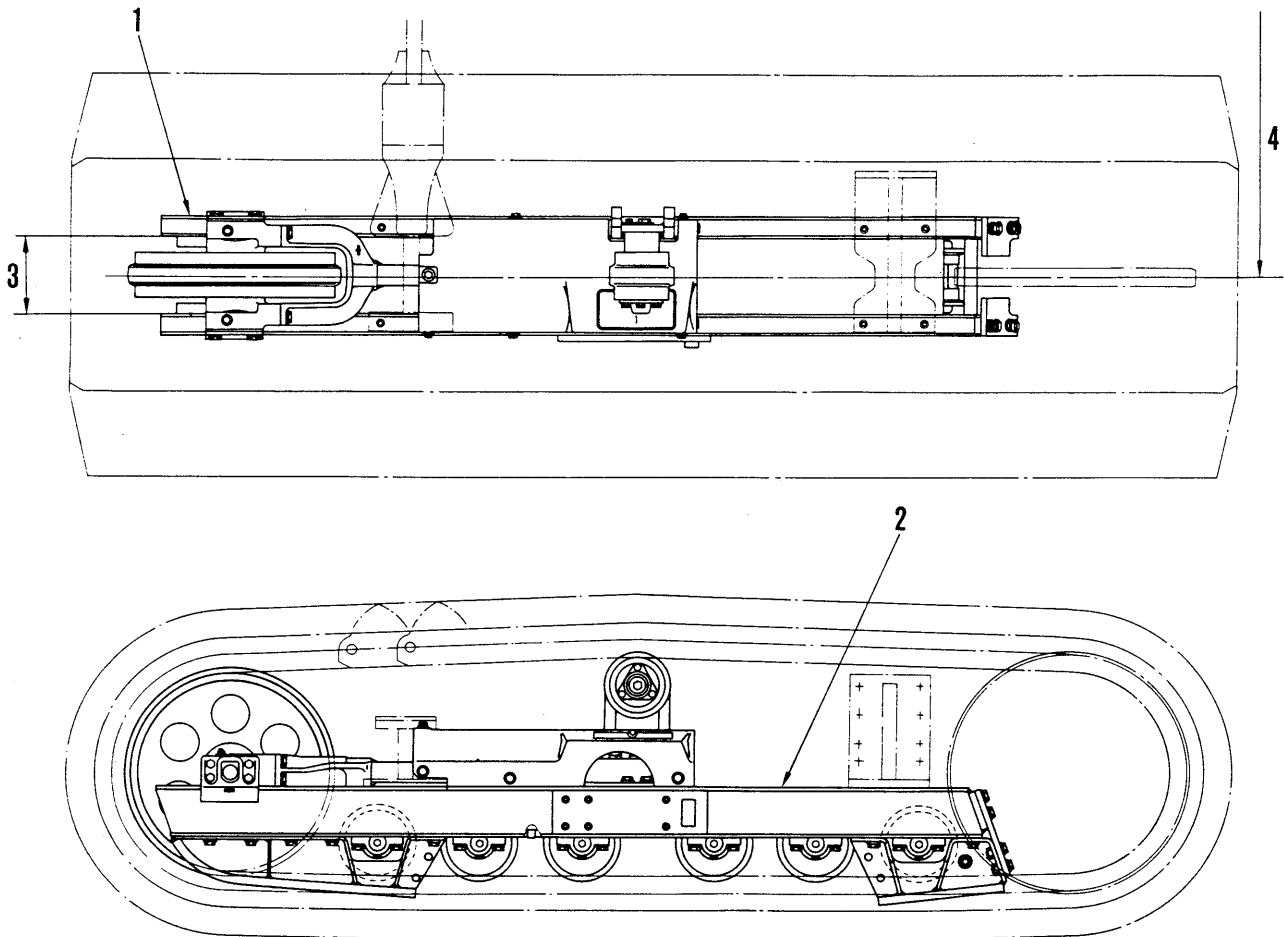
Unit: mm

No.	Check item	Criteria				Remedy	
		Standard size	Tolerance		Repair limit		
1	Link pitch	154.25			—	Turn or replace	
2	Height of grouser	Semi double type D31S-18	a	40.0	20.0	Lug weld, repair by build-up welding, or replace	
			b	20.0	—		
		Swamp type D31Q-18	74.5	67.5			
3	Link height	87.0			80.0	Repair by build-up welding or replace	
4	Outside diameter of bushing	47.0			42.2 (Normal loading) 44.2 (Hard loading)	Turn or replace	
5	Interference between link and bushing	Standard size	Tolerance		Standard interference	Interference limit	
			Shaft	Hole			
		47	+0.287 +0.247	+0.062 0	-0.185 – -0.287	0.1	
6	Interference between link and pin	28	+0.100 0	-0.148 -0.200	0.148 – 0.300	0.14	Replace
7	Clearance between bushing and pin	Standard size	Tolerance		Standard clearance	Clearance limit	
			Shaft	Hole			
		28	+0.100 0	+0.785 +0.285	0.185 – 0.785	—	
8	Protrusion of bushing	2.75				Adjust	
9	Protrusion of pin	4.0					
10	Tightening torque for shoe bolts	Initial tightening		Additional tightening angle		Retighten	
		15 ± 2 kgm		60 ± 10°			
11	Tightening torque for master link connecting bolts	15 ± 2 kgm		180° ± 10°			

# TRACK FRAME

D31E, P, PL, PLL-18, D31S, Q-18  
 D37E-2 Serial No. 1501-2500  
 D37P-2 Serial No. 1501-2000

★ The diagram shows the D31E-18 track.

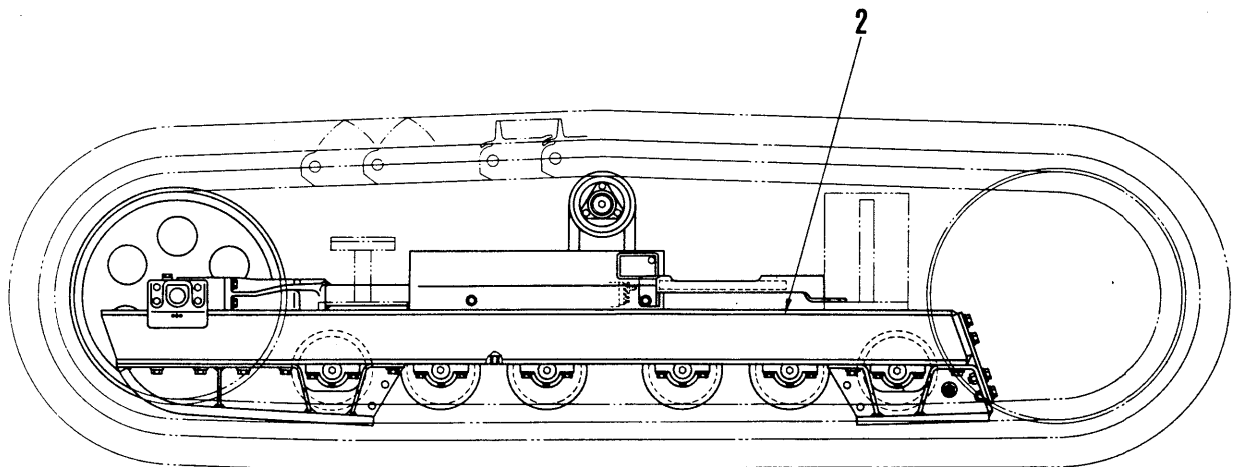
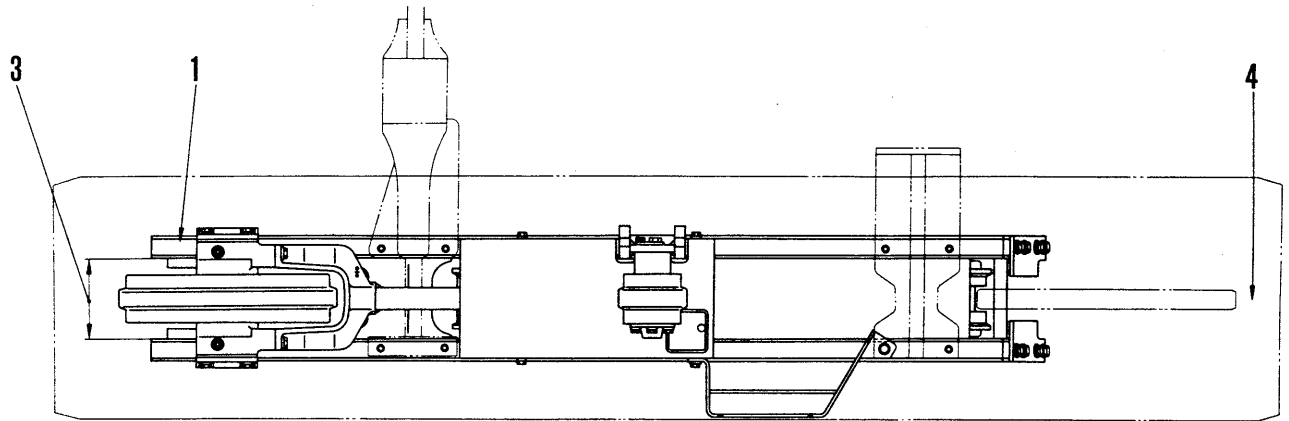


F11318064

Unit: mm

No.	Check item	Criteria		Remedy
		Standard size	Repair limit	
1	Bending of track frame	Standard size	Repair limit	Repair or replace
		-	7 (In length of 3,000 mm)	
2	Torsion of track frame	-	3 (In length of level of 300 mm)	
3	Width of idler portion	198	203	
4	Distance between right and left track frame center	D31E, P, S-18 D37E-2	1,450	Max. 6 (Difference of forward and rearward)
		D31Q-18 D37P-2	1,650	Max. 6 (Difference of forward and rearward)
		D31PL, PLL-18	1,900	Max. 6 (Difference of forward and rearward)

D31P-18A Serial No. 40001 and up  
 D37E-2 Serial No. 2501 and up  
 D37P-2 Serial No. 2001 and up



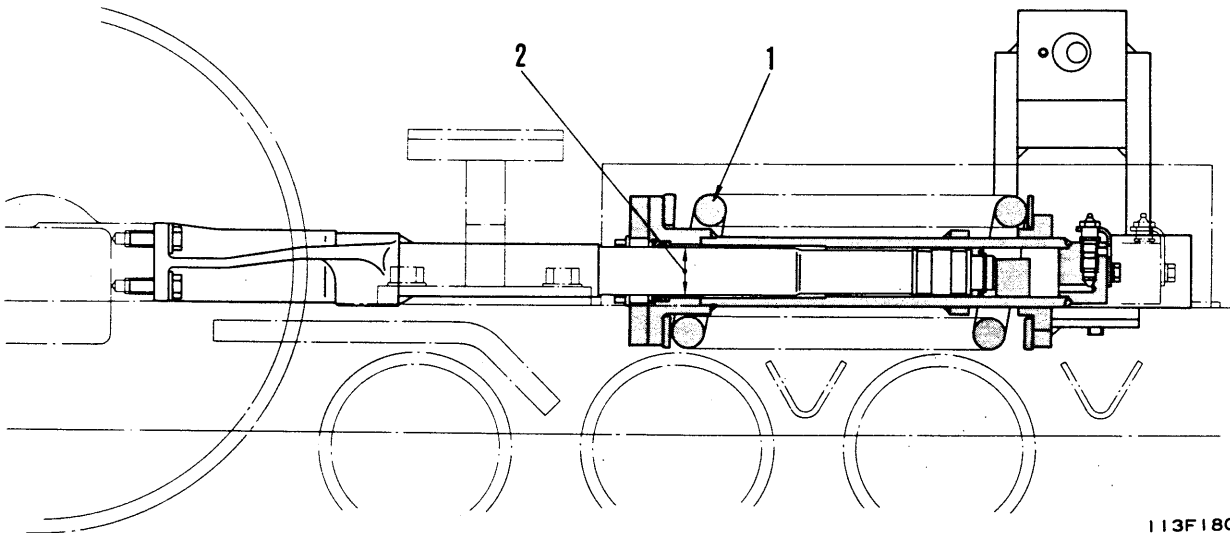
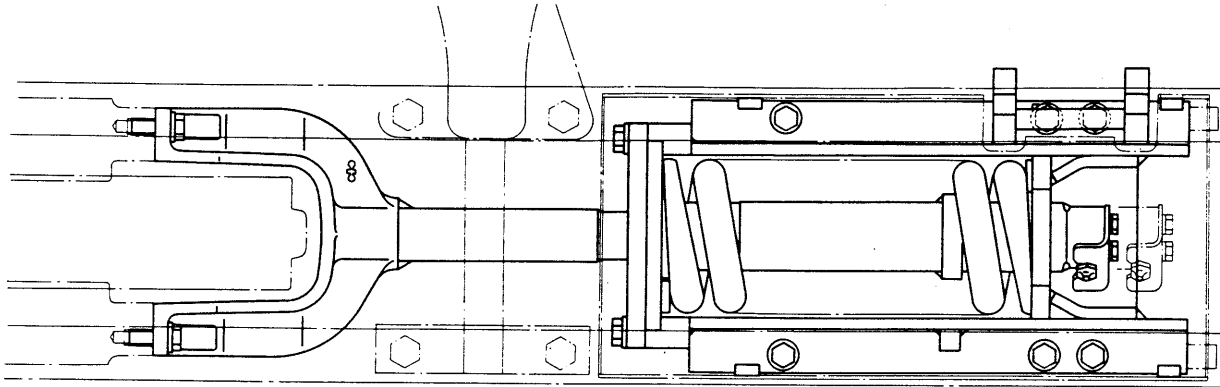
011418

113F18316

				Unit: mm
No.	Check item	Criteria		Remedy
		Standard size	Repair limit	
1	Bending of track frame			Repair or replace
		-	7 (In length of 3,000 mm)	
2	Torsion of track frame	-	3 (In length of level of 300 mm)	
3	Width of idler portion	198	203	
4	Distance between right and left track frame center	D37E-2	1,450	Max. 6 (Difference of forward and rearward)
		D31P-18A D37P-2	1,650	Max. 6 (Difference of forward and rearward)

# IDLER CUSHION

- D31E-18 Serial No. 40001-40389
- D31P-18 Serial No. 40001-40528
- D31P-18A Serial No. 40001-40550
- D31PL-18 Serial No. 40001-40518
- D31PLL-18 Serial No. 40001-40520
- D31S-18 Serial No. 40001-40096
- D31Q-18 Serial No. 40001-40090
- D37E-2 Serial No. 1501-1793
- D37P-2 Serial No. 1501-1591

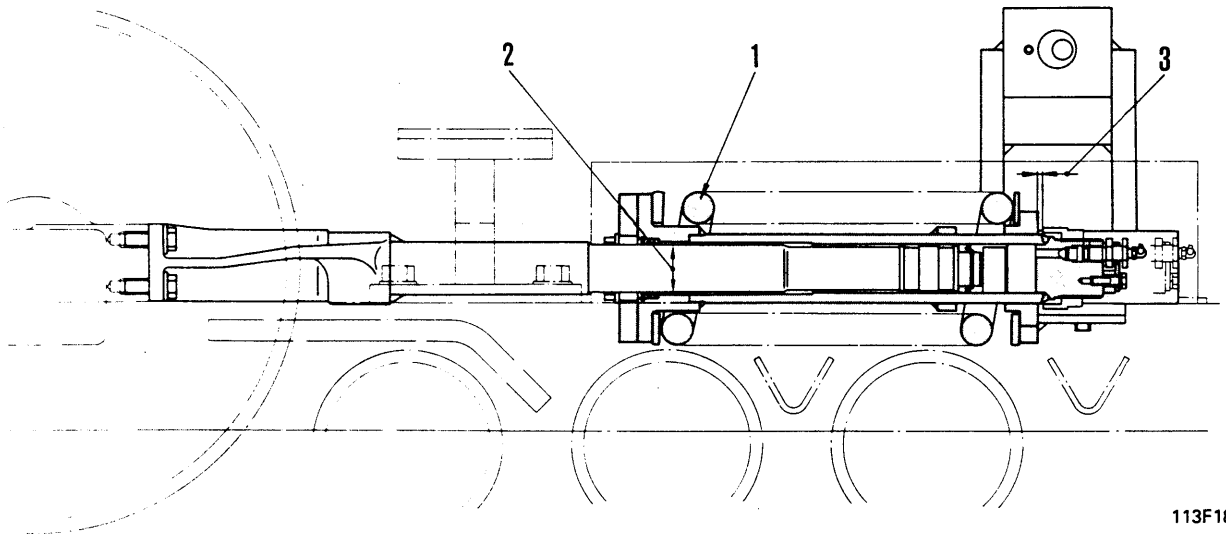
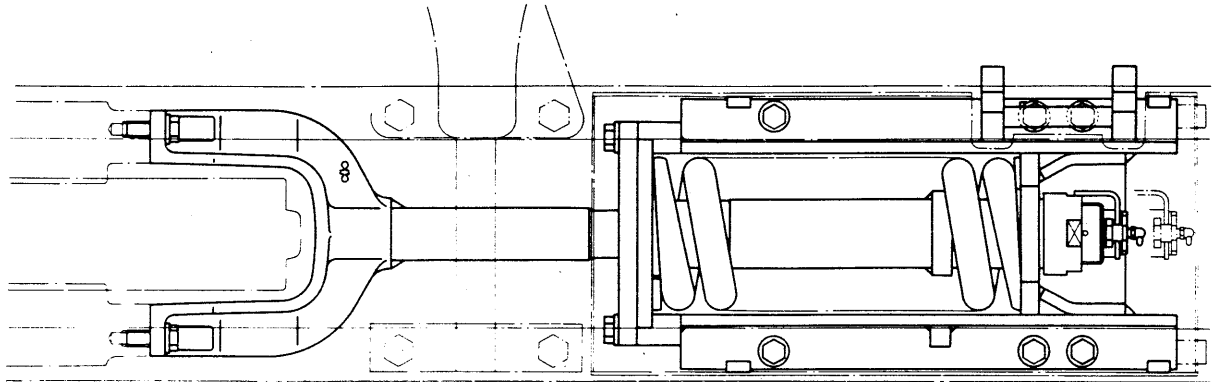


113F18060

Unit: mm

No.	Check item	Criteria				Remedy
		Standard size		Repair limit		
1	Recoil spring	Free length	Installation length	Installation load	Free length	Installation load
		465	379	7,000 kg	454	6,230 kg
2	Clearance between yoke shaft and bushing	Standard size	Tolerance		Standard clearance	Clearance limit
			Shaft	Hole		
		50	0 -0.1	+0.164 +0.007	0.007 - 0.264	0.5

- D31E-18 Serial No. 40390 and up
- D31P-18 Serial No. 40529 and up
- D31P-18A Serial No. 40551 and up
- D31PL-18 Serial No. 40519 and up
- D31PLL-18 Serial No. 40521 and up
- D31S-18 Serial No. 40097 and up
- D31Q-18 Serial No. 40091 and up
- D37E-2 Serial No. 1794 and up
- D37P-2 Serial No. 1592 and up



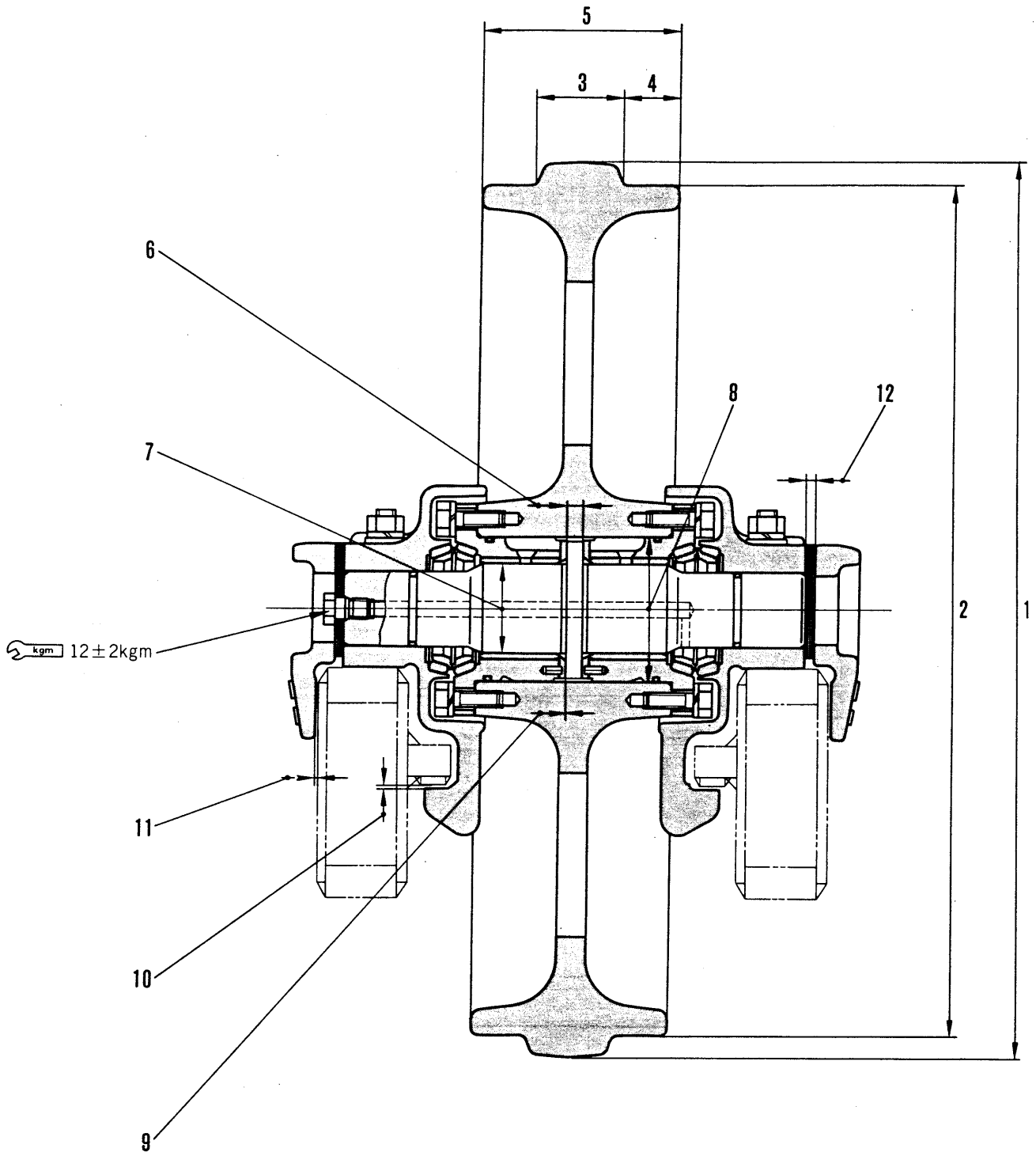
011418

113F18317

Unit: mm

No.	Check item	Criteria					Remedy
		Standard size			Repair limit		
1	Recoil spring	Free length	Installation length	Installation load	Free length	Installation load	Replace
		465	379	7,000 kg	454	6,230 kg	
2	Clearance between yoke shaft and bushing	Standard size	Tolerance		Standard clearance	Clearance limit	
			Shaft	Hole			
		50	0 -0.1	+0.164 +0.007	0.007 - 0.264	0.5	
3	Clearance between bracket and nut	5			5		Adjust

# IDLER



011418

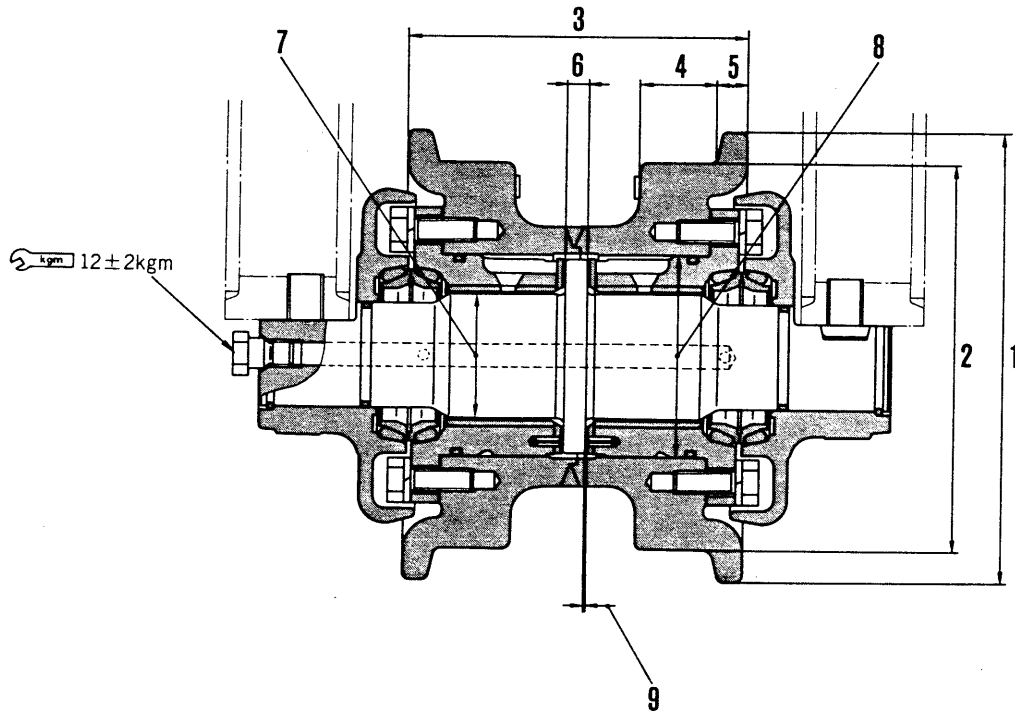
113F18061

011418

Unit: mm

No.	Check item	Criteria				Remedy	
1	Outside diameter of protruding section on idler	Standard size		Repair limit		Repair by build-up welding or replace	
		552		540			
2	Outside diameter of idler tread face	520		508			
3	Width of protruded section on idler	52		40			
4	Width of idler tread face	33		39			
5	Overall width of idler	118		110			
6	Width of collar on shaft	10		9		Replace	
7	Clearance between shaft and bushing	Standard size	Tolerance		Standard clearance		Clearance limit
			Shaft	Hole			
		55	-0.250 -0.300	+0.060 +0.020	0.270 - 0.360		1.5
8	Interference between idler and bushing	Standard size	Tolerance		Standard interference	Interference limit	
			Shaft	Hole			
		88	+0.072 +0.037	+0.035 0	-0.072 - -0.002	-	
9	Free play of shaft in the axial direction	Standard clearance		Clearance limit			
		0.40 - 0.85		1.5			
10	Clearance between guide plate and support	1.0		5.0		Repair or replace	
11	Clearance between guide plate and side plate	0.5		3.0		Adjust or replace	
12	Thickness of shim for guide plate	5.0					

# TRACK ROLLER



113F18062

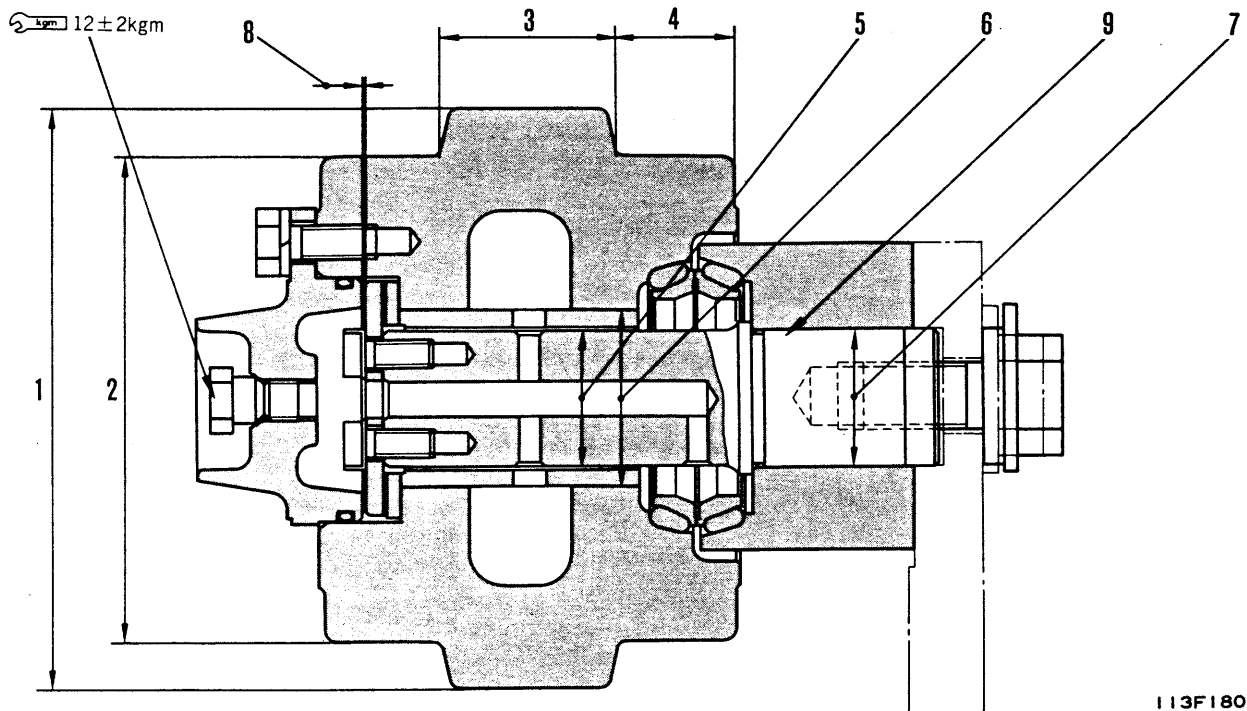
Unit: mm

No.	Check item	Criteria				Remedy
		Standard size		Repair limit		
1	Outside diameter of flange	198.0		188.0		Repair by build-up welding or replace
2	Outside diameter of track roller tread face	170.0		160.0		
3	Overall width of track roller	151.0		-		
4	Width of track roller tread face	34.5		40.5		
5	Width of flange	14.0		8.0		
6	Width of collar on shaft	10.0		9.0		
7	Clearance between shaft and bushing	Standard size	Tolerance		Standard clearance	Clearance limit
			Shaft	Hole		
		55	-0.250 -0.300	+0.074 0	0.250 - 0.374	1.5
8	Interference between shaft and bushing	Standard size	Tolerance		Standard interference	Interference limit
			Shaft	Hole		
		88	+0.072 +0.037	+0.035 0	-0.072 - -0.002	-
9	Free play of shaft in the axial direction	Standard clearance			Clearance limit	
		0.40 - 0.85			1.5	

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# CARRIER ROLLER



I 13F 18063

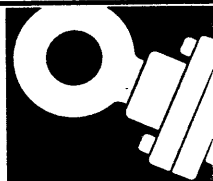
Unit: mm

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No.	Check item	Criteria				Remedy
		Standard size		Repair limit		
1	Outside diameter of flange	170		160		Repair by build-up welding or replace
2	Outside diameter of carrier roller tread face	142		130		
3	Width of flange	52		42		
4	Width of carrier roller tread face	35		42		
5	Clearance between shaft and bushing	Standard size	Tolerance		Standard clearance	Clearance limit
			Shaft	Hole		
		40	-0.080 -0.119	+0.039 0	0.080 - 0.158	1.0
6	Interference between carrier roller and bushing	Standard size	Tolerance		Standard interference	Interference limit
			Shaft	Hole		
		52	+0.062 +0.032	+0.030 0	-0.062 - -0.002	-
7	Interference between shaft and support	40	+0.070 +0.050	+0.039 0	-0.070 - -0.011	-
8	Free play of roller in the axial direction	Standard clearance		Clearance limit		
		0.525 - 0.700		1.5		
9	Fitting pressure of shaft	4 - 12 ton				Adjust

# HYDRAULIC SYSTEM

## 61 STRUCTURE AND FUNCTION

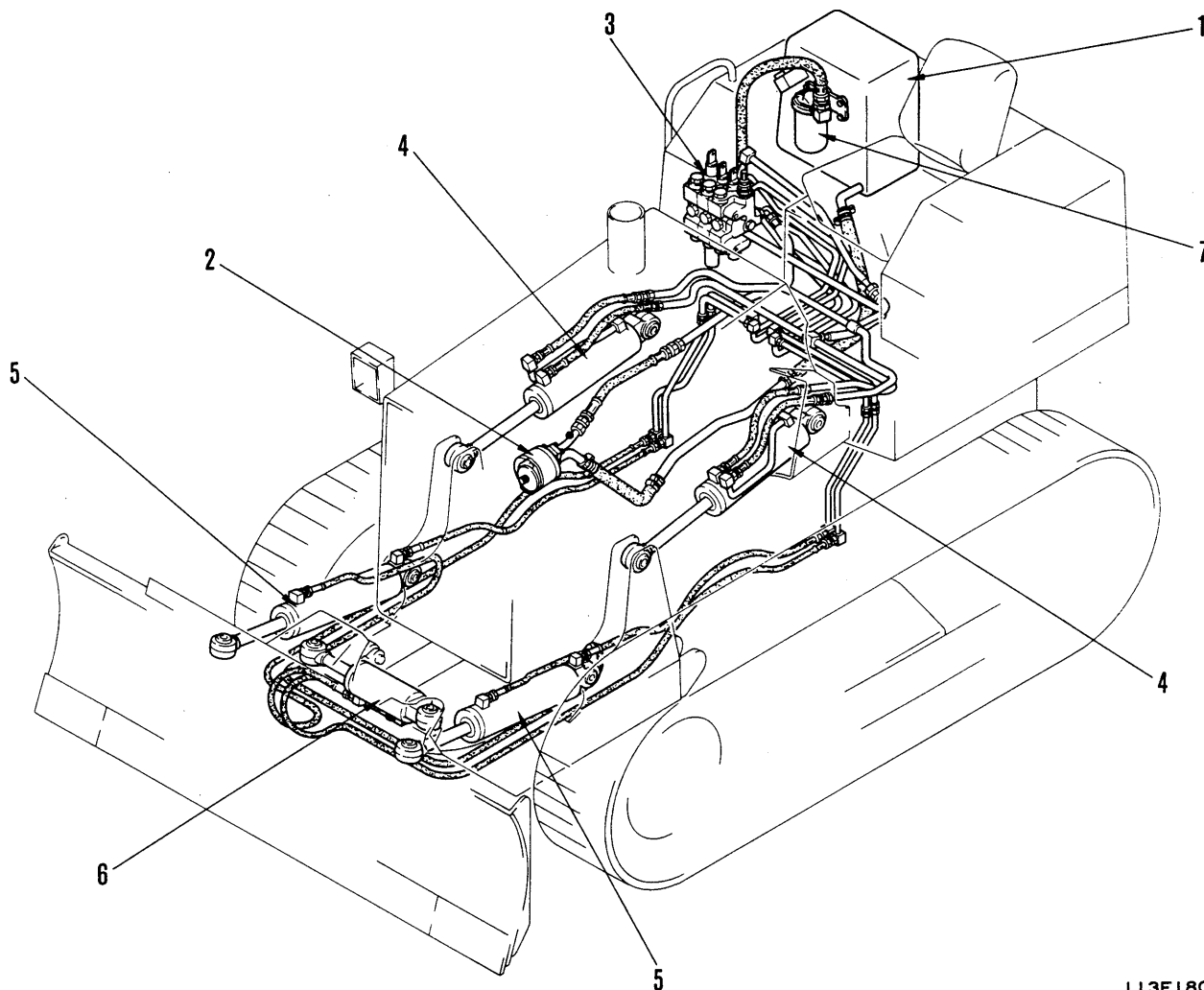


Hydraulic piping (D31E-18, D31P-18A, D37E, P-2) .....	61- 2
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# HYDRAULIC PIPING

D31E-18, D31P-18A, D37E, P-2



- 1. Hydraulic tank
- 2. Hydraulic pump
- 3. Hydraulic control valve
- 4. Blade lift cylinder
- 5. Blade angle cylinder
- 6. Blade tilt cylinder
- 7. Hydraulic filter

## OUTLINE

- The oil in hydraulic tank (1) is sucked up by hydraulic pump (2) installed to the engine, and is sent to hydraulic control valve (3). The hydraulic control valve sets the pressure in the circuit to 175 kg/cm<sup>2</sup>. It switches the flow of oil to lift cylinder (4), angle cylinder (5), or tilt cylinder (6) to operate the blade according to the movement of the work equipment control lever. If the hydraulic control valve is at the "HOLD" position, the oil enters hydraulic filter (7) installed to the hydraulic tank and returns to the hydraulic tank.

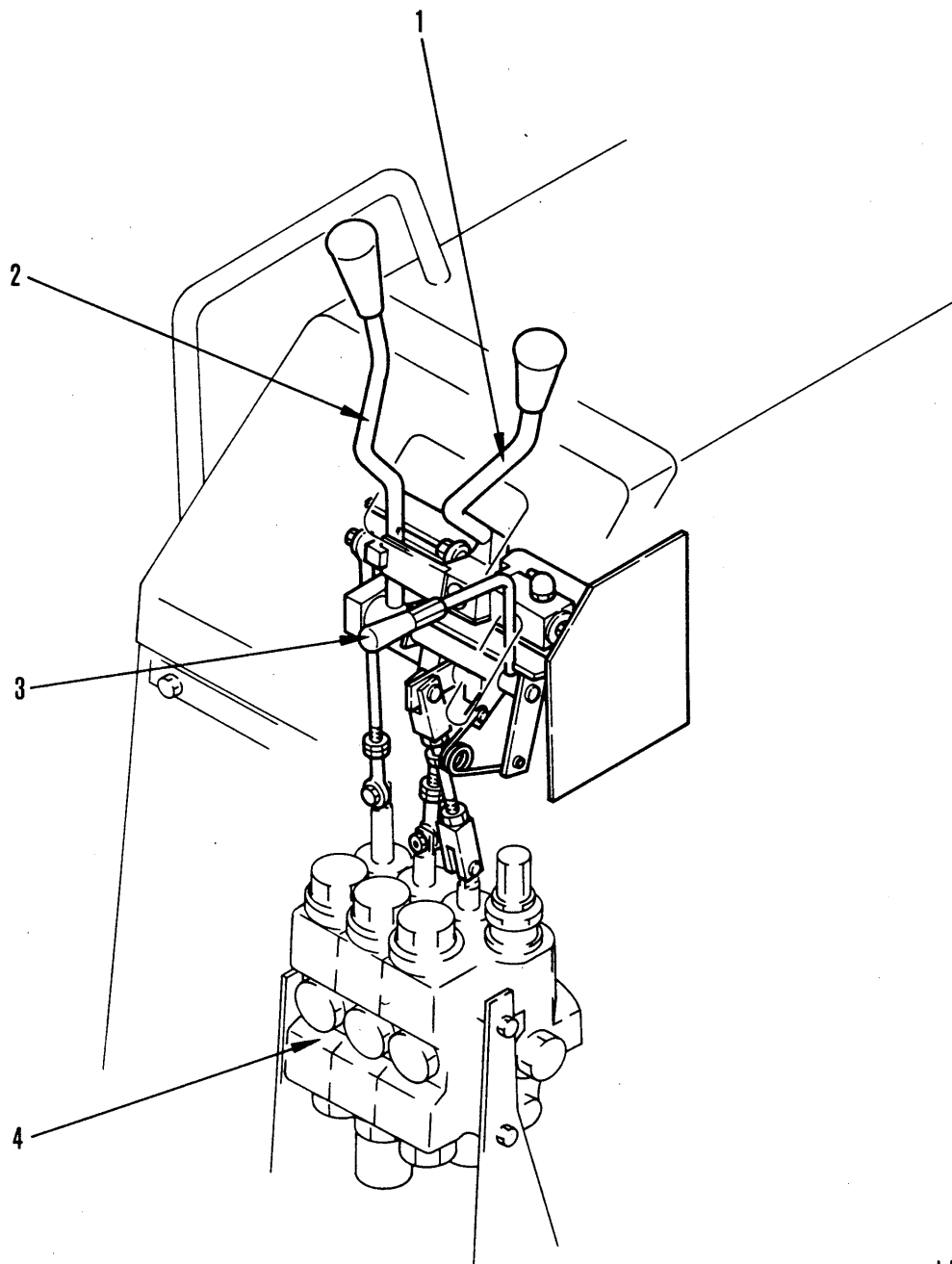
The hydraulic filter is a cartridge type with a filtering precision of 10 $\mu$ , and a maximum filtering rate of 100 $\ell$ /min, and the normal pressure is set to 1.5 kg/cm<sup>2</sup>.

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# HYDRAULIC CONTROL

D31E-18, D31P-18A, D37E, P-2



- 1. Work equipment control lever  
(For blade lift and tilt)
- 2. Work equipment control lever  
(For blade angle)
- 3. Lock lever
- 4. Hydraulic control valve

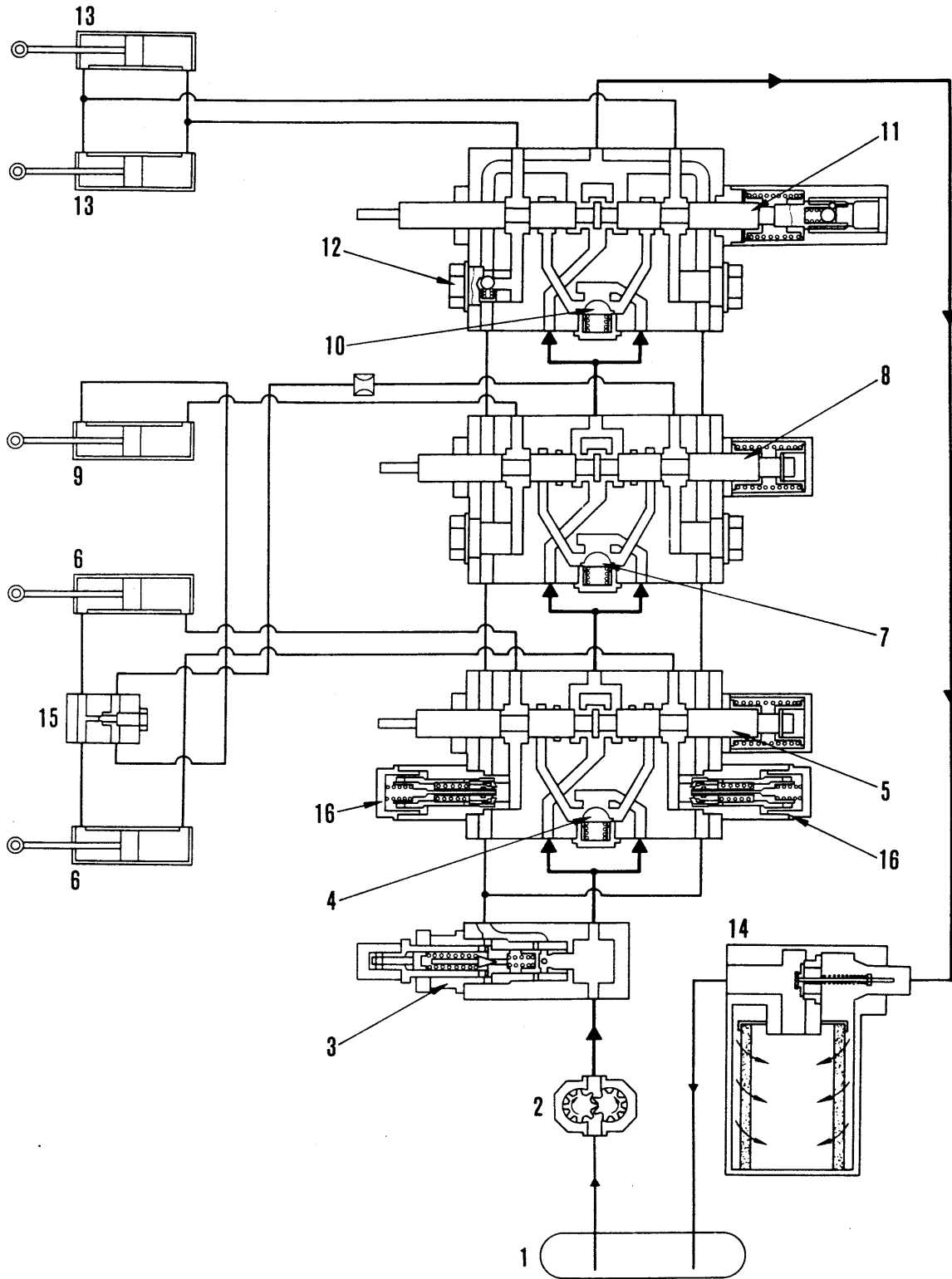
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# HYDRAULIC CIRCUIT SYSTEM D31E-18, D31P-18A, D37E, P-2

## POWER ANGLE AND TILTDOZER

★ Engine running, hydraulic control lever in "HOLD".



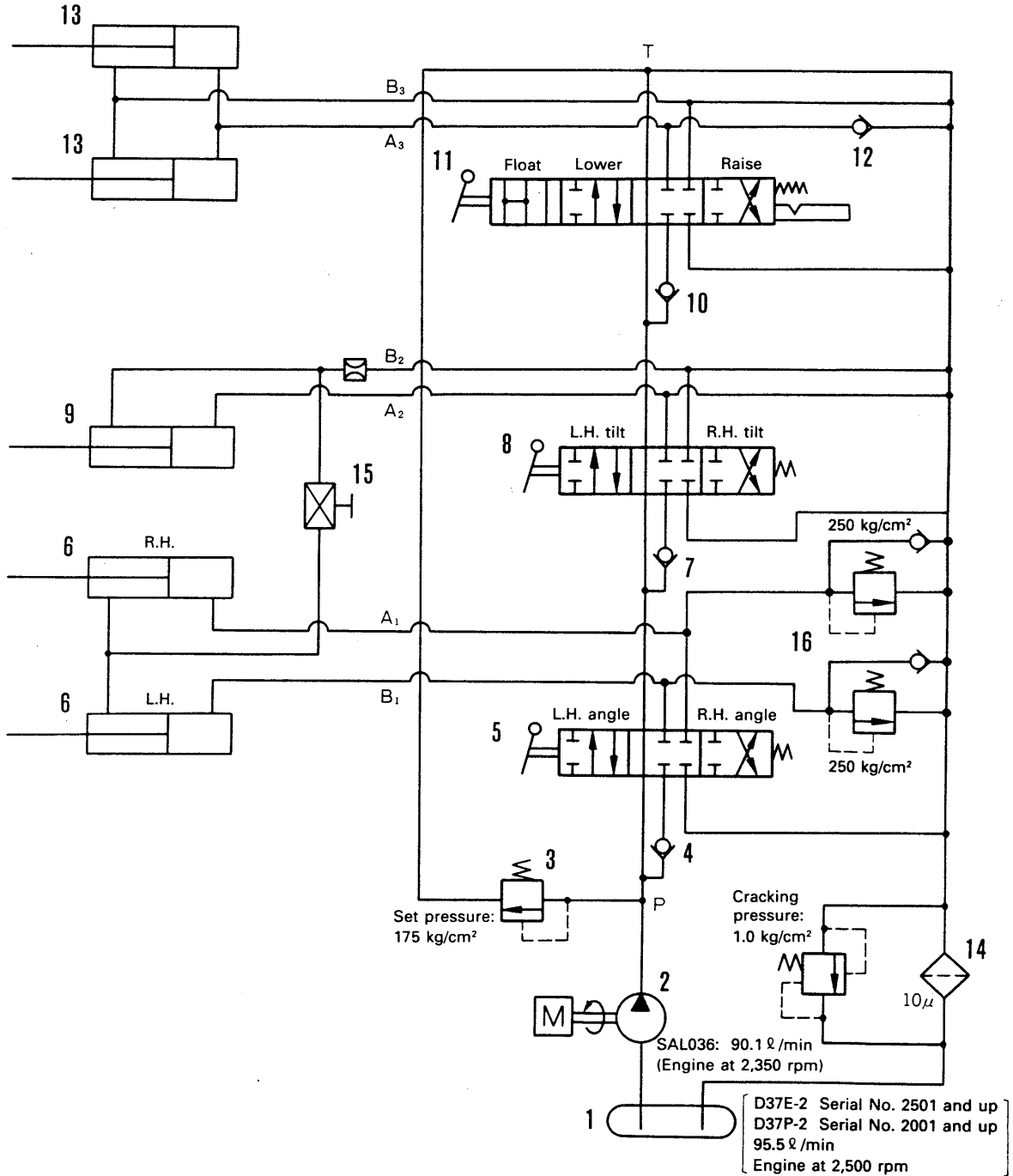
011418

F11318034-1

# HYDRAULIC CIRCUIT DIAGRAM D31E-18, D31P-18A, D37E, P-2

## POWER ANGLE AND TILTDOZER

★ Engine running, hydraulic control lever in "HOLD".

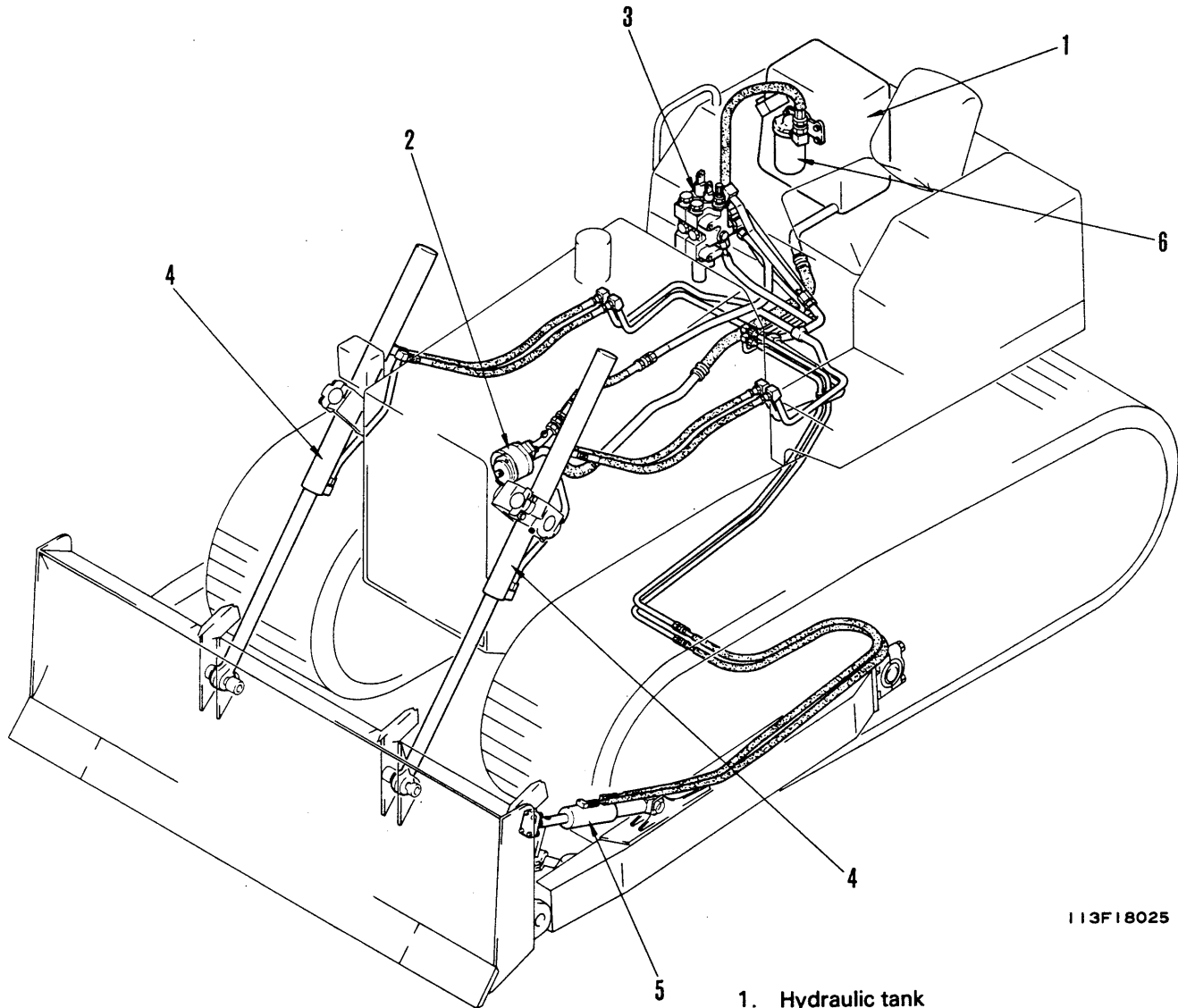


- |                            |                                   |
|----------------------------|-----------------------------------|
| 1. Hydraulic tank          | 9. Blade tilt cylinder            |
| 2. Hydraulic pump          | 10. Check valve                   |
| 3. Main relief valve       | 11. Blade lift valve spool        |
| 4. Check valve             | 12. Suction valve for blade lower |
| 5. Blade angle valve spool | 13. Blade lift cylinder           |
| 6. Blade angle cylinder    | 14. Hydraulic filter              |
| 7. Check valve             | 15. Air bleeding valve            |
| 8. Blade tilt valve spool  | 16. Suction safety valve          |

113F18309

# HYDRAULIC PIPING

D31P, PL, PLL-18



1. Hydraulic tank
2. Hydraulic pump
3. Hydraulic control valve
4. Blade lift cylinder
5. Blade tilt cylinder
6. Hydraulic filter

I 13F 18025

011418

## OUTLINE

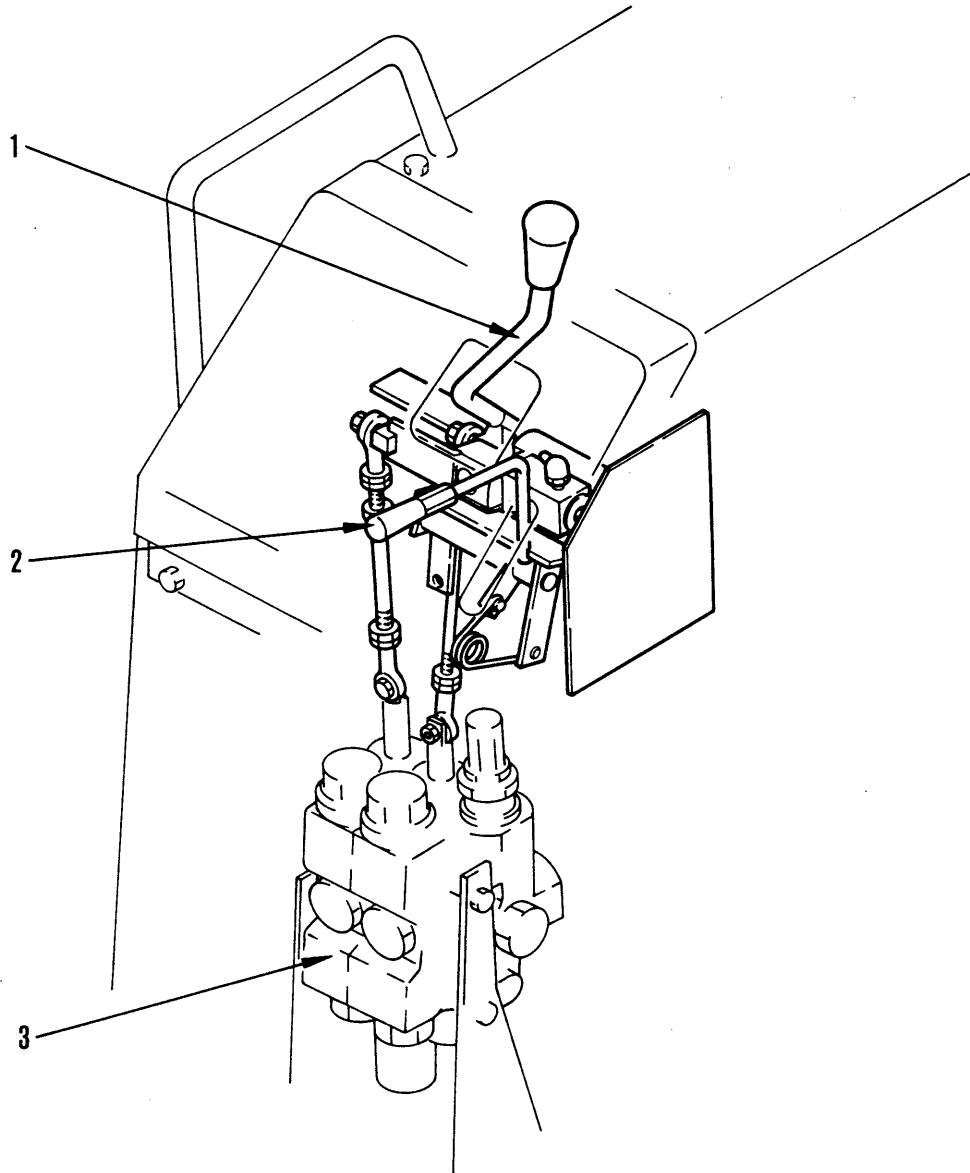
- The oil in hydraulic tank (1) is sucked up by hydraulic pump (2) installed to the engine, and is sent to hydraulic control valve (3). The hydraulic control valve sets the pressure in the circuit to 175 kg/cm<sup>2</sup>. It switches the flow of oil to lift cylinder (4), or tilt cylinder (5) to operate the blade according to the movement of the work equipment control lever. If the hydraulic control valve is at the "HOLD" position, the oil enters hydraulic filter (6) installed to the hydraulic tank and returns to the hydraulic tank.

The hydraulic filter is a cartridge type with a filtering precision of 10 $\mu$ , and a maximum filtering rate of 100 $\ell$ /min, and the normal pressure is set to 1.5 kg/cm<sup>2</sup>.

The total capacity of the hydraulic tank is 49 liters, with the amount of oil inside the tank set to 33 litres.

# HYDRAULIC CONTROL

D31P, PL, PLL-18



011418

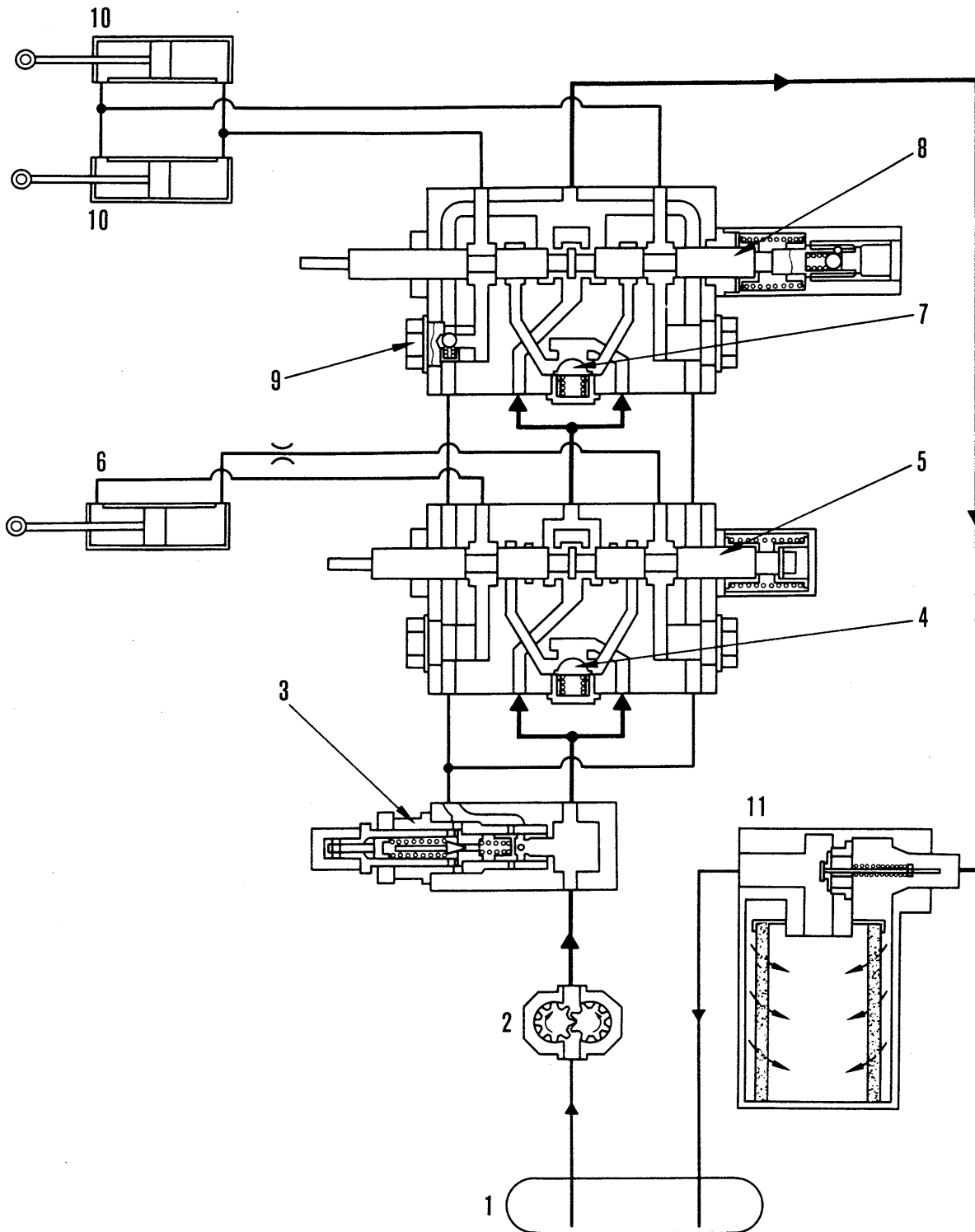
113F18036

1. Work equipment control lever  
(For blade lift and tilt)
2. Lock lever
3. Hydraulic control valve



# HYDRAULIC CIRCUIT SYSTEM D31P, PL, PLL-18

★ Engine running, hydraulic control lever in "HOLD".

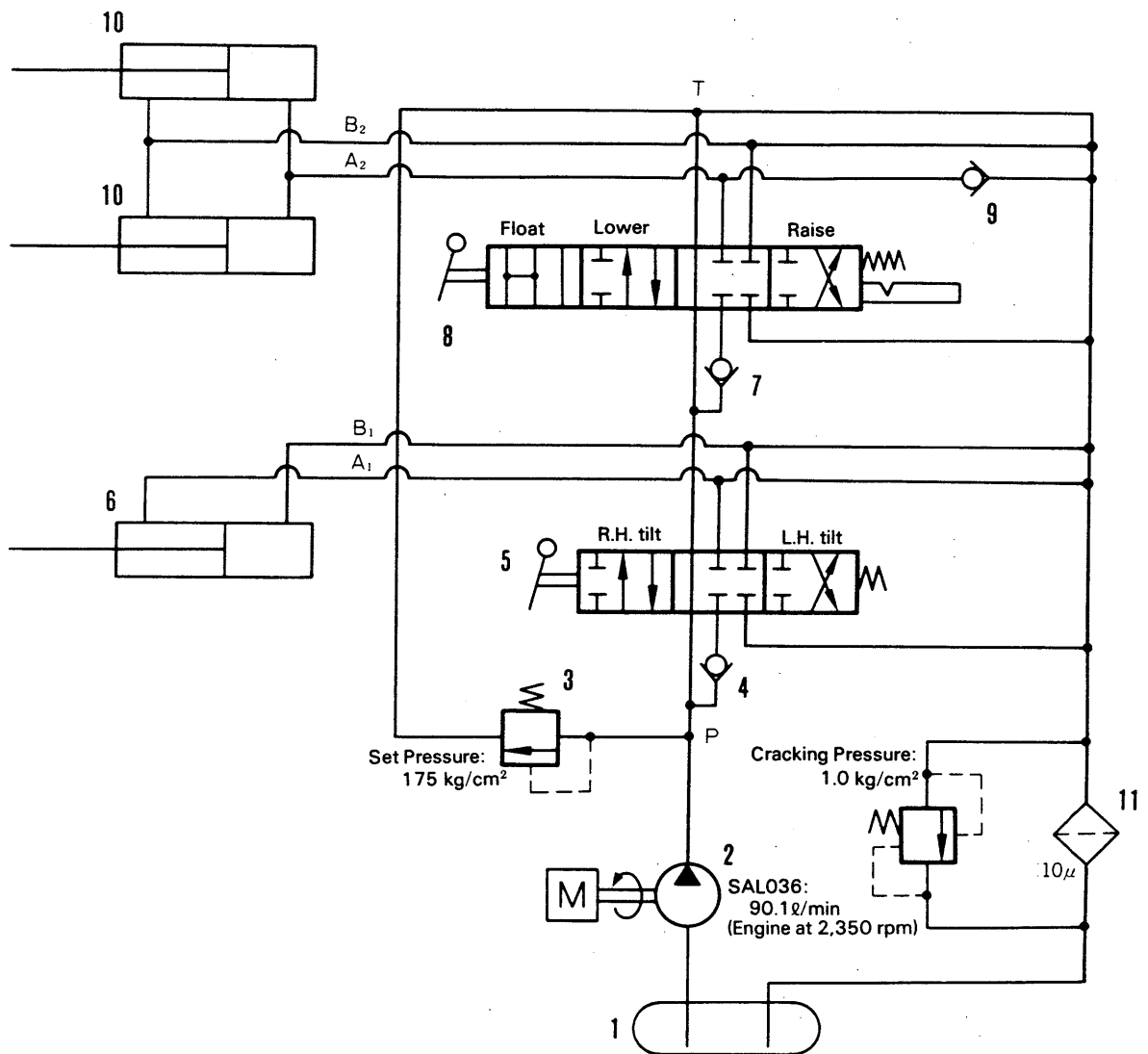


011418

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# HYDRAULIC CIRCUIT DIAGRAM D31P, PL, PLL-18

★ Engine running, hydraulic control lever in "HOLD".



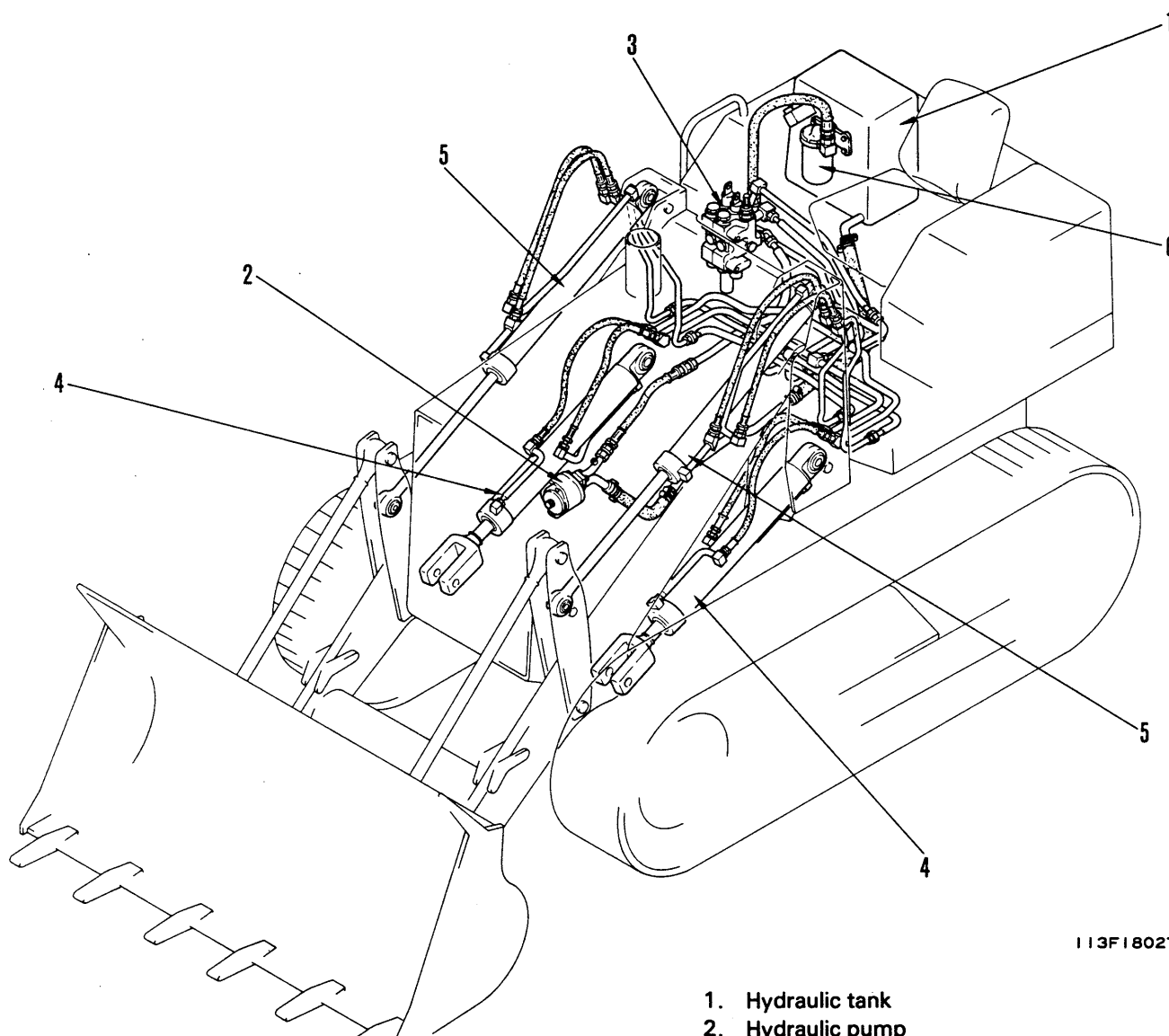
113F18026

- |                           |                                  |
|---------------------------|----------------------------------|
| 1. Hydraulic tank         | 7. Check valve                   |
| 2. Hydraulic pump         | 8. Blade lift valve spool        |
| 3. Main relief valve      | 9. Suction valve for blade lower |
| 4. Check valve            | 10. Blade lift cylinder          |
| 5. Blade tilt valve spool | 11. Hydraulic filter             |
| 6. Blade tilt cylinder    |                                  |

011418

# HYDRAULIC PIPING

D31S, Q-18



1. Hydraulic tank
2. Hydraulic pump
3. Hydraulic control valve
4. Bucket lift cylinder
5. Bucket dump cylinder
6. Hydraulic oil filter

113F18027

## OUTLINE

- The oil in hydraulic tank (1) is sucked up by hydraulic pump (2) installed to the engine, and is sent to hydraulic control valve (3).

The hydraulic control valve sets the pressure in the circuit to 175 kg/cm<sup>2</sup>. It switches the flow of oil to lift cylinder (4), or dump cylinder (5) to operate the bucket according to the movement of the work equipment control lever.

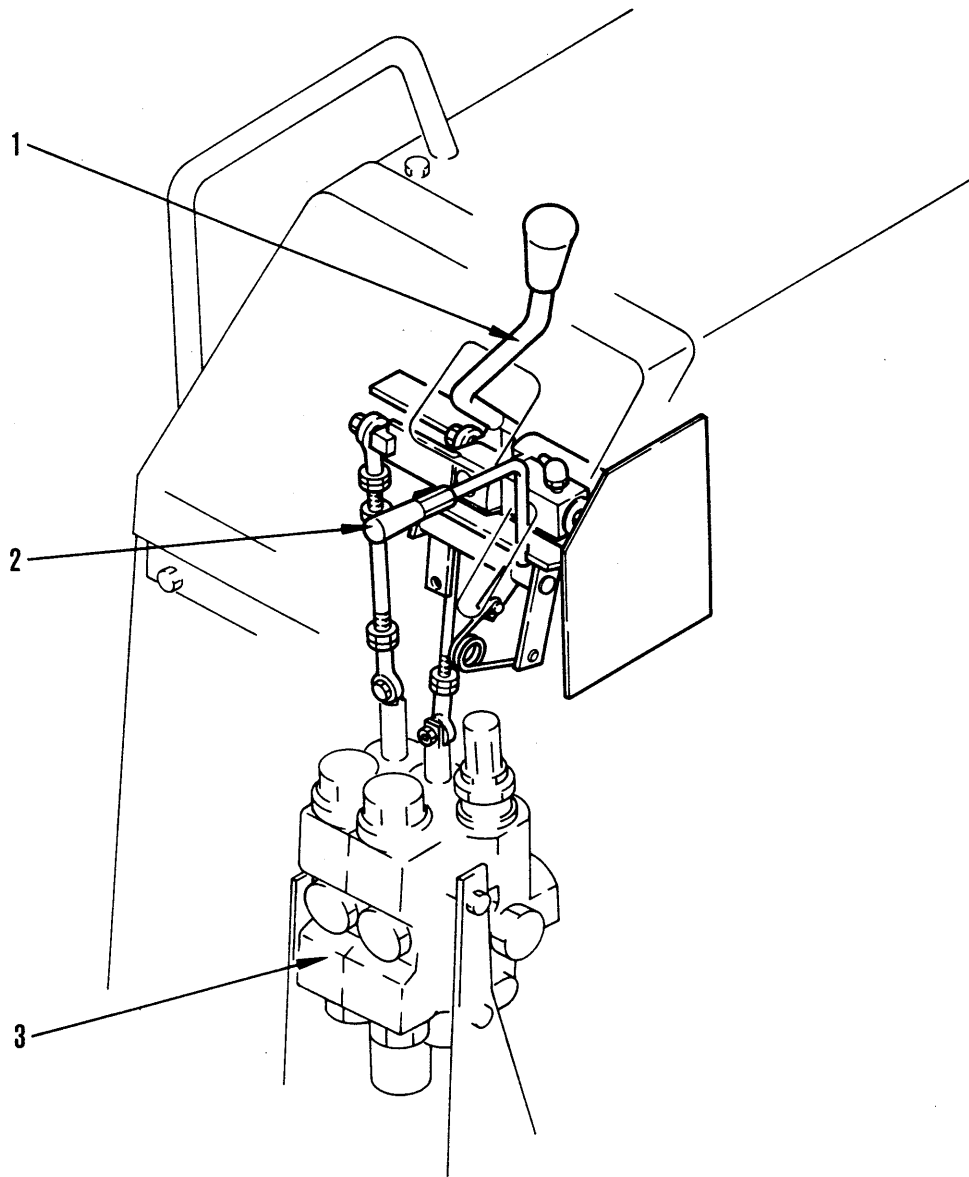
If the hydraulic control valve is at the "HOLD" position, the oil enters hydraulic filter (6) installed to the hydraulic tank and returns to the hydraulic tank.

The hydraulic filter is a cartridge type with a filtering precision of 10 $\mu$ , and a maximum filtering rate of 100 l/min, and the normal pressure is set to 1.5 kg/cm<sup>2</sup>.

The total capacity of the hydraulic tank is 52 liters, with the amount of oil inside the tank set to 33 litres.

# HYDRAULIC CONTROL

D31S, Q-18



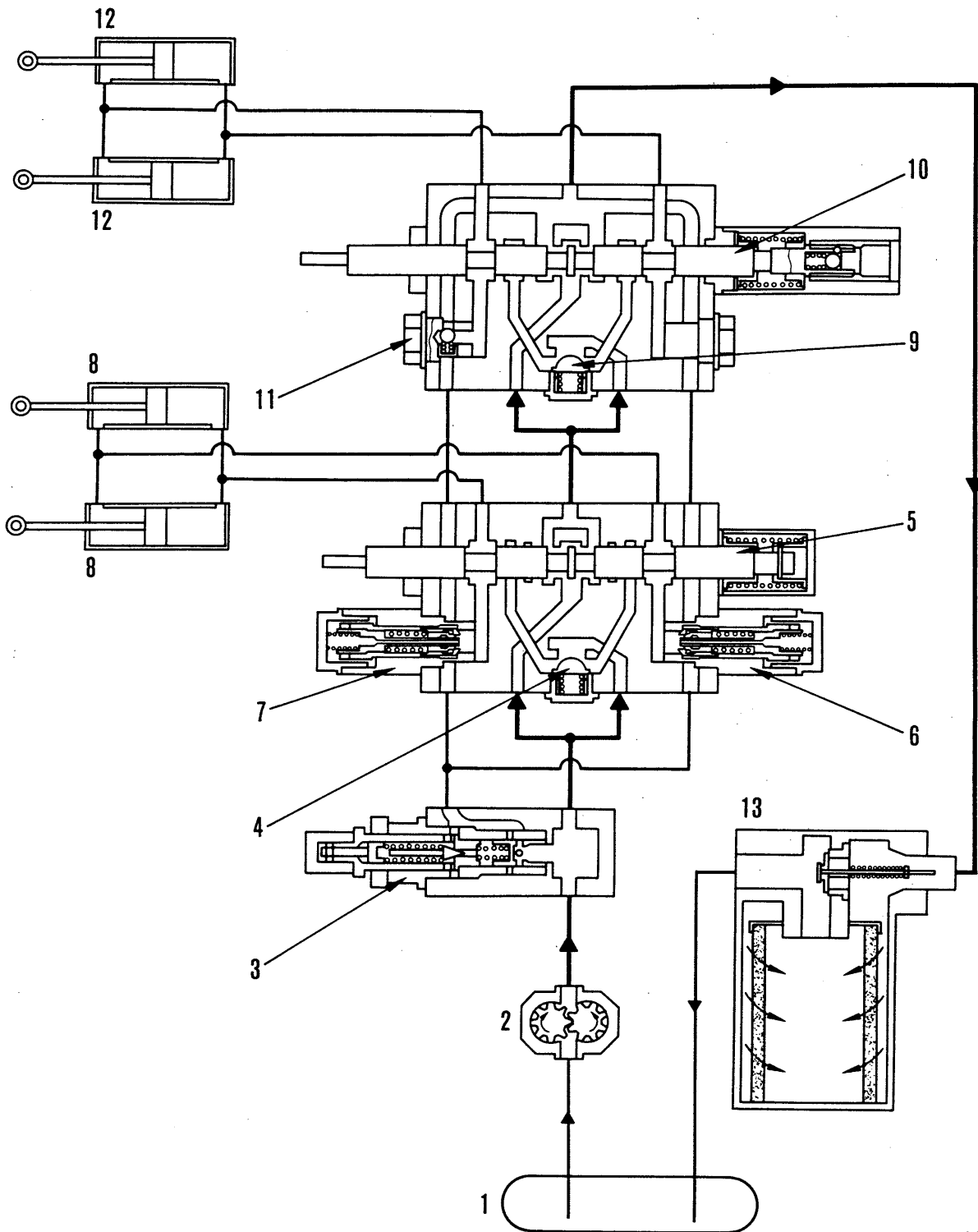
- 1. Work equipment control lever  
(For bucket)
- 2. Lock lever
- 3. Hydraulic control valve

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011418

# HYDRAULIC CIRCUIT SYSTEM D31S, Q-18

★ Engine running, hydraulic control lever in "HOLD".

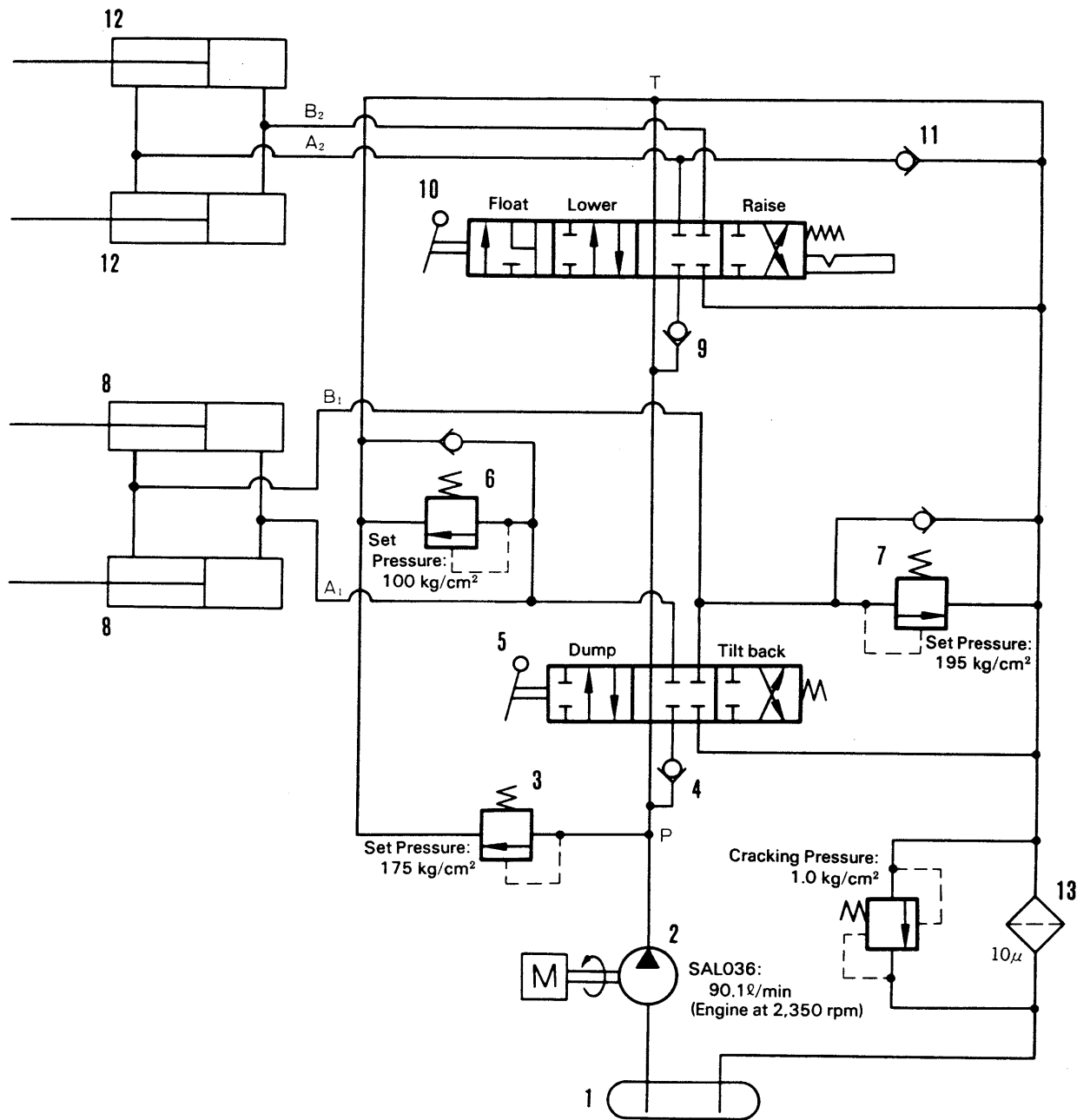


011418

F11318036

# HYDRAULIC CIRCUIT DIAGRAM D31S, Q-18

★ Engine running, hydraulic control lever in "HOLD".

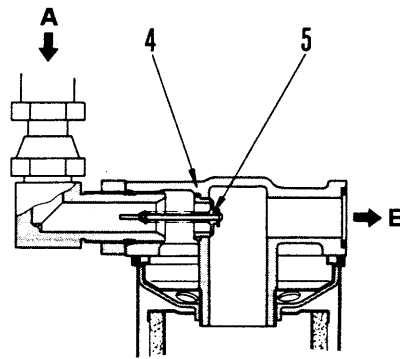
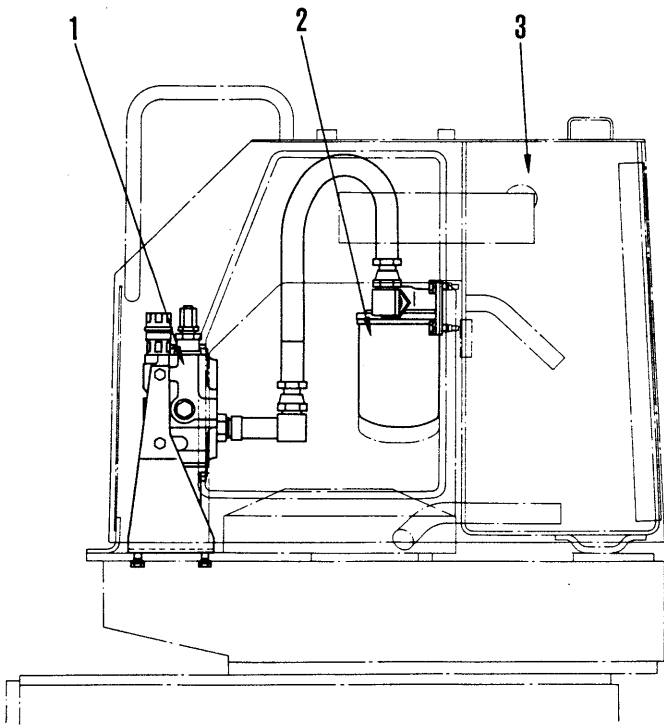
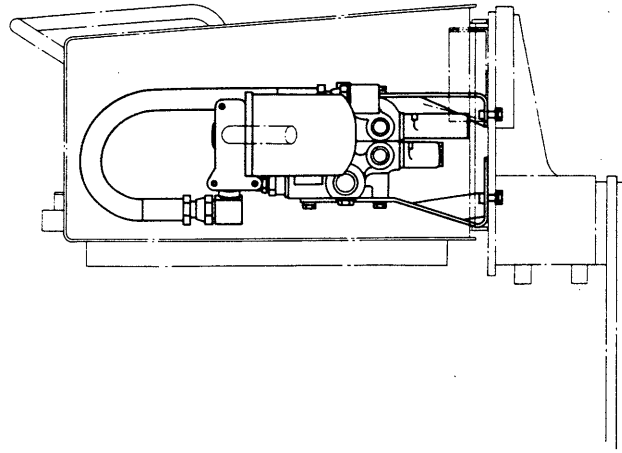
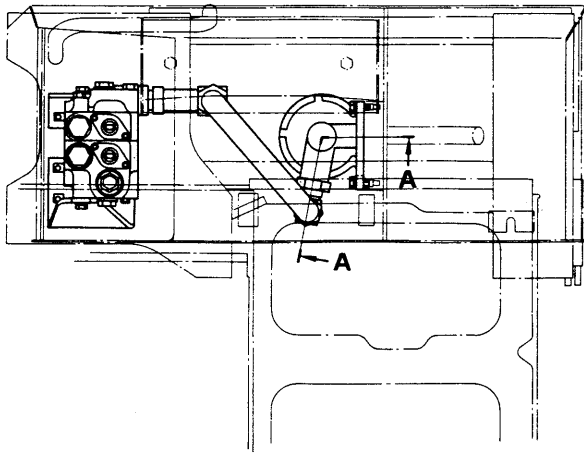


113F18028

- |                                 |                                    |
|---------------------------------|------------------------------------|
| 1. Hydraulic tank               | 8. Bucket dump cylinder            |
| 2. Hydraulic pump               | 9. Check valve                     |
| 3. Main relief valve            | 10. Bucket lift valve spool        |
| 4. Check valve                  | 11. Suction valve for bucket lower |
| 5. Bucket dump valve spool      | 12. Bucket lift cylinder           |
| 6. Safety valve for bucket dump | 13. Hydraulic filter               |
| 7. Safety valve for bucket tilt |                                    |

011418

# HYDRAULIC TANK AND FILTER



Section A-A

F11318037

- 1. Hydraulic control valve
- 2. Hydraulic filter
- 3. Hydraulic tank
- 4. Filter head
- 5. Bypass valve
- A. From control valve
- B. To hydraulic tank

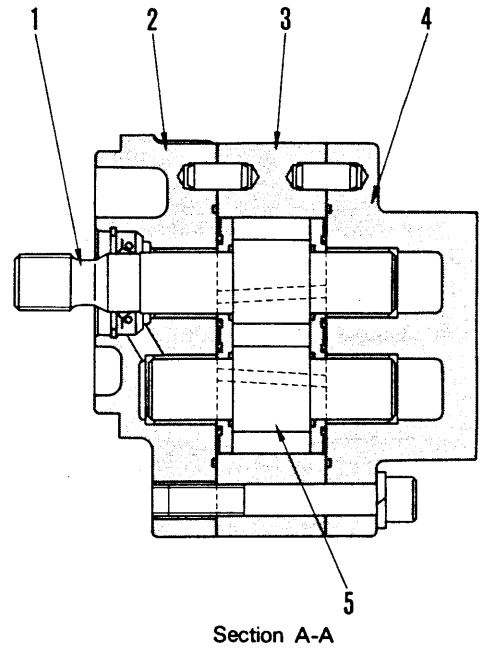
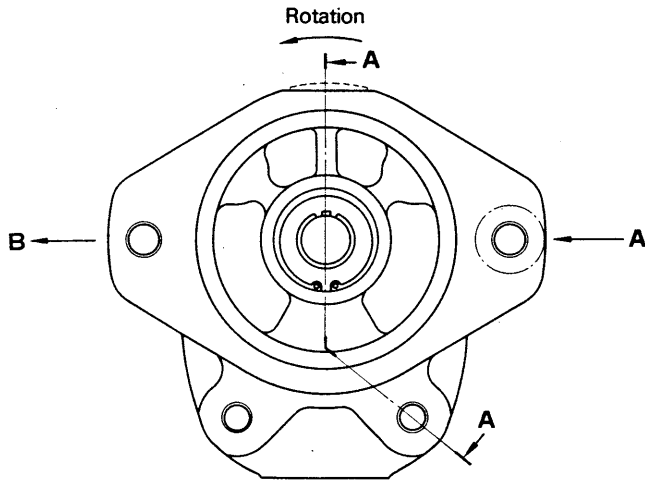
## OUTLINE

- The hydraulic filter is a cartridge type with a filtering precision of  $10\mu$ , and a maximum filtering rate of  $100\ell/\text{min}$ , and the normal pressure is set to  $1.5\text{ kg/cm}^2$ .
- The capacity of the hydraulic tank is as shown below.

	D31E, S, Q-18 D31P-18A D37E, P-2	D31P, PL, PLL-18
Total capacity	52ℓ	49ℓ
Amount of oil inside tank	33ℓ	33ℓ

011418

# HYDRAULIC PUMP (SAL036)



011418

F11318038

- 1. Drive gear
- 2. Bracket
- 3. Gear case
- 4. Cover
- 5. Driven gear
- A. Suction
- B. Discharge

## OUTLINE

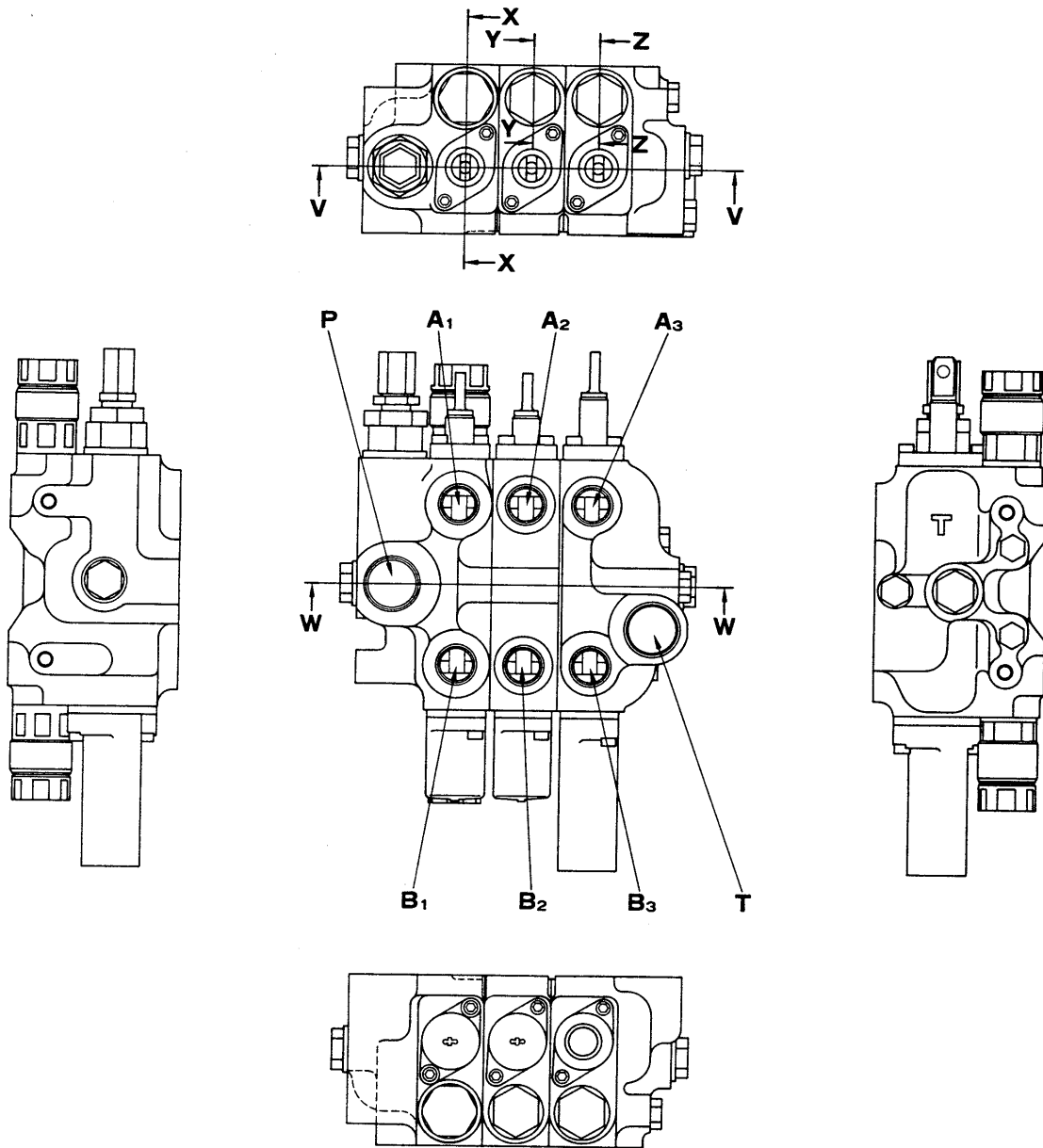
- The hydraulic pump is installed to the engine. The D31-18 and D37-2 use an SAL036.
- The main specifications are as shown below.

Item	Model	D31-18 D37E-2 D37P-2	Serial No. 1501-2500 Serial No. 1501-2000	D37E-2 D37P-2	Serial No. 2501 and up Serial No. 2001 and up
	Discharge		90.1 ℓ /min		95.5 ℓ /min
Setting pressure		175 kg/cm <sup>2</sup>		175 kg/cm <sup>2</sup>	
Engine revolution		2,350 rpm		2,500 rpm	
Oil		Class-CD SAE 10W			



# HYDRAULIC CONTROL VALVE (3-spool VALVE)

D31E-18, D31P-18A, D37E, P-2



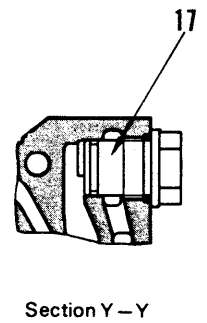
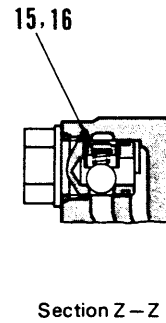
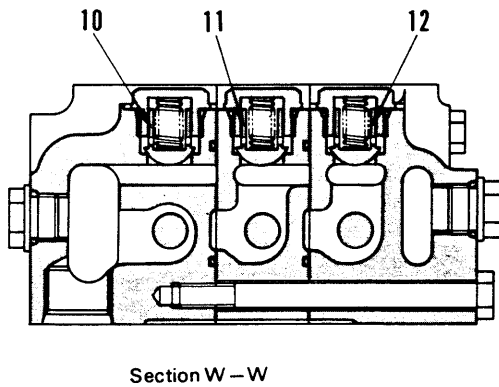
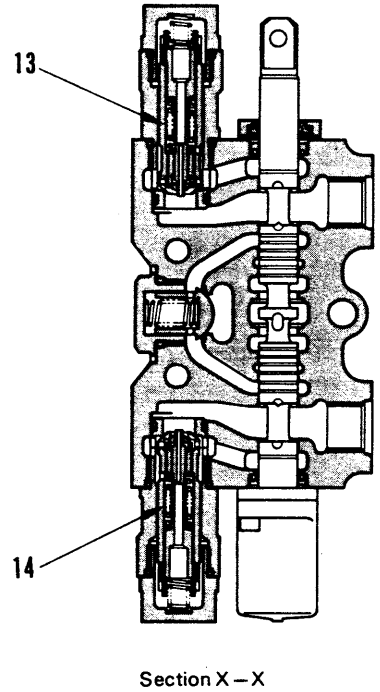
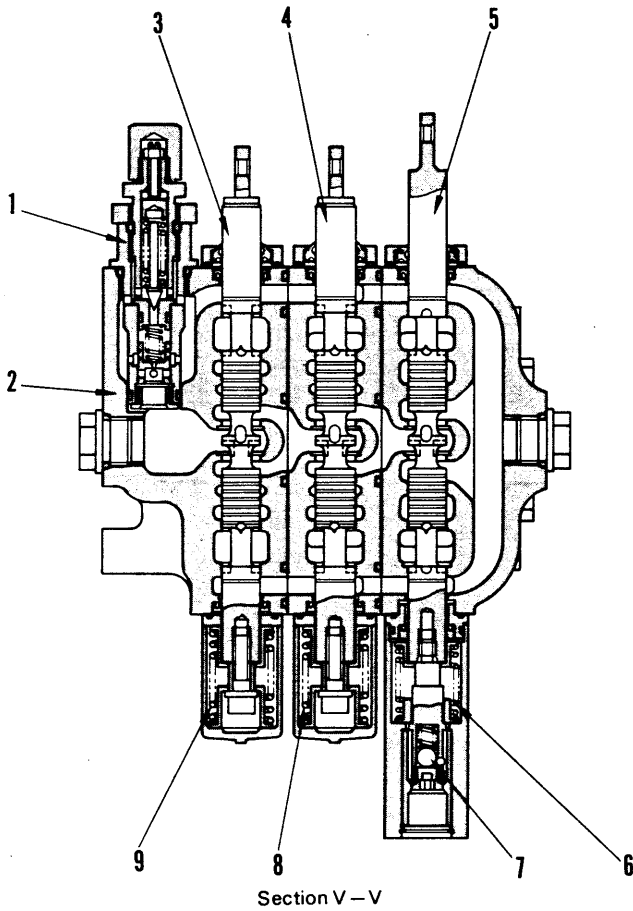
124F05031

- P. From hydraulic pump
- A<sub>1</sub>. To R.H. angle cylinder bottom (L.H. ANGLE)
- B<sub>1</sub>. To L.H. angle cylinder bottom (R.H. ANGLE)
- A<sub>2</sub>. To tilt cylinder head (R.H. TILT)
- B<sub>2</sub>. To tilt cylinder bottom (L.H. TILT)
- A<sub>3</sub>. To lift cylinder bottom (LOWER)
- B<sub>3</sub>. To lift cylinder head (RAISE)
- T. To hydraulic tank

## OUTLINE

- The control valve is a 3-spool valve with spools for blade lift, tilt, and angle.
- Main relief valve (1) sets the pressure in the circuit to 175 kg/cm<sup>2</sup>.
- The set pressure of the main relief valve can be adjusted by adjustment screw. One turn of the adjustment screw adjusts the pressure by 24.8 kg/cm<sup>2</sup>.

011418

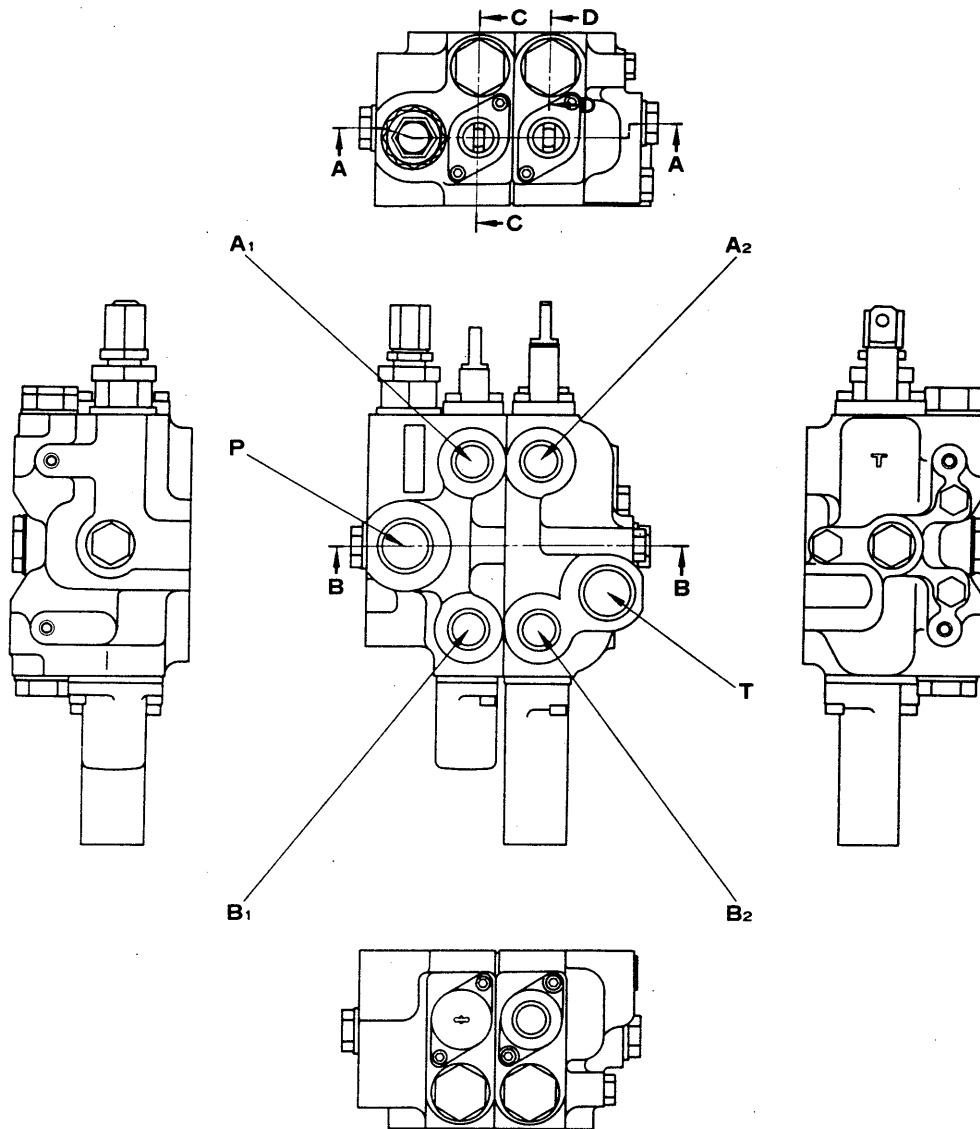


I 24F05032

- |                               |  |  |
|-------------------------------|--|--|
| 1. Main relief valve assembly | 8. Spool return spring                     | 14. Suction safety valve (R.H. angle side) |
| 2. Valve body                 | 9. Spool return spring                     | 15. Suction valve (Lower side)             |
| 3. Angle valve spool          | 10. Tilt check valve                       | 16. Suction valve (Upper side)             |
| 4. Tilt valve spool           | 11. Angle check valve                      | 17. Plug                                   |
| 5. Lift valve spool           | 12. Lift check valve                       |  |
| 6. Spool return spring        | 13. Suction safety valve (L.H. angle side) |  |
| 7. Detent assembly            |  |  |

# HYDRAULIC CONTROL VALVE

D31P, PL, PLL-18



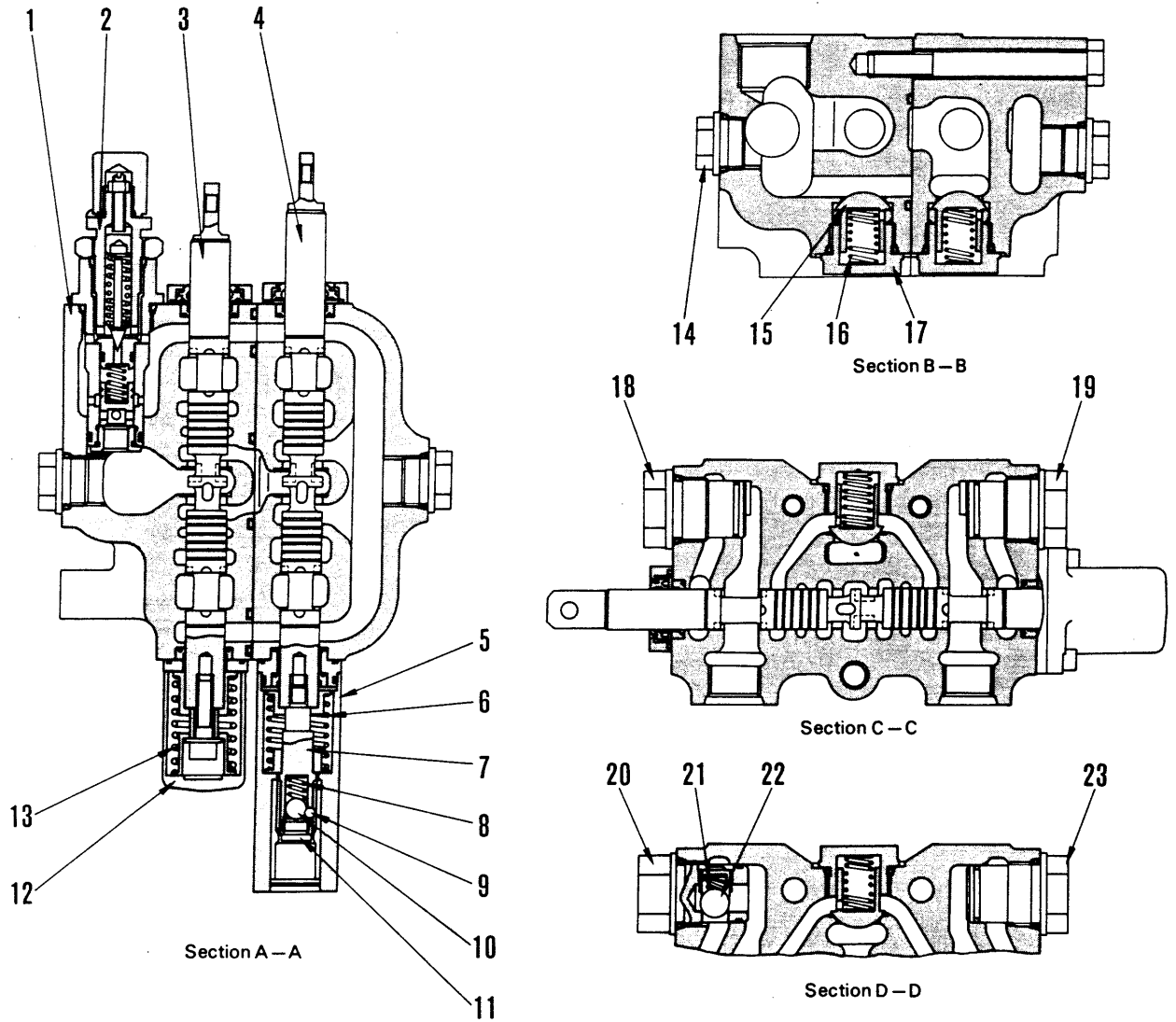
113F18031

- P. From hydraulic pump
- A<sub>1</sub>. To tilt cylinder bottom (R.H. TILT)
- B<sub>1</sub>. To tilt cylinder head (L.H. TILT)
- A<sub>2</sub>. To lift cylinder bottom (LOWER)
- B<sub>2</sub>. To lift cylinder head (RAISE)
- T. To hydraulic tank

## OUTLINE

- The control valve is a 2-spool valve with spools for blade lift, and tilt.
- Main relief valve (2) sets the pressure in the circuit to 175 kg/cm<sup>2</sup>.
- Suction valve (22) acts to prevent negative pressure from being formed at the lift cylinder bottom when the blade is lowered.

011418



113F18032

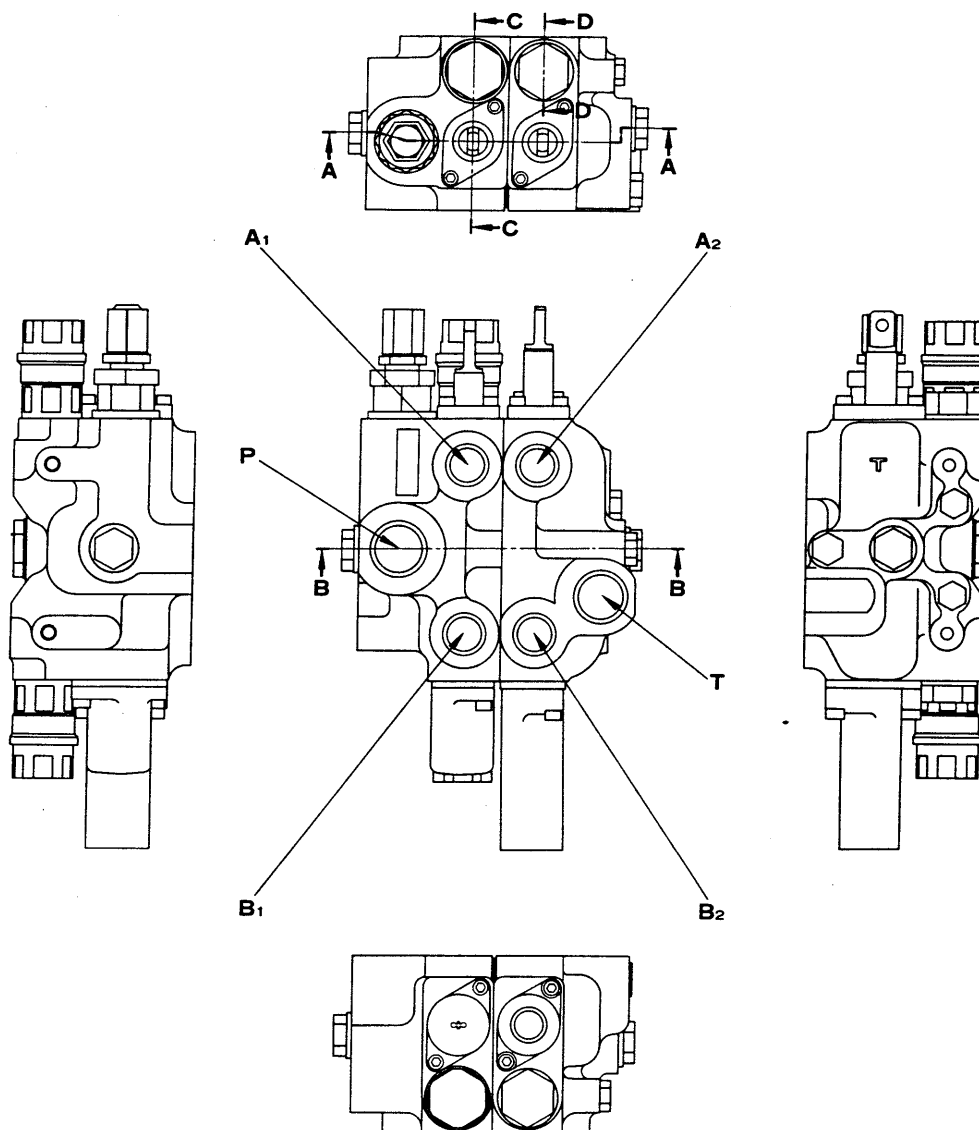
- 1. Valve body
- 2. Main relief valve
- 3. Blade tilt spool
- 4. Blade lift spool
- 5. Detent and spring case
- 6. Return spring
- 7. Detent plug
- 8. Detent spring

- 9. Detent ball
- 10. Detent ball
- 11. Plug
- 12. Spring case
- 13. Return spring
- 14. Plug
- 15. Check valve
- 16. Check valve spring

- 17. Plug
- 18. Plug
- 19. Plug
- 20. Plug
- 21. Suction valve spring
- 22. Suction valve
- 23. Plug

# HYDRAULIC CONTROL VALVE

D31S, Q-18



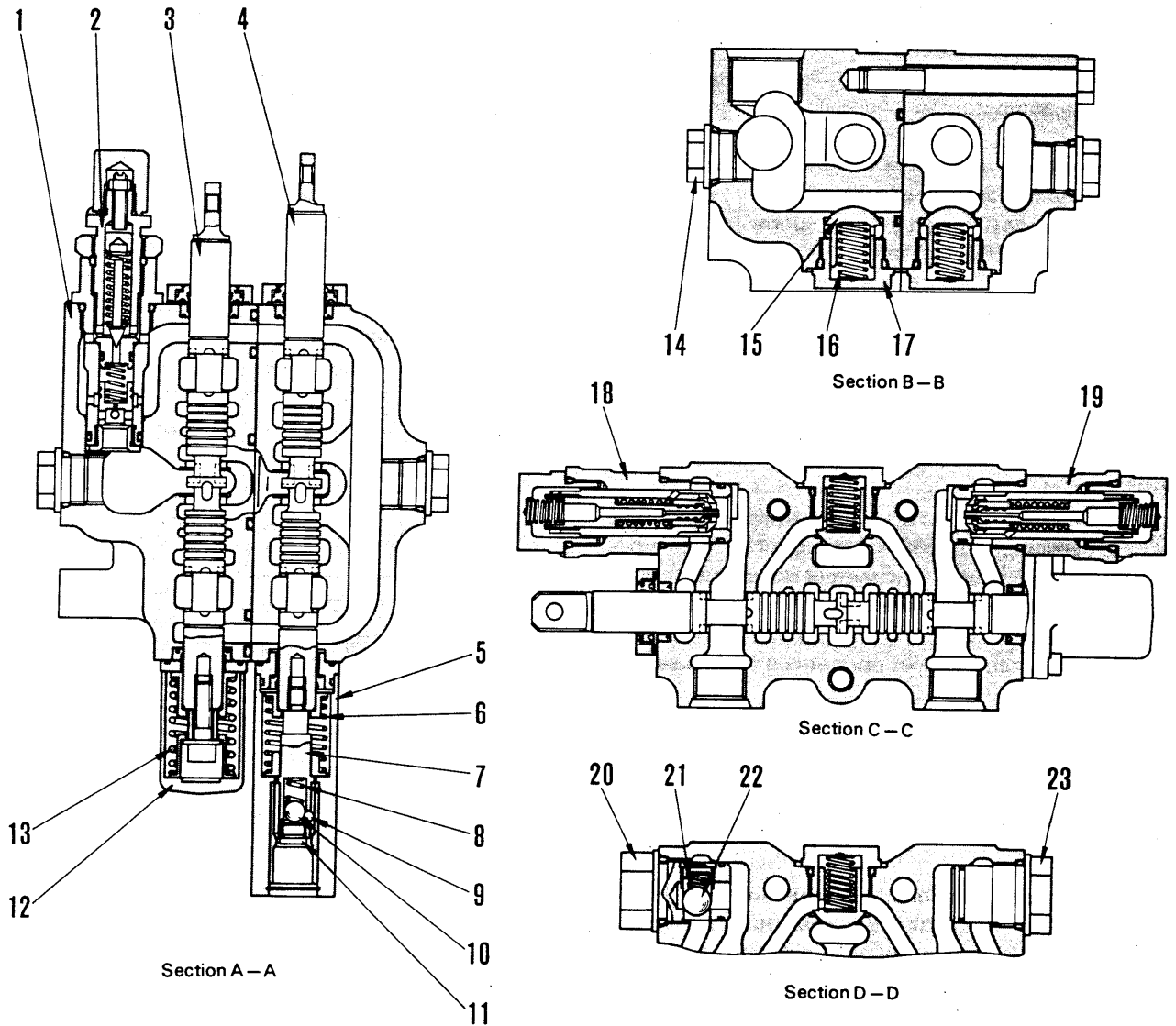
P. From hydraulic pump  
A<sub>1</sub>. To dump cylinder head (TILT BACK)  
B<sub>1</sub>. To dump cylinder bottom (DUMP)

A<sub>2</sub>. To lift cylinder head (LOWER)  
B<sub>2</sub>. To lift cylinder bottom (RAISE)  
T. To hydraulic tank

## OUTLINE

- The control valve is a 2-spool valve with spools for bucket lift, and dump.
- Main relief valve (2) sets the pressure in the circuit to 175 kg/cm<sup>2</sup>.
- Suction valve (22) acts to prevent negative pressure from being formed at the lift cylinder head when the bucket is lowered.
- Safety valves (18) and (19) have a suction function, and relieve the circuit when external shock causes abnormally high pressure. Tilt safety valve (19) relieves the circuit at 195 kg/cm<sup>2</sup>, and dump safety valve (18) relieves the circuit at 100 kg/cm<sup>2</sup>.

011418



- 1. Valve body
- 2. Main relief valve
- 3. Bucket dump spool
- 4. Bucket lift spool
- 5. Detent and spring case
- 6. Return spring
- 7. Detent plug
- 8. Detent spring

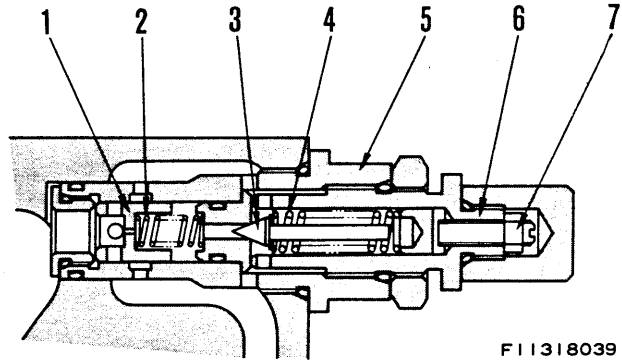
- 9. Detent ball
- 10. Detent ball
- 11. Plug
- 12. Spring case
- 13. Return spring
- 14. Plug
- 15. Check valve
- 16. Check valve spring

- 17. Plug
- 18. Bucket dump safety valve
- 19. Bucket tilt safety valve
- 20. Plug
- 21. Suction valve spring
- 22. Suction valve
- 23. Plug

113F18034

## MAIN RELIEF VALVE

- The main relief valve is in the circuit between the hydraulic pump and the control valve. When the control valve is operated, the main relief valve sets the pressure of the oil flowing from the hydraulic pump to the hydraulic cylinder to 175 kg/cm<sup>2</sup>.
- The set pressure of the main relief valve can be adjusted by adjustment screw (6). One turn of the adjustment screw adjusts the pressure by 24.8 kg/cm<sup>2</sup>.

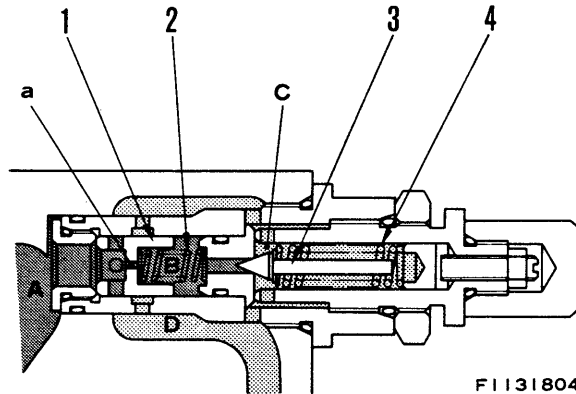


F11318039

- |                  |                     |
|------------------|---------------------|
| 1. Main valve    | 5. Valve body       |
| 2. Valve spring  | 6. Adjustment screw |
| 3. Pilot poppet  | 7. Lock nut         |
| 4. Poppet spring |                     |

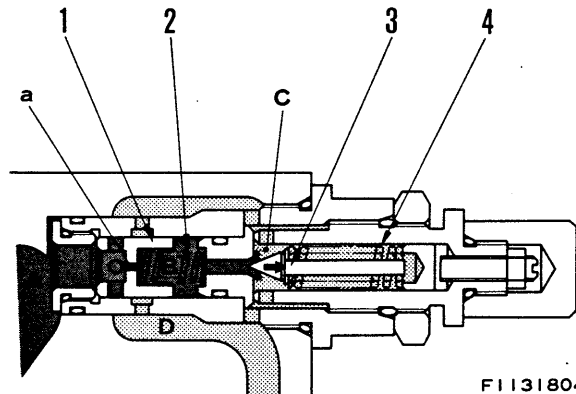
### OPERATION.

- Chamber A forms the circuit from the pump to the cylinder. Chamber D forms the tank drain circuit. The oil flows into chamber B through orifice "a" to keep the chamber filled. If the pressure in chamber B is less than the poppet spring (set pressure), the pilot poppet sits in the seat of the body.



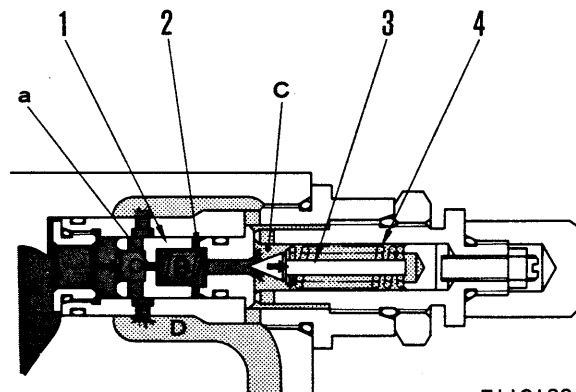
F11318040

- If the pressure in chamber B reaches the poppet spring (4) force (set pressure), the pilot poppet (3) moves, allowing the oil in chamber B to flow into chamber D through chamber C. In addition, the oil flows from chamber A to B through orifices.



F11318041

- If the oil flows through the orifice "a", a differential pressure occurs between the chambers A and B, moving valve (2) to the right. This allows the oil in chamber A to flow into chamber D.



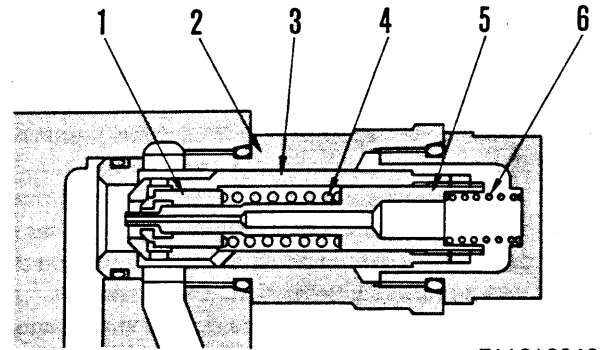
F11318042

011418

## SAFETY VALVE WITH SUCTION

### FUNCTION

- There are two safety valves: one is in the circuit between the bucket dump control valve and cylinder head (bucket tilt back end), and the other between the bucket dump control valve and the cylinder bottom end (bucket dump end). When external shock acting on the dump cylinder generates abnormally high pressure, the safety valve relieves the pressure, and moves the cylinder to prevent damage to the cylinder. The relief pressure at the head end (tilt back end) is set to 195 kg/cm<sup>2</sup> and at the bottom end (dump end) to 100 kg/cm<sup>2</sup>. The safety valves also act as suction valves when negative pressure is generated at the dump cylinder head end or bottom end.



F11318043

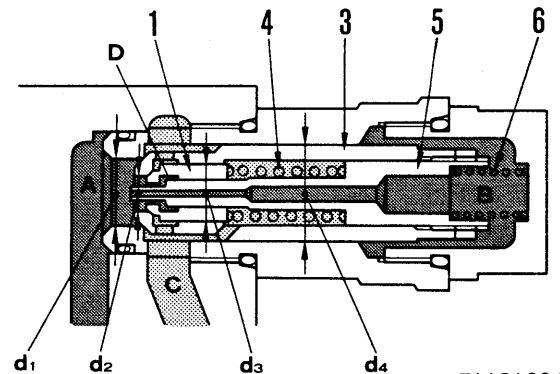
- |               |                         |
|---------------|-------------------------|
| 1. Poppet     | 4. Safety valve spring  |
| 2. Valve body | 5. Piston               |
| 3. Valve      | 6. Suction valve spring |

### FLOW OF OIL WHEN SAFETY VALVE IS ACTUATED

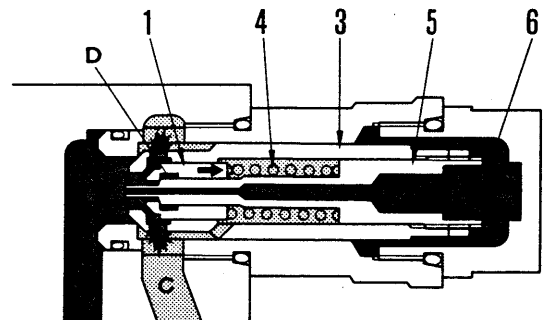
- Chamber A is in the cylinder circuit and always joins chambers B and D. Chamber C is connected to the tank drain circuit. The relationship between the sizes of the areas taking pressure inside the valves is as follows.  
★  $d_4 > d_1 > d_3 > d_2$
- When the cylinder is operated, the oil fills chambers A, B, and D. However, the surface pressure ( $d_4$ ) of chamber B is larger than the surface pressure ( $d_1$ ) of chamber A, so valve (3) is pushed against the body seat and the passage between chambers A and C is closed.

While the hydraulic pressure in chamber A is smaller than the tension of spring (4), poppet (1) is pushed into the seat of valve (3).

- When the cylinder is being operated, or when it is at HOLD, and a large shock is applied to the cylinder, momentarily high pressure is formed in chambers A, B, and D. When this hydraulic pressure becomes larger than the tension of spring (4), poppet (1) moves to the right, and the passage between chambers A and C is opened. The hydraulic pressure in chamber A is relieved to chamber C and the hydraulic pressure in the cylinder circuit goes down. Even if abnormally high pressure is generated, when the relationship is  $d_4 > d_1$ , valve (3) is not actuated.



F11318044

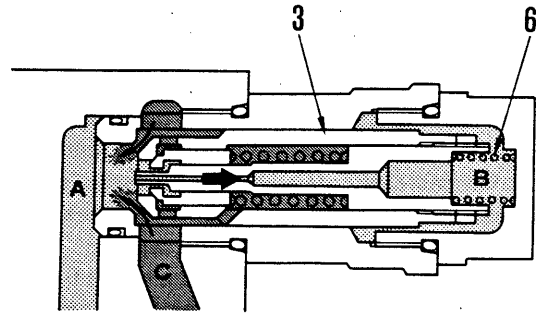


F11318045



### FLOW OF OIL WHEN SUCTION VALVE IS ACTUATED

- When negative pressure is formed in the cylinder circuit, the hydraulic pressure in chambers **A** and **B** also becomes negative pressure. When this happens, the hydraulic pressure in chamber **C** becomes relatively higher. Therefore, the hydraulic pressure in chamber **C** becomes the surface pressure  $d_4 - d_3$ , and acts on valve (3). At the point where this surface pressure becomes greater than the tension of spring (6), valve (3) moves to the right, the passage between chambers **C** and **A** is opened and the oil in the tank drain circuit is supplied to the cylinder circuit to prevent negative pressure.



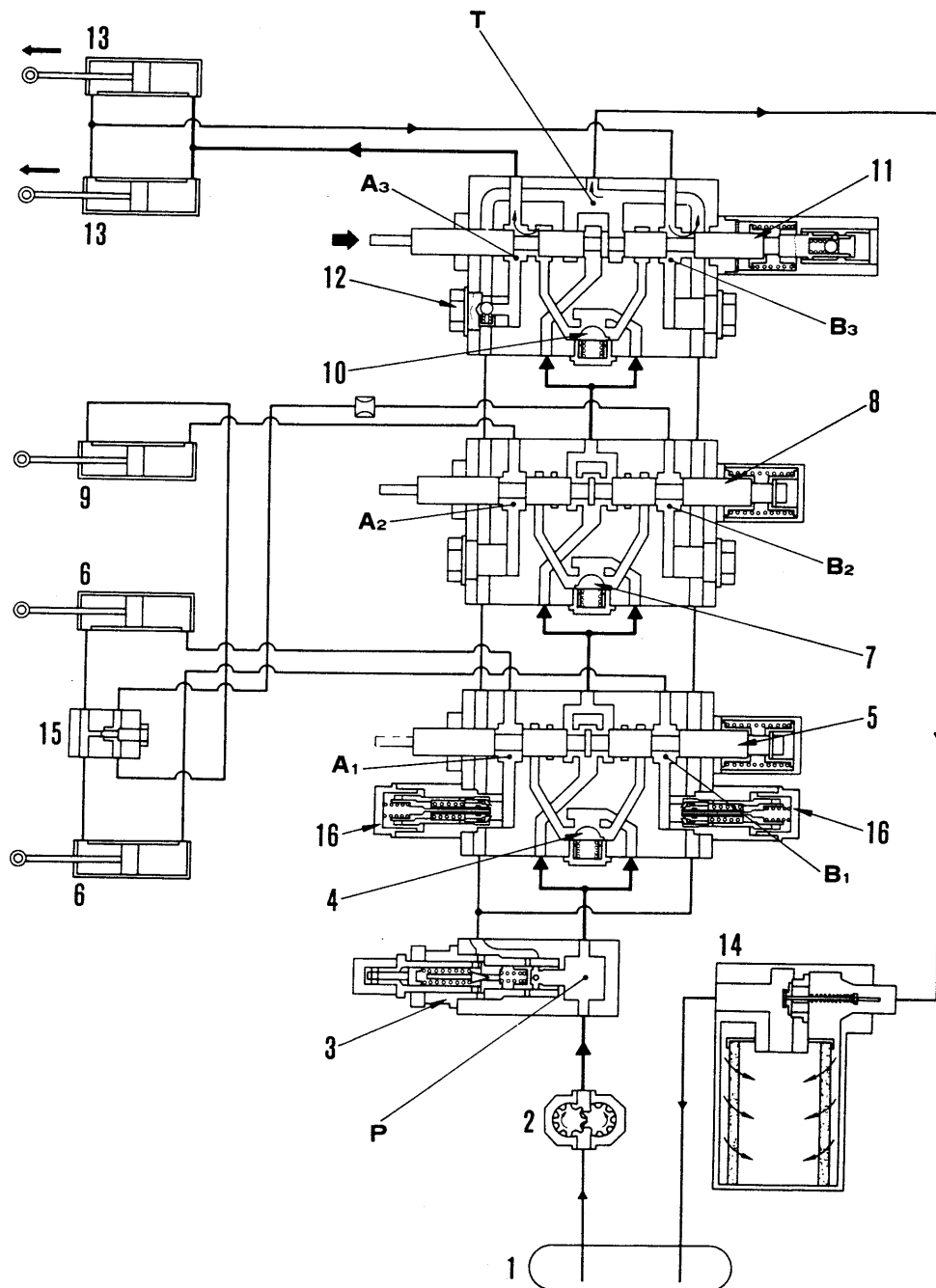
F11318046

011418

# HYDRAULIC LEVER OPERATION D31E, P, PL, PLL-18, D31P-18A, D37E, P-2

## POWER ANGLE AND TILTDOZER BLADE LIFT AND TILT CONTROL LEVER IN "LOWER"

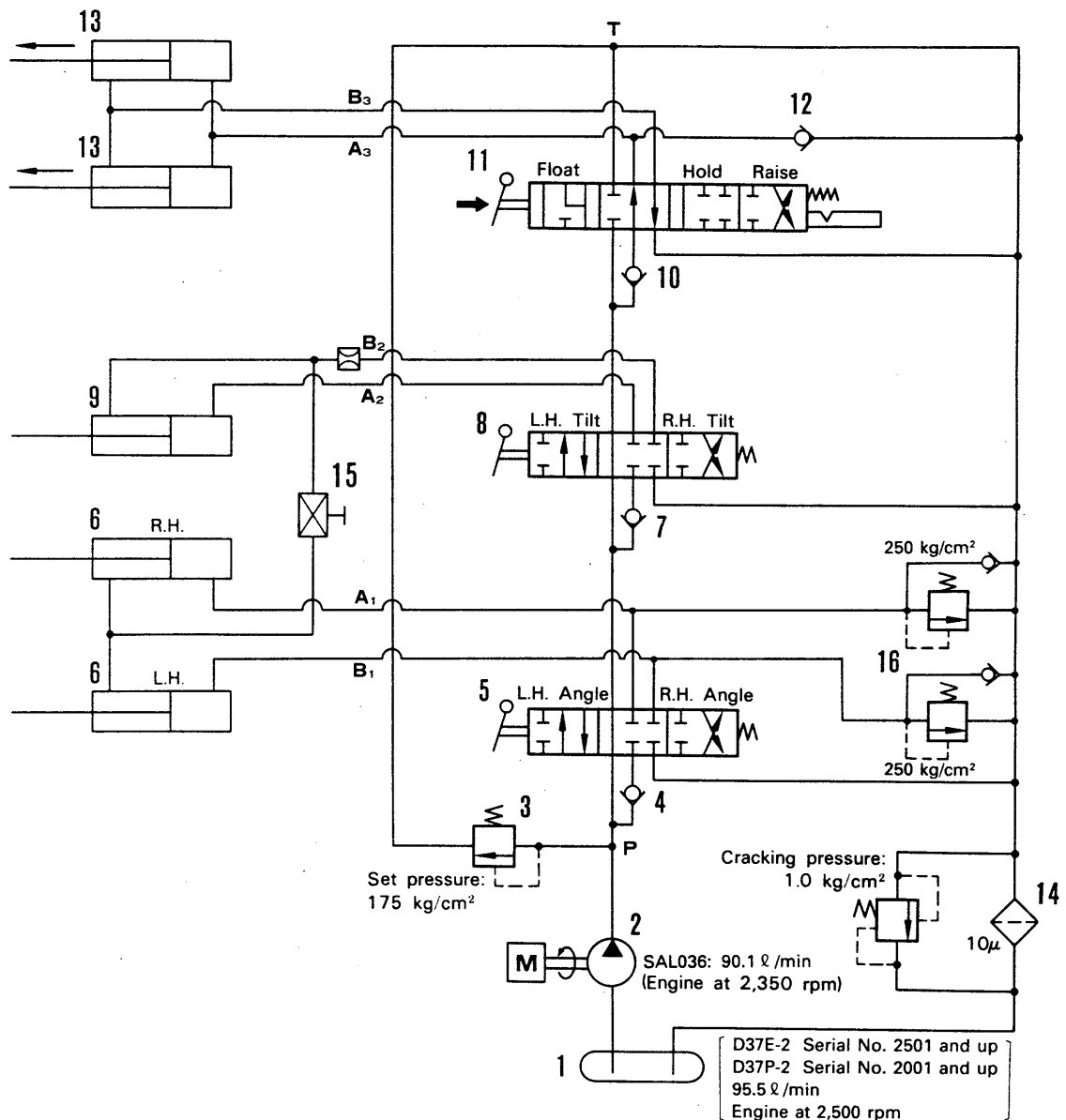
★ The diagram shows the D31E-18, D31P-18A and D37E, P-2, but the explanation of the operation for the D31P, PL, PLL-18 is the same.



F11318047-1

- |                            |                                   |                          |
|----------------------------|-----------------------------------|--------------------------|
| 1. Hydraulic tank          | 7. Check valve                    | 13. Blade lift cylinder  |
| 2. Hydraulic pump          | 8. Blade tilt valve spool         | 14. Hydraulic filter     |
| 3. Main relief valve       | 9. Blade tilt cylinder            | 15. Air bleeding valve   |
| 4. Check valve             | 10. Check valve                   | 16. Suction safety valve |
| 5. Blade angle valve spool | 11. Blade lift valve spool        |                          |
| 6. Blade angle cylinder    | 12. Suction valve for blade lower |                          |

**POWER ANGLE AND TILTDOZER  
BLADE LIFT AND TILT CONTROL LEVER IN "LOWER"**



F11318048A

**FLOW OF OIL**

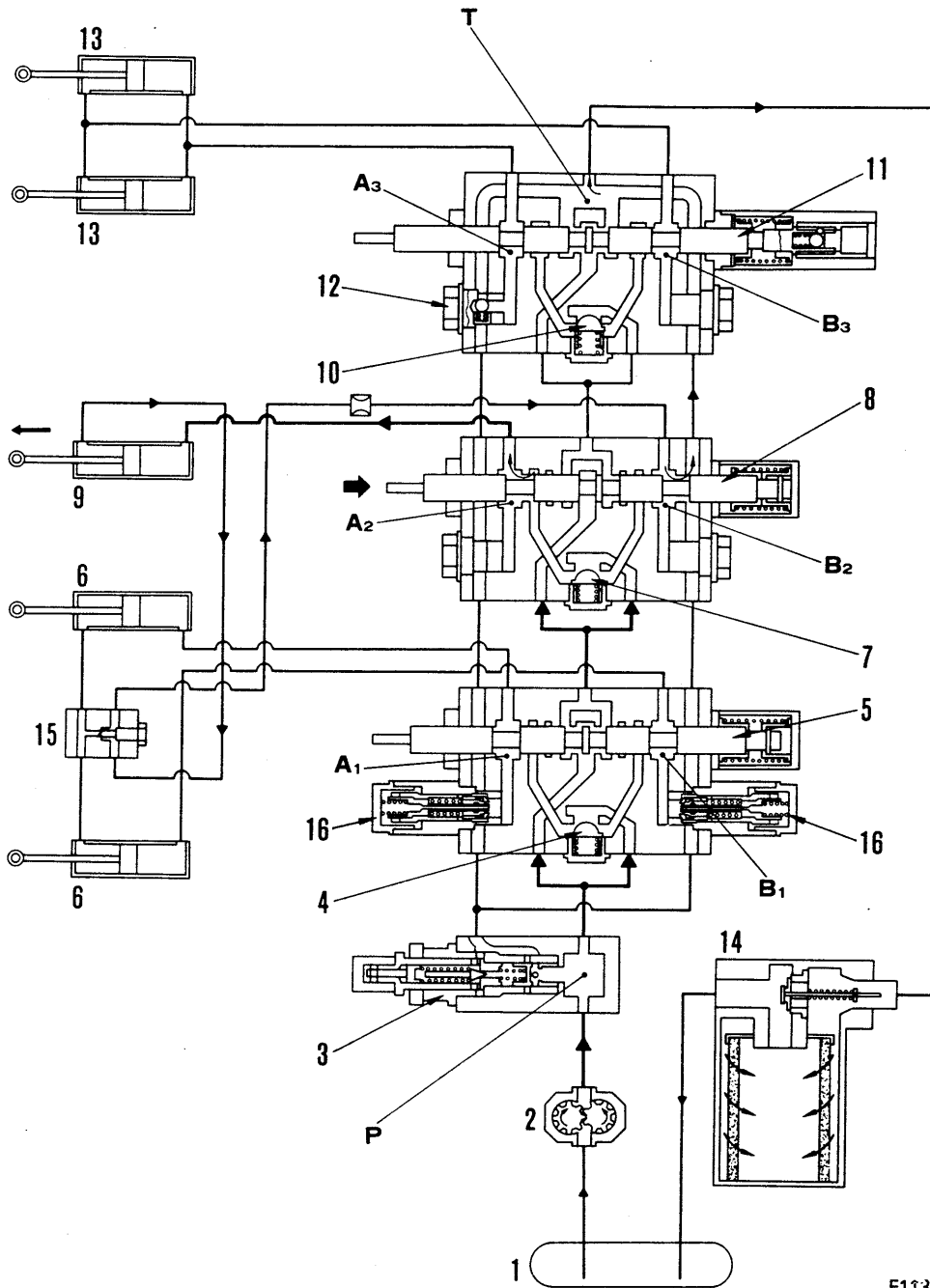
- When the blade control lever is moved to the "LOWER" position, lift spool (11) moves to the right. When this happens, the pump port P and lift cylinder bottom port A<sub>3</sub> and the tank port T and lift cylinder head port B<sub>3</sub> are connected.
- The pressurized oil from the pump passes through angle spool (5) and tilt spool (8), and pushes open check valve (10). It then goes from the lift spool and enters the bottom end of lift cylinder (13).
- When the hydraulic pressure in the circuit rises, the lift cylinder is extended and the blade is lowered. At the same time, the oil at the lift cylinder head is pushed out by the cylinder piston, returns to the lift spool and is drained to the hydraulic tank.

- When this happens, if the lift cylinder is extended suddenly because of the weight of the blade, there will be a shortage of oil from the pump and negative pressure will form at the cylinder bottom end. Therefore, suction valve (12) opens, and oil is sucked in from the drain circuit to prevent negative pressure from forming in the circuit at the cylinder bottom end.
- When the lift cylinder reaches the end of its stroke, the hydraulic pressure in the circuit rises to the set pressure and the oil is relieved from main relief valve (3).

011418

**POWER ANGLE AND TILTDOZER  
BLADE LIFT AND TILT CONTROL LEVER IN "LEFT TILT"**

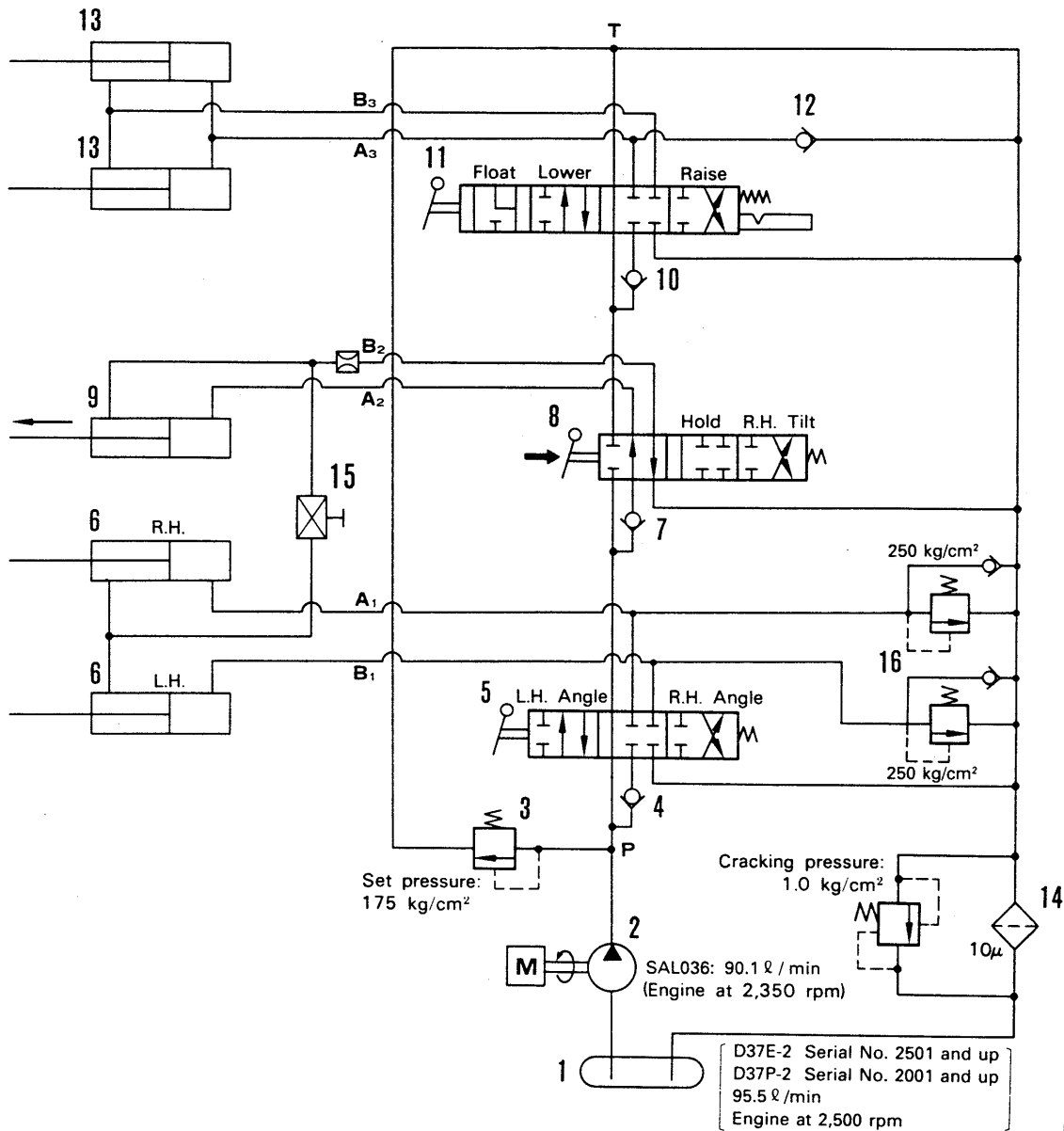
★ The diagram shows the D31E-18, D31P-18A and D37E, P-2, but the explanation of the operation for the D31P, PL, PLL-18 is the same.



F11318049-1

- |                            |                                   |                          |
|----------------------------|-----------------------------------|--------------------------|
| 1. Hydraulic tank          | 7. Check valve                    | 13. Blade lift cylinder  |
| 2. Hydraulic pump          | 8. Blade tilt valve spool         | 14. Hydraulic filter     |
| 3. Main relief valve       | 9. Blade tilt cylinder            | 15. Air bleeding valve   |
| 4. Check valve             | 10. Check valve                   | 16. Suction safety valve |
| 5. Blade angle valve spool | 11. Blade lift valve spool        |                          |
| 6. Blade angle cylinder    | 12. Suction valve for blade lower |                          |

**POWER ANGLE AND TILTDOZER  
BLADE LIFT AND TILT CONTROL LEVER IN "LEFT TILT"**



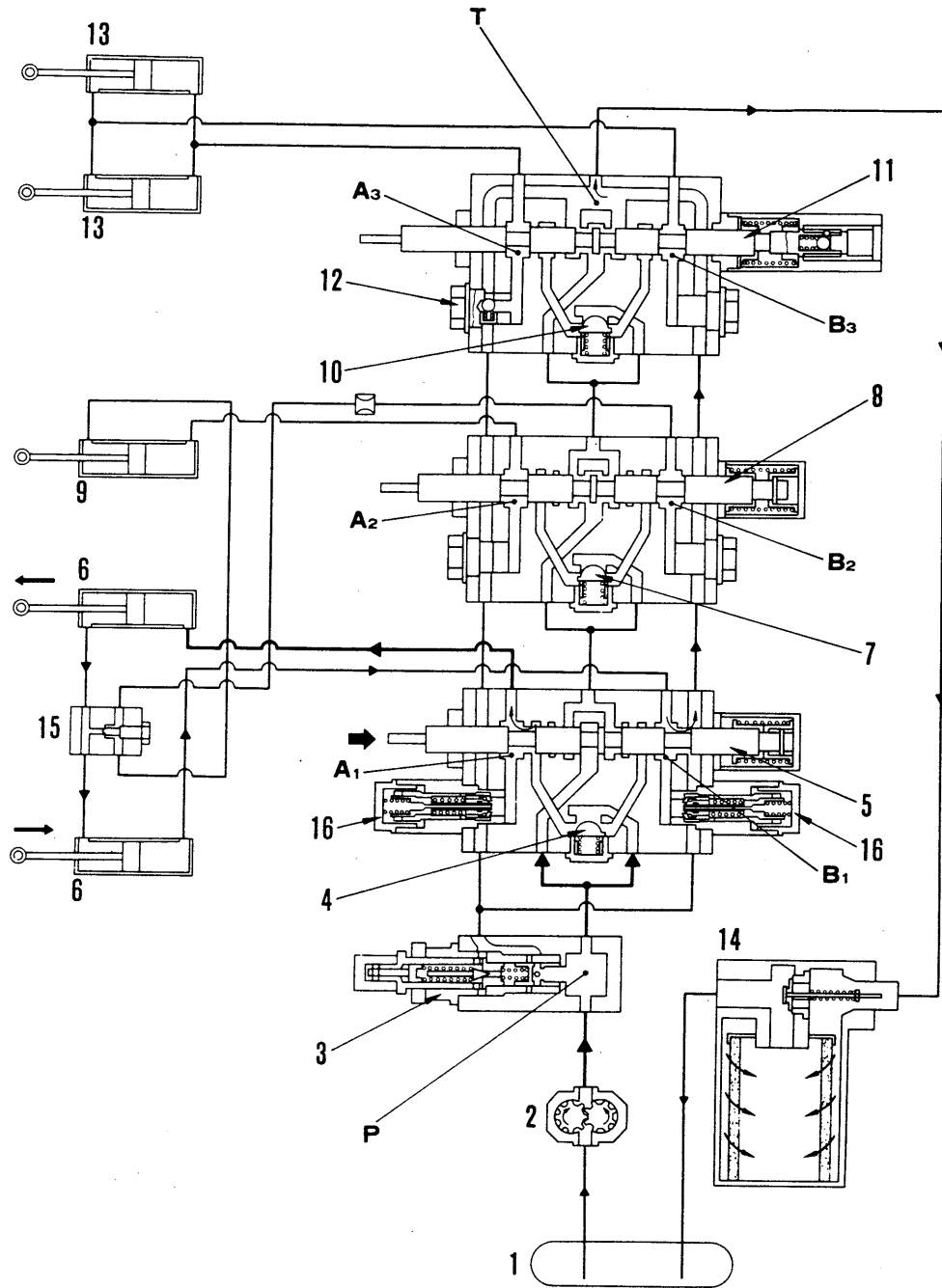
F11318050A

**FLOW OF OIL**

- When the blade control lever is moved to the "LEFT TILT" position, tilt spool (8) moves to the right.  
When this happens, the pump port P and tilt cylinder bottom port A<sub>2</sub> and the tank port T and tilt cylinder head port B<sub>2</sub> are connected.
- The pressurized oil from the pump passes through angle spool (5) and pushes open check valve (7). It then goes from the tilt spool and enters the bottom end of tilt cylinder (9).
- When the hydraulic pressure in the circuit rises, the tilt cylinder is extended and the blade is tilted to the left. At the same time, the oil at the tilt cylinder head is pushed out by the cylinder piston. The oil at the tilt cylinder head returns to the tilt spool and is drained to the hydraulic tank.
- When the tilt cylinder reaches the end of its stroke, the hydraulic pressure in the circuit rises to the set pressure and the oil is relieved from main relief valve (3).

011418

**POWER ANGLE AND TILTDOZER  
BLADE ANGLE CONTROL LEVER IN "LEFT ANGLE"**

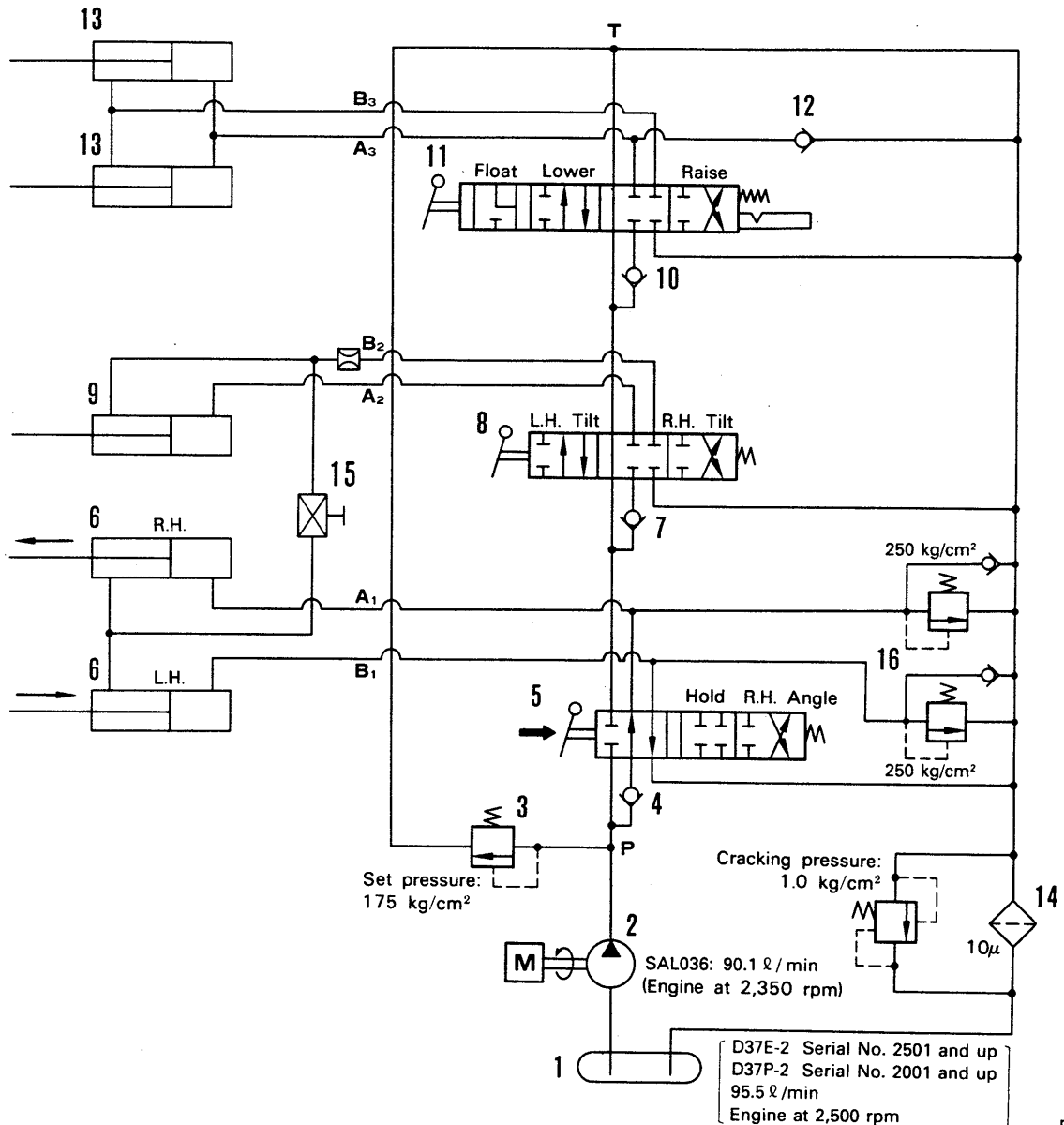


011418

F11318051-1

- |                            |                                   |                          |
|----------------------------|-----------------------------------|--------------------------|
| 1. Hydraulic tank          | 7. Check valve                    | 13. Blade lift cylinder  |
| 2. Hydraulic pump          | 8. Blade tilt valve spool         | 14. Hydraulic filter     |
| 3. Main relief valve       | 9. Blade tilt cylinder            | 15. Air bleeding valve   |
| 4. Check valve             | 10. Check valve                   | 16. Suction safety valve |
| 5. Blade angle valve spool | 11. Blade lift valve spool        |                          |
| 6. Blade angle cylinder    | 12. Suction valve for blade lower |                          |

**POWER ANGLE AND TILTDOZER  
BLADE ANGLE CONTROL LEVER IN "LEFT ANGLE"**



011418

**FLOW OF OIL**

- When the blade control lever is moved to the "LEFT ANGLE" position, angle spool (5) moves to the right.  
When this happens, the pump port P and right angle cylinder bottom port A<sub>1</sub> and the tank port T and left angle cylinder bottom port B<sub>1</sub> are connected.
- The pressurized oil from the pump pushes open check valve (4). It then goes from the angle spool and enters the bottom end of right angle cylinder (6).
- When the hydraulic pressure in the circuit rises, the right angle cylinder is extended.  
At the same time, the oil at the right angle cylinder head is pushed out by the cylinder piston and goes to the head end of left angle cylinder (6).

The oil pushes back the piston of the left angle cylinder to retract the left angle cylinder and angle the blade to the left.

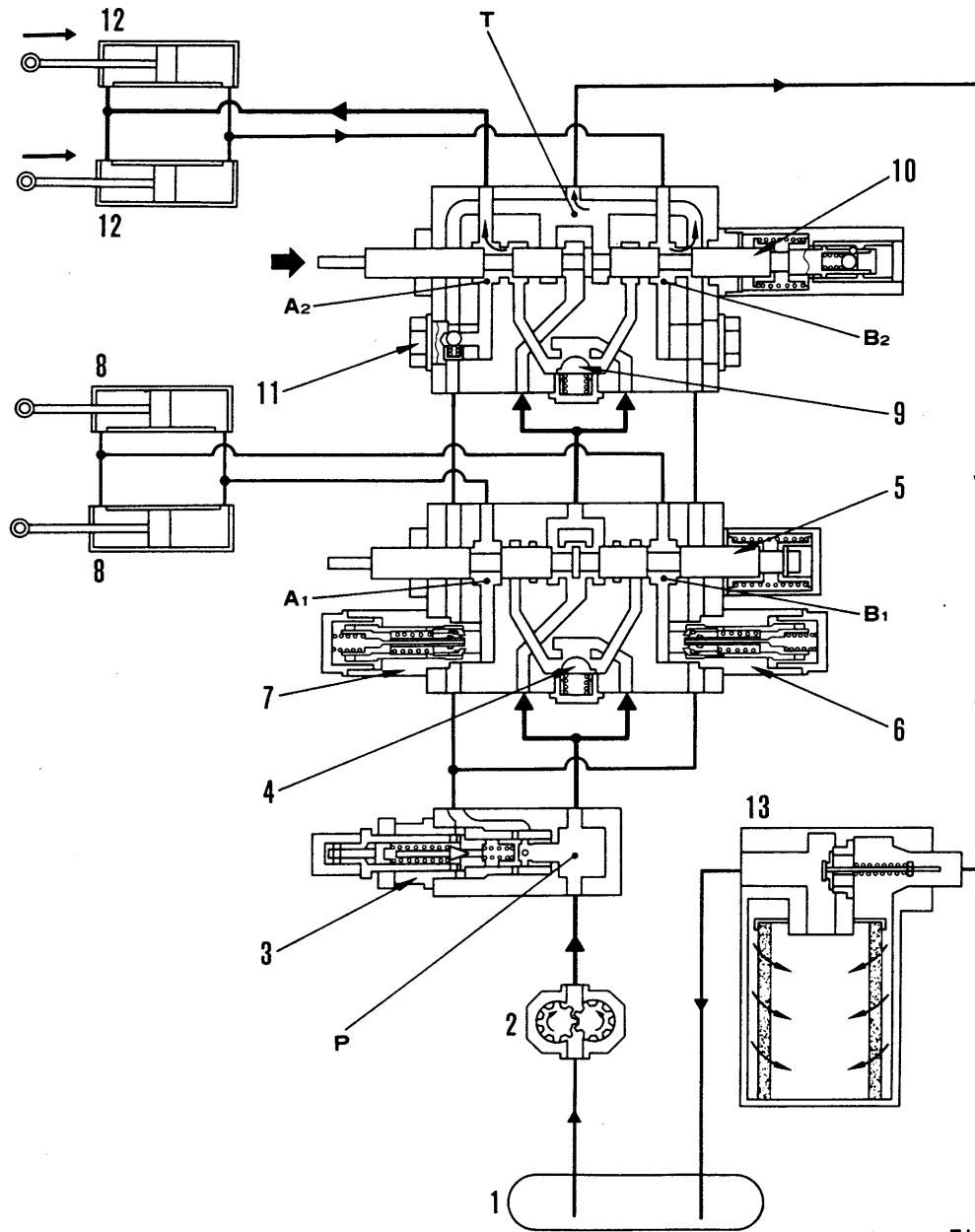
At the same time, the oil at the left angle cylinder bottom returns to the angle spool and is drained to the hydraulic tank.

- When the right angle cylinder reaches the end of its stroke, the hydraulic pressure in the circuit rises to the set pressure and the oil is relieved from main relief valve (3).
- Priming valve (15) is installed for adjusting if the left and right angle cylinders do not reach the end of their strokes at the same time.

F11318052A

# HYDRAULIC LEVER OPERATION D31S, Q-18

## BUCKET CONTROL LEVER IN "LOWER"

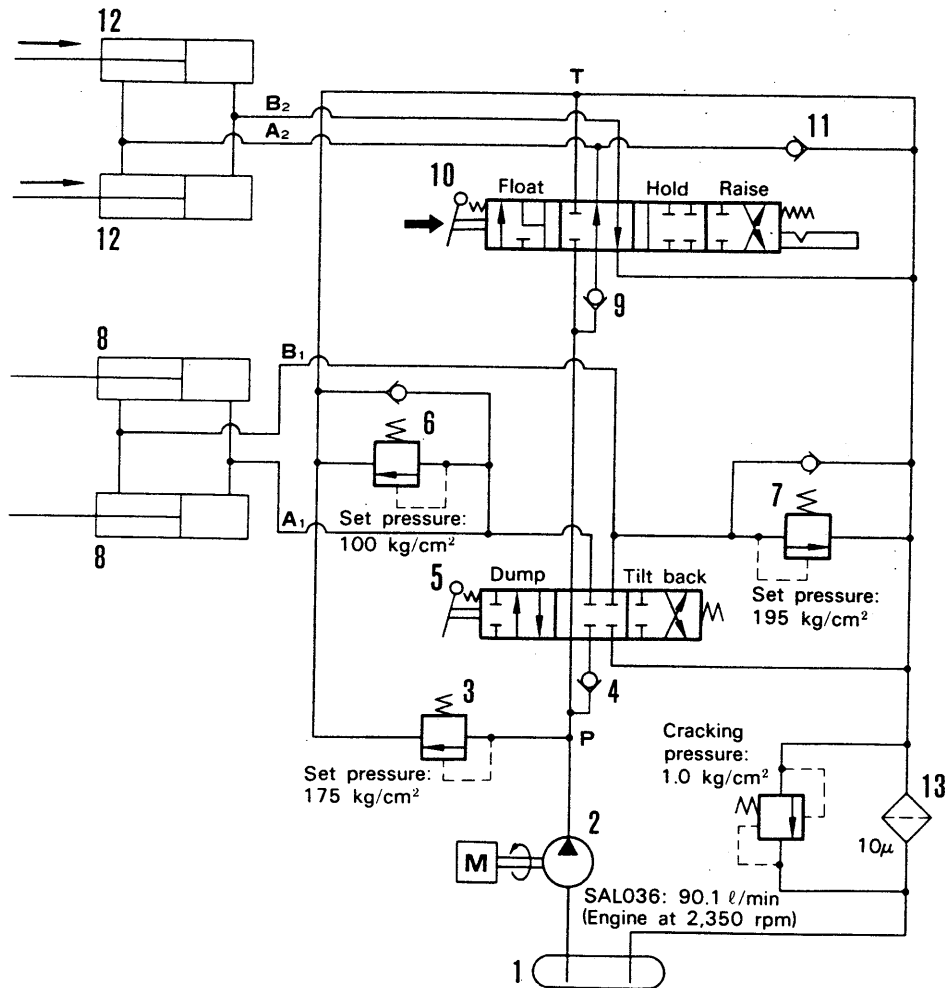


F11318053

- |                                 |                                    |
|---------------------------------|------------------------------------|
| 1. Hydraulic tank               | 8. Bucket dump cylinder            |
| 2. Hydraulic pump               | 9. Check valve                     |
| 3. Main relief valve            | 10. Bucket lift valve spool        |
| 4. Check valve                  | 11. Suction valve for bucket lower |
| 5. Bucket dump valve spool      | 12. Bucket lift cylinder           |
| 6. Safety valve for bucket dump | 13. Hydraulic filter               |
| 7. Safety valve for bucket tilt |                                    |

011418





F11318054

### FLOW OF OIL

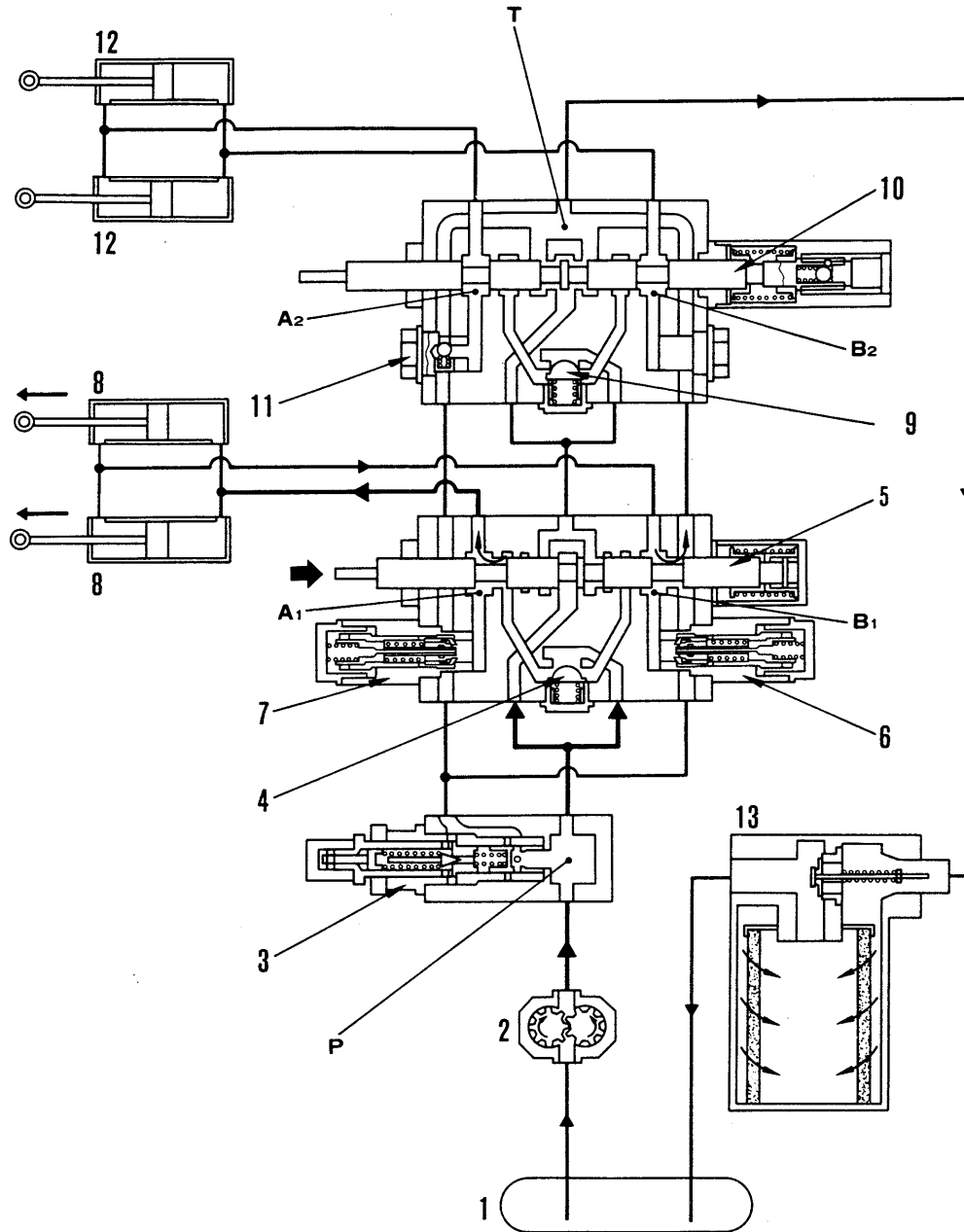
- When the bucket control lever is moved to the "LOWER" position, lift spool (10) moves to the right.  
When this happens, the pump port P and lift cylinder head port A<sub>2</sub> and the tank port T and lift cylinder bottom port B<sub>2</sub> are connected.
- The pressurized oil from the pump passes through dump spool (5) and pushes open check valve (4). It then goes from the lift spool and enters the head end of lift cylinder (12).
- When the hydraulic pressure in the circuit rises, the lift cylinder is retracted and the lift arm and bucket are lowered.  
At the same time, the oil at the lift cylinder bottom is pushed out by the cylinder piston, returns to the lift spool and is drained to the hydraulic tank.

When this happens, if the lift cylinder is retracted suddenly because of the weight of the load, or lift arm and bucket, there will be a shortage of oil from the pump and negative pressure will form at the cylinder head end.

Therefore, suction valve (11) opens, and oil is sucked in from the drain circuit to prevent negative pressure from forming in the circuit at the cylinder head end.

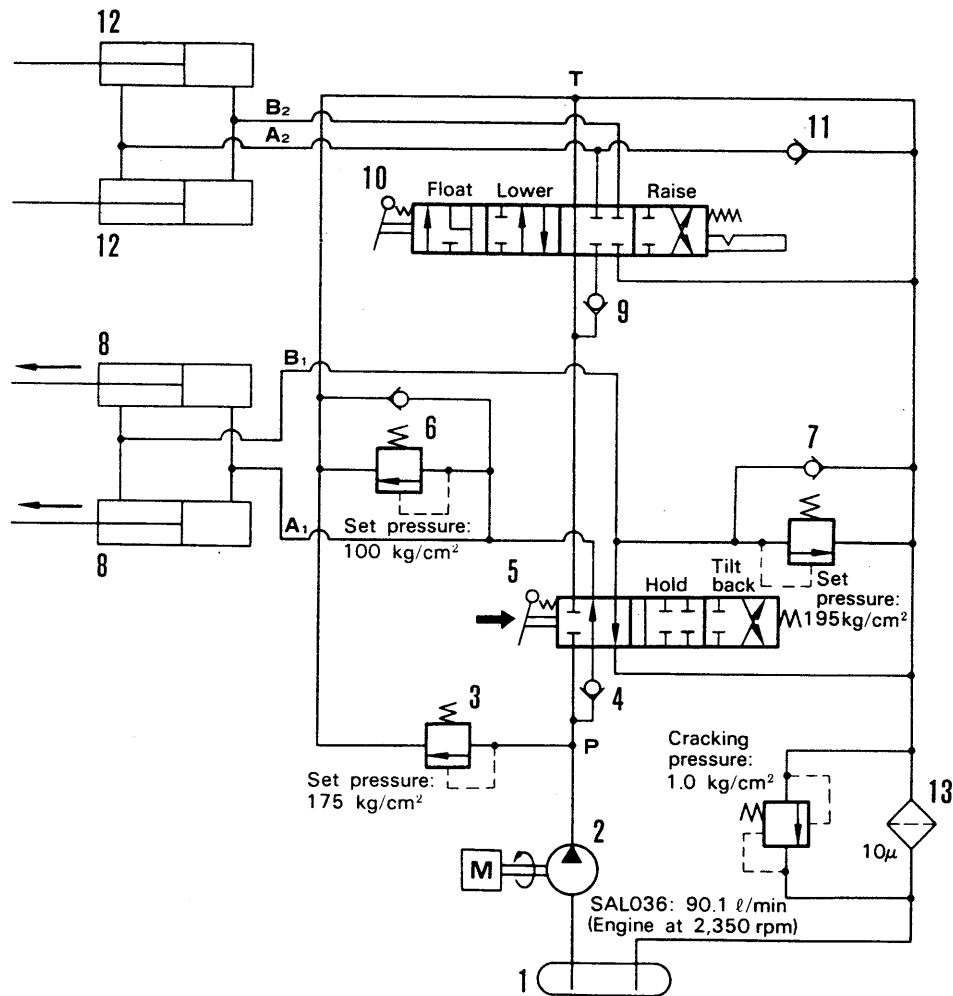
- When the lift cylinder reaches the end of its stroke, the hydraulic pressure in the circuit rises to the set pressure and the oil is relieved from main relief valve (3).

**BUCKET CONTROL LEVER IN "DUMP"**



- |                                 |                                    |
|---------------------------------|------------------------------------|
| 1. Hydraulic tank               | 8. Bucket dump cylinder            |
| 2. Hydraulic pump               | 9. Check valve                     |
| 3. Main relief valve            | 10. Bucket lift valve spool        |
| 4. Check valve                  | 11. Suction valve for bucket lower |
| 5. Bucket dump valve spool      | 12. Bucket lift cylinder           |
| 6. Safety valve for bucket dump | 13. Hydraulic filter               |
| 7. Safety valve for bucket tilt |                                    |

F11318055



F11318056

### FLOW OF OIL

- When the bucket control lever is moved to the "DUMP" position, dump spool (5) moves to the right. When this happens, the pump port P and dump cylinder bottom port A<sub>1</sub> and the tank port T and dump cylinder head port B<sub>1</sub> are connected.
- The pressurized oil from the pump pushes open check valve (4). It then goes from the dump spool and enters the bottom end of dump cylinder (8).
- When the hydraulic pressure in the circuit rises, the dump cylinder is extended and the bucket is tipped forward. At the same time, the oil at the dump cylinder head is pushed out by the cylinder piston, returns to the dump spool and is drained to the hydraulic tank. When this happens, if the dump cylinder is extended suddenly because of the weight of the load or bucket, there will be a shortage of oil from the pump and negative pressure will form at the cylinder bottom end.

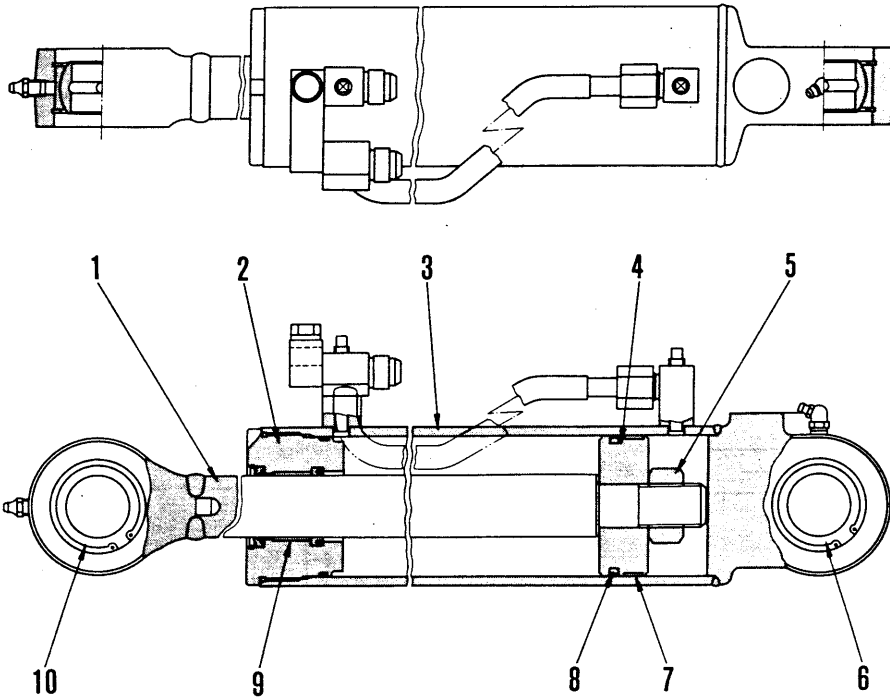
Therefore, the suction function of safety valve (6) is actuated, and oil is sucked in from the drain circuit to prevent negative pressure from forming in the circuit at the cylinder bottom end.

If external force is applied to the dump cylinder and the pressure in the circuit exceeds 100 kg/cm<sup>2</sup>, safety valve (6) acts to relieve the oil, so the pressure in the circuit does not rise any further.

- Therefore, even if the dump cylinder reaches the end of its stroke when the bucket is dumped, the hydraulic pressure in the circuit does not rise to the set pressure of main relief valve (3).
- However, the set pressure of safety valve (7) in the bucket tilt circuit is 195 kg/cm<sup>2</sup>, so when the bucket is tilted if the dump cylinder reaches the end of its stroke, the hydraulic pressure in the circuit rises to the set pressure of main relief valve (3) (175 kg/cm<sup>2</sup>) and the oil is relieved from the main relief valve.

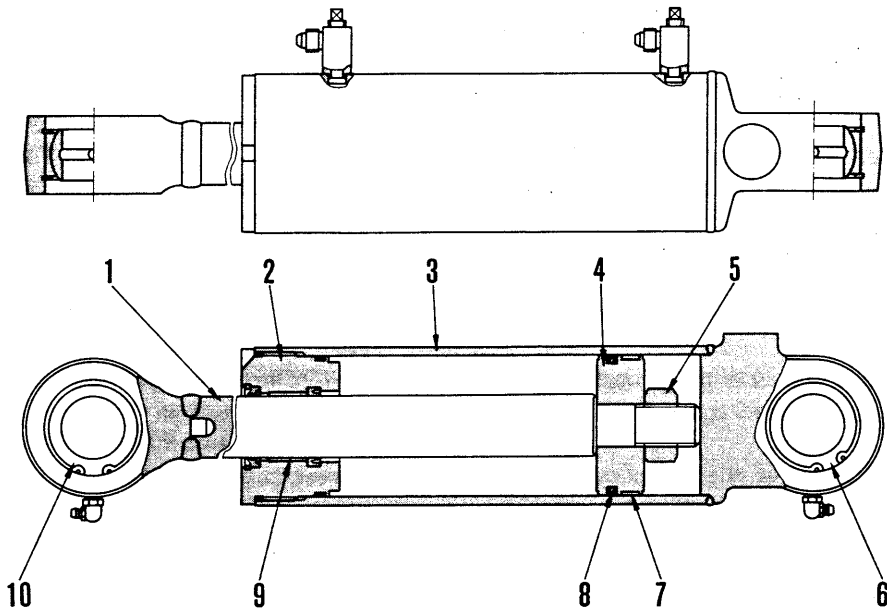
# HYDRAULIC CYLINDER D31E-18, D31P-18A, D37E, P-2

## 1. BLADE LIFT CYLINDER



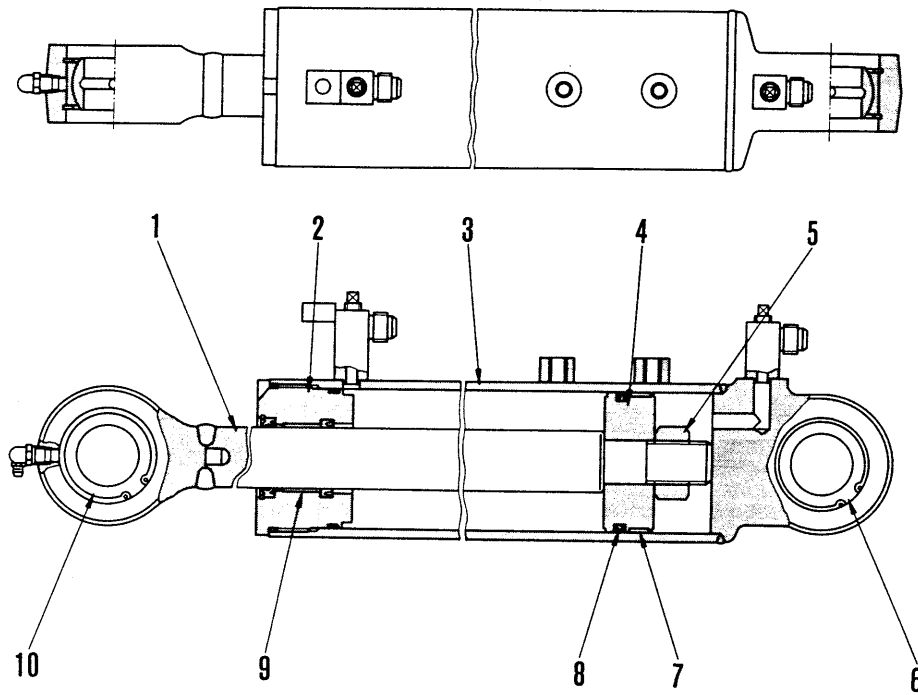
F11318057

## 2. BLADE TILT CYLINDER



F11318058

### 3. BLADE ANGLE CYLINDER



011418

F11318059

1. Piston rod
2. Cylinder head
3. Cylinder
4. Piston
5. Piston nut
6. Bushing
7. Wear ring
8. Piston ring
9. Bushing
10. Bushing

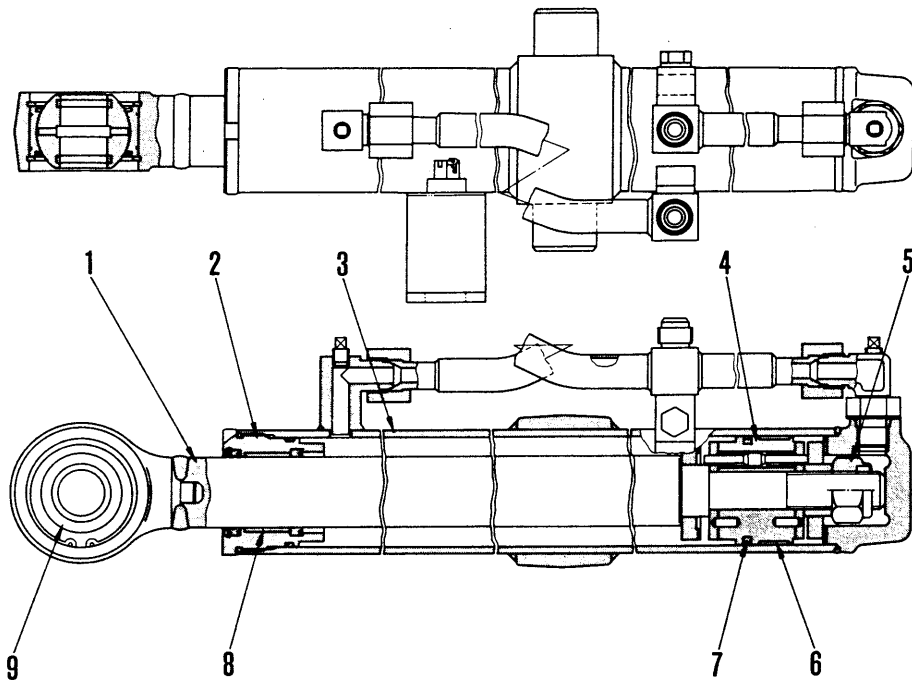
#### OUTLINE

- Each hydraulic cylinder has a reciprocal motion piston. The dimensions and strokes are as shown below.

	Unit: mm		
	Lift cyl.	Tilt cyl.	Angle cyl.
Outside diameter of piston rod	40	40	40
Cylinder bore	90	90	90
Piston stroke	393	145	393
Max. distance between pins	1,109	613	1,109
Min. distance between pins	716	468	716
Width across flats of piston nut	41	41	41

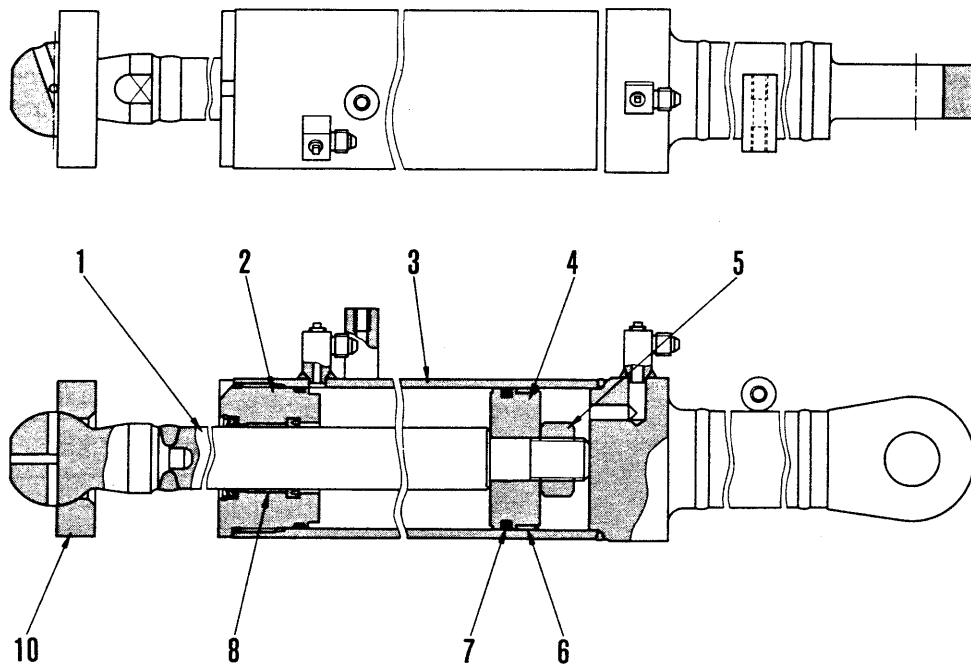
# HYDRAULIC CYLINDER D31P, PL, PLL-18

## 1. BLADE LIFT CYLINDER



F11318060

## 2. BLADE TILT CYLINDER



F11318061

011418

## OUTLINE

- Each hydraulic cylinder has a reciprocal motion piston. The dimensions and strokes are as shown below.

Unit: mm

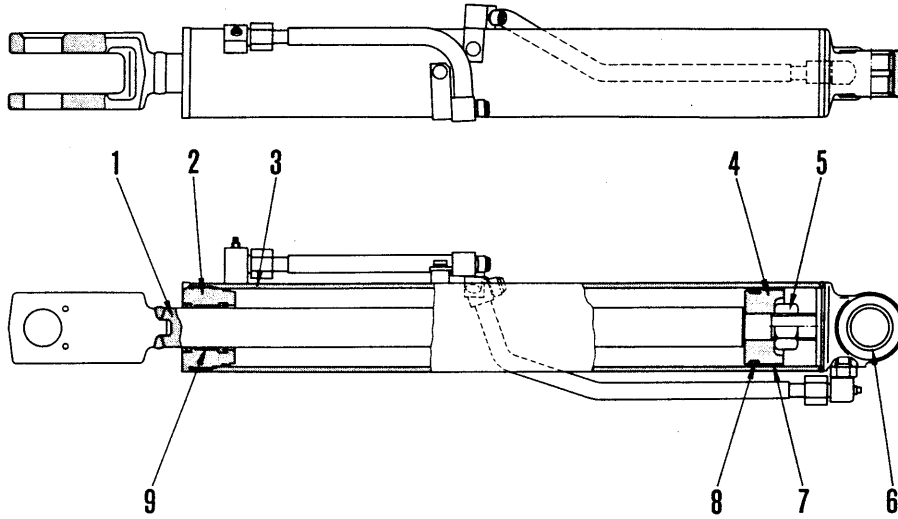
	Lift cyl.	Tilt cyl.
Outside diameter of piston rod	45	40
Cylinder bore	70	90
Piston stroke	850	120
Max. distance between pins	1,350	790
Min. distance between pins	500	670
Width across flats of piston nut	36	41

1. Piston rod
2. Cylinder head
3. Cylinder
4. Piston
5. Piston nut
6. Wear ring
7. Piston ring
8. Bushing
9. Bushing
10. Flange

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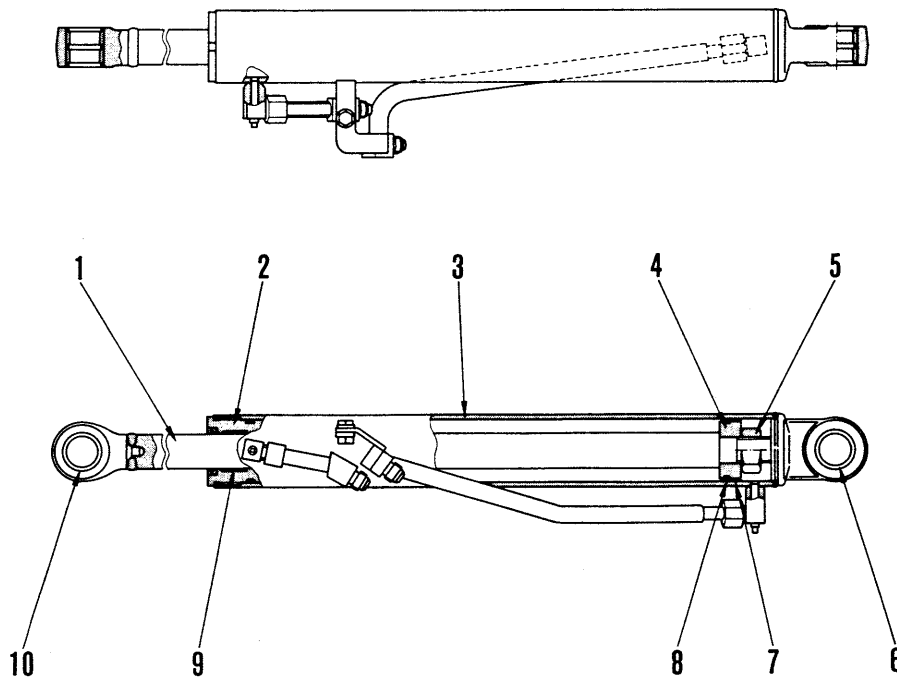
# HYDRAULIC CYLINDER D31S, Q-18

## 1. BUCKET LIFT CYLINDER



F11318062

## 2. BUCKET DUMP CYLINDER



F11318063



**OUTLINE**

- Each hydraulic cylinder has a reciprocal motion piston. The dimensions and strokes are as shown below.

Unit: mm

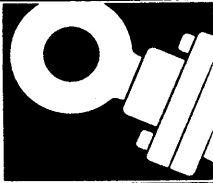
	Lift cyl.	Dump cyl.
Outside diameter of piston rod	50	45
Cylinder bore	100	80
Piston stroke	650	595
Max. distance between pins	1,710	1,880
Min. distance between pins	1,060	1,285
Width across flats of piston nut	50	50

1. Piston rod
2. Cylinder head
3. Cylinder
4. Piston
5. Piston nut
6. Bushing
7. Wear ring
8. Piston ring
9. Bushing
10. Buching

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# HYDRAULIC SYSTEM

## 62 TESTING AND ADJUSTING



Standard for testing and adjusting .....	62-2
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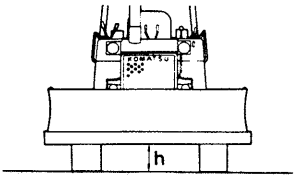
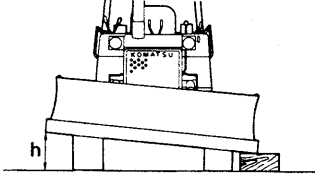
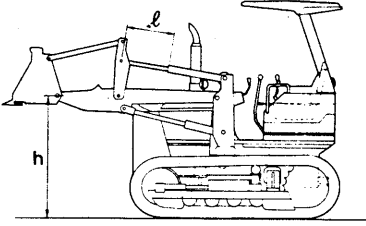
-  When carrying out testing, adjusting or troubleshooting, stop the machine on level ground, install the safety pins and block the tracks.
-  When working in groups, use agreed signals and do not allow unauthorized persons near the machine.
-  When checking the water level in the radiator, wait for the water to cool. Do not remove the radiator cap while the water is hot. Boiling water may spurt out.
-  Be careful not to get caught in rotating parts.
-  Bleeding air from hydraulic cylinder.  
After replacing or installing hydraulic cylinders or hydraulic piping, bleed the air from the hydraulic cylinders as follows:
  1. Start the engine and run at idling for about 5 minutes.
  2. Run the engine at low idling, and raise and lower the work equipment 4 – 5 times.
    - ★ Stop the piston rod about 100 mm from the end of the stroke. Never operate it to the relief position.
  3. Run the engine at full throttle and repeat the above procedure. Then run the engine at low idling and operate the piston rod to the end of the stroke to relieve the circuit.

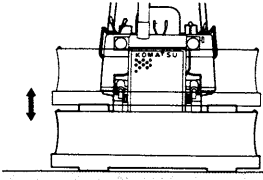
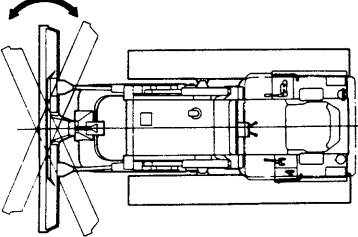
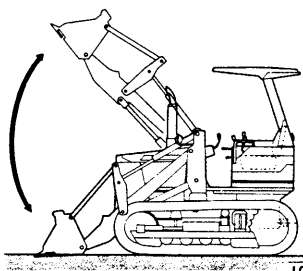
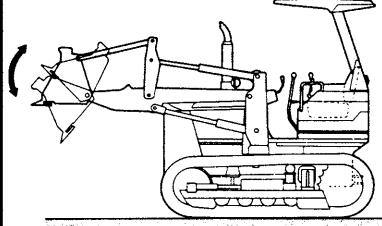
# STANDARD FOR TESTING AND ADJUSTING

	Check item	Conditions	Unit	Standard value	Permissible value	
Travel of control lever	Blade	<ul style="list-style-type: none"> <li>Center of lever knob</li> <li>Engine stopped</li> </ul>	mm	N → RAISE	69 - 79	69 - 79
				N → LOWER	62 - 72	62 - 72
				LOWER → FLOAT	61 - 71	61 - 71
				N → L.H. TILT	64 - 74	64 - 74
				N → R.H. TILT	64 - 74	64 - 74
				N → L.H. ANGLE	62 - 72	62 - 72
				N → R.H. ANGLE	62 - 72	62 - 72
	Bucket	<ul style="list-style-type: none"> <li>Center of lever knob</li> <li>Engine stopped</li> </ul>	mm	N → RAISE	69 - 79	69 - 79
				N → LOWER	62 - 72	62 - 72
				LOWER → FLOAT	61 - 71	61 - 71
N → TILT BACK				64 - 74	64 - 74	
N → DUMP				64 - 74	64 - 74	
Operating force of control lever	Blade	<ul style="list-style-type: none"> <li>Center of lever knob</li> <li>Engine stopped</li> </ul>	kg	N → RAISE	2.0 - 3.0	2.0 - 3.0
				N → LOWER	2.0 - 3.0	2.0 - 3.0
				LOWER → FLOAT	3.0 - 6.0	3.0 - 6.0
				FLOAT → N	1.5 - 4.5	1.5 - 4.5
				N → TILT	3.0 - 5.0	3.0 - 5.0
				N → ANGLE	2.5 - 3.5	2.5 - 3.5
	Bucket	<ul style="list-style-type: none"> <li>Center of lever knob</li> <li>Engine stopped</li> </ul>	kg	N → RAISE	2.0 - 3.0	2.0 - 3.0
				N → LOWER	2.0 - 3.0	2.0 - 3.0
				LOWER → FLOAT	3.0 - 6.0	3.0 - 6.0
				FLOAT → N	1.5 - 4.5	1.5 - 4.5
Hydraulic pressure	<ul style="list-style-type: none"> <li>Hydraulic oil temperature: 40 - 60°C</li> <li>Hydraulic cylinder at stroke end</li> </ul>	Engine low idling	kg/cm <sup>2</sup>	Min. 155	Min. 155	
		Engine full throttle		175 - 183	175 - 183	

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Check item	Conditions	Unit	Standard value	Permissible value
Hydraulic drift	 <p>103F06216</p> <p>★ Raise blade from ground to 300 mm.</p>		100	100
	 <p>103F06217</p> <p>★ Put the corner of the blade on a block, and operate the tilt to raise the chassis fully.</p> <ul style="list-style-type: none"> <li>• From this position, measure hydraulic drift "h" of the blade.</li> <li>• Start to measure immediately after setting in position.</li> <li>• Measure the amount of hydraulic drift for the next 15 minutes.</li> <li>• Machine on level ground</li> <li>• Control lever in HOLD position</li> <li>• Engine stopped</li> <li>• Hydraulic oil temperature: 45 – 55°C</li> </ul>		50	50
Bucket lift arm (D31S, Q-18)	 <p>103F06218</p>	mm	30	30
Bucket (D31S, Q-18)	<p>★ Top surface of lift arm, bottom of bucket horizontal.</p> <p>★ From this position, measure hydraulic drift "h" of the bucket hinge pin and extension "l" of the dump cylinder</p> <ul style="list-style-type: none"> <li>• Machine on level ground</li> <li>• Control lever in HOLD position</li> <li>• Engine stopped</li> <li>• Hydraulic oil temperature: 45 – 55°C</li> </ul>		100	100

Check item	Conditions	Unit	Standard value	Permissible value		
Work equipment speed	<b>Blade</b> (D31E-18 D31P-18A D37E, P-2)	Ground → raise fully  103F06211	RAISE	2.2	2.2	
			LOWER	1.6	1.6	
			L.H. TILT	2.0	2.0	
			R.H. TILT	2.0	2.0	
			L.H. ANGLE	2.0	2.0	
			R.H. ANGLE	2.0	2.0	
	<b>Blade</b> (D31P, PL, PLL-18)	★ Raise blade from ground to 300 mm L.H. angle fully → R.H. angle fully   103F06212	RAISE	1.8	1.8	
			LOWER	1.5	1.5	
			L.H. TILT	0.9	0.9	
			R.H. TILT	0.9	0.9	
	<b>Bucket</b> (D31S, Q-18)	★ Raise blade from ground to 300 mm • Machine on level ground • Engine: full throttle • Hydraulic oil temperature: 40 – 60°C	Ground ↔ raise fully  103F06214	RAISE	5.9	5.9
				LOWER	3.0	3.0
			DUMP	2.5	2.5	
			Dump fully → tilt back fully  103F06215	TILT	2.1	2.1
	★ Top surface of lift arm horizontal. • Machine on level ground • Engine: full throttle • Hydraulic oil temperature: 300 mm					


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## TESTING AND ADJUSTING TOOL LIST

No.	Check item	Tool	Part No.	Remarks
1	Oil temperature	Thermistor kit	799-101-6000	0 – 1,000°C
2	Oil pressure	Hydraulic tester D	799-101-5000	Pressure gauge: 25, 60, 400, 600 kg/cm <sup>2</sup>
3	Engine speed	Multi-tachometer	799-203-8000	Digital display L: 60 – 2,000 rpm H: 60 – 19,999 rpm
4	Operating force	Push-pull scale	Commercially available	—
5	Stroke, hydraulic drift	Scale	Commercially available	—
6	Work equipment speed	Stopwatch	Commercially available	—
7	Pump performance	Flowmeter kit	790-303-1001	—

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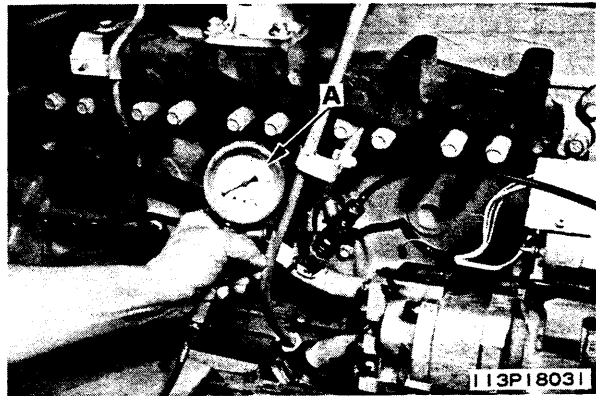
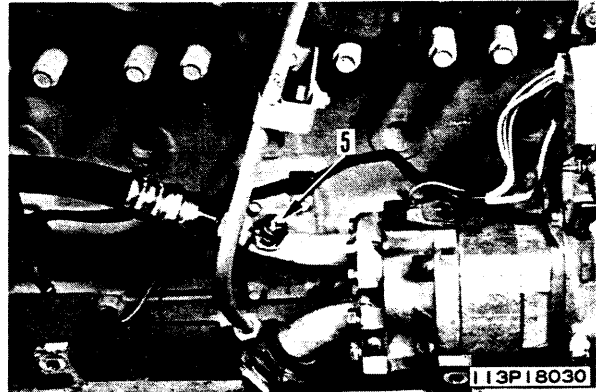
# MEASURING AND ADJUSTING OIL PRESSURE

 Stop the machine on level ground and lower the work equipment to the ground.

 Loosen the oil filler cap slowly to release the remaining oil pressure in the hydraulic tank.

## 1. Measuring main relief pressure

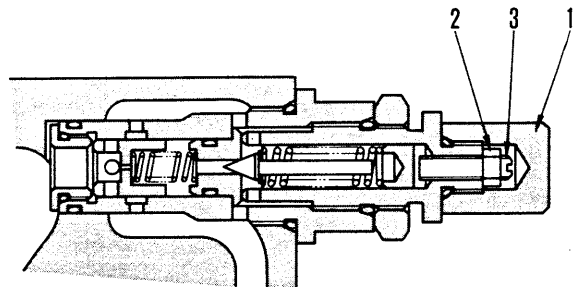
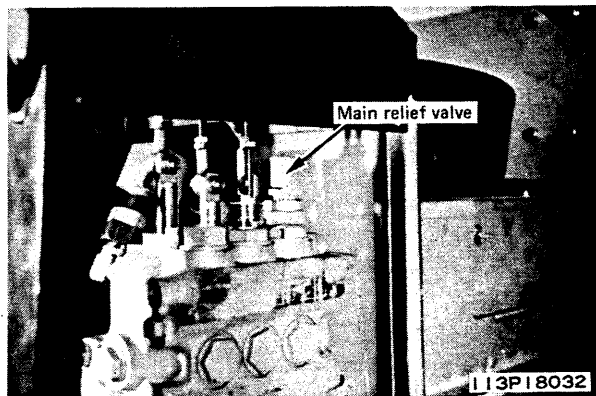
- 1) Remove plug (1).
- 2) Install hydraulic tester A (400 kg/cm<sup>2</sup>).
- 3) Start engine, operate work equipment control lever, and measure main relief pressure with cylinder at stroke end.



## 2. Adjusting main relief pressure


★ If the main relief pressure is not within the standard range, adjust as follows.


- 1) Remove cap (1), loosen locknut (2), and turn adjustment screw (3) to adjust.
  - ★ To INCREASE pressure, turn CLOCKWISE.
  - To DECREASE pressure, turn COUNTERCLOCKWISE.
  - ★ One turn of the adjustment screw adjusts by 24.8 kg/cm<sup>2</sup>.



113F18101

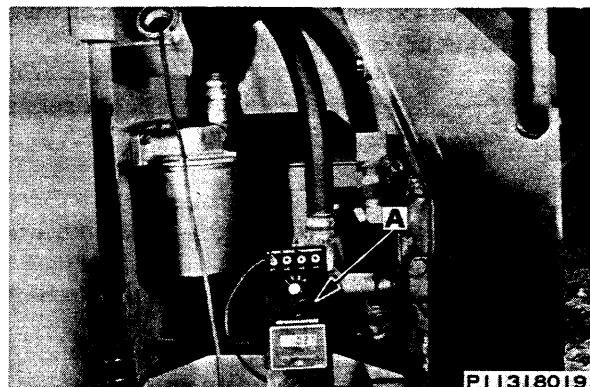
## MEASURING OIL TEMPERATURE

 Stop the machine on level ground, lower the work equipment to the ground.

 Loosen the oil filler cap slowly to release the remaining oil pressure in the hydraulic tank.

### 1. Measuring hydraulic oil temperature

- 1) Remove oil filler cap.
- 2) Using thermistor **A**, measure temperature of oil in hydraulic tank.



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# BLEEDING AIR FROM ANGLE CYLINDER CIRCUIT


(POWER ANGLE AND TILTDOZER)

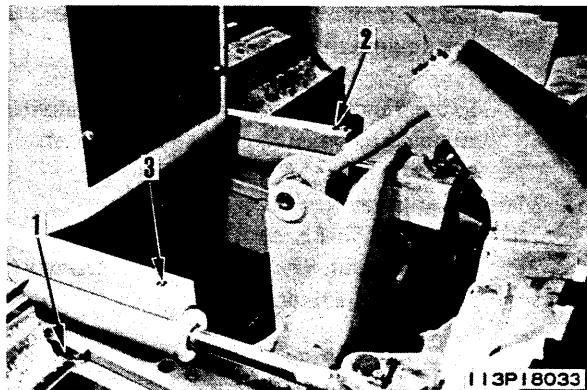


When loosening the plug, remember that it is still under hydraulic pressure.



Operate the tilt slowly. If it is not operated slowly, oil will spurt out.

1. Loosen the hydraulic tank cap.
  2. Raise the blade approx. 400 – 500 mm from the ground.
    - ★ Raise the angle cylinder to horizontal or higher.
  3. Run the engine at low idling.
  4. Operate LEFT TILT and RIGHT TILT to the end of the cylinder stroke 10 times in turn to fill the tilt cylinder circuit with oil.
  5. Angle the blade to the maximum left angle (retract the left angle cylinder).
  6. Loosen air bleed valve (1) two turns, and loosen air bleed plug (2) of the left angle cylinder three turns.
  7. Operate the RIGHT TILT (retract tilt cylinder) continuously and when no more bubbles come out with the oil from plug (2), tighten plug (2).
  8. Angle the blade to the maximum right angle (retract the right angle cylinder).
  9. Loosen air bleed valve (3) of the right angle cylinder three turns.
  10. Operate the RIGHT TILT (retract tilt cylinder) continuously and when no more bubbles come out with the oil from plug (3), tighten plug (3).
  11. Tighten air bleed valve (1).
-  Valve:  $2.5 \pm 0.5$  kgm
12. After bleeding the air, check the hydraulic tank oil level, then tighten the hydraulic tank cap.



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# TROUBLESHOOTING

## D31E,P,PL-18, D31P-18A, D37E,P-2

1. Blade lacks lifting power and lifting speed is slow ..... 62-10
2. Blade does not rise, the front of machine cannot be raised off ground  
when lowering the blade ..... 62-11
3. Hydraulic drift of blade lift cylinder is excessive ..... 62-12
4. Blade moves unsteadily when leveling the ground. (Control lever at HOLD) ..... 62-13
5. Blade lowers under the following conditions ..... 62-13
6. Blade lacks tilting power, blade tilting speed is slow.  
The machine cannot be raised off ground by blade tilting power. .... 62-14
7. Blade tilt cylinder does not move (Tilting is impossible) ..... 62-15
8. Hydraulic drift of blade tilt cylinder is excessive ..... 62-16
9. Blade lacks angling power, blade angling speed is slow (For power angle and tilt dozer) .... 62-17
10. Blade angle cylinder does not move (Angling is impossible)  
(For power angle and tilt dozer) ..... 62-18
11. Blade returns straightly or moves unsteadily when loading by angling  
(Control lever at HOLD) (For power angle and tilt dozer) ..... 62-19

## D31S,Q-18

12. Lift arm lacks lifting power and lifting speed is slow ..... 62-20
13. Lift arm does not rise, the front of machine cannot be raised off ground  
when lowering the bucket ..... 62-21
14. Hydraulic drift of bucket lift cylinder is excessive ..... 62-22
15. Bucket lacks tilt back power and bucket tilt speed is slow ..... 62-23
16. Bucket dump cylinder does not move (Bucket tilt back is impossible) ..... 62-24
17. Bucket dump cylinder does not move (Dumping is impossible),  
machine cannot be raised off ground by the dump cylinder ..... 62-25
18. Bucket dump speed is slow ..... 62-26
19. Hydraulic drift of bucket dump cylinder is excessive ..... 62-27
20. Bucket moves up and down along ground and lift arm moves  
unsteadily when leveling the ground. (Control lever at HOLD) ..... 62-28
21. Lift arm lowers under the following conditions ..... 62-28
22. Bucket moves unsteadily when leveling the ground with machine traveling in reverse.  
(Control lever at HOLD) ..... 62-28
23. Bucket dumps ..... 62-28
24. Lift arm cannot be raised when bucket dumps fully ..... 62-28
25. Operating force of work equipment control lever is heavy ..... 62-29

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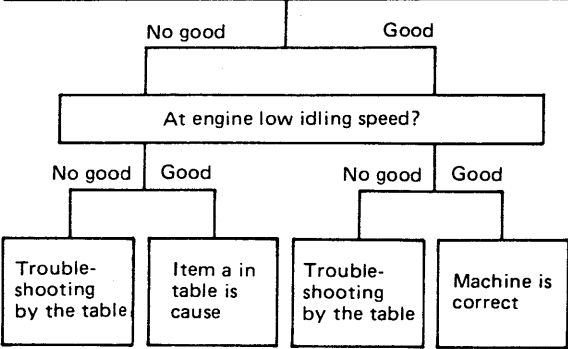
# 1. Blade lacks lifting power and lifting speed is slow

## Check before troubleshooting

- Is oil quantity in hydraulic tank normal?
- Are the travel of hydraulic control lever and valve spool normal?

## Check the trouble

Is the hydraulic pressure obtained the setting pressure at engine full speed when lifting the blade fully?



Cause	Tank to pump	Hydraulic control valve	Lift cylinder
Strainer clogged	a	e	
Hydraulic pump sucking air	b	f	
Hydraulic pump defective	c	g	
Oil leakage from piping between pump and control valve	d	h	
Acting of check valve defective			i
Drop of main relief valve defective			
Suction valve on the raise side defective			
Oil leakage from the raise side defective, blocked orifice and head			
Packing on the lift cylinder defective			

No.	Problems	Remedy											
			C	a	b	c	d	e	f	g	h	i	
1	Hydraulic pressure is low at engine full throttle when tilting the blade fully.			○	○	○		○					
2	Hydraulic pressure is normal at engine full throttle when tilting the blade fully.									○			
3	Unusual noise is heard from hydraulic pump.		○										
4	Hydraulic drift of lift cylinder is large.											○	
5	Discharge of hydraulic pump is too small.		○	○									
6	Blade lifting speed is slow when operating the control lever, but hydraulic pressure is too high.					○							

Troubleshooting tools	Hydraulic tester	
	Flow meter kit	

The following symbols are used to indicate the action to be taken when a cause of failure is located.  
 X: Replace      Δ: Repair  
 A: Adjust      C: Clean

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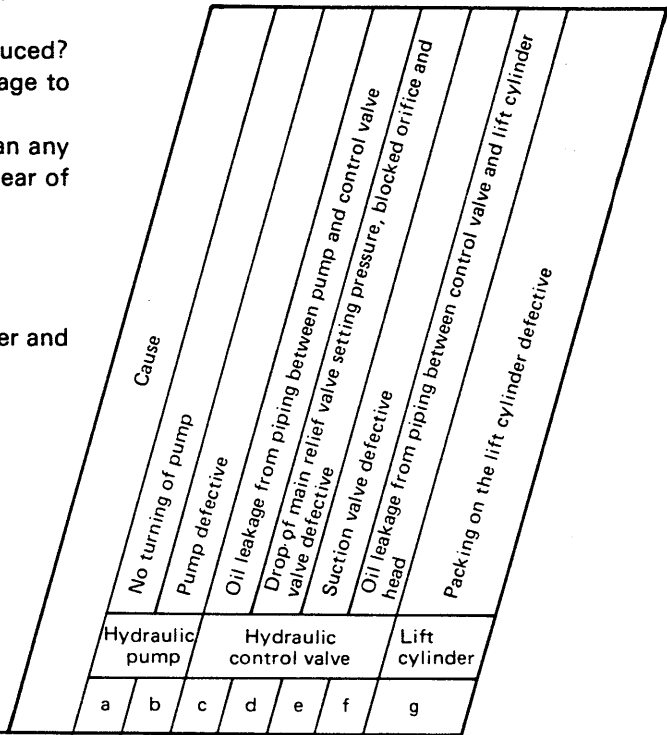
**2. Blade does not rise, the front of machine cannot be raised off ground when lowering the blade.**

**Ask the operator the following questions**

- Didn't the blade move off suddenly? → Seizure and damage to various units.
- In this time, was an unusual noise produced? (where did it emanate from?) → Damage to various units.
- Was the blade lifting speed slower than any speed has been obtained so far. → Wear of parts or flattening of spring.

**Check before troubleshooting**

- Is oil quantity in hydraulic tank normal?
- Are the travels of hydraulic control lever and control valve spool normal?



No.	Problems	Remedy	Cause						
			a	b	c	d	e	f	g
			△ X	X	△ X	A C X	C X	△ X	X
1	No oil comes out when the pressure take-off plug is removed, and the engine is cranked.		○						
2	Hydraulic pressure does not rise at engine full throttle in blade RAISE and LOWER circuit.			○	○		○		
3	Hydraulic pressure does not rise at engine full throttle when tilting blade fully.			○	○				
4	Hydraulic pressure is normal at engine full throttle when tilting blade fully.						○		
5	Remove bottom piping from lift cylinder, run engine at low idling and operate control lever to RAISE, cylinder does not move, but oil comes out from bottom end of lift cylinder.								○
6	There is almost no discharge from hydraulic pump when there is load.		○	○					

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Troubleshooting tools	Hydraulic tester	
	Flow meter kit	

The following symbols are used to indicate the action to be taken when a cause of failure is located.

X: Replace                      △: Repair  
A: Adjust                        C: Clean

### 3. Hydraulic drift of blade lift cylinder is excessive.

**Ask the operator the following questions**

- Did the hydraulic drift of lift cylinder suddenly become large? → Logged dirt in valve or damaged parts.
- Did the hydraulic drift of lift cylinder gradually become large? → Worn parts.

**Check before troubleshooting**

- If the rod of control elver is disconnected from the control valve spool, is the hydraulic drift of lift cylinder normal? → Bend of rod or seizure of rod bushing.

No.	Problems	Remedy	Cause			
			Hydraulic control valve			Lift cylinder
			a	b	c	d
			Oil leakage from lift spool (by damaged spool)	Suction valve defective	Oil leakage from lift cylinder head	Packing on lift cylinder defective
			△	C	△	X
		X	X	X		
1	Hydraulic drift of lift cylinder is excessive even if the piping from lift cylinder head is blocked.					○
2	Hydraulic drift of lift cylinder becomes normal when upper and lower suction valves are interchanged.		○			
3	Raise blade to maximum, remove bottom piping from lift cylinder, run engine at low idling and operate control lever to RAISE. Oil comes out from bottom end of lift cylinder.					○
4	Oil does not come out at item 3.	○				

The following symbols are used to indicate the action to be taken when a cause of failure is located.

X: Replace                      △: Repair  
A: Adjust                        C: Clean

**4. Blade moves unsteadily when leveling the ground. (Control lever at HOLD)**

- Check hydraulic drift of blade lift cylinder.

It is above the standard value → Go to "3. Hydraulic drift of blade lift cylinder is excessive".

It is within the standard value → Forming a vacuum in cylinder →

It is corrected by raising the machine with blade lift cylinder and lowering the machine slowly.

★ But if it is frequent → Suction valve defective.

**5. Blade lowers under the following conditions**

- 1) Blade lowers momentarily when control lever is changed from HOLD position to RAISE position.
- 2) Blade lowers gradually when control lever is at RAISE position with engine stopped.

Cause: Check valve for blade control valve defective → Remedy  
C.X

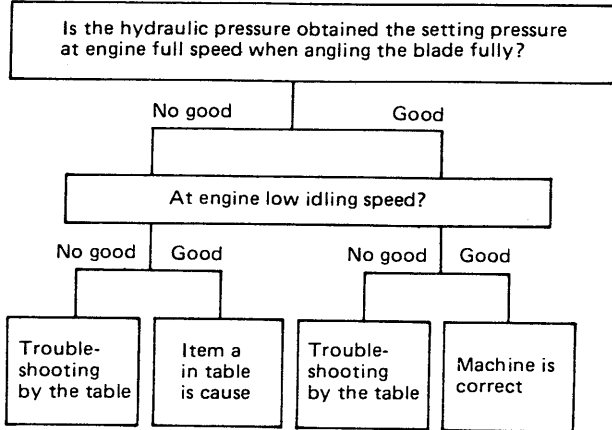
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**6. Blade lacks tilting power, blade tilting speed is slow. The machine cannot be raised off ground by blade tilting power.**

**Check before troubleshooting**

- Is oil quantity in hydraulic tank normal?
- Are the travels of control lever and control valve spool normal?

**Check the trouble**



Cause	Tank to pump	Hydraulic control valve	Tilt cylinder
Strainer clogged	a	d	g
Hydraulic pump sucking air	b	e	
Hydraulic pump defective	c	f	
Oil leakage from piping between pump and control valve			
Acting of check valve defective			
Drop of main relief valve setting pressure, blocked orifice and valve defective			
Packing on the tilt cylinder defective			

No.	Problems	Remedy								
			a	b	c	d	e	f	g	
			C	Δ	X	Δ	Δ	A	C	X
1	Hydraulic pressure is low at engine full throttle when blade is fully raised.		○	○	○		○			
2	Hydraulic pressure is normal at engine full throttle when blade is fully raised.									○
3	The lifting speed of blade is variable at engine full throttle.		○							
4	Tilt blade to maximum left, remove head piping from tilt cylinder, run engine at low idling and operate control lever to LEFT TILT. Oil comes out from head end of tilt cylinder. (For power angle and tilt dozer)									○
5	Tilt blade to maximum right, remove head piping from tilt cylinder, run engine at low idling and operate control lever to RIGHT TILT. Oil comes out from head end of tilt cylinder. (For straight tilt dozer)									○
6	Discharge of hydraulic pump is too small.		○	○						
7	Blade tilting speed is slow when operating the control lever, but hydraulic pressure is too high.					○				

Troubleshooting tools	Hydraulic tester	
	Flow meter kit	

The following symbols are used to indicate the action to be taken when a cause of failure is located.

X: Replace                      Δ: Repair  
 A: Adjust                        C: Clean

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## 7. Blade tilt cylinder does not move (Tilting is impossible)

### Ask the operator the following questions

- Didn't the tilt cylinder move off suddenly?  
→ Seizure and damage to various units.
- In this time, was an unusual noise produced?  
(where did it emanate from?) → Wear of parts of flattening of spring.
- Was the blade tilting speed slower than any speed has been obtained so far.

### Check before troubleshooting

- Is oil quantity in hydraulic tank normal?
- Are the travels of hydraulic control lever and control valve spool normal?

No.	Problems	Remedy	Cause					
			Hydraulic pump		Hydraulic control valve			Tilt cylinder
			a	b	c	d	e	f
			△	X	△	A	△	
			X	X	X	C	X	X
1	No oil comes out when the pressure take-off plug is removed, and the engine is cranked.		○					
2	Hydraulic pressure does not rise at engine full throttle in blade tilting circuit.			○	○	○	○	○
3	Hydraulic pressure does not rise at engine full throttle when raising blade fully.			○	○			
4	Hydraulic pressure is normal at engine full throttle when raising blade fully.					○	○	
5	Remove outlet piping on side where tilt cylinder does not tilt, run engine at low idling and operate control lever to side which does not tilt. Cylinder does not move, but oil comes out from outlet port on side where blade does not tilt.						○	
6	There is almost no discharge from hydraulic pump when there is load.		○	○				

Troubleshooting tools	Hydraulic tester	
	Flow meter kit	

The following symbols are used to indicate the action to be taken when a cause of failure is located.

X: Replace                      △: Repair  
A: Adjust                        C: Clean

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## 8. Hydraulic drift of blade tilt cylinder is excessive.

### Ask the operator the following questions

- Did the hydraulic drift of tilt cylinder suddenly become large? → Damaged parts.
- Did the hydraulic drift of tilt cylinder gradually become large? → Worn parts.

### Check before troubleshooting

- If the rod of control lever is disconnected from the control valve spool, is the hydraulic drift of tilt cylinder normal? → Bend of rod or seizure of rod bushing.

### Confirmation of trouble

- Check for the amount of hydraulic drift compared with "standard value table" when tilting.

No.	Problems	Remedy	Cause		
			Hydraulic control valve		Tilt cylinder
			a	b	c
			△	△	X
			X	X	
1	Tilt blade to maximum left, remove head piping from tilt cylinder, run engine at low idling and operate control lever to LEFT TILT. Oil comes out from head end of tilt cylinder. (For power angle and tiltadozer)				○
2	Tilt blade to maximum right, remove head piping from tilt cylinder, run engine at low idling and operate control lever to RIGHT TILT. Oil comes out from head end of tilt cylinder. (For straight tiltadozer)				○
3	Oil does not come out at items 1 and 2.		○	○	

The following symbols are used to indicate the action to be taken when a cause of failure is located.

X: Replace  
A: Adjust

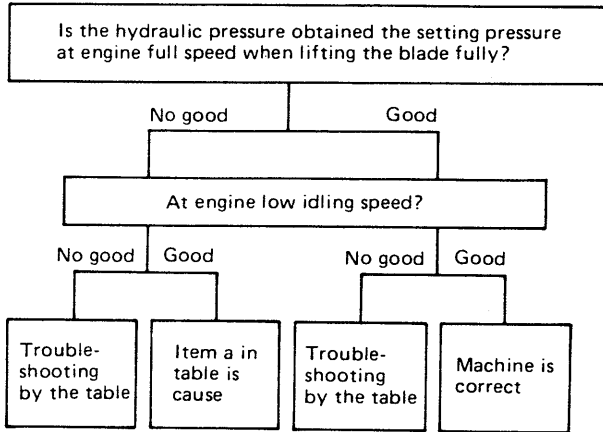
△: Repair  
C: Clean

## 9. Blade lacks angling power, blade angling speed is slow. (For power angle and tilt dozer)

### Check before troubleshooting

- Is oil quantity in hydraulic tank normal?
- Are the travels of control lever and control valve spool normal?

### Check the trouble



- ★ This table indicates when the right angling is impossible. When the left angling is impossible, use the tables after replacing RIGHT to LEFT.

Cause	Tank to pump			Control valve		Angling cylinder	
	a	b	c	d	e	f	g
	Strainer clogged						
Hydraulic pump sucking air							
Hydraulic pump defective							
Drop main relief valve defective							
Check valve defective							
Packing on left angling cylinder defective							
Packing on right angling cylinder defective							

No.	Problems	Remedy							
			C	X	X	X	A	Δ	X
1	Hydraulic pressure does not rise at engine full throttle when raising blade fully.		○	○	○				
2	Hydraulic pressure is normal at engine full throttle when raising blade fully.							○	
3	Unusual noise is heard from hydraulic pump.		○						
4	Set blade to maximum right angle, remove bottom piping from right angle cylinder, run engine at low idling and operate control lever to RIGHT ANGLE. Oil comes out from bottom end of right angle cylinder.							○	
5	Discharge of hydraulic pump is too small.		○	○					
6	Blade angling speed is slow when operating the control lever, but hydraulic pressure is too high.					○			

Troubleshooting tools	Hydraulic tester	
	Flow meter kit	

The following symbols are used to indicate the action to be taken when a cause of failure is located.

X: Replace                      Δ: Repair  
A: Adjust                        C: Clean

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## 10. Blade angle cylinder does not move (Angling is impossible) (For power angle and tilt dozer)

### Ask the operator the following questions

- Didn't the cylinder move off suddenly? → Seizure and damage to various unit.
- In this time, was an unusual noise produced? (where did it emanate from?) → Damage to various units.
- Was the blade angling speed slower than any speed has been obtained so far?

### Check before troubleshooting

- Is oil quantity in hydraulic tank normal?
- Are the travels of control lever and control valve spool normal?

★ This table indicates when the right angling is impossible. When the left angling is impossible, use the table after replacing RIGHT to LEFT.

No.	Problems	Remedy	Cause				
			Hydraulic pump		Control valve	Angling cylinder	
			a	b	c	d	e
			△ X	X X	A C X	X	X
1	No oil comes out when the pressure take-off plus is removed, and the engine is cranked.		○				
2	Hydraulic pressure does not rise at engine full throttle in blade angling circuit.			○	○	○	
3	Hydraulic pressure does not rise at engine full throttle when raising blade fully.			○	○		
4	Hydraulic pressure is normal at engine full throttle when raising blade fully.					○	
5	Remove bottom piping from right angle cylinder, run engine at low idling and operate control lever to RIGHT ANGLE. Cylinder does not move, but oil comes out from bottom end of right angle cylinder.					○	
6	Remove bottom piping from left angle cylinder, run engine at low idling and operate control lever to LEFT ANGLE. Cylinder does not move, but oil comes out from bottom end of left angle cylinder.					○	
7	There is almost no discharge from hydraulic pump when there is load.			○			

Troubleshooting tools	Hydraulic tester	
	Flow meter kit	

The following symbols are used to indicate the action to be taken when a cause of failure is located.

X: Replace                      △: Repair  
A: Adjust                        C: Clean

**11. Blade returns straightly or moves unsteadily when loading by angling (Control lever at HOLD) (For power angle and tilt dozer)**

**Check before troubleshooting**

- Is oil quantity in hydraulic tank normal?
- Are the travels of control lever and control valve spool normal?

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No.	Problems	Remedy	Cause		
			a	b	c
			X	X	△
1	Set blade to maximum right angle, remove bottom piping from right angle cylinder, run engine at low idling and operate control lever to RIGHT ANGLE. Oil comes out from bottom end of right angle cylinder.		○		
2	Set blade to maximum left angle, remove bottom piping from left angle cylinder, run engine at low idling and operate control lever to LEFT ANGLE. Oil comes out from bottom end of left angle cylinder.			○	
3	Oil comes out at items 1 and 2.		○	○	
4	Oil does not come out at items 1 and 2.				○

← Bleed the air

Troubleshooting tools	Hydraulic tester	
	Flow meter kit	

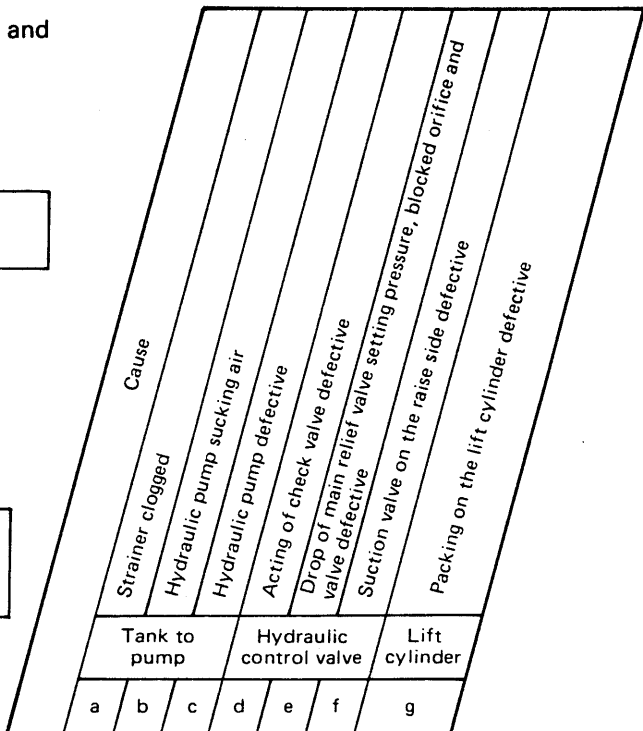
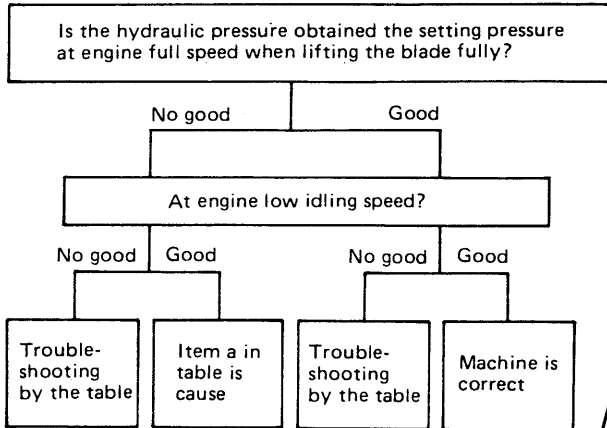
The following symbols are used to indicate the action to be taken when a cause of failure is located.  
 X: Replace                      △: Repair  
 A: Adjust                        C: Clean

## 12. Lift arm lacks lifting power and lifting speed is slow.

### Check before troubleshooting

- Is oil quantity in hydraulic tank normal?
- Are the travels of hydraulic control lever and control valve spool normal?

### Check the trouble



No.	Problems	Remedy							
			C	Δ	X	Δ	A	C	X
1	Hydraulic pressure is low at engine full throttle when tilting back the bucket fully.		○	○		○			
2	Hydraulic pressure is normal at engine full throttle when tilting back the bucket fully.						○	○	
3	Unusual noise is heard from hydraulic pump.		○						
4	Raise lift arm to maximum, remove head piping from lift cylinder, run engine at low idling and operate control lever to RAISE. Oil comes out from head end of lift cylinder.							○	
5	Discharge of hydraulic pump is too small.		○	○					
6	Lift arm raising speed is slow when operating the control lever, but hydraulic pressure is too high.				○				

Troubleshooting tools	Hydraulic tester	
	Flow meter kit	

The following symbols are used to indicate the action to be taken when a cause of failure is located.

X: Replace                      Δ: Repair  
 A: Adjust                      C: Clean

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**13. Lift arm does not rise, the front of machine cannot be raised off ground when lowering the bucket.**

**Ask the operator the following questions**

- Didn't the lift arm move off suddenly? → Seizure and damage to various units.
- In this time, was an unusual noise produced? (when did it emanate from?) → Damage to various units.
- Was the lift arm lifting speed slower than any speed has been obtained so far → Wear of parts or flattening of spring.

**Check before troubleshooting**

- Is oil quantity in hydraulic tank normal?
- Are the travels of hydraulic control lever and control valve spool normal?

**Check the trouble**

- Relief oil pressure

Cause	No turning of pump	Pump defective	Oil leakage from piping between pump and control valve	Drop of main relief valve setting pressure, blocked orifice and valve defective	Suction valve (on the raise side) defective	Oil leakage from piping between control valve and lift cylinder	Packing on the lift cylinder defective
	Hydraulic pump		Hydraulic control valve			Lift cylinder	
	a	b	c	d	e	f	g

No.	Problems	Remedy	$\Delta$	X	$\Delta$	A	C	$\Delta$	X
1	No oil comes out when the pressure take-off plug is removed, and the engine is cranked.		$\Delta$	X					
2	Hydraulic pressure does not rise at engine full throttle in lift arm RAISE and LOWER circuit.			$\Delta$	$\Delta$				
3	Hydraulic pressure does not rise at engine full throttle when tilting back the bucket fully.			$\Delta$	$\Delta$				
4	Hydraulic pressure is normal at engine full throttle when tilting back the bucket fully.						$\Delta$		$\Delta$
5	Remove head piping from lift cylinder, run engine at low idling and operate control lever to RAISE. Cylinder does not move, but oil comes out from head end of lift cylinder.								$\Delta$
6	There is almost no discharge from hydraulic pump when there is load.		$\Delta$	$\Delta$					

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Troubleshooting tools	Hydraulic tester	
	Flow meter kit	

The following symbols are used to indicate the action to be taken when a cause of failure is located.

X: Replace                       $\Delta$ : Repair  
A: Adjust                        C: Clean

## 14. Hydraulic drift of bucket lift cylinder is excessive.

### Ask the operator the following questions

- Did the hydraulic drift of lift cylinder suddenly become large? → Logged dirt in valve or damaged parts.
- Did the hydraulic drift of lift cylinder gradually become large? → Wear parts.

### Check before troubleshooting

- If the rod of control lever is disconnected from the control valve spool, is the hydraulic drift of lift cylinder normal? → Bend of rod or seizure of rod bushing.

No.	Problems	Remedy	Cause		
			Hydraulic control valve		Lift cylinder
			a	b	c
			Oil leakage from lift spool (by damaged spool)	Suction valve defective	Packing on lift cylinder defective
			△	C	X
			X	X	X
1	Raise lift arm to maximum, remove head piping from lift cylinder, run engine at low idling and operate control lever to RAISE. Oil comes out from head end of lift cylinder.				○
2	Oil does not come out at item 1.		○		
3	Hydraulic drift of lift cylinder becomes normal when upper and lower suction valves are interchanged.			○	

The following symbols are used to indicate the action to be taken when a cause of failure is located.

X: Replace

△: Repair

A: Adjust

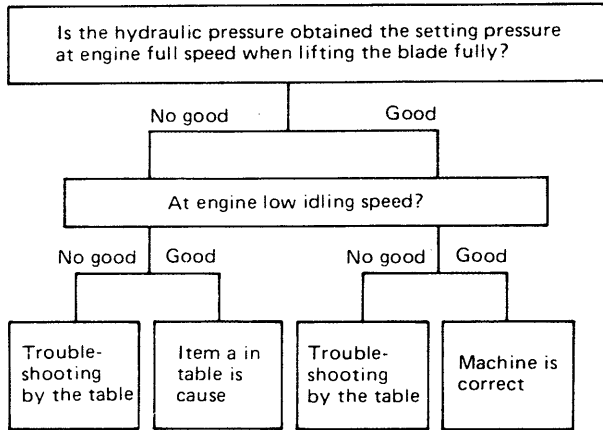
C: Clean

### 15. Bucket lacks tilt back power and bucket tilt speed is slow.

#### Check before troubleshooting

- Is oil quantity in hydraulic tank normal?
- Are the travels of control lever and control valve spool normal?

#### Check the trouble



Cause						
Strainer clogged		Hydraulic pump sucking air		Hydraulic pump defective		Drop of main relief valve defective
Acting of check valve defective		Drop of safety valve setting on tilt pressure		Packing on dump cylinder defective		
Tank to pump			Hydraulic control valve		Dump cylinder	
a	b	c	d	e	f	g

No.	Problems	Remedy									
			C	X	X	X	A	Δ	C	X	
1	Hydraulic pressure is low at engine full throttle when raising the lift arm fully.		○	○	○						
2	Hydraulic pressure is normal at engine full throttle when raising the lift arm fully.							○		○	
3	Unusual noise is heard from hydraulic pump.		○								
4	Tilt back bucket to maximum, remove bottom piping from dump cylinder, run engine at low idling and operate control lever to TILT BACK. Oil comes out from bottom end of dump cylinder.									○	
5	Discharge of hydraulic pump is too small.		○	○							
6	Lifting speed of lift arm is normal.							○			
7	Bucket tilting back speed is slow when operating the control lever, but hydraulic pressure is too high.					○					

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Troubleshooting tools	Hydraulic tester	
	Flow meter kit	

The following symbols are used to indicate the action to be taken when a cause of failure is located.

X: Replace                      Δ: Repair  
 A: Adjust                        C: Clean



## 16. Bucket dump cylinder does not move (Bucket tilt back is impossible)

### Ask the operator the following questions

- Didn't the bucket move off suddenly? → Seizure and damage to various unit.
- In this time, was an unusual noise produced? (where did it emanate from?) → Damage to various units.
- Was the bucket tilting speed slower than any speed has been obtained so far. → Wear of parts of flattening of spring.

### Check before troubleshooting

- Is oil quantity in hydraulic tank normal?
- Are the travels of hydraulic control lever and control valve spool normal?

No.	Problems	Remedy	Cause					
			Hydraulic pump		Hydraulic control valve		Dump cylinder	
			a	b	c	d	e	
			△ X	X	A C X	C X	X	
1	No oil comes out when the pressure take-off plug is removed, and the engine is cranked.		○					
2	Hydraulic pressure does not rise at engine full throttle in bucket tilting back circuit.			○	○	○	○	
3	Hydraulic pressure does not rise at engine full throttle when raising the lift arm fully.			○	○			
4	Hydraulic pressure is normal at engine full throttle when raising the lift arm fully.					○	○	
5	Remove bottom piping from dump cylinder, run engine at low idling and operate control lever to TILT BACK. Cylinder does not move, but oil comes out from bottom end of dump cylinder.						○	
6	There is almost no discharge from hydraulic pump when there is load.						○	

Troubleshooting tools	Hydraulic tester	
	Flow meter kit	

The following symbols are used to indicate the action to be taken when a cause of failure is located.

X: Replace                      △: Repair  
A: Adjust                        C: Clean

**17. Bucket dump cylinder does not move (Dumping is impossible), machine cannot be raised off ground by the dump cylinder.**

**Check before troubleshooting**

- Is oil quantity in hydraulic tank normal?
- Are the travels of hydraulic control lever and control valve spool normal?

No.	Problems	Remedy	Cause					
			Hydraulic pump	Control valve			Control valve to cylinder	
			a	b	c	d	e	f
			C X	C X	Δ X	X	C X	Δ X
1	No oil comes out when the pressure take-off plug is removed, and the engine is cranked.	○						
2	Hydraulic pressure is low at engine full throttle when tilting back the bucket fully.							} "15. Bucket lacks tilt back power and bucket tilt speed is slow".
3	Hydraulic pressure is low at engine low idling when tilting back the bucket fully.							
4	Hydraulic pressure does not rise at engine full throttle in bucket dump circuit.			○		○		
5	Hydraulic pressure of bucket is too high at engine low idling.						○	
6	Remove head piping from dump cylinder, run engine at low idling and operate control lever to DUMP. Cylinder does not move, but oil comes out from head end of dump cylinder.					○		

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Troubleshooting tools	Hydraulic tester	

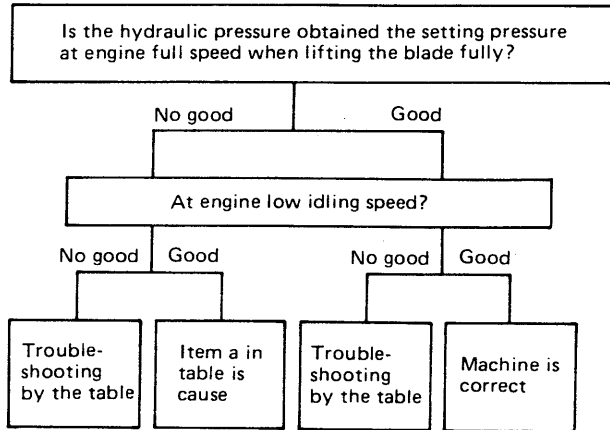
The following symbols are used to indicate the action to be taken when a cause of failure is located.  
 X: Replace                      Δ: Repair  
 A: Adjust                        C: Clean

## 18. Bucket dump speed is slow.

### Check before troubleshooting

- Is oil quantity in hydraulic tank normal?
- Are the travels of control lever and control valve spool normal?

### Check the trouble



Cause						
Hydraulic pump			Hydraulic control valve			Dump cylinder
a	b	c	d	e	f	g
Strainer clogged						
Hydraulic pump sucking air						
Hydraulic pump defective						
Drop of main relief valve setting pressure, blocked						
Acting of check valve defective						
Drop of safety valve setting on dump pressure						
Packing on dump cylinder defective						

No.	Problems	Remedy							
			C	Δ	X	A	Δ	C	X
1	Hydraulic pressure is low at engine full throttle when raising the lift arm fully.		○	○	○				
2	Hydraulic pressure is normal at engine full throttle when raising the lift arm fully.						○	○	
3	Unusual noise is heard from hydraulic pump.		○						
4	Dump bucket to maximum, remove head piping from dump cylinder, run engine at low idling and operate control lever to DUMP. Oil comes out from head end of dump cylinder.							○	
5	Discharge of hydraulic pump is too small.		○	○					
6	Raising speed of lift arm is proper.						○		
7	Bucket dump speed is slow when operating the control lever, but hydraulic pressure is higher.					○			

Troubleshooting tools	Hydraulic tester	
	Flow meter kit	

The following symbols are used to indicate the action to be taken when a cause of failure is located.

X: Replace      Δ: Repair  
 A: Adjust      C: Clean

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## 19. Hydraulic drift of bucket dump cylinder is excessive.

### Ask the operator the following questions

- Did the hydraulic drift of dump cylinder suddenly become large? → Logged dirt in valve of damaged parts.
- Did the hydraulic drift of dump cylinder gradually become large? → Worn parts.

### Check before troubleshooting

- If the rod of control lever is disconnected from the control valve spool, is the hydraulic drift of dump cylinder normal? → Bend or rod or seizure of rod bushing.

No.	Problems	Remedy	Cause		
			Hydraulic control valve		Dump cylinder
			a	b	c
			△ X	C X	X
1	Tilt back bucket to maximum, remove bottom piping from dump cylinder, run engine at low idling and operate control lever to TILT BACK. Oil comes out from bottom end of dump cylinder.				○
2	The oil does not come out at item 1.		○	○	
3	Hydraulic drift of dump cylinder becomes normal when upper and lower suction valves are interchanged.			○	

Cause

Oil leakage from dump spool (by damaged spool)

Safety valve on tilt defective

Packing on dump cylinder defective

Hydraulic control valve

Dump cylinder

a

b

c

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The following symbols are used to indicate the action to be taken when a cause of failure is located.

X: Replace                      △: Repair  
A: Adjust                        C: Clean

**20. Bucket moves up and down along ground and lift arm moves unsteadily when leveling the ground. (Control lever at HOLD)**

**Problems and cause**

- Check the hydraulic drift of bucket lift cylinder;

It is above the standard value → Go to "14. Hydraulic drift of bucket lift cylinder is excessive"

It is within the standard value → Forming an vacuum in cylinder →  
It is corrected by raising the machine with lift arm (bucket lift cylinder) and lowering the machine slowly.

★ But if it is frequent → Suction valve defective.

**21. Lift arm lowers under the following conditions.**

- 1) Lift arm lowers momentarily when control lever is changed from HOLD position to RAISE position.
- 2) Lift arm lowers gradually when control lever is at RAISE position with engine stopped.

Cause: Check valve for bucket lift control valve defective → Remedy  
C.X

**22. Bucket moves unsteadily when leveling the ground with machine traveling in reverse. (Control lever at HOLD)**

**Problems and cause**

- Check

It is above the standard value → Problems as "19. Hydraulic drift of bucket dump cylinder is large"

It is within the standard value → Forming an vacuum in cylinder →  
It is corrected corrected by raising the machine with bucket dump cylinder and lowering the machine slowly.

★ But if it is frequent → Suction valve of bucket dump circuit defective.

**23. Bucket dumps**

- 1) Bucket dumps momentarily when control lever is changed from HOLD position to TILT BACK position.
- 2) Bucket dumps gradually when control lever is at TILT BACK position with engine stopped.

Cause: Check valve for bucket dump control valve defective → Remedy  
C.X

**24. Lift arm cannot be raised when bucket dumps fully.**

Cause: Safety valve in dump circuit defective → Remedy  
C.X

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## 25. Operating force of work equipment control lever is heavy.

### Check the trouble

Confirm the trouble in according with the following table.

No.	Problems	Remedy	Cause					
			Control valve					
			a	b	c	d	e	f
			Deformed control valve by tightening the mounting bolts uneven	Bend of control valve spool	Control valve detent defective	Clearance between control valve body and spool defective	Deformed control valve by valve body	Roundness of control valve body of spool defective
			△ X	X	△ X	△ X	X	X
1	Operating force is heavy when hydraulic pressure is high.							○
2	Operating force is heavy when hydraulic oil temperature is high.				○			
3	Operating force is often heavy regardless of hydraulic pressure and temperature.			○				
4	Operating force is always heavy regardless of hydraulic pressure and temperature.	○						

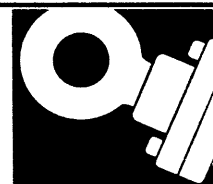
The following symbols are used to indicate the action to be taken when a cause of failure is located.

X: Replace                      △: Repair  
A: Adjust                        C: Clean

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# HYDRAULIC SYSTEM


## 63 DISASSEMBLY AND ASSEMBLY



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HYDRAULIC CYLINDER	
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## REMOVAL OF HYDRAULIC PUMP ASSEMBLY

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

1. Remove drain plug and drain oil from hydraulic tank.



Hydraulic tank: Approx. 33 ℓ

2. Remove engine side cover.
3. Disconnect pump tubes (1) and (2). (See P1)
4. Remove mounting bolts, and remove hydraulic pump assembly (3). (See P1)

## INSTALLATION OF HYDRAULIC PUMP ASSEMBLY

1. Fit O-ring and install hydraulic pump assembly (4). (See P1)
2. Fit O-ring and connect pump tubes (1) and (2). (See P1)
3. Install engine side cover.
4. Tighten drain plug and add hydraulic oil through oil filler to the specified level.



Hydraulic tank: Approx. 33 ℓ

- ★ Run the engine to circulate the oil through the system then check the oil level again.

## REMOVAL OF MAIN RELIEF VALVE ASSEMBLY

1. Remove cover (1). (See P2)
2. Remove main relief valve assembly (2). (See P3)

## INSTALLATION OF MAIN RELIEF VALVE ASSEMBLY

1. Fit O-ring and install main relief valve assembly (2). (See P3)



Valve assembly:  $7 \pm 1$  kgm



Locknut:  $8.5 \pm 1.5$  kgm

2. Install cover (1). (See P2)

## REMOVAL OF HYDRAULIC CONTROL VALVE ASSEMBLY



Lower the work equipment completely to the ground and stop the engine. Operate the control levers several times to release the remaining pressure in the hydraulic piping.

1. Remove floor plate and cover (1). (See P2)
2. Disconnect control rods (2). (See P4)
3. Disconnect tube (3), and remove tube (4).
4. Disconnect tubes (5) and (6). (See P6)
5. Remove hydraulic control valve assembly (7) together with bracket (8). (See P6)

## INSTALLATION OF HYDRAULIC CONTROL VALVE ASSEMBLY

- ★ When connecting the piping, clean all dirt and dust from the sleeve nut and nipple contact surface.

1. Install hydraulic control valve assembly (7) together with bracket (8). (See P6)

2. Connect tubes (6) and (5). (See P6)

3. Install tube (4) and connect tube (3). (See P5)



Sleeve nut (Width across flats 24 mm)  
:  $8 \pm 2$  kgm



Sleeve nut (Width across flats 32 mm)  
:  $23 \pm 3$  kgm



Sleeve nut (Width across flats 41 mm)  
:  $27 \pm 3$  kgm

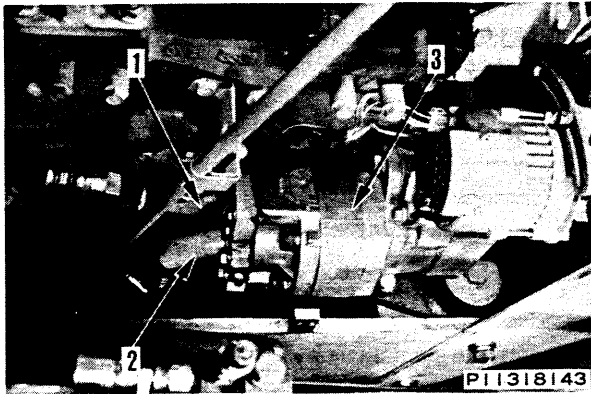
4. Connect control rods (2). (See P4)

5. Install cover (1) and floor plate. (See P2)

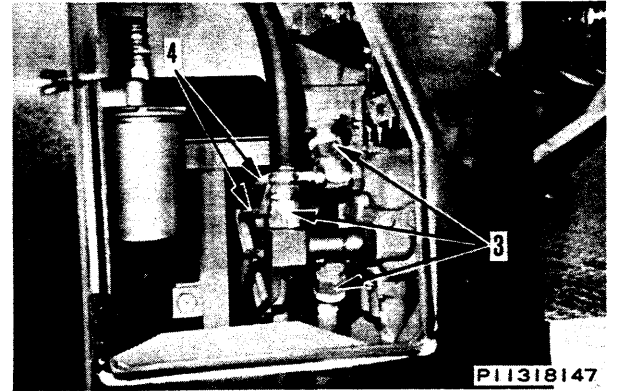
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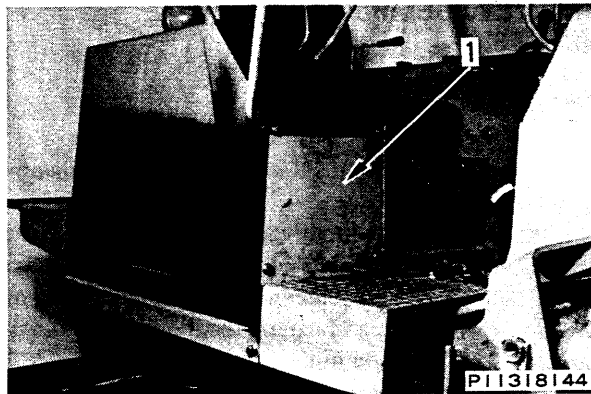
P1



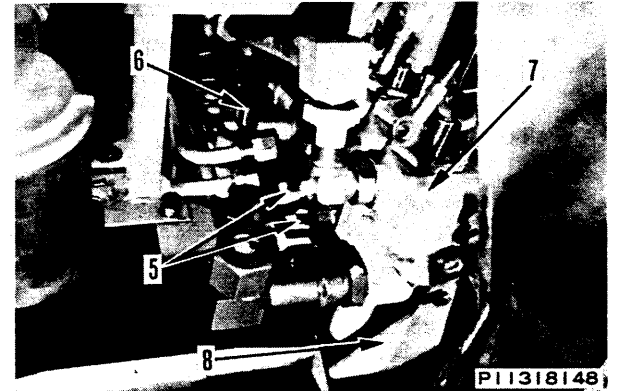
P5



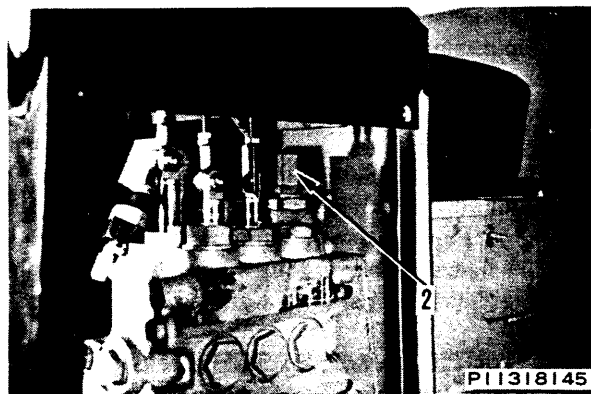
P2



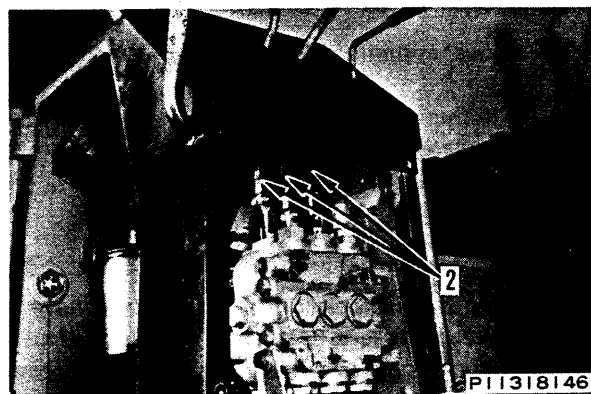
P6



P3



P4



011418

20-18

# DISASSEMBLY OF HYDRAULIC CONTROL VALVE ASSEMBLY

(POWER ANGLE, TILDOZER)

D31E-18, D31P-18A, D37E, P-2

## LIFT CONTROL VALVE ASSEMBLY (See F1)

1. Remove case (1) together with detent (2), plate (3), and snap ring (4).
2. Remove ball (5).
3. Loosen plug (6).
  - ★ Loosen the plug while the spool is still inserted in the body.
4. Pull out lift spool (7) from body (8).
5. Remove plug (9), then remove ball (10) and spring (11).
6. Remove plug (6), then remove retainer (12), spring (13) and spacer (14).
7. Remove plates (15).
8. Remove plate (16) and collar (17).
9. Remove plug (18), then remove spring (19) and check valve (20).
10. Remove suction valve assembly (21).

## TILT CONTROL VALVE ASSEMBLY (See F1)

11. Remove case (22).
12. Loosen bolts (23).
  - ★ Loosen the bolts while the spool is still inserted in the body.
13. Pull out tilt spool (24) from body (25).
14. Remove bolt (23) from tilt spool, then remove collar (26), retainer (27) and spring (28).
15. Remove plate (29).
16. Remove plate (30) and collar (31).
17. Remove plug (32), then remove spring (33) and check valve (34).

## ANGLE CONTROL VALVE ASSEMBLY (See F1)

18. The procedure for disassembly of the angle control valve assembly (35) is the same as the procedure for disassembly of the tilt control valve assembly.
19. Remove main relief valve assembly (36).
20. Remove suction safety valve assembly (37).

## FINE DISASSEMBLY OF MAIN RELIEF VALVE ASSEMBLY (See F3)

21. Remove cap (38).
22. Loosen locknut (39), then remove adjustment screw (40).
  - ★ To make the set dimension when assembling the same as when disassembling, check the set dimension of the adjustment screw (40) and end face of the holder (42) before removing the nut.
23. Loosen locknut (41), then remove holder (42).
24. Remove poppet (43), spacer (44), spring (45) and retainer (46) from holder (42).
25. Remove seat (47) from sleeve (48).
26. Remove plug (49), then remove valve (50) and spring (51) from sleeve (48).
  - ★ If there is any abnormality in the valve or sleeve, replace the whole valve assembly. These parts are not available individually.

## LIFT SUCTION VALVE ASSEMBLY (See F4)

27. Remove screw (52).
28. Remove spring (53) and ball (54) from sleeve (55).
  - ★ If there is any abnormality in these parts, replace the whole assembly. These parts are not available individually.

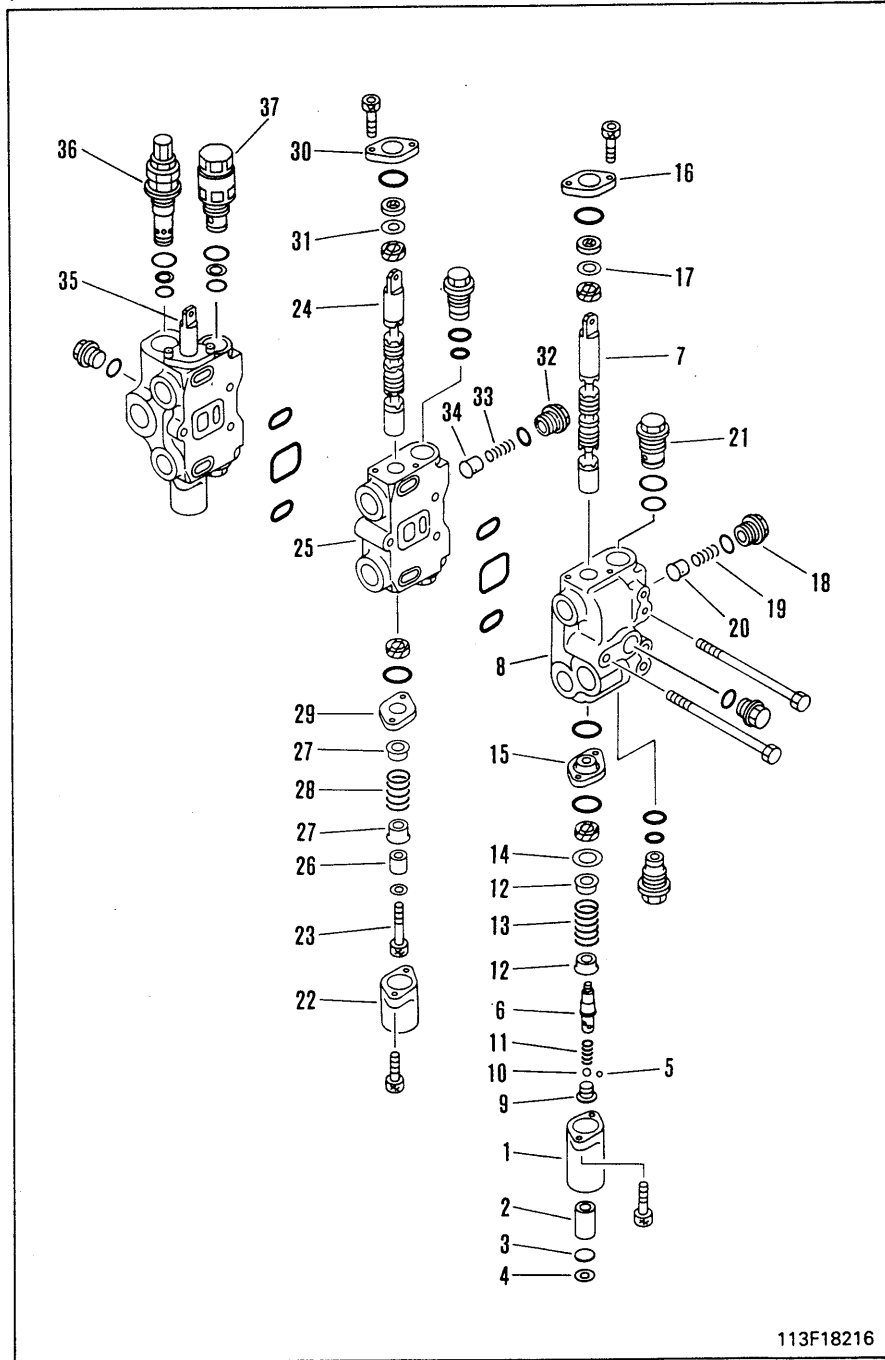
## SUCTION SAFETY VALVE ASSEMBLY

- ★ Do not disassemble the suction safety valve assembly because a test stand is required to adjust the set pressure if the valve has been disassembled.

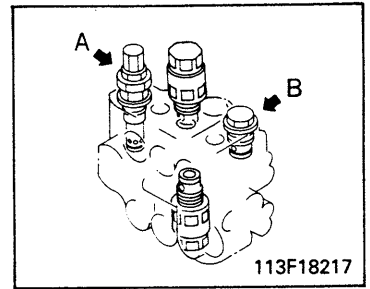
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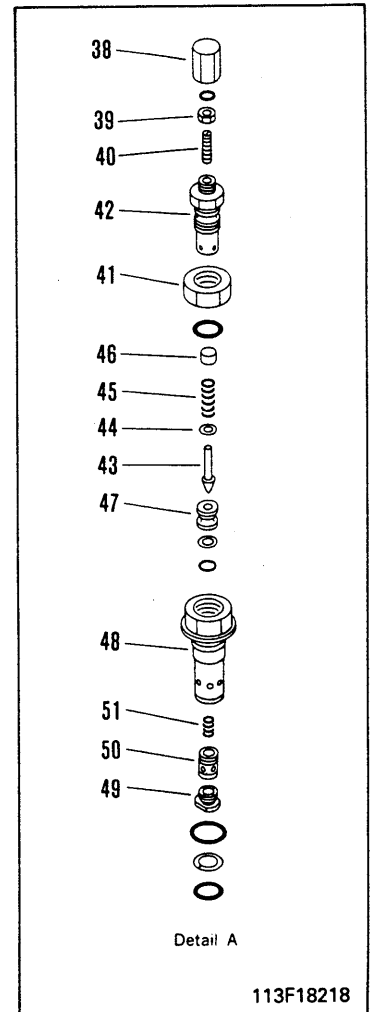
F1



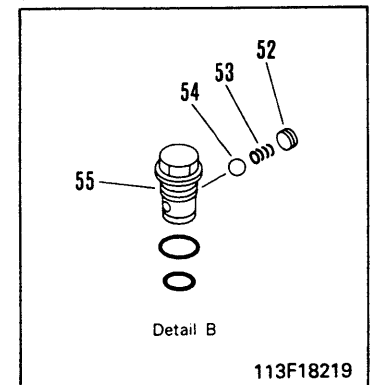
F2



F3



F4



90-16

# ASSEMBLY OF HYDRAULIC CONTROL VALVE ASSEMBLY

(POWER ANGLE, TILTDOZER)

D31E-18, D31P-18A, D37E, P-2


- ★ Clean all parts, and check for dirt or damage. Coat the sliding surfaces of all parts with engine oil before installing.

## LIFT SUCTION VALVE ASSEMBLY (See F4)

1. Assemble ball (54) and spring (53) in sleeve (55).
2. Tighten with screw (52).


## FINE ASSEMBLY OF MAIN RELIEF VALVE ASSEMBLY (See F3)

3. Assemble spring (51) and valve (50) in sleeve (48), and install plug (49).
4. Fit O-ring and back-up ring, then assemble seat (47) in sleeve (48).
5. Assemble retainer (46), spring (45), spacer (44) and poppet (43) in holder (42).
6. Fit O-ring and assemble holder (42) in sleeve (48), then tighten locknut (41).

 Holder:  $4 \pm 1$  kgm


 Locknut:  $7 \pm 1$  kgm

7. Screw adjustment screw (40) in holder (42).
8. Adjust set dimension of adjustment screw (40) and end face of holder (42) to same dimension as when disassembling, then tighten nut (39).
  - ★ Make the final adjustment after installing to the machine, and adjust so that the set pressure is  $175 - 183$  kg/cm<sup>2</sup>.
  - ★ For details of the adjustment procedure, see 62 TESTING AND ADJUSTING.
9. Fit O-ring and install cap (38).


 Cap:  $3.5 \pm 0.5$  kgm

## ANGLE CONTROL VALVE ASSEMBLY (See F1)

10. The procedure for assembly of the angle control valve assembly (35) is the same as the procedure for assembly of the tilt control valve assembly.
11. Fit O-ring and install suction safety valve assembly (37).

 Suction safety valve assembly:  
 $5.25 \pm 0.75$  kgm.


12. Fit O-ring and install main relief valve assembly (36).

 Main relief valve assembly:  
 $8.5 \pm 1.5$  kgm

- ★ When installing the main relief valve assembly, fix with grease (G2-LI) so that the back-up ring does not protrude from the outside circumference of the sleeve.

## TILT CONTROL VALVE ASSEMBLY (See F1)

13. Assemble spring (33) and check valve (34) in body (25), then fit O-ring and install plug (32).

 Plug:  $11 \pm 1.5$  kgm

14. Press fit dust seal to plate (30), then fit O-ring and install collar (31) and plate (30).


15. Fit dust seal to body (25), then fit O-ring and install plate (29).

16. Assemble retainer (27), spring (28) and collar (26) to tilt spool (24), then tighten bolt (23) temporarily.

- ★ Tighten the bolt fully after installing the spool in the body.

17. Assemble tilt spool (24) in body (25).


18. Tighten bolt (23).

 Bolt:  $3.5 \pm 0.5$  kgm


19. Install case (22).

## LIFT CONTROL VALVE ASSEMBLY (See F1)

20. Fit O-ring and install suction valve assembly (21).

 Suction valve assembly:  $5.5 \pm 0.5$  kgm

21. Assemble check valve (20) and spring (19) in body (8), then fit O-ring and install plug (18).

 Plug:  $11 \pm 1.5$  kgm


22. Fit U-packing to body (8), press fit dust seal to plate (16), then fit O-ring and install collar (17) and plate (16).

23. Press fit U-packing, then fit O-ring and install plate (15).

24. Assemble spacer (14), retainer (12) and spring (13) to lift spool (7), then install plug (6) temporarily.


- ★ Tighten the plug fully after installing the spool in the body.

25. Assemble spring (11) and ball (10) to plug (6), then install plug (9).

 Plug:  $0.75 \pm 0.25$  kgm

26. Assemble lift spool (7) in body (8).

27. Tighten plug (6).

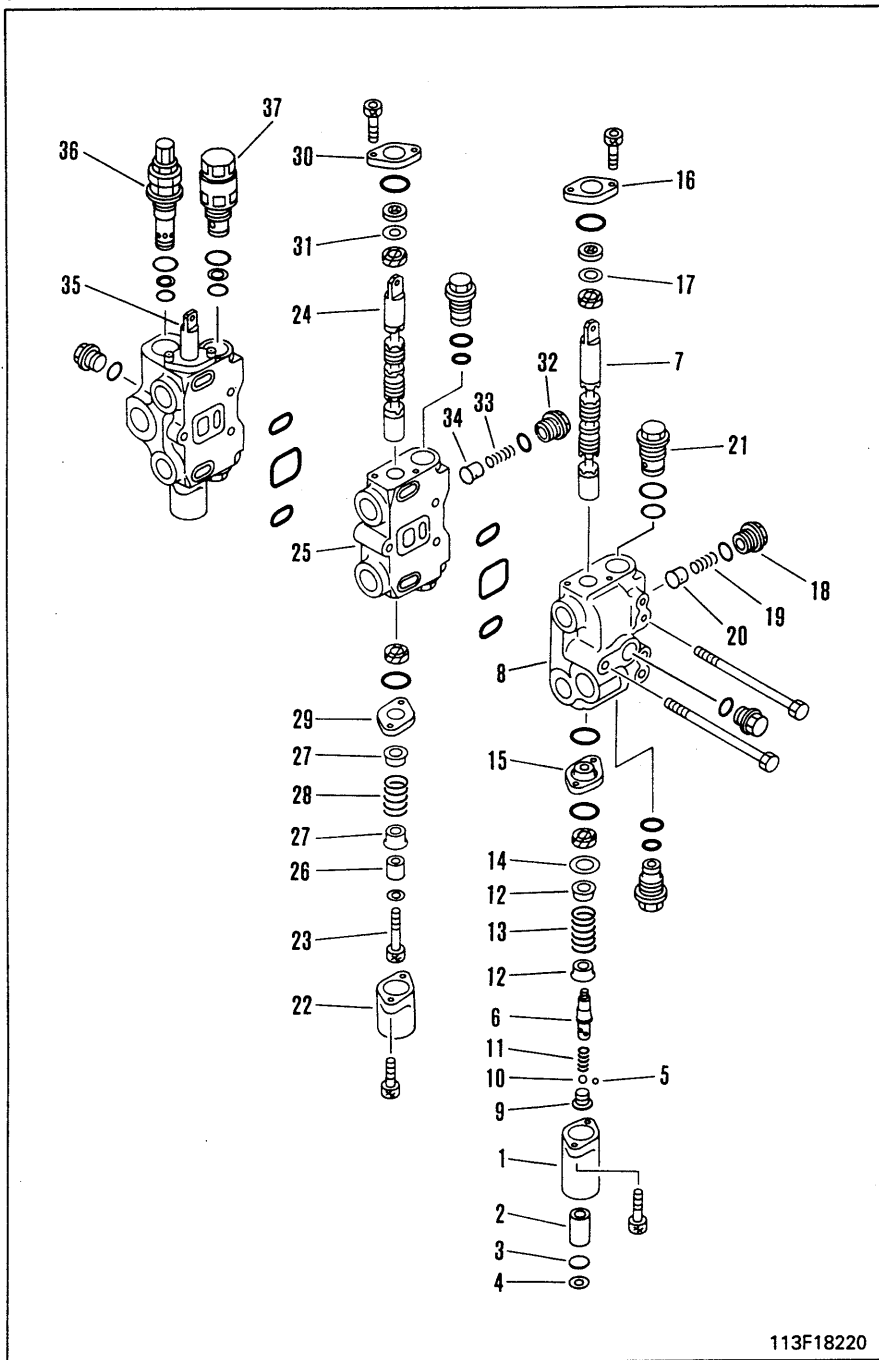
 Plug:  $1.5 \pm 0.5$  kgm

28. Install ball (5).

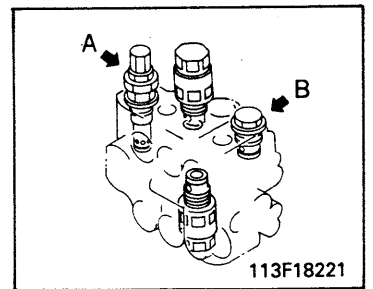
29. Assemble detent (2), plate (3), and snap ring (4) to case (1), then install to body.

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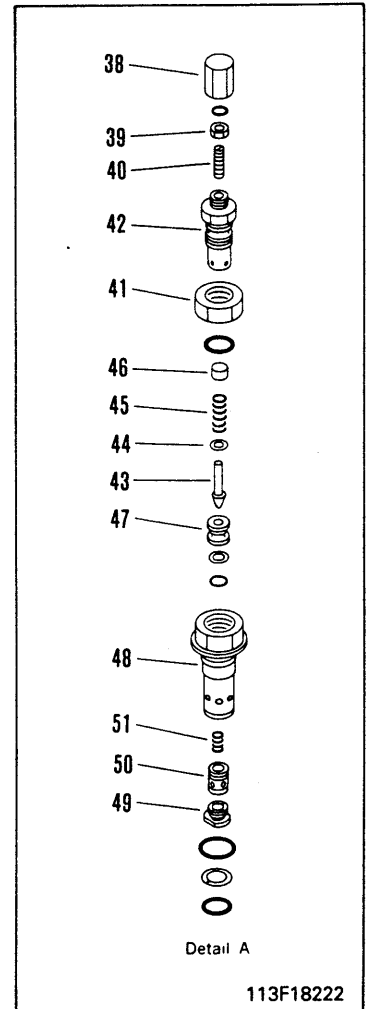
F1



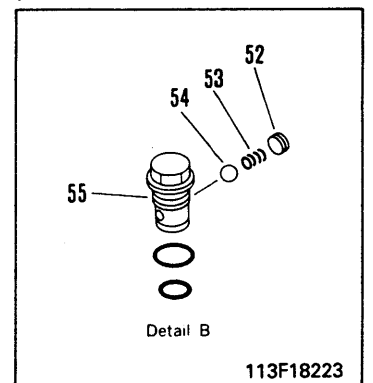
F2



F3



F4



011418

30-75

# DISASSEMBLY OF HYDRAULIC CONTROL VALVE ASSEMBLY

(STRAIGHT TILTDOZER)  
D31P, PL, PLL-18

## LIFT CONTROL VALVE ASSEMBLY (See F1)

1. Remove case (1) together with detent (2), plate (3), and snap ring (4).
2. Remove ball (5).
3. Loosen plug (11).
  - ★ Loosen the plug while the spool is still inserted in the body.
4. Pull out lift spool (6) from body (7).
5. Remove plug (8), then remove ball (9) and spring (10).
6. Remove plug (11), then remove retainer (12), spring (13) and spacer (14).
7. Remove plates (15).
8. Remove plate (16) and collar (17).
9. Remove plug (18), then remove spring (19) and check valve (20).
10. Remove suction valve assembly (21).

## TILT CONTROL VALVE ASSEMBLY (See F1)

11. Remove case (22).
12. Loosen bolt (23).
  - ★ Loosen the bolts while the spool is still inserted in the body.
13. Pull out tilt spool (27) from body (28).
14. Remove bolt (23) from tilt spool, then remove collar (24), retainer (25) and spring (26).
15. Remove plate (29).
16. Remove plate (30) and collar (31).
17. Remove plug (32), then remove spring (33) and check valve (34).
18. Remove main relief valve assembly (35).

## FINE DISASSEMBLY OF MAIN RELIEF VALVE ASSEMBLY (See F3)

19. Remove cap (37).
20. Loosen locknut (38), then remove adjustment screw (39).
  - ★ To make the set dimension when assembling the same as when disassembling, check the set dimension of the adjustment screw (39) and end face of holder (41) before removing the nut.
21. Loosen locknut (40), then remove holder (41).
22. Remove poppet (42), spacer (43), spring (44) and retainer (45) from holder (41).
23. Remove seat (47) from sleeve (46).
24. Remove plug (48), then remove valve (49) and spring (50) from sleeve (46).
  - ★ If there is any abnormality in the valve or sleeve, replace the whole assembly. These parts are not available individually.

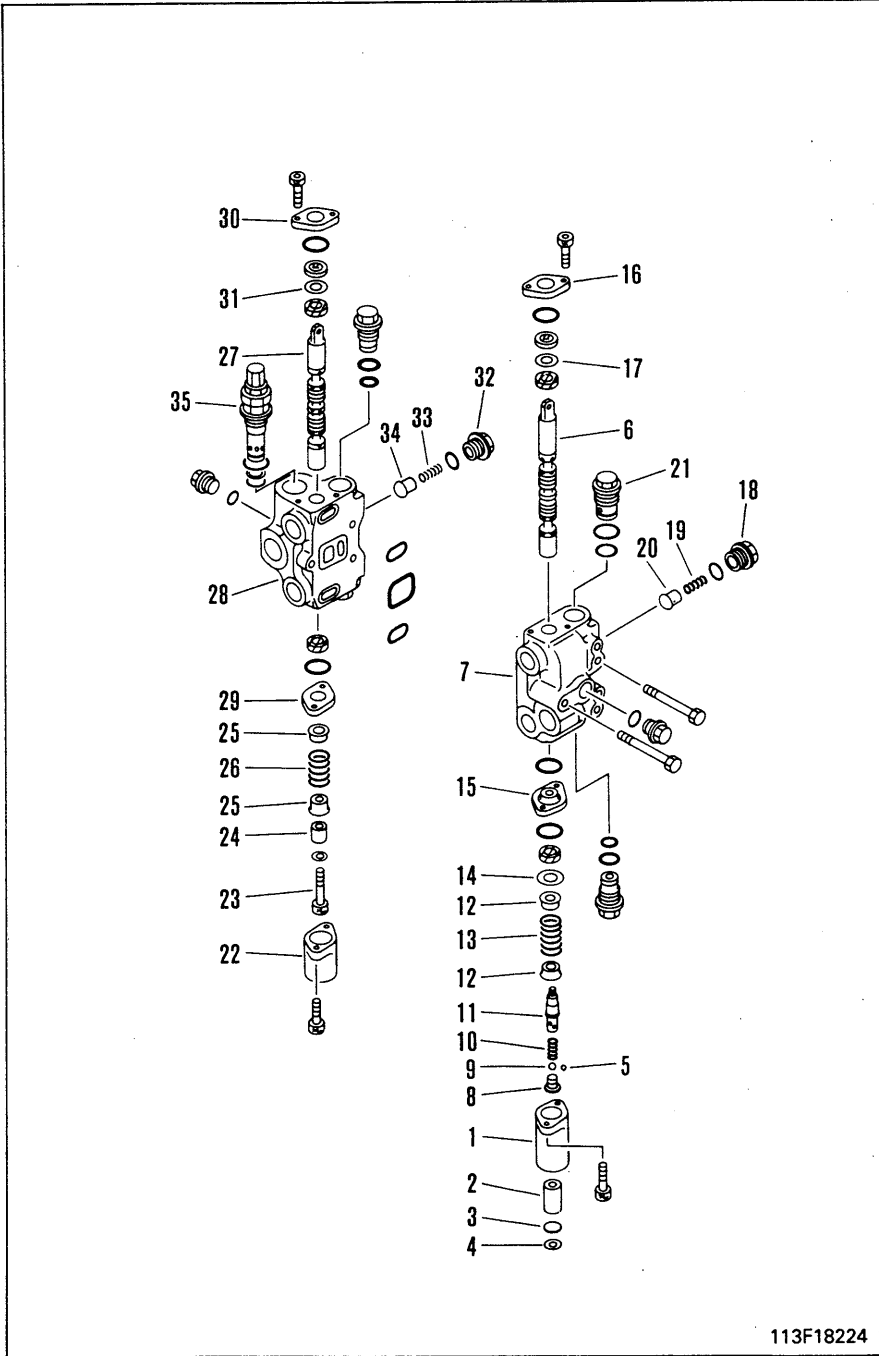
## LIFT SUCTION VALVE ASSEMBLY (See F4)

25. Remove screw (51).
26. Remove spring (52) and ball (53) from sleeve (54).
  - ★ If there is any abnormality in these parts, replace the whole valve assembly. These parts are not available individually.

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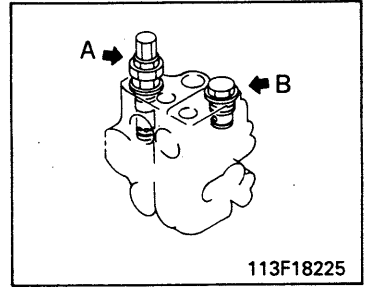
011418

F1



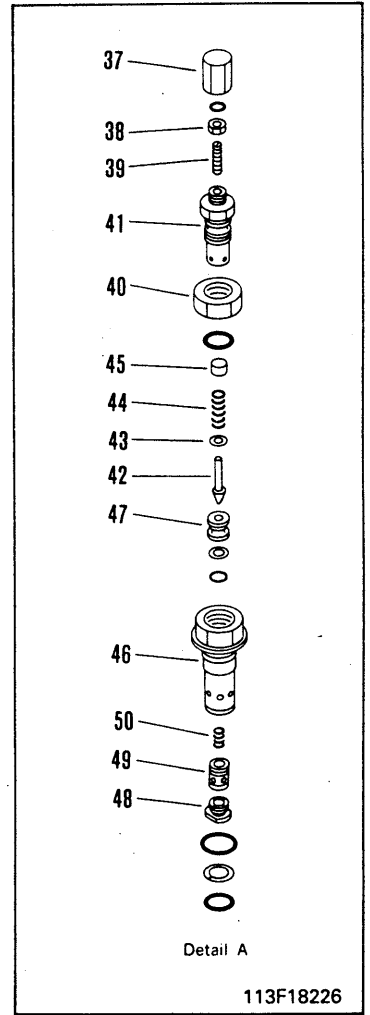
113F18224

F2



113F18225

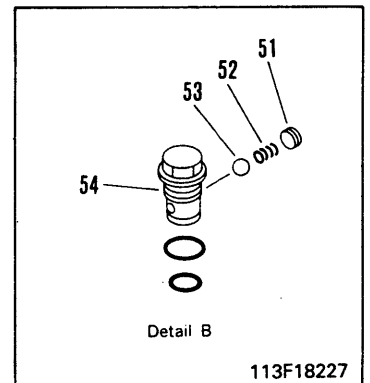
F3



Detail A

113F18226

F4



Detail B

113F18227

30-80

# ASSEMBLY OF HYDRAULIC CONTROL VALVE ASSEMBLY



(STRAIGHT TILTDOZER)  
D31P, PL, PLL-18

- ★ Clean all parts, and check for dirt or damage. Coat the sliding surfaces of all parts with engine oil before installing.


## LIFT SUCTION VALVE ASSEMBLY (See F4)

1. Assemble ball (53) and spring (52) in sleeve (54).
2. Tighten with screw (51).


## FINE ASSEMBLY OF MAIN RELIEF VALVE ASSEMBLY (See F3)

3. Assemble spring (50) and valve (49) in sleeve (46), and install plug (48).
4. Fit O-ring and back-up ring, then assemble seat (47) in sleeve (46).
5. Assemble retainer (45), spring (44), spacer (43) and poppet (42) in holder (41).
6. Fit O-ring and assemble holder (41) in sleeve (46), then tighten locknut (40).
  -  Holder: 4 ± 1 kgm
  -  Locknut: 7 ± 1 kgm
7. Screw adjustment screw (39) in holder (41).
8. Adjust set dimension of adjustment screw (39) and end face of holder (41) to same dimension as when disassembling, then tighten nut (38).
  - ★ Make the final adjustment after installing to the machine, and adjust so that the set pressure is 175 – 183 kg/cm<sup>2</sup>.
  - ★ For details of the adjustment procedure, see 62 TESTING AND ADJUSTING.

9. Fit O-ring and install cap (37).

 Cap: 3.5 ± 0.5 kgm


10. Fit O-ring and install main relief valve assembly (35).

 Main relief valve assembly: 8.5 ± 1.5 kgm

- ★ When installing the main relief valve assembly, fix with grease (G2-L1) so that the back-up ring does not protrude from the outside circumference of the sleeve.

## TILT CONTROL VALVE ASSEMBLY (See F1)

11. Assemble spring (33) and check valve (34) in body (28), then fit O-ring and install plug (32).

 Plug: 11 ± 1.5 kgm

12. Press fit dust seal to plate (30), then fit O-ring and install collar (31) and plate (30).


13. Fit dust seal to body (28), then fit O-ring and install plate (29).

14. Assemble retainer (25), spring (26) and collar (24) to tilt spool (27), then tighten bolt (23) temporarily.

- ★ Tighten the bolt fully after installing the spool in the body.

15. Assemble tilt spool (27) in body (28).

16. Tighten bolt (23).

 Bolt: 3.5 ± 0.5 kgm


17. Install case (22).

## LIFT CONTROL VALVE ASSEMBLY (See F1)

18. Fit O-ring and install suction valve assembly (21).

 Suction valve assembly: 5.5 ± 0.5 kgm

19. Assemble check valve (20) and spring (19) in body (7), then fit O-ring and install plug (18).

 Plug: 11 ± 1.5 kgm


20. Fit U-packing to body (7), press fit dust seal to plate (16), then fit O-ring and install collar (17) and plate (16).

21. Press fit U-packing, then fit O-ring and install plate (15).

22. Assemble spacer (14), retainer (12) and spring (13) to lift spool (6), then install plug (11) temporarily.


- ★ Tighten the plug fully after installing the spool in the body.

23. Assemble spring (10) and ball (9) to plug (11), then install plug (8).

 Plug: 0.75 ± 0.25 kgm

24. Assemble lift spool (6) in body (7).

25. Tighten plug (11).

 Plug: 1.5 ± 0.5 kgm

26. Install ball (5).

27. Assemble detent (2), plate (3), and snap ring (4) to case (1), then install to body.



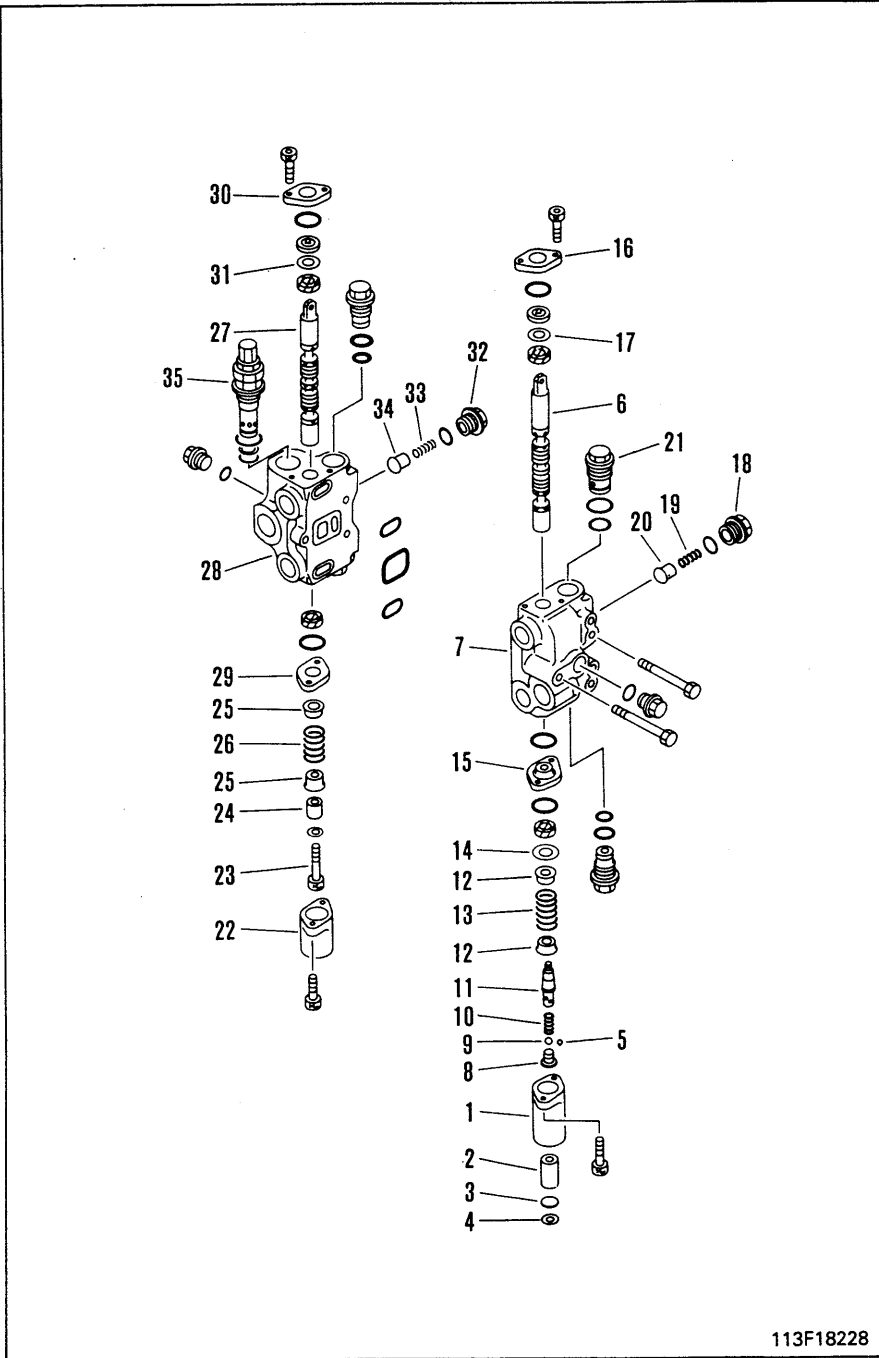
011418



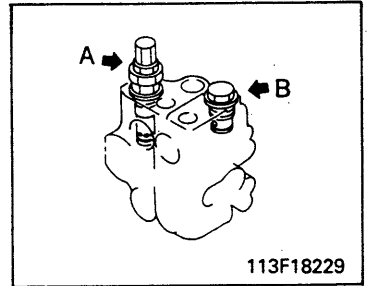


011418

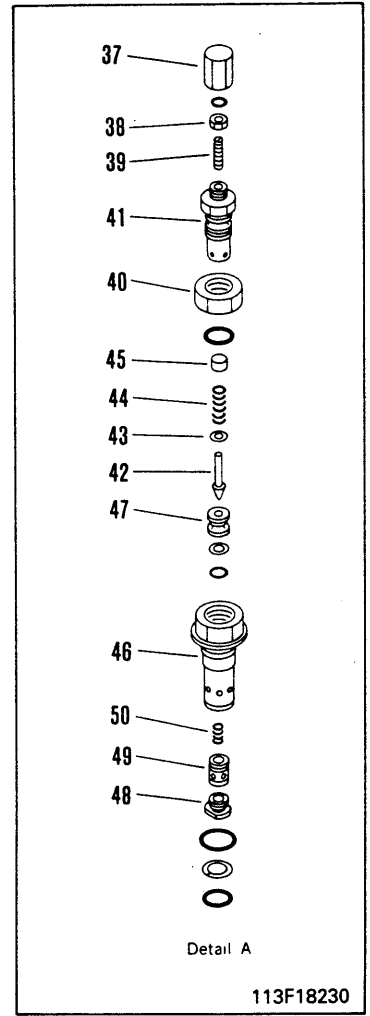
F1



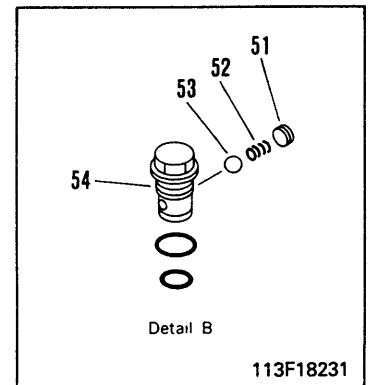
F2



F3



F4



# DISASSEMBLY OF HYDRAULIC CONTROL VALVE ASSEMBLY

D31S, Q-18

## LIFT CONTROL VALVE ASSEMBLY (See F1)

1. Remove case (1) together with detent (2), plate (3), and snap ring (4).
2. Remove ball (5).
3. Loosen plug (11).
  - ★ Loosen the plug while the spool is still inserted in the body.
4. Pull out lift spool (6) from body (7).
5. Remove plug (8), then remove ball (9) and spring (10).
6. Remove plug (11), then remove retainer (12), spring (13) and spacer (14).
7. Remove plate (15).
8. Remove plate (16) and collar (17).
9. Remove plug (18), then remove spring (19) and check valve (20).
10. Remove suction valve assembly (21).

## DUMP CONTROL VALVE ASSEMBLY (See F1)

11. Remove case (22).
12. Loosen bolt (23).
  - ★ Loosen the bolts while the spool is still inserted in the body.
13. Pull out dump spool (27) from body (28).
14. Remove bolt (23) from dump spool (27), then remove collar (24), retainer (25) and spring (26).
15. Remove plate (29).
16. Remove plate (30) and collar (31).
17. Remove plug (32), then remove spring (33) and check valve (34).
18. Remove main relief valve assembly (35).
19. Remove dump and tilt back suction safety valve assemblies (36).

## FINE DISASSEMBLY OF MAIN RELIEF VALVE ASSEMBLY (See F3)

20. Remove cap (37).
21. Loosen locknut (38), then remove adjustment screw (39).
  - ★ To make the set dimension when assembling the same as when disassembling, check the set dimension of the adjustment screw (39) and end face of holder (41) before removing the nut.
22. Loosen locknut (40), then remove holder (41).
23. Remove poppet (42), spacer (43), spring (44) and retainer (45) from holder (41).
24. Remove seat (47) from sleeve (46).
25. Remove plug (48), then remove valve (49) and spring (50) from sleeve (46).
  - ★ If there is any abnormality in the valve or sleeve, replace the whole assembly. These parts are not available individually.

## LIFT SUCTION VALVE ASSEMBLY (See F4)

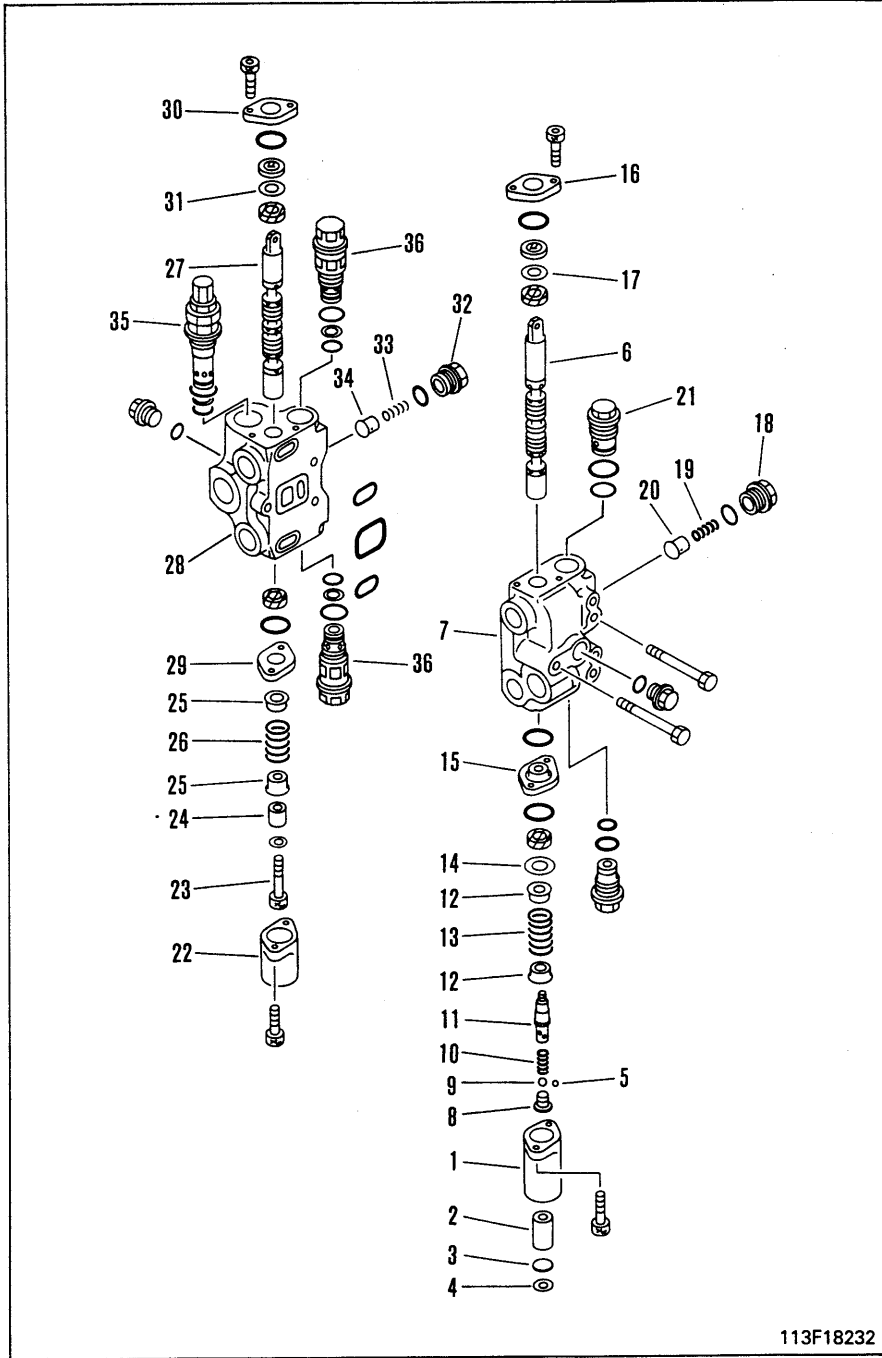
26. Remove screw (51).
27. Remove spring (52) and ball (53) from sleeve (54).
  - ★ If there is any abnormality in these parts, replace the whole valve assembly. These parts are not available individually.

## DUMP AND TILT BACK SUCTION SAFETY VALVE ASSEMBLY (See F2-C, D)

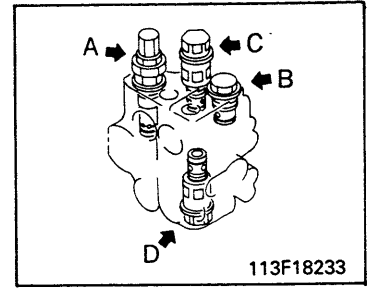
- ★ Do not disassemble the suction safety valve assembly because a test stand is required to adjust the set pressure if the valve has been disassembled.

011418

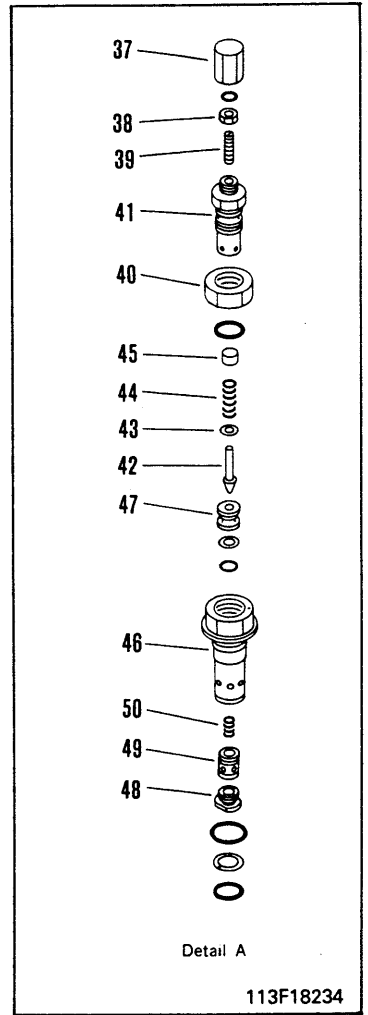
F1



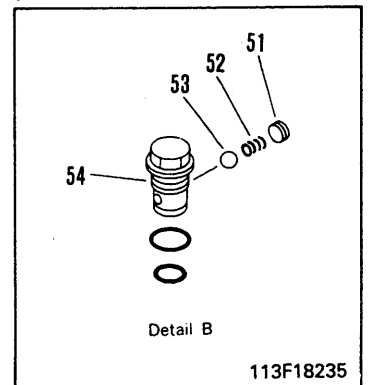
F2



F3



F4



36-84

# ASSEMBLY OF HYDRAULIC CONTROL VALVE ASSEMBLY

## D31S, Q-18

- ★ Clean all parts, and check for dirt or damage. Coat the sliding surfaces of all parts with engine oil before installing.

## LIFT SUCTION VALVE ASSEMBLY (See F4)

1. Assemble ball (53) and spring (52) in sleeve (54).
2. Tighten with screw (51).

## FINE ASSEMBLY OF MAIN RELIEF VALVE ASSEMBLY (See F3)


3. Assemble spring (50) and valve (49) in sleeve (46), and install plug (48).
4. Fit O-ring and back-up ring, then assemble seat (47) in sleeve (46).
5. Assemble retainer (45), spring (44), spacer (43) and poppet (42) in holder (41).
6. Fit O-ring and assemble holder (41) in sleeve (46), then tighten locknut (40).

 Holder:  $4 \pm 1$  kgm


 Locknut:  $7 \pm 1$  kgm

7. Screw adjustment screw (39) in holder (41).
8. Adjust set dimension of adjustment screw (39) and end face of holder (41) to same dimension as when disassembling, then tighten nut (38).
  - ★ Make the final adjustment after installing to the machine, and adjust so that the set pressure is  $175 - 183$  kg/cm<sup>2</sup>.
  - ★ For details of the adjustment procedure, see 62 TESTING AND ADJUSTING.


9. Fit O-ring and install cap (37).

 Cap:  $3.5 \pm 0.5$  kgm

10. Fit O-ring and install dump and tilt back suction safety valve assembly (36).

 Dump and tilt back suction safety valve assembly:  $5.5 \pm 0.5$  kgm


11. Fit O-ring and install main relief valve assembly (35).

 Main relief valve assembly:  $8.5 \pm 1.5$  kgm

- ★ When installing the main relief valve assembly, fix with grease (G2-LI) so that the back-up ring does not protrude from the outside circumference of the sleeve.

## DUMP CONTROL VALVE ASSEMBLY (See F1)

12. Assemble spring (33) and check valve (34) in body (28), then fit O-ring and install plug (32).

 Plug:  $11 \pm 1.5$  kgm

13. Press fit dust seal to plate (30), then fit O-ring and install collar (31) and plate (30).


14. Fit dust seal to body (28), then fit O-ring and install plate (29).

15. Assemble retainer (25), spring (26) and collar (24) to dump spool (27), then tighten bolt (23) temporarily.

- ★ Tighten the bolt fully after installing the spool in the body.

16. Assemble dump spool (27) in body (28).


17. Tighten bolt (23).

 Bolt:  $3.5 \pm 0.5$  kgm


18. Install case (22).

## LIFT CONTROL VALVE ASSEMBLY (See F1)

19. Fit O-ring and install suction valve assembly (21).

 Suction valve assembly:  $5.5 \pm 0.5$  kgm

20. Assemble check valve (20) and spring (19) in body (7), then fit O-ring and install plug (18).

 Plug:  $11 \pm 1.5$  kgm


21. Fit U-packing to body (7), press fit dust seal to plate (16), then fit O-ring and install collar (17) and plate (16).

22. Press fit U-packing, then fit O-ring and install plate (15).

23. Assemble spacer (14), retainer (12) and spring (13) to lift spool (6), then install plug (11) temporarily.


- ★ Tighten the plug fully after installing the spool in the body.

24. Assemble spring (10) and ball (9) to plug (11), then install plug (8).

 Plug:  $0.75 \pm 0.25$  kgm

25. Assemble lift spool (6) in body (7).

26. Tighten plug (11).

 Plug:  $1.5 \pm 0.5$  kgm

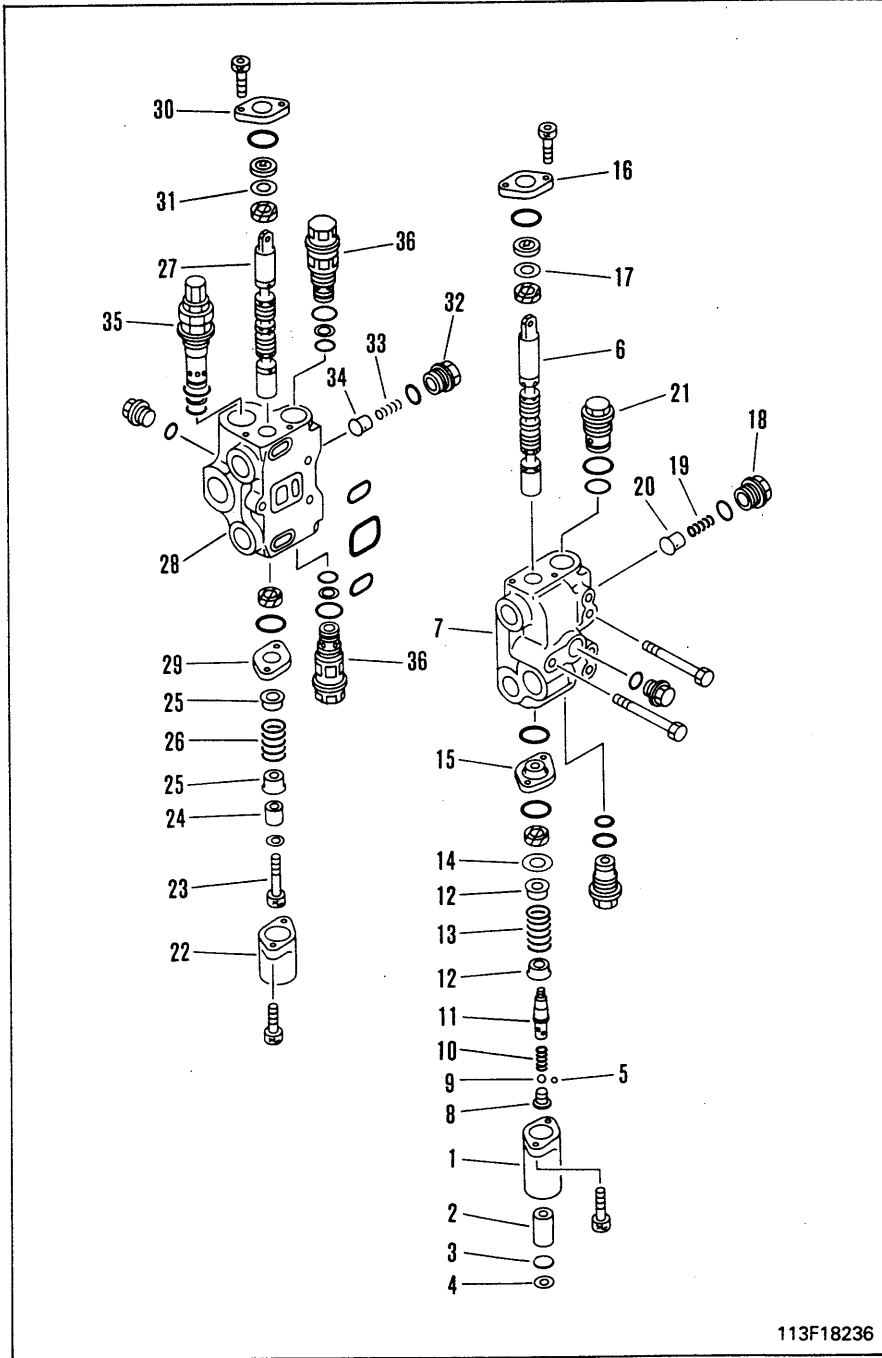
27. Install ball (5).

28. Assemble detent (2), plate (3), and snap ring (4) to case (1), then install to body.

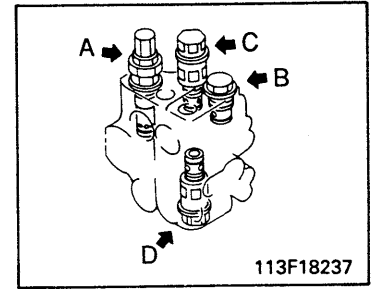
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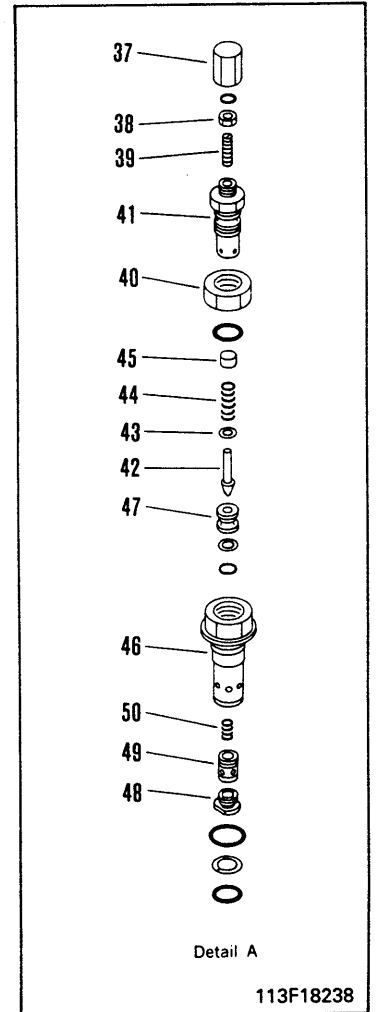
F1



F2

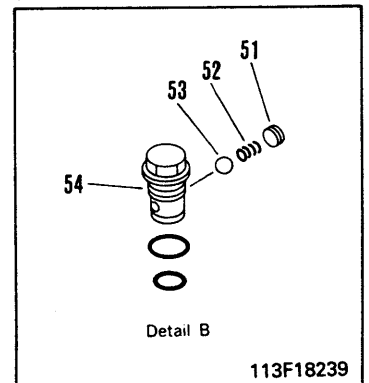


F3



Detail A

F4



Detail B

## REMOVAL OF BLADE LIFT CYLINDER ASSEMBLY

D31E-18, D31P-18A, D37E, P-2



Lower the work equipment completely to the ground and stop the engine. Operate the control levers several times to release the remaining pressure in the hydraulic piping.

1. Disconnect hoses (1). (See P1)
2. Sling lift cylinder assembly (2) and pull out pins (3) and (4). (See P1, P2)
3. Lift off lift cylinder assembly (2) (See P2).



Lift cylinder assembly: 30 kg

## INSTALLATION OF BLADE LIFT CYLINDER ASSEMBLY

D31E-18, D31P-18, D37E, P-2

1. Raise lift cylinder assembly (2), align with mount, then knock in pins (3) and (4). (See P1, P2)
  2. Connect hoses (1). (See P1)
- ★ After bleeding air, check the oil level of hydraulic tank.

## REMOVAL OF BLADE LIFT CYLINDER ASSEMBLY

D31P, PL-18

1. Pull out pin (1). (See P3)
2. Start engine and retract rod, then disconnect hoses (2) (See P3)



Stop the engine, operate the control levers several times to release the remaining pressure in the hydraulic piping.

3. Lift off lift cylinder assembly (3). (See P4)



Lift cylinder assembly: 35 kg

## INSTALLATION OF BLADE LIFT CYLINDER ASSEMBLY

D31P, PL-18

1. Raise lift cylinder assembly (3) and set in mounting position, then install. (See P4)
  2. Connect hoses (2), run engine and extend rod, then align with mount. (See P3)
  3. Knock in pin (1). (See P3)
- ★ After bleeding air, check the oil level of hydraulic tank.

## REMOVAL OF BLADE TILT CYLINDER ASSEMBLY

D31E-18, D31P-18A, D37E, P-2



Lower the work equipment completely to the ground and stop the engine. Operate the control levers several times to release the remaining pressure in the hydraulic piping.

1. Disconnect hoses (1) and pull out pin (2) of cylinder bottom end. (See P5)
2. Pull out pin (3) and remove tilt cylinder assembly (4). (See P6)

## INSTALLATION OF BLADE TILT CYLINDER ASSEMBLY

D31E-18, D31P-18A, D37E, P-2

1. Align tilt cylinder assembly (4) with mount, then knock in pin (3). (See P6)
  2. Knock in pin (2) of cylinder bottom end, then connect hoses (1). (See P5)
- ★ After bleeding air, check the oil level of hydraulic tank.

## REMOVAL OF BLADE TILT CYLINDER ASSEMBLY

D31P, PL-18

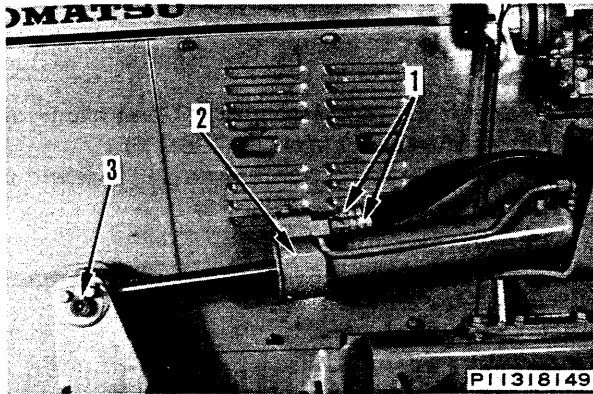
1. Remove cover (1), then disconnect hoses (2) and (3). (See P7, P8)
2. Remove cap (4) and pull out pin (5). (See P8)
3. Remove tilt cylinder assembly (6). (See P8)

## INSTALLATION OF BLADE TILT CYLINDER ASSEMBLY

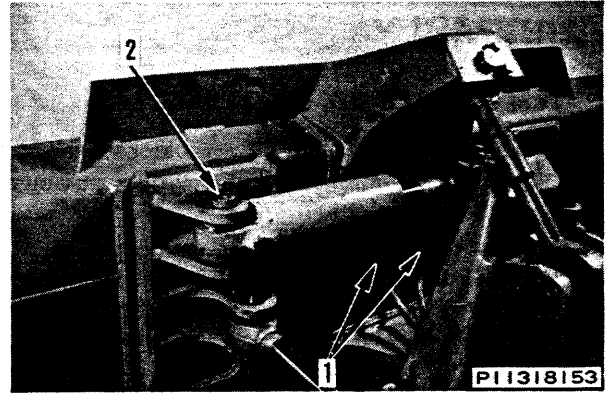
D31P, PL-18

1. Align tilt cylinder assembly (6) with mount, then knock in pin (5). (See P8)
  2. Install cap (4) and connect hoses (2) and (3). (See P8)
  3. Install cover (1). (See P7)
- ★ After bleeding air, check the oil level of hydraulic tank.

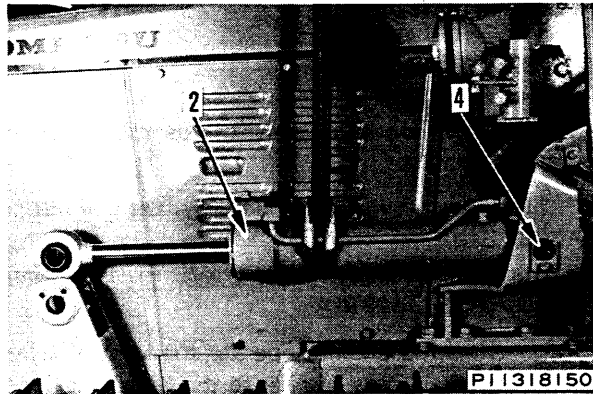
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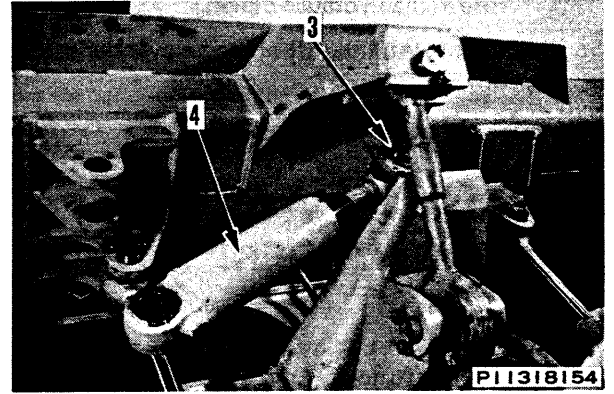
P5



P2

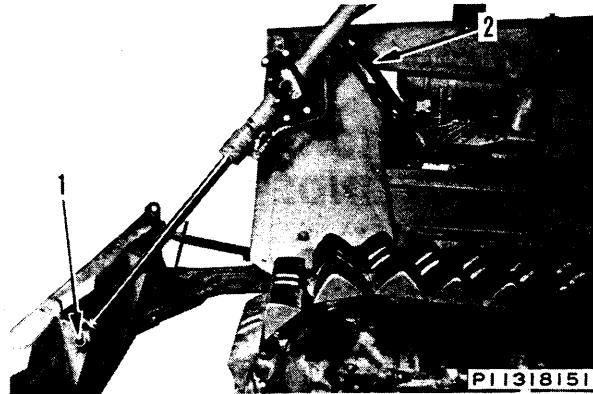


P6

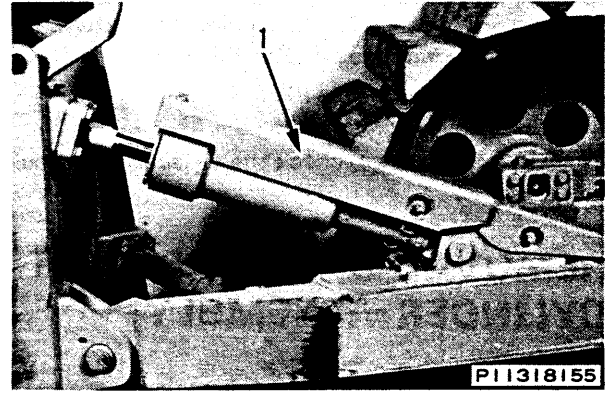


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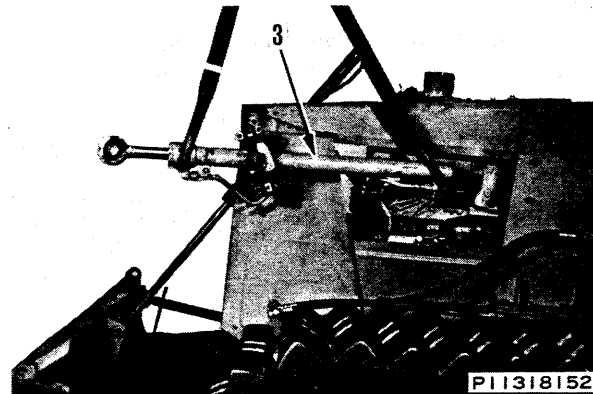
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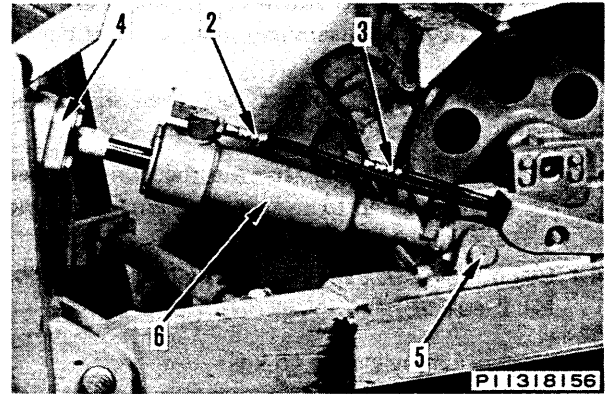
P7



P4




P8



## REMOVAL OF BLADE ANGLE CYLINDER ASSEMBLY

D31E-18, D31P-18A, D37E, P-2

1. Jack up machine and insert blocks (height: approx. 150 mm), then lower work equipment assembly to ground.
2. Remove cover. (See P1)
3. Insert block (height: approx. 100 mm) under the cylinder assembly, then pull out pin (2). (See P2)
4. Start engine and retract rod, then disconnect hoses (3). (See P3)

 Stop the engine, operate the control levers several times to release the remaining pressure in the hydraulic piping.

5. Pull out pin (4), then lift off angle cylinder assembly (5). (See P4)



Angle cylinder: 25 kg

## INSTALLATION OF BLADE ANGLE CYLINDER ASSEMBLY

D31E-18, D31P-18A, D37E, P-2


1. Align angle cylinder assembly (5) with mount, then knock in pin (4). (See P4)
2. Connect hoses (3), run engine and extend rod, then align with mount. (See P3)
3. Knock in pin (2). (See P2)
4. Install cover (1). (See P1)

★ After bleeding air, check the oil level of hydraulic tank.

## REMOVAL OF BUCKET LIFT CYLINDER ASSEMBLY

D31S, Q-18

1. Place stand ① (height: approx. 800 mm) under the cross bar of lift arm securely. (See P5)
2. Sling lift cylinder assembly, then pull out pin (1). (See P5)
3. Start engine and retract rod, then disconnect hoses (2). (See P6)

 Stop the engine, Operate the control levers several times to release the remaining pressure in the hydraulic piping.

4. Pull out pin (3), then lift off lift cylinder assembly (4). (See P6)



Lift cylinder: 45 kg

## INSTALLATION OF BUCKET LIFT CYLINDER ASSEMBLY

D31S, Q-18


1. Raise lift cylinder assembly (4) and align with mount, then knock in pin (3). (See P6)
  2. Connect hoses (2), run engine and extend rod, then align with mount. (See P6)
  3. Knock in pin (1). (See P5)
- ★ After bleeding air, check the oil level of hydraulic tank.

## REMOVAL OF BUCKET DUMP CYLINDER ASSEMBLY

D31S, Q-18

 Lower work equipment assembly to ground securely.

1. Sling dump cylinder assembly, then pull out pin (1). (See P7)
2. Start engine and retract rod, then disconnect hoses (2). (See P8)

 Stop the engine, operate the control levers several times to release the remaining pressure in the hydraulic piping.

3. Pull out pin (3), then lift off dump cylinder assembly (4). (See P8)



Dump cylinder: 35 kg

## INSTALLATION OF BUCKET DUMP CYLINDER ASSEMBLY

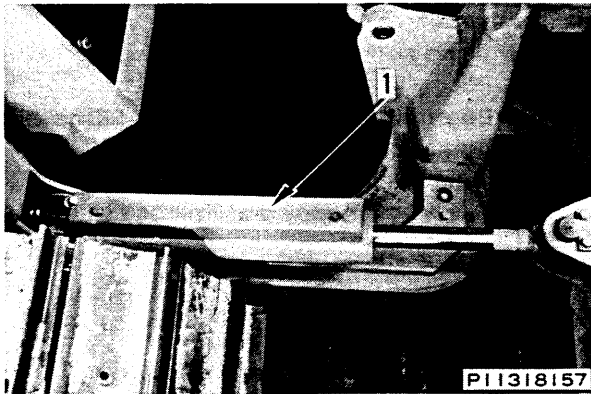
D31S, Q-18

1. Raise dump cylinder assembly (4) and align with mount, then knock in pin (3). (See P8)
2. Connect hoses (2), run engine and extend rods, and align with mount. (See P8)
3. Knock in pin (1). (See P7)



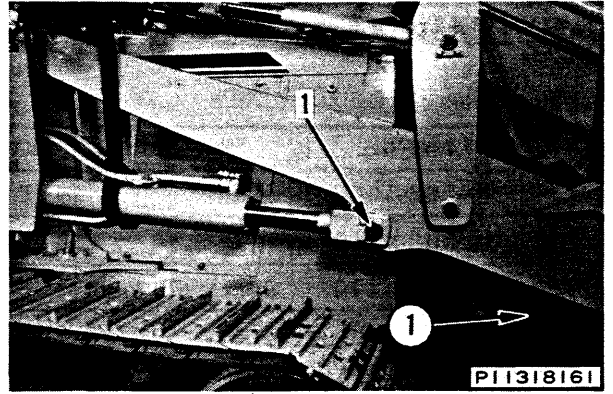
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P1



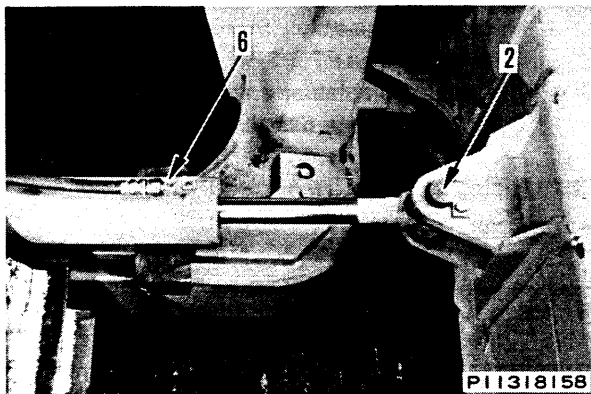
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P5



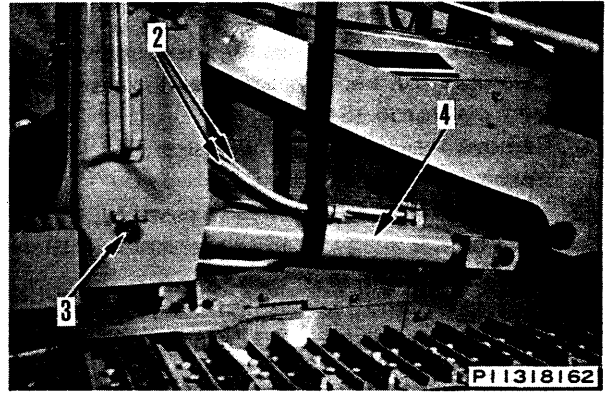
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P2



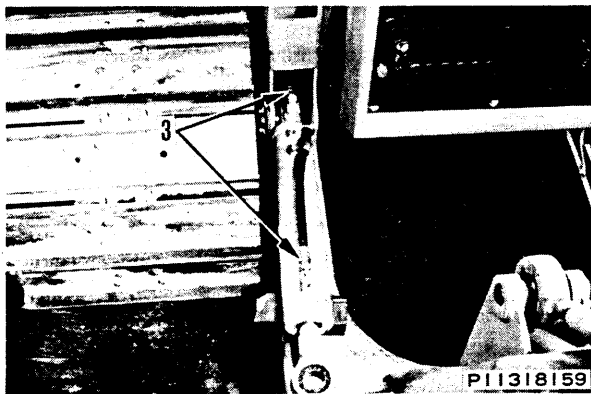
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P6



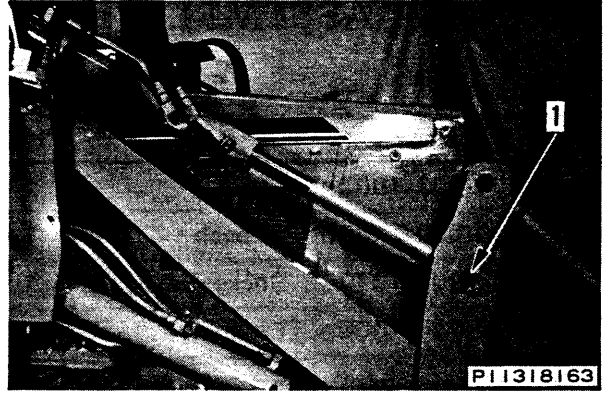
PI1318162

P3



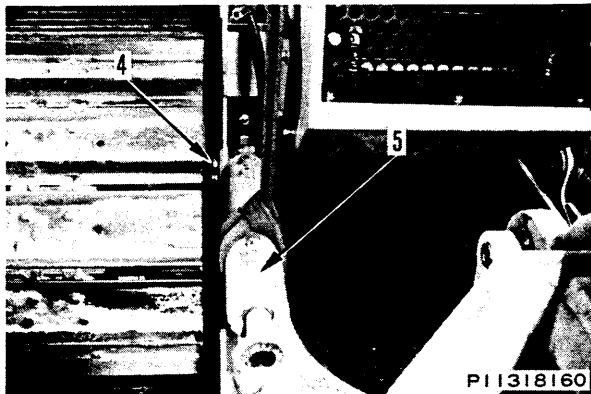
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P7



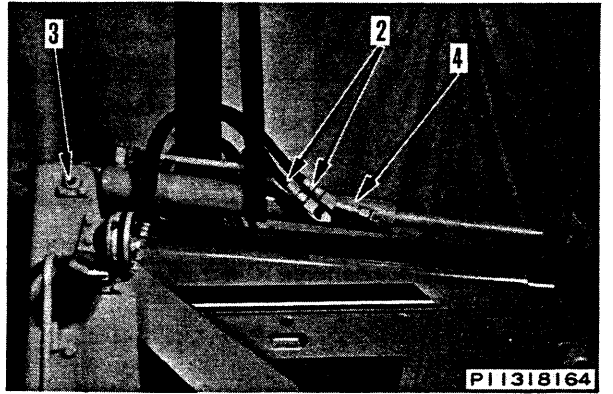
PI1318163

P4



PI1318160

P8



PI1318164

# DISASSEMBLY OF HYDRAULIC CYLINDER ASSEMBLY

## Special tools

	Part No.	Part Name	Q'ty
A	790-502-1002	Stand	1
B	790-330-1100	Wrench	1
C	790-302-1270	Socket (50 mm)	1

- Set cylinder assembly (1) in tool A, then using tool B, loosen cylinder head assembly (2). (See P1)
- Remove piston rod assembly (3) from cylinder assembly (1). (See P2)
- Using tool C, remove nut (4), then remove piston assembly (5) and cylinder head assembly (2) from piston rod. (See P2)
- Remove wear ring (6) and piston ring (7) from piston assembly (5). (See P3)
- Disassembly of cylinder head assembly
  - Remove snap ring (8), then remove dust seal (9). (See P4)
  - Remove rod packing (10). (See P5)
  - Pull out bushing (11) from cylinder head. (See P5)

# ASSEMBLY OF HYDRAULIC CYLINDER ASSEMBLY

## Special tools

	Part No.	Part Name	Q'ty
A	790-502-1002	Stand	1
B	790-330-1100	Wrench	1
C	790-302-1270	Socket (50 mm)	1
D	790-720-1000	Expander	1
E	796-720-1640	Ring (For cylinder bore: 65 – 75 mm)	1
E <sub>1</sub>	07281-00909	Clamp	1
F	796-720-1650	Ring (For cylinder bore: 85 – 95 mm)	1
G	796-720-1660	Ring (For cylinder bore: 100 – 105 mm)	1
G <sub>1</sub>	07281-01159	Clamp	1

- ★ Clean all parts, and check for dirt or damage. Be careful not to damage the rod packing, dust seals or O-rings when installing.

- Assembly of cylinder head assembly
  - Using push tool, press fit bushing (11). (See P5)

★ Be careful not to deform the bushing when press fitting.

  - Assemble rod packing (10). (See P5)
  - Using push tool, press fit dust seal (9). (See P4)
  - Install snap ring (8). (See P4)

- Assembly of piston assembly
  - Using tool D, expand piston ring (7) and assemble to piston assembly. (See P6, P3)
  - Assemble cylinder head assembly to rod (3).
  - Using tool E and E<sub>1</sub>, install piston ring to piston assembly (5), then assemble wear ring (6). (See P7, P3)
  - Assemble retainer and install piston assembly to rod, then assemble nut (4). (See P2)

- Using tool C, tighten nut (4). (See P2)

 Piston nut

	Blade (Except lift of D31P, PL-18)	Blade lift (D31P, PL-18)	Bucket
Width across flats of nut (4) (mm)	41	36	50
Nut tightening torque (kgm)	63 ± 6.3	42 ± 4.2	110 ± 11

- Set cylinder assembly (1) in tool A, then using tool B, tighten cylinder head assembly (2). (See P1)

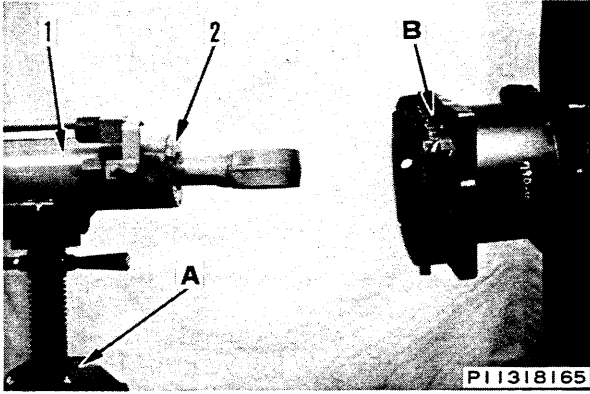
 Cylinder head:

	Blade (Except lift of D31P, PL-18)	Blade lift (D31P, PL-18)	Bucket lift	Bucket dump
Cylinder bore (mm)	90	70	100	80
Head tightening torque (kgm)	69 ± 6.9	55 ± 5.5	60 ± 6.0	60 ± 6.0

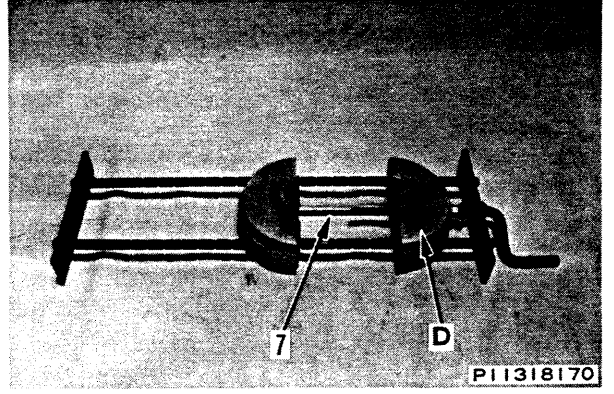
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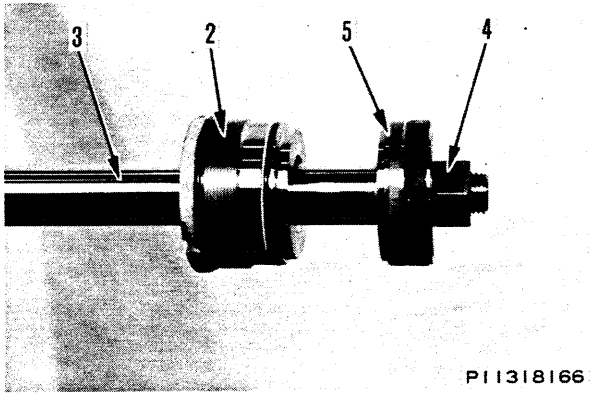
P1



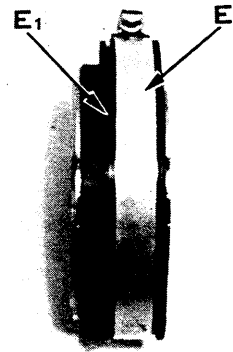
P6



P2

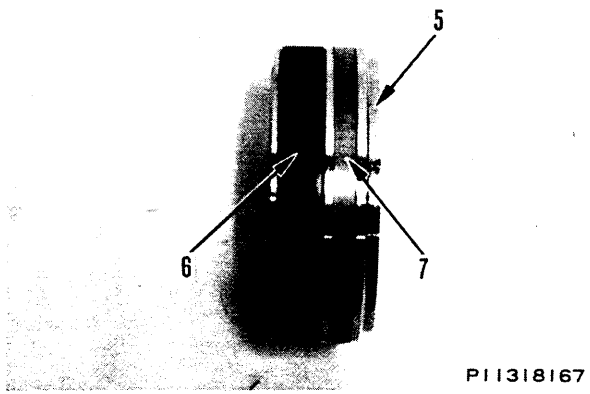


P7

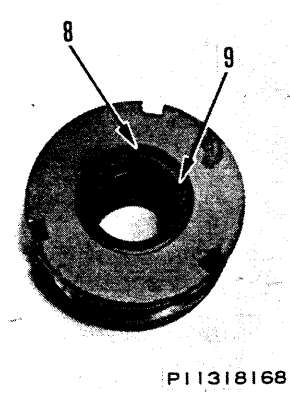


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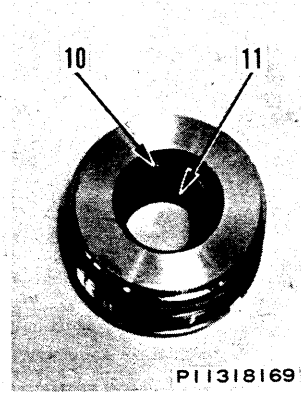
P3



P4

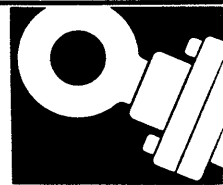


P5



# HYDRAULIC SYSTEM

## 64 MAINTENANCE STANDARD

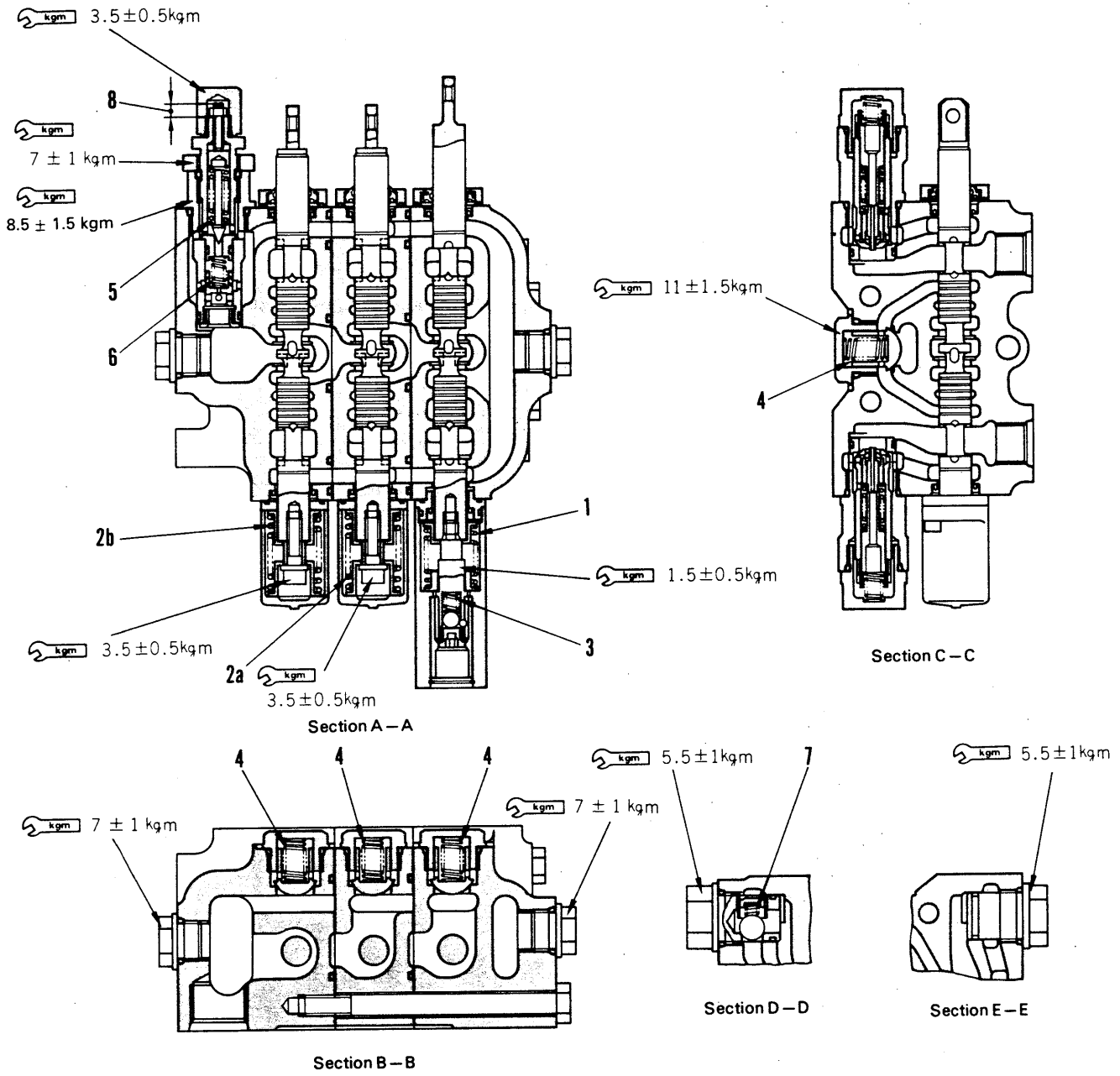


Hydraulic control valve (3-spool valve) (D31E-18, D31P-18A, D37E, P-2) .....	64- 2
Hydraulic control valve (D31P, PL, PLL-18) .....	64- 4
Hydraulic control valve (D31S, Q-18) .....	64- 6
Hydraulic cylinder (D31E, P, PL-18, D31P-18A, D37E, P-2) .....	64- 8
Hydraulic cylinder (D31S, Q-18) .....	64-10
Hydraulic pump .....	64-11

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# HYDRAULIC CONTROL VALVE (3-SPOOL)

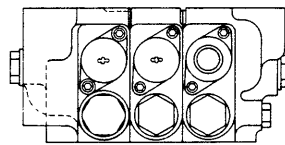
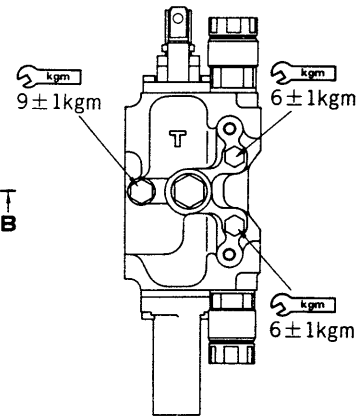
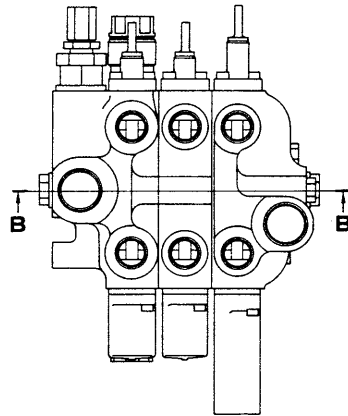
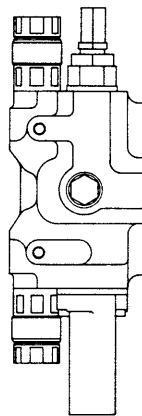
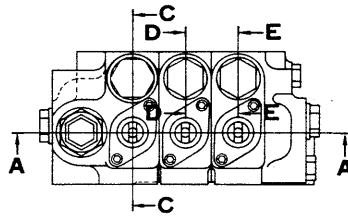
D31E-18, D31P-18A, D37E, P-2



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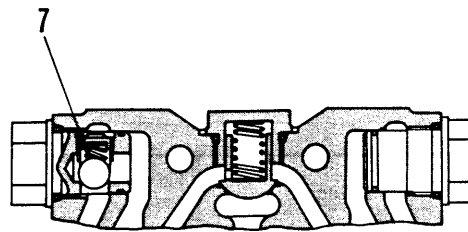
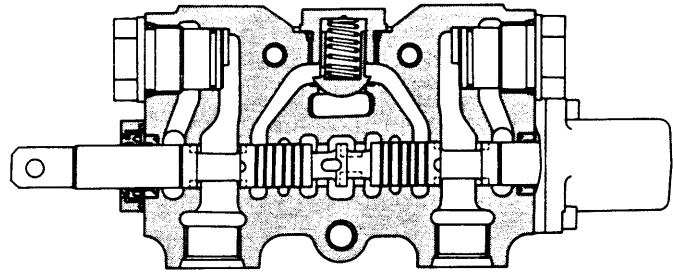
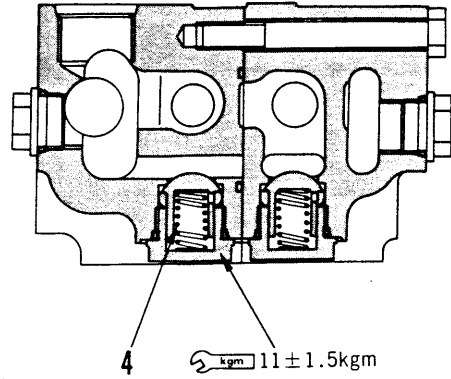
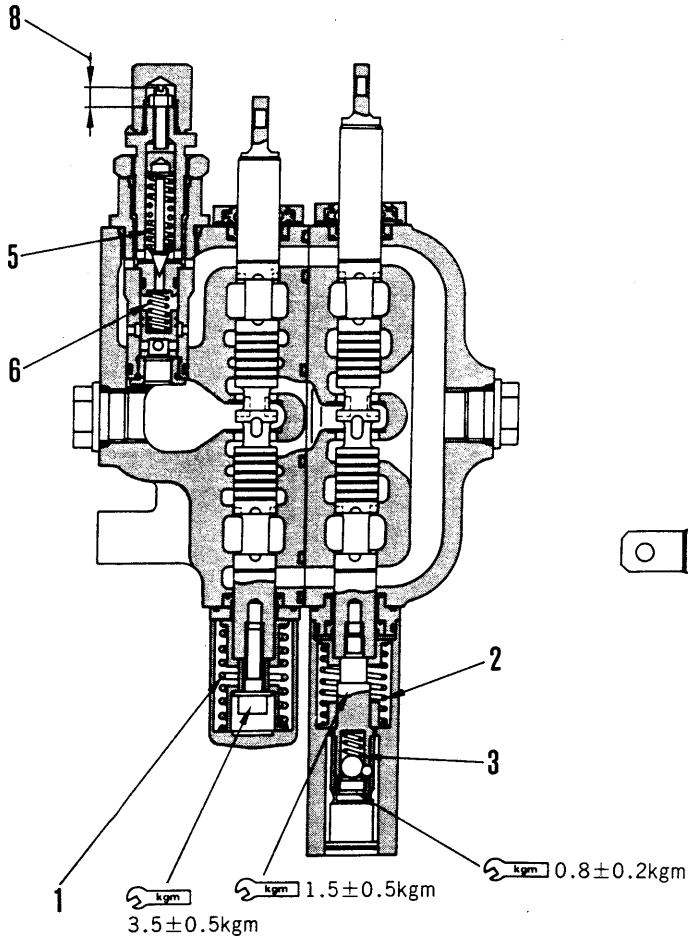
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Unit: mm

No.	Check item	Criteria				Remedy	
		Standard size		Clearance limit			
		Free length	Installation length	Installation load	Free length	Installation load	
1	Spool return spring (for lift)	68.8	36.0	13.0 kg	62.2	10.4 kg	Replace
2	Spool return spring (2a: tilt, 2b: angle)	74.5	45.2	13.5 kg	68.6	10.8 kg	
3	Detent spring	15.9	12.5	5.0 kg	15.2	4.0 kg	
4	Check valve spring	38.5	26.0	0.5 kg	26.0	0.4 kg	
5	Main relief valve poppet spring	41.1	32.6	26.4 kg	39.4	21.2 kg	
6	Main relief valve sleeve spring	31.9	18.3	3.2 kg	30.7	2.6 kg	
7	Suction valve spring (for lift)	15.5	8.0	0.16 kg	13.9	0.13 kg	
8	Height of main relief pressure adjustment screw	8 (One turn of the screw charges the pressure of 24.8 kg/cm <sup>2</sup> )				Adjust	

# HYDRAULIC CONTROL VALVE

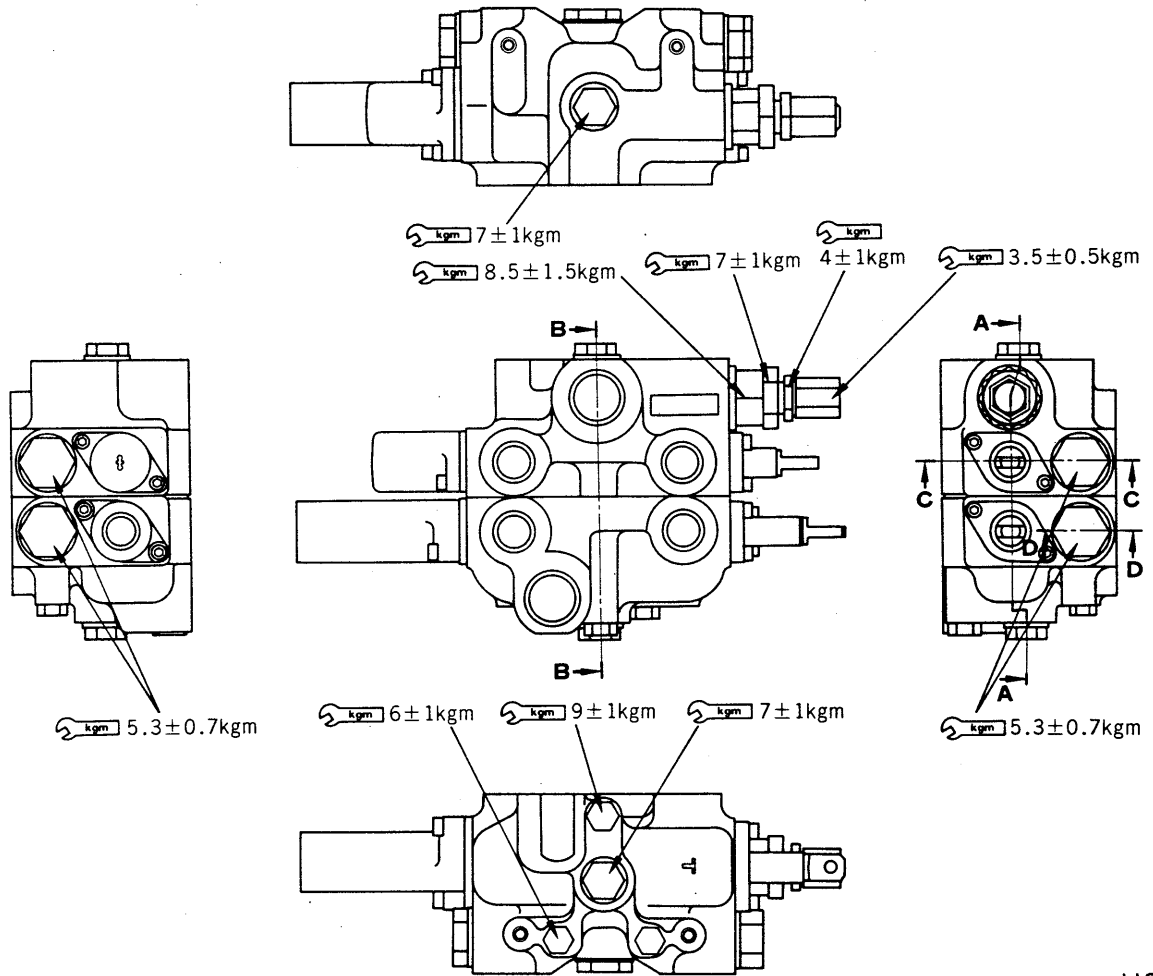
D31P, PL, PLL-18



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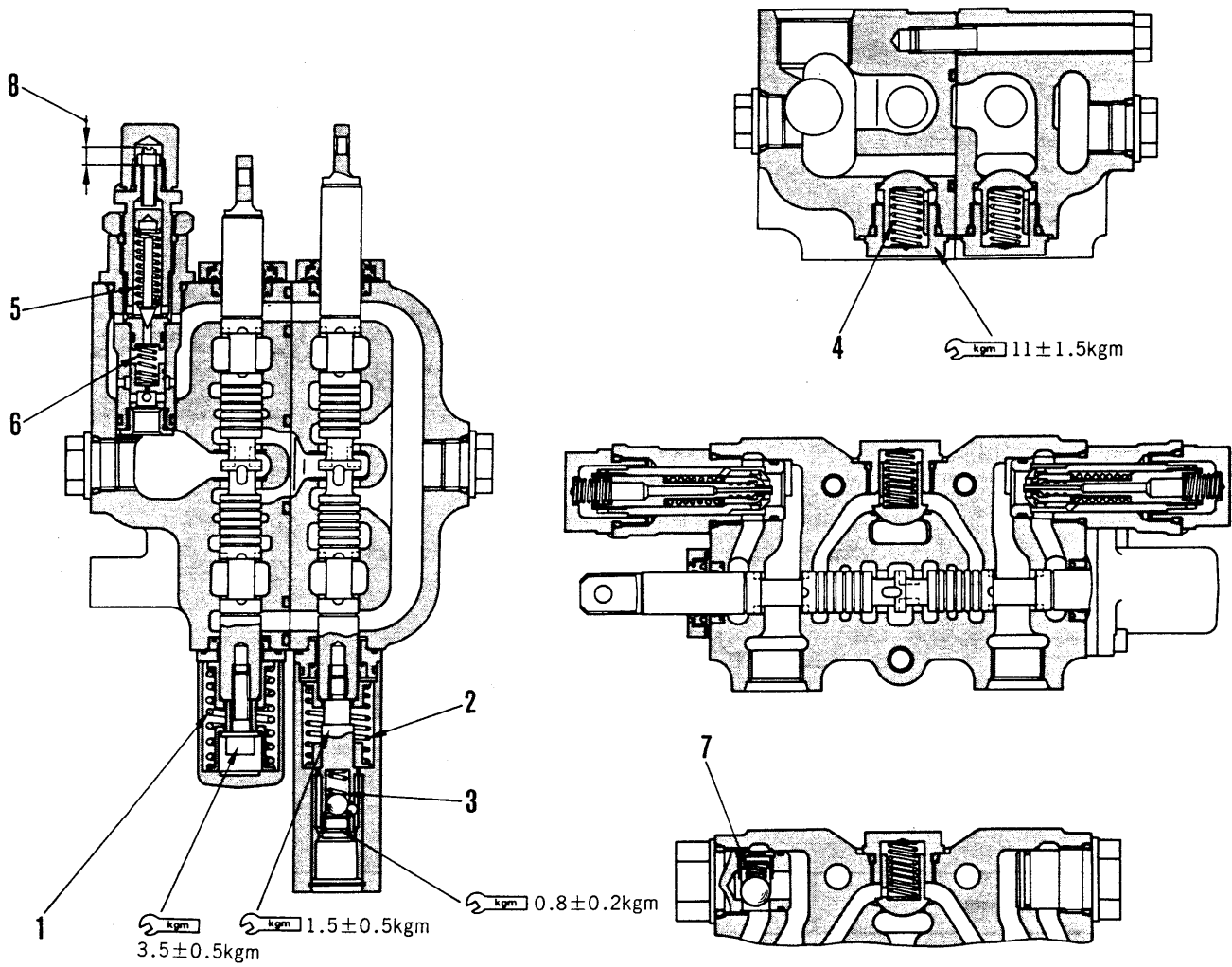
Unit: mm

No.	Check item	Criteria					Remedy
		Standard size			Repair limit		
		Free length	Installation length	Installation load	Free length	Installation load	
1	Spool return spring	74.0	45.2	15.5 kg	68.3	12.4 kg	Replace
2	Spool return spring	68.8	36.0	13.0 kg	62.3	10.4 kg	
3	Detent spring	15.9	12.5	5.0 kg	15.3	4.0 kg	
4	Check valve spring	38.5	26.0	0.5 kg	36.0	0.4 kg	
5	Poppet spring for main relief valve	41.0	34.0	22.0 kg	39.6	17.6 kg	
6	Main relief valve spring	23.4	18.3	3.2 kg	23.2	2.6 kg	
7	Suction valve spring	16.0	8.0	0.16 kg	14.4	0.13 kg	
8	Height of main relief pressure adjustment screw	8.35 (One turn of the screw oil charge the pressure: 24.8 kg/cm <sup>2</sup> )					



# HYDRAULIC CONTROL VALVE

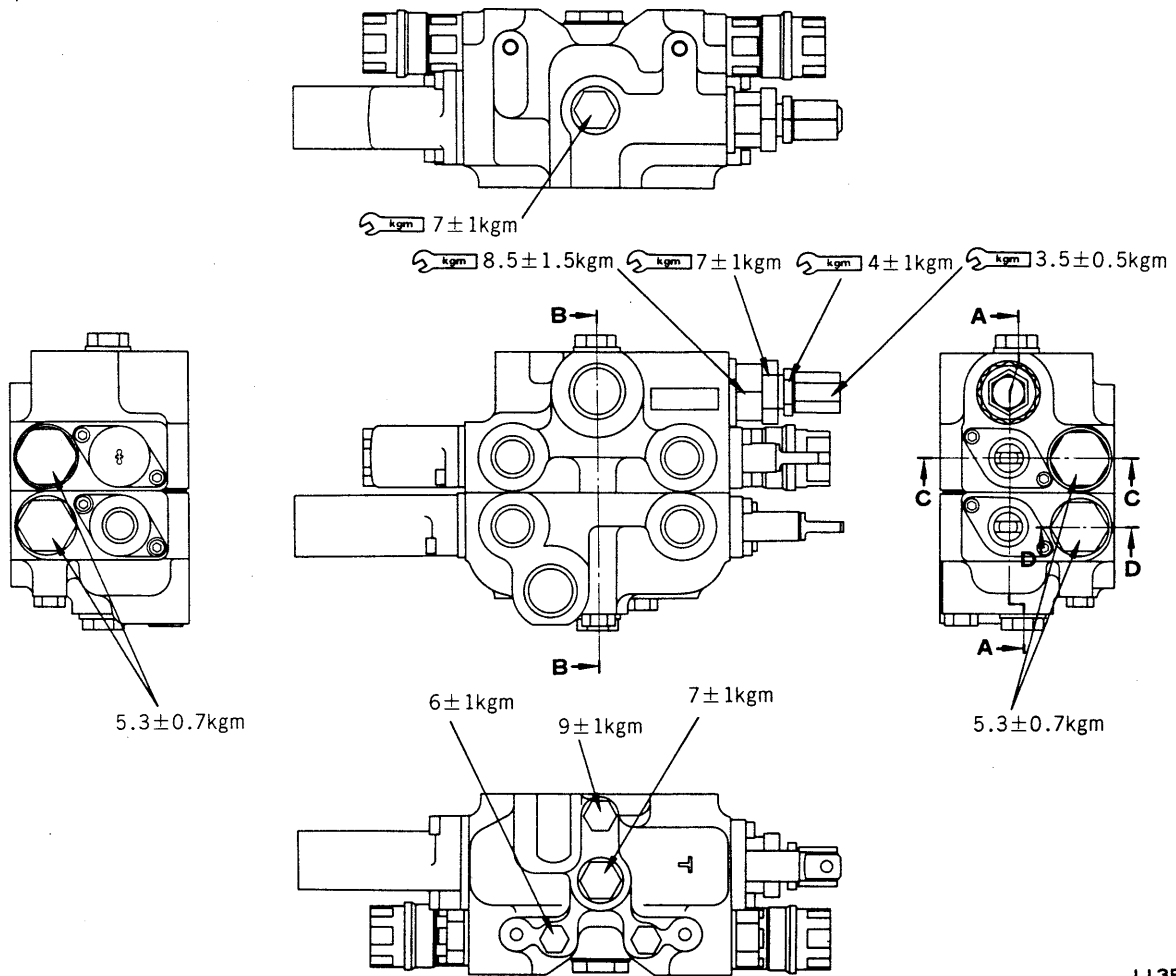
D31S, Q-18



113F18073

011418

011418



113F18074

Unit: mm

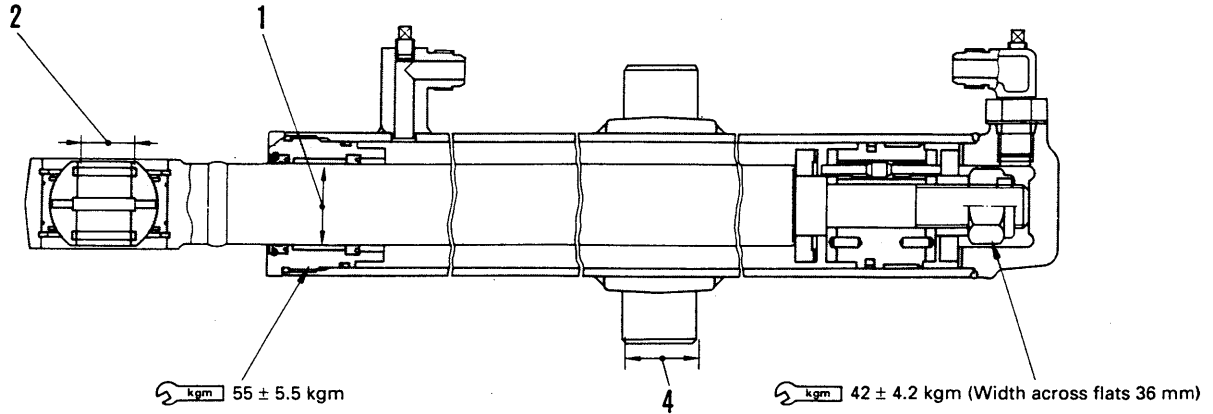
No.	Check item	Criteria					Remedy
		Standard size			Repair limit		
		Free length	Installation length	Installation load	Free length	Installation load	
1	Spool return spring	74.0	45.2	15.5 kg	68.3	12.4 kg	Replace
2	Spool return spring	68.8	36.0	13.0 kg	62.3	10.4 kg	
3	Detent spring	15.9	12.5	5.0 kg	15.3	4.0 kg	
4	Check valve spring	38.5	26.0	0.5 kg	36.0	0.4 kg	
5	Poppet spring for main relief valve	41.0	34.0	22.0 kg	39.6	17.6 kg	
6	Main relief valve spring	24.3	18.3	3.2 kg	23.2	2.6 kg	
7	Suction valve spring	16.0	8.0	0.16 kg	14.4	0.13 kg	
8	Height of main relief pressure adjustment screw	8.35 (One turn of the screw oil charge the pressure: 24.8 kg/cm <sup>2</sup> )					Adjust

# HYDRAULIC CYLINDER D31P, PL, PLL-18

## STRAIGHT TILTDOZER

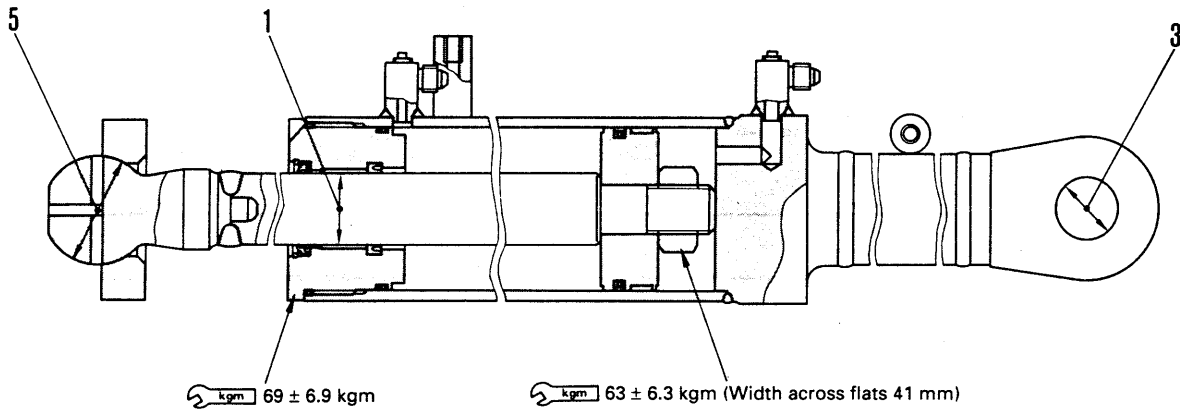
### 1) LIFT CYLINDER

★ The diagram shows the D31P-18 lift cylinder.



113F18076-1

### 2) TILT CYLINDER



F11318100

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011418

Unit: mm

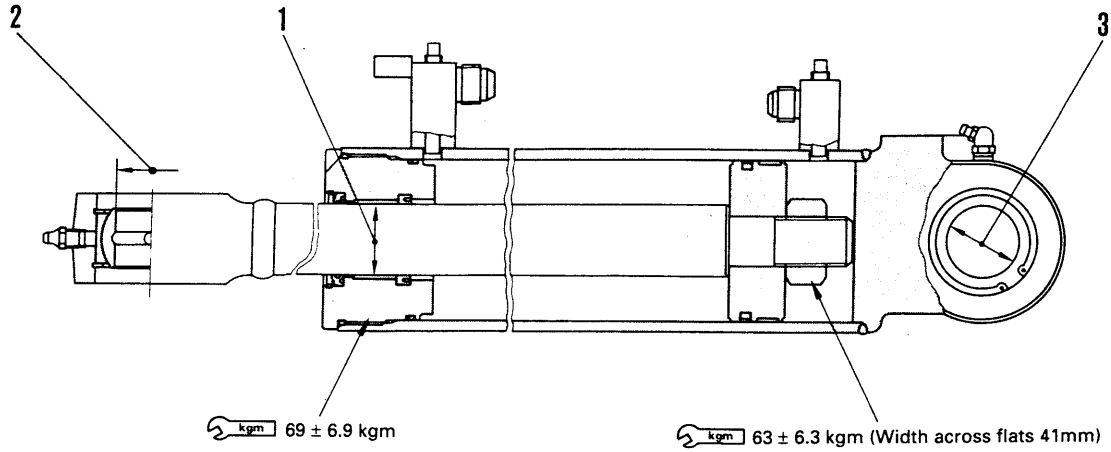
No.	Check item	Criteria					Remedy	
		Standard size	Tolerance		Standard clearance	Clearance limit		
			Shaft	Hole				
1	Clearance between piston rod and bushing	Lift cylinder	45		+0.164 +0.007		Replace bushing	
		Tilt cylinder	40	-0.080 -0.142	+0.132 +0.006	0.086 – 0.274		0.574
2	Clearance between piston rod supporting shaft and bushing	Lift cylinder	30	-0.020 -0.072	+0.033 0	0.020 – 0.105		1.0
3	Clearance between cylinder bottom supporting shaft and bushing	Tilt cylinder	35	-0.200 -0.400	+0.142 +0.080	0.280 – 0.542		1.0
4	Clearance between cylinder trunnion and bushing	Lift cylinder	40	-0.080 -0.142				1.0
5	Clearance between piston rod and retainer	Tilt cylinder	60				Replace	

# HYDRAULIC CYLINDER D31E-18, D31P-18A, D37E, P-2

## POWER ANGLE AND TILTDOZER

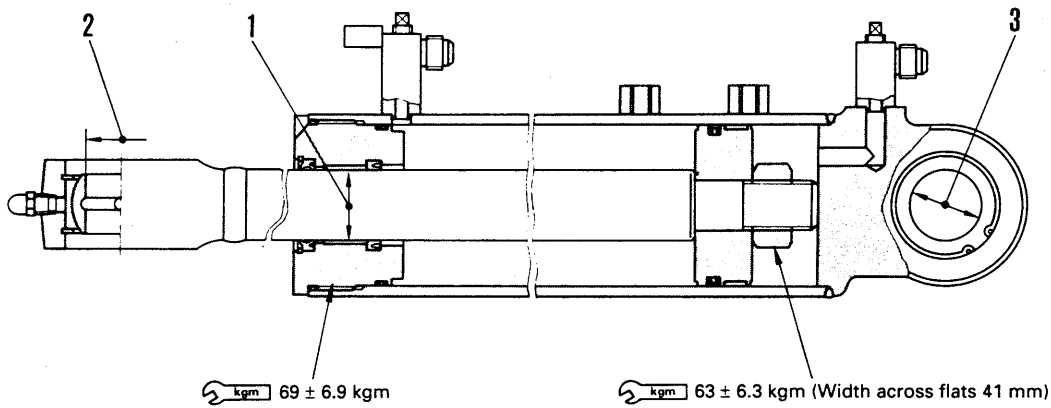
### 1) LIFT CYLINDER

★ The diagram shows the D31A-18 lift cylinder.



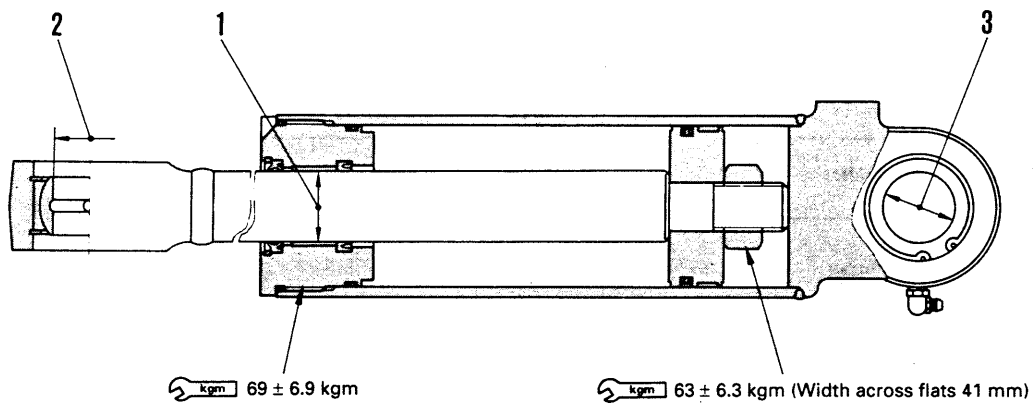
113F18319

### 2) ANGLE CYLINDER



F11318059-1

### 3) TILT CYLINDER



113F18322

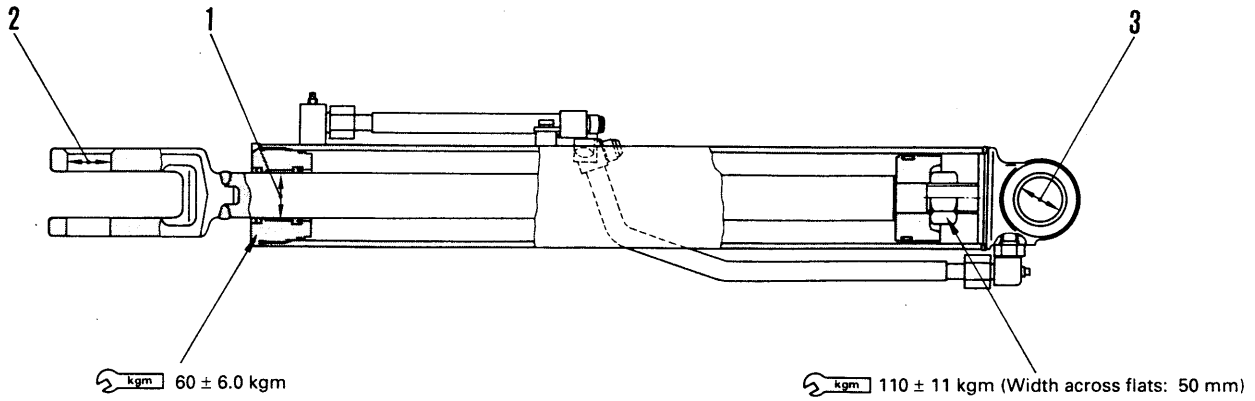
011418

Unit: mm

No.	Check item	Criteria					Remedy
		Standard size	Tolerance		Standard clearance	Clearance limit	
			Shaft	Hole			
1	Clearance between piston rod and bushing	Lift cylinder	40	-0.080 -0.142	+0.132 +0.006	0.086 – 0.274	0.574
		Tilt cylinder	40	-0.080 -0.142	+0.132 +0.006	0.086 – 0.274	0.574
		Angle cylinder	40	-0.080 -0.142	+0.132 +0.006	0.086 – 0.274	0.574
2	Clearance between piston rod supporting shaft and bushing	Lift cylinder	40	-0.025 -0.064	0 -0.012	0.013 – 0.064	1.0
		Tilt cylinder	40	-0.025 -0.064	0 -0.012	0.013 – 0.064	1.0
		Angle cylinder	40	-0.025 -0.064	0 -0.012	0.013 – 0.064	1.0
3	Clearance between cylinder bottom supporting shaft and bushing	Lift cylinder	40	-0.025 -0.064	0 -0.012	0.013 – 0.064	1.0
		Tilt cylinder	40	-0.025 -0.064	0 -0.012	0.013 – 0.064	1.0
		Angle cylinder	40	-0.025 -0.064	0 -0.012	0.013 – 0.064	1.0

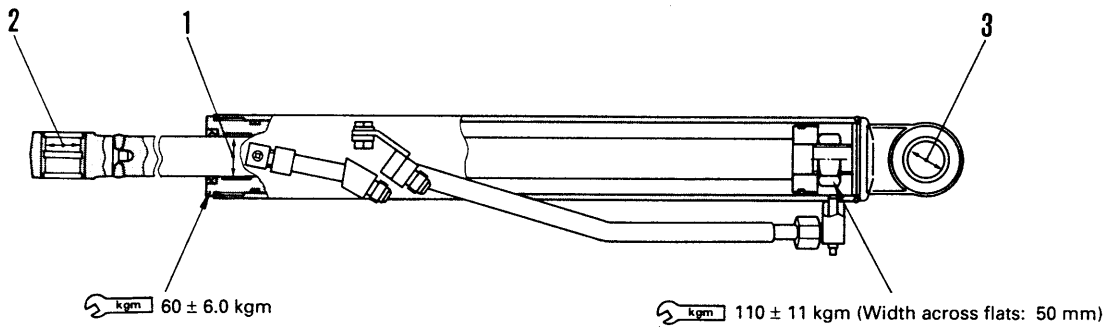
# HYDRAULIC CYLINDER D31S, Q-18

## 1) BUCKET LIFT CYLINDER



113F18328

## 2) BUCKET DUMP CYLINDER

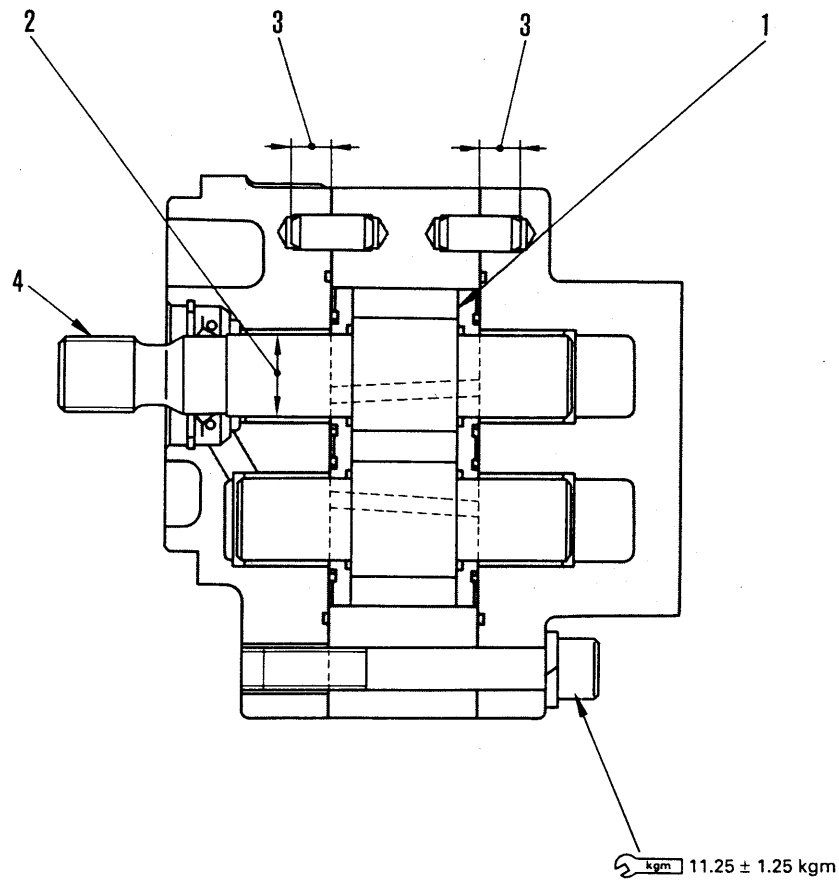


113F18329

Unit: mm

No.	Check item	Criteria					Remedy	
		Standard size	Tolerance		Standard clearance	Clearance limit		
	Shaft		Hole					
1	Clearance between piston rod and bushing	Lift cylinder	50				Replace bushing	
		Dump cylinder	45					
2	Clearance between piston rod supporting shaft and bushing	Lift cylinder	50	-0.025 -0.064	+0.039 0	0.025 - 0.103		1.0
		Dump cylinder	40	-0.025 -0.064	+0.142 +0.080	0.105 - 0.206		1.0
3	Clearance between cylinder bottom supporting shaft and bushing	Lift cylinder	50	-0.025 -0.064	+0.142 +0.080	0.105 - 0.206		1.0
		Dump cylinder	40	-0.025 -0.064	+0.142 +0.080	0.105 - 0.206		1.0

# HYDRAULIC PUMP (SAL036)



113F18318

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No.	Check item	Criteria				Remedy
		Standard size		Repair limit		
1	Clearance between gear case and side plate, gear	0.10 - 0.15		0.19		Replace
2	Clearance between inside diameter of plain bearing and outside diameter of gear shaft	0.06 - 0.125		0.20		
3	Pin insertion depth	12		0 -0.5		
4	Rotating torque of spline shaft	0.3 - 0.7 kgm				
-	Delivery EO10 CD 45 - 55°C	Speed (rpm)	Delivery pressure (kg/cm <sup>2</sup> )	Standard delivery (ℓ/min.)	Delivery limit (ℓ/min.)	-
		3,000	210	100	92	

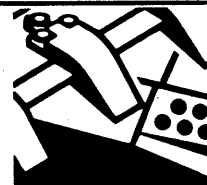


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# WORK EQUIPMENT

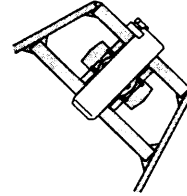
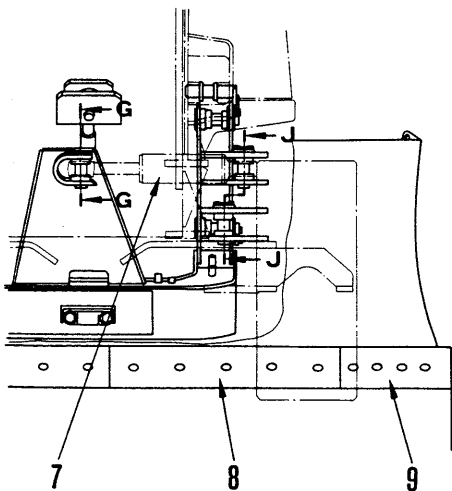
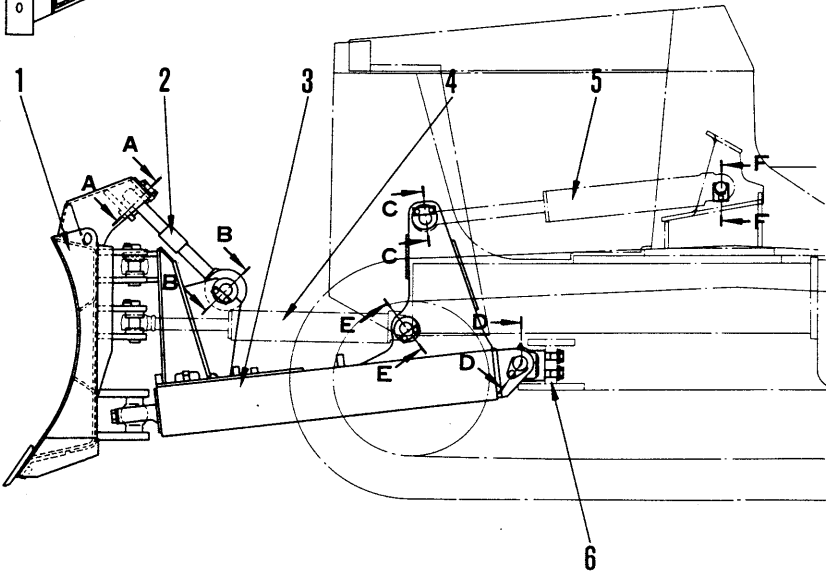
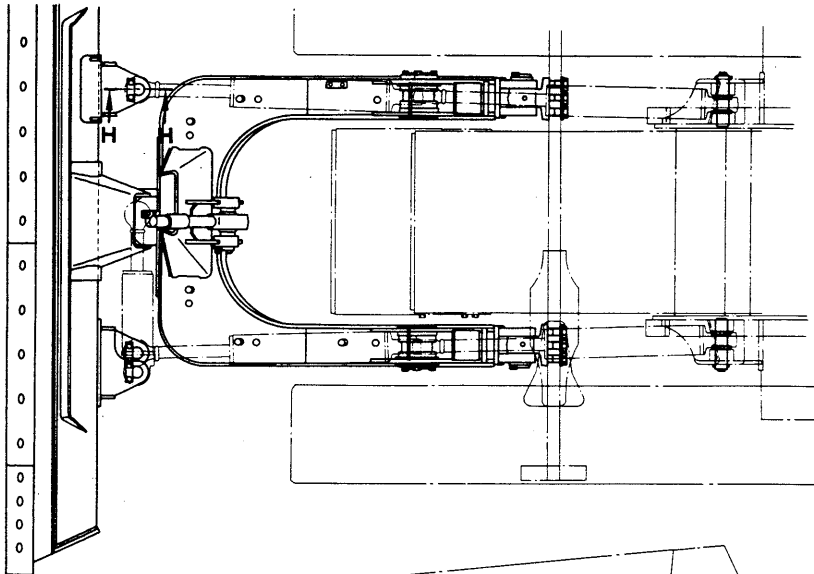
## 71 STRUCTURE AND FUNCTION

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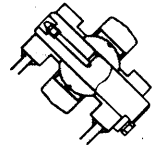


Power angle and tilt dozer (D31E-18, D31P-18A, D37E, P-2) .....	71- 2
Straight tilt dozer (D31P, PL, PLL-18) .....	71- 4
Bucket and link (D31S, Q-18) .....	71- 6

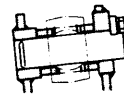
**POWER ANGLE AND TILTDOZER D31E-18, D31P-18A, D37E, P-2**



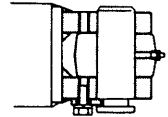
Section A-A



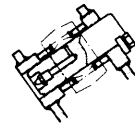
Section B-B



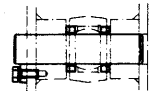
Section C-C



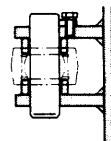
Section D-D



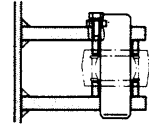
Section E-E



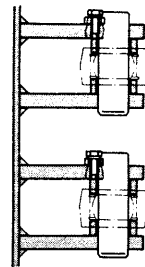
Section F-F



Section G-G



Section H-H



Section J-J

011418

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## OUTLINE

- The dozing attachment can be broadly divided into the blade and the hydraulic control which operates the blade. The diagram shows the power angle and tilt dozer for the D31E-18 and D37E, P-2.

The table on the below shows the dimensions and specifications of the power angle and tilt dozer for the D31E-18, D31P-18A and D37E, P-2.

- Table of comparisons

Unit: mm

	D31E-18	D31P-18A	D37E-2	D37P-2
Distance between left and right frame	800	800	840	840
Length of frame	1,300	1,300	1,300	1,300
Width of blade	2,416	2,874	2,415	2,875
Height of blade	841	795	940	895
Max. blade raise	860	944	865	935
Max. blade lower	376	281	370	300
Max. blade tilt	175	210	350	420
Max. blade forward angle	471	569	471	471
Max. blade rear angle	550	645	550	550

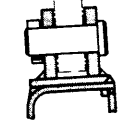
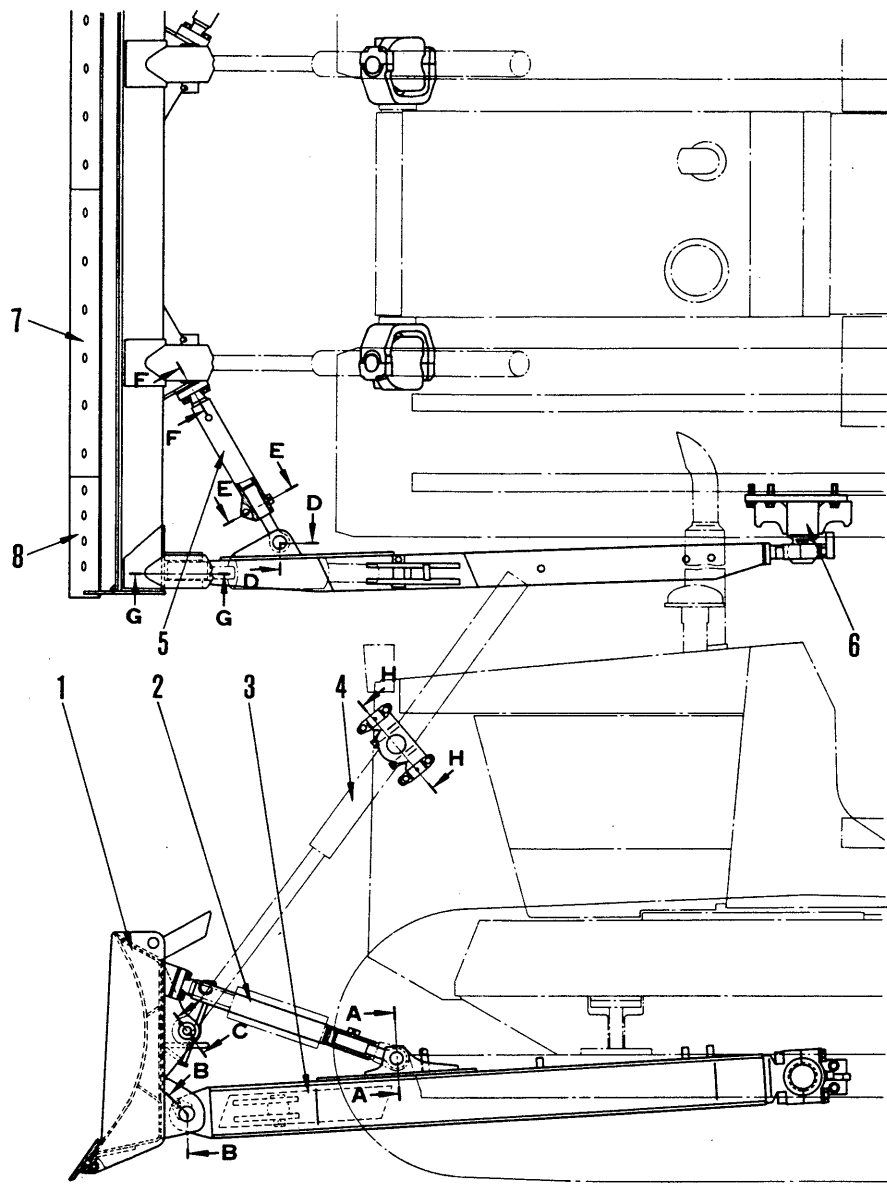
011418

- Blade
- Picking rod
- U-frame
- Blade angle cylinder
- Blade lift cylinder
- Bracket
- Blade tilt cylinder
- Cutting edge
- End bit

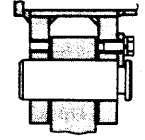
## OPERATION

- The blade is moved by hydraulic cylinders.
- RAISE:** The left and right lift cylinders retract and raise the frame and blade together.
- LOWER:** The left and right lift cylinders extend and lower the blade to the ground.
- LEFT TILT:** The tilt cylinder extends and lowers the left side of the blade to the ground.
- RIGHT TILT:** The tilt cylinder retracts and lowers the right side of the blade to the ground.
- LEFT ANGLE:** The right angle cylinder extends, and the left angle cylinder retracts, so the left side of the blade is pulled back.
- RIGHT ANGLE:** The left angle cylinder extends, and the right angle cylinder retracts, so the right side of the blade is pulled back.

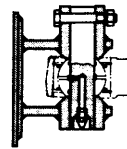
# STRAIGHT TILTDOZER D31P, PL, PLL-18



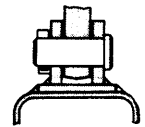
Section A-A



Section B-B



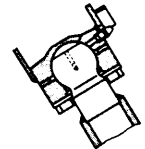
Section C-C



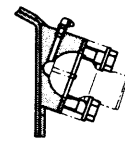
Section D-D



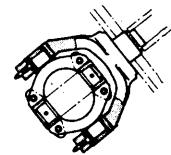
Section E-E



Section F-F



Section G-G



Section H-H

011418

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**OUTLINE**

- The dozing attachment can be broadly divided into the blade and the hydraulic control which operates the blade. The diagram shows the straight tilt dozer for the D31P-18. The table on the right shows the dimensions and specifications of the straight tilt dozer for the D31P, PL, PLL-18.

**OPERATION**

- The blade is moved by hydraulic cylinders.
- RAISE: The left and right lift cylinders retract and raise the frame and blade together.
- LOWER: The left and right lift cylinders extend and lower the blade to the ground.
- LEFT TILT: The tilt cylinder extends and lowers the left side of the blade to the ground.
- RIGHT TILT: The tilt cylinder retracts and lowers the right side of the blade to the ground.

- Table of comparisons

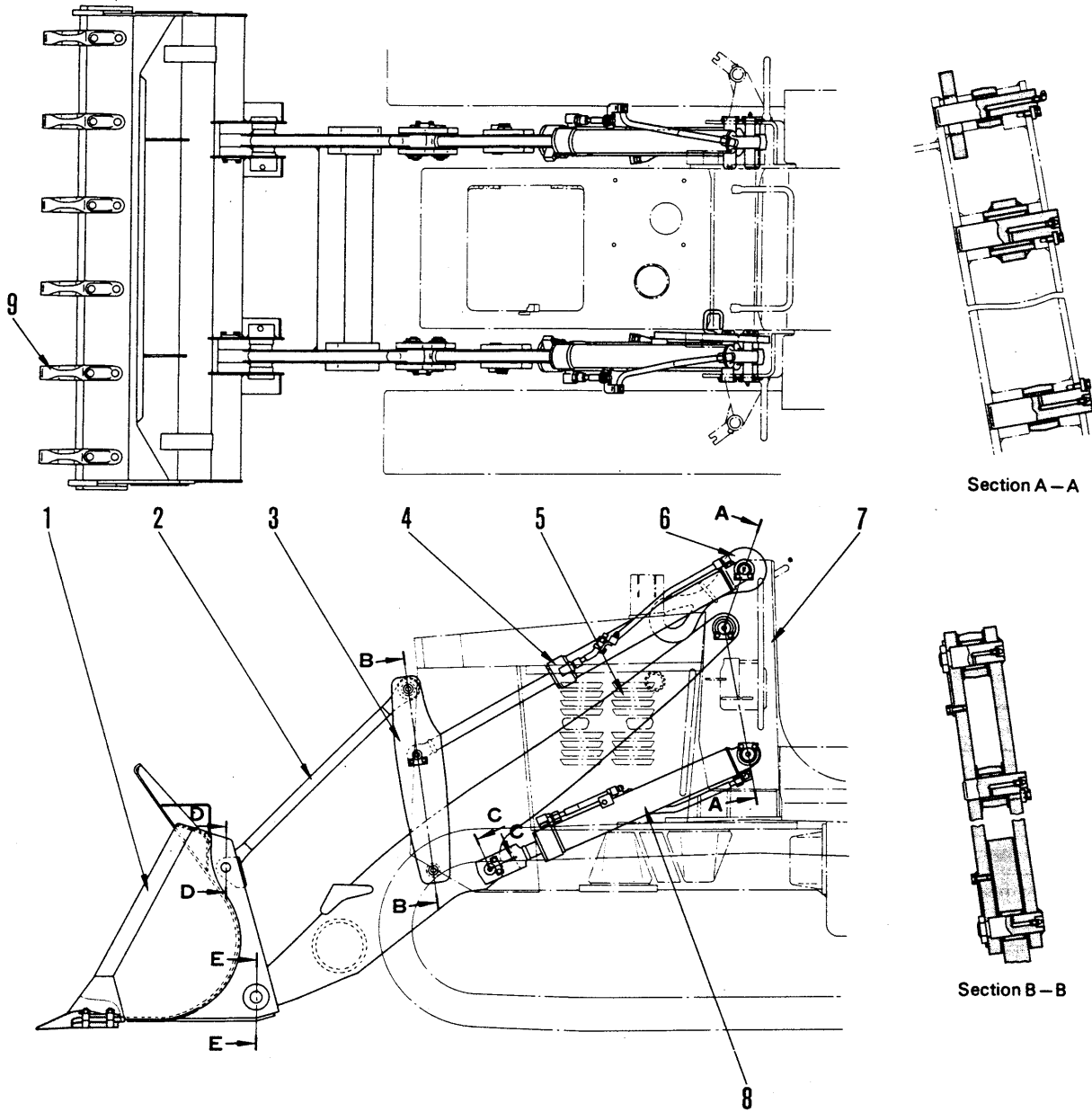
Unit: mm

	D31P-18	D31PL-18	D31PLL-18
Distance between left and right frame	2,140	3,124	3,124
Length of frame	1,920	1,920	2,105
Width of blade	2,436	3,425	3,425
Height of blade	780	545	545
Max. blade raise	875	835	1,035
Max. blade lower	335	345	430
Max. blade tilt	335	415	450

1. Blade
2. Blade tilt cylinder (Left frame side)
2. Brace (Right frame side)
3. Straight frame
4. Blade lift cylinder
5. Brace
6. Trunnion
7. Cutting edge
8. End bit

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# BUCKET AND LINK D31S, Q-18



Section A-A

Section B-B

Section C-C

Section D-D

Section E-E

011418

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**OUTLINE**

- The bucket attachment can be broadly divided into the bucket and the hydraulic control which operates the bucket.  
The diagram shows the bucket and lift arm for the D31S-18.  
The table on the right shows the dimensions and specifications of the bucket and lift arm for the D31S, Q-18.

**OPERATION**

- The blade is moved by hydraulic cylinders.
- **RAISE:** The left and right lift cylinders extend and raise the lift arm and bucket.
- **LOWER:** The left and right lift cylinders retract and lower the bucket to the ground.
- **DUMP:** The left and right dump cylinders extend and push out the lever and rod to face the opening of the bucket down.
- **TILT:** The left and right dump cylinders retract and pull back the lever and rod to face the opening of the bucket up.

• **Table of comparisons**

Unit: mm

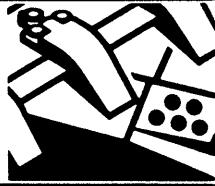
	D31S-18	D31Q-18
Distance between left and right lift arm	850	850
Length of lift arm	2,330	2,330
Width of bucket	1,904	2,300
Height of bucket	1,037	874
Bucket capacity (m <sup>3</sup> )	0.8	0.8
No. of bucket teeth	6	7
Max. hinge pin height	3,105.3	3,173.8
Dumping clearance	2,539.6	2,639.9
Dumping reach	807.6	747.3

011418

1. Bucket
2. Rod
3. Lever
4. Bucket dump cylinder
5. Lift arm
6. Link
7. Loader frame
8. Bucket lift cylinder
9. Bucket tooth

# WORK EQUIPMENT

## 73 DISASSEMBLY AND ASSEMBLY



WORK EQUIPMENT	
Removal and Installation .....	73-2
BLADE	
Removal and Installation .....	73-4
WORK EQUIPMENT	
Removal and Installation .....	73-6
BUCKET	
Removal and Installation .....	73-6

011418



## REMOVAL OF WORK EQUIPMENT ASSEMBLY

### D31E-18, D31P-18A, D37E, P-2

1. Stop machine on level ground, then lower blade to ground.
2. Sling lift cylinder assembly (1), then pull out pin (2).
3. Start engine and retract piston rod fully.



Stop the engine, operate the control levers several times to release the remaining pressure in the hydraulic piping.

4. Remove cover (3), then disconnect hoses (4). (See P2, P3)
5. Place jack ① under the U-frame (5), then pull out pin (6). (See P4)
6. Start engine, then move machine slowly in reverse to separate work equipment assembly from machine.

## INSTALLATION OF WORK EQUIPMENT ASSEMBLY

### D31E-18, D31P-18A, D37E, P-2

1. Place jack ① under U-frame (5). (See P4)
2. Move machine slowly forward, align with work equipment mount, knock in pin (6), then lock in position. (See P4)
3. Connect hoses (4) and install cover (3). (See P3, P2)
4. Sling lift cylinder assembly (1), run engine and extend rod. Align frame and pin hole, then knock in pin (2). (See P1)

## REMOVAL OF WORK EQUIPMENT ASSEMBLY

### D31P, PL-18

1. Stop machine on level ground, lower blade to ground, and place block under right and left sides of straight frame (near trunnion boss).
2. Remove covers (1), (2) and (3). (See P5)
3. Disconnect hoses (4) and (5) at tilt cylinder end, and gather together at rear of machine. (See P6)
4. Pull out pin (6). (See P7)
5. Remove trunnion cap (7). (See P8)
6. Start engine, move machine slowly in reverse and separate straight frame from trunnion to remove work equipment assembly.

## INSTALLATION OF WORK EQUIPMENT ASSEMBLY

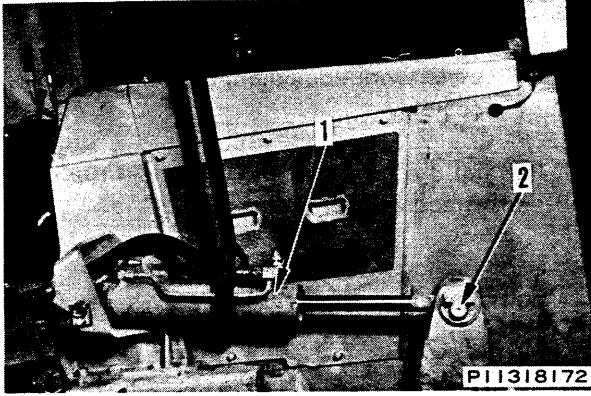
### D31P, PL-18

1. Place block under right and left sides of straight frame (near trunnion boss).
2. Start engine, move machine slowly forward and align straight frame with trunnion boss.
3. Install trunnion cap (7). (See P8)
4. Knock in pin (6). (See P7)
5. Connect hoses (4) and (5). (See P6)  
★ Install hoses without twisting.
6. Install covers (3), (2) and (1). (See P5)

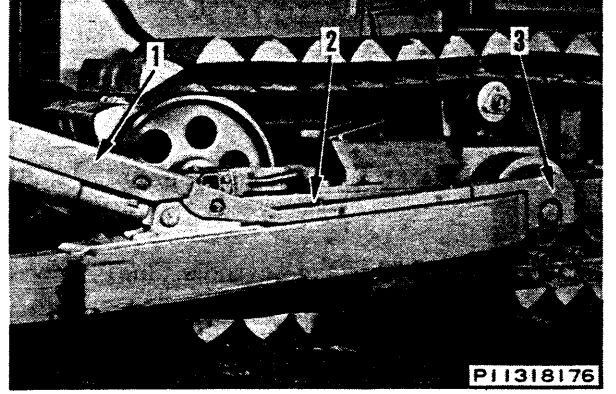
011418



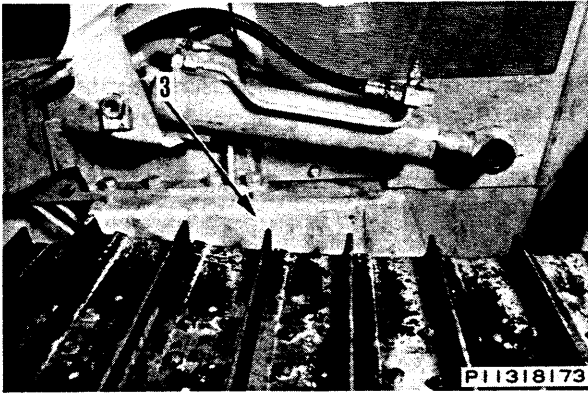
P1



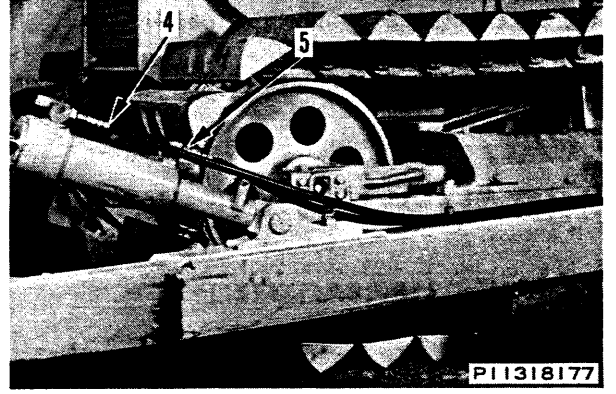
P5



P2

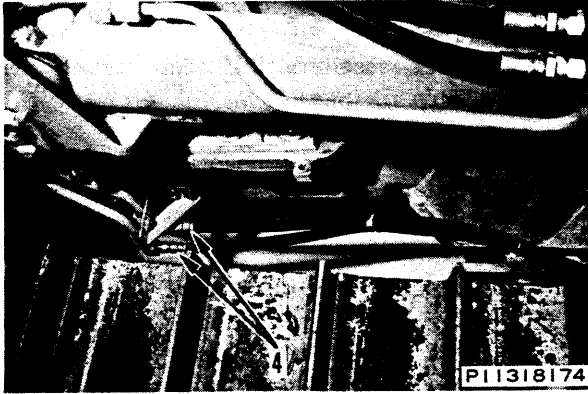


P6

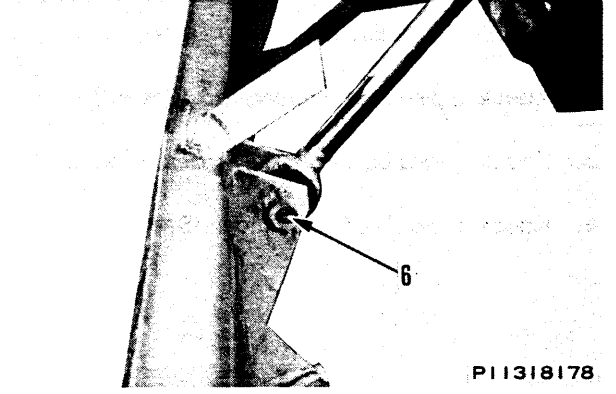


011418

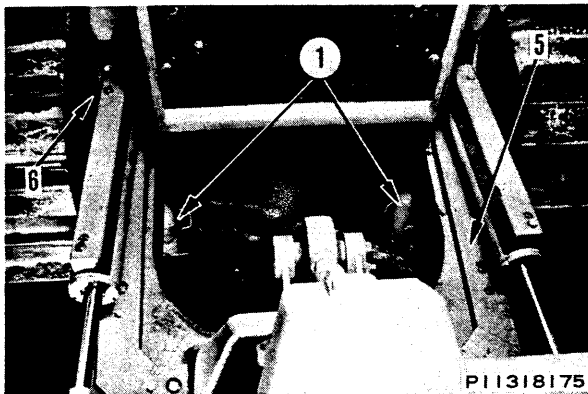
P3



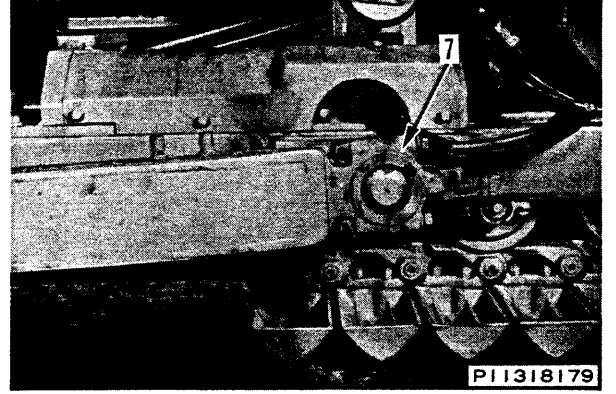
P7



P4



P8



## REMOVAL OF BLADE

### D31E-18, D31P-18A, D37E, P-2

 Lower work equipment assembly to ground securely.

1. Pull out pin (1) of tilt cylinder bottom end. (See P1)
2. Pull out pins (2) of angle cylinder. (See P2)
3. Sling blade assembly, then pull out pin (3) of pitching rod. (See P2)
4. Remove cap (4). (See P3)
5. Lift off blade assembly (5). (See P4)



Blade assembly: 730 kg

## INSTALLATION OF BLADE

### D31E-18, D31P-18A, D37E, P-2

1. Sling blade assembly (5), align mount of U-frame, then install cap (4), and secure blade. (See P4, P3)



Mounting bolt: Thread tightener (LT-2)



Mounting bolt:  $95 \pm 10$  kgm

2. Knock in pin (3) of pitching rod. (See P2)
3. Knock in pins (2) of angle cylinder. (See P2)
4. Knock in pin (1) of tilt cylinder. (See P1)

## REMOVAL OF BLADE

### D31P, PL-18

 Lower work equipment assembly to ground securely.

1. Pull out pin (1) of lift cylinder, then run engine and retract rod fully. (See P5)
2. Sling tilt cylinder assembly, remove mounting bolts, then disconnect tilt cylinder assembly (2). (See P6)
3. Start engine and retract rod of tilt cylinder fully.
4. Disconnect center brace (3) at straight frame end. (See P7)
5. Sling blade assembly and disconnect tilt braces (4). (See P7)
6. Pull out pin (5), then lift off blade assembly (6). (See P7)



Blade assembly: 350 kg

## INSTALLATION OF BLADE

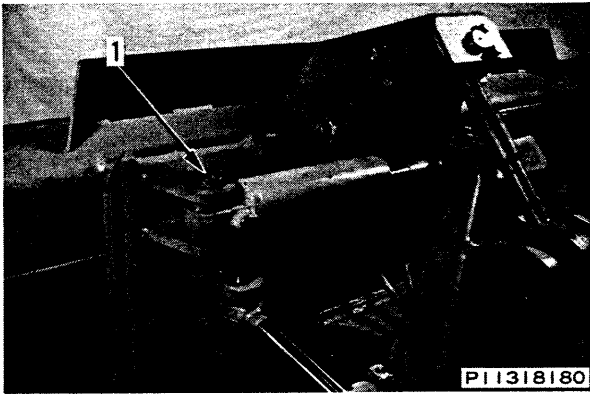
### D31P, PL-18

1. Sling blade assembly (6), align mount, then knock in pin (5). (See P7)
2. Assemble shims, and connect tilt brace (4). (See P7)
  - ★ Standard shim thickness: 5 mm
3. Connect center brace (3). (See P7)
4. Sling tilt cylinder assembly (2), start engine and extend rod, align with mount, then assemble shims and tighten bolt. (See P6)
  - ★ Standard shim thickness: 5 mm
5. Start engine and extend piston rod of lift cylinder, align with mount, then knock in pin (1). (See P5)

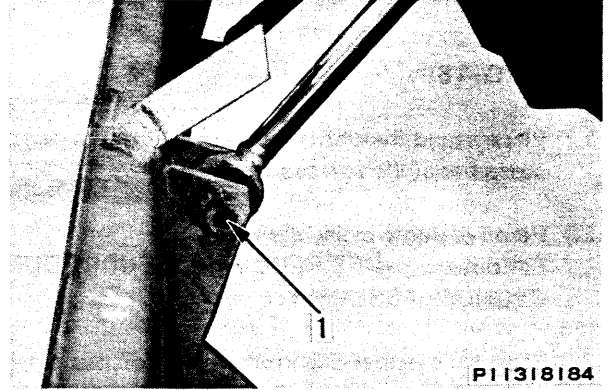
011418



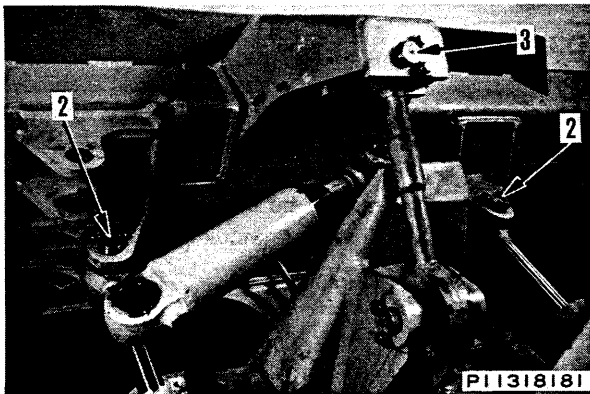
P1



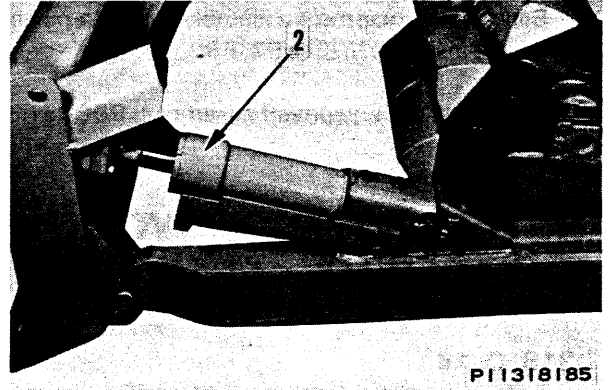
P5



P2

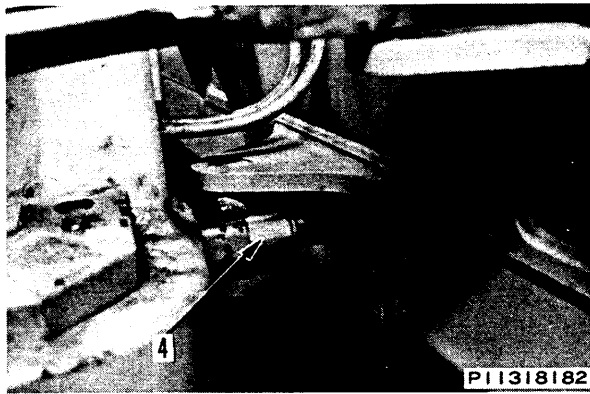


P6

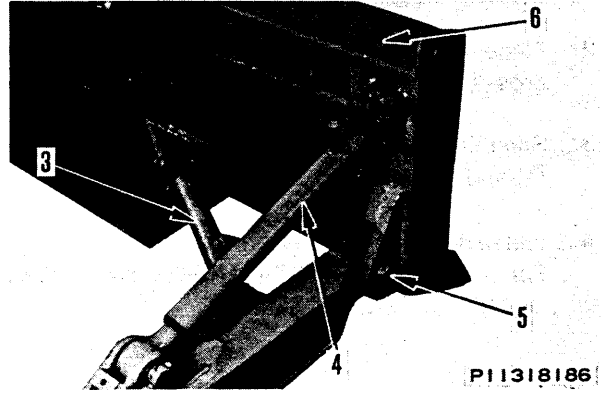


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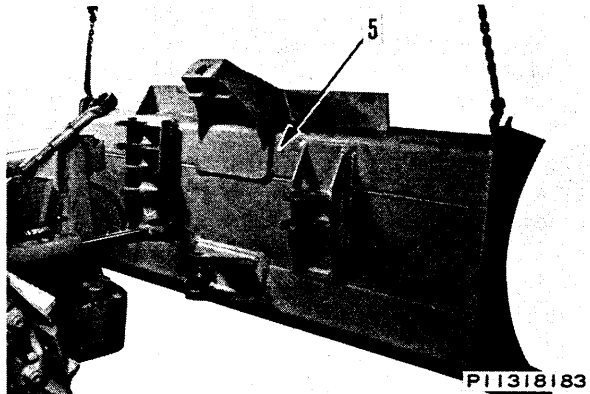
P3



P7



P4



## REMOVAL OF WORK EQUIPMENT ASSEMBLY

### D31S, Q-18

1. Place stand (height: approx. 800 mm) under the cross bar of lift arm securely.
2. Remove dump cylinder assembly.  
For details, see 63 REMOVAL OF BUCKT DUMP CYLINDER ASSEMBLY.
3. Sling lift cylinder assembly, then pull out pin (1) and disconnect lift cylinder assembly (2). (See P1)
4. Sling work equipment assembly (4), then pull out pin (3) and lift off. (See P2, P3)



Work equipment assembly: 800 kg

## INSTALLATION OF WORK EQUIPOMENT ASSEMBLY

### D31S, Q-18

1. Sling work equipment assembly (4) and align with mount, then knock in pin (3). (See P3, P2)
2. Place stand (height: approx. 800 mm) under the cross bar of lift arm securely.
3. Sling lift cylinder assembly (2), then knock in pin (1) and connect.
4. Install dump cylinder assembly.  
For details, see INSTALLATION OF BUCKET DUMP CYLINDER ASSEMBLY.

## REMOVAL OF BUCKET

### D31S, Q-18



Lower work equipment assembly to ground.

1. Pull out pin (1). (See P4)
2. Sling bucket assembly (3), then pull out pin (2) and lift off. (See P5)



Bucket assembly: 370 kg

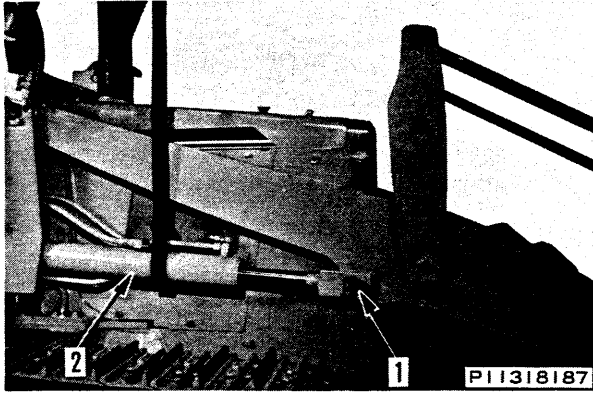
## INSTALLATION OF BUCKET

### D31S, Q-18

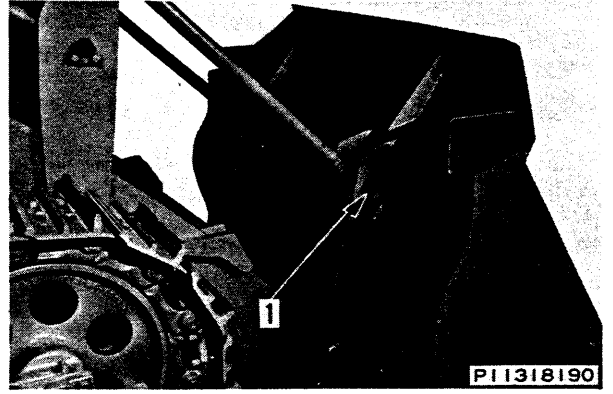
1. Sling bucket assembly (3) and align with mount, then knock in pin (2). (See P5)
2. Start engine, align hole of bucket and piston rod of dump cylinder and knock in pin (1). (See P4)

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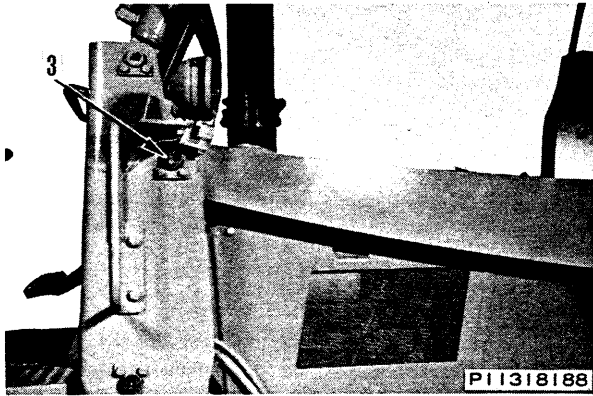
P1



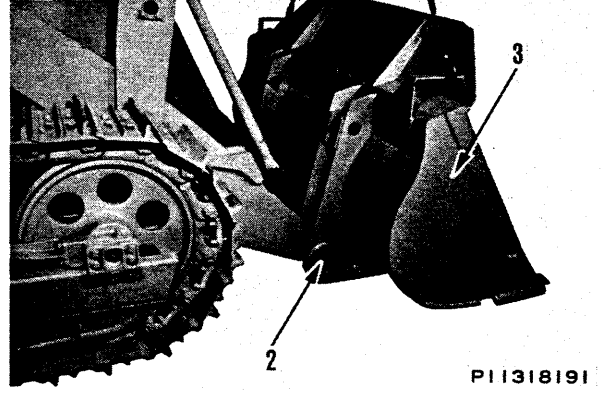
P4



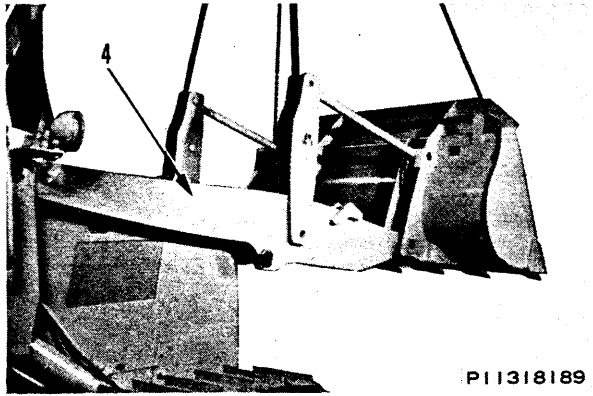
P2



P5



P3

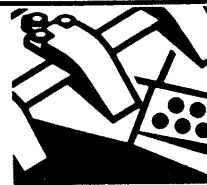


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# WORK EQUIPMENT

## 74 MAINTENANCE STANDARD

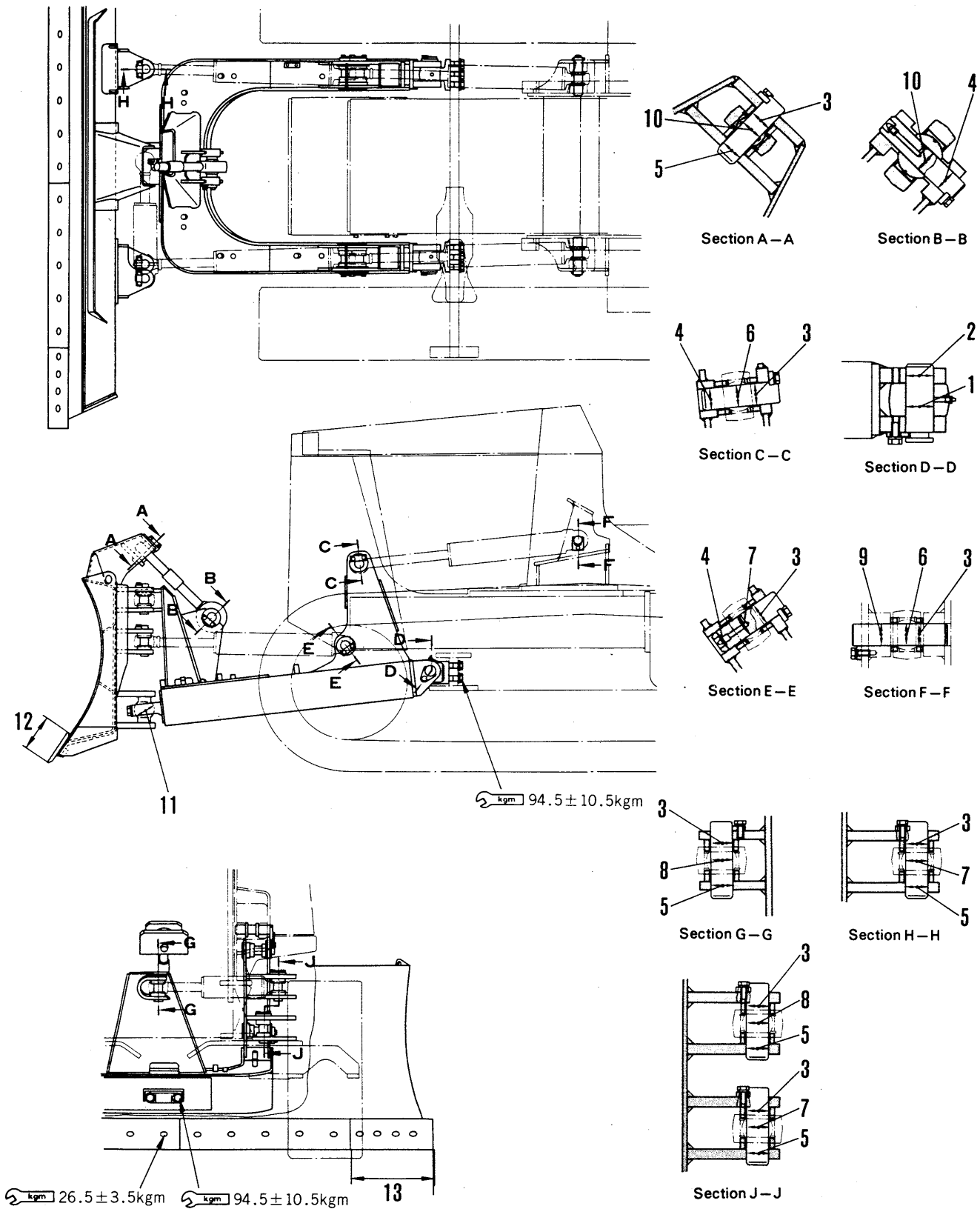
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Power angle and tiltdozer (D31E-18, D31P-18A, D37E, P-2) .....	74- 2
Straight tiltdozer (D31P, PL, PLL-18) .....	74- 4
Bucket and link (D31S, Q-18) .....	74- 6

# POWER ANGLE AND TILTDOZER

D31E-18, D31P-18A, D37E, P-2



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113F18078



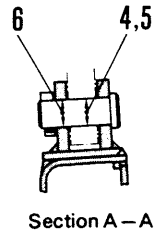
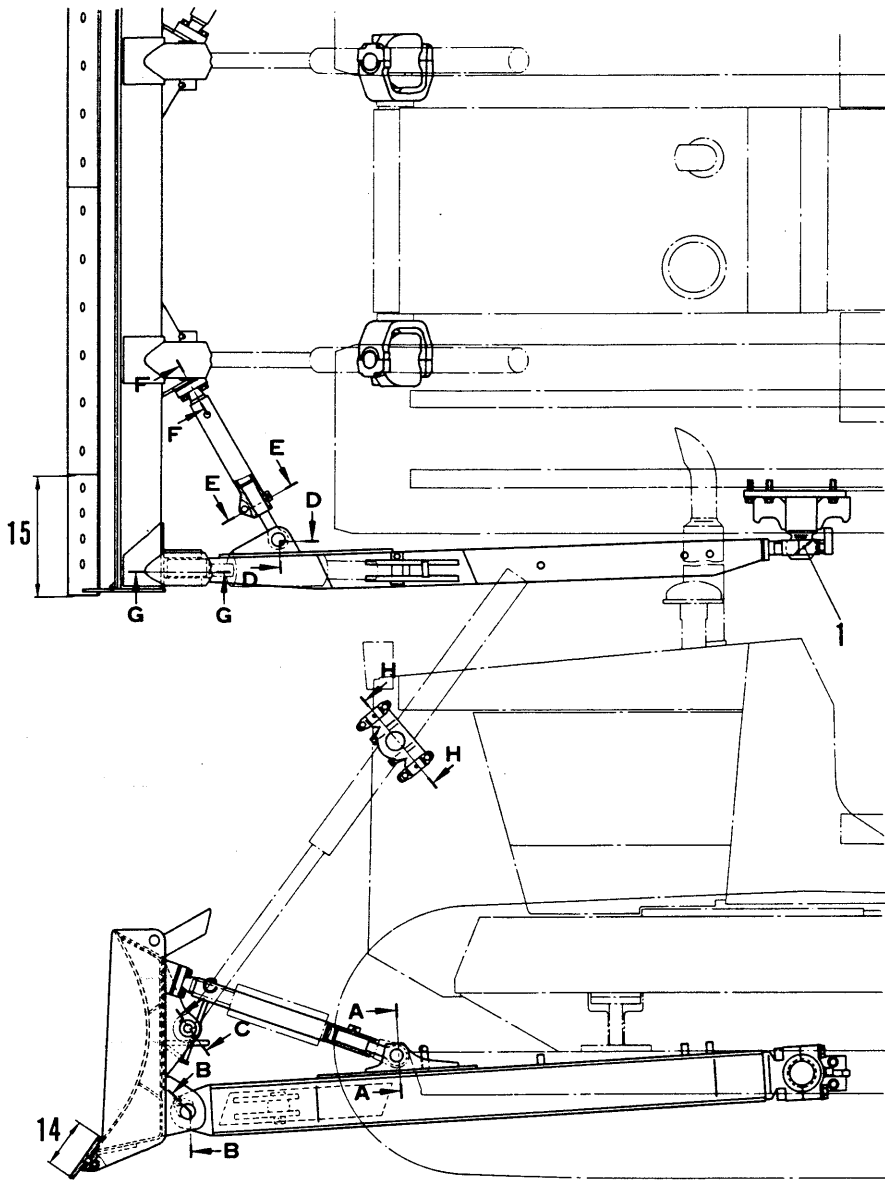
011418

Unit: mm

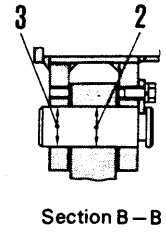
No.	Check item	Criteria				Remedy
		Standard size	Tolerance		Standard clearance	
Shaft	Hole					
1	Clearance between pin and frame support bracket	50	-0.050 -0.100	+0.500 +0.300	0.350 - 0.600	Replace
2	Clearance between pin and frame	50		+0.500 +0.300		
3	Clearance between pin and collar bushing	40	-0.025 -0.064	+0.050 0	0.025 - 0.144	
4	Clearance between pin and frame	40	-0.025 -0.064	+0.400 +0.100	0.125 - 0.464	
5	Clearance between pin and blade bracket	40	-0.025 -0.064	+0.400 +0.100	0.125 - 0.464	
6	Clearance between pin and lift cylinder bushing	40	-0.025 -0.064	0 -0.012	0.013 - 0.064	
7	Clearance between pin and angle cylinder bushing	40	-0.025 -0.064	0 -0.012	0.013 - 0.064	
8	Clearance between pin and tilt cylinder	40	-0.025 -0.064	0 -0.012	0.013 - 0.064	
9	Clearance between pin and loader frame	40	-0.025 -0.064	+0.200 0	0.025 - 0.264	
10	Clearance between pin and pitching rod bushing	40	-0.025 -0.064	+0.039 0	0.025 - 0.103	
11	Spherical clearance between blade trunnion and trunnion cap				0.5	
12	Height of cutting edge and end bit	Standard size	Tolerance		Repair limit	Replace
			±2			
13	Width of end bit		0 -1			

# STRAIGHT TILTDOZER

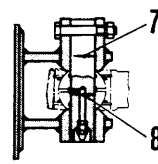
D31P, PL, PLL-18



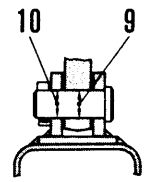
Section A-A



Section B-B



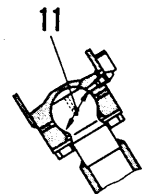
Section C-C



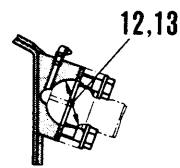
Section D-D



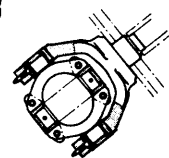
Section E-E



Section F-F



Section G-G



Section H-H

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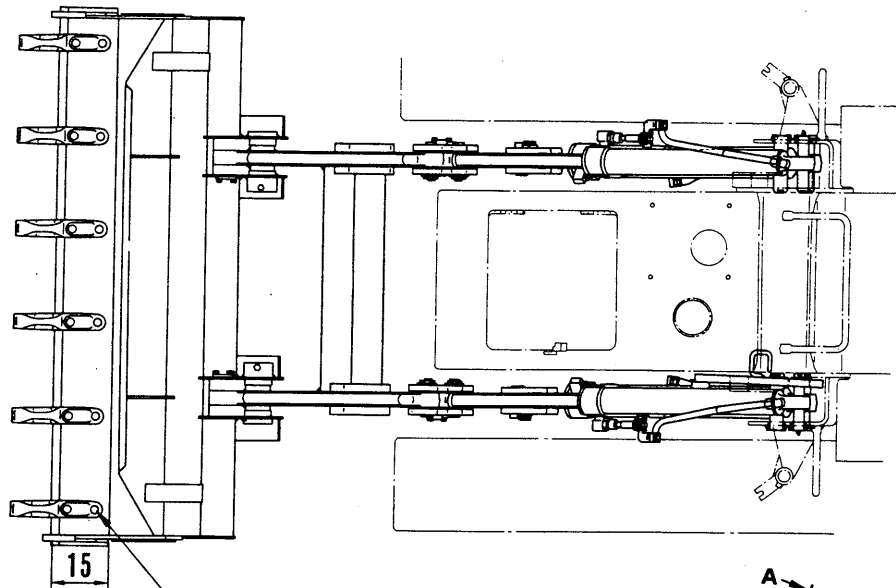
011418

Unit: mm

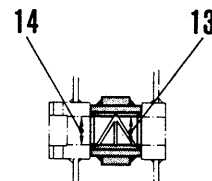
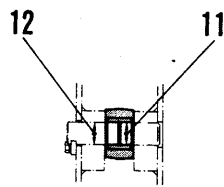
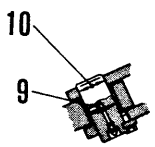
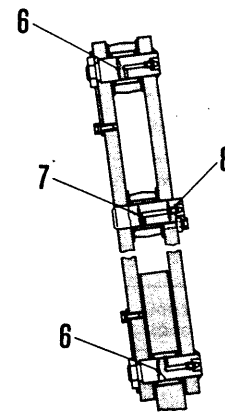
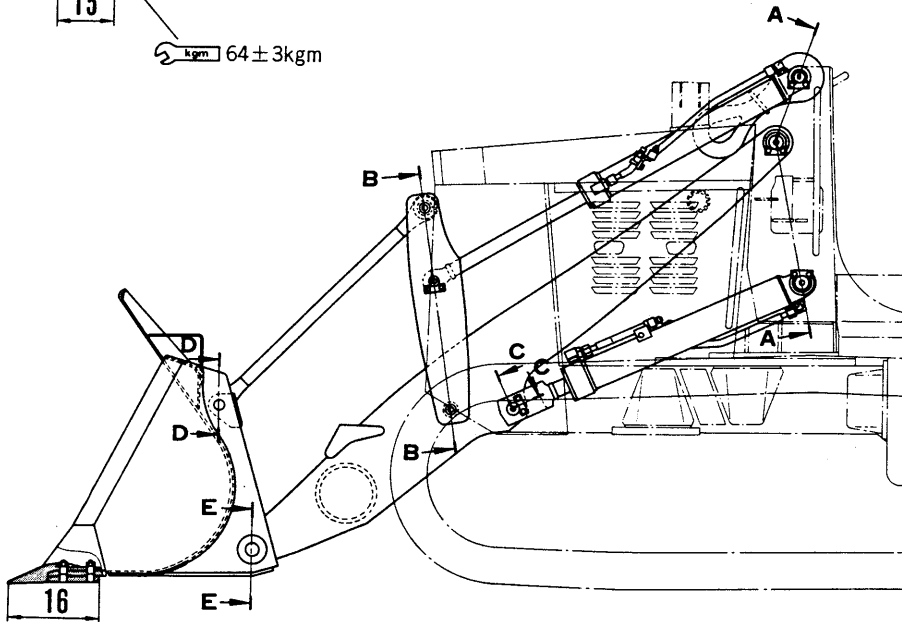
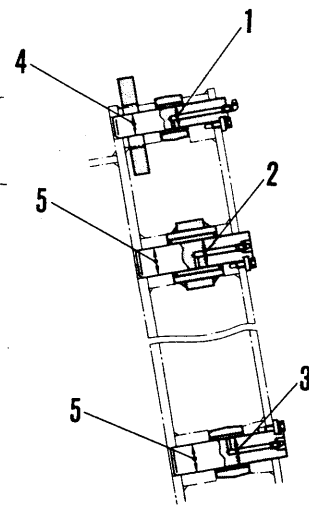
No.	Check item	Criteria				Remedy	
		Standard size	Tolerance		Standard clearance		Clearance limit
Shaft	Hole						
1	Spherical clearance between trunnion and trunnion cap	90	-0.500 -1.000	+1.500 0	0.500 – 2.500	Replace	
2	Clearance between pin and frame	50	-0.050 -0.100	+0.400 +0.050	0.100 – 0.500		
3	Clearance between pin and bracket of blade	50	-0.050 -0.100	+0.500 +0.300	0.350 – 0.600		
4	Clearance between pin and brace	35	-0.200 -0.400	+0.200 0	0.200 – 0.600		
5	Clearance between pin and tilt cylinder bushing	35	-0.200 -0.400	+0.142 +0.080	0.280 – 0.542		
6	Clearance between pin and frame	35	-0.200 -0.400	+0.500 +0.300	0.500 – 0.900		
7	Clearance between pin and bracket of blade	30	-0.020 -0.072	+0.250 0	0.020 – 0.322		
8	Clearance between pin and lift cylinder bushing	30	-0.020 -0.072	+0.033 0	0.020 – 0.105		
9	Clearance between pin and arm	35	-0.200 -0.400	+0.200 0	0.200 – 0.600		
10	Clearance between pin and frame	35	-0.200 -0.400	+0.500 +0.300	0.500 – 0.900		
11	Spherical clearance between arm and cap	61	-1.000 -1.100	+1.000 0	1.000 – 2.100	Adjust	
12	Spherical clearance between brace and cap	61	0 -0.100	+1.000 0	0 – 1.100		
13	Spherical clearance between tilt cylinder and cap	61	-0.200 -0.300	+1.000 0	0.200 – 1.300		
14	Height of cutting edge and end bit	Standard size	Tolerance		Repair limit		Replace
			±2				
15	Width of end bit		0 -1				

# BUCKET LINK

D31S, Q-18



kgm  $64 \pm 3$ kgm



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113F18080

Unit: mm

No.	Check item	Criteria					Remedy
		Standard size	Tolerance		Standard clearance	Clearance limit	
			Shaft	Hole			
1	Clearance between pin and dump cylinder	40	-0.025 -0.064	+0.142 +0.080	0.105 - 0.206	1.0	Replace
2	Clearance between pin and link bushing	50	-0.025 -0.064	+0.182 +0.132	0.157 - 0.246	1.0	
3	Clearance between pin and lift cylinder bushing	50	-0.025 -0.064	+0.142 +0.080	0.105 - 0.206	1.0	
4	Clearance between pin and loader frame	40	-0.025 -0.064	+0.039 0	0.025 - 0.103	1.0	
5	Clearance between pin and loader frame	50	-0.025 -0.064	+0.039 0	0.025 - 0.103	1.0	
6	Clearance between pin and tilt rod bushing and lift arm bushing	40	-0.025 -0.064	+0.192 +0.131	0.156 - 0.256	1.0	
7	Clearance between pin and dump cylinder bushing	40	-0.025 -0.064	+0.142 +0.080	0.105 - 0.206	1.0	
8	Clearance between pin and tilt lever	40	-0.025 -0.064	+0.039 0	0.025 - 0.103	1.0	
9	Clearance between pin and lift cylinder bushing	50	-0.025 -0.064	+0.142 +0.080	0.105 - 0.206	1.0	
10	Clearance between pin and lift arm	50	-0.025 -0.064	+0.039 0	0.025 - 0.103	1.0	
11	Clearance between pin and tilt rod bushing	40	-0.025 -0.064	+0.192 +0.131	0.156 - 0.256	1.0	
12	Clearance between pin and bracket of bucket	40	-0.025 -0.064	+0.200 +0.040	0.065 - 0.264	1.0	
13	Clearance between pin and lift arm bushing	50	-0.025 -0.064	+0.182 +0.132	0.157 - 0.246	1.0	
14	Clearance between pin and bracket of bucket	50	-0.025 -0.064	+0.200 +0.040	0.065 - 0.264	1.0	
15	Height of cutting edge	Standard size	Tolerance		Repair limit		
			±2				
16	Length of bucket tooth		-				

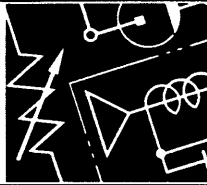
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# **ELECTRICAL SYSTEM**

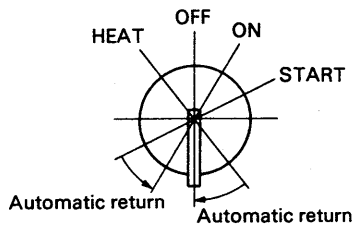
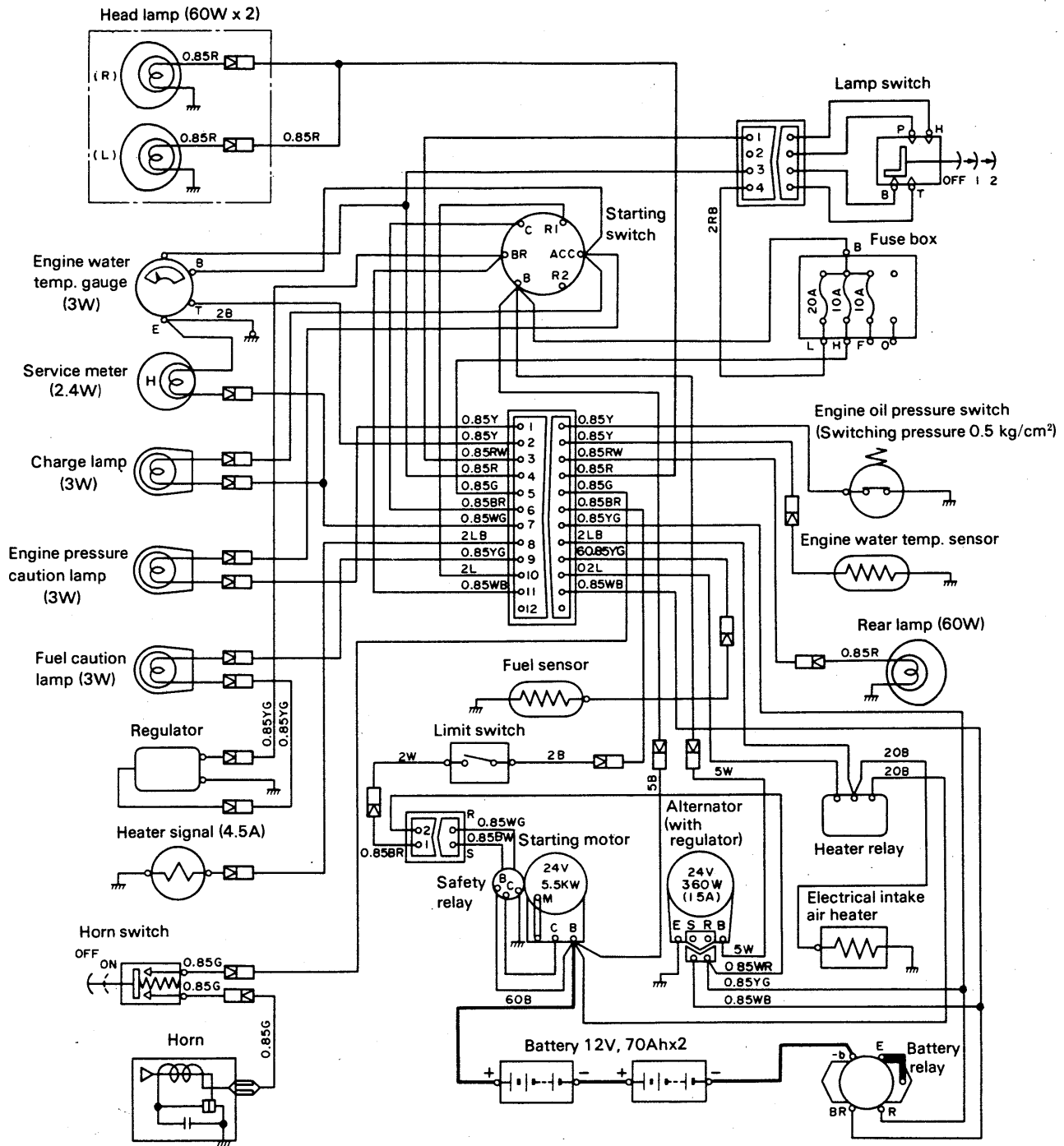
## **81 STRUCTURE AND FUNCTION**

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Wiring diagram ..... 81- 2

# WIRING DIAGRAM



Starting switch connecting table

	B	BR	R1	R2	C	ACC
OFF	○					
HEAT	○	○	○			○
ON	○	○				○
START	○	○	○	○	○	○

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