TO THE READER

- This Workshop Manual provides comprehensive instructions and information on the servicing of Kubota M-Series Tractors. It consists of five parts: "Preparatory Steps for Disassembly and Servicing", "Engine", "Tractor Body", "Hydraulic System" and "Electrical System". Each part covers the following content:
  - **Part 1: "Preparatory Steps for Disassembly and Servicing"**
    This part explains the disassembling procedures for each block needed before disassembling and servicing an individual component. When repairing, checking or servicing a given component, refer to this part to find out which block must be taken out.
  - **Parts 2 and 3: "Engine" and "Tractor Body"**
    Parts 2 and 3 give disassembling procedures, checking and servicing instructions, together with trouble shooting charts.
  - **Parts 4 and 5: "Hydraulic System" and "Electrical System"**
    Parts 4 and 5 give basic explanations on the construction and operation of the major components of the hydraulic and electrical systems, in addition to disassembling procedures, checking and servicing instructions, and trouble shooting charts.
- The trouble shooting charts are added at the end of each part to make it easy to trace the cause of a misfunction under abnormal conditions. For the convenience of quick trouble-tracing, servicing and checking jobs, reference pages are given with the sources of trouble so that you can find a full explanation in the text.
- A list of symbols for fasteners, tools and test instruments is given on page 7. It will enable you to easily identify all the fasteners, tools and test instruments referred to in the text with the same symbols.
  The article numbers for Kubota Tractor's special tools and test instruments are given at the symbol reference chart.

If you have any questions or need more information than is contained in this manual, please contact the Internal Combustion Engine and Implement Service Headquarters, Kubota, Ltd., 22 Funade-cho, Naniwa-ku, Osaka, Japan.

CONTENTS

SYMBOL REFERENCE CHART OF FASTENERS, TOOLS AND TEST INSTRUMENTS

STANDARD FASTENERS

Screw	Bolts		Nuts		Plugs
	Hexagon bolt 	Hexagon bolt, Plain washer 	Hexagon nut 	Self-locking nut 	Plug (oil drain) 
Round head screw 	Joint bolt 	Hexagon bolt, Spring washer, Plain washer 	Slotted nut 		Plug (oil feed) 
Set screw 	Hexagon socket head bolt 	Reamer bolt, Spring washer 	Hexagon nut, Spring washer 		
Flat head machine screw 	Stud bolt	Reamer bolt, Spring washer, Plain washer 	Hexagon nut, Plain washer 		
	Wing bolt 	Rod bolt 	Hexagon nut, Spring washer, Plain washer 		
	Hexagon bolt, Spring washer 				

Washers		Cir-clips	Pins	Keys	Others
Spring washer 	Copper packing 	External cir-clip 	Cotter pin 	Feather key 	Drain cock 
Plain washer 	Claw washer 	Internal cir-clip 	Head pin 	Woodruff key 	O-ring 
Tongued washer 		Band 	Spring pin 		Rubber packing 
Lock plate (rectangulor) 			Straight pin 		
Lock plate (arc) 					
Seal washer 					

STANDARD TOOLS

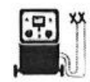
		Pliers	Screw drivers	Hammers	Auxiliary tools
Wrenches	Extension bar	Chain nose cutting pliers	Phillips screw driver	Ball-peem hammer	Chisel
Open-end wrenches	Universal joint	Combination pliers	Regular screw driver	Copper hammer	Pin punch
Double-end box wrench	"T" type wrench	Snapring pliers (external)	Impact screw driver	Wooden hammer	Center punch
Socket wrench	Socket	Snapring pliers (internal)		Plastic hammer	Brass rod
Allen wrench					Steel rod
Torque wrench					Vice

	Others	SPECIAL TOOLS			
Crosscut chisel 	Drip tray 		Pitman arm puller  07916-06781	Valve lifter 	Bushing driving guide 
	Sand paper 	Clutch center tool  07916-50012	Special-purpose puller  07916-09031	Bushing puller set  07916-06071	24x35 "T" type wrench  36200-99151
	Soldering iron 	Tie rod pin puller  07916-06021	Dry liner changer  07916-30042	Box wrench (46)  14201-91313	Crankshaft nut socket (46)  07916-30821
	Saw blade 	Piston ring tool 	Nozzle holder socket wrench (27)  07916-30841	Main clutch disassembly/reassembly tool  07916-50002	
	Jack 	Puller 	Ball guide  07916-08031	Filter wrench  15221-86611	
		Steering wheel puller 	Piston ring compressor 	Tool, for removal and installation of king pin bushing  07916-51011	

TEST INSTRUMENTS

Length measurement			Weight measurement	Temperature measurement	Pressure measurement
	Lever type indicator with magnetic base 	Depth gauge 	Spring balance 	Thermometer 	Radiator (cap) tester 
Scale 	Feeler gauge 	Caliper gauge 	Push-pull scale 		Engine oil pressure gauge 
Vernier calipers 	Cylinder gauge 				Compression tester  07909-30201
Outside micrometer 	Connecting rod aligner 		**Specific gravity measurement**	**Rpm measurement**	Nozzle tester 
Inside micrometer 	Toe-in gauge 		Battery hydrometer 	Revolution counter 	Spring tester 
Dial gauge with magnetic stand 	Press gauge 			Electric revolution counter 	Tire gauge 

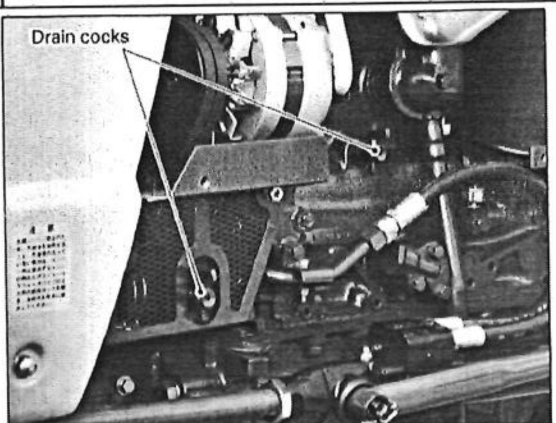
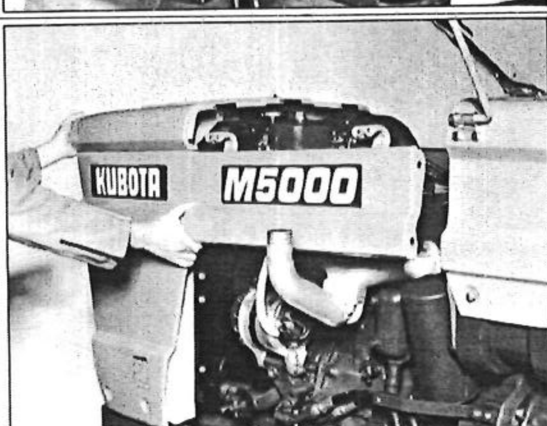
SERVICING TOOLS AND APPARATUS

	Electrical measurement	Time measurement	Others	Auxiliary measurement tools	
Relief-valve set-pressure tester  07916-50041	Circuit tester 	Stop watch 	Diesel timing tester 	Surface plate 	
Fuel pump oil-tight tester 	Battery tester 			V-block 	Battery charger 
	Armature tester 			Square 	Hand valve lapper 
	Volt-ammeter 	**Degree measurement**		Straightedge 	Valve seat cutter 
		Turning radius gauge 		Cables 	Reamer
		Camber-Castor-King pin gauge 		Scriber 	

I. PREPARATORY STEPS FOR DISASSEMBLY AND SERVICING

1. SEPARATION OF THE FRONT AXLE

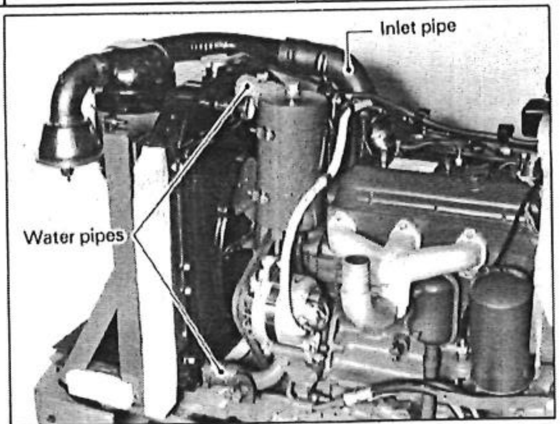
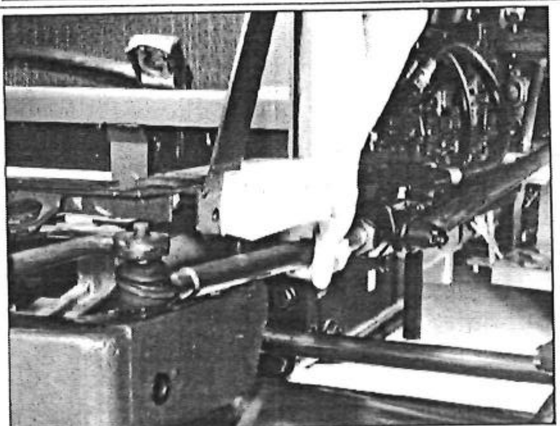
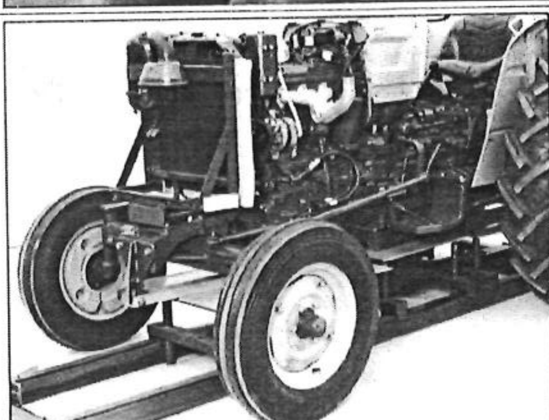
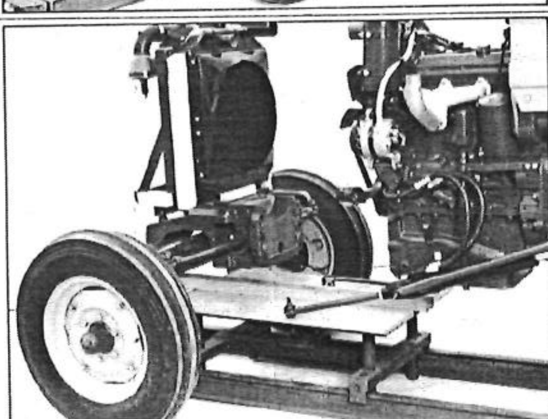
1-1. 2-Wheel drive

Item	Location	Bolts and nuts	Tools
Disassembly (1) Radiator coolant		M8 x 20 ·········· 2 M8····· 2 M8····· 2	
Disassembly (2) Battery		M8 x 18 ·········· 2 M8····· 2 M8····· 2	13 14
Disassembly (3) Bonnet		M8 x 20 ·········· 2 M8······4 M8····· 4 M8 x 65 ·········· 1 M8 x 16 ·········· 4 M6 x 25 ·········· 2 Bonnet set bolt ····· 4 M10x20 ·········· 4 M10x20 ·········· 2 M10··· 2	10 12 13 14 14 14

Procedure	Remarks
1) Remove the cover (left). 2) Drain the coolant from the radiator through the two drain cocks, one on the water pipe (1) and the other on the side of the crank case.	• Remove the radiator cap and then completely drain the coolant. • **Amount of coolant**
1) Disconnect both negative and positive battery cables from their terminals. 2) Remove the battery cover. 3) Remove the battery clamp bands (1) and (2). 4) Remove the battery.	(When reassembling) • Be sure to connect the positive cable first.
1) Remove the bonnet (front). 2) Remove the cover (right). 3) Remove the belt covers (right, left). 4) Remove the bonnet (front) complete with the side covers and the bonnet cover.	

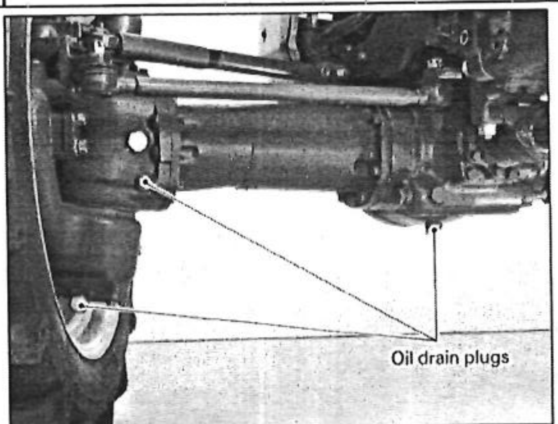
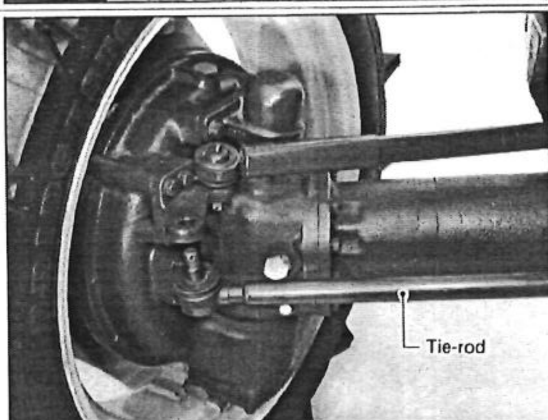
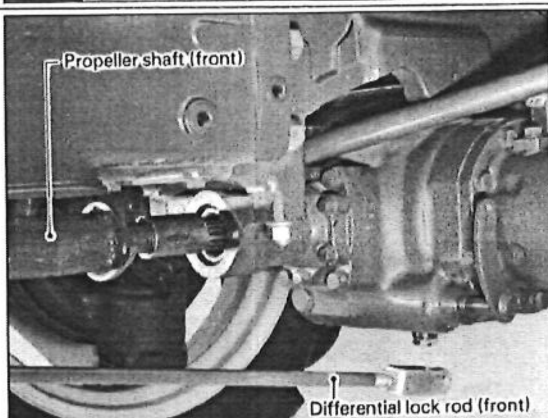
Amount of coolant:

S2200 S2600	8.4 liters (2.2 gal.)
D3000	11.6 liters (3.1 gal.)
V4000L V4000	13.0 liters (3.4 gal.)

Item	Location	Bolts and nuts	Tools
Disassembly (4) Inlet pipe, Water pipe		 3	
Disassembly (5) Drag link		.... 1 M14··· 1	22 (When reassembling)
Disassembly (6) Disassembly and reassembly bases		M20x45 .... 2 M16x65 P1.5··· 4	22 27 Disassembly and reassembly base
Disassembly (7) Separation		M16x70 6	22 (When reassembling)

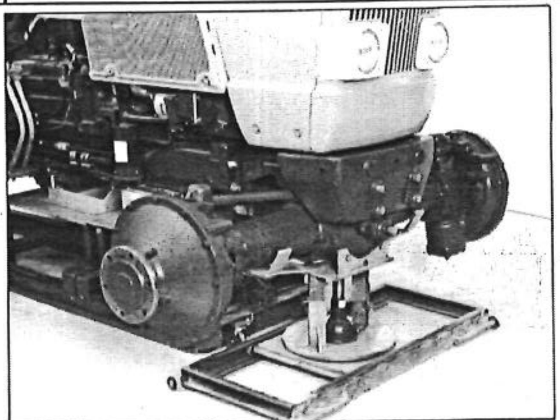
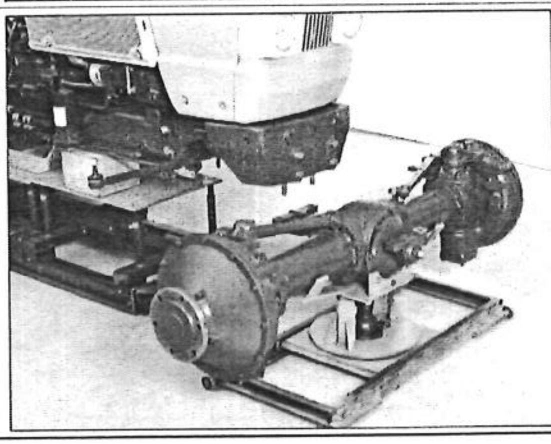
<table>
<tr><th>Procedure</th><th>Remarks</th></tr>
<tr><td>1) Slacken the clamp band and then disconnect the inlet pipe.
2) Slacken the clamp band and then disconnect the water pipes (1) and (2).</td><td></td></tr>
<tr><td>1) Remove the nut and draw out the rod end by using the tie-rod pin puller.</td><td>(When reassembling)
● Tighten the drag link nut to 49.0 to 78.4 N·m. (5 to 8 kgf·m., 36.2 to 57.9 lb.ft.)</td></tr>
<tr><td>1) Detach the 3-point hitch.
2) Remove the swing drawbar.
3) Remove the front bumper.
4) Place the base under the clutch housing and then jack the base up.
5) Set up the base under the front axle bracket.</td><td></td></tr>
<tr><td>1) Separate the front axle assembly from the engine block.</td><td>(When reassembling)
● Set bolt torque
<table>
<tr><td>M4000</td><td rowspan="2">196.1 to 225.5 N·m.
(20 to 23 kgf·m., 144.7 to 166.4 lb.ft.)</td></tr>
<tr><td>M4500</td></tr>
<tr><td>M5500</td><td rowspan="3">259.9 to 304.0 N·m.
(26.5 to 31 kgf·m., 191.7 to 224.2 lb.ft.)</td></tr>
<tr><td>M6500</td></tr>
<tr><td>M7500</td></tr>
</table></td></tr>
</table>

1-2. 4-Wheel drive

Item	Location	Bolts and nuts	Tools
Disassembly (1) Front differential case oil, Bevel gear case oil, Front wheel case oil	 	M20··· 3 M10··· 2 ········· 5	14 27
Disassembly (2) Tie-rod	 	·········· 2 M22··· 2	22 (When reassembling)
Disassembly (3) Propeller shaft cover (front), Differential lock rod (front)	 	M8 × 22 ·········· 2 $\phi 8 \times 25$ ·········· 1 M8····· 1 ·········· 1	12

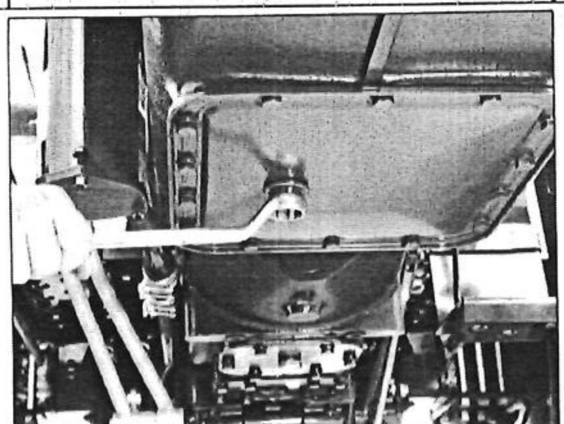
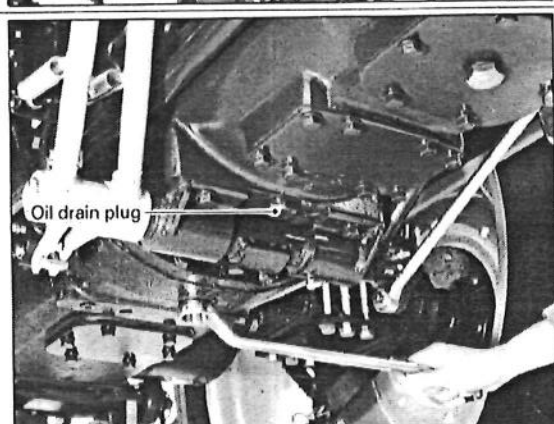
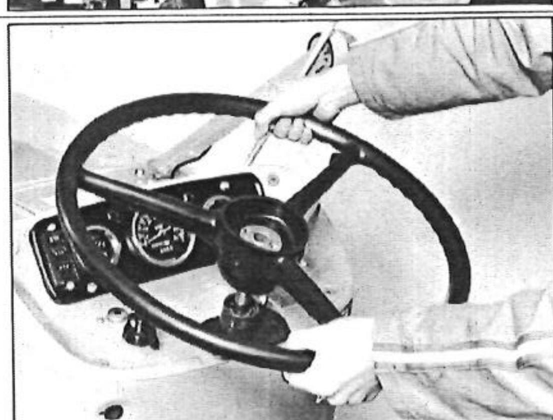
Procedure	Remarks
1) Drain oil from the front differential case. 2) Drain oil from the bevel gear case. 3) Drain oil from the front wheel case.	See the oil amount table below.
1) Remove the lock nut and draw out the rod end by using the tie-rod pin puller.	(When reassembling) ● Tighten the drag link nut to 98.1 to 127.5 N·m. (10 to 13 kgf·m., 72.3 to 94.0 lb.ft.)
1) Shift the propeller cover (front) rearward. 2) Shift both the external circlip and the coupling rear-ward. 3) Remove the differential lock rod (front).	

	Front differ-ential case	Bevel gear case	Front wheel case
Amount of oil	3.5 liters (0.9 gal.)	0.8 liter x 2 (0.2 gal. x 2)	3.5 liters x 2 (0.9 gal. x 2)

Item	Location	Bolts and nuts	Tools
Disassembly (4) Disassembly and reassembly bases		M16x30 ....12 Spring washer 12	17 24 Disassembly and reassembly bases (When reassembling)
Disassembly (5) Separation		M16··· 4	24 (When reassembling)

Procedure	Remarks
1) Set the base under the engine block and jack the base up. 2) Set the base under the front axle and jack the base up. 3) Remove both front wheels.	(When reassembling) • Tighten front wheel mounting bolts to 259.9 to 304.0 N·m. (26.5 to 31 kgf·m., 191.7 to 224.2 lb.ft.)
1) Remove lock nuts from the brackets (front and rear). 2) Separate the front axle assembly.	(When reassembling) • Tighten the bracket (front and rear) mounting nuts to 259.9 to 304.0 N·m. (26.5 to 31 kgf·m., 191.7 to 224.2 lb.ft.)

2. SEPARATION OF THE CLUTCH HOUSING FROM THE ENGINE

Item	Location	Bolts and nuts	Tools
Disassembly (1) Engine oil		.... 1 Gasket 1	22
Disassembly (2) Transmission oil		.... 2 2	27
Disassembly (3) Steering wheel		M14··· 1	21 (When reassembling)

BLOCK

<table>
<tr><th>Procedure</th><th>Remarks</th></tr>
<tr><td>1) Drain engine oil.</td><td>

● **Amount of oil**

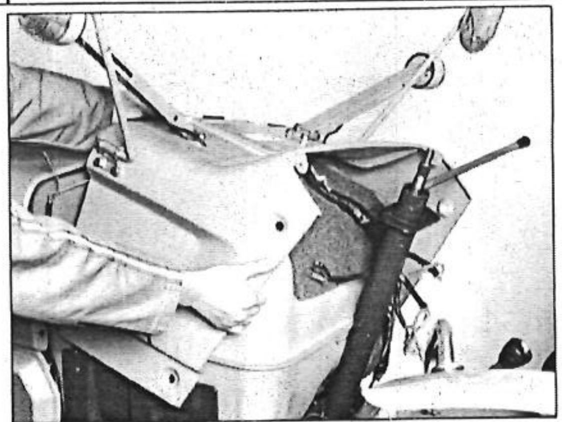
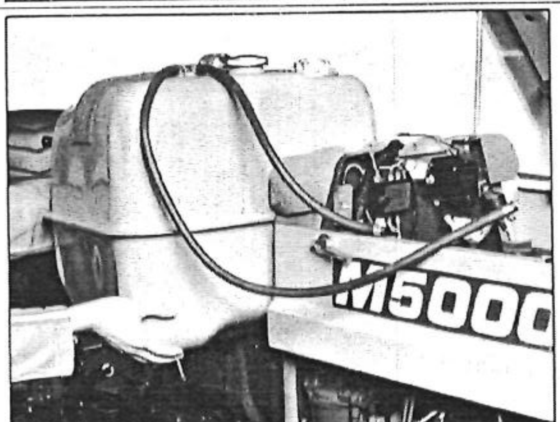
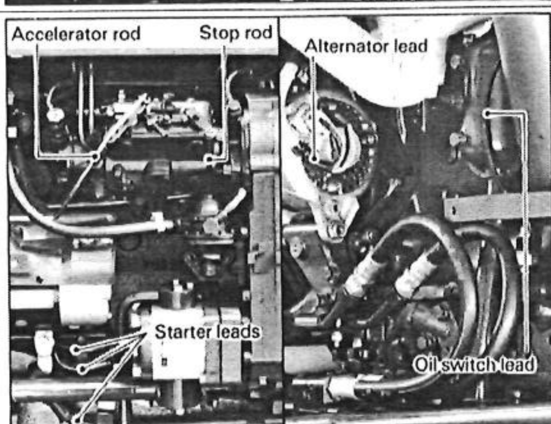
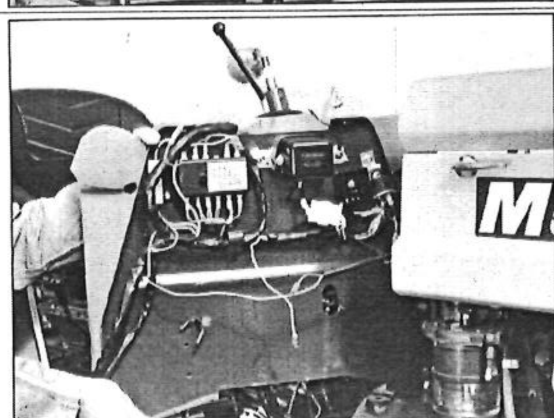
<table>
<tr><td>S2200</td><td rowspan="2">12.0 liters (3.2 gal.)</td></tr>
<tr><td>S2600</td></tr>
<tr><td>D3000</td><td>9.8 liters (2.6 gal.)</td></tr>
<tr><td>V4000L</td><td rowspan="2">11.8 liters (3.1 gal.)</td></tr>
<tr><td>V4000</td></tr>
</table>

</td></tr>
<tr><td>1) Drain gear oil from both the clutch housing and the transmission case.</td><td>

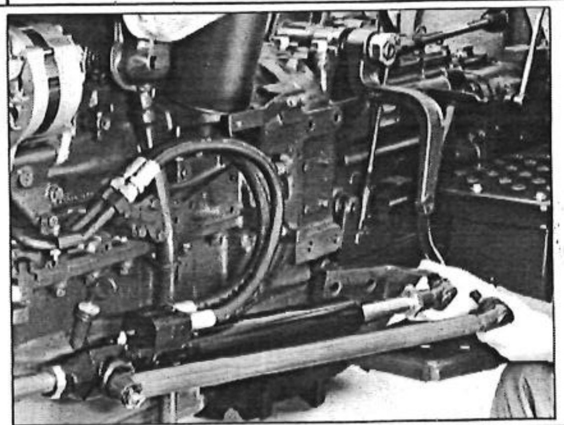
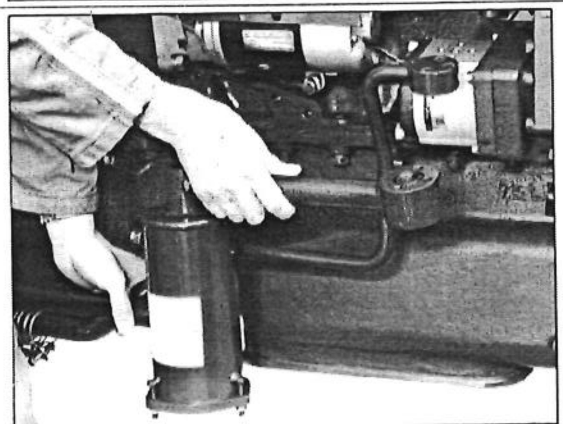
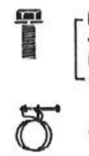
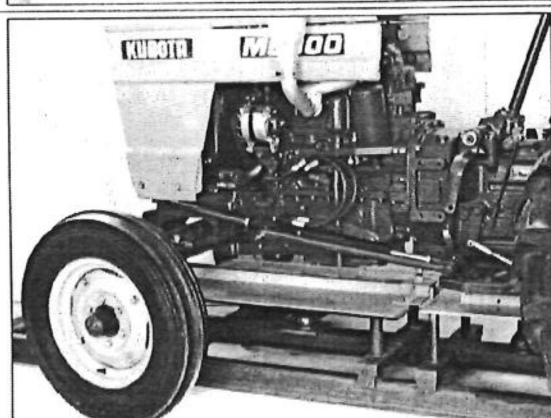
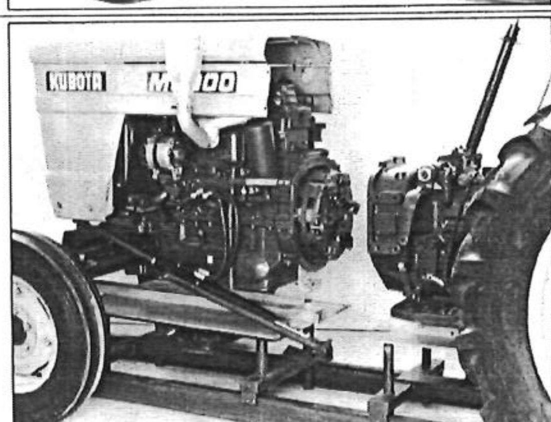
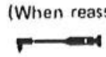
● **Amount of oil**

<table>
<tr><td>M4000 (DT)</td><td rowspan="5">45 liters (11.9 gal.)</td></tr>
<tr><td>M4500 (DT)</td></tr>
<tr><td>M5500 (DT)</td></tr>
<tr><td>M6500 (DT)</td></tr>
<tr><td>M7500 (DT)</td></tr>
</table>

</td></tr>
<tr><td>1) Remove the steering wheel cap.
2) Remove the lock nut and the steering wheel.</td><td>(When reassembling)
● Tighten the steering wheel mounting nut to 58.8 to 78.4 N·m. (6 to 8 kgf·m., 43.4 to 57.9 lb.ft.)</td></tr>
</table>

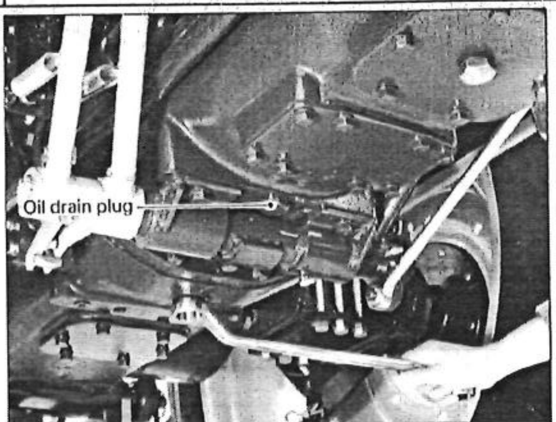
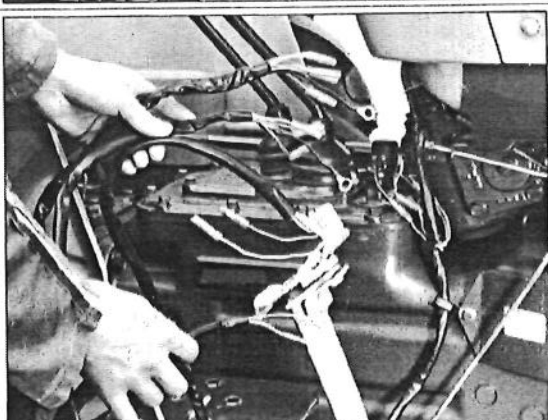
Item	Location	Bolts and nuts	Tools
Disassembly (4) Bonnet, Panel		M8 x 20 ·········· 4 M8····· 4 M8····· 4 Bonnet set bolt ·········· 6 M10x20 ·········· 6 M8 x 16 ·········· 4	14
Disassembly (5) Fuel tank		M10x75 ·········· 1 Lock nut M10··· 1 M10··· 1 M4····· 1	7 14
Disassembly (6) Electrical wiring, Control rods		Round nut M4····· 1 M4····· 1 M4····· 2 M10x16 ·········· 1 M6····· 1 [M6····· 4 M4····· 1 ·········· 3	10 13 14
Disassembly (7) Fuel tank support		M12x30 ·········· 2 M12x50 ·········· 2 M12··· 2 Spacer ·········· 2	17

Procedure	Remarks
1) Remove the covers (right and left). 2) Remove the bonnet (rear) complete, the bonnet (rear) and the panel.	
1) Close the cock. 2) Disconnect the fuel pipe (1) from the filter (1). 3) Disconnect the fuel pipe (2) from the filter (2). 4) Disconnect the fuel pipe (3) from the nozzle. 5) Disconnect both the tank unit ground lead and the connector lead from the tank unit. 6) Remove the tank clamp bands (right and left) and then the fuel tank.	
1) Remove the bonnet (front) and then disconnect negative battery cable from its terminal. 2) Disconnect the glow plug lead. 3) Disconnect the horn leads. 4) Disconnect the oil switch lead. 5) Disconnect the water thermometer switch lead. 6) Disconnect the starter lead. 7) Disconnect the alternator lead. 8) Disconnect the accelerator rod and the stop rod.	
1) Remove the fuel tank supports (right, left and front).	(When reassembling) ● Insert the plain washer into under the spacer.

Item	Location	Bolts and nuts	Tools
Disassembly (8) Drag link, Booster bracket		 M14··· 1 ·········· 1 M16x75 ·········· 2	 22 (When reassembling) 
Disassembly (9) Hydraulic pipes		 M6 x 35 ·········· 3 M8 x 50 ·········· 3 ·········· 2	 10 12
Disassembly (10) Disassembly and reassembly bases		 M14··· 2	 22
Disassembly (11) Separation		 M12x40 ·········13	 17 (When reassembling) 

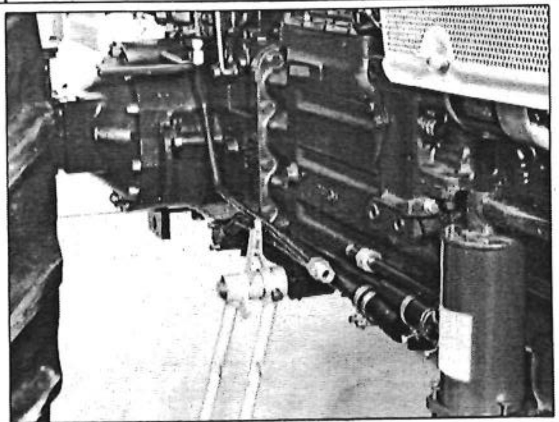
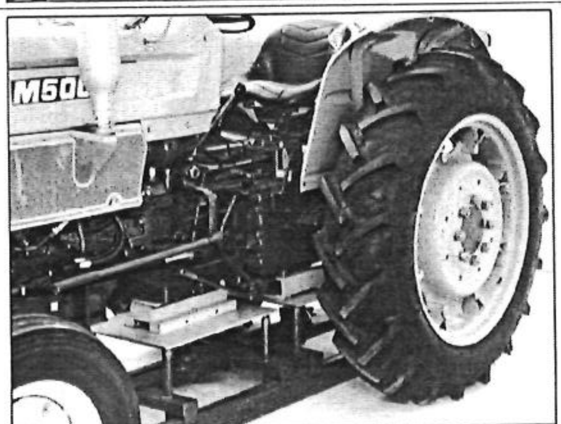
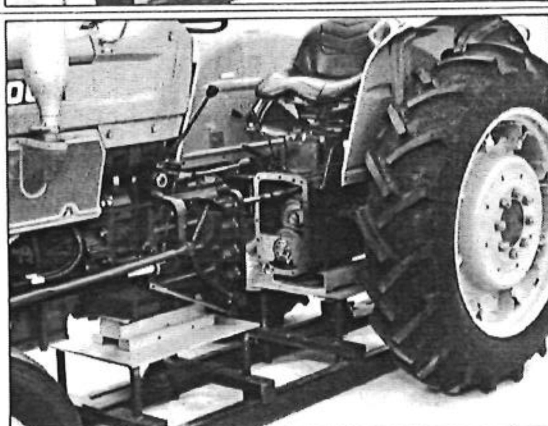
Procedure	Remarks
1) Disconnect the drag link by using the tie-rod pin puller. 2) Remove the booster bracket.	(When reassembling) ● Tighten the drag link nut to 49.0 to 78.4 N·m. (5 to 8 kgf·m., 36.2 to 57.9 lb.ft.) In case of DT model, tighten the drag link nut to 98.1 to 127.5 N·m. (10 to 13 kgf·m., 72.3 to 94.0 lb.ft.)
1) Disconnect the suction pipe and the delivery pipe from the hydraulic pump.	
1) Set two bases under the tractor main frame, one under the engine block and the other under the clutch housing and then jack them up to the same level.	
1) Separate the clutch housing from the engine block.	(When reassembling) ● Tighten the set bolts to 77.5 to 90.2 N·m. (7.9 to 9.2 kgf·m., 57.1 to 66.5 lb.ft.)

3. SEPARATION OF THE CLUTCH HOUSING FROM THE TRANS-

Item	Location	Bolts and nuts	Tools
Disassembly (1) Transmission oil		·········· 2 ·········· 2	27
Disassembly (2) Electrical wiring		M8 x 28 ·········· 2 M8 x 14 ·········· 2 M5····· 2 M5····· 2	12 14 12
Disassembly (3) Fender covers, Steps, Brake rods		M10x20 ·········· 4 M10x20 ·········· 5 M10··· 4 ·········· 1 ·········· 5 ϕ10x28 ·········· 2 ϕ10x35 ·········· 2 M10··· 4 M6····· 1	14 14

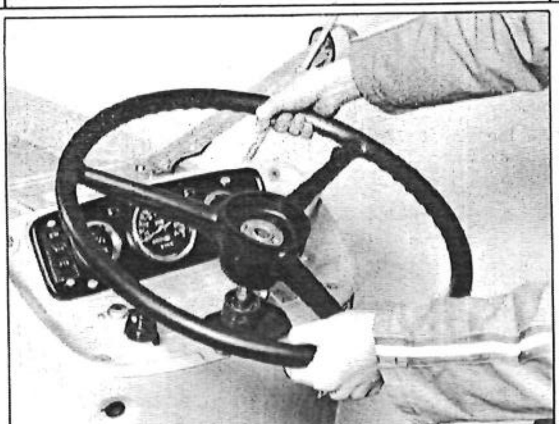
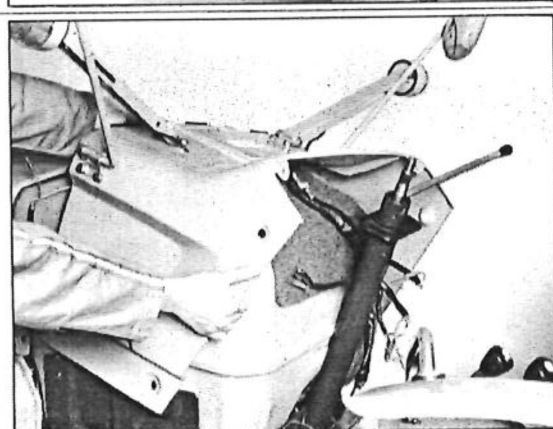
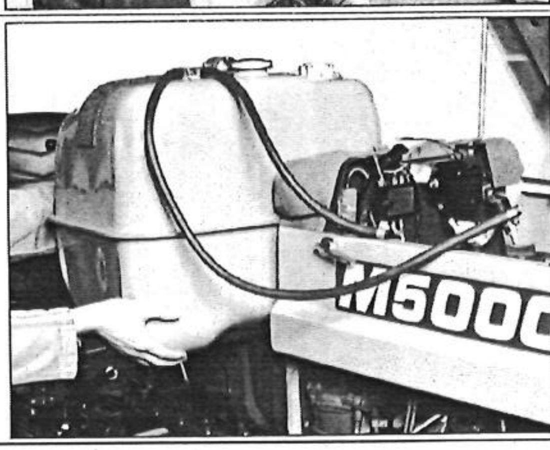
MISSION CASE

Procedure	Remarks
1) Drain gear oil from the clutch housing and the transmission case.	
1) Remove the bonnet (front) and the battery negative cable. 2) Disconnect the flasher lamp leads and the tail lamp leads. 3) Disconnect the reverse lamp leads and the license plate lamp leads. 4) Remove the trailer socket. 5) Remove the cable clamp. 6) Disconnect the stop lamp switch leads from connectors.	
1) Remove the fender covers (right and left). 2) Remove the external circlip from the brake pedal shaft and the hand brake rod. 3) Remove the four springs. 4) Remove the brake rods (right and left). 5) Remove the steps (right and left).	

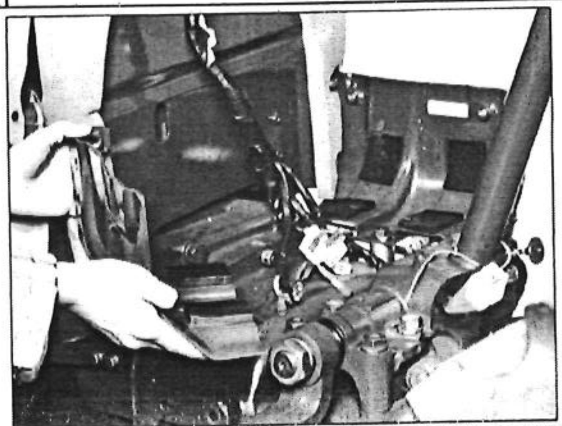
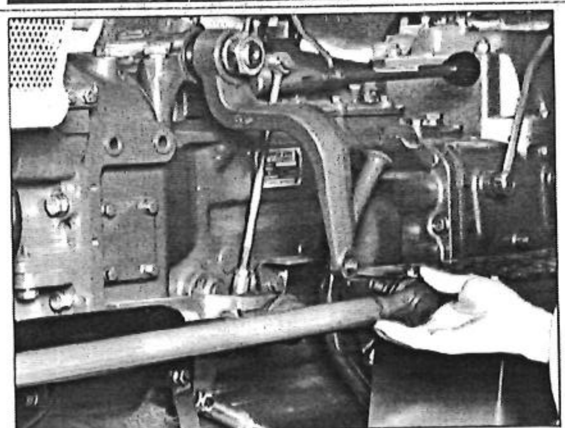
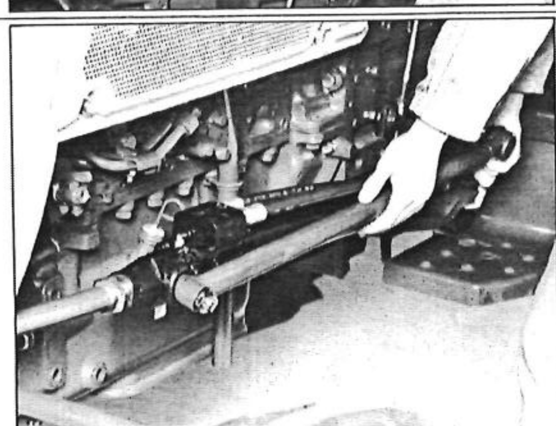
Item	Location	Bolts and nuts	Tools
Disassembly (4) Hydraulic pipes		·········· 2 M8 x 50 ·········· 3	12 22 27
Disassembly (5) Disassembly and reassembly bases	 	M14··· 2 M12··· 2	17 22 Disassembly and reassembly base
Disassembly (6) Separation		M12x40 ·········12 M12x50 ········· 1 M8 x 28 ········· 2	17 12 (When reassembling)

Procedure	Remarks
1) Disconnect the suction pipe from the transmission case. 2) Disconnect the delivery pipe from the auxiliary control valve.	
1) Set two bases under the tractor main frame, one under the clutch housing and the other under the transmission case, and then jack them up to the same level.	
1) Remove the transmission case cover (top). 2) Separate the transmission case from the clutch housing.	(When reassembling) • Tighten the set bolts to 77.5 to 90.2 N·m. (7.9 to 9.2 kgf·m., 57.1 to 66.5 lb.ft.)

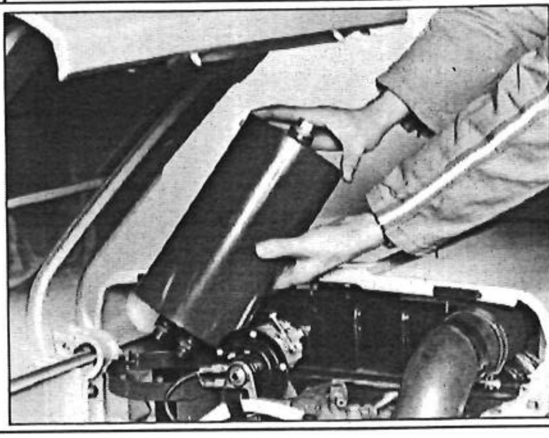
4. REMOVING OF THE STEERING ASSEMBLY

Item	Location	Bolts and nuts	Tools
Disassembly (1) Steering wheel		M14··· 1	21 (When reassembling)
Disassembly (2) Bonnet, Panel		Bonnet set bolt ·········· 6 M10x20 ·········· 6 M8 x 16 ·········· 4	14
Disassembly (3) Fuel tank		M10x75 ·········· 1 Lock nut M10··· 1 M10··· 1 M4····· 1	7 14

Procedure	Remarks
1) Remove the steering wheel cap. 2) Remove the lock nut and then the steering wheel.	(When reassembling) ● Tighten the lock nut to 58.8 to 78.4 N·m. (6 to 8 kgf·m., 43.4 to 57.9 lb.ft.)
1) Remove the bonnet (rear) complete, the bonnet (rear) and the panel.	
1) Close the cock. 2) Disconnect the fuel pipe (1) from the filter (1). 3) Disconnect the fuel pipe (2) from the filter (2). 4) Disconnect the fuel pipe (3) from the nozzle. 5) Disconnect both the fuel tank unit ground lead and the connector lead from the fuel tank unit. 6) Remove the fuel tank clamp bands (right and left) and then the fuel tank.	

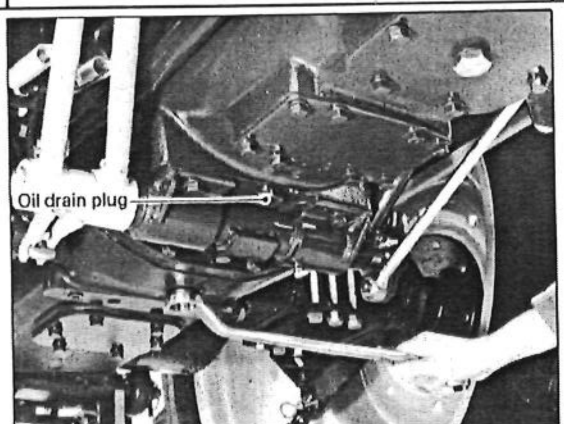
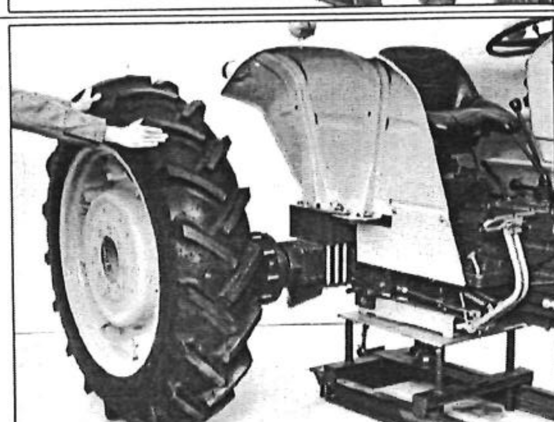
Item	Location	Bolts and nuts	Tools
Disassembly (4) Fuel tank support (left)		M12x30 .... 1 M12x50 .... 1 M10x20 .... 1 M12... 1 Spacer 1	14 17
Disassembly (5) Drag link		.... 1 M14... 1	22 (When reassembling)
Disassembly (6) Steering assembly		.... 1 M5.... 1 M16x90 4	23 (When reassembling)
Disassembly (7) Booster assembly		M16x75 2	23 36

Procedure	Remarks
1) Remove the fuel tank support (left)	
1) Disconnect the drag link by using the tie-rod pin puller.	(When reassembling) ● Tighten the drag link nut to 49.0 to 78.4 N·m. (5 to 8 kgf·m., 36.2 to 57.9 lb.ft.)
1) Remove the accelerator rod. 2) Remove the steering assembly.	(When reassembling) ● Tighten the steering assembly mounting bolts to 196.1 to 225.5 N·m. (20 to 23 kgf·m., 144.7 to 166.4 lb.ft.)
1) Drain oil from the auxiliary tank by disconnecting the high- and low-pressure hoses. 2) Remove the booster bracket. 3) Slacken the lock nut at the link end (front) and then remove the booster assembly.	● The amount of oil in the auxiliary tank is 2 liters (0.5 gal.)

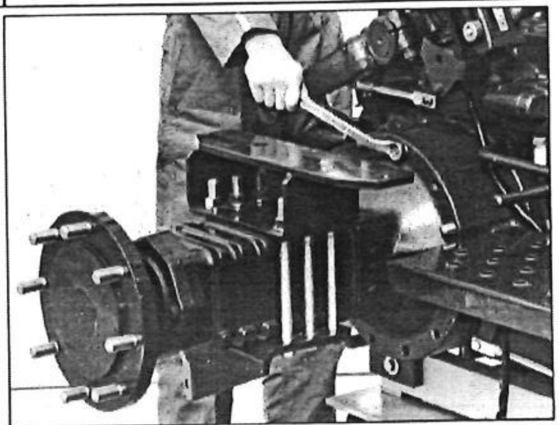
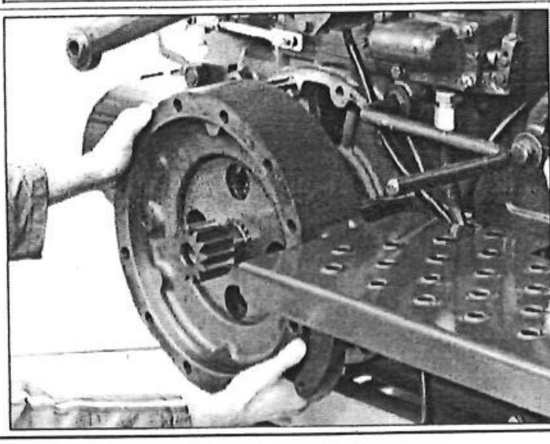
Item	Location	Bolts and nuts	Tools	
Disassembly (8) Auxiliary tank		M8 x 20 .... 2 M8····· 2 M8······2	22 10	

Procedure	Remarks
1) Remove the cover (left). 2) Disconnect the suction pipe joint and the return pipe joint from the auxiliary tank. 3) Slacken the tank clamp band. 4) Remove the auxiliary tank.	

5. REMOVING OF THE REAR AXLE CASES AND THE BRAKES

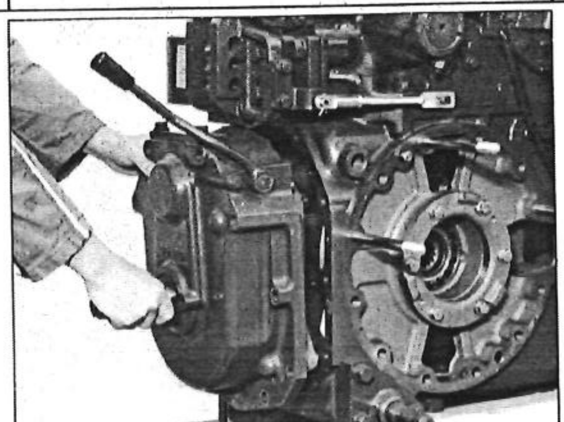
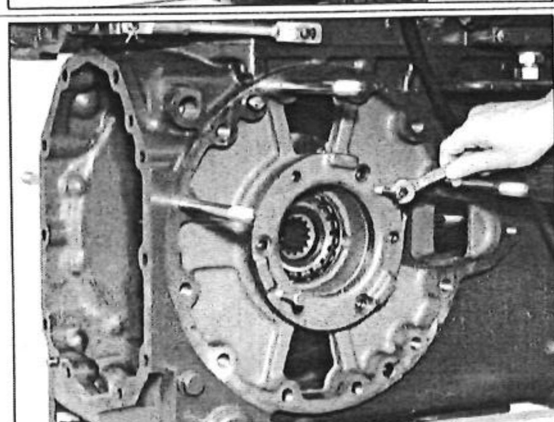
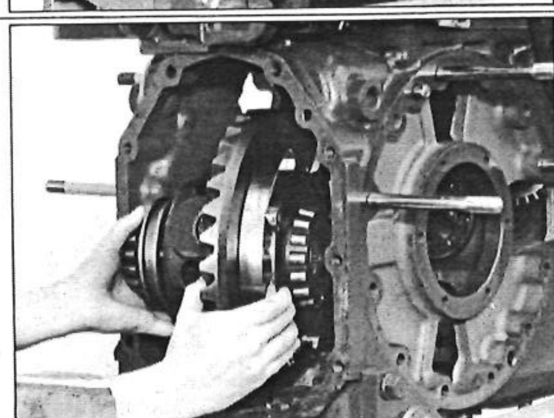
Item	Location	Bolts and nuts	Tools
Disassembly (1) Transmission oil	 	.... 2 2	27
Disassembly (2) Disassembly and reassembly bases	 	M12x40 .... 2 M10x30 .... 2 M10··· 2	14 19
Disassembly (3) Rear wheels, Fenders		Rear wheel set nut .... 16 Spring washer .... 16 M12x40 ....10 Washer .... 8 Pad .... 10 Distance piece 10	17 (When disassembling)

Procedure	Remarks
1) Drain gear oil from both the clutch housing and the transmission case.	
1) Set a base under the transmission case and then jack it up.	
1) Remove the rear wheels. 2) Remove the leads of the flasher lamps and tail lamps. 3) Remove the fenders and the mud covers.	(When reassembling) • Tighten rear wheel lock nuts to 362.8 to 402.0 N·m. (37 to 41 kgf·m., 267.6 to 296.6 lb.ft.)

Item	Location	Bolts and nuts	Tools
Disassembly (4) Rear axle cases		M14x140 ·········· 18 M14····· 6	19 (When reassembling)
Disassembly (5) Brake cases		M12x75 ·········· 2 ϕ10x35 ·········· 2 M10··· 2 ·········· 2	17

Procedure	Remarks
1) Remove the rear axle cases.	(When reassembling) • Tighten the rear axle case mounting bolts and nuts to 123.6 to 147.1 N·m. (12.6 to 15 kgf·m., 91.1 to 108.5 lb.ft.)
1) Remove the brake rods. 2) Remove the brake cases.	

6. REMOVING OF THE DIFFERENTIAL (Refer to 'REMOVING OF THE

Item	Location	Bolts and nuts	Tools	
Disassembly (1) Transmission case rear cover		M12x115 ··········· 2 M12x105 ··········· 2 M12x55 ··········· 2 M12x35 ··········· 4 M8 x 22 ··········· 2	17 12	
Disassembly (2) Differential bearing support		M10 x 30 ·········· 12	14	
Disassembly (3) Differential				

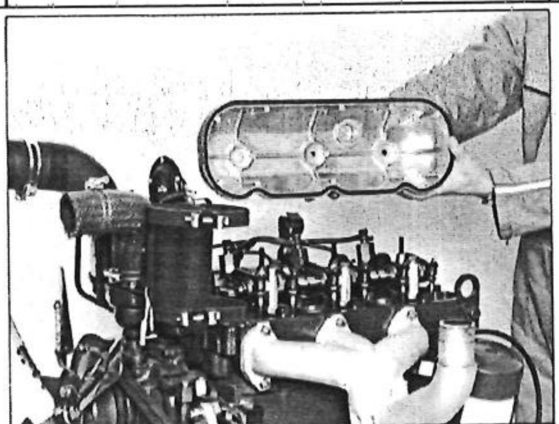
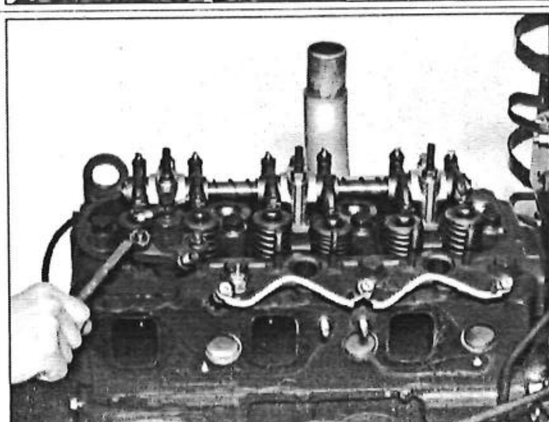
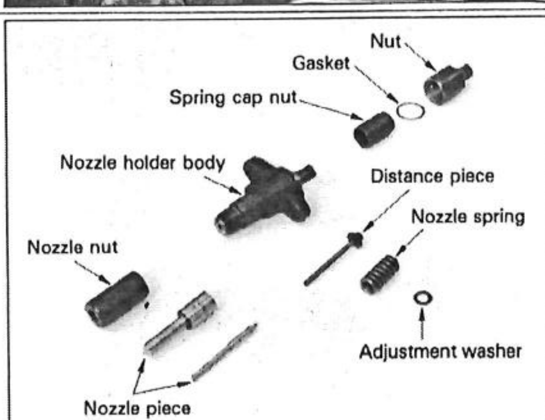
REAR AXLE CASES AND THE BRAKES' on page 26)

Procedure	Remarks
1) Remove the PTO cover. 2) Remove the transmission case rear cover.	
1) Remove the differential bearing support set bolts. 2) Remove the support, using two M8 bolts screwed into the tapped holes in support as an extractor.	• When disassembling, take note of the number of shims both right and left.
1) Remove the differential assembly from the transmission case.	

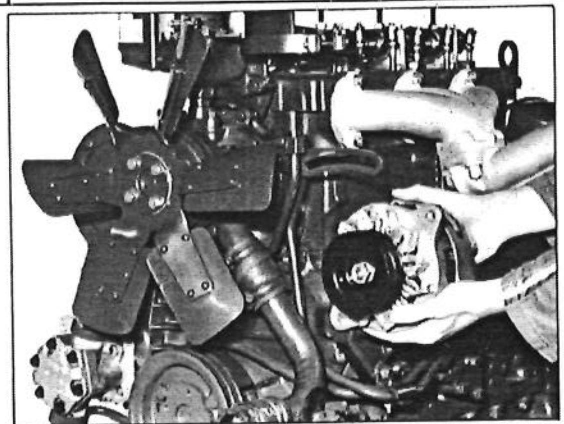
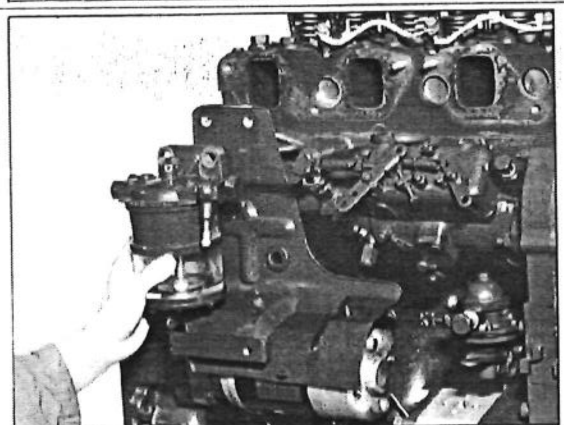
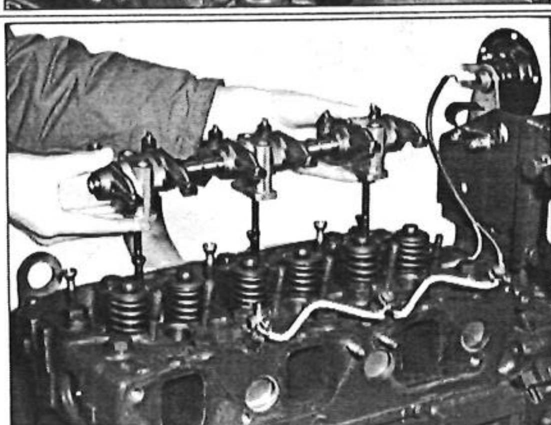
II. ENGINE

DISASSEMBLY (D3000, V4000L, V4000)

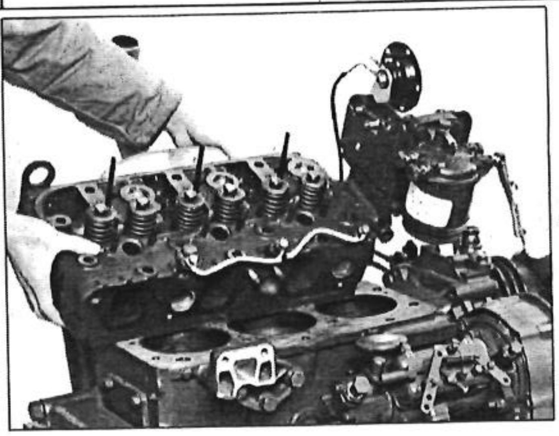
1. CYLINDER HEAD

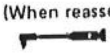
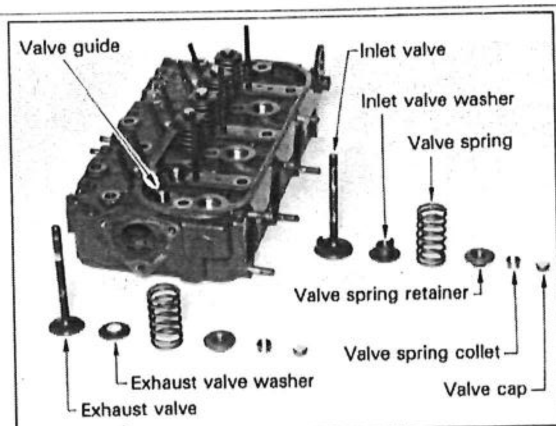
Item	Location	Bolts and nuts	Tools
Disassembly (1) Cylinder head cover, Muffler		M8······ 3 M8······ 3 (Copper) M8x85 ············ 1 M8······ 1	13
Disassembly (2) Inlet manifold, Injection pipes, Nozzle holders		M8x22 ············ 2 M10x35 ············ 1 M8······ 8 Pipe clip ·········· 4	13 17 13 17
Disassembly (3) Disassembling nozzle holder			20 (When reassembling)

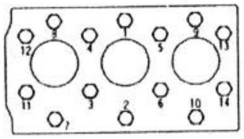
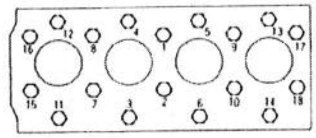
Procedure	Remarks
1) Remove the cylinder head cover. 2) Remove the muffler.	
1) Remove the inlet manifold. 2) Disconnect the injection pipes. 3) Remove the fuel over-flow pipes. 4) Remove the nozzle holders and the copper gaskets.	(When reassembling) • Take care that no carbon or dirt gets in. • Replace the copper gaskets with new ones.
1) Clamp the nozzle holder body in a vise. 2) Remove the nut, the spring cap nut and the nozzle spring. 3) Remove the nozzle nut and take out parts inside.	• When disassembling and reassembling the nozzle piece, dip it in clean fuel. (When reassembling) • Tighten the nut to 67.8 to 71.1 N·m. (691 $^{+34}_{0}$ kgf·cm., 50.0 to 52.4 lb.ft.), and the nozzle nut to 81.4 to 85.4 N·m. (830 $^{+41}_{0}$ kgf·cm., 60.0 to 63.0 lb.ft.).

Item	Location	Bolts and nuts	Tools
Disassembly (4) Alternator		M10x48 ············ 1 M10x120 ············ 1 M10 ··· 2	17
Disassembly (5) Fuel pipes 1, 2 and 3, Sedimenter		············ 6 ············ 12 (Copper) M10x35 ············ 2	14 17 19 17
Disassembly (6) Thermostat		M8x28 ············ 1 M8x25 ············ 1 M8x30 ············ 1	13
Disassembly (7) Rocker arm, Push-rods		M8x65 ············ 3 M8······ 3	13 (When reassembling)

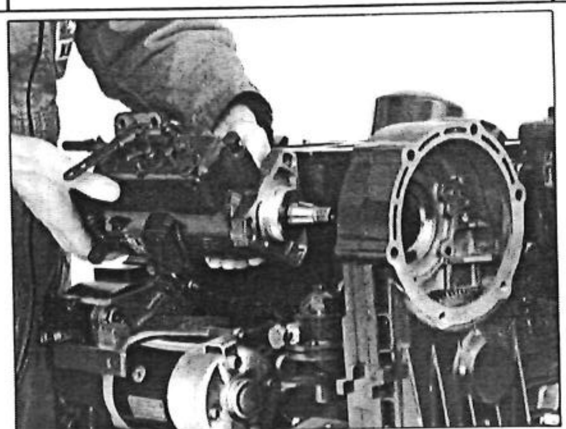
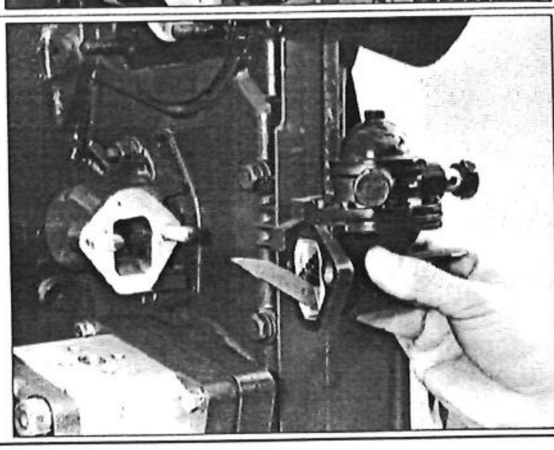
Procedure	Remarks
1) Remove the alternator. 2) Remove the fan belt.	
1) Disconnect the fuel pipes 1, 2 and 3. 2) Remove the sedimenter and the starter cover.	
1) Remove the thermostat cover. 2) Remove the thermostat.	
1) Remove the rocker arm bracket. 2) Remove the push-rods.	(When reassembling) ● Insert the push-rods into the tappets securely. ● Tighten the rocker arm bracket mounting bolts to 23.5 to 27.5 N·m. (2.4 to 2.8 kgf·m.,17.4 to 20.3 lb.ft.).

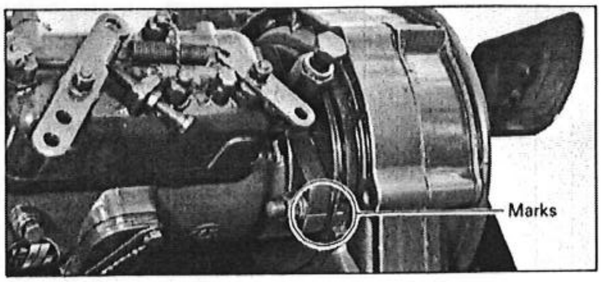
<table>
<tr><th>Item</th><th>Location</th><th>Bolts and nuts</th><th>Tools</th></tr>
<tr><td>Disassembly (8)
Cylinder head</td><td></td><td>Cylinder head bolt
.... 14
Cylinder head washer
.... 14
 M10x28
.... 1
M10x40
.... 2</td><td> 19
14

(When reassembling)
</td></tr>
<tr><td>Disassembly (9)
Valves</td><td>
</td><td></td><td>
</td></tr>
</table>

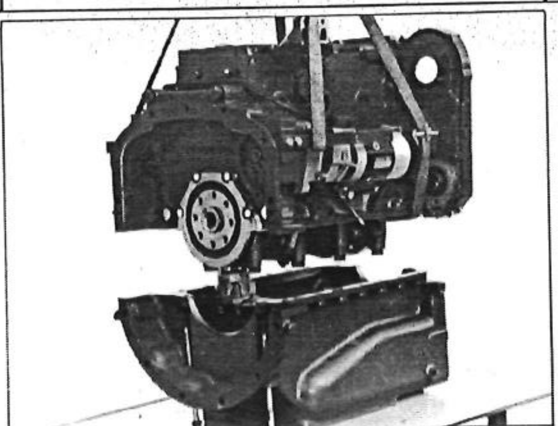
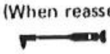
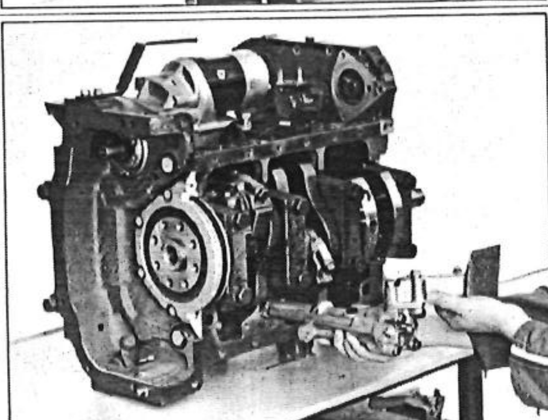
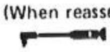
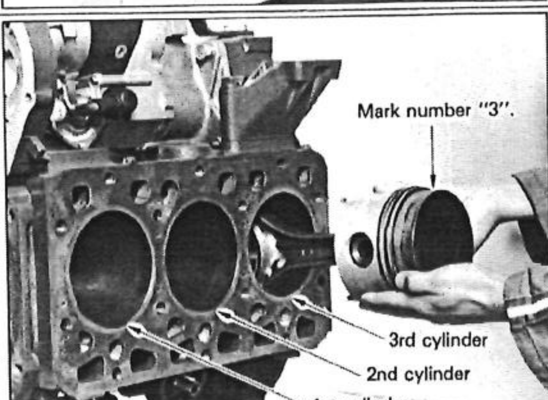
<table>
<tr><th>Procedure</th><th>Remarks</th></tr>
<tr><td>1) Remove the cylinder head.
2) Remove the cylinder head gasket and its shim.
3) Remove the thermostat support.</td><td>(When reassembling)
• Apply engine oil to each head bolt; tighten them equally and in the right order.
Tighten them to 127.5 to 137.3 N·m. (13 to 14 kgf·m., 94.0 to 101.3 lb.ft.).
Fig. 1 Cylinder head tightening steps
D3000

Gear case side Flywheel side
V4000L
V4000

• When overhauling the engine, replace the gasket with a new one. Be sure the right side is facing up.
Insert the cylinder head gasket shim between the cylinder head and the cylinder head gasket. Retighten the cylinder head after running the engine for 30 minutes.</td></tr>
<tr><td>1) Remove the valve caps and the valve spring collets.
2) Remove the valve spring retainers and the valve springs.
3) Remove the valve washers and the valves.</td><td></td></tr>
</table>

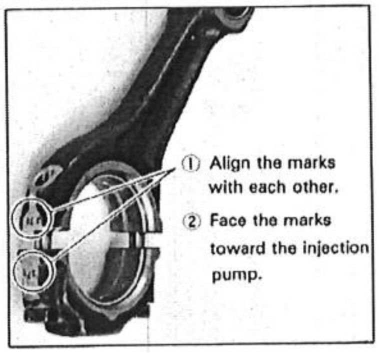
2. INJECTION PUMP

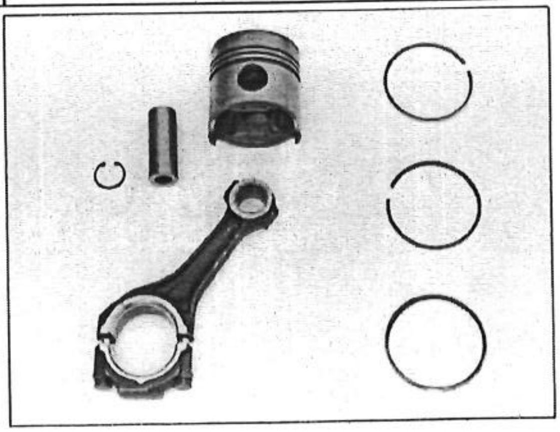
Item	Location	Bolts and nuts	Tools
Disassembly (1) Injection pump		M8x18 ········· 2 M8x50 ········· 4 ········· 1 Special spring washer ········· 1 M10x20 ········· 2 M8······ 3	13 17 19
Disassembly (2) Fuel pump		M8······ 2	13

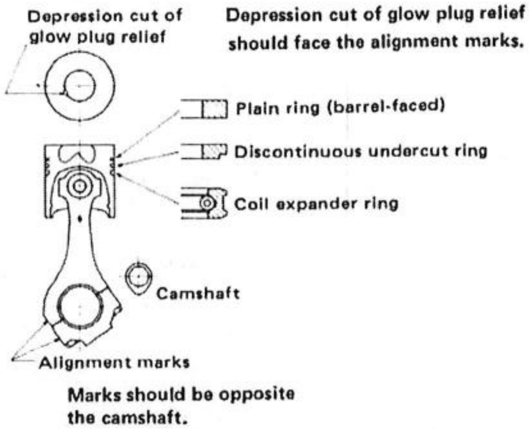
Procedure	Remarks
1) Remove the injection pump cover. 2) Remove the injection pump gear. 3) Remove the injection pump and the injection pump base.	(When reassembling) ● Make sure the marks on the injection pump and the gear case line up with each other. 
1) Remove the fuel pump.	

3. PISTONS AND OIL PUMP

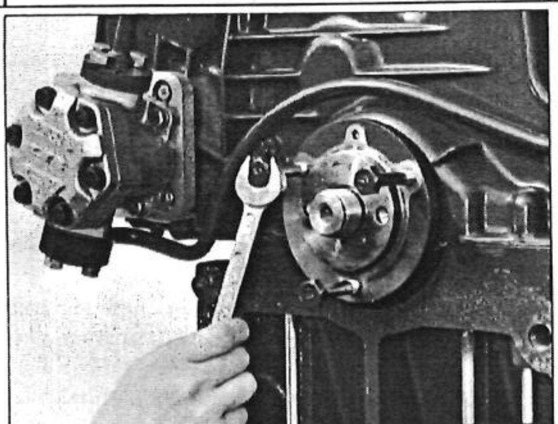
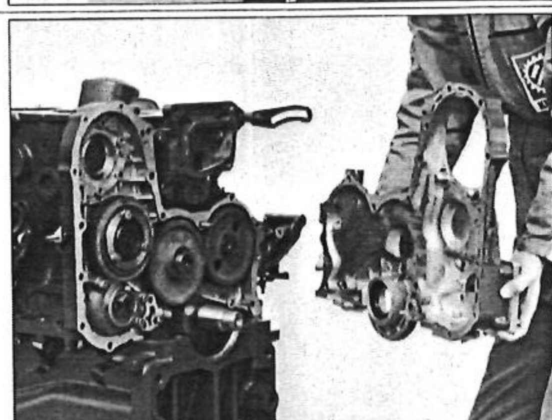
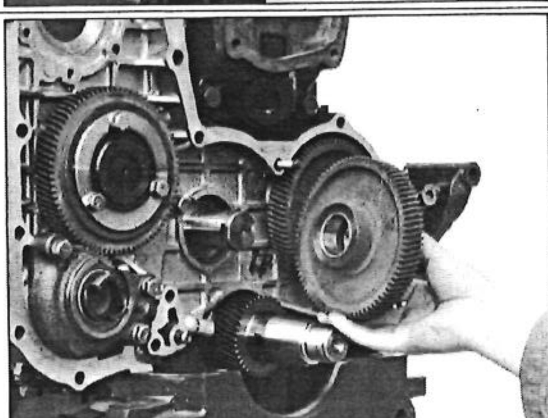
Item	Location	Bolts and nuts	Tools
Disassembly (1) Oil pan		 M10x40 ············ 14 M10x30 ············ 2 Special bolt ············ 2  M10 ··· 5	 17 17 (When reassembling) 
Disassembly (2) Oil pump, Oil filter		 M8x25 ············ 2	 13 (When reassembling) 
Disassembly (3) Pistons		 ············ 6	 19 (When reassembling) 

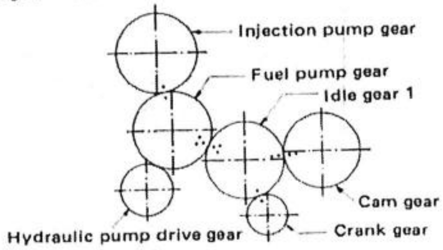
Procedure	Remarks
1) Remove the oil pan.	(When reassembling) ● Tighten the oil pan mounting bolts to 60.8 to 70.6 N·m. (6.2 to 7.2 kgf·m., 44.8 to 52.1 lb.ft.).
1) Remove the oil pump and the oil filter as an assembly.	(When reassembling) ● Tighten the oil pump mounting bolts to 23.5 to 27.5 N·m. (2.4 to 2.8 kgf·m., 17.4 to 20.3 lb.ft.).
1) Remove the cap from the large end of the connecting rod. 2) Push out the piston to the cylinder head side with a hammer grip. After pushing the piston out, mark each piston to indicate its number.	(When reassembling) ● Before tightening, apply engine oil to the connecting rod bolts. Tighten them to 98.1 to 107.9 N·m. (10 to 11 kgf·m., 72.3 to 79.6 lb.ft.). **Reassembling of connecting rod** 

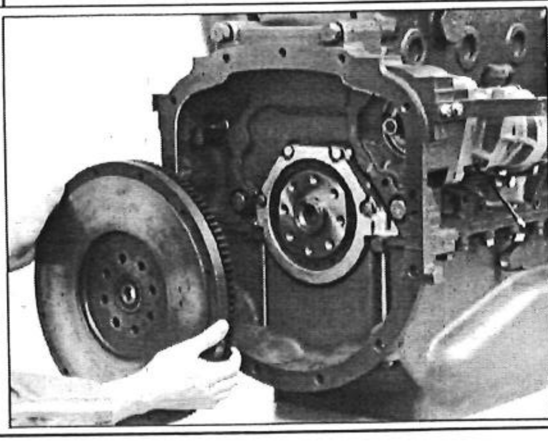
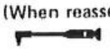
Item	Location	Bolts and nuts	Tools
Disassembly (4) Piston rings, Piston pin		 2	

Procedure	Remarks
1) Remove the piston rings. 2) Remove the piston pin. To avoid wrong reassembling, write down the number of the piston and the connecting rod as a pair. **For example; No. of piston ..... No. of connecting rod.**	(When reassembling) **Fig. 2 Reassembling of piston, piston rings and connecting rod**  • When reassembling a connecting rod to the piston, check the numbers on them first, and face the depression cut of the glow plug relief toward the numbers on the connecting rod. Tap in the piston pin without heating the piston. • When reassembling the piston rings to the piston, face the mark (manufacturer's name or "TOP") toward the piston head. • When installing the coil expander in the ring, place the expander joint on the opposite side (180°) of the ring gap. • Place the piston rings so that there are gaps every 90° with no gap facing the piston pin in the cylinder.

4. GEAR CASE AND FLYWHEEL

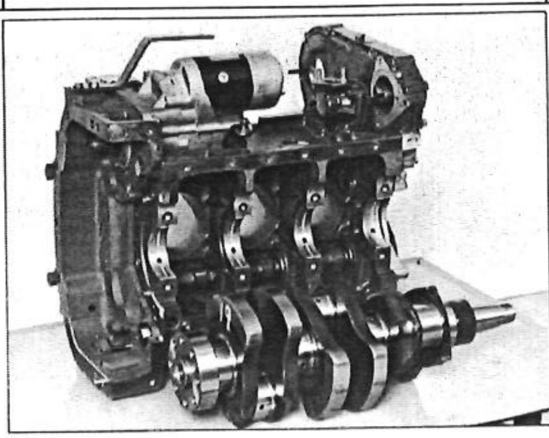
Item	Location	Bolts and nuts	Tools
Disassembly (1) Fan drive pulley, Pulley flange		M10x55 .... 3 Crankshaft nut .... 1 Crankshaft washer 1	 17 17 46 46
Disassembly (2) Gear case cover		M6x30 .... 4 M8x30 .... 1 M8x50 .... 5 M8x70 .... 6 M10x70 .... 1 M8 ...... 1 M8x22 .... 4 M8x30 .... 2 M8x65 .... 1 Special bolt ... 3 M10 ... 3	 13 10 17
Disassembly (3) Idle gear		 1	

Procedure	Remarks
1) Remove the fan drive pulley. 2) Screw in the three M10 bolts to remove the pulley flange.	
1) Remove the hydraulic pump for the power steering. 2) Remove the hydraulic pump for implement control and the pump base. 3) Remove the gear case cover.	
1) Remove the idle gear.	(When reassembling) ● Line up the marks on each of the gears. **Fig. 3 Gear marks** 

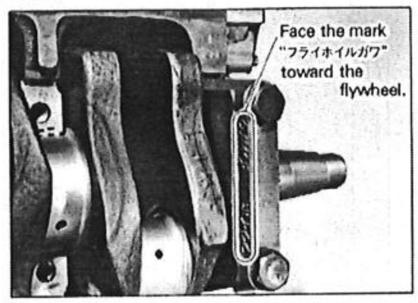
Item	Location	Bolts and nuts	Tools
Disassembly (4) Flywheel		Flywheel washer .... 1 Flywheel bolt 8	 19 (When reassembling) 

Procedure	Remarks
1) Remove the flywheel.	(When reassembling) • Tighten the flywheel bolts to 98.1 to 107.9 N·m. (10 to 11 kgf·m., 72.3 to 79.6 lb.ft.).

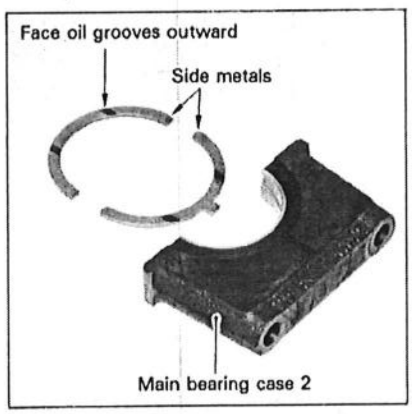
5. CRANKSHAFT AND CAMSHAFT

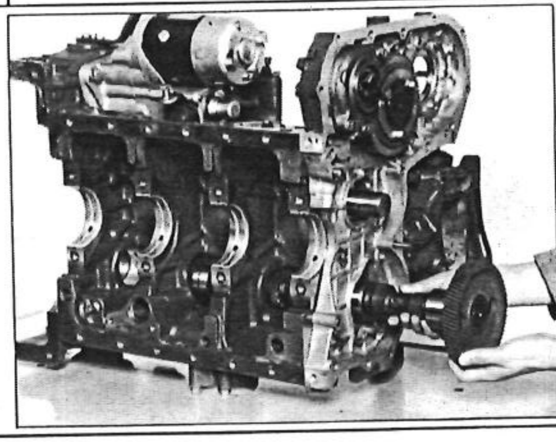
Item	Location	Bolts and nuts	Tools
Disassembly (1) Crankshaft		M8x32 .... 4 Bearing case bolt 8	24 13 (When reassembling)

Procedure	Remarks
1) Remove the bearing case cover. 2) Remove the main bearing cases 1 and 2. 3) Remove the crankshaft.	(When reassembling) • Tighten the bearing case bolts to 176.5 to 186.3 N·m. (18 to 19 kgf·m., 130.2 to 137.4 lb.ft.). • Reassemble the main bearing case to the crankcase with the same number. Face the mark " フライホイルガワ " toward the flywheel.



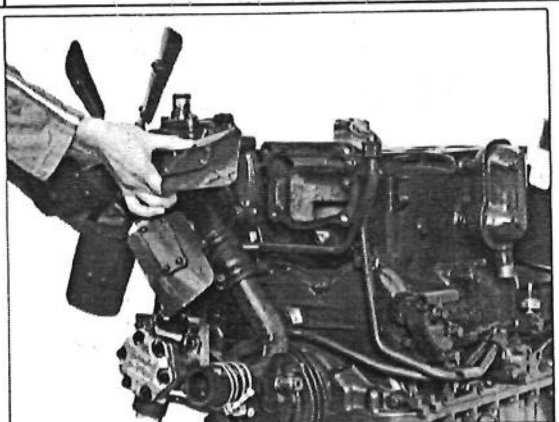
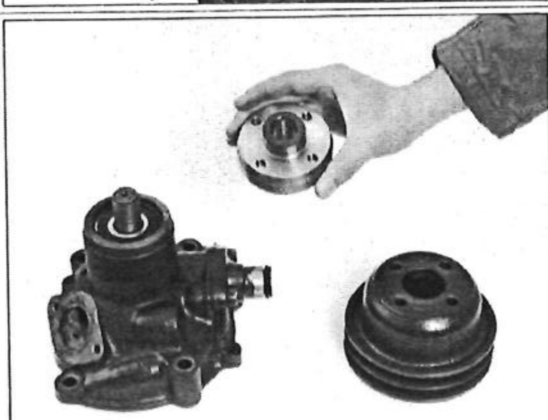
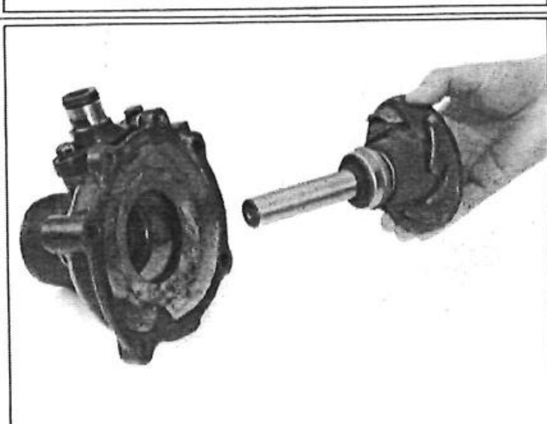
• Face outward the oil grooves of the side metal attached to the main bearing case 2.



Item	Location	Bolts and nuts	Tools
Disassembly (2) Camshaft, Tappets		M8x20 2	13

Procedure	Remarks
1) Remove the camshaft stopper. 2) Remove the camshaft. 3) Remove the tappets.	

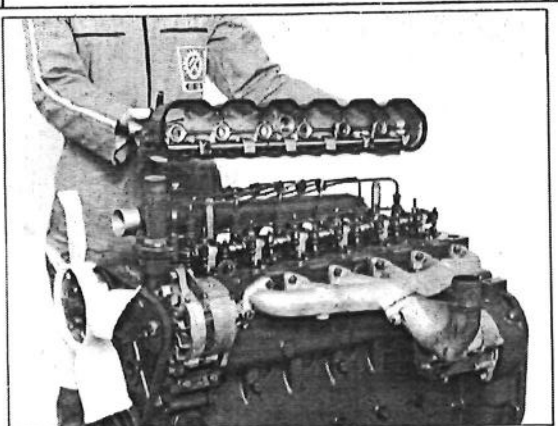
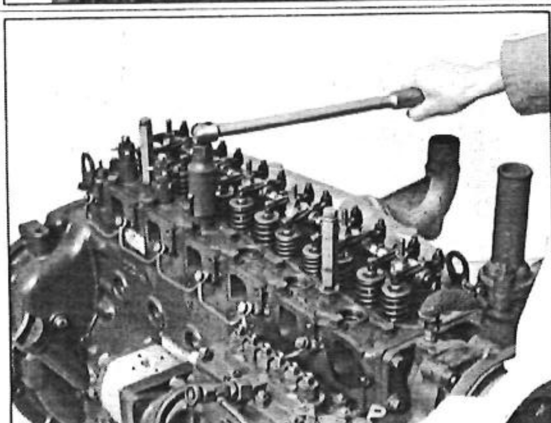
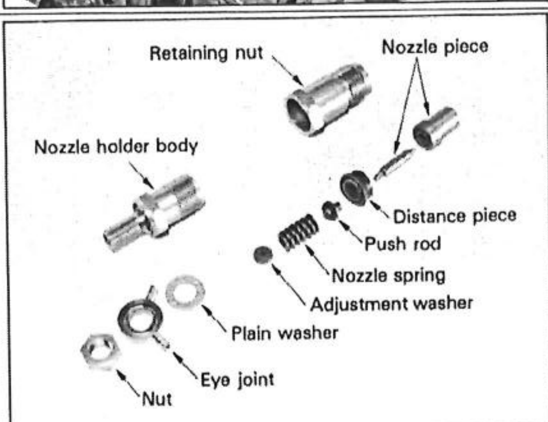
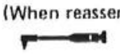
6. WATER PUMP

Item	Location	Bolts and nuts	Tools
Disassembly (1) Water pump		 M10x35 .... 1 M10x55 3	 17
Disassembly (2) Fan pulley		 M8x30 4	 13
Disassembly (3) Water pump shaft, Mechanical seal		 M8x20 .... 2 1	 13

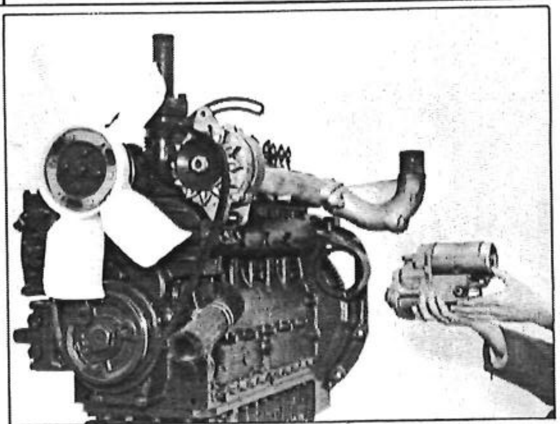
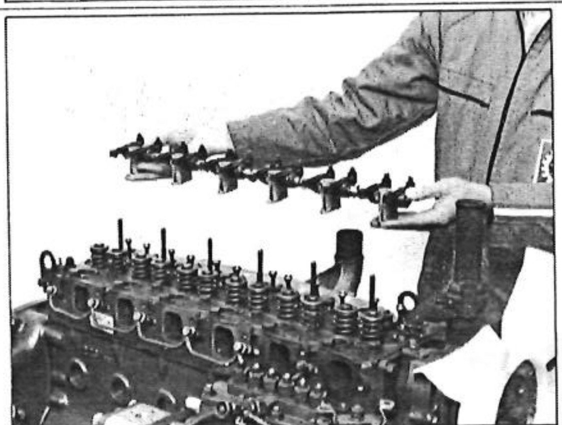
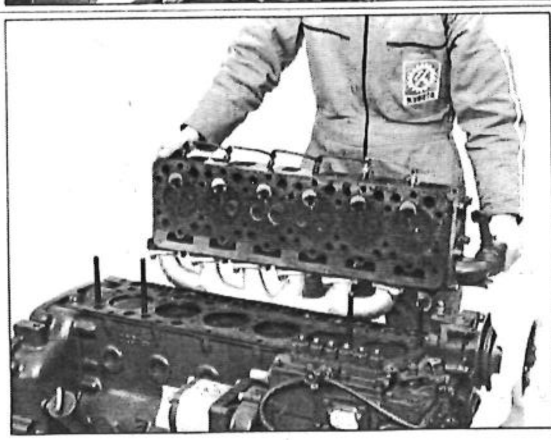
Procedure	Remarks
1) Remove the water pump from its support.	
1) Remove the fan pulley from the water pump shaft flange. 2) Remove the water pump shaft flange.	
1) Remove the water pump body cover. 2) Tap out the water pump shaft from the water pump shaft flange side. 3) Remove the mechanical seal.	

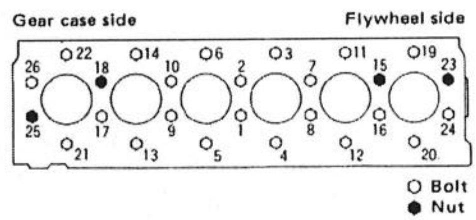
DISASSEMBLY (S2200, S2600)

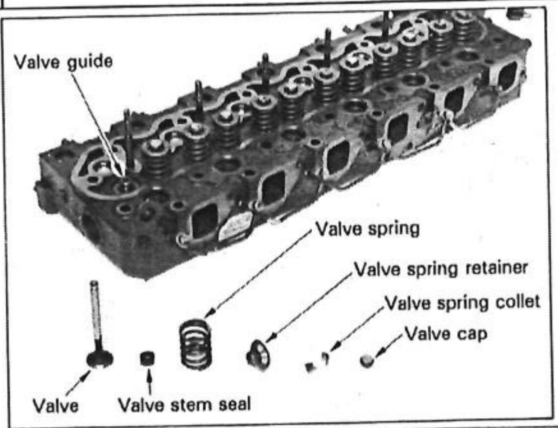
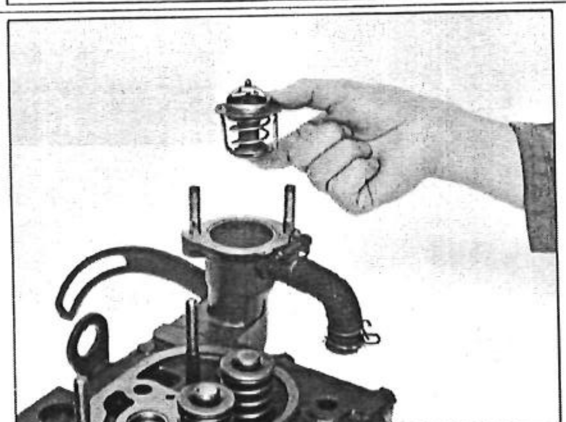
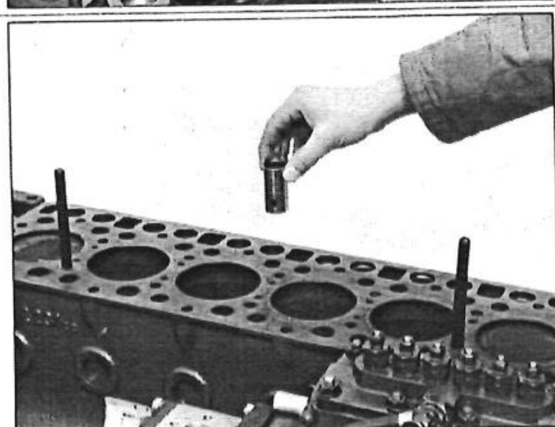
1. CYLINDER HEAD

<table>
<tr><th>Item</th><th>Location</th><th>Bolts and nuts</th><th>Tools</th></tr>
<tr>
<td>Disassembly (1)
Cylinder head cover</td>
<td></td>
<td>Head cover nut 6
Head cover washer 6
Rubber packing .... 6</td>
<td> 10</td>
</tr>
<tr>
<td>Disassembly (2)
Nozzle holders,
Injection pipes,
Inlet manifold</td>
<td></td>
<td> M8x22 11
 6
(Copper)</td>
<td> 13
17
19</td>
</tr>
<tr>
<td>Disassembly (3)
Disassembling nozzle holder</td>
<td>
</td>
<td></td>
<td>
 19
22
(When reassembling)
</td>
</tr>
</table>

Procedure	Remarks
1) Remove the cylinder head cover and head cover gasket.	
1) Disconnect the injection pipes. 2) Remove the nozzle holders and the copper gaskets. 3) Remove the inlet manifold.	(When reassembling) • Take care that no carbon or dirt gets in. • Replace copper gaskets with new ones.
1) Clamp the retaining nut in a vise. 2) Remove the nut, the eye joint and the plain washer. 3) Remove the nozzle holder body and take out the inside parts.	• When disassembling and reassembling the nozzle piece, dip it in clean fuel. (When reassembling) • Make sure the push-rod is not upside down. • Tighten the retaining nut to 58.8 to 78.4 N·m. (6 to 8 kgf·m., 43.4 to 57.9 lb.ft.), tightening torque above this may cause the needle valve to stick, impairing the injection performance of the nozzle.

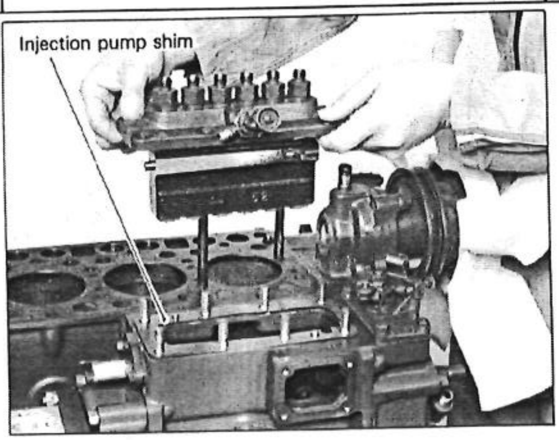
Item	Location	Bolts and nuts	Tools
Disassembly (4) Alternator, Starter		M8x30 .... 1 M10x30 .... 1 Special bolt .... 1 M8 ...... 1 M10 ... 1	13 14
Disassembly (5) Rocker arm, Push-rods		M8 6	13 (When reassembling)
Disassembly (6) Cylinder head		Cylinder head bolt .... 22 Cylinder head nut .... 4 Special plain washer 26 1	14 (When reassembling)

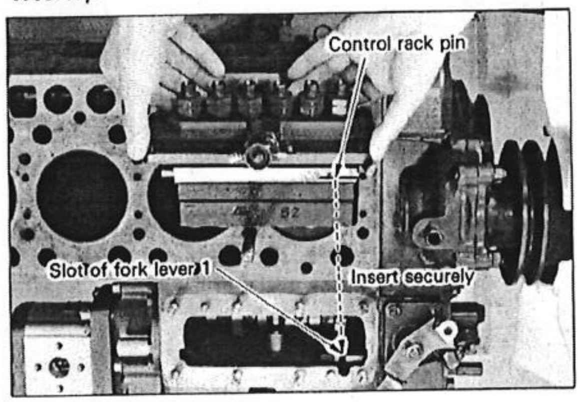
Procedure	Remarks
1) Remove the alternator. 2) Remove the fan belt. 3) Remove the starter.	
1) Remove the rocker arm bracket. 2) Remove the push-rods.	(When reassembling) • Insert the push-rods into the tappets securely. • Tighten the rocker arm bracket nuts to 23.5 to 27.5 N·m. (2.4 to 2.8 kgf·m., 17.4 to 20.3 lb.ft.).
1) Disconnect the water return pipe. 2) Remove the cylinder head. 3) Remove the cylinder head gasket, shim and O-ring.	(When reassembling) • Apply engine oil to the cylinder head bolts and nuts, and tighten them equally and in the right order. Tightening torque is 73.5 to 83.4 N·m. (7.5 to 8.5 kgf·m., 54.2 to 61.5 lb.ft.). **Fig. 4 Cylinder head tightening steps** **S2200, S2600**  • When overhauling the engine, replace the gasket with a new one. Be sure the right side is facing up. • Insert the cylinder head gasket shim between the cylinder head and the gasket. Retighten the cylinder head after running the engine for 30 minutes. • Do not forget to refit the O-ring.

Item	Location	Bolts and nuts	Tools
Disassembly (7) Valves			 
Disassembly (8) Thermostat		 M8······ 2	 13
Disassembly (9) Tappets			

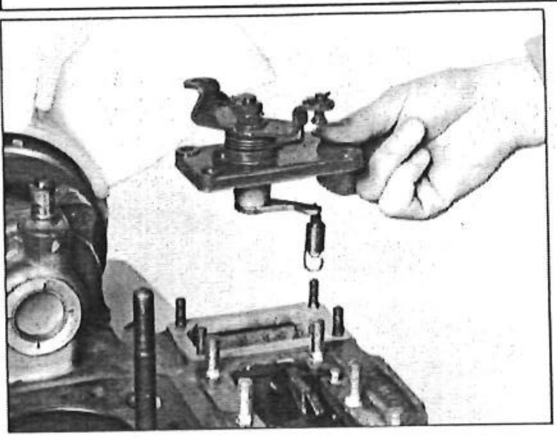
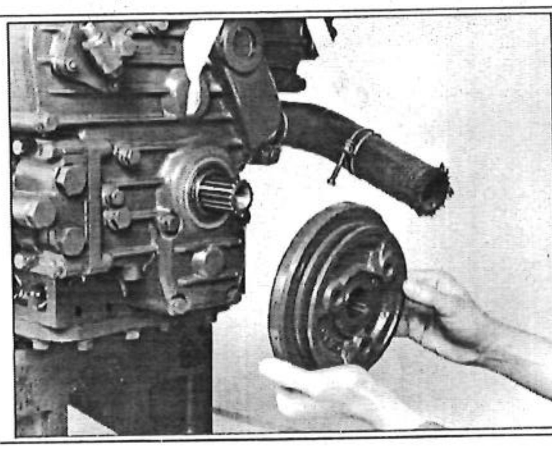
Procedure	Remarks
1) Remove the valve caps and the valve spring collets. 2) Remove the valve spring retainers and the valve springs. 3) Remove the valve stem seals and the valves.	(When reassembling) • When overhauling the engine, replace the valve stem seals with new ones. When reassembling them, apply engine oil.
1) Remove the thermostat cover. 2) Remove the thermostat.	
1) Remove the tappets.	

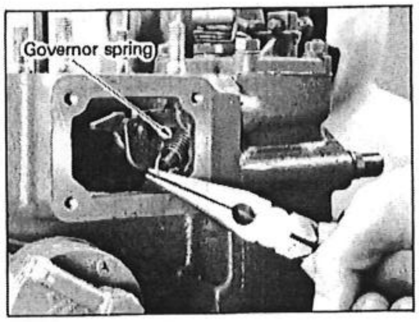
2. INJECTION PUMP

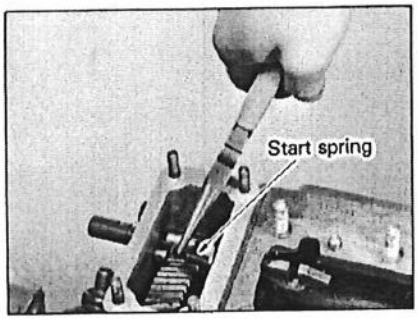
Item	Location	Bolts and nuts	Tools
Disassembly (1) Injection pump	 	 M6x12 .... 4  M8...... 8	 10  13

Procedure	Remarks
1) Remove the injection pump cover. 2) Line up the control rack pin to the slot on the crank case and then remove the injection pump. 3) Remove the injection pump shims. Write down the number of the shims for reference.	(When reassembling) ● Insert the control rack pin into the slot of fork lever 1 securely. 

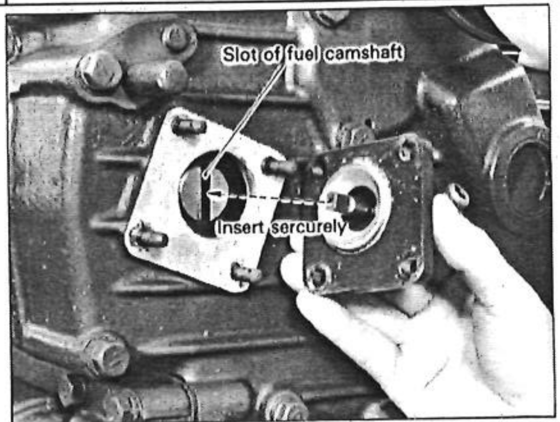
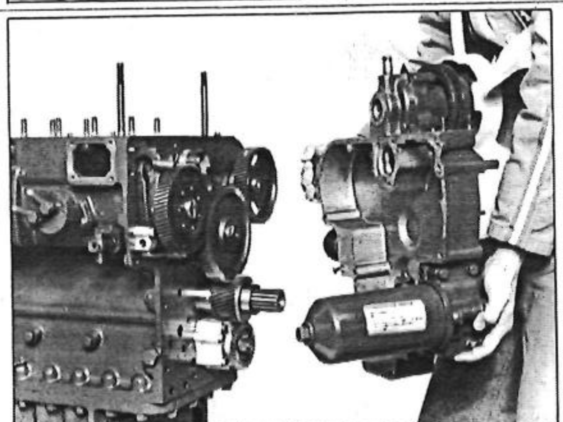
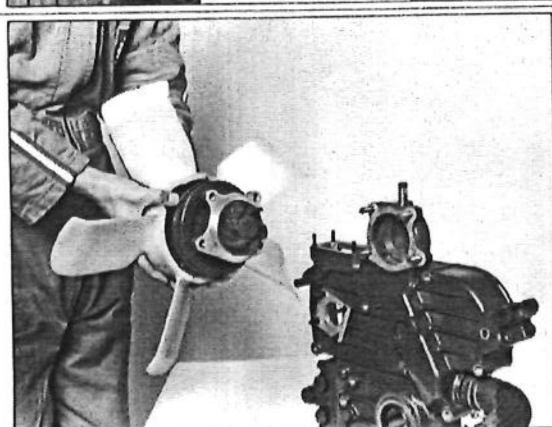
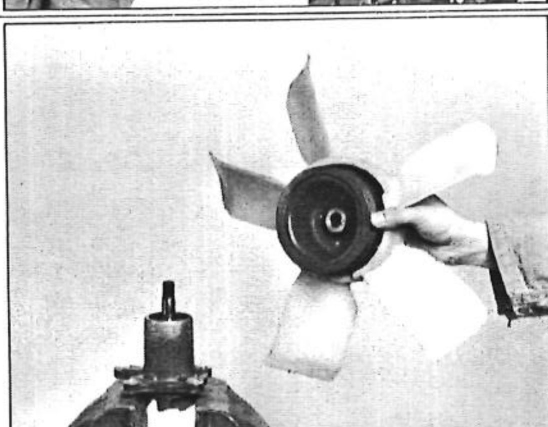
3. GEAR CASE

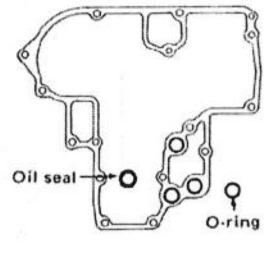
Item	Location	Bolts and nuts	Tools
Disassembly (1) Speed control plate		M6······ 4	10
Disassembly (2) Fan drive pulley		Special bolt ············ 1 ············ 1	36

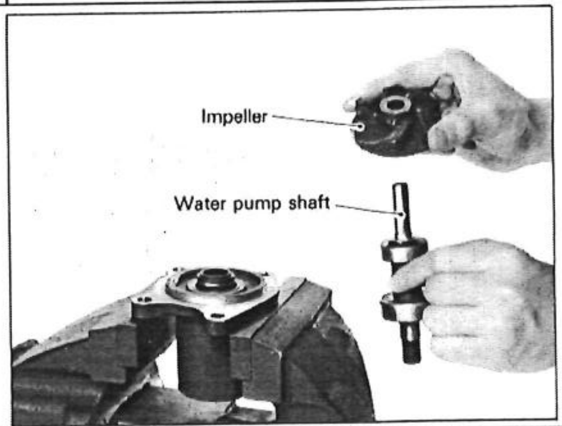
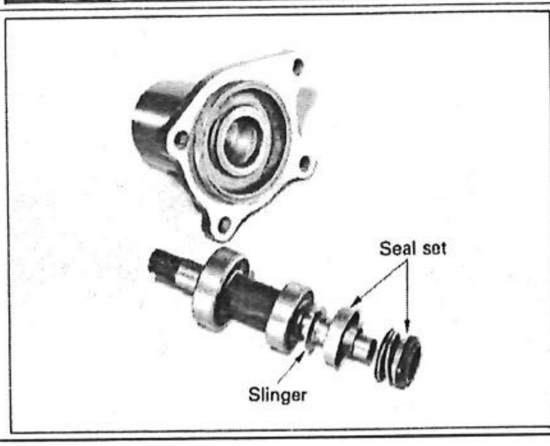
<table>
<tr><th>Procedure</th><th>Remarks</th></tr>
<tr><td>1) Remove the governor spring from governor fork lever 2.
2) Remove the speed control plate and the governor spring together.
3) Remove the start spring from the gear case.</td><td>How to remove governor spring


How to remove start spring


(When reassembling)
● Be careful not to drop the springs into the gear case.</td></tr>
<tr><td>1) Remove the fan drive pulley.</td><td></td></tr>
</table>

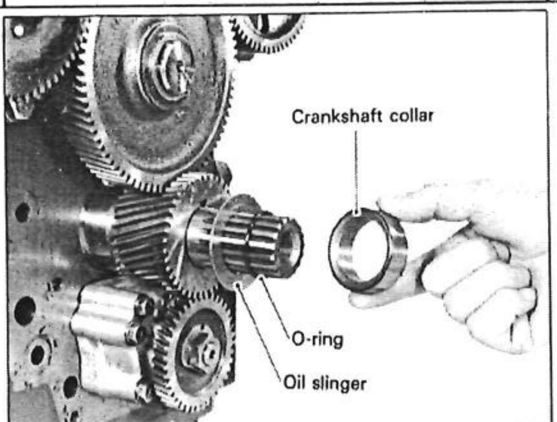
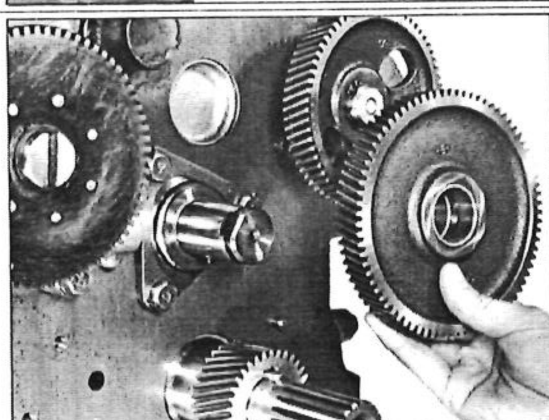
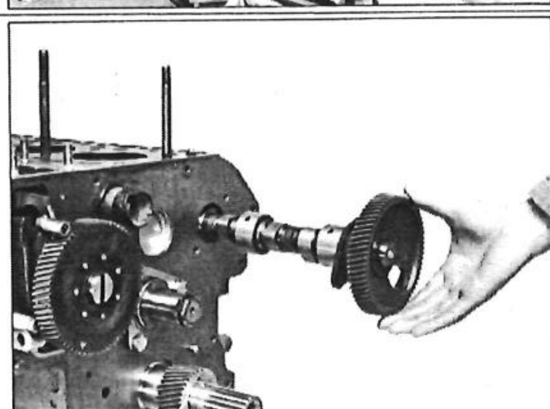
Item	Location	Bolts and nuts	Tools
Disassembly (3) Hour meter unit		M6······ 4	10
Disassembly (4) Gear case		M8x70 ············ 3 M8x80 ············ 10 M8x85 ············ 1	13
Disassembly (5) Water pump		M8······ 4	13
Disassembly (6) Disassembling water pump (1) Fan pulley		M14 ···1 ············ 1	22 (When reassembling)

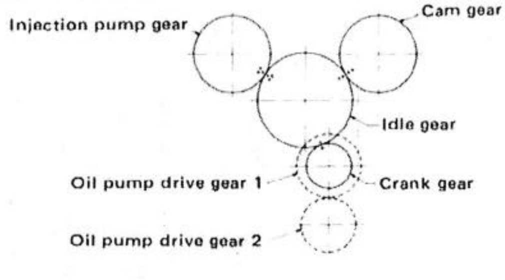
Procedure	Remarks
1) Remove the hour meter unit.	(When reassembling) ● Insert the tip of the hour meter unit shaft into the slot on the fuel camshaft securely.
1) Remove the gear case.	(When reassembling) ● Do not forget to refit the O-rings. ● Apply grease to the oil seal and refit it, being careful not to let the lip come off. Fig. 5 Position of O-rings 
1) Remove the water pump from the gear case.	
1) Clamp the fan pulley in a vise, and remove the nut. 2) Remove the fan pulley with a puller. 3) Remove the key.	

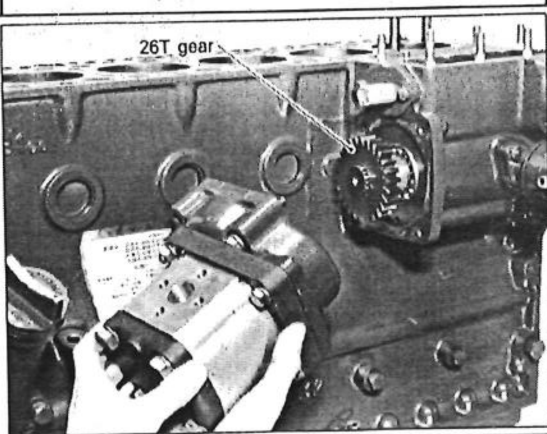
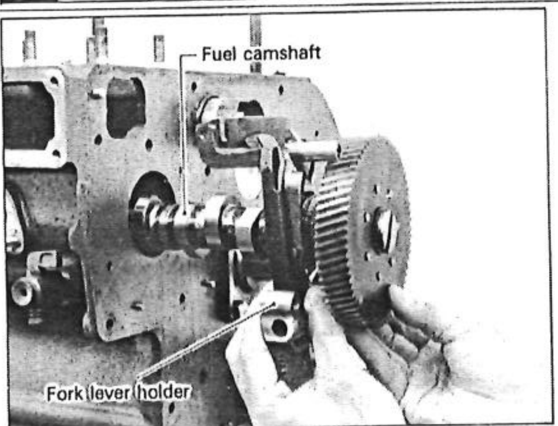
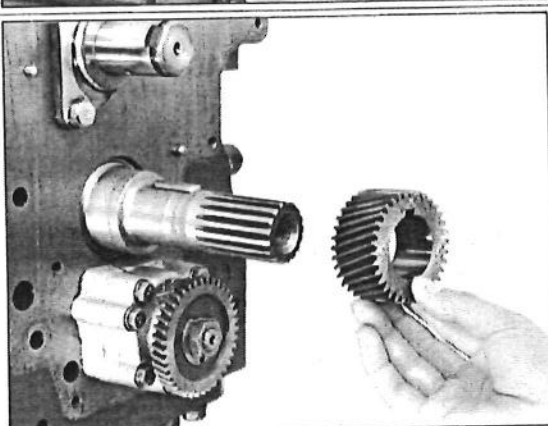
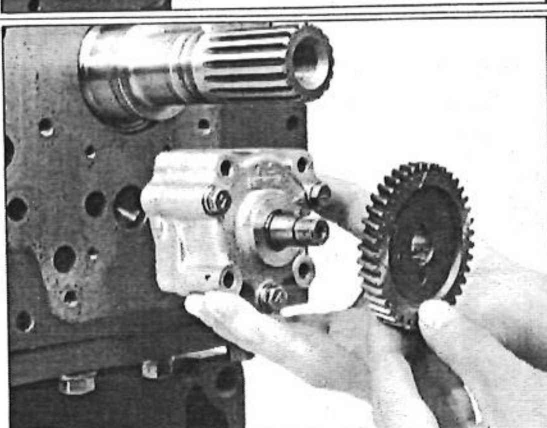
Item	Location	Bolts and nuts	Tools
Disassembly (2) Water pump shaft		 1	
Disassembly (3) Seal set			

Procedure	Remarks
1) Remove the internal circlip. 2) Tap out the water pump shaft from the impeller side of the water pump.	
1) Remove the seal set.	

4. TIMING GEARS, CAMSHAFT AND OIL PUMP

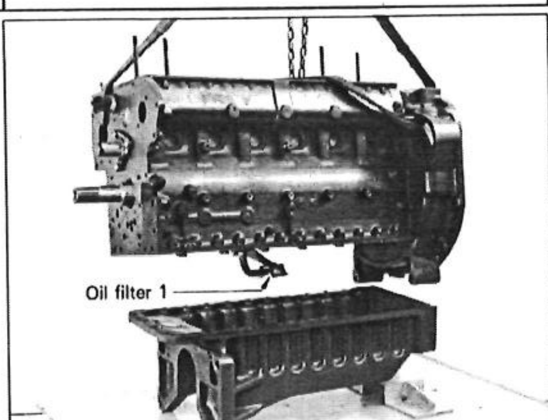
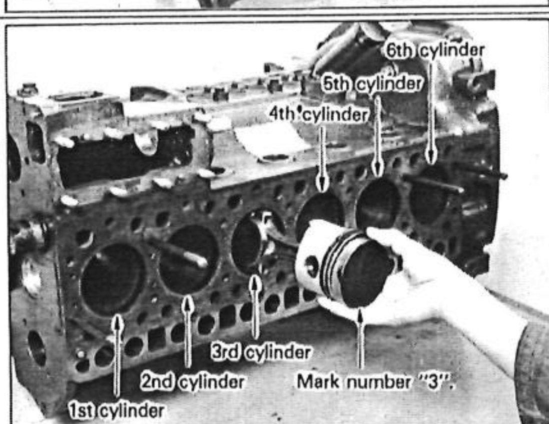
Item	Location	Bolts and nuts	Tools
Disassembly (1) Crankshaft collar, Oil slinger			
Disassembly (2) Oil pump drive gears, Idle gear		 1	 
Disassembly (3) Camshaft		 M8x10 .... 2  1	 13

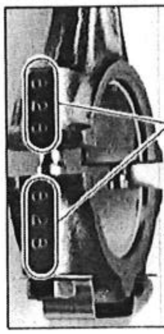
Procedure	Remarks
1) Remove the crankshaft collar, the O-ring and the oil slinger, in that order.	(When reassembling) • Apply oil to the O-ring. Do not confuse assembling order.
1) Remove the oil pump drive gears. 2) Remove the idle gear and idle gear collar 1.	(When reassembling) • Line up the marks on each of the gears. **Fig. 6 Gear marks** 
1) Remove the camshaft stopper. 2) Remove the camshaft.	

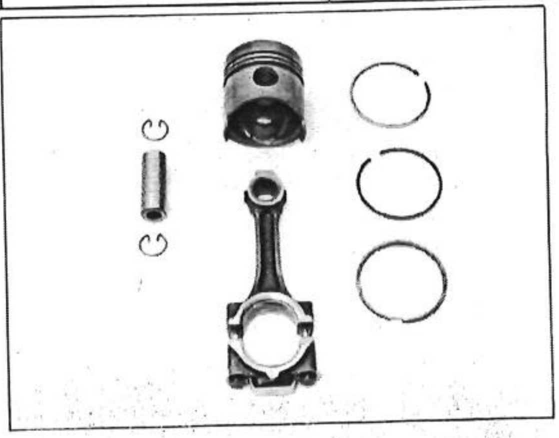
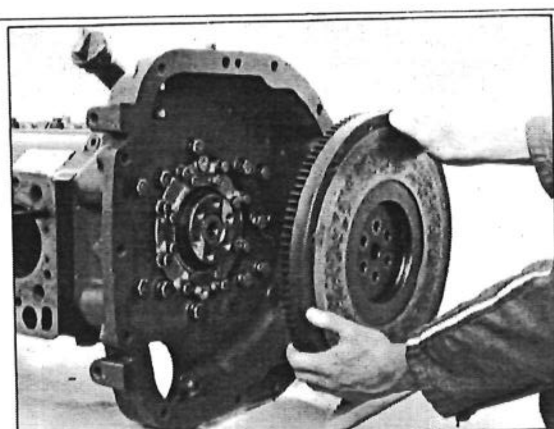
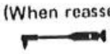
Item	Location	Bolts and nuts	Tools
Disassembly (4) Hydraulic pump, 26T gear	 	M8x50 ············ 4 ············ 1	 12
Disassembly (5) Fuel camshaft, Fork lever holder	 	M8x32 ············ 2 M6x28 ············ 1 M8x14 ············ 2 M6······ 2	 13 10
Disassembly (6) Crank gear		············ 1	
Disassembly (7) Oil pump		Special nut ············ 1 ············ 1 ············ 1 M6x48 ············ 4	 19 10

Procedure	Remarks
1) Remove the hydraulic pump and the pump base together. 2) Remove the 26T gear (hydraulic pump drive gear) and its collar.	(When reassembling) ● Reassemble the 26T gear in the right direction.
1) Remove the three set bolts for the fork lever holder. 2) Remove the fuel camshaft stopper. 3) Remove the fuel pump. 4) Remove the fuel camshaft and the fork lever holder at the same time.	
1) Remove the crank gear.	
1) Remove the oil pump driver gear. 2) Remove the oil pump.	

5. PISTONS AND CRANKSHAFT

Item	Location	Bolts and nuts	Tools
Disassembly (1) Oil pan, Oil filter 1	 	M10x32 .... 26 M10x95 .... 2 M10x115 .... 4 M12x90 .... 2 M8 x 16 1	 13 14 14 19
Disassembly (2) Pistons	 	 12 6	 13 (When reassembling) 

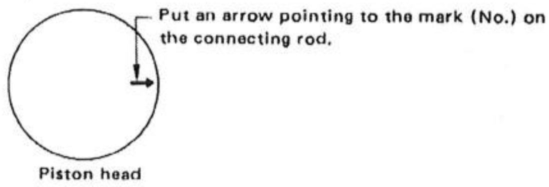
Procedure	Remarks
1) Remove the oil pan. 2) When removing oil filter 1, be careful not to drop the O-ring.	
1) Remove the cap from the large end of the connecting rod. 2) Push out the piston to the cylinder head side with a hammer grip. After pushing the piston out, mark each piston to indicate its number.	(When reassembling) ● Apply engine oil to the connecting rod bolts and tighten them to 36.3 to 41.2 N·m. (3.7 to 4.2 kgf·m., 26.8 to 30.4 lb.ft.). **Reassembling of connecting rod**  ① Align the marks with each other. ② Face the marks toward the injection pump.

Item	Location	Bolts and nuts	Tools
Disassembly (3) Piston rings			
Disassembly (4) Flywheel		Flywheel bolt .... 6 Flywheel washer 3	 19 (When reassembling) 

Procedure	Remarks

1) Remove the piston rings. .
2) Remove the piston pin. Mark the piston head so that the piston will be reassembled in the right direction. Also, to avoid wrong reassembling, write down the number of the piston and the connecting rod as a pair. For example; No. of piston ..... No. of connecting rod.

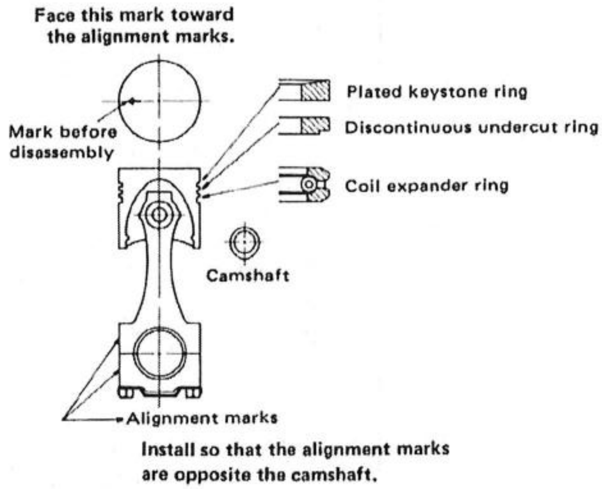
Fig. 7



Piston 1 ..... The mark (No.) on the connecting rod.

(When reassembling)

Fig. 8 Reassembling of piston, piston rings and connecting rod

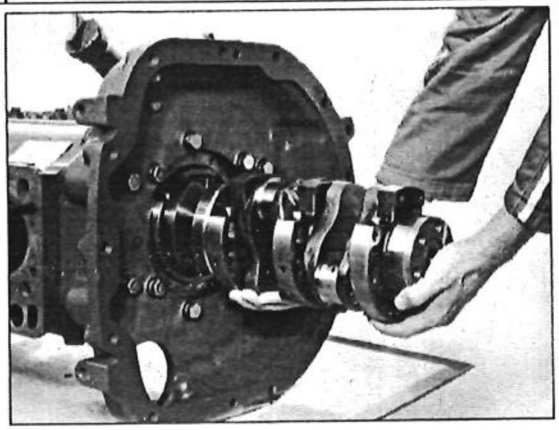
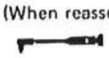
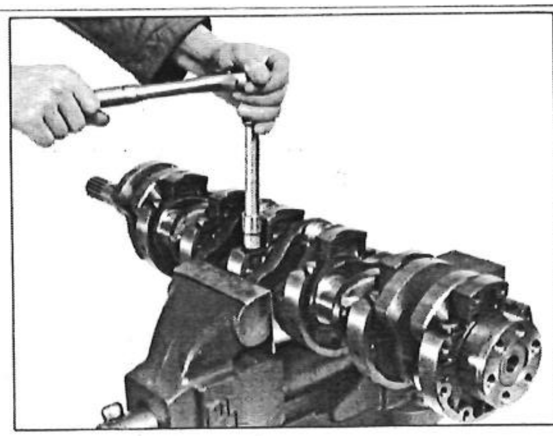
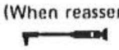


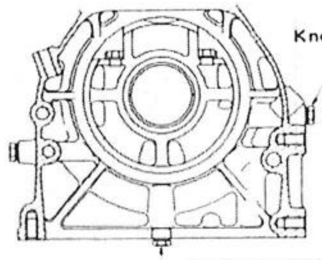
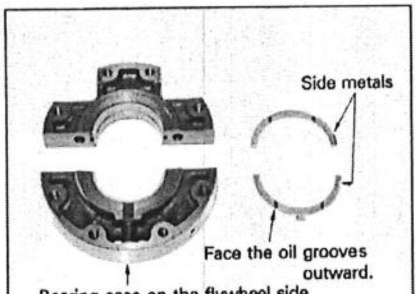
- When reassembling the connecting rod to the piston, heat the piston well and tap in the piston pin. Make sure that the piston is reassembled with the right connecting rod. Face the mark on the piston head toward the connecting rod.
- When installing a piston ring onto the piston, face the mark (manufacturer's name or "TOP") toward the piston head.
- When installing the coil expander in the ring, place the expander joint on the opposite side (180°) of the ring gap.
- Place the piston rings so that there are gaps every 90° with no gap facing the piston pin in the cylinder.

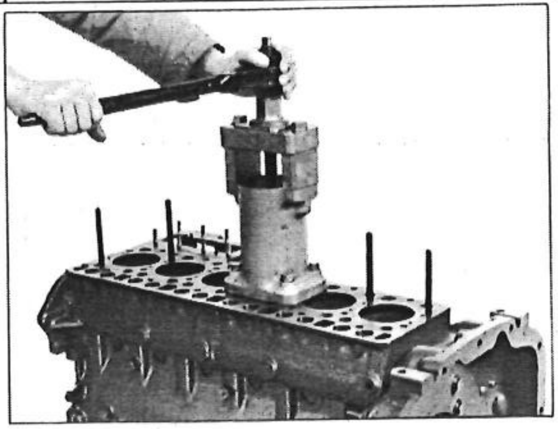
1) Remove the flywheel.

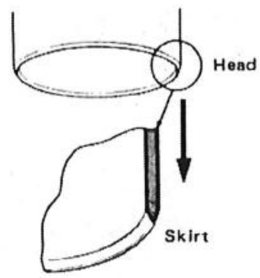
(When reassembling)

- Tighten the flywheel bolts to 98.1 to 107.9 N·m. (10 to 11 kgf·m., 72.3 to 79.6 lb.ft.).

Item	Location	Bolts and nuts	Tools
Disassembly (5) Crankshaft		Bearing case bolt 2 .... 5 Bearing case washer 3 .... 5 Knock bolt .... 5  .... 5 (Copper)	 17 13 (When reassembling) 
Disassembly (6) Bearing cases		Bearing case bolt 1 .... 12 Bearing case washer 12	 13 (When reassembling) 

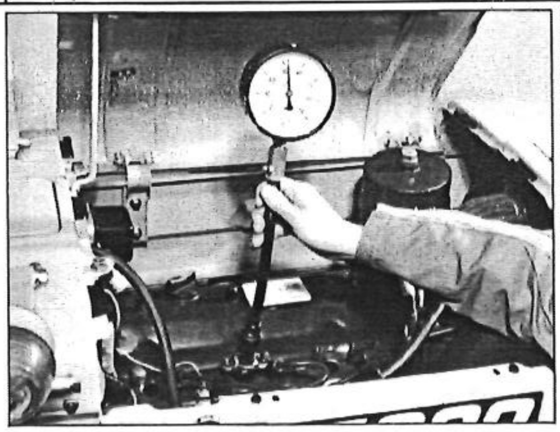
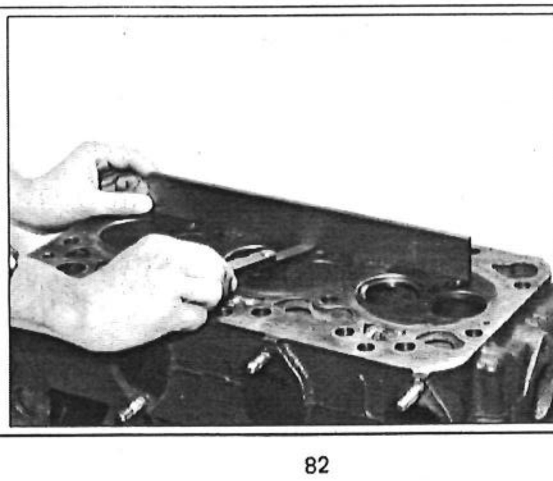
Procedure	Remarks
1) Remove the bearing case bolts 2. 2) Remove the knock bolts. 3) Screw two M8 bolts into the bearing cover and pull the cover out. 4) Tap the crankshaft until it comes out of the flywheel side; be careful not to scratch crankshaft metals 1.	(When reassembling) ● Line up the hole on the bearing case with that on the crankcase, then tighten bearing case bolts 2 and the knock bolts. Tighten bolts 2 to 63.7 to 68.6 N·m. (6.5 to 7.0 kgf·m., 47.0 to 50.6 lb.ft.). **Fig. 9 Position of bolts**  ● Apply grease to the oil seal of the bearing cover and refit the cover, being careful not to let the lip come off.
1) Remove the bearing case. 2) Remove the side metals in the bearing case on the flywheel side.	(When reassembling) ● Tighten the bearing case bolts 1 to 29.4 to 34.3 N·m. (3.0 to 3.5 kgf·m., 21.7 to 25.3 lb.ft.). ● Face the oil grooves of the side metals outward.  ● Reassemble the bearing cases to each other by lining up the marks. Face the mark " フライホイル " toward the flywheel. ● Reassemble the bearing cases, starting with the one with the smallest outside diameter as seen from the crank gear side.

Item	Location	Bolts and nuts	Tools	
Disassembly (7) Cylinder liner			 	

Procedure	Remarks
1) Attach the dry cylinder liner changer to the crankcase. (See the Kubota Repairing Tools Catalog for details.) 2) Draw out the cylinder liner.	(When reassembling) • Clean and oil the frame holes into which the liner is to be fitted. • Clean and oil the outside surface of the liner to be inserted. • Insert the liner with the most chamfered end (skirt) downward. **Fig. 10 How to insert cylinder liner**  • After inserting the cylinder liner, bore and hone to the standard size.

SERVICING

1. CYLINDER HEAD

Item	Location	Reference value
Servicing (1) Compression pressure		see table below
Servicing (2) Distortion of cylinder head surface		see table below

Servicing (1) — Reference value

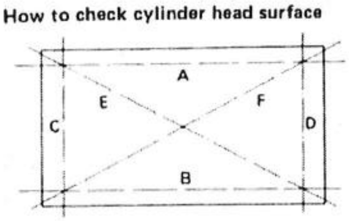
Model	Reference compression pressure	Compression pressure allowable limit
S2200	2,971.2 kPa. 30.3 kgf/cm² 430.9 lb./sq.in.	2,235.8 kPa. 22.8 kgf/cm² 324.2 lb./sq.in.
S2600		
D3000	3,030.1 kPa. 30.9 kgf/cm² 439.4 lb./sq.in.	2,088.7 kPa. 21.3 kgf/cm² 302.9 lb./sq.in.
V4000L		
V4000		

- Difference in compression pressure among cylinders should be within 10%.

Servicing (2) — Reference value

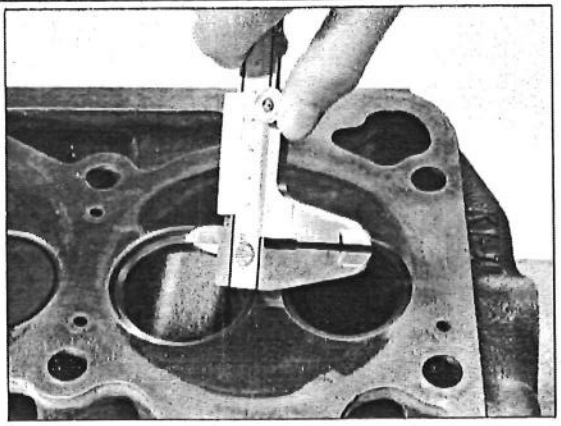
- Allowable limit

S2200	± 0.03 mm ± 0.0012 in.
S2600	
D3000	± 0.05 mm ± 0.0020 in.
V4000L	
V4000	

Tools and test instruments	Procedure	Remarks
	1) Warm up the engine. 2) Remove the air cleaner and the nozzle holders from all the cylinders. 3) Attach a compression tester to the cylinder to be measured. 4) Run the engine with the starter at 200 to 300 rpm and read constant maximum on the tester. Execute test at least twice. (Run the engine for 5 to 10 seconds for each test.)	• For the test, use a fully charged battery and the specified valve clearance. • If the compression pressure is below the given allowable limit, pour a small amount of oil through the nozzle holder hole and test again. ■ Judgment. 1) If the pressure recovers to standard level, inadequate pressure may be caused by wear or adhesion of the piston rings. Check the related points. 2) If the pressure does not recover, cylinder head or valve problems may be the cause. Check the related points. 3) If the compression differs more than 10% among the cylinders, trace the cause of pressure variation and take corrective measures.
Surface grinder 	1) Clean the surface of the cylinder head. 2) Place a straight edge on each of the cylinder head's four sides and two diagonally as shown at the right to check the straightness of the surface. 3) Insert a feeler gauge between the straight edge and the cylinder head surface. 4) The maximum thickness that can be inserted is the amount of distortion. 5) If the measurement exceeds the allowable limit, correct with a surface grinder.	• Do not place the straight edge on the combustion chamber or the sleeves. **Fig. 11 How to check cylinder head surface** 

Item	Location	Reference value

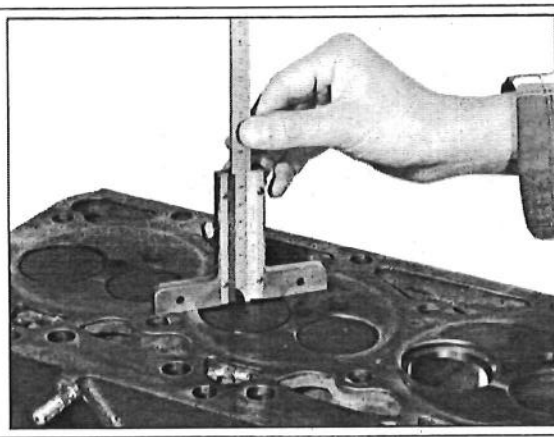
Servicing (3)
Valve seat width



• Reference value

	Width	Angle
S2200	2.1mm 0.0827in.	45°
S2600		
D3000	2.5 to 3.25mm 0.0984 to 0.1280in.	45.5°
V4000L		
V4000		

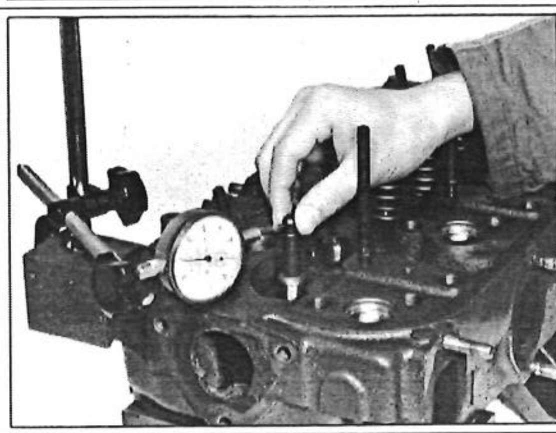
Servicing (4)
Valve recessing



• Reference value

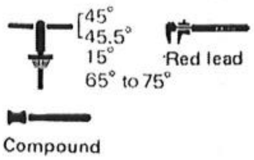
S2200	1.1 to 1.3mm 0.0433 to 0.0512in.
S2600	
D3000	0.7 to 1.1mm 0.0276 to 0.0433in.
V4000L	
V4000	

Servicing (5)
Stem guide clearance



	Reference value	Allowable limit
S2200	0.04 to 0.07mm 0.0016 to 0.0028in.	0.1mm 0.0039in.
S2600		
D3000	0.025 to 0.055mm 0.0010 to 0.0022in.	
V4000L		
V4000		

Tools and test instruments	Procedure	Remarks

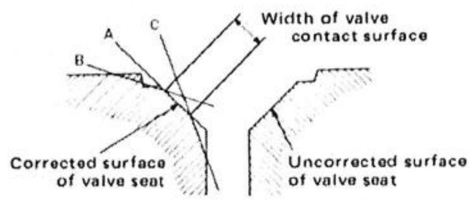


1) Clean the valve seat surface.
2) Measure the width of the valve seat using a set of vernier calipers.
3) Apply red lead on the valve face to check if the valve seat is not scratched or dented.

- To correct the valve seat width using a valve seat cutter, follow these steps:

1) Use a cutter suitable for the valve guide and the valve seat.
2) Grind off the front surface of the valve seat with a 15° cutter, since it becomes wider than before.
3) Grind off the rear surface of the valve seat with a 65° to 75° cutter to finish it to the reference value.
4) Reface the valve.

Fig. 12 How to repair the valve seat



	S2200 S2600	D3000, V4000L V4000
A	45° cutter	45.5° cutter
B	15° cutter	
C	65° to 75° cutter	

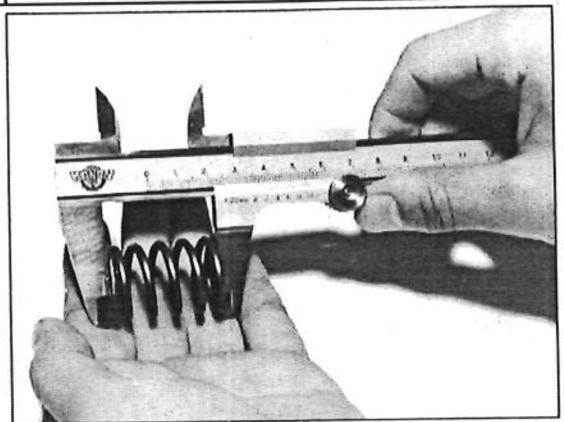
1) Clean the face of the valve.
2) Measure the recessing with a depth gauge.

- If a valve seat is corrected many times, the valve seat will recede in deeply and the valve spring will stretch and lose its tension. When the valve recessing is 1 mm (0.0394 in.) or more larger than the reference value, place a washer of appropriate thickness inside the spring.

1) Remove carbon from the valve guide.
2) After making sure that the valve stem is straight, insert the valve into the valve guide.
3) Measure the stem guide clearance with a dial gauge.
4) If the measurement exceeds the allowable limit, replace the stem guide and the valve.

Item	Location	Reference value

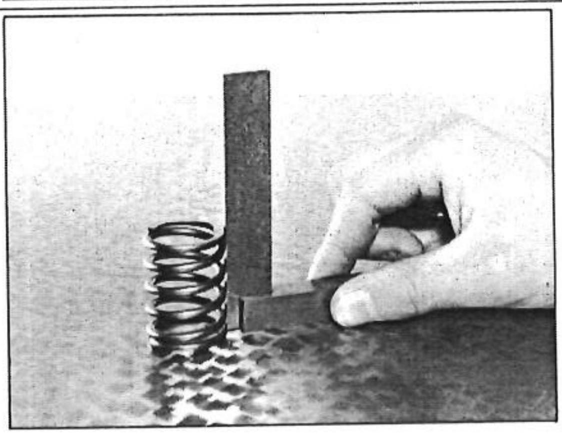
Servicing (6)
Free length of valve spring



• Reference value

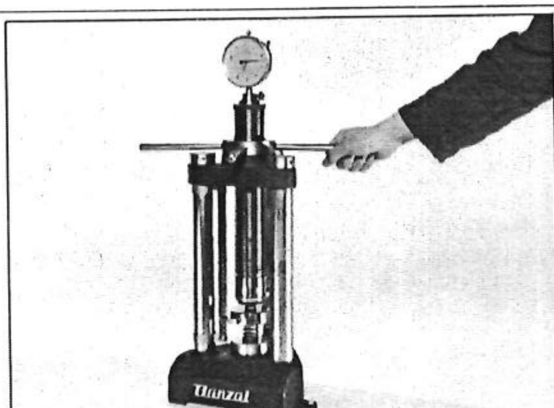
S2200	41.7 to 42.2mm 1.6417 to 1.6614 in.
S2600	
D3000	65.5mm 2.5787in.
V4000L	
V4000	

Servicing (7)
Valve spring squareness



• Allowable limit
3% or less

Servicing (8)
Valve spring tension

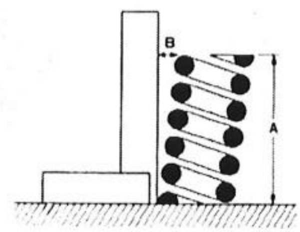


• Reference value

S2200	117.7N./35.15mm 12kgf/35.15mm 26.5lb./1.3839in.
S2600	
D3000	313.8N./41±0.5mm 32kgf/41±0.5mm 70.6lb./1.6142±0.0197in.
V4000L	
V4000	

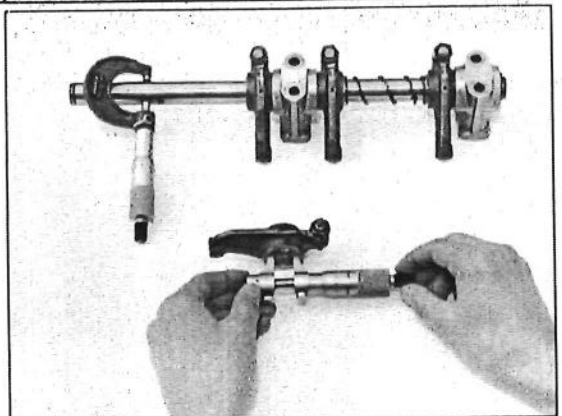
• Allowable limit

S2200	100.0N./35.15mm 10.2kgf/35.15mm 22.5lb./1.3839in.
S2600	

Tools and test instruments	Procedure	Remarks
	1) Measure the spring with a set of vernier calipers. 2) Replace it if it is not within the reference value.	
	1) Put the spring on a surface plate, place a square on the side of the spring, and check to see if the entire side is in contact with the square. 2) Rotate the spring and measure the maximum B. (See the illustration at right.) 3) The flat surface at the end of the spring coil must exceed the full circumference by two-thirds. 4) Check the entire surface of the spring for scratches. 5) If the measurement exceeds the allowable limit, replace the valve spring.	• Squareness of a spring is expressed by B in relation to A, where A is the free length of the spring which is placed on a surface plate and B is the distance between the top of the spring and the vertical line. (See the illustration below.) **Fig. 13 How to measure squareness of valve spring** 
	1) Place the spring on a tester and compress it to the same degree that it is actually compressed in the engine. 2) Read the compression load on the gauge. 3) If the measurement exceeds the allowable limit, replace the valve spring.	

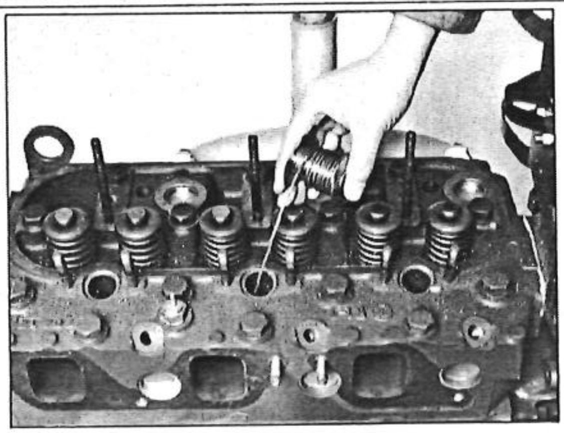
Item	Location	Reference value

Servicing (9)
Oil clearance between rocker arm shaft and bushings



	Reference value	Allowable limit
S2200 S2600	0.01 to 0.07mm 0.0004 to 0.0028in.	0.15mm 0.0059in.
D3000 V4000L V4000	0.016 to 0.052mm 0.0006 to 0.0020in.	0.12mm 0.0047in.

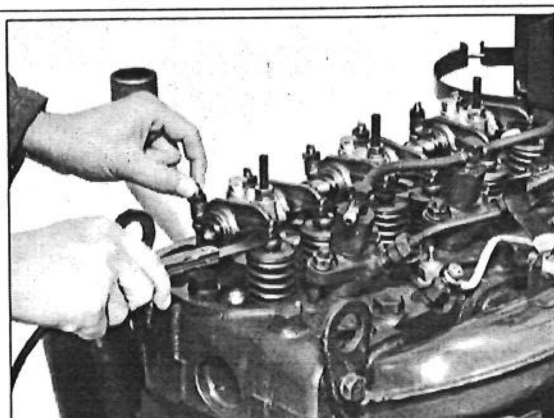
Servicing (10)
Top clearance



• **Reference value**

S2200 S2600	0.7 to 0.9mm 0.0276 to 0.0354in.
D3000 V4000L V4000	0.8 to 1.0mm 0.0315 to 0.0394in.

Servicing (11)
Valve clearance



• **Reference value**
For either intake or exhaust valve (when cool)

S2200 S2600	0.18 to 0.22mm 0.0071 to 0.0087in.
D3000 V4000L V4000	~~0.45mm~~ 0.25m ~~0.0177in~~ 0.098in

Tools and test instruments	Procedure	Remarks

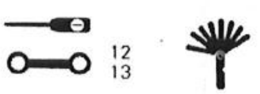
1) Measure the inside diameter of the rocker arm bushings.
2) Measure the outside diameter of rocker arm shaft and then calculate the clearance.
3) If the measurement exceeds the allowable limit, replace.

	O.D. of rocker arm shaft	I.D. of rocker arm bushing
S2200 S2600	13.973 to 13.984mm 0.5501 to 0.5506in.	14.002 to 14.043mm 0.5513 to 0.5529 in.
D3000 V4000L V4000	17.982 to 18.000mm 0.7080 to 0.7087 in.	18.016 to 18.034mm 0.7093 to 0.7100 in.

Fuse

1) Remove the nozzle holder.
2) Lower the piston in the cylinder to be measured.
3) Insert a high-quality fuse from the nozzle holder hole. Be careful not to let the fuse touch the valve surface.
4) Rotate the engine with your hand.
5) Take the fuse out carefully.
6) Measure the place where the fuse was crushed with a set of vernier calipers.
7) If the measurement is not within the reference value, adjust by inserting a shim between the cylinder head and the gasket.

	Thickness of gasket when new	Thickness of gasket shim
S2200 S2600	1.45mm 0.0571in. grommet	0.15mm 0.0059in.
D3000 V4000L V4000	1.6±0.08mm 0.0630±0.0031in.	0.20mm 0.0079in.



12
13

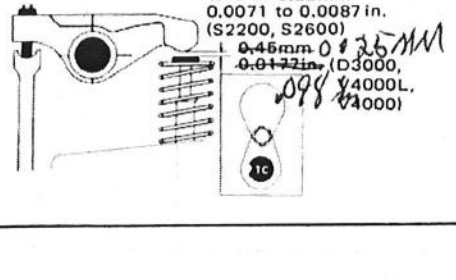
1) Measure the clearance with a feeler gauge after aligning each cylinder with the top dead center of compression.
2) Adjust them in the sequence of their explosion:

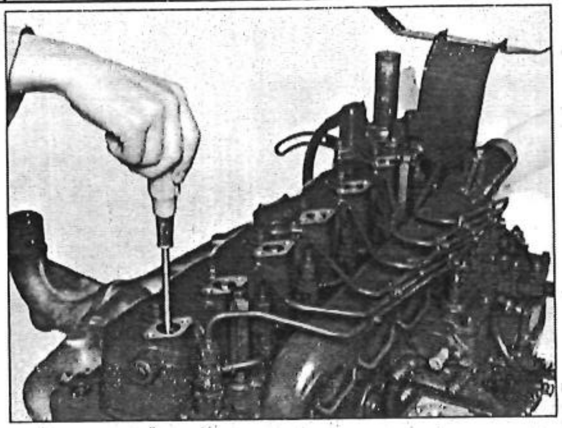
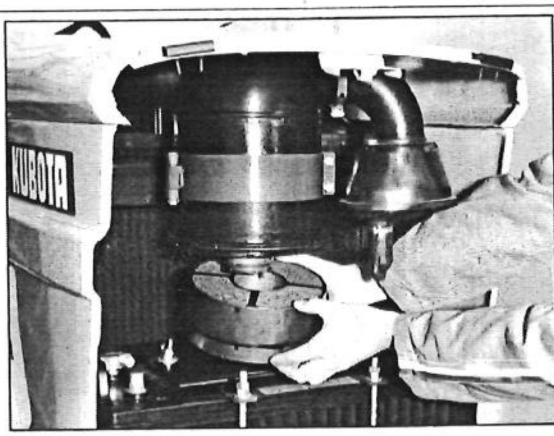
■ **Sequence of explosions**

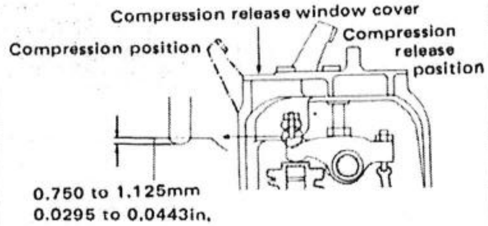
S2200, S2600	1→5→3→6→2→4
D3000	1→2→3
V4000L, V4000	1→3→4→2

- Align the mark (TC) on the flywheel with the timing check window of the flywheel housing.

Fig. 14 Valve clearance



Item	Location	Reference value
Servicing (12) Adjustment of compression release (S2200, S2600)		• Reference value 0.750 to 1.125mm 0.0295 to 0.0443in.
Servicing (13) Air cleaner element		• **Reference value** Dry-type element Clean the element every 100 to 200 service hours. Replace every 6 cleanings or every year. Wet-type element Check the oil level in the oil pan every 50 service hours. Clean the element every 200 service hours.

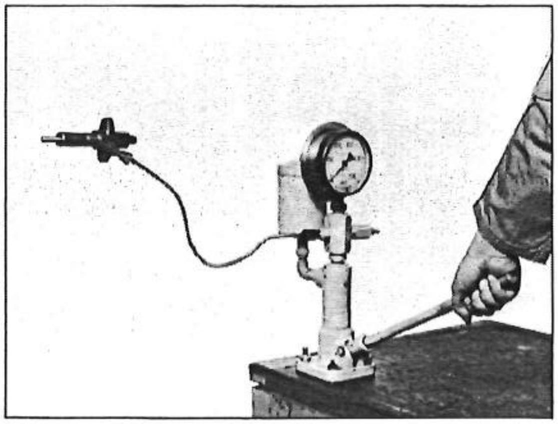
Tools and test instruments	Procedure	Remarks
 10	1) Close the exhaust valve completely. 2) Remove the compression release window cover from the head cover. 3) Pull the compression release lever. 4) Reduce the valve clearance to zero by means of the compression release adjustment bolt. Reach for the bolt through the window. Then, screw in the bolt by 1 to 1.5 turns and tighten the lock nut.	• After adjustment, turn the crankshaft by hand and check to see if the compression release pushes the exhaust valve too much so that the valve and the piston are in contact with each other. **Fig. 15 Compression release adjustment** 
	For a dry-type element 1) How to clean using compressed air: Directly blow compressed air of less than 686.4 kPa. (7 kgf/cm², 99.5 lb./sq.in.) from inside to outside. 2) How to clean using solution: Add 1.5 g (0.03 lb.) Kubota genuine element detergent to 1 liter (0.26 gal.) water. Let the element soak in the solution for 15 minutes and then wash it well in the solution. Rinse well in clean water and dry. **For a wet-type element** 1) Check the oil level in the oil pan and check to see if the oil contains any dirt every 50 service hours. 2) Clean the element in kerosene every 200 service hours. When refitting the element, apply oil to its surface.	• To remove dirt and dust, use compressed air. • To remove carbon and grease, use a solution.

2. FUEL SYSTEM

Item	Location	Reference value

Servicing (1)

Opening pressure of nozzle

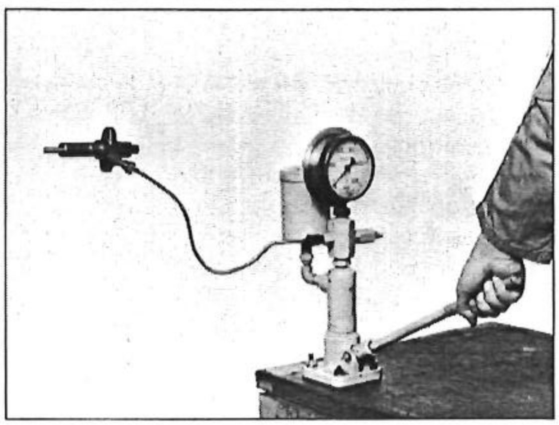


• Reference value

S2200 S2600	13.7 to 14.7 MPa. 140^{+10}_{0} kgf/cm² 1,990.8 to 2,133.0 lb./sq.in.
D3000 V4000L V4000	22.3 to 22.6 MPa. 230^{0}_{-3} kgf/cm² 3,227.9 to 3,270.6 lb./sq.in.

Servicing (2)

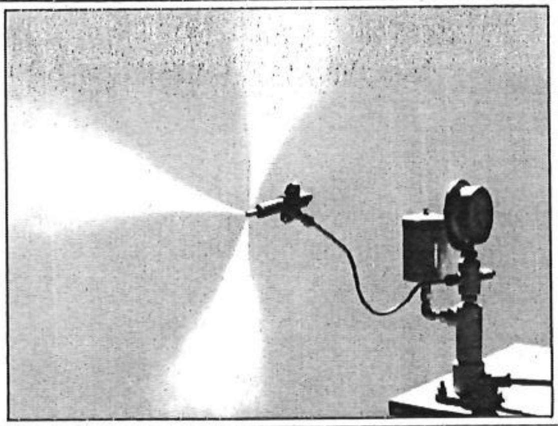
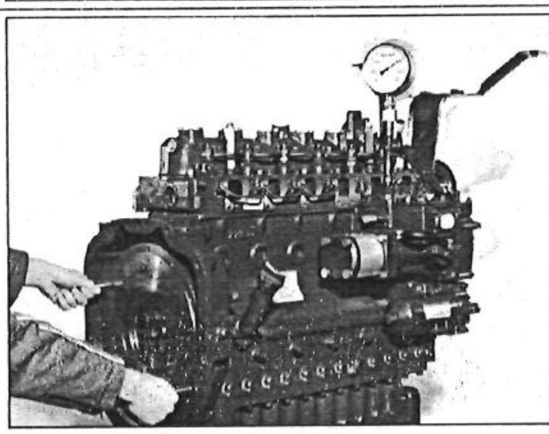
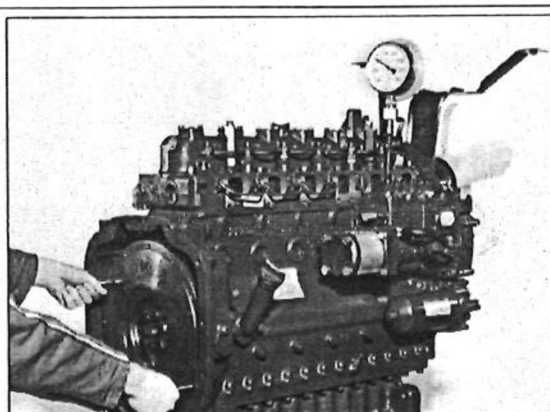
Fuel tightness of nozzle valve seat

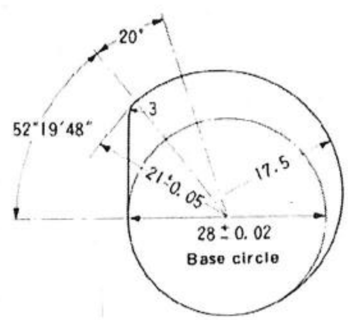


• Reference value

S2200 S2600	When the pressure is 980.6 kPa. (10kgf/cm², 142.2lb./sq.in.) lower than the opening pressure, the valve seat must be oil-tight.
D3000 V4000L V4000	When the pressure is 15.2 to 10.2MPa(155 to 104 kgf/cm², 2,204.1 to 1,478.9 lb./sq.in.), the valve seat must be oil-tight for 6 seconds or more.

Tools and test instruments	Procedure	Remarks
	1) Move the tester handle up and down to prime fuel. Measure the pressure of fuel gushing out from the nozzle tip. 2) If the measurement is not within the reference value, adjust with the adjustment washer inside the nozzle holder. (See page 34 and 56) An increase of every 0.1 mm (0.0039 in.) of washer thickness causes an approximate 980.6 kPa. (10 kgf/cm², 142.2 lb./sq.in.) increase in fuel injection pressure.	• Be careful not to come into direct contact with the injected fumes. The fumes destroy any cells they may touch. They may also cause blood poisoning.
	**S2200, S2600** 1) Apply a pressure 980.6 kPa. (10 kgf/cm², 142.2 lb./sq.in.) lower than the opening pressure. 2) After keeping the nozzle under this pressure for 10 seconds, check to see if fuel leaks from the nozzle valve seat. 3) If fuel should leak, replace the nozzle piece. **D3000, V4000L, V4000** 1) Apply a pressure of 15.2 to 10.2 MPa. (155 to 104 kgf/cm², 2204.1 to 1478.9 lb./sq.in.). 2) After keeping the nozzle under this pressure for 6 or more seconds, check to see if fuel leaks from the nozzle valve seat. 3) If fuel should leak, replace the nozzle piece.	

Item	Location	Reference value
Servicing (3) Shape of fumes across nozzle tip		
Servicing (4) Fuel tightness of fuel injection pump plunger (S2200, S2600)		• **Reference value** 8 seconds or more • **Allowable limit** 4 seconds or less
Servicing (5) Fuel tightness of fuel injection pump delivery valve (S2200, S2600)		• **Reference value** 10 seconds or more • **Allowable limit** 5 seconds or less

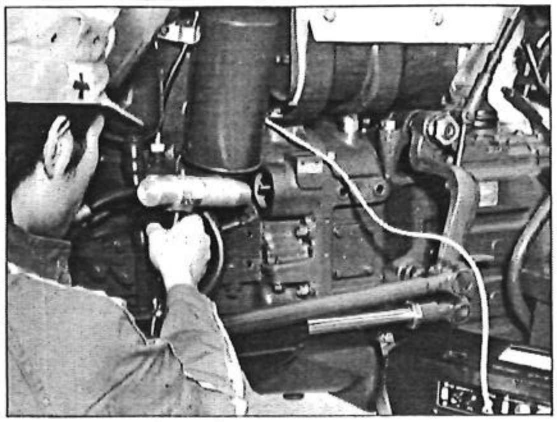
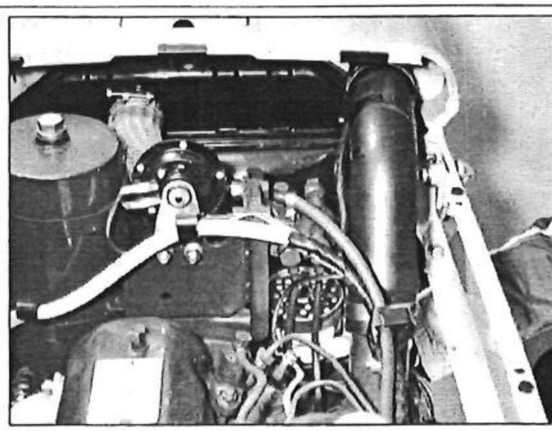
Tools and test instruments	Procedure	Remarks
	1) Attach the nozzle to a nozzle tester and shoot it in the air. Check the shape of the fumes. 2) If the shape is not acceptable, replace the nozzle piece.	
	1) Attach a pressure gauge to the pump. 2) Rotate the flywheel to increase the pressure to 58.8 MPa. (600 kgf/cm², 8532 lb./sq.in.). 3) Align the plunger with the top dead center. 4) Measure the time needed to decrease the initial pressure from 58.8 MPa. to 49.0 MPa. (600 kgf/cm² to 500 kgf/cm², 8532 lb./sq.in. to 7110 lb./sq.in.) 5) If the measurement is not acceptable, replace the pump element. In this case, ask a repair shop to do the replacement. Be sure to give them adjustment reference data on the fuel injection pump. (Shown right)	• Adjustment reference data of fuel injection pump ■ Test Conditions Nozzle.................. ND-DN12SD12 Opening pressure... 140 kg/cm² Pipe .... 6mm in diameter x 2mm in diameter x 600mm Fuel feed pressure...0.03 kg/cm² Cam profile .... See Fig. 16 below. Prestroke .... 2.2±0.05mm Test fuel .... Diesel No.2 light oil **Fig. 16 Profile of fuel pump cam** 

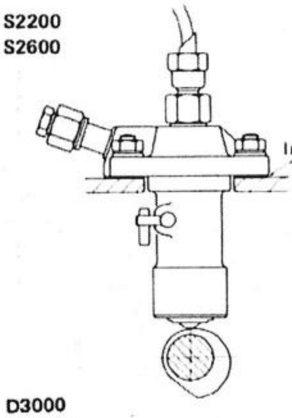
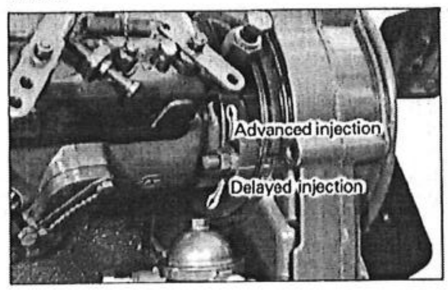
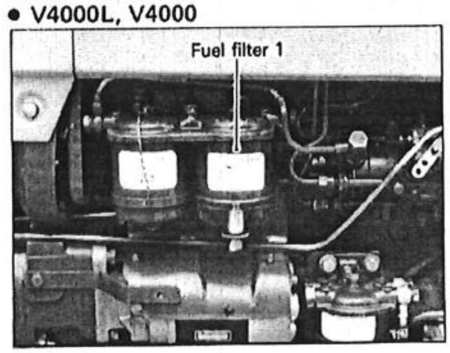
■ Adjustment of injection

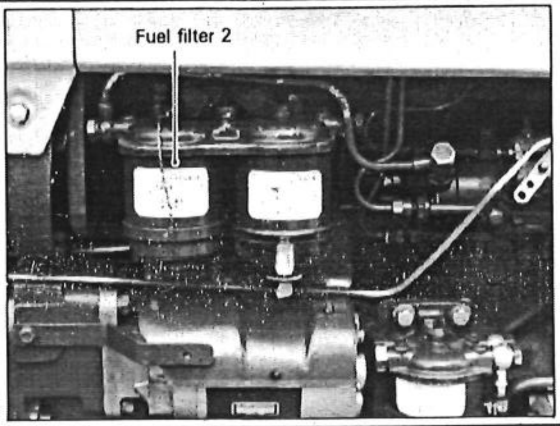
Control rack position(*1)	Speed (rpm)	Amount of injection (mm³/st)	Allowance (mm³)(*3)
9	1,400	23 ± 1.5	± 1.5 or less
8	1,400	18.5 ± 7.5	± 3.8 or less
7	1,400	18.5 ± 7.5	± 3.8 or less
0 to 3.5	1,400	0 (*2)	

*1: Travel distance from non-injecting point of control rack
*2: Zero opening pressure and no injection
*3: Allowance on the basis of standard cylinder

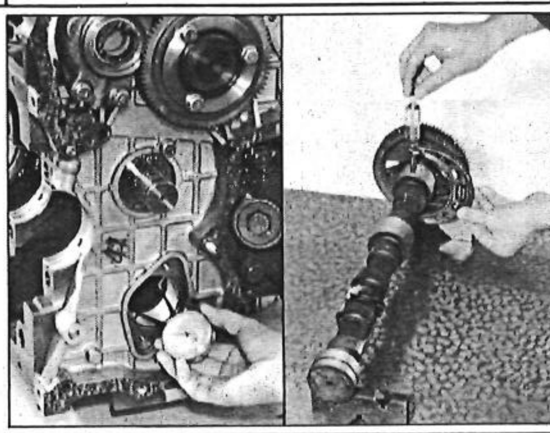
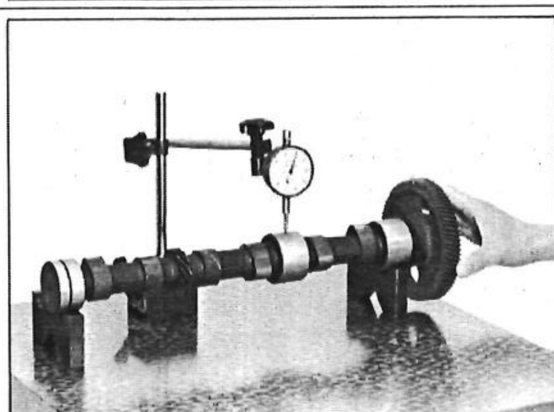
Tools and test instruments	Procedure	Remarks
	1) Attach a pressure gauge to the pump. 2) Rotate the flywheel to increase the pressure to 9.8 MPa. (100 kgf/cm², 1,422 lb./sq.in.). 3) Align the plunger with the bottom dead center. 4) Measure the time needed to decrease the initial pressure from 9.8 MPa. to 490.3 kPa. (100 kgf/cm² to 5 kgf/cm², 1,422 lb./sq.in. to 71.1 lb./sq.in.) 5) If the measurement is not acceptable, replace the delivery valve.	

Item	Location	Reference value
Servicing (6) Injection timing		• Reference value S2200, S2600: 25° to 26° before TDC D3000, V4000L, V4000: 14° before TDC
Servicing (7) Replacing fuel filter (S2200, S2600, D3000), fuel filter 1 (V4000L, V4000)		• Reference value Replace every 400 service hours.

Tools and test instruments	Procedure	Remarks
	1) Start and run the engine at idle. 2) Attach a timing light to the injection pipe. 3) Check to see if the timing check window of the clutch housing is aligned with the FI mark on the flywheel. 4) If timing of the fuel injection is off, adjust as follows: **S2200, S2600** Use shims. Each shim changes the crank angle by about 1.5°. **D3000, V4000L, V4000** Adjust by changing the fuel injection pump mounting angle.	**Fig. 17 How to adjust the injection timing** **S2200** **S2600**  **D3000** **V4000L** **V4000** 
	**S2200, S2600** 1) Remove the filter with a filter wrench. Replace with a new one. 2) Apply a thin film of fuel to the packing and refit the filter by tightening well by hand. **D3000, V4000L, V4000** 1) Disassemble the fuel filter and replace the element inside with a new one.	• **S2200, S2600**  • **V4000L, V4000** 

<table>
<tr><th>Item</th><th>Location</th><th>Reference value</th></tr>
<tr><td>Servicing (8)
Replacing fuel filter 2
(V4000L, V4000)</td><td></td><td>• Reference value
Replace every 800 service hours.</td></tr>
</table>

3. TIMING GEARS AND CAMSHAFT

<table>
<tr><th>Item</th><th>Location</th><th>Reference value</th></tr>
<tr><td>Servicing (1)
Oil clearance of camshaft</td><td></td><td><table>
<tr><th></th><th>Reference value</th><th>Allowable limit</th></tr>
<tr><td>S2200</td><td rowspan="2">0.050 to 0.091mm
0.0020 to 0.0036in.</td><td rowspan="2">0.15mm
0.0059in.</td></tr>
<tr><td>S2600</td></tr>
<tr><td>D3000</td><td rowspan="3">0.060 to 0.149mm
0.0024 to 0.0059in.</td><td rowspan="3">–</td></tr>
<tr><td>V4000L</td></tr>
<tr><td>V4000</td></tr>
</table></td></tr>
<tr><td>Servicing (2)
Camshaft alignment</td><td></td><td>• Allowable limit
0.08mm
0.0031in.</td></tr>
</table>

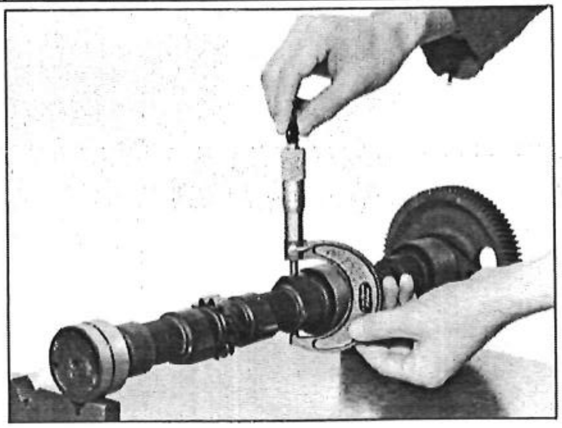
<table>
<tr><th>Tools and test instruments</th><th>Procedure</th><th>Remarks</th></tr>
<tr><td></td><td>1) Disassemble the fuel filter and replace the element inside with a new one.</td><td></td></tr>
</table>

<table>
<tr><th>Tools and test instruments</th><th>Procedure</th><th>Remarks</th></tr>
<tr><td></td><td>1) Measure the camshaft bearing in the crankcase with a caliper gauge.
2) Measure the camshaft journal with an outside micrometer. Calculate the clearance.
3) If the measurement exceeds the allowable limit, replace the bearing or the camshaft.</td><td>S2200, S2600
<table>
<tr><td>O.D. of camshaft bearing journal</td><td>39.934 to 39.950mm
1.5722 to 1.5728in.</td></tr>
<tr><td>I.D. of camshaft bearing</td><td>40.000 to 40.025mm
1.5748 to 1.5758in.</td></tr>
</table>
D3000, V4000L, V4000
<table>
<tr><td>O.D. of camshaft bearing journal</td><td>1</td><td>50.921 to 50.940mm
2.0048 to 2.0055in.</td></tr>
<tr><td></td><td>2</td><td>50.421 to 50.440mm
1.9851 to 1.9858in.</td></tr>
<tr><td></td><td>3</td><td>49.934 to 49.950mm
1.9659 to 1.9665in.</td></tr>
<tr><td>I.D. of camshaft bearing</td><td>1</td><td>51.000 to 51.070mm
2.0079 to 2.0106in.</td></tr>
<tr><td></td><td>2</td><td>50.500 to 50.570mm
1.9882 to 1.9909in.</td></tr>
<tr><td></td><td>3</td><td>50.010 to 50.080mm
1.9689 to 1.9717in.</td></tr>
</table></td></tr>
<tr><td></td><td>1) Slightly put the camshaft on V blocks.
2) Attach a dial gauge to the journal.
3) While slowly rotating the camshaft, read the dial gauge. The camshaft flexure is half of the reading.
4) If the measurement exceeds the allowable limit, replace the camshaft.</td><td></td></tr>
</table>

Item	Location	Reference value

Servicing (3)

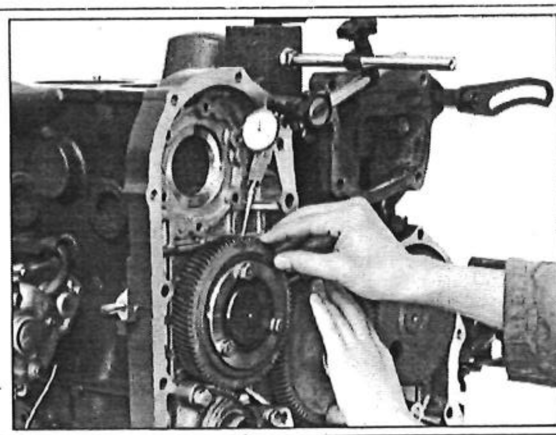
Cam heights of intake and exhaust



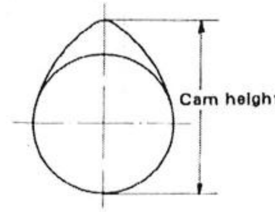
	Reference value	Allowable limit
S2200 S2600	33.36mm 1.3134in.	33.31mm 1.3114in.
D3000 V4000L V4000	Cam height of intake 41.50mm 1.6339in. Cam height of exhaust 42.027mm 1.6546in.	Cam height of intake 41.45mm 1.6319in. Cam height of exhaust 41.977mm 1.6526in.

Servicing (4)

Gear backlash



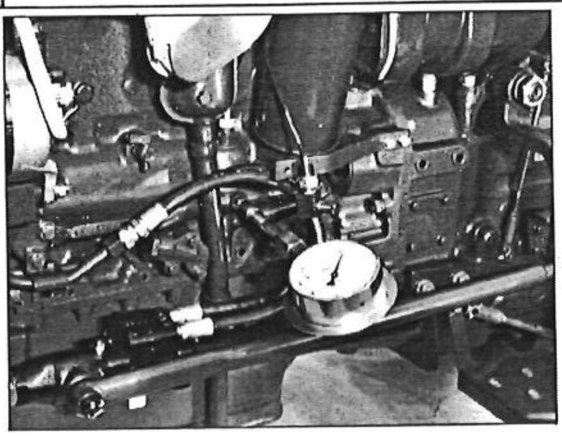
	Reference value	Allowable limit
S2200 S2600	0.041 to 0.115mm 0.0016 to 0.0045in.	0.3mm 0.0118in.
D3000 V4000L V4000	0.044 to 0.139 mm 0.0017 to 0.0055in.	

Tools and test instruments	Procedure	Remarks
	1) Measure the height of the cam at its highest point with a micrometer. 2) If the measurement exceeds the allowable limit, replace the camshaft.	Fig. 18 Cam height measuring points 
	1) Install a lever-type indicator between the gear teeth. 2) Clamp one gear, rotate the other, and measure the backlash. 3) If the measurement exceeds the allowable limit, replace.	

4. LUBRICATING SYSTEM

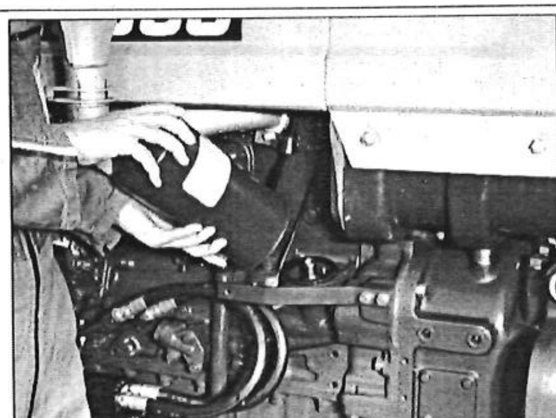
Item	Location	Reference value

Servicing (1)
Oil pressure

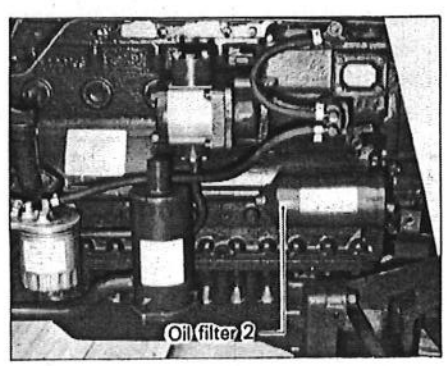


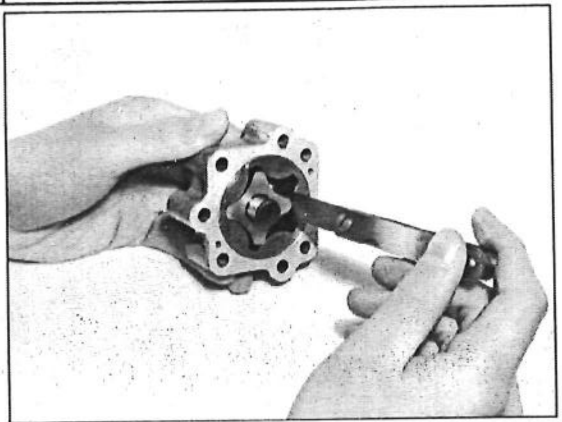
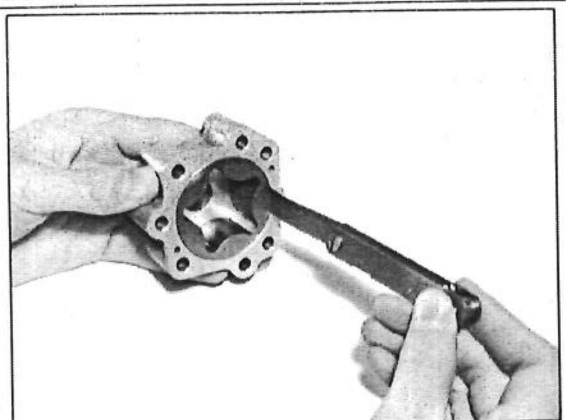
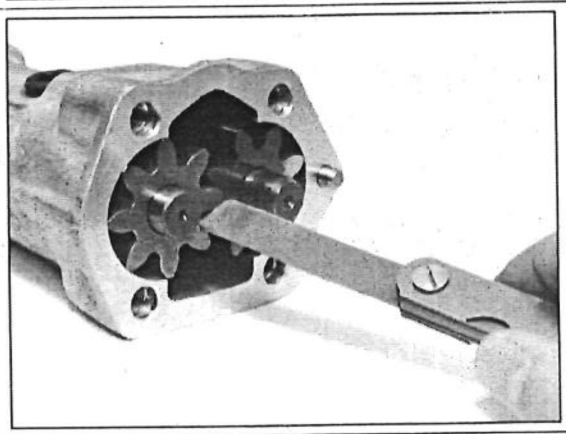
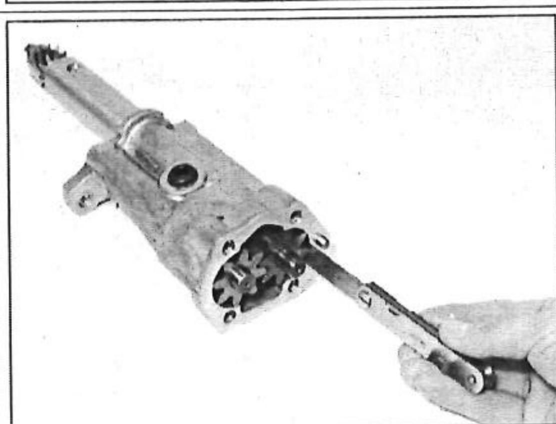
<table>
<tr><th rowspan="2"></th><th colspan="2">At rated engine speed</th><th rowspan="2">At idling speed</th></tr>
<tr><th>Reference value</th><th>Allowable limit</th></tr>
<tr><td>S2200</td><td rowspan="4">294.2 to 441.3kPa.
3.0to4.5 kgf/cm²
42.7 to 64.0lb./sq.in.</td><td rowspan="5">245.2kPa.
2.5 kgf/cm²
35.6lb./sq.in.</td><td>98.1kPa(1.0kgf/cm²,14.2lb./sq.in.) or more (at 600rpm)</td></tr>
<tr><td>S2600</td><td rowspan="4">49.0kPa.(0.5kgf/cm², 7.1 lb./sq.in.) or more (at 500rpm)</td></tr>
<tr><td>D3000</td></tr>
<tr><td>V4000L</td></tr>
<tr><td>V4000</td><td>294.2 to 392.2kPa.
3.0 to 4.0kgf/cm²
42.7 to 56.9lb./sq.in.</td></tr>
</table>

Servicing (2)
Replacing oil filter

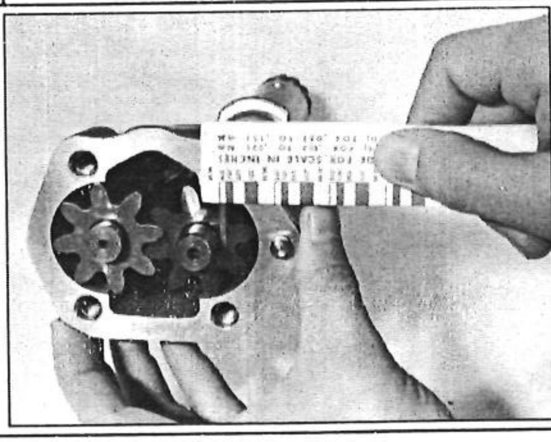


- **Reference value**
  Replace every 150 service hours (S2200, S2600).
  Replace every 450 service hours (D3000, V4000L, V4000).

Tools and test instruments	Procedure	Remarks
	1) Remove the oil switch and attach a pressure gauge. 2) Start the engine. Measure the oil pressure both at idling and at the rated speed. 3) If the measurement is not within the reference value, check the oil pump, oilways, oil clearances and pressure regulating valve.	(When measuring) • Supply the specified amount of recommended oil. • The oil filter must not be clogged or broken.
	S2200, S2600 1) Disassemble the oil filter and replace the element and the O-ring with new ones. **D3000, V4000L, V4000** 1) Remove the oil filter by turning it with your hand, and replace with a new one.	

Item	Location	Reference value
Servicing (3) Oil pump (1) Trochoid pump (S2200, S2600) i) Rotor lobe clearance		• **Reference value** 0.10 to 0.16mm. 0.0039 to 0.0063in. • **Allowable limit** 0.2mm 0.0079in.
Servicing ii) Radial clearance between outer rotor and pump body		• **Reference value** 0.11 to 0.18mm 0.0043 to 0.0071in. • **Allowable limit** 0.25mm 0.0098in.
Servicing (2) Gear pump (D3000, V4000L, V4000) i) Gear backlash of oil pump		• **Reference value** 0.054 to 0.162mm 0.0021 to 0.0064in.
Servicing ii) Radial clearance between gears and pump body		• **Reference value** 0.030 to 0.084mm 0.0012 to 0.0033in.

Tools and test instruments	Procedure	Remarks
	1) Insert a feeler gauge into the gap between the inner and outer rotors and measure the clearance. 2) If the measurement exceeds the allowable limit, replace.	
	1) Insert a feeler gauge into the gap between the oil pump body and the outer rotor and measure the clearance. 2) If the measurement exceeds the allowable limit, replace.	
	1) Insert a feeler gauge into the gap between the gears and measure the backlash. 2) If the measurement is not within the reference value, replace.	
	1) Insert a feeler gauge into the gap between the pump body and the gear and measure the clearance. 2) If the measurement is not within the reference value, replace.	

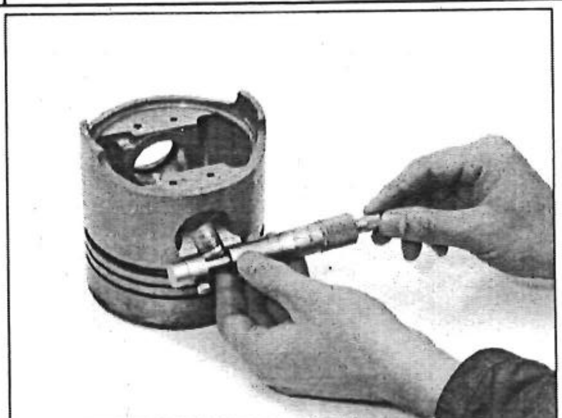
Item	Location	Reference value
Servicing iii) End clearance between gears and cover		• **Reference value** 0.025 to 0.089mm 0.0010 to 0.0035in.

Tools and test instruments	Procedure	Remarks
	1) Paste a press gauge to the surface of the gear with grease. 2) Attach the cover. 3) Gently remove the cover. Measure the clearance by placing the gauge (paper) on the press gauge where it is crushed. 4) If the measurement is not within the reference value, replace.	

5. PISTONS AND CONNECTING RODS

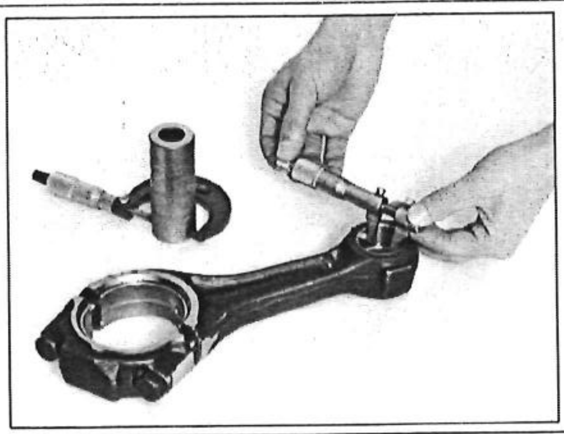
Item	Location	Reference value

Servicing (1)
Inside diameter of piston bosses



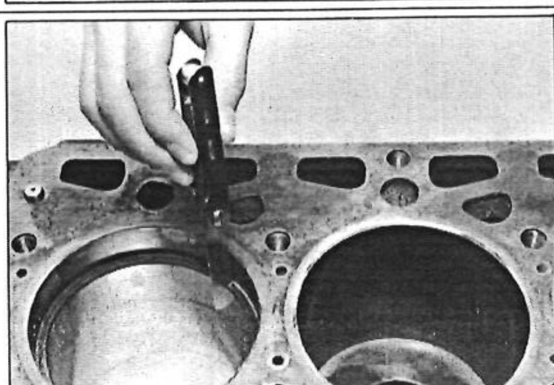
	Reference value	Allowable limit
S2200 S2600	23.000 to 23.013mm 0.9055 to 0.9060in.	23.053mm 0.9076in.
D3000 V4000L V4000	33.993 to 34.000mm 1.3383 to 1.3386in.	34.04mm 1.3402in.

Servicing (2)
Clearance between piston pin and small end bushing



	Reference value	Allowable limit
S2200 S2600	0.014 to 0.038mm 0.0006 to 0.0015in.	0.15mm 0.0059in.
D3000 V4000L V4000	0.015 to 0.029mm 0.0006 to 0.0011in.	

Servicing (3)
Piston ring gaps



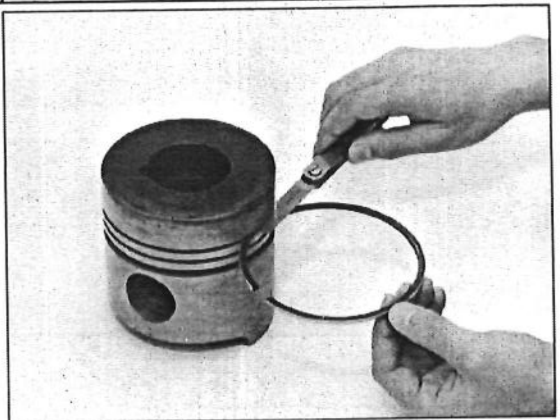
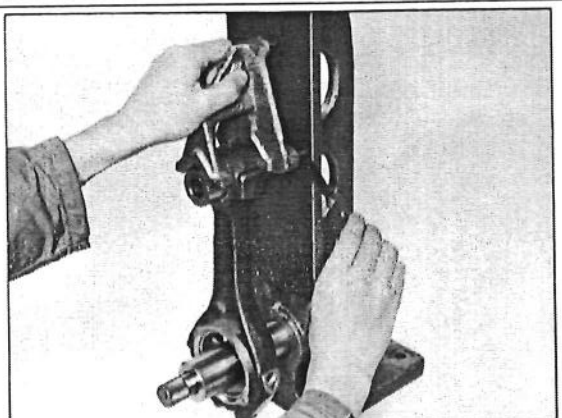
S2200, S2600

	Reference value	Allowable limit
Top ring Second ring	0.30 to 0.45mm 0.0118 to 0.0177in.	1.25mm 0.0492in.
Oil ring	0.25 to 0.40mm 0.0098 to 0.0157in.	

D3000, V4000L, V4000

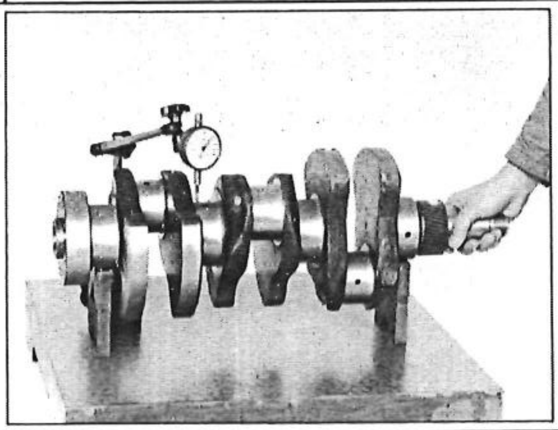
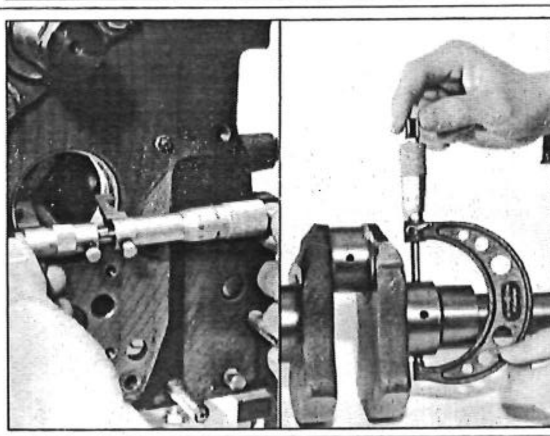
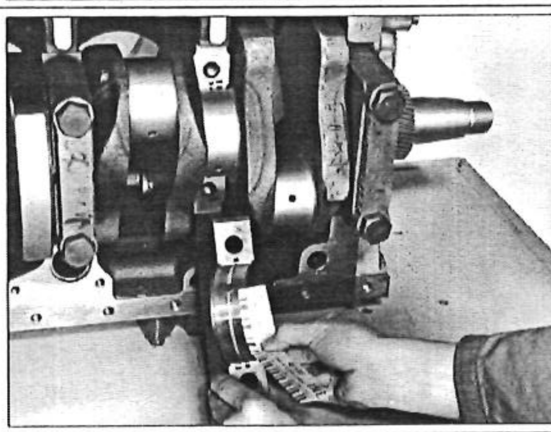
	Reference value	Allowable limit
Top ring Second ring	0.40 to 0.60mm 0.0157 to 0.0236in.	1.5mm 0.0591in.
Oil ring	0.25 to 0.50mm 0.0098 to 0.0197in.	

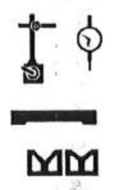
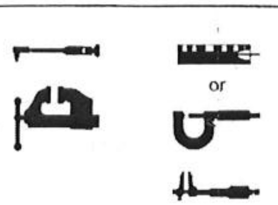
<table>
<tr><th>Tools and test instruments</th><th>Procedure</th><th>Remarks</th></tr>
<tr><td></td><td>1) Measure the piston bosses with an inside micrometer.
2) If the measurement exceeds the allowable limit, replace.</td><td></td></tr>
<tr><td>
</td><td>1) Measure the piston pin with an outside micrometer.
2) Measure the inside diameter of connecting rod small end bushing with an inside micrometer. Calculate the clearance.
3) If the measurement exceeds the allowable limit, replace.</td><td><table>
<tr><th></th><th>O.D. of piston pin</th><th>I.D. of connecting rod small end bushing</th></tr>
<tr><td>S2200</td><td>23.002 to 23.011mm</td><td>23.025 to 23.040mm</td></tr>
<tr><td>S2600</td><td>0.9056 to 0.9059 in.</td><td>0.9065 to 0.9071 in.</td></tr>
<tr><td>D3000
V4000L</td><td>33.983 to 33.990mm</td><td>34.005 to 34.012mm</td></tr>
<tr><td>V4000</td><td>1.3379 to 1.3382 in.</td><td>1.3388 to 1.3391 in.</td></tr>
</table></td></tr>
<tr><td></td><td>1) Put the piston ring in the cylinder.
2) Turn the piston upside down and push the ring into the cylinder with the piston head.
3) Insert a feeler gauge into the piston ring gap.
4) If the measurement exceeds the allowable limit, replace.</td><td>• Measure the piston ring gap at the point of the minimum inside diameter of the cylinder liner.</td></tr>
</table>

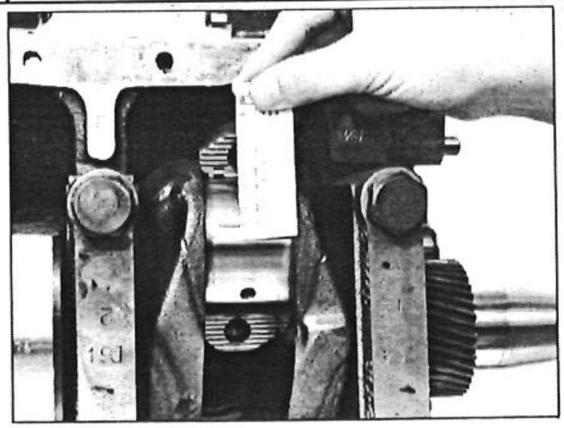
Item	Location	Reference value
Servicing (4) Side clearance of ring in groove		S2200, S2600 <table><tr><th></th><th>Reference value</th></tr><tr><td>Second ring</td><td>0.093 to 0.120mm 0.0037 to 0.0047in.</td></tr><tr><td>Oil ring</td><td>0.020 to 0.052mm 0.0008 to 0.0020in.</td></tr></table>D3000, V4000L, V4000 <table><tr><th></th><th>Reference value</th></tr><tr><td>Top ring</td><td>0.088 to 0.125mm 0.0035 to 0.0049in.</td></tr><tr><td>Second ring</td><td>0.050 to 0.082mm 0.0020 to 0.0032in.</td></tr><tr><td>Oil ring</td><td>0.040 to 0.072mm 0.0016 to 0.0028in.</td></tr></table>
Servicing (5) Connecting rod alignment		• **Reference value** 0.02mm 0.0008in. • **Allowable limit** 0.05mm 0.0020in.

Tools and test instruments	Procedure	Remarks
	1) Remove the piston ring from the piston. 2) Place the ring in its groove as is shown at left, and measure the clearance. 3) If the measurement is not within the reference value, replace the ring.	• As the top ring for S2200, S2600 is a keystone type, it cannot be measured by this method.
 	1) Remove the connecting rod crank pin metal, and tighten the rod bolts. 2) Attach the connecting rod to a connecting rod aligner. 3) Place the gauge on the piston pin. Measure the gap between the pin of the gauge and the flat surface of the aligner. 4) If the measurement exceeds the allowable limit, replace.	• Because the inside diameter of the connecting rod small end bushing is used as the basis for this check, be sure if it is not worn beforehand.

6. CRANKSHAFT

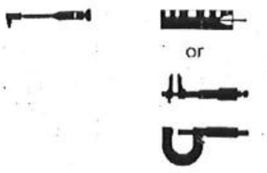
<table>
<tr><th>Item</th><th>Location</th><th>Reference value</th></tr>
<tr><td>Servicing (1)
Crankshaft alignment</td><td></td><td>• Reference value
0.02mm
0.0008in.
• Allowable limit
0.08mm
0.0031in.</td></tr>
<tr><td>Servicing (2)
Oil clearance between crank shaft journal and bearing 1
(S2200, S2600)</td><td></td><td>• Reference value
0.040 to 0.118mm
0.0016 to 0.0046in.
• Allowable limit
0.2mm
0.0079 in.</td></tr>
<tr><td>Servicing (3)
Oil clearance between crank-shaft journals and bearings (crankshaft bearing 2 for S2200, S2600)</td><td></td><td>
<table>
<tr><th></th><th>Reference value</th><th>Allowa-ble limit</th></tr>
<tr><td>S2200</td><td rowspan="2">0.040 to 0.104mm
0.0016 to 0.0041 in.</td><td rowspan="5">0.2mm
0.0079 in.</td></tr>
<tr><td>S2600</td></tr>
<tr><td>D3000</td><td rowspan="3">0.044 to 0.105mm
0.0017 to 0.0041 in.</td></tr>
<tr><td>V4000L</td></tr>
<tr><td>V4000</td></tr>
</table>
</td></tr>
</table>

<table>
<tr><th>Tools and test instruments</th><th>Procedure</th><th>Remarks</th></tr>
<tr>
<td></td>
<td>1) Place V blocks on the surface plate, and support the journals at both ends of the crankshaft on the V blocks.
2) Attach a dial gauge to the central journal.
3) Read the dial gauge while rotating the crankshaft slowly. Crankshaft flexure is half of the reading.
4) If the reading exceeds the allowable limit, replace.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1) Measure the crankshaft journal (on the side of the crankshaft bearing 1) with an outside micrometer.
2) Measure the crankshaft bearing with an inside micrometer. Calculate the clearance.
3) If the measurement exceeds the allowable limit, replace.</td>
<td><table>
<tr><th></th><th>O.D. of crankshaft journal</th><th>I.D. of crankshaft bearing 1</th></tr>
<tr><td>S2200</td><td rowspan="2">51.921 to 51.940mm
2.0441 to 2.0449in.</td><td rowspan="2">51.980 to 52.039mm
2.0465 to 2.0488in.</td></tr>
<tr><td>S2600</td></tr>
</table></td>
</tr>
<tr>
<td>
</td>
<td>1) Paste a press gauge on the crankshaft bearing with grease.
2) Tighten the crankshaft bearing case onto the crankshaft journal to the specified torque. (29.4 to 34.3 N·m. (3.0 to 3.5 kgf·m., 21.7 to 25.3 lb.ft.) for S2200, S2600 or 176.5 to 186.3 N·m. (18 to 19 kgf·m., 130.2 to 137.4 lb.ft.) for D3000, V4000L, V4000).
3) Remove the bearing case gently and measure the depression of the press gauge with a sheet of gauge (paper).
4) If the measurement exceeds the allowable limit, replace.</td>
<td>(When measuring)
(1) When tightening, fasten the crankshaft so that it does not turn.
(2) Do not insert the press gauge into the crank pin holes.
<table>
<tr><th></th><th>O.D. of crankshaft journal</th><th>I.D. of crankshaft bearing</th></tr>
<tr><td>S2200</td><td rowspan="2">51.921 to 51.940mm
2.0441 to 2.0449 in.</td><td rowspan="2">51.980 to 52.025mm
2.0465 to 2.0482in.</td></tr>
<tr><td>S2600</td></tr>
<tr><td>D3000</td><td rowspan="3">75.977 to 75.990mm
2.9912 to 2.9917in.</td><td rowspan="3">76.034 to 76.082mm
2.9935 to 2.9954 in.</td></tr>
<tr><td>V4000L</td></tr>
<tr><td>V4000</td></tr>
</table></td>
</tr>
</table>

Item	Location	Reference value
Servicing (4) Oil clearance between crank pins and crank pin bearings		See table below

<table>
<tr><th></th><th>Reference value</th><th>Allowable limit</th></tr>
<tr><td>S2200</td><td rowspan="2">0.035 to 0.093mm
0.0014 to 0.0037in.</td><td rowspan="5">0.2mm
0.0079in.</td></tr>
<tr><td>S2600</td></tr>
<tr><td>D3000</td><td rowspan="3">0.030 to 0.082mm
0.0012 to 0.0032in.</td></tr>
<tr><td>V4000L</td></tr>
<tr><td>V4000</td></tr>
</table>

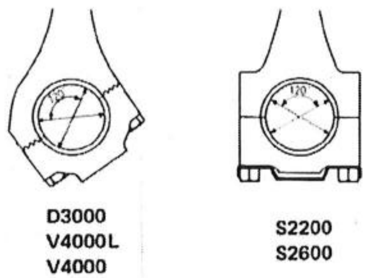
Tools and test instruments	Procedure	Remarks



1) Paste a press gauge onto the crank pin bearing with grease.
2) Tighten the connecting rod onto the crank pin to the specified torque. (36.3 to 41.2 N·m. (3.7 to 4.2 kgf·m., 26.8 to 30.4 lb.ft.) for S2200, S2600 or 98.1 to 107.9 N·m. (10 to 11 kgf·m., 72.3 to 79.6 lb.ft.) for D3000, V4000L, V4000)
3) Remove the large end-cap gently, and measure the depression of the press gauge with a sheet of gauge (paper).
4) If standard-sized bearings cannot be used due to excessive wear on the crank pin, use undersized bearings. When using undersized bearings, follow the directions below:
   (1) Cut the corner radius of the crank pin precisely to 3.5R ± 0.2 mm (0.1378R ± 0.0079 in.) for S2200, S2600 or 4.0R ± 0.2 mm (0.1575R ± 0.0079 in.) for D3000, V4000L, V4000.
   (2) Be sure to chamfer the oil hole circumference with an oil stone.
   (3) The crank pin must be fine-finished to higher than ▽▽▽▽ (0.4S).

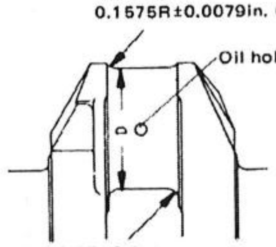
(When mesuring)
1) When tightening, fasten the crankshaft so that it does not turn.
2) Do not insert the press gauge into the crank pin holes.

Fig. 19 Crank pin measuring points

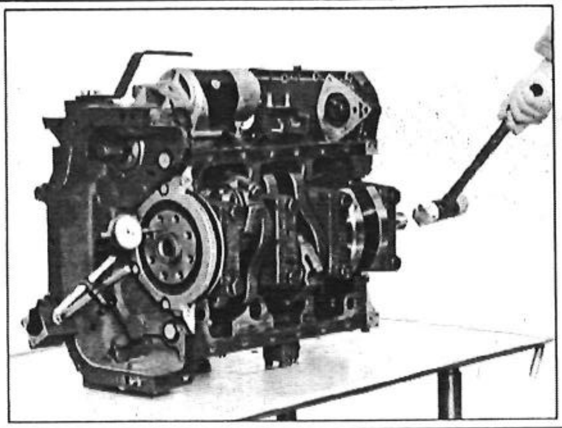


<table>
<tr><th></th><th>O.D. of crank pin</th><th>I.D. of crank pin bearing</th></tr>
<tr><td>S2200</td><td rowspan="2">43.959 to 43.975mm
1.7307 to 1.7313in.</td><td rowspan="2">44.010 to 44.052mm
1.7327 to 1.7343 in.</td></tr>
<tr><td>S2600</td></tr>
<tr><td>D3000</td><td rowspan="3">63.977 to 63.990mm
2.5188 to 2.5193 in.</td><td rowspan="3">64.020 to 64.059mm
2.5205 to 2.5220 in.</td></tr>
<tr><td>V4000L</td></tr>
<tr><td>V4000</td></tr>
</table>

Fig. 20 Crank pin for undersized bearing

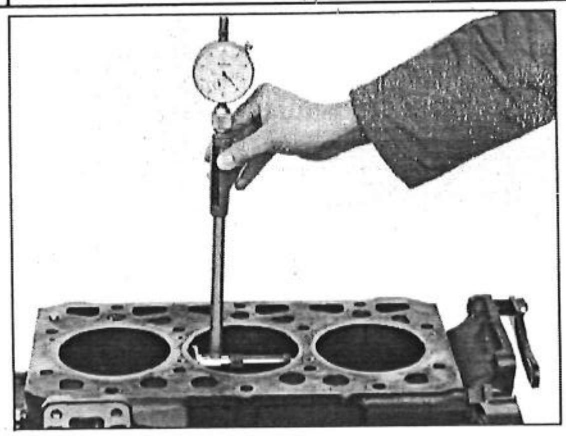


	S2200, S2600		D3000, V4000L, V4000		
Size	0.20mm 0.0079in.	0.40mm 0.0157in.	0.25mm 0.0098in.	0.50mm 0.0197in.	0.75mm 0.0295in.
Code number	15221-2297-1	15221-2298-1	15451-2297-1	15451-2298-1	15451-2299-1
Part name	Crank pin bearing 0.20 minus	Crank pin bearing 0.40 minus	Crank pin bearing 025	Crank pin bearing 050	Crank pin bearing 075
O.D. of crank pin	$\phi 43.8f6^{-0.025}_{-0.041}$ 1.7228 to 1.7234in.	$\phi 43.6f6^{-0.025}_{-0.041}$ 1.7149 to 1.7156 in.	$\phi 63.75g5^{-0.010}_{-0.023}$ 2.5089 to 2.5094in.	$\phi 63.5g5^{-0.010}_{-0.023}$ 2.4991 to 2.4996in.	$\phi 63.25g5^{-0.010}_{-0.023}$ 2.4893 to 2.4898in.
Metal grade mark	0.20US	0.40US	0.25US	0.50US	0.75US

<table>
<tr><th>Item</th><th>Location</th><th>Reference value</th></tr>
<tr>
<td>Servicing (5)
End play of crankshaft</td>
<td></td>
<td>• Reference value
<table>
<tr><td>S2200</td><td rowspan="2">0.15 to 0.31mm
0.0059 to 0.0122in.</td></tr>
<tr><td>S2600</td></tr>
<tr><td>D3000</td><td rowspan="3">0.082 to 0.332mm
0.0032 to 0.0131in.</td></tr>
<tr><td>V4000L</td></tr>
<tr><td>V4000</td></tr>
</table>
</td>
</tr>
</table>

Tools and test instruments	Procedure	Remarks
	1) Move the crankshaft to the crank gear side. 2) Attach a dial gauge to the crankshaft. 3) Push the crankshaft toward the flywheel and measure the clearance. 4) If the measurement is not within the reference value, replace the side metal.	• When replacing the side metal, pay attention to the direction of the metal's oil grooves. (See page 51 and 79)

7. CYLINDER LINERS

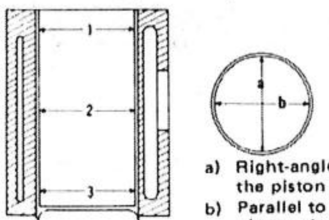
Item	Location	Reference value
Servicing (1) Wear of cylinder liners		see table below

	Reference value	Allowable limit
S2200	$\phi 76^{+0.019}_{0}$ 2.9921 to 2.9929 in.	+0.15 mm +0.0059 in.
S2600	$\phi 82^{+0.019}_{0}$ 3.2283 to 3.2291 in.	
D3000 V4000L V4000	$\phi 105^{+0.18}_{0}$ 4.1339 to 4.1346 in.	

Tools and test instruments	Procedure	Remarks

1) Set a cylinder gauge and adjust it to the reference value of the cylinder liner with an outside micrometer.
2) To find out the maximum wear, measure the diameters at six points on the cylinder liner with the cylinder gauge, as shown below.

Fig. 21 Measuring points of cylinder liner



a) Right-angle to the piston pin
b) Parallel to the piston pin

1) Top
2) Middle
3) Bottom (Skirt)

- When the cylinder liner is worn beyond the allowable limit, bore and hone it by 0.5 mm (0.0197 in.) for S2200, S2600 or 0.2 mm (0.0079 in.), 0.4 mm (0.0157 in.), 0.6 mm (0.0236 in.) for D3000, V4000L, V4000.

1) For the finish dimensions of the cylinder liners, refer to the table below.
2) Use oversized pistons and piston rings for the cylinder liners which have been bored and honed to oversizes. (Refer to the table below).

- When oversized cylinder liners are worn beyond the allowable limit, replace and hone new ones.

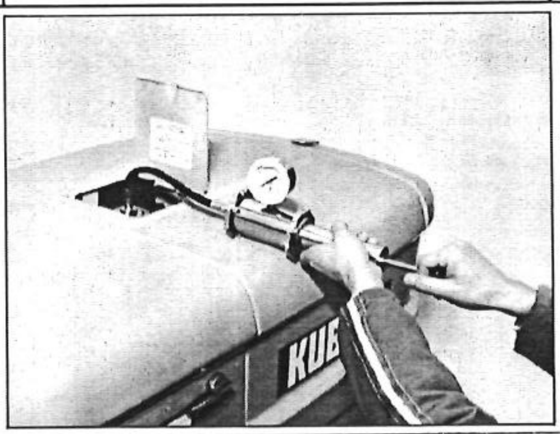
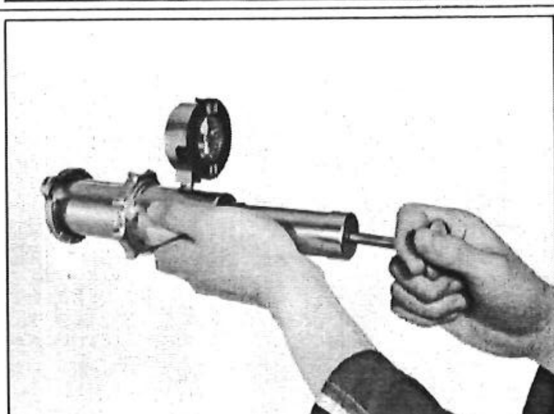
Finish dimensions of cylinder liner

S2200	$\phi\,76.5^{+0.019}_{0}$ 3.0118 to 3.0126in.	Hone to 1.2 to 2μR max. ▽▽▽
S2600	$\phi\,82.5^{+0.019}_{0}$ 3.2480 to 3.2488in.	
D3000 V4000L V4000	$\phi\,105.2^{+0.18}_{0}$ 4.1417 to 4.1488in. $\phi\,105.4^{+0.18}_{0}$ 4.1496 to 4.1567in. $\phi\,105.6^{+0.18}_{0}$ 4.1575 to 4.1646in.	

Oversized pistons and piston rings

	Oversize	Part name	Code number	Mark
S2200	0.5mm 0.0197in.	Piston 05	15221-2191-1	050 S (cut)
		Piston ring 05 assy	15221-2109-1	050 S (cut)
S2600	0.5mm 0.0197in.	Piston 05	15201-2191-1	050 S (cut)
		Piston ring 05 assy	15201-2109-1	050 S (cut)
D3000 V4000L V4000	0.2mm 0.0079in.	Piston 02	15451-2190-1	OS02 (stamped by indelible ink)
		Piston ring 02 assy	15451-2109-1	20 (cut)
	0.4mm 0.0157in.	Piston 04	15451-2191-1	OS04 (stamped by indelible ink)
		Piston ring 04 assy	15451-2110-1	40 (cut)
	0.6mm 0.0236in.	Piston 06	15451-2192-1	OS06 (stamped by indelible ink)
		Piston ring 06 assy	15451-2120-1	60 (cut)

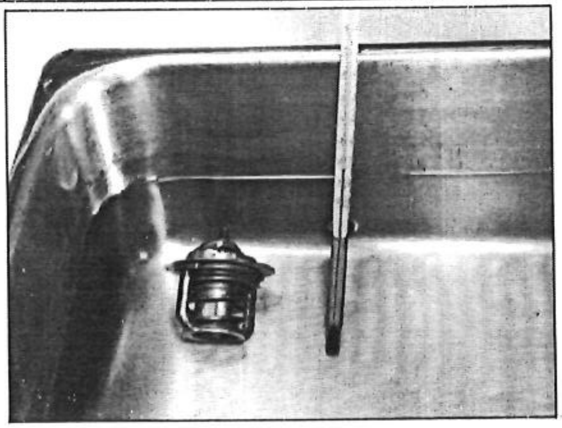
8. COOLING SYSTEM

Item	Location	Reference value
Servicing (1) Water tightness of radiator		• **Reference value** Water tight at the specified pressure.
Servicing (2) Opening pressure of radiator cap.		• **Reference value** Pressure should drop by 29.4kPa. (0.3 kgf/cm^2, 4.3lb./sq.in.) or less in 10 seconds.

<table>
<tr><th>Tools and test instruments</th><th>Procedure</th><th>Remarks</th></tr>
<tr><td></td><td>1) Pour the specified amount of water into the radiator.
2) Warm up the engine.
3) Attach a radiator tester. Increase to the specified pressure.
4) Check to see if water leaks from any part.</td><td>• Test pressure
<table>
<tr><td>S2200</td><td rowspan="2">176.5 kPa.
1.8 kgf/cm^2
25.6 lb./sq.in.</td></tr>
<tr><td>S2600</td></tr>
<tr><td>D3000</td><td rowspan="3">147.1 kPa.
1.5 kgf/cm^2
21.3 lb./sq.in.</td></tr>
<tr><td>V4000L</td></tr>
<tr><td>V4000</td></tr>
</table></td></tr>
<tr><td>
</td><td>1) Attach a radiator tester to the radiator cap.
2) Apply the specified pressure 88.3 kPa. (0.9 kgf/cm^2, 12.8 lb./sq.in.).
3) Check to see if the pressure drops by 29.4 kPa. (0.3 kgf/cm^2, 4.3 lb./sq.in.) or more in 10 seconds.</td><td></td></tr>
</table>

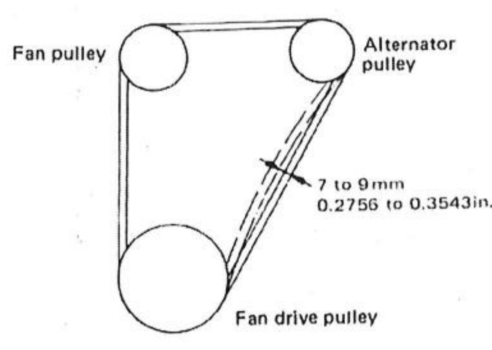
Item	Location	Reference value

Servicing (3)
Operating temperature of thermostat



	Temperature at which thermostat should start to open	Temperature at which thermostat completely opens	Distance of lift
S2200	82 ± 1.5°C 176.9°F to 182.3°F	95°C 203°F	8mm 0.3150in.
S2600			
D3000	79 ± 1.5°C 171.5°F to 176.9°F		
V4000L			
V4000			

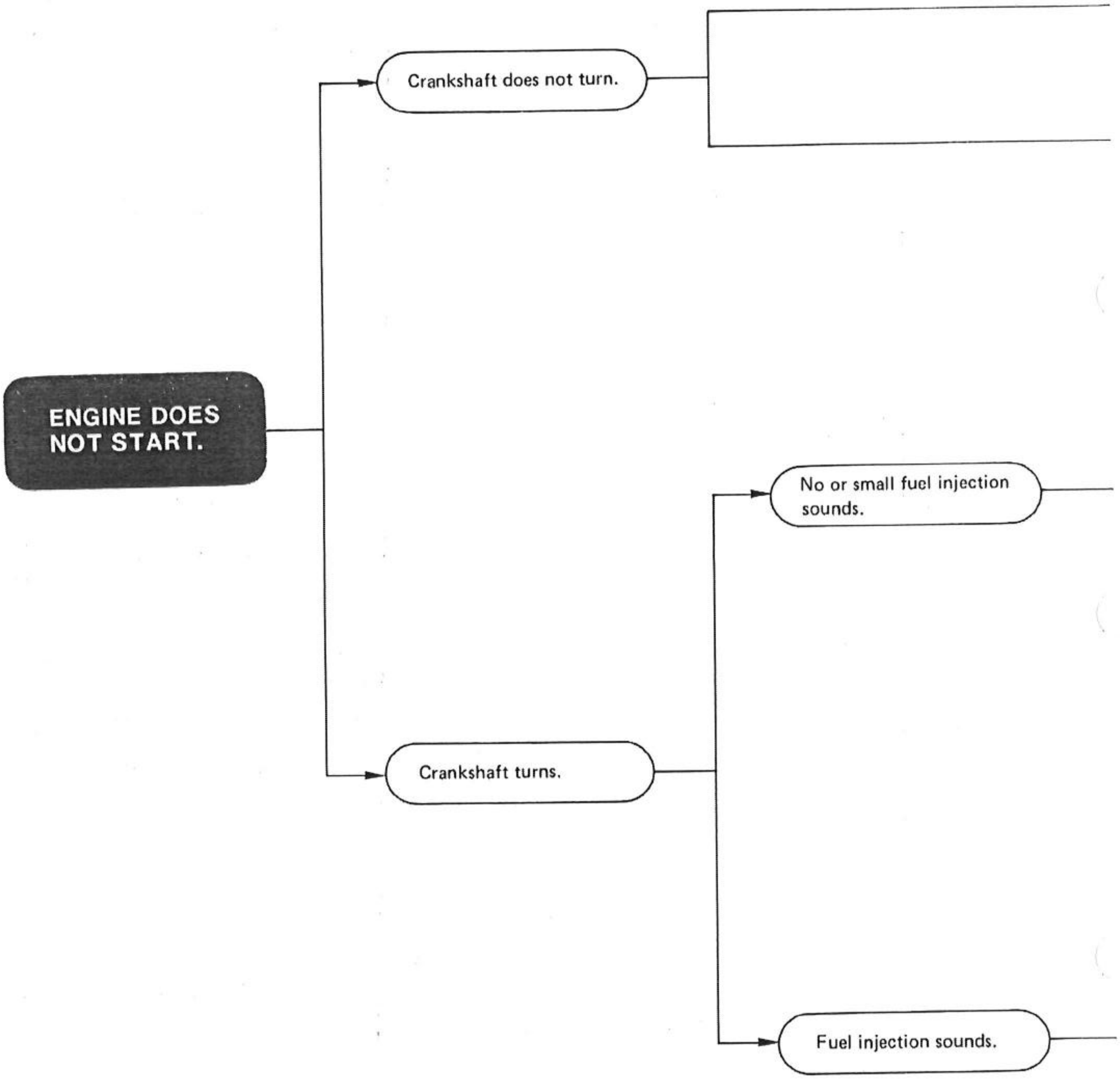
Servicing (4)
Fan belt tension



- **Reference value**
  7 to 9mm
  0.2756 to 0.3543in.

<table>
<tr><th>Tools and test instruments</th><th>Procedure</th><th>Remarks</th></tr>
<tr><td></td><td>1) Put the thermostat and a thermometer into hot water.
2) Check to see if the thermostat begins to open at 79 to 82°C (174 to 180°F) and completely opens around 95°C (203°F).</td><td></td></tr>
<tr><td></td><td>1) Check to see if the belt tension allows a depression of the specified amount when the belt is pressed down by a finger mid-way between the fan drive pulley and the alternator pulley.
2) Adjust the tension by moving the alternator.</td><td>• Size of fan belts
<table>
<tr><td>S2200</td><td rowspan="2">A44 1</td></tr>
<tr><td>S2600</td></tr>
<tr><td>D3000</td><td rowspan="3">MH46 2</td></tr>
<tr><td>V4000L</td></tr>
<tr><td>V4000</td></tr>
</table></td></tr>
</table>

TROUBLE SHOOTING



		Reference
Moving parts have too much friction.	Crankshaft and camshaft have seized up.	98,112 114
	Piston and cylinder liner have seized up.	42 74
	Bearings stuck together by oil.	42,50,52 70,74,78
	Lubrication system is not working properly.	102~ 106
	Starter faulty.	346 ~ 358
	Battery capacity is low or terminal loose.	310~ 314
Fuel supply to injection pump is insufficient.	Fuel pipe broken.	36
	Air enters fuel pipe through connection.	36
	Fuel filter clogged.	96 98
	Fuel pump faulty.	40
Injection pump does not send out fuel.	Plunger has worn or seized up.	94
	Delivery valve spring broken.	94
	Delivery valve not completely oil-tight.	94
	Regulating valve has seized up.	40
	Metering valve has seized up.	40
	Rotor and plunger have worn or seized up.	40
	Transfer pump faulty.	40
Fuel does not inject through injection nozzle.	Needle valve stuck.	34,56 92
	Nozzle spring broken.	34,56 92
	Injection pressure maladjusted.	92
	Injection pipe mounting nut loose.	34 56
Injection mistimed.	Injection timing maladjusted.	96
Compressed air leaks.	Contact between intake/exhaust valve and seat not close enough.	84
	Intake/exhaust valve spring broken.	38,60 86
	Intake/exhaust valve stuck.	38,60 84
	Gasket faulty.	38 58
	Tightening torque of cylinder head not enough.	38 58
	Piston ring stuck.	44 76
	Piston ring worn.	108
	Cylinder liner worn.	118
	Tightening torque of injection nozzle and glow plug not enough.	34 56
Valve action timing is off.	Valve clearance excessive.	88

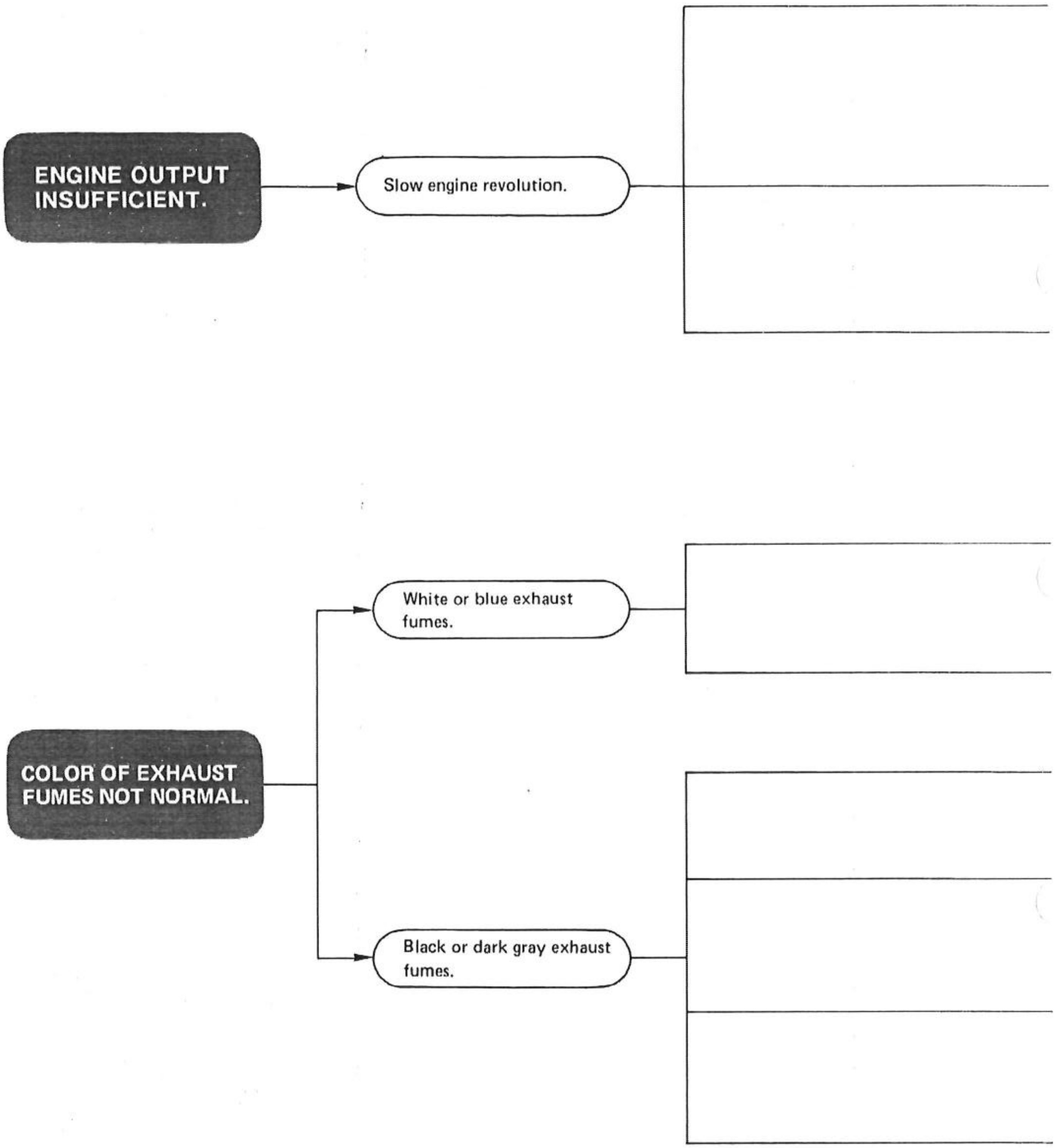
ENGINE DOES NOT TURN NORMALLY.

Revolution irregular.

Revolution not smooth at high speeds.

Revolution not smooth at idle.

		Reference
	Fuel filter clogged.	96 98
	Pipes broken or loose.	
Feed pump not working properly.	Filter clogged.	96 98
	Inlet/outlet valve faulty.	40
	Diaphragm broken.	40
	Control link broken.	40
Injection pump not working properly.	Air in pump.	36
	Pump capacity fluctuates.	94
	Tappet roller and pin worn.	62
	Delivery valve not completely oil-tight.	94
	Regulating valve has seized up.	40
	Metering valve has seized up.	40
	Rotor and plunger have worn or seized up.	40
	Transfer pump faulty.	40
Timing control device not working properly.	Manual retard device clogged.	40
	Ball-type check valve stuck.	40
	Piston scratched; functions improperly.	40
	Spring deformed or broken.	40
	Fuel leaks from timing control device.	40
Injection nozzle not working properly.	Fuel leaks from nozzle tip.	92
	Fuel not injected properly.	94
	Governor spring deformed.	64
	Valve clearance incorrect.	88
	Injection pump or nozzle not working properly.	92 94
	Each cylinder's compression pressure is different.	82
Governor not functioning normally.	Governor sleeve not sliding properly.	72
	Fork lever not working properly.	72
	Start spring deformed.	64
	Control rack not sliding properly.	62
	Thrust sleeve not sliding properly.	40
	Governor arm spring deformed or broken.	40
	Governor link deformed.	40
	Idling spring deformed.	40
	Governor spring deformed.	40
Idling maladjusted.	Idling regulator maladjusted.	
	Accelerator rod maladjusted.	


ENGINE OUTPUT INSUFFICIENT.
Slow engine revolution.
COLOR OF EXHAUST FUMES NOT NORMAL.
White or blue exhaust fumes.
Black or dark gray exhaust fumes.

Cause	Detail	Reference
	Main moving parts are about to seize up.	112 114
	Engine overheated.	120 122
	Injection mistimed.	96
	Governor not functioning properly.	72

Cause	Detail	Reference
Fuel supply insufficient.	Filter clogged.	96 98
	Pipes broken or loose.	34,36 56
	Feed pump capacity insufficient.	40
	Injection pump capacity insufficient.	94
	Nozzle needle valve worn.	34,56 92

Cause	Detail	Reference
Compression pressure not enough.	Compressed air leaks.	82
	Air cleaner clogged.	90

Cause	Detail	Reference
Lubricant rises through piston gap.	Piston ring stuck.	44 76
	Piston ring worn.	108
	Excessive gap between cylinder liner and piston.	118
	Too much oil.	10

Cause	Detail	Reference
	Injection delayed.	96
	Compression pressure insufficient.	82

Cause	Detail	Reference
Injection mistimed.	Injection too early.	96
	Injection delayed.	96

Cause	Detail	Reference
Fuel pump injection capacity inconsistent.	Plunger does not return completely because spring is stuck or broken.	94
	Plunger worn.	94

Cause	Detail	Reference
Nozzle does not inject fuel properly.	Needle valve stuck.	34,56 92
	Nozzle spring broken.	34,56 92
	Too much carbon sticks to nozzle tip.	34,56 92
	Injection pressure insufficient.	34,56 92

Cause	Detail	Reference
	Compressed air leaks.	82
	Air insufficient.	88 90

EXCESSIVE LUBRICANT CONSUMPTION.

LUBRICANT INCREASES.

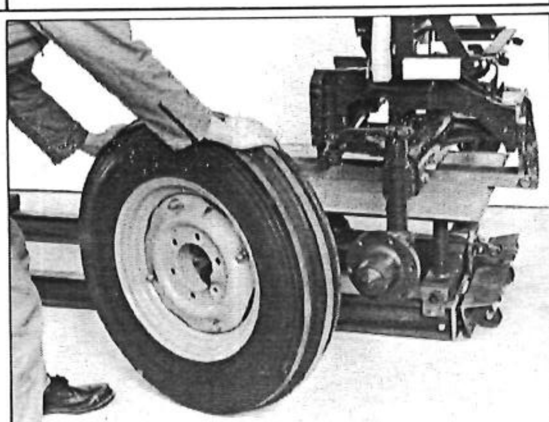
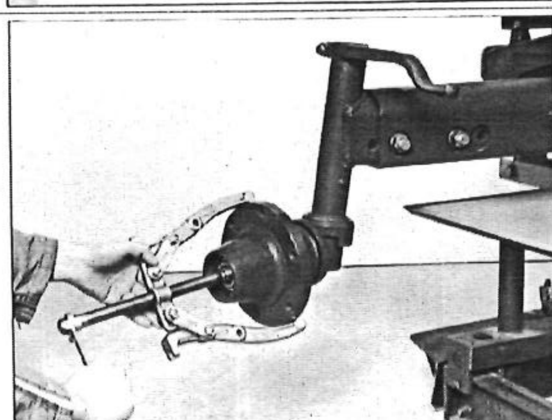
Cause	Reference
Excessive gap between piston and cylinder liner.	118
Piston ring stuck.	44 76
Piston ring worn.	108
Excessive gap between intake/exhaust valve and valve stem.	84
Valve stem seal broken.	60
Oil leaks from defective packing.	

Symptom	Cause	Reference
Fuel in lubricant.	Much fuel leaks from injection pump plunger.	94
	Much fuel leaks from fuel pump.	40
Water in lubricant.	Cylinder head gasket faulty.	38 58
	Crankcase cracked.	
Gear oil in lubricant.	Hydraulic pump oil seal broken.	224 ~

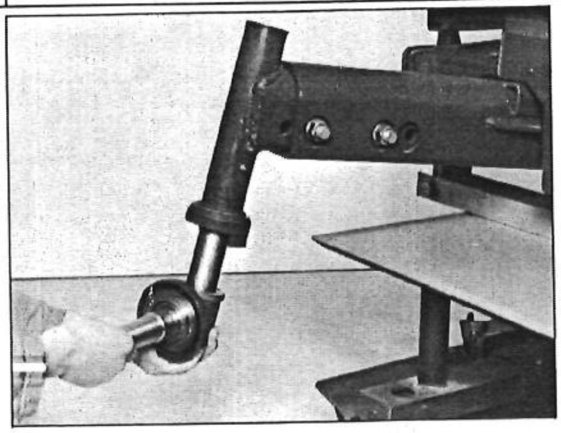
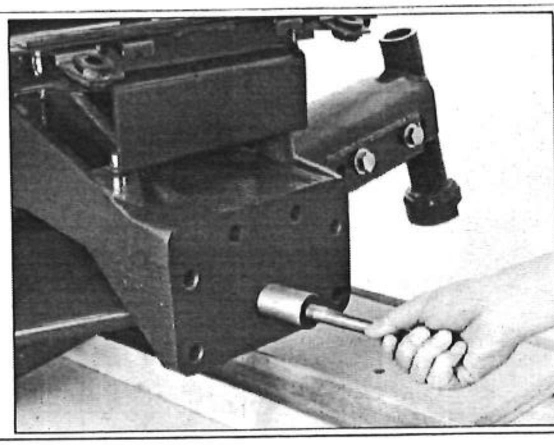
III. TRACTOR BODY

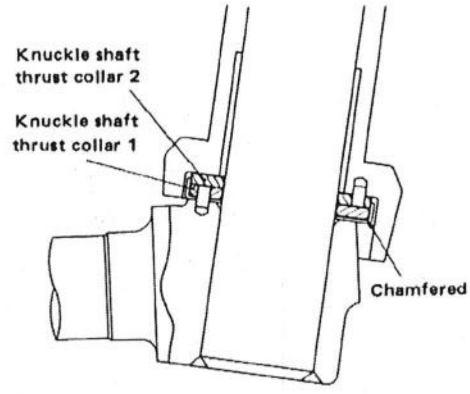
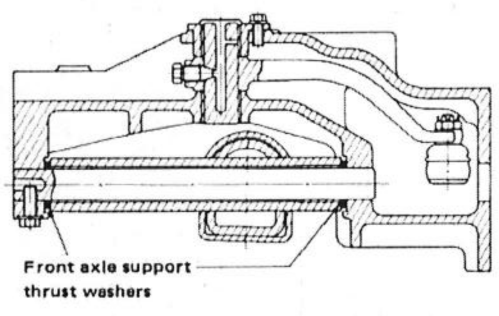
DISASSEMBLY

1. 2-WHEEL DRIVE FRONT AXLE

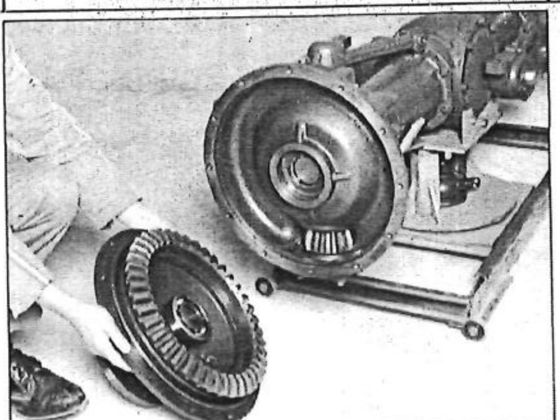
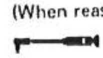
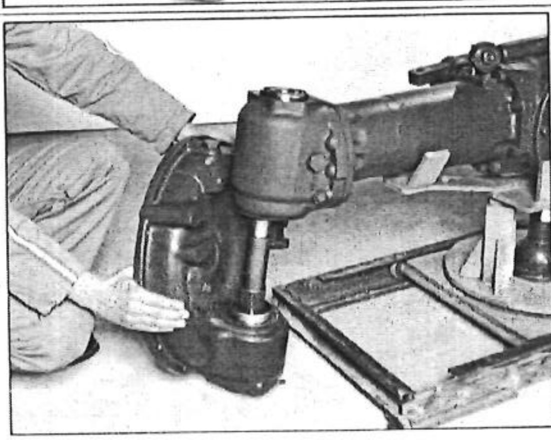
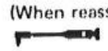
Item	Location	Bolts and nuts	Tools
Disassembly (1) Front wheels		Front wheel set bolt 6	24 (When reassembling)
Disassembly (2) Front wheel hubs		.... 1 M18 ... 1	24 27 (When reassembling)

<table>
<tr><th>Procedure</th><th>Remarks</th></tr>
<tr><td>1) Remove the front wheel.</td><td>(When reassembling)
● Tighten the front wheel mounting bolts to 196.1 to 245.2 N·m. (20 to 25 kgf·m., 144.7 to 180.8 lb.ft.).</td></tr>
<tr><td>1) Remove the front wheel hub cover.
2) Remove the slotted nut.
3) Remove the front wheel hub.
4) Remove the bearing and the oil seal inside the hub.</td><td>(When reassembling)
<table>
<tr><th>Model</th><th>Amount of grease for front wheel hub</th><th>Slotted nut tightening torque</th></tr>
<tr><td>M4000, M4500
M5500, M6500
M7500</td><td>80g (0.18lb.) or more</td><td>215.7 to 274.6 N·m.
22 to 28 kgf·m.
159.1 to 202.5lb.ft.</td></tr>
</table>
</td></tr>
</table>

Item	Location	Bolts and nuts	Tools
Disassembly (3) Knuckel shafts		M12×65 .... 1 M12... 1	17 (When reassembling)
Disassembly (4) Front axle support		M16×65 .... 4 M12×40 1	17 22

Procedure	Remarks
1) Remove the knuckle arm. 2) Remove the knuckle shaft.	(When reassembling) ● Tighten the knuckle arm bolts and nuts to 77.5 to 90.2 N·m. (7.9 to 9.2 kgf·m., 57.1 to 66.5 lb.ft.). **Fig. 22 How to reassemble thrust collars 1 and 2** 
1) Remove the front bumper. 2) Remove the front axle support set bolts and draw out the support by screwing in an M14 bolt.	(When reassembling) **Fig. 23 Position of front axle support thrust washers** 

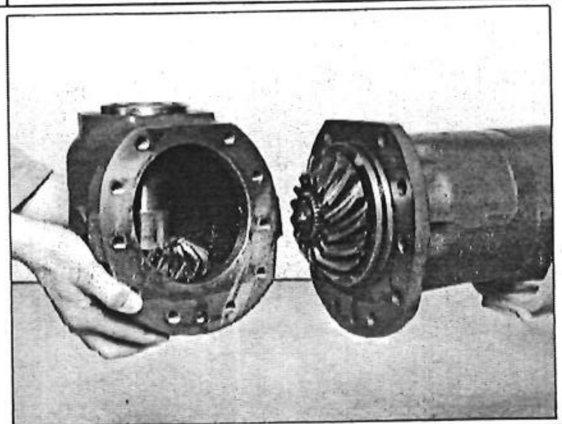
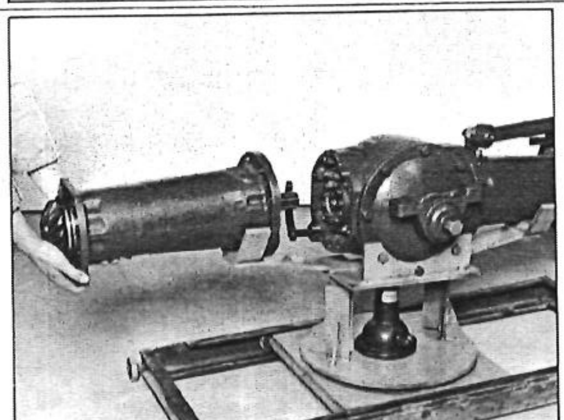
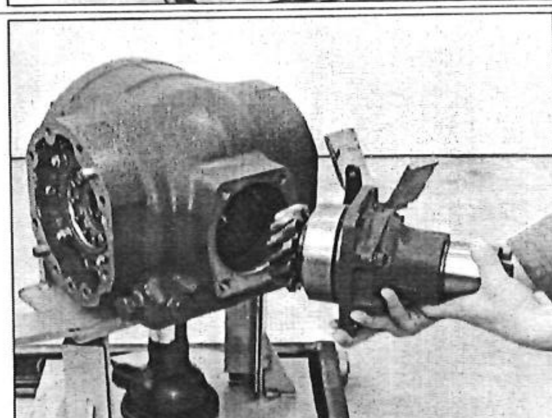
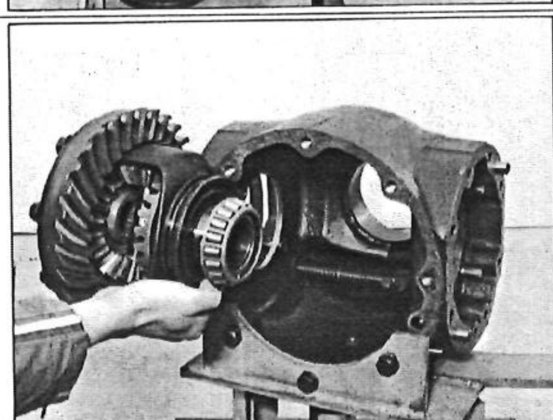
2. 4-WHEEL DRIVE FRONT AXLE

Item	Location	Bolts and nuts	Tools
Disassembly (1) Front wheel case cover, 42T bevel gear		M10x28 12	 14 (When reassembling) 
Disassembly (2) Separating bevel gear case from front wheel case		M12x35 .... 2 M10x30 .... 6 M10x28 .... 4 M35··· 1 M16··· 1 1	 17 14 50 (When reassembling) 

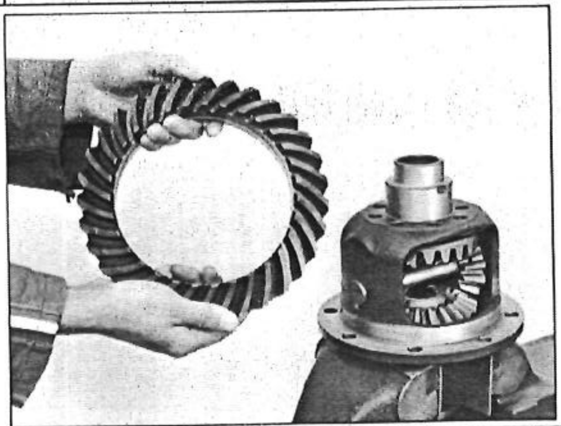
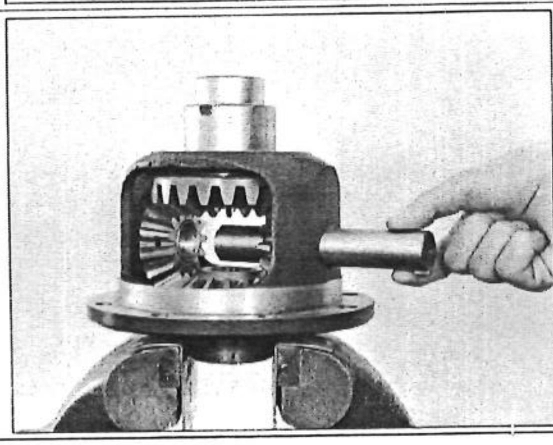
<table>
<tr><th>Procedure</th><th>Remarks</th></tr>
<tr><td>1) Remove the front wheel case cover and the 42T bevel gear at the same time.</td><td>(When reassembling)
• Make sure of the number of shims and O-rings of the front wheel case cover.
• Tighten the front axle self-locking nuts to 274.6 to 313.8 N·m. (28 to 32 kgf·m., 202.5 to 231.5 lb.ft.).
• Tighten the bevel gear set bolts to 103.0 to 117.7 N·m. (10.5 to 12 kgf·m., 75.9 to 86.8 lb.ft.).</td></tr>
<tr><td>1) Remove the steering damper.
2) Remove the front wheel support.
3) Remove the bearing retainer.
4) Remove the self-locking nut.
5) Remove the bearing case.
6) Tap the king pin on top, and remove the front wheel case and the pin at the same time.</td><td>(When reassembling)
• Be careful about the installation direction of the oil seals and the seal collars.

Fig.24


• Tighten the self-locking nut to 245.2 to 294.2 N·m. (25 to 30 kgf·m., 180.8 to 217.0 lb.ft.).
• Tighten the slotted nut to 98.1 to 127.5 N·m. (10 to 13 kgf·m., 72.3 to 94.0 lb.ft.).
• Reassemble the bearing case so that the drain plug is on the side of the knuckle arm.
• Make sure of the number of shims and O-rings on the bearing case.</td></tr>
</table>

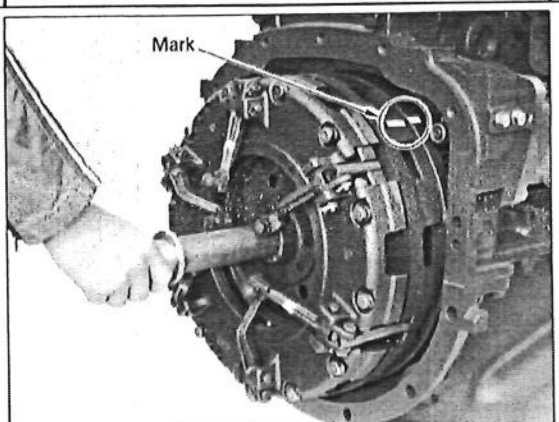
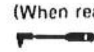
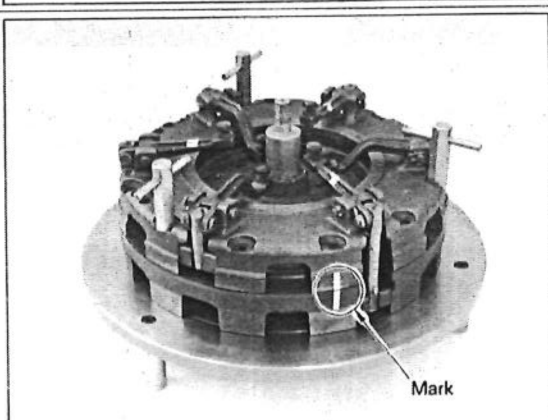
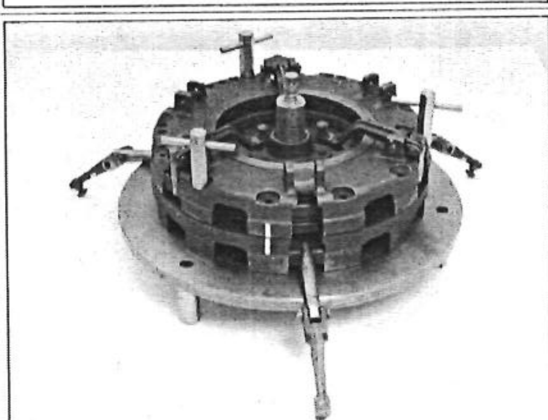
Item	Location	Bolts and nuts	Tools
Disassembly (3) Separating front axle support from bevel gear case.		M12··· 10 ·········· 1	17
Disassembly (4) Front axle support		M12x30 ·········· 2 M12x40 ·········· 9	17 17
Disassembly (5) Spiral bevel pinion shaft		M12x35 ·········· 4	17 (When reassembling)
Disassembly (6) Differential assembly		M12x30 ·········· 8 M6 x 10 ·········· 2 M10··· 4	10 14 17

Procedure	Remarks
1) Remove the bevel gear case from the front axle support.	(When reassembling) ● Make sure of the number of shims and O-rings of the front axle support. ● Be careful to reassemble the bevel pinions and the bevel gears to the right positions; they are marked "R" and "L".
1) Remove the damper bracket. 2) Remove the front axle support.	
1) Remove the pinion bearing case and the pinion shaft as an assembly.	(When reassembling) ● Tighten the spiral bevel pinion shaft nuts to 225.5 to 245.2 N·m. (23 to 25 kgf·m., 144.7 to 180.8 lb.ft.). ● Make sure of the number of shims on the pinion bearing case.
1) Remove the front differential case cover. 2) Remove the differential bearing case. 3) Remove the differential assembly.	

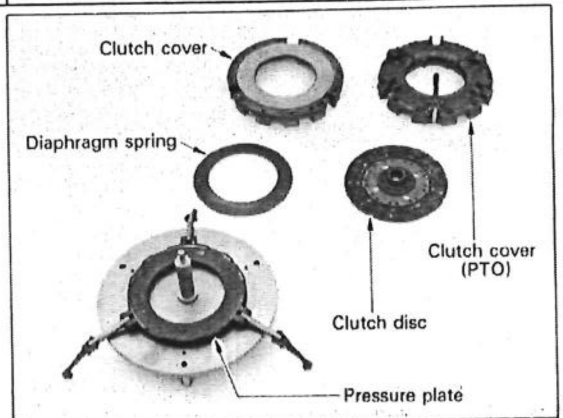
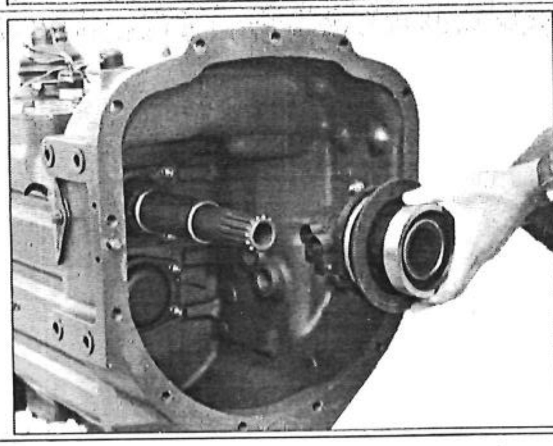
Item	Location	Bolts and nuts	Tools
Disassembly (7) Differential lock shifter, Spiral bevel gear		Special bolt 8	   17 (When reassembling) 
Disassembly (8) Pinion gear, Differential side gears, Washers			 

Procedure	Remarks
1) Remove the bearings on the right and left side of the differential case. 2) Remove the differential lock shifter. 3) Remove the spiral bevel gear.	(When reassembling) ● Tighten the bolts to 103.0 to 117.7 N·m. (10.5 to 12 kgf·m., 75.9 to 86.8 lb.ft.).
1) Push out the differential pinion shaft. 2) Remove the differential pinion gear. 3) Remove the differential side gears.	(When reassembling) ● Be sure to reassemble the gears and the washers where they were.

3. CLUTCH

Item	Location	Bolts and nuts	Tools
Disassembly (1) Clutch		 M8×100 ········ 12	 12 (When reassembling) 
Disassembly (2) Disassembling clutch i) Attaching to main clutch disassembly/assembly tool			
Disassembly ii) Release lever		 ·········· 6  M8····· 6	

Procedure	Remarks
1) Mark the clutch cover and the flywheel. 2) Remove the clutch.	• When disassembling and reassembling the clutch, use a clutch center tool, and take great care not to drop the clutch disc and the pressure plate. (When reassembling) • Tighten the clutch mounting bolts to 23.5 to 27.5 N·m. (2.5 to 2.8 kgf·m., 17.4 to 20.3 lb.ft.). • Tighten the bolts equally.
1) Mark the clutch cover and the pressure plate. 2) Attach the clutch to a main clutch disassembly/assembly tool.	(When reassembling) • Align the marks on the clutch cover and the pressure plate to each other, and dynamic balance will be achieved.
1) Remove the pin which fixes the release lever to the clutch lever.	

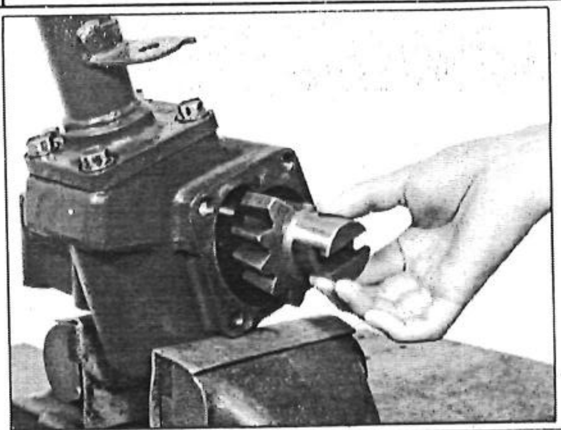
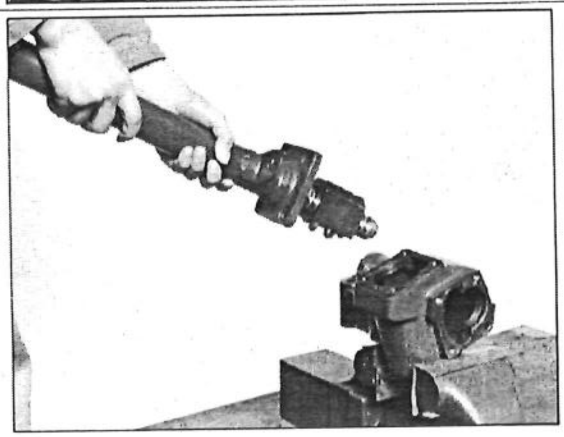
Item	Location	Bolts and nuts	Tools
Disassembly iii) Clutch disc, Pressure plate			
Disassembly (3) Clutch release hub		M8······3 M10··· 1 M12··· 1 ·········· 2	12 17 (When reassembling)

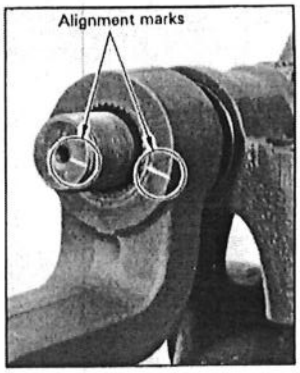
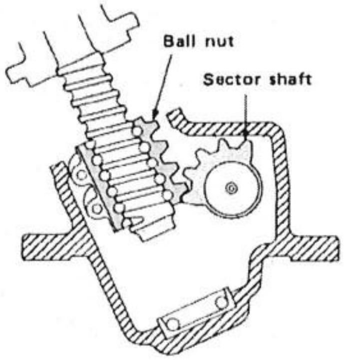
4. STEERING SYSTEM

Item	Location	Bolts and nuts	Tools
Disassembly (1) Oil drainage		·········· 1	10

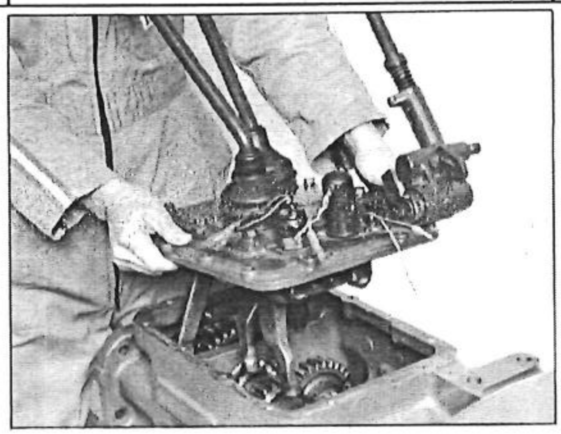
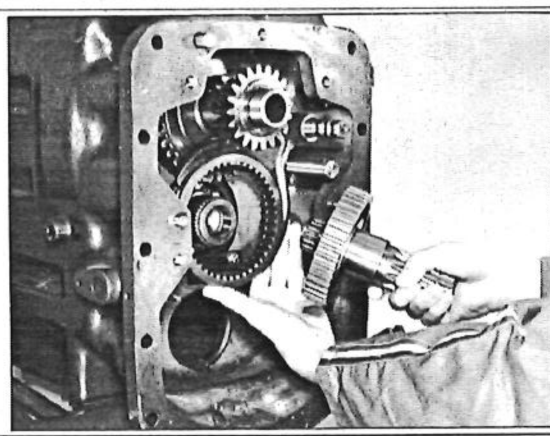
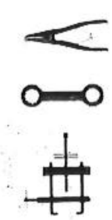
Procedure	Remarks
1) Loosen the three bolts gradually and equally, then remove them. 2) Remove the clutch cover (PTO) and the pressure plate. At the same time, remove the clutch disc, the clutch cover, the diaphragm spring and the pressure plate in that order.	(When reassembling) ● Before reassembly, apply a thin film of bearing grease to the following sliding surfaces: (1) Between clutch cover and pressure plate (2 places). (2) Between pressure plate and rod. (3) Between release lever and clutch cover and release lever and rod.
1) Remove the clutch control rod and the clutch pedal rod. 2) Remove the wire locks and the set bolts of the clutch release forks 1 and 2. 3) Draw out the clutch control lever and the control lever shaft at the same time. Remove the clutch release forks 1 and 2. 4) Remove the clutch release hub and the release coupling at the same time. 5) Remove the bearing case.	(When reassembling) ● Apply bearing grease to the clutch release hub. ● Tighten the clutch release fork set bolts to 176.5 to 196.1 N·m. (18 to 20 kgf·m., 130.2 to 144.7 lb.ft.). ● After tightening the fork set bolts, lock them with wire.

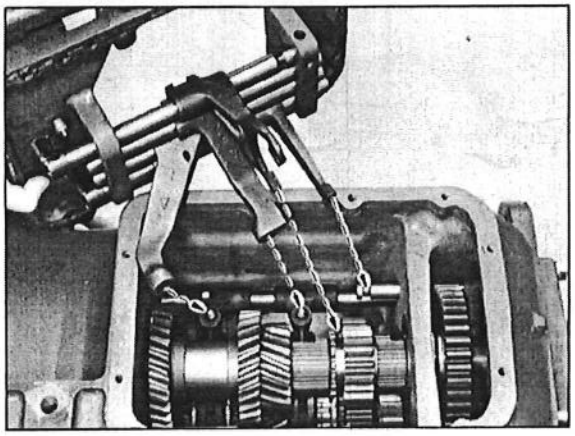
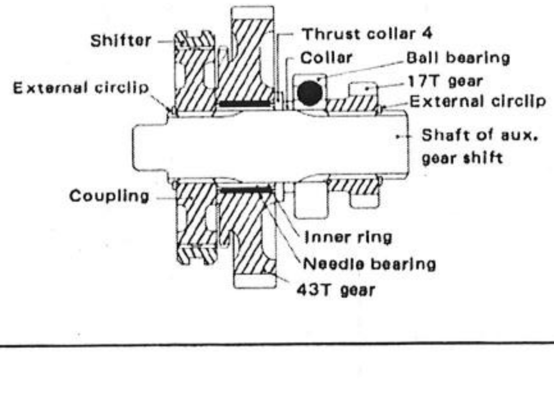
Procedure	Remarks
1) Drain oil.	● **Type and amount of oil** <table><tr><td>Type</td><td>Gear oil SAE #80</td></tr><tr><td>Amount</td><td>0.3 liter (0.08 gal.)</td></tr></table>

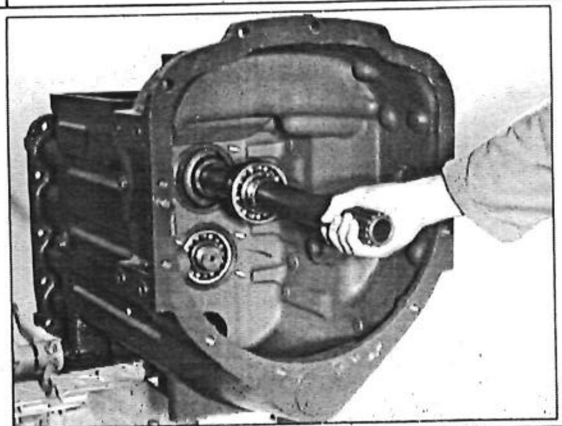
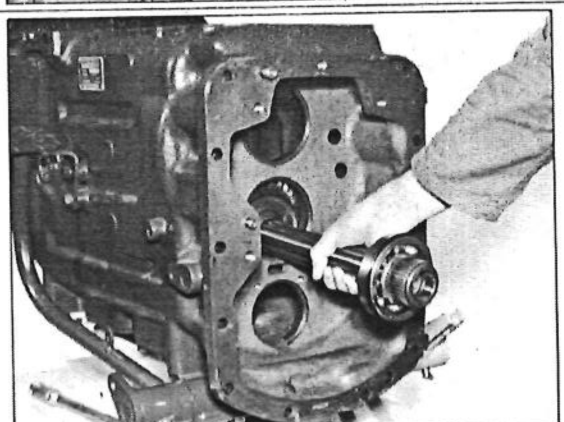
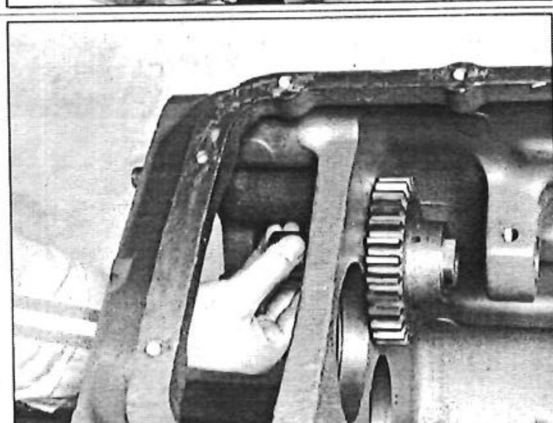
Item	Location	Bolts and nuts	Tools
Disassembly (2) Sector shaft		M28··· 1 M28··· 1 M10x25 ·········· 4	14 41 (When reassembling)
Disassembly (3) Steering shaft		M10x25 ·········· 4	14

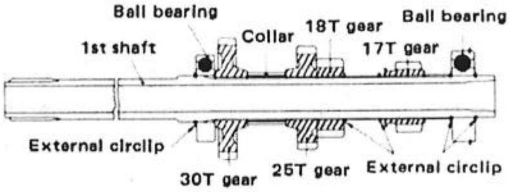
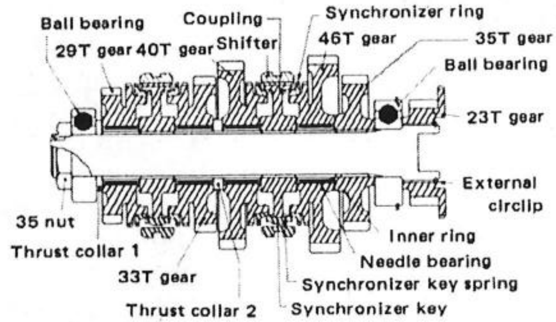
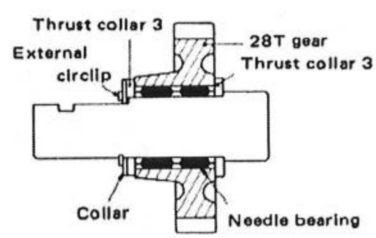
Procedure	Remarks
1) Remove the pitman arm. 2) Remove the side cover. 3) Tap the sector shaft off.	(When reassembling) • Align the alignment marks on the sector shaft and the pitman arm with each other. • Tighten the pitman arm nut to 176.5 to 245.2 N·m. (18 to 25 kgf·m., 130.2 to 180.8 lb.ft.). 
1) Remove the rear cover. 2) Remove the steering shaft. 3) Remove the bearing outer ring with a bushing puller.	(When reassembling) • Make sure of the number of rear cover shims. • How to reassemble the steering gear box. (1) Place the sector shaft in the gear box and turn it fully to the right. (2) Place the ball nut assembly in the gear box and engage it with the sector gear. (3) Be careful not to let the thrust bearing balls slip off the outer ring. Fig. 25 

5. CLUTCH HOUSING

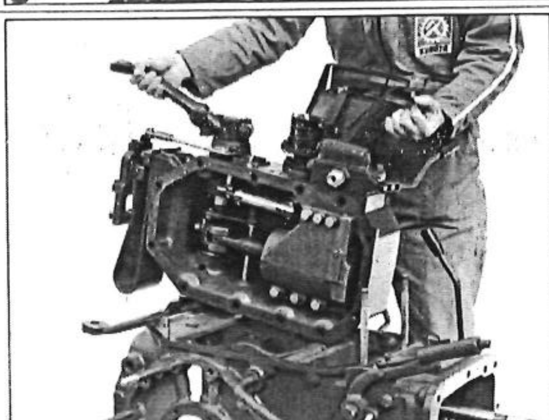
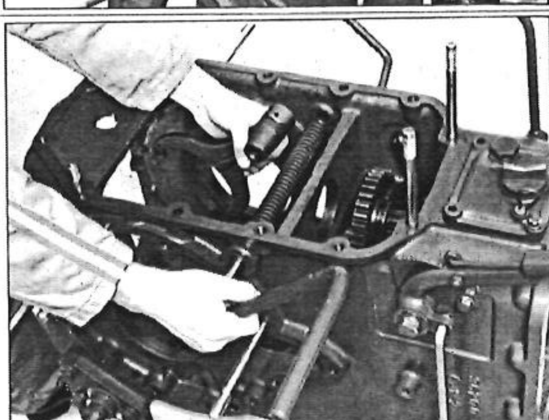
Item	Location	Bolts and nuts	Tools
Disassembly (1) Speed change cover		M8 x 28 .... 10 M8 x 30 1	 12
Disassembly (2) Shaft of aux. gear shift		M12x40 .... 4 2	 17

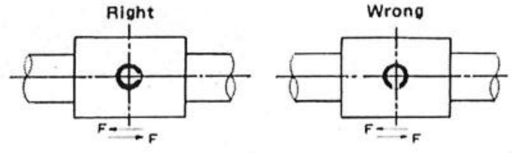
Procedure	Remarks
1) Remove the speed change cover.	(When reassembling) ● Install the 1st/2nd shift lever, the 3rd/4th shift lever, the reverse shift fork and aux. gear shift lever securely. 
1) Remove the 17T gear. 2) Remove the bearing support by screwing two M8 bolts in. 3) Remove the bearing with a special puller. Remove the shaft of aux. gear shift and the gear. 4) Remove the 23T gear. 5) Remove the 20-40T gears, aux. gear shift rod 2 and the aux. gear shift fork at the same time.	**Fig.26 Shaft of aux. gear shift** 

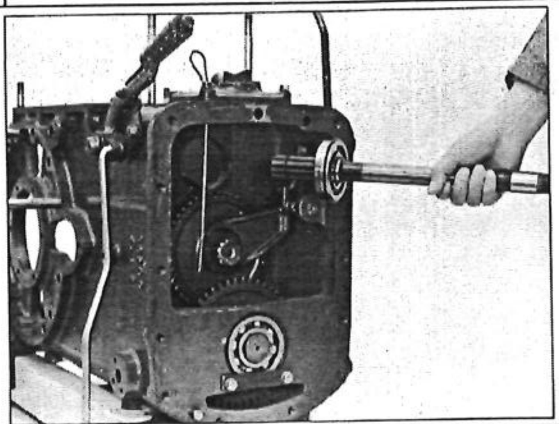
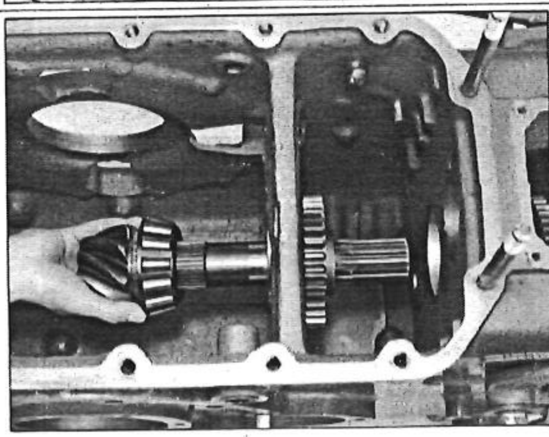
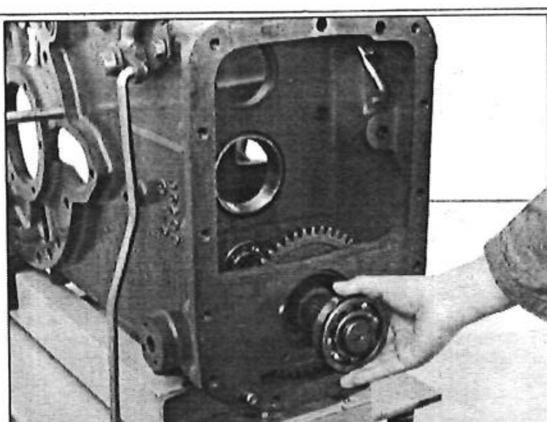
Item	Location	Bolts and nuts	Tools
Disassembly (3) 1st shaft		M8····· 4 M35··· 1 ·········· 4	 12 50 (When reassembling) 
Disassembly (4) Counter shaft		M8 x 18 ·········· 2	 12 (When reassembling) 
Disassembly (5) Reverse idler shaft		M10··· 1 ·········· 1 ·········· 1	 14 17

<table>
<tr><th>Procedure</th><th>Remarks</th></tr>
<tr><td>1) Remove the counter shaft cover, engage the idler gear with two mating gears to fix the counter shaft, and remove the nuts.
2) Remove the external circlips, tap the 1st shaft out the front, and remove the gears.</td><td>(When reassembling)
• Replace the counter shaft nut with a new one.
• Tighten the counter shaft nut to 245.2 to 294.2 N·m. (25 to 30 kgf·m., 180.8 to 217.0 lb.ft.).
Fig.27 1st shaft

</td></tr>
<tr><td>1) Draw the 1st, 2nd, 3rd and 4th gear shift rods out the rear. Remove the 1st, 2nd, 3rd and 4th gear shift forks.
2) Remove the bearing retainer, tap the counter shaft out the rear, and remove the gears.</td><td>Fig.28 Counter shaft

</td></tr>
<tr><td>1) Remove the set screw and the external circlip. Tap the reverse idler shaft out the rear.</td><td>Fig.29 Reverse idler shaft

</td></tr>
</table>

6. TRANSMISSION

Item	Location	Bolts and nuts	Tools
Disassembly (1) Seat		M12··· 4	17
Disassembly (2) Hydraulic cylinder body		M12x40 ·········· 3 Special bolt ··············· 3 Special bolt ··············· 2 M12··· 4	17 17 (When reassembling)
Disassembly (3) Differential lock pedal, Shift fork		$\phi 6 \times 36$ ·········· 1	

Procedure	Remarks
1) Remove the seat and the seat support at the same time.	
1) Remove the hydraulic cylinder body.	(When reassembling) ● Tighten the bolts to 77.5 to 90.2 N·m. (7.9 to 9.2 kgf·m., 57.1 to 66.5 lb.ft.).
1) Remove the differential lock cam, the shift fork and the pedal at the same time.	(When reassembling) ● When tapping the spring pin into the differential lock cam, make sure of the direction of the groove on the pin. Fig. 30 How to tap in the spring pin 

Item	Location	Bolts and nuts	Tools
Disassembly (4) PTO clutch shaft		 M8x18 2	 12
Disassembly (5) Bevel pinion shaft		 M40··· 1 .... 1 1	 12 56 (When reassembling) 
Disassembly (6) Creep shaft		 M8 x 18 2	 12

Procedure	Remarks
1) Remove the bearing retainer, and tap the PTO clutch shaft out the front. 2) Remove the 31T gear.	

Procedure

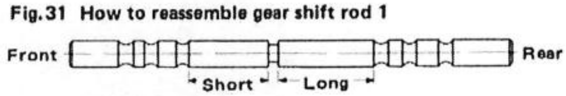
1) Remove the set screw, tap the gear shift rod 1 out the rear, and remove the creep shift fork and the 43T gear.
2) Remove the pinion shaft nut, and tap the bevel pinion shaft out the rear.

Remarks

(When reassembling)

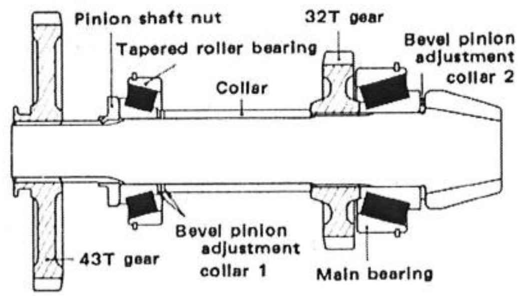
- Tighten the gear shift rod set bolt to 23.5 to 27.5 N·m. (2.4 to 2.8 kgf·m., 17.4 to 20.3 lb.ft.).

Fig.31 How to reassemble gear shift rod 1



- Replace the pinion shaft nut with a new one.
- Tighten the pinion shaft nut to 274.6 to 343.2 N·m. (28 to 35 kgf·m., 202.5 to 253.2 lb.ft.).

Fig.32 Bevel pinion shaft

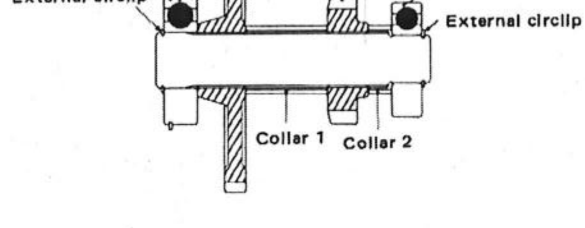


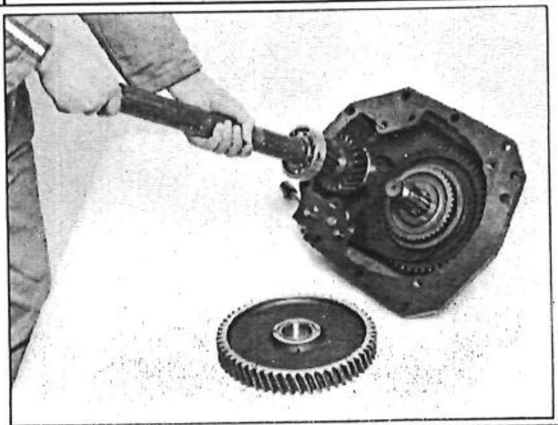
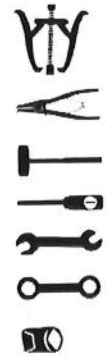
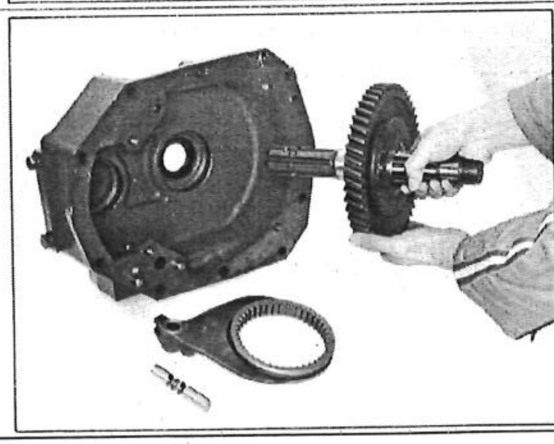
Procedure

1) Remove the bearing retainer, and tap the creep shaft out the front.

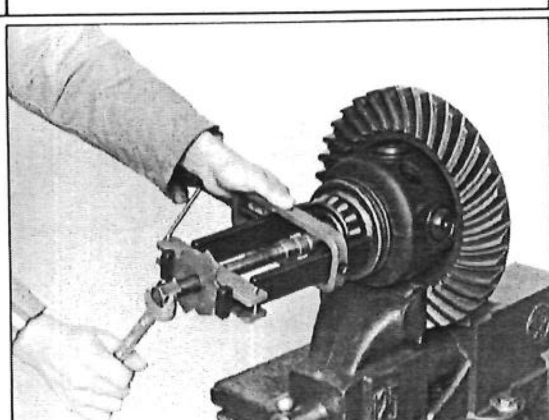
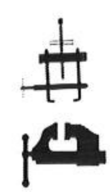
Remarks

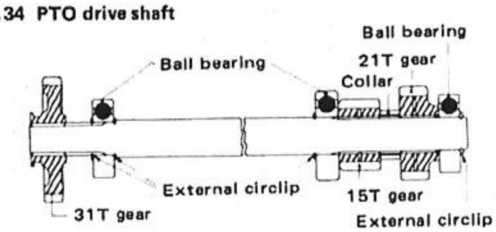
Fig.33 Creep shaft

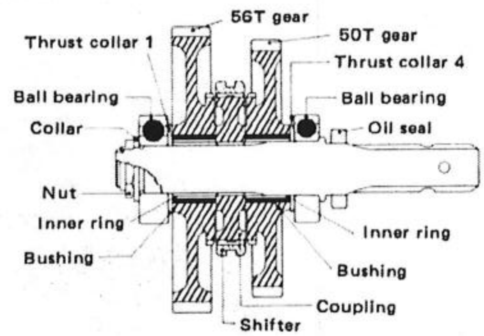


Item	Location	Bolts and nuts	Tools
Disassembly (7) PTO drive shaft		M12x60 .... 4 M8 x 22 .... 4 M30··· 1	 12 17 38
Disassembly (8) PTO shaft		M8 x 16 .... 1 $\phi 6 \times 28$ 1	 12 (When reassembling) 

7. DIFFERENTIAL GEAR

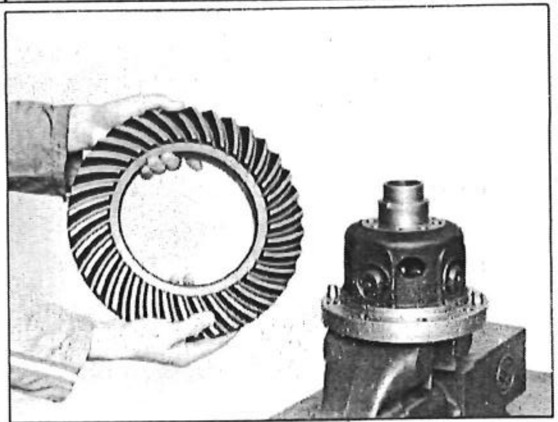
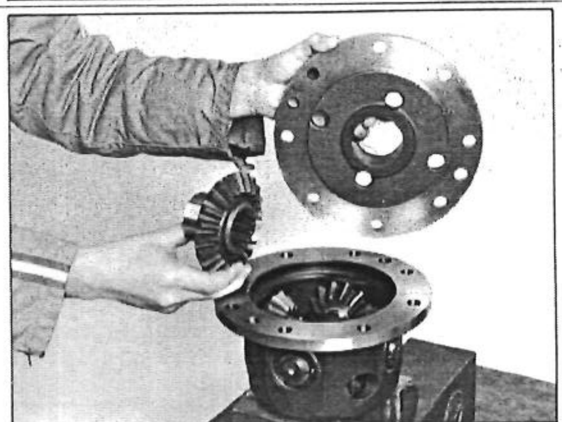
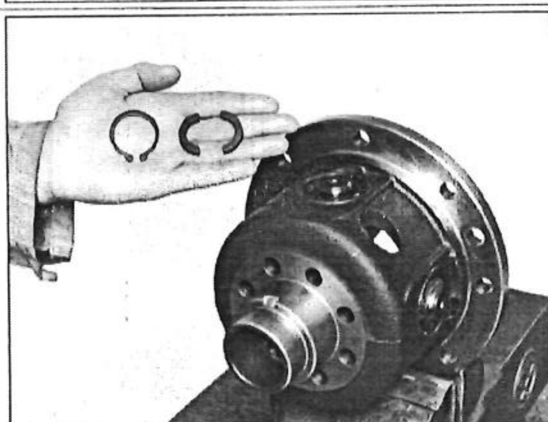
Item	Location	Bolts and nuts	Tools
Disassembly (1) Disassembling 4-pinion differential gear (M5500, M6500, M7500) i) Tapered roller bearings			

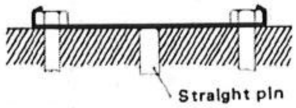
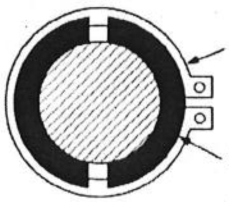
<table>
<tr><th>Procedure</th><th>Remarks</th></tr>
<tr><td>
1) Remove the PTO cover and the PTO shaft cover.
2) Remove the bearing with a puller.
3) Remove the PTO bearing support.
4) Remove the PTO shaft nut and the bearing.
5) Remove the 56T gear and the PTO drive shaft at the same time.
</td><td>
(When reassembling)
● Replace the PTO shaft nut with a new one.
● Tighten the PTO shaft nut to 225.5 to 264.8 N·m. (23 to 27 kgf·m., 166.4 to 195.3 lb.ft.).
Fig.34 PTO drive shaft


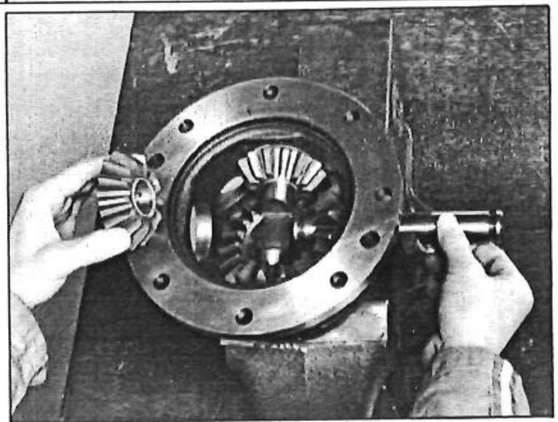
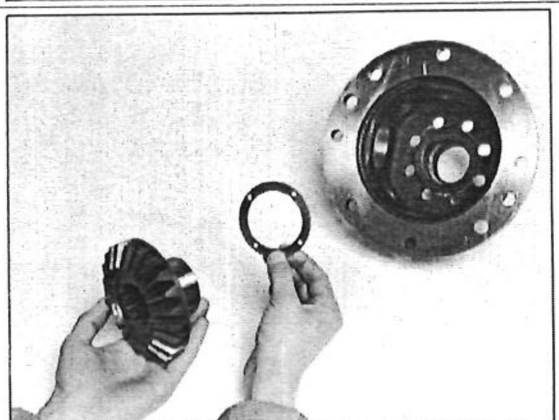
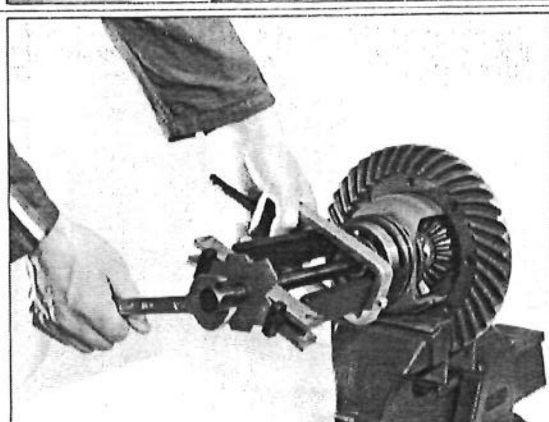
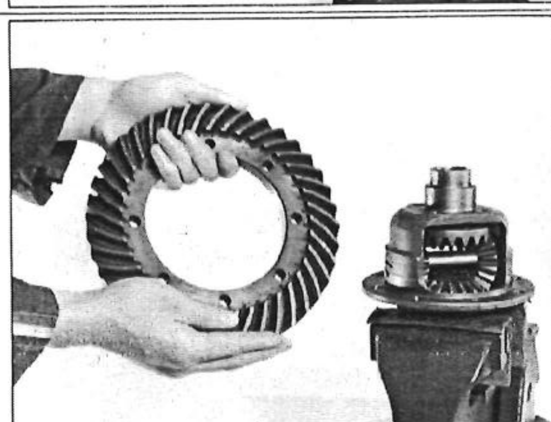
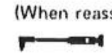
</td></tr>
<tr><td>
1) Remove the PTO gear shift lever.
2) Remove the PTO gear shift rod.
3) Remove the shift fork, the shifter, the coupling, the 50T gear and the PTO shaft at the same time.
</td><td>
Fig.35 PTO shaft


</td></tr>
</table>

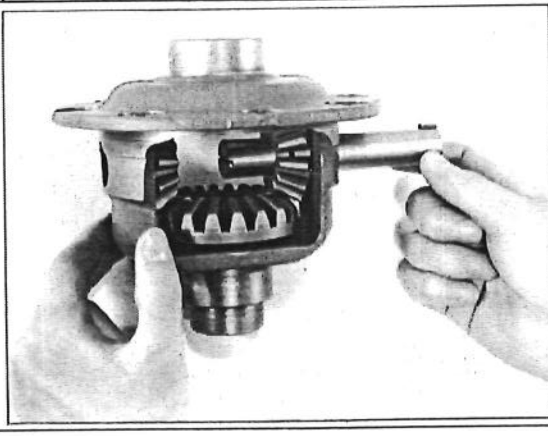
<table>
<tr><th>Procedure</th><th>Remarks</th></tr>
<tr><td>
1) Remove the bearings on both sides of the differential case.
2) Remove the differential lock shifter.
</td><td></td></tr>
</table>

Item	Location	Bolts and nuts	Tools
Disassembly ii) Spiral bevel gear		M10x30 .... 8 4	17 (When reassembling)
Disassembly iii) Differential case cover		$\phi 13 \times 20$ 2	
Disassembly iv) Set collars		 4	
Disassembly v) Bushings, Differential pinion washers		 4	

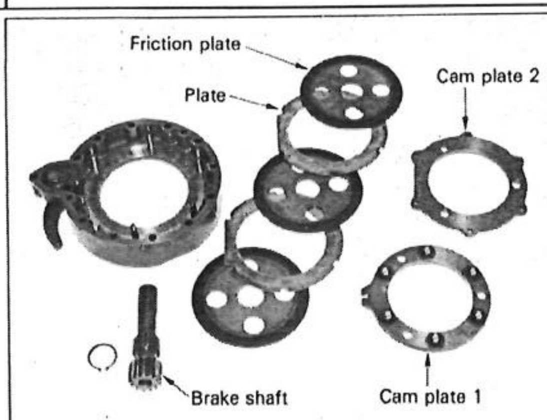
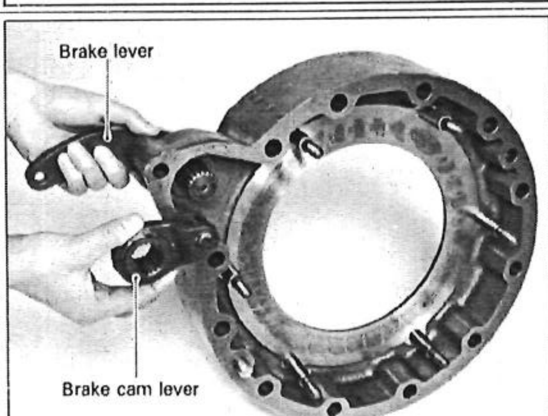
Procedure	Remarks
1) Remove the bolts. 2) Remove the spiral bevel gear.	(When reassembling) ● Tighten the bolts to 103.0 to 117.7 N·m. (10.5 to 12 kgf·m., 75.9 to 86.8 lb.ft.). ● Reassemble the lock washers over the knock holes. Fig.36 How to reassemble lock washer 
1) Remove the straight pins. 2) Remove the differential case cover. 3) Remove the differential side gear 1 and the washer.	● There are the differential side gear washer of two different thicknesses: 1.5±0.025mm (0.0591±0.001in.) and 1.6±0.025mm (0.0630±0.001in.).
1) Remove the external circlip. 2) Remove the set collars.	Fig.37 How to reassemble external circlip 
1) Screw two M6 bolts into the bushing, and pull it out. 2) Remove the key. 3) Remove the differential pinion washer.	● Thickness of differential pinion washer 1.5±0.04mm (0.0591±0.0016in.).

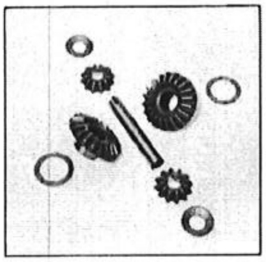
Item	Location	Bolts and nuts	Tools
Disassembly vi) Differential pinions, Pinion shafts			
Disassembly vii) Differential side gears, Washers			
Disassembly (2) Disassembling 2-pinion differential gear (M4000, M4500) i) Tapered roller bearings			
Disassembly ii) Spiral bevel gear		M12x28 .... 6 Special bolt .... 2 M12... 2 8	 17 (When reassembling) 

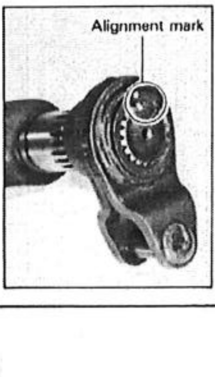
Procedure	Remarks
1) Shift the differential pinion shaft to the side, and remove the pinion. Keep them so that the pinions and the pinion shafts can be reassembled as they were.	
1) Remove the differential side gear 2. 2) Remove the differential side gear washers.	
1) Remove the tapered roller bearings on both sides of the differential case. 2) Remove the differential lock shifter.	
1) Remove the bolts. 2) Remove the spiral bevel gear.	(When reassembling) • Tighten the bolts to 103.0 to 117.7 N·m. (10.5 to 12 kgf·m., 75.9 to 86.8 lb.ft.).

Item	Location	Bolts and nuts	Tools
Disassembly iii) Differential pinions, Side gears, Washers		 1	

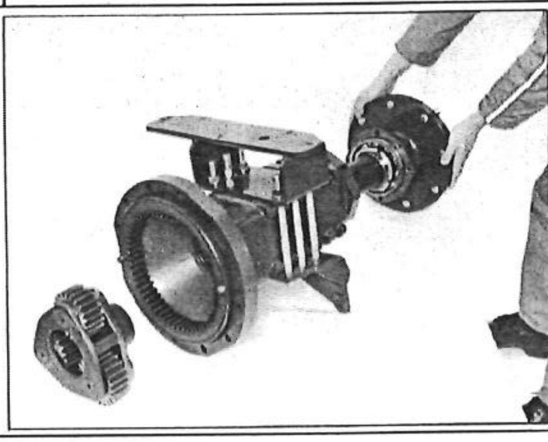
8. BRAKE SYSTEM

Item	Location	Bolts and nuts	Tools
Disassembly (1) Cam plates 1 and 2, Friction plates		M10··· 6 1	14
Disassembly (2) Brake lever		 1	

Procedure	Remarks
1) Push the differential pinion shaft toward the key to remove it. 2) Remove the differential pinions. 3) Remove the differential side gears.	(When reassembling) ● Be sure to reassemble all the gears and washers to their original positions. ● Make sure of the direction of the groove of the washers. 

Procedure	Remarks
1) Remove the pin, and then the spring. 2) Remove the nuts. Remove the cam plate 2, the cam plate 1, the friction plate and the plate, in that order. 3) Remove the external circlip and the friction plate.	(When reassembling) ● The holes of the friction plates are a port of the oil-ways. Reassemble them so that their holes are at least 2/3 aligned.
1) Remove the external circlip. Remove the brake cam lever and the brake lever.	(When reassembling) ● Be sure to align the alignment marks on the brake lever with that of the brake cam lever. 

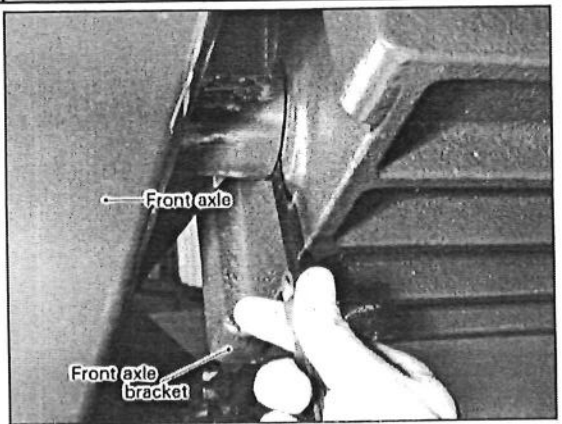
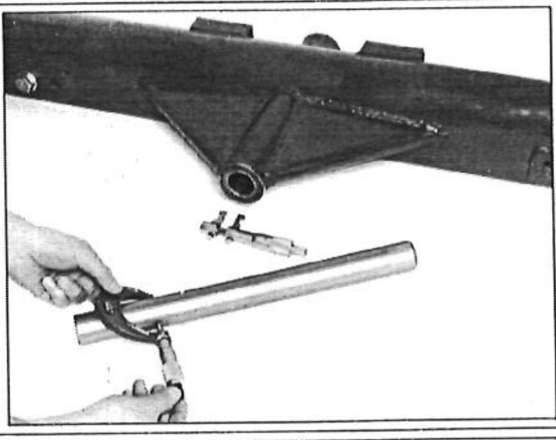
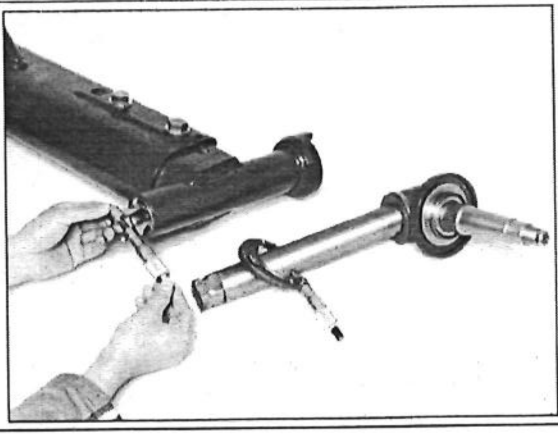
9. REAR AXLE CASE

Item	Location	Bolts and nuts	Tools
Disassembly (1) Rear axle		 M12x25 ·········· 1 M10x40 ·········· 4  M75··· 1 (Only M4000 M60)	 17 14 (When reassembling)

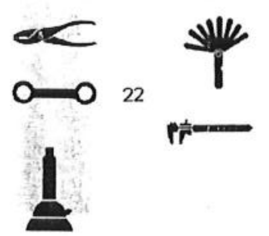
Procedure	Remarks
1) Remove the planetary gear support. 2) Remove the rear axle cover. 3) Tap the rear axle toward the cover side to remove it. 4) Remove the nuts, and remove the bearing and the seal.	(When reassembling) ● Replace the rear axle nut with a new one. ● Tighten the nut to 392.2 to 490.3 N·m. (40 to 50 kgf·m., 289.3 to 361.7 lb.ft.).

SERVICING

1. 2-WHEEL DRIVE FRONT AXLE

Item	Location	Reference value
Servicing (1) End play of front axle		• **Reference value** 0 to 0.5mm 0 to 0.0197in. • **Allowable limit** 1.0mm 0.0394in.
Servicing (2) Clearance between front axle support and bushing		• **Reference value** 0.025 to 0.112mm 0.0010 to 0.0044in. • **Allowable limit** 0.35mm 0.0138in.
Servicing (3) Clearance between knuckle shaft and bushing		• **Reference value** 0.020 to 0.125mm 0.0008 to 0.0049in. • **Allowable limit** 0.35mm 0.0138in.

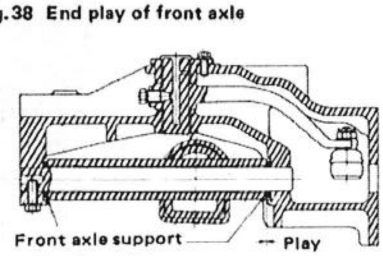
Tools and test instruments	Procedure	Remarks



1) Remove the tie-rod from the knuckle arm.
2) Jack up the front axle.
3) Measure the end play of the front axle with a feeler gauge.
4) If the measurement exceeds the allowable limit, replace the front axle suppprt thrust washers.

	Reference value	Allowable limit
Thickness of thrust washer	5.100 to 5.250mm 0.2008 to 0.2067in.	4.0mm 0.1575in.

Fig.38 End play of front axle



1) As the support tends to wear partially, measure the support outside diameter at several points where the support contacts the bushing.
2) Measure the bushing inside diameter in the same manner. Calculate the clearance.
3) If the measurement exceeds the allowable limit, replace the bushing.

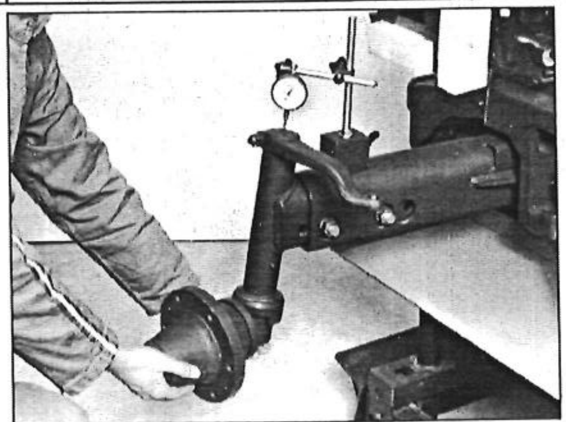
O.D. of front axle support	31.975 to 32.000mm 1.2589 to 1.2598in.
I.D. of bushing	32.025 to 32.087mm 1.2608 to 1.2633in.

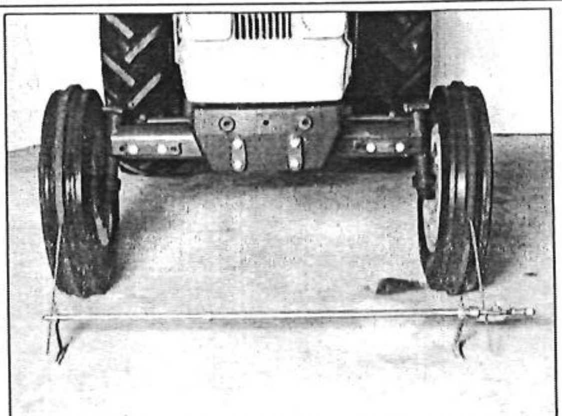
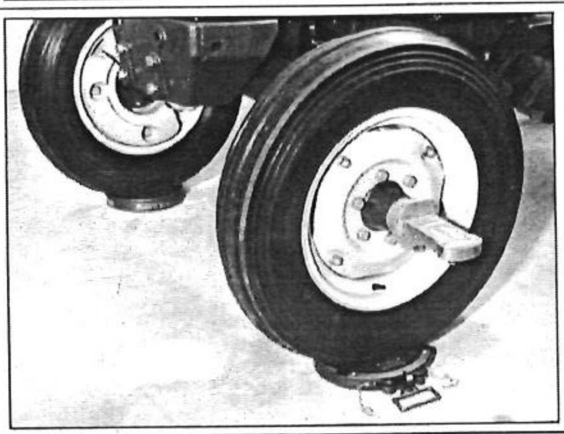
(When reassembling)
- After tapping in the bushing, ream it.

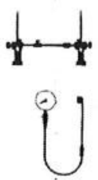
1) As the knuckle arm tends to wear partially, measure the shaft outside diameter at several points where it contacts the bushing.
2) Measure the bushing inside diameter in the same manner. Calculate the clearance.
3) If the measurement exceeds the allowable limit, replace the bushing.

O.D. of knuckle shaft	37.975 to 38.000mm 1.4951 to 1.4961in.
I.D. of bushing	38.020 to 38.100mm 1.4969 to 1.5000in.

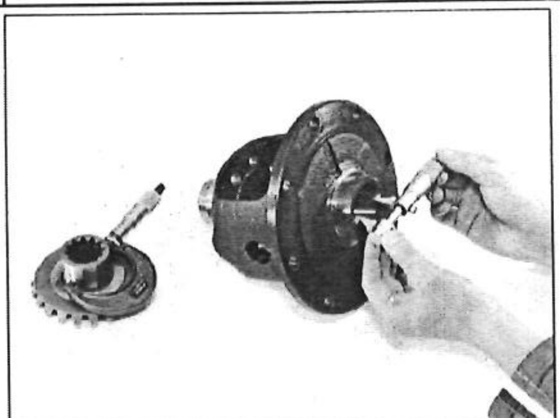
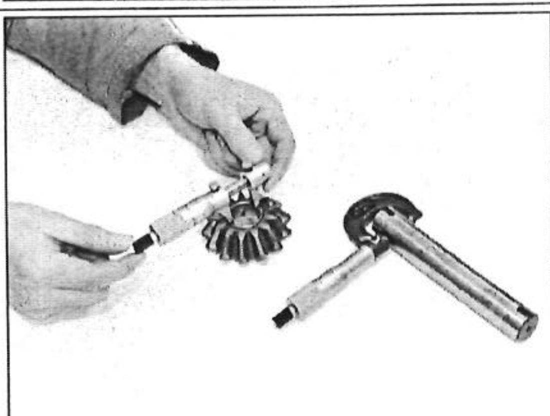
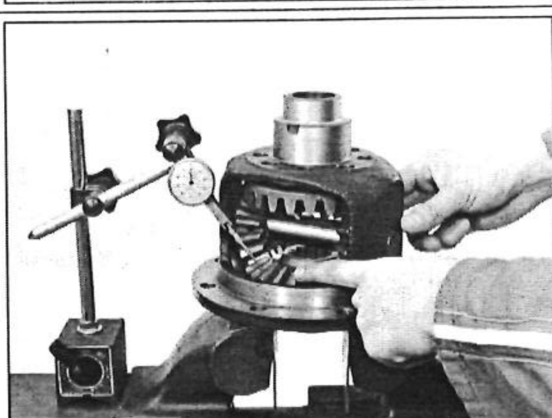
(When reassembling)
- After tapping in the bushing, ream it.

<table>
<tr><th>Item</th><th>Location</th><th>Reference value</th></tr>
<tr><td>Servicing (4)
End play of knuckle shaft</td><td></td><td>Thickness of thrust collar
• Reference value
3.925 to 4.000mm
0.1545 to 0.1575in.

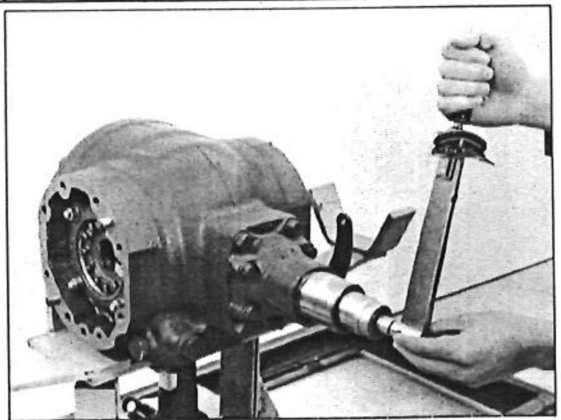
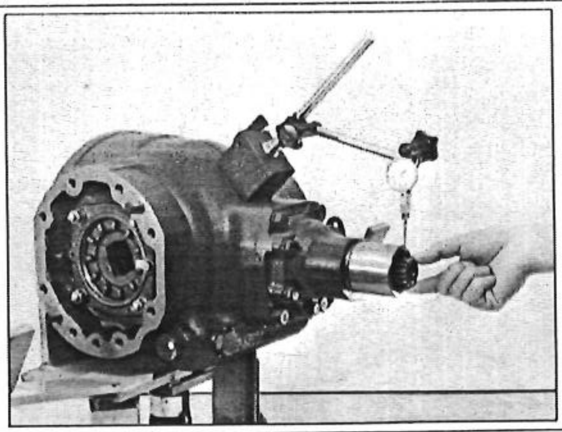
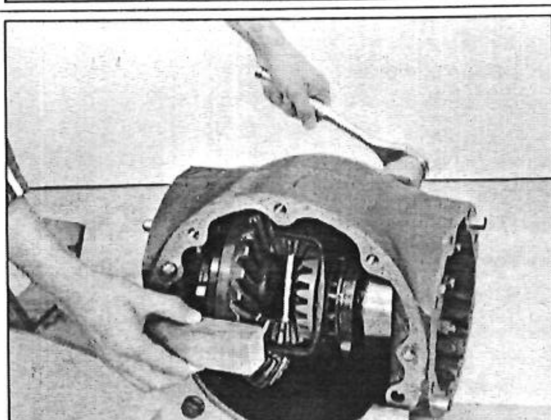
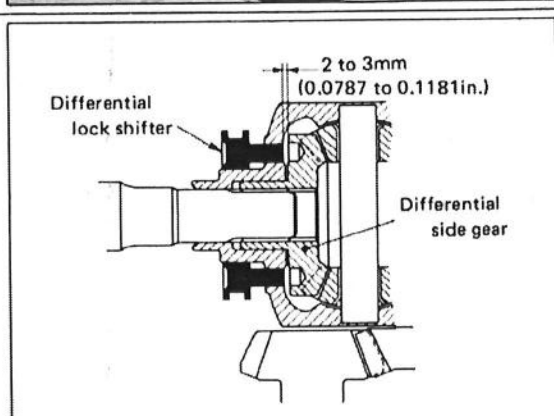
• Allowable limit
3mm
0.1181in.</td></tr>
<tr><td>Servicing (5)
Toe-in</td><td></td><td>• Reference value
<table><tr><td>2-wheel drive</td><td>0 to 5mm
0 to 0.1969in.</td></tr><tr><td>4-wheel drive</td><td>5 to 10mm
0.1969 to 0.3937in.</td></tr></table></td></tr>
<tr><td>Servicing (6)
Camber angle,
Castor angle,
King pin inclination</td><td></td><td>• Reference value
<table><tr><th>Camber angle</th><th>Castor angle</th><th>King pin inclination</th></tr><tr><td>2°</td><td>2°</td><td>8°</td></tr></table></td></tr>
</table>

<table>
<tr><th>Tools and test instruments</th><th>Procedure</th><th>Remarks</th></tr>
<tr><td></td><td>1) Measure the end play of the knuckle shaft with a dial gauge.
2) If the measurement exceeds the allowable limit, replace the thrust collar 2 (bronze).</td><td></td></tr>
<tr><td></td><td>1) Adjust to the specified tire pressure.
2) Align the front wheels forward.
3) Measure the front and rear distances between the right and left front wheels. Calculate the difference.
4) Adjust by changing the length of the tie-rod.</td><td>• Tire pressure
<table>
<tr><th></th><th>2-wheel drive</th><th>4-wheel drive</th></tr>
<tr><td>M4000</td><td rowspan="4">333.4 to 372.6kPa.
3.4 to 3.8kgf/cm²
48.3 to 54.0lb./sq.in.</td><td rowspan="3">196.1 to 235.3kPa.
2.0 to 2.4kgf/cm²
28.4 to 34.1lb./sq.in.</td></tr>
<tr><td>M4500</td></tr>
<tr><td>M5500</td></tr>
<tr><td>M6500</td><td rowspan="2">137.3 to 176.5kPa.
1.4 to 1.8kgf/cm²
19.9 to 25.6lb./sq.in.</td></tr>
<tr><td>M7500</td><td>245.2 to 284.4kPa.
2.5 to 2.9kgf/cm²
35.6 to 41.2lb./sq.in.</td></tr>
</table></td></tr>
<tr><td></td><td>1) Adjust to the specified tire pressure.
2) Put the front wheels on a turning radius gauge.
3) Remove the front wheel hub cap.
4) Set the camber-castor-king pin gauge and measure the angles.</td><td>• DT
<table>
<tr><th>Camber angle</th><th>Castor angle</th><th>King pin inclination</th></tr>
<tr><td>1.5° to 2.5°</td><td>1.5° to 2.5°</td><td>7° to 8°</td></tr>
</table></td></tr>
</table>

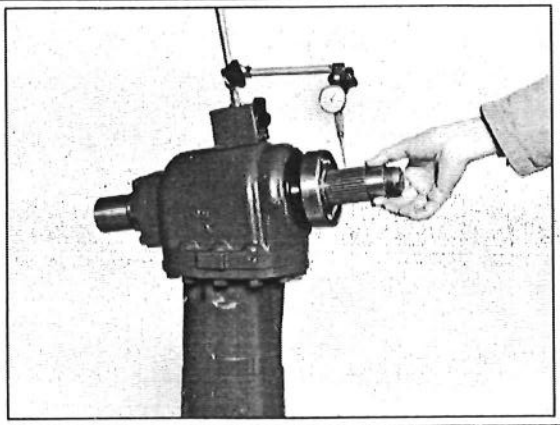
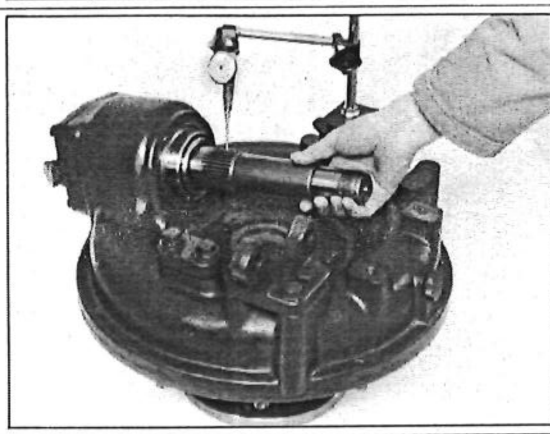
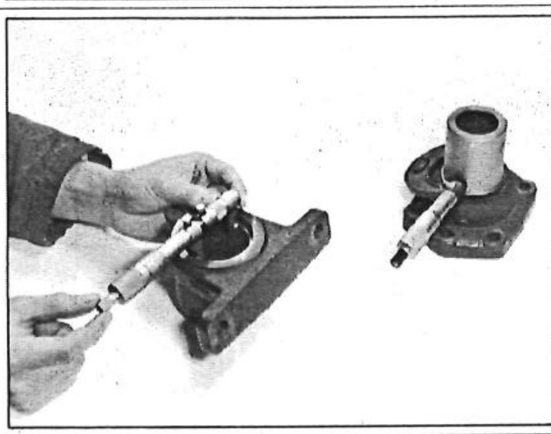
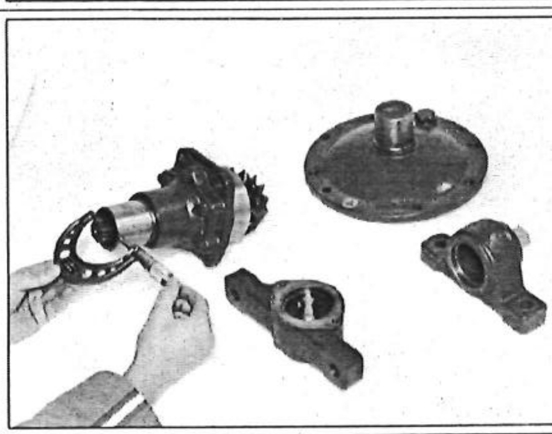
2. 4-WHEEL DRIVE FRONT AXLE

Item	Location	Reference value
Servicing (1) Clearance of differential gear hubs		• Reference value 0.080 to 0.150mm 0.0031 to 0.0059in. • Allowable limit 0.35mm 0.0138in.
Servicing (2) Clearance of differential pinion shaft		• Reference value 0.060 to 0.133mm 0.0024 to 0.0052in. • Allowable limit 0.25mm 0.0098in.
Servicing (3) Tooth backlash between differential pinion and side gear		• Reference value 0.15 to 0.30mm 0.0059 to 0.0118in. • Allowable limit 0.40mm 0.0157in.

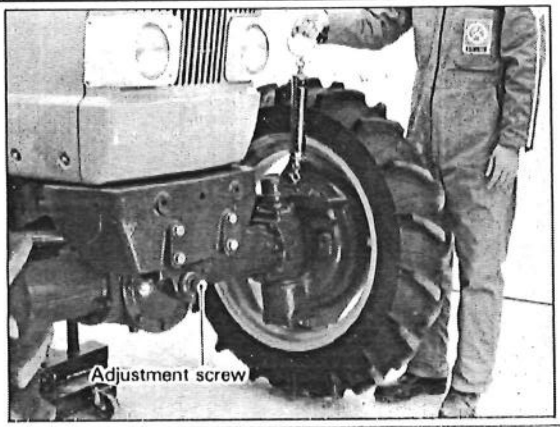
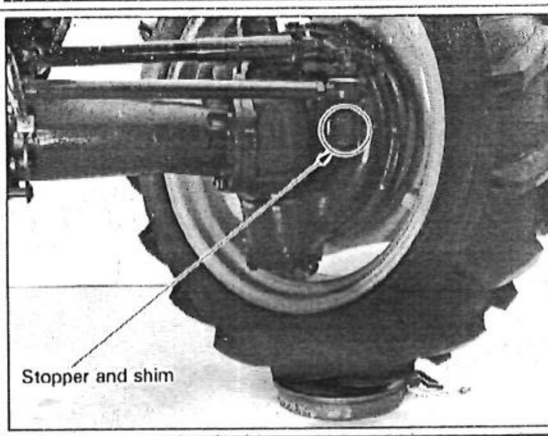
Tools and test instruments	Procedure	Remarks
	1) Measure the bearing outside diameter of the differential side gear with an outside micrometer. 2) Measure the bearing inside diameter of the differential case. Calculate the clearance. 3) If the measurement exceeds the allowable limit, replace.	
	1) Measure the diameter of the pinion shaft with an outside micrometer. 2) Measure the inside diameter of the pinion gear with an inside micrometer. Calculate the clearance. 3) If the measurement exceeds the allowable limit, replace.	
	1) Clamp the differential case in a vise. 2) Press the differential pinion and the side gear against the differential case. 3) Set a lever-type indicator between the teeth of the differential side gear. 4) Fix the mating pinion. 5) Measure the backlash by moving the side gear by hand. 6) If the measurement exceeds the allowable limit, replace the swivel washer and the washer of the differential side gear.	

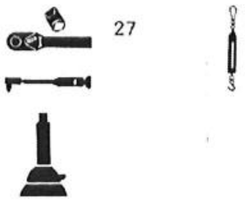
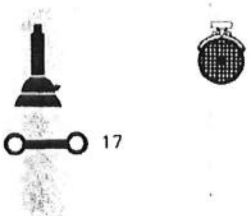
Item	Location	Reference value
Servicing (4) Differential gear rolling torque		• Reference value 2.0 to 3.9 N·m. 0.2 to 0.4 kgf·m. 1.4 to 2.9 lb.ft.
Servicing (5) Tooth backlash between spiral bevel pinion and bevel gear		• Reference value 0.2 to 0.3mm 0.0079 to 0.0118in. • Allowable limit 0.4mm 0.0157in.
Servicing (6) Bevel gear and pinion tooth contact		• Reference value 35% or more
Servicing (7) Clearance between differential side gears and differential lock shifter pins		• Reference value 2 to 3mm 0.0787 to 0.1181in.

Tools and test instruments	Procedure	Remarks
	1) Refit the spiral bevel pinion shaft. 2) Refit the differential gear so that there is some backlash between bevel pinion and bevel gear. 3) Set a torque wrench on the spiral pinion shaft, and measure the differential gear rolling torque. 4) Adjust the torque by means of the adjustment screw on the left-hand side.	
 	1) Insert a regular screwdriver through the drain plug hole of the differential gear case, and fix the bevel gear. 2) Set a lever-type indicator on the spiral bevel pinion. 3) Measure the backlash by moving the bevel pinion by hand.	• How to adjust the backlash (1) If the backlash is too great: Loosen the adjustment screw on the left-hand side, and tighten the screw on the right-hand side by the amount the former has been loosened. (2) If the backlash is too small: Loosen the right-hand adjustment screw, and tighten the left-hand screw by the amount the former has been loosened.
Red lead Wood block	1) Visually divide the bevel gear teeth into three equal parts. Apply a small amount of red lead to a few teeth of each part. 2) Turn the pinion shaft while lightly braking the circumference of the bevel gear with a wooden block. 3) Check to see if the tooth contact is proper. 4) Adjust the tooth contact by means of the pinion setting adjustment shims. Shim thickness: 0.1 mm (0.0039 in.) 0.3 mm (0.0118 in.)	• For checking and adjusting the tooth contact, see p. 196.
	1) Visually check the clearance between differential side gear and differential lock shifter pins. 2) Adjust the clearance by altering the position of the differential lock shift rod by means of shims.	

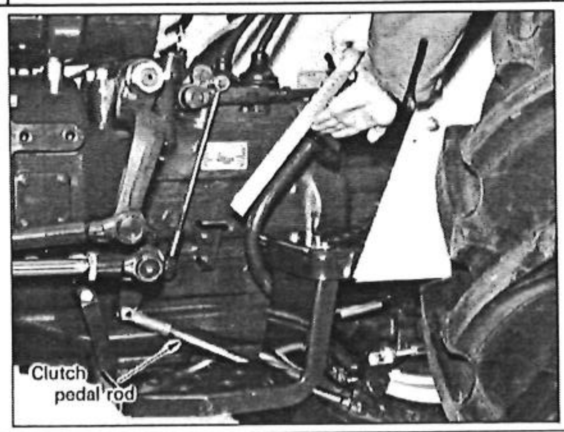
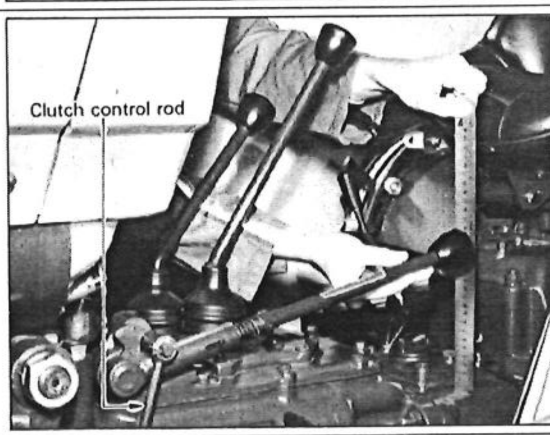
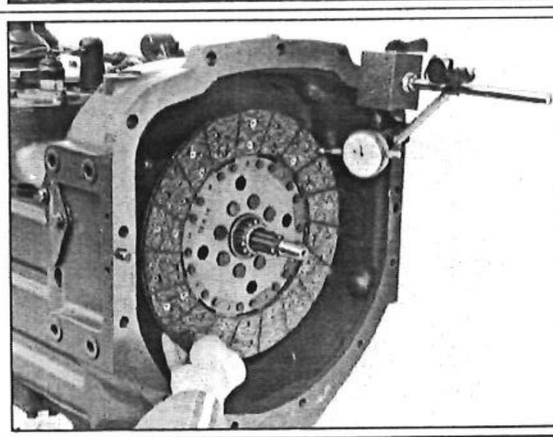
Item	Location	Reference value
Servicing (8) Bevel gear tooth backlash in bevel gear case		• **Reference value** 0.2 to 0.25mm 0.0079 to 0.0098in. • **Allowable limit** 0.4mm 0.0157in.
Servicing (9) Bevel gear tooth backlash in front axle case		• **Reference value** 0.3 to 0.5mm 0.0118 to 0.0197in. • **Allowable limit** 0.6mm 0.0236in.
Servicing (10) Clearance between bearing retainer and front wheel case support bushing		• **Reference value** 0.035 to 0.161mm 0.0014 to 0.0063in. • **Allowable limit** 0.3mm 0.0118in.
Servicing (11) Clearance between pinion shaft case or differential case cover and bracket bushing		• **Reference value** 0.045 to 0.194mm 0.0018 to 0.0076in. • **Allowable limit** 0.55mm 0.0217in.

Tools and test instruments	Procedure	Remarks
	1) Fix the differential gear shaft. 2) Set a lever-type indicator on the king pin. 3) Measure the backlash by moving the king pin by hand. 4) Adjust by means of front axle support shims. Shim thickness: 0.1 mm (0.0039 in.) 0.3 mm (0.0118 in.)	• Tooth contact should be more than 35 % of the tooth face.
	1) Fix the front axle. 2) Set a lever-type indicator on the king pin. 3) Measure the backlash by moving the king pin by hand. 4) Adjust by means of front wheel case cover shims. Shim thickness: 0.2 mm (0.0079 in.)	• Tooth contact should be more than 35% of the tooth face.
	1) Measure the diameter of the bearing retainer with an outside micrometer. 2) Measure the diameter of the bushing with an inside micrometer. Calculate the clearance. 3) If the measurement exceeds the allowable limit, replace the bushing.	
	1) Measure the diameter of pinion shaft case cover, and front differential case cover with an outside micrometer. 2) Measure the inside diameter of the bracket bushing with an inside micrometer. Calculate the clearance. 3) If the measurement exceeds the allowable limit, replace.	

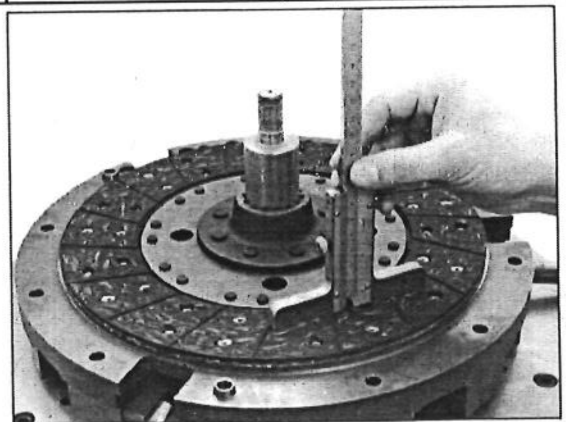
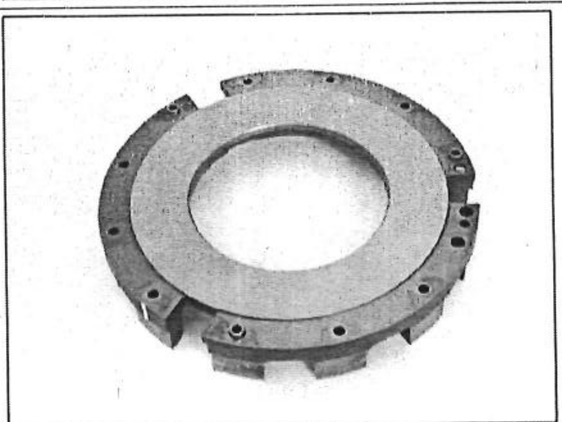
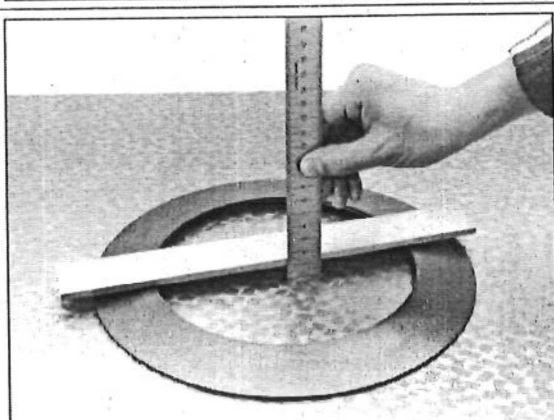
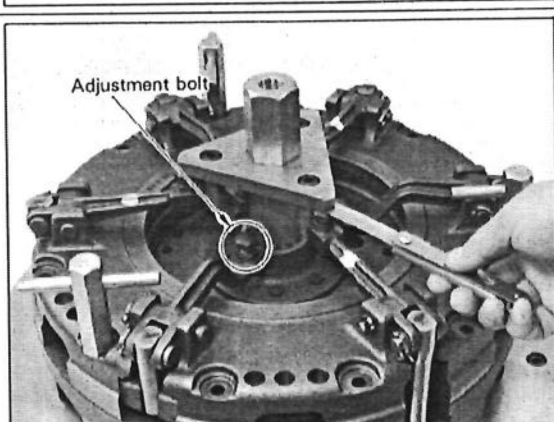
Item	Location	Reference value
Servicing (12) End play of front axle		• **Reference value** Front axle suspension force 98.1 to 147.1 N. (10 to 15 kgf., 22.1 to 33.0 lb.)
Servicing (13) Adjusting front wheel steering angle		• **Reference value** 41° to 45°

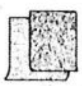
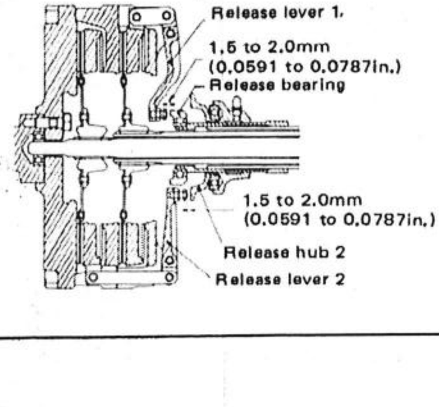
Tools and test instruments	Procedure	Remarks
 27	1) Press the front axle case backward. 2) Remove the lock nut, and tighten the adjustment screw to 9.8 to 19.6 N·m. (1 to 2 kgf·m., 7.2 to 14.5 lb.ft.) to give the front axle a suspension force of 98.1 to 147.1 N. (10 to 15 kgf., 22.1 to 33.0 lb.)	
 17	1) Put the front wheels on a turning radius gauge. Turn the steering wheel. 2) Measure the front wheel steering angle. 3) If the measurement is not within the reference value, adjust by means of the stoppers and shims on both sides.	• Adjust the steering angle of the front wheels after the toe-in adjustment.

3. CLUTCH

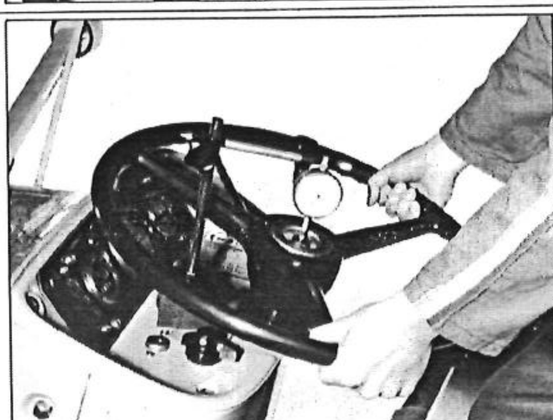
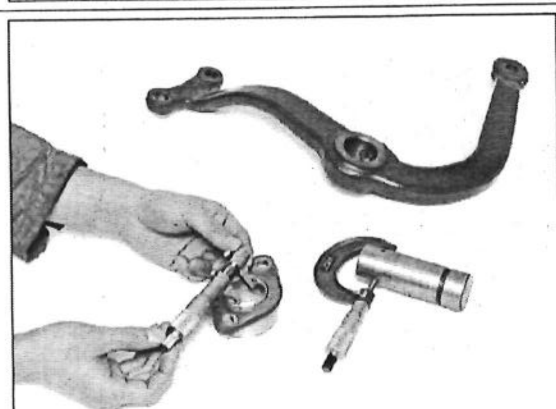
Item	Location	Reference value
Servicing (1) Clutch pedal free travel		• **Reference value** 30 to 40mm (1.1811 to 1.5748in.) at the pedal edge • **Allowable limit** 25mm 0.9843in.
Servicing (2) PTO clutch lever free travel		• **Reference value** 40 to 50mm (1.5748 to 1.9685in.) at the lever edge • **Allowable limit** 20mm 0.7874in.
Servicing (3) Spline backlash of clutch disc hubs		• **Reference value** 0.070 to 0.148mm 0.0028 to 0.0058in. • **Allowable limit** 0.3mm 0.0118in.

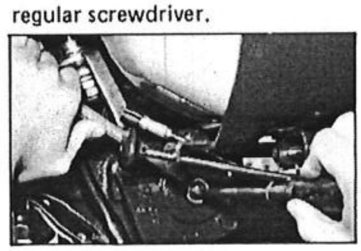
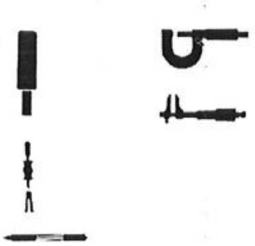
Tools and test instruments	Procedure	Remarks
19	1) Measure the clutch pedal free travel by pressing the pedal by hand. 2) Adjust by altering the length of the clutch rod.	
14	1) Measure the free travel by pulling up the PTO clutch lever by hand. 2) Adjust by altering the length of the clutch control rod.	
	1) Attach the PTO clutch disc to the PTO clutch shaft. 2) Set a dial gauge on the tip of the PTO clutch disc. 3) Measure the spline backlash by moving the clutch disc back and forth by hand. 4) If the measurement exceeds the allowable limit, replace the disc. 5) Measure and adjust the spline backlash between transmission clutch disc and 1st shaft spline in the same manner.	

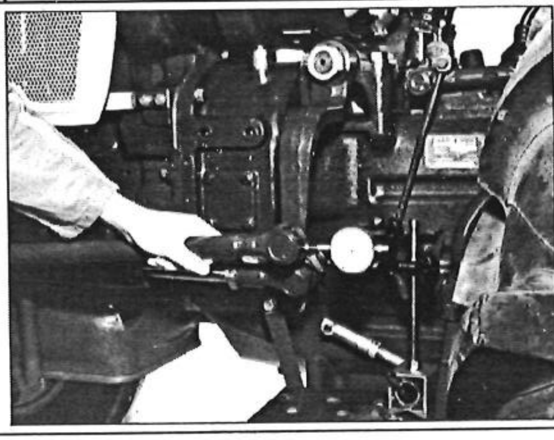
<table>
<tr><th>Item</th><th>Location</th><th>Reference value</th></tr>
<tr><td>Servicing (4)
Thickness of transmission clutch disc and PTO clutch disc</td><td></td><td>• Reference value
8.1 to 8.7mm
0.3189 to 0.3425in.
• Allowable limit
0.1mm (0.0039in.) from the rivet top or 5.6mm (0.2205in.)</td></tr>
<tr><td>Servicing (5)
Flaw on pressure plate</td><td></td><td></td></tr>
<tr><td>Servicing (6)
Free length of clutch springs (diaphragm spring)</td><td></td><td>• Reference value
10.68mm
0.4205in.
• Allowable limit
10mm
0.3937in.</td></tr>
<tr><td>Servicing (7)
Height of release levers</td><td>
</td><td>• Reference value
<table>
<tr><th></th><th>Height above flywheel surface</th><th>Mutual difference</th></tr>
<tr><td>Transmission clutch release lever</td><td>105±1mm
4.1386±
0.0394in.</td><td>0.3mm
0.0118in.</td></tr>
<tr><td>PTO clutch release lever</td><td>130±1mm
5.1181±
0.0394in.</td><td>0.7mm
0.0276in.</td></tr>
</table></td></tr>
</table>

Tools and test instruments	Procedure	Remarks
 or 	1) Measure the distance from the clutch disc surface to the top of the rivets. 2) If the measurement exceeds the allowable limit, replace.	• Allowable limit is 0.1mm (0.0039 in.); it is recommended, however, to replace when disassembling if it is 0.3mm (0.0118 in.) or less from the top of the rivet.
	1) If there is any flaw on the pressure plate, remove it with sandpaper or replace the pressure plate. 2) If oil sticks to the plate surface, clean with gasoline.	
	1) Place the clutch spring on a surface plate. Measure the height with a rule or vernier caliper. 2) If the measurement exceeds the allowable limit, replace. 3) Visually check with care to see if there is any crack on the spring.	
 	1) Attach the clutch to the main clutch disassembly/assembly tool. 2) Measure with a feeler gauge to see if the clearance between the tip of the release lever and the block gauge is 0.1mm (0.0039 in.). 3) If the measurement is not 0.1 mm (0.0039 in.), adjust by means of the adjustment bolt at the tip of the release lever.	**Fig. 39 Clearance between release lever and release bearing** 

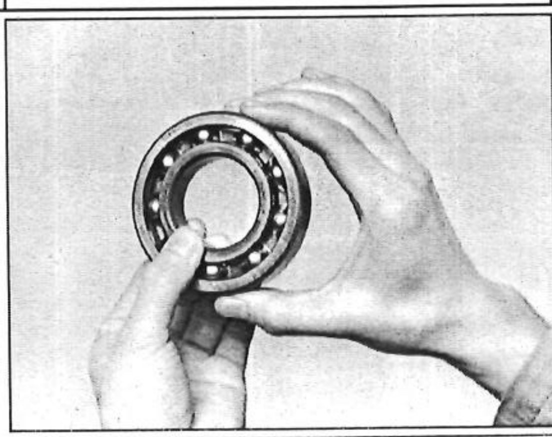
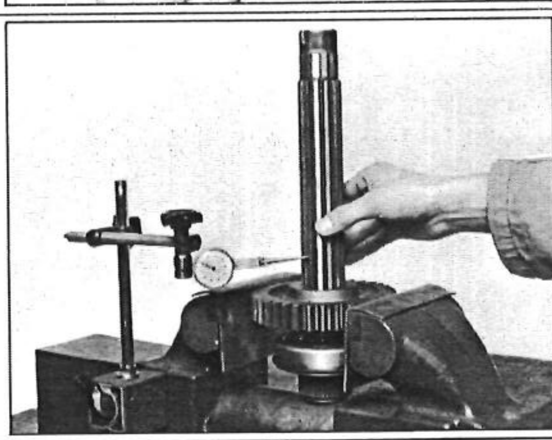
4. STEERING SYSTEM

Item	Location	Reference value
Servicing (1) Free movement of steering wheel		• **Reference value** 20 to 50mm (0.7874 to 1.9685in.) at steering wheel circumference
Servicing (2) End play of steering shaft		• **Reference value** 0.2mm 0.0079in.
Servicing (3) Clearance between steering lever shaft and bushing		• **Reference value** 0.050 to 0.137mm 0.0020 to 0.0054in. • **Allowable limit** 0.35mm 0.0138in.

<table>
<tr><th>Tools and test instruments</th><th>Procedure</th><th>Remarks</th></tr>
<tr><td> 17 </td><td>1) Put a surface gauge on the bonnet, and mark the steering wheel rim for free movement.
2) Measure the free movement of the wheel with a rule.</td><td>• Adjustment:
(1) Loosen the adjustment screw lock nut on the steering gear box.
(2) Adjust by turning the screw with a regular screwdriver.
</td></tr>
<tr><td></td><td>1) Remove the steering wheel cap.
2) Set a dial gauge.
3) Measure the end play by moving the steering wheel up and down.
4) Adjust by changing the rear cover shims.
Shim thickness: 0.05mm (0.0020 in.)
0.07mm (0.0028 in.)
0.08mm (0.0031 in.)
0.10mm (0.0039 in.)
0.20mm (0.0079 in.)</td><td></td></tr>
<tr><td></td><td>1) Measure the outside diameter of the steering lever shaft and the inside diameter of the bushing. Calculate the clearance.
2) If the measurement exceeds the allowable limit, replace the bushing.</td><td><table><tr><td>O.D. of steering lever shaft</td><td>34.975 to 35.000mm
1.3770 to 1.3780in.</td></tr><tr><td>I.D. of bushing</td><td>35.050 to 35.112mm
1.3799 to 1.3824in.</td></tr></table>(When reassembling)
• After tapping in the bushing, ream it.</td></tr>
</table>

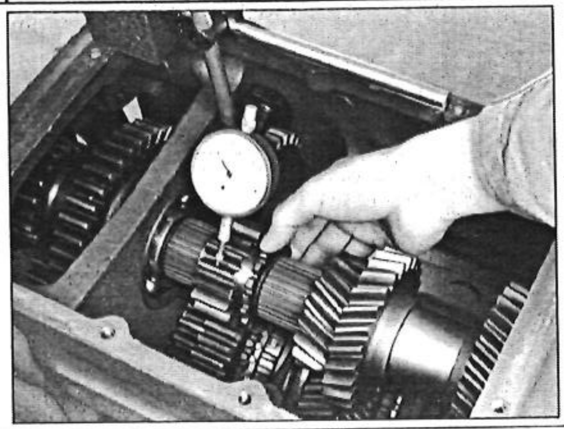
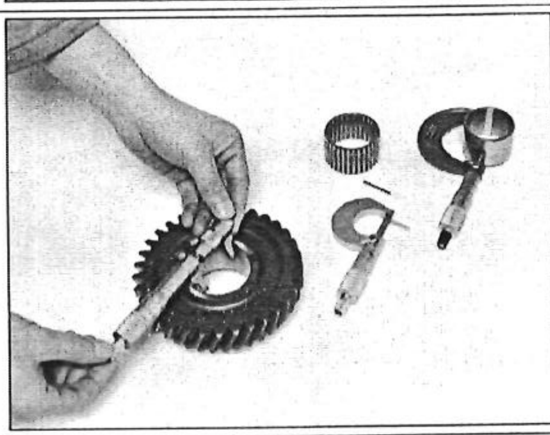
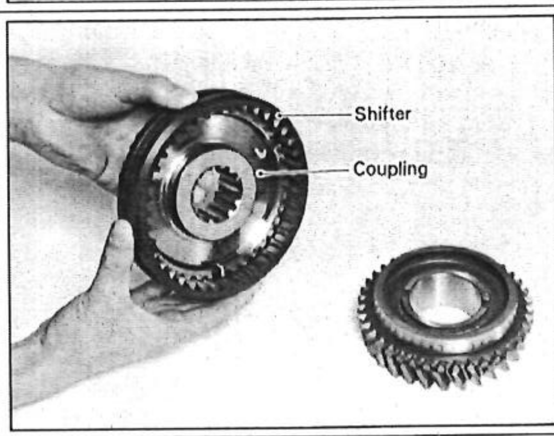
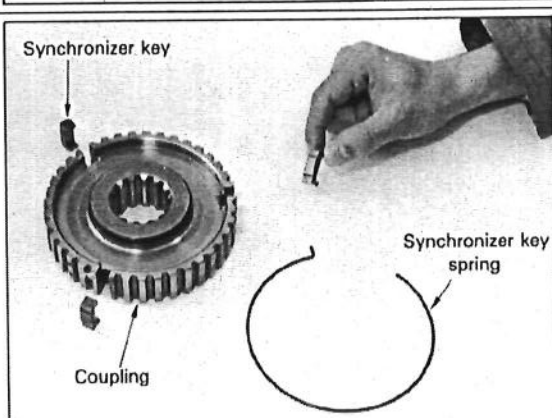
Item	Location	Reference value
Servicing (4) End play of drag link and tie-rod		• Allowable limit 0.4mm 0.0157in.

5. TRANSMISSION

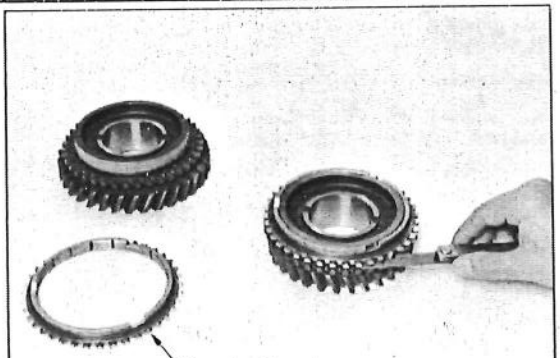
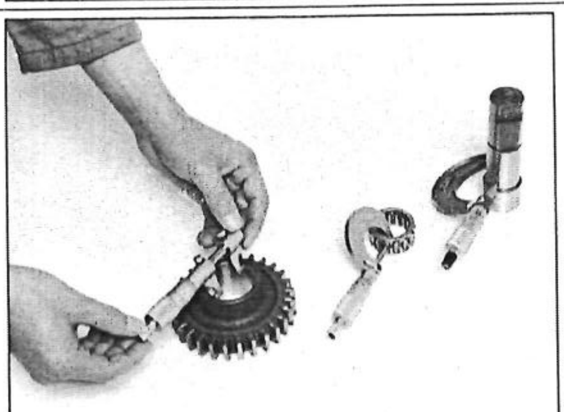
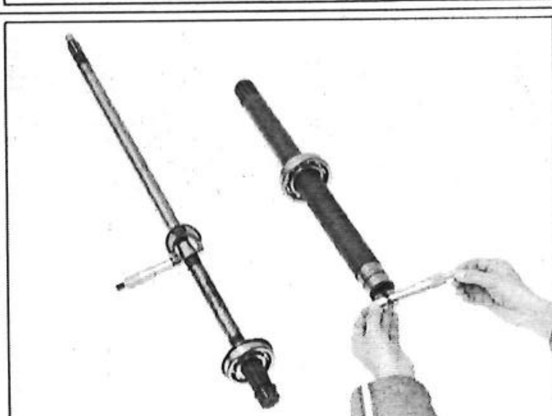
Item	Location	Reference value
Servicing (1) Checking bearings		• Reference value ① Not much play ② Smooth rotation ③ No noise ④ Not discolored
Servicing (2) Spline backlash between gear and shaft		• Reference value 0 to 0.175mm 0 to 0.0069in. • Allowable limit 0.4mm 0.0157in.

Tools and test instruments	Procedure	Remarks
	1) Remove one of the tie-rod ends. 2) Set a dial gauge on the tie-rod end. 3) Read the dial gauge while pushing the tie-rod by hand. 4) If the reading exceeds the allowable limit, replace.	

Tools and test instruments	Procedure	Remarks
	1) Fix the inner race. Check the outer race for any play while pushing it up and down, and to left and right with force. 2) Apply gear oil to the bearing. Fix the inner race, and check to see if the outer race turns smoothly.	• Checking needle bearings Line up the needle rollers, and check to see if there is any scratch or peel-off on them.
 	1) Clamp the gear in a vise. 2) Set a lever-type indicator on the spline shaft. 3) Measure the spline backlash while moving the shaft by hand. 4) If the measurement exceeds the allowable limit, replace.	

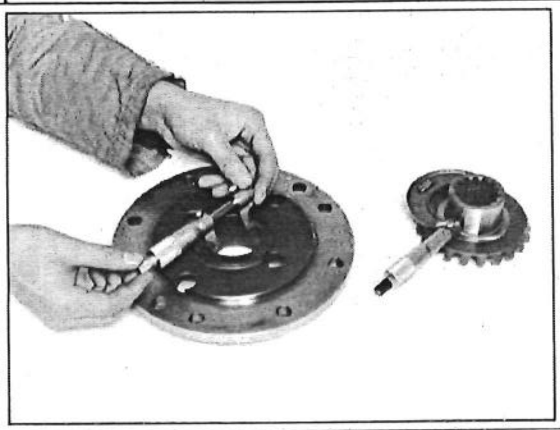
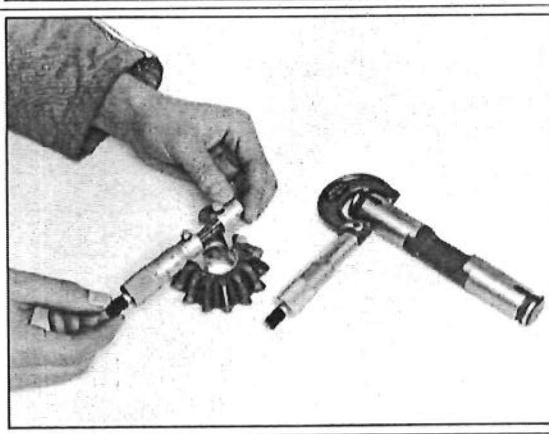
Item	Location	Reference value
Servicing (3) Gear backlash		• **Reference value** 0.1 to 0.2mm 0.0039 to 0.0079in. • **Allowable limit** 0.5mm 0.0197in.
Servicing (4) Clearance of inner rings, needles and gears		• **Reference value** 0.009 to 0.057mm 0.0004 to 0.0022in. • **Allowable limit** 0.3mm 0.0118in
Servicing (5) Checking contact between coupling and shifter		• **Reference value** Slides smoothly
Servicing (6) Flaw on synchronizer key and spring		• **Reference value** No flaws or wear

<table>
<tr><th>Tools and test instruments</th><th>Procedure</th><th>Remarks</th></tr>
<tr><td></td><td>1) Set a dial gauge on a tooth face of the gear.
2) Clamp the mating gear.
3) Measure the backlash by moving the gear by hand.
4) If the measurement exceeds the allowable limit, replace.</td><td>• Visually divide the gear teeth into three equal parts. Measure the backlash in each part, and calculate the average which will be the backlash of the gear.</td></tr>
<tr><td></td><td>1) Measure the inside diameter of the transmission gear hub.
2) Measure the inner ring outside diameter.
3) Measure the diameter of two needles of the needle bearing.
4) Calculate the difference between the hub inside diameter, and the total diameters of inner ring and two needles.
5) If the clearance exceeds the allowable limit, replace.</td><td><table>
<tr><td>I.D. of transmission gear hub</td><td>50.050 to 50.075mm
1.9705 to 1.9715in.</td></tr>
<tr><td>O.D. of inner ring</td><td>45.030 to 45.041mm
1.7728 to 1.7733in.</td></tr>
<tr><td>O.D. of bearing needle</td><td>2.494 to 2.500mm
0.0982 to 0.0984in.</td></tr>
</table></td></tr>
<tr><td></td><td>1) Check to see if there is any flaw or wear on the spline and the key groove on the coupling circumference.
2) Check to see if there is any flaw or wear on the spline on the shifter.
3) Engage the shifter with the coupling, and check to see if they slide smoothly.</td><td>• Check to see if there is any flaw or wear on the tooth face of the transmission gear where the shifter makes contact.</td></tr>
<tr><td></td><td>1) Check to see if the projection in the center of the synchronizer key wears.
2) Check to see if the spring has worn or there is wear where the spring contacts the key. If the spring is defective, replace.</td><td></td></tr>
</table>

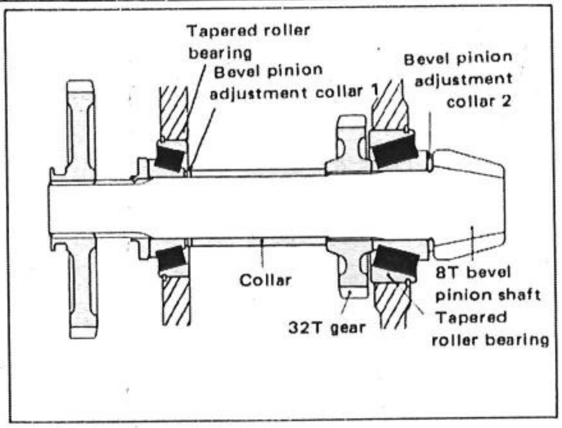
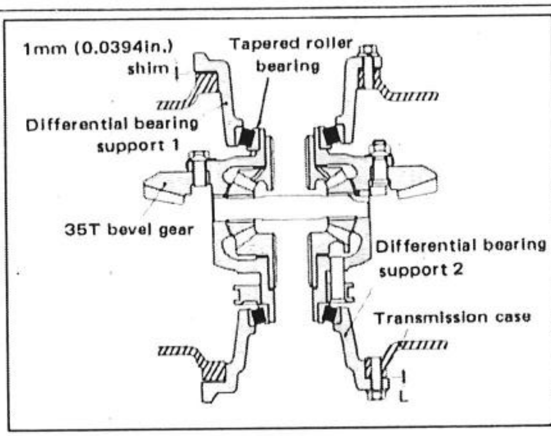
Item	Location	Reference value
Servicing (7) Side clearance between synchronizer cones and gears (in contact)	 Synchronizer ring	• Allowable limit 0.35mm 0.0138in. Contact should be 80% or more
Servicing (8) Side clearance of shift fork in shifter groove		• Reference value 0.2 to 0.4mm 0.0079 to 0.0157in. • Allowable limit 0.8mm 0.0315in.
Servicing (9) Clearance of reverse gear, needle and shaft		• Reference value 0.009 to 0.046mm 0.0004 to 0.0018in. • Allowable limit 0.3mm 0.0118in.
Servicing (10) Clearance between PTO clutch shaft and bushing		• Reference value 0.075 to 0.148mm 0.0030 to 0.0058in. • Allowable limit 0.3mm 0.0118in.

<table>
<tr><th>Tools and test instruments</th><th>Procedure</th><th>Remarks</th></tr>
<tr><td>
Red lead</td><td>1) Press the synchronizer ring against the tapered section of the transmission gear. Measure the side clearance.
2) Apply a thin film of red lead to the tapered section, press the ring against it by hand, rub them together a few times, and check the contact.
3) If the measurement exceeds the allowable limit, replace.</td><td>● If the ring turns with ease when it is pressed, it may be excessively or partially worn.
● Check to see if the tooth face of the ring and the key groove is worn.</td></tr>
<tr><td></td><td>1) Place the shift fork in the shifter groove, and measure the side clearance with a feeler gauge.
2) If the measurement exceeds the allowable limit, replace.</td><td></td></tr>
<tr><td></td><td>1) Measure the inside diameter of the reverse gear.
2) Measure the diameter of the reverse shaft.
3) Measure the diameter of two needles of the needle bearing.
4) Calculate the difference between the gear inside diameter and the total diameters of reverse shaft and two needles.
5) If the measurement exceeds the allowable limit, replace.</td><td><table>
<tr><td>I.D. of reverse gear</td><td>40.009 to 40.025mm
1.5752 to 1.5758in.</td></tr>
<tr><td>O.D. of reverse shaft</td><td>29.991 to 30.000mm
1.1807 to 1.1811in.</td></tr>
<tr><td>O.D. of bearing needle</td><td>4.994 to 5.000mm
0.1966 to 0.1969in.</td></tr>
</table></td></tr>
<tr><td></td><td>1) Measure the outside diameter of the PTO clutch shaft.
2) Measure the inside diameter of the bushing. Calculate the clearance.
3) If the measurement exceeds the allowable limit, replace the bushing.</td><td><table>
<tr><td>O.D. of PTO clutch shaft</td><td>24.964 to 24.985mm
0.9828 to 0.9837in.</td></tr>
<tr><td>I.D. of bushing</td><td>25.060 to 25.112mm
0.9866 to 0.9887in.</td></tr>
</table>
(When reassembling)
● After tapping in the bushing, ream it.</td></tr>
</table>

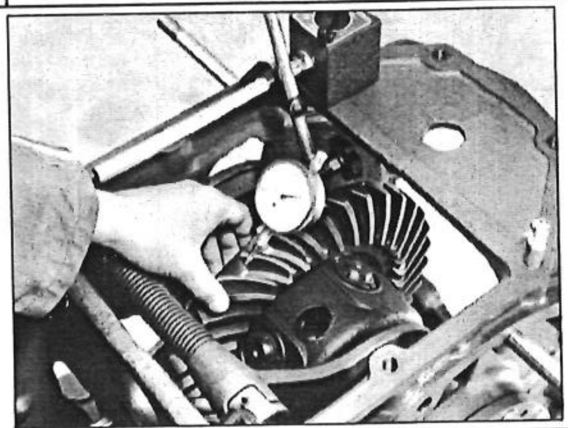
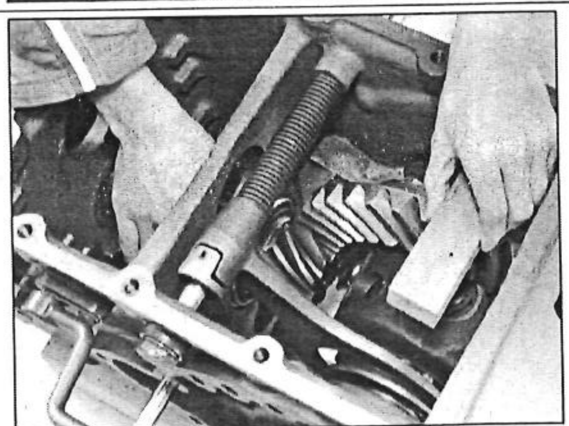
6. DIFFERENTIAL GEAR

Item	Location	Reference value
Servicing (1) Clearance between differential side gear hub and case		• Reference value 0.080 to 0.150mm 0.0031 to 0.0059in. • Allowable limit 0.35mm 0.0138in.
Servicing (2) Clearance between differential pinion shaft and bushing		• Reference value 0.060 to 0.133mm 0.0024 to 0.0052in. • Allowable limit 0.25mm 0.0098in.
Servicing (3) Tooth backlash between differential pinion and side gear		• Reference value 0.1 to 0.2mm 0.0039 to 0.0079in. • Allowable limit 0.4mm 0.0157in.

<table>
<tr><th>Tools and test instruments</th><th>Procedure</th><th>Remarks</th></tr>
<tr>
<td></td>
<td>1) Measure the inside diameter of the differential case and the outside diameter of the differential gear hub. Calculate the clearance.
2) If the measurement exceeds the allowable limit, replace.</td>
<td><table>
<tr><td>I.D. of differential case</td><td>44.080 to 44.119mm
1.7354 to 1.7370in.</td></tr>
<tr><td>O.D. of differential side gear hub</td><td>43.961 to 44.000mm
1.7307 to 1.7323in.</td></tr>
</table></td>
</tr>
<tr>
<td> </td>
<td>1) Measure the outside diameter of the differential pinion shaft and the inside diameter of the bushing. Calculate the clearance.
2) If the measurement exceeds the allowable limit, replace the bushing.</td>
<td><table>
<tr><td>O.D. of differential pinion shaft</td><td>23.939 to 23.960mm
0.9425 to 0.9433in.</td></tr>
<tr><td>I.D. of bushing</td><td>24.020 to 24.072mm
0.9457 to 0.9477in.</td></tr>
</table>
(When reassembling)
• After tapping in the bushing, ream it.</td>
</tr>
<tr>
<td>
Fuse</td>
<td>1) Place two fuses on each of the differential side gears.
2) Turn the side gears with a regular screwdriver until the fuses are compressed by them and the differential pinions.
3) Take out the fuses, and measure with an outside micrometer.
4) Backlash equals half of the total of the thicknesses of the two crushed fuses.</td>
<td>• Adjustment of backlash
Adjustment by means of washers and set collars of the differential side gears.
<table>
<tr><th></th><th>Reference value</th><th>Allowable limit</th></tr>
<tr><td>Differential pinion washer thickness</td><td>1.5±0.04mm
0.0591±0.0016in.</td><td rowspan="3">1mm
0.394in.</td></tr>
<tr><td rowspan="2">Differential side gear washer thickness</td><td>1.5±0.04mm
0.0591±0.0016in.</td></tr>
<tr><td>1.6±0.04mm
0.0630±0.0016in.</td></tr>
</table>
Set collar thickness: $5.5^{\ 0}_{-0.05}$ mm
0.2146 to 0.2165 in.</td>
</tr>
</table>

Item	Location	Reference value
Servicing (4) Tooth backlash between bevel pinion and bevel gear (Adjustment of the backlash should be done in the following three steps:) i) Collar adjustment of bevel pinion shaft tapered roller bearings	 	• Reference value Bevel pinion shaft rolling torque 0.5 to 0.9 N·m. (5 to 9 kgf·cm., 0.4 to 0.7 lb.ft.)
Servicing ii) Installing bevel gear tapered roller bearings and determining the thickness of shims	 	• Reference value Differential rolling torque 1.1 to 1.9 N·m. (11.0 to 19.0 kgf·cm., 0.8 to 1.4 lb.ft.) (measured on pinion shaft)

Tools and test instruments	Procedure	Remarks
 36	1) Refit the bevel pinion shaft together with the bevel pinion adjustment collars 1 and 2, the tapered roller bearing, the 32T gear and the collar. Check to see if they closely fit each other. 2) Apply oil to the nut screw of the pinion shaft and tighten it to the specified torque (274.6 to 343.2 N·m. (28 to 35 kgf·m., 202.5 to 253.2 lb.ft.)). At this point, tap the pinion shaft longitudinally with a plastic hammer to eliminate distortion. 3) Measure the rolling torque of the pinion shaft. 4) If the measurement exceeds the reference value, adjust by altering the thickness of bevel pinion adjustment collar 1.	• There are eleven collars 1 of different thicknesses: 1 ± 0.01 mm (0.0394 ± 0.0004 in.) 1.5 ± 0.01 mm (0.0591 ± 0.0004 in.) 1.7 ± 0.01 mm (0.0669 ± 0.0004 in.) 1.75 ± 0.01 mm (0.0689 ± 0.0004 in.) 1.8 ± 0.01 mm (0.0709 ± 0.0004 in.) 1.9 ± 0.01 mm (0.0748 ± 0.0004 in.) 2.0 ± 0.01 mm (0.0787 ± 0.0004 in.) 2.1 ± 0.01 mm (0.0827 ± 0.0004 in.) 2.2 ± 0.01 mm (0.0866 ± 0.0004 in.) 2.25 ± 0.01 mm (0.0886 ± 0.0004 in.) 2.3 ± 0.01 mm (0.0906 ± 0.0004 in.)
 36 	1) Insert a 1 mm (0.0394 in.) shim between differential bearing support 1 (right) and transmission case, and fix it to the transmission case by tightening the three bolts to 44.1 to 55.9 N·m. (4.5 to 5.7 kgf·m., 32.5 to 41.2 lb.ft.). 2) Install the differential gear, and attach differential bearing support 2 (left) to the transmission case with three bolts without shims. 3) Set the torque increase per bolt to 1.0 to 5.9 N·m. (0.1 to 0.6 kgf·m., 0.7 to4.3 lb.ft.) with a torque wrench, and tighten the three bolts little by little. Check to see if the bearings can move smoothly by turning the bevel gear a few times by hand. 4) With a feeler gauge, measure the clearance (L) between the transmission case and differential bearing support 2 at three points making an angle of 120° to each other. Calculate the average. 5) Calculate the total thickness of shims required, from the following formula: 1 mm (0.0394 in.) + average L + 0.05 mm (0.0020in.), where 0.05mm (0.0020 in.) is the allowance required after the	• There are three shims of different thicknesses: 0.1 mm (0.0039 in.) 0.3 mm (0.0118 in.) 0.5 mm (0.0197 in.) bolts are tightened. Round off the answer to one decimal. 6) Attach shims of half of the total thickness to differential bearing supports 1 and 2. 7) Measure the differential gear rolling torque on the pinion shaft. Check to see if the measurement lies within the reference value.

Item	Location	Reference value
Servicing iii) Adjustment of backlash		• Reference value 0.15 to 0.25mm 0.0059 to 0.0098in. • Allowable limit 0.4mm 0.0157in.
Servicing (5) Tooth contact between bevel gear and pinion		• Reference value 35% or more

Cross contacts (b)

In cross contacts (b), the pinion shaft is located below the center of the gear as shown above.

Large end contacts

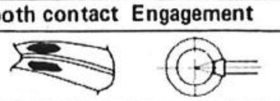
In large end contacts, the angle between the pinion shaft and the center of the bevel gear is smaller than 90°.

Cross contacts (a)

In cross contacts (a), the pinion shaft is located above the center of the gear as shown above.

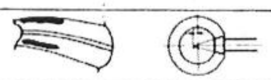
Tools and test instruments	Procedure	Remarks
Pinion shaft locking tool 	1) Fix the bevel pinion shaft. 2) Set a dial gauge on the tooth face vertically, measure the backlash by moving the bevel gear by hand.	• Adjust the backlash by interchanging the left and right shims of the differential bearing supports. (1) If the backlash is too great, move the right shim to the left. (2) If the backlash is too small, move the left shim to the right.
 36 Red lead Wood block	1) Eliminate any load on the differential gear (or remove the axle case). 2) Divide the bevel gear circumference into three equal parts and mark a few teeth in each part with red lead. 3) Turn the pinion shaft while braking lightly the bevel gear circumference with a wooden block, and check the tooth contact.	• Adjust the tooth contact by means of bevel pinion adjustment collars 2. • There are five collars 2 of different thicknesses: 2.8 ± 0.02 mm (0.1102 ± 0.0008 in.) 3.0 ± 0.02 mm (0.1181 ± 0.0008 in.) 3.2 ± 0.02 mm (0.1260 ± 0.0008 in.) 3.4 ± 0.02 mm (0.1339 ± 0.0008 in.) 3.6 ± 0.02 mm (0.1417 ± 0.0008 in.) • Judgement and adjustment of gear tooth contacts.

Gear tooth contact Engagement



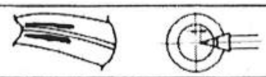
Correct contacts

A gear tooth contact area should exceed 35% of the entire gear tooth surface and the center of the contact should be located one-third of the way in from the small end.



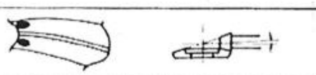
Flank contacts

Flank contacts mean that the pinion cone is located as shown above. To correct it, the pinion shaft should be shifted, by means of shims, so that the vertex of the pinion cone meets the center of the bevel gear. Since this adjustment increases the amount of backlash, it should be readjusted to 0.15 to 0.25 mm (0.0059 to 0.0098 in.) by means of the differential support shims.



Tip contacts

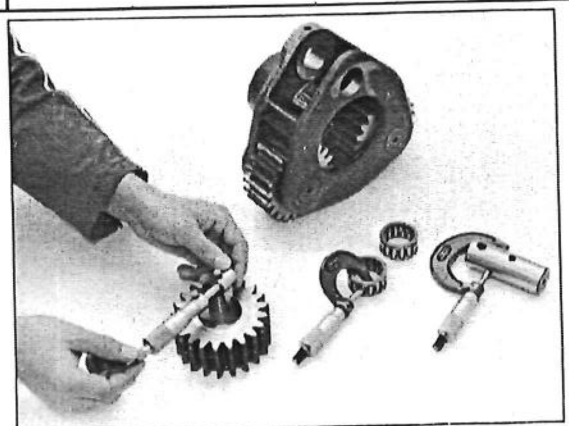
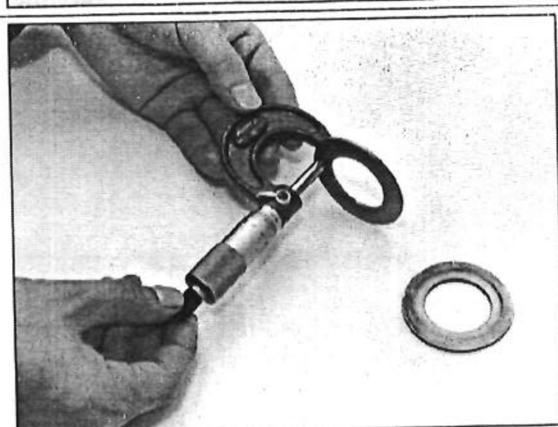
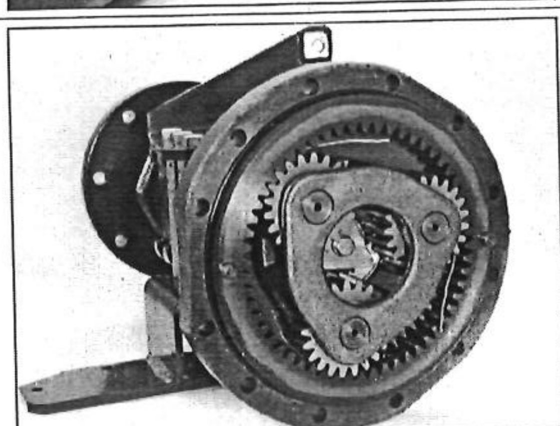
Tip contacts mean that the pinion cone is located as shown above with respect to the bevel gear. To correct it, the pinion shaft should be shifted, by means of shims, so that the vertex of the pinion cone meets the center of the bevel gear. Since this adjustment decreases the amount of backlash, it should be readjusted to 0.15 to 0.25 mm (0.0059 to 0.0098 in.) by means of the differential bearing support shims.



Small end contacts

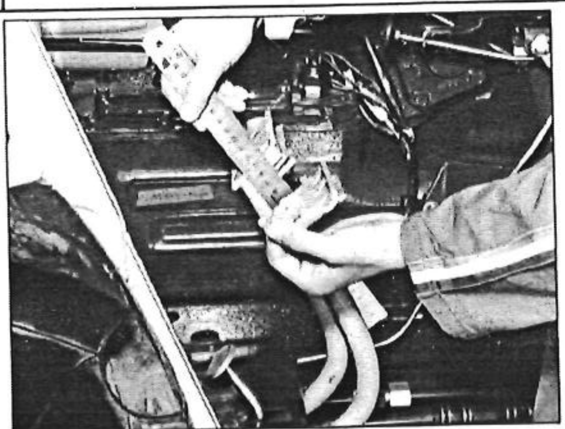
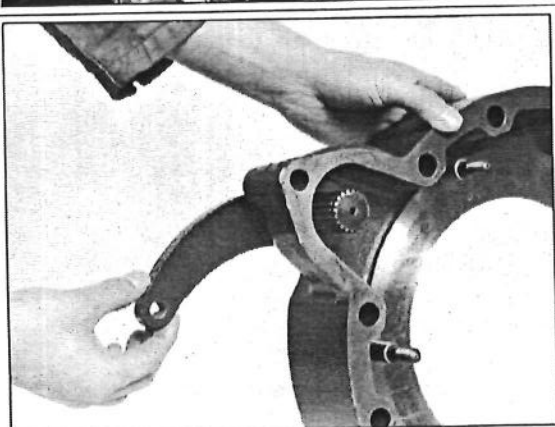
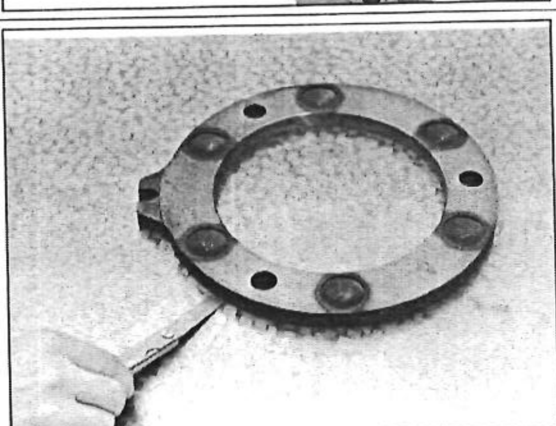
In small end contacts, the angle between the pinion shaft and the center of the bevel gear is greater than 90°.

7. REAR AXLE CASE

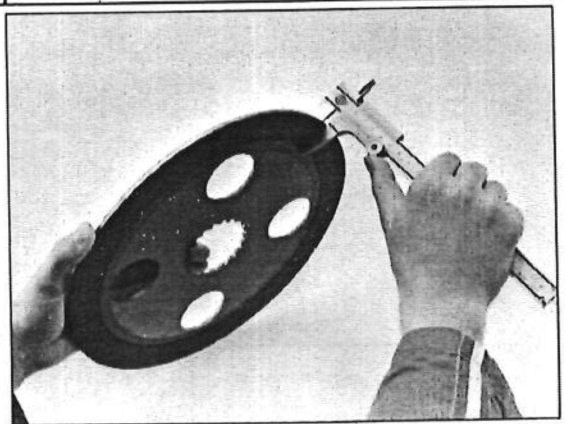
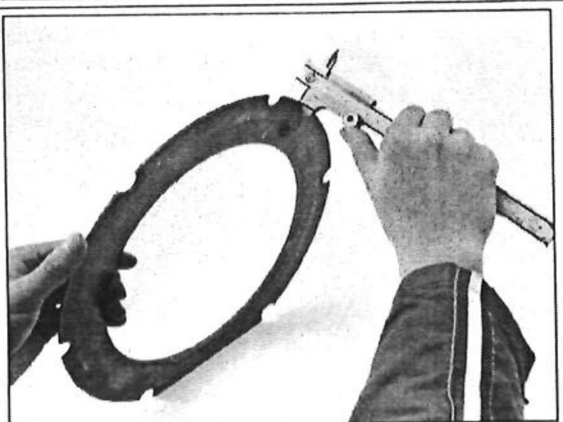
Item	Location	Reference value
Servicing (1) Clearance of planetary pinion needle and pinion pin		• Reference value 0.009 to 0.053mm 0.0004 to 0.0021in. • Allowable limit 0.3mm 0.0118in.
Servicing (2) Thickness of planetary pinion thrust washers		• Reference value 0.95 to 1.05mm 0.0374 to 0.0413in. • Allowable limit 0.6mm 0.0236in.
Servicing (3) Gear backlash		• Reference value 0.1 to 0.2mm 0.0039 to 0.0079in. • Allowable limit 0.5mm 0.0197in.

Tools and test instruments	Procedure	Remarks
 	1) Measure the inside diameter of the planetary pinion. 2) Measure the planetary pinion pin. 3) Measure the diameter of two needles of the needle bearing. 4) Calculate the difference between the pinion inside diameter, and the total of the diameters of pinion pin and two needles. 5) If the measurement exceeds the allowable limit, replace.	I.D. of planetary pinion: 39.009 to 39.025mm 1.5358 to 1.5364in. O.D. of planetary pinion pin: 31.984 to 32.000mm 1.2592 to 1.2598in. O.D. of needle bearing needle: 3.494 to 3.500mm 0.1376 to 0.1378in.
	1) Measure the thickness of the thrust washer with an outside micrometer. 2) If the measurement exceeds the allowable limit, replace.	
 Fuse	1) Place three fuses on the three planetary pinions. 2) Take out the fuses, and measure the thickness of them with an outside micrometer. 3) Backlash $= \dfrac{\text{Total of thickness of three fuses} \binom{mm}{in.}}{3}$	

8. BRAKE

<table>
<tr><th>Item</th><th>Location</th><th>Reference value</th></tr>
<tr><td>Servicing (1)
Brake pedals free travel</td><td></td><td>• Reference value
At the brake pedal edge
<table><tr><td>M4000
M4500</td><td>35 to 45mm
1.3780 to 1.7717in.</td></tr><tr><td>M5500
M6500
M7500</td><td>40 to 50mm
1.5748 to 1.9685in.</td></tr></table></td></tr>
<tr><td>Servicing (2)
Brake cam action</td><td></td><td>• Reference value
Move lightly</td></tr>
<tr><td>Servicing (3)
Distortion of brake cam plates</td><td></td><td>• Reference value
0.3mm (0.0118in.) or less</td></tr>
</table>

Tools and test instruments	Procedure	Remarks
	1) Step on the right and left brake pedals three times each with 392.2 to 490.3 N. (40 to 50 kgf., 88.2 to 110.3 lb.) load. 2) Measure free travel by pressing the center of the pedal with 98.1 N. (10 kgf., 22.1 lb.). 3) Adjust by altering the length of the brake rod.	• Adjust the difference between the right and left pedals' free travel to 5 mm (0.1969 in.) or less. • Be sure that the parking brake locks when the brake pedals are pressed to the fifth or sixth latch pawl.
	1) Check to see if the brake cam actuates smoothly by throwing the brake cam lever. 2) If not, grind off the cam and the brake case with sandpaper.	
 	1) Place the brake cam plate on a surface plate, and measure the flatness. 2) If the measurement exceeds the allowable limit, replace.	• Check to see if there is any partial wear in the cam plate ball holes.

Item	Location	Reference value
Servicing (4) Thickness of friction plates		• **Reference value** 4.12 to 4.28mm 0.1622 to 0.1685in. • **Allowable limit** 3.2mm 0.1260in.
Servicing (5) Thickness of plates		• **Reference value** 2.22 to 2.38mm 0.0874 to 0.0937in. • **Allowable limit** 1.5mm 0.0591in.

Tools and test instruments	Procedure	Remarks
	1) Measure the thickness of the friction plate with vernier caliper. 2) If the measurement exceeds the allowable limit, replace.	
	1) Measure the plate thickness with vernier caliper. 2) If the measurement exceeds the allowable limit, replace.	

TROUBLE SHOOTING

	Reference
Release lever 1 missing.	144
Clutch release fork 1 broken.	146
Set bolt missing.	146
Clutch control lever broken.	146

Clutch pedal rod maladjusted.	180
Clutch disc rusted.	146

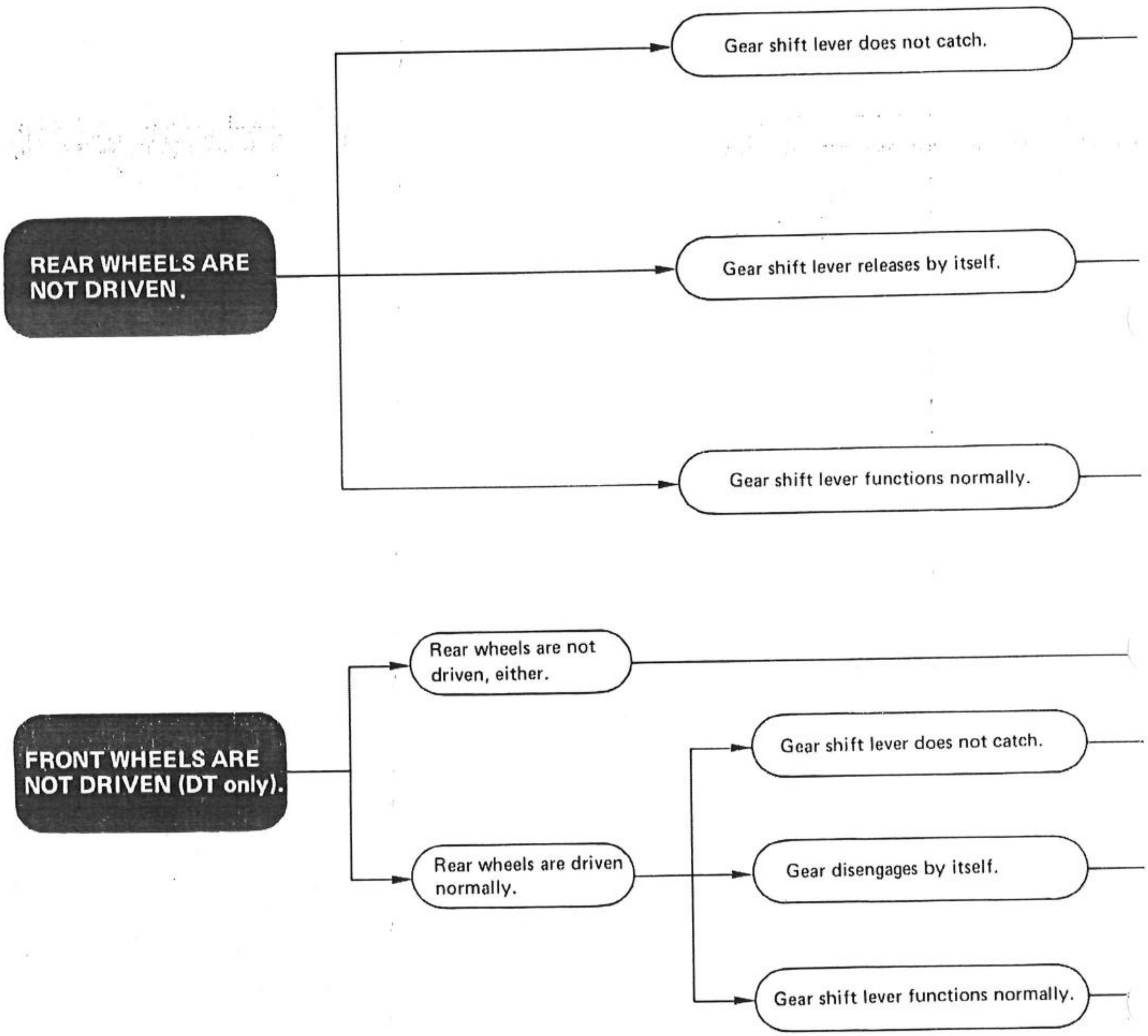
Clutch pedal rod maladjusted.	180
Thrust bearing broken.	146

Clutch disc shakes.	180
Diaphragm spring broken.	182

Clutch pedal rod maladjusted.	180

Oil sticks to clutch disc and pressure plate.	182
Clutch disc carbonized.	182
Clutch disc worn.	182
Diaphragm spring broken.	182

Clutch pedal rusted.	
Clutch control lever rusted.	146
Clutch release hub rusted.	146


REAR WHEELS ARE NOT DRIVEN.
Gear shift lever does not catch.
Gear shift lever releases by itself.
Gear shift lever functions normally.
FRONT WHEELS ARE NOT DRIVEN (DT only).
Rear wheels are not driven, either.
Rear wheels are driven normally.
Gear shift lever does not catch.
Gear disengages by itself.
Gear shift lever functions normally.

	Reference
Main/creep gear shift lever or aux. gear shift lever broken.	150
Main gear shift or aux. gear shift lever spring pin broken.	150
Creep gear shift lever broken.	156
Shift fork broken.	150

Gear shift lever stopper spring slacken.	150
Gear shift lever stopper spring broken.	150
Synchronizer key broken.	188
Synchronizer key spring broken.	188
Excessive play between shift fork and gear fork groove.	190
Excessive axial play of driven gear when changing speeds.	

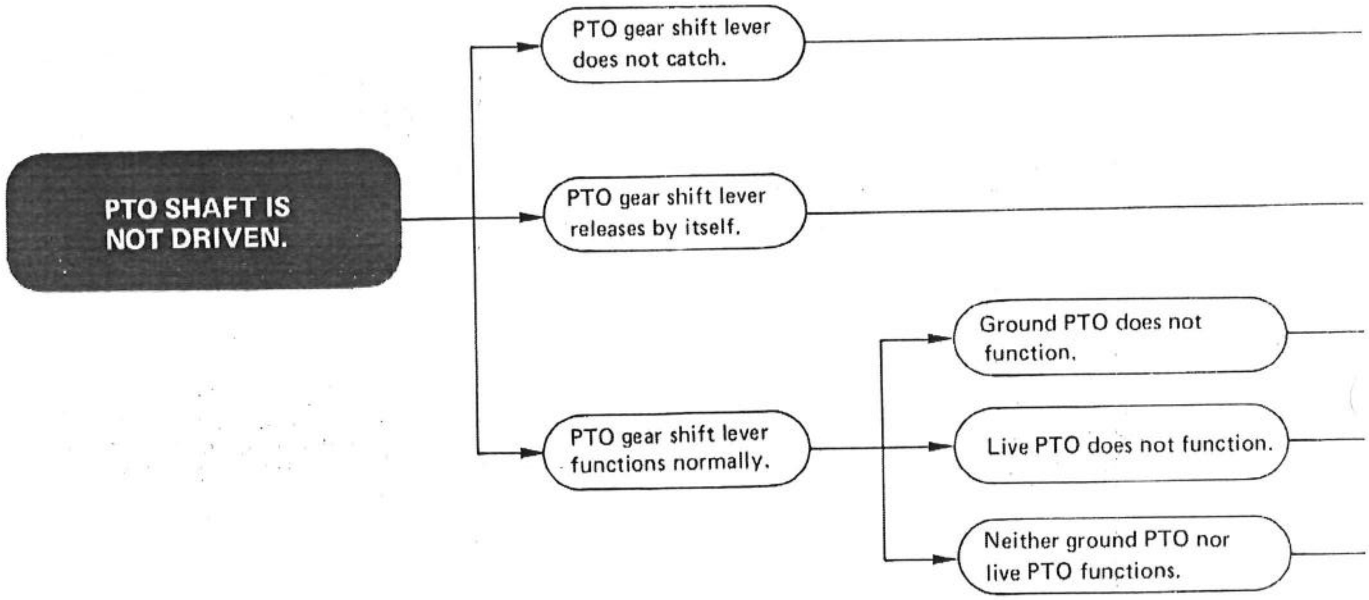
Transmission medium in clutch housing or transmission case broken.	160~ 164
Transmission medium in rear axle case broken.	166

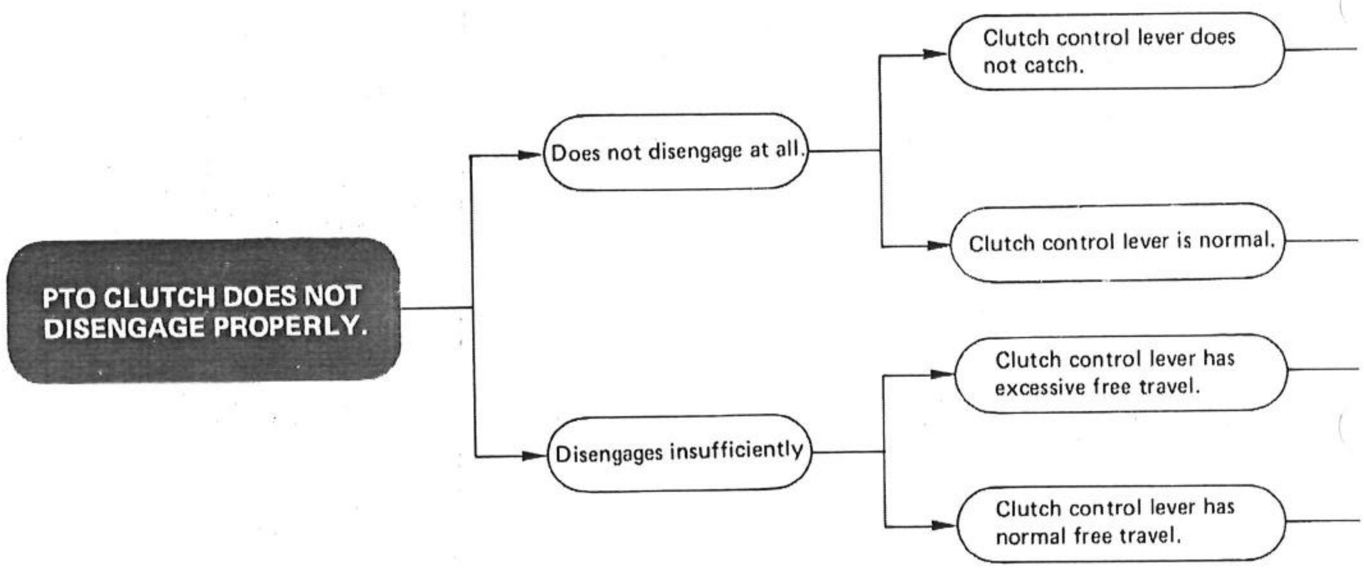
Refer to item: Rear wheels are not driven.	

Shift fork mounting spring pin broken.	
Shift fork broken.	

Lever guide worn.	
Lever guide broken.	
Set screw missing.	

Propeller shaft broken.	
Transmission medium in differential gear case, bevel gear case, or front axle case broken.	138~ 142


PTO SHAFT IS NOT DRIVEN.
PTO gear shift lever does not catch.
PTO gear shift lever releases by itself.
PTO gear shift lever functions normally.
Ground PTO does not function.
Live PTO does not function.
Neither ground PTO nor live PTO functions.


PTO CLUTCH DOES NOT DISENGAGE PROPERLY.
Does not disengage at all.
Disengages insufficiently
Clutch control lever does not catch.
Clutch control lever is normal.
Clutch control lever has excessive free travel.
Clutch control lever has normal free travel.

	Reference
PTO gear shift lever spring pin broken.	158
Shift lever broken.	158
Shift fork broken.	158

Gear shift lever stopper spring broken.	158
PTO gear shift rod broken.	158
Shift fork deformed.	158

Ground/Live PTO shift gear broken.	156

Ground/Live PTO shift gear broken.	156
PTO clutch shaft broken.	156

Transmission medium in clutch housing or transmission case broken.	150~164

Release lever 2 missing.	144
Clutch release coupling broken.	146
Clutch release fork 2 broken.	146
Set bolt missing.	146
Control lever shaft broken.	146

Clutch control rod maladjusted.	180
Clutch disc rusted.	146

Clutch control rod maladjusted.	180
Thrust bearing broken.	146

Bearing in flywheel broken.	144
Clutch disc shakes.	180
Diaphragm spring broken.	182

PTO CLUTCH SLIPS.

- Clutch control lever has insufficient free travel.
- Clutch control lever has normal free travel.

PTO CLUTCH ACTION IS HEAVY.

UNUSUAL NOISES OCCUR, IN CLUTCH HOUSING, TRANSMISSION CASE OR FRONT WHEEL DRIVE SECTION.

- Continuous beating noise.
- Irregular noise.
- Noise occurs when tractor turns.

	Reference
Clutch control rod maladjusted.	180

Oil sticks to clutch disc or pressure plate.	182
Clutch disc carbonized.	182
Clutch disc worn.	182
Diaphragm spring broken.	182

Control lever guide rusted.	
Gear shift lever pin stuck.	
Control lever shaft rusted.	146

Gear oil degraded.	
Deficient gear oil.	10
Gear backlash too great or too small.	172 ~ 176, 188, 192, 196
Excessive backlash between gear and spline shaft.	186
Bearing worn.	186

Bearing broken.	186
Gear tooth missing.	
Foreign matter caught in moving parts.	
Thrust washer worn.	
Fasteners loose.	

Backlash between differential side gear and pinion gear too great.	172 192
Gear tooth missing.	

DIFFERENTIAL LOCK MALFUNCTIONING.

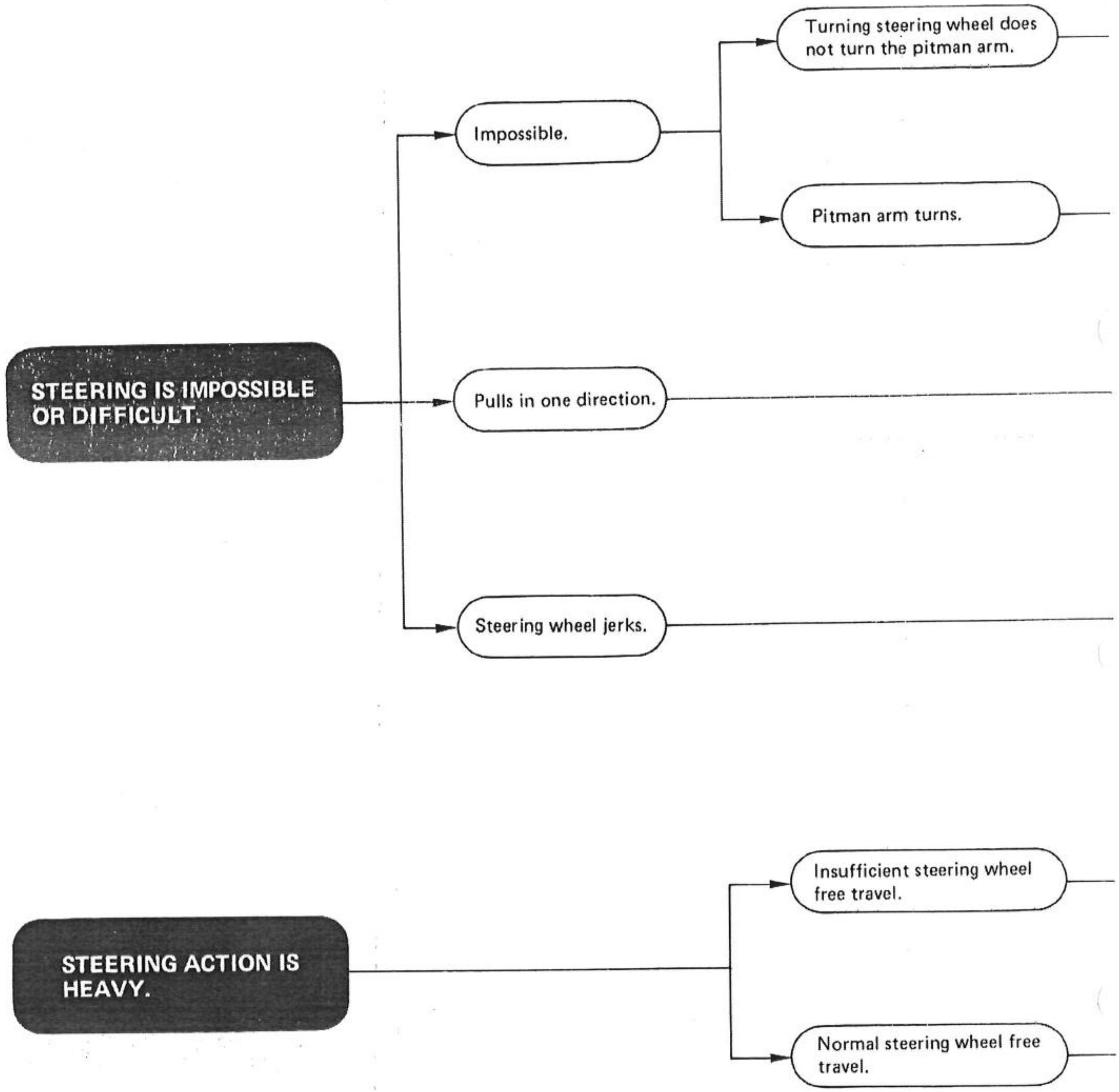
- Does not lock.
- Does not unlock.

BRAKE DOES NOT WORK.

- Does not work at all.
  - Brake pedals do not catch.
  - Normal brake pedalling.
- Works improperly.
  - Excessive pedal free travel.
  - Normal pedal free travel.
- Noisy.

BRAKING ACTION IS HEAVY.

	Reference
Differential lock cam mounting spring pin broken.	154
Shift fork broken.	154
Differential lock spring slacken or broken.	154
Differential lock shifter pin flawed.	154
Joint pin on brake rod connection missing.	200
Brake cam lever broken.	200
Brake lever broken.	200
Brake case broken.	28
Brake rod maladjusted.	200
Brake disc worn.	202
Cam plate worn.	202
Oil degraded.	
Brake disc or cam plate not flat enough.	200
Brake pedal or pedal shaft rusted.	
Brake lever rusted.	200


STEERING IS IMPOSSIBLE OR DIFFICULT.
Impossible.
Turning steering wheel does not turn the pitman arm.
Pitman arm turns.
Pulls in one direction.
Steering wheel jerks.
STEERING ACTION IS HEAVY.
Insufficient steering wheel free travel.
Normal steering wheel free travel.

Some element in steering gear case broken.

	Reference
Ball nut assembly broken.	148
Sector shaft broken.	148
Steering wheel shaft broken.	148
Steering wheel mounting key broken.	20

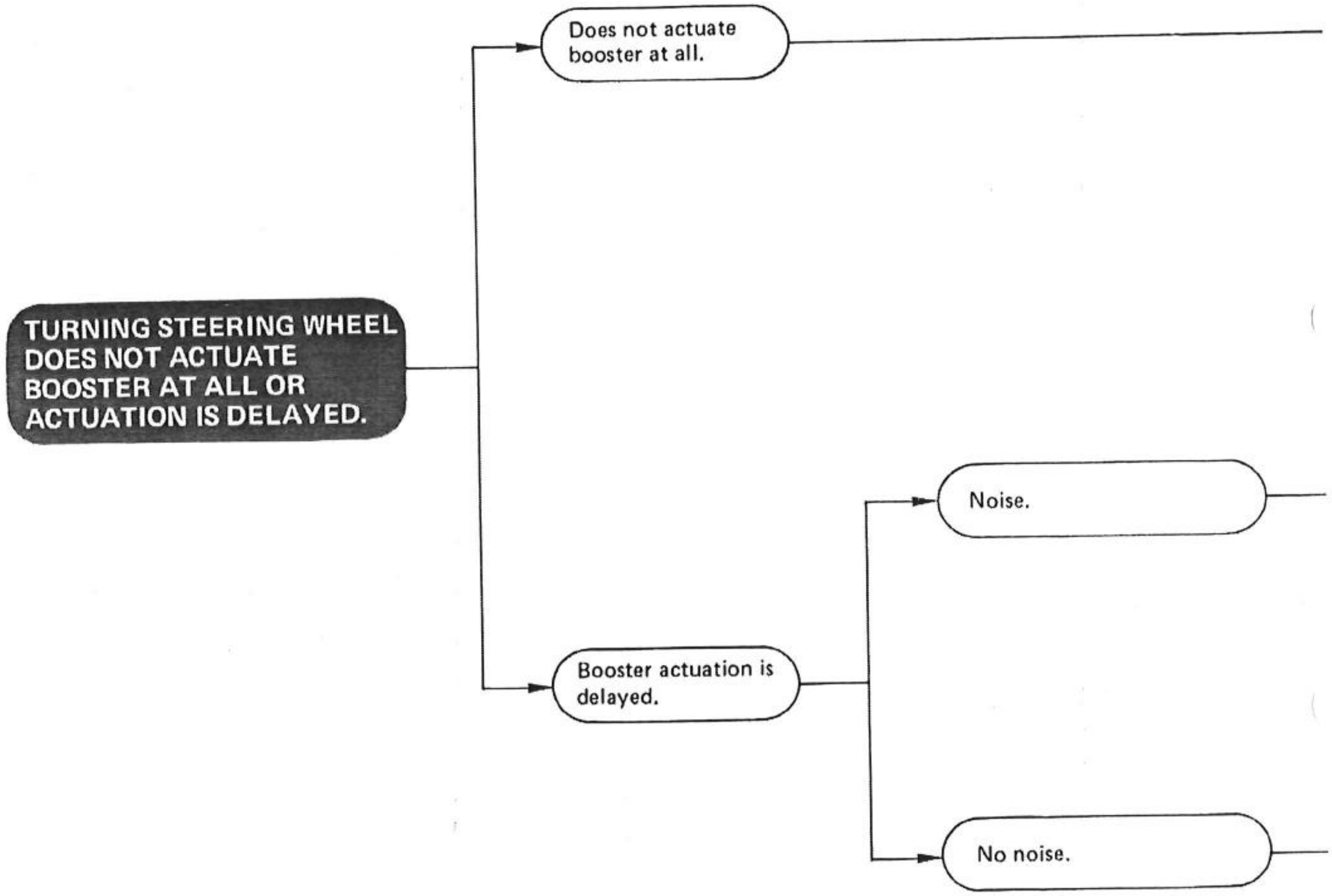
Drag link and end broken.	
Tie-rod and end broken.	
Knuckle shaft feather key broken.	
Knuckle arm broken.	136

Uneven tire pressures.	170
No steering wheel free travel.	184
Front wheel hub bearing worn.	134
Front wheels not in alignment.	170

Front wheel mounting bolt and nut loose.	134
Knuckle shaft bushing worn.	168
Front wheels not in alignment.	170
Front wheel hub bearing worn.	134
Drag link end or tie-rod end worn.	186
Uneven tire pressures.	170
Front wheel disc deformed.	

Steering wheel free travel adjustment improper.	180

Column bushing has seized up.	
Oil insufficient.	146
Thrust ball bearing maladjusted.	184
Each end not lubricated enough.	
Front wheels not in alignment.	170
Knuckle shaft not lubricated enough.	
Thrust ball bearing broken.	148

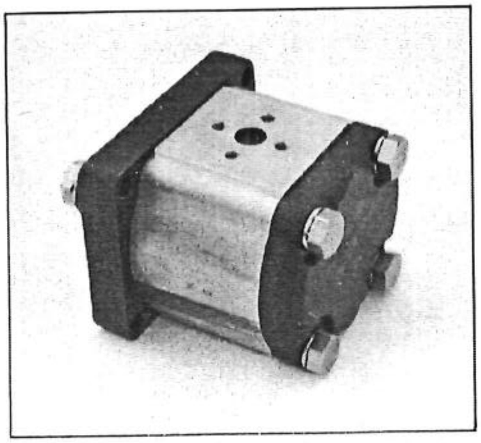

TURNING STEERING WHEEL DOES NOT ACTUATE BOOSTER AT ALL OR ACTUATION IS DELAYED.
Does not actuate booster at all.
Booster actuation is delayed.
Noise.
No noise.

Cause	Detail	Reference
Hydraulic pump broken.	Shaft, key and hub broken.	226 230
Turning steering wheel does not move spool.	Screw loose.	290
	Self-locking nut loose.	288
	Spool flawed.	280
Relief valve defective.	Relief valve spring broken.	290
Cavitation.	Suction pipe clogged.	
	Oil degraded.	
	Oil temperature too low.	
Air in hydraulic system.	Inlet pipe slacken.	22
	Inlet pipe O-ring flawed.	
	Pump shaft oil seal flawed or worn.	226 230
	Oil insufficient.	22
Hydraulic pump broken.	Gear and bushing seized up.	226 230
Relief valve defective.	Setting of relief valve too low.	294
	Oil leaks inside hydraulic pump.	234~ 238
	Oil leaks inside control valve.	292
	Oil leaks inside hydraulic cylinder.	292
	Relief valve seat surface flawed or has imbedded foreign matter.	290

IV. HYDRAULIC SYSTEM

HYDRAULIC PUMP

1. CONSTRUCTION AND NAME OF PARTS



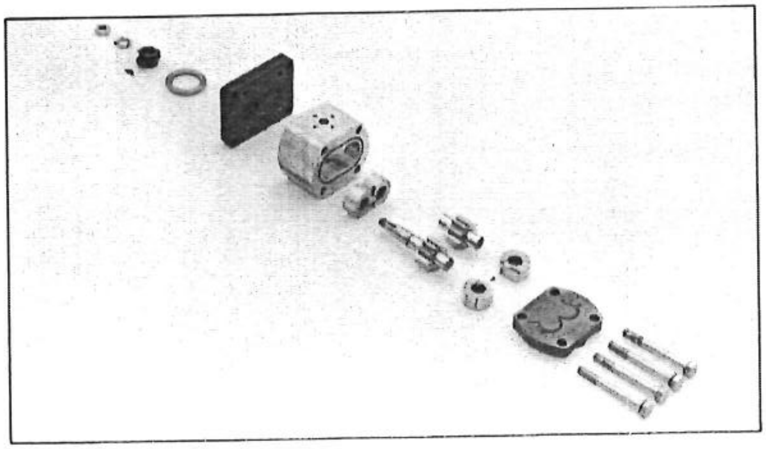
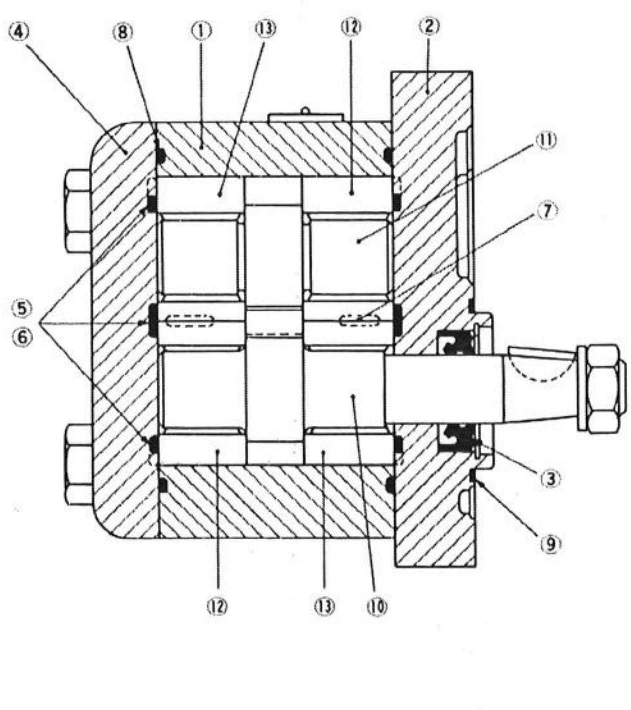


Fig.40



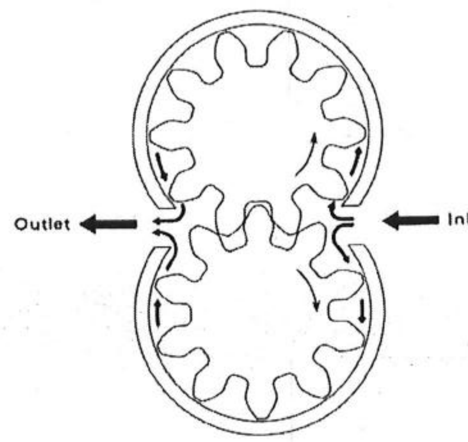
■ **Name of Parts**

① Housing
② Flange
③ Oil seal
④ Cover
⑤ Seal element
⑥ Backup element
⑦ Key
⑧, ⑨ O-ring
⑩, ⑪ Gear
⑫, ⑬ Bushing

2. FUNCTION

Power from the engine drives the drive shaft, which in turn rotates the gears inside the pump. The gear rotation draws in the hydraulic oil(gear oil SAE # 80)from the inlet and forces it to the hydraulic cylinder through the control valves. The faster the gears turn, the more the hydraulic oil flows out from the outlet, thus accelerating implement lifting speed.

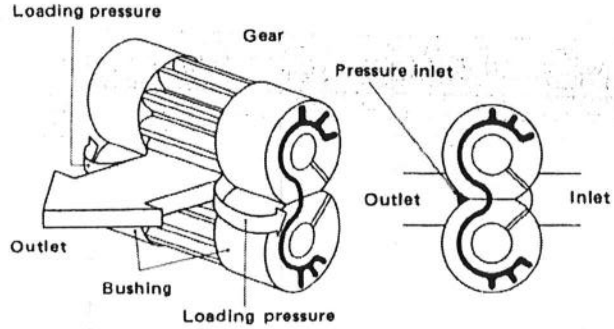
Fig.41



■ **Pressure balance system**

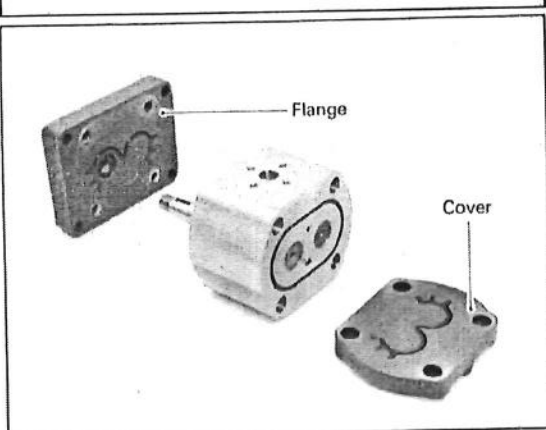
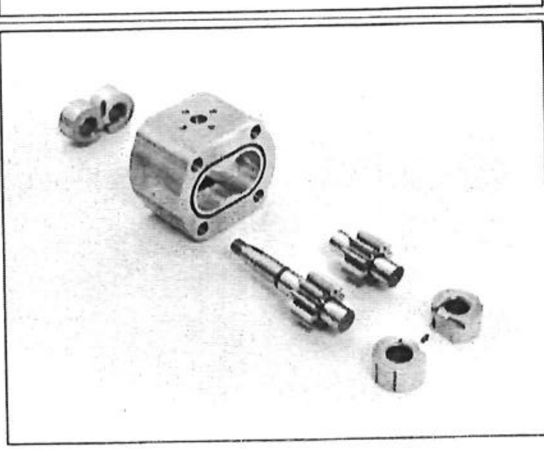
A pressure balance system is introduced to minimize as much as possible the space between the side face of the gear and the mating bushing to attain higher pumping efficiency. Outlet oil of high pressure acting on the side faces of the bushings forces the bushings against the sides of the gears to automatically adjust the gap between the gears and the bushings. Accordingly, oil leakage does not increase under high pressure.

Fig.42

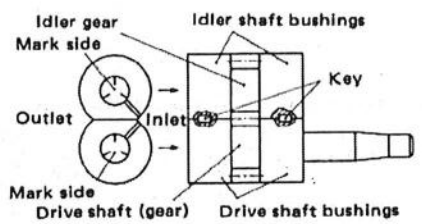


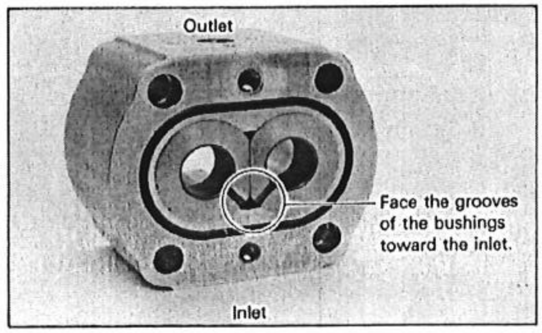
3. DISASSEMBLY

3-1. Implement lifting gear pump (M4000,M5500,M6500,M7500)

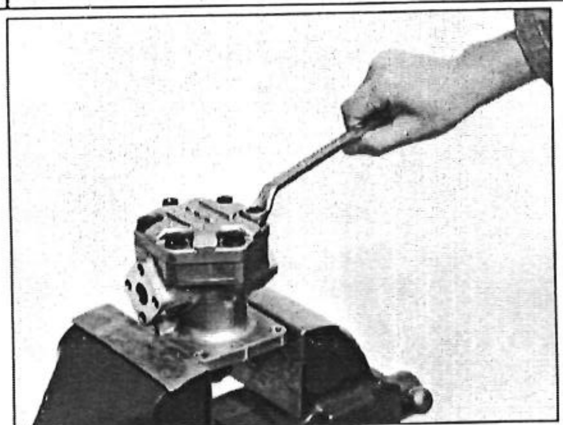
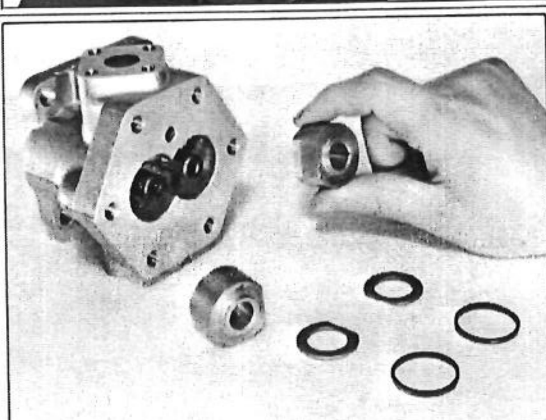
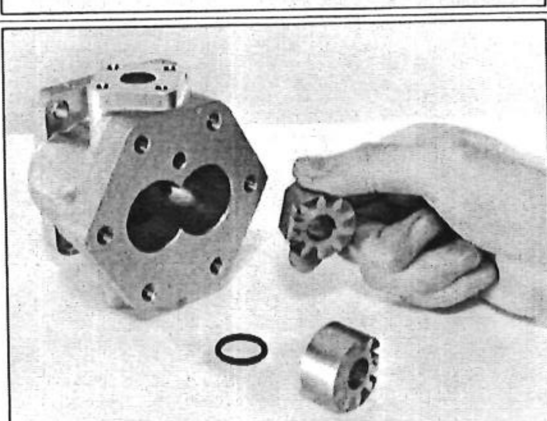
Item	Location	Bolts and nuts	Tools
Disassembly (1) Cover, Flange		 M10x90 .... 4 M12··· 1 .... 1 1	 17 19
Disassembly (2) Bushings, Gears			

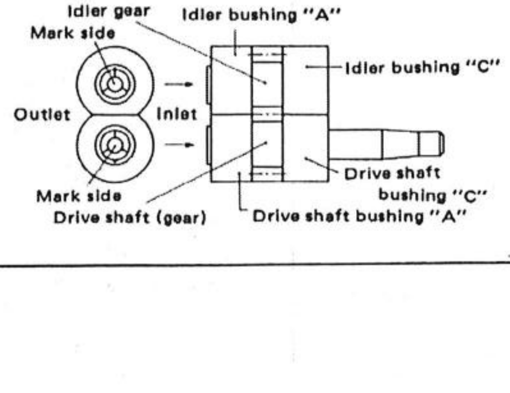
<table>
<tr><th>Procedure</th><th>Remarks</th></tr>
<tr><td>1) Remove the nut and then the hub and the ring (1).
2) Remove the bolt and then the cover and the flange.</td><td>• Be sure to mark the cover, the housing and the flange so that they can be correctly positioned when reassembled.</td></tr>
<tr><td>1) Pull out the bushings and the gears from the housing case.</td><td>(When reassembling)
• Be sure not to mistake the bushing on the drive shaft for the one on the idler shaft. Be careful to refit the idler gear in the correct direction.
• Be careful not to lose or damage the keys joining the two bushings.

Fig.43


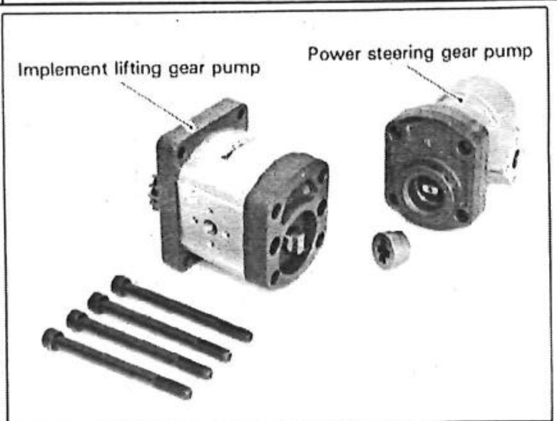
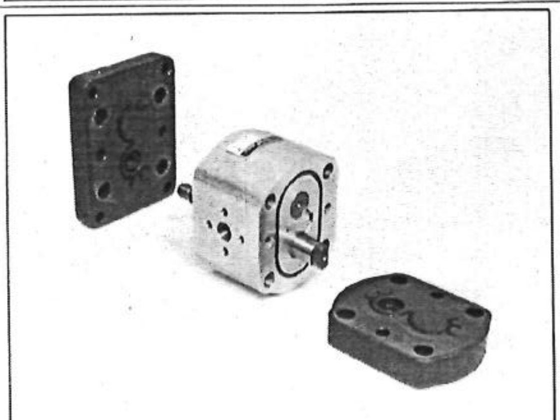
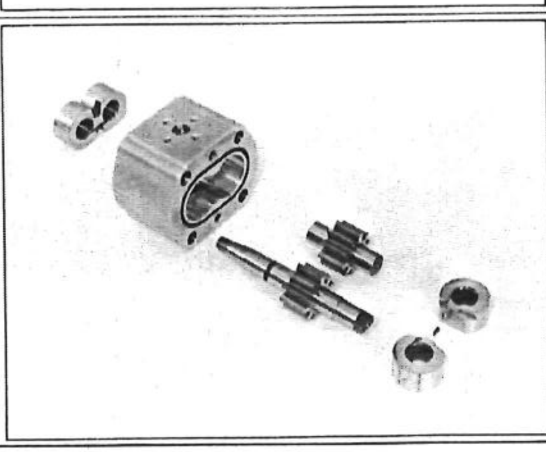

</td></tr>
</table>

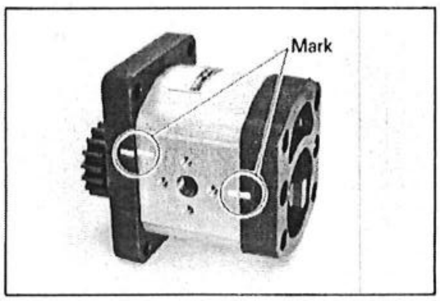
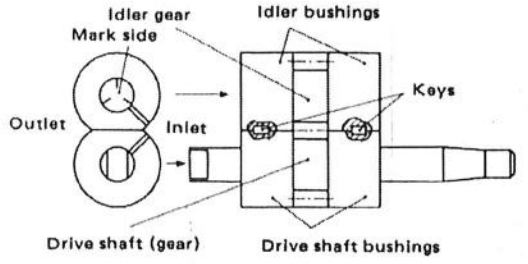
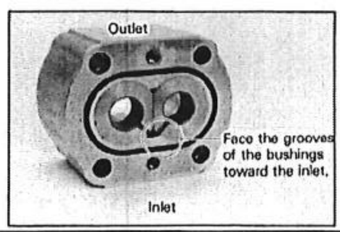
3-2. Power steering gear pump (M5500,M6500,M7500)

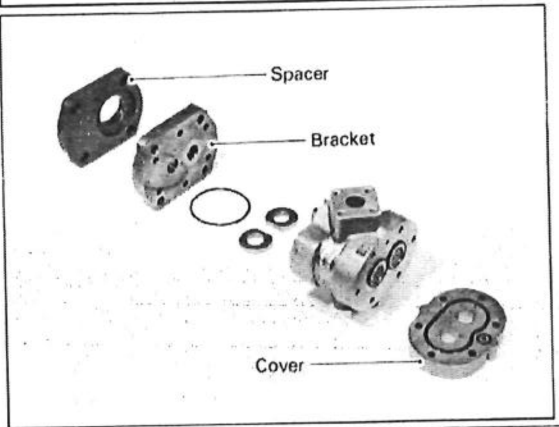
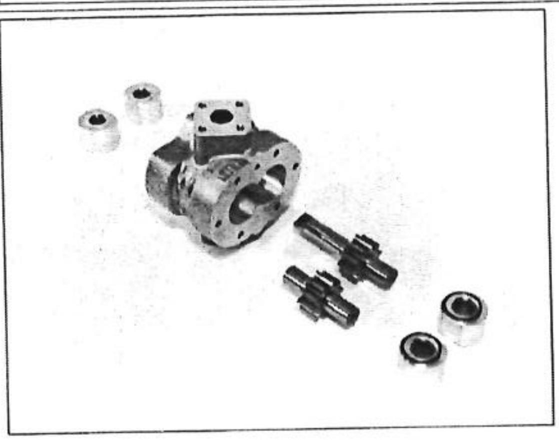
Item	Location	Bolts and nuts	Tools
Disassembly (1) Hub, End cover		 M12x25 .... 6  M8..... 1  .... 1  1	 12 13
Disassembly (2) "A" bushings			
Disassembly (3) Gear, "C" bushings			

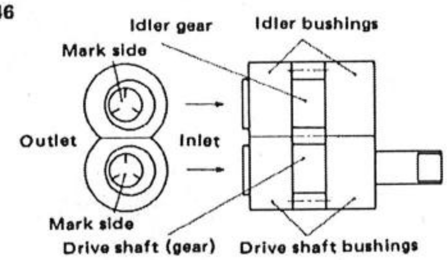
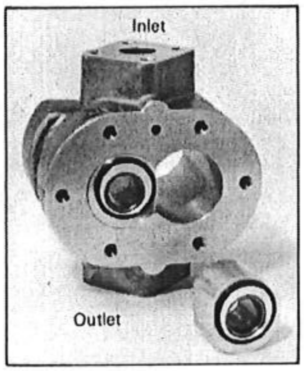
Procedure	Remarks
1) Remove the hub. 2) Remove the end cover.	(When reassembling) ● Take care to correctly position the oil port of the end cover.
1) Push the drive shaft toward the end cover. 2) Remove the seal ring and the support as one unit. 3) Removing the "A" bushings as one unit.	
1) Pull off the gear. 2) Tap the pump body against something soft to let the "C" bushings out as one unit. 3) Remove the O-rings.	(When reassembling) ● Be careful not to mistake the bushing on the drive shaft for the one on the idler shaft. Be careful to refit the idler gear in the correct direction. Fig.44 

3-3. Gear pump (M4000S,M4500)

Item	Location	Bolts and nuts	Tools
Disassembly (1) Separating the implement lifting gear pump from the power steering gear pump.		M10x120 4	 8
Disassembly (2) Disassembling the implement lifting gear pump i) Cover, Flange		M12····1 .... 1 M8····· 4	 19
Disassembly ii) Bushings, Gears			

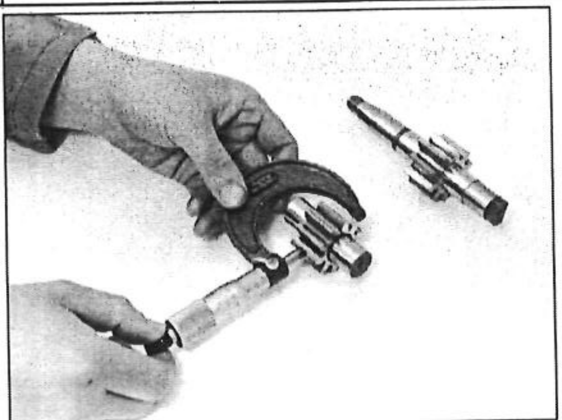
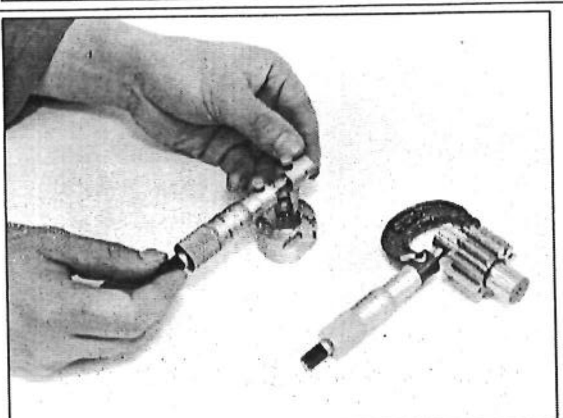
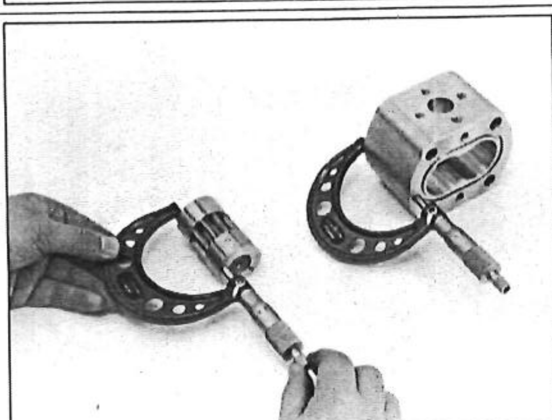
<table>
<tr><th>Procedure</th><th>Remarks</th></tr>
<tr><td>1) Clamp the pump assembly in a vise and remove the bolts.
2) Separate the pumps.</td><td>(When reassembling)
• Be careful to refit the coupling in the correct direction.</td></tr>
<tr><td>1) Remove the nut, and then take off the drive gear, the ring and the woodruff key.
2) Unscrew and remove the cover and the flange.</td><td>• Mark the cover, the flange and the housing so that they will be correctly positioned at time of reassembly.

</td></tr>
<tr><td>1) Pull out the bushings and the gears from the housing case.
Fig.45

</td><td>(When reassembling)
• Be careful not to mistake the bushing on the drive shaft for the one on the idler shaft. Be sure to refit the idler gear in the correct direction.
• Be careful not to lose or damage the keys joining the two bushings.

</td></tr>
</table>

Item	Location	Bolts and nuts	Tools
Disassembly (3) Disassembling the power steering gear pump i) Cover, Bracket		M6······· 12	5
Disassembly ii) Bushings, Gears			

Procedure	Remarks
1) Remove the spacer. 2) Remove the cover. 3) Remove the bracket while taking care not to drop or damage the shim.	• Mark the cover, the case and the bracket to ensure that they will be correctly positioned during reassembly. (When reassembling) • Be careful not to damage the O-rings on the cover and the bracket.
1) Pull out the bushings and gears from the housing case.	(When reassembling) • Be careful not to mistake the bushing on the drive shaft for the one on the idler shaft. Be sure to refit the idler gear in the correct direction. Fig.46  

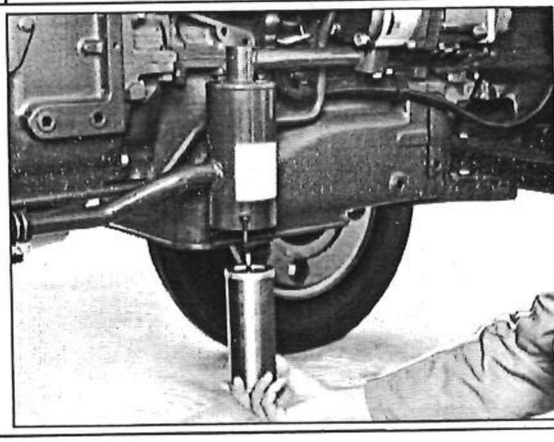
4. SERVICING

4-1. Implement lifting gear pump (M4000,M4000S,M4500,M5500,M6500,

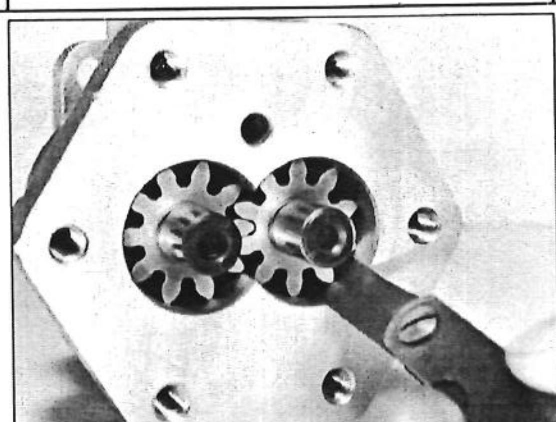
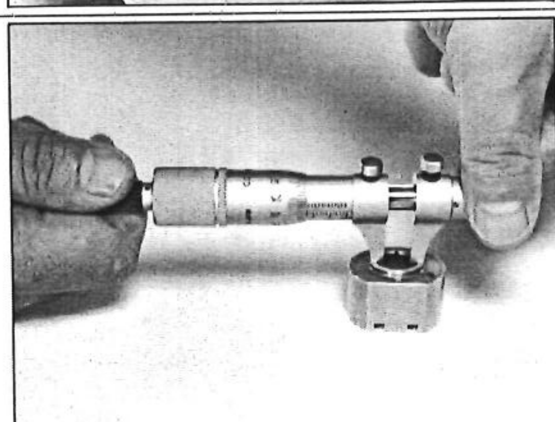
<table>
<tr><th>Item</th><th>Location</th><th>Reference value</th></tr>
<tr><td>Servicing (1)
Outside diameter of gear</td><td></td><td>• Allowable limit
37.14mm
1.4622in.</td></tr>
<tr><td>Servicing (2)
Clearance between the bushing and shaft</td><td></td><td><table><tr><th></th><th>Allowable limit</th></tr><tr><td>Shaft diameter</td><td>17.968mm
0.7074in.</td></tr><tr><td>Clearance</td><td>0.150mm
0.0059in.</td></tr></table></td></tr>
<tr><td>Servicing (3)
Difference in the widths of housing, bushing and gear.</td><td></td><td>• Allowable limit
0.25mm
0.0098in.</td></tr>
</table>

M7500)

Tools and test instruments	Procedure	Remarks
	1) Measure the outside diameter of the gear with an outside micrometer. 2) If wear is excessive, replace the gear.	
 	1) Measure the shaft diameter with an outside micrometer. 2) Measure the inside diameter of the bushing with an inside micrometer. 3) If wear is excessive, replace the bushings.	• If the inside wall of the housing is scored to a visible extent, the bushing and the gear shafts are probably worn. So they should be carefully checked.
	1) Measure the width of the housing with an outside micrometer. 2) Measure the width of the bushing and gear with an outside micrometer. 3) Obtain the difference between the measurements taken in steps 1) and 2) above. If it exceeds the allowable limit, replace the related parts.	

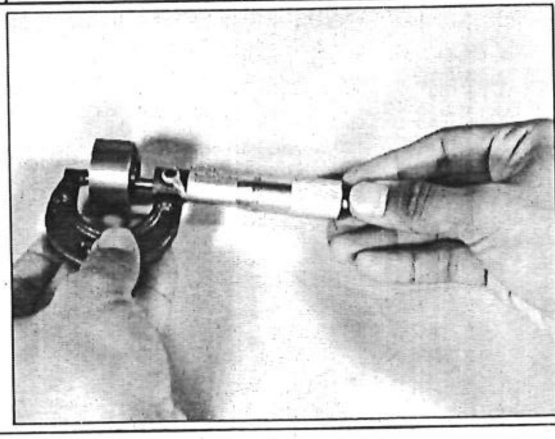
Item	Location	Reference value
Servicing (4) Cleaning the filter		• **Reference value** Clean the filter every 200 service hours.

4-2. Power steering gear pump (M5500,M6500,M7500)

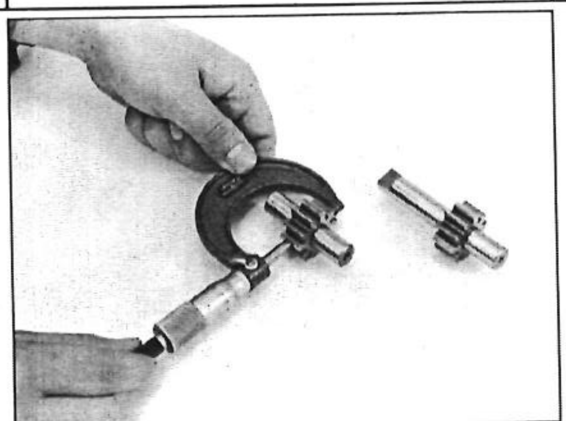
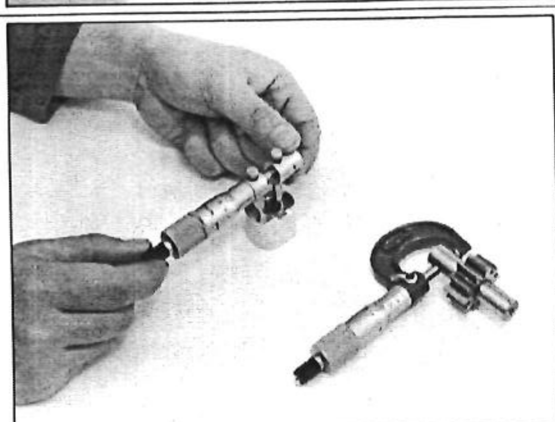
<table>
<tr><th>Item</th><th>Location</th><th>Reference value</th></tr>
<tr><td>Servicing (1)
Radial clearance between gear and pump body</td><td></td><td>• Allowable limit
0.05mm
0.0020in.</td></tr>
<tr><td>Servicing (2)
Clearance between bushing and shaft</td><td></td><td><table><tr><th></th><th>Allowable limit</th></tr><tr><td>Shaft diameter</td><td>12.598mm
0.4960in.</td></tr><tr><td>Clearance</td><td>0.177mm
0.0070in.</td></tr></table></td></tr>
</table>

Tools and test instruments	Procedure	Remarks
 10	1) Take out the hydraulic filter and the magnet filter from the filter case and rinse them with light oil.	

Tools and test instruments	Procedure	Remarks
	1) Fit the bushing "C" into the pump body. 2) Fit the drive shaft and the idler shaft into the pump body. 3) Measure the radial clearance between the gear and the pump body with a feeler gauge. 4) If it exceeds the allowable limit, replace the related parts.	• To achieve best pumping efficiency, the gear tooth crest slightly contacts the pump body when turning.
	1) Measure the shaft diameter with an outside micrometer. 2) Measure the inside diameter of the bushing with an inside micrometer. 3) If the clearance exceeds the allowable limit, replace the bushing and the shaft.	• If the inside wall of the housing is scored to a visible extent, the bushing and the gear shaft are probably worn. So they should be carefully checked.

Item	Location	Reference value
Servicing (3) Bushing width "A" and "C"		• Allowable limit 18.669mm 0.7350in.

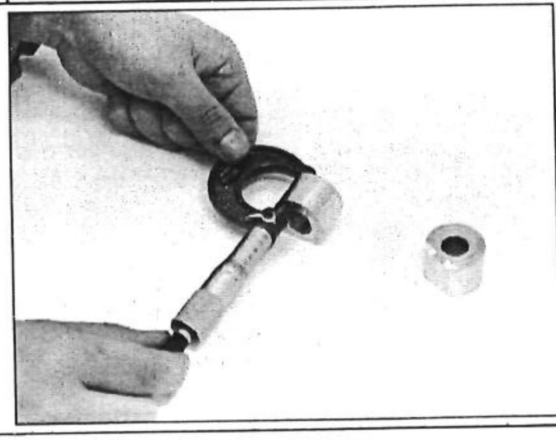
4-3. Power steering gear pump (M4000S,M4500)

Item	Location	Reference value
Servicing (1) Outside diameter of gear		• Allowable limit 31.260mm 1.2307in.
Servicing (2) Clearance between bushing and shaft		see table below

	Allowable limit
Shaft diameter	13.92mm 0.5480in.
Clearance	0.18mm 0.0071in.

Tools and test instruments	Procedure	Remarks
	1) Measure the width of the bushing with an outside micrometer. 2) If it exceeds the allowable limit, replace.	• Replace the bushing in the following cases: 1) When the slide face contacting the pump body is scored or pitted to such an extent that it can be caught by a nail. 2) When the side face is scratched all over in the rotational direction to such an extent that it can be caught by a nail. 3) When the slide face (inside diameter) and/or the side face are pitted by foreign solids.

Tools and test instruments	Procedure	Remarks
	1) Measure the outside diameter of the gear with an outside micrometer. 2) If wear exceeds the allowable limit, replace the gear.	
 	1) Measure the shaft diameter with an outside micrometer. 2) Measure the inside diameter of the bushing with an inside micrometer. 3) If wear exceeds the allowable limit, replace the related parts.	• If the inside wall of the housing is scored to a visible extent, the bushing and the shaft are probably worn more or less. So they should be checked carefully.

Item	Location	Reference value	
Servicing (3) Bushing width		• Allowable limit 22.370mm 0.8807in.	

Tools and test instruments	Procedure	Remarks
	1) Measure the width of the bushing with an outside micrometer. 2) If it exceeds the allowable limit, replace.	

5. BREAKING-IN AND PERFORMANCE CHECKS

■ **Checks before breaking-in**

After completing the disassembly, servicing and reassembly of the gear pump, check its performance in the following manner prior to putting it in service (this check is not necessary for a brand-new gear pump). If the gear pump should seize up or its internal parts wear abnormally, be sure to change all of the used hydraulic oil and clean the filter.

5-1. Breaking-in instructions

1) Before checking the performance of the gear pump (before installing on the engine), turn the pump by hand to see that it runs smoothly.
2) Run the gear pump for 10 minutes under no load with the engine at idle. (To achieve no-load running, throw the control lever to the lowest setting.)
3) Run the gear pump for 15 minutes under no load with the engine at half throttle. (approx. 1300 rpm).
4) Run the gear pump under load with the engine at high speed and actuate the relief valve 5 times (each time for 5 seconds) with a buzzing sound.

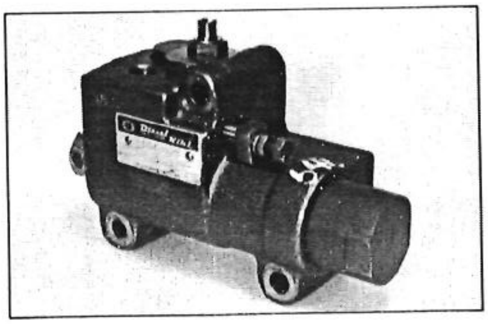
5-2. Recheck

Check the gear pump again in case its temperature rises abnormally during the braking-in.

CONTROL VALVE AND LINKAGE

1. CONSTRUCTION AND NAME OF PARTS

1-1. Control valve



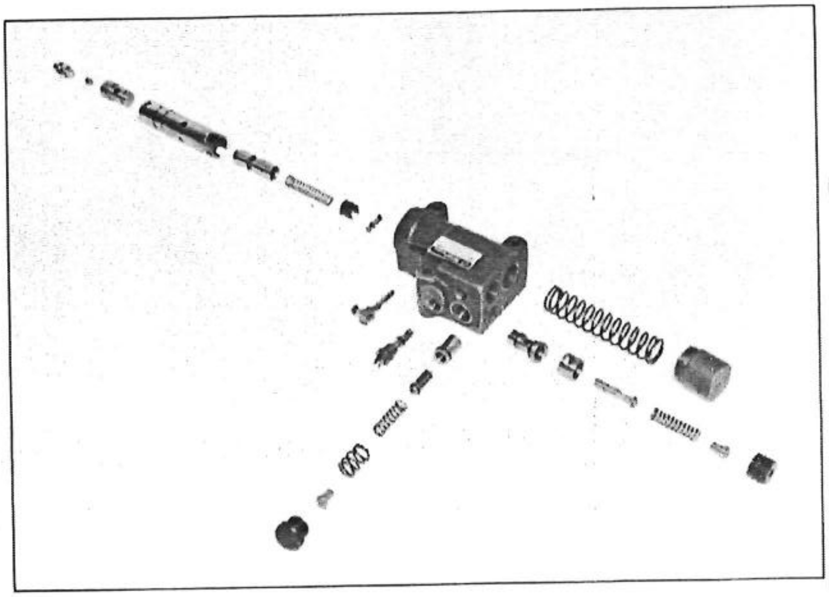
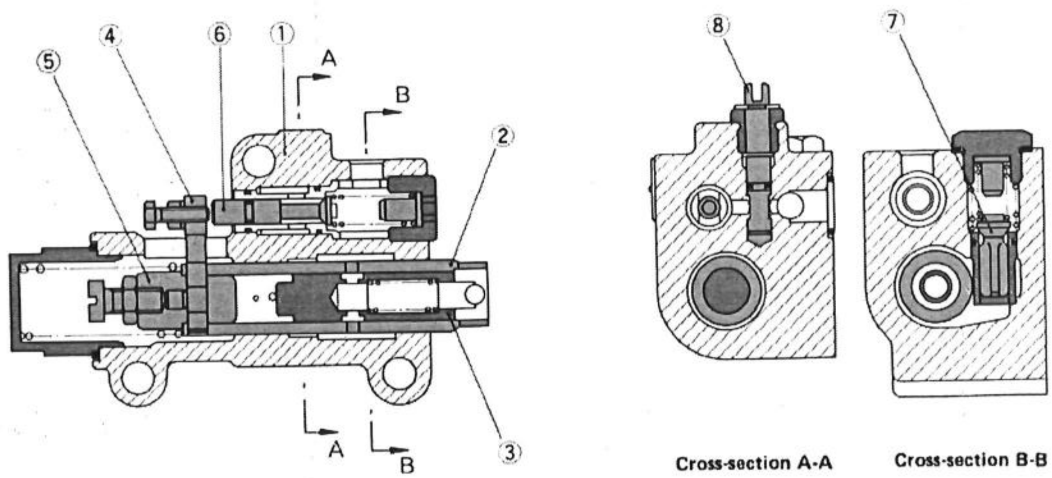


Fig.47



Cross-section A-A

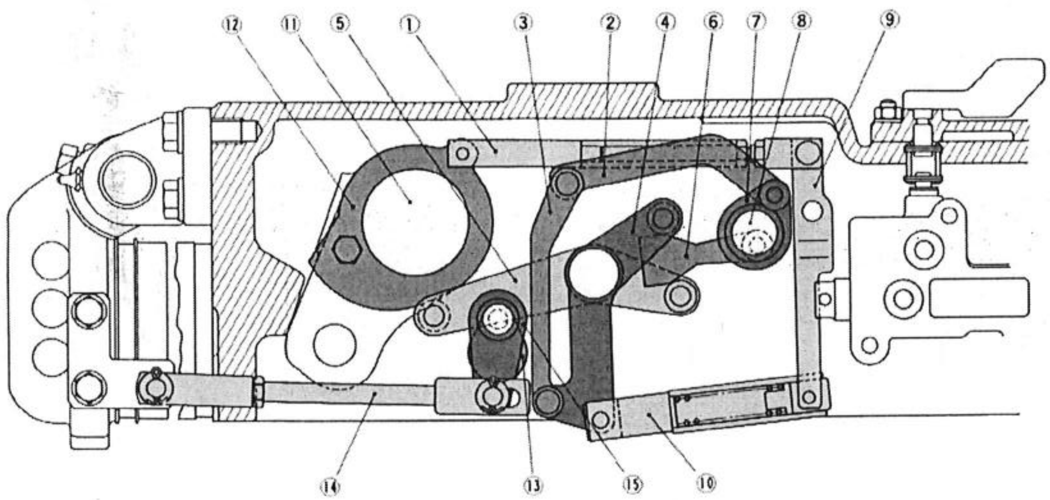
Cross-section B-B

■ **Name of Parts**

① Housing
② Pilot spool
③ Shut-off spool
④ Pin
⑤ Plug
⑥ Lowering valve
⑦ Check valve
⑧ Throttle valve

1-2. Linkage

Fig.48

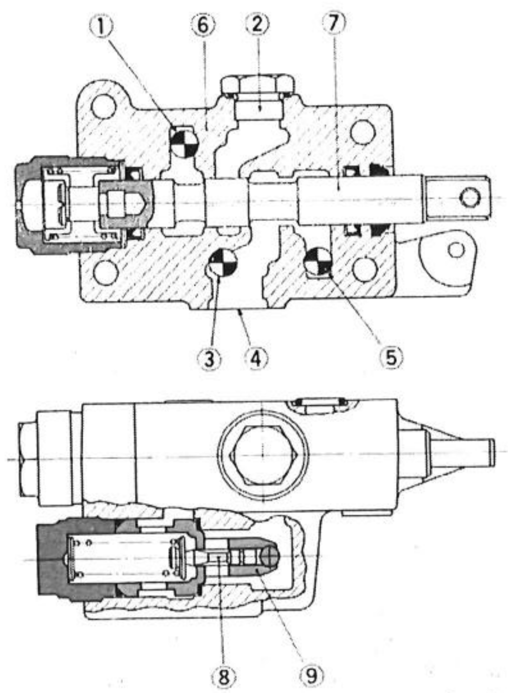


■ **Name of Parts**

1. Feedback rod
2. Draft link 1
3. Draft link 2
4. Connector
5. Position balancer
6. Position connector
7. Draft control shaft
8. Position control shaft
9. Spool retainer
10. Push rod
11. Hydraulic arm shaft
12. Position cam
13. Draft cam
14. Draft control rod
15. Draft control lever

1-3. Single-acting auxiliary control valve and relief valve

Fig. 49



■ Name of Parts

① Return port
② Cylinder port
③ Feed port for double-acting additional valve
④ Feed port
⑤ Neutral port
⑥ Housing
⑦ Spool
⑧ Relief valve
⑨ Body (relief valve)

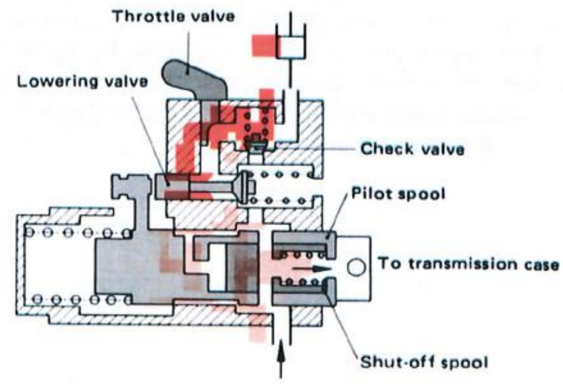
2. FUNCTION

2-1. Oil flow in control valve

(1) "NEUTRAL" POSITION

The oil forced from the hydraulic pump flows along the circumference of the pilot spool and then into the inside of the pilot spool so that the oil moves the shut-off spool to the right. Thus the motion of the shut-off spool causes the oil to return to the transmission case. The flow of oil from the hydraulic cylinder causes the check valve and the lowering valve to shut off the channels to the cylinder and the pump so that the implement is maintained at a consistent height.

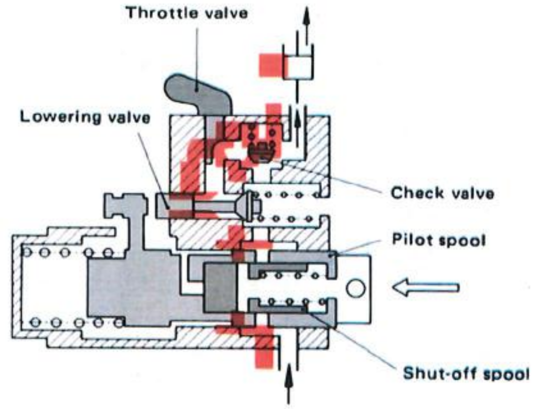
Fig.50



(2) "UP" POSITION

Setting the control lever at "UP" causes the spool retainer to depress the pilot spool and then shut off the channels from the pilot spool to the shut-off spool, so that the shut-off spool moves to the left by the force of the inside spring. As the result, the channels in the pump and transmission case are closed off. The flow of oil forced from the pump flows along the circumference of the shut-off spool and then opens the check valve. Lastly it rushes into the cylinder and causes it to lift the implement.

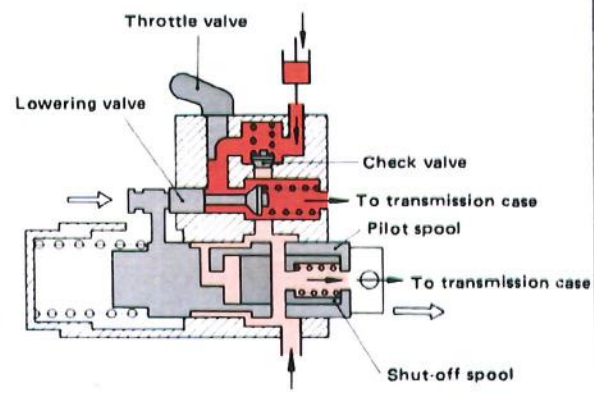
Fig.51



(3) "DOWN" POSITION

Setting the control lever at "DOWN" causes the spool return spring to push the pilot spool and lowering valve to the right. The oil from the cylinder is forced down from the lowering valve by means of the weight of the implement. The drop speed of the implement is controlled by regulating the flow rate with the throttle valve. The oil forced from the hydraulic pump returns from the inside of the shut-off spool to the transmission case.

Fig.52

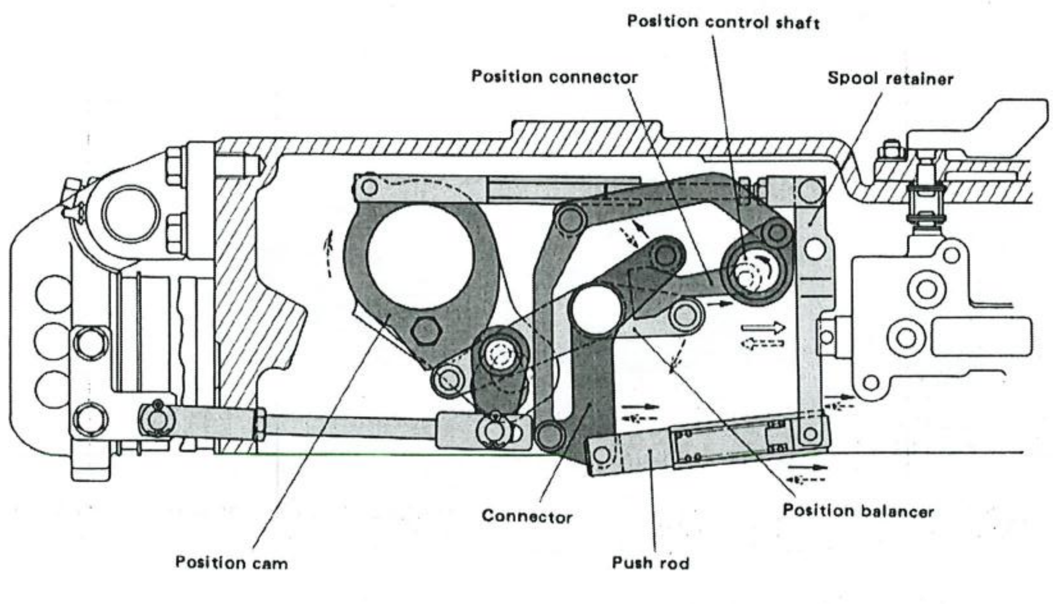


2- 2. Position control

(1) "UP" POSITION

Setting the position control lever at "UP" causes the position connector, the connector, the push rod, and the spool retainer to operate as shown by the real lines, so that the spool is pushed in to make a "UP" circuit.
When the cylinder draws in oil, the lift arm goes up and at the same time the position cam rotates to operate the position balancer, the connector, the push rod, and the spool retainer as shown by the broken lines. Whereupon, the spool is pushed out and returns to neutral by spool return spring pressure.

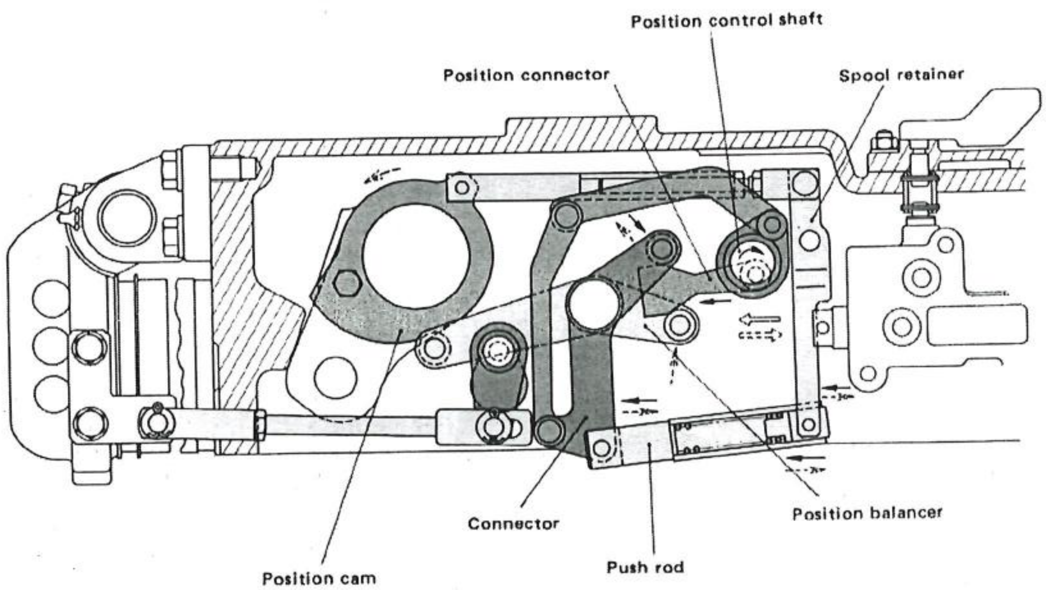
Fig.53



(2) "DOWN" POSITION

Setting the position control lever at "DOWN" causes the position connector, the connector, the push rod and the spool retainer to operate as shown by the real lines, so that the spool is pushed out by spool return spring pressure, making a "DOWN" circuit.
When the cylinder discharges oil, the lift arm goes down and at the same time the position cam rotates to operate the position balancer, the position connector, the connector, the push rod, and the spool retainer as shown by the broken lines.
Whereupon, the spool is pushed in and returns to neutral.

Fig.54

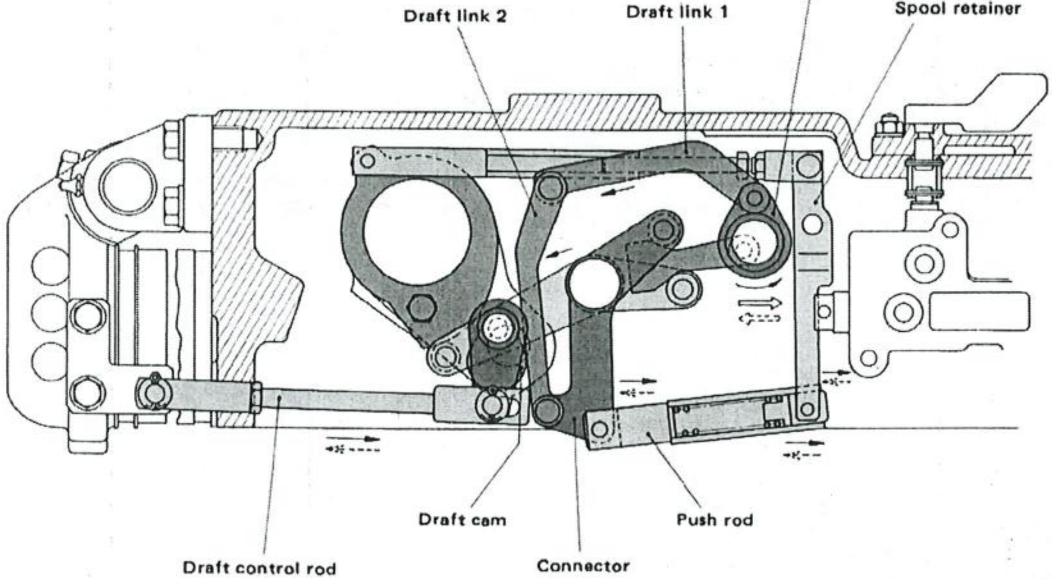


2-3. Draft control

Operating the draft control lever moves the draft link (2) into contact with the draft cam. The load the implement takes on through the top link is transmitted to the U-shape spring. The displacement of the U-shape spring so far obtained finally reaches the spool retainer by the way of the following media: the draft control rod, the draft cam, the draft link, the connector, and the push rod. As the result, the spool retainer is pushed in, making an "UP" circuit.

For this reason, the oil forced from the hydraulic pump goes into the cylinder and raises the lift arm. As the lift arm goes up, the load imposing on the top link decreases, so that the individual links move by the force of the U-shaped spring as shown by the broken lines. Thus the spool is pushed out and a "DOWN" circuit is then made. The oil in the cylinder returns to the transmission case and the lift arm goes down.

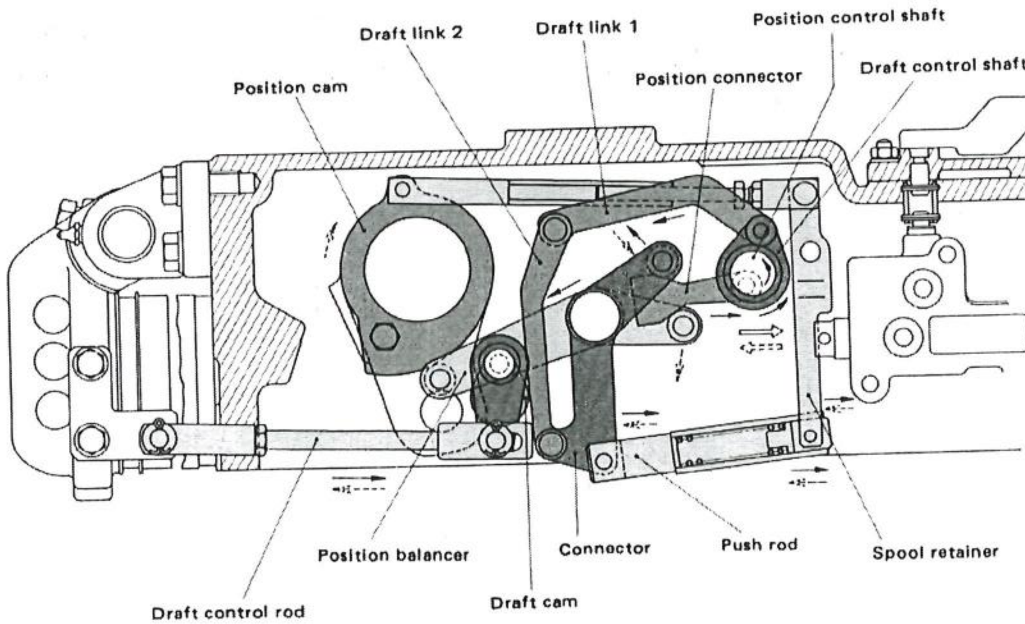
Fig.55



2-4. Mix control

Operating the position control lever moves the individual links for position control so that the lift arm goes up to a height level and stops. Next, if the draft control lever is set within the draft-responsive range, then a large load the top link takes on actuates the individual links for draft control to raise the lift arm, which then goes down as the load imposing on the top link decreases. However, the lift arm does not descend below the setting of the position control lever.

Fig.56

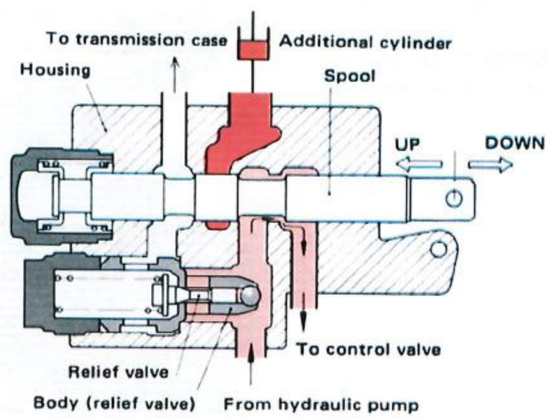


2-5. Oil flow in single-acting auxiliary control valve

(1) "NEUTRAL" POSITION

The oil forced from the hydraulic pump goes through the relief valve and along the journal of the spool, and then reaches the control valve. The oil from the hydraulic cylinder is blocked by the spool from flowing to the additional cylinder and transmission case.

Fig.57



(2) "UP" POSITION

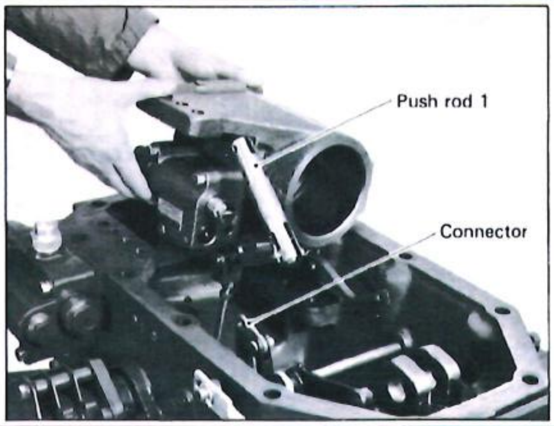
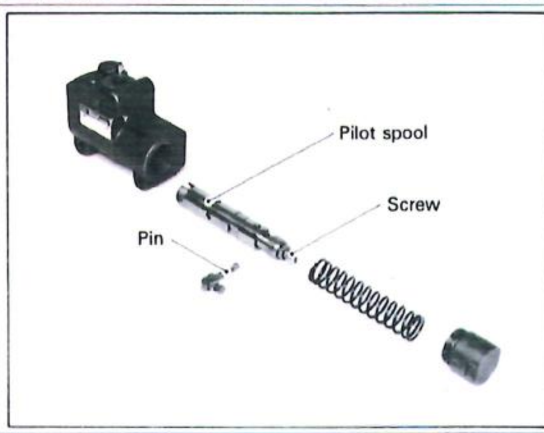
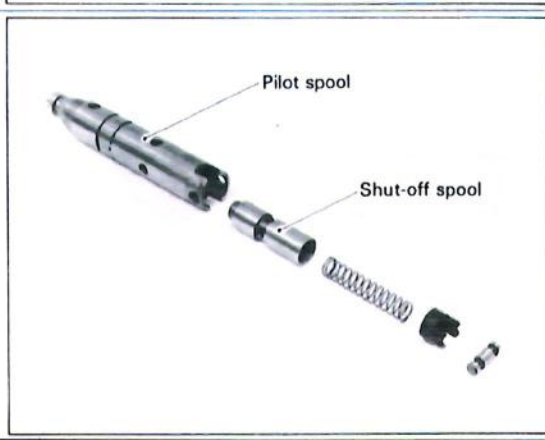
Operating the auxiliary control lever at "UP" causes the spool to move to the left so that the oil forced from the pump passes along the journal of the spool and then goes into the cylinder.
However, if the cylinder undergoes a great load (more than 17.2 MPa, 175 kgf/cm^2, 2,488.5 lb./sq.in.), then the relief valve will open to divert the oil to the transmission case. When the auxiliary control lever is released, the spool returns to neutral by spring pressure.

(3) "DOWN" POSITION

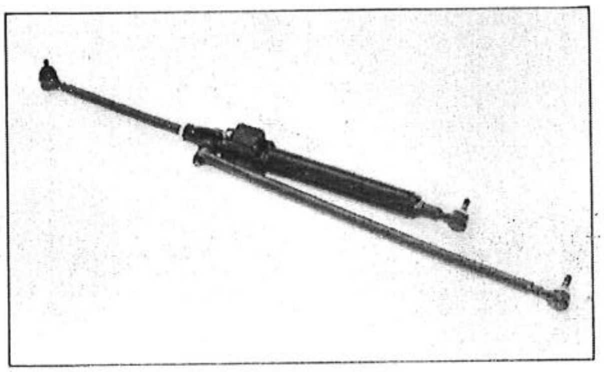
Operating the auxiliary control lever at "DOWN" causes the spool to move to the right so that the oil in the cylinder diverts to the transmission case. The oil forced from the hydraulic pump flows into the control valve.

3. DISASSEMBLY

3-1. Control valve

Item	Location	Bolts and nuts	Tools
Disassembly (1) Control valve removal		 M10x16 .... 1 M10x22 .... 1 M12x40 .... 3 M12x75 .... 3 M8 x 55 .... 3 M6 ..... 1 $\phi 6 \times 25$ 1	 12 14 17
Disassembly (2) Pilot spool			 30 13
Disassembly (3) Shut-off spool			

1. CONSTRUCTION AND NAME OF PARTS



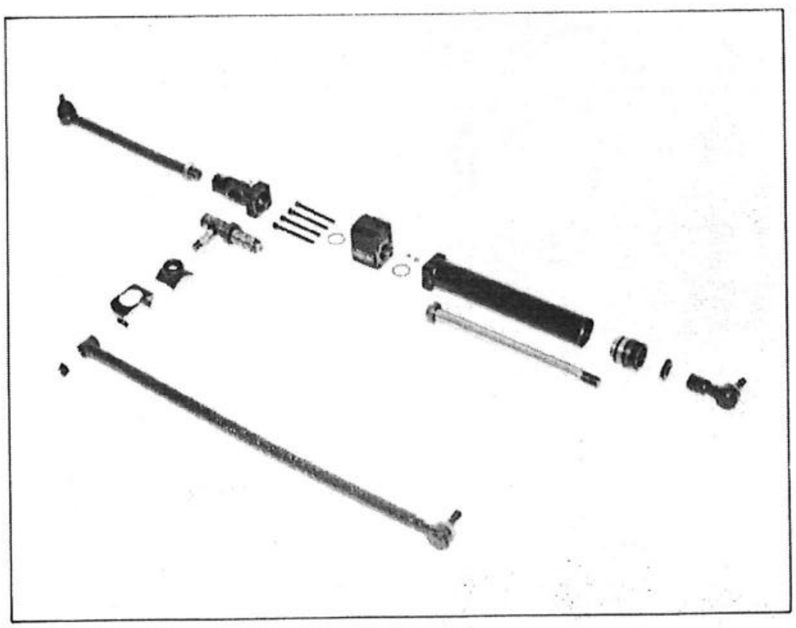
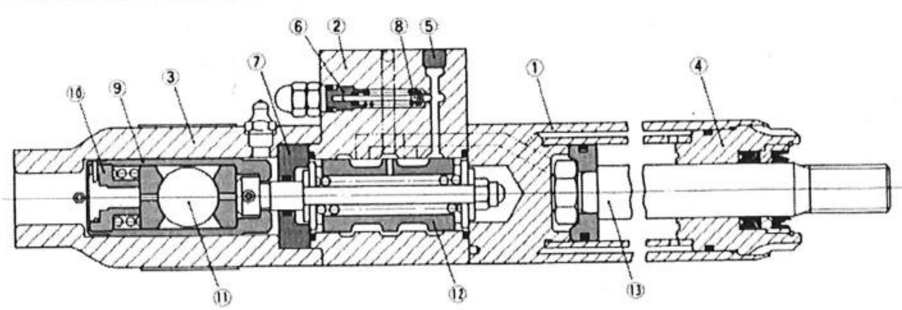


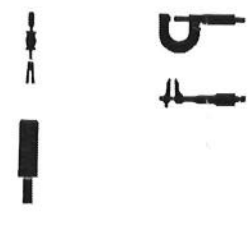
Fig. 65

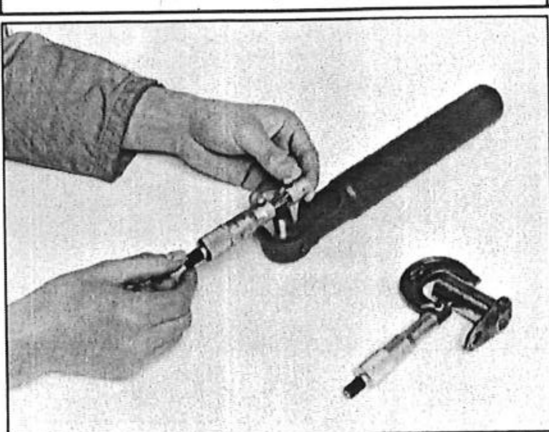
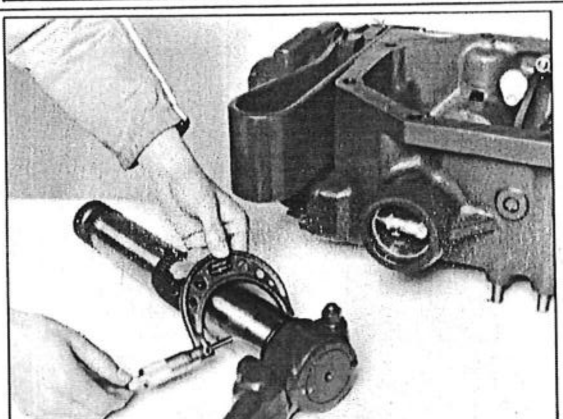
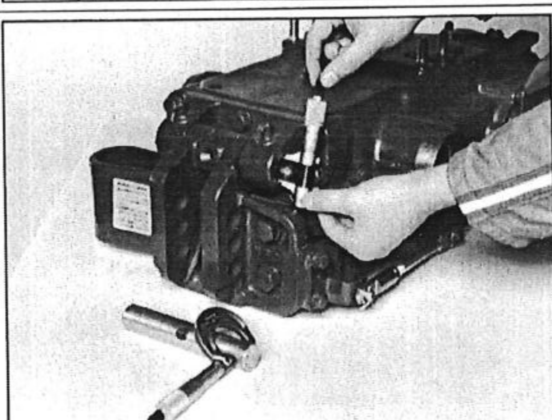
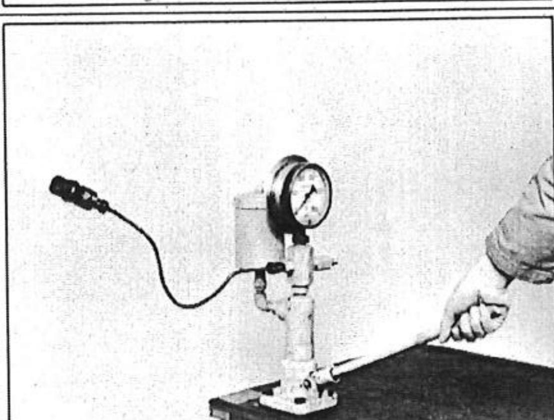


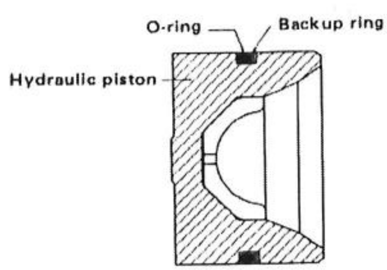
■ **Name of Parts**

1 Cylinder assembly
2 Valve housing
3 Shifter housing
4 Box
5 Plug
6 Adjuster
7 Cap
8 Plunger
9 Sleeve
10 Screw
11 Stud
12 Spool valve
13 Piston and rod assembly

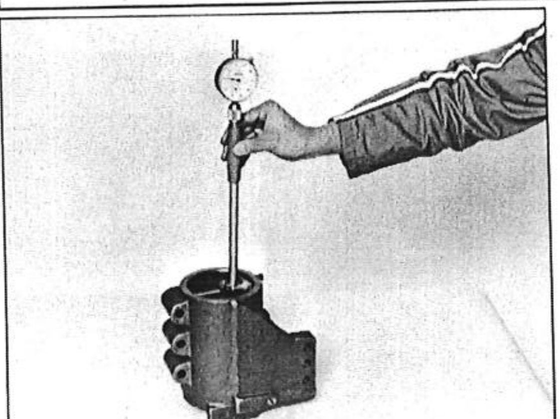
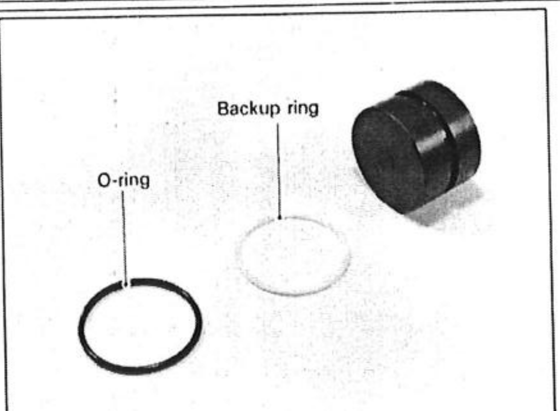
POWER STEERING BOOSTER

<table>
<tr><th>Tools and test instruments</th><th>Procedure</th><th>Remarks</th></tr>
<tr><td></td><td>1) Measure the set pin hole of the hydraulic piston rod with an inside micrometer.
2) Measure the set pin diameter with an outside micrometer, and obtain the clearance between the set pin hole and the set pin.
3) If the clearance exceeds the allowable limit, replace the set pin and the piston rod.</td><td><table>
<tr><td>I.D. of piston rod hole</td><td>22.020 to 22.072mm
0.8669 to 0.8690in.</td></tr>
<tr><td>O.D. of set pin</td><td>21.979 to 22.000mm
0.8653 to 0.8661in.</td></tr>
</table></td></tr>
<tr><td></td><td>1) Measure the outside diameter of the hydraulic arm shaft an outside micrometer.
2) Measure the inside diameter of the bushing, and obtain the clearance between the shaft and the bushing.
3) If the clearance exceeds the allowable limit, replace the bushing.</td><td><table>
<tr><th></th><th>Left</th><th>Right</th></tr>
<tr><td>O.D. of hydraulic arm shaft</td><td>49.975 to 50.000mm
1.9675 to 1.9685in.</td><td>54.970 to 55.000mm
2.1642 to 2.1654in.</td></tr>
<tr><td>I.D. of bushing</td><td>50.125 to 50.195mm
1.9734 to 1.9762in.</td><td>55.210 to 55.240mm
2.1736 to 2.1748in.</td></tr>
</table>
(When reassembling)
• After driving the bushing in, ream it.</td></tr>
<tr><td></td><td>1) Measure the diameter of the top link bracket shaft with an outside micrometer.
2) Measure the inside diameter of the bushing, and obtain the clearance between the shaft and the bushing.
3) If the clearance exceeds the allowable limit, replace the bushing.</td><td><table>
<tr><td>O.D. of top link bracket shaft</td><td>24.939 to 24.960mm
0.9819 to 0.9827in.</td></tr>
<tr><td>I.D. of bushing</td><td>25.020 to 25.071mm
0.9850 to 0.9870in.</td></tr>
</table>
(When reassembling)
• After driving the bushing in, ream it.</td></tr>
<tr><td>
Adapter</td><td>1) Attach the cylinder safety valve to a nozzle tester.
2) Apply increasing pressure up to the specified pressure (19.6 MPa., 200 kgf/cm^2, 2,844 lb./sq.in.).
3) Check to see if pressure drops below 9.8 MPa. (100 kgf/cm^2, 1,422 lb./sq.in.) in 6 seconds.
4) If pressure drops below 9.8 MPa. (100 kgf/cm^2, 1,422 lb./sq.in.), replace the cylinder safety valve.</td><td></td></tr>
</table>

Item	Location	Reference value
Servicing (3) Hydraulic piston rod (clearance between set pin hole and set pin)		• **Reference value** 0.020 to 0.093mm 0.0008 to 0.0037in. • **Allowable limit** 0.4mm 0.0157in.
Servicing (4) Clearance between hydraulic arm shaft and bushing		• **Reference value** (Right) 0.210 to 0.270mm 0.0083 to 0.0106in. (Left) 0.125 to 0.220mm 0.0049 to 0.0087in. • **Allowable limit** 0.5mm 0.0197in.
Servicing (5) Clearance between top link bracket shaft and bushing		• **Reference value** 0.06 to 0.132mm 0.0024 to 0.0052in. • **Allowable limit** 0.4mm 0.0157in.
Servicing (6) Oil-tightness of cylinder safety valve		• **Reference value** Pressure drop falls below 9.8 MPa.(100 kgf/cm², 1422 lb./sq.in.) 6 seconds after pressure is applied to 19.6 MPa.(200 kgf/cm², 2844 lb./sq.in.).

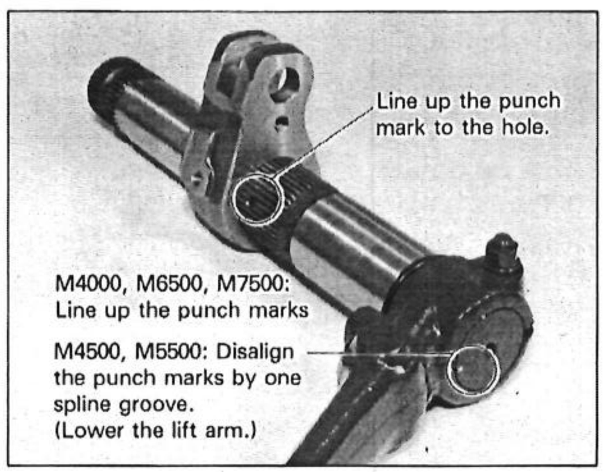
Tools and test instruments	Procedure	Remarks
	1) Measure the inside diameter of the cylinder with a cylinder gauge. 2) Check to see if the inside of the cylinder is flawed. 3) If flaw and wear exceed the allowable limit, replace the cylinder.	• Flaw check (visually) Depth ....0.50 mm (0.0197 in.) or less Width ....0.10 mm (0.0039 in.) or less Especially be careful of vertical flaws.
	1) Rinse the disassembled parts with light oil. 2) Dry them out with a high-pressure blast and check them visually. 3) Replace if heavily damaged.	Fig.63 Fitting direction of the backup rings  Fig.64 Backup ring arrangement 

3. SERVICING

Item	Location	Reference value
Servicing (1) Wear and flaw of hydraulic cylinder		see table below
Servicing (2) Flaw and distortion of piston, O-ring and backup ring	 	• **Reference value** Replace if heavily flawed.

Servicing (1) reference values:

	Reference value	Allowable limit
M4000 M4500 M5500	90.036 to 90.071 mm 3.5447 to 3.5461 in.	90.15 mm 3.5492 in.
M6500 M7500	95.036 to 95.071 mm 3.7416 to 3.7430 in.	95.15 mm 3.7461 in.

Procedure	Remarks
1) Introduce high-pressure air into the hydraulic piston head and take off the hydraulic piston. 2) Remove the cylinder safety valve.	• For the removal of the hydraulic cylinder liner, see Disassembly (1) page on 252.
1) Remove the lift arm (right). 2) Remove the hydraulic arm set bolts. 3) Remove the hydraulic arm shaft, the distance collar, and the O-ring.	(When reassembling) 

2. DISASSEMBLY

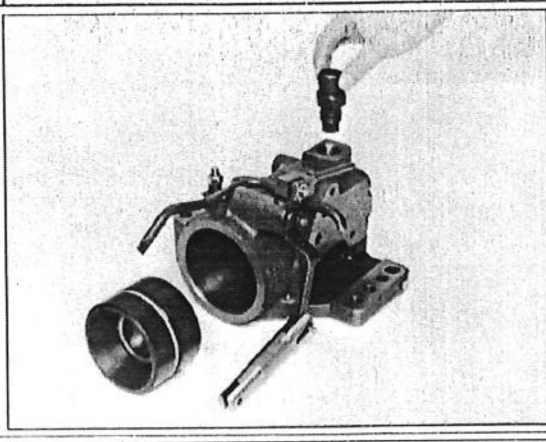
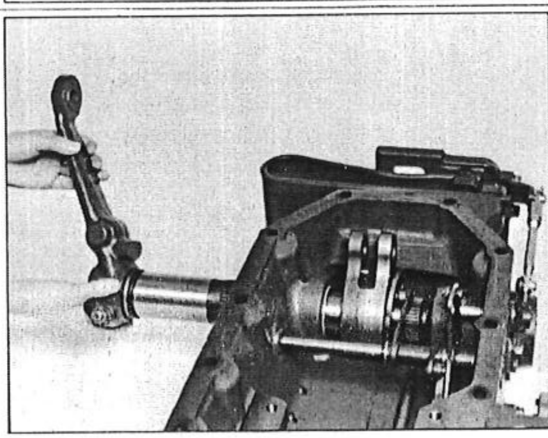
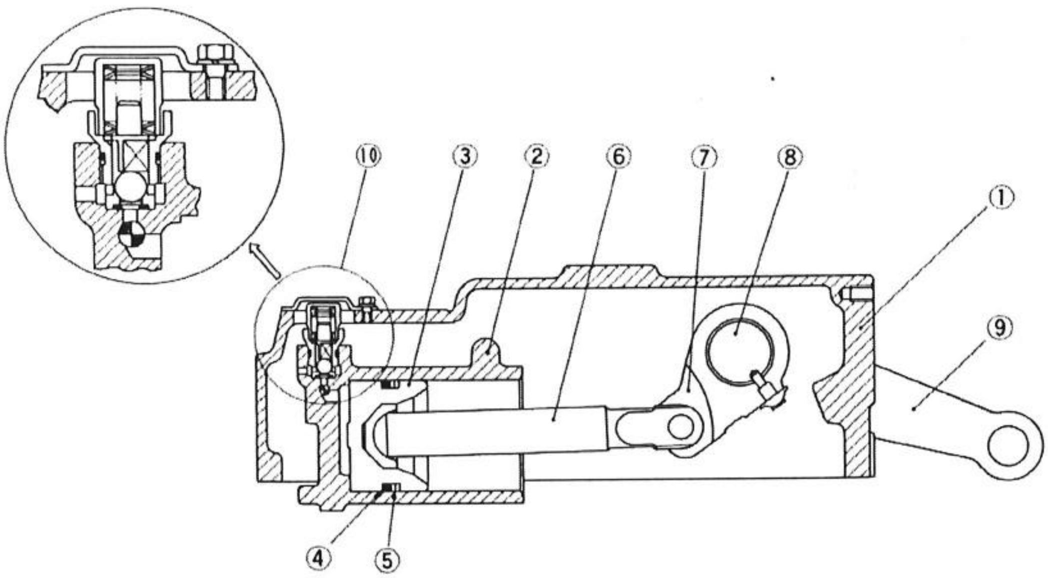
Item	Location	Bolts and nuts	Tools
Disassembly (1) Hydraulic piston, Cylinder safety valve			30
Disassembly (2) Hydraulic arm shaft		M12x80 .... 1 .... 1 Special bolt 1	12 17

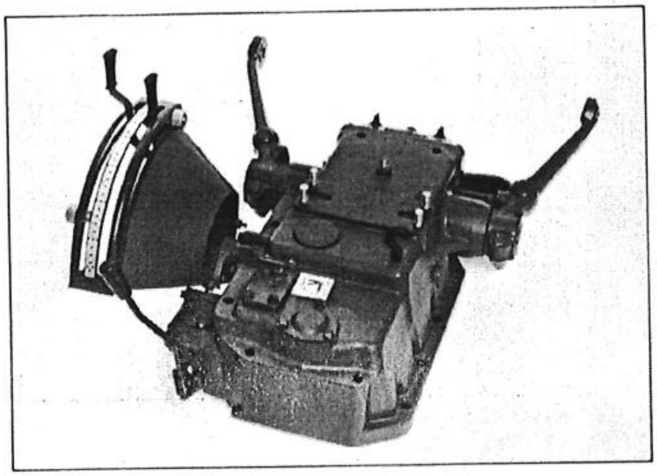
Fig. 62

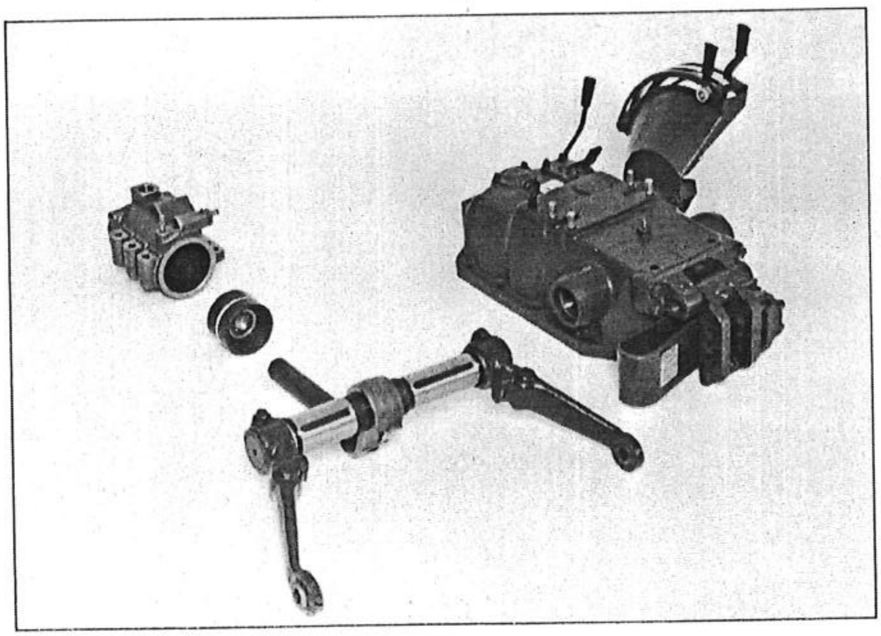


■ Name of Parts

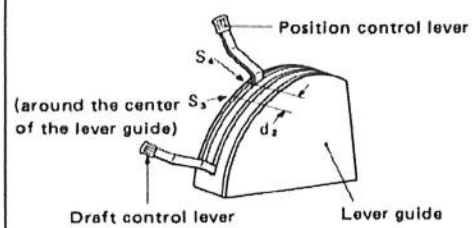
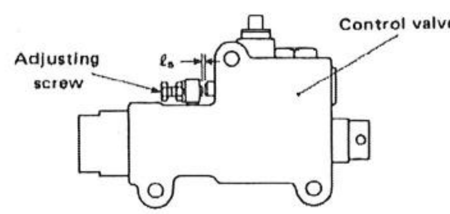
1 Hydraulic cylinder body
2 Hydraulic cylinder liner
3 Hydraulic piston
4 O-ring
5 Backup ring
6 Hydraulic piston rod
7 Hydraulic arm
8 Hydraulic arm shaft
9 Lift arm
10 Cylinder safety valve

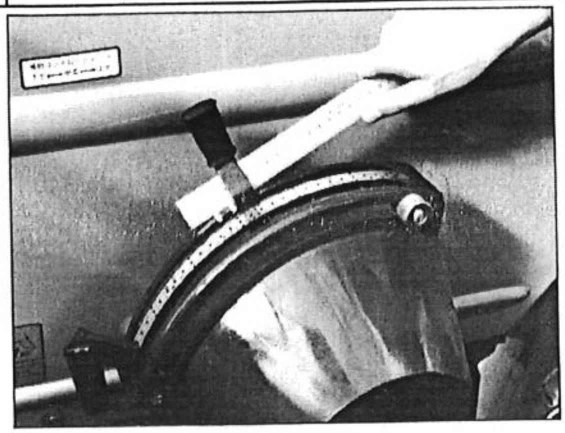
1. CONSTRUCTION AND NAME OF PARTS

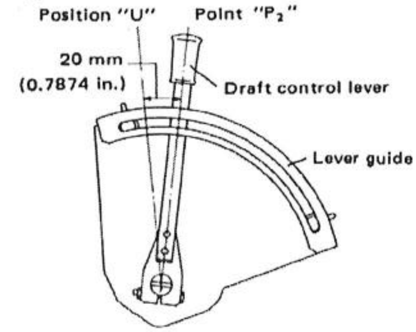


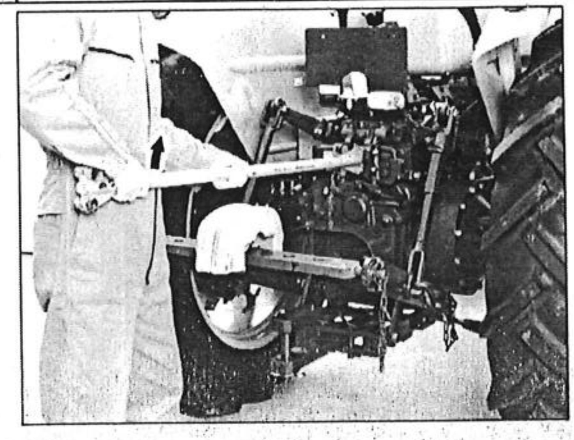
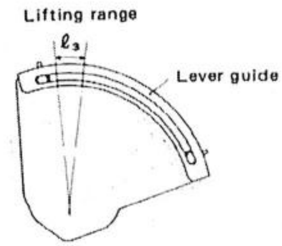
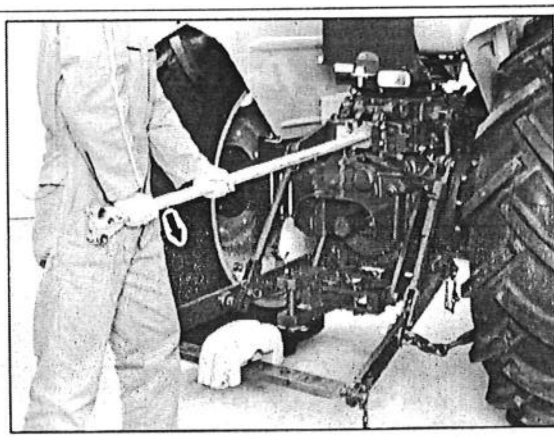
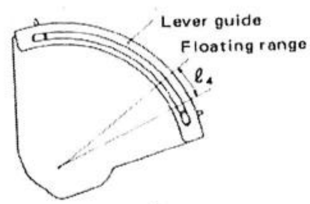


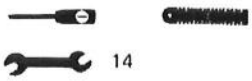
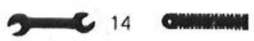
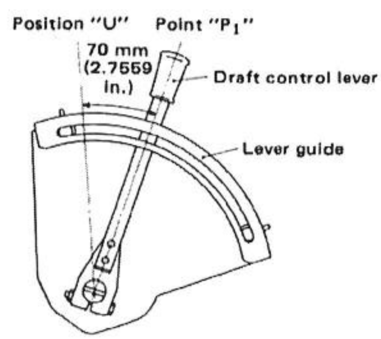
HYDRAULIC CYLINDER

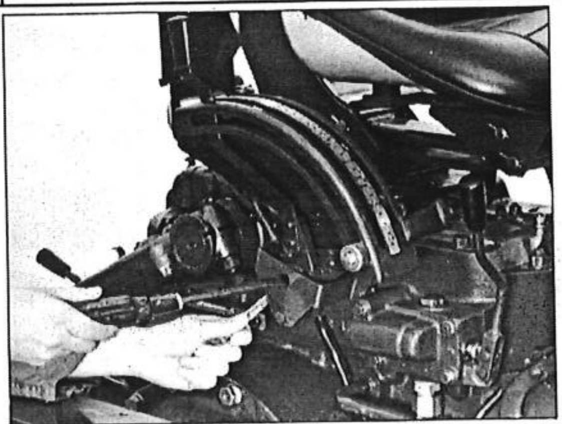
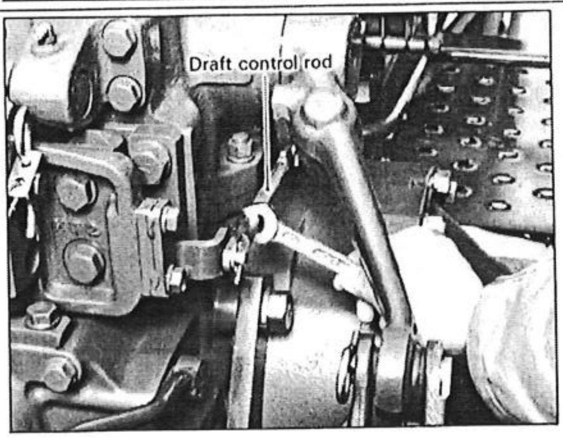
Tools and test instruments	Procedure	Remarks
	1) Lower the draft control lever all the way down. 2) Throw the position control lever all the way up and then lower it down to the center of the lever guide. As shown in fig. 61, mark the lever position with S_3. 3) Stop the lever at S_3 for approx. 10 seconds. Then slowly operate it upward until the lift arm begins to rise. Mark the lever position S_4 where the lift arm begins to rise. 4) Measure the offset d_2 of S_3 from S_4 so far obtained at (2) and (3) above. 5) If d_2 exceeds 16 mm (0.6299 in.), reduce the gap ℓ_5 with the adjusting screw. 6) If d_2 falls below 13 mm (0.5118 in.), increase the gap ℓ_5 with the adjusting screw.	(When adjusting) • Engine speed: medium speed • Attach a weight of approx. 490.3 N. (50 kgf., 110.3 lb.) to the end of the lower link. Fig.61  

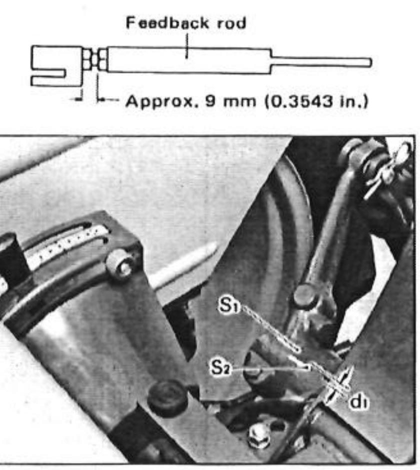
Item	Location	Reference value
Adjustment (7) Sensitivity adjustment		• **Reference value** Adjust the gap ℓ_s with the adjusting screw to a point where d_2 is 13 to 16 mm (0.5118 to 0.6299in.).

Tools and test instruments	Procedure	Remarks
14 Test bar	1) Set the draft control lever at "P_2" approx. 20 mm (0.7874 in.) below the "U" position. (See Fig. 60.) 2) Attach a test bar to the top link bracket and raise it until the top link bracket comes in contact with the lock bracket. 3) In so doing, check to see that the lift arm does not drop. 4) If the lift arm drops at this point, lengthen the draft control rod.	(When adjusting) • Engine speed: 1,000 to 1,200 rpm • Attach a weight of approx. 490.3 N· (50 kgf., 110.3 lb.) to the end of the lower link. Fig.60 
14 Test bar	1) Lower the draft control lever all the way down. 2) Attach a test bar to the top link bracket and press the test bar downward until the spring is fully compressed. 3) Slowly throw the draft control lever up until the lift arm begins to rise. At this point, measure the travel distance (ℓ_4) of the control lever on the lever guide. 4) If ℓ_4 falls below 20 mm (0.7874 in.), lengthen the draft control rod. 5) If ℓ_4 falls above 40 mm (1.5748 in.), shorten the draft control rod.	(When adjusting) • Engine speed: 1,000 to 1,200 rpm • Attach a weight of approx. 490.3 N· (50 kgf., 110.3 lb.) to the end of the lower link.

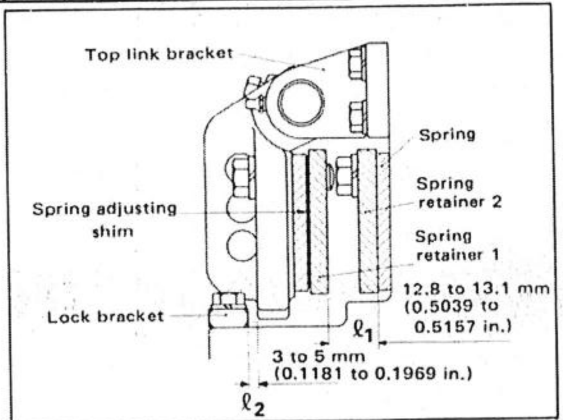
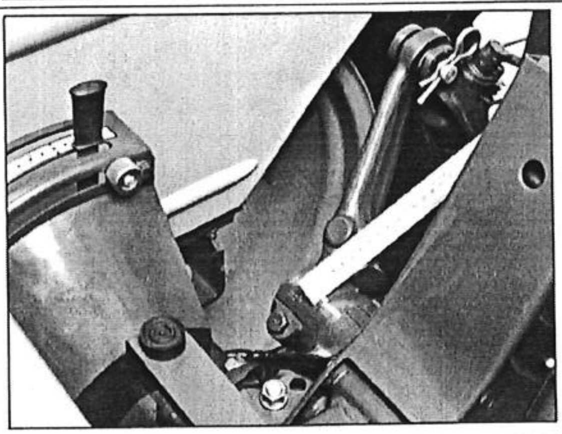
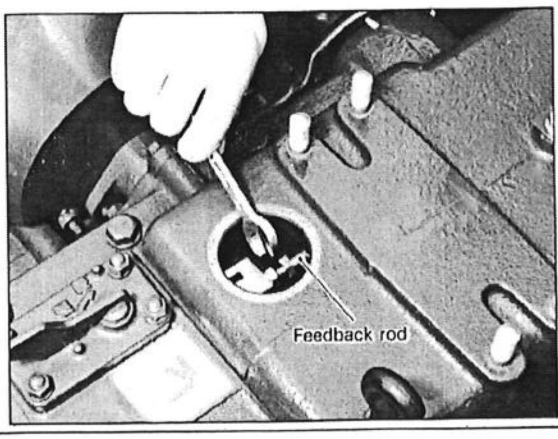
Item	Location	Reference value
Adjustment (5) Lifting range check		• **Reference value** The lift arm should not drop when the draft control lever is placed at the P_1 point about 20mm (0.7874in.) below the "U" point and then the top link bracket is pulled downward until it comes in touch with the lock bracket. Lifting range ℓ_3 = approx. 20mm (0.7874in.) 
Adjustment (6) Floating range check		• **Reference value** Floating range ℓ_4 = approx. 20 to 40mm (0.7874 to 1.5748in.). 

Tools and test instruments	Procedure	Remarks
 14	1) Set the draft control lever at "DOWN" and the position control lever at "UP". 2) Turn the position control shaft with a regular screwdriver so that the offset d_1 (S_1 to S_2) obtained at Adjustment (2)-3) may fall between 3 and 4 mm (0.1181 and 0.1575 in.). 3) Secure the position control lever and the position control shaft with a set bolt.	(When adjusting) • Engine speed: 1,000 to 1,200 rpm • Attach a weight of approx. 490.3 N. (50 kgf., 110.3 lb.) to the end of the lower link.
 14	1) Repeat Adjustment (2) and confirm the length of the feedback rod. 2) Temporarily adjust the length of the draft control rod to approx. 180 mm (7.0866 in.). 3) Set the draft control lever at "P_1" 70 mm (2.7559 in.) below the "U" position. (See Fig. 59.) 4) Adjust the length of the draft control rod to a point where the lower link begins to rise. 5) After adjustment, be sure to proceed with Adjustments (5) and (6) on the next page.	(When adjusting) • Engine speed: 1,000 to 1,200 rpm • Attach a weight of approx. 490.3 N. (50 kgf., 110.3 lb.) to the end of the lower link. Fig.59 

Item	Location	Reference value
Adjustment (3) Position control lever		• **Reference value** Secure the position control lever to the position control shaft so that d_1 may be 3 to 4mm (0.1181 to 0.1575in.).
Adjustment (4) Draft control rod		• **Reference value** Adjust the length of the draft control rod to a point where the lower link begins to rise when the draft control lever is placed at the P_1 point about 70mm (2.7559in.) below the "U" point.

Tools and test instruments	Procedure	Remarks
17 19	1) Measure the gap (ℓ_1) between the spring and the spring retainer. If the measurement deviates from the reference value, execute shim adjustment. 2) Measure the gap (ℓ_2) between the top link bracket and the lock bracket. If the measurement deviates from the reference value, adjust the gap by varying the lock bracket.	
14 A weight of 490.3N. (50kgf., 110.3lb.)	1) Adjust the length of the feedback rod to approx. 9 mm (0.3543 in.) (Fig. 58.). 2) Start the engine and run it at 1,000 to 1,200 rpm. 3) Attach a weight of approx. 490.3 N· (50 kgf., 110.3 lb.) to the end of the lower link. 4) Raise the lift arm all the way up by hand and then mark the hydraulic cylinder and the lift arm with S_1 and S_2 respectively. 5) Set the draft control lever at "UP". 6) Measure the offset d_1 of S_1 from S_2 obtained at (4) above. 7) If the offset d_1 does not reach the reference value, adjust the length of the feedback rod.	Fig.58 

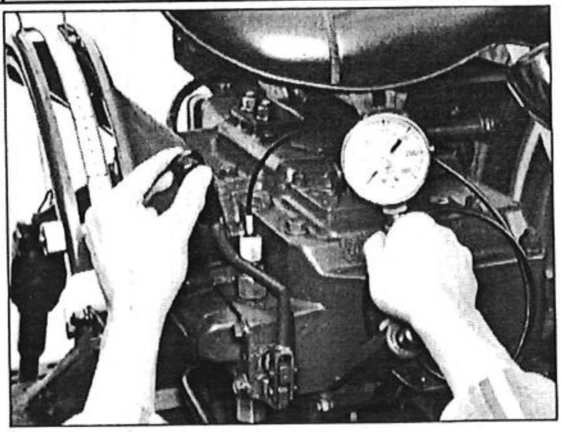
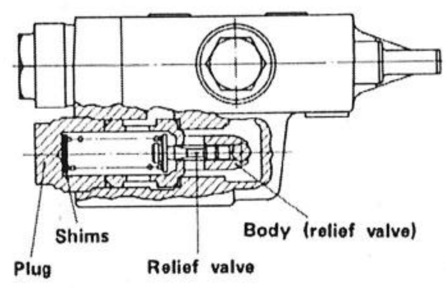
5-2. Hydraulic control adjustment (Adjust in the sequence noted below)

Item	Location	Reference value
Adjustment (1) Top link bracket		• **Reference value** ℓ_1 = 12.8 to 13.1mm 0.5039 to 0.5157 in. ℓ_2 = 3 to 5mm 0.1181 to 0.1969in.
Adjustment (2) Feedback rod	 	• **Reference value** Adjust the length of feedback rod so that d_1 may be 3 to 4mm (0.1181 to 0.1575in.).

Tools and test instruments	Procedure	Remarks
 22  Seal tape	1) Remove the plug from the auxiliary control valve and attach a pressure gauge to the plug hole (apply a strip of sealing tape to the thread to prevent oil leakage). 2) Start the engine and accelerate the speed to the maximum. Then throw the auxiliary control lever to "UP". Read the pressure gauge dial when the relief valve starts to buzz. 3) When the reading is below 16.7 MPa. (170 kgf/cm^2, 2,417.4 lb./sq.in.): Remove the plug from the relief valve and add a shim. Shim thickness: 0.25 mm (0.0098 in.), 0.50 mm (0.0197 in.), 2.50 mm (0.0984 in.) 4) When the reading is above 17.7 MPa. (180 kgf/cm^2, 2,559.6 lb./sq.in.): Reduce shim thickness. Note that if the hydraulic pump should operate at more than 17.7 MPa. (180 kgf/cm^2, 2,559.6 lb./sq.in.), it will lead to damage to the pump.	(Precaution for resetting the relief valve) • The need for resetting the relief valve is strictly limited to occasions where it is replaced or the lift capacity drops. Absolutely do not reset it on other occasion.

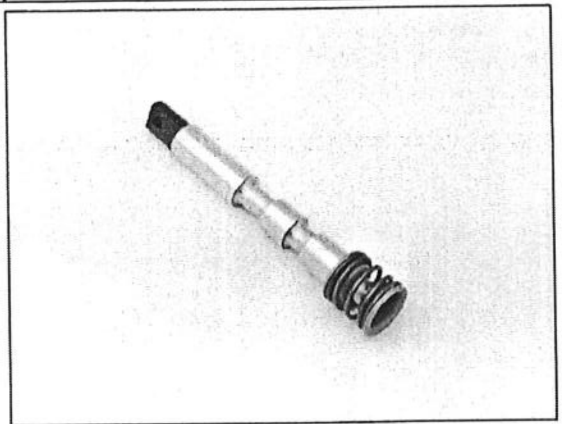
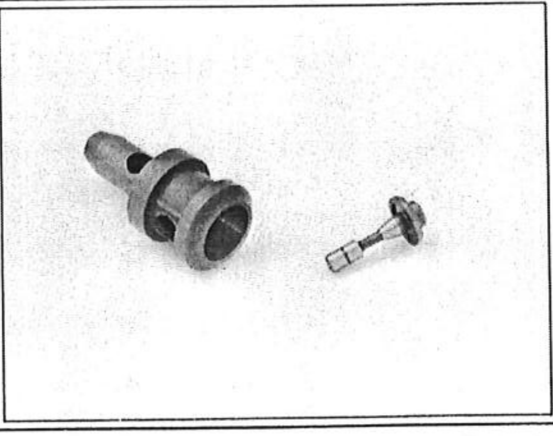
5. ADJUSTMENT

5-1. Resetting the relief valve

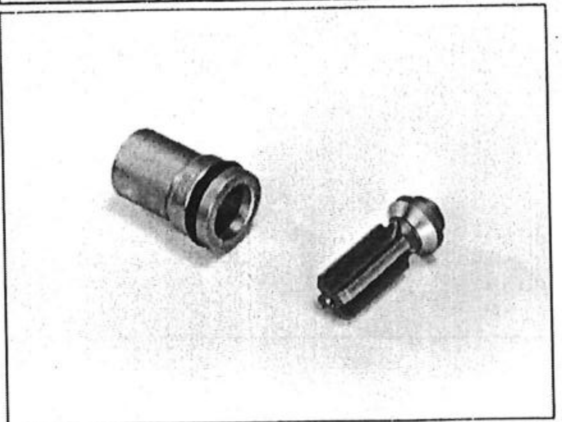
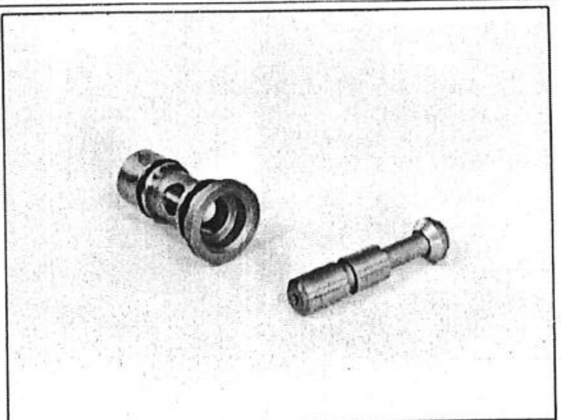
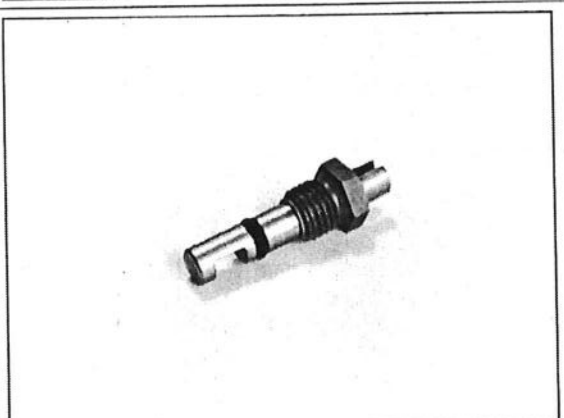
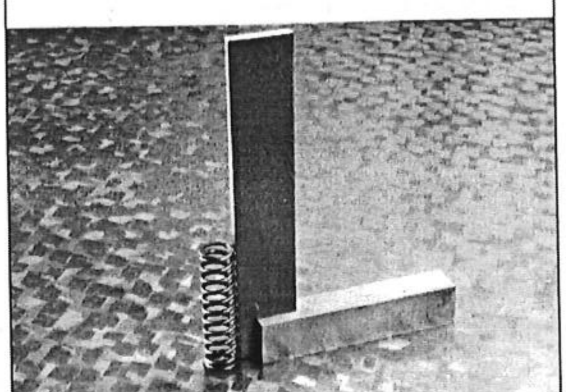
Item	Location	Reference value
Adjustment (1) Setting of relief valve	  	• **Reference value** 16.7 to 17.7 MPa 170 to 180 kgf/cm^2 2,417.4 to 2,559.6lb./sq.in.

Tools and test instruments	Procedure	Remarks
	1) Rinse the parts with light oil. 2) Dry out them with a high-pressure blast and check them visually.	• Check the dust seal and the oil seal in the housing.
	1) Rinse the parts with light oil. 2) Dry out them with a high-pressure blast and check visually.	• Check the O-ring and the spring.

4- 2. Single-acting auxiliary control valve

Item	Location	Reference value
Servicing (1) Spool flaw		• **Reference value** All the surface is free of burrs, scratches and nickes.
Servicing (2) Contact between relief valve and seat		• **Reference value** Seat is not scored.

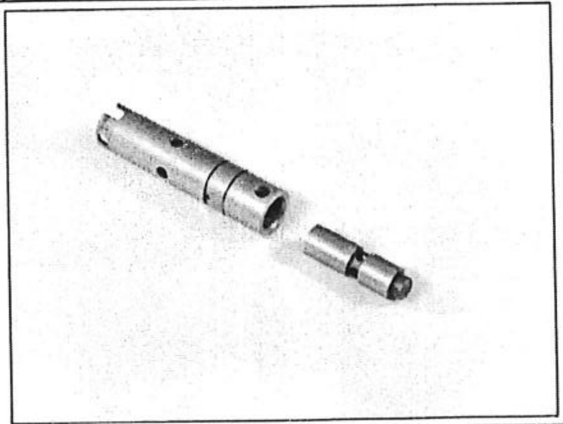
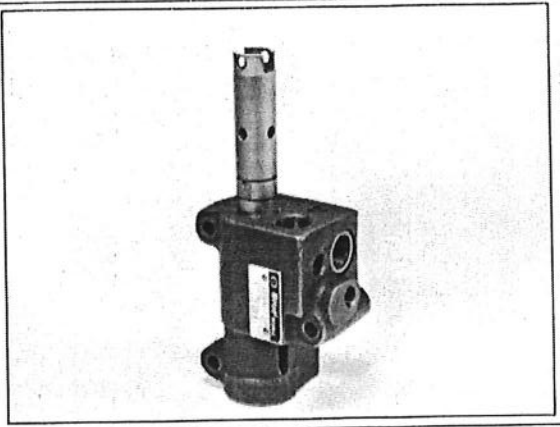
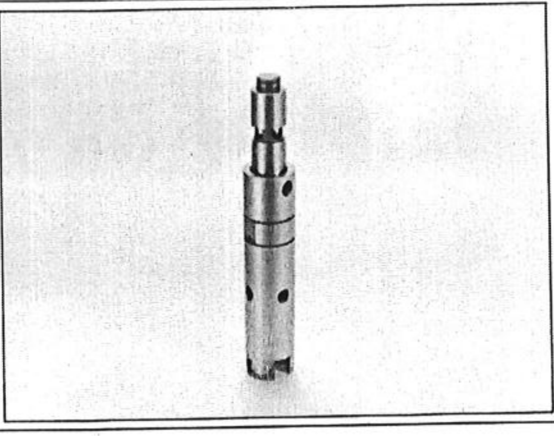
Tools and test instruments	Procedure	Remarks
	1) Rinse the disassembled parts with light oil. 2) Dry out the parts with a high-pressure blast and then check them visually.	• Check the O-rings in the plug and bushing.
	1) Rinse the parts with light oil. 2) Dry out them with a high-pressure blast and then check them visually.	• Check the O-ring in the lowering valve.
	1) Rinse the parts with light oil. 2) Dry out them with a high-pressure blast and check them visually.	• Check the O-ring in the throttle valve.
	1) Place the spring on a surface plate and place a square along the length of the spring. Check to see that the square is in contact with the entire length of the spring.	

Item	Location	Reference value
Servicing (4) Contact between check valve and bushing		• Reference value Seat is not scored.
Servicing (5) Contact between lowering valve and seat		• Reference value Seat is not scored.
Servicing (6) Throttle valve flaw		• Reference value All the surface is free of burrs, scratches and nickes.
Servicing (7) Breakage and distortion of spring		• Reference value Squareness Less than 3% of the free length

Tools and test instruments	Procedure	Remarks
	1) Rinse the disassembled parts with light oil. 2) Dry out the parts with a high-pressure blast and check visually.	
	1) Rinse the disassembled parts with light oil. 2) Set the valve body upright and insert the spool into it a little. 3) Check to see if the spool slides smoothly by itself.	
	1) Rinse the disassembled parts with light oil. 2) Set the pilot spool upright and then insert the shut-off spool into it a little. 3) Check to see if the shut-off spool slides smoothly by itself.	

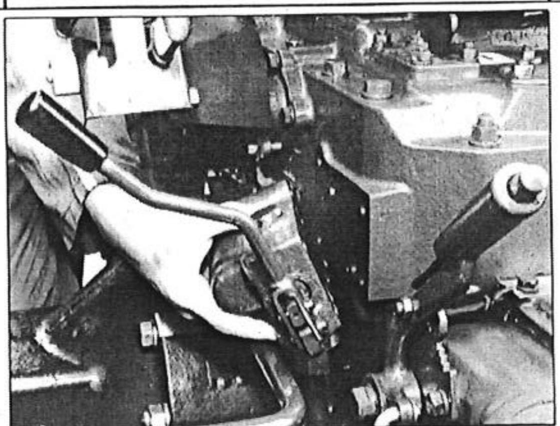
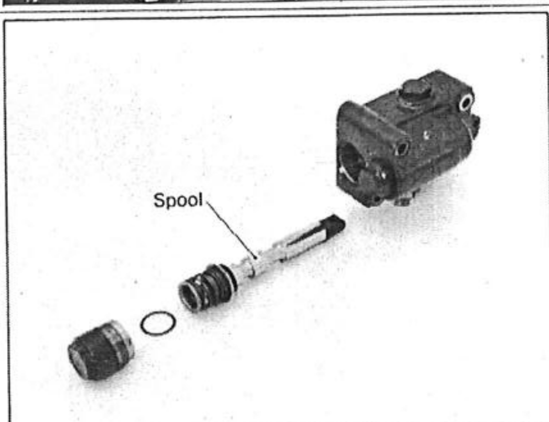
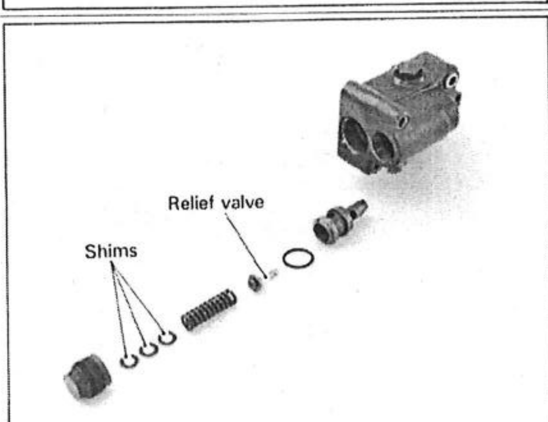
4. SERVICING

4-1. Control valve

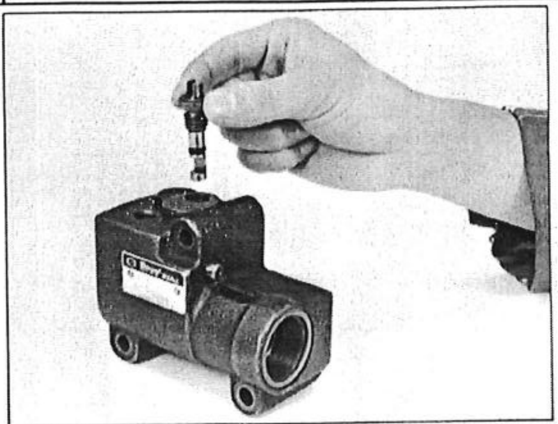
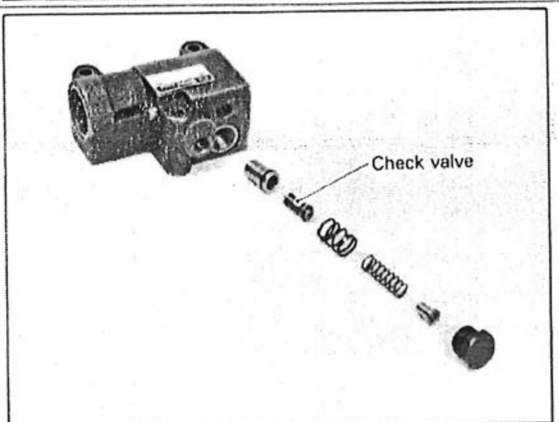
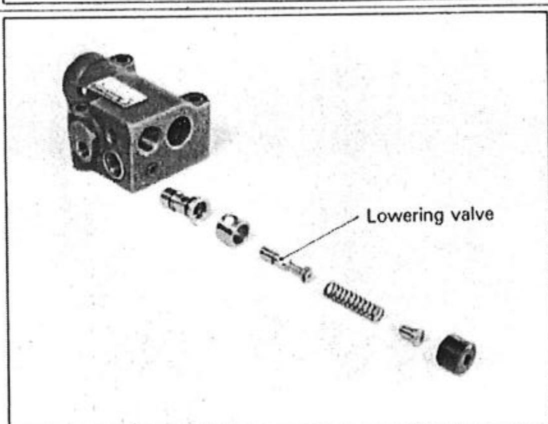
Item	Location	Reference value
Servicing (1) Flaws of pilot spool and shut-off spool		• **Reference value** All the surface is free of burrs, scratches and nickes.
Servicing (2) Checking the pilot spool for sliding motion		• **Reference value** Slide down by itself.
Servicing (3) Checking the shut-off spool for sliding motion		• **Reference value** Slide down by itself.

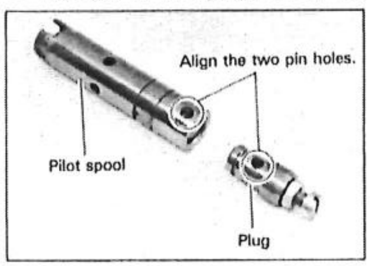
Procedure	Remarks
1) Unbolt and remove the auxiliary control valve.	(When reassembling) • Be careful not to drop or damage the O-ring and backup ring.
1) Remove the auxiliary control lever. 2) Remove the cap nut. 3) Pull off the spool.	(When reassembling) • Be careful not to drop or damage the shim in the cap.
1) Remove the plug. 2) Remove the spring. 3) Remove the relief valve.	(When reassembling) • Be careful not to damage the O-ring in the plug. • Be careful not to damage the gasket in the relief valve body. • Make sure of the number of shims in the plug. Shim thickness: 0.25 mm (0.0098 in.) 0.50 mm (0.0197 in.) 2.50 mm (0.0984 in.)

3- 2. Single-acting auxiliary control valve

Item	Location	Bolts and nuts	Tools
Disassembly (1) Auxiliary control valve removal		M8 x 55 .... 3 M8 x 80 1	12 27
Disassembly (2) Spool	 	M6 ..... 2 M6 ..... 2 2	 27
Disassembly (3) Relief valve	 		22

Procedure	Remarks
1) Remove the throttle valve assembly.	(When reassembling) ● Be careful not to damage the O-ring in the throttle valve.
1) Remove the plug. 2) Remove the spring and the spring seat. 3) Remove the check valve.	(When reassembling) ● Be careful not to damage the O-rings in the plug and bushing.
1) Remove the plug. 2) Remove the collar, the spring seat and the spring. 3) Remove the lowering valve.	(When reassembling) ● Be careful not to damage the O-ring.

Item	Location	Bolts and nuts	Tools
Disassembly (4) Throttle valve			14
Disassembly (5) Check valve			22
Disassembly (6) Lowering valve			6

Procedure	Remarks
1) Remove the joint pin securing the push rod (1) to the connector. 2) Remove the hydraulic piston rod. 3) Remove the set bolt from the position cam. 4) Remove the hydraulic cylinder liner and the control valve at the same time. 5) Remove the control valve from the hydraulic cylinder liner.	
1) Remove the cap and then take off the spring. 2) Loosen the screw and pull off the pin. 3) Pull off the pilot spool.	(When reassembling) ● Be sure of the position of the plug. 
1) Remove the pin and the spring seat. 2) Pull off the spring and the shut-off spool.	

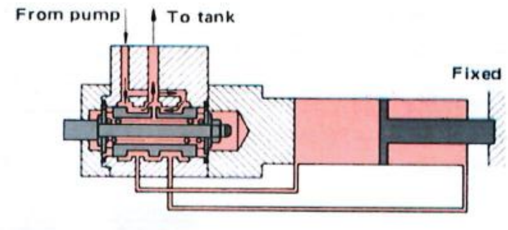
2. FUNCTION

2-1. Oil flow in power steering booster

(1) "NEUTRAL" POSITION

When the steering wheel is not held, the spool is set at the center position by spring pressure. Therefore, the oil forced from the hydraulic pump returns to the tank via the journals on both sides of the spool.

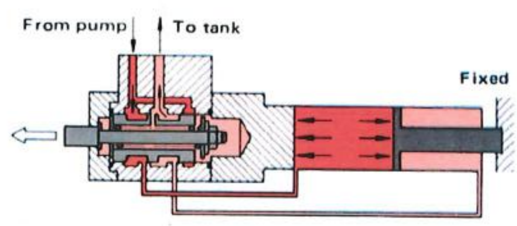
Fig.66



(2) "OUT-STROKE" POSITION

Turning the steering wheel to the right actuates the drag link and the related members to move the spool to the left (Fig. 67). Therefore, the oil forced from the hydraulic pump goes into the left chamber of the cylinder piston through the journal on the left side of the spool. Meanwhile, the oil in the right chamber returns to the tank via the valve. When the piston advances, the spool returns to neutral.

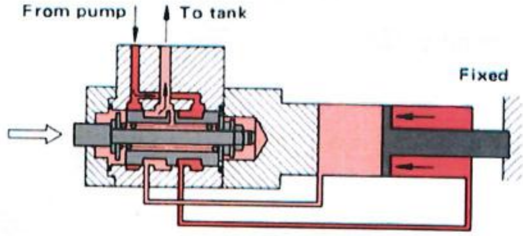
Fig.67



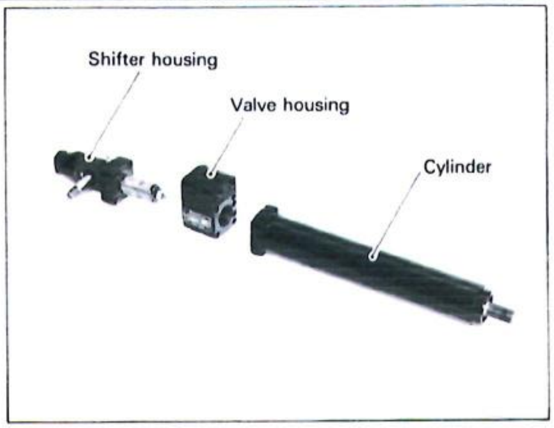
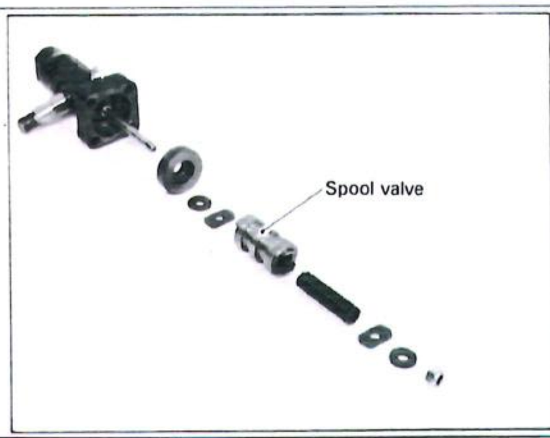
(3) "IN-STROKE" POSITION

Turning the steering wheel to the left moves the spool to the right. Thus the oil forced from the hydraulic pump goes into the right chamber of the cylinder piston through the journal on the right side of the spool. Meanwhile, the oil in the left chamber returns to the tank through the valve.

Fig.68



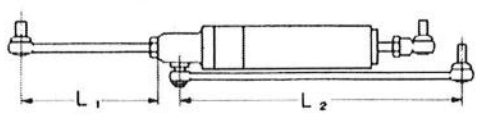
3. DISASSEMBLY

Item	Location	Bolts and nuts	Tools
Disassembly (1) Separation of valve housing from cylinder		M8 × 95 .... 4 M24··· 1 M20··· 1 M16··· 1 .... 1 Tap screw 1	23 36 12
Disassembly (2) Spool valve		M8····· 1	14

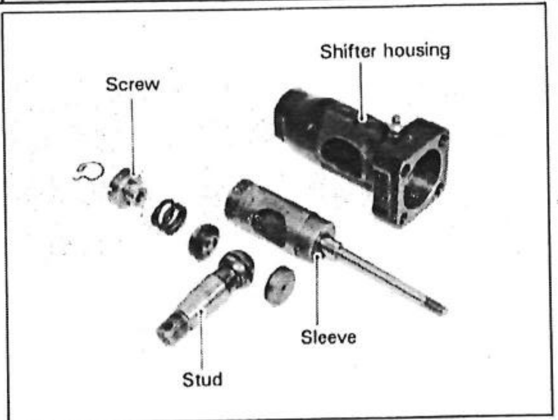
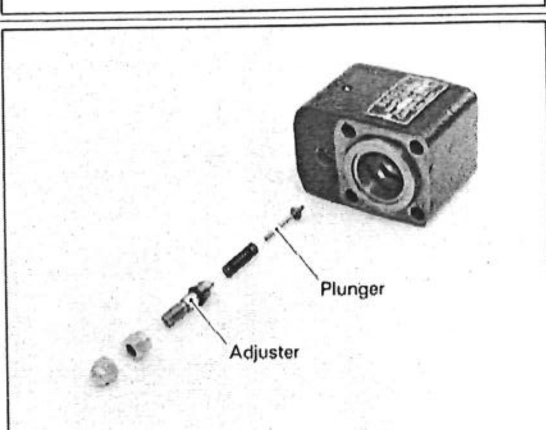
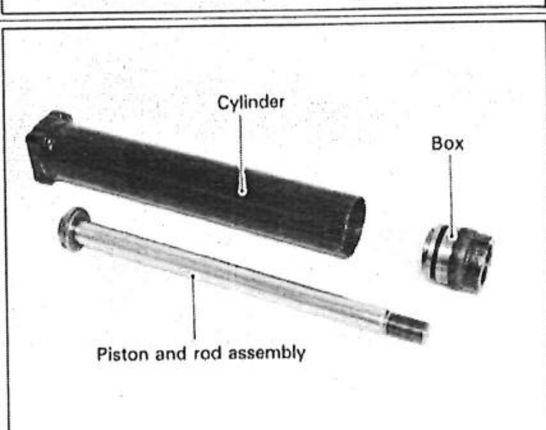
Procedure	Remarks
1) Disconnect the front end of the link. 2) Disconnect the rear end of the link. 3) Remove the drag link. 4) Remove the retainer and take off the dust seal. 5) Separate the assembly into the shifter housing, the valve housing and the cylinder.	(When reassembling) • The length of the booster assembly (in in-stroke position)

	L_1	L_2
M4000S M4500	220mm 8.6614in.	830mm 32.6772in.
M5500 M6500 M7500	383mm 15.0787in.	Fixed type (without adjustment)
M4000DT M4500DT	310±3mm 12.2047±0.1181in.	Fixed type (without adjustment)
M5500DT M6500DT M7500DT	375±3mm 14.7638±0.1181in.	Fixed type (without adjustment)

Fig.69

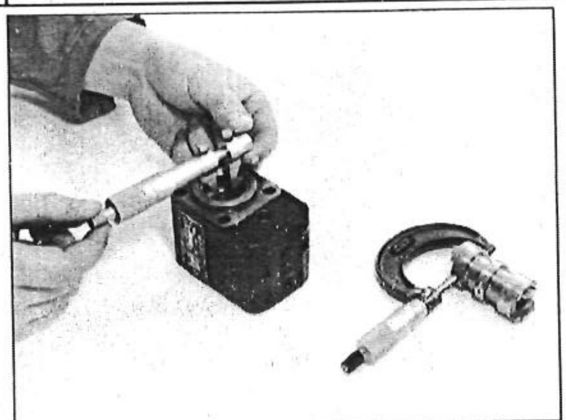
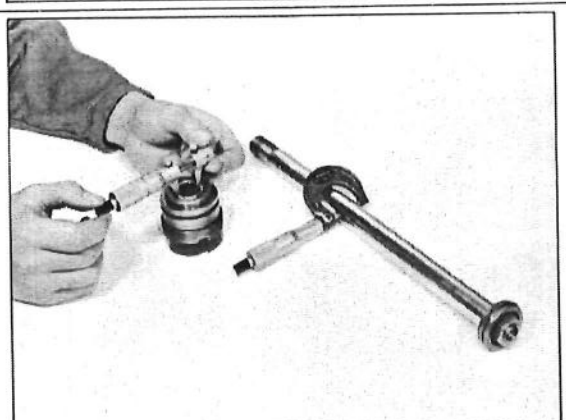
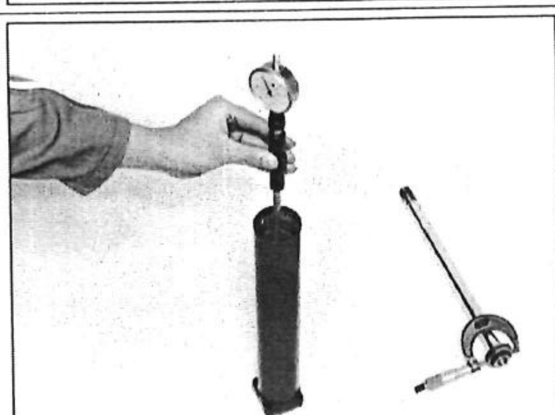


Procedure	Remarks
1) Remove the nut and take off the washer and the spring seat. 2) Remove the spool valve and the spring. 3) Remove the cap.	(When reassembling) • Make sure of the direction of the spool valve. • Make sure of the direction of the cap and note that the O-ring is not missing. • Tightening torque of nut is 7.8 N·m. (0.8 kgf·m., 5.8 lb.ft.).

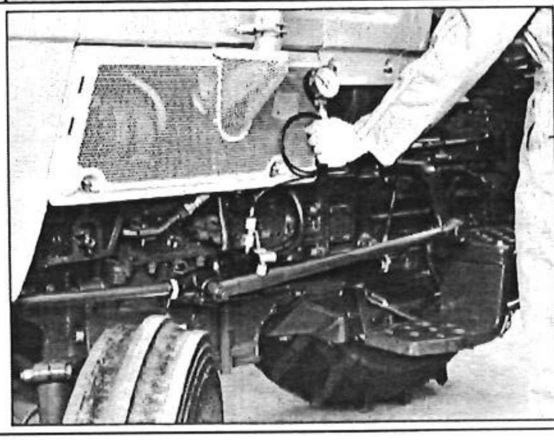
Item	Location	Bolts and nuts	Tools
Disassembly (3) Stud			  8
Disassembly (4) Relief valve		 M8 ····· 1	 12
Disassembly (5) Piston and rod assembly			  Hook wrench

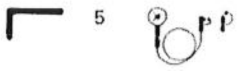
Procedure	Remarks
1) Remove the snap ring from the shifter housing; remove the screw and pull off the stud. 2) Pull off the sleeve from the shifter housing and take off the screw, the spring and the seat in that order.	(When reassembling) • The screw should be turned back approx. 80° after it has been fully tightened.
1) Remove the nut and then the adjuster. 2) Remove the spring and the plunger.	(When reassembling) • Tightening torque of nut is 9.8 N·m. (1 kgf·m., 7.2 lb.ft.).
1) Unstake the cylinder and take off the box. 2) Draw out the piston and rod assembly.	(When reassembling) • Tightening torque of box is 78.4 to 98.1 N·m. (8 to 10 kgf·m., 57.9 to 72.3 lb.ft.).

4. SERVICING

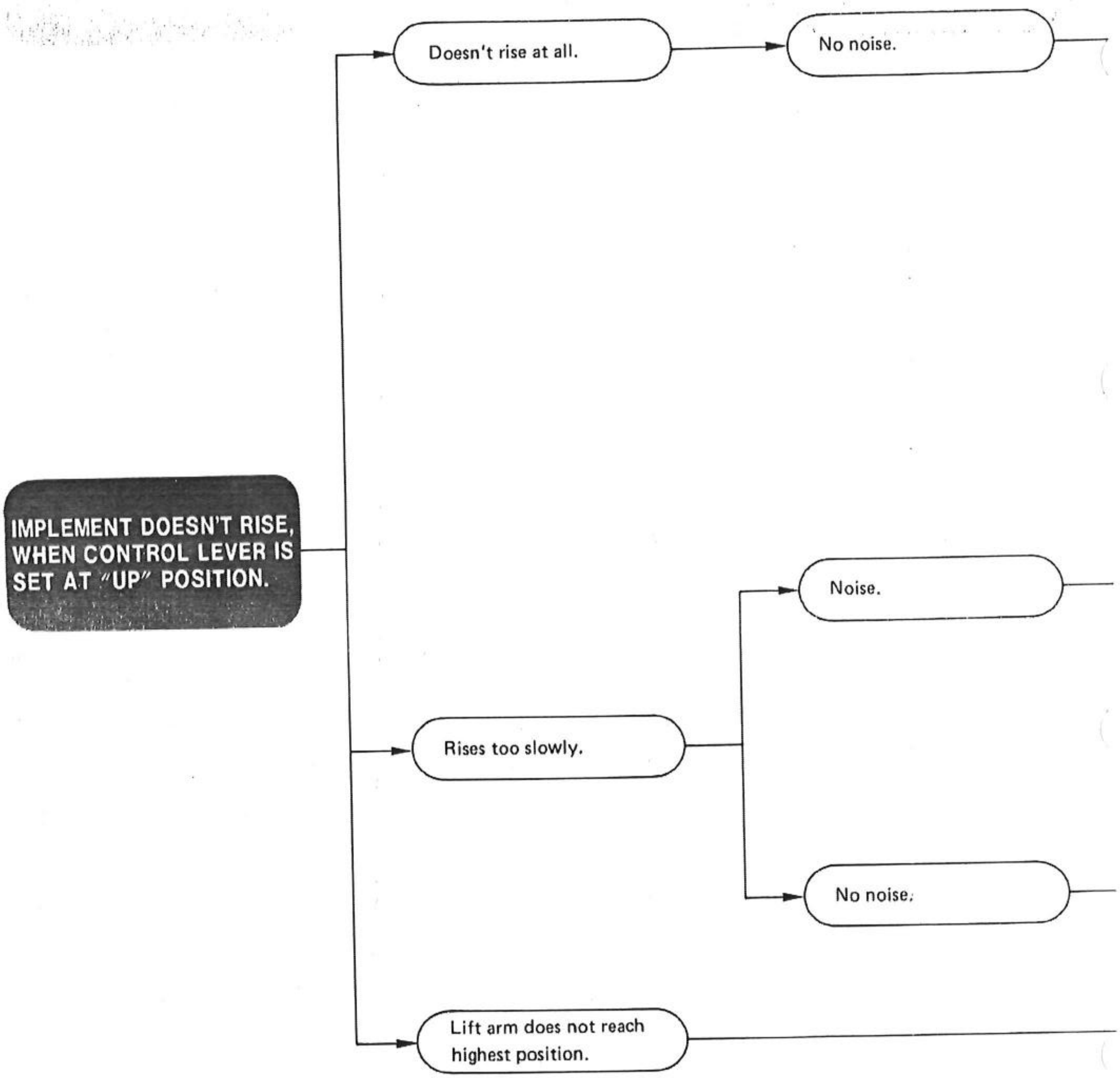
Item	Location	Reference value
Servicing (1) Clearance between spool valve and valve housing		• Reference value 0.022mm 0.0009in. • Allowable limit 0.04mm 0.0016in.
Servicing (2) Clearance between box and rod		• Reference value 0.074mm 0.0029in. • Allowable limit 0.11mm 0.0043in.
Servicing (3) Clearance between piston and cylinder		• Reference value 0.121mm 0.0048in. • Allowable limit 0.2mm 0.0079in.

Tools and test instruments	Procedure	Remarks
	1) Measure the spool diameter with an outside micrometer. 2) Measure the inside diameter of the valve housing with an inside micrometer, and find the clearance between them. 3) If the clearance exceeds the allowable limit, replace.	
	1) Measure the inside diameter of the bushing in the box with an inside micrometer. 2) Measure the rod diameter with an outside micrometer, and find the clearance between them. 3) If the clearance exceeds the allowable limit, replace.	
	1) Measure the piston diameter with an outside micrometer. 2) Measure the inside diameter of the cylinder with a cylinder gauge, and find the clearance between them. 3) If the clearance exceeds the allowable limit, replace.	

Item	Location	Reference value
Servicing (4) Resetting the relief valve		• **Reference value** 9.8 Mpa. 100 kgf/cm² 1,422 lb./sq.in.

Tools and test instruments	Procedure	Remarks
	1) Remove the plug from the valve housing, and install a pressure gauge in its place. 2) Start the engine and fully turn the steering wheel. Read the pressure gauge dial when the relief valve buzzes. 3) If the reading does not meet the reference value, reset relief valve with an adjuster.	

TROUBLE SHOOTING



		Reference
Spool does not move when position control lever is operated.	Position control lever loose.	268
	Position balancer broken.	243
	Connector broken.	243
	Position connector broken.	243
	Push rod broken.	243
	Spool retainer broken.	243
Spool does not move when draft control lever is operated.	Draft control shaft key broken.	243
	Draft links (1) and (2) broken.	243
	Draft cam broken.	243
	Push rod broken.	243
	Spool retainer broken.	243
Shut-off spool stays open.	Sliding face of shut-off spool imbedded with foreign material or flawed.	252
	Spring broken.	252
Relief valve defective.	Relief valve spring broken.	256
Hydraulic pump broken.	Shaft, key, or hub broken.	224 228
Cavitation.	Oil filter clogged.	234
	Inlet pipe obstructed.	
	Oil degraded.	
	Oil temperature too low.	
Air in hydraulic system.	Inlet pipe loose.	
	Inlet pipe O-ring flawed or distorted.	
	Inlet pipe broken.	
	Pump shaft oil seal flawed or worn.	224 228
	Oil insufficient.	10
Hydraulic pump broken.	Gear and bushing seized up.	224 228
Relief valve defective.	Setting of relief valve too low.	264
	Oil leaks inside hydraulic pump.	232
	Oil leaks inside control valve.	258 260
	Oil leaks inside hydraulic cylinder.	280
	Relief valve seat flawed or imbedded with foreign material.	262
	Feedback rod maladjusted.	266
	Position control lever maladjusted.	268

IMPLEMENT DOES NOT LOWER WHEN CONTROL LEVER IS SET AT "DOWN" POSITION.

Implement does not lower when both control levers are set at "DOWN" position.

Implement does not lower when draft control lever is set at "DOWN" position.

IMPLEMENT CANNOT BE HELD IN ONE POSITION.

Implement moves up and down quickly while engine is running, but drops when engine stops.

Implement drops while tractor is traveling.

		Reference
Control valve defective.	Sliding face of spool imbedded with foreign material or flawed.	258
	Spool return spring broken.	260
	Lowering valve sticks.	254
	Lowering valve adjusting screw maladjusted.	254
Draft sensitivity poor.	Top link bracket shaft seized up.	282
	Draft cam shaft seized up.	243
	Drop speed adjuster lever broken.	243
	Joint or spring pin broken.	243
	Throttle valve damaged.	254
Oil leaks inside hydraulic cylinder.	O-ring and backup ring flawed, worn, or distorted.	280
	Hydraulic cylinder flawed or worn.	280
	O-ring in hydraulic cylinder flawed or worn.	277
	O-ring in hydraulic cylinder safety valve flawed or worn.	278
Oil leaks from hydraulic cylinder safety valve.	Steel ball or seat flawed.	282
	O-ring flawed, worn, or distorted.	282
Oil leaks inside control valve.	Seat in check valve flawed.	260
	Bushing in check valve and O-ring in cap flawed, worn, or distorted.	254
	Seat in lowering valve flawed.	260
	O-ring in lowering valve flawed, worn or distorted.	254
	O-ring and backup ring in control valve flawed, worn, or distorted.	277
	O-ring in throttle valve flawed, worn, or distorted.	254
Control lever is not secure.	Spring retainer loose.	
	Spring broken or distorted.	
	Friction washer broken.	
	Setting of hydraulic cylinder safety valve too low.	282

DRAFT CONTROL IS NOT EFFECTED.

- Not effected at all.
- Implement does not go down from "UP" position.
- Not completely effected.

UNUSUAL NOISES.

- Buzzing when implement reaches highest lift position.

	Reference
"UP" circuit not completed. → Refer to Item: Implement does not rise when control lever is set at "UP" position.	296 297
Draft control rod broken.	243
Draft control lever spring pin broken.	243
Top link bracket shaft seized up.	282
Refer to Item: Implement does not lower when control lever is set at "DOWN" position.	298 299
Top link bracket maladjusted.	266
Draft control rod maladjusted.	268
Top link bracket shaft seized up.	282
Draft cam shaft seized up.	243
Feedback rod maladjusted.	266

Cavitation.

Air in hydraulic system.

Hydraulic pump broken.

Piping contacts proximate parts.

V. ELECTRICAL SYSTEM

BATTERY

1. CONSTRUCTION AND NAME OF PARTS

The battery basically consists of:

1) Positive plate
   Lead alloy grid plus lead peroxide (PbO_2)
2) Negative plate
   Lead alloy grid plus spongy lead (Pb)
3) Electrolyte
   Sulfuric acid (H_2SO_4) plus water (H_2O)
4) Separator and glass mat
5) Container
6) Cover
7) Pole
8) Cell connector
9) Sealing compound
10) Vent plug

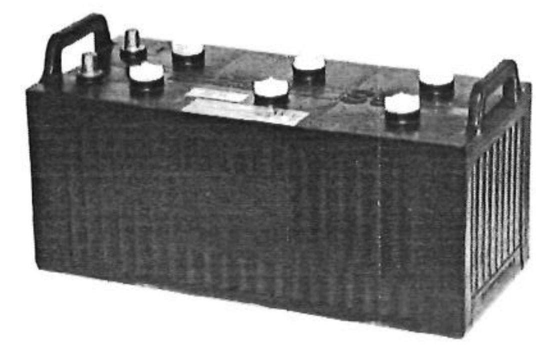
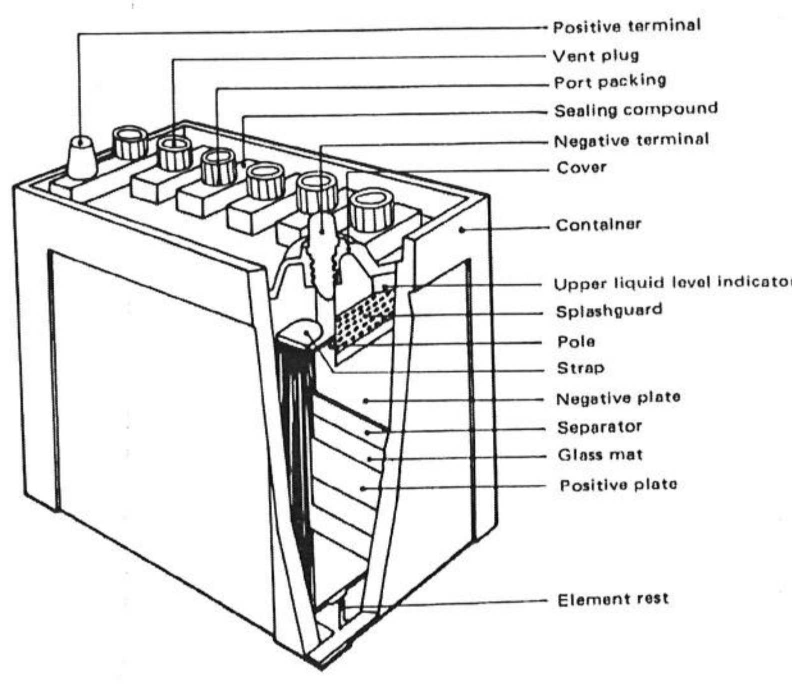


Fig. 70 Battery construction and name of parts



2. CHEMICAL ACTION

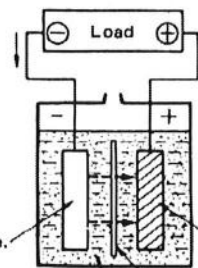
2-1. Chemical action in discharging

When you start the engine or turn one of the lights on, sulfuric acid contained in the electrolyte combines with the positive and negative plates, resulting in lead sulfate on the plates. Thus as the electrolyte reduces the amount of sulfate, its concentration and specific gravity decreases.

■ Chemical changes in positive plate, negative plate and electrolyte

- Positive plate (lead peroxide) → Lead sulfate
- Negative plate (spongy lead) → Lead sulfate
- Electrolyte (sulfuric acid) → Water

Fig.71 Chemical changes in discharging



Positive plate		Electrolyte		Negative plate		Positive plate		Electrolyte		Negative plate
PbO_2	+	$2H_2SO_4$	+	Pb	→	$PbSO_4$	+	$2H_2O$	+	$PbSO_4$
					Discharging					

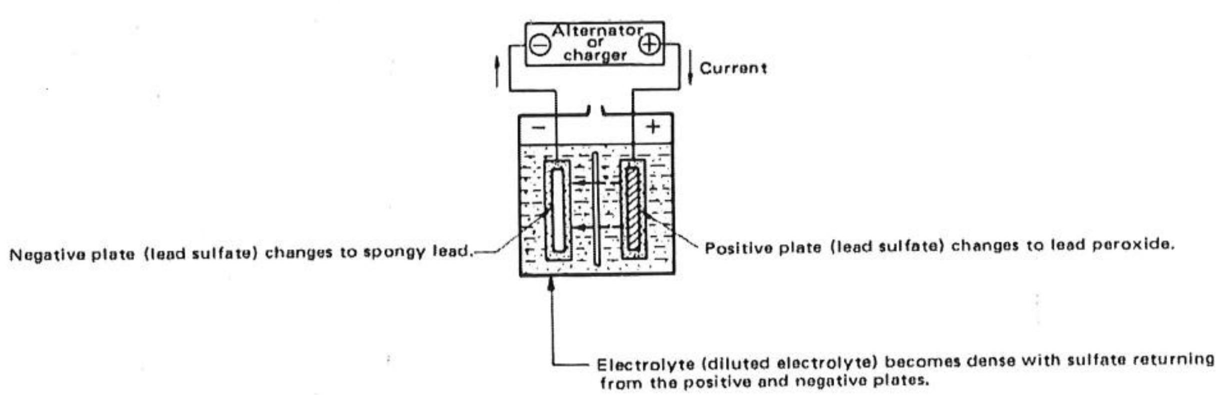
2-2. Chemical action in charging

When a discharged battery is being recharged (using a direct current), the sulfate is displaced from the positive and negative plates due to chemical reaction and goes into the electrolyte. As a result, the positive and negative plates (lead sulfate) change to lead peroxide and spongy lead respectively. Further, because the content of sulfate in the electrolyte increases with the addition from the plates, the specific gravity of the electrolyte increases and the positive and negative voltages rise accordingly. When the battery approaches full charge, the charging current then begins to electrolyze the water contained in the dilute sulfuric acid, producing oxygen from the positive plate and hydrogen from the negative plate.

- Chemical changes in positive plate, negative plate and electrolyte

- Positive plate (lead sulfate) → Lead peroxide
- Negative plate (lead sulfate) → Spongy lead
- Electrolyte (water) → Sulfuric acid

Fig.72 Chemical changes in charging



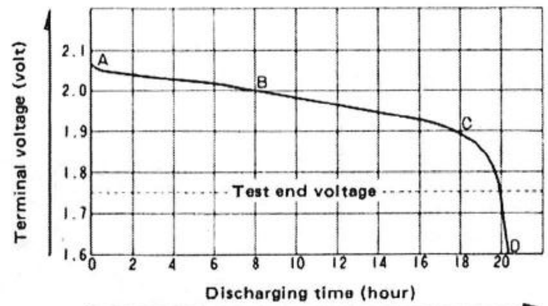
Positive plate		Electrolyte		Negative plate		Positive plate		Electrolyte		Negative plate
$PbSO_4$	+	$2H_2O$	+	$PbSO_4$	$\xrightarrow{}$ Charging	PbO_2	+	$2H_2O$	+	Pb

3. DEFINITION OF BATTERY PERFORMANCE

3-1. Test end voltage

Test end voltage means a voltage at the practical end of discharging. It suggests a critical level of voltage under which the battery should not be discharged. The relationship between discharging time and terminal voltage may be represented by the curve in the graph (Fig. 73) when the battery is being discharged at a moderate constant current rate. The terminal voltage sharply drops from A to B shortly after discharging starts and then maintains a virtually constant level between B and C. After that, as discharging further proceeds the terminal voltage sharply drops from C to D. From C on, battery electrical output is insufficient and further discharging badly damages the positive and negative plates. The battery will not longer function after that. This critical level of terminal voltage is referred to as the test end voltage. Test end voltage per cell is approx. 1.7 to 1.8 volts. (Terminal voltage is 2.1 volts at full charge.)

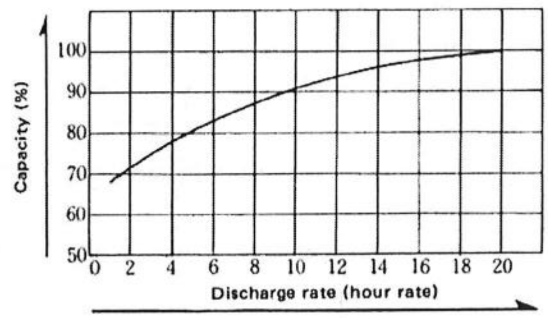
Fig. 73 Discharging curve



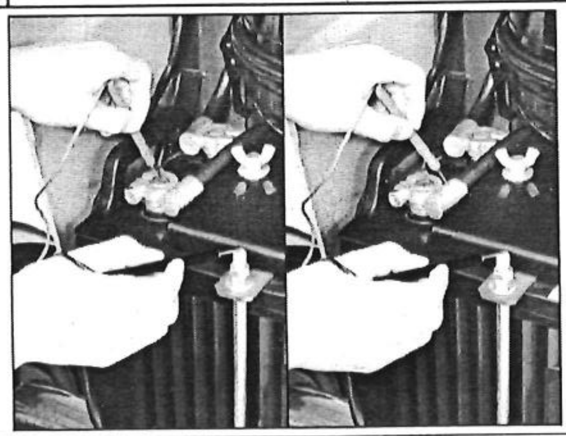
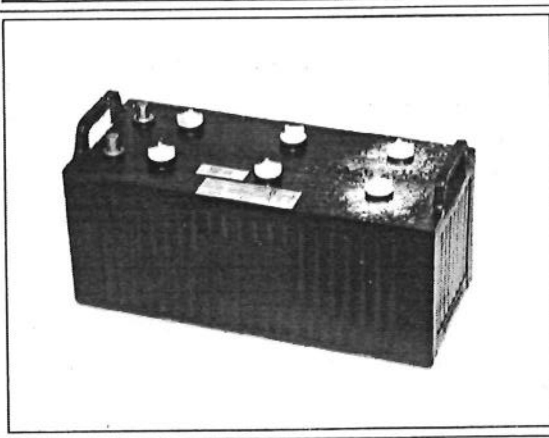
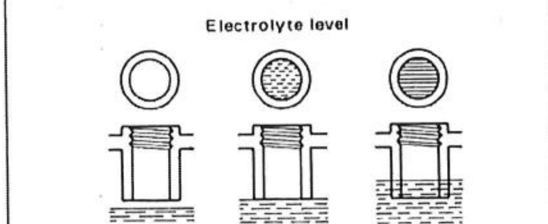
3-2. Capacity

Battery capacity is defined as the amount of electric energy (AH) which a fully charged battery delivers until its terminal voltage drops to the test end voltage. Battery capacity (amperage x time) is related to the discharging current rate. Other factors remaining constant, the higher the discharging current rate, the smaller the capacity. For example, let us assume that battery capacity is used up in 20 hours and that the capacity is 100%. If the current rate is doubled so the capacity is used up in 10 hours, the capacity then falls to 90%. As discussed above, because the service efficiency of a battery depends upon the rate of discharging current, a discharge (hour) rate must be indicated to specify a battery capacity. Usually battery capacity is represented in a 20-hour rate.

Fig. 74 Relationship between discharge rate and capacity



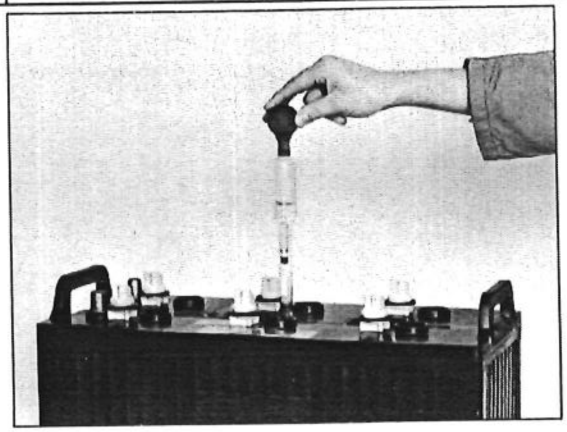
4. CHECKING AND SERVICING

Item	Location	Reference value
Servicing (1) Terminal and bolt looseness		• Reference value Voltage drop less than 0.1V
Servicing (2) Cleaning battery surface		
Servicing (3) Checking electrolyte level		• Reference value 10 to 13mm (0.3937 to 0.5118 in.) above positive and negative plates

Tools and test instruments	Procedure	Remarks
 10 14 	1) Measure the voltage across the battery positive terminal and the tractor body. 2) Measure the voltage across the battery positive cable and the tractor body. 3) If the difference between the first and second measurements exceeds 0.1 volt, clean the battery terminal and retighten.	
	1) Clean the battery surface, which is sometimes stained by electrolyte gas coming through the air vent.	
	1) The electrolyte decreases because of chemical reaction during charging or vaporization. Thus check to see that the liquid level is up to the indicator line. 2) If the electrolyte level has dropped below the indicator line, add distiled water up to the indicator line.	

Item	Location	Reference value

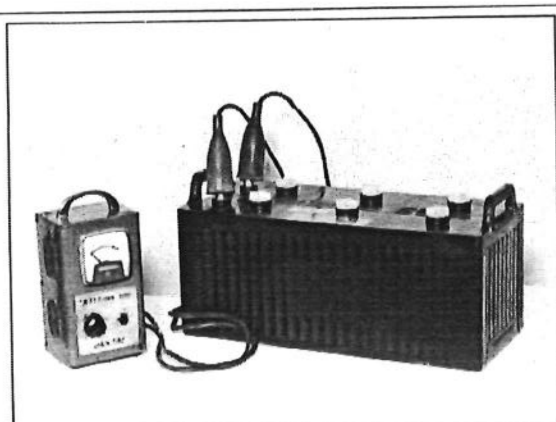
Servicing (4)
Checking state of charge
i) Checking with hydrometer



Specific gravity	State of charge		
1.260	100%	Charged	Usable
1.230	75%	Charged	Usable
1.200	50%	Allowable limit	Must be recharged immediately
1.170	25%	Discharged	Must be recharged immediately
1.140	10%	Discharged	Must be recharged immediately
1.110	0%	Totally discharged	

When specific gravity of electrolyte is 1.260 (at 20°C (80°F)) in fully charged state.

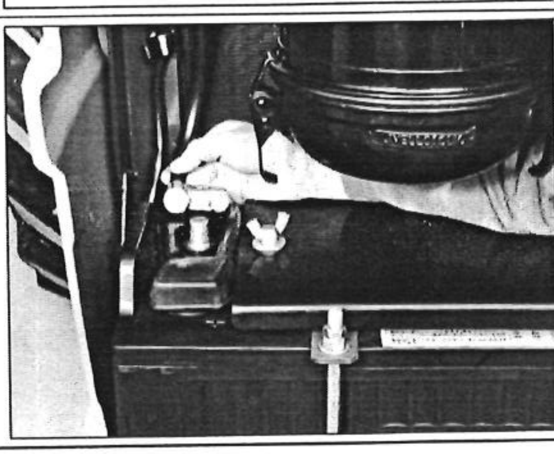
Servicing
ii) Checking with battery tester



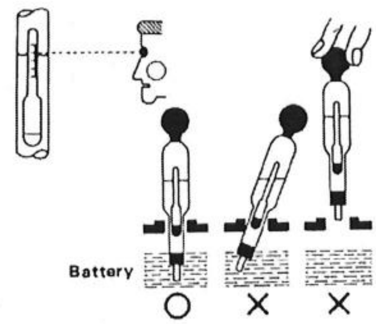
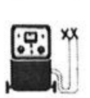
• **Reference value**

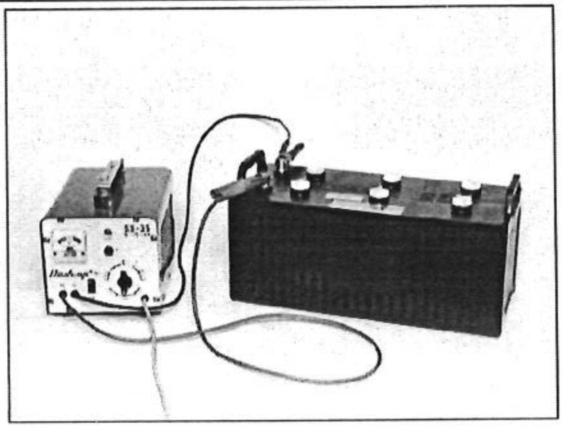
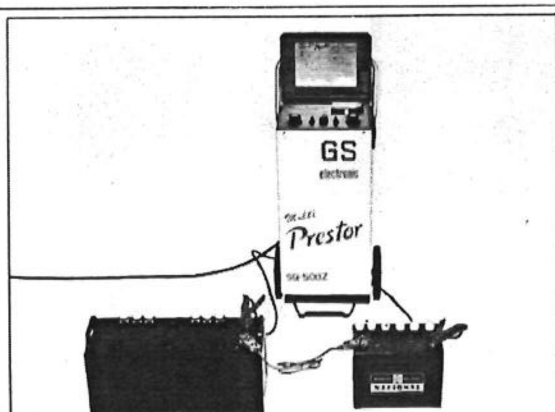
75% or more	Good
45 to 75%	Must be recharged
45% or less	Must be replaced

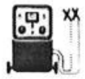
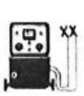
Servicing (5)
Precautions and checks in long-term storage



<table>
<tr><th>Tools and test instruments</th><th>Procedure</th><th>Remarks</th></tr>
<tr>
<td></td>
<td>1) Draw a little electrolyte into the hydrometer and read the level on the graduated float inside the hydrometer.
2) Measure the electrolyte temperature with a thermometer.
3) Note that the specific gravity of electrolyte slightly varies with its temperature. Thus it is not correct to regard the reading on the hydrometer scale as the specific gravity of the liquid.
The specific gravity of the electrolyte lowers by 0.0007 (0.0004) for every 1°C (1°F) rise and it rises by the same amount for every 1°C (1°F) drop. So, the specific gravity must be corrected on the basis of the specified temperature 20°C (80°F). The formula is as follows:
A specific gravity corrected on the basis of 20°C (80°F)=measured specific gravity + 0.0007 (0.0004) x (electrolyte temperature −20 (80)).</td>
<td>(Precautions for check)
• Due to surface tension, the level of the electrolyte is slightly higher at the edge where it touches the float. The top of this swell gives the correct reading.
• Hold the hydrometer at eye level.
• Hold the hydrometer upright.
• Do not hold the hydrometer above the electrolyte port.

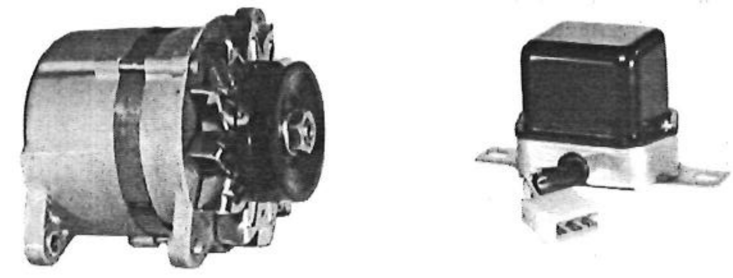
Fig.75 Precautions for handling a hydrometer

</td>
</tr>
<tr>
<td></td>
<td>1) Connect the probes of the battery tester to the positive and negative terminals of the battery, respectively. Set the tester knob at the capacity of the battery to be tested and press the switch button for approx. 5 seconds. Then read the dial.</td>
<td></td>
</tr>
<tr>
<td> 10
14
 XX</td>
<td>1) After fully charging, store the battery in a well-ventilated place out of direct sunlight.
2) A battery in storage must be recharged once a month. This is because it self-discharges by approx. 0.5% per day even in storage.
3) When storing the battery mounted on the tractor disconnect the negative cable from the terminal.</td>
<td>• **Self-discharging rate**
<table><tr><th>Temperature</th><th>Self-discharging rate</th></tr><tr><td>30°C (86°F)</td><td>Approx. 1.0% per day</td></tr><tr><td>20°C (68°F)</td><td>0.5% per day</td></tr><tr><td>10°C (50°F)</td><td>0.25% per day</td></tr></table></td>
</tr>
</table>

Item	Location	Reference value
Servicing (6) Recharging i) Slow charging		• **Reference value** If three out of the four check points noted below are satisfied, the battery may be regarded as fully charged. 1) The specific gravity of the electrolyte exceeds 1.230 and maintains a constant level for longer than one hour. 2) The terminal voltage exceeds 15V during recharging and maintains a constant level for longer than one hour. 3) A lot of fumes are given off by the respective cells. 4) The battery has been charged for a specified time.
Servicing ii) Quick charging		

Tools and test instruments	Procedure	Remarks
 	1) If the electrolyte is insufficient, add distilled water. Distilled water should be added to a point slightly below the indicator line because there is the risk of overflow during recharge. 2) Do not reverse the polarity when connecting the battery to the charger. As a rule, the charger's red cable should be connected to the battery's positive terminal and the black cable to the negative terminal. 3) Use a charging current rate of 1/10 to 1/20 the battery capacity. 4) Maintain the electrolyte temperature below 45°C (113°F). If temperature rises above 45°C (113°F), lower the charging current rate or stop charging for a while. 5) Remove the vent plugs, as the electrolyte emits fumes during charging. 6) Determine the proper charging time using the following formula: Charging time $= \dfrac{\text{Discharging current rate (AH)}}{\text{Charging current (A)}} \times 1.2 \text{ to } 1.5$ 7) When recharging batteries having different capacities from one another at the same time, determine the charging current rate on the basis of the smallest capacity battery. 8) When recharging a battery mounted on a tractor, disconnect the ground cable from its terminal.	
 	1) Determine the proper charging current rate and charging time using the tester provided for the quick charger. 2) Determine the proper charging current rate as 1/1 the battery capacity. If the battery capacity exceeds 50AH, however, consider 50A as the maximum. 3) When recharging a battery mounted on a tractor, disconnect the ground cable from its terminal.	(Precautions for handling a quick charger) • Operation with a quick charger differs according to their type. Consult the instruction manual and use accordingly.

ALTERNATOR AND REGULATOR

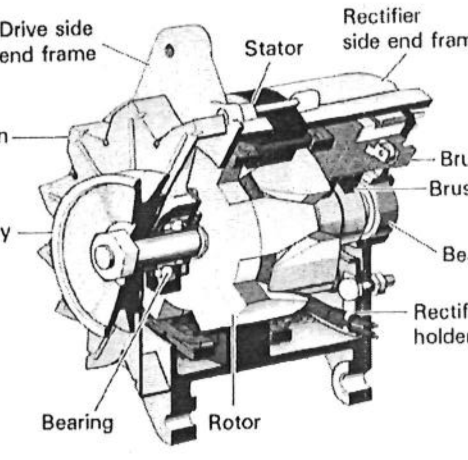
1. CONSTRUCTION AND NAME OF PARTS



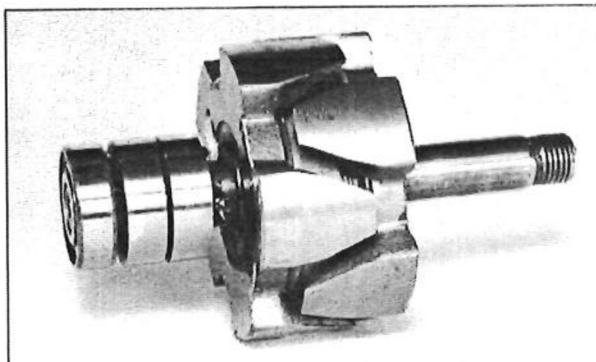
1-1. Alternator

The alternator is an alternating current generator containing a rectifier. Alternating current is induced in a stator coil by means of the revolution of magnetic poles around the coil. The alternating current is then rectified into a direct current through diodes. An alternator and DC dynamo are common in producing an alternating current and then rectifying it into a direct current, but differ in that a 3-phase alternating current is full-wave-rectified through diodes.

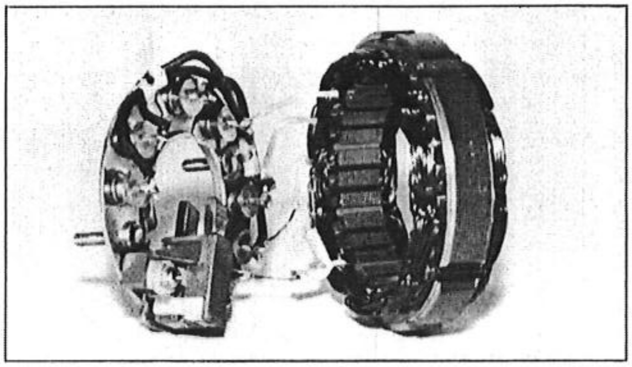
Fig. 76 Construction of alternator



- Rotor
  The rotor consists of a core, coil, slip ring and shaft, and serves to produce a magnetic field necessary for producing electric power.



- Stator
  The stator consists of a core and coil, and serves to produce a 3-phase alternating current.
- Rectifier
  The rectifier consists of six diodes and diode holder. It rectifies an alternating current from the stator coil into a direct current.



1-2. Regulator

As engine speed varies with the mode of tractor operation, the alternator speed varies accordingly, resulting in change of output voltage. However, constant voltage needs to be supplied to the battery being charged, lights, etc. That is where the regulator comes in to maintain the supply voltage at a constant level.

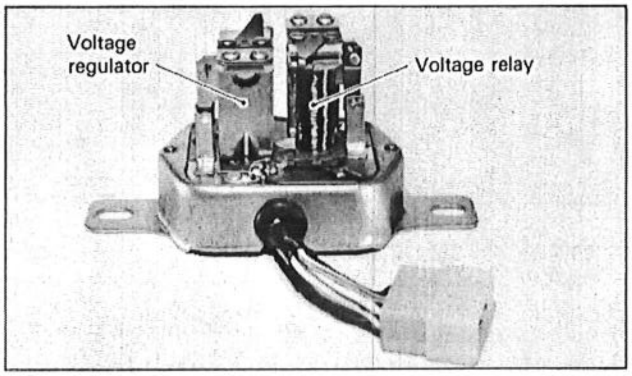
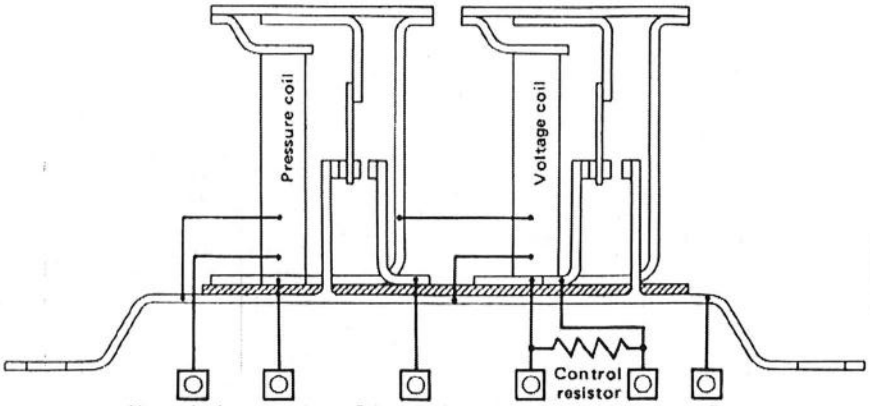


Fig.77 Regulator

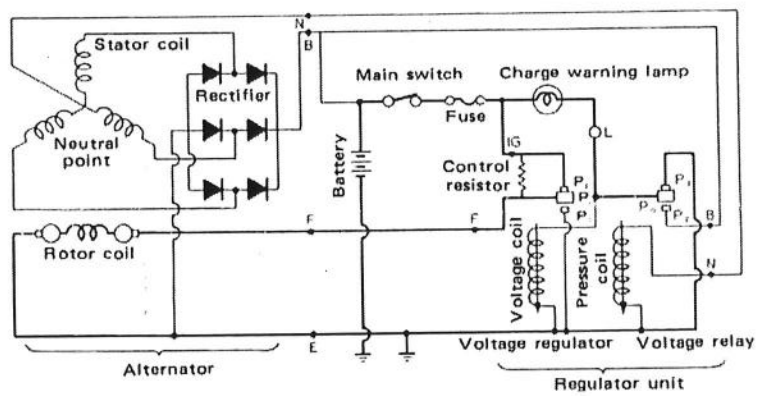


2. CHARGING OPERATION

2-1. Turning the main switch on

After the current drawn from the battery has passed through the main switch and fuse, it branches into two parts. One flows to the regulator IG, from which it then goes to the rotor coil via the contacts (P_3, P_4) and the F terminal. After it energizes the rotor core, it is grounded via the E terminal. The other flows to the charge warning lamp, turning it on, and then flows on to the ground through the voltage relay contacts (P_0, P_1).

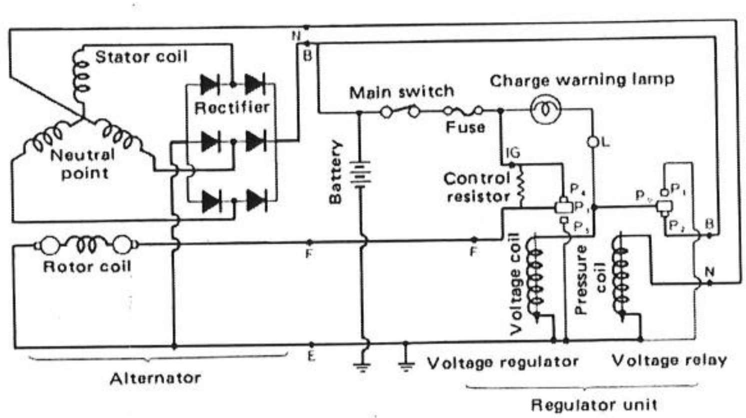
Fig. 78 Turning the main switch on.



2-2. Low-speed running

When the engine starts, a 3-phase alternating current is induced in the stator coil and is then rectified through the diodes. At this point, if the supply voltage exceeds the battery terminal voltage, the battery is recharged through the B terminal. At the same time, N terminal voltage is applied to the pressure coil. When the voltage in the pressure coil reaches the operating voltage, the contact P_0 is attracted to P_2 so that the charge warning lamp goes off.

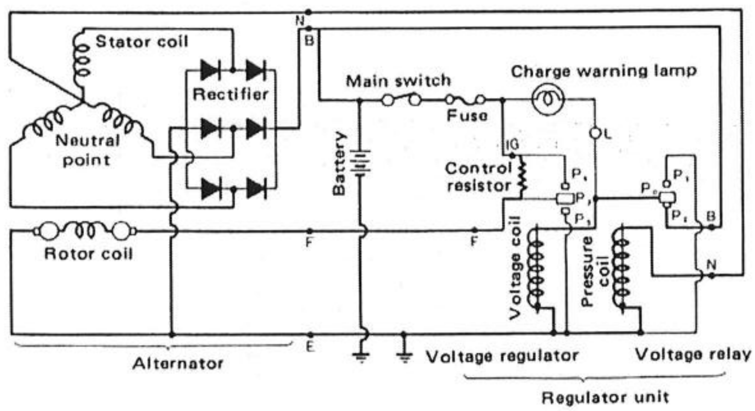
Fig. 79 Low-speed running



2-3. Medium-speed running

When the alternator speeds up to a certain level, the voltage coil is energized so that the contact P_3 is attracted toward P_5 and takes a neutral position. At this point, the rotor coil and control resistor are connected in series so that the current flowing to the rotor coil decreases. This causes the magnetism of the rotor to weaken, maintaining the generated voltage at a constant level.

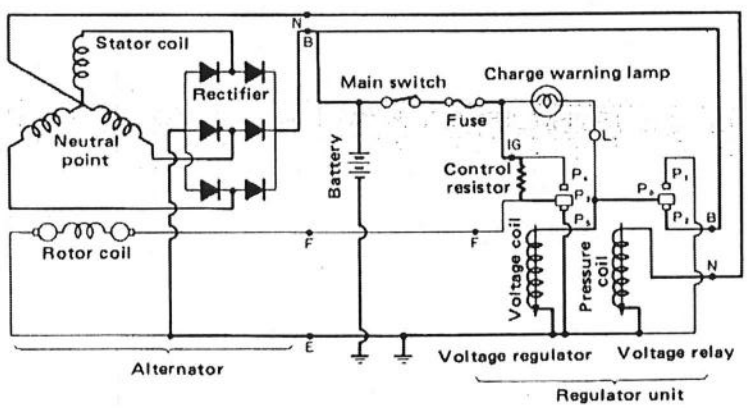
Fig.80 Medium-speed running



2-4. High-speed running

When the engine runs at a high speed, the increased attraction force of the voltage coil causes the contact P_3 to come in contact with P_5. The current flows to the control registor and then is directly grounded. Thus the current flowing to the rotor is much less than during medium-speed running and the generated voltage is maintained at a constant level.

Fig.81 High-speed running

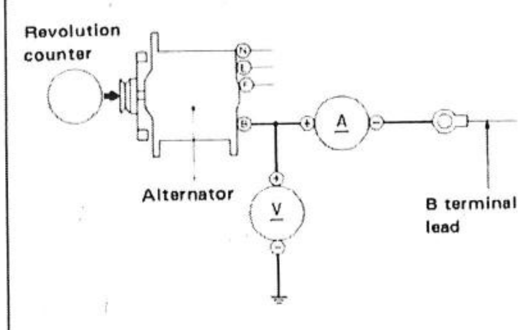
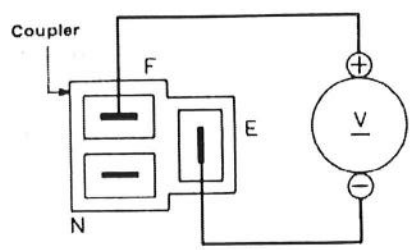


3. CHECK

Checking Sequence

If the charging system is malfunctioning, check as follows to find the cause.

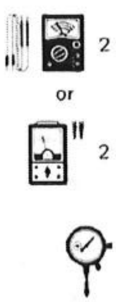
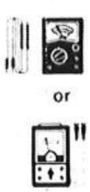
(1) Output current check
- (2) Coupler voltage check
- (3) No load testing of alternator
- (6) Cut-in voltage check
- (7) No-load regulating voltage check

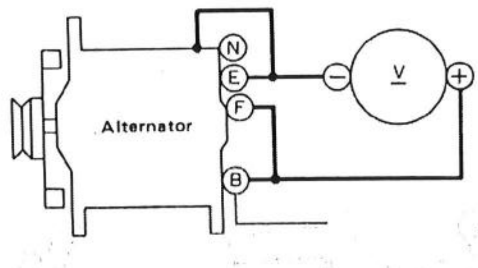
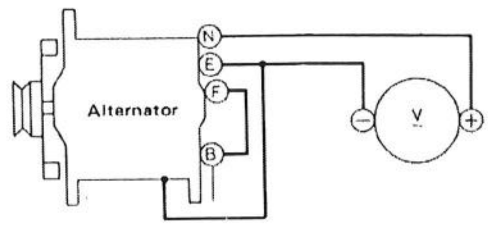
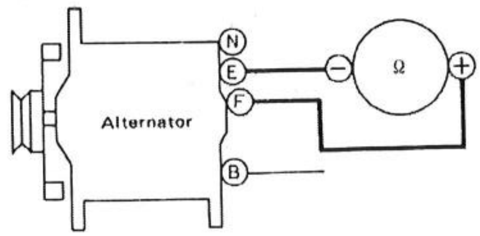
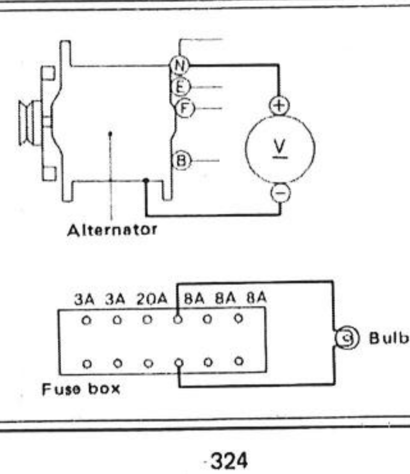
Item	Location	Reference value
Check 1 Output current		• Reference value <table><tr><td></td><td>Output current</td><td>Voltage</td><td>Rotational speed</td></tr><tr><td>M4000 M4500</td><td>25A</td><td>14V</td><td>4,000 rpm or less</td></tr><tr><td>M5500 M6500 M7500</td><td>45A</td><td>14V</td><td>4,500 rpm or less</td></tr></table>
Check 2 Coupler voltage		• Reference value 12V

(4) Diode check

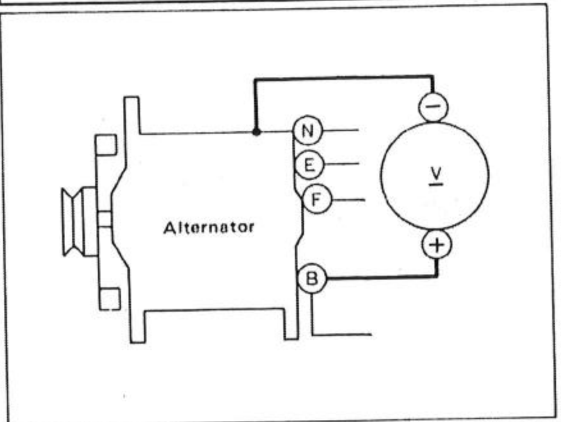
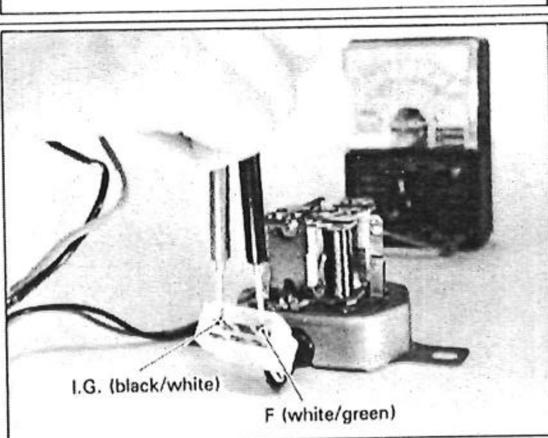
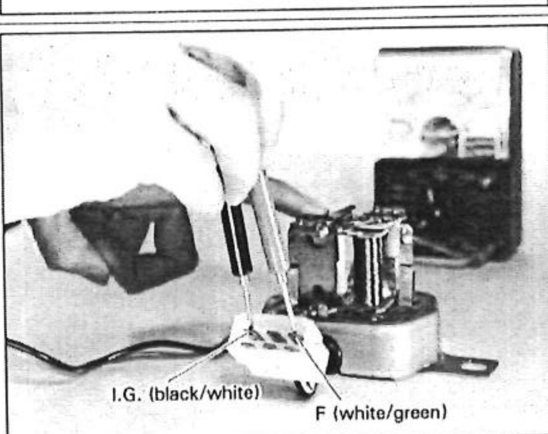
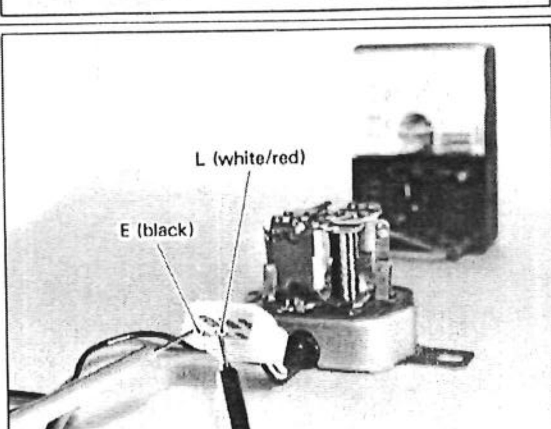
(5) Rotor coil, slip ring and brush check

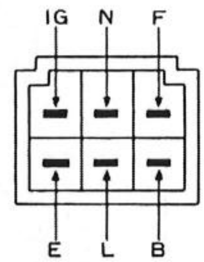
(8) Regulator check

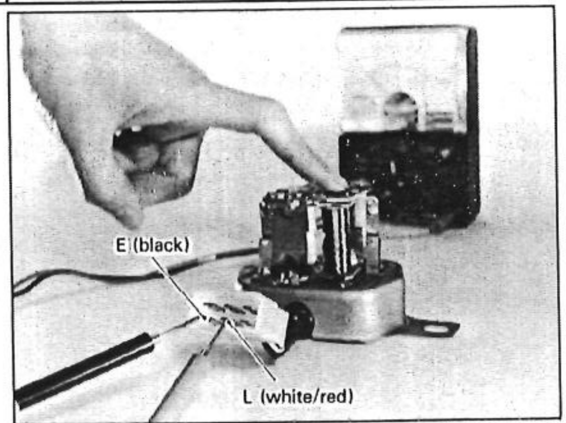
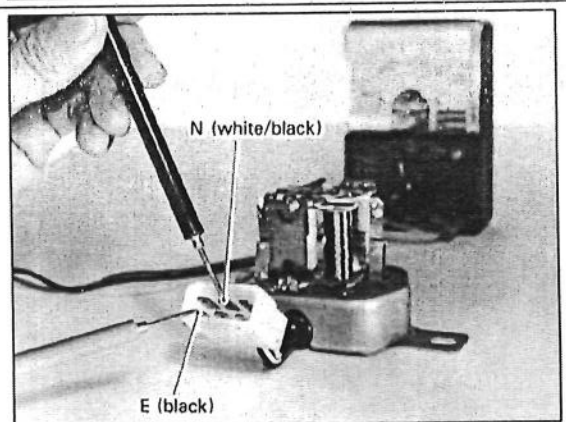
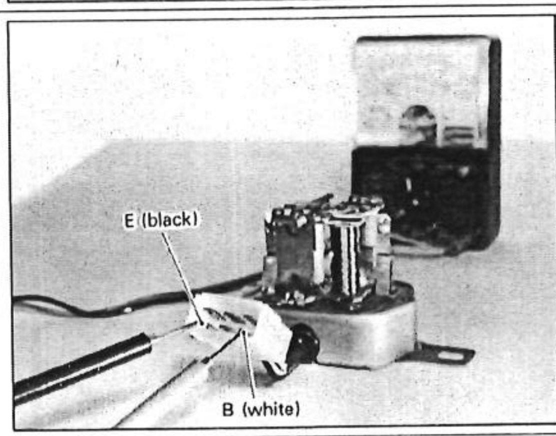
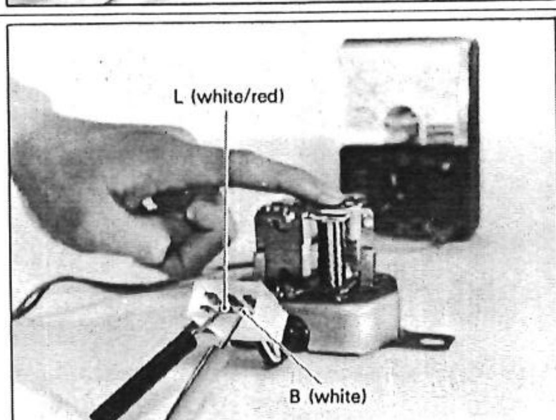
Tools and test instruments	Procedure	Remarks
	1) Disconnect the cable from the alternator's B terminal and connect an ammeter and voltmeter to B terminal. Then switch on all electrical loads (such as lights) and read the meters.	(Precautions for check) • Be sure to disconnect the battery's negative cable before setting the ammeter and voltmeter. • When the electrical load is considerably low or the battery is fully charged, the specified reading cannot be obtained.
	1) Remove the coupler from the alternator. 2) Turn the main switch on and then measure the voltage across the alternator coupler's F and E terminals.	

Item	Location	Reference value
Check 3 No-load testing of alternator		• **Reference value** <table><tr><th></th><th>Voltage</th><th>Rotational speed</th></tr><tr><td>M4000</td><td rowspan="5">14V</td><td rowspan="2">1200 ± 150rpm</td></tr><tr><td>M4500</td></tr><tr><td>M5500</td><td rowspan="3">830 ± 100rpm</td></tr><tr><td>M6500</td></tr><tr><td>M7500</td></tr></table>
Check 4 Diodes		• **Reference value** N terminal voltage should be 1/2 the B terminal voltage.
Check 5 Rotor coil, Slip ring, Brush		• **Reference value** 6Ω • **Allowable limit** 10Ω
Check 6 Cut-in voltage		• **Reference value** 4.5 to 5.8V

Tools and test instruments	Procedure	Remarks
 or   	1) Remove the alternator's coupler, connect the alternator's F terminal to B terminal, and ground E terminal to the body. 2) Connect a voltmeter across B terminal and the ground. 3) Start the engine and speed up the alternator to the specified rate. Next, turn the main switch off, disconnect the battery's negative cable and measure the voltage.	(Precaution for check) • Be sure to disconnect the battery's negative cable before setting the voltmeter.
 or  	1) Follow the same steps as in no-load testing of alternator. 2) Connect a voltmeter across B terminal and the ground and measure the voltage. 3) Connect a voltmeter across N terminal and the ground and measure the voltage.	• The diodes need not be tested if B terminal voltage measures 14V when the alternator is tested at no load.
	1) Disconnect the alternator coupler and then measure the resistance across the alternator's F and E terminals.	
 or  Bulb 30W	1) Connect a voltmeter across the alternator's N terminal and the body. 2) Remove the 4th 8A fuse from the left and connect a bulb (30W) in its place. 3) Speed up the alternator until the charge warning lamp goes off or dims, then read the voltmeter.	

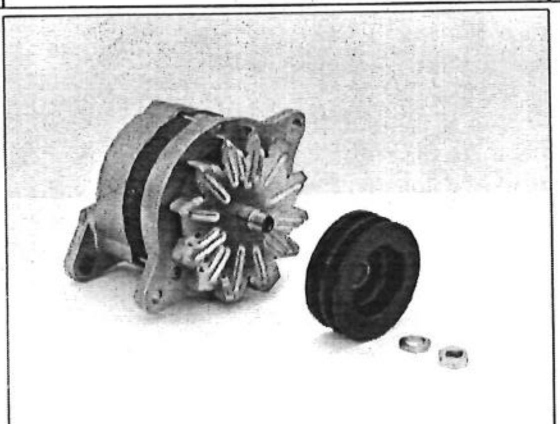
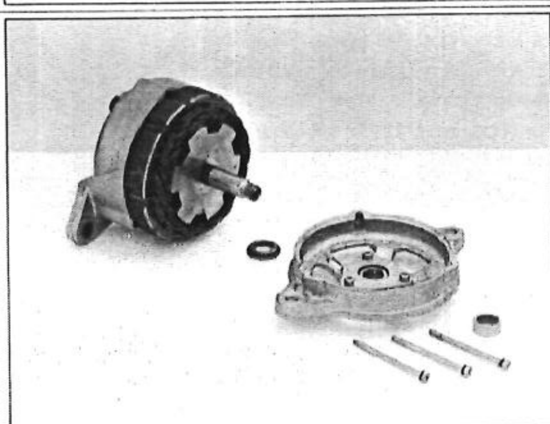
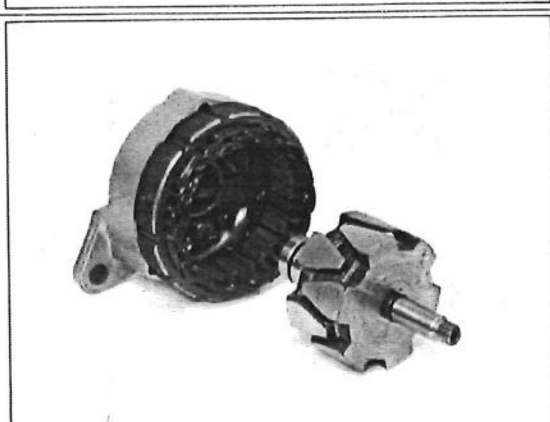
Item	Location	Reference value
Check 7 No-load regulating voltage		• **Reference value** 13.8 to 14.8V
Check 8 Regulator i) Test terminals IG-F		• **Reference value** Voltage regulator in stationary state 0Ω
Check ii) Test terminals IG-F		• **Reference value** Voltage regulator in attracted state approx. 11Ω
Check iii) Test terminals L-E		• **Reference value** Voltage relay in stationary state 0Ω

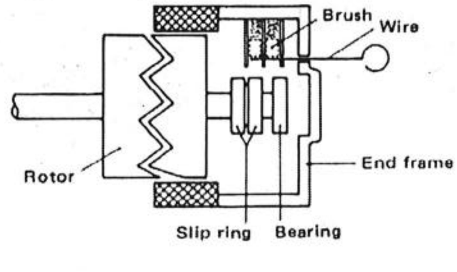
Tools and test instruments	Procedure	Remarks
 or 	1) Connect a voltmeter across the alternator's B terminal and the ground. 2) Start the engine, speed up to a rate (approx. 1,300 rpm) where the alternator is self-excited, and disconnect the battery's negative cable. 3) Read the voltmeter while gradually accelerating the engine.	(Precaution for check) ● Be sure to gradually accelerate the engine while reading the voltmeter. To read the voltmeter, do not decelerate the engine from maximum speed.
	1) Connect a circuit tester across the regulator's coupler IG (black/white) and F (white/green) terminal and measure the resistance. 2) If the reading exceeds zero ohms, the voltage regulator's low-speed side contact is faulty.	Fig.82 
	1) Connect a circuit tester across IG (black/white) and F (white/green) and read the tester while pressing the voltage regulator with a finger. 2) If the reading is infinity, the control resistor is broken.	
	1) Connect a circuit tester across L (white/red) and E (black) and measure the resistance. 2) If the reading exceeds zero ohms, the voltage relay contact is faulty.	

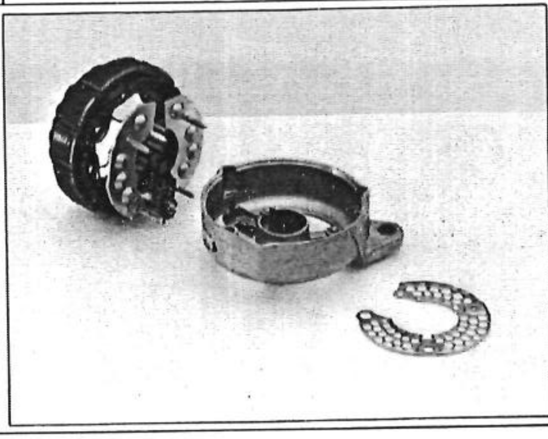
Item	Location	Reference value
Check iv) Test terminals L-E		• **Reference value** Voltage relay in attracted state approx. 100Ω
Check v) Test terminals N-E		• **Reference value** Approx. 32Ω
Check vi) Test terminals B-E		• **Reference value** Voltage relay in stationary state infinity
Check vii) Test terminals B-L		• **Reference value** Voltage relay in attracted state 0Ω

Tools and test instruments	Procedure	Remarks
	1) Connect a circuit tester across L (white/red) and E (black) and measure the resistance while pressing the voltage relay with a finger. 2) If the reading is zero ohms, the voltage relay contacts have fused together. 3) If the reading is infinity, the voltage coil is broken.	
	1) Connect a circuit tester across N (white/black) and E (black) and measure the resistance. 2) If the reading is under 32 ohms, the pressure coil has shorted. 3) If the reading is infinity, the pressure coil is broken.	
	1) Connect a circuit tester across B (white) and E (black) and measure the resistance. 2) If the reading is not infinity, the voltage relay contacts have fused together.	
	1) Connect a circuit tester across B (white) and L (white/red) and measure the resistance while pressing the voltage relay with a finger. 2) If the reading exceeds zero ohms, the voltage relay contacts are faulty.	

4. DISASSEMBLY OF ALTERNATOR

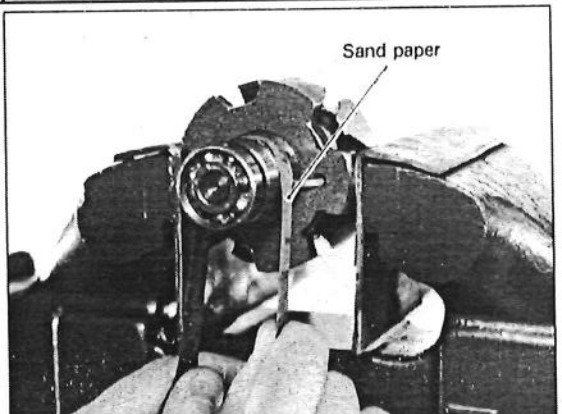
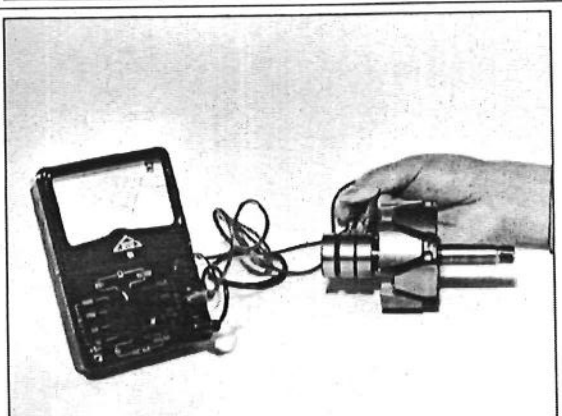
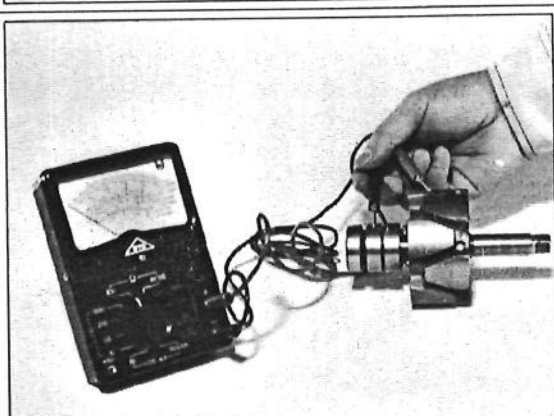
Item	Location	Bolts and nuts	Tools
Disassembly (1) Pulley		M14·········· 1	21 6
Disassembly (2) Drive end frame		M5 x 75 ············ 3 M5······· 3	
Disassembly (3) Rotor			

Procedure	Remarks
1) Clamp the shaft with a hexagonal wrench and remove the nut. 2) Remove the pulley. 3) Remove the fan.	
1) Remove the three through bolts. 2) Remove the drive end frame.	(When reassembling) • Do not forget to refit the collar and the spacer.
1) Draw the rotor out.	(When reassembling) • To refit the rotor, thread a wire through the access hole and lift the brush up with it. Fig.83 

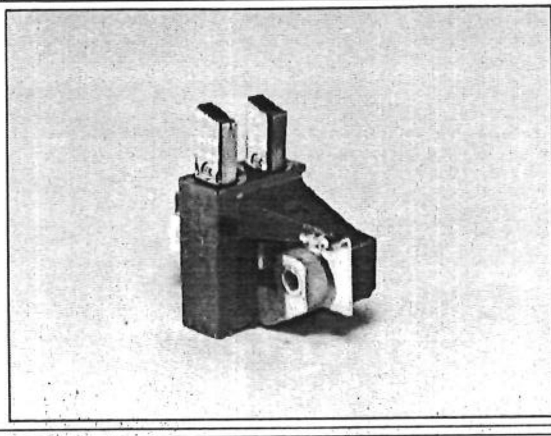
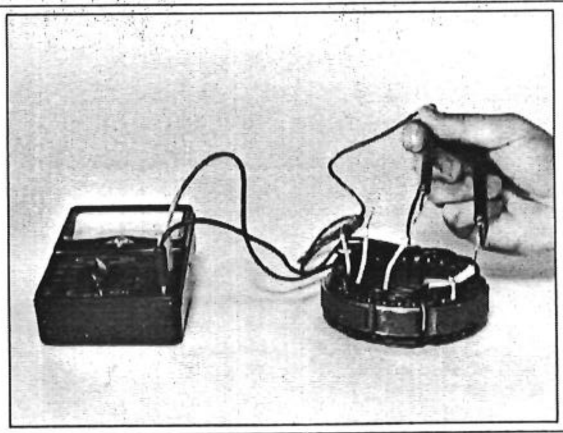
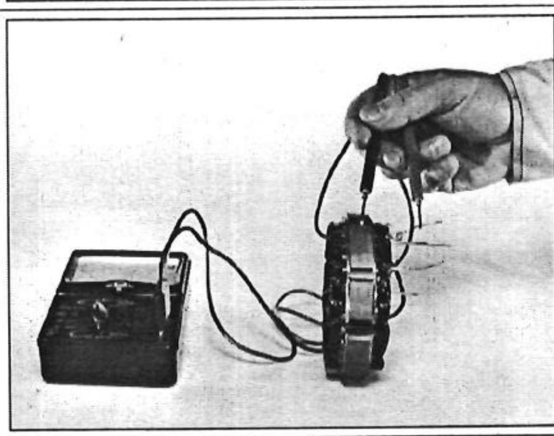
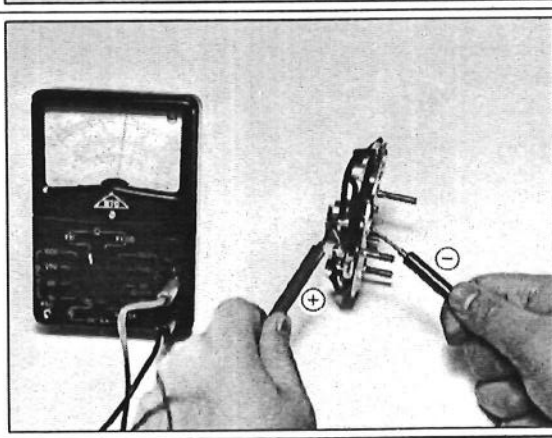
Item	Location	Bolts and nuts	Tools
Disassembly (4) End frame		M6······ 1 M5······ 3	8 10

Procedure	Remarks
1) Remove the nuts. 2) Remove the end cover.	

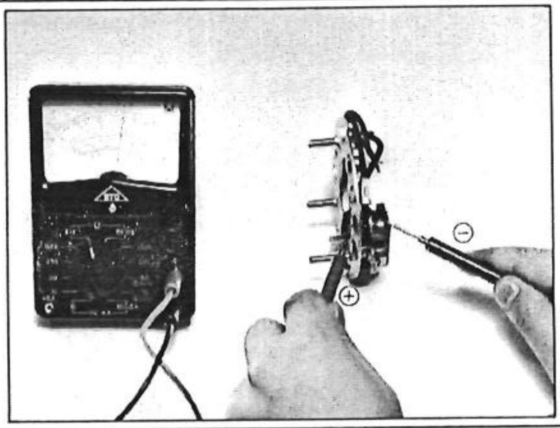
5. SERVICING OF ALTERNATOR

Item	Location	Reference value
Servicing (1) Slip ring		
Servicing (2) Rotor coil resistance		• **Reference value** Approx. 4.2Ω
Servicing (3) Grounding of rotor coil		• **Reference value** If not conducting, it is normal; if conducting, it is faulty.

Tools and test instruments	Procedure	Remarks
	1) Check to see if the slip ring is flawed. 2) If it is flawed, correct with sand paper or on a lathe.	
	1) Measure the resistance across the slip rings. 2) If the measurement is above or under the reference value, replace.	
	1) Check conduction across the slip ring and core. 2) If conducting, replace.	

Item	Location	Reference value
Servicing (4) Brush wear		• **Allowable limit** If the brush is worn by more than 1/3 the standard dimensions, replace it.
Servicing (5) Stator coil breakage		• **Reference value** If conducting, it is normal; if not, it is faulty.
Servicing (6) Grounding of stator coil		• **Reference value** If not conducting, it is normal; if conducting, it is faulty.
Servicing (7) Checking positive diodes		• **Reference value** If the ohmmeter indicates a specified value when the positive probe is applied to the holder and the negative probe to the diode terminal, and if it indicates infinity when the probes are reversed, the positive diodes are normal.

<table>
<tr><th>Tools and test instruments</th><th>Procedure</th><th>Remarks</th></tr>
<tr><td></td><td>1) Check the length of the brush.
2) Make sure that no powder clings to the brush and that the brush moves smoothly.
3) If the brush is faulty, replace.</td><td>● Brush dimensions
<table>
<tr><th></th><th>Length</th><th>Width</th><th>Thickness</th></tr>
<tr><td>M4000
M4500</td><td>15.5mm
0.6102in.</td><td>8.0mm
0.3150in.</td><td>7.0mm
0.2756in.</td></tr>
<tr><td>M5500
M6500
M7500</td><td>15.5mm
0.6102in.</td><td>8.0mm
0.3150in.</td><td>5.0mm
0.1969in.</td></tr>
</table></td></tr>
<tr><td></td><td>1) Check conduction across the stator coil's N terminal and each lead.
2) If not conducting, replace.</td><td></td></tr>
<tr><td></td><td>1) Check conduction across the stator coil's N terminal and core.
2) If conducting, replace.</td><td></td></tr>
<tr><td></td><td>1) Check the resistance across each diode holder and diode terminal.
2) If any diode is faulty, replace its whole positive assembly.</td><td>(When reassembling)
● Remember that diodes are very sensitive to heat.</td></tr>
</table>

Item	Location	Reference value
Servicing (8) Checking negative diodes		• **Reference value** If the ohmmeter indicates a specified value when the positive probe is applied to the diode terminal and the negative probe to the holder, and if it indicates infinity when the probes are reversed, the negative diodes are normal.

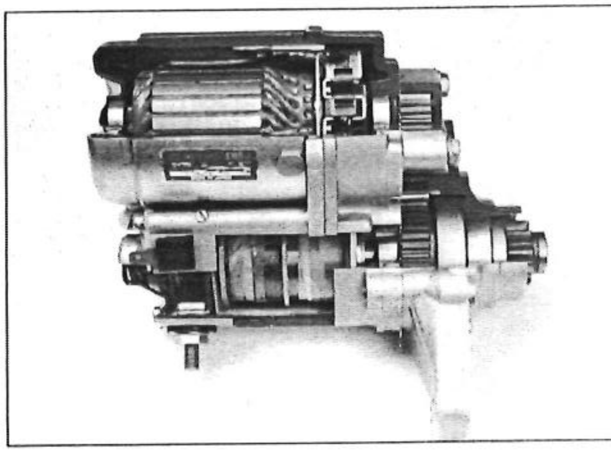
Tools and test instruments	Procedure	Remarks
 	1) Check the resistance across each diode holder and diode terminal. 2) If any diode is faulty, replace its whole negative assembly.	(When reassembling) • Remember that diodes are very sensitive to heat.

STARTER AND GLOW PLUGS

■ REDUCTION STARTER

1. CONSTRUCTION AND NAME OF PARTS

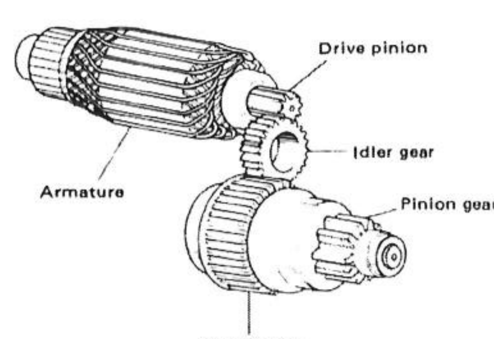
Unlike an ordinary starter whose armature drives the pinion gear without reducing speed, the reduction starter uses a small high-speed motor with 3 gears that reduce speed to 1/3 to drive the pinion gear.



- **Motor and Reduction Gear**

The motor consists of an armature, a stater and a brush. The drive pinion is splined to the end of the armature shaft. Since the drive pinion permanently engages with the idler gear and the clutch gear, the gear train reduces the rotational speed of the armature to about 1/3: drive pinion → idler gear → clutch gear. Finally power is transmitted to the pinion gear through the clutching mechanism.

Fig.84 Motor and reduction gear



• **Clutch**

As illustrated in Fig. 85, the clutch consists basically of a pinion gear and shaft, a spline tube (inner element), a clutch gear (outer element), and a clutch roller. The spline tube is internally splined to permanently mesh with splines on the pinion shaft. Unlike conventional roller type clutches, since the inner and outer elements rest on bearings secured to the housing, they do not pop out and only transmit torque from the outer to the inner element. Only the pinion shaft in mesh with the spline tube (inner) is pushed out by the magnet switch so that the pinion gear coupled with the pinion shaft moves into mesh with the ring gear. (Fig. 86) The clutch roller is an outer roller type. While the starter is in motion, the roller fits into the recess of the outer (clutch gear) so that the outer interlocks with the inner (spline tube) to transmit torque from the outer to the inner. In reverse, when the engine starts and speeds up to a point where the ring gear begins to drive the pinion gear, the inner engaged with the pinion shaft by their splines outpaces the outer. Therefore, as illustrated in Fig. 87, the roller compresses the roller spring to the point ② so that the outer de-meshes with the inner, preventing the armature from over-running.

Fig.85 Clutch OFF

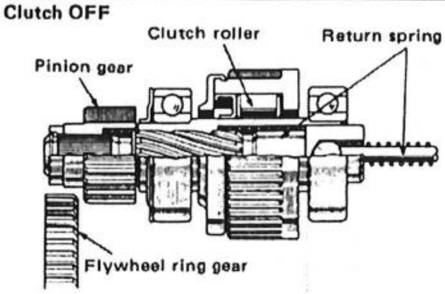


Fig.86 Clutch ON

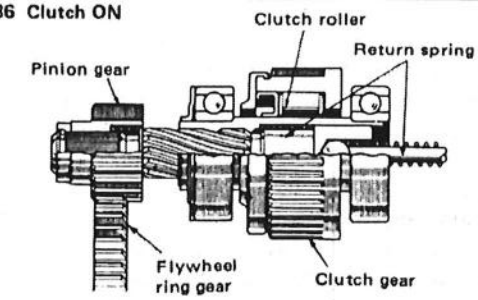
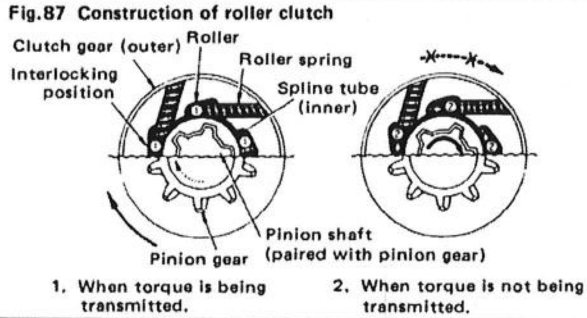


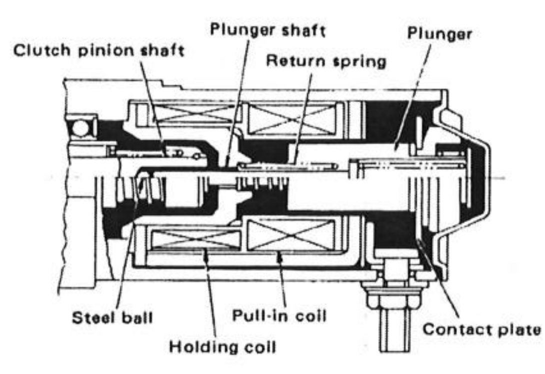
Fig.87 Construction of roller clutch



• **Magnet Switch**

As shown in Fig. 88, the magnet switch consists of a pull-in coil, a holding coil, a plunger, a plunger shaft, a contact plate, and contacts. Since the plunger, the contact plate, and the plunger shaft are all assembled into one unit, when the starter switch is turned on the plunger is attracted so that the plunger shaft pushes the clutch pinion shaft out. Therefore, the pinion gear moves into mesh with the ring gear, which in turn causes the contact plate to close its contacts letting the main current flow to the armature. When the starter switch is turned off, the plunger returns to the rest position under pressure from the return spring.

Fig.88 Construction of magnet switch



2. WIRING AND OPERATION

(1) STARTER SWITCH ON

(1) When the starter switch is turned on, current flows to the holding coil (H.C) and to the pull-in coil (P.C) concurrently and then to the armature coil. (At this point, both the holding coil and pull-in coil are magnetized in the same direction.)

(2) The plunger of the magnet switch is attracted to the left by the magnetism of the pull-in coil and holding coil, so that the pinion gear moves into mesh with the ring gear.

(3) Since the contact plate of the plunger closes its main contact when the pinion gear meshes with the ring gear, the field coil and the armature coil are directly connected to the battery, allowing a large current to flow from the battery.

(4) Then the armature rotates at a high speed. The high rotational speed is reduced to about 1/3 by the gear train of the drive pinion, the idler gear and the clutch gear. At this point, the pull-in coil is grounded, so that the plunger is retained only by the holding coil.

Fig.89 Starter switch ON

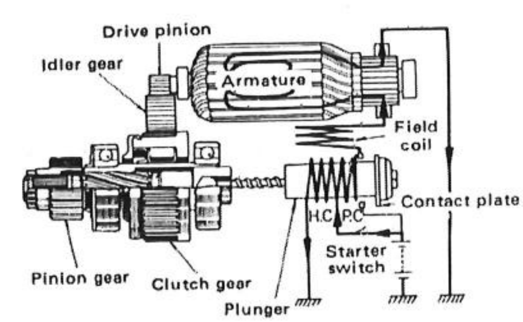
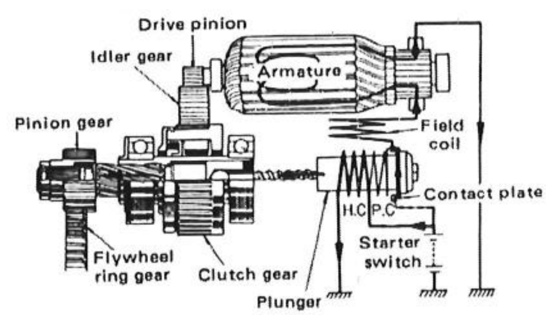


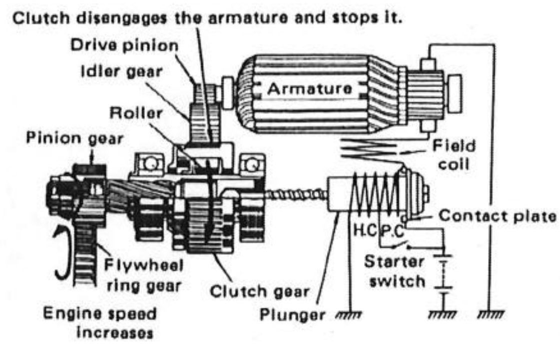
Fig.90 Magnet switch ON



(2) ENGINE STARTS

(1) When the engine starts, the armature begins to be driven by the ring gear. Then, the clutch is disengaged to prevent the armature from being driven at too high a speed.

Fig.91 When engine speed increases

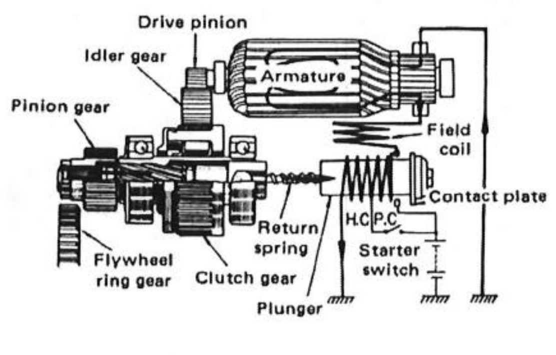


(3) STARTER SWITCH OFF

(1) Turning the starter switch off shuts off the current to the holding coil, releasing the plunger. The pinion gear returns to the rest position under pressure from the return spring.

(2) The main contact opens shutting off the current to the armature, causing the armature to stop. There is no armature brake as if found in conventional starters. Instead, the high-speed motor is braked by the friction between the brush and the commutator.

Fig.92 Starter switch OFF

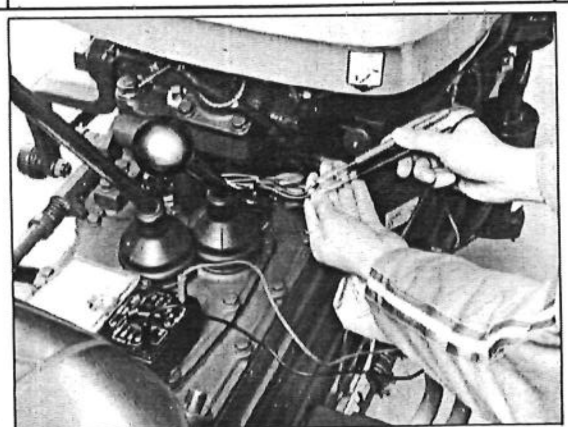
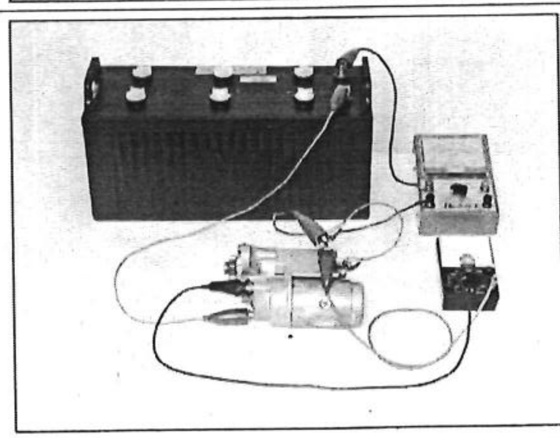


3. CHECK

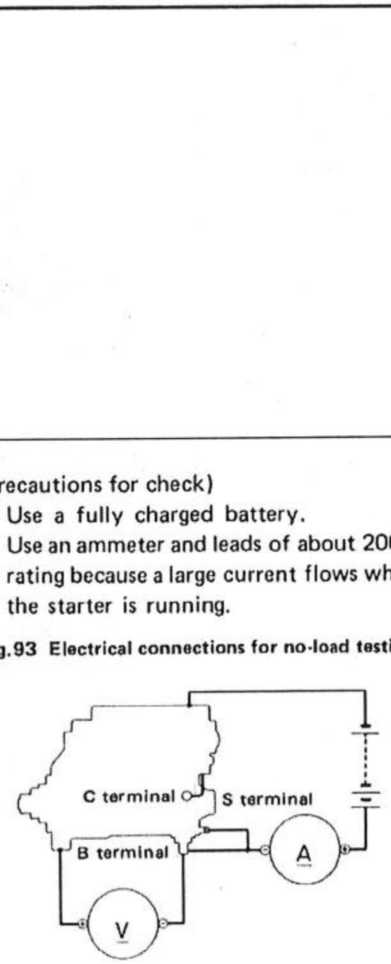
Checking Sequence

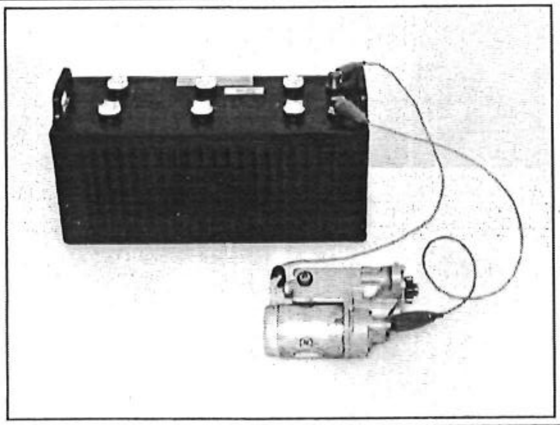
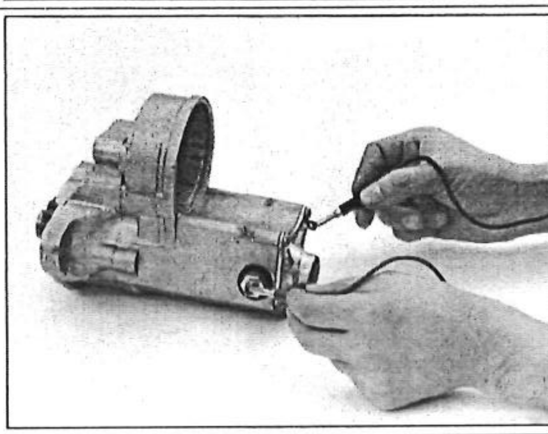
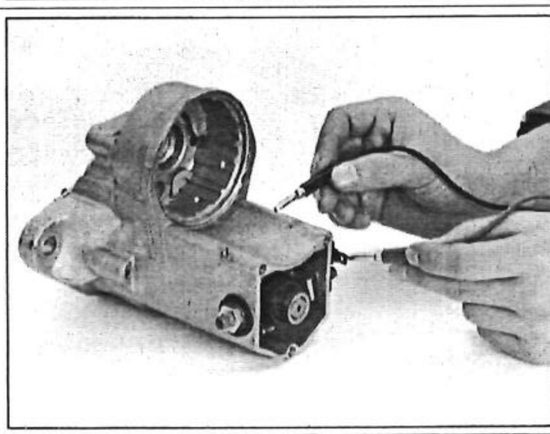
If the starter system malfunctions, do the following checks to locate the cause:

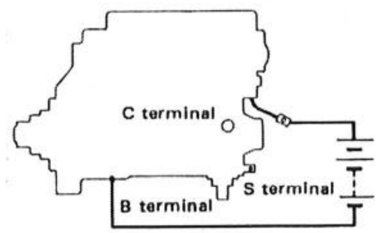
- (1) Check the safety switch
  - Battery terminal check
  - Wiring check
- (2) Test the starter at no-load
  - (3) Motor test
  - (4) Magnet switch check

Item	Location	Reference value
Check (1) Safety switch		• Reference value 0Ω
Check (2) No-load testing of starter		

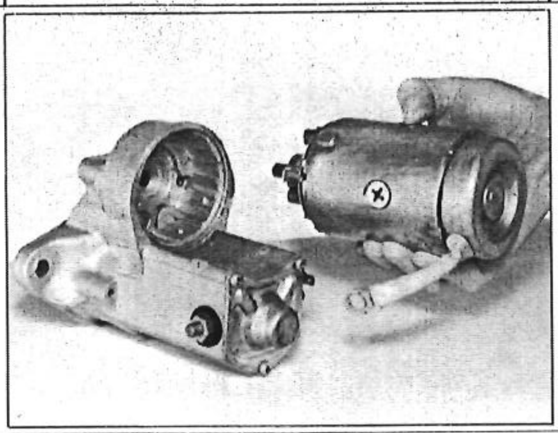
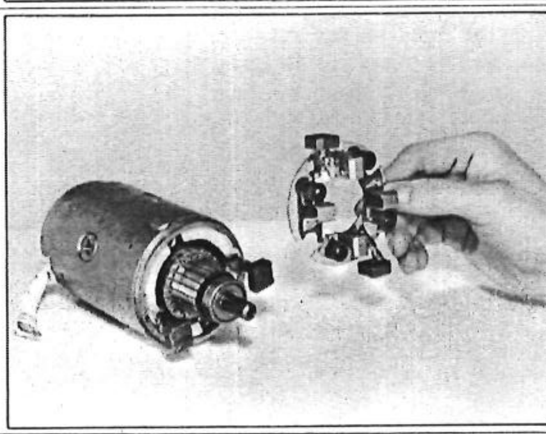
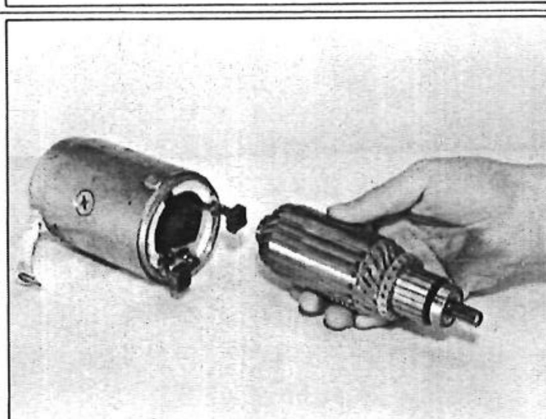
Model	Current	Voltage	Rotational speed
M4000	90A or less	11.5V	3,500 rpm or more
M4500			
M5500	180A or less	11V	
M6500			
M7500			

Tools and test instruments	Procedure	Remarks
	1) Remove the safety switch leads. 2) Connect a circuit tester to the safety switch side leads. 3) Measure the resistance with the auxiliary gear shift lever in neutral. 4) If the safety switch is faulty, replace it.	
Battery	1) Connect the ammeter's positive probe to the battery's positive terminal and the negative probe to the starter's B terminal. 2) Connect the battery's negative terminal to the starter body. 3) Connect the voltmeter's positive probe to the starter's B terminal and the negative probe to the satarter body. 4) Set a tachometer. 5) Connect the starter's B terminal to the magnet switch's S terminal. 6) Check to see that the magnet switch is operating and that the specified speed, current and voltage are obtained.	(Precautions for check) • Use a fully charged battery. • Use an ammeter and leads of about 200A rating because a large current flows when the starter is running. **Fig.93 Electrical connections for no-load testing** 

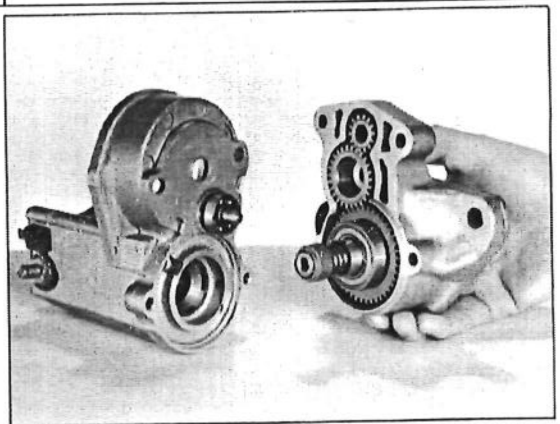
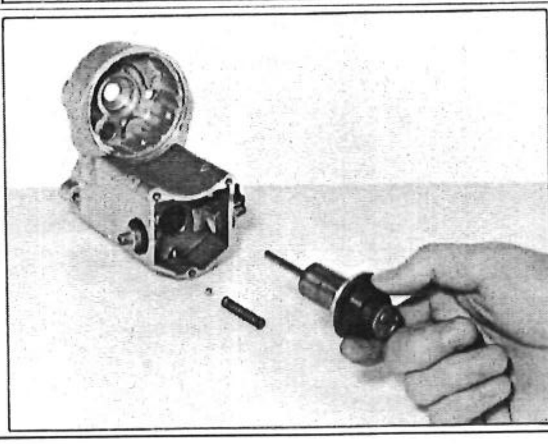
Item	Location	Reference value
Check (3) Motor test		• **Reference value** If it turns lightly, normal.
Check (4) Magnet switch i) Pull-in coil (Attraction test)		• **Reference value** If the plunger is attracted strongly, the pull-in coil is normal; if not, it is faulty.
Check ii) Holding coil (Retention test)		• **Reference value** If the plunger remained attracted, the holding coil is normal; if not, it is faulty.

Tools and test instruments	Procedure	Remarks
Battery	1) Remove the connecting leads from the starter's C terminal and connect them directly to the battery's positive terminal. Then connect the battery's negative terminal to the starter body. 2) If the starter runs normally, the magnet switch is defective; if not, the motor is defective.	Fig.94 Electrical connections for motor test 
Battery	1) Apply 1/2 the rated voltage (approx. 6V) across the S terminal and C terminal. 2) If the plunger is attracted strongly, the pull-in coil is good; if not, it is defective.	
Battery	1) Apply 1/2 the rated voltage (approx. 6V) across the S terminal and the body, push the plunger in by hand, and then release it. 2) If the plunger stays attracted, the holding coil is good; if not, it is defective.	

4. DISASSEMBLY

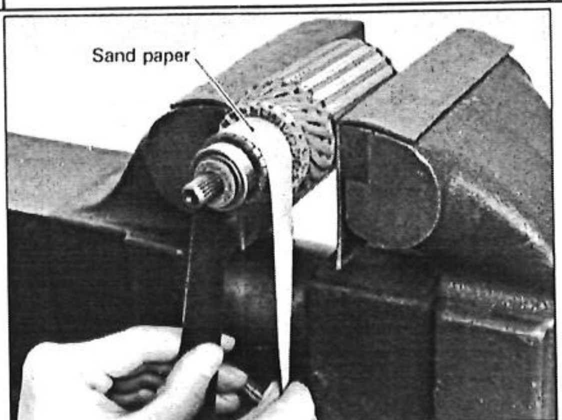
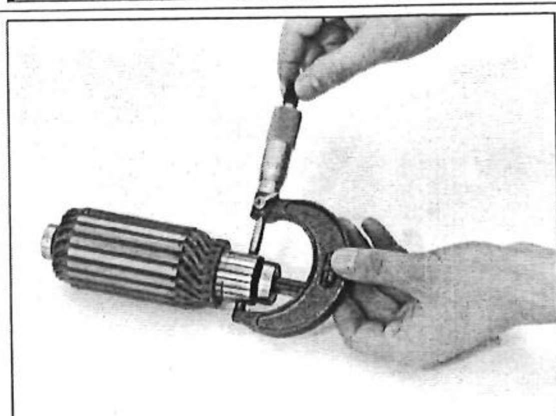
Item	Location	Bolts and nuts	Tools
Disassembly (1) Motor removal		M8······· 1 Special bolt ····· 2 M6······· 2 M6······· 2 ············ 2	 10 12
Disassembly (2) Brush holder			
Disassembly (3) Armature			

Procedure	Remarks
1) Disconnect the connecting lead. 2) Remove the through bolts. 3) Remove the motor unit.	
1) Release the spring and draw the brush out from the holder. 2) Remove the brush holder.	
1) Draw the armature out.	

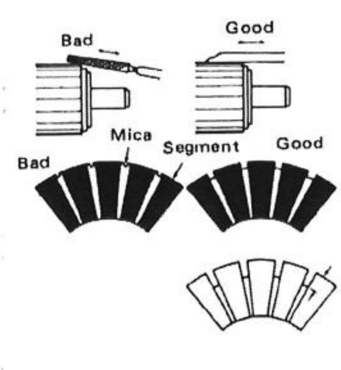
Item	Location	Bolts and nuts	Tools
Disassembly (4) Drive end frame		M6x40 .... 2 M6 2	
Disassembly (5) Plunger		M5x10 3	

Procedure	Remarks
1) Remove the drive end frame. 2) Remove the gears (drive pinion, idler gear) and clutch.	
1) Remove the end cover from the magnet switch. 2) Draw the plunger out. 3) Remove steel balls.	

5. SERVICING

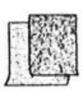
<table>
<tr><th>Item</th><th>Location</th><th>Reference value</th></tr>
<tr><td>Servicing (1)
Staining or burning of commutator</td><td>
</td><td></td></tr>
<tr><td>Servicing (2)
Commutator wear</td><td></td><td>

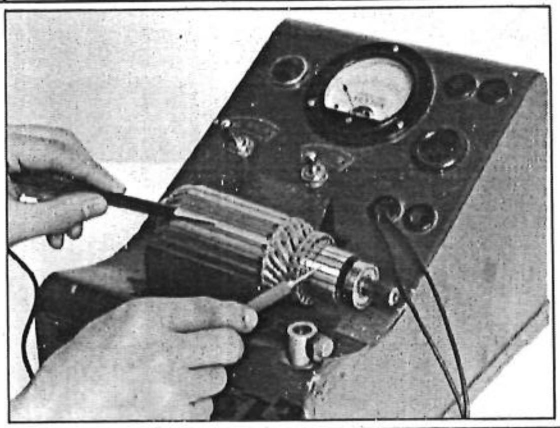
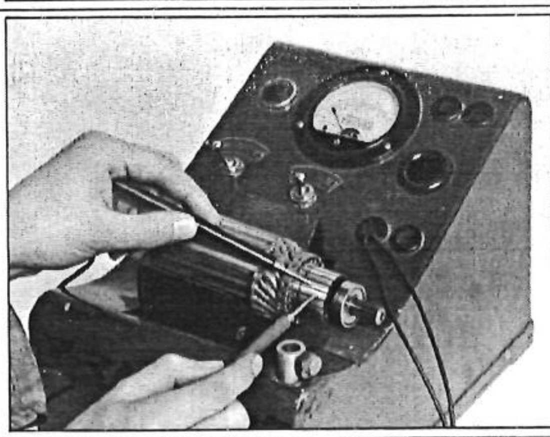
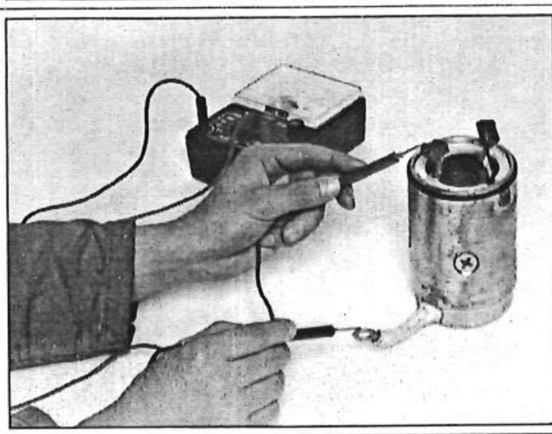
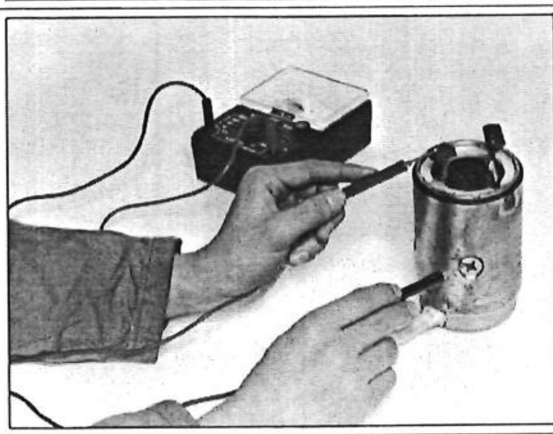
• Commutator diameter

<table>
<tr><th>Model</th><th>Reference value</th><th>Allowable limit</th></tr>
<tr><td>M4000
M4500</td><td>30.0mm
1.1811in.</td><td>29.0mm
1.1417in.</td></tr>
<tr><td>M5500
M6500
M7500</td><td>36.0mm
1.4173in.</td><td>34.0mm
1.3386in.</td></tr>
</table>
</td></tr>
<tr><td>Servicing (3)
Mica (Undercut)</td><td>
</td><td>

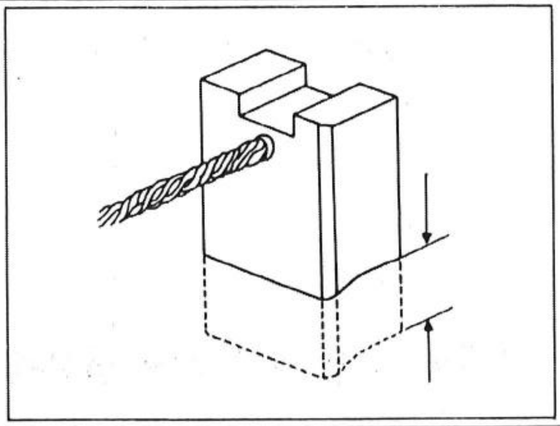
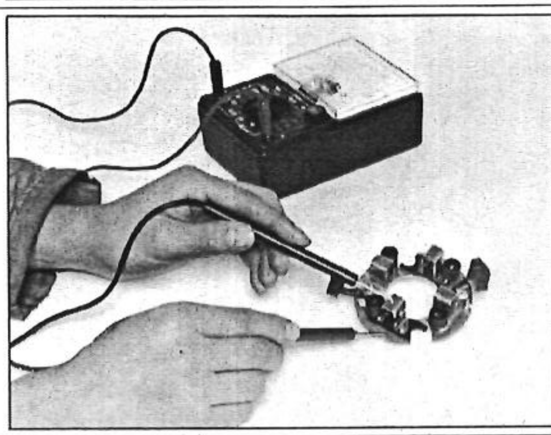
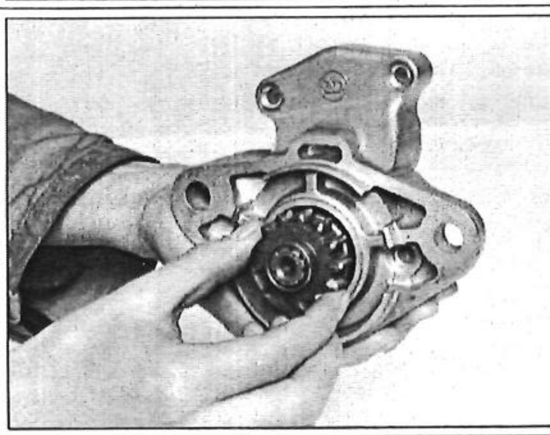
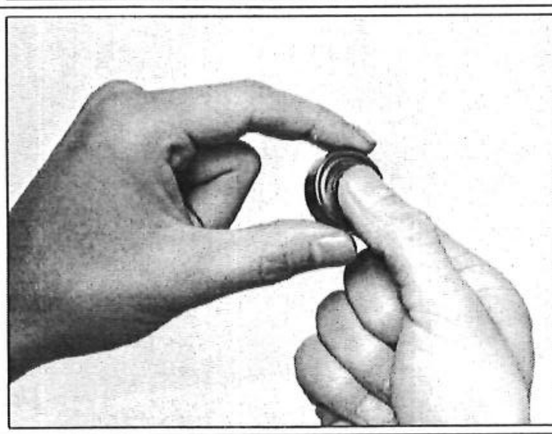
• Mica depth

<table>
<tr><th>Model</th><th>Reference value</th><th>Allowable limit</th></tr>
<tr><td>M4000
M4500</td><td>0.5 to 0.9mm
0.0197 to 0.0354in.</td><td rowspan="2">0.2mm
0.0079in.</td></tr>
<tr><td>M5500
M6500
M7500</td><td>0.3 to 0.7mm
0.0118 to 0.0276in.</td></tr>
</table>
</td></tr>
</table>

Tools and test instruments	Procedure	Remarks
	1) Check to see if the commutator surface is stained or burnt. 2) If it is burnt, grind off with fine-grain sand paper.	
 	1) Check to see if the contact face of the brush is scored. 2) If scored, grind off with sand paper or on a lathe. 3) If the commutator diameter must be ground to below the allowable limit, replace it.	
	1) Check to see the mica undercut. 2) If it has high mica, rectify with a saw blade. As the edge of the segment will be rough, chamfer it.	

Item	Location	Reference value
Servicing (4) Grounding of armature coil		• **Reference value** If not conducting, it is normal; if conducting, it is faulty.
Servicing (5) Armature coil breakage		• **Reference value** If conducting, it is normal; if not conducting, it is faulty.
Servicing (6) Field coil breakage		• **Reference value** If conducting, it is normal; if not conducting, it is faulty.
Servicing (7) Grounding of field coil		• **Reference value** If not conducting, it is normal; if conducting, it is faulty.

Tools and test instruments	Procedure	Remarks
	1) Check conduction across the commutator and the armature shaft. 2) If conducting, replace.	
	1) Check conduction across each pair of segments adjacent to the commutator. 2) If any are not conducting, replace.	
	1) To check conduction, place the tester probes onto the lead and brush. 2) If either are not conducting, replace.	
	1) Place the tester probes onto the field coil and yoke. 2) If either are conducting, replace.	

Item	Location	Reference value
Servicing (8) Brush wear		• **Allowable limit** If the brush is worn by more than 1/3 the standard dimensions, replace it.
Servicing (9) Grounding of brush holder		• **Reference value** If not conducting, it is normal; if conducting, it is faulty.
Servicing (10) Clutch		
Servicing (11) Bearing		

<table>
<tr><th>Tools and test instruments</th><th>Procedure</th><th>Remarks</th></tr>
<tr><td></td><td>1) Check to see if the brush has worn to more than 2/3 below the standard dimensions.
2) If wear exceeds the allowable limit, replace.</td><td>• Starter brush dimensions
<table>
<tr><th>Tractor model</th><th>Length</th><th>Width</th><th>Thickness</th></tr>
<tr><td>M4000
M4500</td><td>19mm
0.7480in.</td><td>25mm
0.9843in.</td><td>8mm
0.3150in.</td></tr>
<tr><td>M5500
M6500
M7500</td><td>19mm
0.7480in.</td><td>12mm
0.4724in.</td><td>7mm
0.2756in.</td></tr>
</table></td></tr>
<tr><td></td><td>1) Check the insulation of the positive brush holder.
2) If the insulation is defective, replace.</td><td></td></tr>
<tr><td></td><td>1) Check to see if the clutch gear is worn or damaged.
2) Check to see if the gear locks in the driving direction and rotates smoothly in reverse.</td><td></td></tr>
<tr><td></td><td>1) Apply torque to the inner ring with your finger tips and check to see if it turns smoothly.
2) Check to see if there are any strange noises when driven quickly.</td><td></td></tr>
</table>

■GLOW PLUG

1. CONSTRUCTION AND NAME OF PARTS

One glow plug is provided in each auxiliary chamber of the diesel engine such as the precombustion and swirl chambers. Glow plugs have two kinds of configuration: the coil-type for series connection and the bar-type for parallel connection. In a Kubota Diesel Engine, bar-type glow plugs (sheathed-type) are used.

Fig.106 Bar-type glow plug

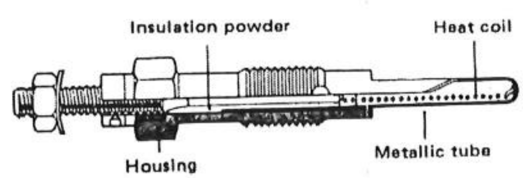
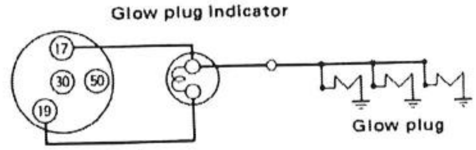
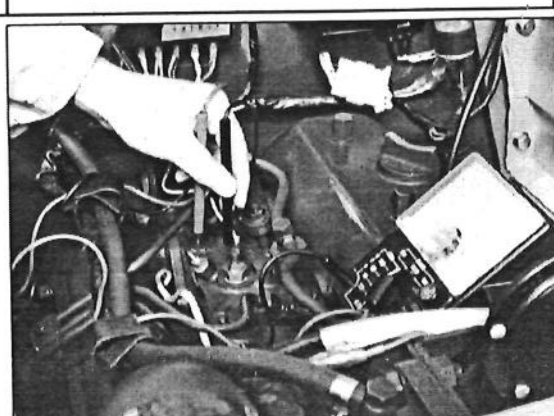


Fig.107 Glow plug circuit

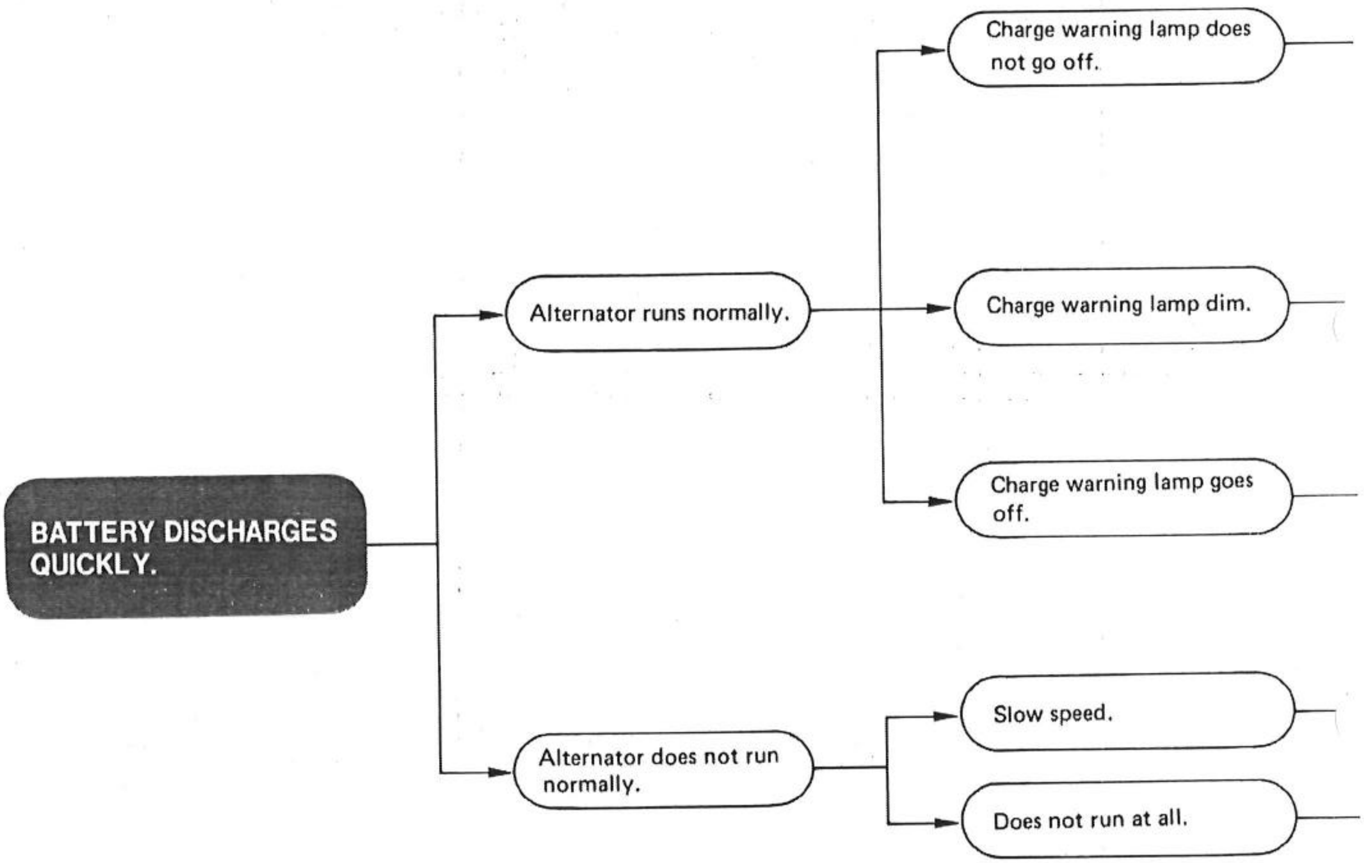


2. CHECK

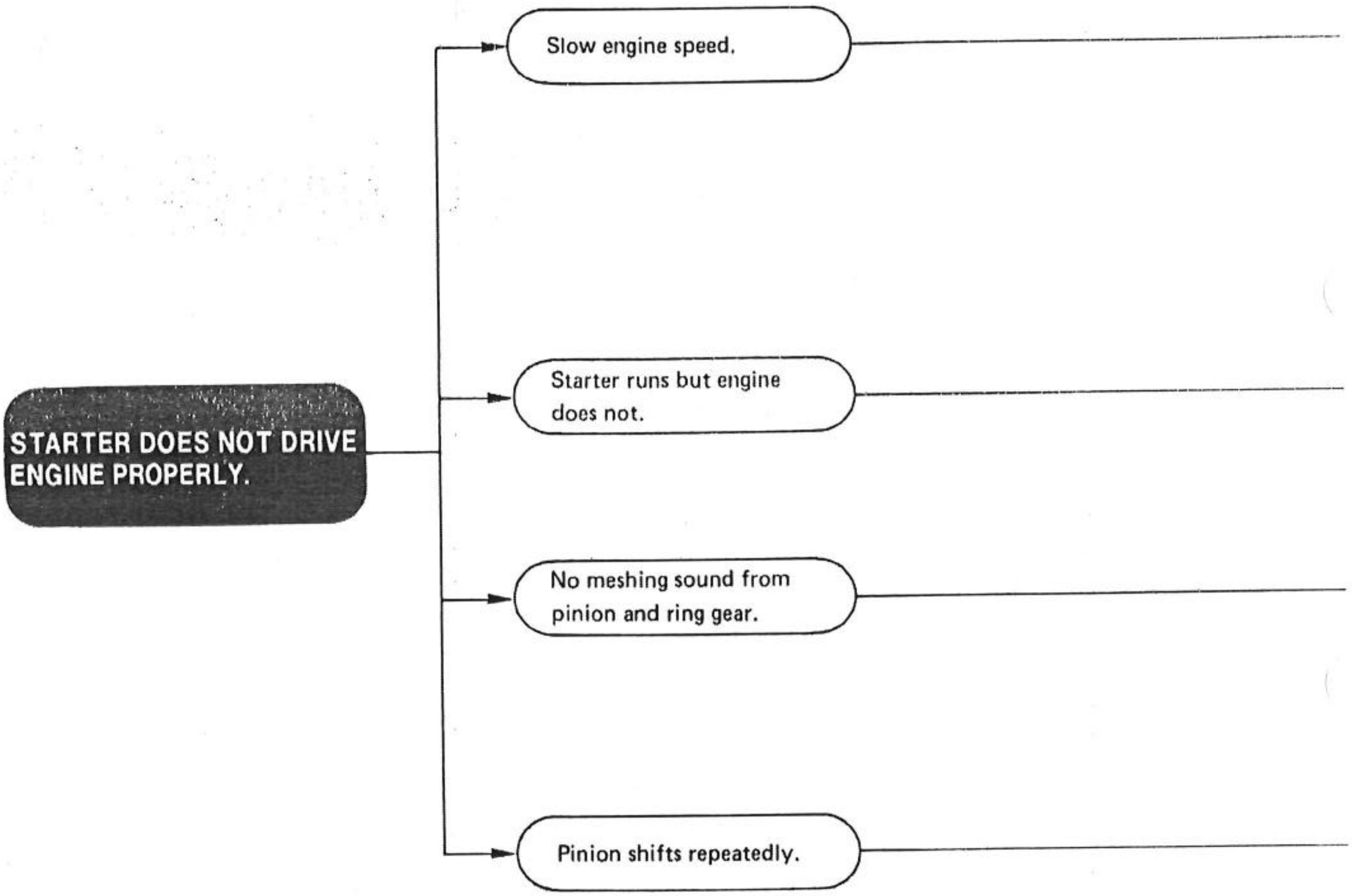
Item	Location	Reference value
Check (1) Glow plug broken or short-circuited		• **Reference value** Approx. 1.6Ω

Tools and test instruments	Procedure	Remarks
	1) Disconnect the glow plug cables and leads. 2) Connect a circuit tester across the screw of the glow plug end and the body. ■ If the resistance is zero ohms, the glow plug is shorted. ■ If the resistance is infinite, the glow plug coil is broken.	

TROUBLE SHOOTING



		Reference
Incorrect wiring.	Coupler disconnects from alternator.	
Faulty alternator.	Faulty rotor.	324 334
	Faulty stator.	324 336
	Faulty rectifier.	324 338 336
Faulty regulator.	Faulty voltage relay.	326~ 328
Incorrect wiring.	Incorrect wiring between alternator and regulator.	
Faulty regulator.	Faulty voltage relay.	326~ 328
Charging current too low.	Faulty alternator.	322~
Charging current normal.	Faulty battery.	310~ 314
	Alternator speed too slow.	
	Extra electrical loads (such as lamp) installed.	
	Fan belt slips.	
	Alternator V-pulley slips.	330
	Fan belt broken.	


STARTER DOES NOT DRIVE ENGINE PROPERLY.
Slow engine speed.
Starter runs but engine does not.
No meshing sound from pinion and ring gear.
Pinion shifts repeatedly.

Cause	Detail	Reference
Faulty battery.	Battery not sufficiently charged.	310~314
	Terminal contact poor.	310
	Poor grounding.	310
Faulty starter.	Over-running clutch slips.	358
	Poor contact of contact plate.	346
	Poor contact between brush and commutator.	354 358
	Armature and field coil shorted.	356
	Bearing worn.	358
Pinion and ring gear do not mesh.	Pinion and ring gear worn.	
	Plunger and shaft distorted.	
Clutch slips.	Over-running clutch worn.	358
Pinion does not pop out by the attraction force of magnet switch.	Main switch or starter switch faulty.	
	Faulty magnet switch.	348
	Screw spline rusted.	
	Faulty battery.	310~314
Faulty battery.	Battery not sufficiently charged.	314
	Poor terminal contact.	310
	Grounded poorly.	310
Faulty magnet switch.	Holding coil broken.	348

GLOW PLUG INDICATOR DOES NOT TURN RED PROPERLY.

- Does not turn red at all.
- Turns red too quickly.

FLASHER LAMPS DO NOT BLINK.

- Lamps do not turn on at all.
- Lamps stay on without blinking.
- One of the lamps does not blink.

		Reference
Faulty battery.	Battery not charged sufficiently.	314
	Poor terminal contact.	310
	Poorly grounded	310
Incorrect wiring.	Incorrect wiring between battery and glow plug.	
	Glow plug indicator disconnected.	360
	Glow plug disconnected.	360
	Main switch or starter switch faulty.	

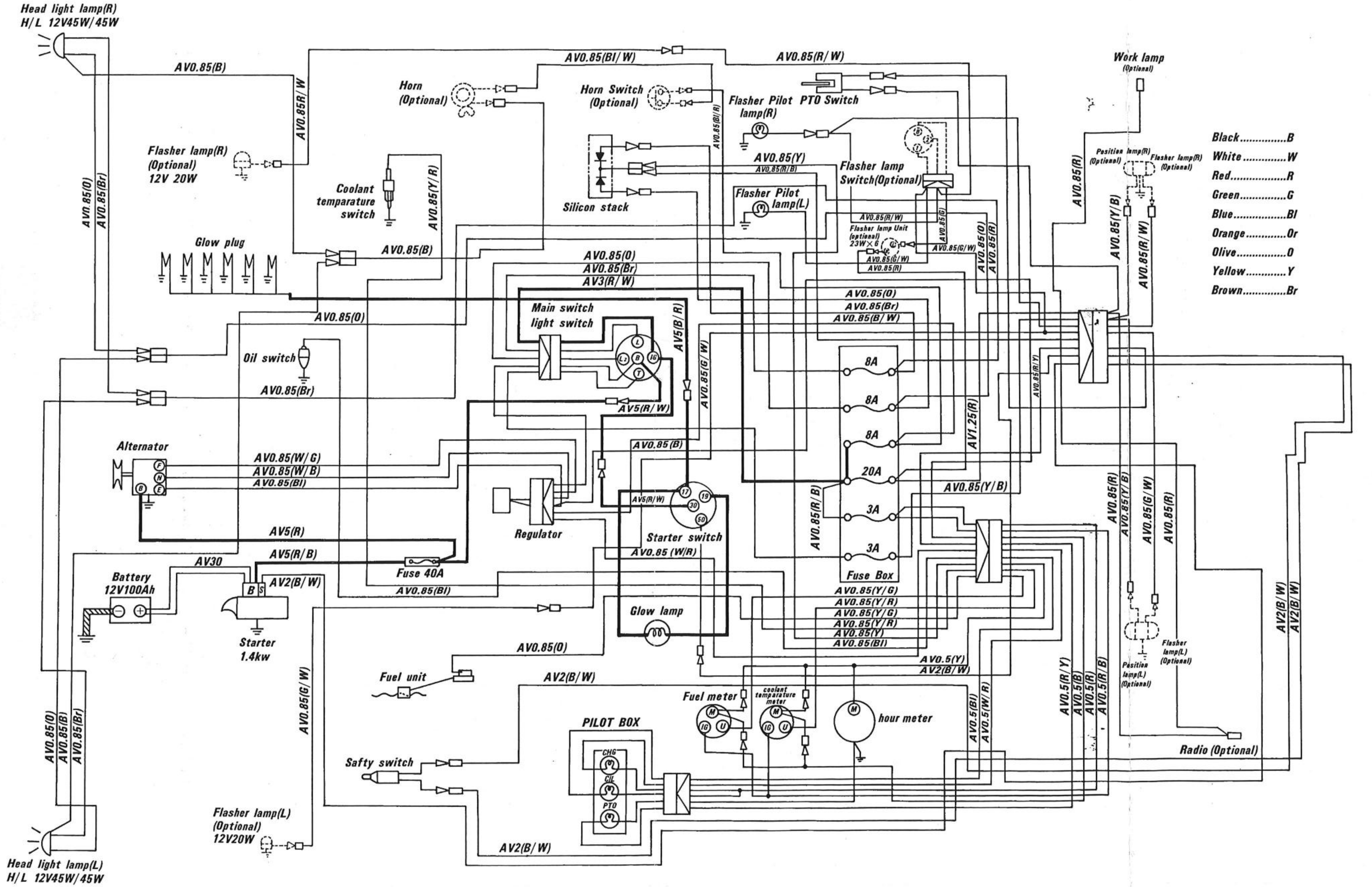
Circuit shorted.	Shorted between glow plug indicator and glow plug.	378
	Glow plug indicator shorted.	378
	Glow plug shorted.	378
	Glow plug cable shorted.	378

Faulty battery.	Battery not charged sufficiently.	314
Incorrect wiring.	Fuse broken.	
	Disconnected between battery and flasher lamp.	
Faulty switch.	Circuit in flasher unit broken.	
	Poor contact in flasher switch.	
	Electric bulb burnt out.	

Flasher unit contacts fused together.	

Disconnected between flasher switch and flasher lamp.	
Electric bulb burnt out.	

ELECTRICAL WIRING



SERVICE DIRECTIONS

			S2200	S2600	D3000	V4000L	V4000
CYLINDER HEAD	Distortion of cylinder head surface		±0.03 mm ±0.0012 in.		±0.05 mm ±0.0020 in.		
	Thickness of gasket		1.45 mm 0.0571 in.		1.6±0.08 mm 0.0630±0.0031 in.		
	Thickness of gasket shims		0.15 mm 0.0059 in.		0.20 mm 0.0079 in.		
	Top clearance		0.7 to 0.9 mm 0.0276 to 0.0354 in.		0.8 to 1.0 mm 0.0315 to 0.0394 in.		
	Tightness of head bolts and nuts		73.5 to 83.4 N·m. 7.5 to 8.5 kgf·m. 54.2 to 61.5 lb.ft.		127.5 to 137.3 N·m. 13 to 14 kgf·m. 94.0 to 101.3 lb.ft.		

			S2200	S2600	D3000	V4000L	V4000
VALVES	Valve seat width		2.1 mm 0.0827 in.		2.5 to 3.25 mm 0.0984 to 0.1280 in.		
	Valve seat angle		45°		45.5°		
	O.D. of valve stems (Intake, Exhaust)		7.959 to 7.975 mm 0.3133 to 0.3140 in.		9.960 to 9.975 mm 0.3921 to 0.3927 in.		
	I.D. of valve guides (Intake, Exhaust)		8.015 to 8.030 mm 0.3156 to 0.3161 in.		10 to 10.015 mm 0.3937 to 0.3943 in.		
	Clearance between valve stems and guides	(R.V.)	0.04 to 0.07 mm 0.0016 to 0.0028 in.		0.025 to 0.055 mm 0.0010 to 0.0022 in.		
		(A.L.)	0.1 mm 0.0039 in.				
	Valve recessing		1.1 to 1.3 mm 0.0433 to 0.0512 in.		0.7 to 1.1 mm 0.0276 to 0.0433 in.		
	Valve clearance (Intake, Exhaust)	Cold	0.18 to 0.22 mm 0.0071 to 0.0087 in.		~~0.45 mm~~ 0.25 mm ~~0.0177 in.~~ 0.098 in.		

			S2200	S2600	D3000	V4000L	V4000
VALVE SPRINGS	Free length		41.7 to 42.2 mm 1.6417 to 1.6614 in.		65.5 mm 2.5787 in.		
	Fitted length		35.15 mm 1.3839 in.		40.5 to 41.5 mm 1.5945 to 1.6339 in.		
	Load to compress to fitted length	(R.V.)	117.7 N. 12 kgf. 26.5 lb.		313.8 N. 32 kgf. 70.6 lb.		
		(A.L.)	100.0 N. 10.2 kgf. 22.5 lb.		—		
	Squareness		3% or less				

		S2200	S2600	D3000	V4000L	V4000
VALVE ROCKER ARMS	O.D. of rocker arm shafts	13.973 to 13.984 mm 0.5501 to 0.5506 in.		17.982 to 18.000 mm 0.7080 to 0.7087 in.		
	I.D. of rocker arm bushings	14.002 to 14.043 mm 0.5513 to 0.5529 in.		18.016 to 18.034 mm 0.7093 to 0.7100 in.		
	Clearance between rocker arm shafts and bushings (R.V.)	0.01 to 0.07 mm 0.0004 to 0.0028 in.		0.016 to 0.052 mm 0.0006 to 0.0020 in.		
	Clearance between rocker arm shafts and bushings (A.L.)	0.15 mm 0.0059 in.		0.12 mm 0.0047 in.		
	Adjustment of compression release	0.750 to 1.125 mm 0.0295 to 0.0443 in.		————		

		S2200	S2600	D3000	V4000L	V4000
CAMSHAFT	O.D. of camshaft bearing journal 1	39.934 to 39.950 mm 1.5722 to 1.5728 in.		50.921 to 50.940 mm 2.0048 to 2.0055 in.		
	O.D. of camshaft bearing journal 2	————		50.421 to 50.440 mm 1.9851 to 1.9858 in.		
	O.D. of camshaft bearing journal 3	————		49.934 to 49.950 mm 1.9659 to 1.9665 in.		
	I.D. of camshaft bearing 1	40.000 to 40.025 mm 1.5748 to 1.5758 in.		51.000 to 51.070 mm 2.0079 to 2.0106 in.		
	I.D. of camshaft bearing 2	————		50.500 to 50.570 mm 1.9882 to 1.9909 in.		
	I.D. of camshaft bearing 3	————		50.010 to 50.080 mm 1.9689 to 1.9717 in.		
	Clearance between camshaft bearing journals and bearing (R.V.)	0.050 to 0.091 mm 0.0020 to 0.0036 in.		0.060 to 0.149 mm 0.0024 to 0.0059 in.		
	Clearance between camshaft bearing journals and bearing (A.L.)	0.15 mm 0.0059 in.		————		
	Alignment of camshaft (A.L.)	0.08 mm 0.0031 in.				
	Cam height (Intake) (R.V.)	33.36 mm 1.3134 in.		41.50 mm 1.6339 in.		
	Cam height (Intake) (A.L.)	33.31 mm 1.3114 in.		41.45 mm 1.6319 in.		
	Cam height (Exhaust) (R.V.)	33.36 mm 1.3134 in.		42.027 mm 1.6546 in.		
	Cam height (Exhaust) (A.L.)	33.31 mm 1.3114 in.		41.977 mm 1.6526 in.		
		continued				

			S2200	S2600	D3000	V4000L	V4000
CAMSHAFT	Gear backlash	(R.V.)	0.041 to 0.115 mm 0.0016 to 0.0045 in.		0.044 to 0.139 mm 0.0017 to 0.0055 in.		
		(A.L.)	0.3 mm 0.0118 in.				
CYLINDER LINERS	I.D. of cylinder liner	(R.V.)	76.000 to 76.019mm 2.9921 to 2.9929 in.	82.000 to 82.019mm 3.2283 to 3.2291 in.	105.000 to 105.018 mm 4.1339 to 4.1346 in.		
		(A.L.)	+0.15 mm +0.0059 in.				
PISTON RINGS	Ring gap (Top ring, 2nd ring)	(R.V.)	0.3 to 0.45 mm 0.0118 to 0.0177 in.		0.4 to 0.6 mm 0.0157 to 0.0236 in.		
		(A.L.)	1.25 mm 0.0492 in.		1.5 mm 0.0591 in.		
	Ring gap (Oil ring)	(R.V.)	0.25 to 0.40 mm 0.0098 to 0.0157 in.		0.25 to 0.50 mm 0.0098 to 0.0197 in.		
		(A.L.)	1.25 mm 0.0492 in.		1.5 mm 0.0591 in.		
	Side clearance of ring in groove	(Top ring)	————		0.088 to 0.125 mm 0.0035 to 0.0049 in.		
		(2nd ring)	0.093 to 0.120 mm 0.0037 to 0.0047 in.		0.05 to 0.082 mm 0.0020 to 0.0032 in.		
		(Oil ring)	0.020 to 0.052 mm 0.0008 to 0.0020 in.		0.040 to 0.072 mm 0.0016 to 0.0028 in.		
	Oversizes of piston and ring		0.5 mm 0.0197 in.		0.2, 0.4, 0.6 mm 0.0079, 0.0157, 0.0236 in.		

			S2200	S2600	D3000	V4000L	V4000
PISTONS	I.D. of piston bosses	(R.V.)	23.000 to 23.013 mm 0.9055 to 0.9060 in.		33.993 to 34.000 mm 1.3383 to 1.3386 in.		
		(A.L.)	23.053 mm 0.9076 in.		34.040 mm 1.3402 in.		
	O.D. of piston pin		23.002 to 23.011 mm 0.9056 to 0.9059 in.		33.983 to 33.990 mm 1.3379 to 1.3382 in.		
	I.D. of connecting rod small end bushings (fitted)		23.025 to 23.040 mm 0.9065 to 0.9071 in.		34.005 to 34.012 mm 1.3388 to 1.3391 in.		
	Clearance between piston pin and small end bushings	(R.V.)	0.014 to 0.038 mm 0.0006 to 0.0015 in.		0.015 to 0.029 mm 0.0006 to 0.0011 in.		
		(A.L.)	0.15 mm 0.0059 in.				
	Connecting rod alignment	(R.V.)	0.02 mm 0.0008 in.				
		(A.L.)	0.05 mm 0.0020 in.				
CRANK-SHAFT	Crankshaft alignment	(R.V.)	0.02 mm 0.0008 in.				
		(A.L.)	0.08 mm 0.0031 in.				
	O.D. of crankshaft journals		51.921 to 51.940 mm 2.0441 to 2.0449 in.		75.977 to 75.990 mm 2.9912 to 2.9917 in.		
	I.D. of crankshaft bearing 1		51.980 to 52.039 mm 2.0465 to 2.0488 in.		———		
	I.D. of crankshaft bearings (bearing 2)		51.980 to 52.025 mm 2.0465 to 2.0482 in.		76.034 to 76.082 mm 2.9935 to 2.9954 in.		
	Clearance between crankshaft journal and bearing 1	(R.V.)	0.040 to 0.118 mm 0.0016 to 0.0046 in.		———		
		(A.L.)	0.2 mm 0.0079 in.		———		
	Clearance between crankshaft journals and bearings	(R.V.)	0.040 to 0.104 mm 0.0016 to 0.0041 in.		0.044 to 0.105 mm 0.0017 to 0.0041 in.		
		(A.L.)	0.2 mm 0.0079 in.				
	O.D. of crankpins		43.959 to 43.975 mm 1.7307 to 1.7313 in.		63.977 to 63.990 mm 2.5188 to 2.5193 in.		
			continued				

		S2200	S2600	D3000	V4000L	V4000
CRANKSHAFT	I.D. of crankpin bearings	44.010 to 44.052 mm 1.7327 to 1.7343 in.		64.020 to 64.059 mm 2.5205 to 2.5220 in.		
	Clearance between crankpins and bearings (R.V.)	0.035 to 0.093 mm 0.0014 to 0.0037 in.		0.030 to 0.082 mm 0.0012 to 0.0032 in.		
	Clearance between crankpins and bearings (A.L.)	0.2 mm 0.0079 in.				
	Undersizes of crankpin bearings	0.20, 0.40 mm 0.0079, 0.0157 in.		0.25, 0.50, 0.75 mm 0.0098, 0.0197, 0.0295 in.		
	End play of crankshaft	0.15 to 0.31 mm 0.0059 to 0.0122 in.		0.082 to 0.332 mm 0.0032 to 0.0131 in.		

FUEL INJECTION NOZZLES	Opening pressure	13.7 to 14.7 MPa. 140 to 150 kgf./cm^2 1,990.8 to 2,133 lb./sq.in.	22.3 to 22.6 MPa. 227 to 230 kgf./cm^2 3,227.9 to 3,270.6 lb./sq.in.
	Fuel tightness of nozzle valve seat	Dry nozzle at 12.7 to 13.7 MPa. (130 to 140 kgf./cm^2, 1,848.6 to 1,990.8 lb./sq.in.)	Dry nozzle after 6 seconds at 10.2 to 15.2 MPa. (104 to 155 kgf./cm^2, 1,478.9 to 2,204.1 lb./sq.in.)

INJECTION PUMP	Fuel tightness of plunger (R.V.)	8 seconds or more; initial pressure from 58.8 to 49.0 MPa. (600 to 500 kgf./cm^2, 8,532.0 to 7,110.0 lb./sq.in.)	———
	Fuel tightness of plunger (A.L.)	4 seconds or less	———
	Fuel tightness of delivery valve (R.V.)	10 seconds or more; initial pressure from 9.8 to 0.5 MPa. (100 to 5 kgf./cm^2, 1,422.0 to 71.1 lb./sq.in.)	———
	Fuel tightness of delivery valve (A.L.)	5 seconds or less	———
	Injection timing	25° to 26° before T.D.C.	14° before T.D.C.

			S2200	S2600	D3000	V4000L	V4000
OIL PUMP	Oil pressure (normal running)	(R.V.)	294.2 to 441.3 kPa. 3.0 to 4.5 kgf./cm^2 42.7 to 64.0 lb./sq.in.				294.2 to 392.2 kPa. 3.0 to 4.0 kgf./cm^2 42.7 to 56.9 lb./sq.in.
		(A.L.)	245.2 kPa. 2.5 kgf./cm^2 35.6 lb./sq.in.				
ROTOR-TYPE	Rotor lobe clearance	(R.V.)	0.10 to 0.16 mm 0.0039 to 0.0063 in.		———		
		(A.L.)	0.20 mm 0.0079 in.		———		
	Radial clearance between outer rotor and pump body	(R.V.)	0.11 to 0.18 mm 0.0043 to 0.0071 in.		———		
		(A.L.)	0.25 mm 0.0098 in.		———		
GEAR-TYPE	Gear backlash	(R.V.)	———		0.054 to 0.162 mm 0.0021 to 0.0064 in.		
	Radial clearance between gears and pump body	(R.V.)	———		0.030 to 0.084 mm 0.0012 to 0.0033 in.		
	End clearance between gears and cover	(R.V.)	———		0.025 to 0.089 mm 0.0010 to 0.0035 in.		
RADIATOR	Opening pressure of cap		88.3 kPa. 0.9 kgf./cm^2 12.8 lb./sq.in.				
	Test pressure		176.5 kPa. 1.8 kgf./cm^2 25.6 lb./sq.in.		147.1 kPa. 1.5 kgf./cm^2 21.3 lb./sq.in.		
THERMO-STAT	Opening temperature	(beginning)	80.5°C to 83.5°C 176.9°F to 182.3°F		77.5°C to 80.5°C 171.5°F to 176.9°F		
		(full-open)	95°C 203°F				
	Distance of lift		8 mm 0.3150 in.				

		S2200	S2600	D3000	V4000L	V4000
FAN BELT	Belt sag under load of 90N. (9 kgf., 20 lb.)	7 to 9 mm 0.2756 to 0.3543 in.				

BATTERY	Specific gravity of electrolyte at 20°C (80°F)	100% charged	1.260
		50% charged	1.200
		Discharged	1.100
	Electrolyte level		10 to 13 mm above the plate 0.3937 to 0.5118 in. above the plate

ALTERNATOR	Output current		25A/14V /4,000 r.p.m. or less	45A/14V /4,500 r.p.m. or less
	Total resistance of rotor coil, measured between terminal "F" and "E"	(R.V.)	6Ω	
		(A.L.)	10Ω	
	Brush length	(R.V.)	15.5 mm 0.6102 in.	
		(A.L.)	10.3 mm 0.4055 in.	

REGULATOR	Cut-in voltage	4.5 to 5.8V
	No-load regulating voltage	13.8 to 14.8V
	Resistance between terminals: "IG" and "F" with open contacts	0Ω
	"IG" and "F" with contacts	Approx. 11Ω
	"L" and "E" with open contacts	0Ω
	"L" and "E" with contacts	Approx. 100Ω
	"N" and "E"	Approx. 32Ω
	"B" and "E" with open contacts	Infinity
	"B" and "L" with contacts	0Ω
	Point gap	0.3 to 0.45 mm 0.0118 to 0.0177 in.

			S2200	S2600	D3000	V4000L	V4000
STARTER MOTOR	No-load test	Current	90A or less		180A or less		
		Voltage	11.5V		11V		
		Speed	3,500 r.p.m. or more				
	O.D. of commutator	(R.V.)	30.0 mm 1.1811 in.		36.0 mm 1.4173 in.		
		(A.L.)	29.0 mm 1.1417 in.		34.0 mm 1.3386 in.		
	Mica undercutting	(R.V.)	0.5 to 0.9 mm 0.0197 to 0.0354 in.		0.3 to 0.7 mm 0.0118 to 0.0276 in.		
		(A.L.)	0.2 mm 0.0079 in.				
	Brush length	(R.V.)	19 mm 0.7480 in.				
		(A.L.)	12.7 mm 0.5000 in.				

GLOW PLUG	Resistance	Approx. 1.6Ω

		M4000	M4500	M5500	M6500	M7500
FRONT AXLE (2-WHEEL DRIVE)	End play of front axle (R.V.)	0 to 0.5 mm 0 to 0.0197 in.				
	End play of front axle (A.L.)	1.0 mm 0.0394 in.				
	Thickness of thrust washers (R.V.)	5.100 to 5.250 mm 0.2008 to 0.2067 in.				
	Thickness of thrust washers (A.L.)	4.0 mm 0.1575 in.				
	O.D. of front axle support	31.975 to 32.000 mm 1.2589 to 1.2598 in.				
	I.D. of bushings (fitted)	32.025 to 32.087 mm 1.2608 to 1.2633 in.				
	Clearance between front axle support and bushing (R.V.)	0.025 to 0.112 mm 0.0010 to 0.0044 in.				
	Clearance between front axle support and bushing (A.L.)	0.35 mm 0.0138 in.				
	O.D. of knuckle shaft	37.975 to 38.000 mm 1.4951 to 1.4961 in.				
	I.D. of bushings (fitted)	38.020 to 38.100 mm 1.4969 to 1.5000 in.				
	Clearance between knuckle shaft and bushing (R.V.)	0.020 to 0.125 mm 0.0008 to 0.0049 in.				
	Clearance between knuckle shaft and bushing (A.L.)	0.35 mm 0.0138 in.				
	End play of knuckle shaft (R.V.)	3.925 to 4.000 mm 0.1545 to 0.1575 in.				
	End play of knuckle shaft (A.L.)	3.000 mm 0.1181 in.				
	Toe-in	0 to 5 mm 0 to 0.1969 in.				
	Camber angle	2°				
	Castor angle	2°				
	King pin inclination	8°				
	Tire pressure	333.4 to 372.6 kPa. 3.4 to 3.8 kgf./cm² 48.3 to 54.0 lb./sq.in.				245.2 to 284.4 kPa. 2.5 to 2.9 kgf./cm² 35.6 to 41.2 lb./sq.in.

			M4000	M4500	M5500	M6500	M7500
FRONT AXLE (4-WHEEL DRIVE)	Clearance of differential gear hubs	(R.V.)	0.080 to 0.150 mm 0.0031 to 0.0059 in.				
		(A.L.)	0.35 mm 0.0138 in.				
	Clearance of differential pinion shaft	(R.V.)	0.060 to 0.133 mm 0.0024 to 0.0052 in.				
		(A.L.)	0.25 mm 0.0098 in.				
	Tooth backlash between differential side gear and pinion	(R.V.)	0.15 to 0.30 mm 0.0059 to 0.0118 in.				
		(A.L.)	0.40 mm 0.0157 in.				
	Differential gear rolling torque		2.0 to 3.9 N·m. 0.2 to 0.4 kgf·m. 1.4 to 2.9 lb.ft.				
	Tooth backlash between spiral bevel pinion and bevel gear	(R.V.)	0.2 to 0.3 mm 0.0079 to 0.0118 in.				
		(A.L.)	0.4 mm 0.0157 in.				
	Bevel gear and pinion tooth contact		35% or more				
	Thickness of pinion setting adjustment shims		0.1, 0.3 mm 0.0039, 0.0118 in.				
	Clearance between differential side gear and differential lock shifter pins		2 to 3 mm 0.0787 to 0.1181 in.				
	Bevel gear tooth backlash in bevel gear case	(R.V.)	0.2 to 0.25 mm 0.0079 to 0.0098 in.				
		(A.L.)	0.4 mm 0.0157 in.				
	Thickness of pinion setting adjustment shims		0.1, 0.3 mm 0.0039, 0.0118 in.				
	Bevel gear tooth backlash in front axle case	(R.V.)	0.3 to 0.5 mm 0.0118 to 0.0197 in.				
		(A.L.)	0.6 mm 0.0236 in.				
	Thickness of pinion setting adjustment shims		0.1 mm 0.0039 in.				
	Thickness of backlash adjustment shims		0.2 mm 0.0079 in.				
	Clearance between bearing retainer and front wheel case support bushing	(R.V.)	0.035 to 0.161 mm 0.0014 to 0.0063 in.				
		(A.L.)	0.3 mm 0.0118 in.				

continued

			M4000	M4500	M5500	M6500	M7500
FRONT AXLE (4-WHEEL DRIVE)	Clearance between pinion shaft case or differential case cover and bracket bushing	(R.V)	0.045 to 0.194 mm 0.0018 to 0.0076 in.				
		(A.L.)	0.55 mm 0.0217 in.				
	Tightness of front axle end play adjust screw		9.8 to 19.6 N·m. 1 to 2 kgf·m. 7.2 to 14.5 lb.				
	Steering angle		41° to 45°				
	Toe-in		5 to 10 mm 0.1969 to 0.3937 in.				
	Camber angle		1.5° to 2.5°				
	Castor angle		1.5° to 2.5°				
	King pin inclination		7° to 8°				
	Tire pressure		196.1 to 235.3 kPa. 2.0 to 2.4 kgf./cm² 28.4 to 34.1 lb./sq.in.			137.3 to 176.5 kPa. 1.4 to 1.8 kgf./cm² 19.9 to 25.6 lb./sq.in.	

CLUTCH	Pedal free travel (at the pedal edge)	(R.V.)	30 to 40 mm 1.1811 to 1.5748 in.
		(A.L.)	25 mm 0.9843 in.
	P.T.O. clutch lever free travel (at the lever edge)	(R.V.)	40 to 50 mm 1.5748 to 1.9685 in.
		(A.L.)	20 mm 0.7874 in.
	Spline backlash of clutch disc hubs	(R.V.)	0.070 to 0.148 mm 0.0028 to 0.0058 in.
		(A.L.)	0.3 mm 0.0118 in.
	Thickness of clutch discs	(R.V.)	8.1 to 8.7 mm 0.3189 to 0.3425 in.
		(A.L.)	5.6 mm 0.2205 in.
	Free length of clutch springs	(R.V.)	10.68 mm 0.4205 in.
		(A.L.)	10.00 mm 0.3937 in.

continued

		M4000	M4500	M5500	M6500	M7500
CLUTCH	Height of release levers from flywheel surface — Engine transmission	104 to 106 mm 4.0945 to 4.1732 in.				
	Difference	0.3 mm 0.0118 in.				
	P.T.O.	129 to 131 mm 5.0787 to 5.1575 in.				
	Difference	0.7 mm 0.0276 in.				
	Clearance between release levers and bearings	1.5 to 2.0 mm 0.0591 to 0.0787 in.				

		M4000 – M7500
STEERING	Free movement of steering wheel	20 to 50 mm 0.7874 to 1.9685 in.
	End play of steering shaft	0.2 mm 0.0079 in.
	Thickness of steering shaft adjustment shims	0.05, 0.07, 0.08, 0.10, 0.20 mm 0.0020, 0.0028, 0.0031, 0.0039, 0.0079 in.
	O.D. of steering lever shaft	34.975 to 35.000 mm 1.3770 to 1.3780 in.
	I.D. of bushings (fitted)	35.050 to 35.112 mm 1.3799 to 1.3824 in.
	Clearance between shaft and bushing (R.V.)	0.050 to 0.137 mm 0.0020 to 0.0054 in.
	Clearance between shaft and bushing (A.L.)	0.35 mm 0.0138 in.
	End play of drag link and tie-rod	0.4 mm 0.0157 in.

		M4000 – M7500
TRANS-MISSION	Spline backlash between gear and shaft (R.V.)	0 to 0.175 mm 0 to 0.0069 in.
	Spline backlash between gear and shaft (A.L.)	0.4 mm 0.0157 in.
	Gear backlash (R.V.)	0.1 to 0.2 mm 0.0039 to 0.0079 in.
	Gear backlash (A.L.)	0.5 mm 0.0197 in.

continued

		M4000	M4500	M5500	M6500	M7500
TRANSMISSION	O.D. of inner rings	45.030 to 45.041 mm 1.7728 to 1.7733 in.				
	O.D. of bearing needles	2.494 to 2.500 mm 0.0982 to 0.0984 in.				
	I.D. of transmission gear hubs	50.050 to 50.075 mm 1.9705 to 1.9715 in.				
	Clearance of inner rings, needles and gears (R.V.)	0.009 to 0.057 mm 0.0004 to 0.0022 in.				
	Clearance of inner rings, needles and gears (A.L.)	0.3 mm 0.0118 in.				
	Side clearance between synchronizer cones and gears (in contact) (A.L.)	0.35 mm 0.0138 in.				
	Side clearance of shift fork in shifter groove (R.V.)	0.2 to 0.4 mm 0.0079 to 0.0157 in.				
	Side clearance of shift fork in shifter groove (A.L.)	0.8 mm 0.0315 in.				
	O.D. of reverse shaft	29.991 to 30.000 mm 1.1807 to 1.1811 in.				
	O.D. of bearing needles	4.994 to 5.000 mm 0.1966 to 0.1969 in.				
	I.D. of reverse gear hub	40.009 to 40.025 mm 1.5752 to 1.5758 in.				
	Clearance of reverse gear, needle and shaft (R.V.)	0.009 to 0.046 mm 0.0004 to 0.0018 in.				
	Clearance of reverse gear, needle and shaft (A.L.)	0.3 mm 0.0118 in.				
	O.D. of P.T.O. clutch shaft	24.964 to 24.985 mm 0.9828 to 0.9837 in.				
	I.D. of 1st shaft bushing (fitted)	25.060 to 25.112 mm 0.9866 to 0.9887 in.				
	Clearance between P.T.O. clutch shaft and bushing (R.V.)	0.075 to 0.148 mm 0.0030 to 0.0058 in.				
	Clearance between P.T.O. clutch shaft and bushing (A.L.)	0.3 mm 0.0118 in.				

		M4000	M4500	M5500	M6500	M7500
DIFFEREN-TIAL GEAR	O.D. of differential side gear hubs	43.961 to 44.000 mm 1.7307 to 1.7323 in.				
	I.D. of differential case	44.080 to 44.119 mm 1.7354 to 1.7370 in.				
	Clearance between differential side gear hub and case (R.V.)	0.080 to 0.150 mm 0.0031 to 0.0059 in.				
	Clearance between differential side gear hub and case (A.L.)	0.35 mm 0.0138 in.				
	O.D. of differential pinion shafts	23.939 to 23.960 mm 0.9425 to 0.9433 in.				
	I.D. of bushings (fitted)	24.020 to 24.072 mm 0.9457 to 0.9477 in.				
	Clearance between differential pinion shafts and bushings (R.V.)	0.060 to 0.133 mm 0.0024 to 0.0052 in.				
	Clearance between differential pinion shafts and bushings (A.L.)	0.25 mm 0.0098 in.				
	Tooth backlash between differential side gears and pinions (R.V.)	0.1 to 0.2 mm 0.0039 to 0.0079 in.				
	Tooth backlash between differential side gears and pinions (A.L.)	0.4 mm 0.0157 in.				
	Thickness of differential pinion end washers (R.V.)	1.46 to 1.54 mm 0.0575 to 0.0606 in.				
	Thickness of differential pinion end washers (A.L.)	1 mm 0.0394 in.				
	Thickness of differential side gear end washers (R.V.)	1.46 to 1.54, 1.56 to 1.64 mm 0.0575 to 0.0606 in., 0.0614 to 0.0646 in.				
	Thickness of differential side gear end washers (A.L.)	1 mm 0.0394 in.				
	Thickness of set collar	5.45 to 5.5 mm 0.2146 to 0.2165 in.				
	Rolling torque of bevel pinion shaft	0.5 to 0.9 N·m. 5 to 9 kgf·cm. 0.4 to 0.7 lb.ft.				
	Tightness of bevel pinion shaft nut	274.6 to 343.2 N·m. 28 to 35 kgf·m. 202.5 to 253.2 lb.ft.				
	Thickness of bevel pinion shaft adjustment collar 1 (for bearing adjustment)	1, 1.5, 1.7, 1.75, 1.8, 1.9, 2.0, 2.1, 2.2, 2.25, 2.3 mm (±0.01 mm) 0.0394, 0.0591, 0.0669, 0.0689, 0.0709, 0.0748, 0.0787, 0.0827, 0.0866, 0.0886, 0.0906, in. (±0.0004 in.)				

continued

			M4000	M4500	M5500	M6500	M7500
DIFFERENTIAL GEAR	Rolling torque of bevel pinion shaft engaging with bevel gear (measured on pinion shaft)		1.1 to 1.9 N·m. 11.0 to 19.0 kgf·m. 0.8 to 1.4 lb.ft.				
	Tightness of differential bearing-support screw		44.1 to 55.9 N·m. 4.5 to 5.7 kgf·m. 32.5 to 41.2 lb.ft.				
	Thickness of differential bearing-support adjustment shims		0.1, 0.3, 0.5 mm 0,0039, 0.0118, 0.0197 in.				
	Tooth backlash between bevel gear and pinion	(R.V.)	0.15 to 0.25 mm 0.0059 to 0.0098in.				
		(A.L.)	0.4 mm 0.0157 in.				
	Bevel gear and pinion tooth contact		35% or more				
	Thickness of bevel pinion shaft adjustment collar 2 (for tooth contact adjustment)		2.8, 3.0, 3.2, 3.4, 3.6 mm (±0.02 mm) 0.1102, 0.1181, 0.1260, 0.1339, 0.1417 (±0.0008 in.)				

REAR AXLE CASE	O.D. of planetary pinion pin		31.984 to 32.000 mm 1.2592 to 1.2598 in.
	O.D. of bearing needles		3.494 to 3.500 mm 0.1376 to 0.1378 in.
	I.D. of planetary pinion hub		39.009 to 39.025 mm 1.5358 to 1.5364 in.
	Clearance of planetary pinion, needles and pinion pin	(R.V.)	0.009 to 0.053 mm 0.0004 to 0.0021 in.
		(A.L.)	0.3 mm 0.0118 in.
	Thickness of planetary pinion thrust washers	(R.V.)	0.95 to 1.05 mm 0.0374 to 0.0413 in.
		(A.L.)	0.6 mm 0.0236 in.
	Planetary gear tooth backlash	(R.V.)	0.1 to 0.2 mm 0.0039 to 0.0079 in.
		(A.L.)	0.5 mm 0.0197 in.

		M4000	M4500	M5500	M6500	M7500
BRAKES	Pedal free travel (at the pedal edge)	35 to 45 mm 1.3780 to 1.7717 in.		40 to 50 mm 1.5748 to 1.9685 in.		
	Distortion of brake cam plate (A.L.)	0.3 mm or less 0.0118 mm or less				
	Thickness of friction plate (R.V.)	4.12 to 4.28 mm 0.1622 to 0.1685 in.				
	Thickness of friction plate (A.L.)	3.2 mm 0.1260 in.				
	Thickness of plate (R.V.)	2.22 to 2.38 mm 0.0874 to 0.0937 in.				
	Thickness of plate (A.L.)	1.5 mm 0.0591 in.				

		M4000	M4500	M5500	M6500	M7500
HYDRAULIC PUMP (HYDRAULIC LIFT UNIT)	Delivery	27.5ℓ/min. at engine 2,600r.p.m. 7.3gal/min. at engine 2,600r.p.m.		30.5ℓ/min. at engine 2,400r.p.m. 8.1gal/min. at engine 2,400r.p.m.	31.9ℓ/min. at engine 2,200r.p.m. 8.4gal/min. at engine 2,200r.p.m.	30.5ℓ/min. at engine 2,400r.p.m. 8.1gal/min. at engine 2,400r.p.m.
	O.D. of gear (A.L.)	37.14 mm 1.4622 in.				
	Clearance between gear shaft and bushing (A.L.)	0.150 mm 0.0059 in.				
	Difference in the widths of housing, bushing and gear (A.L.)	0.25 mm 0.0098 in.				

PRESSURE RELIEF VALVE	Setting pressure	16.7 to 17.7 Mpa. 170 to 180 kgf./cm^2 2,417.4 to 2,559.6 lb./sq.in.

			M4000	M4500	M5500	M6500	M7500
HYDRAULIC PISTON AND CYLINDER	I.D. of hydraulic piston rod		22.020 to 22.072 mm 0.8669 to 0.8690 in.				
	O.D. of pin		21.979 to 22.000 mm 0.8653 to 0.8661 in.				
	Clearance between hydraulic piston rod and pin	(R.V.)	0.020 to 0.093 mm 0.0008 to 0.0037 in.				
		(A.L.)	0.4 mm 0.0157 in.				
	O.D. of hydraulic arm shaft		L.H. 49.975 to 50.000 mm 1.9675 to 1.9685 in. R.H. 54.970 to 55.000 mm 2.1642 to 2.1654 in.				
	I.D. of bushing		L.H. 50.125 to 50.195 mm 1.9734 to 1.9762 in R.H. 55.210 to 55.240 mm 2.1736 to 2.1748 in.				
	Clearance between hydraulic arm shaft and bushing	(R.V.)	L.H. 0.125 to 0.220 mm 0.0049 to 0.0087 in. R.H. 0.210 to 0.270 mm 0.0083 to 0.0106 in.				
		(A.L.)	0.5 mm 0.0197 in.				
	I.D. of hydraulic cylinder	(R.V.)	90.036 to 90.071 mm 3.5447 to 3.5461 in.				95.036 to 95.071 mm 3.7416 to 3.7430 in.
		(A.L.)	90.15 mm 3.5492 in.				95.15 mm 3.7461 in.
	Cylinder safety valve setting pressure		19.6 MPa. 200 kgf./cm², 2,844 lb./sq.in.				

TOP LINK BRACKET	O.D. of top link bracket shaft		24.939 to 24.960 mm 0.9819 to 0.9827 in.
	I.D. of bushing		25.020 to 25.071 mm 0.9850 to 0.9870 in.
	Clearance between top link bracket shaft and bushing	(R.V.)	0.06 to 0.132 mm 0.0024 to 0.0052 in.
		(A.L.)	0.4 mm 0.0157 in.
	Clearance between control spring and spring retainer 1		12.8 to 13.1 mm 0.5039 to 0.5157 in.
	Clearance between top link bracket and lock bracket		3 to 5 mm 0.1181 to 0.1969 in.

			M4000	M4500	M5500	M6500	M7500
HYDRAULIC PUMP (POWER STEERING)	Delivery		11.9ℓ/min. at engine 2,600r.p.m. 3.1gal./min. at engine 2,600r.p.m.	15.9ℓ/min. at engine 2,600r.p.m. 4.2gal./min. at engine 2,600r.p.m.	19.2ℓ/min. at engine 2,400r.p.m. 5.1gal./min. at engine 2,400r.p.m.	17.6ℓ/min. at engine 2,200r.p.m. 4.6gal./min. at engine 2,200r.p.m.	19.2ℓ/min. at engine 2,400r.p.m. 5.1gal./min. at engine 2,400r.p.m.
	O.D. of gear	(A.L.)	31.26 mm 1.2307 in.		————		
	Clearance between gear shaft and bushing	(A.L.)	0.180 mm 0.0071 in.		0.177 mm 0.0070 in.		
	Bushing width	(A.L.)	22.370 mm 0.8807 in.		18.669 mm 0.7350 in.		
	Radial clearance between gears and pump body	(A.L.)	————		0.05 mm 0.0020 in.		

POWER STEERING BOOSTER	Clearance between spool valve and valve housing	(R.V.)	0.022 mm 0.0009 in.
		(A.L.)	0.04 mm 0.0016 in.
	Clearance between box and rod	(R.V.)	0.074 mm 0.0029 in.
		(A.L.)	0.11 mm 0.0043 in.
	Clearance between piston and cylinder	(R.V.)	0.121 mm 0.0048 in.
		(A.L.)	0.2 mm 0.0079 in.
	Relief valve setting pressure		9.8 MPa. 100 kgf./cm^2 1,422 lb./sq.in.