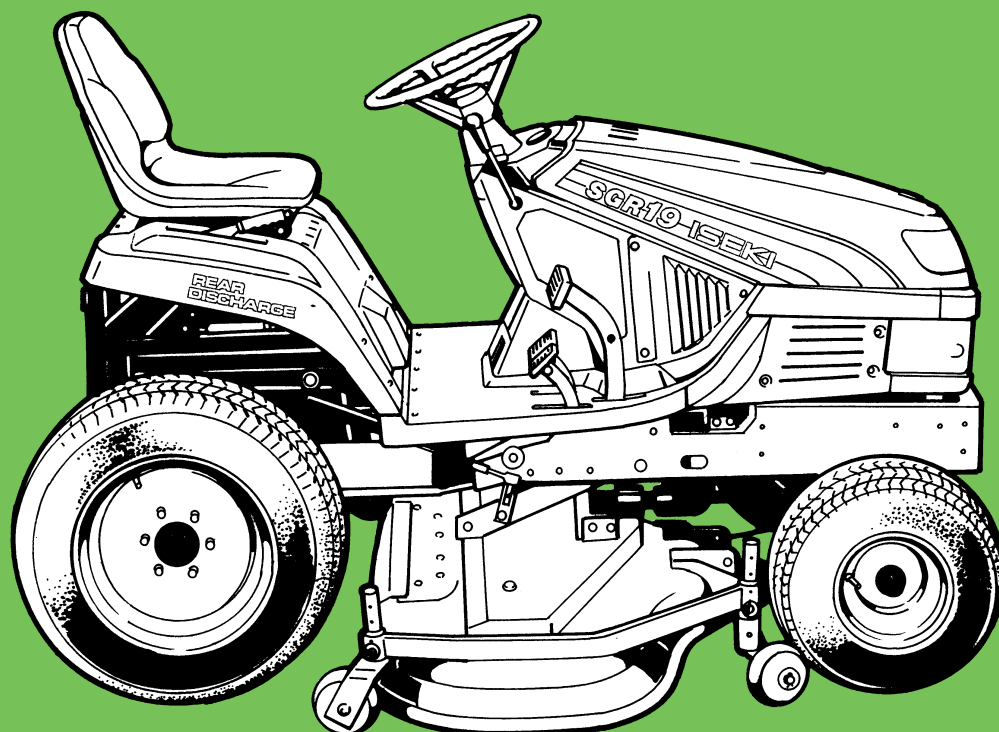


ISEKI LAWN MOWERS



SERVICE MANUAL

LAWN MOWERS:

SGR17 & SGR19

MOWER DECKS:

SCM48 & SCM54



ISEKI

SERVICE MANUAL FOR SGR19 & SGR17

FOREWARD

This service manual has been prepared to provide the information and suggestions necessary for servicing the ISEKI SGR equipped with the hydrostatic transmission. These include construction, specifications, removal and reinstallation of the components, disassembly and reassembly instructions, inspection and adjustment instructions, troubleshooting, general precautions etc.

Figures mentioned in this manual are standard values established by ISEKI for the SGR, consequently when a non-ISEKI part has been installed on the machine or adjustments and repairs have been made in a manner other than as specified in this manual, the pertinent values mentioned herein are no longer valid. ISEKI does not assume responsibility for problems or damage caused by a value deviation due to maladjustment or by the use of unauthorized parts.

Servicing procedures outlined in the manual contain sufficient information to return all component parts of a machine to new condition. In discussion of each component part, it is assumed that a complete overhaul is being performed, consequently, complete disassembly and reassembly are outlined. The machine is relied upon to decide how far disassembly must be carried out when complete overhaul is not required.

Study unfamiliar service procedures thoroughly and understand them clearly before attempting disassembly. Specific data essential for proper overhaul, such as running clearances and torque values, have been provided in interline of inspection and reassembling procedures of each group section.

This manual was compiled from latest information available at time of publication, However ISEKI reserves the right to make changes at any time without notice.

Whenever the terms “left” and “right” are used, this means as viewed by the operator when seated in the operator’s seat.

Whenever servicing the machines, pay sufficient attention to the operational safety to protect you and other persons around the machines from danger by following carefully the instructions given in the manual. Never take chances!

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CHAPTER 1. INTRODUCTION

1. GENERAL INFORMATION

a. Model name and identification numbers

The name plate, which gives the model name, type, production serial number, and production year of the machine, is located on the left-hand side of the chassis.



- (1) Model name: SGR19H in the example
- (2) Type: E42 or UE42
- (3) Production serial number: 000001 in the example
- (4) Production year by the last two digits

Fig. 1-1

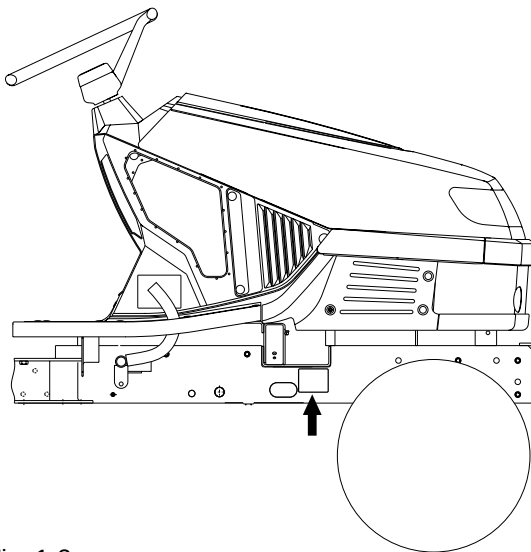


Fig. 1-2

b. Chassis number

The chassis number is punched on the left-hand side of the chassis as shown below.

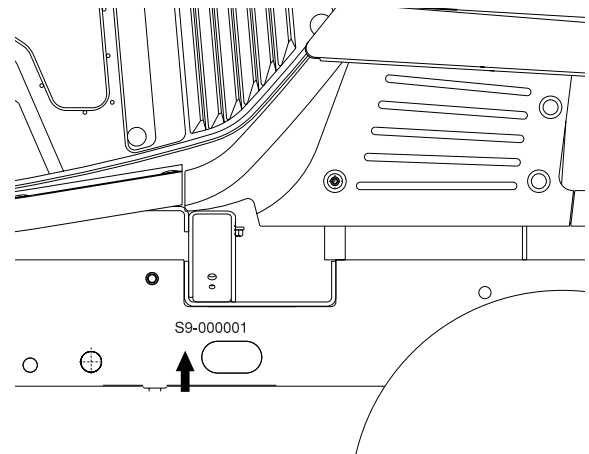


Fig. 1-3

c. Engine model name and serial number

- The engine name is cast into the right-hand side wall of the cylinder block.
- The serial number is punched into the left-hand side wall of the cylinder block.

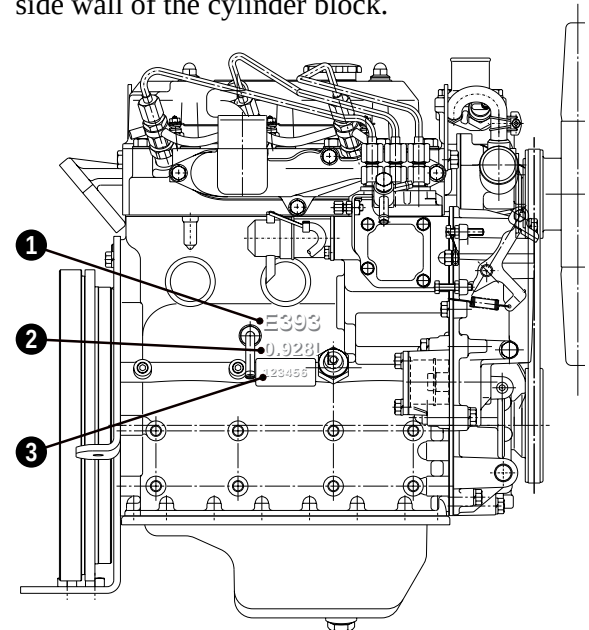


Fig. 1-4

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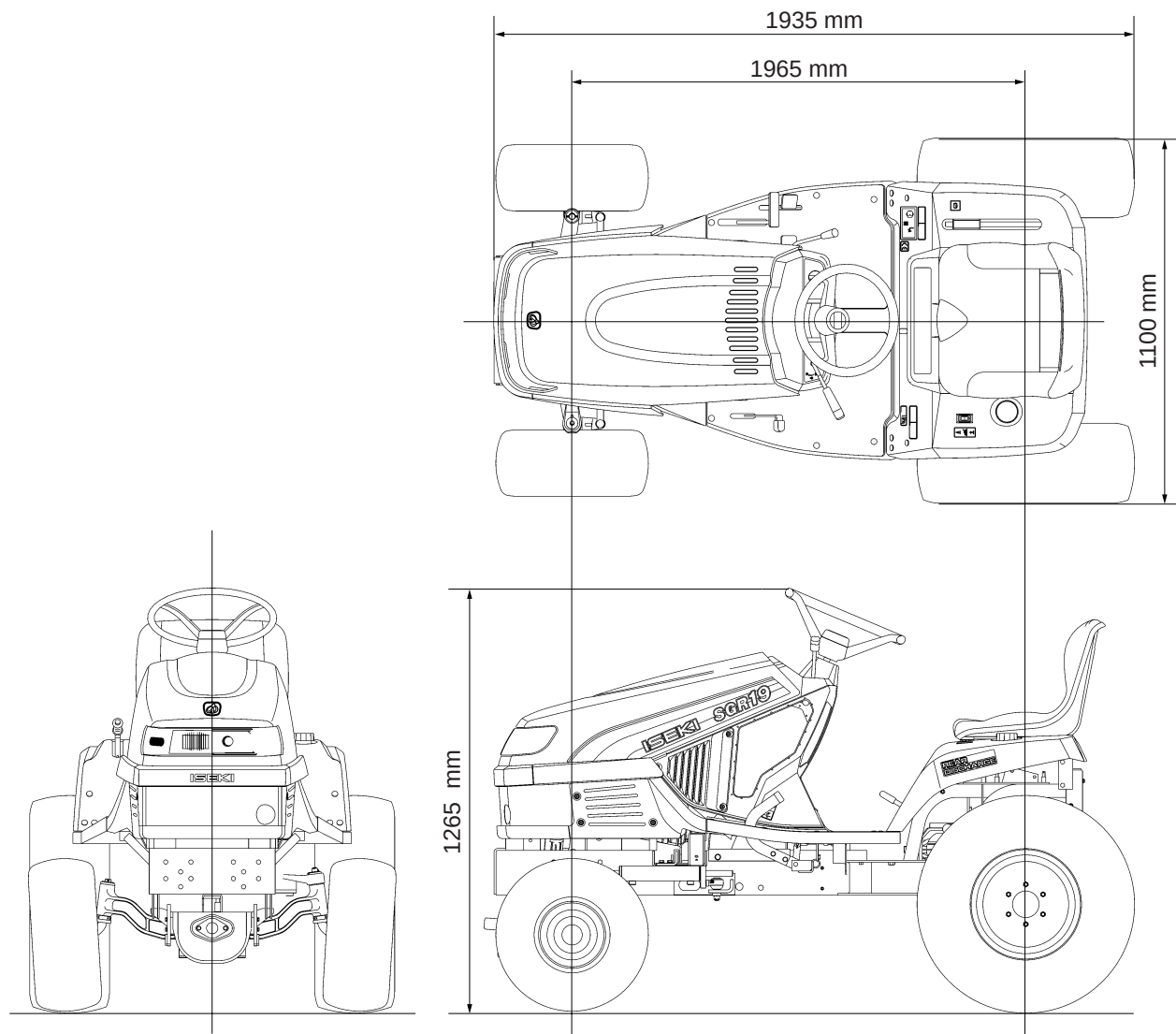
2. SPECIFICATIONS

These specifications are subject to change without notice.

	SGR19H	SGR17H
Dimensions		
Overall length (mm)	1935	
(Ballast weight included) Overall width (mm)	1100	
Overall height (mm)	1265	
Weight	(kg)	430
Engine	Model	E393-G
	Numbre of cylinders	3
	Output kW(PS)/2900rpm	14(19)
	Piston displacement (cc)	928
	Combustion chamber	Swirl chamber
Fuel tank capacity	(litres)	18.5
Transmission	Main transmission	HST (Hydro-Static Transmission)
Travelling speed	Forward	(km/h)
	Reverse	(km/h)
Wheelbase	(mm)	1365
Wheel tread	Front	(mm)
	Rear	(mm)
Tyre size	Front	210/60D-8
	Rear	250/60D-14
Minimum ground clearance	(mm)	
Steering system	Power steering	Manual or Power steering
PTO	Front	(mm)
		(min ⁻¹)
	Mid	(mm)
		(min ⁻¹)
	Rear	(mm)
		(min ⁻¹)

CHAPTER 1. INTRODUCTION

3.EXTERIOR VIEW AND DIMENSIONS



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4.PERIODIC INSPECTION TABLE

○ : Inspection, replenishment, and adjustment
● : Replacement
△ : Cleaning and washing
★ : Consult your dealer.

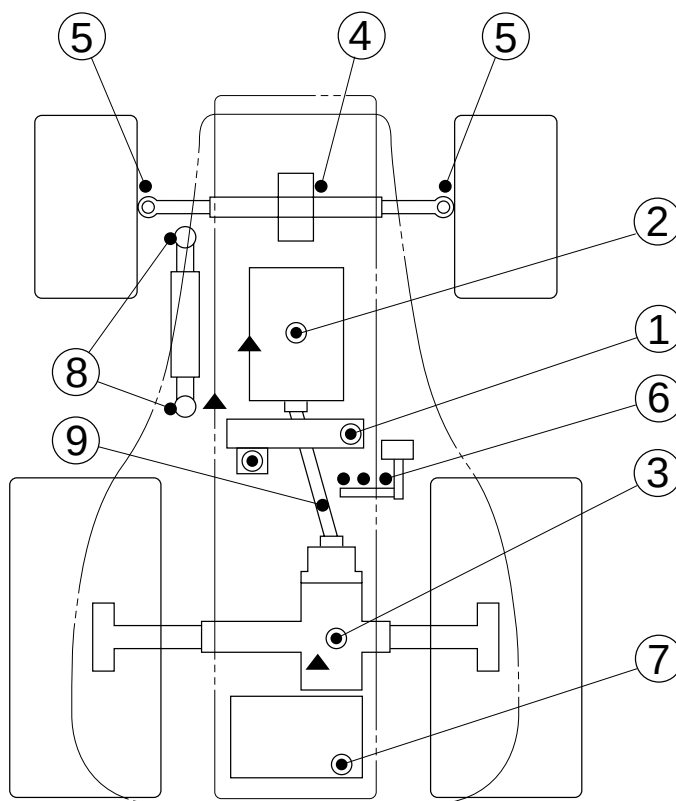
Check points	Pre-operation	Inspection and servicing intervals hours of operation								Intervals after that	Judgement criteria
		50	100	150	200	250	300	350	400		
Engine oil	○	★		●		●		★		Replace after initial 50 h and then every 100 h.	Maintain the specified level.
Air cleaner		△	△	△	△	△	△	△	△	Clean after every 50 h.	
Engine coolant	○									Replace every year.	Maintain the specified level.
Fuel	○										Keep fuel tank always full.
Fuel strainer	○		△		△		●		△	Clean after every 100 h. Replace element after every 300 h.	There should be no dust or water in filter.
Fan belt	○										10 mm (0.4 in.) deflection
Electrolyte level		○	○	○	○	○	○	○	○	Inspect after every 50 h.	Level should be kept properly.
Engine oil filter		★						★		Replace after initial 50 h. Replace after every 300 h.	
Transmission oil	○	★				★				Replace after initial 50 h. and then after every 200 h.	Maintain the specified level.
Hydraulic oil filter		★				★				Replace after initial 50 h. and then replace after every 200 h.	
Suction filter		★				★				Clean after initial 50 h. and then clean after every 200 h.	
Brake pedal play	○										20 to 30 mm (0.8 to 1.2 in.)
Steering wheel	○						★			Check after every 300 h.	There should be no abnormality.
Ball joints of steering system linkage							○			Check after every 300 h.	Loose ball joints should be re-tightened.
Tyre pressure	○										Front: 1.6 x 10 ⁵ Pa (22.7 psi) Rear: 1.6 x 10 ⁵ Pa (22.7 psi)
Toe-in							★			Adjust after every 300 h.	2 to 4 mm (0.08 to 0.16 in.)
Wheel tightening nuts	○										There should be no loose nuts.
Grease-up		○	○	○	○	○	○	○	○	Inject grease after every 50 h.	
Radiator screen	△										There should be no clogging.
Radiator	△										There should be no clogging.
Electrical apparatus	○										All should work properly.
Safety switches	○										All should work properly.
Air intake openings	△										There should be no clogging.
Bolts and nuts	○										There should be no loose ones.
Rubber pipes			○		○		○		○	Check after every 100 h.	

Important:

- Above mentioned service intervals should be used as reference criteria. If working conditions are harder, earlier service is recommended.
- When special technology and special tools are required, consult your dealers.

CHAPTER 2. DISASSEMBLY OF MAJOR COMPONENTS

5.FILLING DIAGRAM



- Oil fillers
- ▲ Oil drains
- Greasing points

Ref. No.	Filling points	Lubricants	Quantity: litre	
			SGR19/17H-U	SGR17H
1	Radiator	Fresh clean water	3.5	
	Reserve tank		0.6	
2	Engine	Engine oil	2.5	
3	Transmission case	HST oil (SHELLDONAX TD)	6.7	6.3
4	Center pivot	Grease	As required	
5	Knuckle arms	Grease	As required	
6	Brake shaft/HST hub	Grease	As required	
7	Fuel	Diesel fuel	18.5	
8	Cylinder ball end	Grease	As required	
9	Drive shaft	Grease	As required	

- Use oil of better than class CC.
- Use ISEKI's recommended oil.

SERVICE MANUAL FOR SGR19 & SGR17

CHAPTER 2. DISASSEMBLY OF MAJOR COMPONENTS

I. GENERAL PRECAUTIONS FOR SEPARATION AND REINSTALLATION

1. BEFORE OPERATION

- a. Always be safety-conscious in selecting clothes to wear and suitable tools to use.
- b. Before disassembly, be sure that you familiarize yourself with the assembled condition for subsequent reference in reassembly.
- c. Keep parts and tools in proper order during operations.
- d. When servicing electrically live parts, be sure to disconnect the negative battery terminal.
- e. To prevent oil or water leaks, use the liquid gasket as required.
- f. When reassembling disassembled parts, discard used gaskets, O-rings, or oil seals and install new ones.
- g. When lifting up only the front or rear part of the tractor, be sure to wedge the grounded wheels.
- h. When the tractor is jacked up, be sure to support the entire tractor with something like a stand. Lifting it up with a jack only is a dangerously unstable procedure.
- i. When replacing parts, use authorized, genuine ISEKI parts only. ISEKI assumes no responsibility for accidents, operating problems or damage caused by the use of imitation parts. Also, the use of unauthorized parts will result in relatively poor machine performance.

2. PRECAUTIONS TO BE FOLLOWED WHEN INSTALLING COMMON PARTS

a. Roller or ball bearings

- When a bearing is fitted in by the outer race, use an installer which is specially designed to push only the outer race and vice versa.
- The installer must be designed to install the bearing on the shaft in a parallel position.
- When installing a bearing which appears the same on both sides, install it so that the face which has the identification number faces in a direction for easy visual identification. All the bearings which are to be installed in the transmission case should be placed so that their identification number faces outward.
- If a shaft or a hole where a bearing is to be installed has a stopper, the bearing should be pushed in completely until it is seated against the stopper.
- Installed bearings should turn smoothly.

b. Oil seals

- Oil seal installer should be designed so as not to deform the oil seals.
- During installation, be careful not to damage the lips, and assure that it is pushed in parallel to the shaft or hole.
- When oil seals are installed, there should be no turnover of the lips nor dislocation of the springs.
- When a multi-lip seal is installed, the grooves between lips should be filled with grease, not adhesive.

CHAPTER 2. DISASSEMBLY OF MAJOR COMPONENTS

- Use a lithium-based grease.
- There should be no oil or water leaks through the installed soil seals.

c. O-rings

- O-rings should be coated with grease before installing.
- Installed O-rings should have no slack or twist.
- Installed O-rings should maintain proper air tightness.

d. Snap-rings

- Snap-ring installers should be designed so as not to permanently deform the snap-rings.
- Installed snap-rings should be seated securely in the groove.
- Be careful not to overload the snap-ring to the extent that it is permanently deformed.
- How to install the snap-ring:

When installing a snap-ring, install it as shown in the figure with its round edge side turned toward the part to be retained. This round edge is formed when the snap-ring is pressed out.

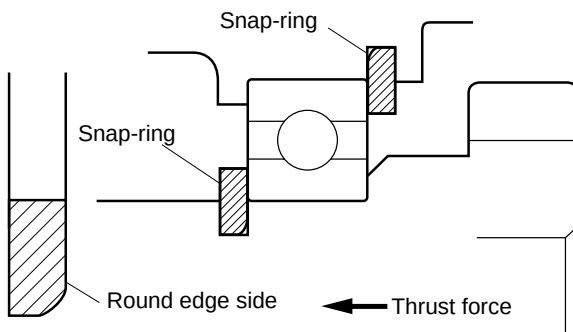


Fig. 2-1

e. Spring (roll) pins

- Spring pins should be driven in properly and tightly.

- Spring pins should be installed so that their seams should face the direction from which the load is applied.

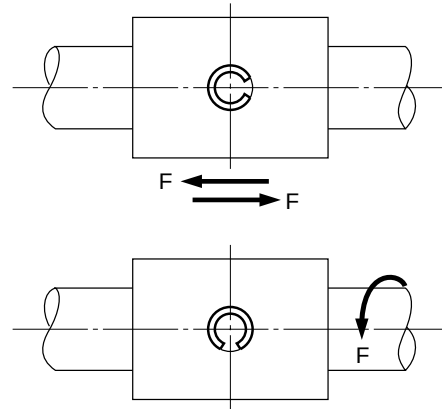


Fig. 2-2

- The roll pins installed in the transmission or other parts where much force is applied should be retained with wire.

f. Cotter pins

- When installed, cotter pins should be bent securely at the ends as shown in the figure.

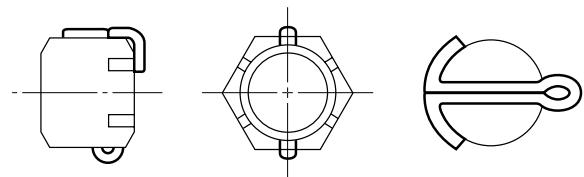


Fig. 2-3

g. Bolts and nuts

- Special bolts are installed at several locations, so be sure not to interchange them other bolts.
- Bolts and nuts should be tightened to their specified torque with a torque wrench.
- When locking the bolts or nuts with wire or a lock washer, be sure to wind the wire paying sufficient attention to its winding direction and bend the lock washer for secure locking.
- When locking bolts and nuts with an adhesive, apply the adhesive on the thread and tighten securely.

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- Apply an adhesive (THREE BOND TB1104) to parts through which there is any possibility of oil leaks, such as stud bolts and tapped-through parts.
- Each lock nut must be tightened securely.
- When tightening bolts and nuts, refer to the tightening torque table.

h. After installation, each grease fitting should be filled with grease.

- When installing grease fittings of types B and C, be sure to turn the fitting tips in a direction that will provide easy access for a grease gun.

i. Other precautions

- Be sure not to damage any finished surfaces or parts.
- Always refrain from forcing installation.
- Each lever knob should be installed coated with an adhesive (SUPER THREE CEMENT TB1702)
- Each contact surface should be coated with an adhesive (THREE BOND TB1215) and tightened evenly with bolts. Adhesive coated surfaces should be installed within 30 minutes after application of the adhesive.
The contact surfaces should be flawless and free from foreign matter,, and especially from grease before application of the adhesive.
 - Contact surfaces of the sleeve metal (support) and front transmission case
 - Contact surfaces of the hydraulic control lever guide and cylinder case
- Precautions for applying adhesives
 - The surface or the thread where an adhesive is to be applied should be completely free of chips and oil.

II. BEFORE STARTING DISASSEMBLY

1. REMOVAL OF THE MOWER DESK

- (1) Change the direction of the rear wheels when in the lifted-up position.



Fig. 2-4

- (2) Start the engine and lower the lift by the lift switch.



Fig. 2-5

- (3) Pull out the link pin and remove the support link.



Fig. 2-6

CHAPTER 2. DISASSEMBLY OF MAJOR COMPONENTS

- (4) Remove the fixed bolt and the stopper brackets.

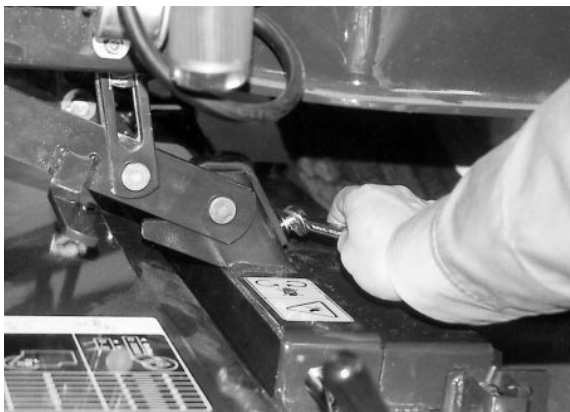


Fig. 2-7

- (5) Disconnect the universal joint of the drive shaft from the front mower.



Fig. 2-8

- (6) Move the mower deck rearward to detach it from the linkage.



Fig. 2-9

- (7) Start the engine and lift up the linkage. Then remove the mower deck sideways from the mower engine.



Fig. 2-10

2. REMOVAL AND REINSTALLATION OF MAJOR FUNCTIONAL COMPONENTS

2.1. REMOVAL AND REINSTALLATION OF ENGINE

REMOVAL

- (1) Open the rear fender.



Fig. 2-11

- (2) Disconnect the negative (-) post of the battery.
- (3) Drain engine coolant through the drain plug.

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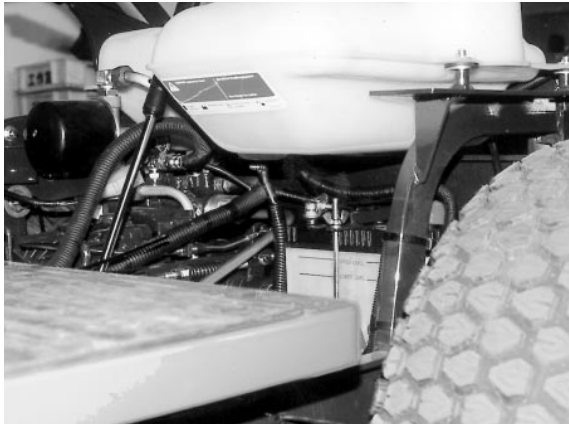


Fig. 2-12

- (4) Remove both the front side covers (RH and LH).

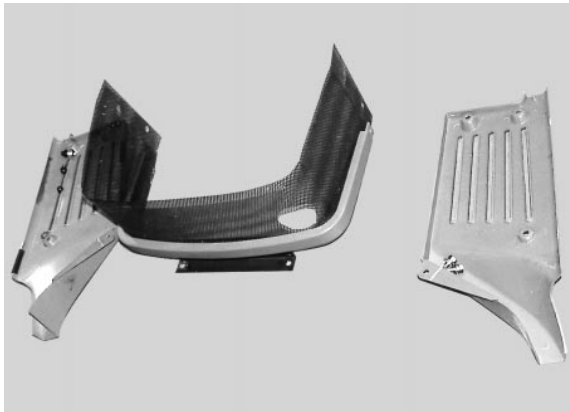


Fig. 2-13

- (5) Remove the engine hood assembly.



Fig. 2-14

- (6) Loosen the lock-nut for the inner wire of the throttle wire and draw out the inner wire.
- (7) Loosen the lock-nut for the throttle wire sheath and then remove the sheath.

- (8) Remove the air-intake pipe by loosening the air-cleaner side and engine side clamps.



Fig. 2-15

- (9) Remove the upper and lower hoses which connect the radiator and engine.

- Remove the drain hose from the cylinder block.

- (10) Disconnect the wire harness from the engine by removing bolts and nuts which holds it.

- Glow plug terminals
- Thermometer
- Oil pressure switch
- Starter
- Alternator
- Fuel cut-off



Fig. 2-16

CHAPTER 2. DISASSEMBLY OF MAJOR COMPONENTS



Fig. 2-17

- (11) Remove the fuel pipes.
 - Remove the fuel return pipes from the nozzles.
- (12) Remove the drive shaft.
 - Loosen the bolts of the joint installed on the shaft end which is connected to the engine.
- (13) Remove the control wire for the front PTO clutch.
 - Remove the tension wire from the tension pulley arm.
- (14) Remove the belt stopper.
 - Remove the belt cover (PTO shield).
 - Remove the two belts.

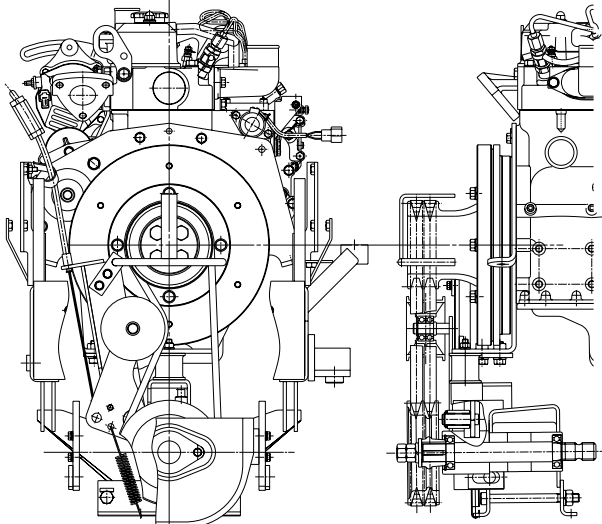


Fig. 2-18

- (15) Remove the snap-ring from the front PTO shaft.

Note:

Remove the spring from the tension pulley.

- Drive the front PTO shaft rearwards with a plastic hammer or a mallet.

- (16) Remove the engine stoppers which are clamped on both sides of the frame with bolts.

- Remove the bolts which tighten the insulators: two insulators on RH and LH and one in front.

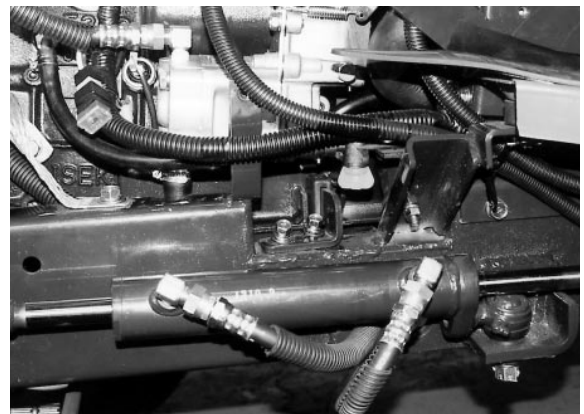


Fig. 2-19



Fig. 2-20

- (17) Remove the engine by lifting it up using the engine hangers.

SERVICE MANUAL FOR SGR19 & SGR17

Note:

Keep on pushing the engine forward while lifting it up to avoid damaging the radiator shroud and cooling fan.

REINSTALLATION

Note:

Reassemble in reverse order of disassembly. But check every part and replace defective ones.

- (1) Install the engine on the frame.
 - Install both insulators so that they are bent slightly outwards.

Note:

- The bolts which tighten the insulators on the frame should be loosened in advance.
- Install both stoppers so that there is a clearance of 1.5 to 4.5 mm on both sides in the engine bracket.
- The engine should not be slanted either to the right or to the left.

- (2) Install the front PTO and related parts.
 - Install the PTO pulley and shaft.
 - Set the belt and tension pulley.
 - Install the stopper and cover.
- (3) Install the drive shaft.
- (4) Install fuel pipes.
 - Install the pipes on the injection pump.
 - Install the fuel return pipes on the nozzles.

- (5) Connect wire harness.
 - Glow plug terminals
 - Thermometer
 - Oil pressure switch
 - Starter
 - Alternator
 - Fuel cut-off unit

- (6) Install radiator hoses.

- (7) Install the air intake pipe, throttle wire, tension arm wire, etc., and then check that they have been installed securely.

- The front PTO clutch control wire should be connected with the tension spring through the wire holder and the hole at the right-hand bottom of the steering post.

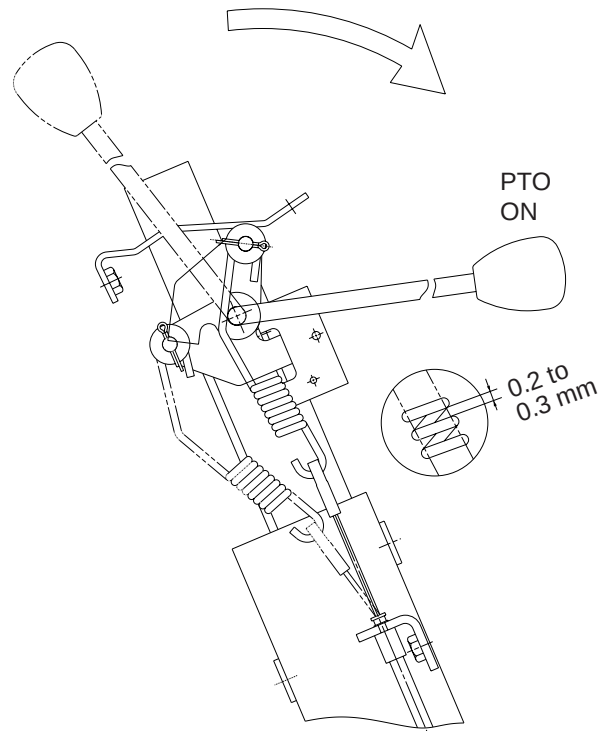


Fig. 2-21

CHAPTER 2. DISASSEMBLY OF MAJOR COMPONENTS

2.2. REMOVAL AND REINSTALLATION OF FENDER AND STEP

REMOVAL OF FENDER

- (1) Remove the five hairpins from the dumper and the rear linkages.



Fig. 2-22



Fig. 2-23

- (2) Remove the wire harness from the fender.



Fig. 2-24

- (3) Remove the fender.



Fig. 2-25

- (4) Remove the fuel tank.



Fig. 2-26

REMOVAL OF STEP

- (1) Remove the connecting bolt from the brake pedal and HST pedals. Also remove the dif-lock pedal at the left-hand side.



Fig. 2-27

SERVICE MANUAL FOR SGR19 & SGR17

- (2) Remove the four hairpins retaining the step on the frame.
- (4) Remove the drive shaft.



Fig. 2-28

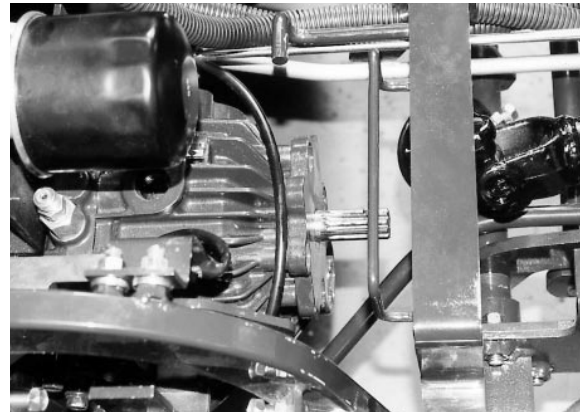


Fig. 2-30

- (5) Remove the following oil hoses.
 - Lifting cylinder connecting hose
 - Solenoid valve connecting hose

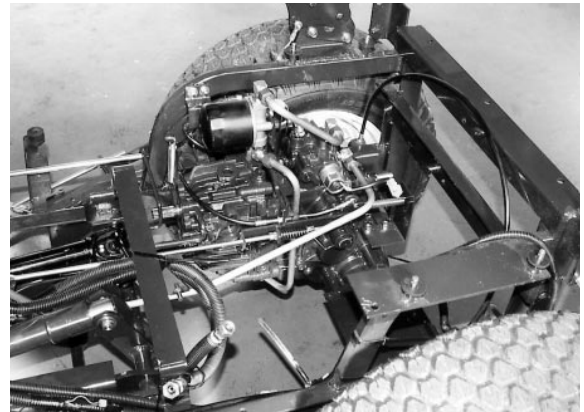


Fig. 2-31

REINSTALLATION

Reinstall in reverse order of removal.

2.3. REMOVAL AND REINSTALLATION OF TRANSMISSION CASE

REMOVAL

- (1) Remove the drain plug located on the bottom of the transmission case.
- (2) Remove the fender and step, referring to 3.2.
- (3) Remove the battery and fuel tank, referring to 3.2.
- (6) Remove the brake rod linkage and parking brake cable.



Fig. 2-29



Fig. 2-32

CHAPTER 2. DISASSEMBLY OF MAJOR COMPONENTS

- (7) Remove the delivery pipe to the solenoid valve.

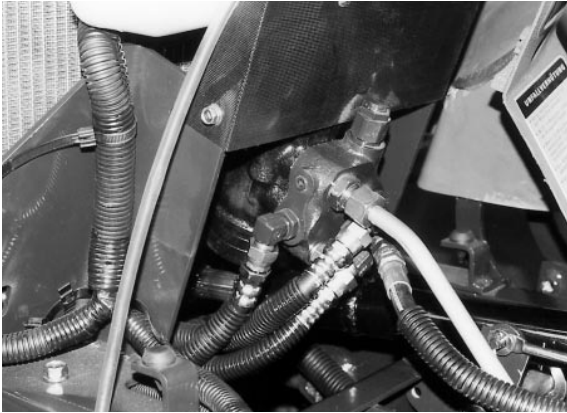


Fig. 2-33

- Hold the transmission case with jacks or other appropriate supports and hang the chassis with a hoist.

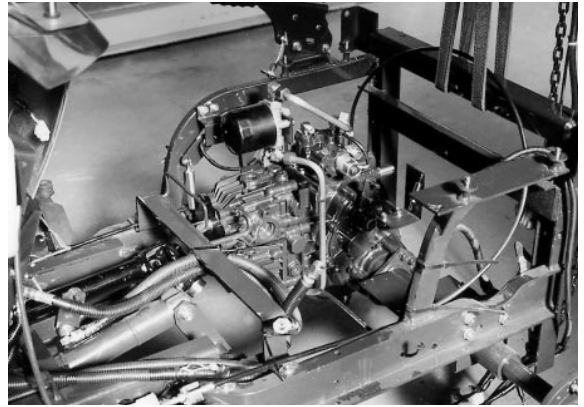


Fig. 2-36

- (8) Remove the HST tension spring and the assembly of the HST controlling rods.



Fig. 2-34

- Remove the transmission tightening bolts.

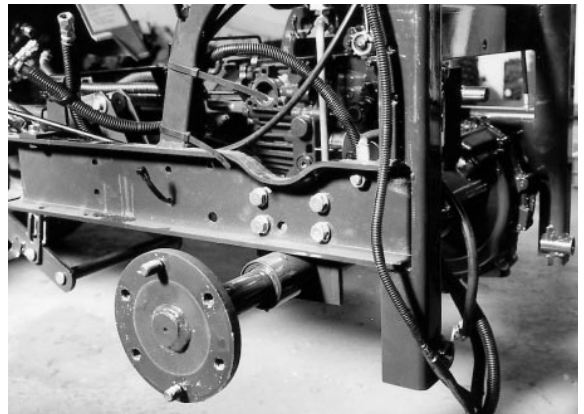


Fig. 2-37

- (10) Remove the HST unit.

- Remove the suction pipe and filter.
- Remove the HST unit tightening bolts. Then the unit can be removed from the transmission case.

REINSTALLATION

Reinstall in reverse order of removal, taking the following precautions.

Reinstall in reverse order of removal, taking the following precautions.

- (9) Remove the transmission case along with the HST unit from the chassis.

- Be sure to install O-rings for all hydraulic pipes.
- Each bolt and nut should be tightened to respective specified torque values referring to the tightening torque table.

II. INSPECTION AND ADJUSTMENT**1. INSPECTION OF ENGINE OIL**

- Draw out the level gauge (dip stick) and wipe the end clean. Then insert and draw out it again. Check to see if the level is between the upper and lower limits. If the level is low, refill oil through the filler to the upper level.

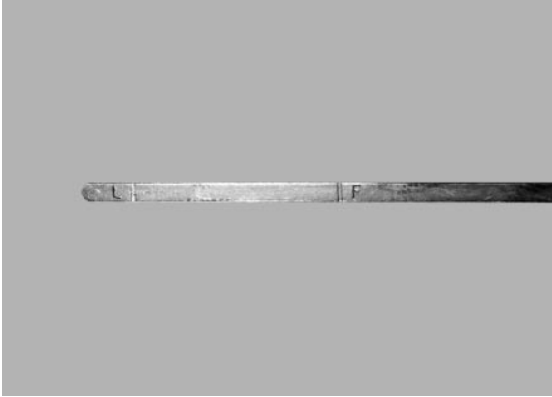


Fig. 3-1

Note:

- When checking oil level, place the machine on level ground.
- Before checking oil level, stop the engine and wait three minutes at least.
- When replenishing oil, use the same kind of oil as that in the engine.

- Oil capacities:

E393-G & E383-G:	2.5 litres
------------------	------------

- Grades and viscosities of usable oil

Temperatures °C	SAE No.	API classifications
-20 – 30	10w-30	CC or over
below 0	10	"
0 – 25	20	"
Above 25	30	"

- Replacing intervals: After the initial 50 hours of operation and then after every 100 hours. Replace the oil filter cartridge after every 300 hours.

a. REPLACEMENT OF OIL FILTER

Remove the oil filter cartridge from the cylinder block, using a cartridge wrench.

b. INSTALLATION OF OIL FILTER

Inject a small amount of engine oil into the cartridge.

Apply engine oil to the O-ring of the cartridge.



Fig. 3-2

Tighten the cartridge by hand until the O-ring comes into contact with the cylinder block surface and then give it three-fourth turn. After filling with new oil, operate the engine more than three minutes. Then check for oil leaks.



Fig. 3-3

2. INSPECTION OF FAN BELT

- Check belt deflection by apply a force of about 10 kgs to the center of the belt between the fan pulley and alternator. Also check the belt for damage such as cracks, peeling, wear, etc.

SERVICE MANUAL FOR SGR19 & SGR17

Specified deflection	5 – 10 mm
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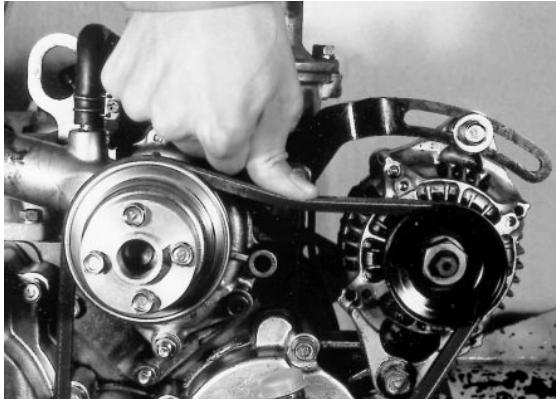


Fig. 3-4

- Adjustment:
When the deflection is more than specified, tension the belt properly by moving the alternator.

3. INSPECTION AND ADJUSTMENT OF VALVE CLEARANCES

- 3.1. Remove the cylinder head cover.
- 3.2. Turn the crankshaft by hand so that the piston in No.1 cylinder reaches at TDC: align the TDC notch in the crankshaft pulley with the projection on the gear case.

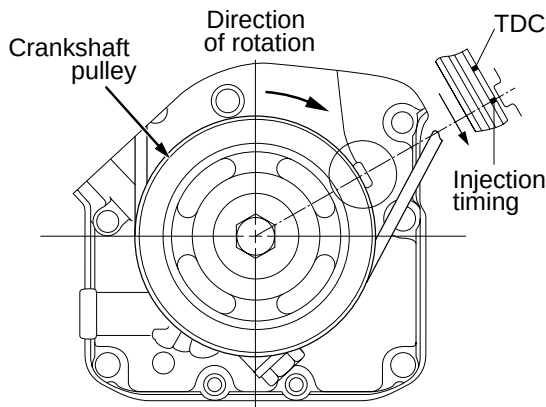


Fig. 3-5

Note:

When it is difficult to distinguish between TDC in compression stroke and TDC in exhaust stroke, use height difference among the push rods as a criterion for judgement. When the heights of the push rods (No.1, 2,3, and 6 viewed from the fan) are about 5 mm lower than those of No.4 and 5,

the piston in No. 1 cylinder is at TDC in compression stroke.

- 3.3. Insert a feeler gauge of a specified thickness and adjust the clearance with the adjusting screw.

Specified valve clearance (cold):

Intake	0.25 mm
Exhaust	0.25 mm

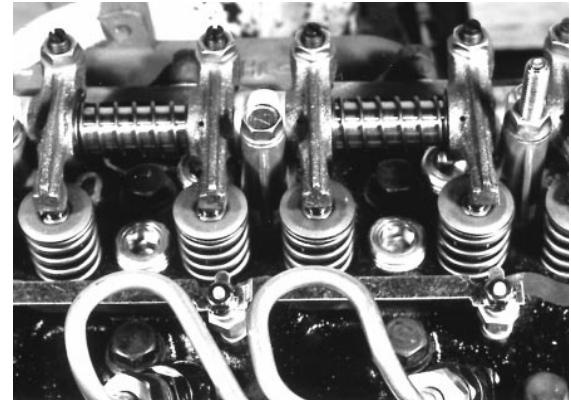


Fig. 3-6

4. INSPECTION AND ADJUSTMENT OF NOZZLE OPENING PRESSURE AND INJECTION TIMING

- 4.1. Adjustment of the valve opening pressure of the injection nozzles
 - Measure the pressure of initial fuel injection on a nozzle tester.

E393-G & E383-G:

Specified pressure	120 kg/cm ²
--------------------	------------------------

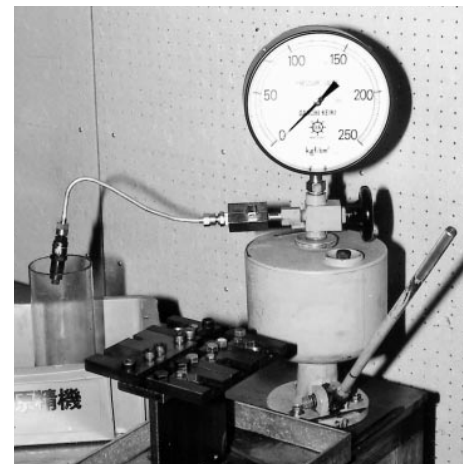


Fig. 3-9

When the pressure is too high, adjust by reducing shimming thickness for the nozzle, or replace the nozzle assembly.

When the pressure is too low, adjust by increasing shimming thickness, or replace the nozzle assembly.

4.2. Inspection of oil tightness of valve seats

Set a nozzle on a nozzle tester, and apply and maintain a pressure of 100 – 110 kg/cm². Check it see if fuel leaks through the seat. If fuel oozes out apparently, the nozzle is defective.

If a nozzle is not oil tight, disassemble it and remove carbon deposit. If this is insufficient to stop the oil leaking, replace the nozzle assembly.

4.3. Spraying condition of injection nozzle

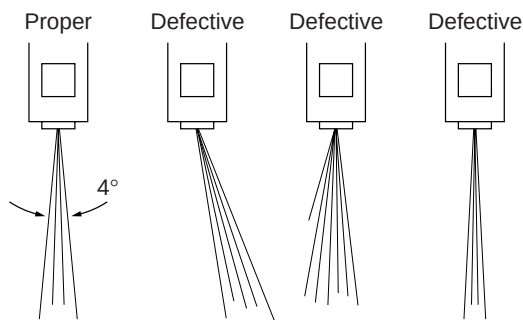


Fig. 3-10

4.4. Inspection and adjustment of injection timing

- Confirmation of injection timing, using No.1 cylinder

- (1) Bring the piston in No.1 cylinder to TDC in compression by aligning the marking on the crankshaft pulley with the one on the timing gear case, turning the crankshaft by hand. (Refer to Fig. 3-5.)

Note:

Be sure not to take TDC in exhaust for that in compression by checking for the opening and

closing of the valves.

- (2) Remove the injection pipes.

Note:

To keep away dust, cap the openings of the injection nozzle, injection pump, and injection pipe.

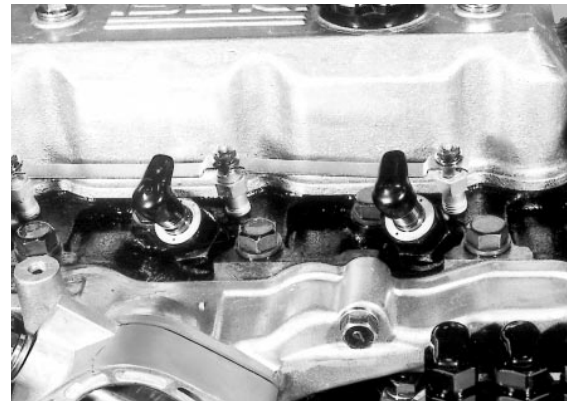


Fig. 3-11

- (3) Remove the delivery valve holder.
- (4) Remove No.1 delivery spring and install a delivery holder.

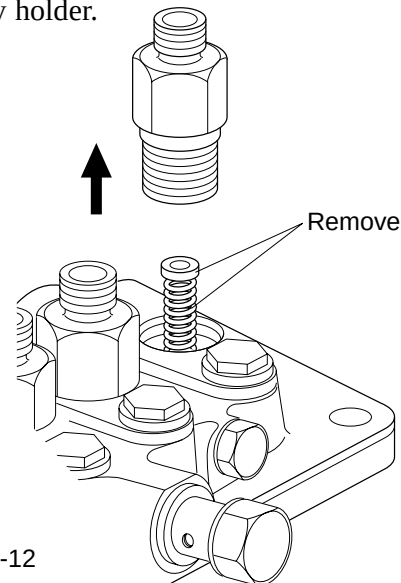


Fig. 3-12

- (5) Turn the crankshaft by hand to the point about 10° before the injection timing (turning the crankshaft in either direction will do).
- (6) Open the fuel cock and turn the key switch to the "ON" position to activate the fuel pump.

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- (7) Make sure that fuel ejects from the delivery holder. Turn the crankshaft slowly in correct direction (clockwise viewed from the fan) until fuel ejection stops. The injection timing is just before fuel ejection stops.

- When fuel ejection stops, the injection timing point is passed. Turn the crankshaft in reverse and repeat operation 6).
- Even when the injection timing point is passed, there is no sign of fuel ejection stopping. The point is BTDC in exhaust stroke. Turn the crankshaft fully by 360° and start operation.
- As a criterion of “just before fuel stops,” use the time to take to refill the fuel in the end of the delivery holder after blowing it off. When it takes 1 to 2 seconds to refill, it is the fuel injection timing point.

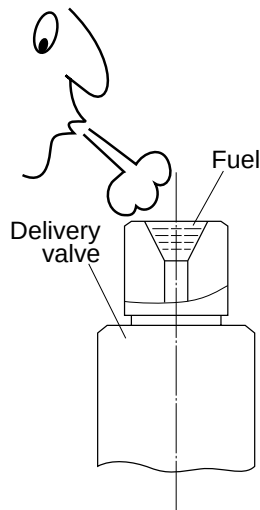


Fig. 3-13

- (8) Check to see the timing mark on the flywheel or the crankshaft pulley is aligned as shown in “3.2. Adjustment of valve clearance.”

For reference:

The crank angle 1° is about 1 mm on the crankshaft pulley and about 2.5 mm on the flywheel.

- (9) Turn the key switch to “OFF” and close the fuel cock.
- (10) After checking to see the fuel injection timing is correct, remove the delivery holder and install the delivery spring and stopper. Then re-tighten the delivery holder to the specified torque.
- (11) Install the injection pipe and tighten the nut to the specified torque.

Tightening torque	1.5 – 2.5 kgf·m
-------------------	-----------------

Note:

- Supply fuel only when fuel injection timing is measured [only for operation 6)].
- It is impossible to measure the fuel injection timing by turning the crankshaft in reverse (counterclockwise viewed from the fan).
- During this operation, be sure to keep dust out of the fuel system.

• Adjustment of injection timing

When the injection timing is improper, it should be corrected.

The injection timing can be adjusted by changing the distance between the camshaft and pump mounting surface with shims.

- Remove the injection pump cover.
- Remove the control link and starting spring from the control rack.
- Remove the injection pump.

- Shimming

Available adjusting shims: 0.1, 0.2, 0.3, 0.4 and 0.5 mm thick

For reference:

Injection timing shift with 0.1 mm thick shimming by crank angle:

Shimming +0.1 mm 1° delay
 Shimming -0.1 mm 1° advance

- Install the injection pump.
- Confirm that the injection timing is proper by the operation mentioned above. Until the proper fuel injection timing is attained, repeat steps from c. to e.
- Install the control link and starting spring on the control rack and then the injection pump cover.

Note:

During this operation, be careful to keep dust out of the fuel system.

CHAPTER 3. ENGINE**5. COMPRESSION AND UNLOADED IDLING SPEEDS****5.1. Inspection of compression**

- 1) Remove the injection pipes.
- 2) Remove a injection nozzle.

Note:

Cap the injection nozzles, injection pump, and injection pipes to avoid dust.

- 3) Install a compression gauge using an adaptor.

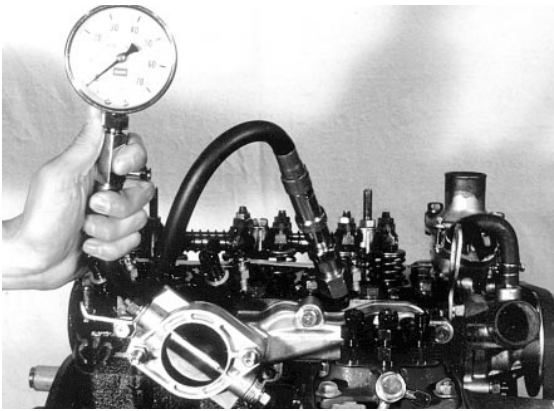


Fig. 3-14

- 4) Activate the starter and measure the compression.

kg/cm² at 300 rpm

Standard	Limit	Difference between cylinders
30	26	3

Note:

- Use a fully charged battery.
- Be sure to remove the fuel pipes in advance to avoid fuel injection.
- Remove only the nozzle for the cylinder whose compression is to be measured. Other nozzles should be left installed.

Caution:

When cranking the engine, take care not to touch rotating parts.

5.2. Inspection and adjustment of the idling speeds

- 1) Check for idling speeds.

Specified value	1250 rpm
-----------------	----------

- 2) When the measured value deviates from the specified value, correct with an adjusting bolt.

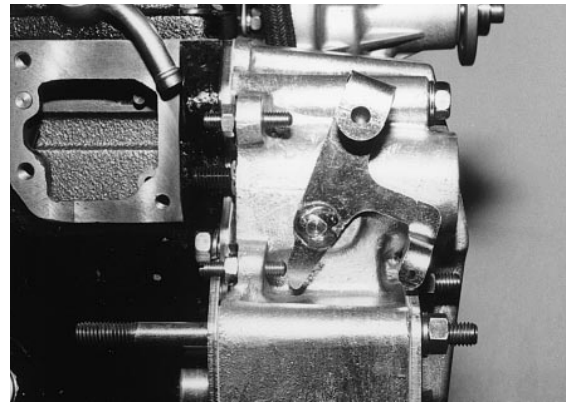


Fig. 3-15

6. INSPECTION OF WATER PUMP**6.1. Inspection of the pump and pulley**

Check the pump for noise or hitching by turning the water pump pulley, applying load vertically to the pump axis.

When noise or hitching occurs, replace the pump assembly.



Fig. 3-16

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6.2. Inspection of the bearing unit

Check the bearing unit for run-out. If the run-out is more than 0.2 mm, replace the pump assembly.

7. INSPECTION OF THERMOSTAT

- Inspection of activating temperatures at which the valve starts to open and opens fully
Put the thermostat in water and heat the water gradually by stirring.
Check for the temperature at which the valve starts to open and that at which the valve opens fully.

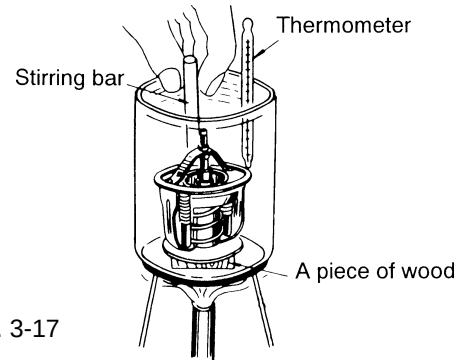


Fig. 3-17

Starts-to-open temperature	76.5±2°C
Full-open temperature	90°C (194°F) [lift: more than 8 mm]

III. ENGINE BODY

III.1. CYLINDER HEAD

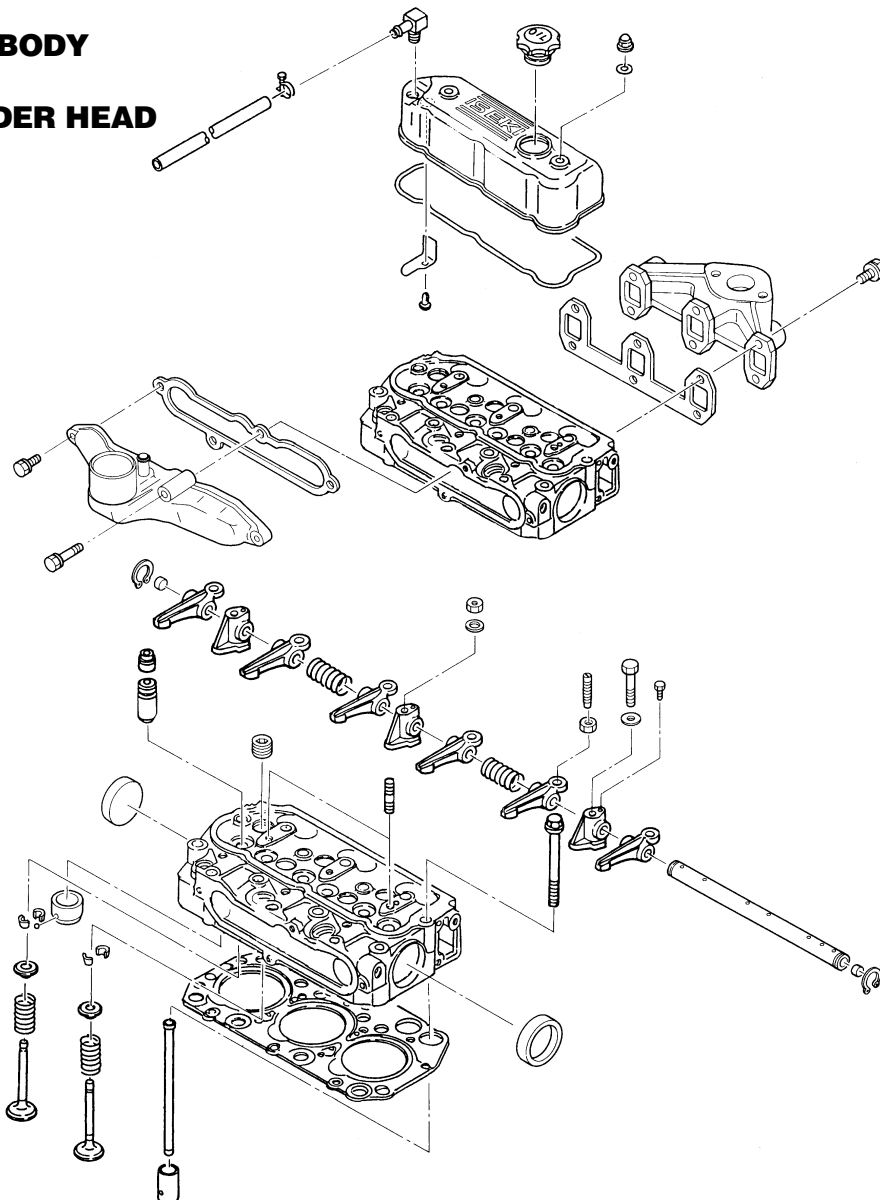


Fig. 3-18 (Exploded view of cylinder head)

CHAPTER 3. ENGINE

1. REMOVAL OF THE CYLINDER HEAD

- (1) Removal of the cylinder head cover.



Fig. 3-19

- (2) Disconnection of the injection piping.

- When the piping has been removed, cap the delivery pipe holders, injection nozzles and injection pipes at once to avoid dust.



Fig. 3-20

- (3) Removal of the fan belt.

- (4) Removal of the oil pipe.

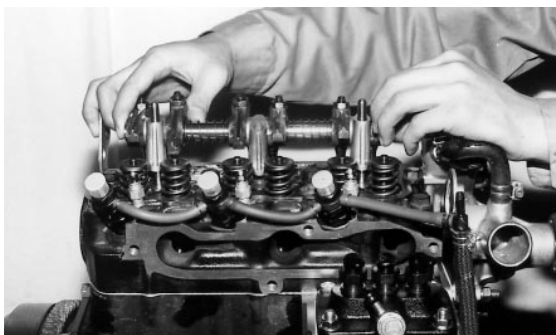


Fig. 3-21

- (5) Removal of the rocker shaft assembly (Fig. 3-20).

- (6) Removal of the push rods.

- (7) Removal of the water by-pass hose.

- (8) Removal of nozzles.

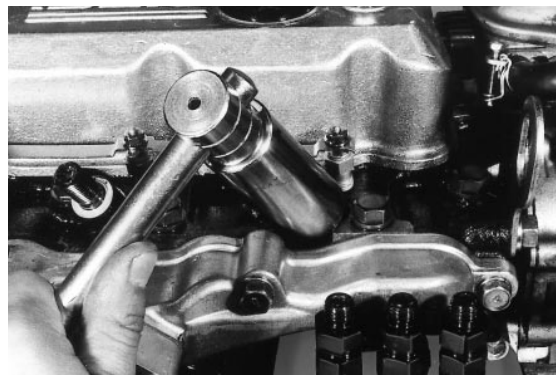


Fig. 3-22

- Remove the cap.
- Remove fuel-return pipes.
- Draw out the nozzle along with the gasket.

Note:

Be careful to keep the nozzle free from dust.

- (9) Removal of glow plugs.

- (10) Removal of the cylinder head.

- Loosen the cylinder head bolts in the sequence shown in the figure.
- After the removal of the cylinder head, remove the dowels and tappets.

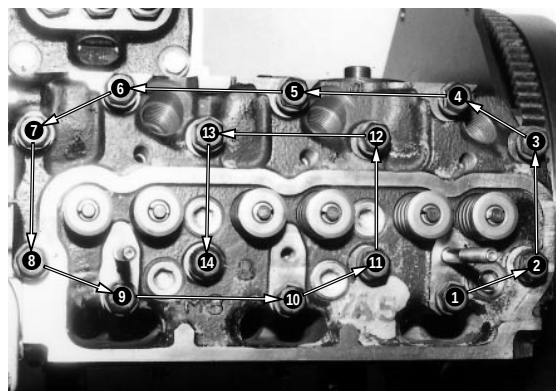


Fig. 3-23

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2. DISASSEMBLY

- (1) Removal of the inlet manifold.
- (2) Removal of the exhaust manifold.
- (3) Removal of the thermostat housing.
- (4) Removal of the valves.

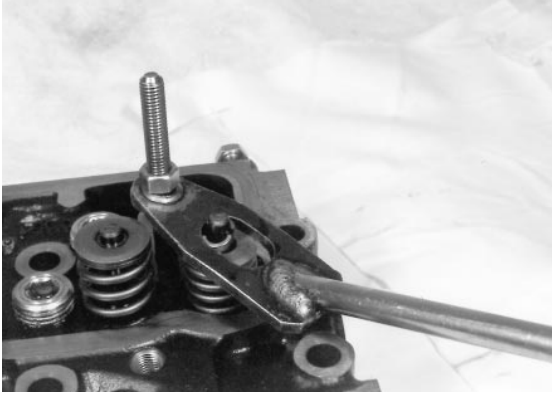


Fig. 3-24

- Compress the valve spring along with the spring seat with a spring compressor, and remove the cotter spring seat retainer.

Note:

Removed valve and related parts should be put aside in order of valve numbers.

- (5) Removal of the valve oil seals.

Note:

Discard removed valve oil seals.

3. INSPECTION

- (1) Inspection of the cylinder head for cracks.

- Remove carbon deposit from the bottom surface of the cylinder head.
- Inspect the bottom surface and inlet and exhaust ports using "COLOR CHECK."

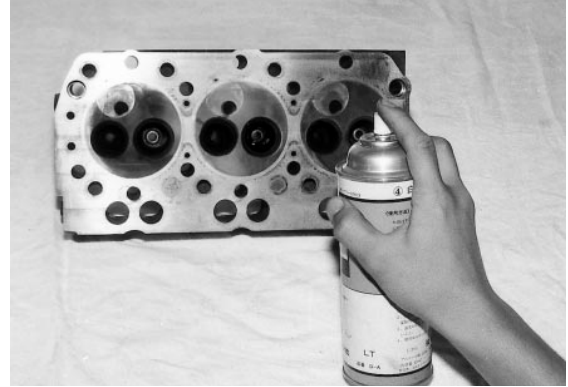


Fig. 3-25

- (2) Inspection of the cylinder head for distortion

- Measure the flatness of the bottom surface of the cylinder head by putting a straight rule diagonally across the four corners on the bottom face and check for clearance with thickness gauges.

	Standard value	Usable limit
Distortion	0.075 mm	0.15 mm

- When the distortion exceeds the usable limit, correct on a surface grinder.
- As the ground-down limit is 0.4 mm (0.016 in.), replace a cylinder head assembly which required more than the ground-down limit to correct.

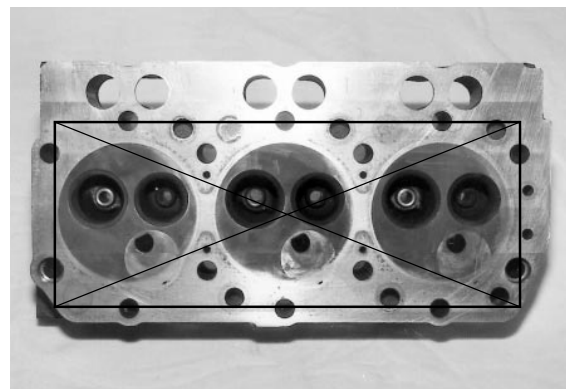


Fig. 3-26

- (3) Inspection of the clearance between the valve guide and valve stem.

- Check the valve for play with a dial indicator. If the play exceeds 0.15 mm for the inlet valve and 0.2 mm for the exhaust valve, replace both the

valve and valve guide as an assembly. Measure the play at a point 10 mm apart above the valve oil seal when the valve lift is 0 mm.



Fig. 3-27

(4) Replacement of the valve guide.

- Drive out the valve guide upwards from the cylinder head bottom.
- Press in a new valve guide from the cylinder head top, taking care not to damage the guide.

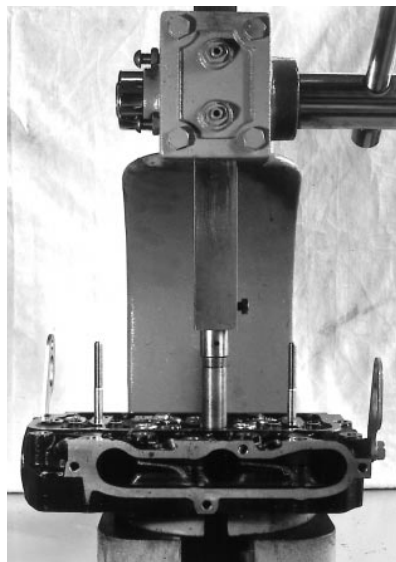


Fig. 3-28

Note:

Apply oil to the new valve guide ahead of time.

- Press in so that the distance from the cylinder head top to the valve guide end becomes 7 mm.
- After installation, correct the bore diameter of the valve guide to the specified value by reaming.

Specified bore	7 mm
----------------	------

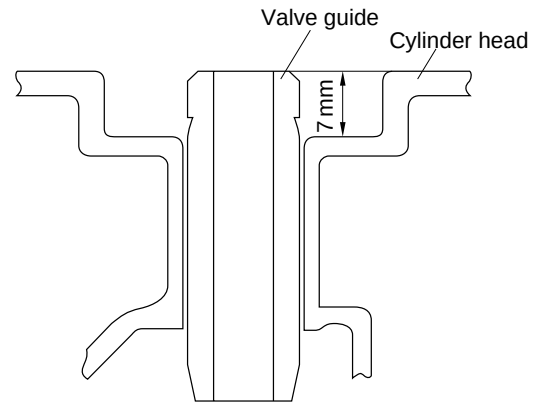


Fig. 3-29

(5) Inspection and correction of valve seats.

- Check for valve contacting width and depression.

When the contact width is wider than specified, correct with a 75° valve seat cutter. When the valve depression is more than specified, replace the cylinder head assembly.

	Standard value	Usable limit
Contact width	1.3 – 1.6 mm	2.0 mm
Valve depression	0.7 mm	1.4 mm

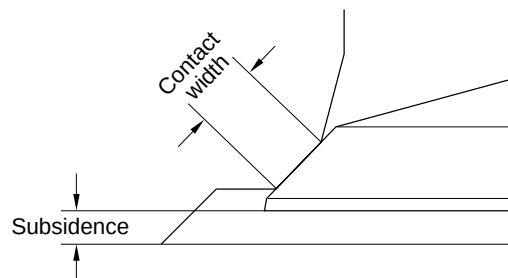


Fig. 3-30

- Apply polishing compound to the valve seat surface and lap with the valve while tapping the valve to secure sufficiently contact with the whole circumference.

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Fig. 3-31

Note:

After lapping, remove the polishing compound completely.

(6) Inspection of valves.

- Measure the valve stem diameter with a micrometer.

	Standard value	Usable limit
Inlet valve	7.00 mm	6.90 mm
Exhaust valve	7.00 mm	6.89 mm

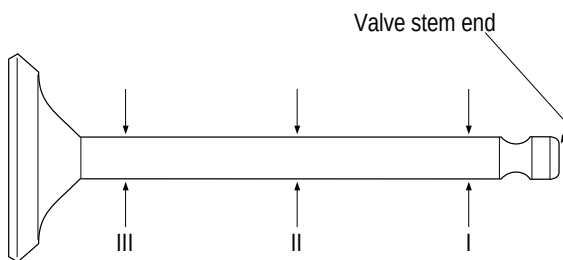


Fig. 3-32

- Check for valve thickness.

	Standard value	Usable limit
Valve thickness	0.8 mm	0.55 mm

When the valve thickness is less than the usable limit, replace the valve.

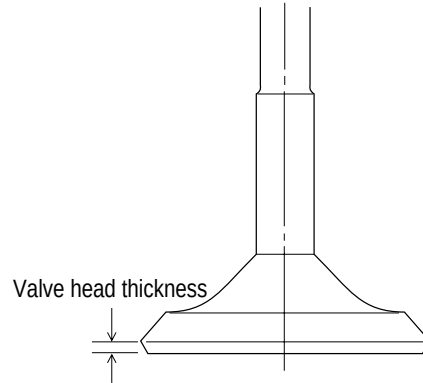


Fig. 3-33

(7) Inspection of valve springs.

- Measure the free length of each valve spring with calipers.

	Standard value	Usable limit
Free length	36.0 mm	35.0 mm
Tension	8.3 kgf (when compressed to 31 mm)	7.35 kgf

- Put a spring upright on a surface table and measure deviation from vertical.

	Usable limit
Deviation from vertical	1.0 mm

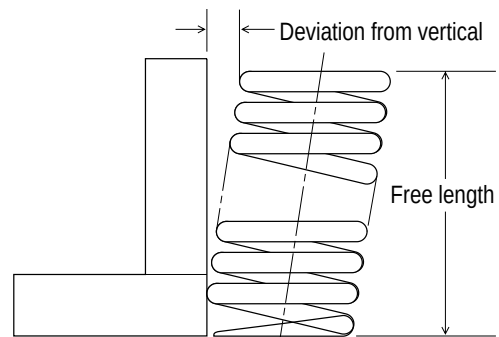


Fig. 3-34

(8) Inspection of intake and exhaust manifold contact surfaces for flatness.

- Measure flatness with a straight rule and thickness gauges.

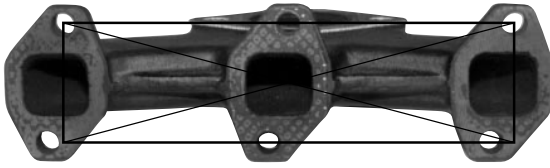


Fig. 3-35

	Usable limit
Surface flatness (both for intake and exhaust manifolds)	0.2 mm

When the deviation exceeds the usable limit, replace the manifold.

4. DISASSEMBLY AND INSPECTION OF THE ROCKER ARM SHAFT

- (1) Disassembly of the rocker arm shaft assembly
 - Put an identification mark on the front side top of the rocker arm shaft for later reference.
 - Remove snap rings C and remove arm brackets.
 - Put away the brackets in order.



Fig. 3-36

- (2) Inspection of the rocker arm shaft for bending
 - Check for bending with a dial gauge.

	Usable limit
Shaft bending	0.5 mm

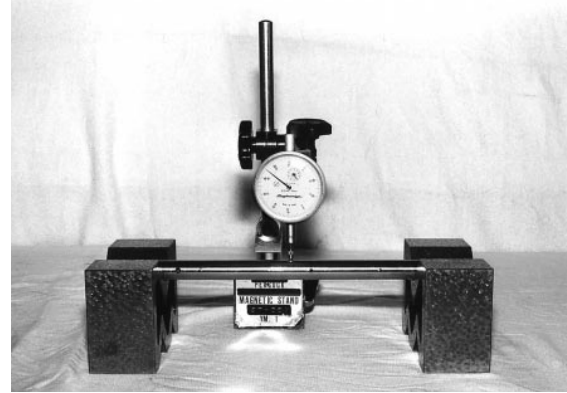


Fig. 3-37

- (3) Inspection of the rocker arm shaft for wear

- Measure diameter at four points where the shaft bears respective rocker arms.
- When wear is in excess of the usable limit, replace the shaft.

	Standard value	Usable limit
Diameter	16.00 mm	15.85 mm

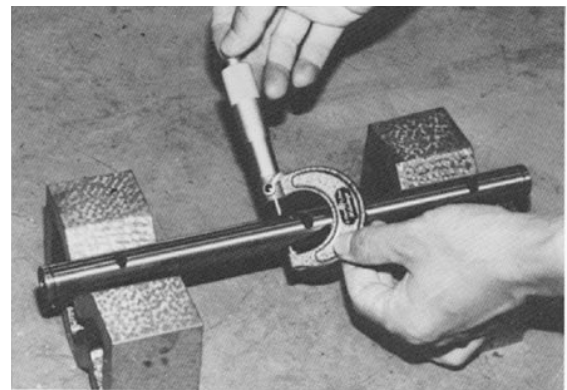


Fig. 3-38

- 4) Inspection of the clearance between the rocker arms and rocker arm shaft
 - Measure the bore diameter of each rocker arm and calculate the difference from the diameter of the rocker arm shaft.

When the difference exceeds the usable limit, replace the assembly of the rocker arm shaft and rocker arms.

SERVICE MANUAL FOR SGR19 & SGR17

	Standard value	Usable limit
Clearance	0.01 – 0.05 mm	0.2 mm

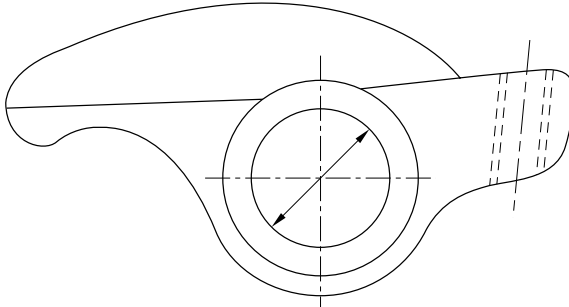


Fig. 3-39

(5) Reassembly of the rocker arm shaft assembly

- Arrange the rocker arms so that the sides where identification markings were put when disassembled are turned forward. Make sure that the shaft is placed with the end having an off-set positioning bolt hole turned forward.

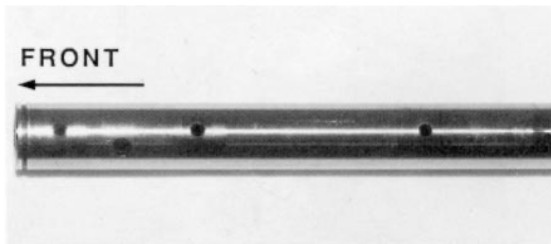


Fig. 3-40

5. INSPECTION OF THE PUSH RODS

- Check both ends of each push rod for wear. Replace excessively worn rods with new ones.
- Check push rods for bending. Place a rod on a surface table and measure bending with thickness gauges.

	Usable limit
Push-rod bending	0.3 mm



Fig. 3-41

6. INSTALLATION OF THE CYLINDER HEAD

(1) Installation of the cylinder head

- Clean the bottom surface of the cylinder head and the top surface of the cylinder block.
- Drive in dowels.
- Insert tappets.
- Put a new gasket with its "TOP" mark turned upward.
- A gasket of different models has a different identification marking: notches in the left top corner as shown below.

Engine model	Cylinder bore (mm)	Identification notches
E393	Ø74	
E383	Ø70	

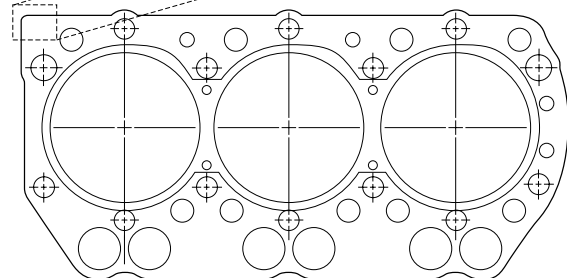


Fig. 3-42

CHAPTER 3. ENGINE

- Place the cylinder head softly on the cylinder block.
 - Apply engine oil to the threads of the cylinder head bolts.
 - Tighten the cylinder head bolts in the sequence as shown in Fig. IV-31 to the specified torque.
 - Be sure to tighten the bolts step by step: first to 2 kgf·m (14 ft·lbs), second to 4 kgf·m (29 ft·lbs), and then lastly to the following torques.
- (4) Installation of the leak hoses.

Specified torque	5.5 – 6.0 kgf·m
------------------	-----------------

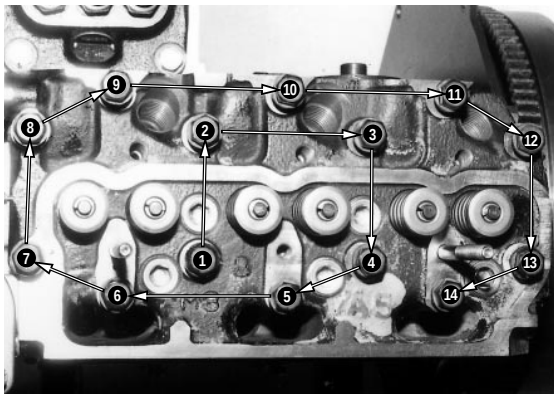


Fig. 3-43

- (2) Installation of the glow plugs
- (3) Installation of the injection nozzles

- Be sure to use new packings and tighten the nozzles to the specified torque.

Specified torque	4.0 – 5.5 kgf·m
------------------	-----------------

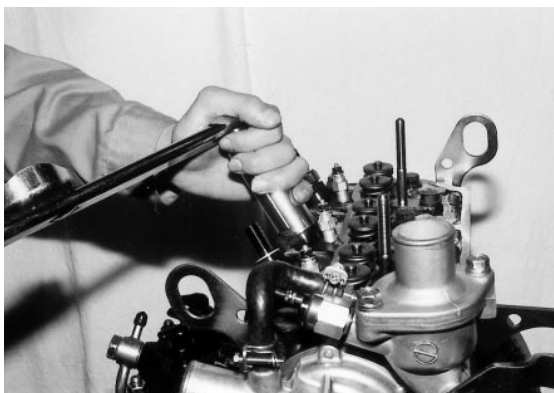


Fig. 3-44

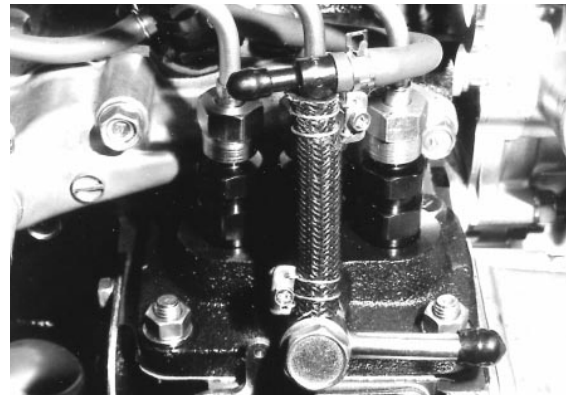


Fig. 3-45

- (5) Installation of the push rods

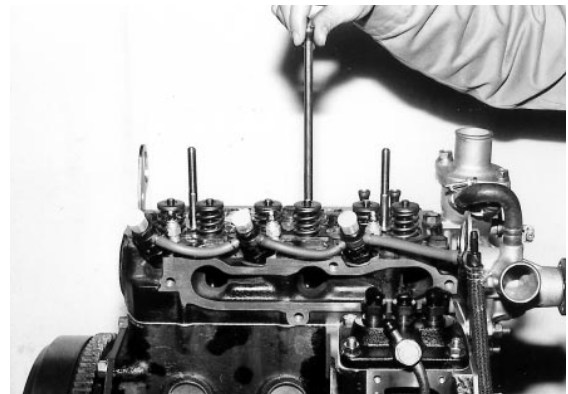


Fig. 3-46

- (6) Installation of the rocker arm assembly

- Loosen all rocker arm adjusting screws.
- Install the rocker arm assembly and tighten it to the specified torque.

Specified torque	1.4 – 2.4 kgf·m
------------------	-----------------

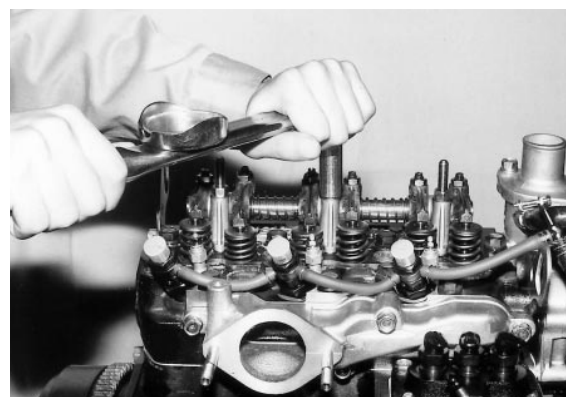


Fig. 3-47

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(7) Installation of the injection pipes

- Install injection pipes for respective cylinders and tighten them securely.

(8) Install water by-pass hose.

(9) Adjustment of the valve clearances

sure to adjust the valve clearances.

(10) Installation of the head cover.

Note:

The head cover seal and gasket are made of rubber, so take care not to tighten the head cover excessively.

When the cylinder head has been removed, be

III.2. GEAR CASE

1. EXPLODED VIEW

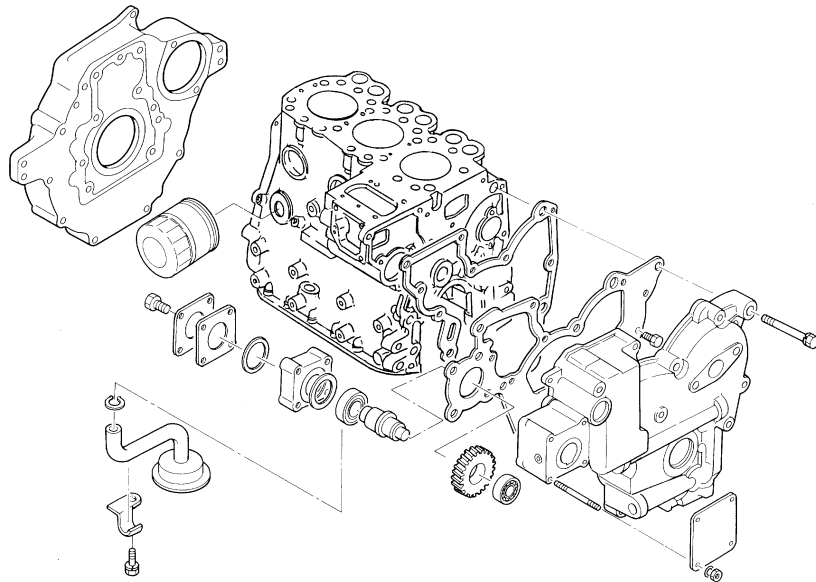


Fig. 3-48

2. REMOVAL OF THE GEAR CASE

- Remove the cooling fan.
- Remove the fan belt.
- Remove the crankshaft pulley.
- Remove the alternator.
- Remove the injection pump cover and then remove the starting spring, setting spring, and control link from the rack.

- Remove the return spring from the control lever.
- Remove the hydraulic pump if installed.
- Remove the hydraulic pump drive gear.
- Remove the gear case

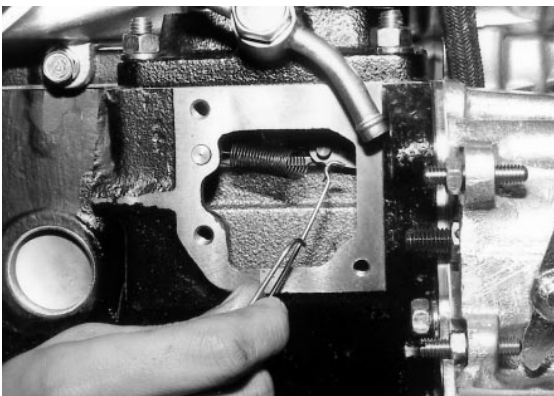


Fig. 3-49

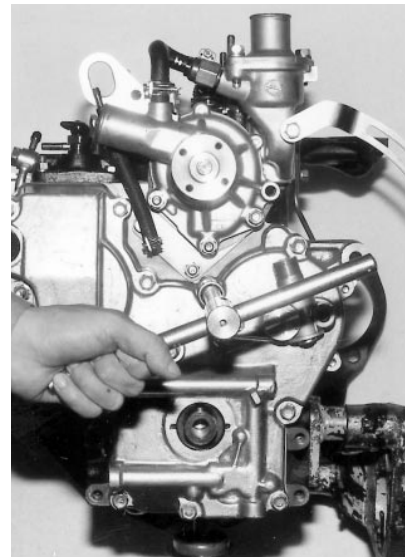


Fig. 3-50

Note:

Note which bolt is to be installed in which place for later reference and remember to remove the bolts which also tighten the case from behind.

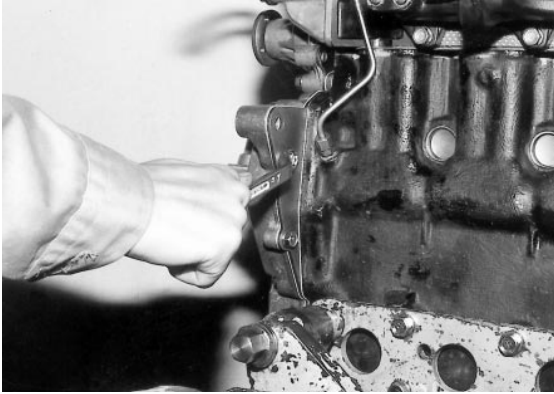


Fig. 3-51

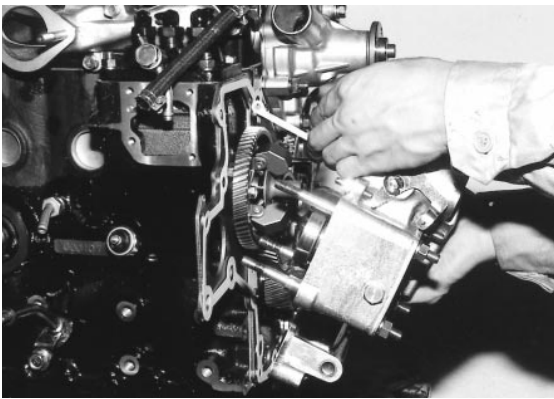


Fig. 3-52

- Discard removed packings and oil seals and use new ones during re-assembly.

Note:

It is recommended not to disassemble the oil pump assembly, relief valve, governor, and related parts which are installed inside the gear case except when required.

3. RE-INSTALLATION OF THE GEAR CASE

- Install the idle gear.
- Apply oil to the bore surface of the idle gear and install taking care to align the timing marks with those of other gears.

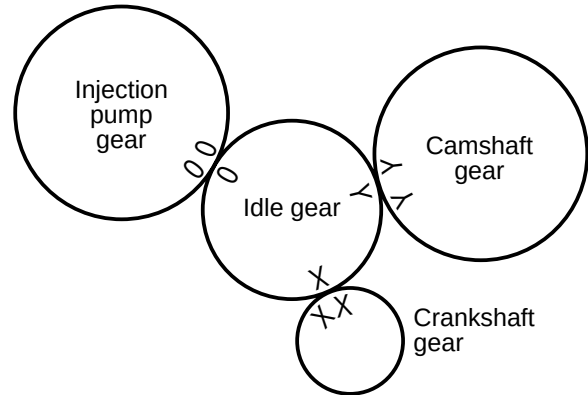


Fig. 3-53

- Install the gear case.

Specified torque	1.4 – 2.4 kgf·m
------------------	-----------------

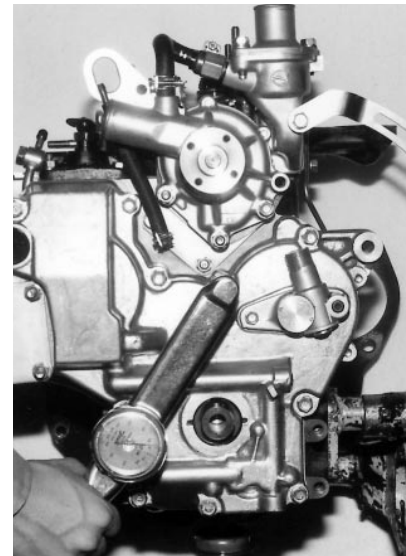


Fig. 3-54

- Connect the rack of the injection pump and the control link with a setting spring. After installation, confirm their smooth working by moving the rack several times.
- Install the starting spring. Take care not to drop the spring.
- Install the injection pump cover, using new packing.
- Install the crankshaft pulley and tighten to the specified torque.

Specified torque	17.0 – 20.8 kgf·m
------------------	-------------------

- Install the alternator.
- Install the fan belt and cooling fan.

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III.3. CYLINDER BLOCK

1. EXPLODED VIEWS

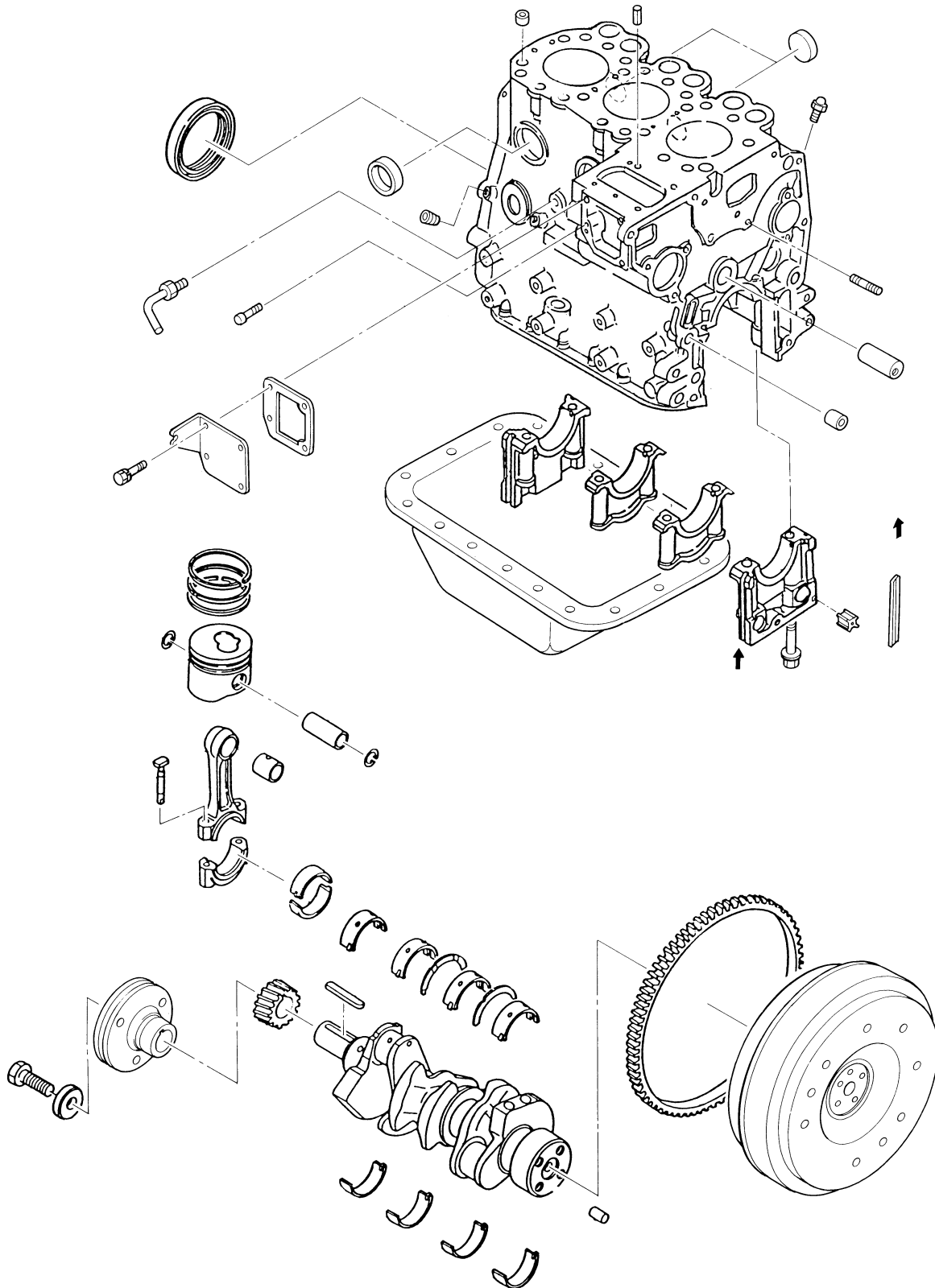


Fig. 3-55

2. DISASSEMBLY OF THE CYLINDER BLOCK

- (1) Install the engine on a engine stand.

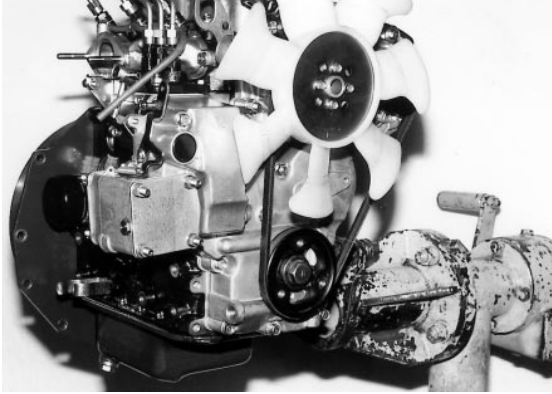


Fig. 3-56

- (2) Drain engine oil.
(3) Remove the cylinder head (Refer to page 33).
(4) Remove the tappets.
(5) Remove the gear case (Refer to page 42).
(6) Remove the camshaft.

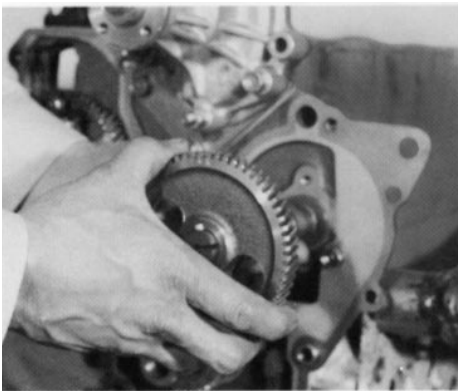


Fig. 3-57

- (7) Remove the injection pump and then remove the pump cam.
(8) Remove the solenoid.
(9) Remove the water pump.

- (10) Remove the water pump spacer.
(11) Remove the oil filter.
(12) Remove the oil pan and oil strainer.
(13) Clean the cylinder bores of carbon deposit.

Remove carbon deposit from the upper part of the cylinder bore with a scraper, taking care not to damage the cylinder walls.



Fig. 3-58

- (14) Removal of the pistons and connecting rods.

- Remove the nuts which tighten the connecting bearing cap.
- Remove the piston/connecting rod assembly toward the cylinder head.

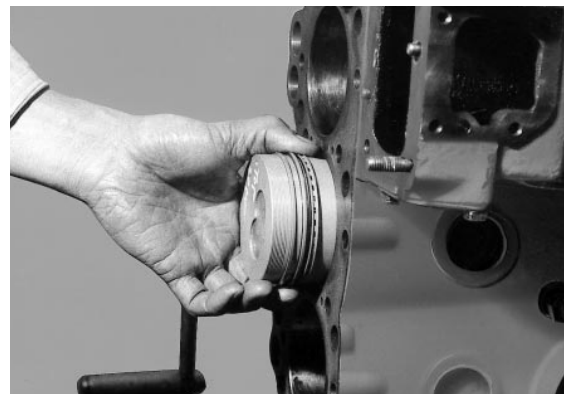


Fig. 3-59

- Put aside removed piston/connecting rod assemblies, connecting rod bearing caps, and bearings in order in accordance with respective cylinders.

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(15) Removal of the flywheel.

- Chock the flywheel.
- Removal of the flywheel.

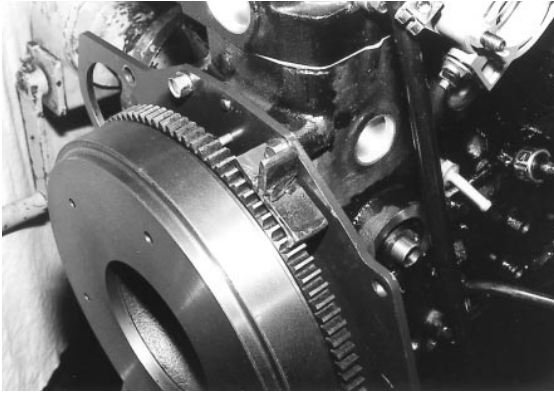


Fig. 3-60

(16) Remove the rear plate.

(17) Removal of the crankshaft.

- Remove bearing caps.

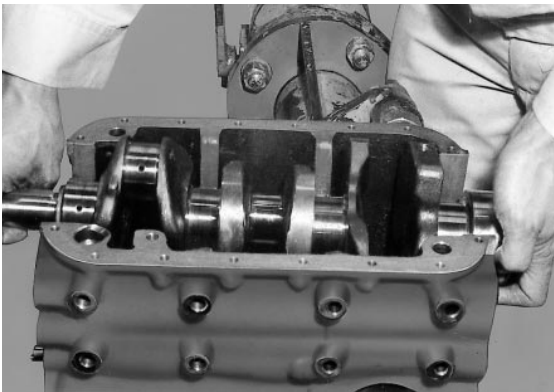


Fig. 3-61

- Put aside removed bearing caps and bearings in order of bearing numbers.
- Remove the crankshaft.

(18) Remove the oil pressure switch.

3. INSPECTION OF CYLINDER BLOCK, CRANKSHAFT, CAMSHAFT, AND TAPPETS

(1) Inspection of the cylinder block

- Inspect the cylinder block for damage.

Check for damage visually.

Use "COLOR CHECK" if necessary to check for cracks and other damage. Repair damage if possible or replace.

- Inspect the cylinder block **top surface for flatness**.

Check the top surface for distortion with a straight rule and thickness gauges in diagonal ways as shown in the figure.

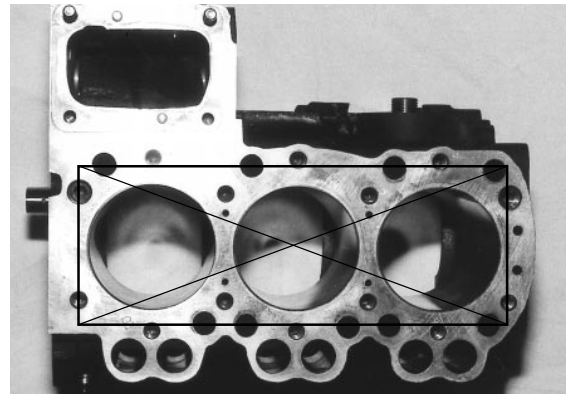


Fig. 3-62

Standard value	Usable limit
0.08 mm or less	0.15 mm

If distortion exceeds the usable limit, correct on a surface grinder. But the ground-down limit is **0.4 mm**. A cylinder block which cannot be corrected within the ground-down limit should be replaced with a new one.

- Check the cylinder bores for wear.

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Fig. 3-63

- Measure cylinder bore diameter at a point of 12 to 14 mm below the cylinder block top surface in two directions: one is in alignment with the crankshaft axis and the other is at right angles to the crankshaft axis.

Wear limit	0.2 mm
------------	--------

- If wear is in excess of 0.2 mm, correct by honing.
- Honing should be done to fit a oversize piston, which should be done at a specialist's workshop.

Oversize	0.5; 1.0 mm
----------	-------------

- Honing accuracy should be to the extent that bore diameters measured in two directions at A and B and in three levels at a, b, and c differ less than 0.02 mm from each other.

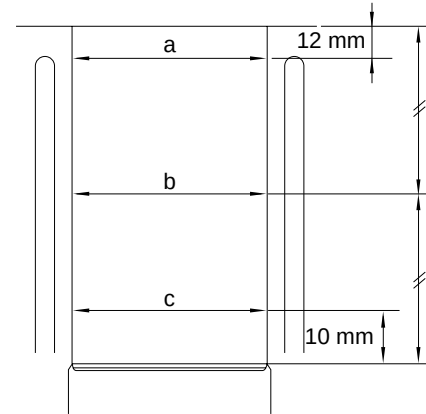
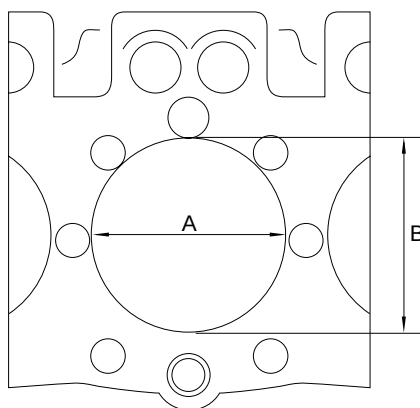


Fig. 3-64

(2) Inspection of the crankshaft

- Check the crankshaft journals for oil clearance.
 - a. Clean the journals and bearings.
 - b. Install the upper bearings and crankshaft on the cylinder block.
 - c. Put plasti-gauge over the journal width.

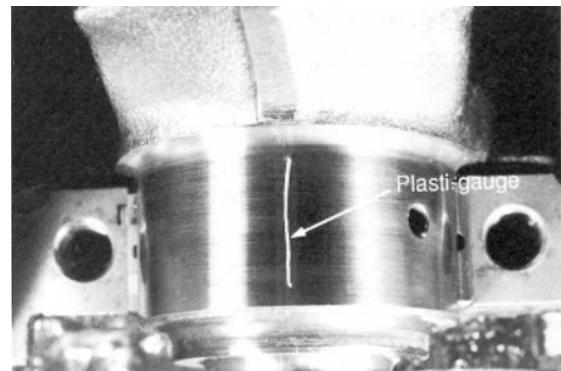


Fig. 3-65

- d. Install the bearings on respective bearing caps. Install the assemblies and tighten them to the specified torque.

Specified torque	4.5 – 5.5 kgf·m
------------------	-----------------

While tightening, the crankshaft should be held securely so as not to turn.

- e. Loosen the tightening bolts and remove the bearing caps carefully. Then measure the most stretched parts of the plasti-gauges.

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Fig. 3-66

Standard value	Usable limit
0.029 – 0.080 mm	0.12 mm

- f. If the oil clearance of a journal is in excess of the usable limit, replace the bearings with new ones and check for oil clearance again. When the clearance exceeds the usable limit ever after new bearings have been installed, polish the journal and use undersize bearings.

Undersize bearings	0.5, 1.0 mm
--------------------	-------------

When the ground-down limit of 1.0 mm is not enough for correction, replace both crankshaft and bearings with new ones.

- Check the pins on the crankshaft for oil clearance.
- Clean the crankshaft pins, connecting-rod big ends, and bearings.
 - Place plasti-gauge over the pin width.

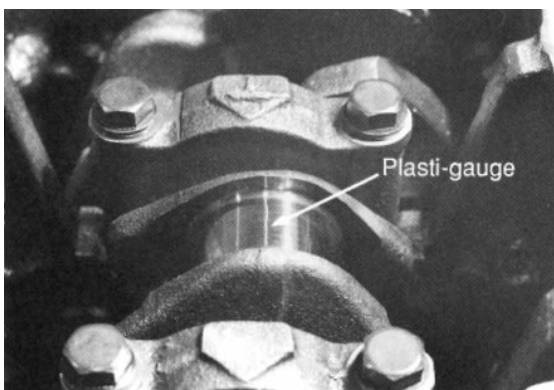


Fig. 3-67

- Tighten the bearings on the connecting rods to the specified torque.



Fig. 3-68

Specified torque	2.7 – 3.3 kgf·m
------------------	-----------------

Note:

Hold the crankshaft securely so as not to turn while tightening.

- Loosen the tightening bolts and remove the connecting-rod bearing caps carefully.
- Measure the most stretched parts of the plasti-gauges.



Fig. 3-69

Standard value	Usable limit
0.027 – 0.075 mm	0.12 mm

- If the oil clearance exceeds the usable limit, replace the bearings with new ones and check for

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oil clearance again. When the clearance exceeds the usable limit ever after new bearing have been installed, polish the pin and use undersize bearings.

Undersize bearings	0.5; 1.0 mm
--------------------	-------------

When the ground-down limit of 1.0 mm (0.039 in.) is enough for correction, replace both crankshaft and bearings with new ones.

• Thrust clearance

Install the connecting rod on the crank pin and measure the thrust play with thickness gauges. If the play exceeds the usable limit, replace the connecting rod.

Standard value	Usable limit
0.04 – 0.215 mm	0.30 mm



Fig. 3-70

(3) Inspection of the flywheel

Check the friction surface for cracks and other damage. If defective, correct or replace with a new flywheel.

Check the ring gear teeth for excessive wear and other damage. If defective, replace the ring gear with a new one.

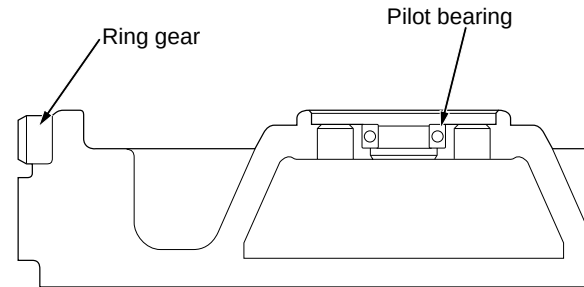


Fig. 3-71

• Replacement of the ring gear

Hammer the circumference of the ring gear evenly via a holding rod to remove the ring gear.



Fig. 3-72

Heat up a new ring gear with a torch, and then drive it onto the flywheel.

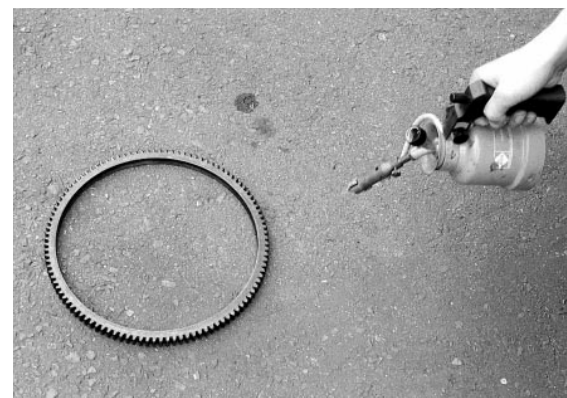


Fig. 3-73

Note:

- Install the ring gear with the chamfered side turned toward the starter.
- After installation, make sure the ring gear is in tight contact with the flywheel.

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- Inspection of the pilot bearing
Check for noise or hitching by turning it. Replace a defective bearing with a new one.
- Removal of the pilot bearing
Remove the flywheel and drive out the bearing from front to rear.



Fig. 3-74

- Installation of the pilot bearing
Drive in the bearing evenly, taking care not to allow it installed slanted. Be sure not to apply load upon the inner race.

(4) Inspection of the camshaft

- Check the journals and cams for wear and other damage.

A worn or defective shaft should be replaced with a new one.



Fig. 3-75

- Cam height

Measure the height with a micrometer.

Standard value	Usable limit
27 mm	26.6 mm

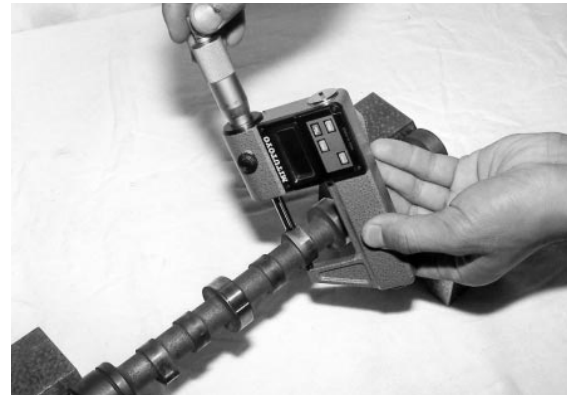


Fig. 3-76

- Measurement of journal wear

Measure the diameter of each journal.

Standard value	Usable limit
33 mm	32.75 mm

If wear is in excess of the usable limit, replace the camshaft with a new one.

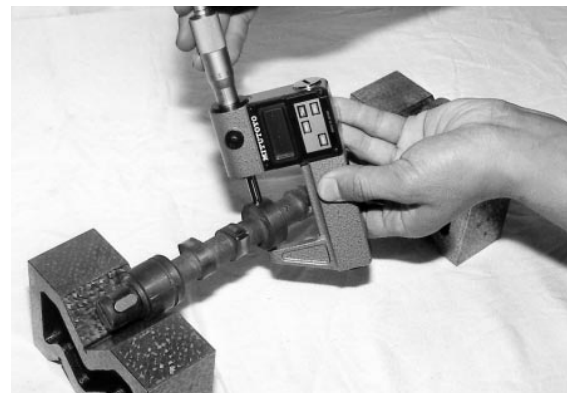


Fig. 3-77

Measure the bore diameter of each bearing. And calculate the difference between the cam journal diameter and bearing bore diameter.

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Clearance between journal and bearing:

Standard value	Usable limit
0.05 – 0.105 mm	0.12 mm

If the clearance exceeds the usable limit, replace the camshaft with a new one.

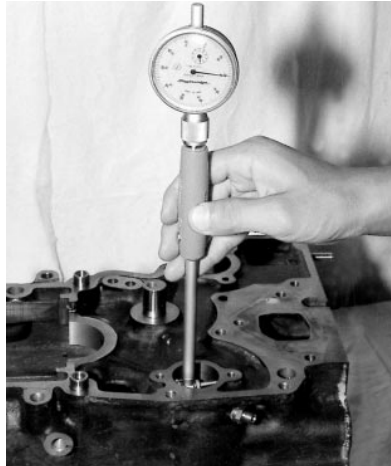


Fig. 3-78

- Thrust play of the camshaft

Install the thrust plate and cam gear on the camshaft. Push the thrust plate fully against the cam gear and measure the clearance between the thrust plate and journal with thickness gauges.

Standard value	Usable limit
0.05 – 0.174 mm	0.3 mm

If the clearance exceeds the usable limit, replace the thrust plate.



Fig. 3-79

(5) Inspection of tappets

- Check the contact surface with the camshaft for

pitting, cracks, etc. Defective tappets should be replaced with new ones.

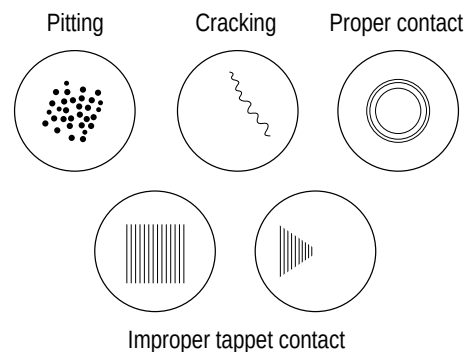


Fig. 3-80

- Check the outer diameter for wear.

Standard value	Usable limit
20 mm	19.95 mm

Replace the tappets having diameters less than the usable limit.

- Clearance of the tappets with the cylinder block

Measure the bore diameter of each tappet hole in the cylinder block and the outer diameter of each tappet. Then calculate the difference.

Replace the tappets which have clearances in excess of the usable limit.

Standard value	Usable limit
0.02 – 0.062 mm	0.1 mm

4. INSPECTION OF PISTONS AND CONNECTING RODS

- Check piston ring gaps.

Push a piston ring into the cylinder, using a piston as a pushing tool, to a point past the position where the ring would be during operation i.e. to the lower end of the cylinder wall.

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Fig. 3-81

Measure the gaps of each piston ring with thickness gauges.

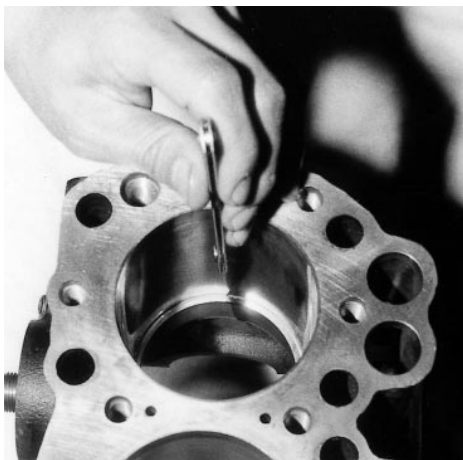


Fig. 3-82

Replace the rings whose gaps are in excess of the usable limit.

	Standard value	Usable limit
No.1 compression ring	0.25 – 0.40 mm	1.5 mm
No.2 compression ring	0.25 – 0.40 mm	1.5 mm
Oil ring	0.25 – 0.40 mm	1.0 mm

- Inspection of piston ring clearance in ring grooves



Fig. 3-83

Clean ring grooves using a used piston ring. Measure the clearance at the outer circumference with thickness gauges as shown in the figure.

	Standard value	Usable limit
No.1 compression ring	0.25 – 0.40	1.5
No.2 compression ring	0.25 – 0.40	1.5
Oil ring	0.25 – 0.40	1.0

When the clearance exceeds the usable limit, replace both piston and rings as an assembly.

- Inspection of the piston pin

The interference between the piston pin and piston pin hole should be such that the pin can be pushed in smoothly at room temperature.



Fig. 3-84

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When the pin has excessive play in the hole at room temperature, replace the piston or the piston pin.

- Inspection of the clearance between the connecting-rod small end and piston pin

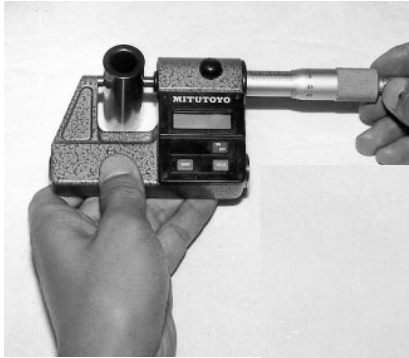


Fig. 3-85



Fig. 3-86

Calculate the difference between the bore in the small end and piston pin diameter.

	Standard value	Usable limit
Clearance	0.008 – 0.02 mm	0.05 mm

When the clearance exceeds the usable limit, replace the connecting rod or the piston pin.

- Connecting-rod twist

Find the twist and parallelism between the big end and small end of the connecting rod.

	Standard value	Usable limit
Twist	0.05 mm or less	0.2 mm
Parallelism	0.05 mm or less	0.15 mm

If either of the measured values exceed the specified value, replace the connecting rod.

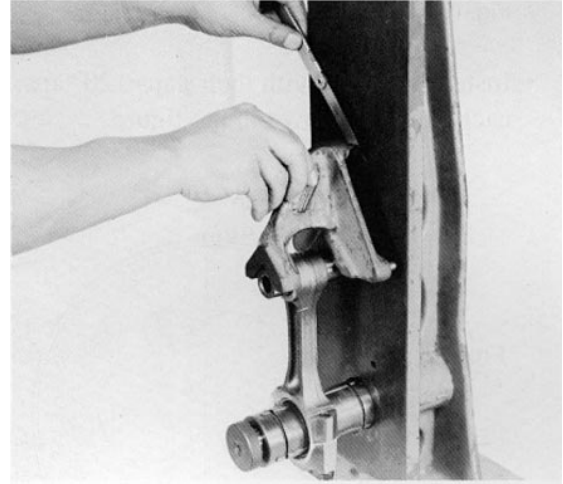


Fig. 3-87

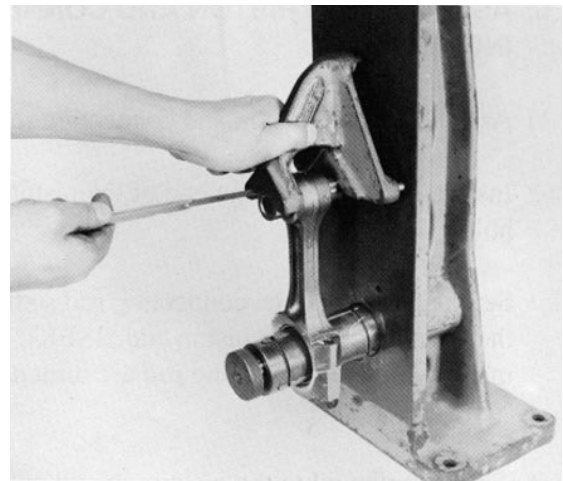


Fig. 3-88

5. ASSEMBLY OF PISTON AND CONNECTING ROD

(1) Assembly of the piston and connecting rod

- Install a snap ring in one end of the piston pin hole.
- Set the piston and the connecting rod so that the front mark on the piston and “ISEKI” marking on the connecting rod are turned in the same direction.
- Apply engine oil to the piston pin and push it into the hole by hand.

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Fig. 3-89

- Install the other snap ring securely in the groove.



Fig. 3-90

(2) Installation of piston rings

- Install the rings using a piston ring expander with their "T" marks turned upwards. But the oil rings have no markings, so they can be installed with either side up.
- The gaps of the ring and ring expander of the oil ring should be set apart 180° from each other.

Note:

As No.1 and No.2 compression rings have different cross sections, take care not to install them in wrong order.

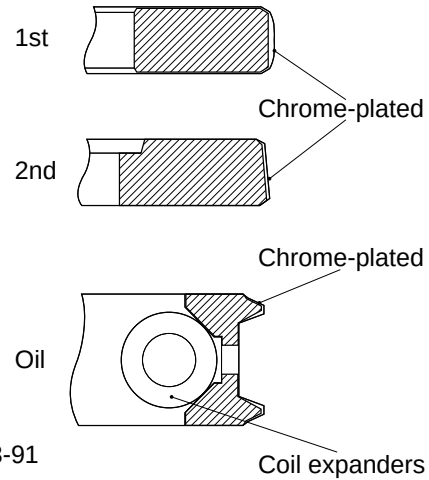


Fig. 3-91

- Install the rings with their gaps 120° apart from each other as shown in the figure.

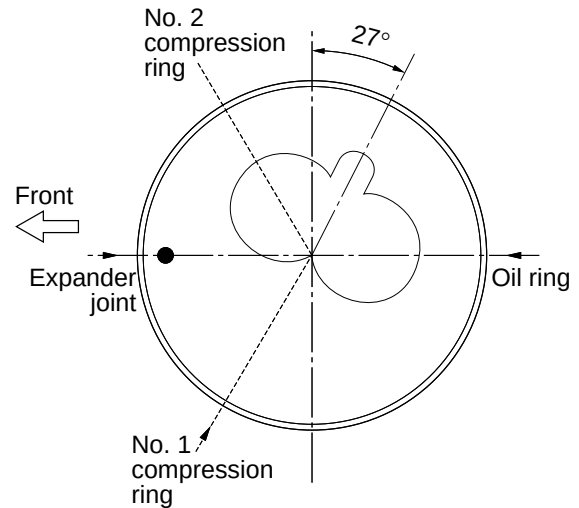


Fig. 3-92

6. INSTALLATION OF CRANKSHAFT

- (1) Install the upper bearings, which have oil grooves or oil holes, in the cylinder block.

Note:

Bearings and bearing fitting surfaces on the cylinder block should be free from any foreign matter.

The projection of each bearing should be securely seated in its notch in the cylinder block.

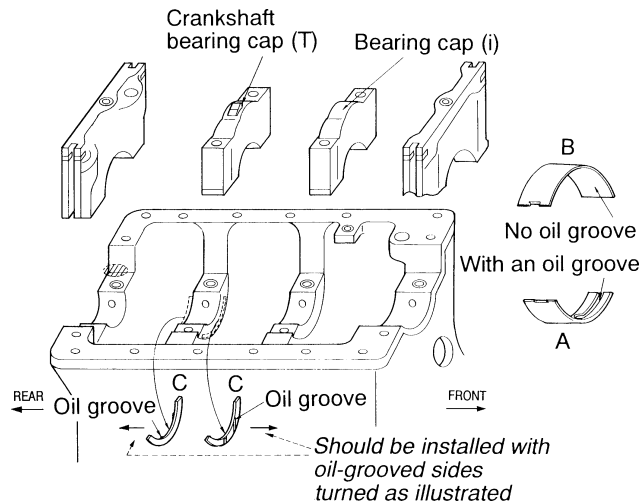


Fig. 3-93

- (2) Apply engine oil to upper bearing surfaces and bring the crankshaft softly in contact with them.

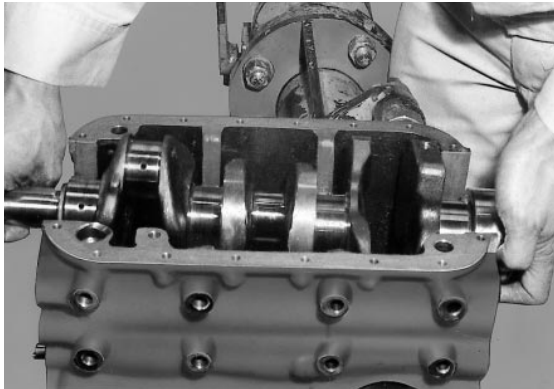


Fig. 3-94

- (3) Install the lower bearings, which have no oil grooves or holes, on bearing caps.

Note:

Bearings and bearing fitting surfaces on the bearing caps should be free from any foreign matter.

- (4) Then install bearing cap seals (B). Drive them in until they subside 0 – 0.3 mm (0 – 0.012 in.) from the cylinder block end. Fill the gaps with silicone compound. Tighten the journal bearing cap to the specified torque.

Specified torque:	4.5 – 5.5 kgf·m
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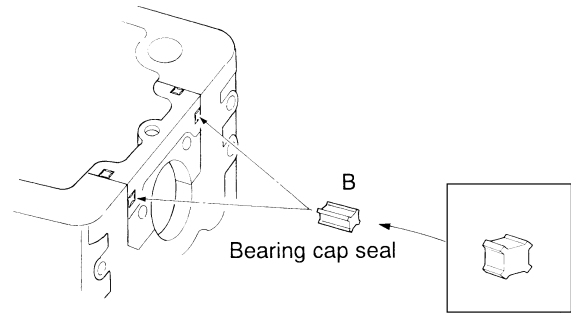


Fig. 3-95

7. INSTALLATION OF PISTON/CONNECTING-ROD ASSEMBLIES

- Install bearings on the connecting-rod big end and bearing cap with the bearing projections seated securely in respective notches in the big end and bearing cap. Apply engine oil to the bearing surfaces.
- Clean the cylinder bores and crankshaft, and apply engine oil to them.
- Set the crankshaft at BDC.
- Turn the front mark on the piston head towards the front and make sure that the piston ring gaps are 120° apart from each other. Then insert the piston/connecting rod assembly, compressing the piston rings with a piston ring compressor, into the cylinder until the connecting rod bearing comes into contact with the crankpin.



Fig. 3-96

- Install the connecting-rod bearing cap having the same number that the connecting rod has.

SERVICE MANUAL FOR SGR19 & SGR17

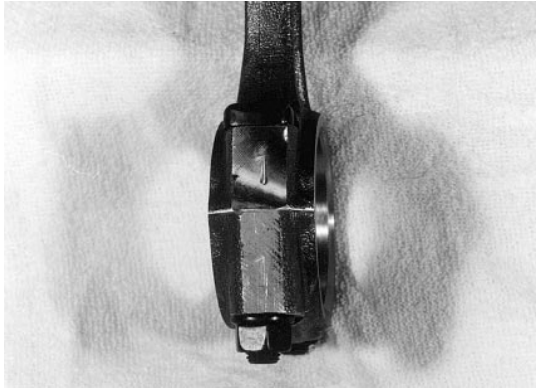


Fig. 3-97

- Tighten the connecting rod bearing cap to the specified torque.



Fig. 3-98

Specified torque	2.7 – 3.3 kgf·m
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The crankshaft should turn smoothly.

8. INSTALLATION OF REAR OIL SEAL

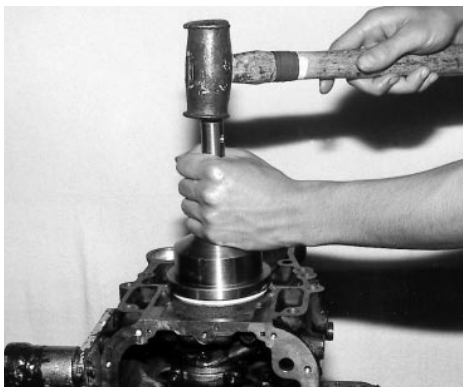


Fig. 3-99

- Apply silicone compound to the outer circumference of the rear oil seal and drive it in evenly to avoid slanted installation.
- Make sure that the crankshaft turns smoothly.
- The projection of the rear oil seal after installation should be 1.5 mm.

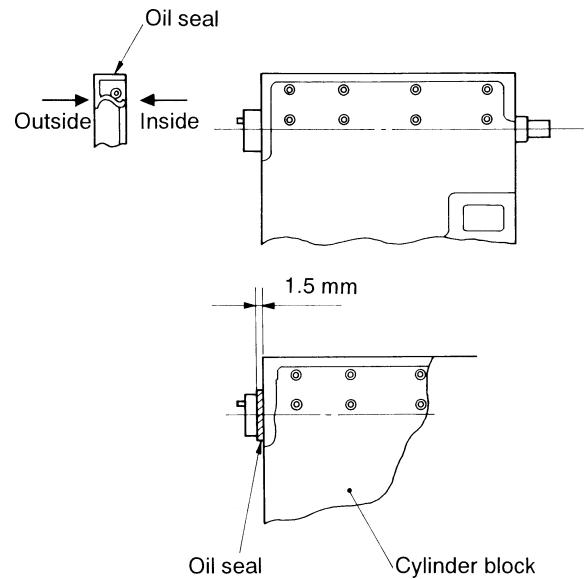


Fig. 3-100

9. INSTALLATION OF STRAINER AND OIL PAN

- Install the O-ring in the groove in the hole for oil strainer installation.
- Apply engine oil to the outer surface of the strainer pipe and install it by turning to avoid dislocation of the O-ring.

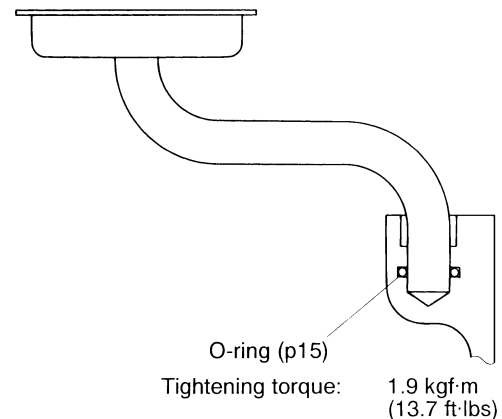


Fig. 3-101

ISEKI LAWN MOWERS

Note:

Be careful not to damage the O-ring.

10. INSTALLATION OF REAR PLATE AND FLYWHEEL

- Installation of the rear plate
Set the rear plate guided by the straight pins and tighten it to the specified torque.

Specified torque	M10: 4.1 kgf·m M12: 8.4 kgf·m
------------------	----------------------------------



Fig. 3-102

- Installation of the flywheel
Apply engine oil to the seats and threads of tightening bolts.



Fig. 3-103

Temporarily tighten the flywheel.
Chock the flywheel, and then tighten the bolts to the specified torque.

Specified torque	9.5 kgf·m
------------------	-----------

11. INSTALLATION OF FRONT PLATE AND GEARS

- Install the front plate.
Apply silicone compound to the contact surfaces of the cylinder block and bearing cap.
Install new packing and tighten the front plate to the specified torque.

Specified torque	1.9 kgf·m
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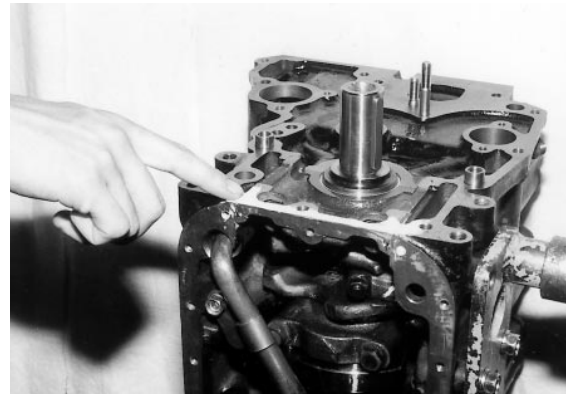


Fig. 3-104

- Install key on the crankshaft.
- Install the crankshaft gear on the crankshaft with the side bearing the front mark turned forward.
- Apply engine oil to the camshaft bearing parts and install the camshaft assembly. Then tighten to the specified torque.

Specified torque	0.8 kgf·m (6 ft·lbs)
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SERVICE MANUAL FOR SGR19 & SGR17

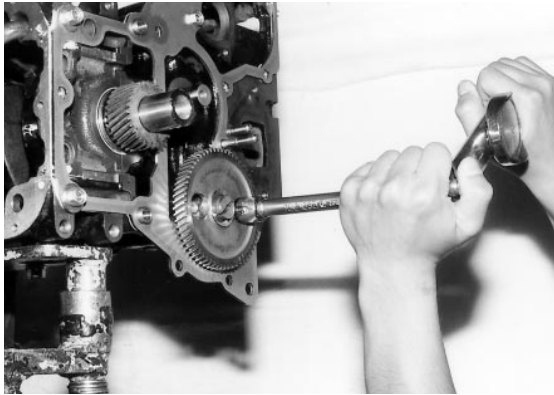


Fig. 3-105

- Sub-assemble the pump cam and the thrust plate in advance, paying attention to thrust plate direction.

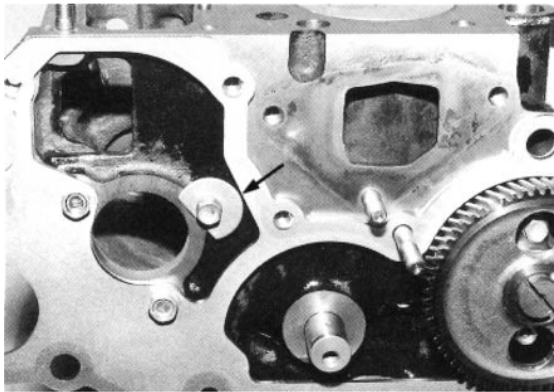


Fig. 3-106

- Insert the starting spring pin into the cylinder block and install the starting spring.

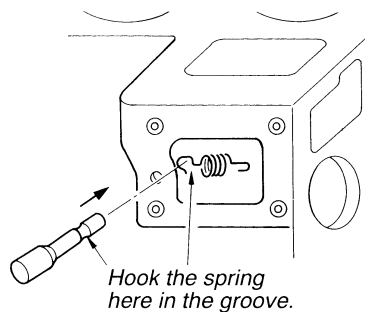


Fig. 3-107

- Install the injection cam gear assembly.
- Retain the injection pump cam shaft with the thrust plate and tighten the gear to the specified torque.

Specified torque	0.8 kgf·m (6 ft·lbs)
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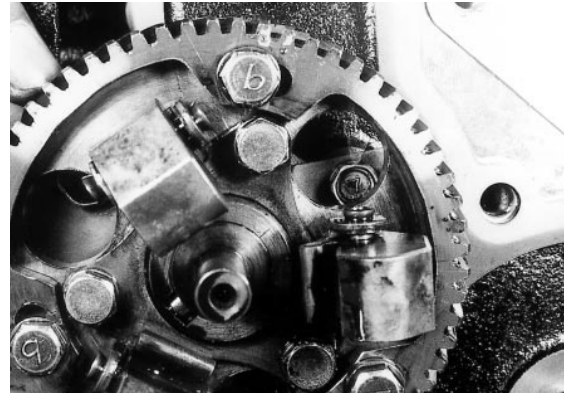


Fig. 3-108

- Install the idle gear.

Apply engine oil to the bore of the gear in advance.

Align respective timing marks with those of other gears.

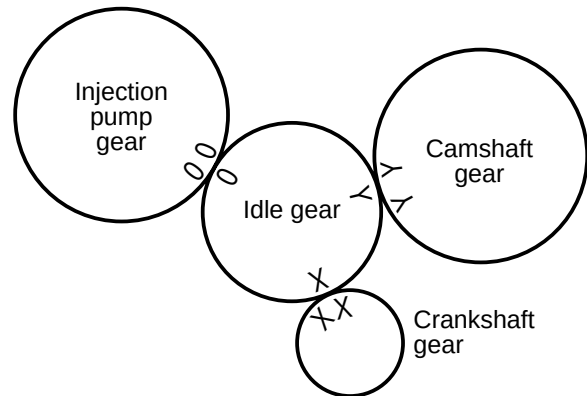


Fig. 3-109

- Installation of the injection pump

Tighten the bolts to the specified torque in sequence as shown in the figure.

Specified torque	0.8±0.2 kgf·m
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Note:

Remember to install adjusting shims.

CHAPTER 4. TRANSMISSION & RELATED PARTS

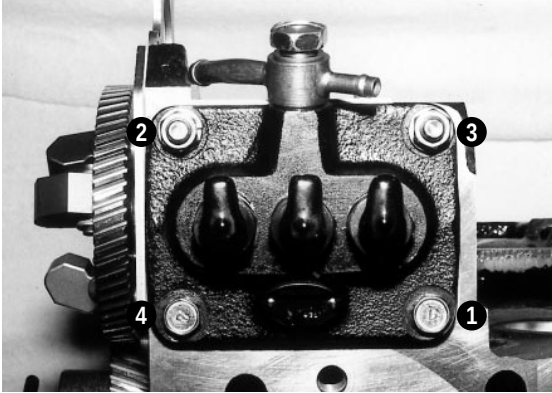


Fig. 3-110

- Installation of the oil pan

Apply liquid gasket to the cylinder block surface in shape of a string of $\varnothing 3 - 3.5$ mm as illustrated. Then install the oil pan and tighten to the specified torque.

Specified torque	0.8 kgf·m
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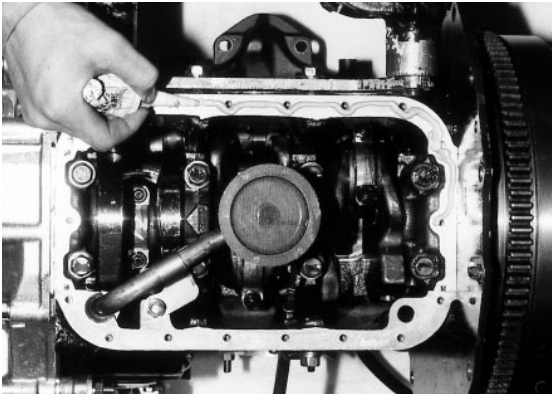


Fig. 3-111

- Install the oil pan with the recessed part turned forward.

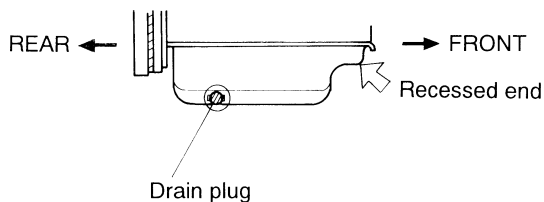


Fig. 3-112

- Install the gear case.
- Install the cylinder head.

- Install the water pump spacer.
- Install the water pump with a new packing and tighten to the specified torque.

Specified torque	1.9 kgf·m
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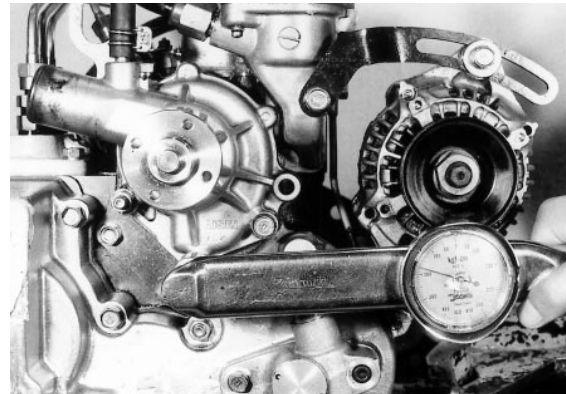


Fig. 3-113

- Install the water by-pass hose.
- Install the generator.
- Install the fan.

Set the fan belt on the fan pulley.

Install the spacer and the fan.

SERVICE MANUAL FOR SGR19 & SGR17

CHAPTER 4. TRANSMISSION & RELATED PARTS

1. DRIVE TRAIN DIAGRAM

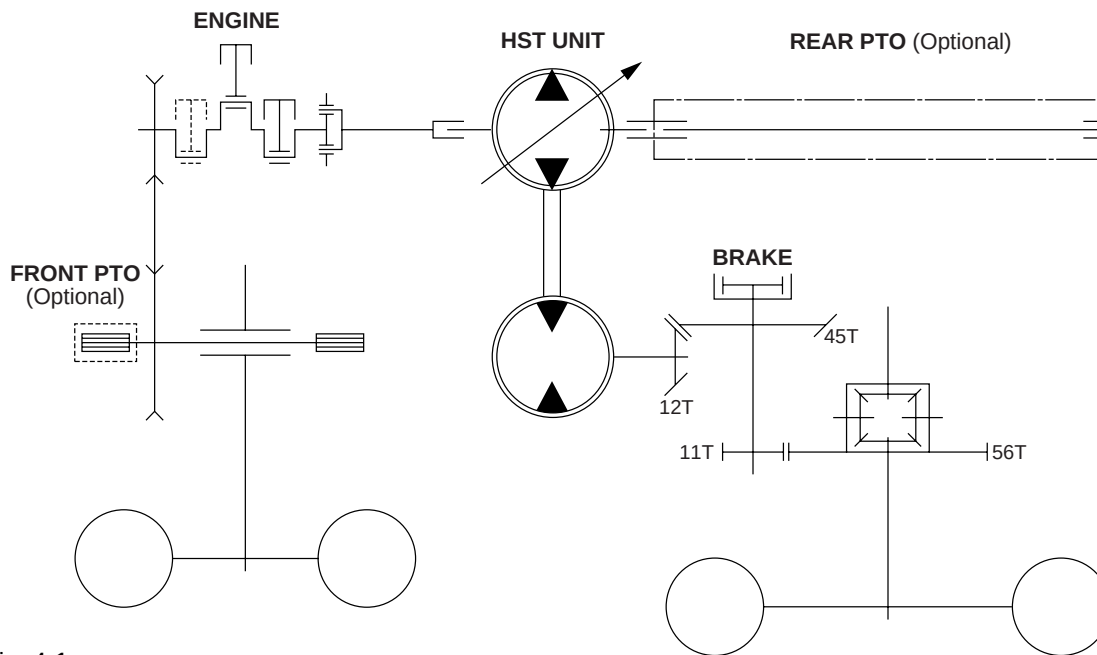


Fig. 4-1

2. TRANSMISSION

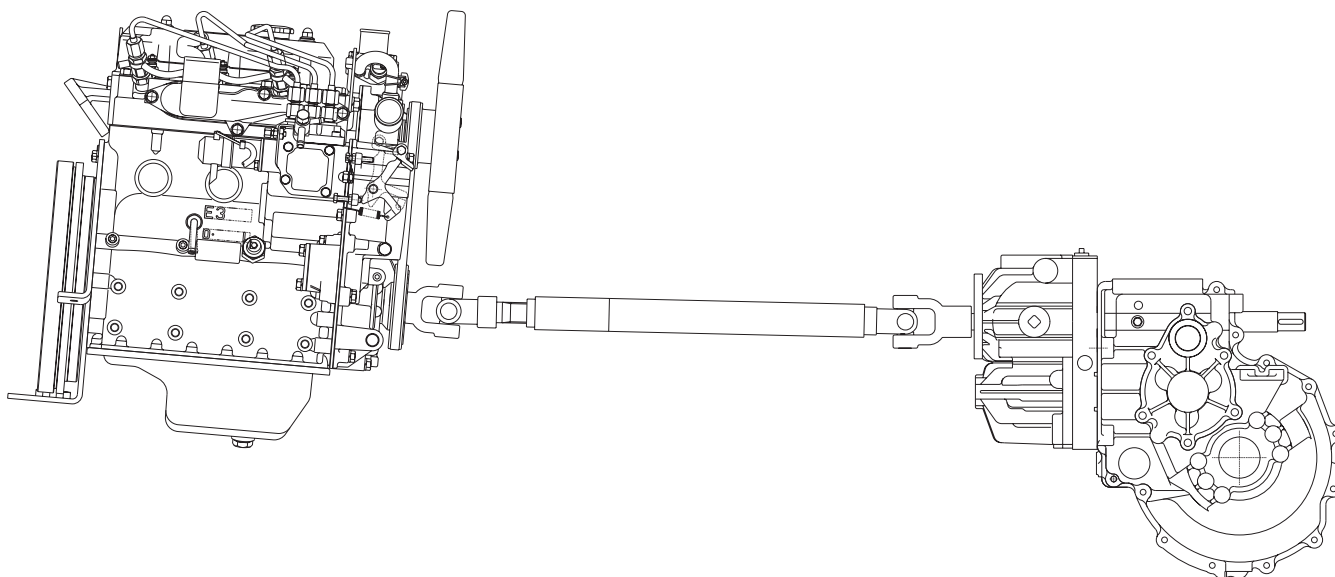


Fig. 4-2

CHAPTER 4. TRANSMISSION & RELATED PARTS

3. REAR WHEEL DRIVING MECHANISM

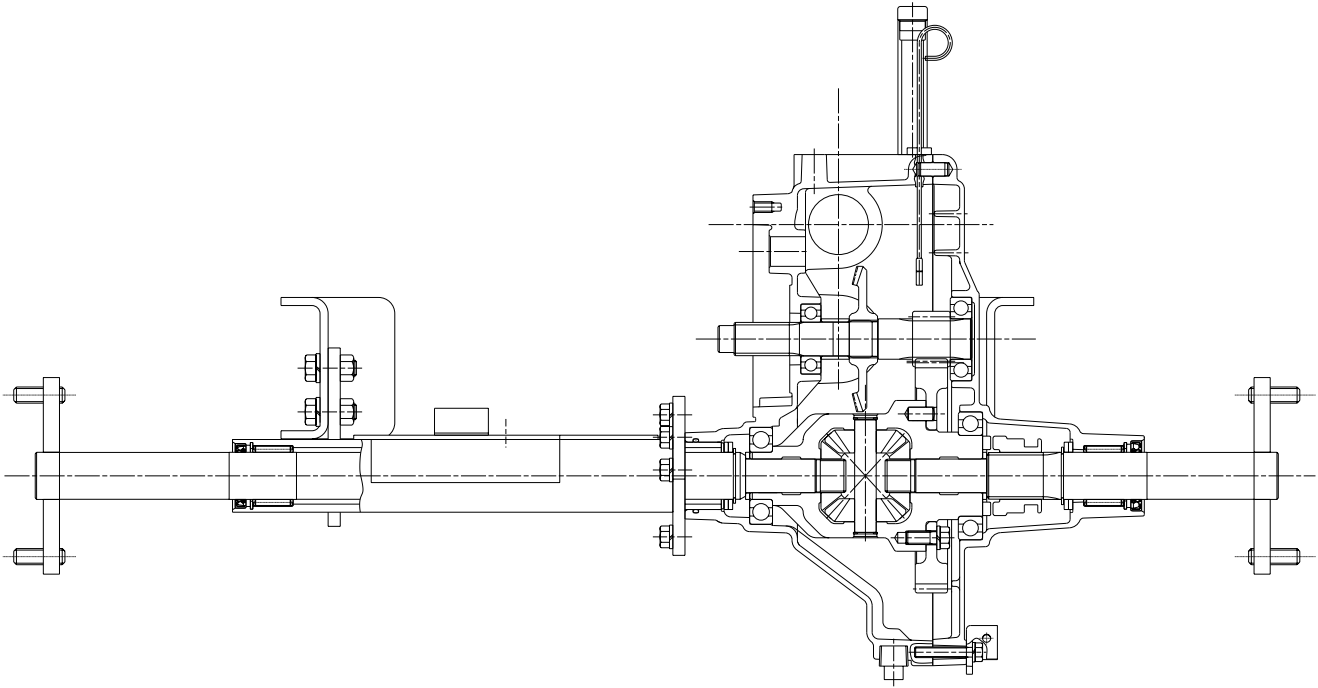


Fig. 4-3

DISASSEMBLY

- (1) Remove the transmission assembly from the chassis, referring to component removal.
- (2) Remove the left wheel shaft from the transmission assembly.
- (4) Remove the tightening bolts and separate the transmission assembly.



Fig. 4-4

- (3) Remove the brake cover tightening bolts and pull out the parts related to the brake system.

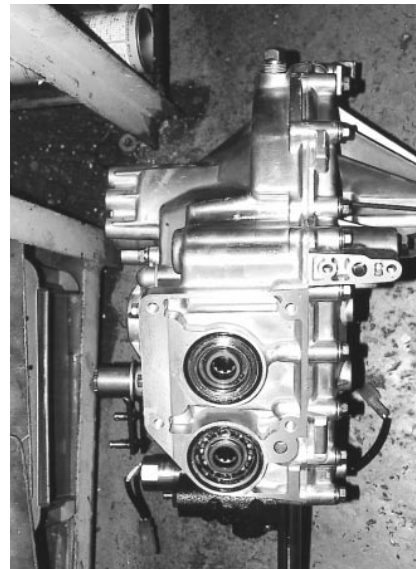


Fig. 4-5

SERVICE MANUAL FOR SGR19 & SGR17**4. REAR TRANSMISSION CASE****INSPECTION**

- (1) Check the gears for damage and tooth bearing.
- (2) Check the bevel gears and thrust collars of the differential for wear.
- (3) Make sure that each bearing turns smoothly.
- (4) Check the oil seal lips and the seal contacting surfaces on the shaft for damage.



Fig. 4-6

REASSEMBLY

Reassemble in reverse order of disassembly, taking the following precautions.

- (1) Sub-assembling of the wheel shaft



Fig. 4-7

- Install the needle roller bearing with snap ring. Apply grease to the bearing ahead of time.

- Install the oil seal and the shaft into the case.
- Install the collars.

Note:

Install the collar (26x35x03) with the chamfered side turned upwards.

- (2) Sub-assembling the differential case

- The assembled differential case should be tightened by the bolts to specified torque with screw locking agent applied.
- Install the spur gear (56T) after having installed bevel gears.

Note:

Install the spur gear with the chamfered side turned towards the differential case.

Tightening torque	9.0 kgf·m
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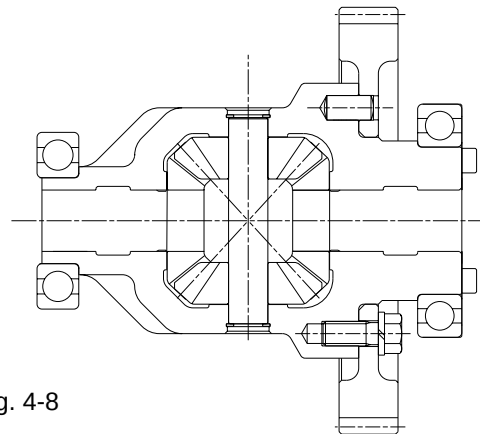


Fig. 4-8

- (3) Install the right wheel shaft into the transmission case cover.

- Install the needle roller bearing and oil seal with grease applied ahead of time.
- Install the collar (26x35x03) with the chamfered side turned outward.

- (4) Assembling the transmission case

- Install the ring gear and the differential case into the left-hand transmission case, and put the right-hand case over it.

Tightening torque	6.0 kgf·m
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CHAPTER 4. TRANSMISSION & RELATED PARTS

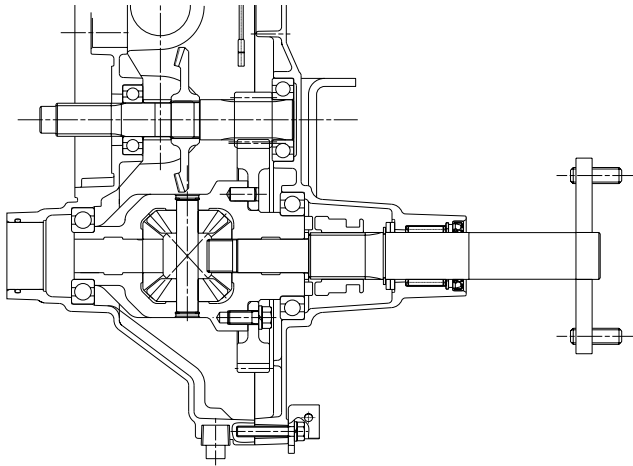


Fig. 4-9

(5) Adjustment of drive pinion backlash

Adjust the backlash between the drive pinion and the ring gear by shimming.



Fig. 4-10



Fig. 4-11

a. Measuring tools

- Holder of drive pinion set
- Dial guage setting tool

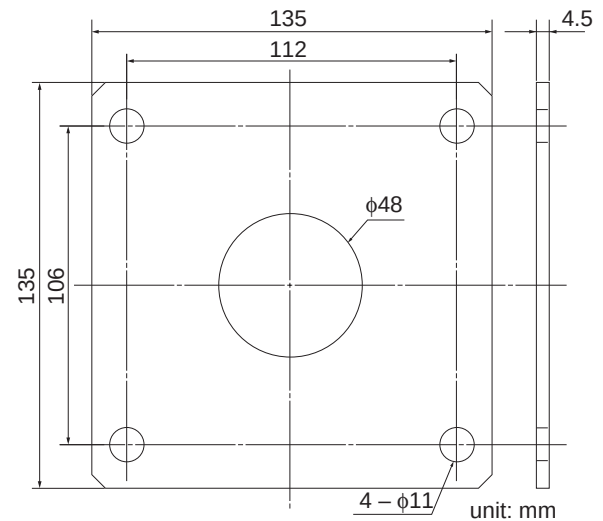


Fig. 4-12

- b. If the measurement is deviates from the specified range at the point 150 mm apart from the drive pinion center, correct by shimming at A and B.

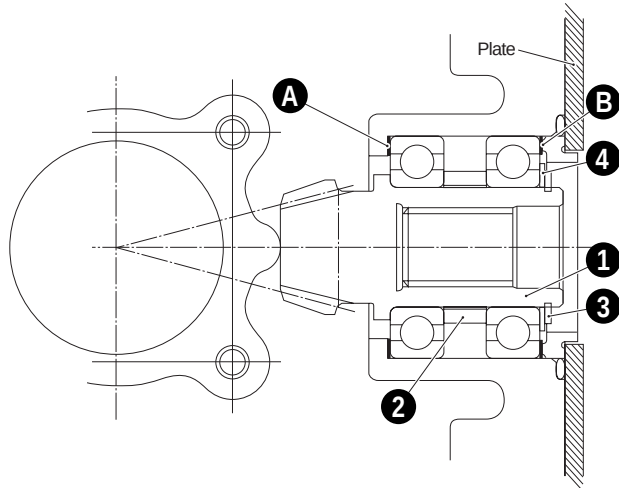
Backlash of drive pinion

Standard value	0.1 – 0.3 mm
----------------	--------------

Required number of shims

	Side A	Side B
Standard	3	3
To extend	4	2
	5	1
	6	0
To close	2	4
	1	5
	0	6

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- (1) Input gear (12T) (4) Washer (31×42×1)
 (2) Collar (31×38×11) A, B: Shimming points
 (3) Snap-ring

Fig. 4-13

(6) Install the left wheel assembly and HST unit.

- Apply grease and take care not to damage the O-ring.

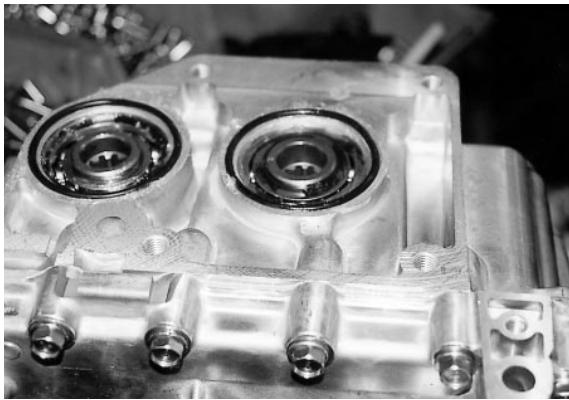


Fig. 4-14

5. BRAKE SYSTEM

5.1. CONSTRUCTION

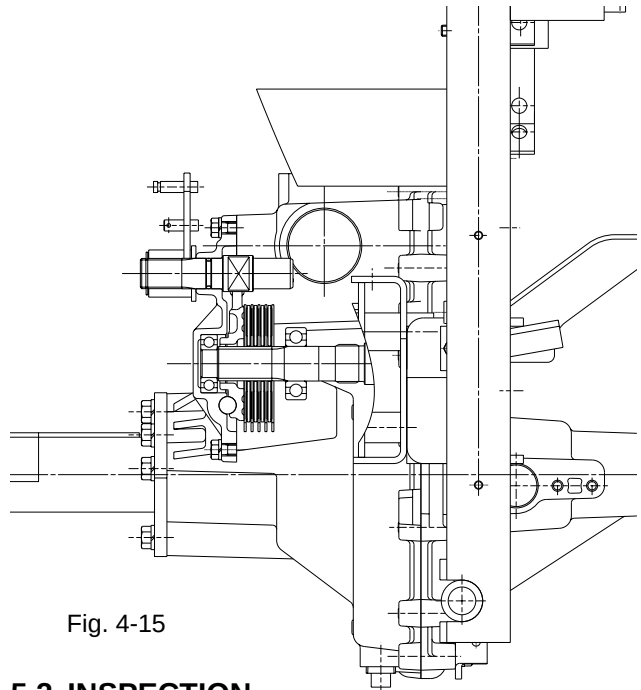


Fig. 4-15

5.2. INSPECTION

- (1) Check the brake discs and separator plates for wear, flaws, deformation, etc. Defective parts should be replaced with new ones.

	Standard value	Usable limit
Brake disc	3.5 mm	2.9 mm
Separator plate	1.52 mm	1.46 mm

- (2) Check the actuator ball and ball way for abnormal wear, defective parts should be replaced with new ones.



Fig. 4-16

CHAPTER 4. TRANSMISSION & RELATED PARTS

5.3. REASSEMBLY

Reassemble in reverse order of disassembly, taking the following precautions mentioned below:

(1) Install the brake discs and separator plates

- Before reinstalling new brake discs, immerse them in oil for a few minutes.



Fig. 4-17

(2) Install the actuator ball.



Fig. 4-18

(3) Install the cover and linkage.

5.4. ADJUSTMENT OF BRAKE PEDAL AFTER REASSEMBLING

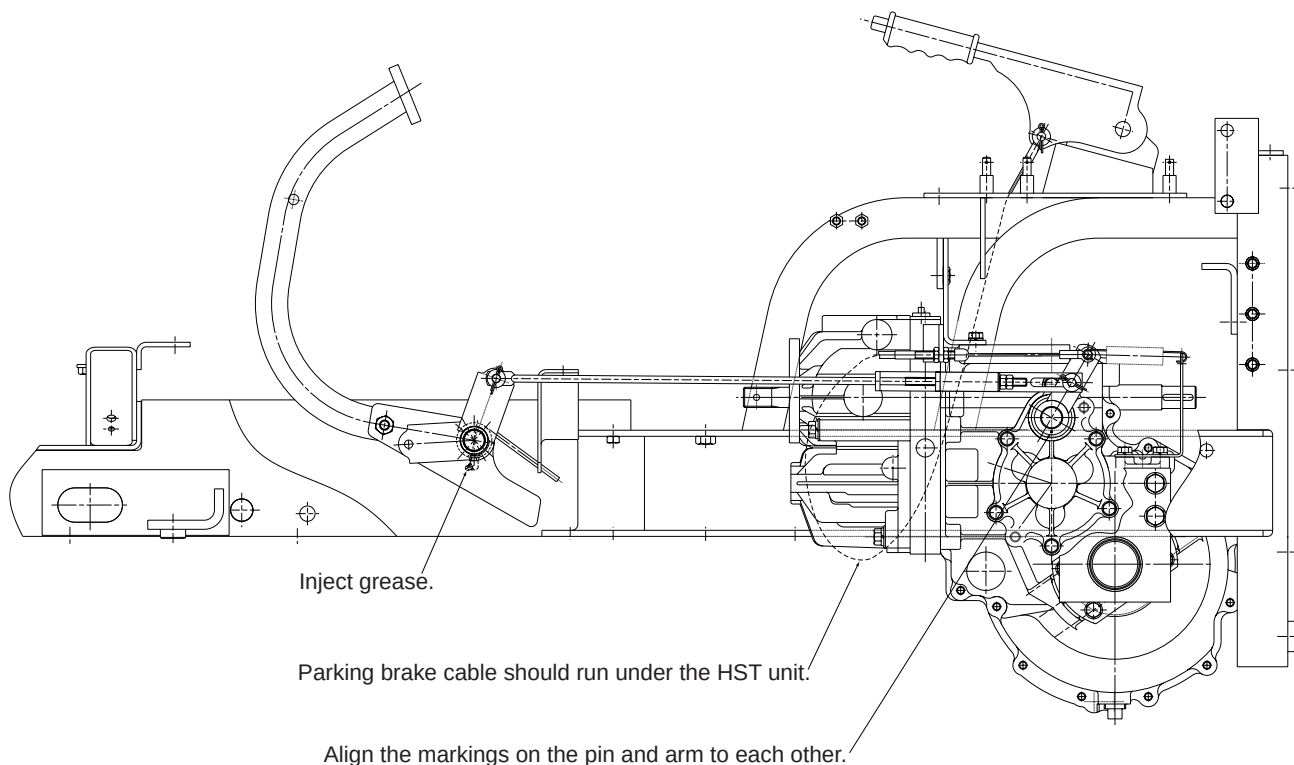


Fig. 4-19

SERVICE MANUAL FOR SGR19 & SGR17

ADJUSTMENT OF THE BRAKES

(1) Brake arm

Make sure that the brake arm is in the vertical position or slanted a little forward and does not move forward any further while the brakes are not applied.

Note:

If the arm moves forward any further, check it for its spline engagement on the brake arm. Re-assemble it if required.

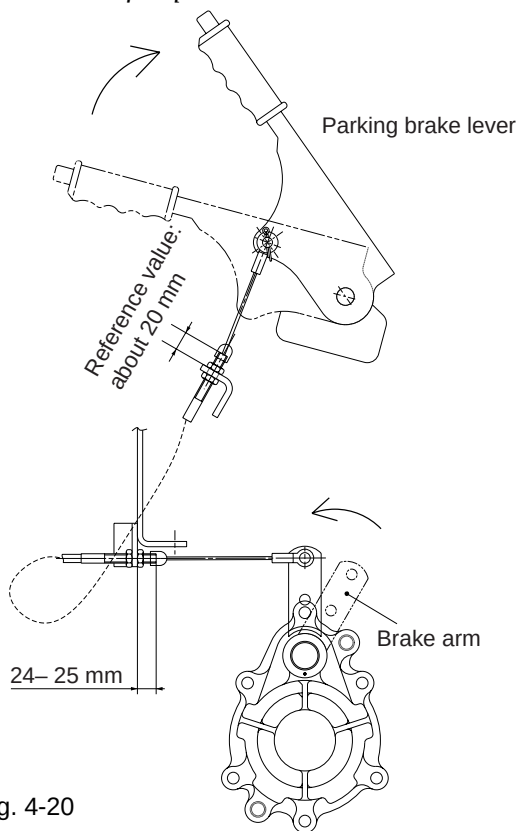


Fig. 4-20

(2) Parking brake adjustment

- Set the wire sheath end so that it protrudes 24 to 25 mm beyond the cable holder.
- Make sure that the four notches have passed when the brake lever is pulled up to the end, where the brake arm is pulled forward fully. This should be adjusted with the adjusting nuts at the cable end on the brake lever side.
- When the parking brake lever is pushed down,

make sure the brake arm returns to the previous position without fail.

(3) Foot brake adjustment

- Make sure the clearance of the brake arm pin in the slot is less than 1 mm when the brake pedals are released. If not, correct the position by turning the front nut.

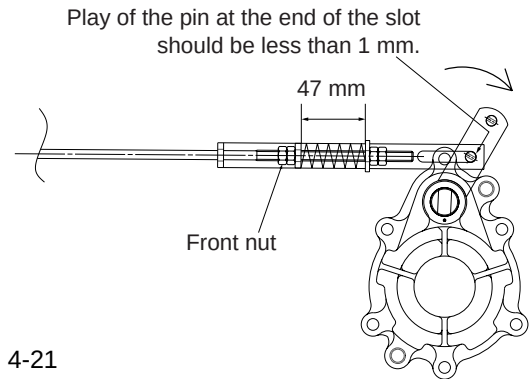


Fig. 4-21

- Adjust the length of the spring to be 47 mm by turning the rear nut when the brake pedals are released.
- Depress the brake pedals to the end and make sure the length of the spring is 41 to 42 mm and clearance between coils is maintained.

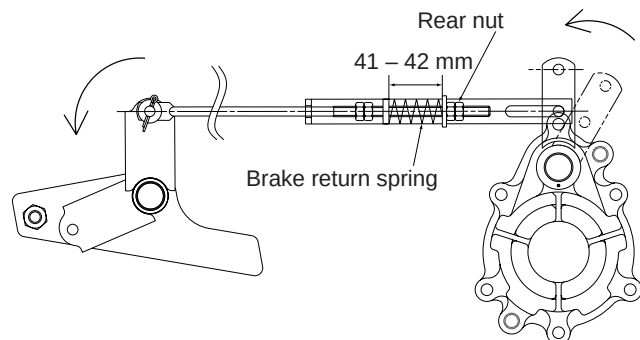


Fig. 4-22

If there is no clearance at all or the spring is deformed, correct the released spring so it is 47 to 50 mm in length by turning the rear nut in order to provide proper clearance between spring coils when the brake pedals are depressed fully.

CHAPTER 5. HYDROSTATIC TRANSMISSION

1. CONSTRUCTION AND NAMES OF MAJOR COMPONENTS

- | | |
|---------------------|-----------------------|
| (1) Case | (37) Snap-ring |
| (2) Port block | (38) Snap-ring |
| (3) Cylinder block | (41) Spring holder |
| (4) Slant board | (42) Oil seal |
| (5) Piston | (47) O-ring |
| (6) Valve plate | (48) O-ring |
| (7) Valve plate | (49) Gasket |
| (8) Pump shaft | (50) Pin |
| (9) Motor shaft | (51) Guide |
| (10) Trunnion shaft | (52) Ping |
| (13) Thrust bearing | (53) Pin |
| (14) Ball bearing | (54) Cradle bearing |
| (15) Needle bearing | (55) Socket head bolt |
| (16) Bush | (61) Oil seal |
| (17) Bush | (62) Pin |
| (18) Sliding piece | (64) Cover |
| (19) Cover | (65) Ball bearing |
| (20) Spring | (66) Ball bearing |
| (21) Spring | (67) Oil seal |
| (27) Valve | (69) Snap-ring |
| (28) Valve | (72) Washer |
| (30) Poppet | (74) Plug |
| (33) Plug | (75) Spring |
| (34) Plug | (76) Piston |
| (36) Snap-ring | (79) Shim A |
| | (80) Shim B |

- | | |
|--------------------|-------------|
| (81) O-ring | (92) Plug |
| (82) O-ring | (93) Spring |
| (89) Oil seal case | (94) Plug |
| (90) O-ring | (95) O-ring |
| (91) Valve body | (96) O-ring |

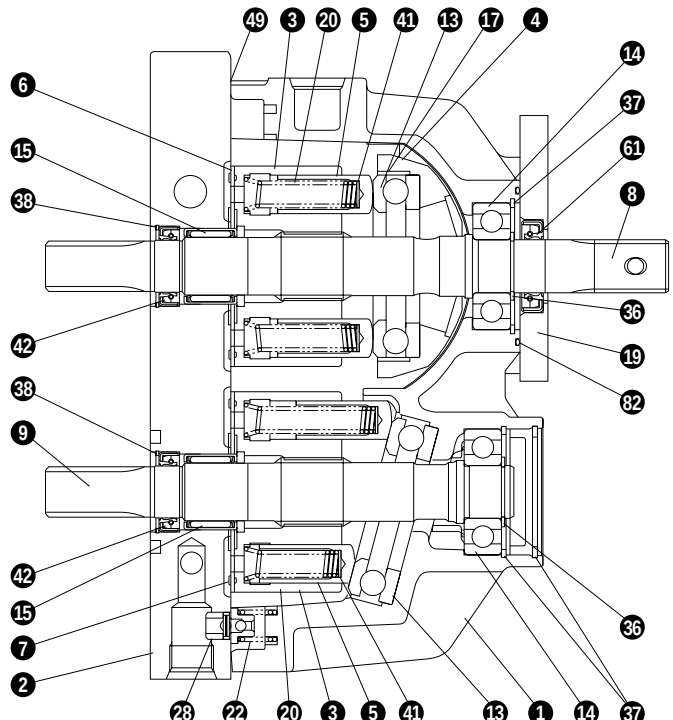
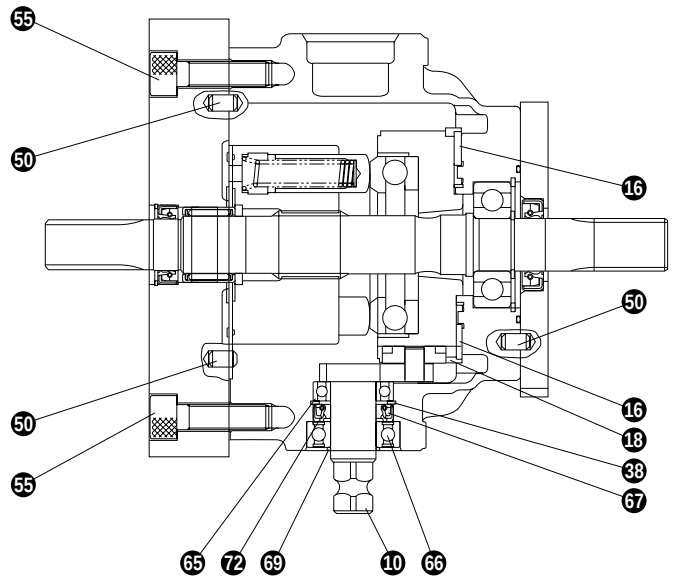
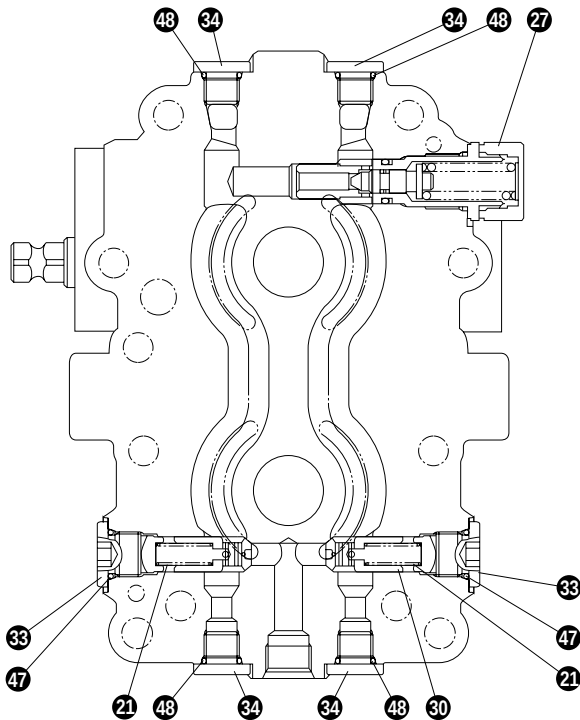


Fig. 5-1

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2. OPERATING DIAGARM OF HST

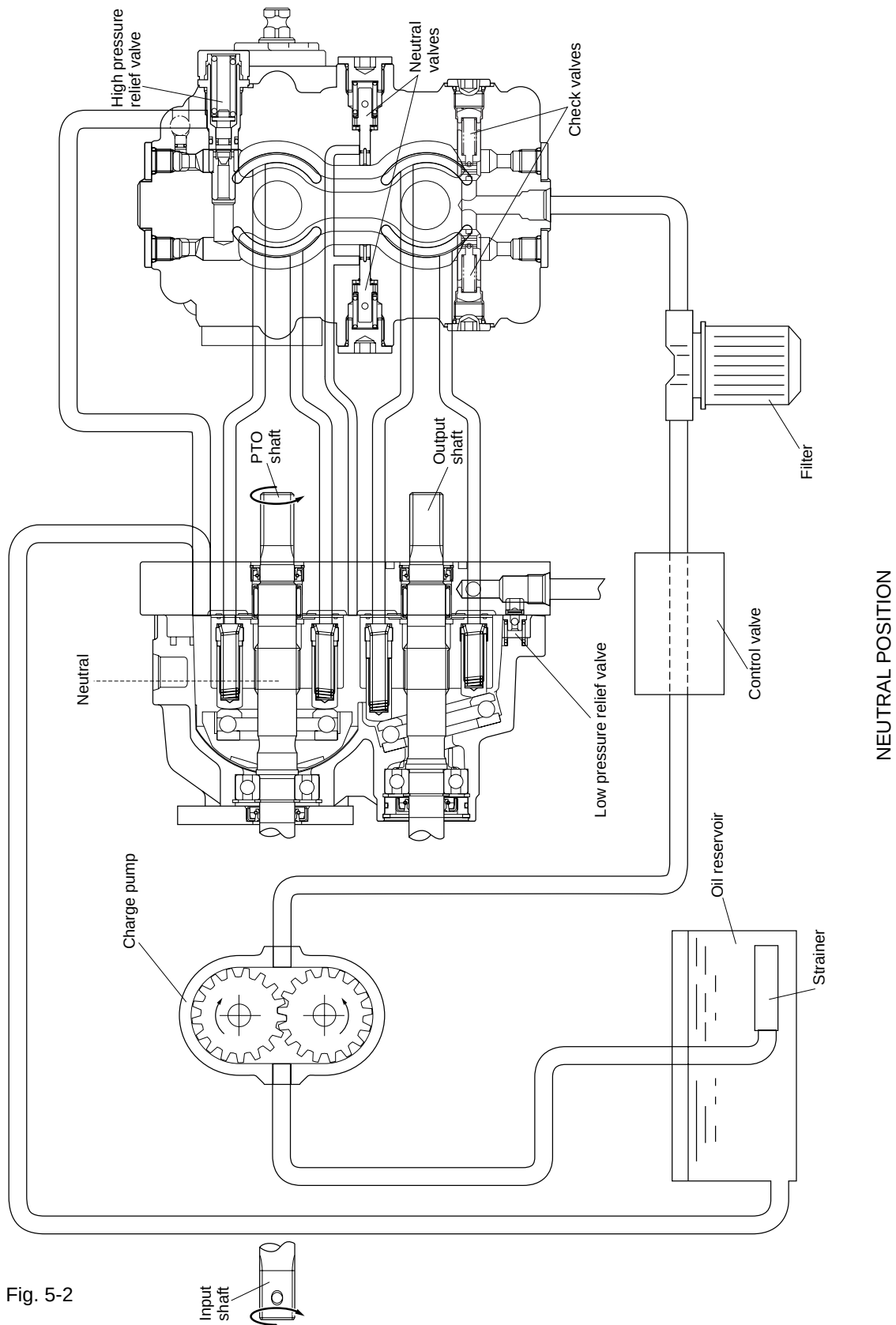


Fig. 5-2

CHAPTER 5. HYDROSTATIC TRANSMISSION

3. FUNCTION

3.1. VARIABLE TYPE PUMP

Nine pistons are housed in the cylinder block, which is connected to the engine and revolves as the engine does, while the slant board does not. When the slant board and shaft are perpendicular to each other, cylinder displacement volumes A and B do not vary, so no delivery or suction takes place.

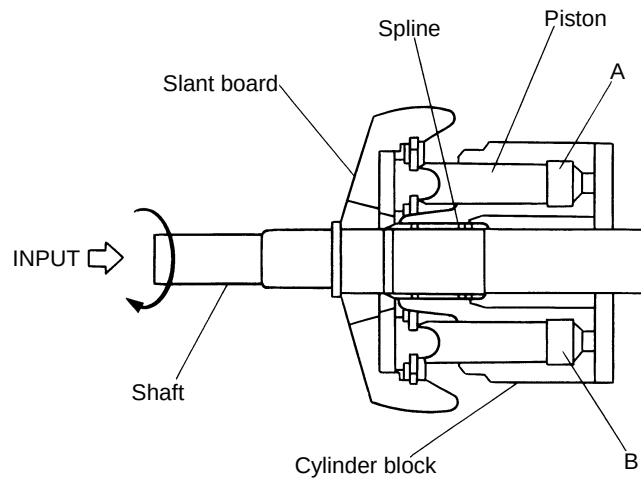


Fig. 8-3

If the slant board is angled by α degrees, displacement volumes A and B become different from each other: $A > B$. If the shaft turns in the direction of "Q," delivery of fluid takes place as the displacement volume varies from B to A. Consequently if delivery and suction pipes are connected to the two arched ports respectively, a pump mechanism is formed. In this case, "Ps" is the suction port and "Pd" is the delivery port.

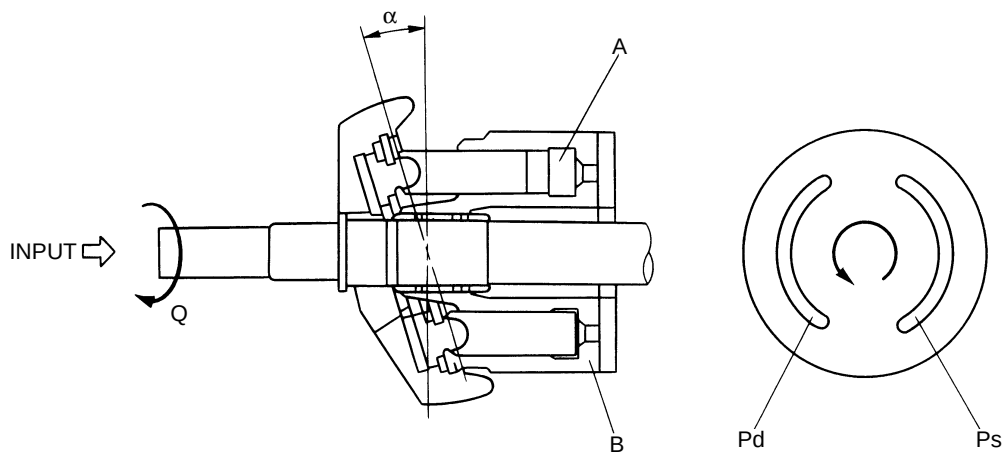


Fig. 8-4

SERVICE MANUAL FOR SGR19 & SGR17

3.2. FIXED TYPE MOTOR

Nine pistons are housed in the cylinder block. A valve plate with two arched ports, Ps and Pd, is in contact with one end of the cylinder block. The ports are connected to the delivery pipe or the suction pipe respectively.

When pressurized fluid is led into the cylinder block port Ps, the fluid pushes the piston, which causes the cylinder block to turn. This further causes the shaft to turn in the direction of "a" through the spline-meshed part between the cylinder block and shaft. Thus a motor mechanism is formed.

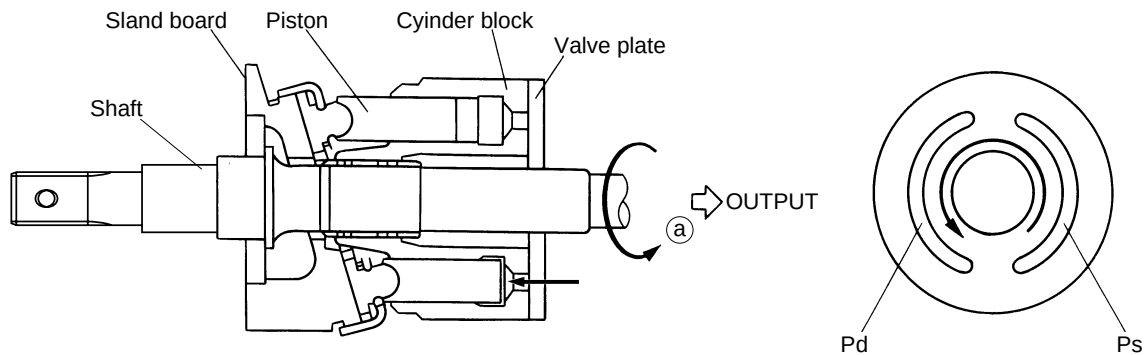


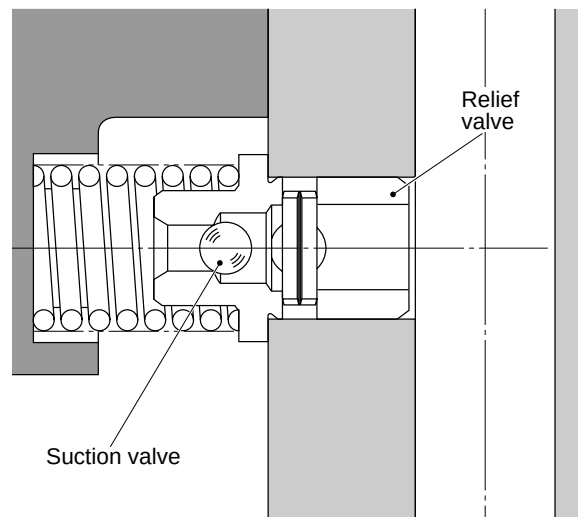
Fig. 5-5

3.3. VALVES

LOW PRESSURE RELIEF VALVE AND SUCTION CHECK VALVE

The low pressure relief valve works to maintain the specified charge pressure from the gear pump. Charge pressure replenishes the lowered flow rate of the charge fluid due to leaks by letting fluid into the case through the check valve. Excessive fluid is drained to the case through the low pressure relief valve.

When the tractor is parked on a slope with the engine shut off, some reverse torque which is applied to the output shaft through the rear axle causes the high pressure side to leak. In this state, if no fluid were replenished to the closed circuit, air would become trapped inside the circuit, spoiling the braking effect of the circuit and allowing the tractor to start rolling down the slope. The suction check valve however prevents materialization of this no braking effect by replenishing the closed circuit.



The suction valve maintains the specified pressure in the closed circuit, while there is no charging pressure, by letting in oil, thus compensating the oil lost due to leaking .

Fig. 5-6

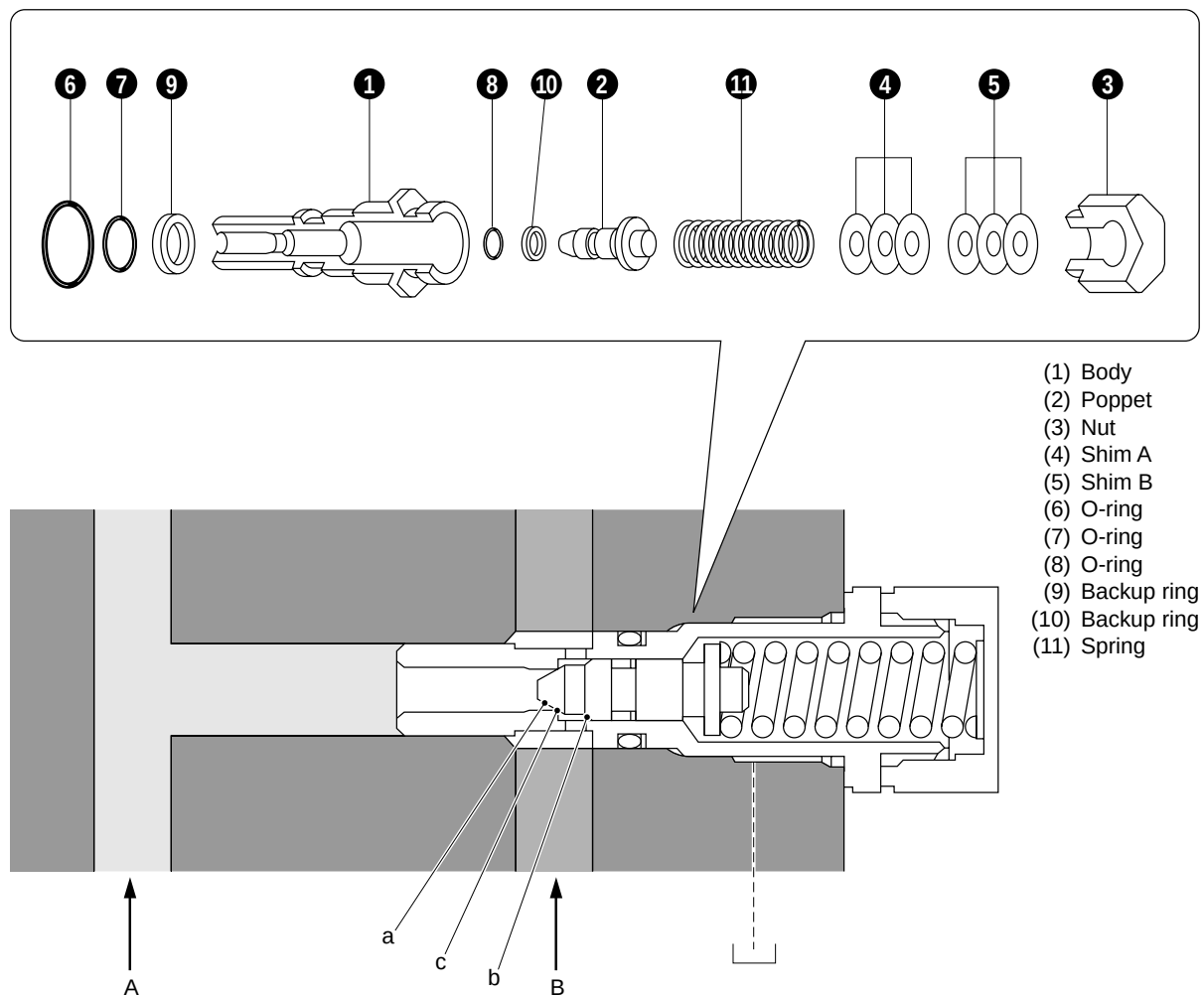
CHAPTER 5. HYDROSTATIC TRANSMISSION

HIGH PRESSURE RELIEF VALVE

A direct type both-direction relief valve is installed across the main passages A and B. The valve controls the pressure in both passages.

When the pressure in the passage A is higher, surface “a” of the poppet receives pressure which pushes the poppet overcoming the force of the spring and opens the valve: to the left as shown in the figure. When the valve (part c) opens, the fluid in the passage A flows to the passage B.

When the pressure in the passage B is higher, surface “b” of the poppet receives pressure which pushes the poppet overcoming the force of the spring and opens the valve: to the right as shown in the figure. When the valve (part c) opens, the fluid in the passage B flows to the passage A.



• 1 mm increase in shimming thickness of shims (4) and (5) increases 40 to 50 kgf in spring force.

Fig. 5-7

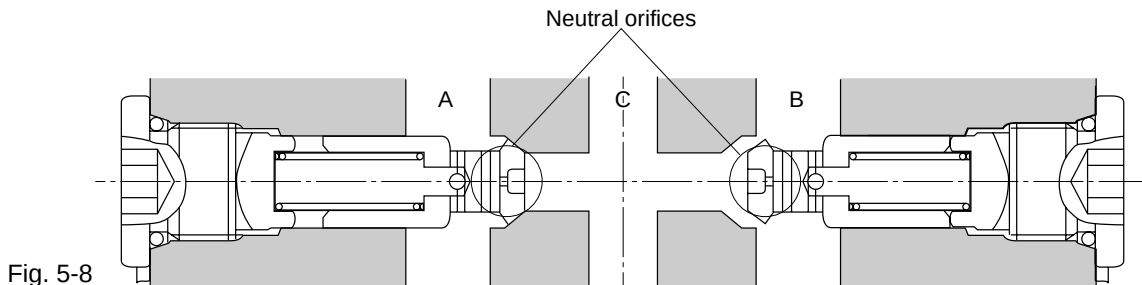
SERVICE MANUAL FOR SGR19 & SGR17

CHECK VALVE

The check valves are installed symmetrically in both sides across the charge passage “C.”

The check valve prevents the fluid from the high pressure passage “A” from flowing back into the charge passage “C” and replenish the charge fluid in the passage “B.” But the fluid flows back through the neutral orifice in accordance with the pressure applied to passage “C.”

The check valve in the high pressure side “A” closes and that in the low pressure side “B” is pushed open by the charge pressure and the check valve end in the high pressure side.



4. DISASSEMBLY AND REASSEMBLY

This section describes the disassembly and reassembly procedures and precautions of the two-axle type HST unit model HVFD-21A21-M.

4.1. REQUIRED TOOLS

Ref.	Name	Size and specified values
1	Plastic hammer	Hammering light alloy parts: 0.3 kgf
2	Screw driver (conventional)	Nominal 150 mm
3	Snap-ring pliers (for hole type)	H-2, H-3
4	Snap-ring pliers (for shaft type)	S-1, S-3
5	Hexagonal spanner	Face-to-face width:: 5 mm 6 mm 8 mm
6	Torque wrench	Specified torque: 51.0 N·m 49.0 N·m 36.8 N·m 29.4 N·m 17.5 N·m
7	Hexagonal bits for torque wrench	Face-to-face width: 5 mm 6 mm 8 mm
8	Socket for torque wrench	Face-to-face width: 26 mm

4.2. PRECAUTIONS FOR DISASSEMBLY

- Clean the exterior of the casing completely first taking care to cover all ports to avoid the entry of dust.
- Drain the case of oil.
- Select a clean, dust-free place to work in to prevent dust affecting precision parts.
- Handle disassembled parts carefully to avoid damage like dents, scratches, etc. by dropping or striking them.

CHAPTER 5. HYDROSTATIC TRANSMISSION

4.3. DISASSEMBLY

(1) Remove the port block.

- a. Remove the eight socket head bolts (M10) (55).
- b. Remove the port block (2).

Note: Take care not to allow the valve plates to fall.

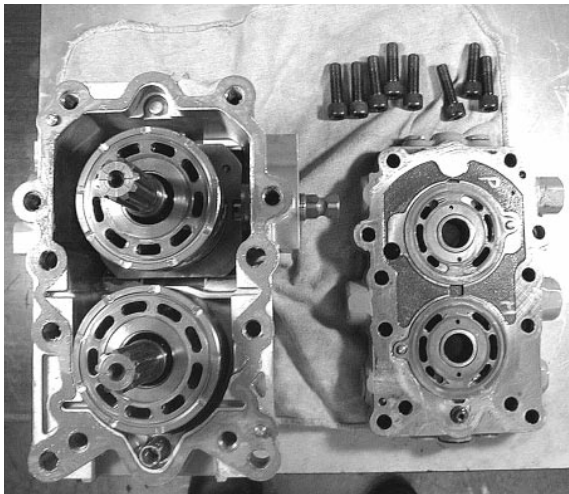


Fig. 5-9

- b. Remove the cover (19) from the case (1)
- c. Remove the two pins (50), valve (28), gasket (49), and spring (22).

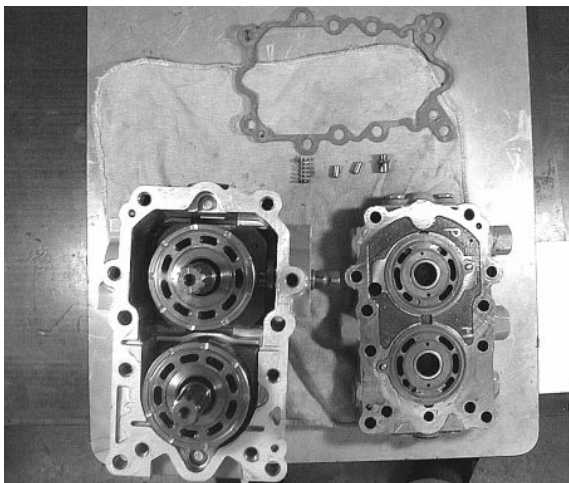


Fig.5-10

- c. Remove the valve plates (6 and 7).

Note: Insert the blade end of a conventional screw driver into the groove and lift up the valve plate as shown in the figure below to remove the valve plates easily.

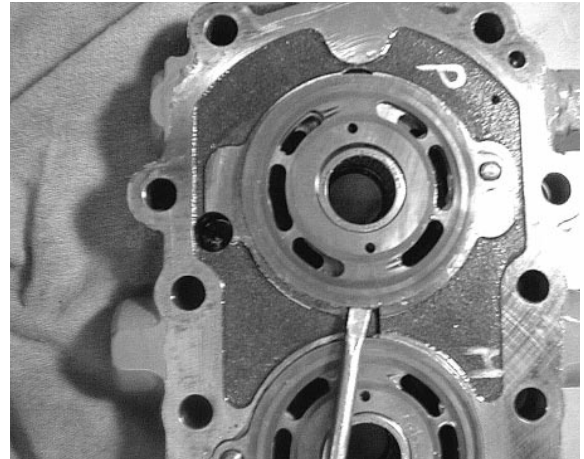


Fig. 5-11

- (2) Remove the cylinder block assembly (pump side).



Fig. 5-12

- (3) Remove the cylinder block assembly (motor side).

SERVICE MANUAL FOR SGR19 & SGR17

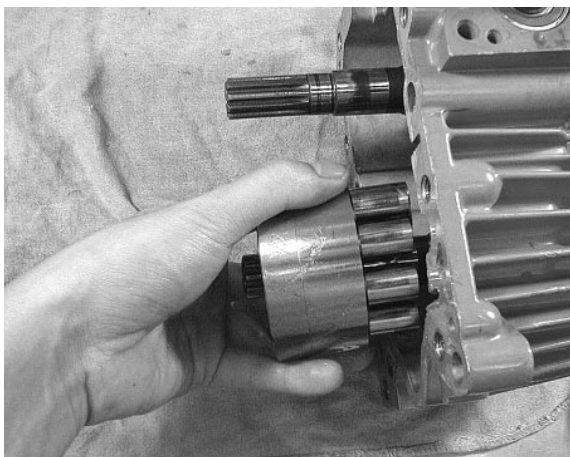


Fig. 5-13

Components of the cylinder block assembly
(Both blocks have the same components.)

- (3) Cylinder block 1
- (5) Pistons 9
- (20) Springs 9
- (41) Spring holders 9

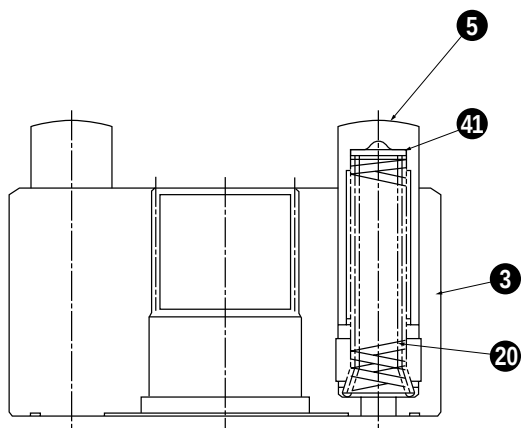


Fig. 5-14

- (4) Remove the slant board assembly, which includes the swash plate (4) and bushing (17) from the case (1) and then take out the thrust bearing (13), bush (16) and sliding piece (18).

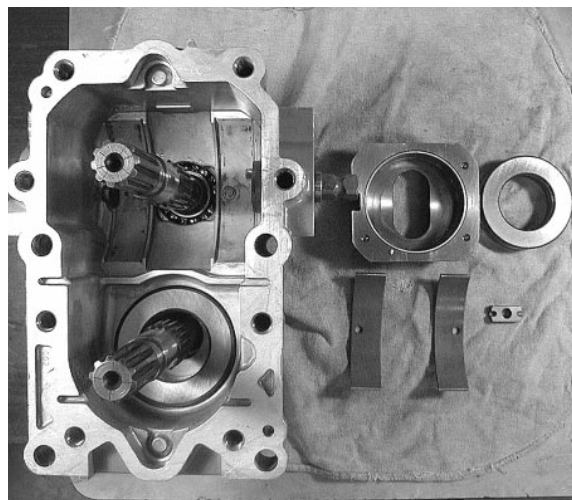


Fig. 5-15

- (5) Remove motor-side thrust bearing (13) from the case (1).

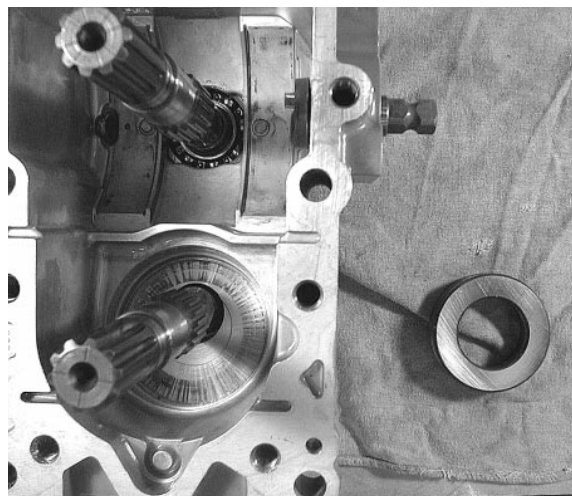


Fig. 5-16

- (6) Removal of the shafts

- Removal of the pump shaft
 - a. Remove the four screws (71) and take out cover (19), pin (50), and O-ring (82) from the case (1).

CHAPTER 5. HYDROSTATIC TRANSMISSION

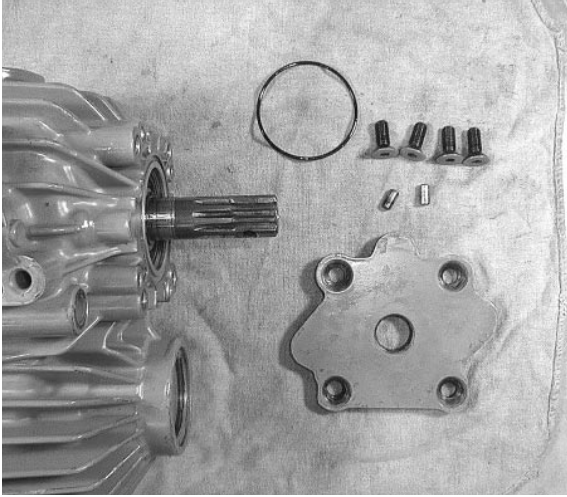


Fig. 5-17

- b. Remove the snap-ring (37) and hit the end of the shaft (8) with a plastic hammer as shown in the figure blow and extract the shaft from the case (1).

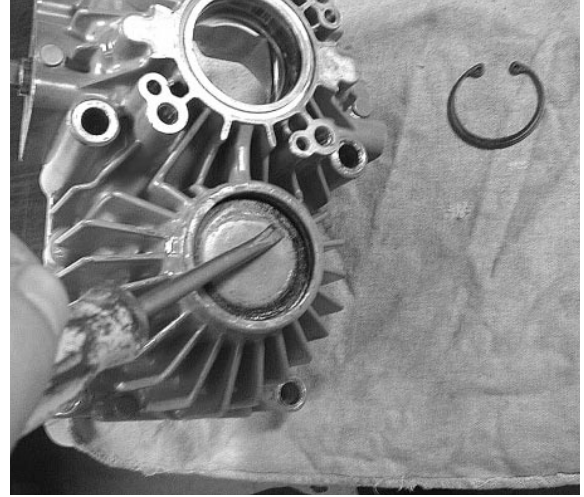


Fig. 5-19

- b. Remove the snap-ring (37), which is inside the case, and hit the end of the shaft (9) with a plastic hammer as shown in the figure below in order to extract the shaft out of the case (1).

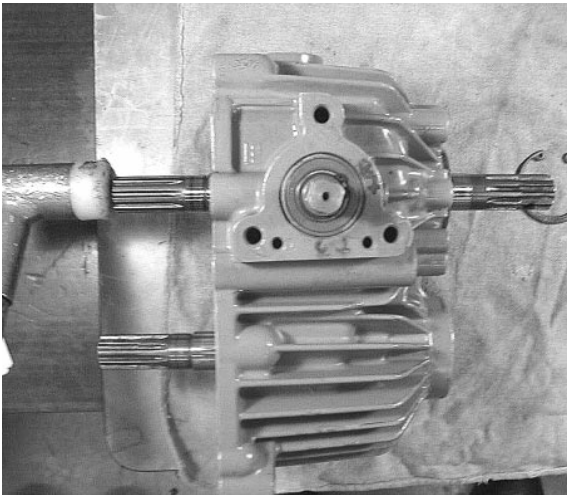


Fig. 5-18

• Removal of motor shaft

- a. Remove the snap-ring (37) and pry off the bore plug (11) with a conventional screw driver.

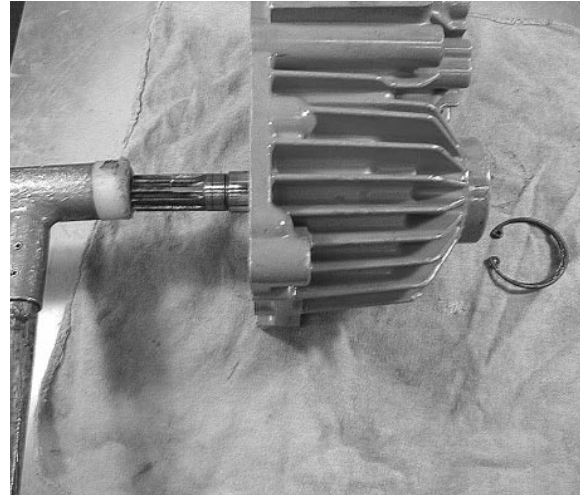


Fig. 5-20

(7) Disassembly of the trunnion shaft

- a. Remove the snap-ring (69) and hit the end of trunnion shaft with a plastic hammer as shown in the figure below in order to extract it out of the case.
- b. Remove the bearing (66).

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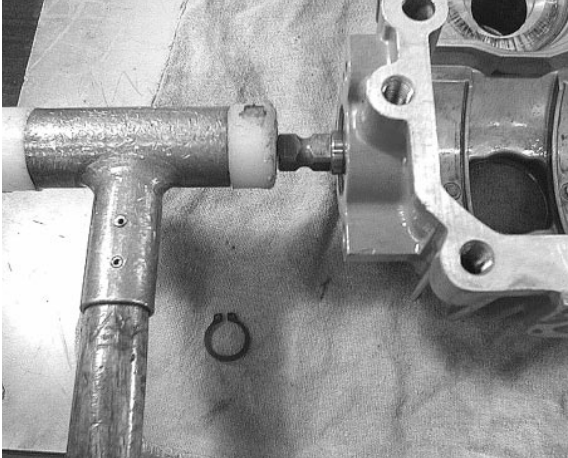


Fig. 5-21

(8) Disassembly of the port block

- a. Remove the plug (33) for the check valve and take out the springs (21) and poppets (30) out of the port block (2).
- b. Remove the valve sub-assembly (27).

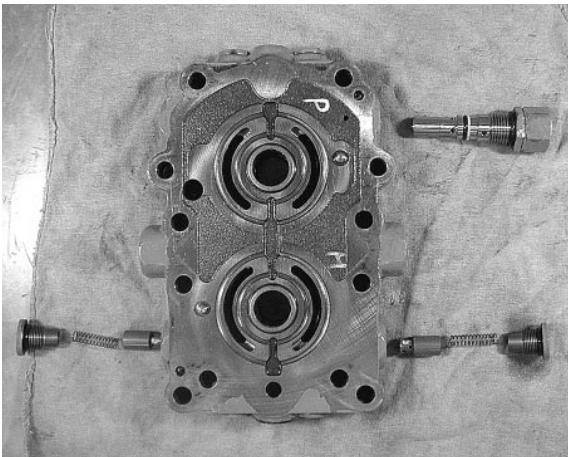
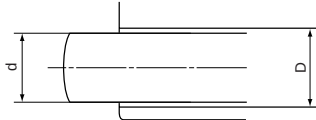


Fig. 5-22

CHAPTER 5. HYDROSTATIC TRANSMISSION

4.4 . CRITERIA FOR REPLACING WORN PARTS

Friction parts which have worn and exceed the specified limit should be replaced with new ones.

No.	Name	Inspection items	Standard value	Usable limit
1	Piston	a. Diameter of cylinder block Clearance: δ $\delta = d - D$ 	0.02 mm	$\delta < 0.03 \text{ mm}$
		b. Roughness of spherical part of piston	0.2a	<0.4a
2	Cylinder block	Roughness of friction surface of valve plate	0.2a	<0.4a
3	Valve plate	Roughness of friction surface of cylinder block		
4	Thrust bearing	Roughness of friction surface against piston	0.2a	<0.4a
5	Swash plate	Roughness of friction surface against bush	0.1a	<0.2a

Note: Scratched friction surfaces should be corrected by lapping. But lapping extent should be less than 0.005 mm. A part with deeper flaw on the friction surface should be replaced with a new one.

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4.5. PRECAUTION BEFORE REASSEMBLY

- a. Wash disassembled parts in fresh cleansing oil and blow them with compressed air.
- b. Handle the cleaned parts carefully to avoid damage such as dents, scratches, etc.
- c. All removed sealing parts should be discarded and replaced with new ones.
- d. All fasteners should be tightened to specified values.
- e. Apply lithium-based grease to oil seals and O-rings: especially to the lips of oil seals.

4.6. REASSEMBLY

(1) Reassembly of the trunnion shaft

- a. Install the snap-ring (38) into the case (1).
Install the oil seal (67).
- * *Press in the oil seal following the instructions on page 75.*
- b. Install the trunnion shaft assembly, which is composed of the trunnion shaft sub-assembly (65) and the ball bearing (65).
- * *Press in the ball bearing following the instructions on page 74.*

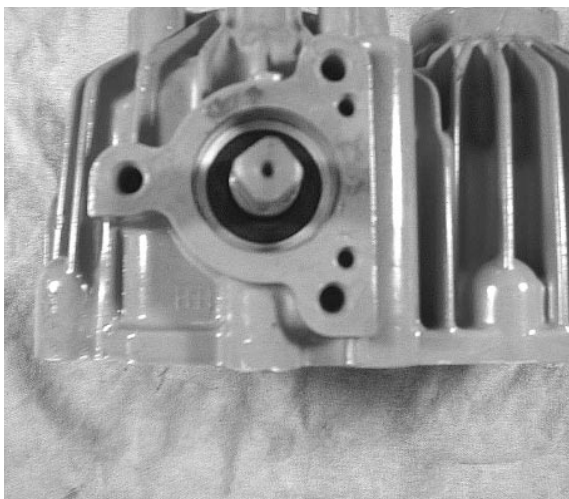


Fig. 5-23

- c. Install the washer (72) and ball bearing (66) and retain the shaft with the snap-ring (69).

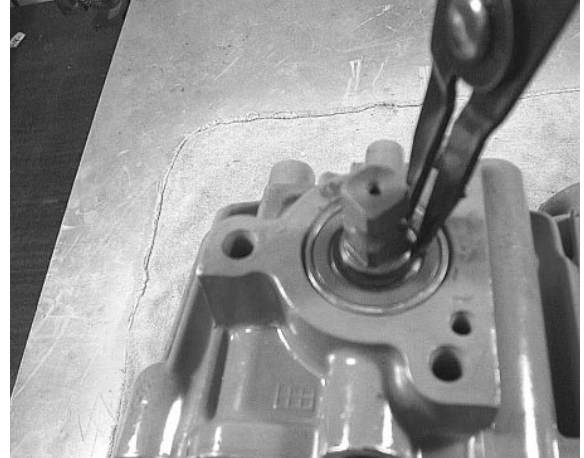


Fig. 5-24

(2) Reassembly of the shafts

- Assembly of the pump-side shaft
- a. Install the pump shaft assembly, which is composed of the shaft (8), ball bearing (14), and snap-ring (36), into the case (1) and retain the shaft with the snap-ring (37).
- * As for the details of the pump shaft assembly refer to Fig. 5-37 and as for ball bearing installation to page 74.



Fig. 5-25

- b. Install the two pins (50) and O-ring (82) and then the cover assembly, which is composed of the cover (19) and oil seal (61). Tighten the cover with the screws (71).

CHAPTER 5. HYDROSTATIC TRANSMISSION



Fig. 5-26

Tightening torque of screw (71)	17.2±2 N·m
------------------------------------	------------

* As for oil seal installation, refer to page 75.

- Reassembly of the motor side shaft

a. Install the motor shaft assembly, which is composed of the shaft (9), ball bearing (14), and snap-ring (36), into the case (1) and retain the shaft with the snap-ring (37).

* As for the details of the motor shaft assembly refer to Fig. 5-37 and as for ball bearing installation to page 74.



Fig. 5-27

b. Press the bore plug (11) into the case (1) and install the snap-ring (37) on the outside.



Fig. 5-28

(3) Reassembly of the slant board and thrust bearing

a. Install the thrust bearing (13) into the case (1).

Install the thrust bearing with the side bearing no marking turned towards the pistons.

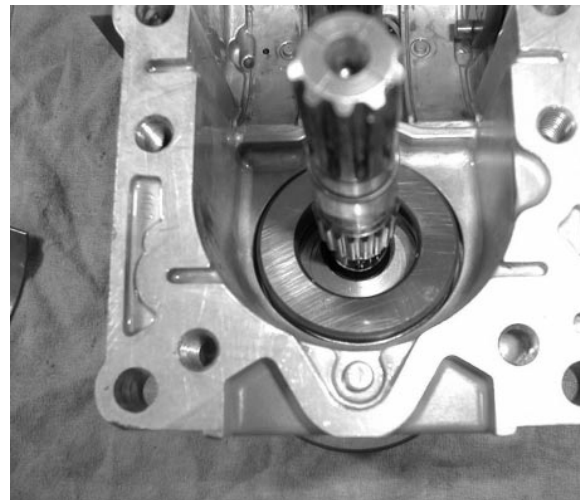


Fig. 5-29

b. Install the two bushes (16) in the case (1).

c. Install the sliding piece (18) onto the trunnion shaft (10).

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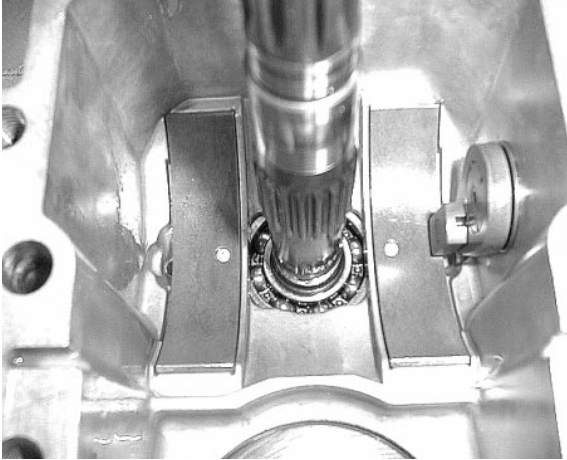


Fig. 5-30

- d. Install the thrust bearing onto the slant board assembly, which includes the swash plate (4) and bush (17). Install the slant board so that the groove in the slant board is aligned with the sliding piece.

Install the thrust bearing so that the side having no marking is turned towards the pistons.

- * As for the details of the slant board and installation of the bush, refer to page 74.

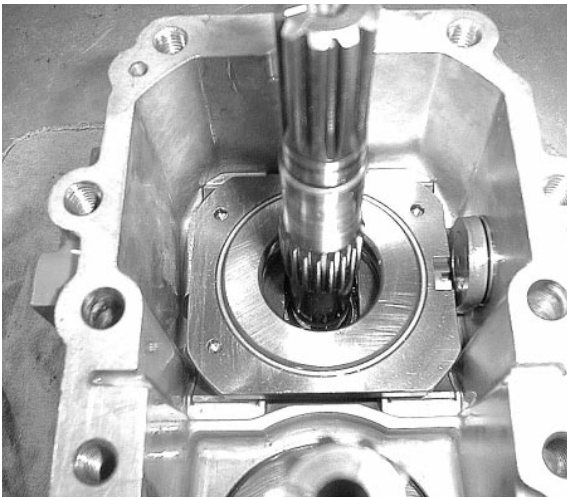


Fig. 5-31

(4) Installation of the cylinder blocks

- a. Install the cylinder block assembly, which is composed of the cylinder block (3), pistons (5), springs (20) and spring holders (41) respectively onto the motor and pump shafts.

When installing the cylinder block, apply working fluid to the pistons ahead of time.

- * As for the details of the cylinder block, refer to Fig. 5-1.

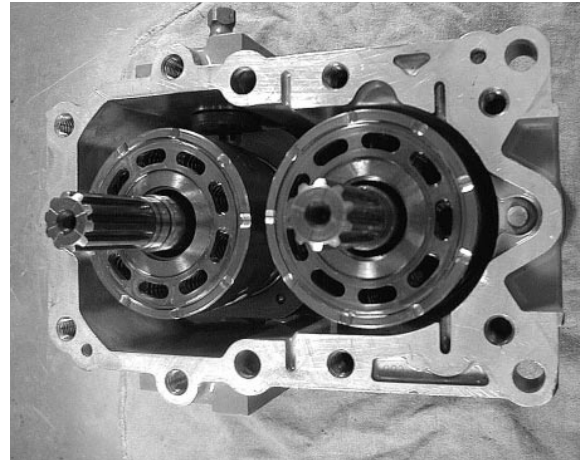


Fig. 5-32

(5) Reassembly of the port block

- a. Install the port block assembly with the copper alloy side turned towards you and install the valve plates (6 & 7).

- As for the details of the port block, refer to page 75.

Apply grease to the valve plate ahead of time to prevent it from falling.

The valve plate with two notches should be installed on the pump.

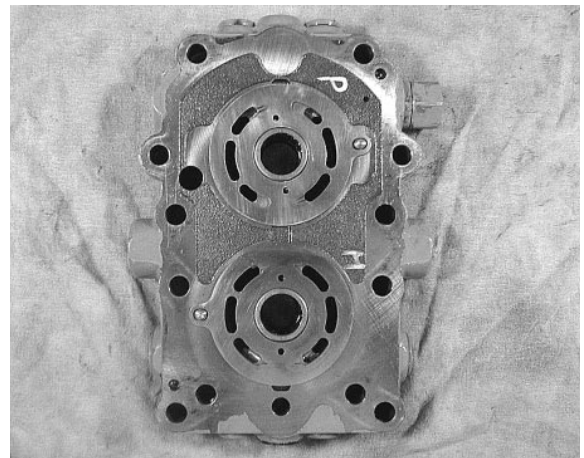


Fig. 5-33

CHAPTER 5. HYDROSTATIC TRANSMISSION

- b. Install the valve sub-assembly (28).

Apply grease to the valve ahead of time to prevent it from falling.

- c. Install the springs (22), pins (50), and gasket (49) onto the case.

Apply grease to the springs ahead of time in order to prevent them from falling.

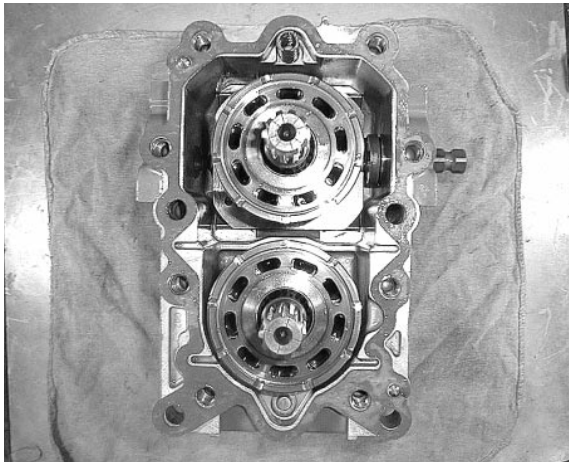


Fig. 5-34

- d. Install the port block assembly onto the case and tighten the eight socket-head bolts (50).

Tightening torque of socket-head bolt (50)	49.0±5 N·m
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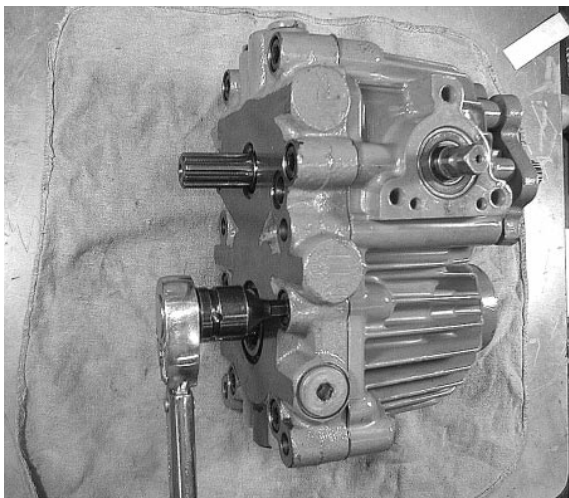


Fig. 5-35

- e. After being reassembled, make sure that the shafts (8 & 9) turn smoothly using an adjustable end wrench.

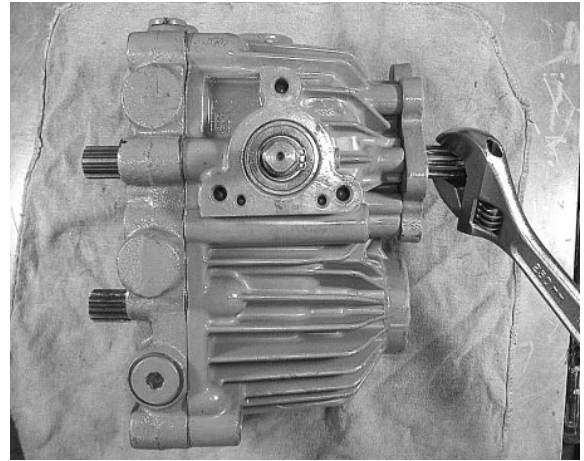


Fig. 5-36

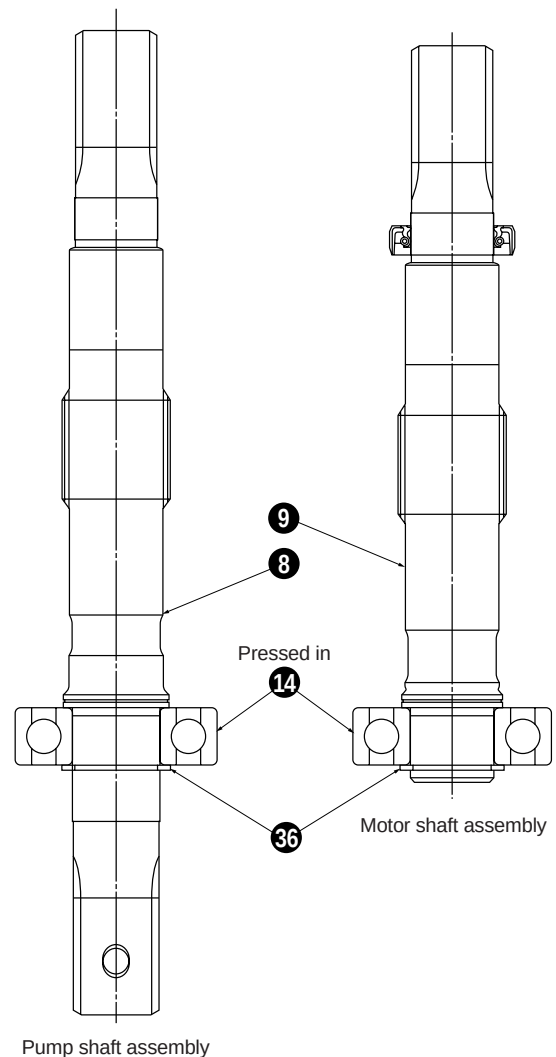


Fig. 5-37

(Unit: mm)

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4.7. PRECAUTIONS FOR REASSEMBLY

a. Installation of shaft bearings

Press in the bearings using the jigs mentioned in the drawing below.

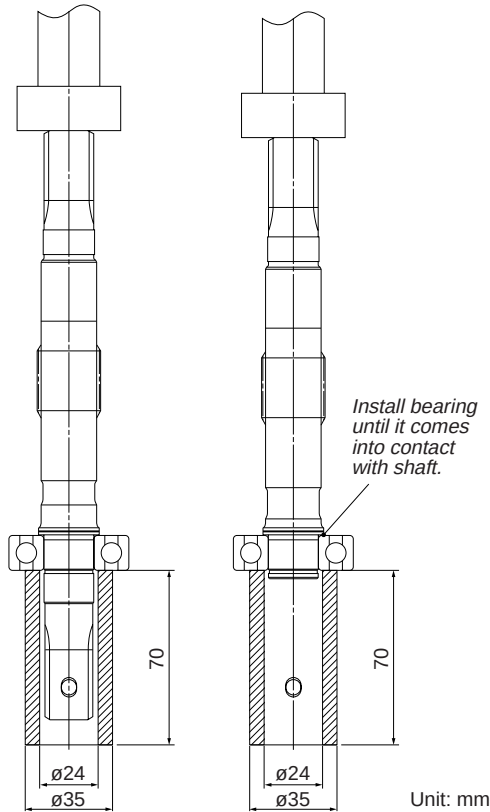


Fig. 5-38

b. Bore plug installation

Note:

- Press in the bore plug (11) until its top sinks to 4.2 mm deep from the case surface.
- Prepare pressing-in jigs in accordance with the dimensions mentioned on the drawing.

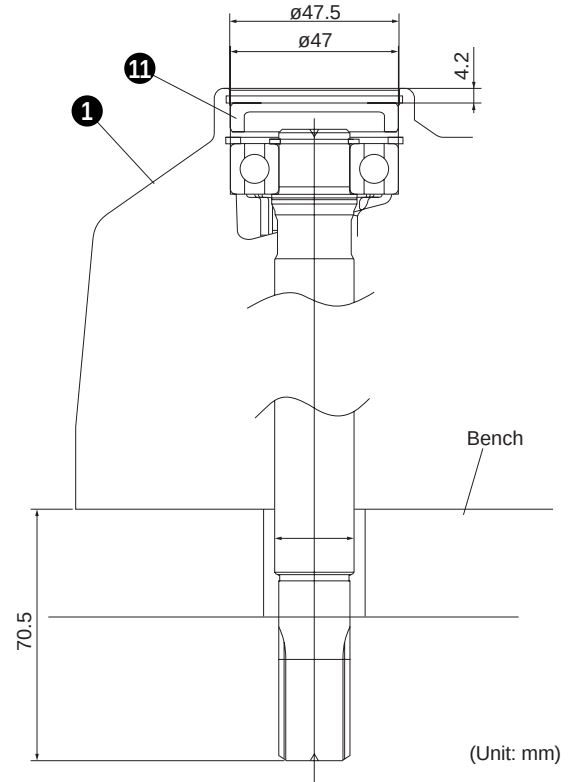


Fig. 5-39

c. Swash plate (slant board) assembly

- Press the bush (17) into the slant board so that the bush end becomes flush with the surface of the swash plate.

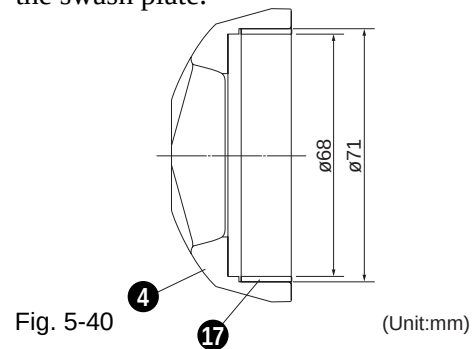


Fig. 5-40

d. Trunnion shaft assembly

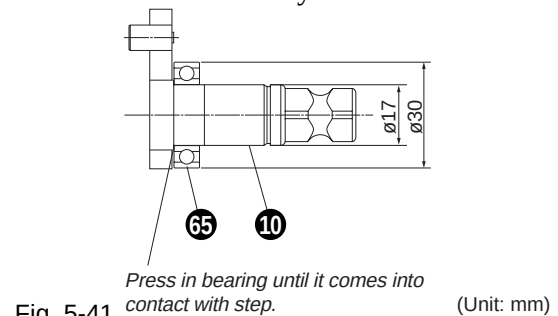


Fig. 5-41

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e. Installation of oil seals

- Press the oil seal (61) into the cover until the oil seal end becomes flush with the cover surface.

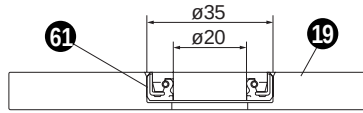


Fig. 5-42

(Unit: mm)

- Press in the oil seal (67) until the oil seal end sinks to 12.5 mm below the case surface.

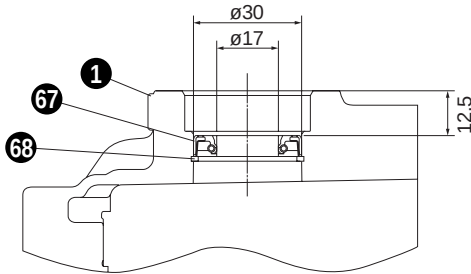


Fig. 5-43

(Unit: mm)

f. Port block assembly

As for the pressed-in parts, refer to paragraph g.

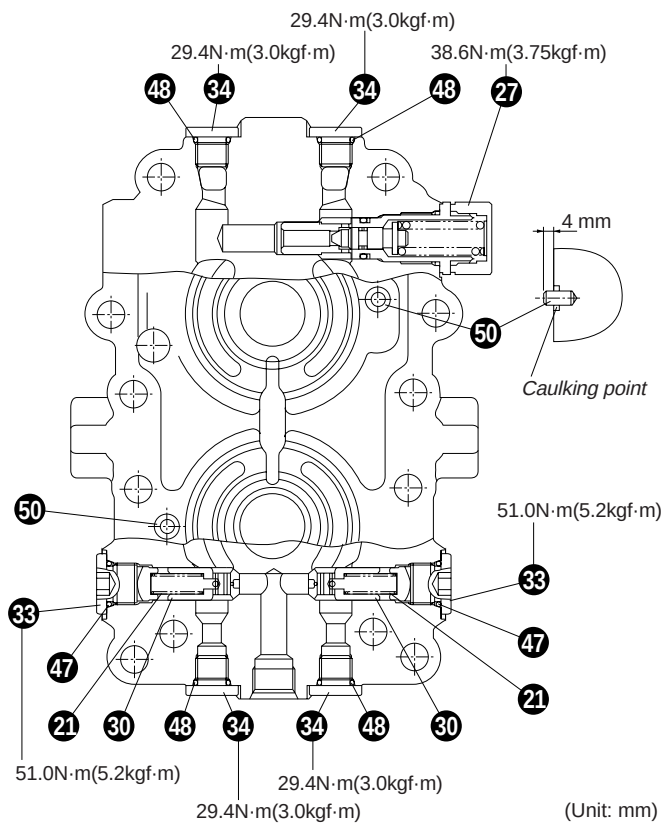


Fig. 5-44

(Unit: mm)

g. Pressed-in parts in the port block

Note:

- The oil seal (42) should be installed with the dust lip turned outward.
- Install the bearing (15) until the end protrudes by 2.5 mm beyond the port block surface.
- Prepare pressing-in jigs in accordance with the dimensions mentioned on the drawing.

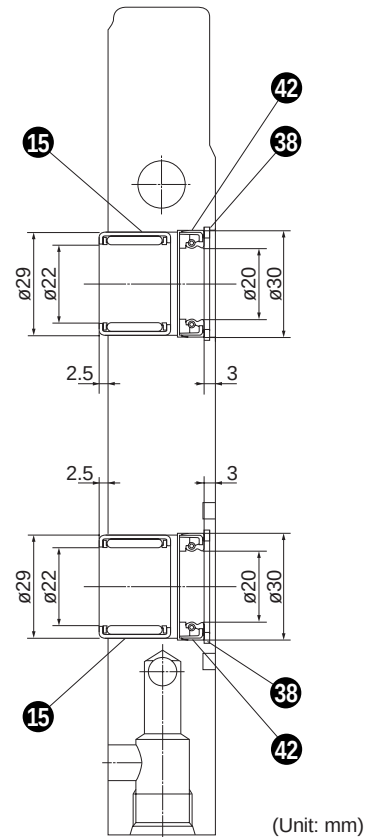
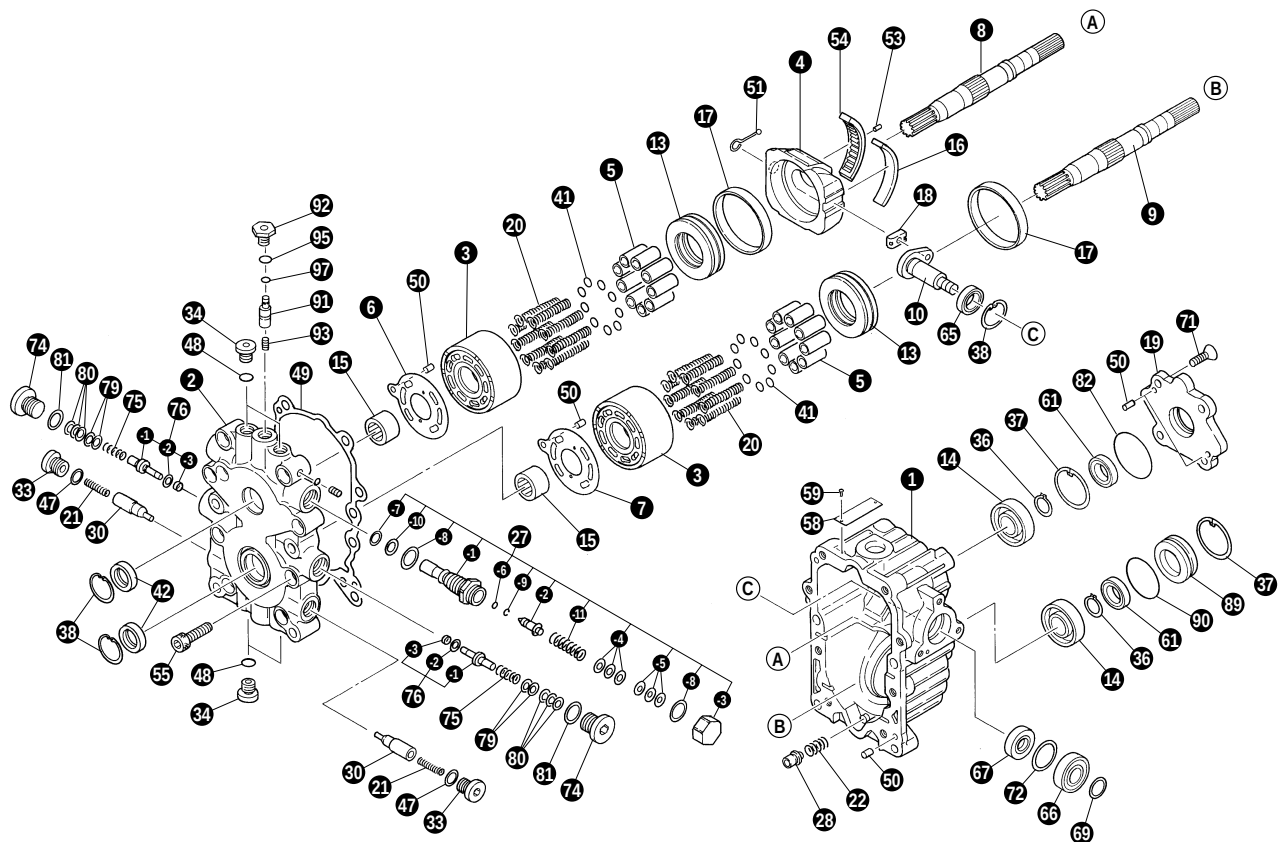


Fig. 5-45

(Unit: mm)

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4.8. LIST OF MAJOR COMPONENTS OF HST



- | | | | |
|---------------------|--------------------|-----------------------|--------------------|
| (1) Case | (21) Spring | (53) Pin | (80) Shim B |
| (2) Port block | (22) Spring | (54) Cradle bearing | (81) O-ring |
| (3) Cylinder block | (27) Valve | (55) Socket head bolt | (82) O-ring |
| (4) Slant board | (28) Valve | (58) Name plate | (89) Oil seal case |
| (5) Piston | (30) Poppet | (59) Drive screw | (90) O-ring |
| (6) Valve plate | (33) Plug | (61) Oil seal | (91) Valve body |
| (7) Valve plate | (34) Plug | (62) Pin | (92) Plug |
| (8) Pump shaft | (36) Snap-ring | (64) Cover | (93) Spring |
| (9) Motor shaft | (37) Snap-ring | (65) Ball bearing | (94) Plug |
| (10) Trunnion shaft | (38) Snap-ring | (66) Ball bearing | (95) O-ring |
| (13) Thrust bearing | (41) Spring holder | (67) Oil seal | (96) O-ring |
| (14) Ball bearing | (42) Oil seal | (69) Snap-ring | |
| (15) Needle bearing | (47) O-ring | (72) Washer | |
| (16) Bush | (48) O-ring | (74) Plug | |
| (17) Bush | (49) Gasket | (75) Spring | |
| (18) Sliding piece | (50) Pin | (76) Piston | |
| (19) Cover | (51) Guide | (79) Shim A | |
| (20) Spring | | | |

Fig. 5-46

CHAPTER 5. HYDROSTATIC TRANSMISSION

4.9. PRECAUTIONS FOR INSTALLATION OF HST UNIT

(1) INSTALLATION OF SHAFTS

- a. The input shaft (output shaft) and the driving shaft (driven shaft) of the two shaft type HST should be aligned correctly. The deviation of centering should be less than 0.05 mm.
- b. When mounting or dismounting the two shaft type HST onto or from the machine, prevent the input and output shaft end from excessive thrust load.

(2) INSTALLATION OF TRUNNION SHAFT

Provide a stopper in place before the maximum inclination of the trunnion shaft when there is a fear of application of stronger force to the trunnion shaft than HST operating force.

4.10. PRECAUTIONS AFTER INSTALLATION OF HST UNIT

(1) STARTING

- a. Fill the HST case with working fluid.
- b. After the installation of the HST system, operate the control lever or pedal slowly several times in order to bleed the system of air completely.
 - When air-bleeding is incomplete, trapped air bubbles make noise. Repeat the above air-bleeding operation until such noise is eliminated.
 - When excessive air is trapped inside the system, the output shaft may not turn. But when the control lever is held at the maximum angle under idling speed for a while, the shaft will begin turning. This may cause the machine to start abruptly, so a safety measure should be provided such as jacking up the drive wheels.
- c. At first make sure there are no abnormal noises or vibrations generated at low speed and then acceralate to the specified speed.

(2) OIL TEMPERATURE

It is a very important factor at what temperature a hydraulic system operates. High operating temperaure will cause working oil to deteriorate faster, that is, oil is oxidized faster. On the other hand excessively low operating temperature increases oil viscosity resulting in poor mechanical efficiency of the HST.

Consequently abide by the following items:

- a. When starting the machine at 10°C or colder temperature, wait until oil temperature becomes higher than 10°C by warm-up operation or using an oil heater. Then start operation.
- b. Normal operating temperature: 20°C to 60°C
- c. Maximum operating temperature
The maximum operating temperature should be 80°C. This limit is determined form the viscosity, oxidation-proof property of working oil and deterioration of O-rings and oil seals. Consequently operation at higher than 80°C will shorten the service life of the HST and working oil.

(3) PERIODICAL INSPECTION AND CHANGING INTERVALS OF WORKING OIL

As the system operates, deposits like sludge accumulate within circuits and oil tank and working oil deteriorates, which will prevent the system from smooth operation in the end.

Consequently working oil should be checked periodically to replace it timely with new one. As it is very difficult to judge how oil has deteriorated visually, a rule of thumb is given below. Normally the oil should be replaced after the intial 50 hours of operaton and then every year (before the new season begins) when the machine is used for less than 250 hours or every 250 hours of operation.

As water and sludge will be deposited in the circuits and oil tank when replacing the working oil, the whole system should be flushed clean before filling it with new oil.

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List of criteria for judging oil deterioration (Draw some oil out of the HST case into a test tube and compare the sample with fresh oil.)

Appearance	Smell	Condition	Countermeasure
Transparent and with no discolouration	Normal	Good	Keep on using as it is
Transparent but with small black dots	Normal	Mixed with foreign matter	Keep on using after filtering
Milky white	Normal	Mixed with water	Replace with new oil
Blackened	Bad	Oxided and deteriorated	Replace with new oil

4.11. TROUBLESHOOTING

When the HST unit is defective, it should be replaced with a new one as a rule. The following table will assist you in understanding the HST system.

Trouble	Presumable cause	Countermeasure
The output shaft does not turn even when the control lever is shifted either to α or β side.	1. Improper set pressure of relief valve in low pressure side (Decreased pressure)	Measure the pressure of low pressure circuit and replace defective parts if necessary.
	2. Improper set pressure of relief valve in high pressure side (Decreased pressure)	Measure the pressure of high pressure circuit and replace defective parts if necessary.
	3. Broken charge pump (Decreased charge flow)	Replace defective parts with new ones.
	4. Air is trapped within the HST system.	Check suction piping of the charge pump and oil level in the tank. (After correction, bleed the HST system of air.)
	5. Erratic operation of the HST unit due to defective inner parts or defective coupling of input or output shaft	Wash the hydraulic circuit of the machine thoroughly, repair the coupling and replace the HST unit assembly with a new one.
The output shaft does not stop turning even when the control lever is shifted to the neutral position.	1. Erratic operation of the check valve (Clogged choke)	Disassemble, wash it clean, and then reassemble.
	2. Defective check valve seat	Replace a defective seat with a new one.
Low revolving speed of output shaft of the HST	1. Highly pressurized oil is leaking through worn frictioning parts of the pump or motor of the HST.	Wash the hydraulic circuit of the machine thoroughly, replace the HST unit assembly with a new one.
	2. Air is trapped within the HST system	Check suction piping of the charge pump and oil level in the tank. (After correction, bleed the HST system of air.)
	3. Decreased circuit flow caused by a clogged filter or strainer	Clean a clogged filter or strainer.

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Trouble	Presumable cause	Countermeasure
	4. Insufficient delivery of charge pump due to abnormal oil temperature	When cold: Warm up sufficiently. When hot: Stop the engine and wait until the machine cools down. Then start.
HST produces abnormal noise.	1. Air is trapped within the HST system	Check suction piping of the charge pump and oil level in the tank. (After correction, bleed the HST system of air.)
	2. Decreased circuit flow caused by a clogged filter or strainer	Clean a clogged filter or strainer.
	3. Insufficient delivery of charge pump due to abnormal oil temperature	When cold: Warm it up sufficiently. When hot: Stop the engine and wait until the machine cools down. Then start.
	4. Loosened or worn linkage of the machine	Adjust or repair the linkage.
	5. Erratic operation of the HST unit due to defective inner parts or defective coupling of input or output shaft	Wash the hydraulic circuit of the machine thoroughly, repair the coupling and replace the HST unit assembly with a new one.
The control lever is very slow to return or is very heavy to operate	1. Worn slant board bearing	Replace the worn bearing with a new one.
	2. Worn, damaged, or dirty frictioning part of the slant board bearing	Correct the frictioning part or replace a defective part with a new one.
Oil is leaking through a shaft or oil seal.	1. Defective or broken oil seal or O-ring	Damaged or defective oil seal or O-ring should be replaced with a new one. When installing an oil seal, take care not to damage the lips of the oil seal.

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5. ADJUSTMENT OF HST

5.1. ADJUSTMENT OF NEUTRAL POSITION

- (1) Place the lawn mower on level, hard ground. Put tyre chocks in the position a little apart from the respective tyres.
- (2) Shift the PTO lever to the OFF position.
- (3) Stop the engine and apply the parking brakes.
- (4) Loosen the lock nut of the adjusting rod.
- (5) When the lawn mower creeps forward, tilt the trunnion arm slightly rearward and when it creeps in reverse, tilt forward by manipulating the adjusting rod. Then tighten it temporarily with the lock-nu.
- (6) Start the engine and turn the throttle lever to the intermediate position.
- (7) Release the parking brake.
- (8) When the lawn mower does not start moving, it shows that the neutral position is poorly set.
- (9) Stop the engine and apply the parking brakes. Tighten the lock-nus securely.

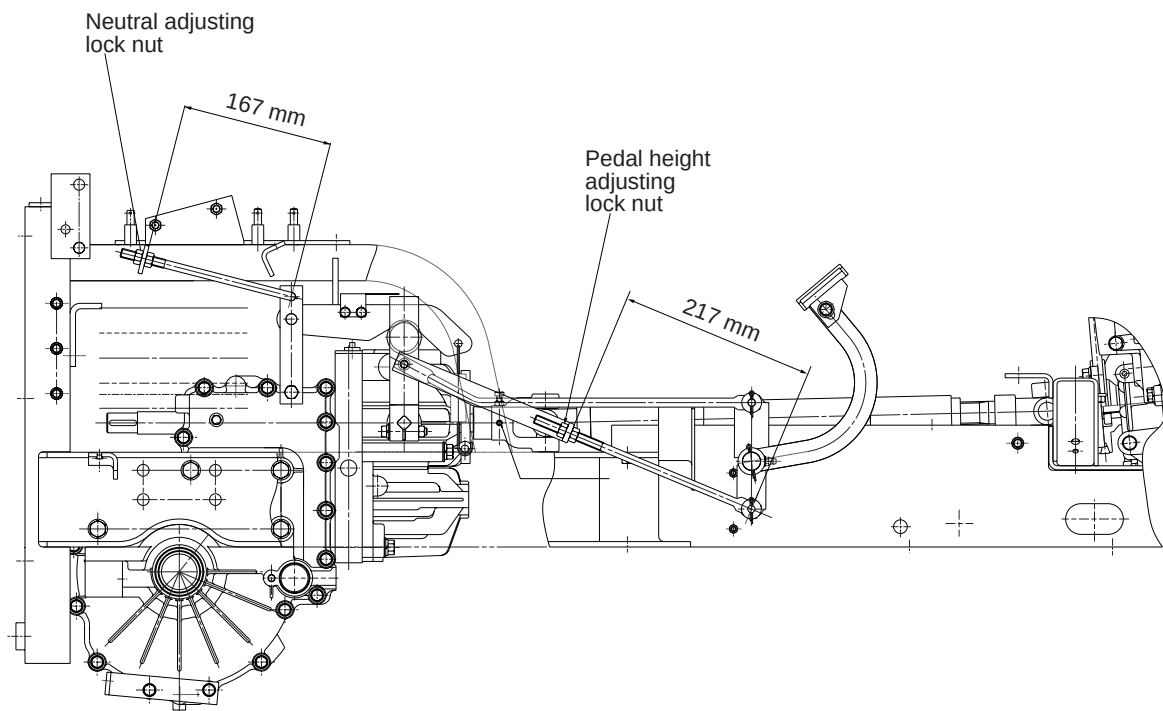


Fig. 5-47

5.2. ADJUSTMENT OF HST PEDALS

Adjust the effective length of the HST rod so that the top faces of both the forward and reverse HST pedals become flush. Be sure to lock the rod by tightening the lock-nus.

CHAPTER 6. HYDRAULIC SYSTEM

5.3. ADJUSTMENT OF TRUNNION ARM STOPPERS

The trunnion arm should be adjusted to turn forward by 21.5° and 13° in reverse by respective stopper bolts as shown.

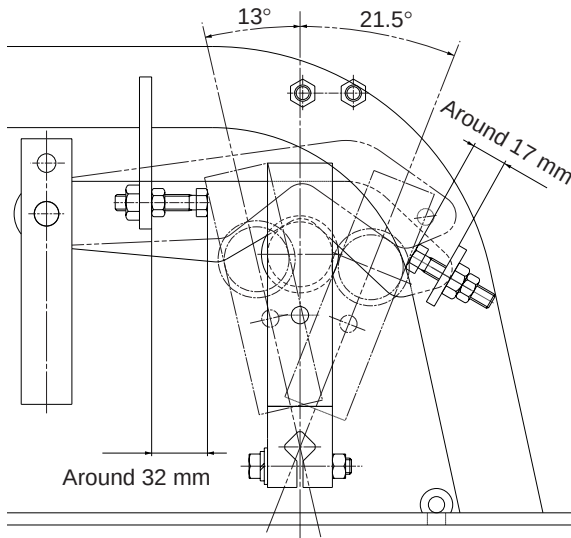


Fig. 5-48

These stopper bolts prevent the respective HST pedals from being depressed beyond the operating limits of the slant board of the HST motor.

Note:

Improper setting of these stoppers may damage the parts inside the HST unit.

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CHAPTER 6. HYDRAULIC SYSTEM

1. HYDRAULIC SYSTEM DIAGRAMS

(SGR17 with manual steering system)

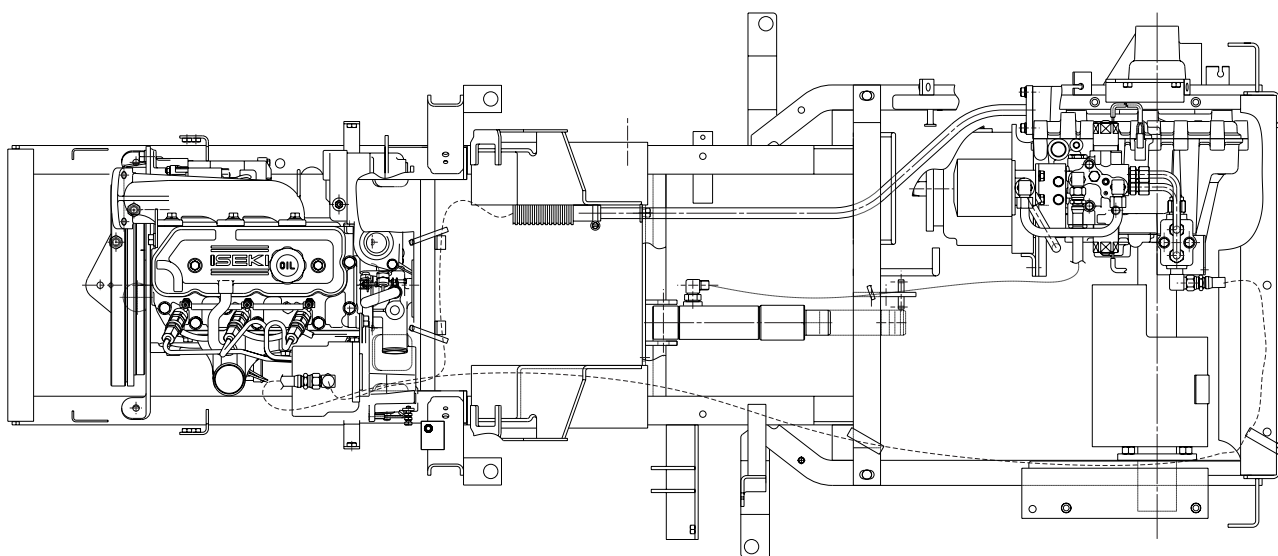
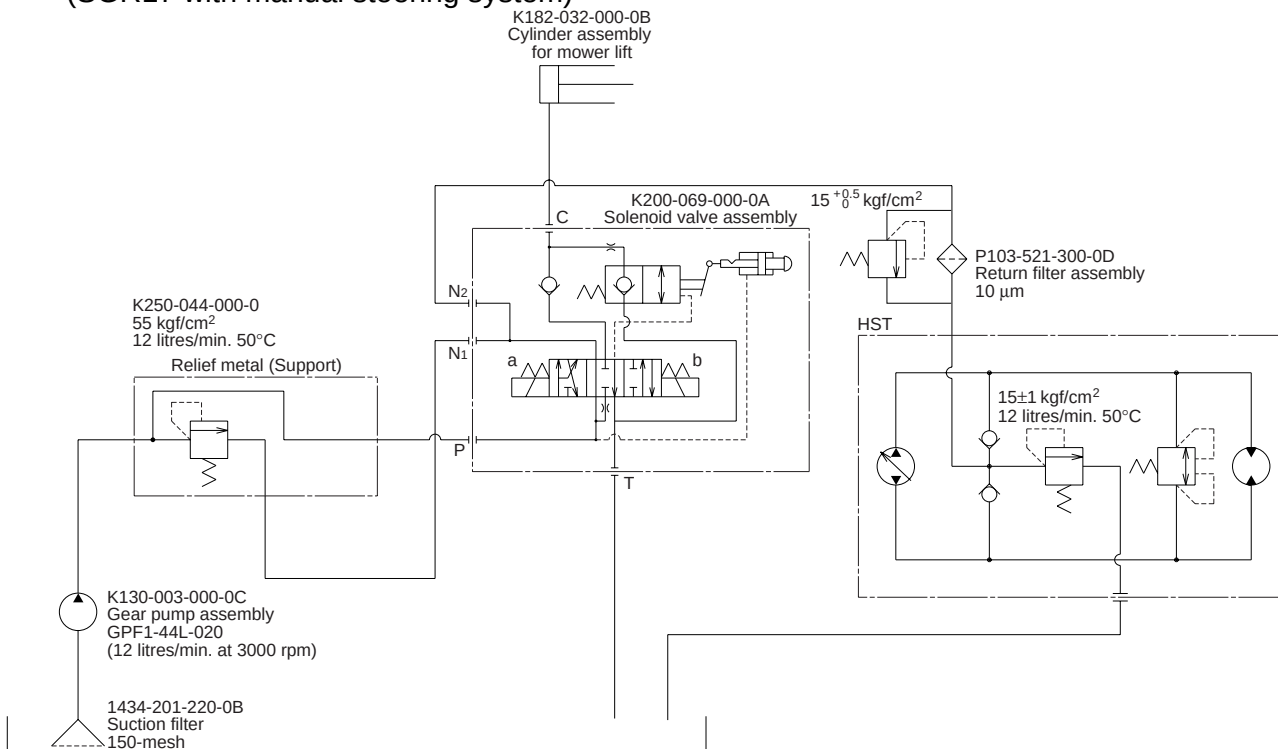


Fig. 6-1

CHAPTER 6. HYDRAULIC SYSTEM

(Type U of SGR19/17)

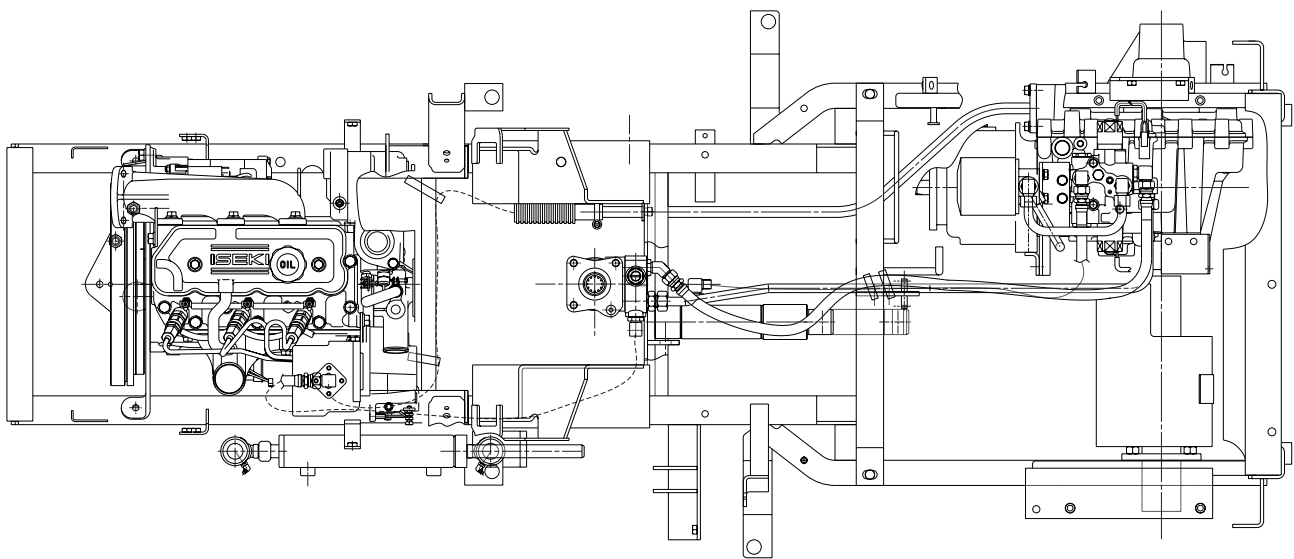
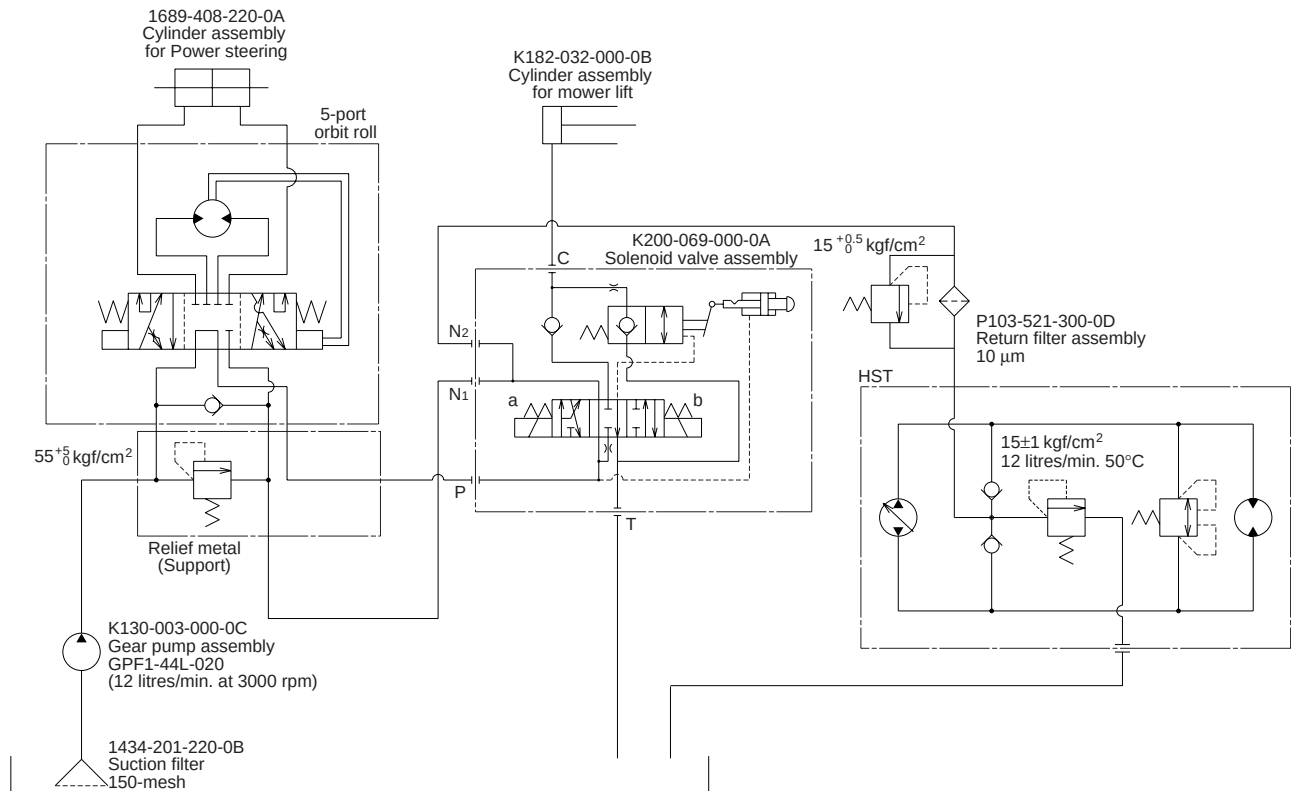


Fig. 6-2

SERVICE MANUAL FOR SGR19 & SGR17

2. INSPECTION OF MAJOR COMPONENTS

2.1 SUCTION FILTER

The filter is installed in the bottom of the transmission case. It has a reusable wire element, which should be washed clean periodically.

2.2. HYDRAULIC PUMP (GEAR PUMP)

Check all disassembled parts for damage and wash undamaged and usable parts except for

rubber parts in clean diesel fuel or kerosene. Inspect all parts and repair or replace defective parts with new ones.

Delivery pressure: 55 kgf/cm² with fluid heated at 50°C (Maximum pressure: 85 kgf/cm²)

Speed (rpm)	Delivery (liter/min.)	
1000	3.30	Under 70 kgf/cm ²
500	1.06	

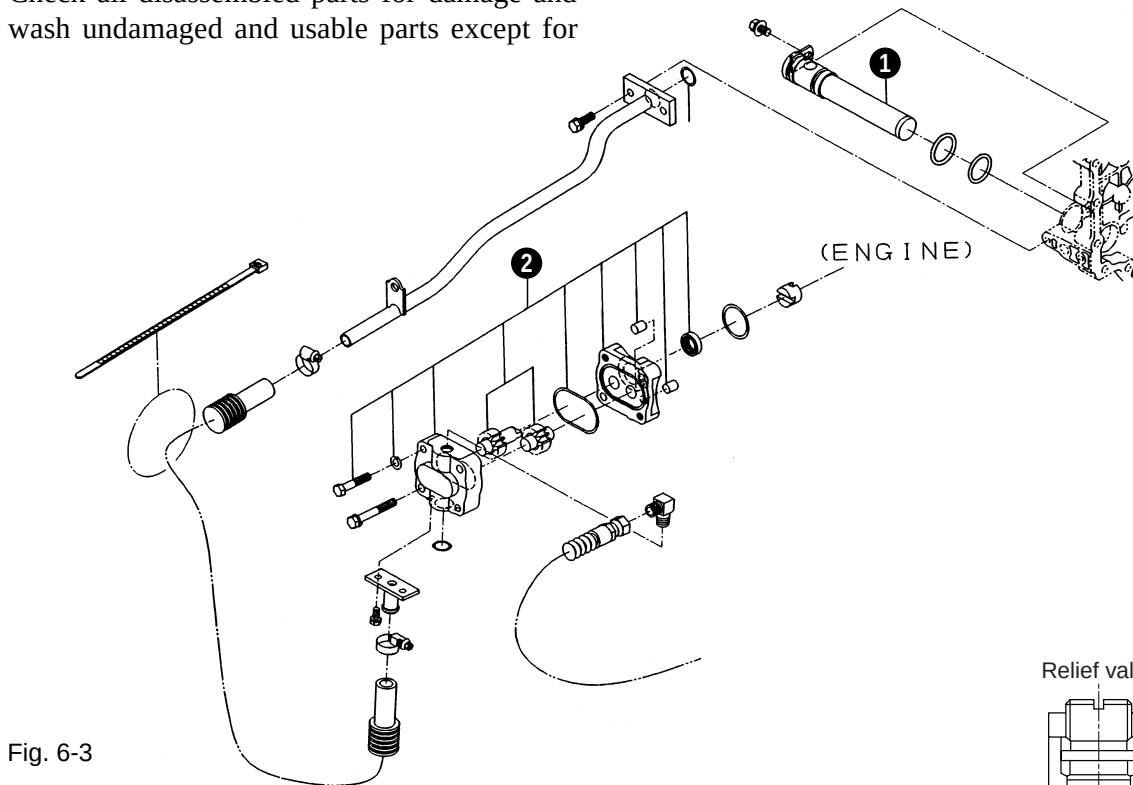


Fig. 6-3

2.3. RELIEF VALVE

FUNCTION

This device functions as a flow-distributor of the pressurized fluid from the pump and the built-in relief valve stabilises the pressure in the mini-orbit roll. It is installed on the mini-orbit roll as shown in the below.

Relief pressure	5.4 Mpa (55 kgf/cm ²) at 10 liters/min. and 50°C
-----------------	--

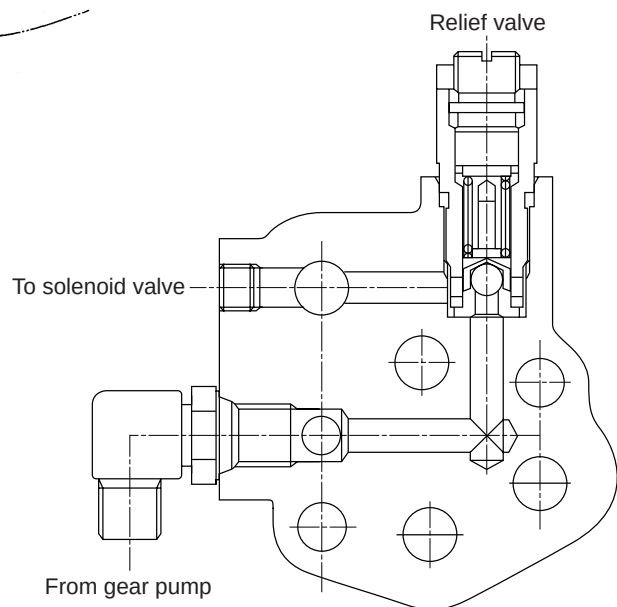


Fig. 6-4

CHAPTER 6. HYDRAULIC SYSTEM

2.4. RELIEF METAL (SUPPORT)

Relief pressure	5.4 Mpa (55 kgf/cm ²) at 10 liters/min. and 50°C
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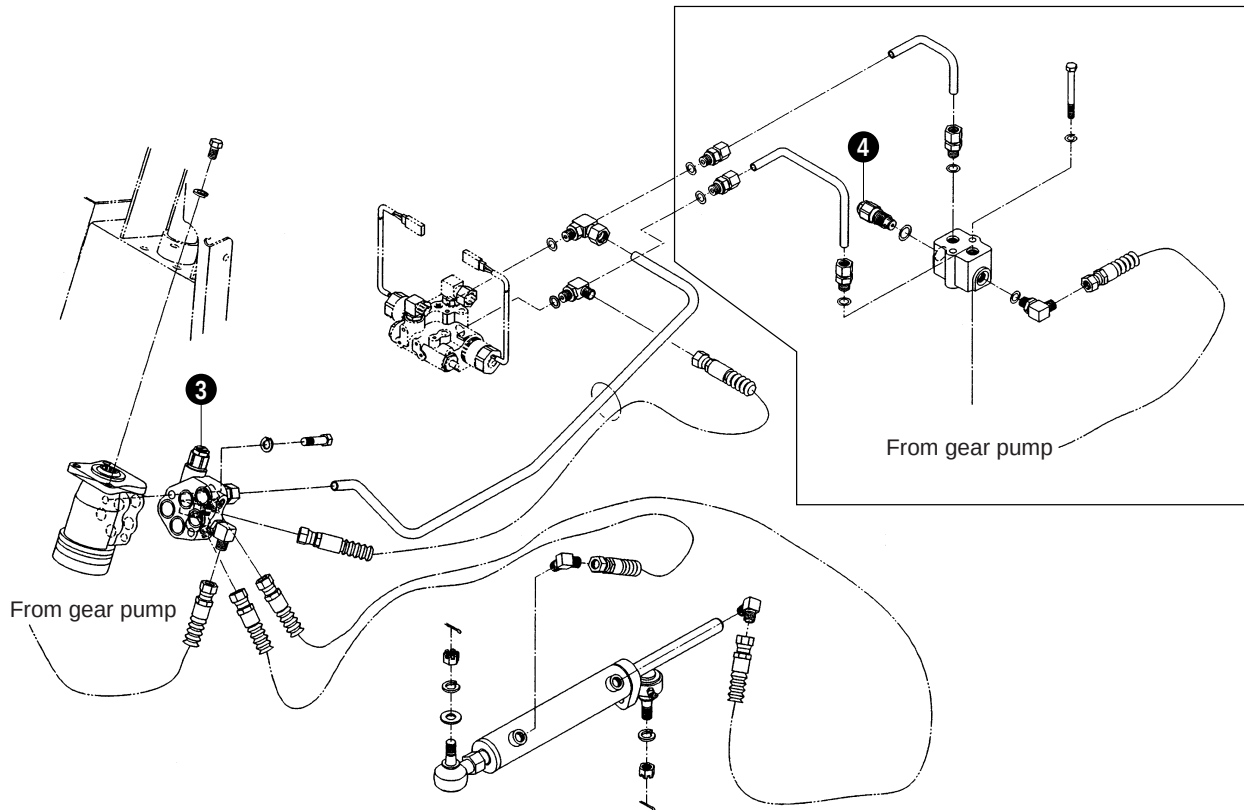


Fig. 6-5

2.5. OIL FILTER (Return filter assembly)

The filter cartridge is attached on the HST unit.

Bypass relief valve in the base

Opening pressure	1.5 MPa (1.5 kgf/cm ²)
------------------	------------------------------------

Replace the cartridge with a new one after the initial 50 hours of operation and then after every 200 hours of operation.

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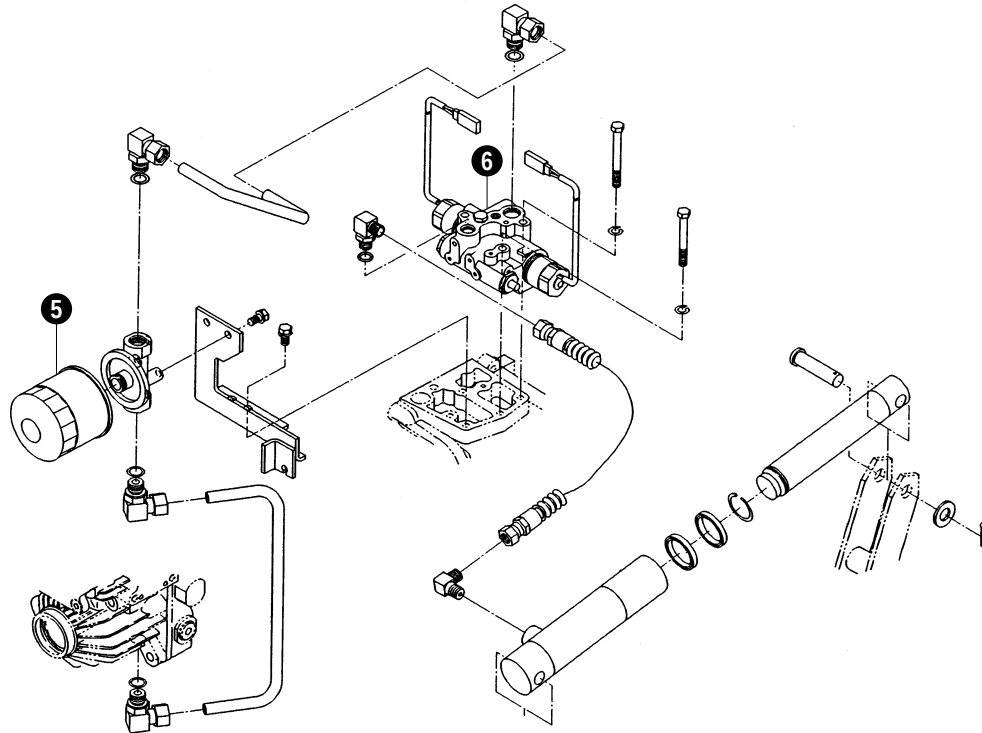


Fig. 6-6

2.6. SOLENOID VALVE ASSEMBLY (K200-069-000-00)

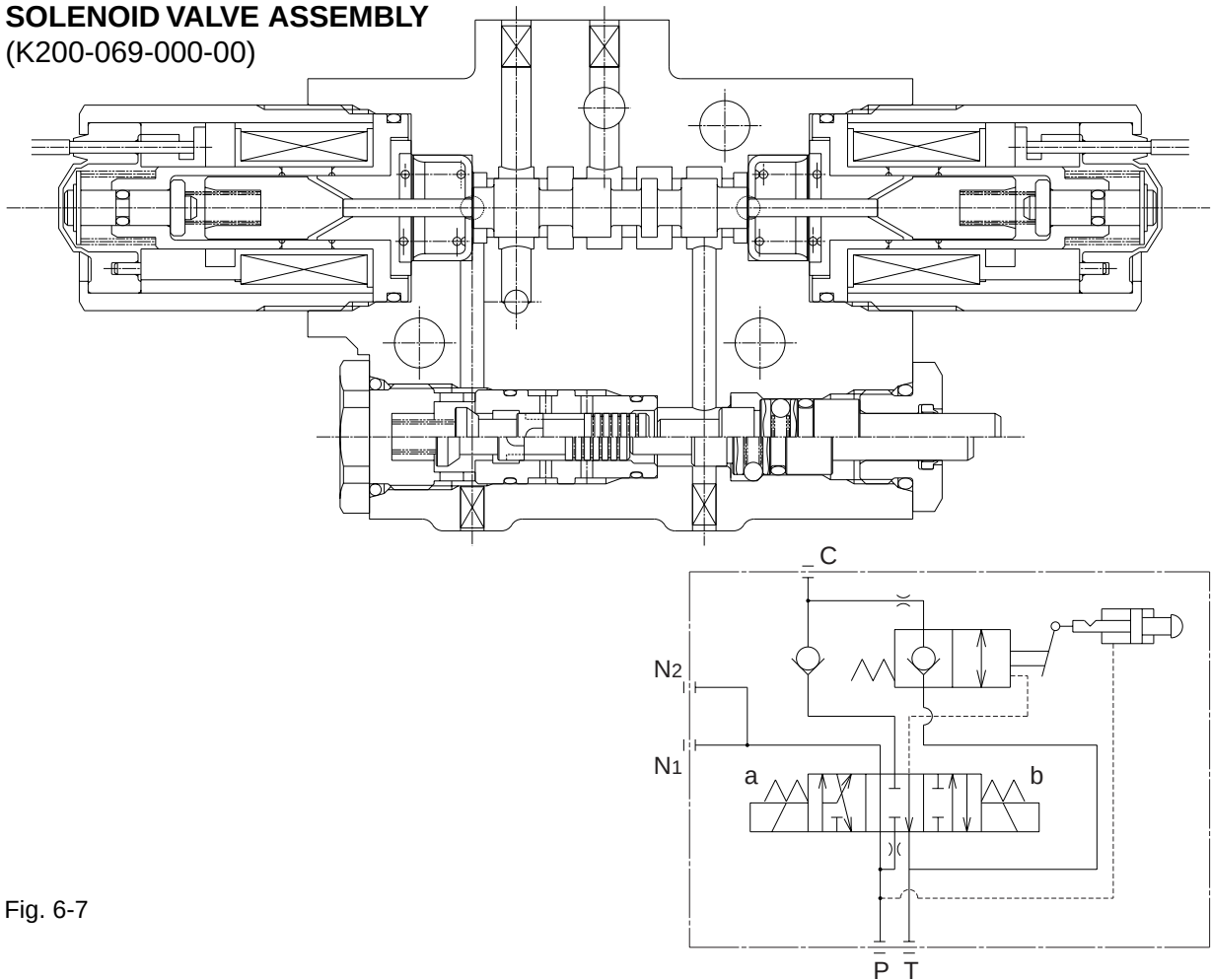


Fig. 6-7

CHAPTER 7. POWER STEERING SYSTEM**INSPECTION**

Normally the operation of the solenoid valve should be checked on the machine, but as for wear of each part or oil leaks it should be removed from the machine and checked according to the standards mentioned below.

• INSPECTION CONDITIONS

- a. Working oil: Equivalent to ISO VG-55
(Contamination degree is NAS112 or lower and solid material of larger than 0.1 mm should not be included.)
- b. Oil temperature: $50 \pm 3^{\circ}\text{C}$
- c. Oil flow: As mentioned below
- d. Working voltage: DC 10.2V (Rated 12V, Maximum 14.4V)

• INSPECTION ITEMS AND CRITERIA

Items	Inspection	Criterion
1. Preparatory operation	With no load at port N1, N2 and C and both solenoid valves turned off, flush the valves by supplying oil through port P. (Flow at port P: 12 litres/min.)	
2. Operating inspection	With a test cylinder connected to port C, confirm that the test cylinder works properly by switching on and off the solenoid valves a and b.	The valves should work properly without hitching, hunting or abnormal noise.
3. Measurement of pressure loss	With all ports opened, solenoid valves at neutral and by supplying oil through port P, measure port P pressure. (Flow at port P: 12 litres/min.)	7 kgf/cm ² or lower
4. Pressure measurement 1	With port C opened and solenoid valve b turned on, by supplying oil through port P, measure port P pressure. (Flow at port P: 5 litres/min.)	42 ± 5 kgf/cm ²
5. Pressure measurement 2	With the manual push-pin depressed to the stroke end, measure port C pressure when oil is supplied through port C. (Flow at port C: 5 litres/min.) (Flow at port P: None with solenoid valve turned off)	30 ± 5 kgf/cm ²
6. Measurement of oil leak	With the solenoid valves at neutral, measure leak while applying load to port C. (Load at port C: 100 kgf/cm ²)	3 cc/min. or less
7. Push-pin operation	With the test cylinder connected to port C and load applied, make sure that the cylinder works when the push-pin is depressed. (Flow at port P: None with solenoid valve turned off) (Load at port C: 50 kgf/cm ²)	The push-pin should work securely to release load.
8. Inspection of appearance	Throughout all inspections there should be no abnormal noise, overheating, leakage, or malfunction.	There should be no abnormality.

*Note: Inspection criteria may differ in accordance with the specifications of a product, make-up of test circuits.
For your reference: Conversion formula of SI units Pressure MPa = 10.197 kgf/cm²*

SERVICE MANUAL FOR SGR19 & SGR17

CHAPTER 7. POWER STEERING SYSTEM

1. CONSTRUCTION

The steering unit (mini-orbit roll) controls hydraulic power and activates the rear wheels directly through the power steering cylinder. It features minimized vibration at the steering wheel because vibration of the rear wheels is not directly transmitted to the steering wheel.

In accordance with the operation of the steering wheel, the rotary valve and metering devices built in the orbit roll controls the direction and flow rate of the hydraulic fluid and activates the power-assisted steering mechanism.

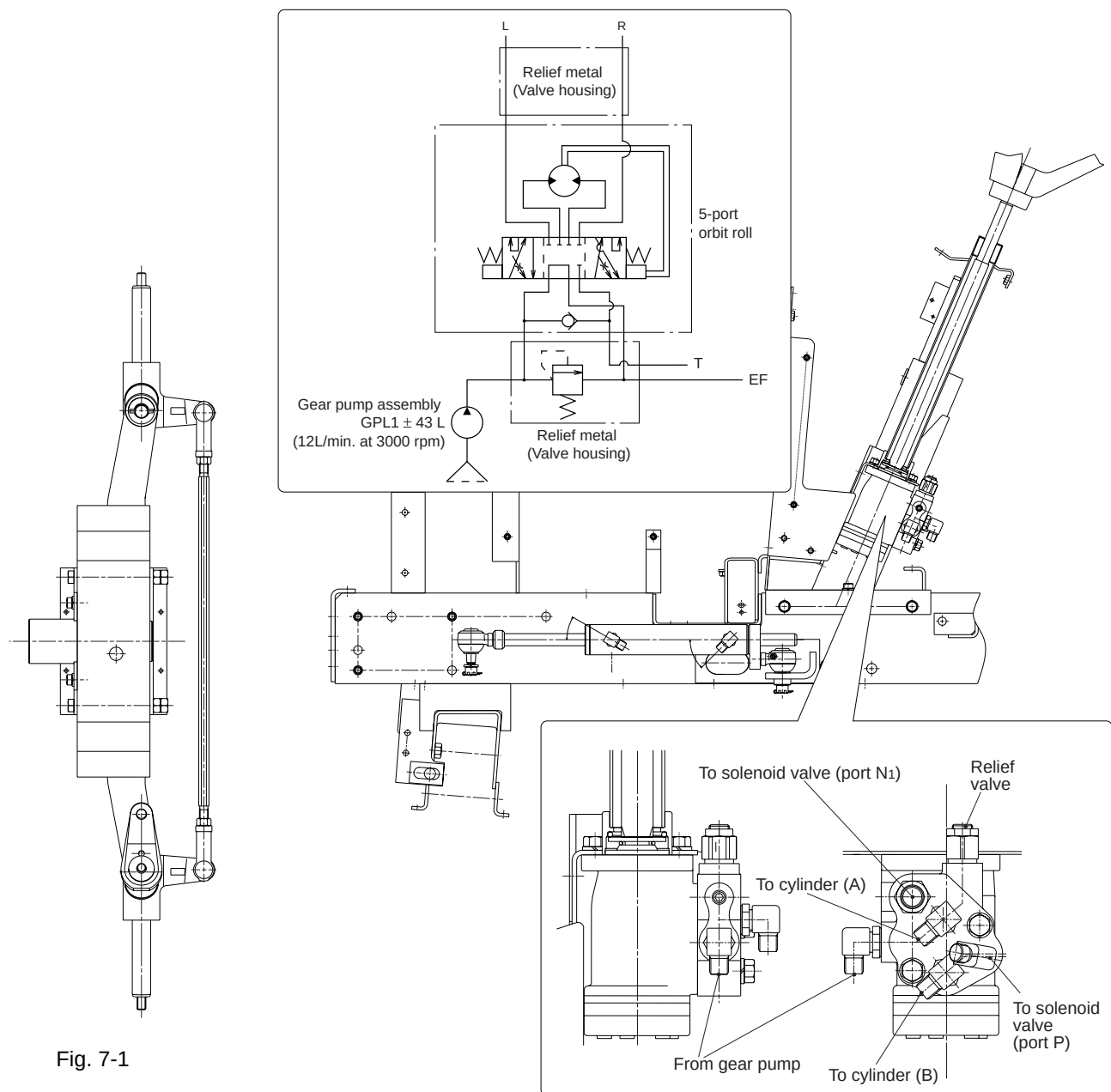


Fig. 7-1

CHAPTER 7. POWER STEERING SYSTEM

2. WORKING PRINCIPLE

The orbit roll has 5 ports as shown in Fig. 7-2. Port EF is connected to another actuator circuit.

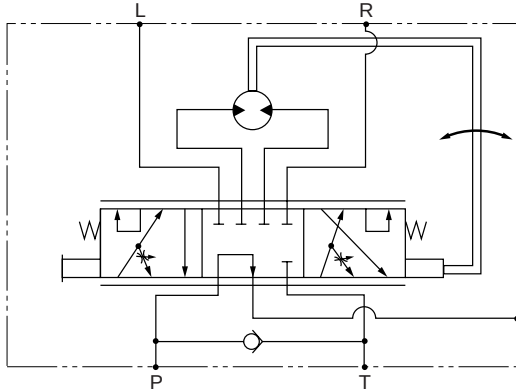


Fig. 7-2

2.1. When the steering wheel is in the neutral position:

Fig. 7-3 is the functional diagram when the mini-orbit roll is shifted in the neutral position. As the diagram shows all the ports except for port EF are blocked. All fluid from the pump goes via port EF to the circuit of another actuator.

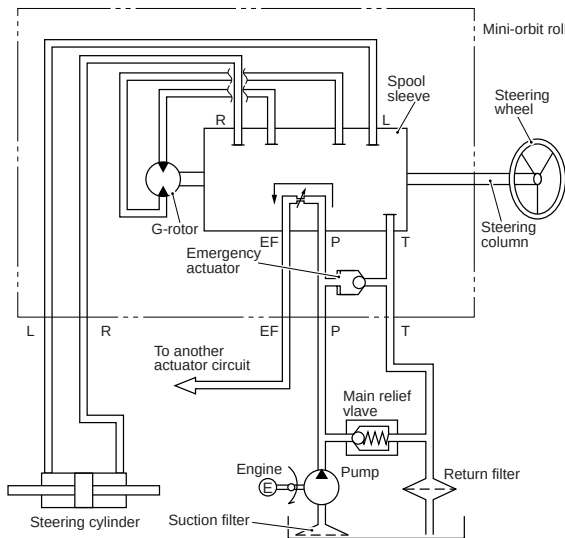


Fig. 7-3: when the steering wheel is in neutral

2.2. When the steering wheel is operated:

The working diagrams when the steering wheel is turned in either direction are shown in Fig. 7-4 and 5: Fig. 7-4 when the steering wheel is

turned to right; Fig. 7-5 when the wheel is turned to left. While the steering wheel is being turned, some fluid from the pump goes to a cylinder port: port R when turned to right; port L when turned to left and the other flows to port EF. The steering system has the priority to other hydraulic functions, the fluid used in the steering system returns via port T to the oil reservoir, and the rest goes to other actuators, which makes simultaneous hydraulic operation partially possible.

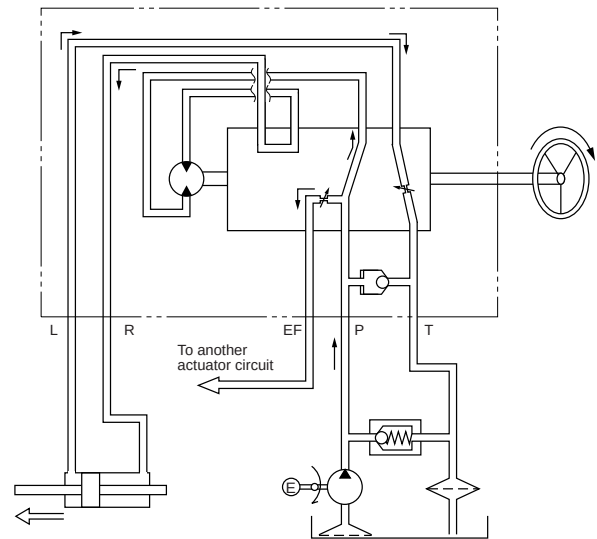


Fig. 7-4 (When the steering wheel is turned to right)

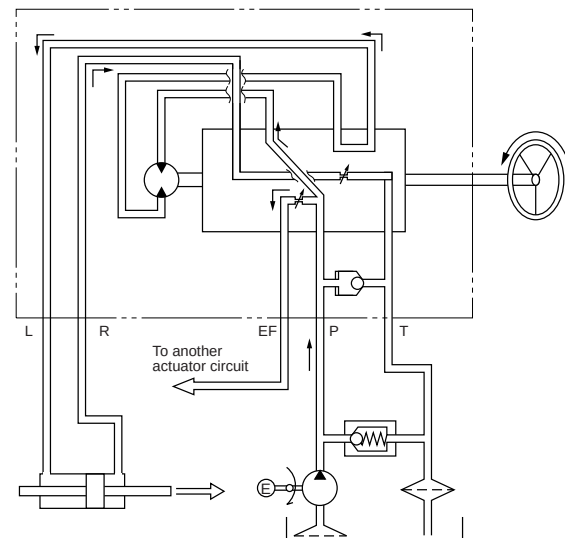
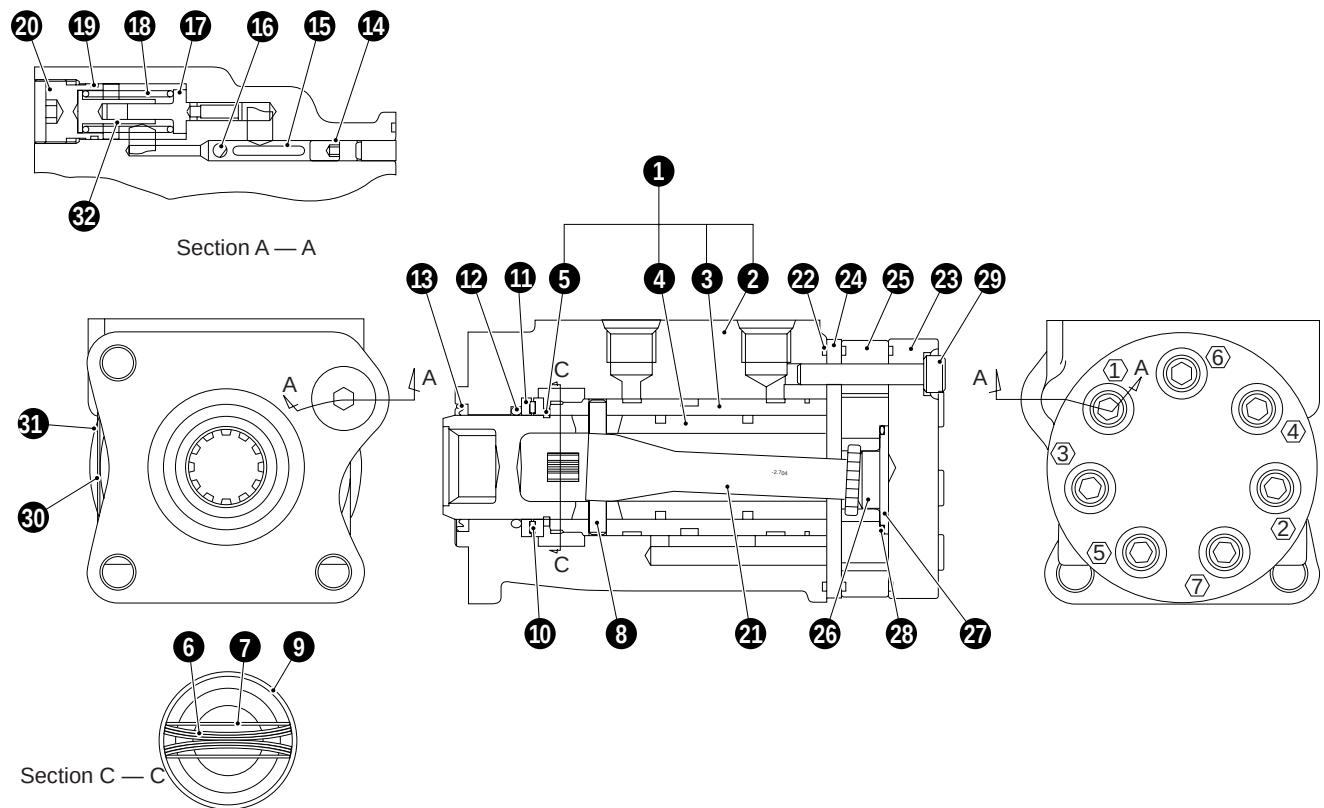


Fig. 7-5 (When the steering wheel is turned to left)

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3. SECTION OF MINI-ORBIT ROLL AND MAJOR COMPONENTS



PARTS LIST OF MINI-ORBIT ROLL

Ref.	Description	Q'ty	Remarks
1	Control valve assembly	1	
2	Housing	(1)	
3	Sleeve	(1)	
4	Spool	(1)	
5	Retaining ring	(1)	
6	Centring spring		6 or 4
7	Flat spring	2	
8	Pin	1	
9	Retaining ring spring	1	
10	Thrust needle bearing	1	
11	Bearing race	2	
12	Oil seal	1	*
13	Dust seal	1	*
14	Retainer screw		1Width across flats: 3.0 mm
15	Retainer pin	1	
16	Ball	1	ø5/32", steel ball
17	Relief poppet	1	
18	Spring	1	
19	O-ring	1	S14, Hs70
20	Relief adjusting plug	1	Width across flats: 6.0 mm
21	Drive	1	
22	O-ring	3	* AS568-037, Hs90

Ref.	Description	Q'ty	Remarks
23	End cap	1	
24	Spacer plate		1
25	G-rotor	1	
26	Spacer	1 or 0	
27	Plate	1	
28	O-ring	1	* AS568-022, Hs90
29	Cap screw	7	Hexagon width: 5.0 mm
30	Name plate	1	
31	Rivet	2	
32	Damper collar	1	
	Seal kit		Asterisked parts included

Required tools

- Torque wrench (Capacity: 2 kgf·m)
- 5.0 mm hexagonal set screw wrench
- 3.0 mm hexagonal set screw wrench
- 6.0 mm hexagonal set screw wrench
- Small blade end screw driver
- Tweezers
- A small amount of grease

Fig. 7-6

CHAPTER 7. POWER STEERING SYSTEM

4. DISASSEMBLY & REASSEMBLY

Disassemble or reassemble the mini-orbit roll referring to the parts list and the drawing in Fig. 7-6.

4.1. DISASSEMBLY

A clean place is essential for this operation. Before disconnecting the piping, clean the body of the mini-orbit roll. Clean all dust accumulated in the joints on the circumference with a wire brush.

(1) Hold the component in the vise with the end cap faced upward. Hold it lightly around the mounting flange via copper plates to refrain from damaging the housing.

(2) Remove seven cap screws (29).

(3) Remove end cap (23).

(4) Detach O-ring (22) from end cap (23).

(5) Remove plate (27) and O-ring (28) from the star rotor of G-rotor (25) and extract spacer (26).

Note: The spacer is not installed in the mini-orbit rolls of 31 cm³/rev and 51 cm³/rev.

(6) Detach G-rotor (25) taking care not to allow the star to fall from the outer ring of the G-rotor.

(7) Detach O-ring (22) from G-rotor (25).

(8) Remove drive (21).

(9) Remove spacer plate (24).

(10) Detach O-ring (22) from housing (2).

(11) Remove housing (2) from the vise and place the housing level axially on cloth so that the finished surfaces are not damaged.

After making pin (8) level by turning spool (4) and sleeve (3), extract the spool/sleeve assembly from the opposite side of the flange of housing (2) by pushing the spline of spool (4) .

Note: The spool/sleeve assembly is composed of sleeve (3), spool (4), pin (8), centring spring (6), thrust spring (7), and spring retaining ring (9). When extracting the assembly from housing (2), take care not to allow the sleeve to bite the bore wall of the housing.

(12) Extract spring retaining ring (9) and pin (8) from the spool/sleeve assembly.

(13) Push spool (4) a little forward from sleeve (4) and disengage centring springs (6) and flat springs (4) carefully by hand.

(14) Extract spool (4) from sleeve (3) by turning the spool slowly.

Note: Do not remove retaining ring (9) from spool (4).

(15) Detach two bearing races (11), thrust needle bearing (10), and oil seal (12) from housing (2).

(16) Pry off dust seal (13) from the flange of housing (2), taking care not to damage the housing.

(17) Take out retainer pin (15) and ball (16) by removing retainer screw (14) from the tapped hole shown by section A – A of the G-rotor side end of housing (2).

Disassembly of relief valve (only when a relief valve is installed)

(18) Place housing (2) with the flange face turned upward, remove relief adjusting plug (20) and O-ring (19).

Note: It is recommended to measure the depth from the flange end to relief adjusting plug (2) before disassembly for the convenience reassembly.

(19) Detach dumper collar (32) and spring (18).

(20) Take out poppet (17) from housing (2) using tweezers.

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4.2. REASSEMBLY

Inspect all disassembled parts for contact surfaces for flaws and burr. The parts which have such defects should be replaced with new ones because such defects will cause oil leaks. All metal parts should be washed in fresh solvent and dried by blowing. Never wipe them with cloth or paper because paper scrap or lint may stick on them, which also may cause troubles. Never try smoothing them with a file or coarse sand paper.

Note: Principally we recommend the use of new O-rings and seals when reassembling the mini-orbit roll. They should be coated with a small amount of fresh grease ahead of time.

Reassembly of relief valve (only when a relief valve is installed)

When reassembling a mini-orbit roll without a relief valve, start reassembling at step 5.

- (1) Hold the spring guide of poppet (17) with tweezers and insert it through the flange of the housing as shown in section A-A. Make sure that the poppet is installed properly.
- (2) Insert spring (18) and damper collar (32).
- (3) Fit O-ring (19) onto relief adjusting plug (20) and screw in the plug into housing (2) as shown in section A – A.
- (4) Adjust the pre-set pressure of the steering relief valve after the mini-orbit roll has been reassembled. When the valve is required to be set to the pre-disassembled pressure, re-set it to the same depth as it is before disassembly at disassembling step 18. The pressure shift by one turn of relief adjusting plus is about 15 kgf·cm².
- (5) Install ball (16) and retainer pin (15) in this order into the tapped hole in housing (2) as shown in section A – A. Then set retainer screw (13) and tighten it to 1.3 kgf·m with a 3.0 m hexagonal set screw wrench.
- (6) Insert dust seal (13) from the end of housing (2)

with the flat surface turned downward.

- (7) Installation of oil seal (12)
 - a. Install one bearing race (11) and sleeve (3) into the bore of housing (2).
 - b. The space formed by the installed bearing race and the housing provides a groove for oil seal (12).
 - c. Push the sleeve inward manually from the G-rotor side so that the centres of the sleeve and the bearing race is almost aligned.
 - d. While keeping the sleeve and bearing race aligned in centre, set oil seal (12) in the groove from the flange side of the housing.
 - e. After having installed the oil seal, remove the pre-installed sleeve and bearing race.
- (8) Place the housing with the flange turned downward and install bearing race (11), thrust needle bearing (10), and bearing race (11) in this order.
- (9) Insert sleeve (3) onto spool (4) and align the spring installation openings in the spool and sleeve. Then first insert two flat springs (7) and next insert all the centring springs to be installed into the openings at the same time while two halves of the centring springs are set as shown in the drawing: the two halves should be faced in opposite directions.
- (10) After inserting the springs, fit spring retaining ring (9) over the springs. Apply grease to the clearance between the sleeve and retaining ring. Insert pin (8) through the sleeve and spool. With this operation, the spool/sleeve assembly is completed.
- (11) Install the spool/sleeve assembly from the G-rotor side.

Note: When inserting the spool/sleeve assembly, take care not to allow it to slant and bite the housing. Insert it with the pin kept level while turning the assembly a little in both directions

CHAPTER 7. POWER STEERING SYSTEM

alternatively. Make the end of the spool/sleeve assembly and the end of the G-rotor side of the housing be flush. In this state, the assembly should turn smoothly.

- (12) Fit O-ring (22) into housing (2).
- (13) Put spacer plate (24) on the housing and align the bolt holes and oil holes in the housing and spacer plate.
- (14) Insert drive (21). Engage the yoke of the drive with pin (8).
- (15) Fit O-ring (22) to G-rotor (25), the O-ring groove side of the G-rotor ring to the spacer plate, and the counter sunk side of the G-rotor star and engage the spline of the drive with that of the star. Then align bolt holes and oil holes.
- (16) Insert spacer (26) into the splined part in the G-rotor star.
- (17) Fit O-ring (28) to plate (27) and install the assembly to the countersunk part in the G-rotor star.
- (18) Fit O-ring (22) to end cap (23) and put the assembly on the G-rotor and align the bolt holes.
- (19) Apply oil to the threads of cap screws (29) and install the screws into end cap (28). The seven screws should be tightened to 0.5 kgf·m first and then tighten them further to 1.0 kgf·m. Set the spool to the steering wheel and make sure that the spool should turn smoothly.

With this, reassembly operation is completed.

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5. MAJOR TROUBLES AND CAUSES, AND COUNTERMEASURES

When the system should suffer troubles, confront them in accordance with the countermeasures mentioned below. In such cases, analyse the trouble properly and check the whole hydraulic system besides the orbit-roll and control valves.

Troubles	Presumable causes	Countermeasures
Steering wheel is hard to turn.	1. Hydraulic system a. Too high back pressure b. Too low set pressure of steering relief valve c. Insufficient output	Correct pressure. Correct pressure. Check pump.
	2. Orbit-roll a. Off-set of steering column axis b. Seized orbit roll due to dust trapped between spool and sleeve or sleeve and housing. c. Excessive tightening torque of end cap bolts d. Mis-installed ball of check valve for emergent steering	Correct. (If steering wheel become easy to turn when the set bolts of the orbit roll are loosened, off-set of the axis is presumable.) Replace. Retighten bolts evenly to specified torque. Install ball.
	3. Directly connected valve and other control valves a. Too high tightening torque of port connectors b. Too high tightening torque of set bolts c. Dust trapped in relief valve d. Dust rapped between housing and spool e. Mal)functioning f. Clogged orifices g. Improper control spring	Correct. Correct. Disassemble, wash, and reset set-pressure or replace valve assembly with a new one. Replace valve assembly with a new one. Replace valve assembly with a new one. Disassemble, wash, and reassemble valve. Replace with a proper spring.
	4. Pump a. Not operating b. Worn out or out of order	Operate pump. Replace with a new one.

CHAPTER 7. POWER STEERING SYSTEM

Troubles	Presumable causes	Countermeasures
	5. Chassis a. Excessively worn mechanical parts	Lubricate joints or replace defective ones with new ones.
Steering wheel does not return to neutral position when releasing it.	1. Hydraulic system a. Excessively high back pressure	Correct.
	2. Orbit-roll a. Seized orbit-roll due to dust trapped between spool and sleeve b. Off-set of steering column axis c. Broken centring springs	Replace orbit-roll with a new one. Correct. Replace with new ones.
Cylinder is not fast in responding or does not respond to turning of steering wheel and wheels slip excessively.	1. Hydraulic system a. Trapped air b. Insufficient pump delivery	Bleed air out of system. Check pump.
	2. Orbit-roll a. Worn internal parts b. Too low tightening torque of end cap screws c. Mis-installed drive or spacer.	Replace with new ones and re-set pressure. Correct tightening torque. Reinstall them properly.
	3. Directly connected valve or other elated valves a. Dust trapped in over load relief valve b. Damaged O-rings	Disassemble, wash, reassemble, and rest pressure or replace defective valve assemblies with new ones. Replace with new ones.
	4. Pump a. Poor efficiency	Replace with a new one.
	5. Cylinder a. Broken piston seal	Replace with a new one.
Steering wheel is turned in opposite direction against will.	1. Hydraulic system Incorrect piping to four ports	Check and correct.
	2. Orbit-roll a. Improperly assembled timing valve	Reassemble correctly.

SERVICE MANUAL FOR SGR19 & SGR17

Troubles	Presumable causes	Countermeasures
Abnormal vibration is observed.	1. Hydraulic system Trapped air	Bleed system of air.
	2. Chassis Worn joints	Replace with new ones.
Abnormal noises (abnormal relief noise included)	1. Hydraulic system a. A specific hydraulic apparatus generates noises. b. Hydraulic pipes interfere with each other.	Consult with manufacturer of such apparatus. Eliminate interference.
	2. Directly connected valve or other related valves a. Dust trapped in steering relief valve or overloadrelief valve, or abnormally worn valves	Disassemble, wash, re-assemble, reset pre-setpressure, or replace defective valve assemblies with new ones.
Oil leakage	1. Orbit-roll – Worn or damaged oil seal of axle (spool) a. Contaminated fluid b. High back pressure c. Rusted spool or sealing surfaces – Damaged O-rings of contact surfaces e. Bitten O-rings when orbit-roll is overhauled f. Too low tightening torque of end cap screws	Replace fluid and filter element with new. Lower back pressure lower than specified level. Replace orbit-roll with a new one. Replace damaged O-rings with new ones. Correct tightening torque.
	2. Directly connected valve or other elated valves a. Loosened bolts tightening valve directly to orbit-roll b. Damaged O-rings c. Damaged sealing surfaces and grooves	Re-tighten bolts to specified torque. Replace with new ones. Replace damaged parts or assemblies.

Although various trouble causes are listed above, almost all troubles reported in the market are caused by dust trapped in the system. Therefore take sufficient care to avoid dust when servicing the hydraulic system.

CHAPTER 8. MANUAL STEERING SYSTEM

1. CONSTRUCTION

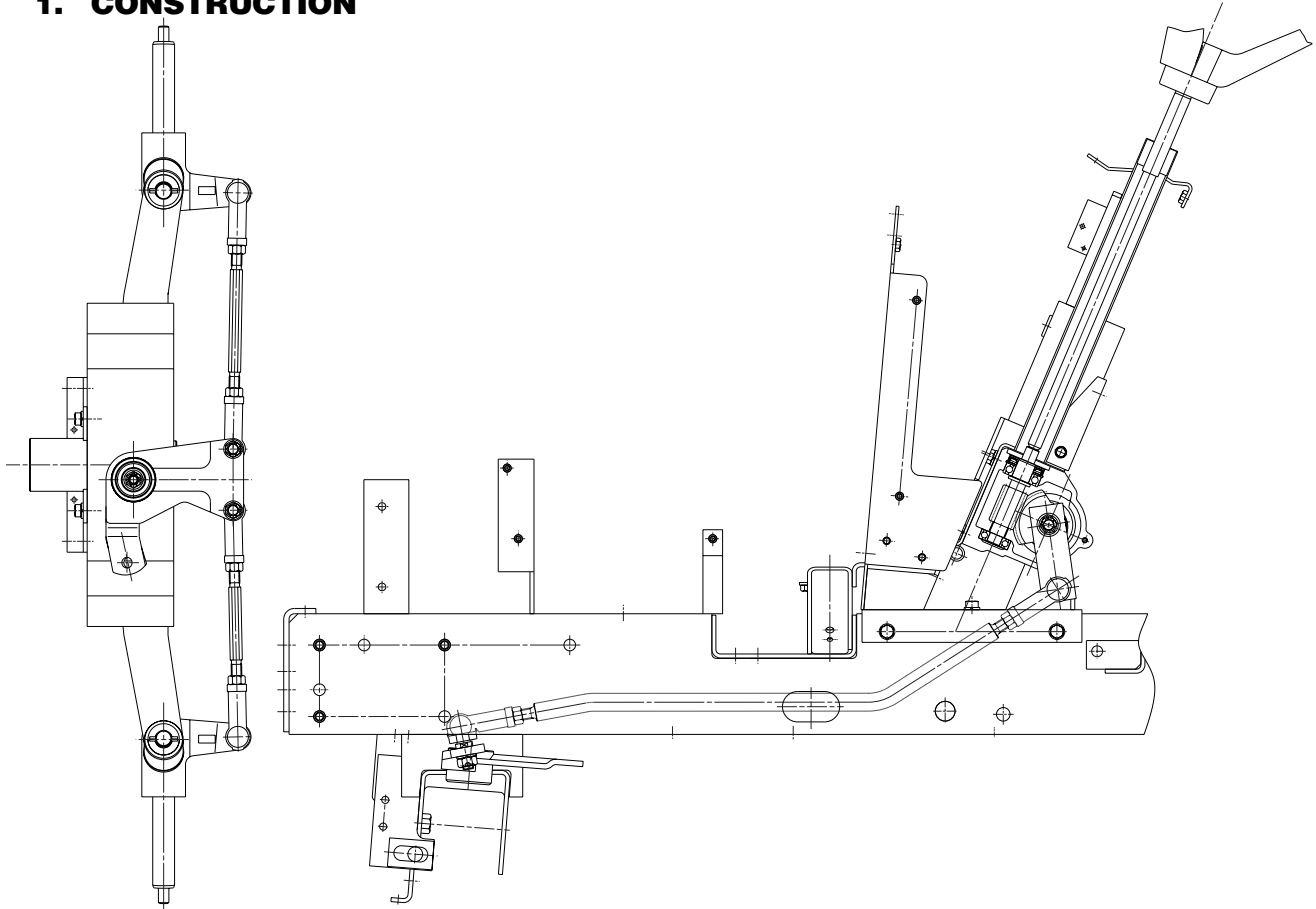


Fig. 8-1

2. GEAR BOX

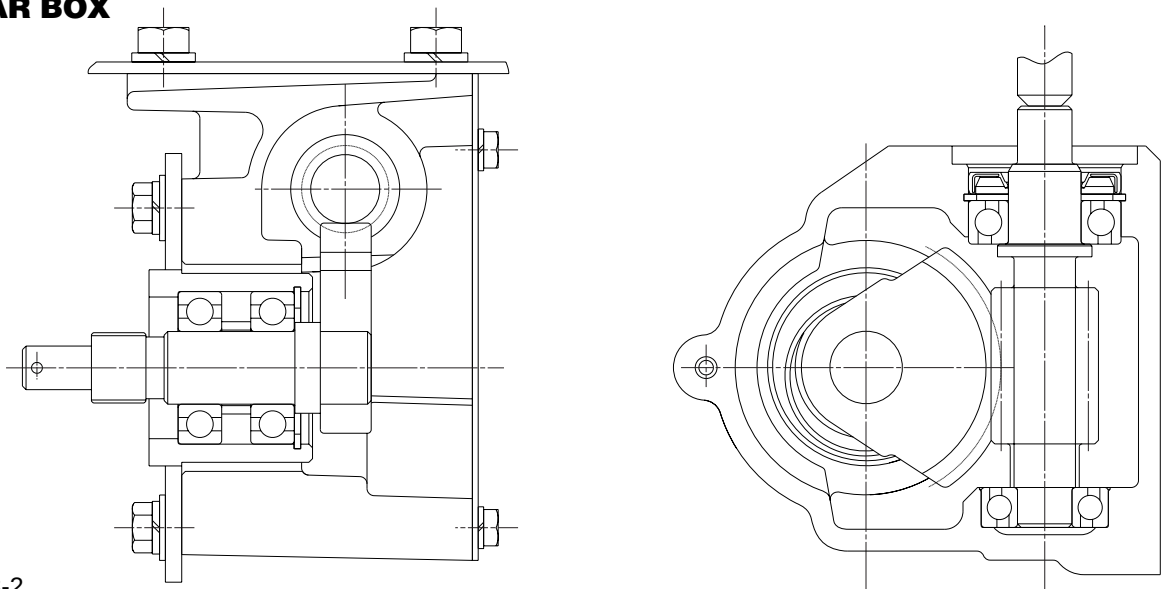


Fig. 8-2

SERVICE MANUAL FOR SGR19 & SGR17

3. DISASSEMBLY

3.1. REMOVAL OF THE STEERING GEAR BOX ASSEMBLY

- Remove the drag rod from the drag arm.
- Remove the steering wheel cap and remove the steering wheel.
- Remove the bolts which tighten the steering gear box between the radiator and the steering post, and remove the steering gear box downwards along with the steering shaft.

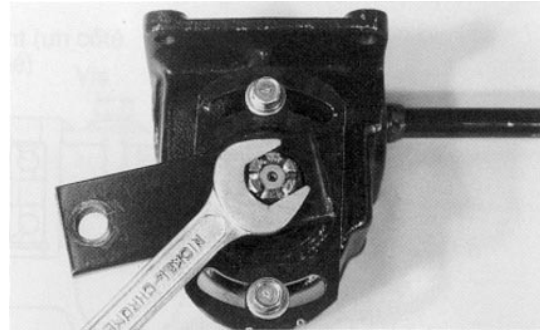


Fig. 8-3

3.2. DISASSEMBLY OF THE STEERING GEAR BOX

- a. Remove the drag arm tightening nut.
 - b. Remove the side plate from the gear box.
 - c. Remove the gear and flange.
 - d. Remove the steering shaft.
- Remove the seal and snap ring, then pull out the steering shaft.

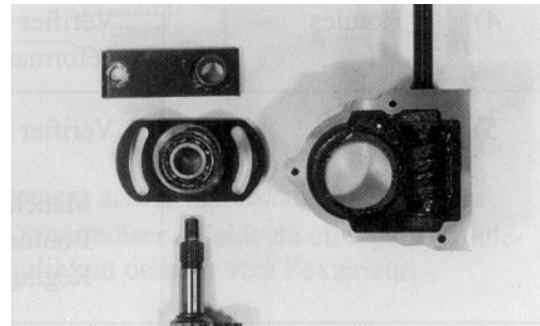


Fig. 8-4

Note:

Remove the angular roller bearing of the steering shaft carefully so as not to impose excessive force in order to avoid the outer race coming off.

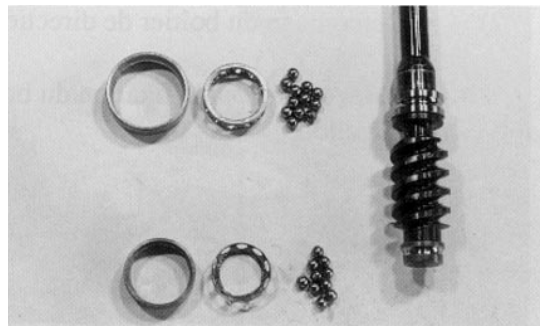


Fig. 8-5

3.3. INSPECTION

1) Bearings	Check for not smooth turning, wear, and play.	Replace defective ones.
2) Gears	Check for wear and damage.	Replace defective ones.
3) Rods and arms	Check for deformation and damage.	Repair or replace defective ones.
4) Steering wheel	Check for improper free play. • Worn bushing • Loose bolts and nuts. • Improper adjustment	Replace. Retighten. Correct.

CHAPTER 9. ELECTRICAL ACCESSORIES

3.4. REINSTALLATION AND ADJUSTMENT

Reassembly of the steering gear box

- Install the control flange (for gear backlash adjustment) offset downwards as illustrated. Install two RBB's and retain them with the snap ring. The outside RBB has a seal on one side only. Install it with the seal turned outward.
- As for the angular roller bearings for the steering shaft, bearing (A) should be installed so that it can support downward thrust. Insert the steering shaft. Install bearing (B) on the steering shaft. Push the bearing to the case

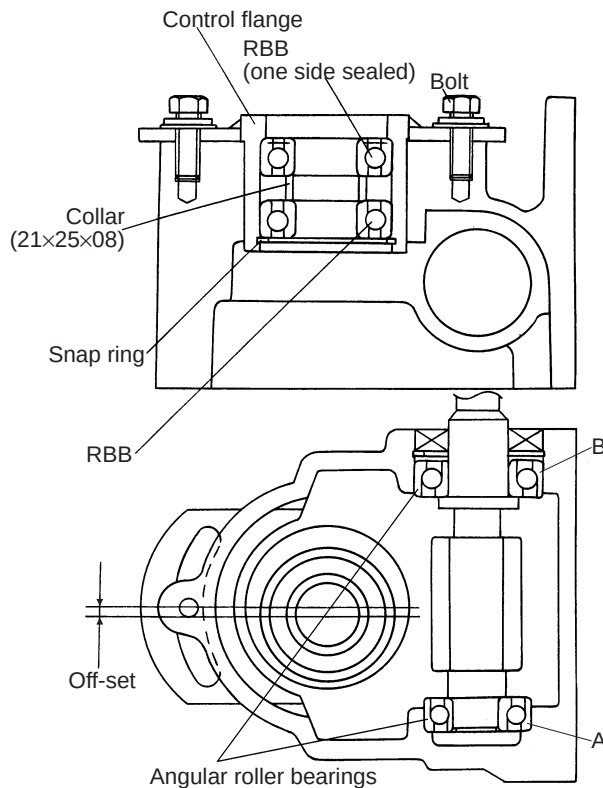


Fig. 8-6

- Install the drag arm on the helical gear shaft by aligning by aligning mutual splines so that the drag arm's centre axis becomes aligned with the axis of the cotter pin hole in the shaft as illustrated.

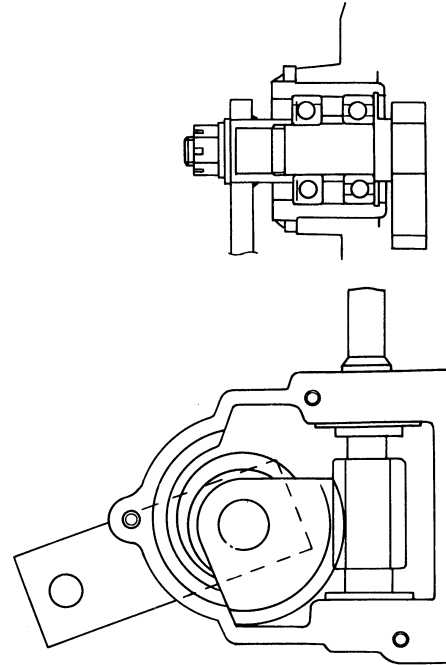


Fig. 8-7

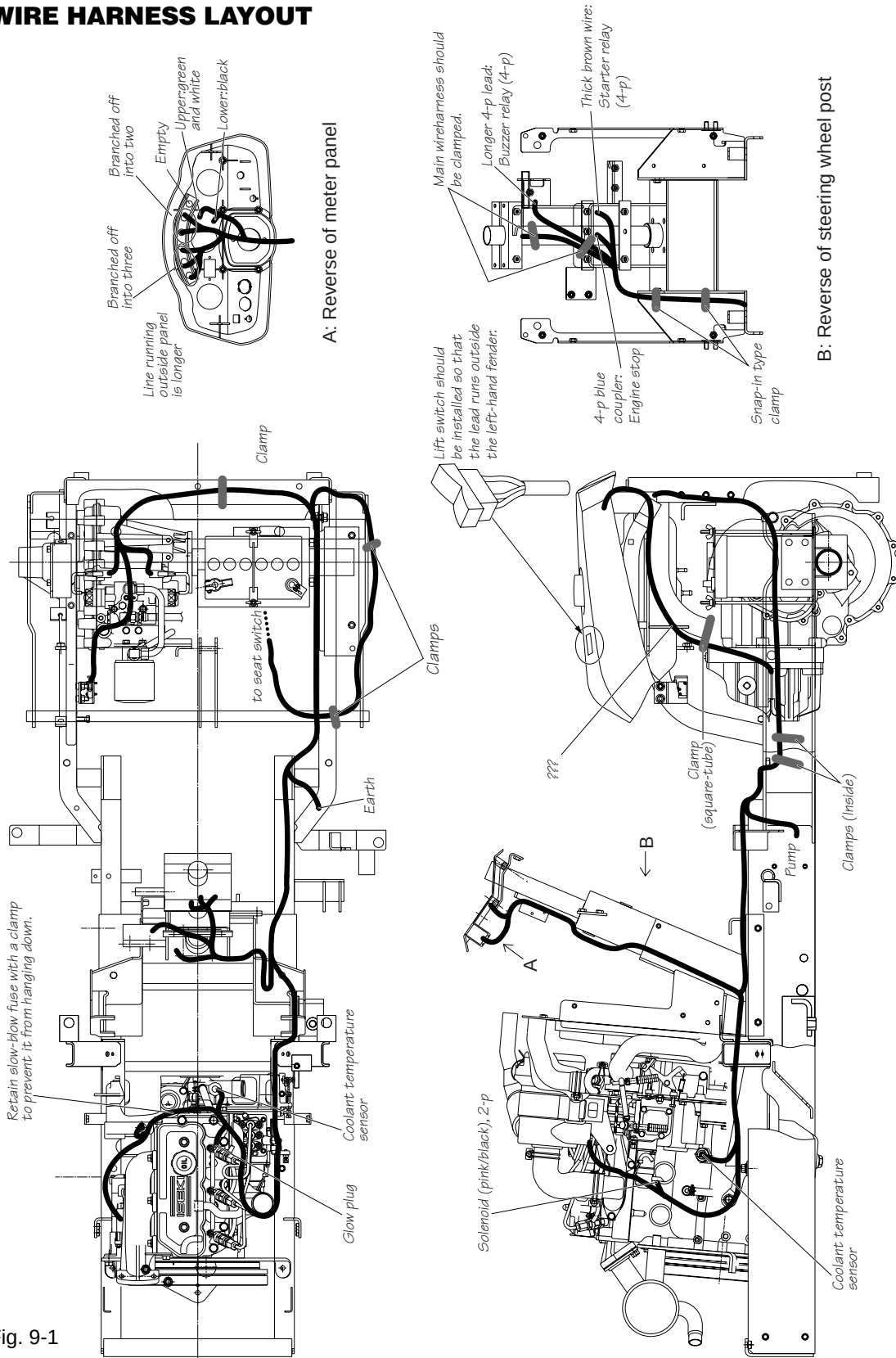
Gear backlash

Loosen the control flange tightening bolts and turn the flange clockwise to increase and counterclockwise to decrease backlash.

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CHAPTER 9. ELECTRICAL ACCESSORIES

1. WIRE HARNESS LAYOUT



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CHAPTER 9. ELECTRICAL ACCESSORIES

4. LIMITTER SWITCH FOR TRUNNION ARM

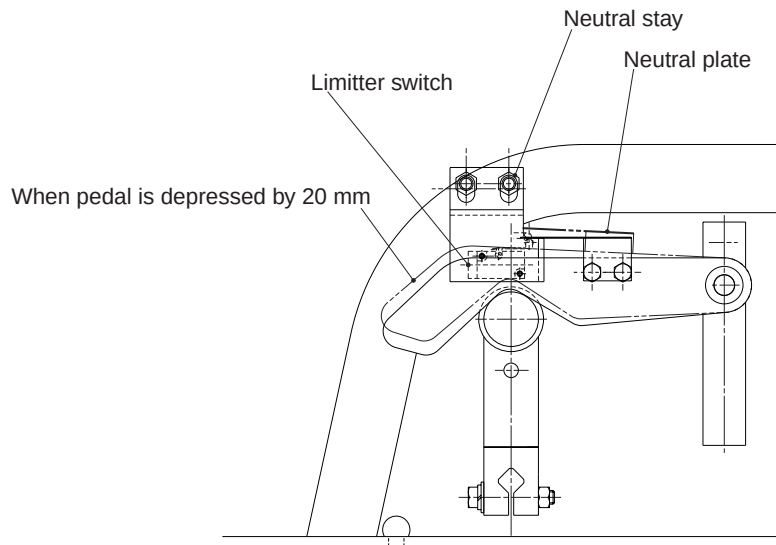


Fig. 9-4

5. STARTER

5.1. CONSTRUCTION

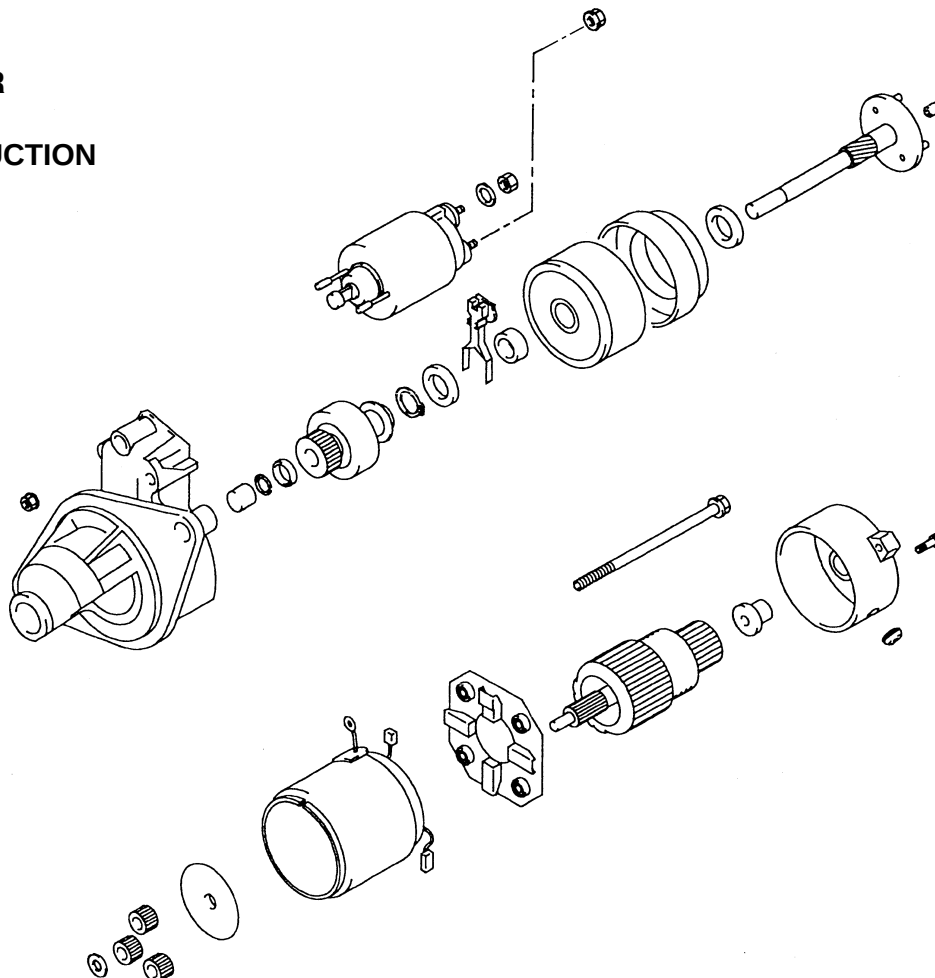


Fig. 9-5

SERVICE MANUAL FOR SGR19 & SGR17

5.2. REMOVAL AND DISASSEMBLY OF STARTER

REMOVAL OF STARTER

- 1) Remove the negative (-) battery cable.
- 2) Remove the starter wiring.
 - Disconnect the wire harness from terminal 30 by removing the nut.
 - Remove the connector from terminal 50.
 - Remove the starter from the engine.

DISASSEMBLY OF STARTER

- 1) Removal of the lead from terminal C.

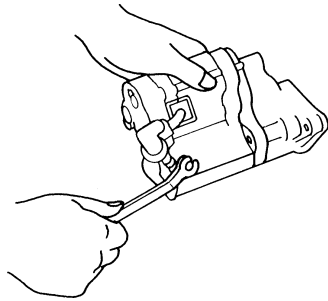


Fig. 9-6

- 2) Removal of the starter yoke/armature assembly
 - Remove the starter yoke/armature assembly and O-ring by removing the two through bolts.
 - Remove the commutator end frame and an O-ring.

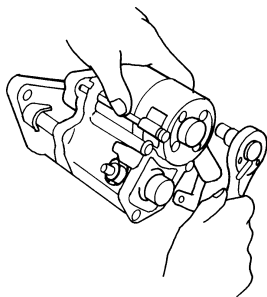


Fig. 9-7

- 3) Removal of the starter housing
 - Disconnect the starter housing from the magnetic switch.
 - Remove the drive pinion.
 - Remove the idle gear and retainer with roller.

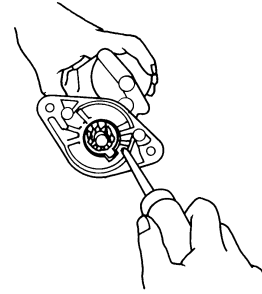


Fig. 9-8

- 4) Removal of the clutch assembly.
 - Remove the clutch assembly from the magnet switch.
- 5) Removal of the steel ball and spring

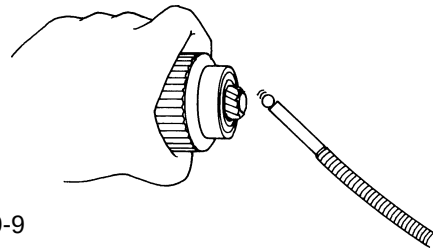


Fig. 9-9

- 6) Removal of the brush holder
 - Lift up the brush spring and take out the brush.

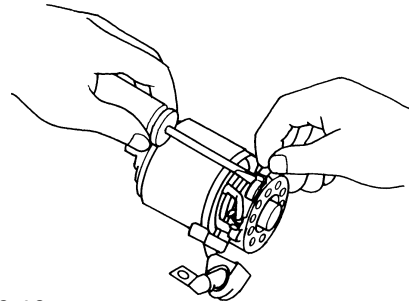


Fig. 9-10

- 7) Removal of the armature
 - Disconnect the brush holder from the starter yoke.
- 7) Removal of the armature
 - Remove the armature from the starter yoke.

5.3. INSPECTION OF COMPONENTS

- 1) Inspection of the armature coil grounding
 - Check continuity across the commutator and an

CHAPTER 9. ELECTRICAL ACCESSORIES

armature coil core. If there is no continuity, the armature coil is normal.

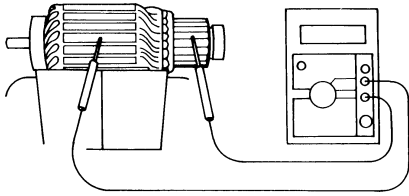


Fig. 9-11

2) Inspection of armature coil for short circuit

- Turn the armature coil on a armature coil tester while holding a piece of iron closely above the armature. If the iron piece does not vibrate nor is attracted to the armature, the armature is normal.

Note: The armature coil surfaces should be cleaned ahead of time.

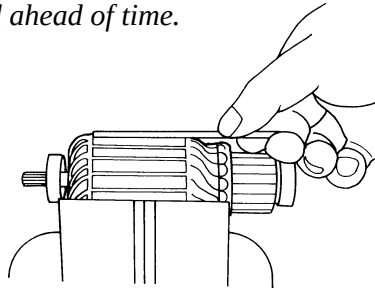


Fig. 9-12

3) Inspection of the commutator

- Inspect the commutator surfaces for dirt, burning, damage, etc. Minor damage can be corrected with sandpaper of #400 or higher no.
- Inspect the commutator for run-out with a dial gauge on a V-block.

Standard value	Usable limit
0.02 mm	0.05 mm

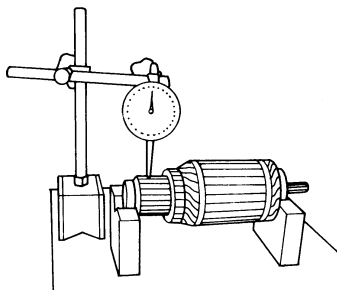


Fig. 9-13

- Measure the commutator diameter with vernier calipers.

Standard value	Usable limit
30 mm	29 mm

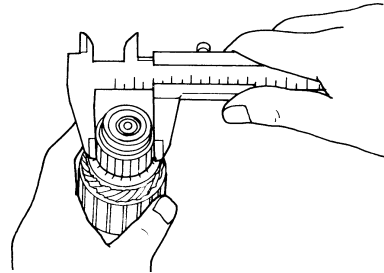


Fig. 9-14

- Measure mica depth against segment top.

Standard value	Usable limit
0.5 - 0.8 mm	0.2 mm

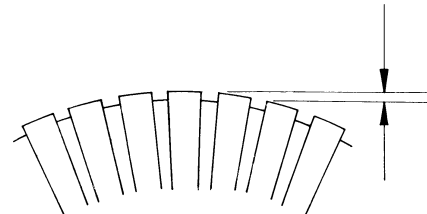


Fig. 9-15

4) Inspection of field coils for short circuit

- Inspect for continuity across the lead from terminal C and field coil brush. If there is continuity, the coils are normal.

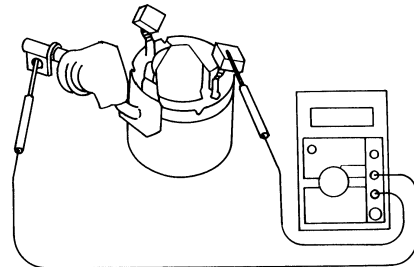


Fig. 9-16

5) Inspection of field coils for grounding

- Inspect continuity across the field coil brush and field coil. If there is no continuity, the coils are normal.

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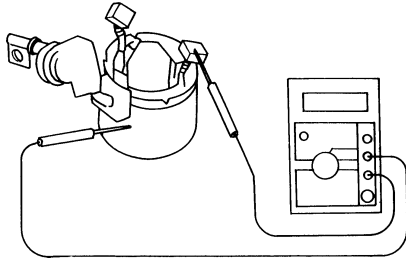


Fig. 9-17

6) Inspection of the brushes

- Measure brush length in the middle.

Standard value	Usable limit
15.0 mm	10.0 mm

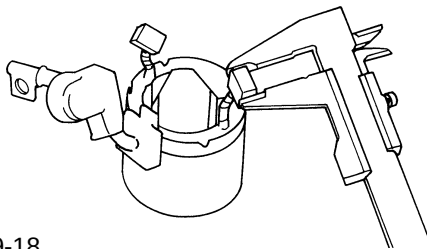


Fig. 9-18

- Correct the contact surfaces of the brushes on the sandpaper wrapped around the commutator.

7) Inspection of brush spring tension

- Measure spring tension with a spring balance and read the balance at the moment when the spring is about to leave the brush.

Standard value	Usable limit
1785 - 2415 gr	1200 gr

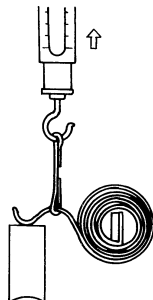


Fig. 9-19

8) Inspection of the brush holder

- Inspect for insulation across positive (+) side and negative (-) side of the brush holder. If there is no continuity, the brush holder is normal.

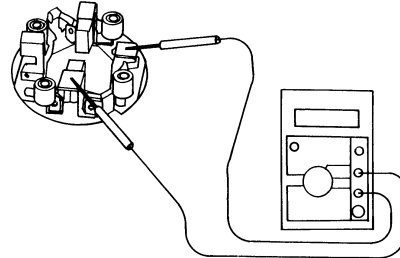


Fig. 9-20

9) Inspection of the clutch

- Inspect the gear for wear and damage.
- Make sure that the gear locks when turned in diving direction and turns smoothly in the reverse direction.

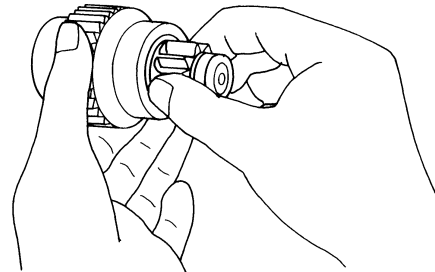


Fig. 9-21

- There should be no hitching when the bearing is turned manually by applying some force to it with fingers.
- It should not make abnormal noises when turned abruptly.

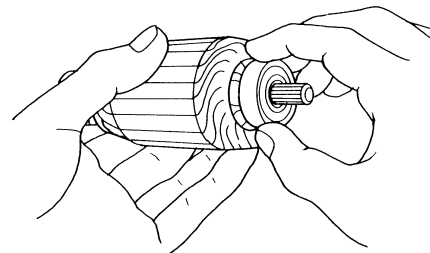


Fig. 9-22

11) Replacement of the bearing

- Remove the bearing or install it as illustrated.

CHAPTER 9. ELECTRICAL ACCESSORIES

5.4. REASSEMBLY OF STARTER

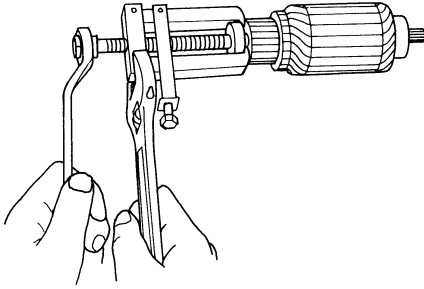


Fig. 9-23

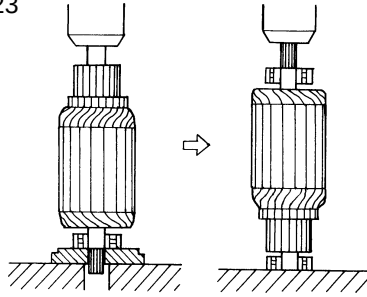


Fig. 9-24

12) Inspection of the magnetic switch

- Inspect for continuity across terminal 50 and terminal C. If there is continuity, the switch is normal.

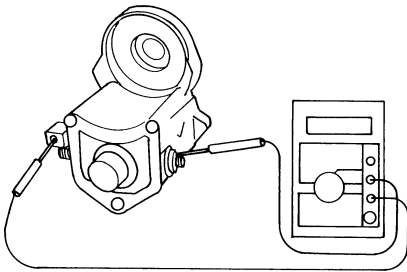


Fig. 9-25

- Inspect for continuity across terminal 50 and magnetic switch body. If there is continuity, the switch is normal.

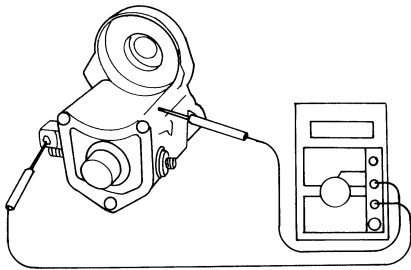


Fig. 9-26

1) Installation of the armature

- Apply grease to the armature bearing and then install the armature on the starter yoke.

2) Installation of the brushes and brush holder

- Lift up and hold the spring and install the brush.

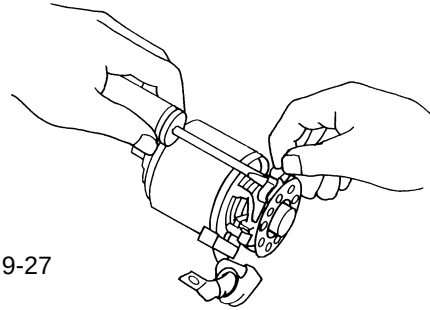


Fig. 9-27

- Install the commutator end frame using an O-ring.

3) Installation of the starter yoke/armature

- Install the starter yoke on the magnetic switch using an O-ring.

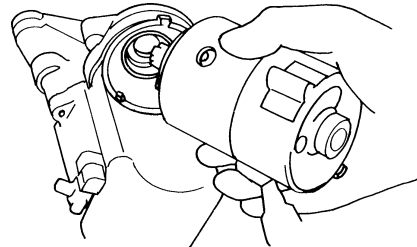


Fig. 9-28

4) Installation of the steel ball and spring

- Apply grease to the ball ahead of time and install the ball and spring.

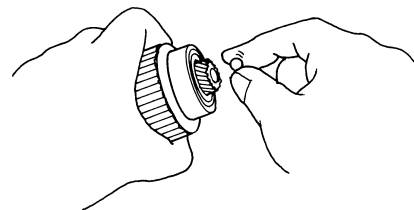


Fig. 9-29

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5) Installation of the gear and clutch

- Install the clutch assembly on the starter housing.
- Apply grease to the roller/retainer assembly and idle gear and then install.
- Install the drive pinion on the armature shaft.
- Apply grease to each gear.

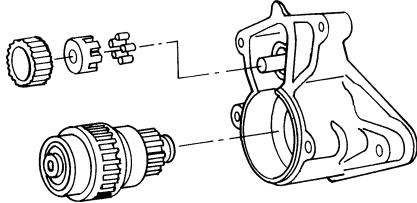


Fig. 9-30

6) Installation of the starter housing

- Install the starter housing on the magnetic switch.
- Install the two through bolts.

7) Connection of the lead of terminal C

5.5. INSPECTION OF THE STARTER AFTER REMOVAL FROM THE TRACTOR

Note:

Each step should be performed within three to five seconds to prevent damage.

1) Pull-in test

- Make sure the pinion is pushed out when the starter is connected as illustrated.

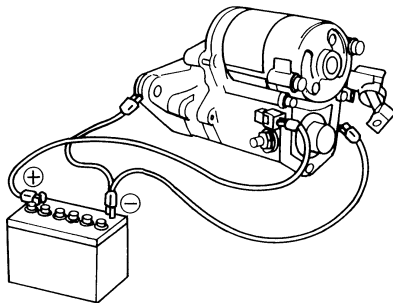


Fig. 9-31

2) Coil holding test

- In the state of the pull-in test, the gear should remain pushed out when the lead is disconnected from terminal C.

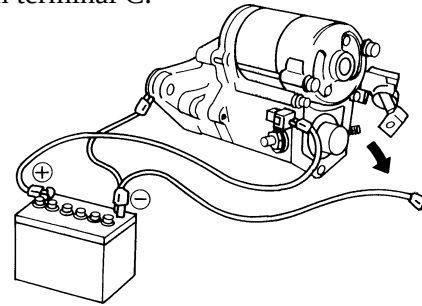


Fig. 9-32

3) Plunger-return test

- In the state of the coil holding test, the pinion should retract when the connection is removed as illustrated.

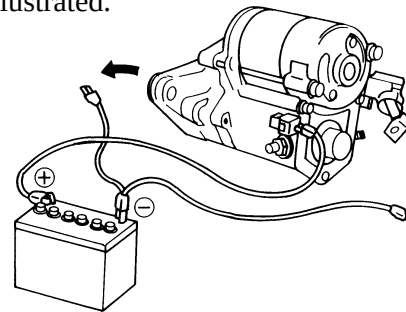


Fig. 9-33

5.6. PERFORMANCE TEST

Note:

- Hold the starter securely in a vise.
- In unloaded test use thick wires because of high current.

1) Unloaded test

Drive the starter independently with a specified battery without any load and check for spinning speed, voltage, and current. Values should be as shown below:

Voltage	11.5 V
Current	90A or less
Speed	3000 rpm or more

CHAPTER 9. ELECTRICAL ACCESSORIES

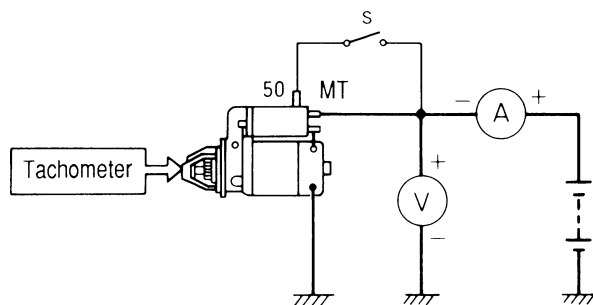


Fig. 9-34

2) Braking test

Install the starter on a test bench and apply brake. Measure each value while the starter is thus prevented from spinning. Each value should be as shown below:

Voltage	8.0 V
Current	230A or less at 1180 rpm or over
Torque	0.65 kgf·m or over

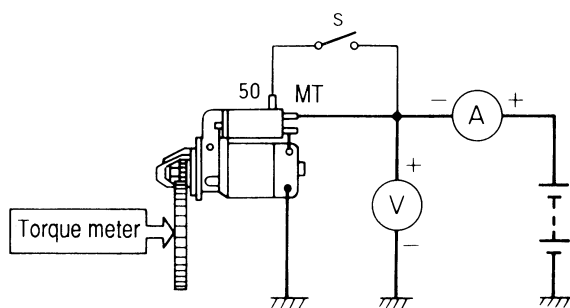


Fig. 9-35

5.7. INSTALLATION OF THE STARTER

1) Connect the wiring.

- Connect the lead to terminal 30 and tighten it with the nut.
- Install the connector on terminal 50.

2) Install the starter on the engine.

3) Connect the negative (-) battery cable.

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6. ALTERNATOR

6.1. EXPLODED VIEW, SPECIFICATIONS, AND PERFORMANCE CURVES

- Exploded view

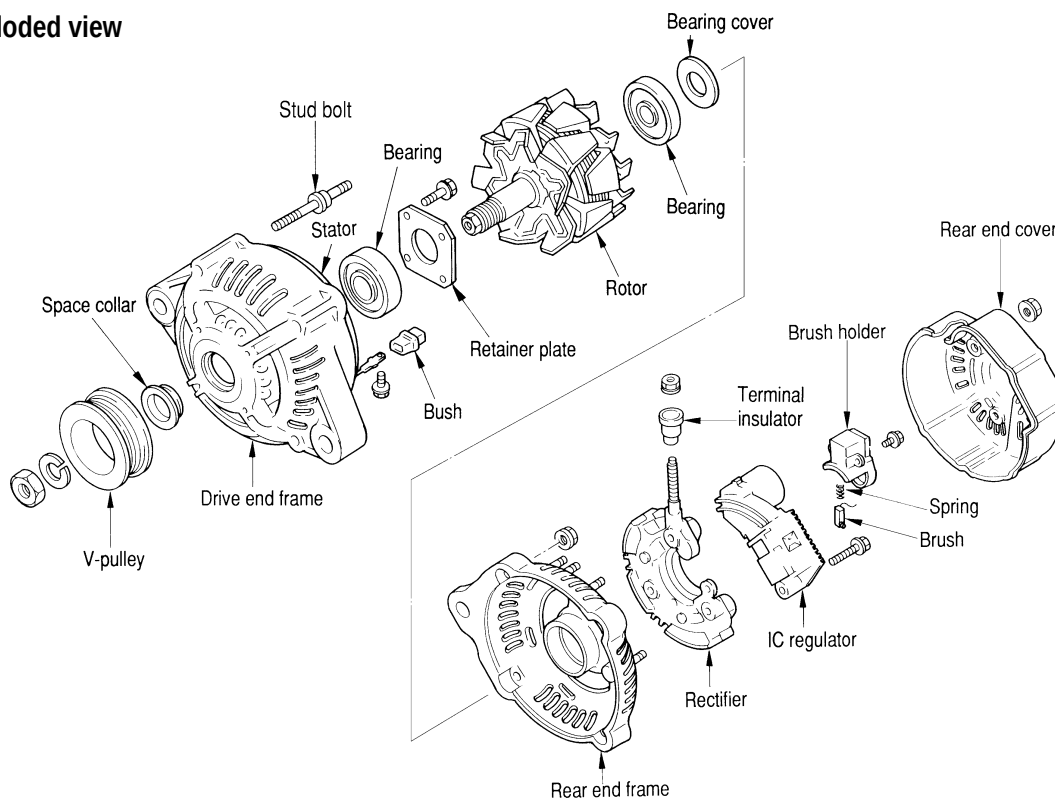


Fig. 9-36

- Specifications

Nominal voltage	12V
Nominal output	40A
Rated speed	5000 rpm
Starting speed	1350 rpm
Allowable maximum speed	15000 rpm
Allowable surrounding temperatures	- 30 – + 90°C
Direction of rotation	Clockwise (as viewed from pulley)
Polarity	Negative earthing
Regulated voltage	14.2 – 14.8V

- Output performance curves

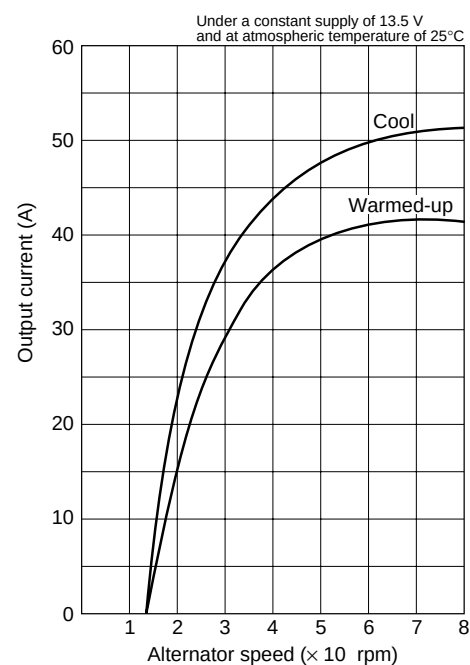
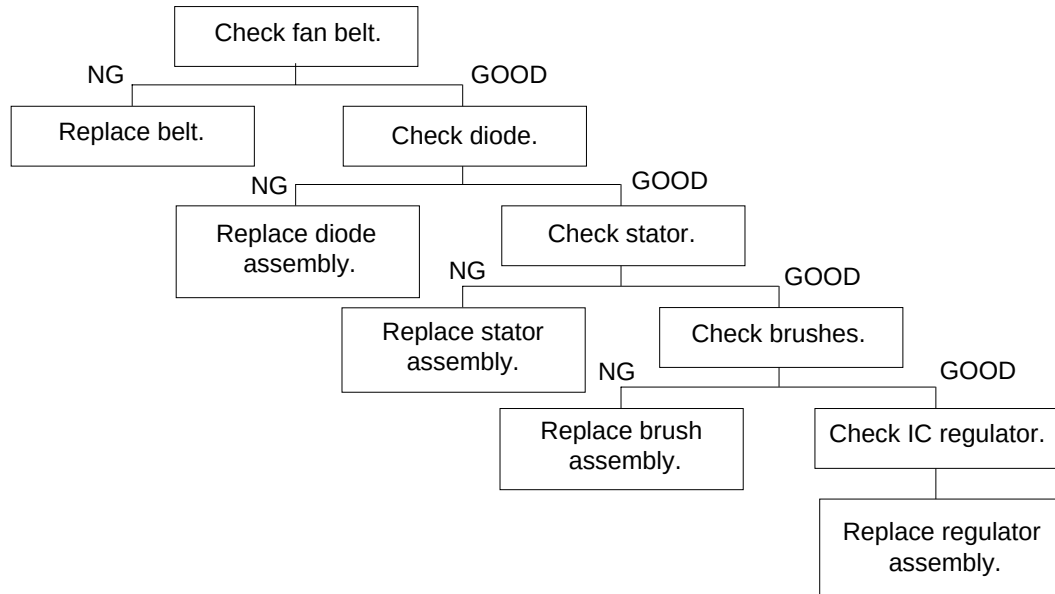


Fig. 9-37

CHAPTER 9. ELECTRICAL ACCESSORIES

6.2. TROUBLESHOOTING



6.3. REMOVAL AND DISASSEMBLY

REMOVAL

- Remove battery wiring.
- Remove the fan and fan belt.
- Remove the tightening bolts and remove the generator.

DISASSEMBLY

a. Removal of the pulley

Hold the hexagonal part of the shaft with a socket wrench and remove the pulley nut with an open end wrench.

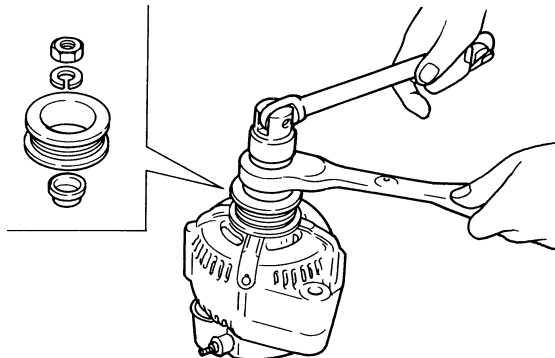


Fig. 9-38

b. Removal of the rear end cover

Remove the three rear end cover tightening bolts and nut for terminal B. Then the rear cover is removed.

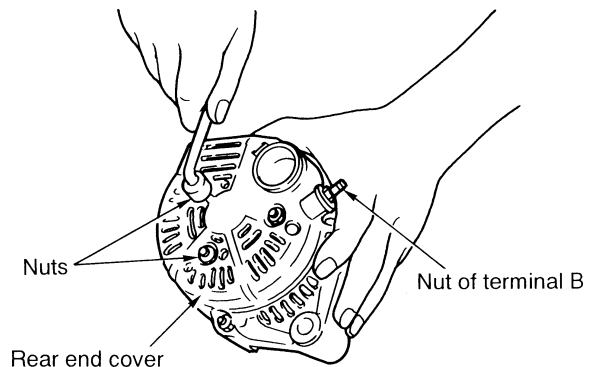


Fig. 9-39

c. Removal of the brush holder

Remove the two screws which tighten the brush holder and rectifier. Then the brush is removed.

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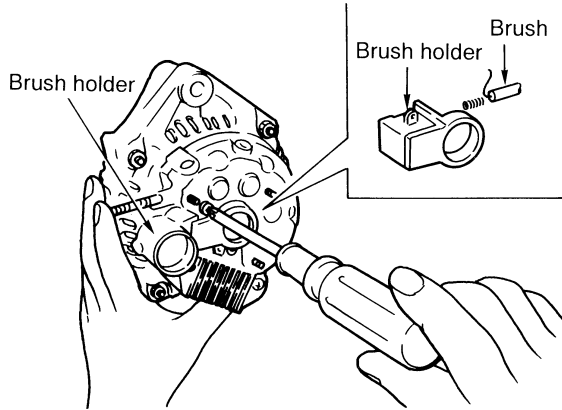


Fig. 9-40

d. Removal of the IC regulator

Remove the three screws which tighten the IC regulator. Then the regulator is removed.

Note:

As screws of different length are used for respective terminals, they should be set aside in order for later reference after disassembly. A wrongly used screw may come into contact with the end frame and cause the regulator out of control, which will lead to battery overcharging and result in serious damage in the end.

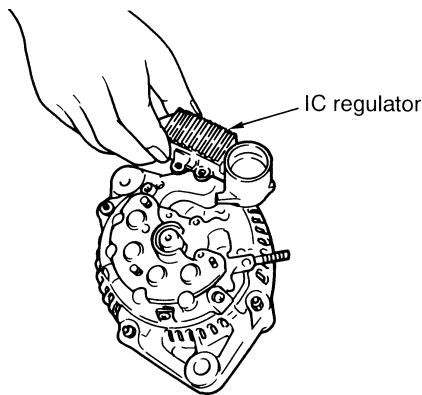


Fig. 9-41

e. Removal of the rectifier

Remove the four screws which tighten the leads for the rectifier and stator. Then the rectifier is removed.

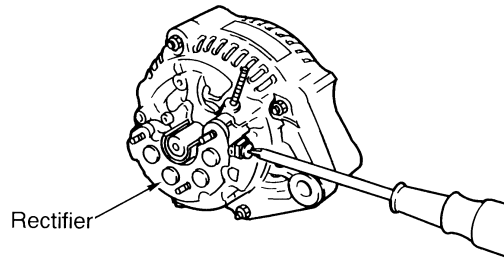


Fig. 9-42

f. Removal of the brushes

Remove the four nuts and bushes which tighten the drive end frame and rear end frame. Then the brush assembly is removed.

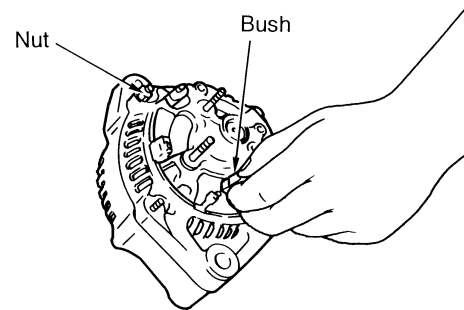


Fig. 9-43

Note:

When removing the bushes, take care not to stretch the wire from the stator.

g. Removal of the rear end frame

Remove the rear end frame using a puller as illustrated.

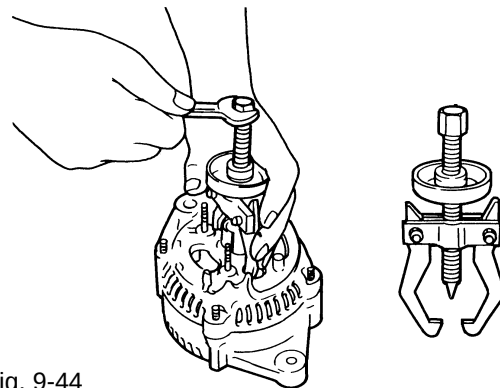


Fig. 9-44

h. Place the drive end frame on blocks as illustrated to make it level and push out the rotor on a press.

CHAPTER 9. ELECTRICAL ACCESSORIES

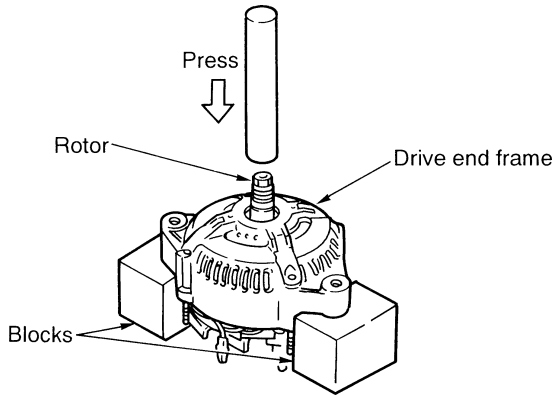


Fig. 9-45

Note:

Take care not to allow the rotor to fall to avoid damaging the slip ring and fan.

i. Removal of the retainer plate

Remove the four screws which tighten the retainer plate. Then the plate is removed.

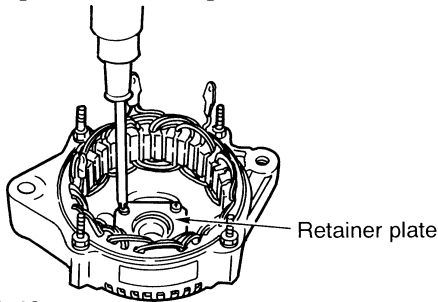


Fig. 9-46

j. Removal of the bearing which is installed on the drive end side

Place the drive end frame level on blocks as illustrated and put a jig on the bearing. Then push out the bearing on a press.

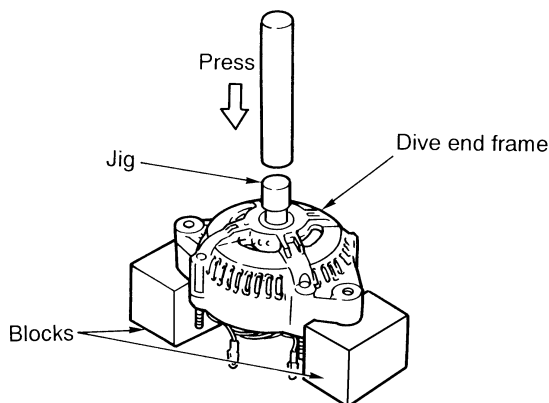


Fig. 9-47

Note:

The bearing is a high speed type, so be sure to use a specified one by ISEKI when replacing. Never give it shock.

k. Removal of the bearing which is installed on the slip ring side

Remove the bearing using a puller as illustrated.

Hold the rotor softly in a vise taking care not to damage it.

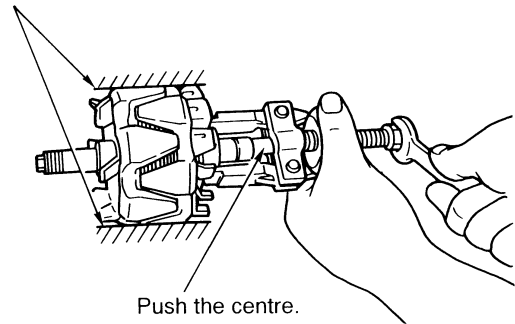


Fig. 9-48

6.4. INSPECTION

a. Inspection of the rotor slip rings

Measure the outer diameter of the rings. If the measured value exceeds the usable limit, replace with a new one.

Standard value	Usable limit
14.4 mm	14.0 mm

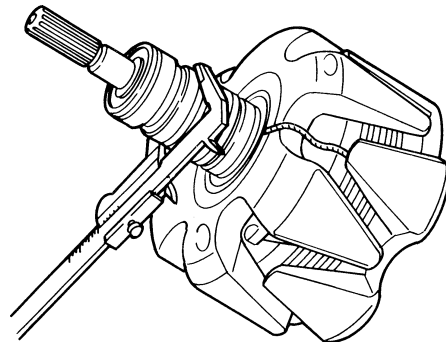


Fig. 9-49

- Make sure that the slip ring surface is smooth, clean, and free from oil. If the surface is roughened, polish with a fine sand paper (#500 – #600).

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If it is smeared with oil, clean with alcohol-soaked cloth.

b. Continuity test of the rotor coil

Check for continuity across the slip rings. If there is no continuity, replace the rotor.

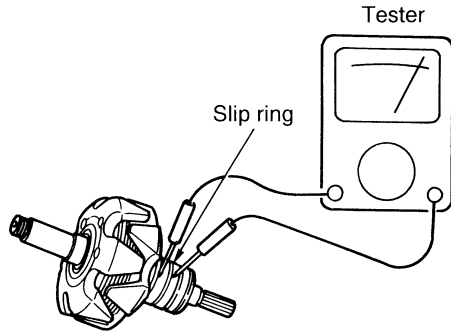


Fig. 9-50

c. Insulation test of the rotor coil

Check for continuity across a slip ring and the rotor core or the shaft. If there is continuity, replace the rotor.

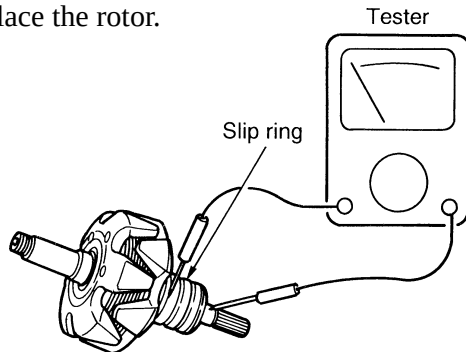


Fig. 9-51

d. Inspection of the bearings

Noisy or hitching bearings should be replaced with new ones.

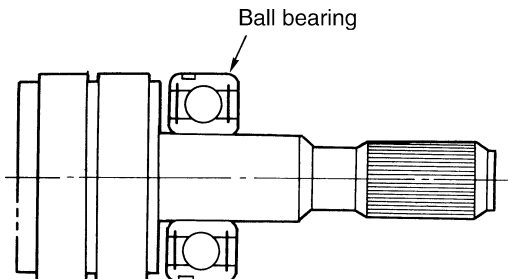


Fig. 9-52

e. Continuity test of the stator coils

Check for continuity across respective coil terminals with a tester. If there is no continuity, replace the stator.

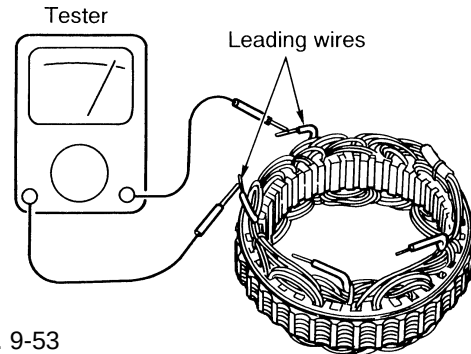


Fig. 9-53

f. Insulation test of the stator coils

Check continuity across one of the stator terminals and stator core. If there is continuity, replace the stator.

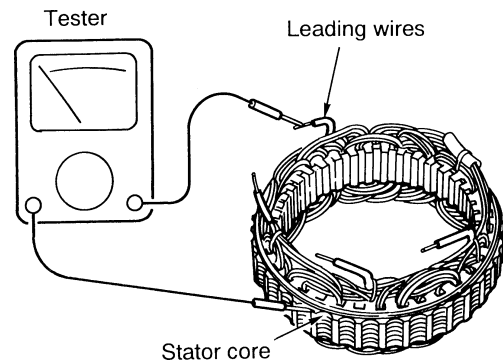


Fig. 9-54

g. Inspection of the rectifier

Set the tester at K Ω range and check continuity across respective terminals. The diode should show continuity only in one direction.

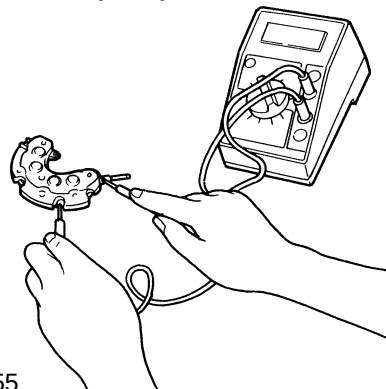


Fig. 9-55

CHAPTER 9. ELECTRICAL ACCESSORIES**Note:**

The rectifier cannot be judged by the resistance value shown in forward direction, because the diode shows greatly different forward current flow in accordance with voltage applied, that is, the tester type and resistance range applied greatly affect resistance reading. Consequently the diode should be considered normal when the resistance difference between the forward direction and reverse direction is large enough.

Never apply $M\Omega$ range of the tester, which may damage the diode.

the brush holder. If the length is less than the usable limit, replace.

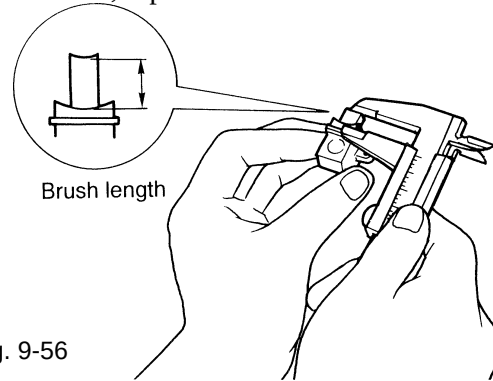


Fig. 9-56

h. Inspection of the brushes

Measure the length of the brush exposed above

Standard value	Usable limit
10.5 mm	4.5 mm

i. Specified tightening torques and service standards

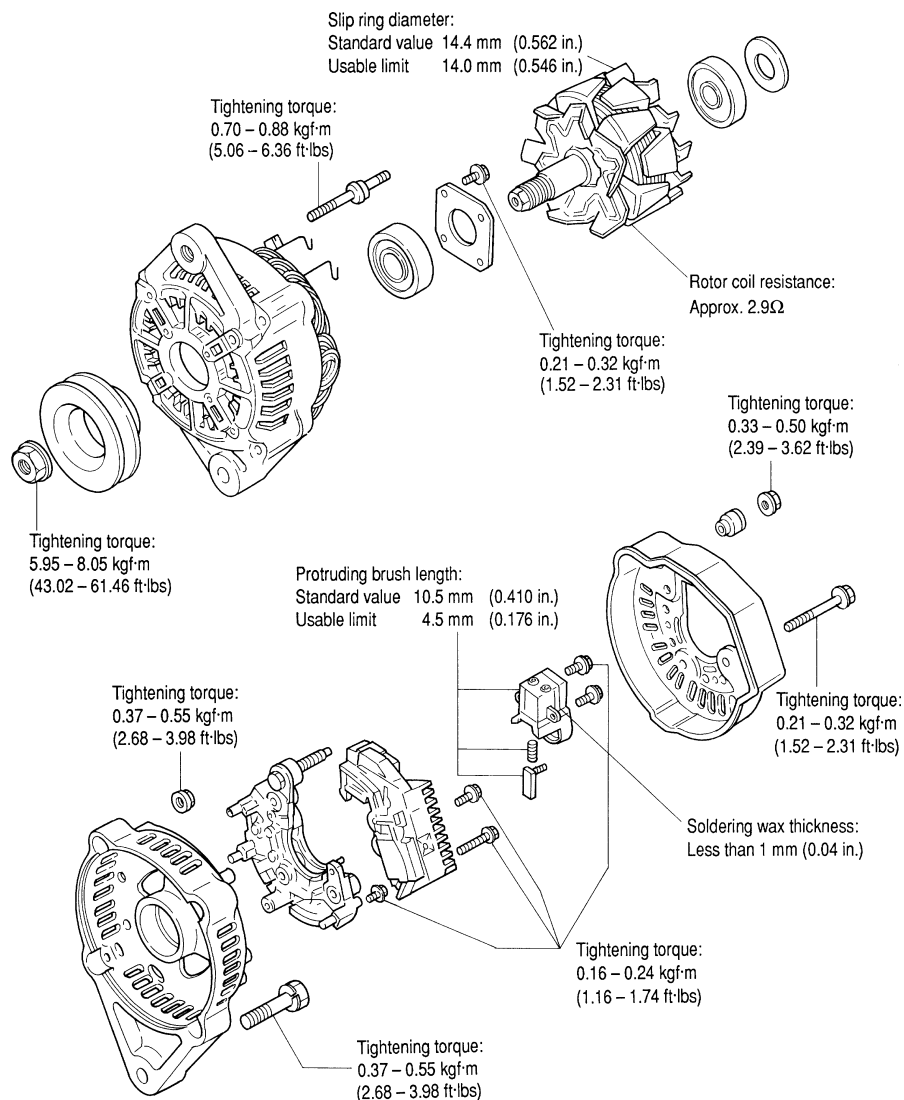


Fig. 9-57

CHAPTER 10. MOWER DECK

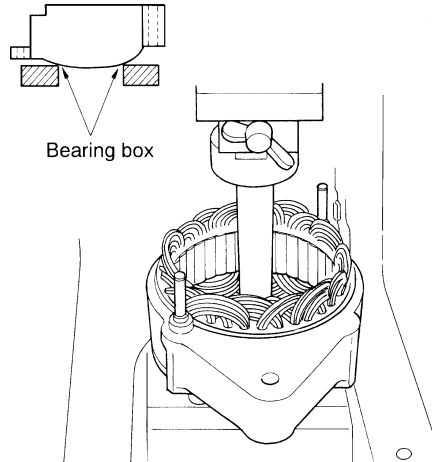


Fig. 9-60

2) Installation of the brush holder

Install the brush holder sideways along with the IC regulator.

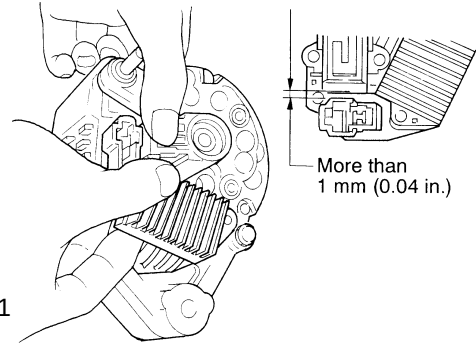


Fig. 9-61

Note:

- The clearance between the brush holder and the connector should be 1 mm or more.
- Rubber packing for the brush holder should not be deformed or pinched.
- As the terminals have screws different in length, be sure not to confuse them when installing.

7. GLOW PLUGS

7.1. SECTIONAL VIEW

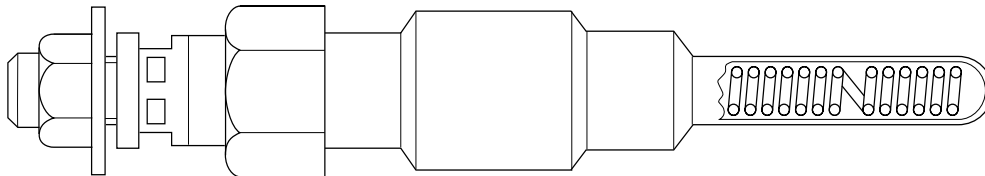
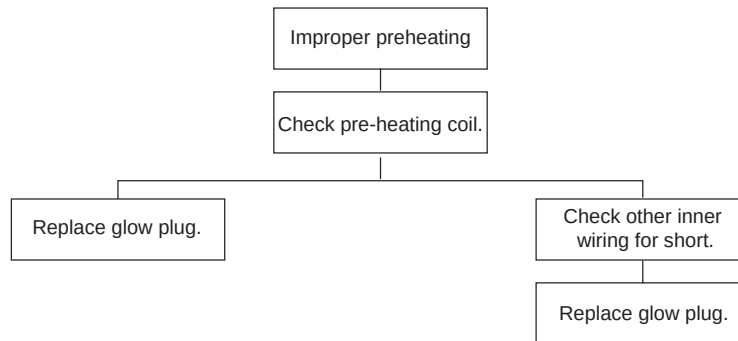


Fig. 9-62

7.2. REMOVAL, INSPECTION, AND RE-ASSEMBLY

a. Troubleshooting



b. Removal

- Remove the connector by loosening the glow plug nut installed on the cylinder head.
- Remove the glow plug.

c. Inspection

- Check for continuity across the sheath and center

electrode. If there is no resistance, it indicates a short circuit, so replace the glow plug. If the resistance is infinite, it shows that pre-heating coil is burnt out, so replace the glow plug.

Standard value	2.0 Ω
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d. Re-installation

- Install the glow plug.
- Install the nut on the glow plug and connect the connector.

SERVICE MANUAL FOR SGR19 & SGR17

CHAPTER 10. MOWER DECK

1. SPECIFICATIONS

Models	SCM48	SCM54
Type	Rotary mower with rear discharge	
Cutting width	1220 mm	1369 mm
Number of blades	3	
Blade driving method	Drive shaft and drive belt	
Belts	SB88-W800	SB96-W800
Blade rotating speeds	3367 mm	3189 mm
Blade rotating speeds	3367 rpm	3189 rpm
(gearbox input speed)	(2424 rpm)	
(engine speed)	(2900 rpm)	
Dimensions		
Overall length	904 mm	982 mm
Overall width	1291 mm	1449 mm
Overall height	326 mm	331 mm
Weight	95 kg	115 kg
	(5-kg linkage is included)	
Cutting-height adjustment	Adjustable in 7 stages by pin shifting	
Cutting height	25 – 115 mm	
Discharge direction	Rearward	

CHAPTER 10. MOWER DECK

2. FILLING DIAGRAM

All the shafts mentioned below have a grease fitting on their end. Grease them periodically. The gear case should also be serviced periodically for oil replenishment and replacement.

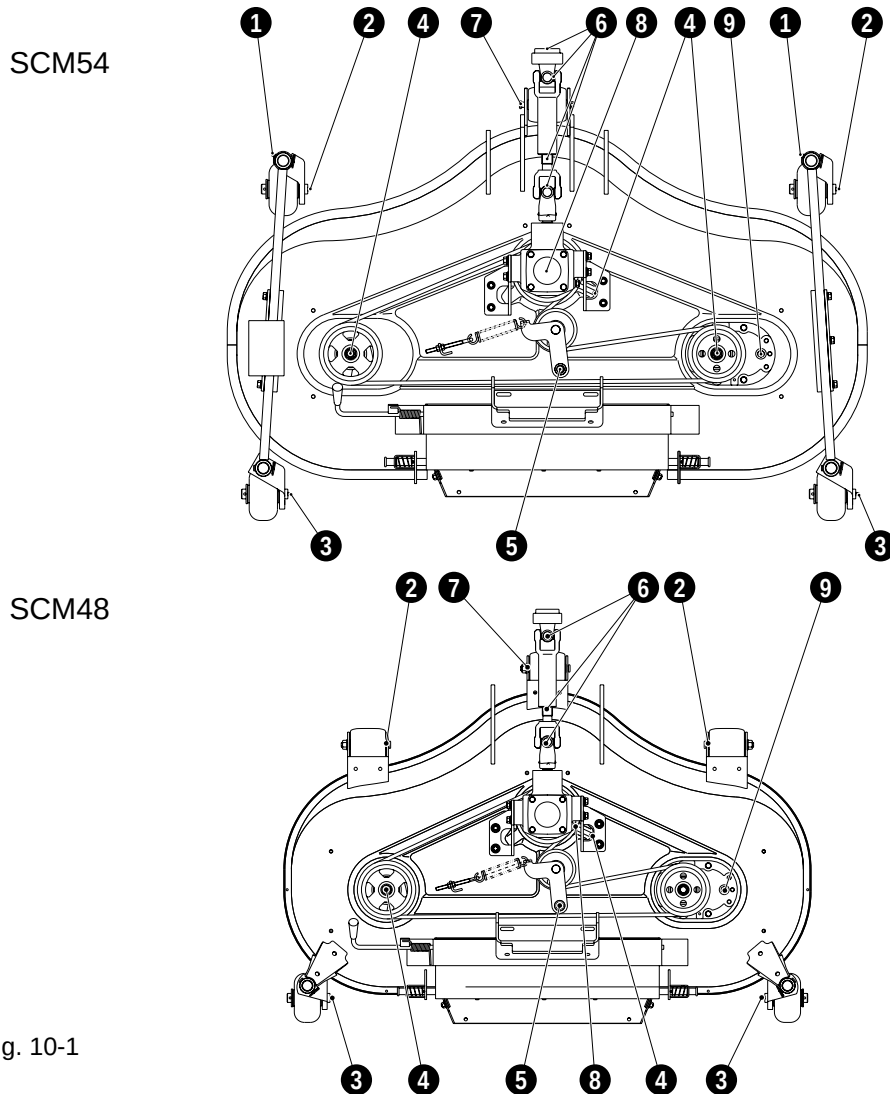


Fig. 10-1

Ref. No.	Filling points	Lubricants	Quantity (cc)
1	Gauge wheel fork	Grease	Inject until grease overflows
2	Front gauge wheel		
3	Rear gauge wheel		
4	Blade shaft		
5	Tension arm		
6	Drive shaft		
7	Roller		As required
8	Bevel gear case	Gear oil SAE80	400
9	Counter gear case	Gear oil SAE80	120

CHAPTER 10. MOWER DECK

3.1.2. BACKLASH ADJUSTMENT

- (1) Prepare the jig as show in the drawing to measure the backlash at R25 mm of the output shaft.

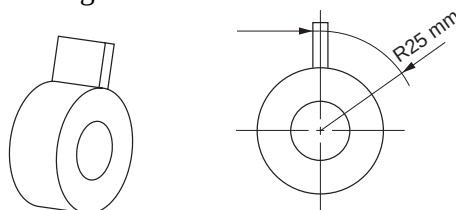


Fig. 10-3

- (2) Reassemble the gear box assembly and place it sideways and lock the input shaft in order to prevent it from turning. (The input shaft has a splined end.)
- (3) Install the jig on the output shaft end.
- (4) Measure the backlash at 25-mm radius circumference and correct it if required by shimming.

Standard value: 0.3 – 0.5 mm (including spline play between respective bevel gear and shaft)

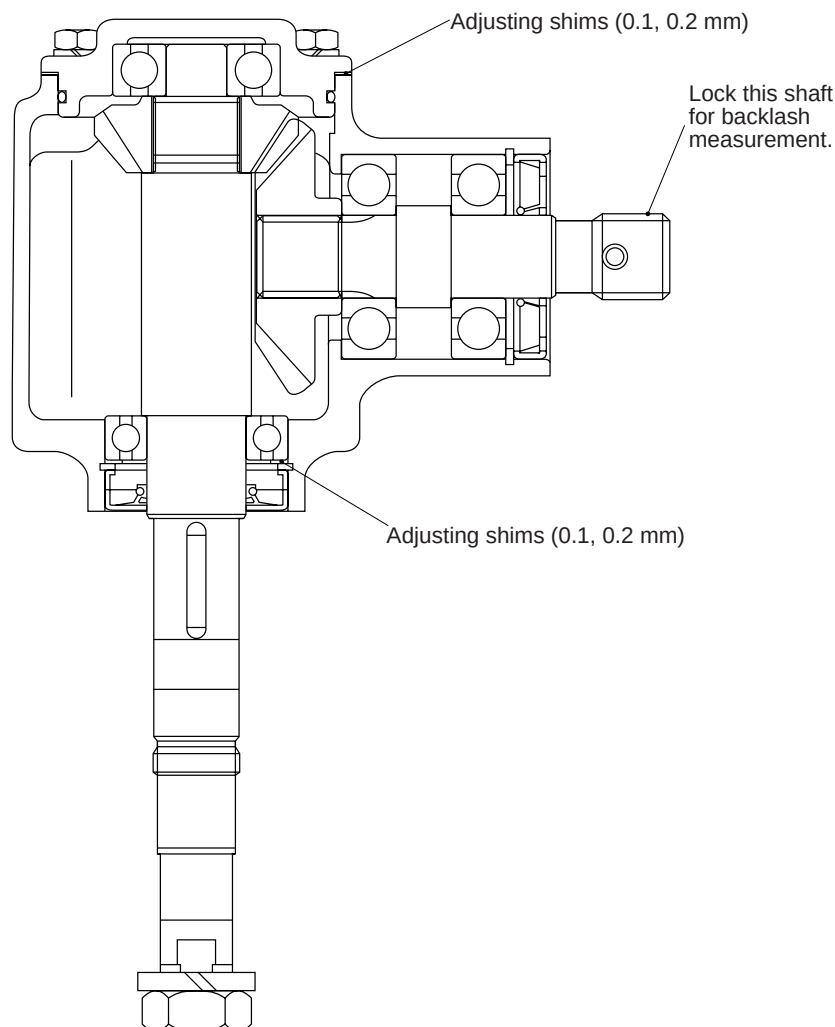


Fig. 10-4

SERVICE MANUAL FOR SGR19 & SGR17

3.2. SIDE AND CENTER METAL (SUPPORTS)

3.2.1. CONSTRUCTION

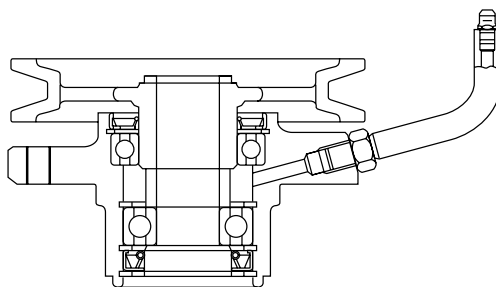


Fig. 10-5

Assembled center metal (support)

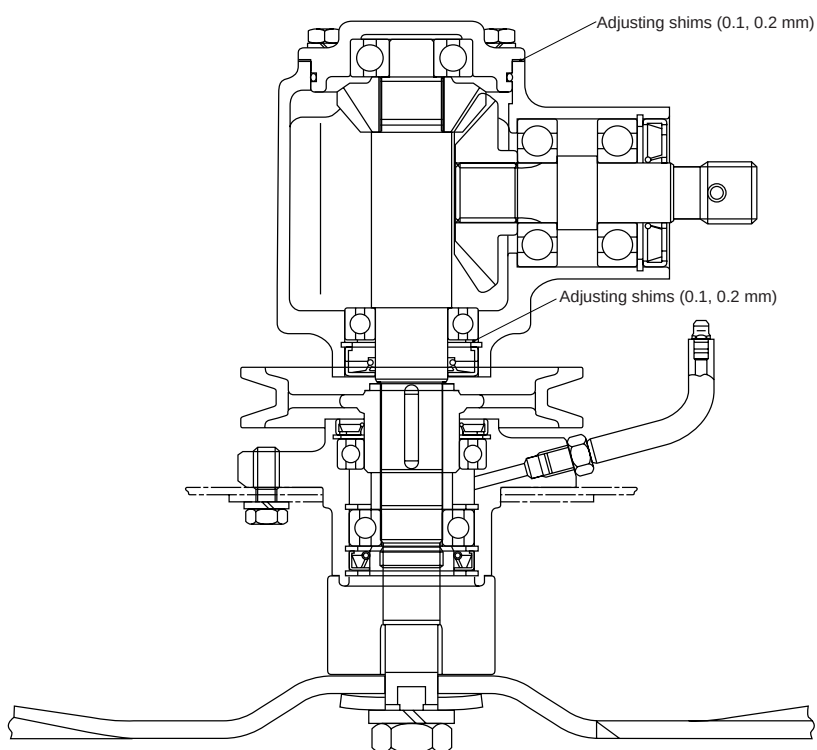


Fig. 10-6

CHAPTER 10. MOWER DECK

Assembled side metal (support)

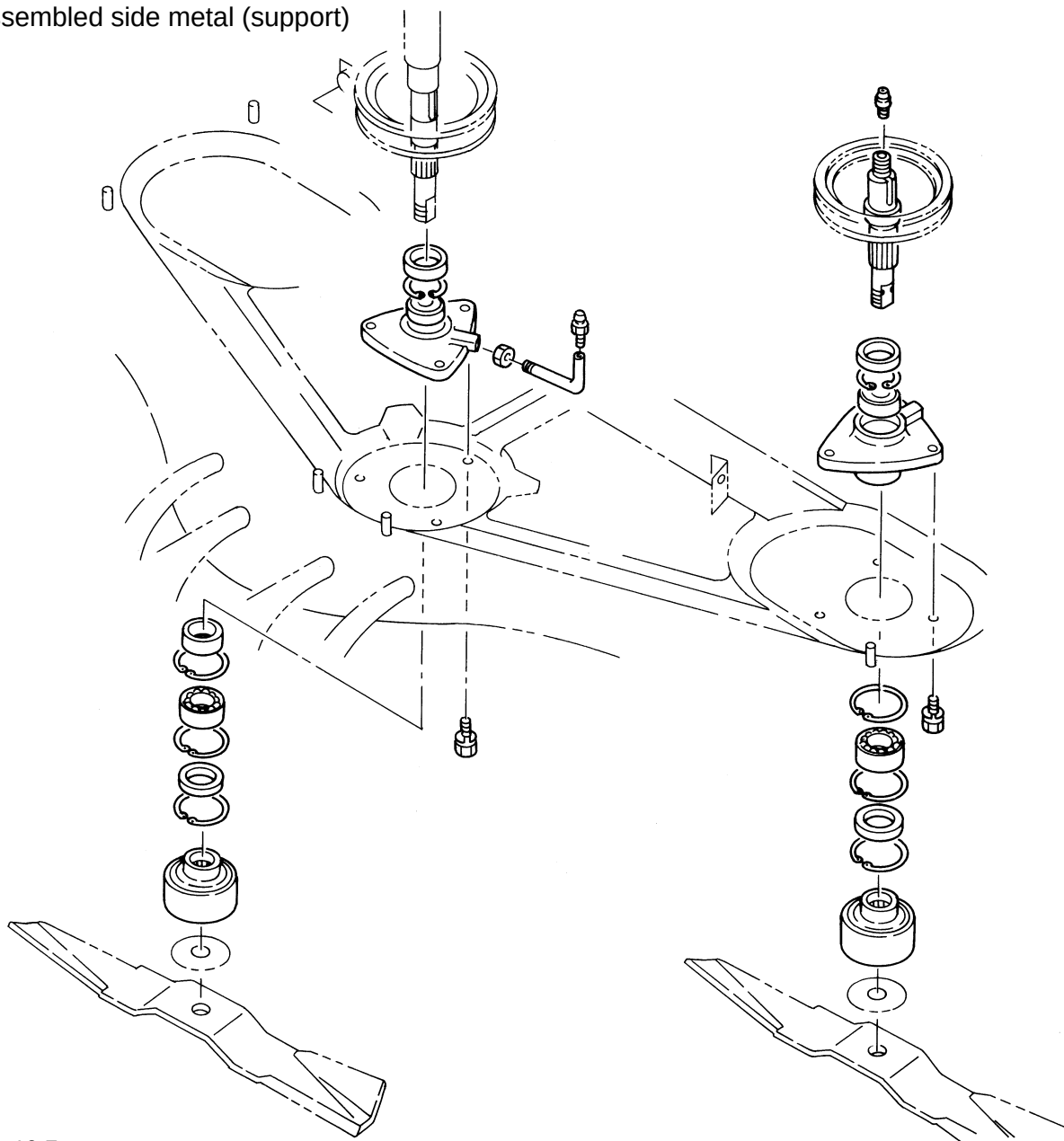


Fig. 10-7

3.2.2. DISASSEMBLY AND REASSEMBLY

Disassemble, inspect, and reassemble the supports in accordance with the following instructions, referring to the drawing above.

- Inspect the oil seals for wear and deformation. (Oil seals are fundamentally consumable parts, so disassemble ones should be replaced with new ones.)
- When installing an oil seal, take care not to allow the lips of the oil seal to turn up or the oil seal to be installed slanted.
- Inspect the bearings for wear or abnormal noise and replace defective ones.
- After reassembly, make sure the shafts turn smoothly.
- After reassembly, apply sufficient grease to lubrication points.

SERVICE MANUAL FOR SGR19 & SGR17

4. TROUBLESHOOTING

Problems	Causes	Countermeasures
Blades do not turn.	• Broken belt	• Replace.
Blade speed does not rise.	• Slippery belt	• Adjust tension spring. • Replace belt when it is worn out where it contacts the pulley.
	• Deck is clogged with grass around blade ends.	• Remove clogged grass.
	• Loose blade nuts	• Tighten them as specified. [1300 kgf·cm (94 ft·lbs)]
Grass is not cut perfectly.	• Worn or broken blade	• Sharpen or replace it.
	• Blade end positions differ too much from each other	• Correct by shimming. [within 1 mm (0.04 in.) difference]
Mower deck does not rise.	• Defective hydraulic system	• Check system. (Refer to chapter for hydraulic system.)

CHAPTER 11. SERVICE STANDARDS**CHAPTER 11. SERVICE STANDARDS****1. SERVICE STANDARDS**

Service Items		Nominal Value when assembled	Usable Limit	Remarks
1.1. CHASSIS				
Brake system				
Brake disc		3.5 mm	2.9 mm	
Separator plate		1.52 mm	1.6 mm	
Max. speed	Forward	16.8 km/h		
	Reverse	10.0 km/h		
Braking distance	Forward	4 – 5 m		
	Reverse	3 – 4 m		
Transmission				
Backlash of drive pinion		0.1 – 0.3 mm		Adjust by shimming.
Backlash of other gears		0.1 – 0.25 mm		
HST transmission				
Clearance of piston in cylinder		0.02 mm	0.03 mm	
Friction roughness				
Piston		0.2a	0.4a	
Cylinder wall		0.2a	0.4a	
Valve plate		0.2a	0.4a	
Thrust bearing		0.2a	0.4a	
Swash plate		0.1a	0.2a	
Hydraulic system				
Relief pressure for HST		17.6 Mpa (180 kg/cm²)	±1.47 Mpa (±15 kg/cm²)	Measured separately
Charge pressure for HST		0.49 Mpa (5 kg/cm²)	±0.1 Mpa (±1 kg/cm²)	
Hydraulic pump (Gear pump):			8.3 Mpa (85 kg/cm²)	
Relief pressure in hydraulic circuit		5.4 Mpa (55 kg/cm²)		
Front and rear wheels				
Tightening torque	Front	500 – 600 kgf·cm		
	Rear	800 – 950 kgf·cm		
Tyre inflation	Front	160 Kpa (1.6 kgf/cm²)		

SERVICE MANUAL FOR SGR19 & SGR17

Service Items	Nominal Value when assembled	Usable Limit	Remarks
Rear	160 Kpa (1.6 kgf/cm ²)		
1.2. ENGINE			
Fan belt			
Belt deflection	5 – 10 mm		10 kg
Valve clearance			
Intake	0.25 mm		Cold
Exhaust	0.25 mm		Cold
Compression			
Cylinder compression	30 kg/cm ²	26 kg/cm ²	at 300 rpm
Injection nozzles			
Injection pressure	120 kg/cm ²		
Cylinder head			
Distortion (flatness)	0.075 mm	0.15 mm	
Tightening torque	5.5 – 6.0 kgf·m		
Cylinder block			
Top surface flatness	0.08 mm	0.15 mm	
Wear limit of cylinder		0.2 mm	
Oversize pistons			0.5 mm, 1.0 mm
Undersize bearings			0.5 mm, 1.0 mm
Clearance between journal and bearing	0.029 – 0.080 mm	0.12 mm	
Thrust play of crankshaft	0.04 – 0.215 mm	0.3 mm	
Tightening torque of bearing cap bolts	2.7 – 3.3 kgf·m		
Tightening torque of journal bearing caps	4.5 – 5.5 kgf·m		
Camshaft			
Journal wear	33 mm	32.75 mm	
Cam lobe height	27 mm	26.6 mm	
Thrust play of camshaft	0.05 – 0.174 mm	0.2 mm	
Oil pump			
Delivery pressure	3.5 – 4.0 kg/cm ²	2.0 kg/cm ²	at 1400 rpm of engine

CHAPTER 11. SERVICE STANDARDS

2. TIGHTENING TORQUE OF MAJOR FASTENERS

Locations	Tightened parts	kgf·m
Cylinder head	Cylinder head bolts Rocker shaft Injection nozzles Glow plugs Glow plug connectors Hangers	6.0±0.5 1.9±0.5 4.5±0.5 1.75±0.25 0.1 – 0.15 4.1±0.6
Cylinder block	Bearing caps Front plate (M8) Thrust plate Rear plate (M10) Oil strainer clamp Injection pump cover	5.0±0.5 1.9±0.5 0.8±0.2 4.1±0.6 1.9±0.5 0.8±0.2
Crankshaft	Connecting rod bearing caps Flywheel Crankshaft pulley	3.0±0.3 9.5±1.0 18.9±1.9
Timing gear case	Gear case Plug (covering governor fulcrum) Oil pump Angleichung (adaptation) unit	1.9±0.5 1.3±0.5 0.8±0.2 2.0 – 3.0
Others	Water pump Thermostat housing Water pump outlet pipe Inlet manifold Exhaust manifold Fan Starter Generator (M10) (M8) Solenoid	1.9±0.5 1.9±0.5 1.9±0.5 1.9±0.5 1.9±0.5 0.8±0.2 8.4±0.8 4.1±0.6 1.9±0.5 0.8±0.2
Fuel injection pump	Injection pump body Fuel pump connector Injection pipe Delivery valve holders Weight bracket	1.9±0.5 2.0 – 2.5 2.0 – 2.5 4.0 – 4.5 0.8±0.2

2.1. Tightening torque for standard bolts:

	(kgf·m)
M6 × 1 (7T)	0.8±0.2
M8 × 1.25 (7T)	1.9±0.5
M10 × 1.25 (7T)	4.1±0.6
M12 × 1.25 (7T)	8.4±0.8

SERVICE MANUAL FOR SGR19 & SGR17

3. STANDARD BOLTS AND NUTS

Size	4T bolts and nuts	7T bolts and nuts	7/9 bolts and nuts
M5	30 – 40	50 – 60	60 – 70
M6	60 – 80	90 – 110	100 – 130
M8	130 – 180	200 – 270	250 – 350
M10	200– 300	450 – 550	550 – 700
M12	500– 600	750 – 900	900 – 1100
M14	700– 800	1000 – 1200	1300 – 1500
M16	1000– 1200	1200 – 1400	1600 – 1800
M18	1200– 1400	1600 – 1800	2000 – 2400
M20	1500– 1700	1900 – 2100	2400 – 2600

4. BEARING NUTS

Description	Nominal dimensions	Tightening torque (kgf.cm)
AN02	M15	200 – 400
AN03	M17	200 – 400
AN04	M20	300 – 500
AN05	M25	300 – 500
AN08	M30	300 – 500
AN07	M35	400 – 600
AN08	M40	600 – 800
AN09	M45	600 – 800
AN10	M50	800 – 1000
AN11	M55	800 – 1000
AN12	M60	800 – 1000

5. LOCKING BOLTS AND NUTS

- When locking bolts and nuts by tightening with wire or bending a washer, pay attention to the direction of winding wire: wire should be wound in direction of tightening nuts or bolts and washer bending for secure locking.
- When locking bolts and nuts by applying screw locking agent, apply agent to threads thoroughly.