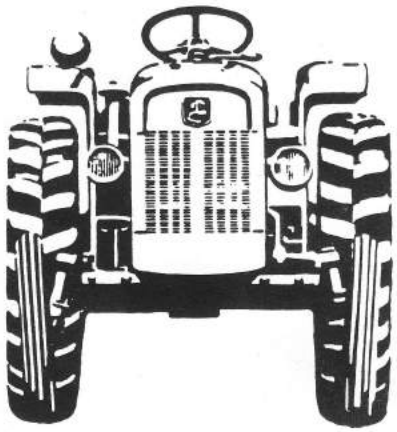
SATOH TRACTOR S-650G REPAIR MANUAL



SATOH AGRICULTURAL MACHINE MFG. CO.,LTD.

Publication No. 03

CONTENTS

SATOH TRACTOR

MODEL S-650G
REPAIR MANUAL

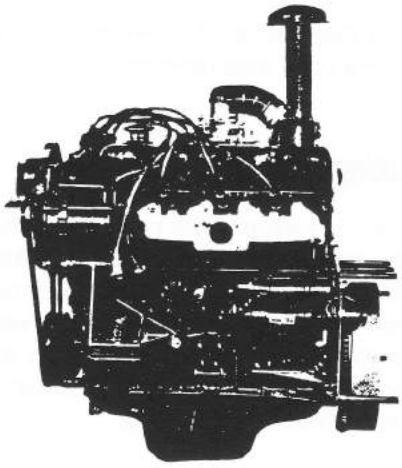
ENGINE SYSTEM

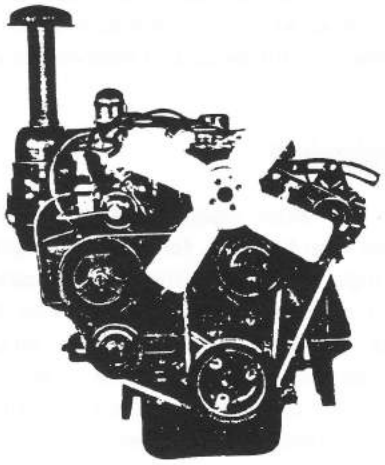
PUBLICATION No.03-A

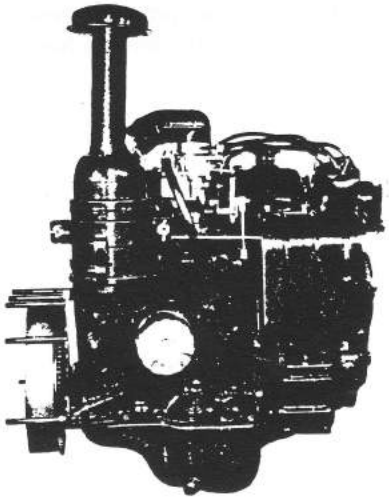
CONTENTS

THE ENGINE-GENERAL

This PB engine is a high performance, water-cooled, 4-cylinder, in-line gasoline engine, employing the overhead valve and high cam shaft system. The cylinder bore and the piston stroke measure 2.6772 in. (68 mm) and 2.6772 in. (68 mm), respectively. In this sense, the cylinder is of a square type, having a total displacement of 60.2 cu. in. (987 cc) and a compression ratio of 8.6 to 1. The maximum output is 25 PS at 2,800 r.p.m. and the maximum torque 46.9 ft-lb/2,200 r.p.m. (6.5 kg-m/2,200 r.p.m.). The description of the engine is as follows:







1. Cylinder Head

Being made of a light alloy, the cylinder head is light in weight, providing excellent radiation efficiency. The dome-shaped combustion chamber is shrinkage-fitted with ductile cast iron valve seats. The intake and the exhaust valves are arranged opposite to each other the cylinder head; that is, the cross-flow design is employed for better combustion efficiency.

2. Cylinder Block

The cylinder block is precision-cast from a light alloy metal by means of pressure die casting. To support the crankshaft, five bearings of the deep skirt type are employed. The cylinder liners are made of special cast iron and replaceable. They are directly cooled by water and sealed with two "O" rings.

3. Pistons and Crankshaft

The pistons are of a conical ellipse type manufactured by LO-EX. The crankshaft is made of ductile cast iron superior in durability and wear-resistance, and supported by five main bearings. The main bearings are made of an aluminum alloyed with tin, which is also excellent in durability and wear-resistance.

4. Valve Mechanism

The high cam shaft design is employed, along with five special iron bearings, for increased rigidity. This permits high speed revolutions. The cam shaft is driven by a Renold-made chain, whose tension is adjustable by means of the chain adjuster and vibration damper. To reduce the chain noise, the contacting surfaces of the chain is finished with heat-proof and wear-proof rubber.

5. Intake and Exhaust Mechanism

The exhaust manifold is made of cast iron, and the intake manifold made of a light alloy metal. Both manifolds are of independent branch type. The hot spot is heated by warmed "cooling water". In the intake system, a Stronberg type carburetor, having a down-draft double-venturi is used.

6. Governor

The Governor is of fly weight type and controlled by means of all speed governor system.

7. Cooling System

Cooling system is the type of forced-circulation, and the pressure in the radiator is 9.954 lbs/sq. in. by which the high efficiency of heat radiation is secured. Their system is incorporated with the Wax type thermostat and the water pump is of the centrifugal type. The material of cooling fan is the synthetic resin, consisting of 4 wings,

8. Lubricating Mechanism

Total pressure lubrication is carried out by a trochoid gear oil pump, which is driven by the cam shaft drive gear. A cartridge type oil filter is employed.

9. Electrical System

Electrical component is of 12-volt capacity. The alternator is 16-amp. capacity, and the starter of 1.0-kW. As the battery, the N40L type is used, and the distributor is provided with a vacuum and centrifugal type automatical advancer.

ENGINE

1. Disassembling Order

Note: Notes on Engine Disassembly

- Both engine and transmission are very heavy in weight. In addition, they must be kept in a horizontal position while being disassembled, and therefore, engine disassembly operations should be performed on solid floors.
- To keep the tractor in a horizontal position, place a wooden wedge between the front extension and the axle beam.
- Be sure that necessary wrenches, such as a special tool (No. N033S SOCKET WRENCH SET), special tool (No. BT-100 DOUBLE OFFSET BOX WRENCH SET), and (No. BT-9 OPEN-END WRENCH SET), and other special tools including a chain block are all available on hand.
- Put a mark on each engine component part such as a piston, piston ring, valve, valve spring, metal, tappet, push rod, etc. in order of the cylinders, so that you will not confuse about parts.
- Take special care not to damage the removed parts, and put them in order.

1-1. Removing the Engine

1. Remove the negative (–) corde from the battery.
2. Remove the wires from the alternator (A), starting motor (B) and head light (C).

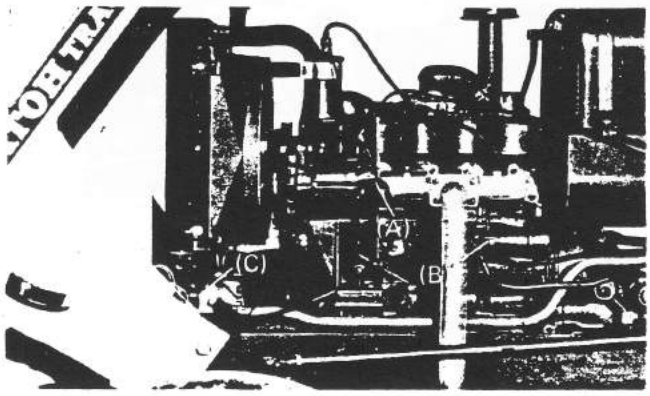


Fig. 1

3. Remove the bonnet.
4. Disconnect the wires from the oil pressure switch (A) and the water heat gauge (B).

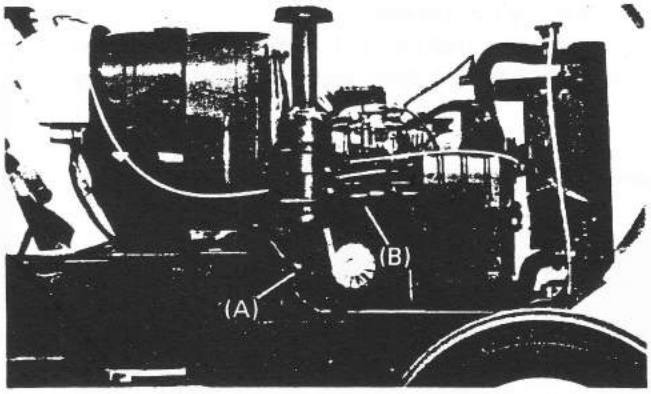


Fig. 2

5. **Removing the radiator**
   Throughly drain off the cooling water from the radiator and cylinder block. Loose the water hose clip (A) and pull out the water hose from the radiator. Remove the radiator mounting bolts (B), (C), and fitting nut for radiator support (D), and remove the radiator.

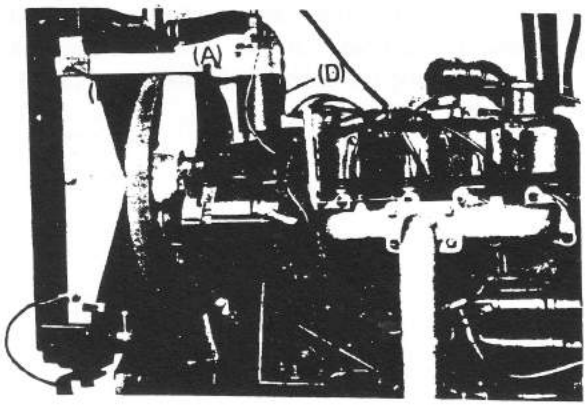


Fig. 3

6. Removing the tractor meter cable, throttle wire and choke wire
   Remove the governor cover (A), and disconnect the tractor meter cable (B), throttle wire (C) and choke wire (D). Remove the governor cover.

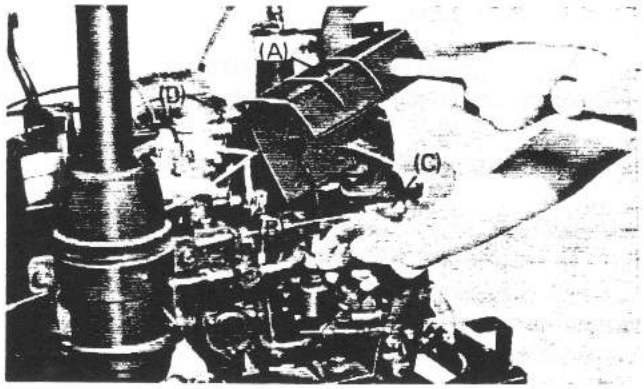


Fig. 4

7. Removing the fuel pipe
   Remove the fuel pipe (A). To prevent dust from entering the fuel tank, cover it with a clean dry cloth.

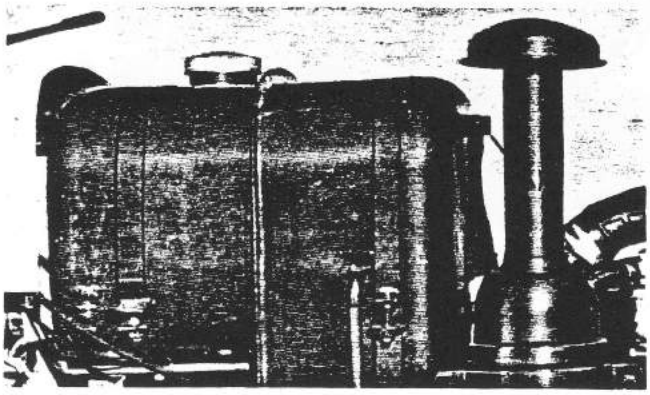


Fig. 5

8. Removing the drag link
   Pull out the split pin from the ball socket connecting the Pitman arm and drag link, and remove the slotted nut (A). Remove the ball socket by using the special tool (No. TRH-12 TIE ROD END REMOVER)

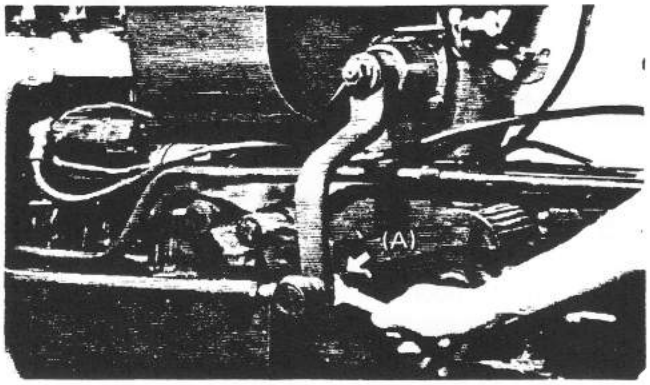
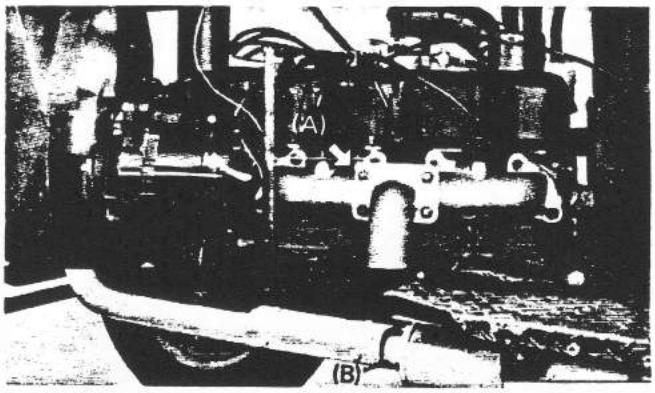


Fig. 6

9. Removing the silencer pipe
   Remove the nut (A) mounting both exhaust manifold and silencer pipe, and remove the silencer mounting nut (B). Then remove the silencer pipe.



Figs. 7 and 8

10. Removing the hydraulic oil pipe
    a. Remove the hydraulic oil pipe clamp (A).

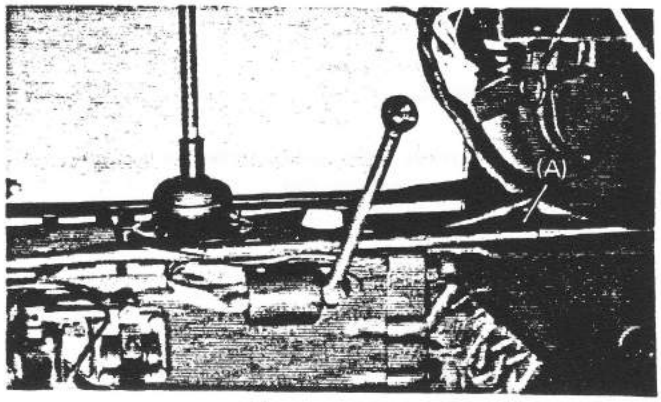


Fig. 9

b. Remove the magnet plug (B), and drain off the hydraulic oil case. When reusing the oil, put it in a clean container while taking care not to allow dust to enter the oil.

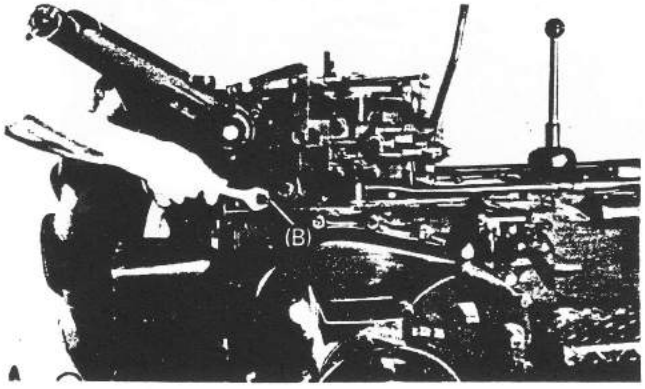


Fig. 10

c. Remove the banjo bolt (C).

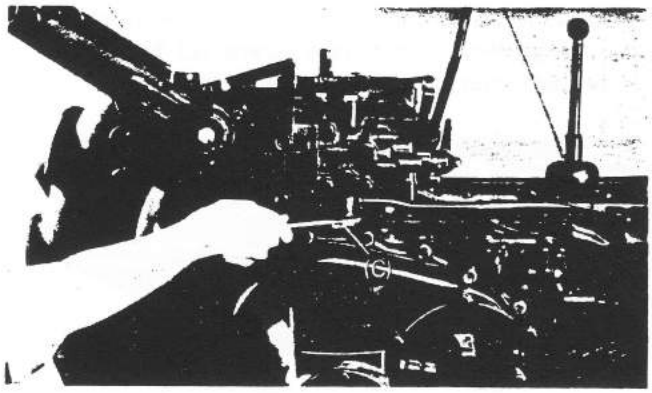


Fig. 11

d. Loosen the strainer body (D), and take it out.

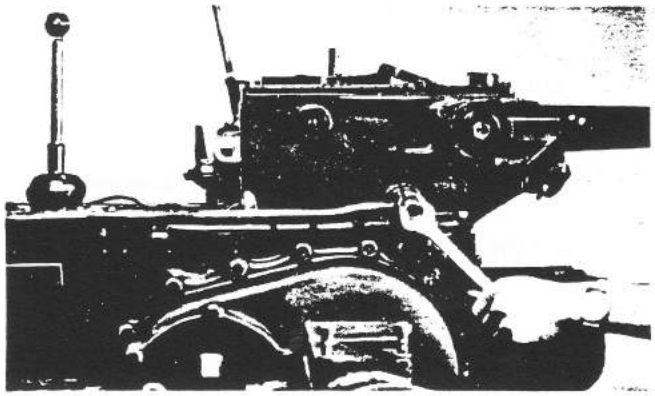


Fig. 12

e. Remove the pump flange mounting bolt (E) from both inlet and outlet sides. Cover the ends of the pipe so that no dust will enter the pipe.

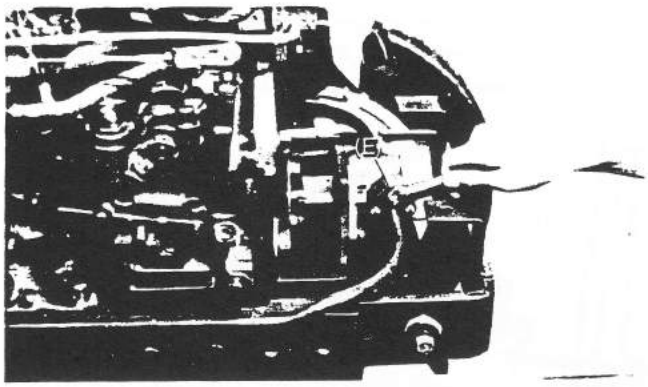


Fig. 13

11. **Removing the hydraulic pump and pump bracket.**
Remove the four bolts setting the pump joint (A), and remove the pump joint. Remove the four nuts (B) from the pump (C). Remove the two screw (M8 x 25) and three bolts (M8 x 45) from the pump bracket, and remove the bracket (D).
Note: As alignment of the center line between crankshaft and the hydraulic oil pump had been correctly fixed at 0.001181 in. (0.03 mm) during factory assembly, do not attempt to remove the pump unless otherwise it is definitely necessary to work out its removal.

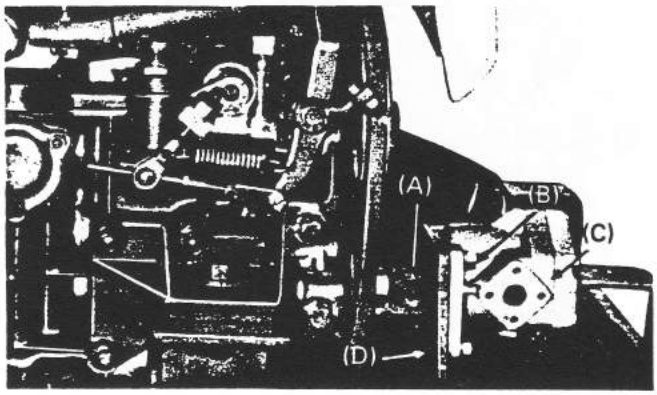


Fig. 14

12. **Removing the flange coupling and CG-type rubber coupling**
Remove the three bolts which fasten the CG-type rubber coupling to the crak pulley, and remove the flange coupling and CG-type rubber coupling.

13. Remove the engine mounting rubber mounting nut (A) on both right and left sides, and remove the engine support mounting bolt (B).

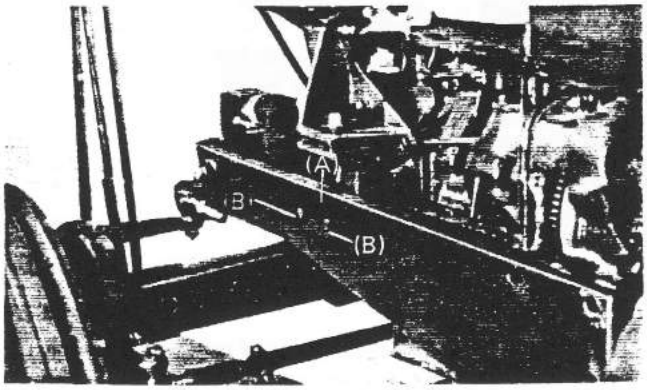


Fig. 15

14. **Removing the alternator and V-belt**
    a. Remove the bolt as shown in Fig. 16, and remove the alternator strap (B) from the alternator (A).
    b. Remove the alternator mounting nut and bolt, and remove the alternator and V-belt (C) from the alternator bracket.

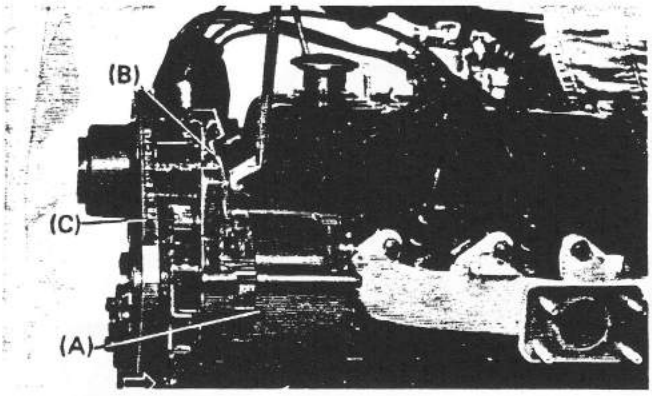


Fig. 16

15. **Install the chain block on the engine hanger (A) on the manifold on both exhaust and intake sides.**
    Do not hoist the engine, but pull the wire so that it becomes slightly tight.

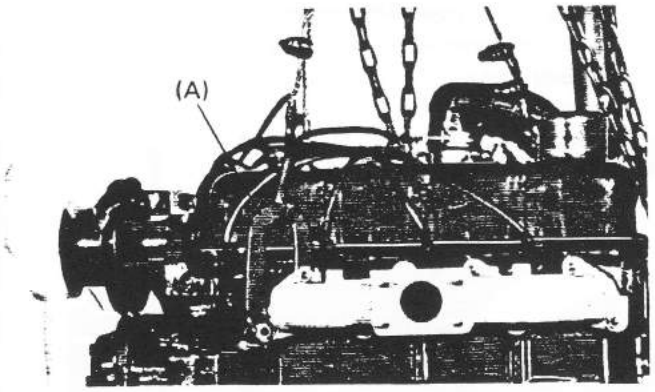


Fig. 17

16. **Place a garage jack under the clutch housing.**
    Do not jack up the tractor, Just raise the jack so that it is just tightly locked under the tractor.

17. Remove the bolts (A), four each on both right and left sides, and the four bolts (B), also four each on both sides, which mounting the chassis and clutch housing. Remove the three screws (C) from the rear plate, and pull the rear plate downward.

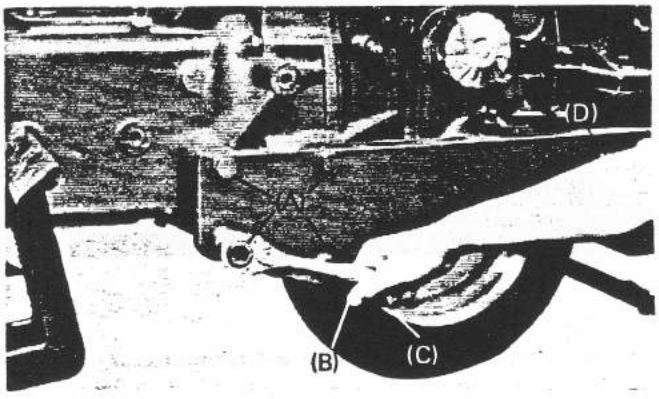


Fig. 18

18. Pull out the chassis and front axle toward the front.

19. **Removing the engine mounting and alternator bracket**
    a. Remove the mounting nut, and remove the engine mounting (A) from the alternator bracket.

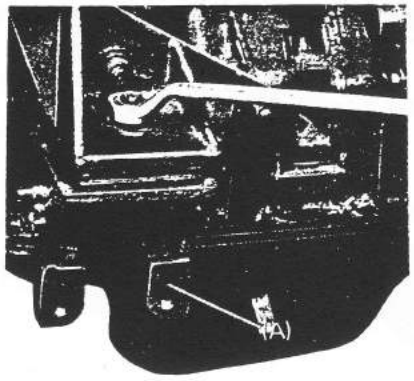


Fig. 19

b. Remove the three mounting nuts, and remove the alternator bracket (B) from the cylinder block.

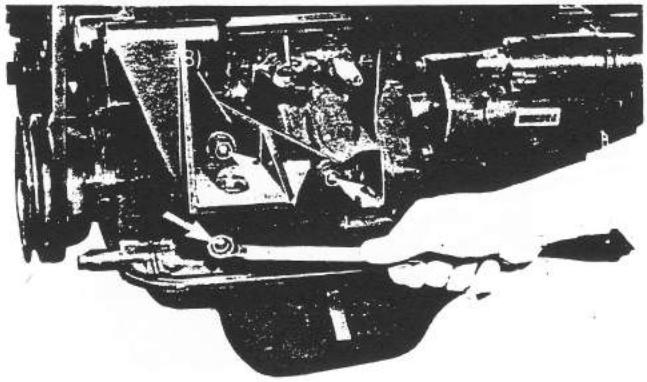


Fig. 20

20. Remove the starter mounting nut, and remove the starter.

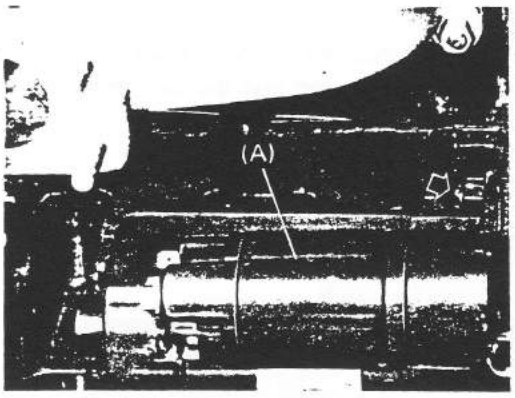


Fig. 21

21. Remove the four nuts (A) and nuts (B) (one each on both right and left sides), which mounting the engine and clutch housing. Next, adjust the chain block suspending the engine so that the stud bolt will not be under excessive load. Then pull the engine toward the front.

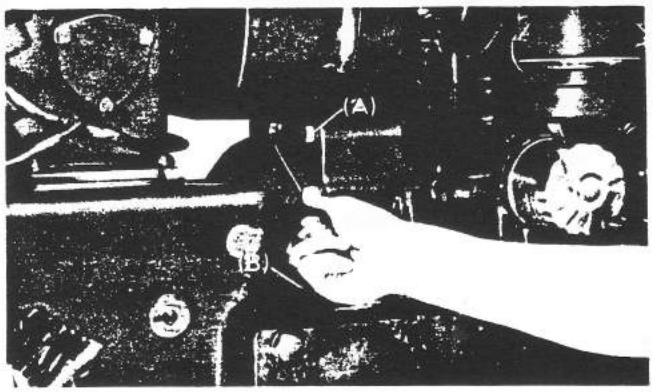


Fig. 22

1-2. Disassembling the Engine

1. Install the engine on the special tool (No. 0490010 ENGINE STAND) by means of one bolt and three nuts then removing the clutch unit.

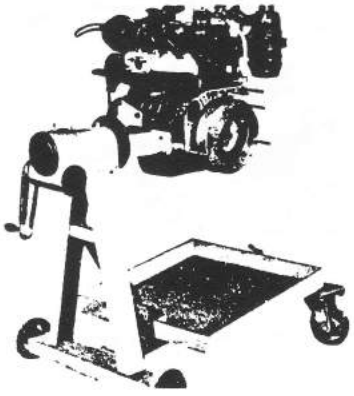


Fig. 23

2. Draining the engine lubricants
Remove the drain plug and drain off the engine lubricants.

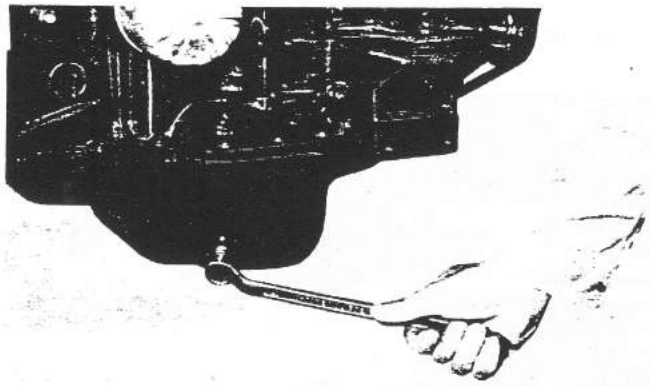


Fig. 24

3. **Remove the clutch, flywheel and crank pulley**

a. As shown in Fig. 25, remove 6 pcs. of screws and remove the clutch. Make sure that the removal order for screws should be diagonally done.

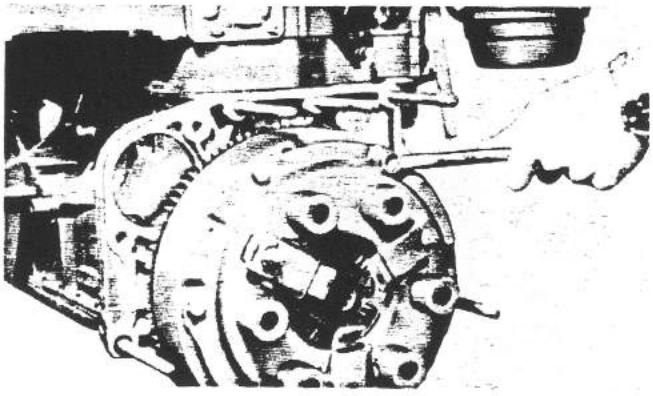


Fig. 25

b. As shown in Fig. 26, raise up the lock washer of its bent portion.

c. As shown in Fig. 26, install the special tool (No. 0490100 RING GEAR BRAKE) so that the crankshaft and flywheel cannot be rotated.

d. Remove 6 pcs. of the lock bolts and remove the flywheel (A) from the crankshaft.

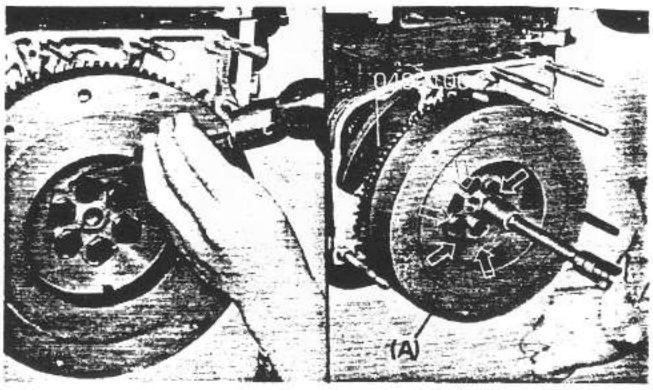


Fig. 26

e. Remove lock bolt from the crank pulley (A) at the front of the engine.

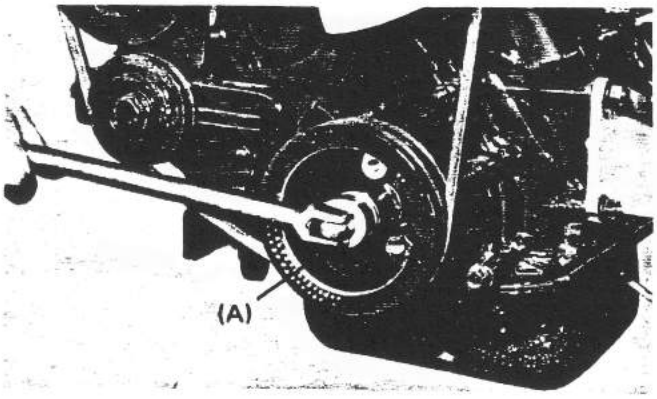


Fig. 27

f. Remove the special tool (No. 0490100 RING GEAR BRAKE).

4. **Removing the air cleaner**

a. Loosen two hose bands, and remove the hot air hose (A) from the air cleaner and the carburetor.

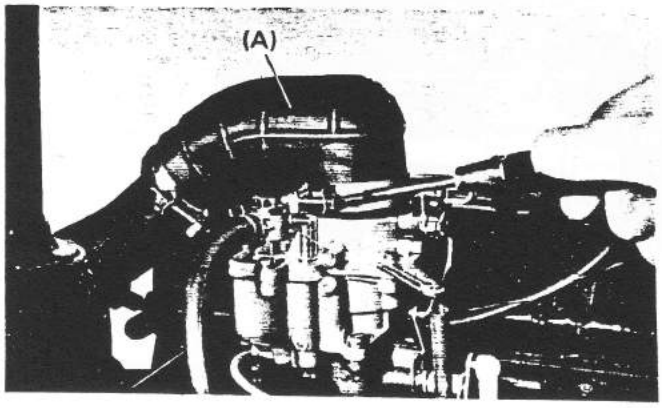


Fig. 28

b. Loosen two wing nuts, and raise the clamp (B). Remove the air cleaner bands (C) and remove the air cleaner.

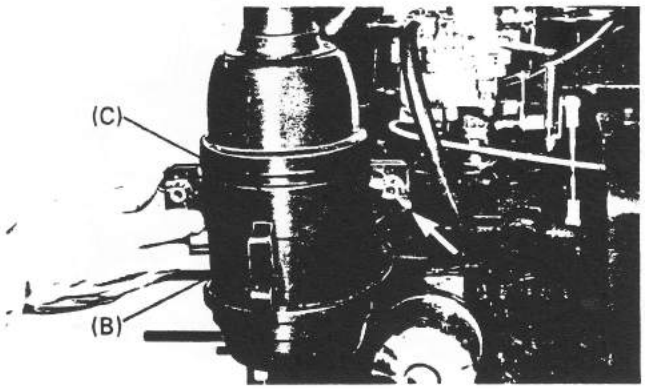


Fig. 29

5. **Removing the distributor**

a. Pull the high tension wire out of each spark plug.

b. Pull out the vacuum advance hose (A) connected to the distributor, as shown in Fig. 30.

c. Unscrew the nuts (B), and pull upward the distributor, as shown in Fig. 31.

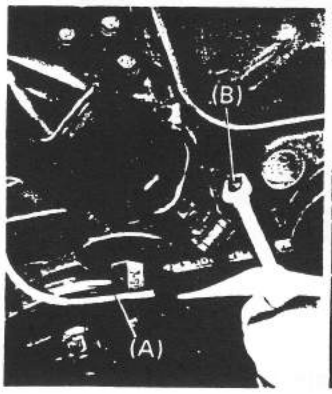


Fig. 30

Fig. 31

6. **Removing the V-belt and idler assembly**

a. Screw in the adjusting bolt (A) to make the V-belt tight, and loosen the governor pulley lock nuts, as shown in Fig. 32.

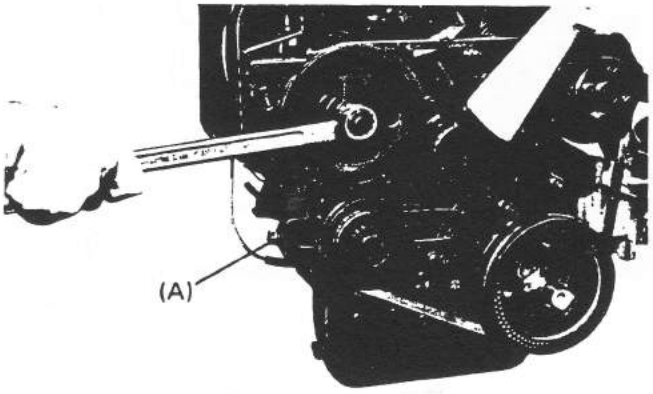


Fig. 32

b. Loosen the adjusting bolt and move the idler pulley (B) in the direction of the arrow shown in Fig. 33.
Then pull down the governor operating lever (C) to the carburetor side, and remove the V-belt (D) from each pulley.

c. Unscrew two nuts and bolts, and remove the idler assembly (E) from the governor bracket and the timing chain cover.

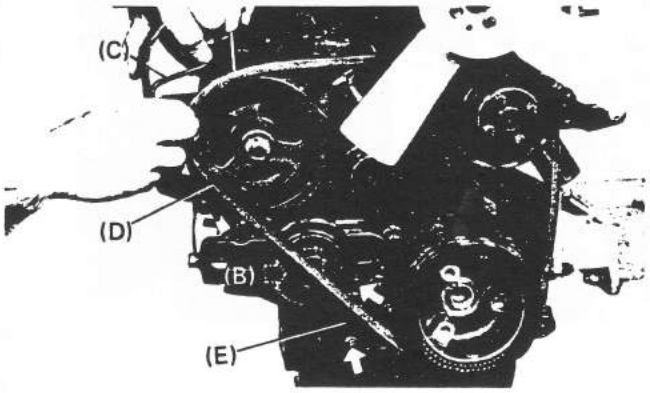


Fig. 33

7. **Removing the governor and governor bracket**

a. Remove the lock nut which has been already loosened according to 6-a above, and slip the governor pulley (A) off the governor shaft. Then remove the key (B) on the governor shaft.

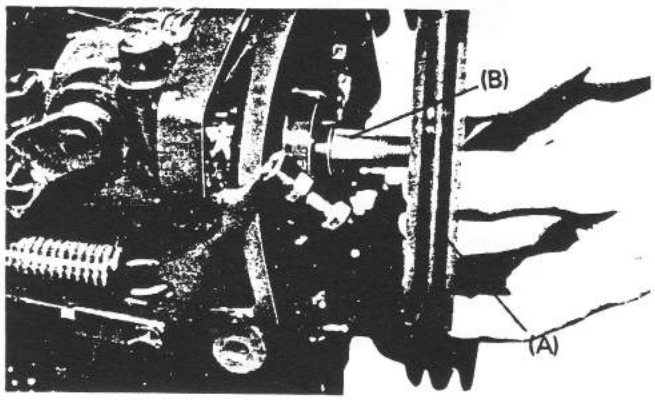


Fig. 34

b. Remove the governor operating lever and remove the rod assembly.
c. Remove the nuts and bolts shown in Fig. 35.
d. Unscrew three nuts shown in Fig. 36, and remove the governor. Remove the governor bracket and remove the engine bracket from the cylinder block.

Fig. 35

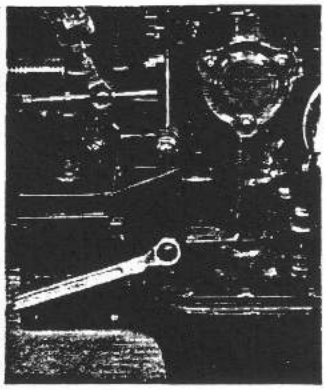


Fig. 36

e. Unscrew three bolts and nuts (D), then, the governor (A), the governor bracket (B) and the engine bracket (C) which have already been removed according to 7-d above, can be separated.

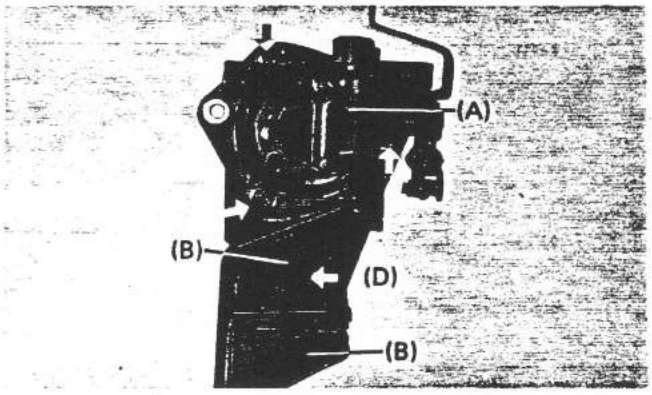


Fig. 37

8. Removing the cooling fan and cooling fan complete
a. Unscrew four bolts, and remove the cooling fan (A), fan spacer, pump pulley (B) from the cooling fan complete.
b. Unscrew three nuts, and remove the cooling fan complete (C) and alternator strap from the cylinder head.

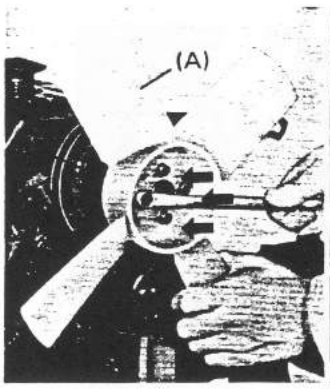


Fig. 38

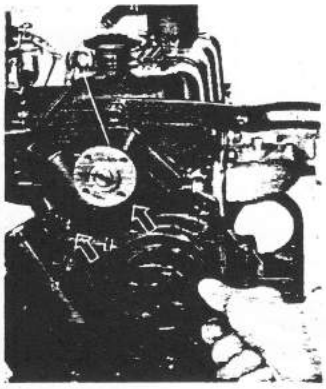


Fig. 39

c. Take out the thermostat from the thermostat casing.

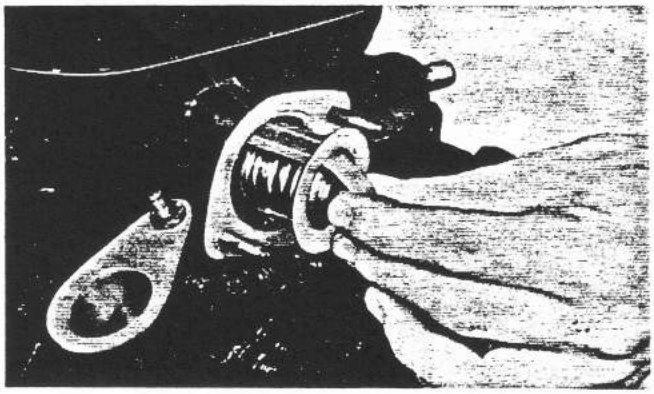


Fig. 40

9. Removing the water pump
a. Pull the intake manifold water hose (A) out of the water pump by loosening the clip.
b. Unscrew four nuts, and remove the alternator stay (C) and water pump (B) from the cylinder head.

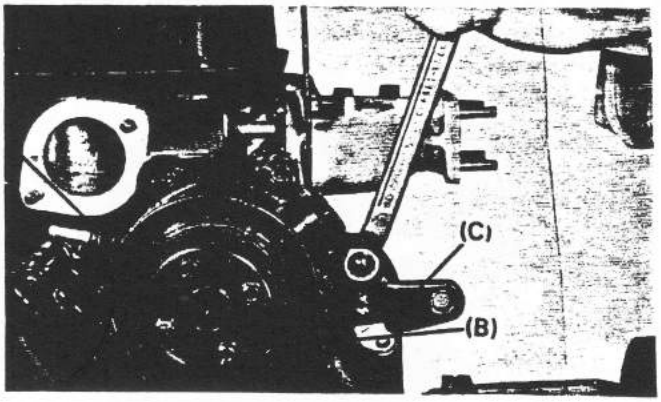


Fig. 41

10. Removing the oil filter
   a. Pull out the oil level gauge.
   b. Remove the oil filter from the cylinder block by using an special tool (No. 0490130 OIL FILTER WRENCH) (A).

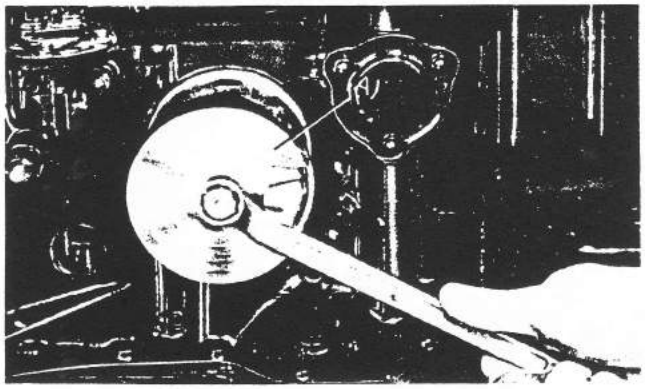


Fig. 42

11. Removing the fuel filter
   a. Unscrew the carburetor connecting bolt, and remove the fuel hose (A) connected to the carburetor.
   b. Unscrew two nuts, and remove the fuel pump (B) from the cylinder block. Then remove the insulator.
   c. Remove the oil pressure switch (C) and the breather pipe (D).

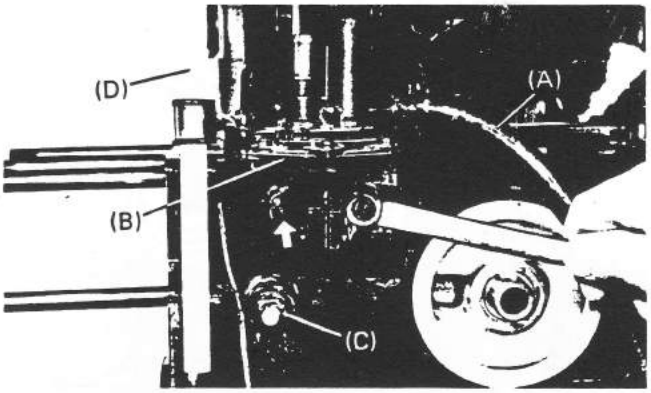


Fig. 43

12. Removing the carburetor
   Unscrew two nuts, and remove the carburetor (A). Remove the insulator (B) from the intake manifold.

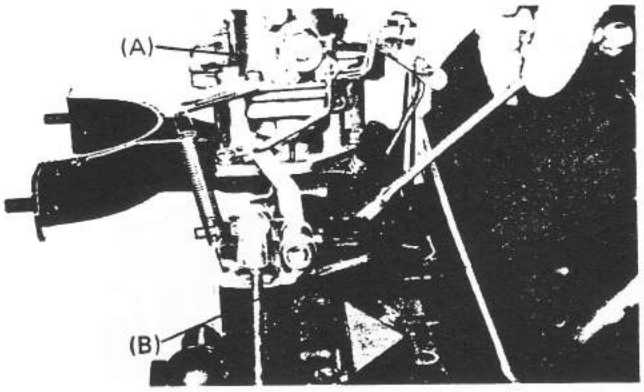


Fig. 44

13. Removing the intake manifold
   Unscrew eight nuts and remove the engine hanger (A). Then remove the intake manifold (B) from the cylinder head, together with the governor cover stay and the air cleaner stay mounted thereon.

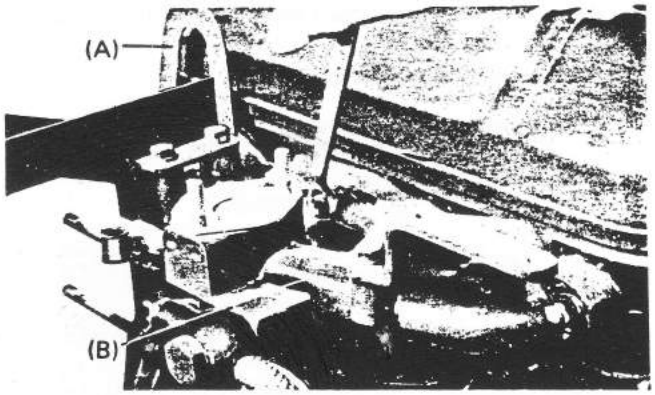


Fig. 45

14. Removing the exhaust manifold
   Unscrew eight nuts, remove the engine hanger (A), and then remove the exhaust manifold (B) from the cylinder head.

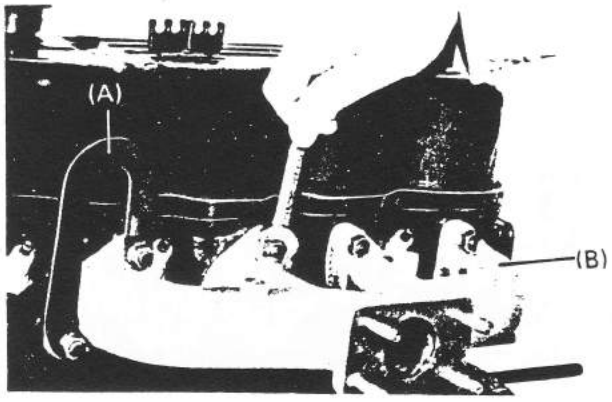


Fig. 46

15. Removing the rocker arm cover
Unscrew two bolts and remove the rocker arm cover from the cylinder head.

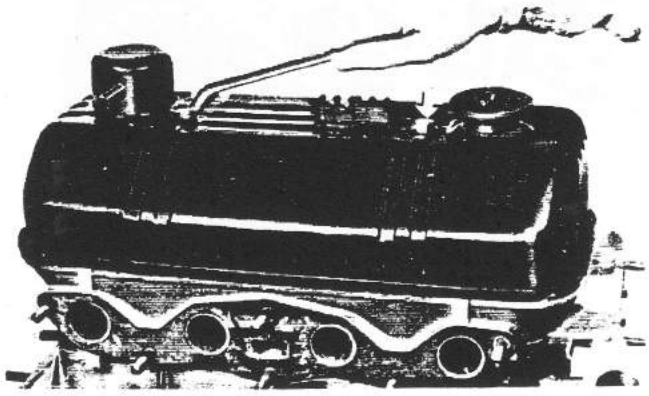


Fig. 47

16. **Removing the cylinder head assembly**
a. Unscrew ten cylinder head nuts.
b. Pull upward rocker arm assembly (A).
c. Pull upward eight push rods (B).
d. Remove the cylinder head assembly (C) from the cylinder block.
e. Remove the cylinder head gasket.

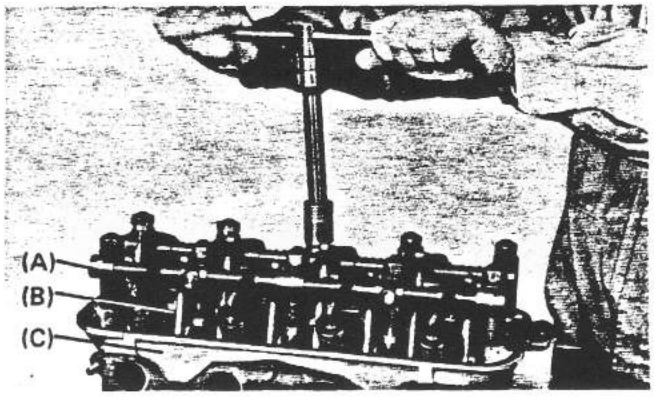


Fig. 48

17. Pull eight tappet followers from the cylinder head by using a proper tool such as a magnet.

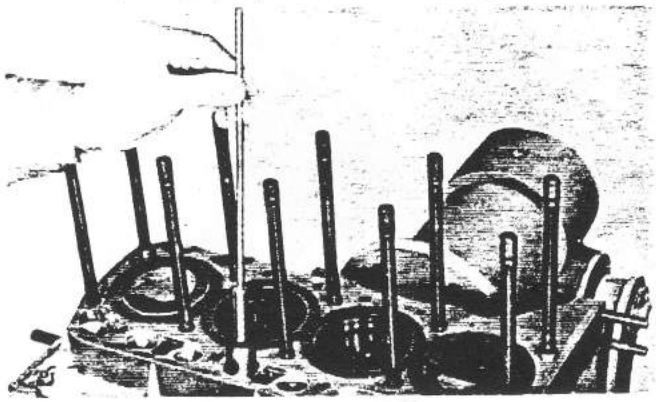


Fig. 49

18. Removing the oil pump drive gear shaft.
a. Unscrew two nuts and remove the oil pump drive gear cover (A).
b. Unscrew three nuts and remove the blind cover (B).
c. Lift off the oil pump drive gear shaft (D) together with the shim (E) and the thrust washer (C).

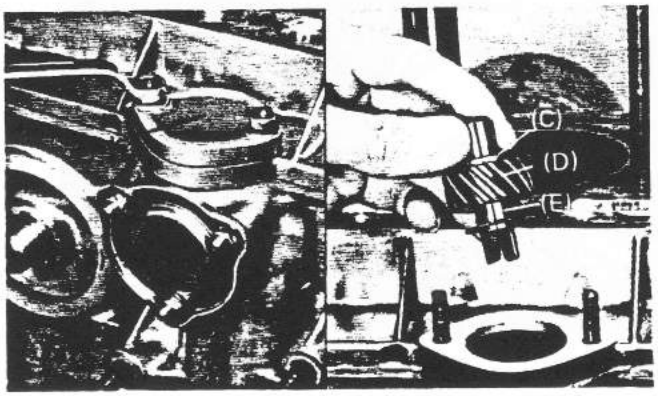


Fig. 50

19. Turn the engine upside down and now the oil pan is upward.

20. **Removing the oil pan.**
Undo twenty-two nuts securing the oil pan (B) and lift off the oil pan from the cylinder block.

21. Unfasten the lock bolts and remove the crankshaft pulley (A) from the crankshaft.

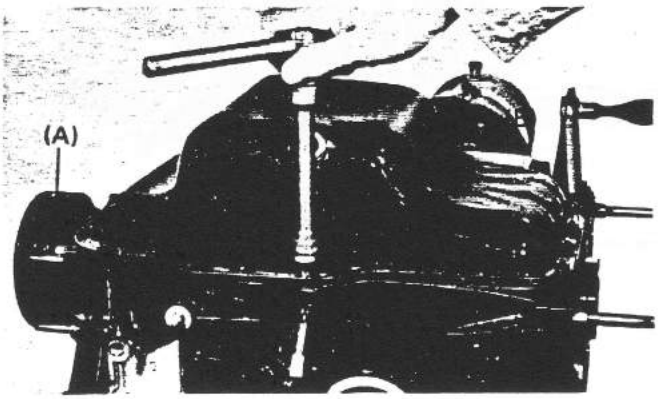


Fig. 51

22. Removing the timing chain cover
Undo nine nuts and remove the timing chain cover (A).

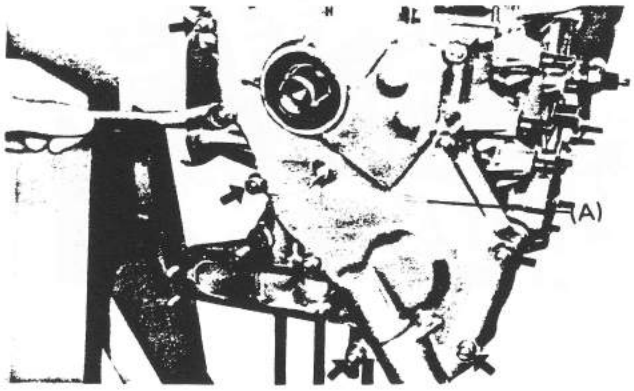


Fig. 52

23. **Removing the chain adjuster assembly.**
a. Undo two nuts and remove the chain adjuster assembly (A).
b. Remove the oil baffle plate (B) from the crankshaft.
c. Remove the key (C) from the crankshaft.
d. Undo two nuts and remove the vibration damper assembly (D).

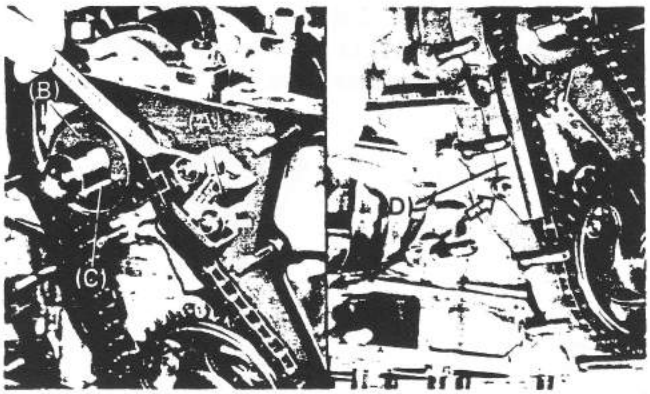


Fig. 53

24. **Removing the timing chain.**
a. Undo two nuts securing the camshaft (A)
b. Remove the camshaft & camsprocket wheel and the timing sprocket wheel together with the timing chain (B) from the crankshaft and the cylinder block as shown in Fig. 54.

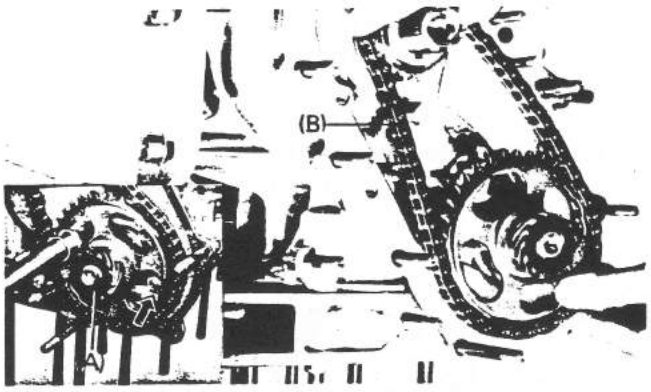


Fig. 54

25. **Removing the front plate.**
Undo two nuts and remove the front plate from the cylinder block.

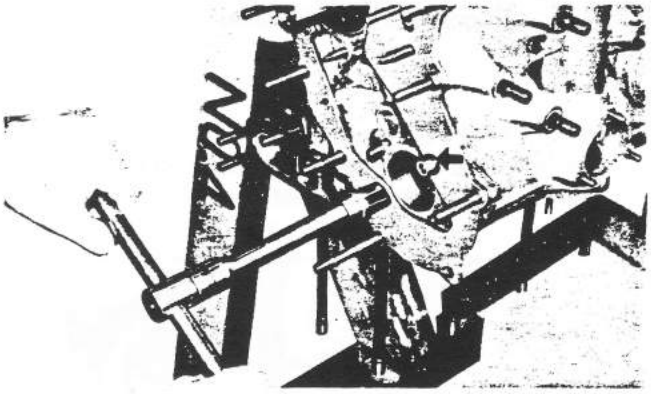


Fig. 55

26. **Removing the oil pump.**
a. Loosen the connection nuts and detach the oil pipe (A) from the cylinder block.
b. Unscrew two nuts and remove the oil strainer (B) from the oil pump (C).
c. Unscrew four nuts and lift up the oil pump.

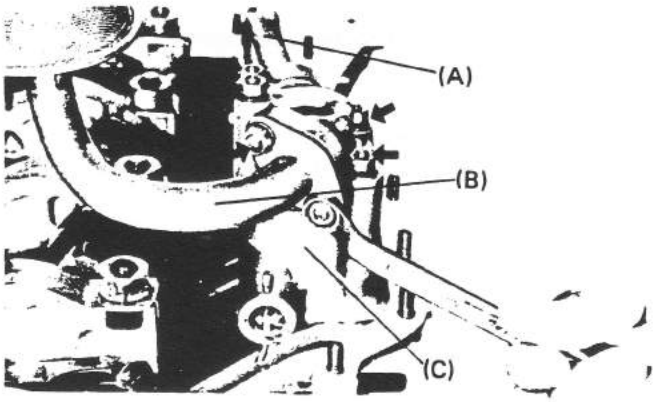


Fig. 56

27. Removing the connecting rod cap
Loosen eight connecting rod lock bolts and remove four connecting rod caps (A) together with the connecting rod bearing metal and the lock bolts.
Note: The connecting rod caps are marked with cylinder numbers (1, 2, 3 and 4), respectively.

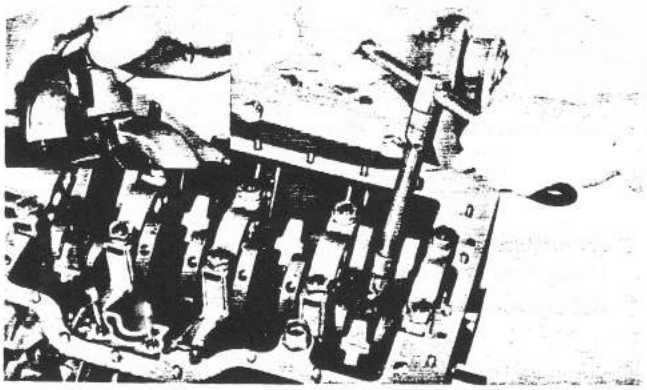


Fig. 57

28. Removing the main bearing cap
a. Straighten the bent edges of the lock washer and ten nuts securing the main bearing caps.

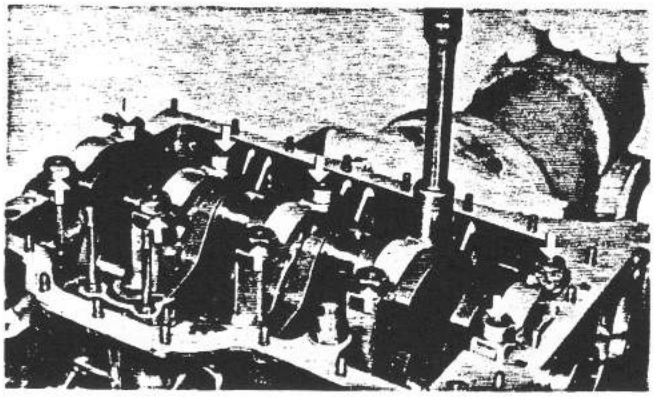


Fig. 58

b. Remove five main bearing caps together with the main bearing metal.

29. Removing the carnkshaft
a. Remove the crankshaft from the cylinder block.

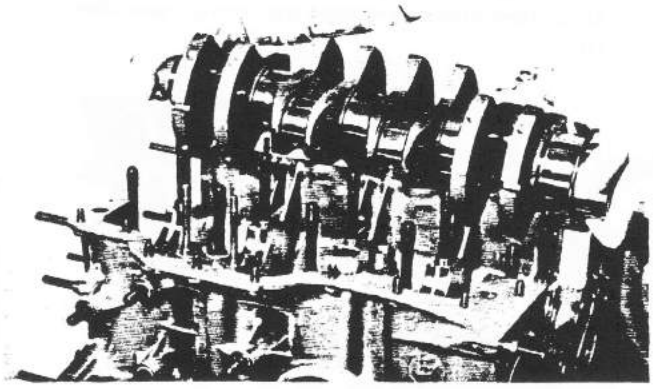


Fig. 59

b. Remove five main bearing metals from the cylinder block.

30. Lift up four piston & connecting rod assemblies from the cylinder block.

31. **Disassembling the piston & connecting rod assembly.**
a. Remove three piston rings and the expander.
b. Remove the clips at both ends of the piston pin.
c. Heat the piston with the piston heater 250 ~ 300°F (120 ~ 150°C) and pull out the piston pin by means of the special tool (No. 0490070 PISTON PIN INSTLLER) (A) and detach the piston from the connecting rod.

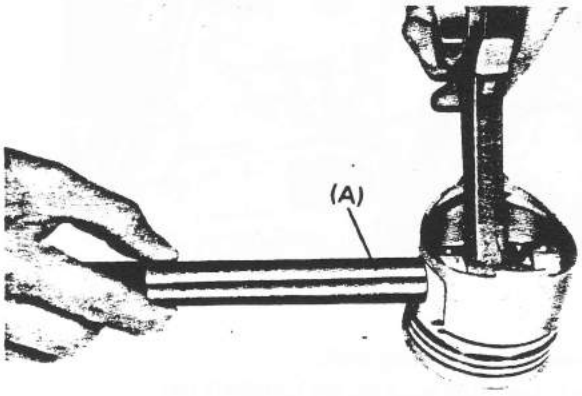


Fig. 60

32. **Disassembling the cylinder head assembly.**
Disassemble each valve mechanism in the following procedure.
a. Press the valve by means of the special tool (No. 0490030 VALVE SPRING LIFTER) (A) and remove the taper sleeves (B).

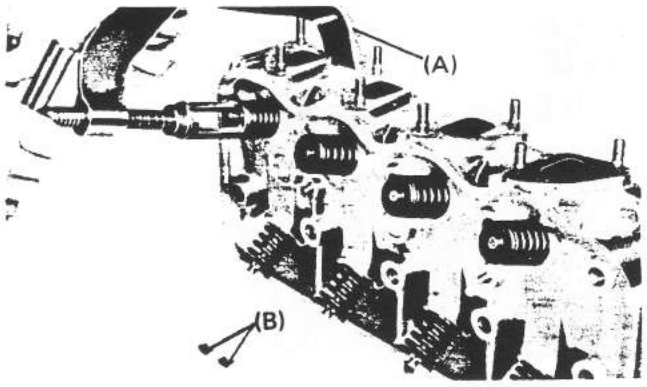


Fig. 61

b. Remove the valve spring lifter and dismantle the valve springs, the spring seat upper and lower, and valves.

2. Checking Maintenance and Limit of Adjustment

Notes: Before inspecting the engine.

- O Clear each component of dust, carbon, fur, etc. and wash it in solvent.
- O Check the cylinder head and cylinder block for leakages and damage.
- O Blow dust and so on off the oil aperture of each component by means of an air gun to ensure that there is no blockage.
- O Put the valves, bearing metals, bearing caps, etc. to be joined in good order and see that they do not get mixed.

2-1. Cylinder Head

1. Wash the cylinder head if there is much fur in the water passage of the cylinder head. Check the oil apertures for blockage.

2. Bend of the cylinder head bottom
   To check the cylinder head bottom for bend, measure the points (1) ~ (6) of the cylinder head bottom shown in Fig. 63 using a thickness gauge and a surface gauge. If the measured value is beyond the limit, correct it with a surface grinder.

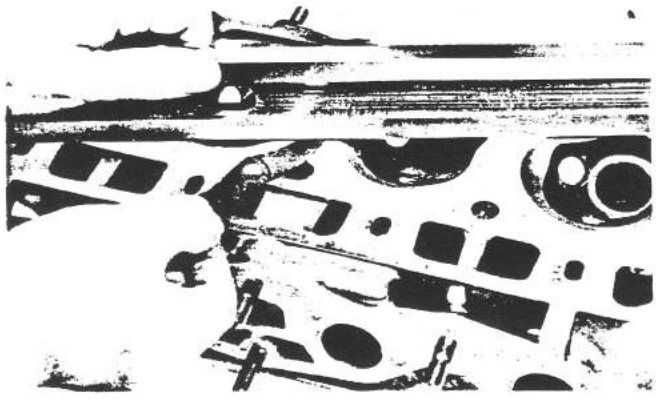


Fig. 62

	Limit	Grinding Limit
Cylinder Head Bend	0.006 in. (0.15 mm)	0.008 in. (0.20 mm)

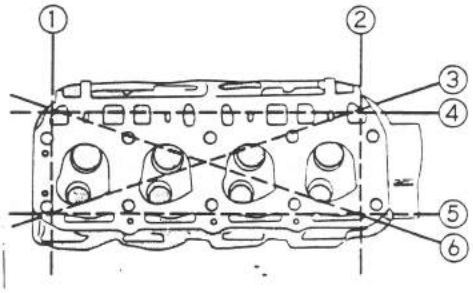


Fig. 63

3. Valve seat
   Check the valve seat for wear and damage, and if it is defective, correct it with a special tool (No. 0490140 VALVE SEAT CUTTER) (A). Besides, if the sinking of the valve seat is more than 0.059 in. (1.5 mm) replace the cylinder head with a new one.

Seat Cutter Pilot
- 45° cutter (for IN side sheet)
- 45° cutter (for EX side sheet)
- 15° cutter (for IN side port)
- 15° cutter (for EX side port)
- 75° cutter (for IN side face)
- 75° cutter (for EX side face)

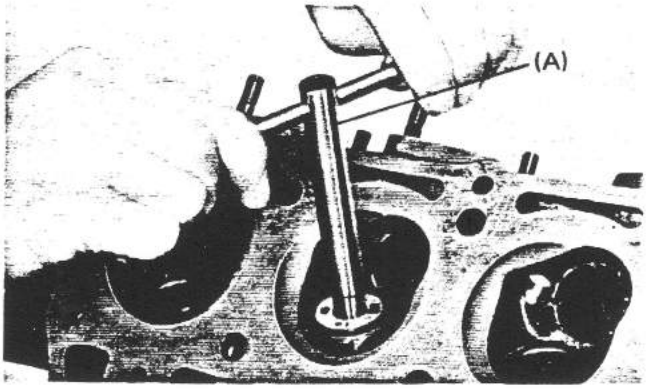
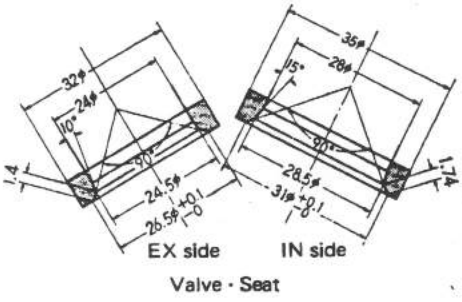


Fig. 64



1.74 (0.0684 in)
1.4 (0.0551 in)
32φ (1.2599 in)
24φ (0.9449 in)
24.5φ (0.9649 in)
26.5φ (1.0433 in)
35φ (1.3780 in)
28φ (1.1023 in)
28.5φ (1.1220 in)
31φ (1.2212 in)

Fig. 65

4. Valve face
Check the valve face for wear and damage, and if is defective, correct it with a valve face grinder. Besides, if the valve head is less than 0.039 in. (1 mm) thick, replace it with a new one as shown Fig. 66.

Valve Head Standard Thickness	IN side	0.059 in. (1.5 mm)
	EX side	0.059 in. (1.5 mm)

Note: After grinding the valve sheet and valve face, insert and adjust the valve spring sheet lower into the spring bottom to obtain the standard measurement (A) 1.596 in. (40.5 mm),
The valve spring seat lower is 0.020 in. (0.5 mm) thick as shown Fig. 67.

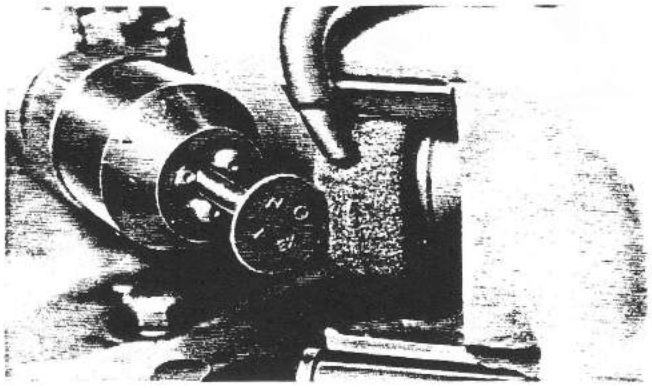


Fig. 66

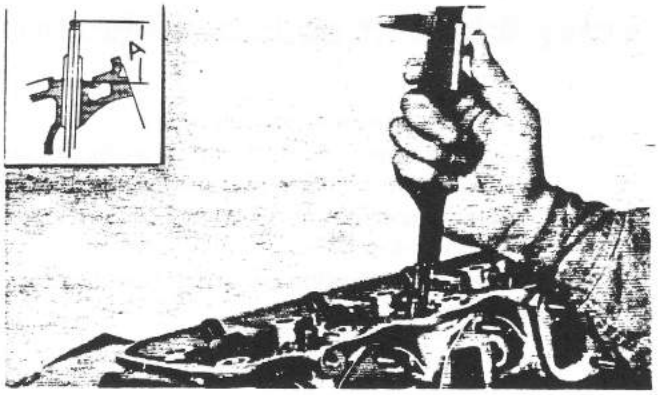


Fig. 67

5. Valve stem diameter
Check the diameter of the valve stem with a micrometer. If the valve stem is worn more than the limit compared with the standard diameter, replace the valve with a new one.

	Standard Valve Stem Diameter	Wear Limit
IN valve	$0.2756^{+0.0039}_{+0.0014}$ in. ($7.0\phi^{+0.010}_{+0.035}$ mm)	0.002 in. (0.05 mm)
EX valve	$0.2756^{+0.0012}_{+0.0006}$ in. ($7.0\phi^{+0.030}_{+0.015}$ mm)	0.002 in. (0.05 mm)

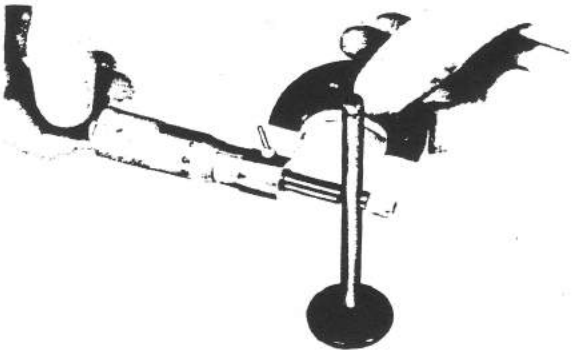


Fig. 68

6. **Clearance between the valve stem and valve guide**
Check the clearance between the valve stem (A) and valve guide (B). If the clearance exceeds the limit, replace the valve and valve guide.

	Standard Stem and Guide Clearance	Limit
IN side	0.001 – 0.003 in. (0.020 – 0.035 mm)	0.008 in. (0.2 mm)
EX side	0.002 – 0.003 in. (0.040 – 0.085 mm)	0.008 in. (0.2 mm)

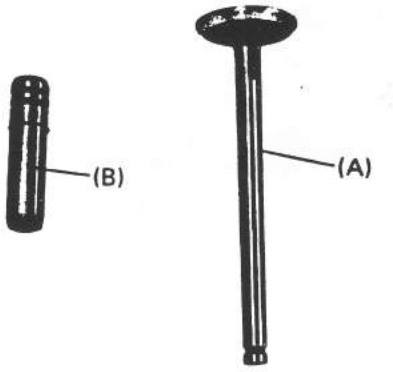


Fig. 69

7. **Valve guide replacement**

a. Remove the valve guide from the cylinder head and new one with a special tool (No. 0490050 VALVE GUIDE INSTALLER) (A) as shown in Fig. 70.

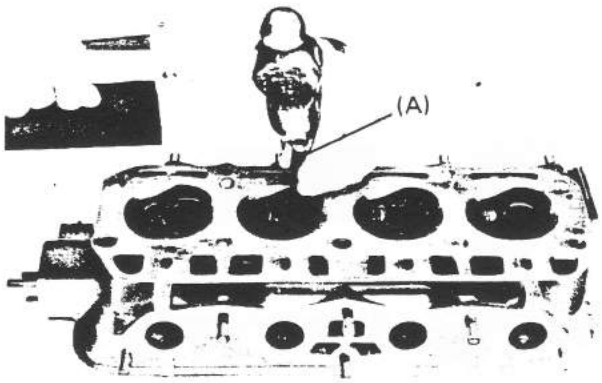


Fig. 70

The valve guide at IN side is different from that as EX side as shown in Fig. 71.

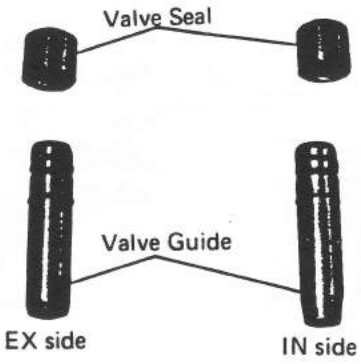


Fig. 71

b. In case the valve seal fitted to the IN and EX valve guides is defective, replace it with a new one using a special tool (No. 0490060 VALVE SEAL PUSHER).

8. **Valve spring check**
Check the valve spring for free length, spring pressure, and squareness in the procedure outlined below, and if it is defective, replace it with a new one.

a. Measure squareness of the valve spring with a level block and a square. Replace the spring if out of squareness is 0.118 in. (3 mm) per 3.937 in. (100 mm).

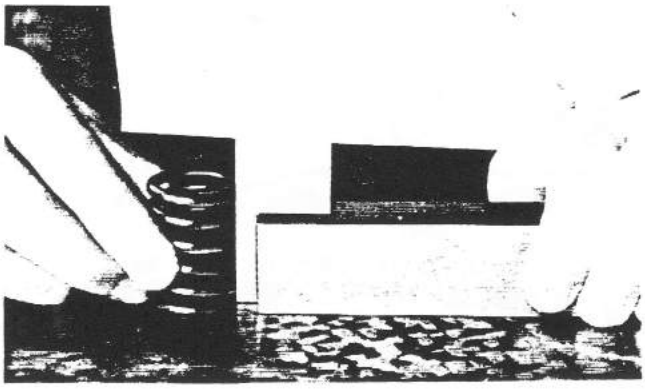


Fig. 72

b. Measure the free length of the valve spring. Replace the spring if it decreases more than 3% of the standard dimension.

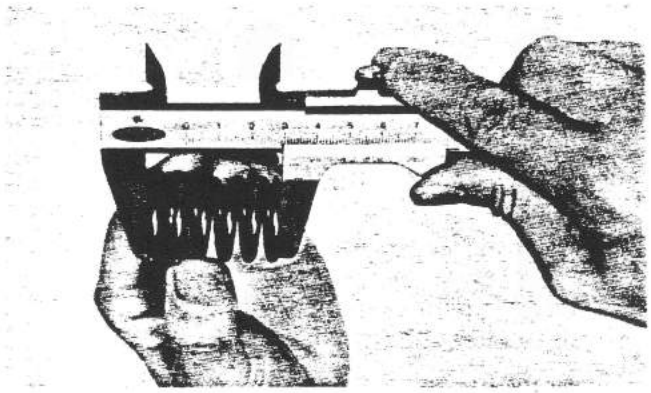


Fig. 73

c. Measure the spring pressure with a valve spring tester. Replace the spring if the spring pressure under set condition reduces more than 15% of the standard dimension.

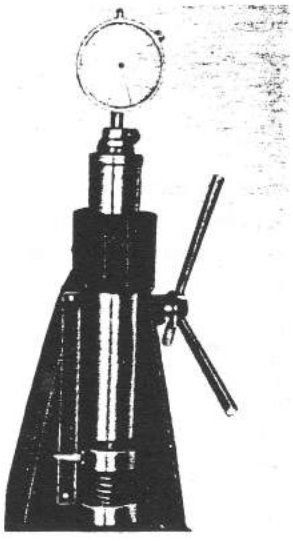


Fig. 74

Valve Spring Specifications	
free length	1.596 in. (40.53 mm)
spring pressure	46.3 lb (21.00kg)
set length	1.378 in. (35.00 mm)

Note: Before measuring the free length and pressure of the valve spring, press the valve spring several times to be fitted.

9. Rocker arm shaft checking

a. Measure the clearance between the rocker arm shaft and rocker arm, and if the measured value exceeds the limit, replace the rocker arm or rocker arm shaft.

	Standard	Limit
Clearance between the shaft and arm	0.001 – 0.003 in. (0.032 – 0.068 mm)	0.004 in. (0.1 mm)

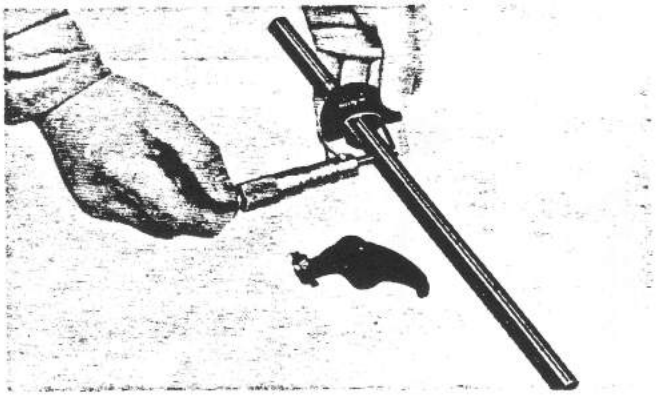


Fig. 75

b. If there is a remarkable bend in the rocker arm shaft, correct it to less than 0.0004 in. (0.001 mm) by means of a press.

2-2. Piston and Cylinder Block

1. Piston checking

a. Check the piston for crank and damage. If it is defective, replace it.

b. Measure the (A) thrust diameter just below the oil ring and (B) thrust skirt diameter.

Standard diameters of (A) and (B) are as follows:

(A) 2.6756 ± 0.0004 in. (67.96 ± 0.01 mm)

(B) 2.6779 ± 0.0004 in. (68.02 ± 0.01 mm)

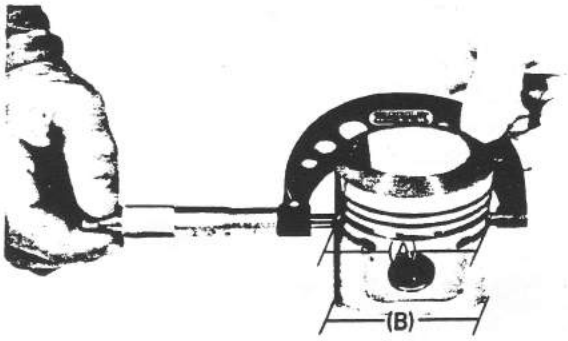


Fig. 76

2. **Fitting the piston and piston pin**
Measure the allowance between the piston and piston pin. If the measured value is too small, replace the piston and piston pin.

Standard allowance between the piston and piston pin	0.0002 – 0.0009 in. (0.004 – 0.023 mm)

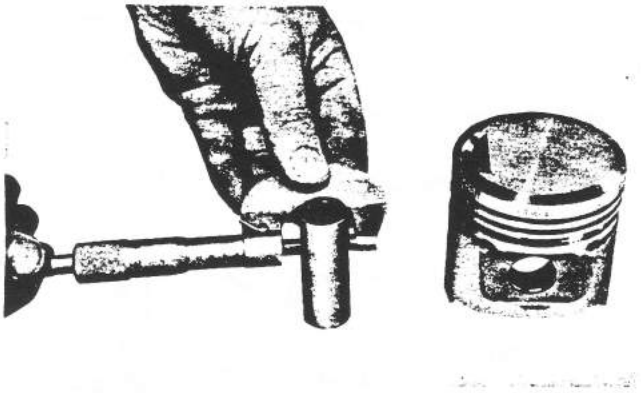


Fig. 77

Note: When fitting and removing the piston and piston pin, heat the piston to 250 ~ 300°F (120 ~ 150°C).

3. **Clearance between the piston ring and ring groove**
Measure the clearance between the piston ring and ring groove with a special tool (No. N026 STANDARD FEELER GAUGE). If the measured value exceeds the clearance limit, replace the piston ring.

Parts	Standard clearance	Clearance limit
Top Ring	0.001 – 0.003 in. (0.035 – 0.070 mm)	0.006 in. (0.15 mm)
Second Ring	0.001 – 0.003 in. (0.030 – 0.064 mm)	0.006 in. (0.15 mm)
Oil Ring	0.001 – 0.002 in. (0.030 – 0.062 mm)	0.006 in. (0.15 mm)

Fig. 78

4. **Piston ring end gap**
Measure the piston ring end gap with a special tool (No. N026 STANDARD FEELER GAUGE) (A) thickness gauge.
If the measured value exceeds the standard end gap remarkably, replace the piston ring.

Parts	Standard end gap
Top Ring Second Ring Oil Ring	0.008 – 0.016 in. (0.20 – 0.40 mm)

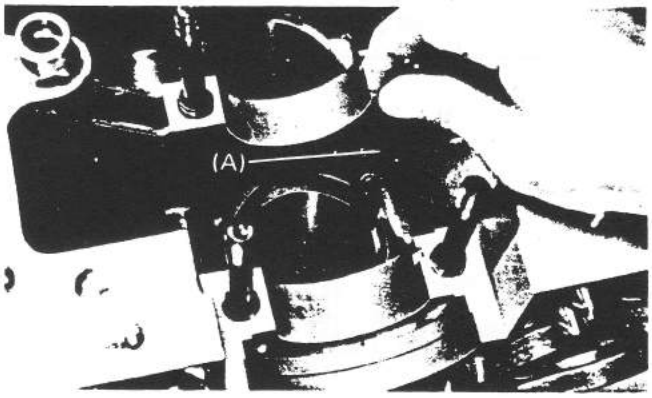


Fig. 79

5. **Cylinder block**

a. Check each water passage and oil aperture of the cylinder block, and if much fur is found, wash it away in solvent.

b. The cylinder is a wet type.
Check the inside of the cylinder for scratching, and if it is defective, replace the cylinder liner.

c. Check the inside of the cylinder liner for wear at six points shown in Fig. 81.

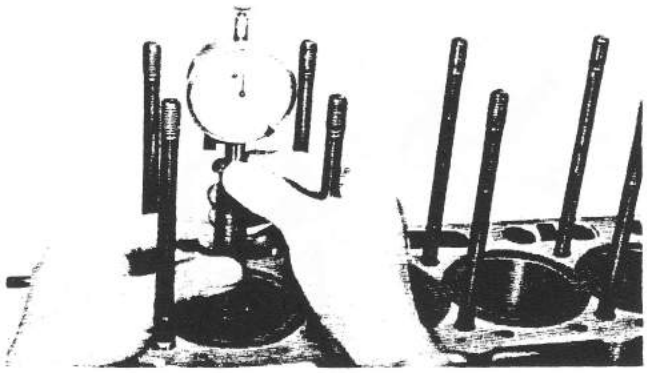


Fig. 80

If the measured value is 0.006 in. (0.15 mm) more than the standard value below, replace the cylinder liner.

Cylinder mark	Standard value	Wear limit
A	$2.6772\ \phi\ ^{+0.0008}_{+0.0005}$ in. $(68\ \phi\ ^{+0.019}_{+0.012}$ mm)	0.006 in. (0.15 mm)
No Mark	$2.6772\ \phi\ ^{+0.0005}_{+0.0002}$ in. $(68\ \phi\ ^{+0.012}_{+0.006}$ mm)	0.006 in.
C	$2.6772\ \phi\ ^{+0.0002}_{+0.0000}$ in. $(68\ \phi\ ^{+0.006}_{+0.000}$ mm)	0.006 in. (0.15 mm)

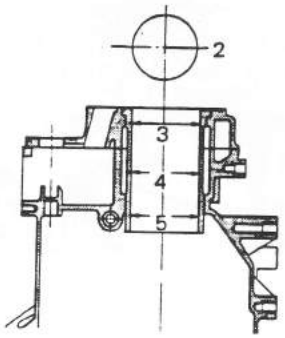


Fig. 81

6. Cylinder liner replacing
When removing and fitting the cylinder liner from and to the cylinder block, use a special tool (No. 0490090 CYLINDER LINER PULLER) (A).
Fig. 82 shows pulling the cylinder liner out from the cylinder block.

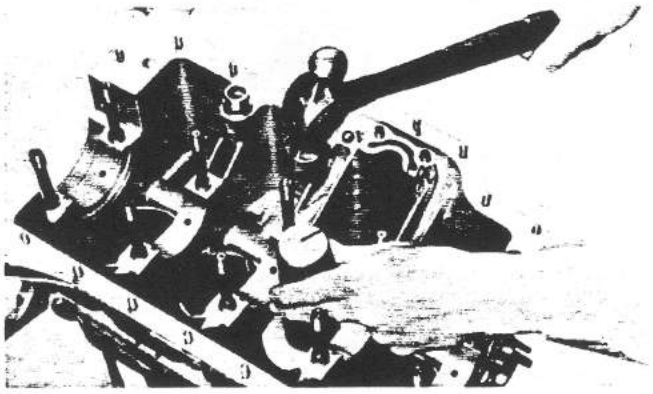


Fig. 82

7. Fitting the cylinder liner and top deck
When fitting the cylinder liner and top deck, fit them together bearing same marks in order to keep the amount of protrusion uniform (marks are classified into two, A and no mark, as shown in Table 1). Marks are on the cylinder liner front and rear and on the top of the top deck.
Fig. 83 shows measuring the cylinder liner protrusion.

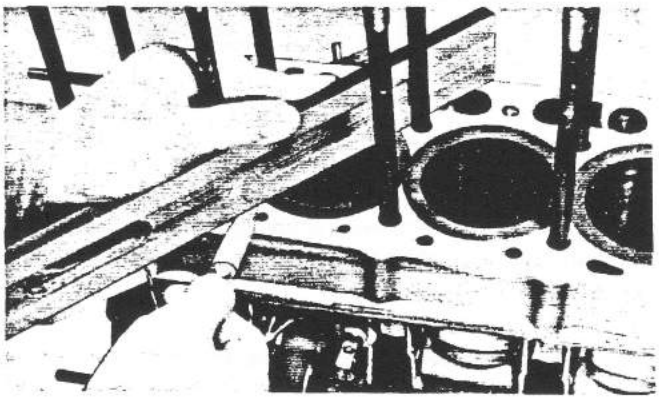


Fig. 83

Mark	Top Deck	Cylinder Liner	Protrusion
A	$0.3464\ ^{+0.0012}_{-0}$ in. $(8.5\ ^{+0.03}_{-0}$ mm)	$0.3464\ ^{+0.0024}_{+0.0016}$ in. $(8.5\ ^{+0.060}_{+0.040}$ mm)	0.0004 ~ 0.0024 in. (0.010 ~ 0.060 mm)
No Mark	$0.3464\ ^{+0}_{-0.0012}$ in. $(8.5\ ^{+0}_{-0.03}$ mm)	$0.3464\ ^{+0.0016}_{+0.0006}$ in. $(8.5\ ^{+0.040}_{+0.015}$ mm)	0.0006 ~ 0.0028 in. (0.015 ~ 0.070 mm)

Cylinder Liner Protrusion

8. **Standard clearance between the cylinder and piston**
The standard clearance between the cylinder and piston is 0.001 ~ 0.007 in. (0.030 ~ 0.069 mm).

The cylinders and pistons are classified into three (A, no mark, and C) and those with same marks are fitted together.

Mark	Cylinder Liner Standard Value	Piston Standard Value	Clearance
A	$2.6772\ ^{+0.0008}_{+0.0005}$ in. $(68\ \phi\ ^{+0.019}_{+0.012}$ mm)	$2.6756\ ^{+0.0004}_{+0.0001}$ in. $(67.96\ \phi\ ^{+0.010}_{+0.003}$ mm)	0.0017 ~ 0.0022 in. (0.042 ~ 0.056 mm)
No Mark	$2.6772\ ^{+0.0005}_{+0.0002}$ in. $(68\ \phi\ ^{+0.012}_{+0.006}$ mm)	$2.6756\ ^{+0}_{-0.0001}$ in. $(67.96\ \phi\ ^{+0}_{-0.003}$ mm)	0.0017 ~ 0.0022 in. (0.046 ~ 0.055 mm)
C	$2.6772\ ^{+0.0002}_{+0}$ in. $(68\ \phi\ ^{+0.006}_{+0}$ mm)	$2.6756\ ^{-0.0001}_{-0.0004}$ in. $(67.96\ \phi\ ^{-0.003}_{-0.010}$ mm)	0.0017 ~ 0.0022 in. (0.043 ~ 0.056 mm)

9. **Clearance between the tappet and guide**
Check the clearance between the tappet and guide, and if the clearance exceeds the limit, replace the tappet.

	Standard clearance	Clearance limit
Tappet and Guide	0.0008 ~ 0.0029 in. (0.020 ~ 0.074 mm)	0.004 in. (0.10 mm)

Fig. 84

10. Push rod
Measure the push rod bend with a special tool (No. N026 STANDARD FEELER GAUGE) and if the measured value exceeds the accuracy remarkably, correct or replace it as shown in Fig. 85.

Push Rod Bend Accuracy	less than 0.004 in. (less than 0.1 mm)

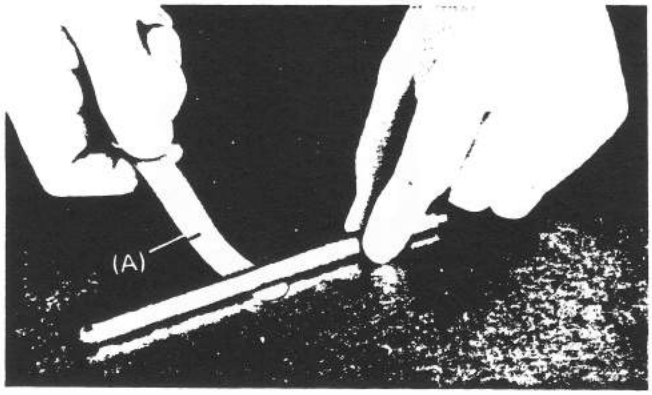


Fig. 85

2-3. Connecting Rod

1. **Connecting rod and piston pin**
Check the clearance between the connecting rod small end bush and piston pin. If the clearance exceeds the limit, replace the piston pin and small end bush.

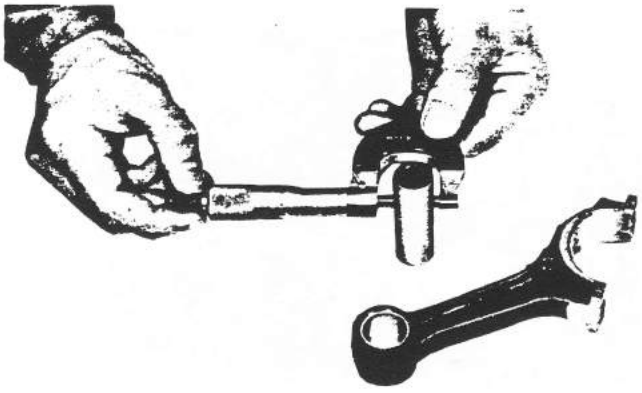


Fig. 86

	Standard clearance	Clearance limit
Small end bush and piston pin	0.0004 ~ 0.0012 in. (0.010 ~ 0.030 mm)	0.006 in. (0.15 mm)

2. Connecting rod small end bush replacing
When pulling and press-fitting the samll end bush, use a bushing tool and a press.

	Internal diameter (after press-fitted)	External diameter
Samll end bush	0.7874 $\phi^{+0.0006}_{+0.0001}$ in. (20 $\phi^{+0.014}_{+0.003}$ mm)	0.9055 $\phi^{+0.0034}_{-0.0022}$ in. (23 $\phi^{+0.086}_{-0.056}$ mm)

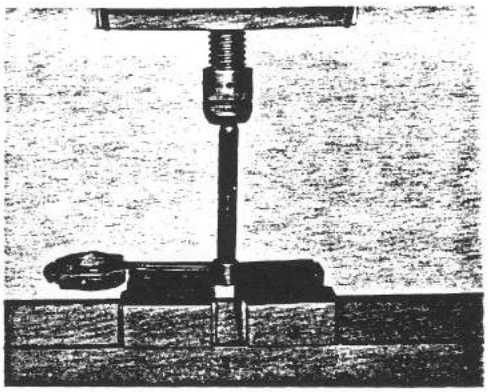


Fig. 87

Note: When press-fitting the small end bush to the connecting rod, align the oil aperture of the small end bush with that of the connecting rod.

3. Connecting rod large end play
Measure the connecting rod large end play with a special tool (No. N026 STANDARD FEELER GAUGE), and it is good if the measured value is in the range of 0.004 ~ 0.008 in. (0.110 ~ 0.214 mm).

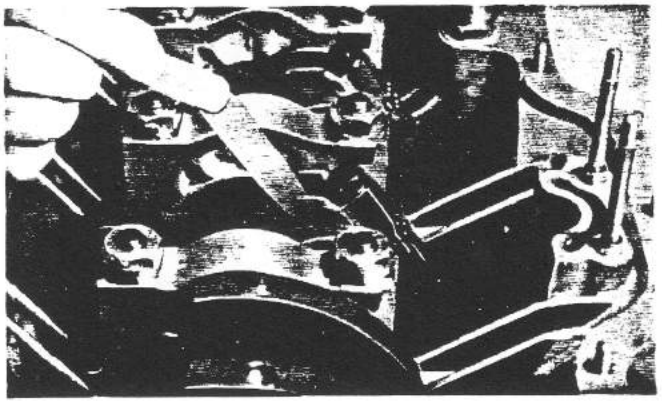


Fig. 88

4. Connecting rod deflection
Check the connecting rod deflection with a con-rod aligner, and if the measured value is not satisfactory, correct the connecting rod with a press or replace it.

Connecting rod deflection	less than 0.002 in. per 3.94 in. (less than 0.04 mm per 100 mm)
Distance between the large end and small end	4.84 ± 0.002 in. (123 ± 0.05 mm)

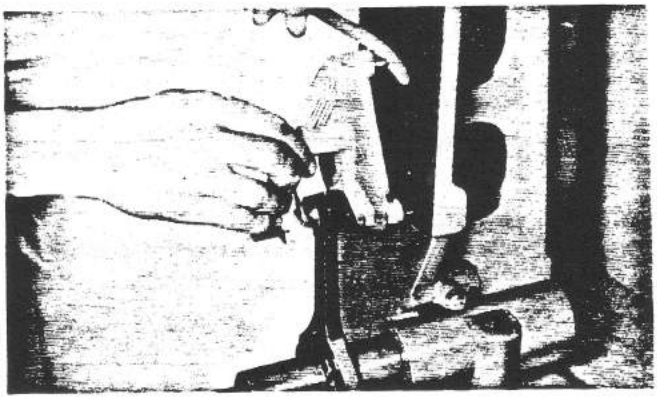


Fig. 89

Note: On the side of the connecting rod cap is inscribed one of the weight marks (B, C, D, E, F, G and H).

5. Connecting rod bearing metal
Check the connecting rod bearing metal for scrape and damage, and if it is defective, replace it.

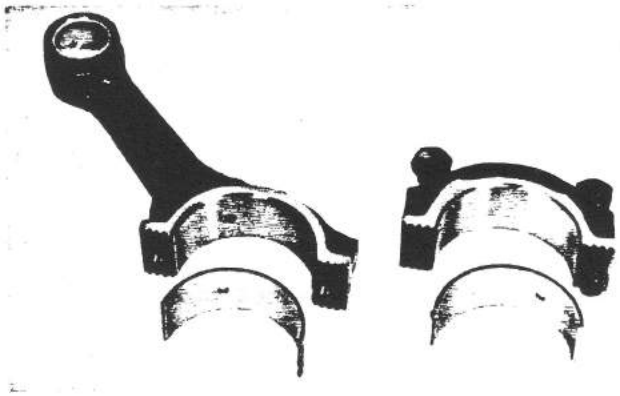


Fig. 90

Note: Connecting rod bearing metals are available in three kinds of the undersize metal, 0.01 in., 0.02 in. and 0.03 in. (0.25 mm, 0.50 mm and 0.75 mm).

6. Oil clearance between the connecting rod bearing metal and crank pin
   Check the oil clearance between the connecting rod bearing metal and crank pin with a plastigauge in the following procedure.

a. Clear the bearing metal and crank pin of dust, oil, etc.
b. Place the plastigauge on the crank pin.
c. Fit the bearing cap to the connecting rod and secure it to the crank pin with cap bolts at the specified torque of 25.3 ~ 28.9 ft-lb (3.5 ~ 4.0 m-kg).
d. Loosen the cap bolts and remove the connecting rod and place the plastigauge as shwon in Fig. 91.

Standard Oil Clearance	0.001 ~ 0.003 in. (0.027 ~ 0.073 mm)

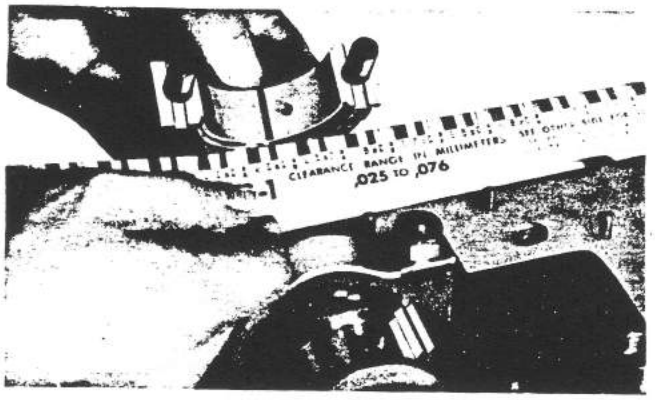


Fig. 91

When the clearance is rather excessive compared with the standard oil clearance, grind the crank pin to an undersize and use the undersize bearing metal to obtain the standard oil clearance.

2-4. Crankshaft and Main Bearing Metal

1. Check the crankshaft for crack and damage, and if it is defective, replace it.
   Check the crankshaft oil passage in dotted line shown in Fig. 92.

Fig. 92

2. Crankshaft warp
   To check warp, mount the crankshaft on the center holding device and measure the warp with special tool (No. 107M DIAL INDICATOR, No. YM-1 MAGNETIC BASE FOR DIAL INDICATOR).
   If the measured value exceeds the limit, correct it with a press.

	Accuracy	Limit
Crankshaft warp	less than 0.0008 in. (less than 0.02 mm)	0.001 in. (0.03 mm)

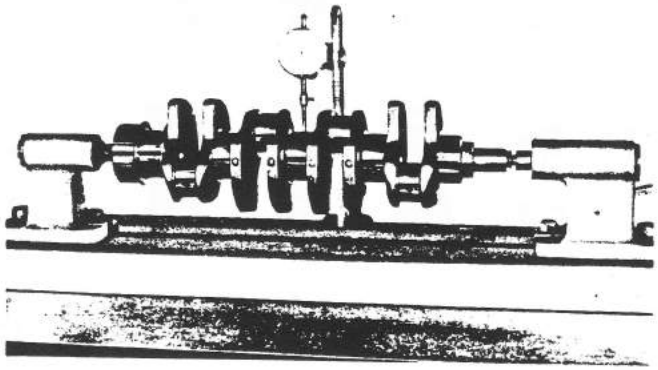


Fig. 93

3. Crank pin and main journal
Measure the diameter of the crank pin and main journal with a special tool (No. 75MB OUTSIDE MICROMETOR CALIPER).
In case wear is more than 0.002 in. (0.05 mm), correct the crankshaft by grinding to the undersize of 0.01, 0.02 or 0.03 in. (0.25, 0.50 or 0.75 mm) with a crankshaft grinder.

LINE BORE MAINS 2.3622 TO 2.3629

ROD BORE BIG END 1.8897 TO 1.8904

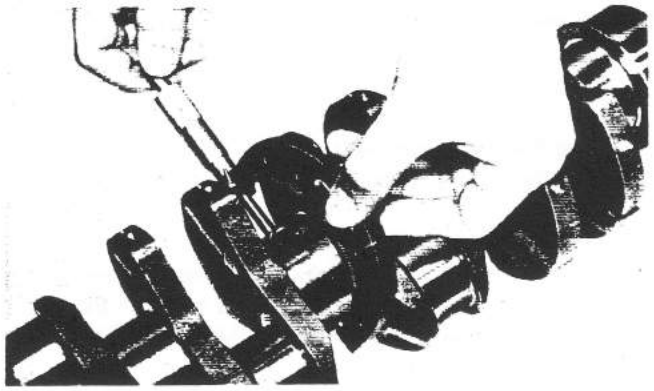


Fig. 94

	Standard diameter	Wear limit	Grinding limit
Crank pin	1.7717 ϕ $^{-0.0018}_{-0.0024}$ in. (45 ϕ $^{-0.045}_{-0.060}$ mm)	0.002 in. (0.05 mm)	0.03 in. (0.75 mm)
Main journal	2.2048 ϕ $^{-0.0018}_{-0.0024}$ in. (56 ϕ $^{-0.045}_{-0.060}$ mm)	0.002 in. (0.05 mm)	0.03 in. (0.75 mm)

4. **Main bearing metal**
The main bearing metal is of interchangeable type, and fit them together in the procedure shown in Fig. 95.
Check the main bearing metal for flaking or any damage, and if it is defective, replace it.

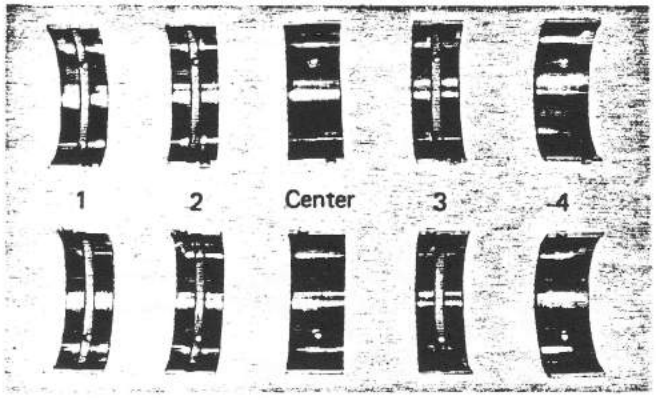


Fig. 95

5. **Oil clearance between the main bearing metal and main journal**
Measure the standard oil clearance between the main bearing metal and main journal with a plastigauge. The measuring and correcting procedures are as in "Oil clearance between connecting rod bearing metal and crank pin".

Standard oil clearance	0.0007 ~ 0.0029 in. (0.019 ~ 0.073 mm)
Main bearing cap torque	43 ~ 47 ft-lb (6.0 ~ 6.5 m-kg)
Undersize metal	0.01 in., 0.02 in., 0.03 in. (0.25 mm, 0.50 mm, 0.75 mm)

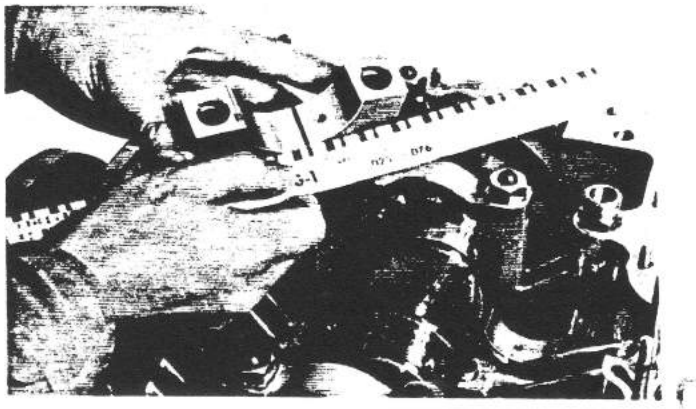


Fig. 96

6. Crankshaft end play
Measure tha crankshaft end play with a special tool (No. N026 STANDARD FEELER GAUGE). If the measured value exceeds the limit, replace the thrust washer inserted into the main bearing cap rear with an oversize washer in order to obtain the standard end play.

	Standard value	Limit
Crankshaft end play	0.004 ~ 0.0011 in. (0.110 ~ 0.274 mm)	0.012 in. (0.3 mm)

Oversize thrust washer	0.01 in., 0.02 in., 0.03 in., (0.25 mm, 0.50 mm, 0.75 mm)

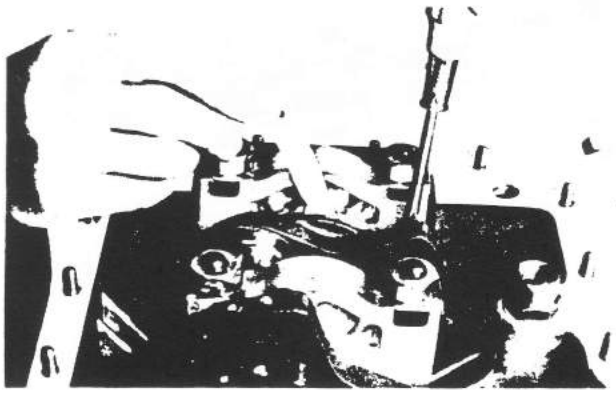


Fig. 97

2-5. Camshaft

1. Check the camshaft distributor drive gear and oil pump drive gear (A) for damage and wear, and the cam and journal for damage. If one is defective, replace it.

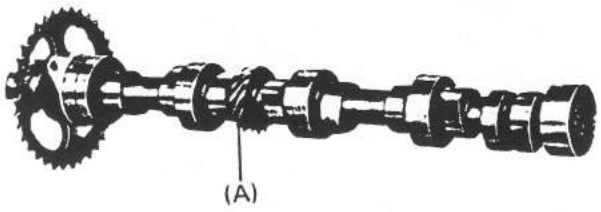


Fig. 98

2. Camshaft journal and cam height

a. Measure the diameter of the camshaft journal with a special tool (No. 75MB OUTSIDE MICROMETER CALIPER), and if the measured value is more than 0.002 in. (0.05 mm) smaller than the standard diameter, replace the journal.

	Journal No.	Standard diameter	Wear limit
Camshaft	1	$1.8898 \begin{smallmatrix}-0.0008\\-0.0014\end{smallmatrix}$ in. ($48 \begin{smallmatrix}-0.020\\-0.036\end{smallmatrix}$ mm)	0.002 in. (0.05 mm)
	2	$1.8111 \begin{smallmatrix}-0.0010\\-0.0016\end{smallmatrix}$ in. ($46 \begin{smallmatrix}-0.025\\-0.041\end{smallmatrix}$ mm)	
	3	$1.7717 \begin{smallmatrix}-0.0010\\-0.0016\end{smallmatrix}$ in. ($45 \begin{smallmatrix}-0.025\\-0.041\end{smallmatrix}$ mm)	
	4	$1.7323 \begin{smallmatrix}-0.0010\\-0.0016\end{smallmatrix}$ in. ($44 \begin{smallmatrix}-0.025\\-0.041\end{smallmatrix}$ mm)	
	5	$1.6929 \begin{smallmatrix}-0.0008\\-0.0014\end{smallmatrix}$ in. ($43 \begin{smallmatrix}-0.020\\-0.036\end{smallmatrix}$ mm)	

b. Measure the cam height with a micrometer, and replace the camshaft if wear is more than 0.008 in. (0.2 mm).

	Standard height	Wear limit
Cam height (IN and EX)	1.4352 in. (36.454 mm)	0.008 in. (0.2 mm)

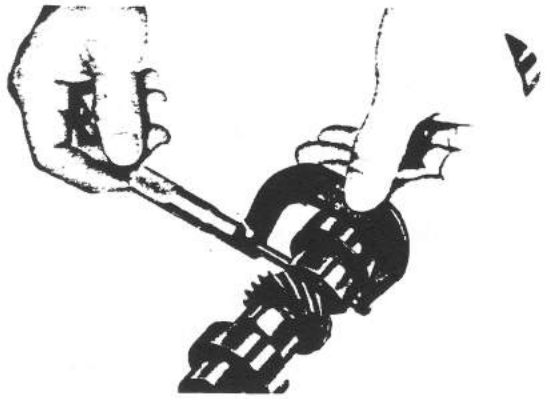


Fig. 99

3. Camshaft warp
Measure the camshaft warp with a special tool (No. 107M DIAL INDICATOR, No. YM-1 MAGNETIC BASE FOR DIAL INDICATOR). If the measured value exceeds the limit, correct it with a press.

	Accuracy (standard)	Limit
Camshaft run-out	less than 0.0004 in. (less than 0.01 mm)	0.001 in. (0.03 mm)

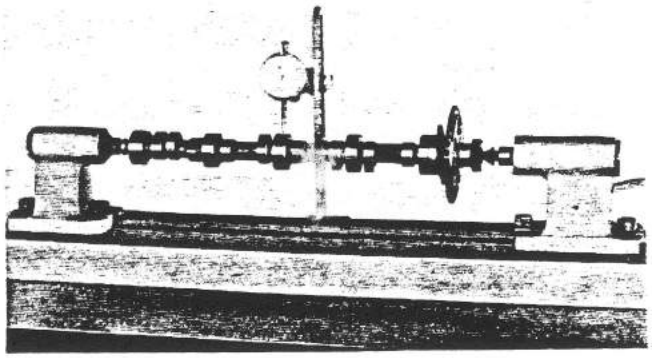


Fig. 100

5. Camshaft end play
Measure the camshaft end play with a special tool (No. N026 STANDARD FEELER GAUGE). Replace the thrust plate if the measured value exceeds the limit.

	Standard value	Limit
Camshaft end play	0.0008 ~ 0.0071 in. (0.02 ~ 0.18 mm)	0.008 in. (0.2 mm)

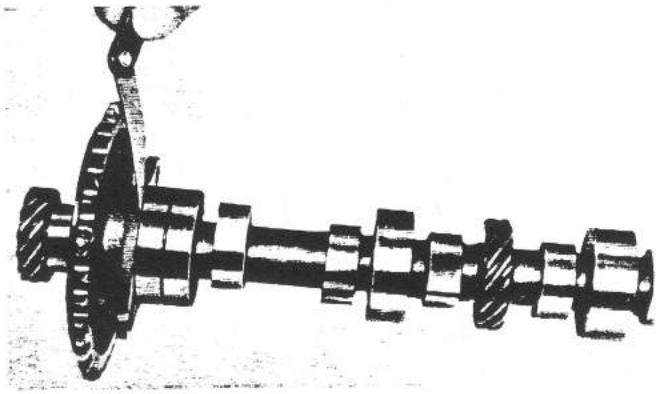


Fig. 101

4. Clearance
Measure the clearance between the camshaft journal and cylinder block journal bearing. Replace the camshaft and cylinder block if the measured value is 0.006 in. (0.15 mm) more than the standard clearance.

	Journal No.	Standard clearance	Clearance limit
Camshaft and journal bearing	1, 5,	0.0008 ~ 0.0018 in. (0.020 ~ 0.061 mm)	0.006 in. (0.15 mm)
	2, 3, 4,	0.0010 ~ 0.0027 in. (0.025 ~ 0.066 mm)	

2-6. Timing Chain Sprocket and Chain Adjuster

1. Timing chain and sprocket wheel
Check the timing chain and sprocket wheel for wear and damage, and if it is defective, replace it.

2. Timing chain tension
To check the timing chain tension, remove the timing chain cover, and it is good if (A) dimension of the chain adjuster is within 0.5 in. (12 mm). If it exceeds 0.5 in. (12 mm), replace the timing chain and sprocket wheel.

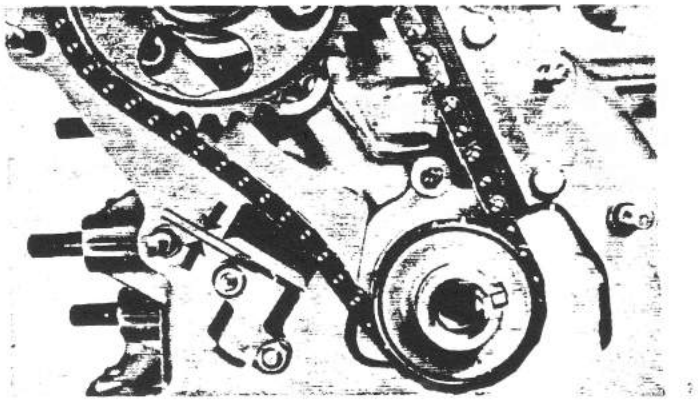


Fig. 102

3. Chain adjuster and vibration damper

a. Check the chain adjuster spring (A) for corrosion, and the slipper head (C) for wear. If one is defective, replace the assembly.

b. The vibration damper (B) is finished with heat-proof, oil-proof and wear-proof synthetic rubber.

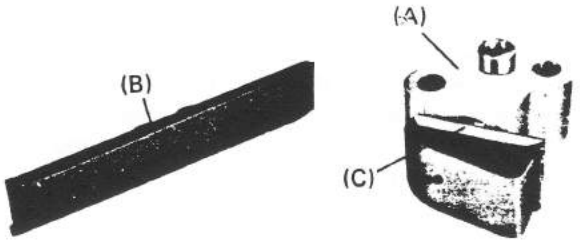


Fig. 103

3. Assembling Order

Notes: On the engine assembling.

- Check the clearances between the engine main parts, oil clearance, and play, bending, etc., referring to Chap. 4 "Engine Checking and Maintenance".
- Be sure to apply engine oil to the engine revolving and sliding parts.
- Usually replace the packings, gaskets, lock washers, etc. with new ones.
- Secure the bolts, nuts, etc. of the engine main parts at the specified torque by means of a torque wrench.
- After installing the engine revolving parts, start the engine to ensure that it runs smoothly without a strange sound, knocking, unreasonable vibration, etc.

3-1. Assembling the Engine

1. **Installing the piston and connecting rod**

a. Fit a clip to the clip groove at one end of the piston.

b. Heat the piston with the piston heater 250 ~ 300°F (120 ~ 150°F) and insert the piston pin quickly into the contact point with the clip by means of the special tool (No. 0490070 PISTON PIN INSTALLER) (A).
Note: When fitting the piston pin to the connecting rod, the mark F (B) on the piston must be positioned in relation to the oil jet hole (C) of the connecting rod as shown in Fig. 104.

c. Fit a clip to the clip groove at the other end of the piston as shown in Fig. 104.

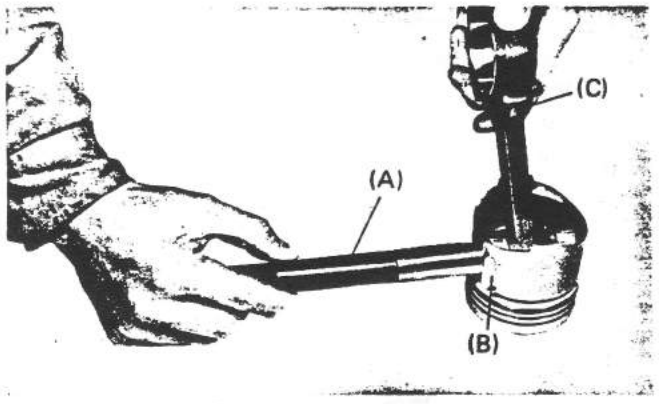


Fig. 104

2. **Fitting the piston ring to the piston**
Fit each piston ring as shown in Fig. 105 following the procedure outlined below:

a. Fit the expander to the lowest groove on the piston and next the oil ring (A).

b. Fit the second ring (B) and top ring (C).
Note: Be sure to fit each piston ring with the mark R (D) upwards. Besides, do not expand rings more than necessary to install.

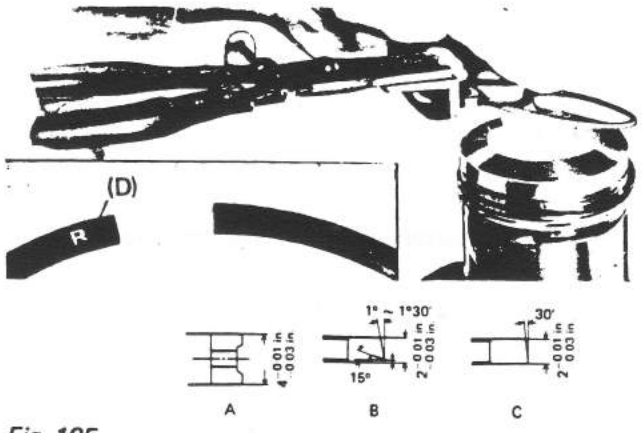


Fig. 105

3. Installing the valve mechanism to the cylinder head
Follow the procedure outlined below to install the valve mechanism to the cylinder head:
a. Fit the valve, spring seat lower, valve spring, and spring seat upper to the cylinder head, and compress the spring valve, using the special tool (No. 0490030 VALVE SPRING LIFTER).
b. Insert the taper sleeves (A) and ease the compression to the valve spring slowly, and remove the valve spring lifter.

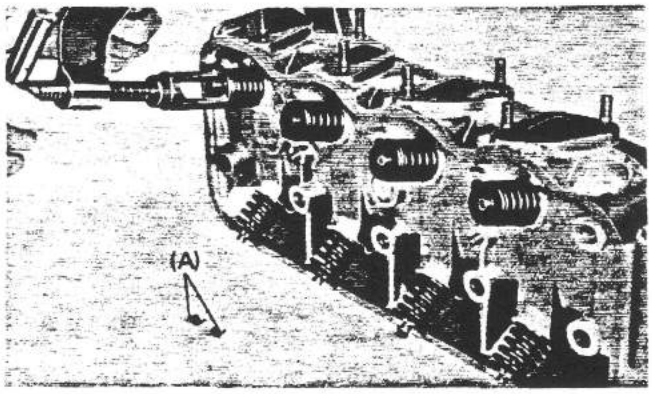


Fig. 106

Note: The taper sleeves at the IN side are differenti from those at the EX side, and the taper sleeve fitting is as shown in Fig. 107.

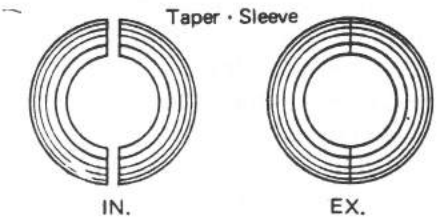


Fig. 107

4. Fit the cylinder block to the special tool (No. 0490010 ENGINE STAND) with the cylinder head upwards.

5. Installing the piston and connecting rod large end
a. Place each piston ring at about 120° apart and alternate the gap of the oil ring and that of the expander (A).

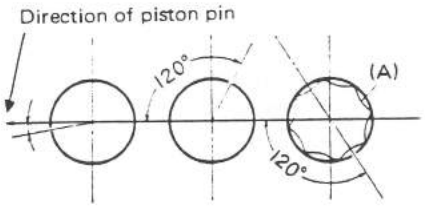


Fig. 108

b. Using a special tool (No. 0490080 PISTON INSERTING GUIDE) (B), install the piston and connecting rod large end with "F" mark on the piston toward the front of the engine, tapping the head of the piston with a plastic hammer.
Note: Prevent the gap of the piston ring from facing the thrust side and the piston pin side.

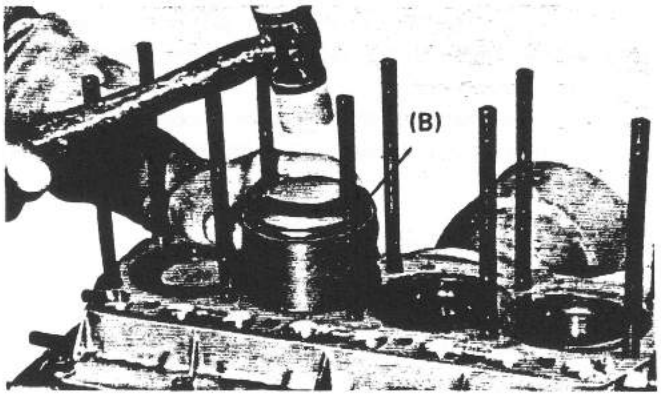


Fig. 109

6. Turn the engine upside down and now the crankshaft is upward.

7. Installing the crankshaft
a. Fit the main bearing metals to the cylinder block and the main bearing cap.
Note: Fit the main bearing metals with the same mark at the disassembly.
b. Fit the block thrust washer to both ends of the cylinder block rear (B) with the oil groove (A) outside.

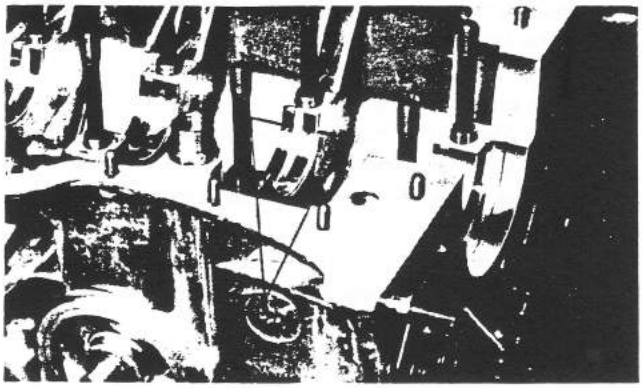


Fig. 110

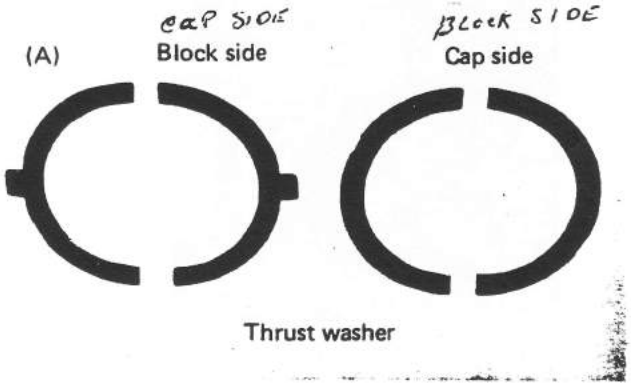


Fig. 111

c. Install the crankshaft on the main bearing metals.
Note: Be careful not to drop the thrust washer.
d. Apply graphite grease to the lip of the oil seal (A) and fit it to the rear of the crankshaft.
e. Insert the side seals (B) into the grooves at both sides of the No. 5 main bearing cap. Then fit the thrust washers (C) to the cap (Fig. 112) and install the cap to the cylinder block and crankshaft.
Note: Apply the special tool (No TL-05 THREE BOND No. 5) to the side seal and fit it with the wider lip of the side seal toward the flank of the engine.

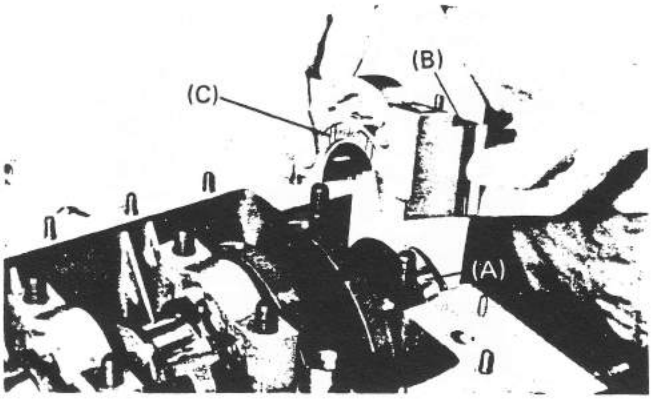


Fig. 112

f. Fit the main bearing caps and tighten them to the specified torque of 43 ~ 47 ft-lb (6.0 ~ 6.5 m-kg) with ten nuts.
Note: Fit the main bearing caps in accordance with the marks showing the arrangement order (A, B, A and D from the front of the engine).
g. Bend the lock washer around the nut.

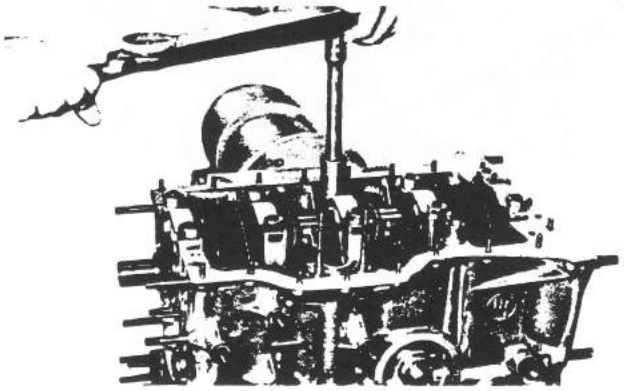


Fig. 113

8. Fitting the piston and connecting rod to the crankshaft

a. Fit the piston and connecting rod large end, and the connecting rod caps to the crankshaft.
Note: When fitting them, be sure to match the mark of the cap with that of the large end.
b. Tighten each connecting rod cap to the specified torque of 25.3 ~ 28.9 ft-lb (3.5 ~ 4.0 m-kg) with eight cap bolts.

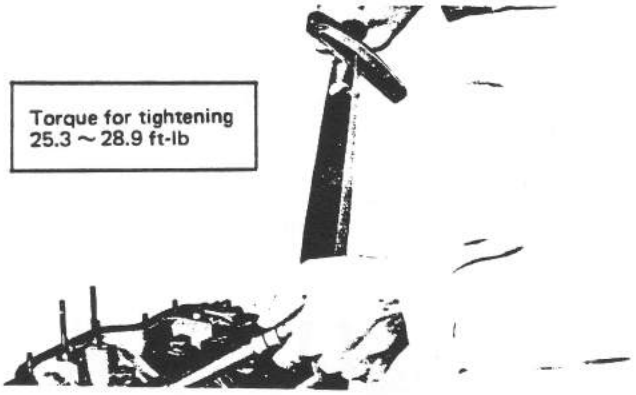


Fig. 114

9. Installing the oil pump and oil strainer

a. Insert the oil pump from above the cylinder block and secure it with four nuts. Then, fit the oil pipe to the cylinder block and oil pump.

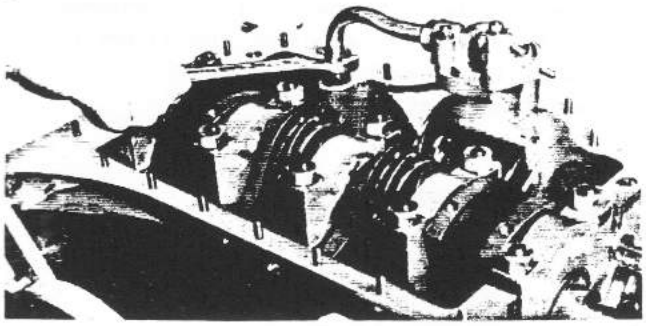


Fig. 115

b. Secure the oil strainer to the oil pump with two nuts.
Note: Insert the "O" ring (A) into the oil strainer as shown in Fig. 116.

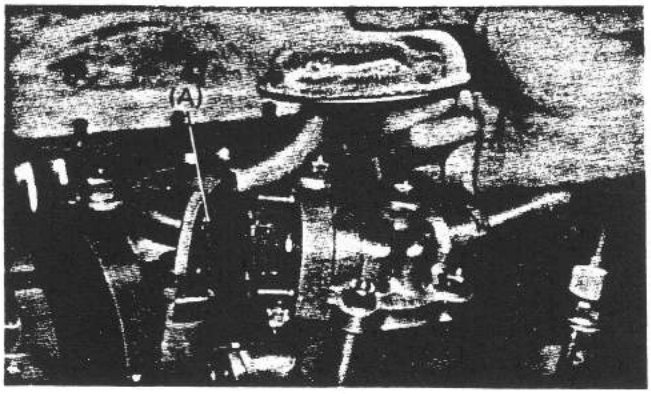


Fig. 116

10. Turn the engine upside down so that the cylinder head is upward.

11. Fitting the front plate
Secure the front plate together with the packings to the cylinder block with two nuts.

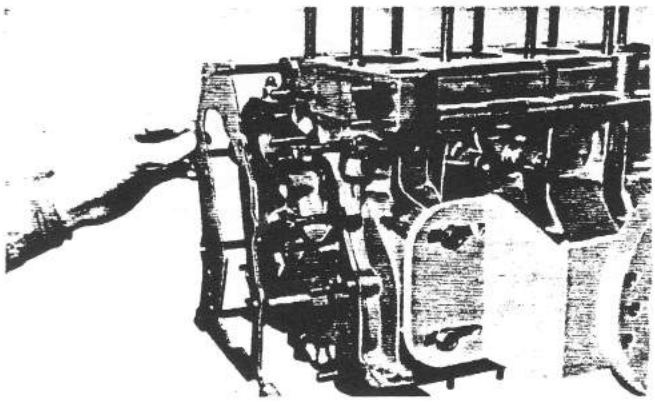
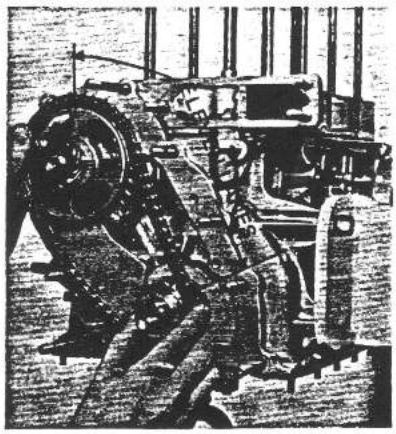


Fig. 117

12. Installing the timing chain and sprocket wheel
a. Set the first cylinder at top dead center.
b. Fit the camshaft & camsprocket wheel and the timing sprocket wheel to the timing chain.
Note: Match the mark of the timing chain with that of each sprocket wheel as shown in Fig. 118. There are eleven lanes between both match marks.
c. When installing the sprocket wheel and timing chain to the cylinder block and crankshaft, be careful not to go wrong the meshing of them.



camshaft keyway at 12 O'clock. Link mark is on 12th tooth going to right.

Fig. 118

d. Turn the camsprocket wheel to match the key grooves of the crankshaft and the timing sprocket wheel, and fit the key (A).
e. Secure the camshaft & camsprocket wheel to the cylinder block with two nuts (B).
f. Fit the oil baffle plate (C).
g. Secure the vibration damper (D) to the front plate with two bolts.

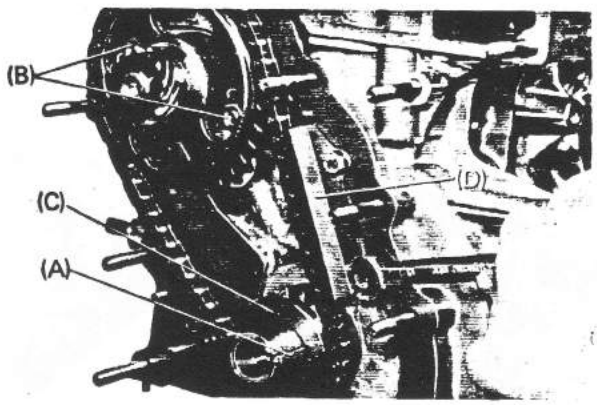


Fig. 119

13. Chain adjuster assembly
   a. Straighten the bent edges of the lock washer (B) and remove the plug (A) from the body (C).
   b. Insert the spring (E) and inner cylinder (D) into the slipper head (F), and fit a hexagonal wrench (G) to the inner cylinder and rotate the wrench clockwise until the inner cylinder enters the slipper head completely.
   c. Insert the slipper head into the body.

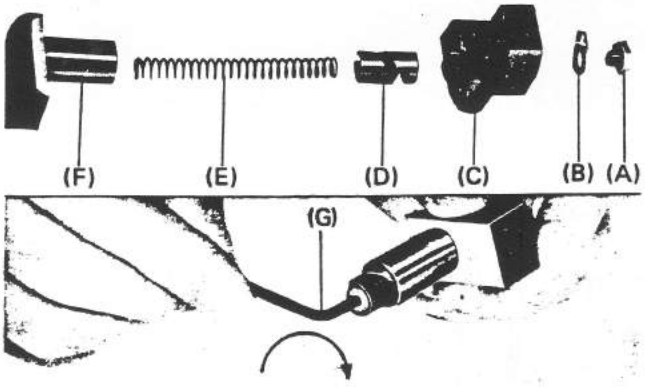


Fig. 120

14. **Installing the chain adjuster assembly**
   a. Secure the chain adjuster assembly to the cylinder block with two bolts.
   b. Rotate the inner cylinder in the direction of the arrow shown in Fig. 66 with the hexagonal wrench and loosen the slipper head.
   c. Secure the lock washer and the plug (A) to the body and bend the lock washer around the plug.

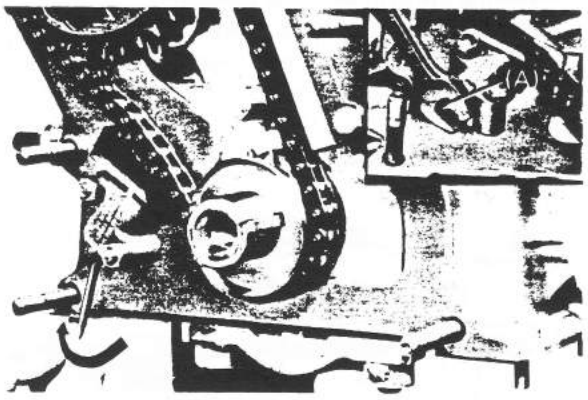


Fig. 121

15. **Installing the timing chain cover and the dynamo drive pulley**
   a. Apply a bit of graphite grease to the oil seal (A) and secure the timing chain cover together with the packings to the cylinder block temporarily with nine nuts.

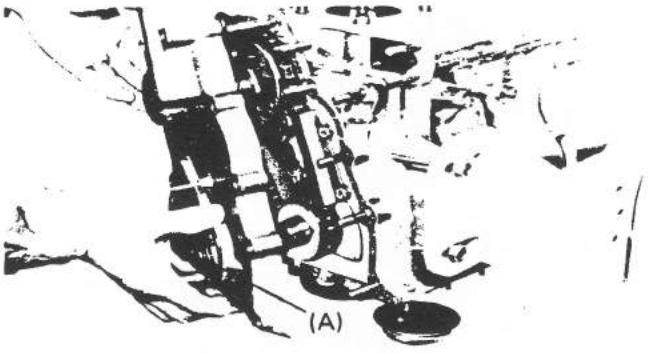


Fig. 122

   b. Secure the crankshaft pulley to the crankshaft temporarily with lock bolts as shown in Fig. 123.
   c. Rotate the crankshaft and ensure that it runs smoothly, and then tighten the timing chain cover holding nuts securely.

16. Turn the engine upside down so that the oil pan is in front. Then, cut off the unnecessary parts (A) of the timing chain cover and the packings with a knife.

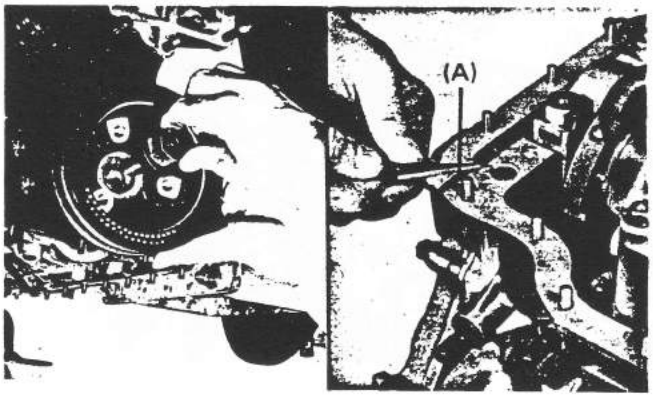


Fig. 123

17. **Installing the oil pan**
   a. Apply a thin coat of the special tool (No. TL-05T THREE BOND No. 5) to the parts on the cylinder block where the No. 5 main bearing cap and the timing chain cover are fitted.
   b. Secure the oil pan together with the packings to the cylinder block with twenty-two nuts.

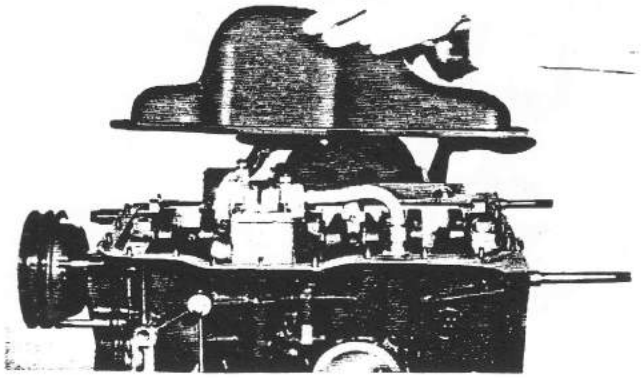


Fig. 124

18. Installing the oil pump driven gear assembly
    a. Insert the oil pump driven gear assembly (B), shim (C) and thrust washer (A) into the cylinder block as shown in Fig. 125, and fit them to the oil pump drive shaft and the camshaft drive gear.
    Tighten the oil pump drive gear cover (D) to 6.6 ft-lb (0.9 m-kg).
    Note: Be sure to fit the "O" ring to the drive gear cover.

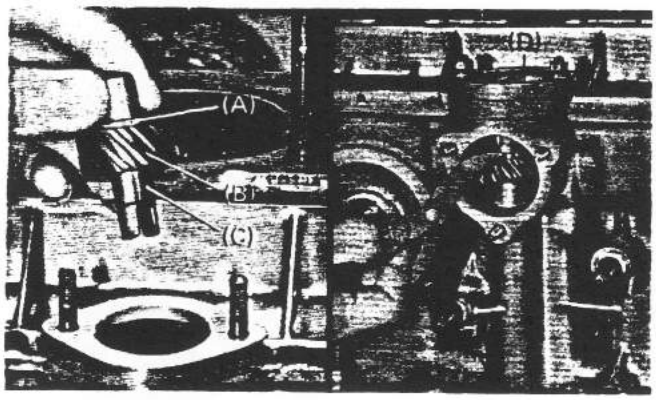


Fig. 125

    b. Check the end play of the oil pump driven gear assembly, and if the measured value is in the range of 0.002 ~ 0.004 in. (0.05 ~ 0.1 mm), it is good. If it is not satisfactory, check the shim and/or thrust washer.
    Note: For the kind of the shim and the thrust washer, refer to Para. "Checking and Adjusting the Oil Pump Driven Gear Shaft" on page 41.
    c. Secure the blind cover together with the packings to the cylinder block with three nuts.

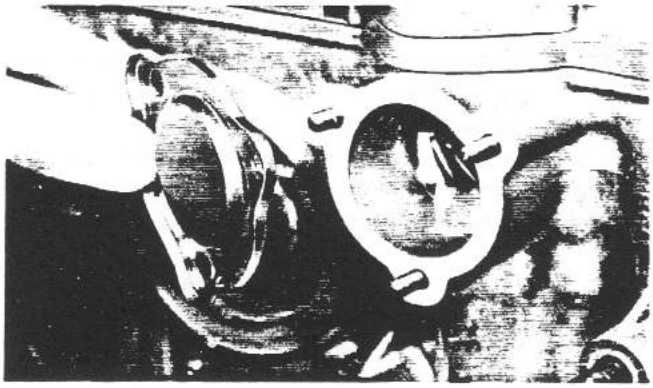


Fig. 126

19. Insert eight tappet floors into the cylinder block.

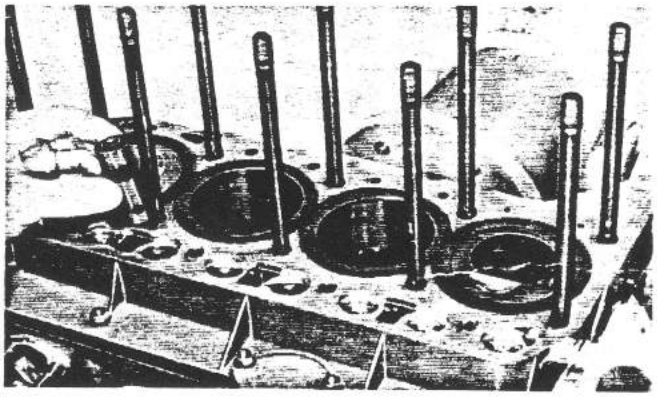


Fig. 127

20. Installing the cylinder head assembly
    a. Place the cylinder head gasket on the cylinder block and install the cylinder head assembly.
    Note: Apply the special tool (No. TL-05T THREE BOND No. 5) to both sides of the cylinder head gasket.

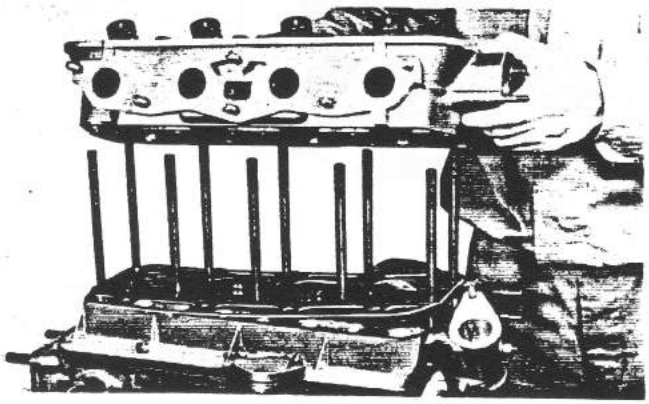


Fig. 128

b. Insert eight push rods into the tappet flower with the longer ones into the EX side.

c. Rocker arm and shaft assembly
Assemble the rocker arm, rocker arm shaft, rocker arm supporter, lock bolts, and washers as shown in Fig. 129.

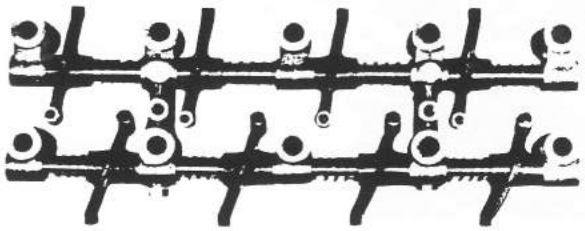


Fig. 129

d. Install the rocker arm assembly on the cylinder head assembly.
Note: Check the adjusting screws of the push rod and rocker arm.

e. Place ten cylinder head holding nuts and adjust the EX rocker arm supporter so that the center of the valve stem is 0.04 in. (1 mm) shifted from that of the rocker arm as shown in Fig. 130

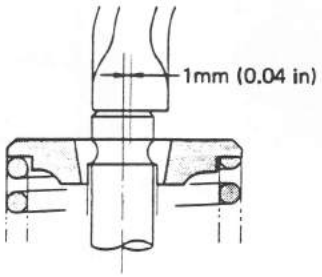


Fig. 130

f. Tighten the cylinder head holding nuts to 47 ~ 51 ft-lb (6.5 ~ 7.0 m-kg) in the order shown in Fig. 131.

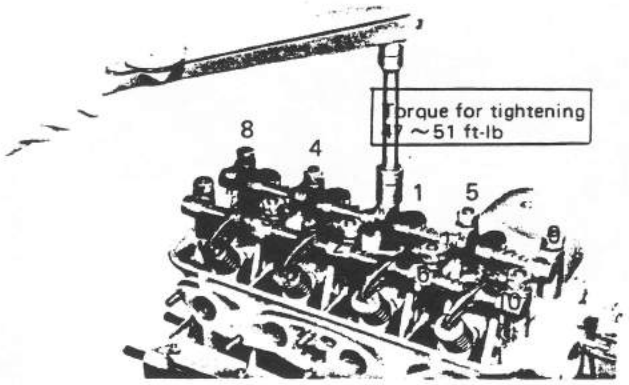


Fig. 131

Note: Fig. 130 shows the EX valve rotation mechanism, and the center of the valve stem is 0.04 in. (1 mm) shifted from that of the arm. There is a clearance of 0.02 in. (0.5 mm).
While the valve is working, the EX valve rotates slowly. This helps clearing away foreign matters between the valve seat and the valve face, and prevents excessive abrasion of the valve face and valve seat and lengthen the valve durability.

21. **Installing the exhaust manifold**
Secure the exhaust manifold together with the gaskets to the cylinder head with eight nuts and the engine hanger.
Tighten the manifold to the specified torque of 7.2 ~ 14.5 ft-lb (1.0 ~ 2.0 m-kg).

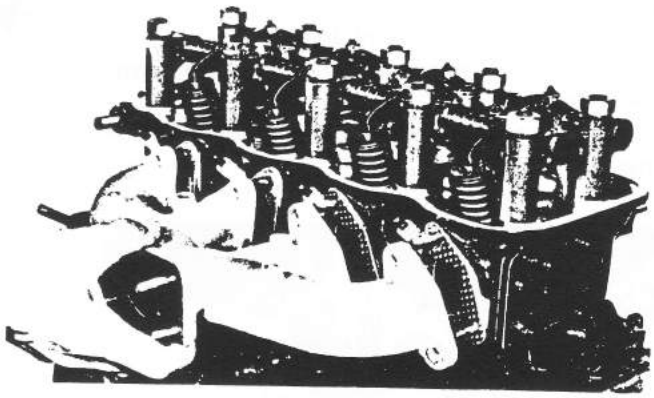


Fig. 132

22. **Installing the intake manifold**
Secure the intake manifold together with the packings and the engine hanger to the cylinder head with six nuts.
Tighten the intake manifold to the specified torque of 11.5 ~ 20.1 ft-lb (1.6 ~ 2.8 m-kg).

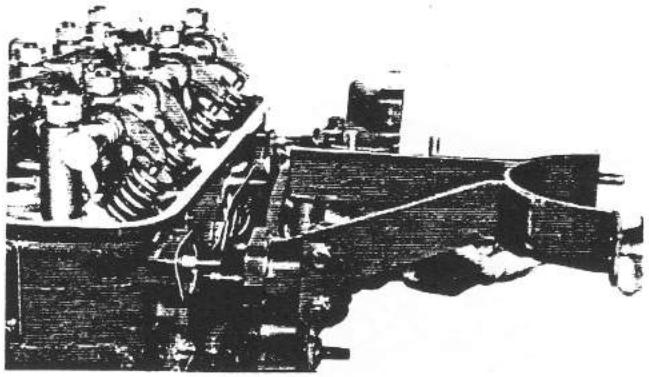


Fig. 133

23. **Installing the carburetor**
Fit the packings and the insulator (A) to the intake manifold, and then secure the carburetor to the intake manifold with two nuts.

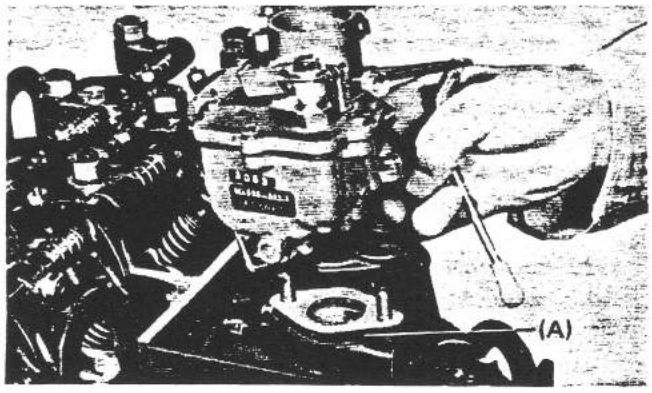


Fig. 134

24. **Installing the fuel pump**
a. Fit the packings and the insulator (A).
b. Secure the fuel pump to the cylinder block with two nuts.
c. Connect the fuel hose to the carburetor and the fuel pump outlet.

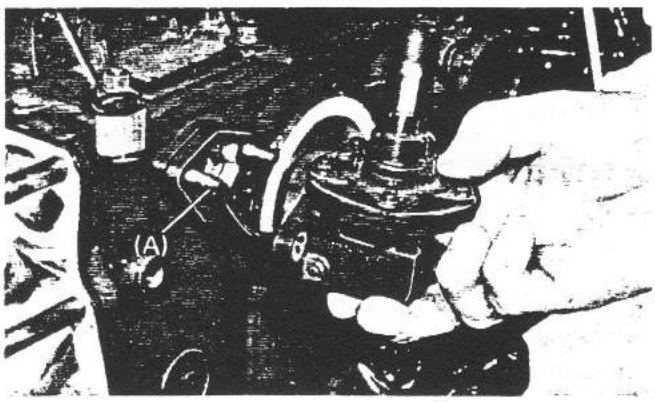


Fig. 135

25. **Installing the oil filter.**
a. Insert the oil pressure switch (A).
b. Apply engine oil to the oil seal of the oil filter and secure it to the cylinder block.

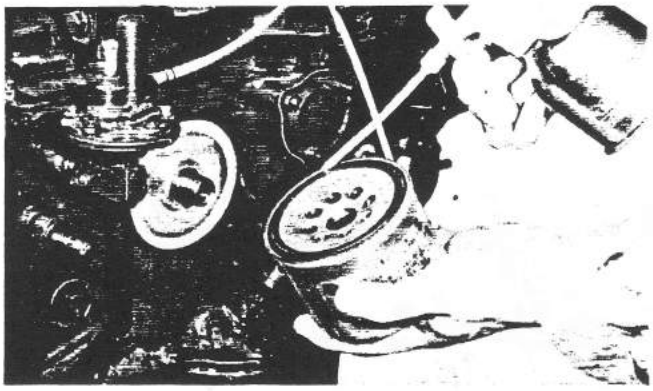


Fig. 136

26. **Installing the distributor**
a. Bring the first cylinder before the top dead point, and set the 16° mark on the crankshaft pulley before the top dead point in line with the indicator pin (A) of the timing chain cover.

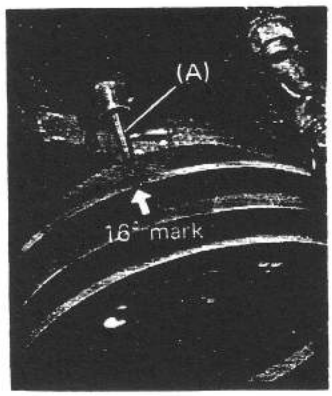


Fig. 137 *Fig. 138*

b. Align the marks on the distributor drive gear and housing as shown in Fig. 138.
c. Install the distributor in the timing chain cover.
Note: When meshed with the drive gear on the camshaft, the mark on the distributor drive gear moves by 49° counterclockwise due to the gear twist.
d. Connect the vacuum advance hose to the carburetor and the distributor.

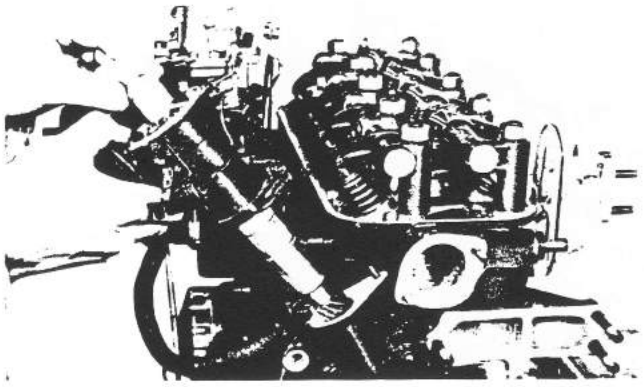


Fig. 139

27. **Installing the water pump**
   a. Connect the water hose to the intake manifold and the water pump.
   b. Secure the water pump (A) together with the packings to the cylinder head with two nuts.
   c. Secure the alternator stay (B) to the water pump with two nuts.

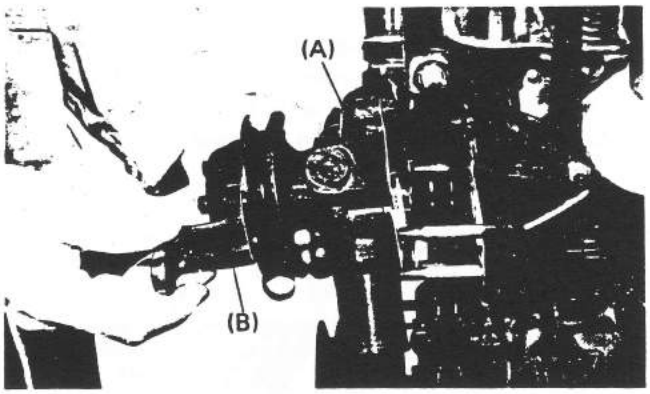


Fig. 140

28. **Installing the cooling fan complete**
   a. Insert the thermostat (A) into the thermostat casing. Fit the packings.
   b. Fit the alternator strap (B) to the cooling fan complete.
   c. Secure the cooling fan complete to the cylinder head with three nuts.

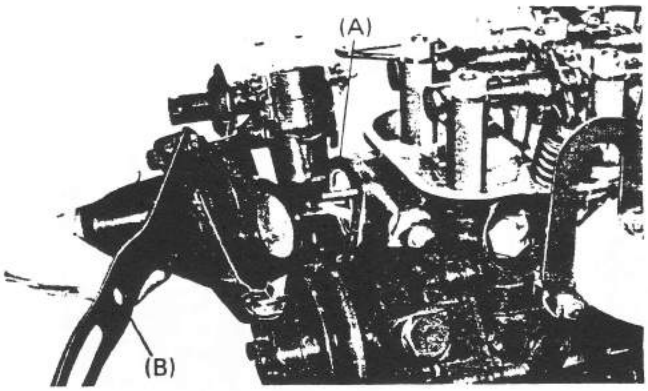


Fig. 141

   d. Fit the spacer (A), fan pulley (B), fan spacer (C), and cooling fan (D) to the pulley boss of the cooling fan complete in that order as shown in Fig. 142 with four holding bolts.

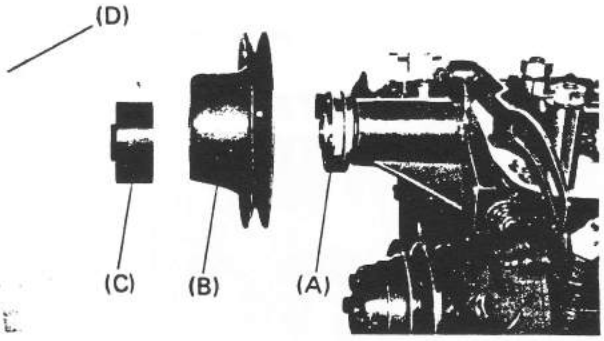


Fig. 142

29. **Installing the governor and governor bracket**
   a. Secure the governor to the governor bracket with three nuts.
   b. Secure the governor together with the spacer (A) in Fig. 143 to the timing chain cover with bolts and nuts.

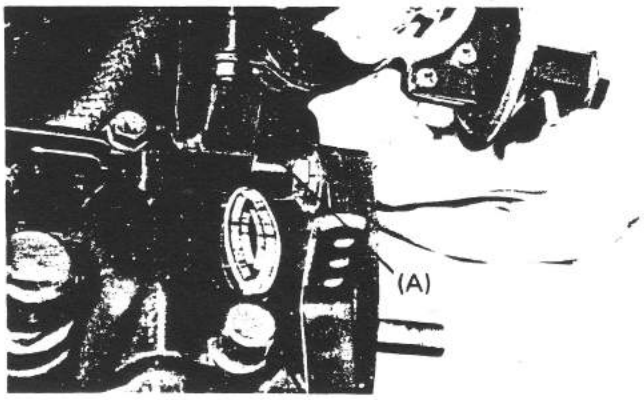


Fig. 143

c. Secure the engine bracket at the lower part to the cylinder block with three nuts.
d. Connect the rod assembly (B) with the carburetor throttle valve closed and the governor operating lever (A) at the top.

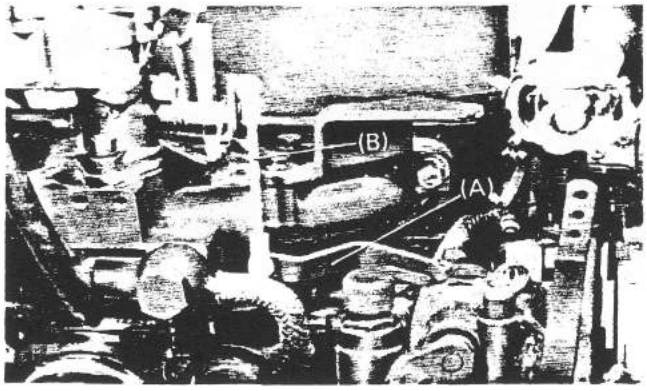


Fig. 144

30. **Installing and adjusting the idler assembly, governor pulley and V-belt**

a. Secure the idler assembly to the timing chain cover and cover bracket with two nuts and one bolt.

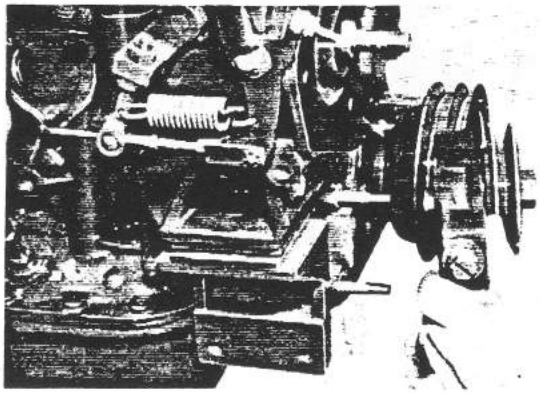


Fig. 145

b. Fit the key (A) to the governor shaft and next the governor pulley (B), and secure them temporarily with lock nuts.

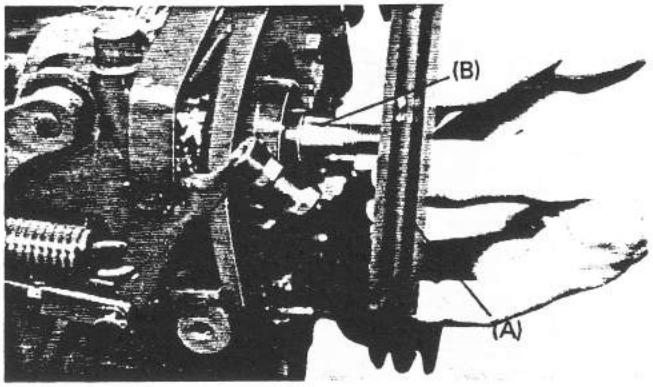


Fig. 146

c. Fit the V-belt (C) to the idle pulley, governor pulley, and pump pulley.
d. Tighten the adjusting bolt (D) to adjust the tension of the V-belt so that the governor lock nut (E) may be tightened to the specified torque of 36.2 ft-lb (5 kg-m).
e. Rotate the adjusting bolt as shown in Fig. 147 so that the V-belt flexes 0.55 ~ 0.78 in. (14 ~ 20 mm) (in case of tension of some 22.05 lb (10 kg)) by depressing with fingers midway between the pulleys. If the belt is a new one, adjust the flexion of the belt to 0.55 ~ 0.67 in. (14 ~ 17 mm).
f. Secure the governor cover to the governor stay and governor bracket with three bolts.

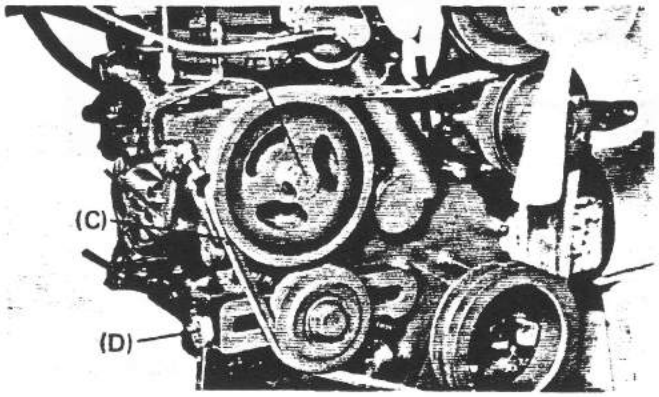


Fig. 147

31. **Valve clearance adjustment**

Adjust the IN and EX valve clearances to 0.01 in. (0.25 mm), setting each piston at the top dead center.

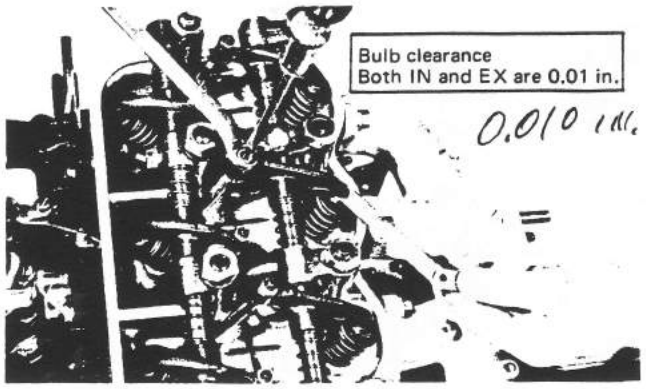


Fig. 148

32. **Installing the cylinder head cover**
Secure the cylinder head cover together with the packings to the cylinder head with two bolts.

33. **Installing the air cleaner**
Fit the air cleaner to the air cleaner stay with the air cleaner band and two wing nuts. Connect the hot air hose to the air cleaner and the carburetor.

34. **Installing the flywheel**
a. Fit the flywheel to the crankshaft rear with lock washers and six lock bolts.
One of the six lock bolts is a reamer bolt and fit it to the holes (A) and (B) as shown in Fig. 149.

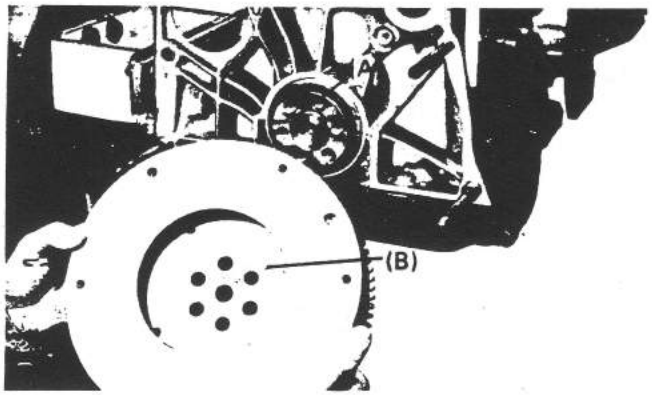


Fig. 149

b. Hold the crankshaft by means of special tool (No. 0490100 RING GEAR BRAKE) and tighten six lock bolts to 60 ~ 65 ft-lb (8.3 ~ 9.0 m-kg) and bend the lock washers around the bolts.

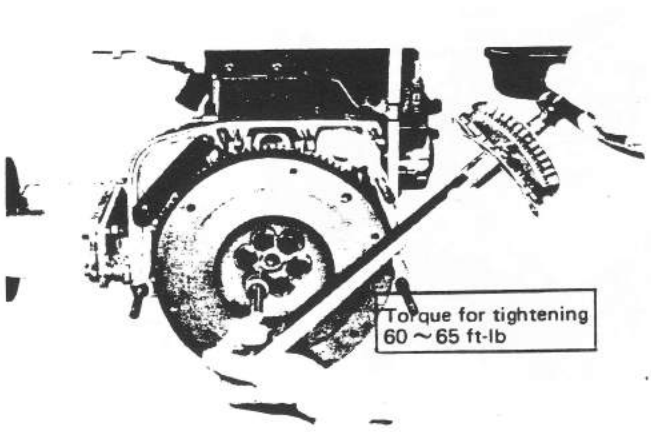


Fig. 150

c. For clutch assembly mounting, see "Clutch System" of Repair Manual.
d. Tighten the lock bolts of the engine front crankshaft pulley to the specified torque of 58 ~ 72 ft-lb (8 ~ 10 m-kg).
e. Remove special tool (No. 0490100 RING GEAR BRAKE).

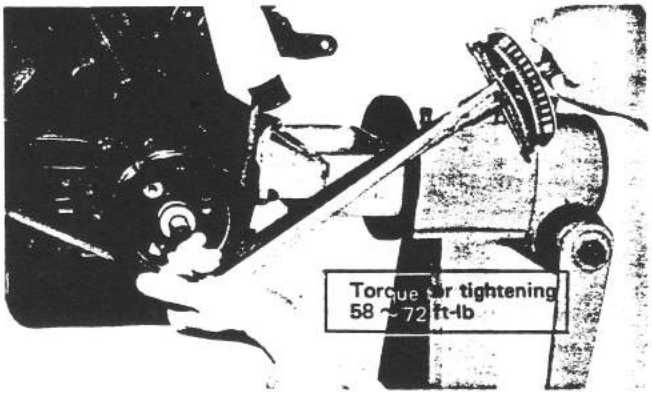


Fig. 151

35. Dismount the engine from the engine stand.

36. **Installing the alternator bracket and alternator.**
a. Secure the alternator bracket (A) to the cylinder block with three nuts.
b. Fit the alternator to the alternator bracket and alternator stay (C), and secure it temporarily with bolts and nuts.
c. Raise the alternator and connect it with the alternator strap (B) and bolts.

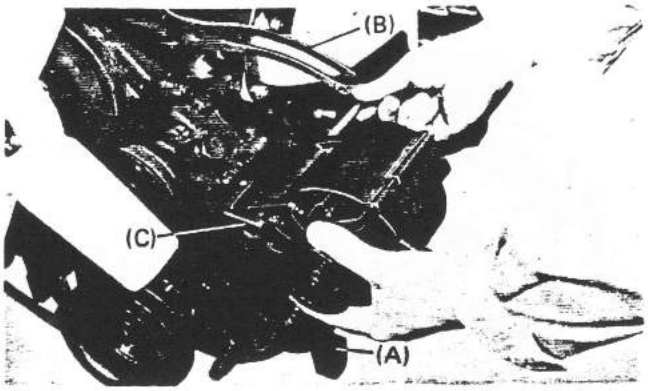


Fig. 152

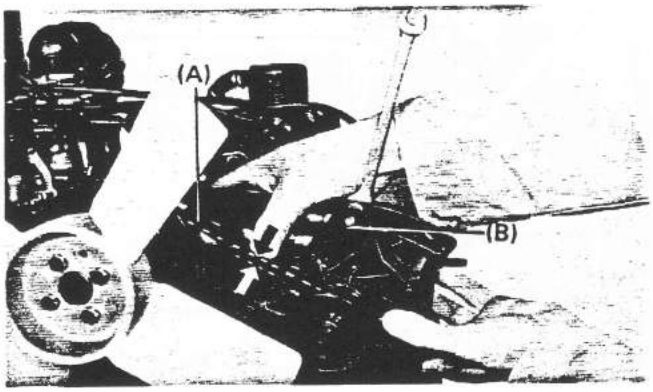


Fig. 153

37. V-belt fitting and adjusting
   a. Fit the V-belt (A) to the cooling fan pulley, alternator pulley, and crankshaft pulley.
   b. Adjust the alternator so that the V-belt flexes 0.47 ~ 0.63 in. (12 ~ 16 mm) (in case of tension of some 22.05 lb (10 kg)) at the center of the belt. Fasten the alternator holding bolt (B) securely. If the V-belt is new, adjust the flexion of the belt to 0.40 ~ 0.51 in. (10 ~ 13 mm).

3-2. Mounting the Engine

1. Engine can be mounted by means of the reverse order for engine removal. (see 1-1 Removing the Engine)

4. Specifications

Type	P.B.
Number of cylinders	4
Cylinder arrangement	In series
Piston displacement	60.2 in³ (987 cc)
Bore and stroke	2.6772 x 2.6772 in. (68 x 68 mm)
Rated r.p.m.	2,800 r.p.m.
Maximum r.p.m.	3,150 r.p.m.
Roted power	23 PS/2,800 r.p.m.
Maximum power	25 PS/2,800 r.p.m.
Masimum torque	46.9 ft-lb/2,200 r.p.m. (6.5 kg-m/2,200 r.p.m.)
Compression ratio	8.6 : 1
Compression pressure	145 lb/in² (10.2 kg/cm²)
Ignition order	1, 3, 4, 2
Valve position	Overhead valve system
Weight	258 lbs (117 kg)
Valve clearance Intake	0.010 in. (0.25 mm)
Exhaust	0.010 in. (0.25 mm)

LUBRICATION SYSTEM

1. Lubrication System-General

A total pressure-feed lubrication system is employed with the oil pump of a trochoid cogwheel type and oil filter of a cartridge type. Lubricant circulates as shown in Fig. 1.
After filtered through the oil pan strainer, it is drawn into the oil pump. In the oil pump, the pressure of lubricant is maintained at a constant level of 53.9 lb/in² (3.8 kg/cm²) by means of the oil pump pressure control mechanism. The oil returns to the oil pan after lubricating every necessary part of the engine as indicated by the arrow.

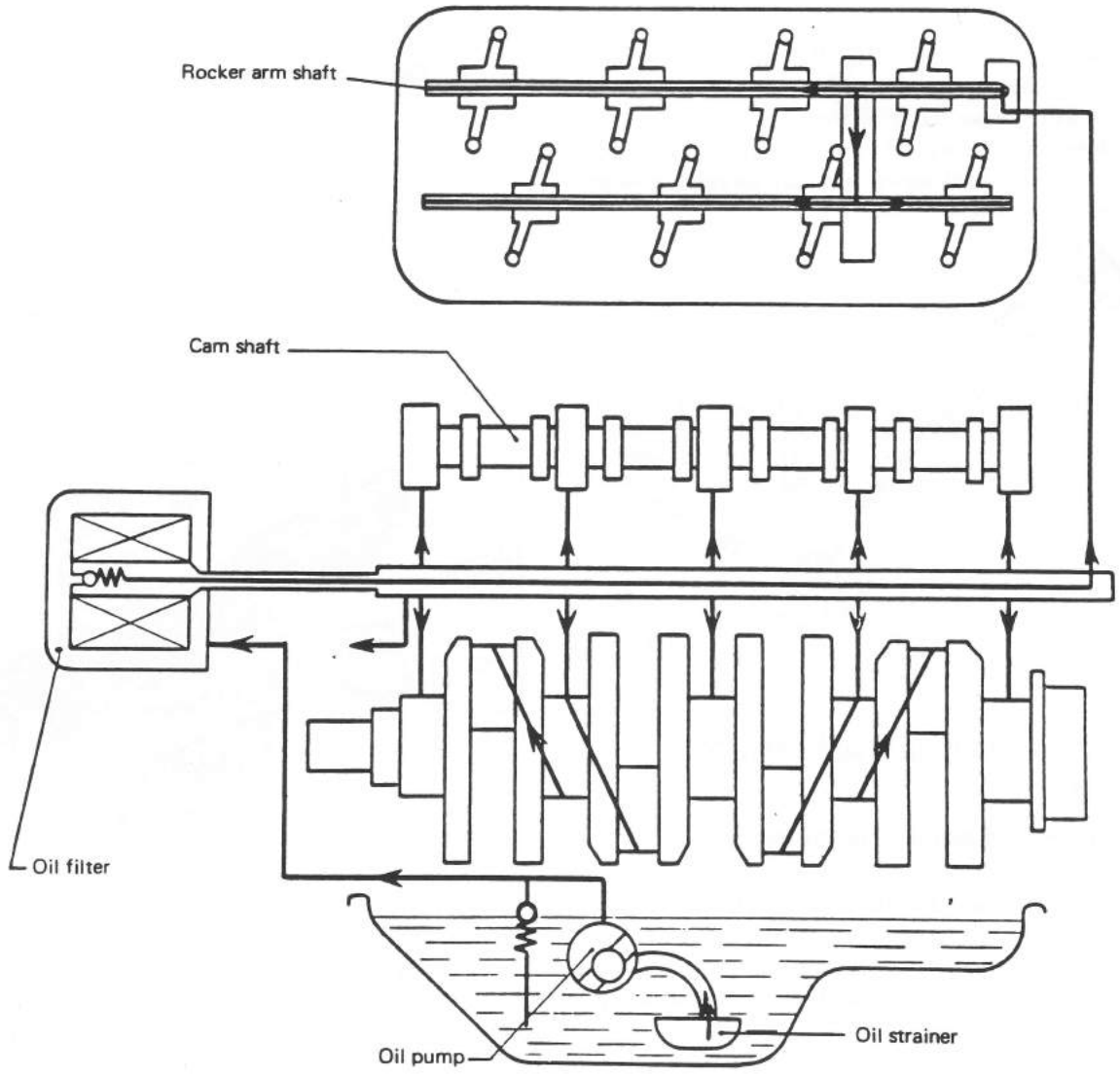


Fig. 154

2. Disassembling the Oil Pump

2-1. Removing the Oil Pump

1. Before disassembling the oil pump, refer to "1-2, Disassembling the Engine".

2-2. Disassembling the Oil Pump

1. Remove the two nuts, and remove the oil strainer from the pump cover.
2. Remove the pump cover (B), outer rotor (C) and pump drive shaft assembly (D) from the pump body (A).
3. Remove the split pin (H). Pull out the spring seat (E), pressure control spring (F) and pressure control plunger (G) from the pump body.
   Note: Take care of that the spring seat and pressure control spring will not spring out when the split pin is removed.

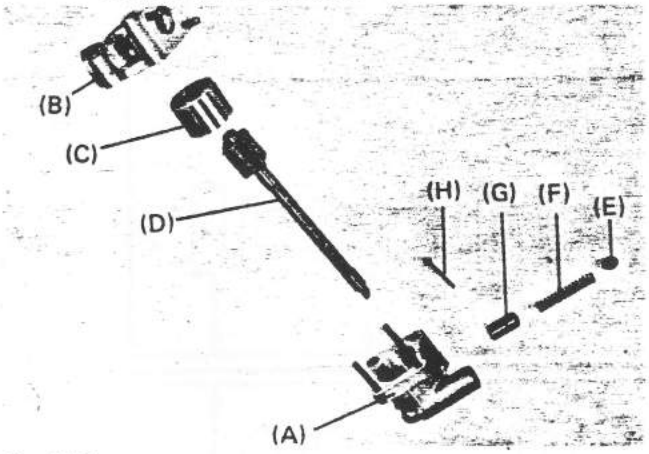


Fig. 155

3. Checking, Maintenance and Limit of Adjustment

3-1. Checking and Adjusting the Oil Pump

- ○ Wash and clean the parts removed from the oil pump.
- ○ Inspect the parts for cranking, heavy damage and breakage. If any of these parts is found faulty, replace it.

1. **Clearance between the oil pump body and outer rotor:**
   Measure the clearance between the oil pump body and outer rotor with a special tool (No. N026 STANDARD FEELER GAUGE). Replace both if the measurement exceeds 0.0118 in. (0.30 mm).

STD clearance between pump body and outer rotor	0.008 ~ 0.011 in. (0.20 ~ 0.27 mm)

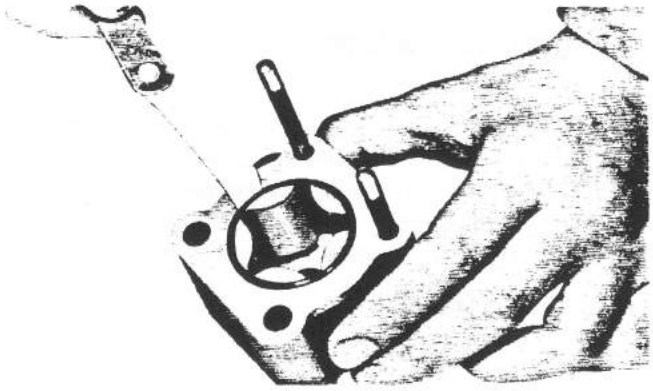


Fig. 156

2. **Clearance between the oil pump cover and outer rotor:**
   Measure the clearance between the oil pump cover and outer rotor with a straight scale and a special tool (No. N026 STANDARD FEELER GAUGE). Replace both parts if the measurement exceeds the maximum limit.

Clear. between oil pump cover and outer rotor	STD clearance	Max. allow clear
	0.0016 ~ 0.0039 in. (0.04 ~ 0.10 mm)	0.0059 in. (0.15 mm)

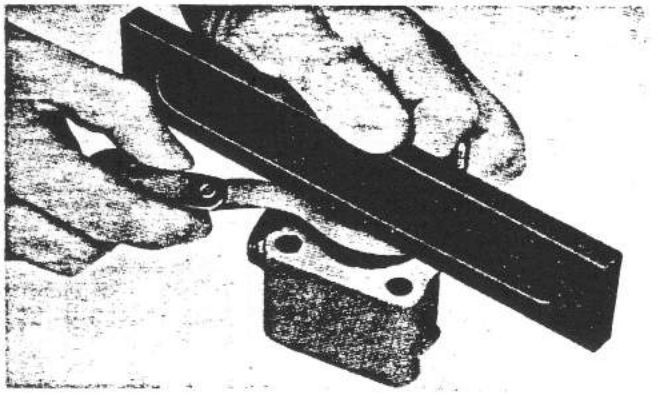


Fig. 157

3. **Oil pump cover**
   Check the oil pump cover bottom (contacting surface with oil pump body, inner rotor and outer rotor). If stepped wear is found, replace the cover. If the wear is slight, smooth it out.

Fig. 158

4. Clearance between the oil pump drive shaft assembly and pump body/pump cover bearing
Measure the clearance between the oil pump drive shaft assembly (1) and the pump body (2) and pump cover (3) bearings (A) and (B). If the measurement exceeds the specified maximum limit, replace the parts.

Clear. between drive shaft ass'y and pump body cover bearings	STD clearance	Max. allow clear
	0.0003 ~ 0.0018 in. (0.007 ~ 0.047 mm)	0.0039 in. (0.1 mm)

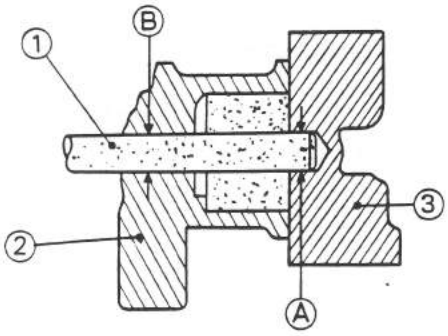


Fig. 159

5. Pressure control spring
Check the pressure control spring for any defects. If it fails to meet the specifications given in the table below, replace it.

Pressure control spring specifications	
Free length	2.1654 in. (55 mm)
Length - when installed.	1.6929 in. (43 mm)
Load - when installed	5.91 lbs. (2.68 kg)

Fig. 160

3-2. Oil Filter Replacement

1. Replace the oil filter (cartridge type) after 300 hours of operation (First replacement: after 30 hours of operation). Replacement must be made as an assembly.

2. Oil filter - removal and installation
a. Use the special tool (No. 0490130 OIL FILTER WRENCH) (A) as shown in Fig. 161 to remove the oil filter.
b. Apply engine oil to the oil filter gasket, and bolt it to the cylinder block with a specified tightening torque 7.2 ~ 10.8 ft-ob (1.0 ~ 1.5 m-kg).
Note: After the installation, make sure that no oil leaks.

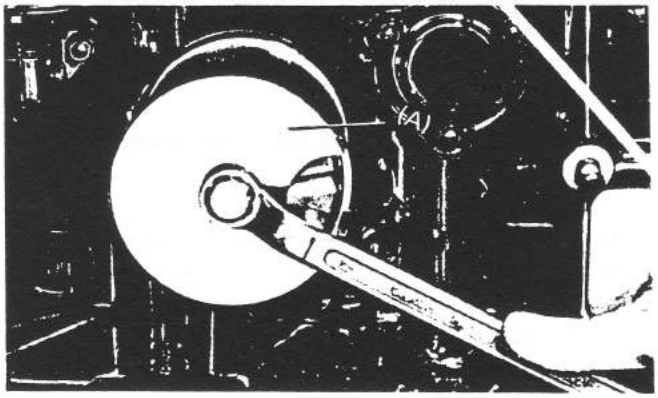


Fig. 161

3-3. Checking and Adjusting the Oil Pump Driven Gear Shaft

1. Remove the blind cover (A).

2. Check the oil pump driven gear shaft (B) for damage and breakage of teeth.

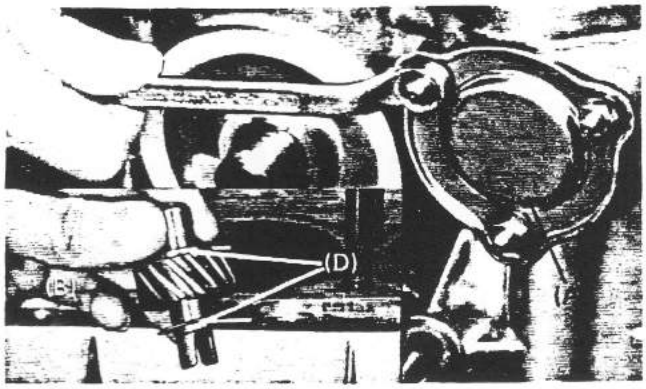


Fig. 162

3. Measure the oil pump driven gear shaft's end play by use of a special tool (No. N026 STANDARD FEELER GAUGE).

Driven gear shaft's end play	0.002 ~ 0.004 in. (0.05 ~ 0.1 mm)

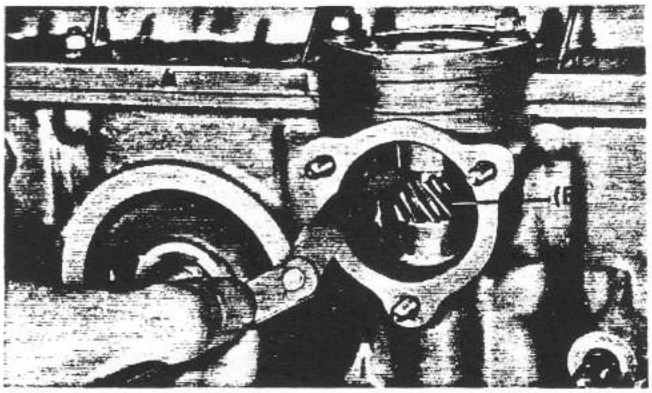


Fig. 163

3-4. Adjusting the End Play of Oil Pump Driven Gear Shaft

If the measurement of the end play is not within the range of 0.002 ~ 0.004 in. (0.05 ~ 0.1 mm), remove the drive gear cover (C), and pull out the thrust washer (D) and driven gear shaft. Adjust the end play by using thrust washers as specified below: (Figs. 162 and 163)

Part No.	Part Name	Thickness
0140050	Thrust washer	0.079±0.0079 in. (2.0±0.2 mm)
0140060	Thrust washer	0.100±0.0079 in. (2.5±0.2 mm)
0140070	Thrust washer	0.004 in. (0.1 mm)
0140090	Thrust washer	0.071±0.0079 in. (1.8±0.2 mm)

4. Assembling Order

4-1. Assembling the Oil Pump

Follow the disassembling procedures in reverse.

4-2. Mounting the Oil Pump

Oil pump can be mounted by means of the reverse order for assembling the engine. (See 3-1 Assembling the Engine of Chapter Engine)
Note: The following-listed engine oils are commendable.

5. Specifications

5-1. Oil Pump Specifications

Type:	Trochoid gear
Drive system:	Total pressure feed
Rated oil delivery:	25.36 US pints/2,000 rpm (12 ℓ/2,000 rpm)
Regulated oil pressure:	53.9 lb/in² (3.8 kg/cm²) at 3,000 rpm

5-2. Oil Filter Specifications

Type:	Cartridge filter
Pressure for adjusting the relief valve	11.4 ~ 17.1 lb/in² (0.8 ~ 1.2 kg/cm²)

COOLING SYSTEM

1. Cooling System-General

The forced-circulation cooling system is imployed with a centrifugal water pump, four-blade cooling fan, and wax-type thermometer.
When the temperature of the cooling water is low, it circulates in the direction of the arrow with a dotted line in Fig. 164. When the temperature is high, the cooling water flows in the direction of the arrow with a solid line.

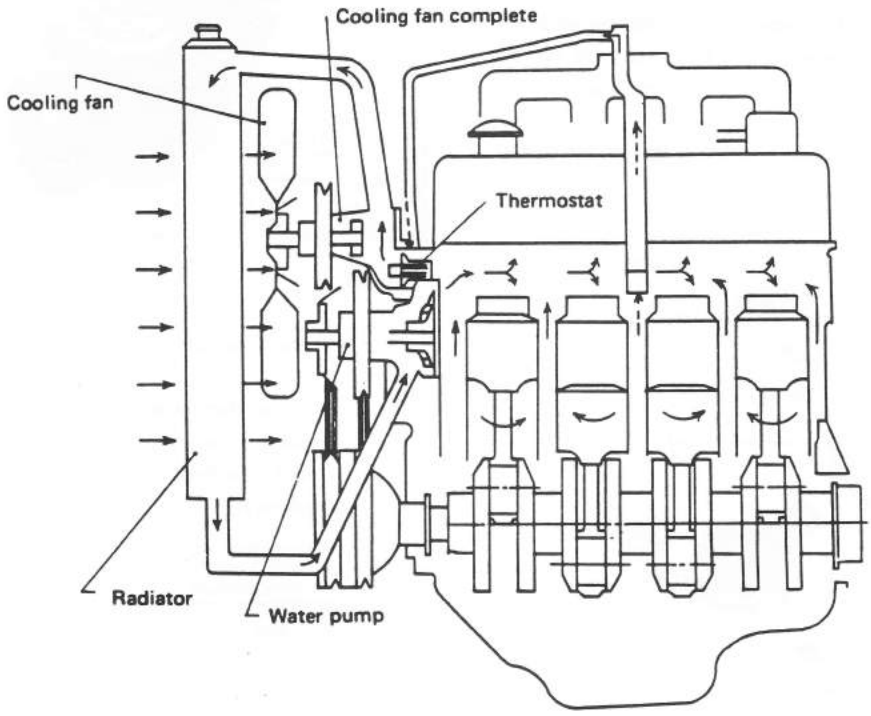


Fig. 164

2. Disassembling Order

2-1. Removing the Water Pump

1. For the removal of the water pump, refer to "1-2. Disassembling the Engine of Chapter. Engine".

2-2. Disassembling the Water Pump

1. Loosen the screw and bolt, and remove the end plat (B).
2. Pull out the water pump impeller (A) by using the special tool (No. 0490110 WATER PUMP IMPELLER PULL).

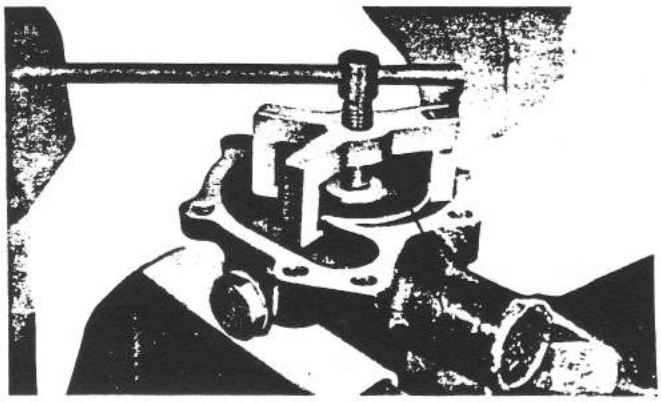


Fig. 165

3. Take out the floating seat and cushion rubber from the water pump impeller.

4. Pull out the water pump pulley boss (G) by using a press.

5. Remove the dust seal plate (F).
   If the water seal, ball bearing, etc. are found defective, perform the following disassembling procedures.

6. Pull out the snap ring (H) by using the snap ring pliers.

7. Remove the ball bearing and water pump shaft from the water pump body (D) by using a pliers.

8. Disassemble the ball bearing and water pump shaft into three parts: pump shaft (E), ball bearing (K) and spacer (J). For this operation, use a press.

9. Pull out the water seal (C) from the water pump body.

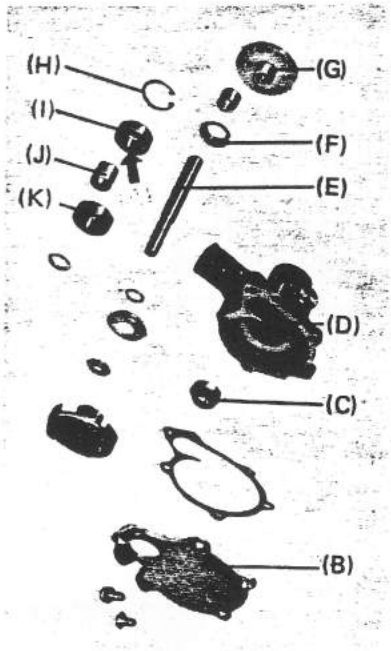


Fig. 166

3. Checking Maintenance and Limit of Adjustment

3-1. Inspection of Water Pump

1. Check the disassembled parts for the following-listed defects. If any of them is found faulty, replace it.

a. Cracks and damage of the water pump body.
b. Cracks and damage of the water pump impeller.
c. Play and noise of the ball bearing.
d. Damage of the water seal.

Whenever the water pump is disassembled, the water seal should be replaced with a new one.

3-2. Checking the Thermostat

1. Check the thermostat spring (A) for cranks and breakage. If found faulty, replace it.

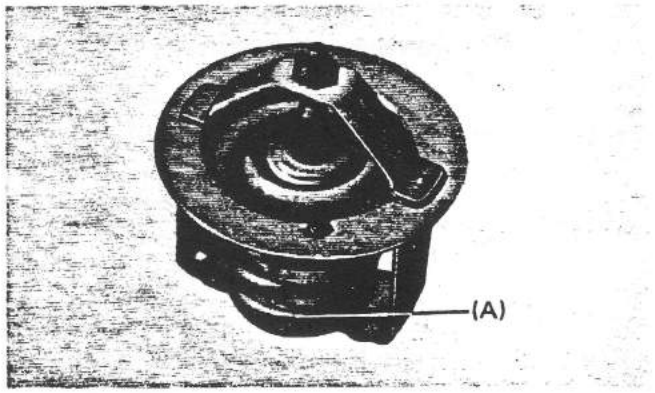


Fig. 167

2. If the thermostat valve is found open, replace it.

3. Put the thermostat into water, and slowly raise the water temperature. Check for temperature at which the thermostat valve opens. If found faulty, replace it.

Valve opening temperature	177 ~ 183°F (80.5 ~ 83.5°C)
Valve lift	0.315 in. or more at 203°F (8 mm or more at 95°C)

4. Assembling the Water Pump

1. Follow the disassembling procedures in reverse order.

2. Notes on water pump assembling

a. Be sure that the two ball bearings are placed with the unsealed side facing toward the spacer.
b. Feed Albania Grease Nos. 2 and 3 so that one-third of the space between the dust seal plate and the ball bearing is filled with the grease.
c. Slightly apply grease to the contacting surfaces between the floating seat and water seal.
d. After assembling the water pump, make sure that the ball bearing turns smoothly without excessive play and noise.

5. Mounting the Water Pump

1. Follow the removal procedures of the water pump in reverse order. For details, refer to "3-1. Assembling the Engine of Chapter. Engine.
   Notes:
   1) Replace all packings with new ones.
   2) Adjust the V-belt so that it will have an up and down movement of 0.55 ~ 0.79 in. (14 ~ 20 mm). When the belt is new, the slackness should be 0.43 ~ 0.55 in. (11 ~ 14 mm).
   3) Make sure that the quantity of cooling water is 18.5 gal (7ℓ).

6. Installing the Thermostat

Follow the removal procedures of the thermostat. Always replace the packings.

7. Specifications

7-1. Water Pump

Type:	Centrifugal
Water pump pulley ratio:	1 : 0.8
Water seal:	Mechanical seal

7-2. Thermostat

Type:	Wax type
Valve diameter:	1.102 in. (28 mm)
Valve opening temperature:	180 ± 2°F (82 ± 1.5°C)
Valve lift:	0.315 in. (8 mm)

MEMO

FUEL SYSTEM

1. Fuel System-General

The carburetor is Nihon Kikaki-made. Stronberg type, 210028-061, double-venturi, single carburetor.
The fuel pump is of mechanical type (PU56U), made by Nihon Kikaki, and the pump rocker arms are operated by cams attached to the cam shaft.
The gasoline filter is of cartridge type, which provides easy access to service, while the air cleaner is of oil bath type.

2. Air Cleaner

2-1. Removing the Air Cleaner Element

1. Remove the clamp (A) from the air cleaner assembly, and remove the oil pan assembly (B).
2. Remove the wing nut (C) fastening the air cleaner and cap assembly (D), and remove the cap assembly by pulling it upward.
3. Remove the two wing nuts, and remove the air cleaner assembly.

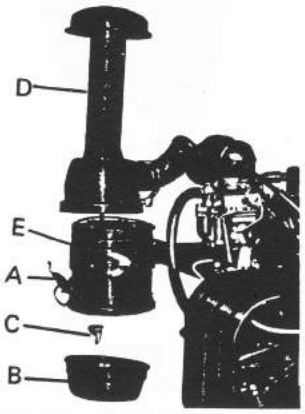


Fig. 168

2-2. Checking the Air Cleaner

1. Check the air cleaner element (A) for dirt accumulation and clogging. If necessary, wash and clean it.
2. Check the oil pan assembly for dirty oil. If the oil is found dirty, replace it.
3. Check whether the oil level in the air cleaner oil pan assembly is between the upper and lower level lines. If necessary, refill with oil. An incorrect oil level will reduce engine performance, and therefore, the oil level must be maintained as specified. The engine oil should be used for refilling.

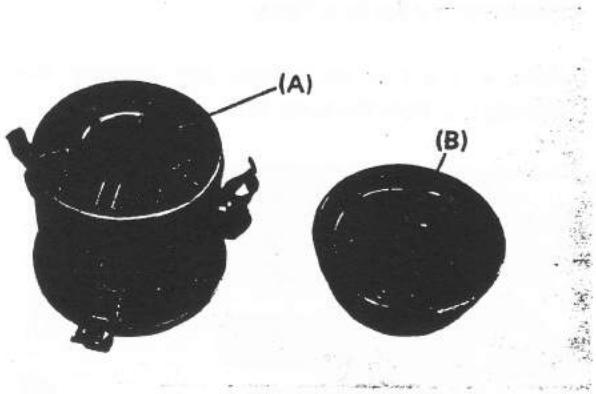


Fig. 169

4. **Cleaning the air cleaner element**
Both air cleaner element and oil pan assembly should be cleaned with cleaning solvent.

Time Intervals of Element Cleaning		
Cleaning	After first 50 hours	Every 100 hours

2-3. Air Cleaner Specifications

Type:	Oil-bath type
Rated air flow rate (max.):	4,731.2 gal/min (1,250 ℓ/min)
Cleaning efficiency: (Initial stage - full life)	95%

3. Fuel Pump

3-1. Removing the Fuel Pump

1. Remove the clip, and disconnect the fuel hoses (A) from the fuel pump (B) at the both inlet and intake sides.

2. Remove the two nuts, and remove the fuel pump.

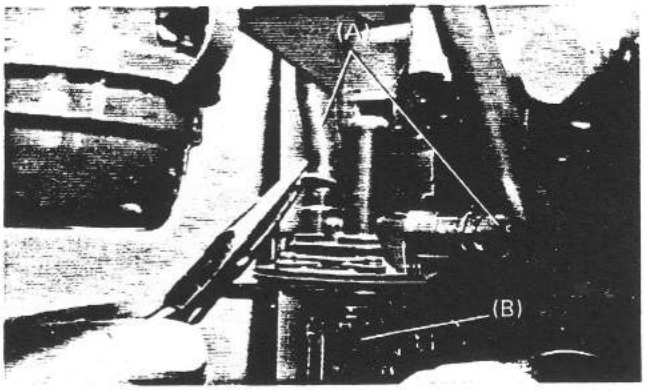


Fig. 170

3-2. Disassembling the Fuel Pump

1. Remove the five set screws, and separate the housing (A) from the body (B).

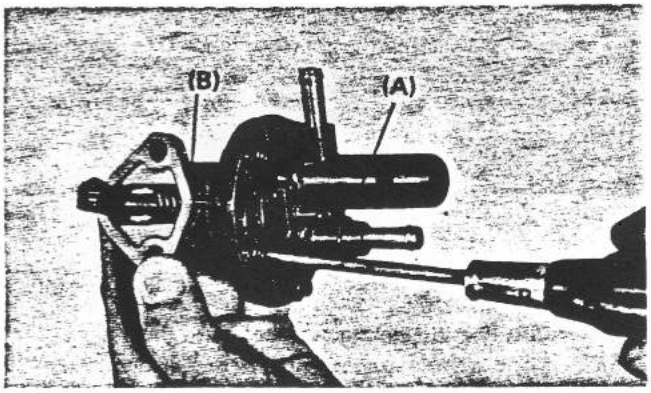


Fig. 171

2. Remove the two screws, and remove the valve (C) from the housing.

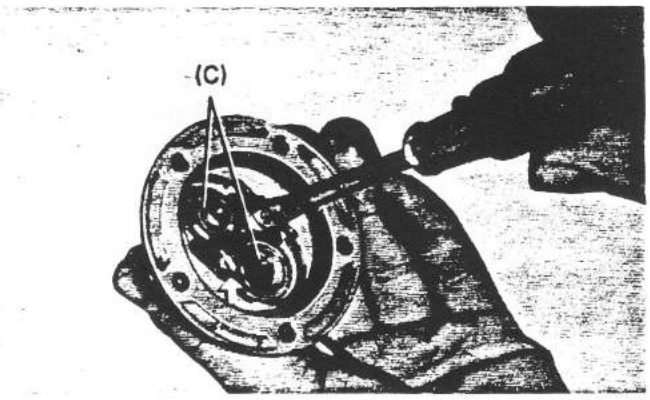


Fig. 172

3. Remove the diaphragm (D) and diaphragm spring (E) from the body.

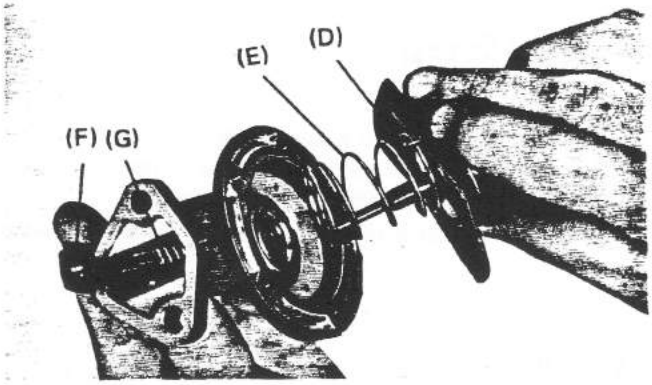


Fig. 173

4. As shown in Fig. 174, pull out the pin, and remove the rocker arm (G) and rocker arm spring (F) from the body. (Fig. 173 and 174)

Fig. 174

3-3. Checking the Fuel Pump

1. Checking the fuel pump

a. Check the valve spring for breakage and fatigue. If the spring is found faulty, replace it. If the valve is found open, even though slightly, it should be replaced.

b. Check the diaphragm for breakage, damage and aging. If it is found faulty, replace it.

c. Check the diaphragm spring for breakage and fatigue. If found faulty, replace it.

d. Check the rock arm bearings for excessive play. (Fig. 171)

3-4. Assembling the Fuel Pump

follow the disassembling procedures in reverse order.

3-5. Installing the Fuel Pump

Follow the removal procedures in reverse order. After installation, make sure that no fuel leaks.

3-6. Fuel Pump Specifications

Model:	Mechanical
Disharge:	0.32 pint/min at low speed (150 cc/min at low speed) 1.5 pint/min with full-open (700 cc/min with full-open)
Fully-closed discharge pressure:	1.42 ~ 2.13 lbs/in² (0.1 ~ 1.5 kg/cm²)
Suction head:	19.7 in. (500 mm)

4. Fuel Filter

1. The fuel filter is of the cartridge type.
2. The fuel filter is not required to be cleaned. If it is found faulty, replace it as a unit assembly. When replacing the fuel filter, make sure that it is installed correctly in direction and no fuel leaks.

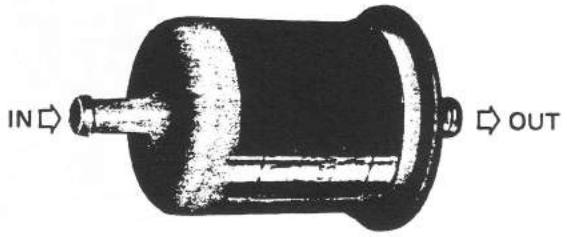
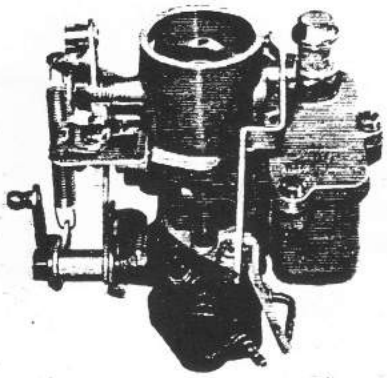


Fig. 175

3. Time intervals of fuel filter replacement
   Fuel filter should be replaced every 300 hours of operation.

5. Carburetor

5-1. Construction



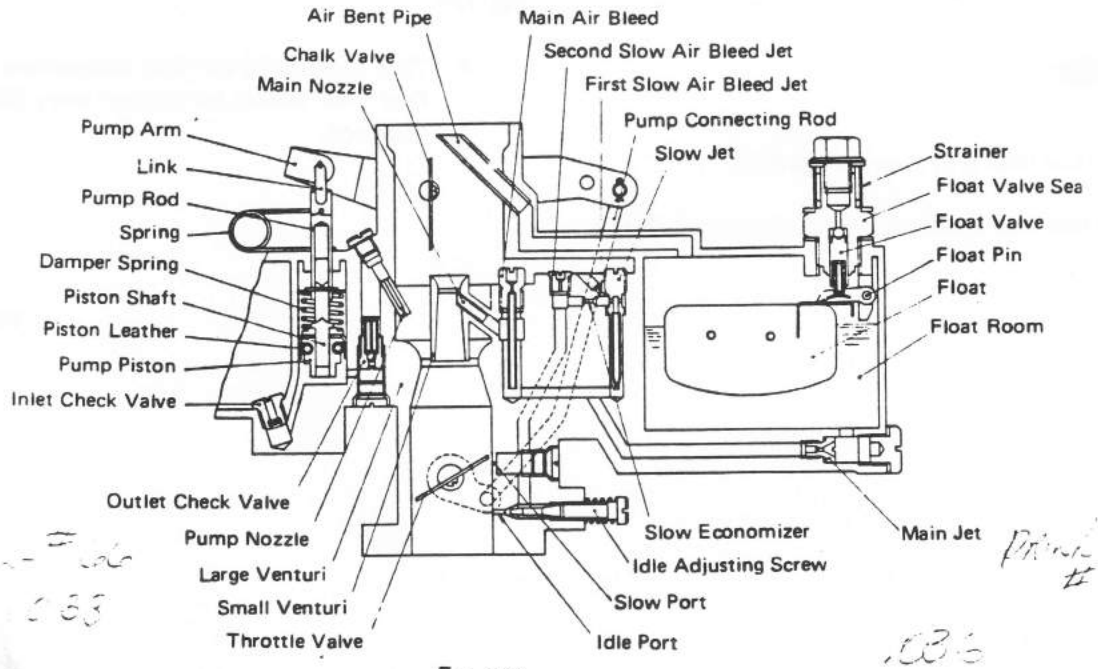


Fig. 176

1. Main jet circuit
   The construction of the main carburetor system is as shown in fig. 176. The fuel flowing out of the float chamber is meered by the main jet and mixed with the air flowing from the main air bleed emulsion hole, then jetted into the air stream at the narrowest zone of the venturi. The main carburetor incorporates a double-venturi, wherein the large venturi has the small venturi skirt at its narrowest portion. The speed of the air flow is extremely high at the narrowest portion of the small venturi, and accordingly, the quick atomization of fuel can be assured. Fuel consumption is also economized.

2. Slow speed circuit
   The fuel passing through the main jet is metered by the slow jet, and mixed with the air flowing from the No. 1 air bleed jet located near the slow jet end. This atomizes the air-fuel mixture, which is further metered by the slow economizer. The metered air-fuel mixture is mixed with the air stream from the No. 2 slow air bleed jet positioned on the top end of the vertical slow passage, and further atomized, then flowing to the slow port. The slow port has a goundshaped hole and positioned on the side wall of the main bore near the throttle valve. The fuel is jetted through this slow port when the engine runs with low load. While the engine runs idle, the fuel is supplied through the idle port located on the intake pipe side of the slow port.
   In general, the air-fuel mixing ratio for engine idling varies depending on the engine, and there-

fore, the idle speed adjust screw is provided to regulate the ratio. The optimum opening of the idle speed adjust screw is the position where the adjust screw is backed off 1-1/2 turns from the fully-closed position.

The slow jet has a very small hole measuring 0.017 in. (0.42 mm) in diameter, and therefore, it is easily clogged with fine dust. The slow jet is designed to be removed with a screw driver, providing great convenience to service.

3. Float circuit

The float system consists of the float valve and the float, and its purpose is to maintain constant the level of fuel in the float chamber. The fuel which is fed from an mechanical fuel pump at a pressure of 1.42 ~ 2.13 lb/in² (0.1 ~ 0.15 kg/cm²) is filtered by the strainer located at the carburetor inlet, and flows into the float chamber through the clearance between the float valve and the valve seat.

As the fuel level rises, the float also rises, and the float valve moves upward accordingly. In this way, the float valve is finally forced tightly against the valve seat, thus stopping the fuel flow to the float chamber. Then, if the fuel level drops, the float moves down and releases the float valve so that the fuel inlet is opened. In this manner, in actual operation, the fuel is maintained at a practically constant level. The float level of this carburetor is 0.616 ± 0.039 in. (15.5 mm ± 1) above the body top. Therefore, the carburetor can be tilted 14° at maximum so that it provides smooth engine start and idling on a slope.

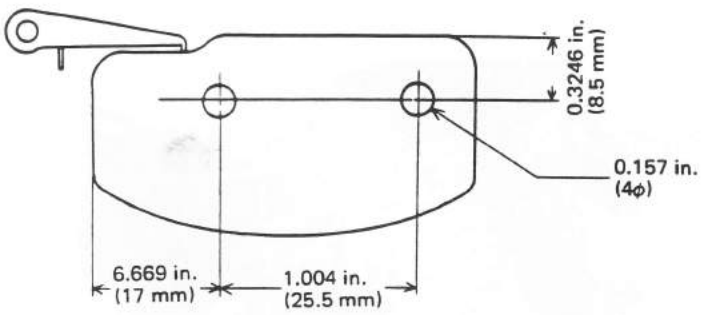


Fig. 177

The float chamber vent is provided immediately before the choke valve; that is, it employs the inner vent system. This prevents the air-fuel mixture from becoming rich due to the clogging of the paper filter element.

The float is made of oil-resistant foamed rubber. Unlike a conventional type float, it is not hollowed. Therefore, there will be no troubles resulting from faulty soldering. Faulty soldering allows fuel to enter the inside of the float, letting it submerge. Further, float and needle valve are incorporated in the float chamber to ensure that the float level can be constantly maintained at a certain position. Overflowing caused by the excessive vibration can be protected by means of the hole on the float.

4. Acceleration-pump circuit

The acceleration-pump circuit includes a vacuum piston linked to a throttle valve, and consists of a pump piston, inlet check valve, outlet check valve and pump nozzle.

The pump piston is separated into two sections, which is connected by a pin fitted in holes in the piston shaft, and is provided with a damper spring. Accordingly, when the pump piston comes to contact the cylinder bottom, the pump rod is pushed by the pump arm. Then the damper spring contracts, and as a result, the pump arm and throttle valve operate so that the valve becomes fully opened.

When the throttle valve quickly opens from the fully-closed position, the pump piston is pushed downward by means of the pump arm, connecting rod, and pump arm link connected to the throttle valve rod. The fuel under the piston causes the inlet check valve to close, thereby stopping the reverse flow of fuel to the float chamber.

As a result, the outlet check valve opens and the fuel is sprayed into the air stream through the pump jet.

The acceleration fuel is sprayed to the narrowest area of the large venturi, where the air flow speed is highest, and accordingly, the atomization of fuel is made easy.

When the throttle valve closes from the fully-opened position, the piston moves up and the pressure under the piston becomes negative. This makes the inlet check valve (in the float chamber) open, and the fuel in the float chamber is drawn out. Then, the outlet check valve closes and prevents the reverse flor of air from the pump jet. In this way, the acceleration pump correctly operates.

A spring is inserted between the pump rod and the upper body, and prevents the excessive play of the pump rod link and pump arm. It also prevents

Two holes are provided on the side opposit to the pump piston, and the fuel spray amount can be chagned by inserting the connecting rod into the inner hole or the outer hole.

In general, the acceleration spray amount of fuel varies according to the operating conditions of the engine as well as to the conditions of climate.

Normally, the amount of fuel spray is less in summer than in winter.

With the connecting rod in the outer hole, the pump spray rate is 0.000528 pt (0.3 cc) per stroke throughout the year, but when the rate has decreased due to the wear of the pump leather and other defects, the inner hole should be used for optimum spray quantity.

As mentioned earlier, this carburetor's pump nozzle also serves as auxiliary fuel system. When the engine runs at high speed or with high load, a large amount of air is required and the negative pressure affecting the pump nozzle raises the outlet check valve weight. The fuel is drawn out through the pump nozzle and mixed with air. The pump weight overcomes the negative pressure until the amount of air drawn in reaches a certain level, and causes the check valve to close. Thus stops its work as auxiliary fuel system.

5. **Starting system**

The starting system of this carburetor includes the choke valve linked with the choke button on the dash board and the fast idle system coupled with the choke valve.

When the choke button is pulled, the choke lever, which is linked by a cable, is also pulled, thereby closing the choke valve. The choke valve is attached to the choke valve shaft with two screws, which is positioned eccentrically in relation to the air horn.

The choke valve shaft is coupled with the choke lever by means of the choke valve spring.

The choke lever is fitted with a link. When the choke lever is pulled, the link makes the throttle lever open so that the opening is suitable for starting. Then, if the starter is turned, a rich mixture is obtained, and easy starting is assured.

When the engine is started, the vacuum in the inlet pipe increases and the choke valve, being affected by negative pressure, overcomes the spring tension. In this stage, the choke valve opens properly so that the over choke is prevented and the engine continues sunning.

As the engine is warmed up, the choke button is depressed to open the choke valve properly. After the engine is fully warmed up, the choke valve fully opens and the throttle valve opens to a specified idling opening.

The use of the choke valve in the position closer to the closed position will result in greater fuel consumption. When you stop your tractor while travelling, depress the choke button as far as the engine will not stall.

5-2. Disassembling the Carburetor

Notes: On carburetor disassembling

- Place the remove parts orderly so that you will not confuse about them when performing reassembly.
- Clean all the removed parts with gasoline. Blow every small hole in parts with compressed air to remove dust.
- Never clean jets and small holes.

1. **Removing the carburetor**

a. Loose the hose band, and remove the hot air hose (A).
b. Remove the connecting bolt (B), and remove the fuel hose.
c. Pull out the vacuum advance hose (C), and remove the rod assembly (D).
d. Remove the two mounting nuts (E), and remove the carburetor from the intake manifold.

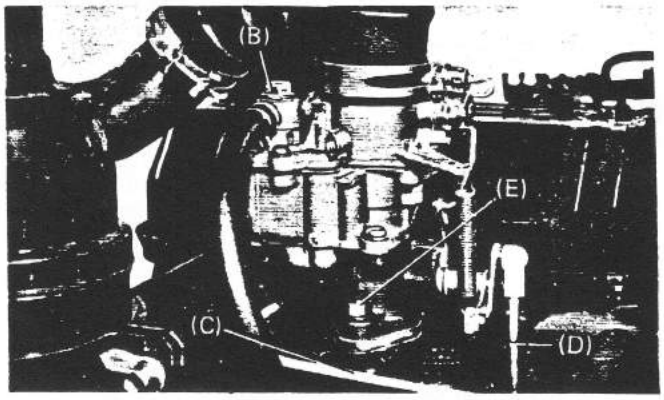


Fig. 178

2. Removing the link mechanism

a. Remove the throttle return spring (A).

b. Remove the split pin, and remove the choke connecting rod (B) from the throttle lever.

c. Remove the split pin, and remove the pump connecting rod from the pump lever (C).

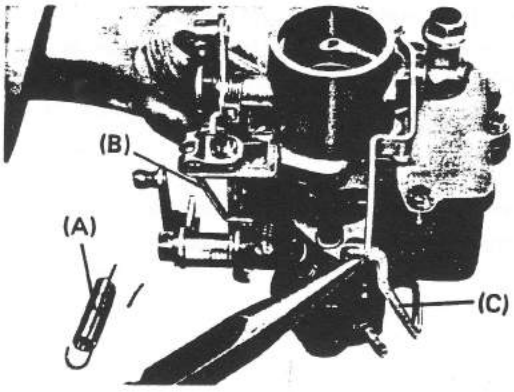


Fig. 179

3. Removing the air horn

a. Remove the pump return spring.

b. Remove the five screws, and remove the air horn from the body, together with the float and needle valve.

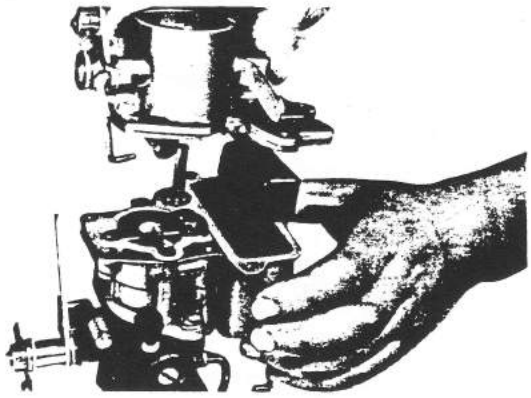


Fig. 180

4. Removing the float valve and float

a. Pull out the float pin from the air horn, and remove the float. (Right in Fig. 181)

b. Remove the valve spring and needle valve. (Left in Fig. 181)

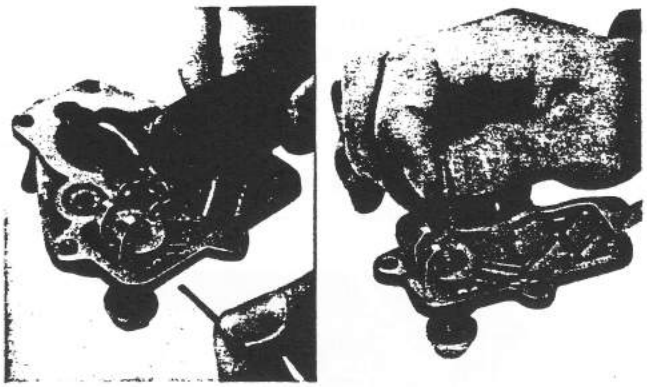


Fig. 181

5. Removing the accelerating pump

Pull out the accelerating pump piston assembly from the body.

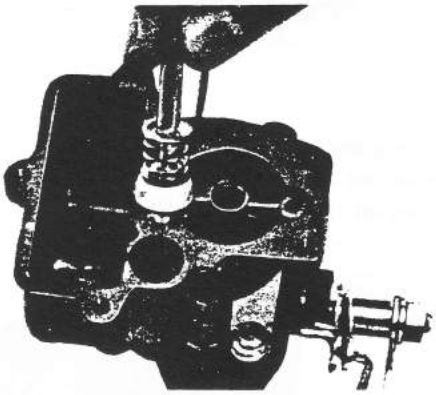
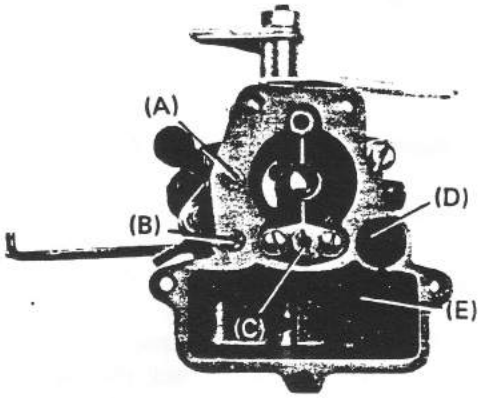


Fig. 182

6. Removing the air bleeds and jets

Remove the slow air bleed, slow jet, main air bleed, injet check valve and power jet from the body, as shown in Fig. 183.



(A) Slow air bleed
(B) Slow jet
(C) Main air bleed
(D) Inlet check valve
(E) Power jet

Fig. 183

To remove and install the power jet, use the special tool (No. 0490120 POWER VALVE LOCK DRIVER).

7. Removing the body
Remove two mounting screws, and remove the body from the throttle chamber.

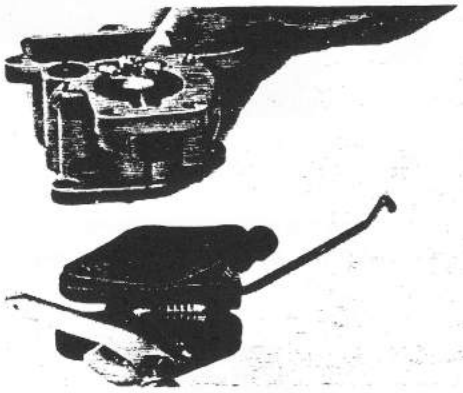


Fig. 184

8. Removing the main jet
Remove the plug (A) from the body, and remove the main jet (B) as shown in Fig. 185.

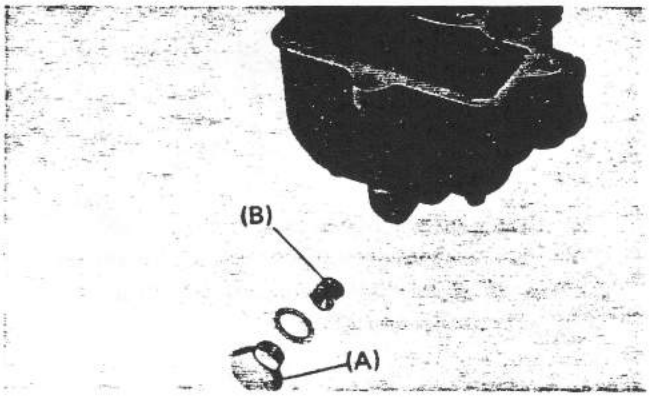


Fig. 185

5-3. Checking, Maintenance and Limit of Adjustment

1. Checking the air horn
Check the air horn for cracks and deformation of contacting surface with the body. Check the choke valve shaft bearing for wear. Check the choke valve for smooth operation. Check the float for damage and deformation. Check the needle valve for contacting surfaces between the valve and seat. If any of these is found faulty, replace it.

2. Checking the throttle chamber
Check the throttle chamber for cracks and deformation of its contacting surface with the body. Check the throttle shaft bearing for wear and throttle valve for smooth operation. If any of these is found faulty, replace it.

3. Checking and repairing the body
a. Check the body for cracks and deformation of contacting surface with the air horn and throttle chamber. If it found faulty, replace it.
b. Check the main jet, slow air bleed, slow jet and power jet for clogging. Check the air passages and fuel passages for clogging. If necessary, clean or replace.

4. Checking the repairing the link mechanism
Check the levers, arms, and connecting rods for deformation, bend and wear. If any of these is found faulty. replace it.

5. Adjusting the throttle opening linked with starting
The choke valve is linked with the throttle valve (A), and therefore, when the choke button is fully pulled, the choke valve is fully closed and the throttle valve opening will be suitable for starting opening is 13° ~ 17°.
When the choke valve is fully opened, the clearance (A) of the throttle valve on the primary side should be 0.039 in. (0.91 mm). If not, adjust it correctly by bending the choke connecting rod (B).

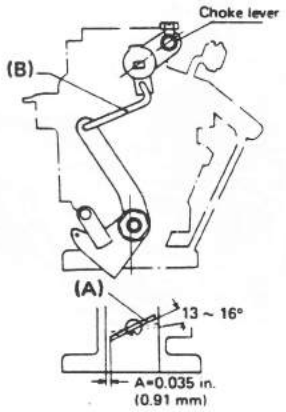


Fig. 186

6. Adjusting the float level
a. Remove the air horn from the carburetor, and raise the float (A).
b. Slowly lower the float (A) and stop it when the float seat (C) contacts the needle valve stem (B). Measure the C, and if the measurement is 0.16 in. (4.0 mm), the float level is correct. If not, adjust it by bending the float seat.

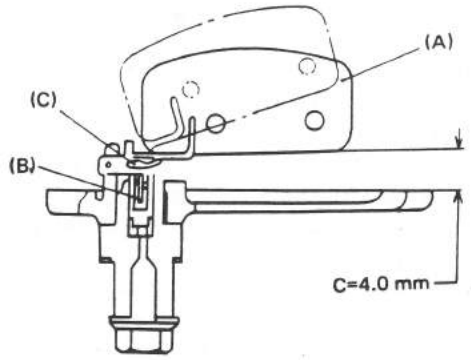


Fig. 187

7. Idle speed adjustments
   For idle speed adjustments, a tachometer should be used. Adjustments are made by using the throttle adjust screw (A) and idle adjust screw (B).

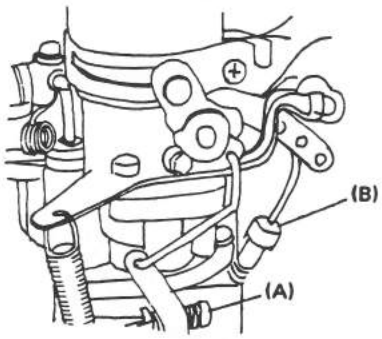


Fig. 188

a. Fully turn in the idle adjust acrew, and back it off 3 turns. Then screw in the throttle adjust screw 2 or 3 turns, and start the engine.
b. Sloly back out the throttle adjust screw, and the engine speed will slow down. Stop turning the screw just before the engine begins to run roughly.
c. Then slowly turn in the idle adjust screw. When the engine begins to run smoothly at maximum speed, stop turning the screw.
d. Slow down the engine speed by turning out the throttle adjust screw. Repeat this operation so that the engine will smoothly run at 700 ~ 800 rpm.
   Note: Do not turn in the idle adjust screw too hard, otherwise, the screw end will be damaged.

5-4. Assembling the Carburetor

For the disassembly procedures in reverse order.
Note:
- O Replace the packing with a new one.
- O After assembling, make sure that the throttle valve and choke valve operate smoothly.

5-5. Mounting the Carburetor

Follow the removal procedures in reverse order.

5-6. Specifications

Model	210028 – 061
Construction	Stronberg type
Draft direction	Downward draft
Outlet diameter	1.024 in. (28 mmφ)
Venturi	0.732 x 0.256 inφ (18.6 x 7 mmφ)
Main jet	#77
Main air bleed	#50
Slow jet	#44
Slow air bleed	P_1 120 P_2 170
Power jet	#45
Pump injector	0.0236 inφ (0.6 mmφ)
Needle valve	0.059 inφ (1.5 mmφ)
Float level	0.610±0.039 in. (15.5±1 mm)
Throttle valve	10°, 0.059 in. (1.5 mm) thick

6. Governor

6-1. Governor System - General

The KSP governor, made by Koshida Shoko K.K., is of the mechanical type. It is used, being interlocked with the Stronberg type carburetor (210028/061) for the PB engine.
The governor is operated by fly-weight centrifugal force, and its adjustment can be done accurately according to the engine specifications.
Engine Specifications:

Specified engine speed	2,800 r.p.m. (25 PS)
Static speed variation	12% or less
Momentary no-load variation	17% or less

Note: The governor has been adjusted most suitably for engine operating conditions, and therefore, you should make no attempt to disassemble it, except for oiling it or for repairing critical defects.

6-2. Governor - Operation and Construction

1. Operation
The governor detects the difference between the actual engine speed and the specified engine speed, and controls the carburetor's throttle valve to adjust the engine speed to the specified value.
As the engine speed changes, variation occurs in fly-weight centrifugal force, and according to the variation, the governor spring length varies. As a result, this variation changes the throttle valve opening by means of the link mechanism, thereby changing the engine speed.

2. Construction
(Refer to Figs. 189, 190 and 191).
The governor shaft (5), which is locked to the governor pulley (6), is provided with two balance weights (9). The balance-weights are constantly in contact with the thrust bearing collar (13), to which the thrust bearing (31) is fitted. The thrust bearing is designed to move back and forth on the governor shaft (5). One end of the thrust bearing (31) is in contact with the fork lever (38) attached to the fork shaft, and variation in centrifugal force is transmitted to the fork lever shaft (5).

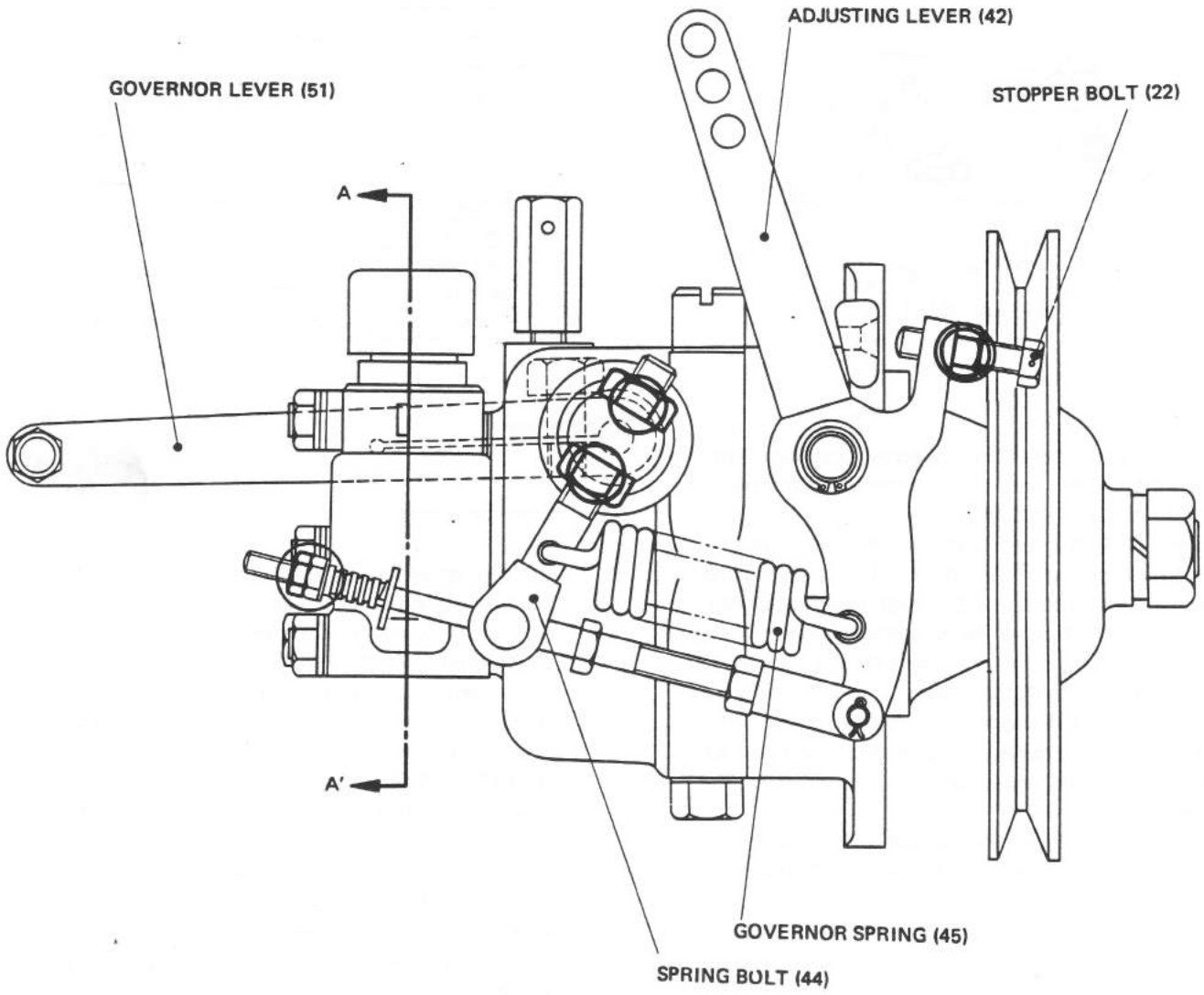


Fig. 189 Side View

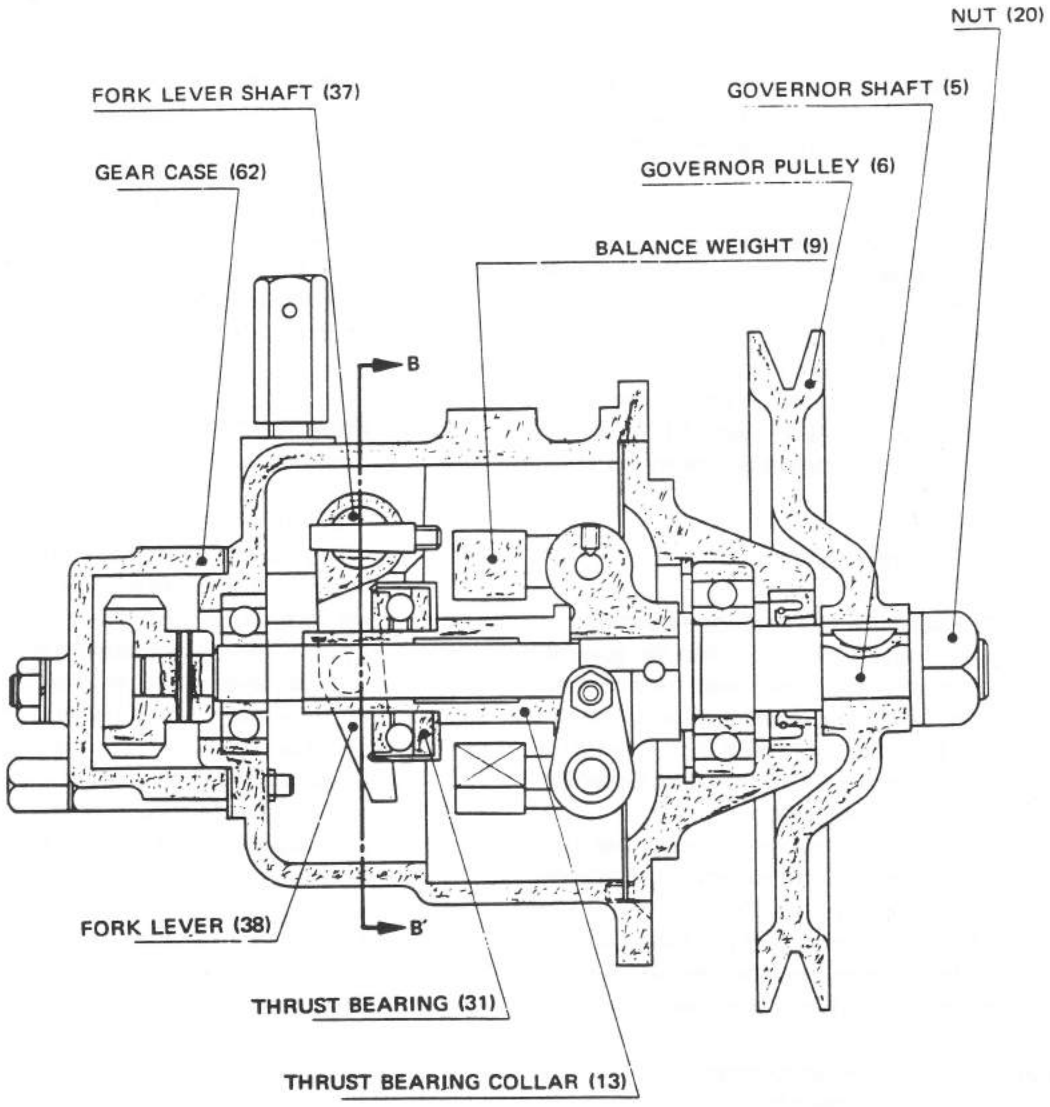


Fig. 190 Sectional View

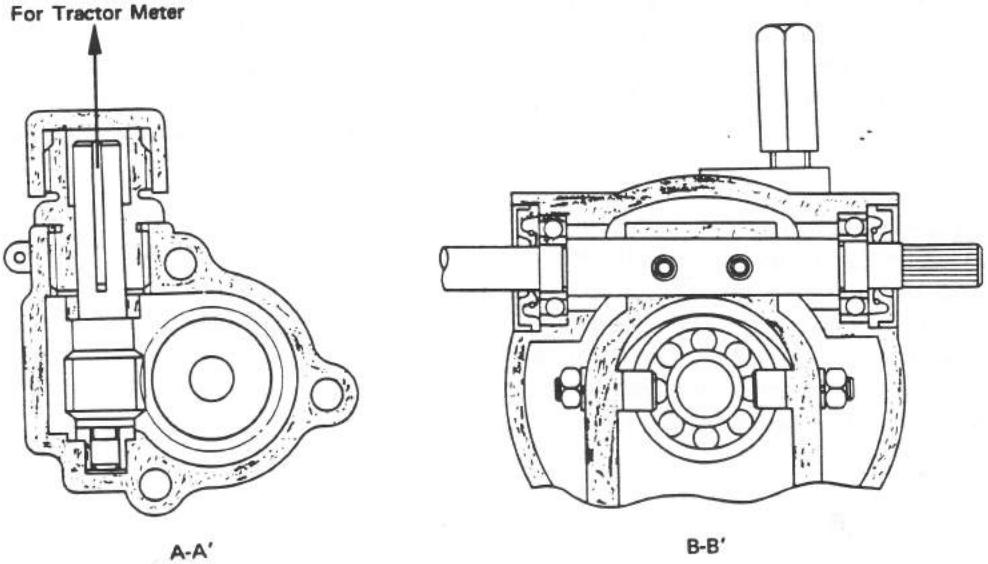


Fig. 191 Sectional Views A and B

3. Construction of control mechanism
The governor spring (45) is hooked on the spring bolt (44) which is attached to the fork shaft (5) and on one of the adjusting lever (42). Variation in centrifugal force affects the spring bolt (44), and thereby the length of the governor spring (45) is changed.

4. Construction of link mechanism
The governor lever (51) is bolted to the fork shaft (37), and the lever has the ball joint (interlocked with the carburetor) on its end.
According to variation in output at the detector, the governor lever (51) moves up and down, and controls the throttle valve opening by means of the link rod, thereby regulating the engine speed.

6-3. Purpose of Governor Adjustments

Note: The adjustment procedures as described in this section is applicable only when the governor itself is required to be adjusted. Accordingly, when the governor is necessary to be adjusted in relation to the carburetor, refer to "5. Adjusting Interlocking between Carburetor and Governor" which will be discussed later.
It should be noted that the governor has been properly adjusted before the tractor is shipped out from the factory. In Fig. 189, the double circle (◎) shows sealing by pinch, and the circle (○) indicates the position painted. Avoid to make an attempt to adjust unnecessarily.

1. Adjusting engine speed as specified
Adjustments can be made by changing the tension of the governor spring (45). The spring tension can be changed by varying the length of the spring by turning in or out the stopper bolt (22) attached to the adjusting lever (42). To increase the engine speed, the spring length should be made longer, while to decrease the speed, it should be shortened.

2. Adjusting speed variation
Speed variation adjustments can be done by changing the length of the spring bolt (44). When the projected part of the spring bolt is longer, speed variation becomes greater, while the part is shorter, speed variation is smaller. If the spring bolt is adjusted, the specified engine speed is also changed, and therefore, readjustment is required.

6-4. Maintenance

To keep the governor in best condition, proper oiling is required, and no other service is necessary. Oiling should be made as follows:

a. Use the same oil as for the engine.
b. Replace the oil after 50 hours of operation, and thereafter, replace it every 100 hours.
c. Oil quantity should be 0.01 gal (40 cc).
Feed the oil so that the oil level is at the lower level line marked on the gauge. (The quantity will be about 0.01 gal. (40 cc)).

6-5. Interlock Adjustment between Carburetor and Governor

The interlock adjustment is required only when the governor is found to be faulty because of instable engine speed, fluctuations in specified engine speed and increases in speed variation.

a. Turn in the throttle adjusting screw to bring the throttle valve opening to zero.
b. Fully pull out the adjusting lever, and loosen the governor lever not so that the throttle valve opening will be between 70° and 75°.
c. Return the adjusting lever to its original position, and adjust the fork lever stopper so that the throttle adjusting valve will return to the zero position.
d. By using the throttle adjusting screw and the idle adjusting screw, perform idle speed adjustments.
   - ○ Idle adjusting screw . . . Adjust so that the vacuum gauge reading will be at maximum.
   - ○ Throttle adjusting screw . . . Use a tachometer.
e. Adjust the adjusting lever position by using the stopper bolt so that the engine speed will be at 3,150±50 r.p.m. with no load and with full throttle.
Note: Disassembling of the whole governor should be done by its manufacturer, and therefore, the disassembling procedures are not described herein.

6-6. Governor – Troubles and Remedies

1. The troubles of the governor can be classified into the following four types:
a. Hunting – periodic variation of engine speed.
b. Variation of specified engine speed.
c. Increase of fluctuation coefficient.
d. Inoperative governor.

2. Causes of troubles and remedies
a. Hunting – periodic variation of engine speed

Cause	Remedy
Fatigued governor spring.	Replace.
Increased friction on link mechanism.	Clean and oil.
Excessive wear on link joints.	Replace.

b. Variation of specified engine speed

Cause	Remedy
Incorrectly adjusted governor spring.	Readjust.

c. Increase of fluctuation coefficient

Cause	Remedy
Lack of lubrication.	Oil.
Increased friction of moving parts.	Disassemble and check.

d. Inoperative governor

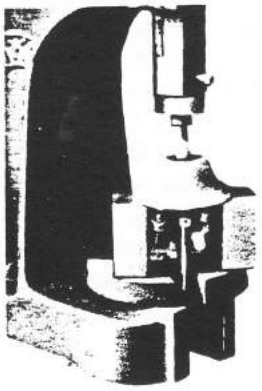
Cause	Remedy
Damage and seizure of inner parts.	Disassemble and check.

6-7. Governor Disassembling Procedures

1. Remove the governor from the engine
a. Remove the ball joint at the end of the governor.
b. Remove the nut at the front of the pulley, and remove the pulley.
c. Remove the bracket mounting bolts, and remove the governor assembly.

2. Disassembling the governor assembly
a. Remove the gear case stud nut, and remove the gear case kid.
b. Pull out the drive gear roll pin, and remove the drive gear.
c. Remove the counter-sunk screw at the front of the governor case.
d. Hold the governor case flange with your hand, and lightly strike the governor shaft projecting to the governor case rear side with a hammer. The governor shaft kid and bearing case kid can be removed.

3. Disassembling the governor shaft kid
a. Pull out the thrust collar. The bearing case kid can be removed in such a manner as shown in the photo.



Do not attempt to further disassemble the removed sections. Necessary check can be made without performing further disassembling.

4. Disassembling the governor shaft kid
a. Remove the bayonet set-screw on the rear of the weight holder. The governor shaft kid can be disassembled into the weight set pins, weights, and weight pins, in that order.
b. Remove the taper pin, and the weight holder can be removed with ease.

5. Disassembling the bearing case kid
a. Remove the snap ring, and disassemble the bearing case kid in order of the oil seal and bearing.

6. Disassembling the governor case kid
a. Pull out the lever joint cotter pin located on the bottom end of the adjust lever.
b. Remove the adjust lever snap ring. The governor case kid can be disassembled into the adjust lever, governor spring, spring bolt, and lever rod, in that order.
c. Remove the spring bolt holder taper pin, and the bolt holder can be pulled out with ease.
d. Loosen the governor lever fitting bolt, and remove the governor lever.
e. Remove the fork lever fitting ten pin in the case.
f. Lightly strike the fork shaft projecting into the case (on the bolt holder side) with a hammer, and the fork lever can be removed. One half of the lever is attached with the oil seal and bearing.

7. Disassembling the gear case
a. Remove the sleeve, and the driven gear can be removed.

6-8. Parts – Inspection

a. When the governor shaft kid is removed from the governor case, inspection should be started.
b. If any parts are found damaged, scratched or excessively worn, they should be replaced.
c. The tolerance of main parts is as follows:
(If any parts are found in excess of tolerance, they should be repaired or replaced.)

Name of Part	Measuring Point	Specified Dimensions	Tolerance
Fork shaft	Wear on bearing contacting surface	$0.3748024\phi\ ^{-0.00019685}_{-0.00055118}$ in. $(0.52\phi\ ^{-0.005}_{-0.014}$ mm)	–0.0007874 in. (–0.02 mm)
	Bend of shaft	0	0.0007874 in. (0.02 mm)
Fork lever pin	Outside diameter	0.31496φ ±0.0019685 in. (8φ ±0.05 mm)	–0.003947 in. (–0.1 mm)
Weight set pin	Outside diameter	$0.23622\phi\ ^{-0.00035433}_{-0.00066929}$ in. $(6\phi\ ^{-0.009}_{-0.017}$ mm)	–0.0007874 in. (–0.02 mm)
	Bend	0.0003937 in. (0.01 mm)	0.0011811 in. (0.03 mm)
Weight Pin	Outside diameter	0.31496φ ±0.0019685 in. (8φ ±0.05 mm)	–0.003937 in. (–0.1 mm)
Thrust collar	Wear inside diameter	$0.43307\phi\ ^{+0.00106299}_{0}$ in. $(11\phi\ ^{+0.0017}_{-0}$ mm)	+0.0011811 in. (+0.03 mm)

Name of Part	Measuring Point	Specified Dimensions	Tolerance
Balance weight	Wear on bush inside diameter	$0.23622\phi\ ^{+0.00047244}_{0}$ in. $(6\phi\ ^{+0.012}_{0}$ mm)	+0.0011811 in. (+0.03 mm)
Governor spring	Free length	2.48031±0.019685 in. (63±0.5 mm)	+0.019685 in. (+0.5 mm)
	Spring constant	5% 23.039 lb/in. (5% 2.0 kg/mm)	−5% −5%
	Initial tension	15.435 lb±1.103 (7.0±0.5 kg)	−1.103 lb (−0.5 kg)
Governor shaft	Wear on thrust collar contacting surface	$0.43307\phi\ ^{-0.00062992}_{-0.00106299}$ in. $(11\phi\ ^{-0.016}_{-0.027}$ mm)	−0.0011811 in. (−0.03 mm)
	Wear on bearing contacting surface	$0.39370\phi\ ^{-0.00019685}_{-0.00059055}$ $(10\phi\ ^{-0.05}_{-0.15}$ mm)	−0.0007874 in. (−0.02 mm)
	Bend of shaft	0 0	0.0007874 in. (0.02 mm)

6-9. Assembling Procedures

1. **For assembly, the disassembly procedures should be followed in reverse order.**

2. **Assembling notes**

a. Thoroughly wash all disassembled parts with light oil.

b. Be sure to replace all gaskets and oil seals with new ones. Otherwise oil leakage may result.
It is also advisable to replace bearings as a rule.

c. When press-fitting the bearing case kid into the governor shaft, grease the oil seal inner surface and bearing side surface.

d. When installing thrust collars, apply a small quantity of mobile oil to contacting surfaces.

e. Feed a plenty of fiber grease into the gear case.

f. Tighten the pulley with a torque of 36.25 ft-lb (5 kg-m).

g. When replacing the balance weights, make sure that new weights are the same in mass as old ones.

h. Make sure that the governor lever is at an angle of 4° to the horizontal line.

i. Set the spring bolt so that the distance from the center of the spring bolt holder to that of the spring hole is 0.1024 in. (28 mm).

j. Make sure that the runout of the pulley V groove is 0.0098 in. (0.25 mm) or less measured from the governor case mounting surface, after assembling is completed.

6-10. Adjusting the Governor

1. **Installing the governor assembly**

a. When installing the governor on the engine, be sure that the V-belt is flexes 0.55 ~ 0.78 in. (14 ~ 20 mm) (in case of tension of some 22.05 lb (10 kg)) by depressing with fingers midway between the pulleys. If the belt is a new one, adjust the flexion of the belt to 0.55 ~ 0.67 in. (14 ~ 17 mm).

2. Adjusting the specified engine speed

a. Adjustment can be done by turning the adjust lever stopper bolt and by changing the governor spring tension. Increasing the length of the spring installed causes the engine speed to increase, and shortening causes the speed to decrease.

b. Adjusting speed fluctuation coefficient
Adjustment can be done by changing the distance from the center of the spring bolt holder to that of the spring hole. When the distance is longer, the coefficient is larger, and vice versa.

3. Correcting periodic speed variation

a. If hunting (to slight degree) is found, it should be adjusted by the damper spring attached to the lever rod end.

b. If hunting is phenomenal, governor adjustment is incorrect. Readjustment should be made by adjusting the specific speed and fluctuation coefficient, alternately.

6-11. Lubrication

It is requested to supply lubricant (Engine Oil) in the volume of approx. 0.01 gal. (0.04 lit.). The standard oil level should be read on the top position of the oil level gauge when it is fully inserted.

IGNITION SYSTEM

1. Spark Plug

1-1. Inspection and Adjustment of Sprk Plug

1. Clean the plug's electrode with a plug cleaner tester.

Fig. 192

2. Check the spark plug for the following and if it is faulty, replace it.

a. Whether the insulator is damaged.
b. Whether the electrode is worn.
c. Whether the gasket is damaged.

3. Measure the plug gap with a plug gap gauge.
Any necessary adjustment can be made by bending the plug's outer electrode.

Sparking plug clearance	0.031 in.-(0.8 mm)

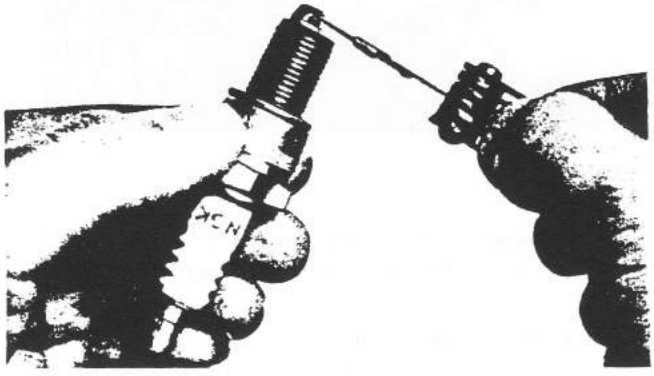


Fig. 193

1-2. Spark Plug Specifications

Type:	B6E (NGK) W20EP (DENSO)
Plug gap:	0.031 in. (0.8 mm)

2. Distributor

2-1. Removing the Distributor

1. Remove the primary coil from the distributor.
2. Remove the high tension code from each spark plug.
3. Remove the vacuum advance hose from the vacuum control assembly.
4. Unscrew the distributor securing nuts and lift up the distributor.

2-2. Disassembling the Distributor

Disassemble the distributor is in the procedure out-lined below.

1. Remove the distributor cap (A) and pull off the rotor (B).
2. Remove two vacuum control assembly securing screw bolts, and clips securing the link to the breaker base assembly, and then the vacuum control assembly (C).
3. Loosen the nut (D) at the primary coil terminal.
4. Remove the breaker assembly and two breaker arm support securing screw bolts, and lift up the breaker base (E) and breaker arm support (F).
5. Remove the condenser (H) from the housing assembly (G).
6. Pull off the pin holding the drive gear (J) and shaft assembly (I), and remove the drive gear and shaft assembly (K) from the housing assembly.
7. Pull off the cam (L) from the shaft assembly.

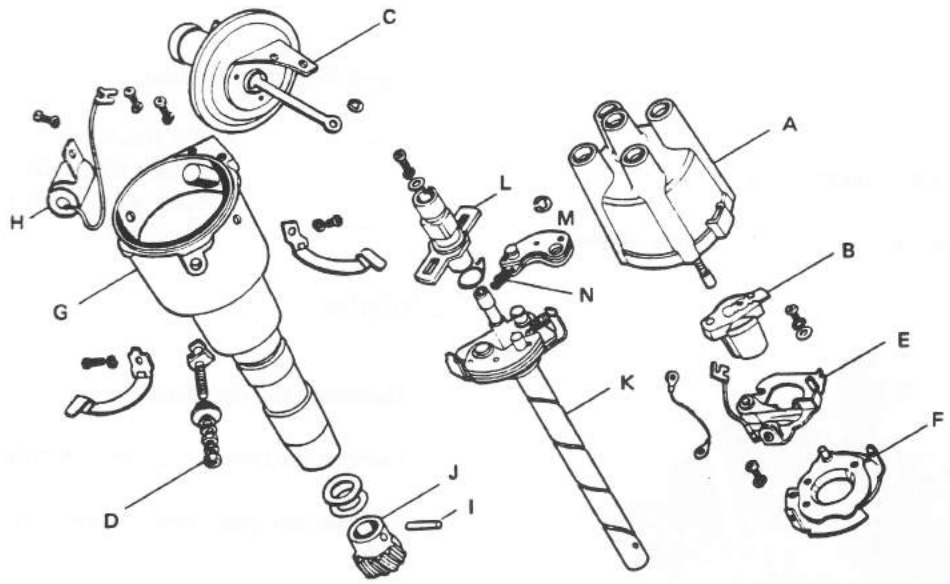


Fig. 194

8. Pull off the clip connecting the shaft assembly to the governor weight, and remove the governor weight (M) and governor spring (N).

2-3 Checking, Maintenance and Limit of Adjustment

Checking the distributor

1. Distributor cap
Check the distributor cap for crack, split or damage, and if it is faulty, replace it. If the high tension terminal is corroded, scrape it off.

2. Rotor
Check the rotor for crack or damage, and check whether the tip of the terminal is burnt. If it is faulty, replace it.

3. Contact point
Check the contact point for wear, burnt part or sticking. If it is only slightly damaged, grind it with an oil stone, while if severely damaged, replace it.

4. Condenser
Measure the condenser capacity with a condenser tester, and if it is faulty, replace it.

Condenser capacity	0.20 ~ 0.24μF

5. Contact arm spring tension
Measure the contact arm spring tension with a spring tension tester, and if the measured value is not satisfactory, replace it.

Contact arm spring tension	1.1 ~ 1.4 lb (500 ~ 650 g)

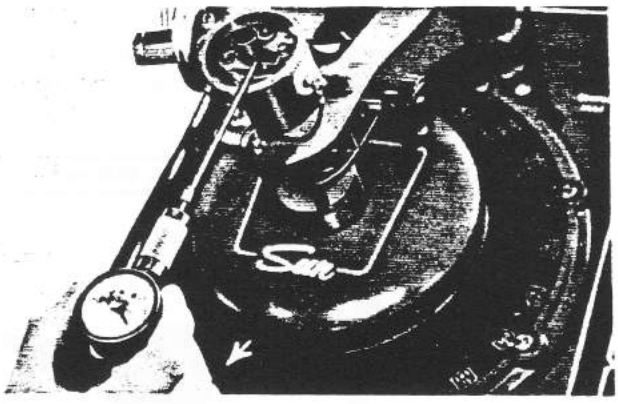


Fig. 195

6. See whether the drive gear teeth are cranked, damaged or broken, and if it is faulty, replace it.

7. Inspecting dowel angle
Measure the dowel angle with a distributor tester. If the measured value is not in the following range, it is assumed due to incorrect point gap, worn cam, worn contact arm heel, deflected contact arm, etc. See what is the trouble, and if it is faulty, correct or replace it.

Dowel angle	56 ~ 61°

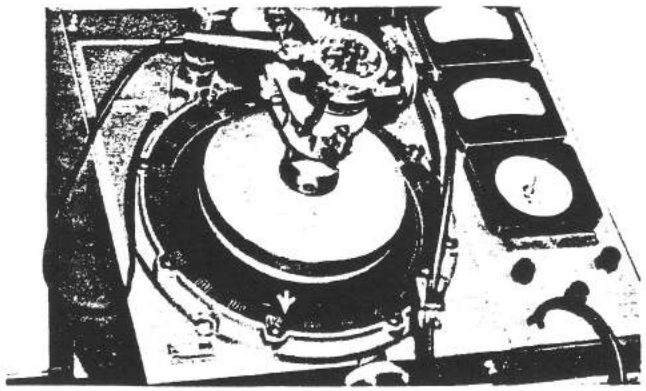


Fig. 196

8. Adjusting the point gap

a. Set the contact arm heel to the high part of the cam so that the clearance between points becomes widest.

b. Insert a special tool (No. N026 STANDARD FEELER GAUGE) into the point gap and measure the point gap.
To adjust the point gap, loosen two screws and adjust the point gap and retighten the screws.

Point gap	0.016 ~ 0.020 in. (0.4 ~ 0.5 mm)

Fig. 197

2-4. Assembling the Distributor

Follow the reverse procedure of "Disassembling".

2-5. Mounting the distributor

Follow the reverse procedure of "Removing".
Note: After installing the distributor, adjust ignition timing with a timing light.

2-6. Ignition Timing Inspection and Adjustment

To inspect and adjust the ignition timing, use No. 1 cylinder together with the timing light and tachometer.

1. Connect the timing light secondary coil to No. 1 spark plug, and each primary coil to the battery terminals (+) and (−).
2. Connect the techometer.
3. Start the engine to reach the ordinary idling revolution of 700 ~ 800 rpm.
4. See the timing mark with the timing light.
It is good if the T (timing) mark notch shown in Fig. 198 is aligned to the indicator pin end.
5. To adjust the ignition timing, loosen the distributor lock nut and move the distributor properly.
6. Retighten the lock nut and again inspect the ignition timing with the timing light.

Fig. 198

2-7. Distributor Specifications

Type:	TVD-4MR
Point gap:	0.016 ~ 0.020 in. (0.45 ~ 0.05 mm)
Point pressure:	1.1 ~ 1.4 lb. (500 ~ 650 g)
Condenser capacity:	0.22μF ±10%
Ignition clearance:	90° ± 15°
Dowel angle:	58.5° ± 3° (distributor axle)
Ignition order:	1–3–4–2

See Page ~~12~~ 34 for degree B.T.D.C which is 16°

MEMO

TROUBLESHOOTING

	Symptom & Possible Cause	Remedy

1. The Engine Lacks Power

1-1. Fuel Compression is Insufficient.

1	Valve clearance improper.	Adjust the clearance.
2	Valve seat leaky.	Smooth contacting surface with valve.
3	Valve stem stuck.	Replace guide and valve.
4	Valve spring weaken or broken.	Replace valve spring.
5	Cylinder head gasket leaky.	Replace gasket.
6	Piston ring stuck or broken.	Replace ring.
7	Piston ring or cylinder worn.	Disassemble engine and correct.

1-2. Ignition Timing is Incorrect

1	Ignition timing incorrect. (Early or late)	Adjust ignition timing.
2	Spark plug faulty.	Clean and correct or replace spark plug.
3	Distributor points faulty.	Correct or replace points.

1-3. Fuel Level is Low

1	Carburetor clogged.	Disassemble and clean carburetor.
2	Fuel pipe clogged.	Clean pipe.
3	Fuel system contains air.	Check joints and retighten.
4	Fuel pump in poor condition.	Correct or replace pump.
5	Fuel filter clogged.	Replace fuel filter.

1-4. Carburetor Draws Insufficient Amount of Air

1	Air cleaner clogged.	Clean air cleaner.

1-5. Engine Overheats

1	Cooling water insufficient.	Add water.
2	V-belt loose or slipery.	Adjust or replace belt.
3	V-belt worn or broken.	Replace V-belt.
4	Thermostat inoperative.	Replace thermostat.
5	Water pump inoperative.	Disassemble and correct pump.
6	Radiator clogged or leaky.	Clean and correct or replace radiator.
7	Ignition timing incorrect.	Adjust timing.

2. Fuel Consumption is Excessive

2-1. Engine Oil Leaks

1	Oil pan drain plug loose.	Retighten plug.
2	Oil pan set bolts loose.	Retighten bolts.
3	Oil pan packing faulty.	Replace packing.
4	Oil seals faulty.	Replace oil seals.
5	Cylinder head gasket broken.	Replace gasket.
6	Oil filter set bolts loose.	Retighten filter set bolts.

	Symptom & Possible Cause	Remedy
7	Rocker arm cover packing faulty.	Replace packing.
8	Timing chain cover packing faulty.	Replace packing.

2-2. Oil Comes Up into the Combustion Chamber

1	Piston ring damaged.	Replace piston ring.
2	Piston ring end gap incorrect.	Adjust end gap.
3	Piston ring worn or stuck.	Replace ring.
4	Piston and cylinder worn.	Replace piston or cylinder liner.

2-3. Oil Comes Down from Valve System

1	Valve seat worn.	Replace valve seat.
2	Valve stem and valve guide worn.	Replace valve and valve guide.

3. Engine is Hard to Start

3-1. Engine has Starting Difficulty

1	Engine oil too thick.	Replace oil with specified brand.
2	Battery discharged.	Charge battery.
3	Battery capacity low.	Replace battery.
4	Battery terminal connection faulty.	Clean and tighten terminals. Replace cables.
5	Starter faulty.	Disassemble starter and correct or replace.
6	Safety switch faulty.	Adjust clearance between cam and switch, or replace switch.

3-2. Ignition System is Defective

1	Distributor points faulty.	Correct or replace points.
2	Point gap incorrect.	Adjust point gap.
3	Spark plug gap incorrect.	Adjust spark plug gap.
4	Spark plug cord loose or faulty.	Tighten cord connection or replace.
5	Ignition coil faulty.	Replace coil.
6	Primary winding connection faulty.	Check and retighten connection.
7	Condenser faulty.	Replace condenser.

3-3. Engine

1	Valve seized up.	Correct valve or replace.
2	Piston, piston ring or cylinder worn.	Disassemble and correct.
3	Cylinder head gasket broken.	Replace gasket.

3-4. Carburetor

1	Choke valve faulty.	Correct or replace choke mechanism.
2	Idle speed circuit faulty.	Adjust.
3	Carburetor clogged or too dirty.	Disassemble and clean.
4	Carburetor mounting bolts loose.	Retighten bolts.

	Symptom & Possible Cause	Remedy

4. Engine is Noisy

4-1. Piston

1	Piston-to-cylinder clearance excessive due to worn cylinder.	Replace piston and cylinder liner.
2	Piston-to-piston pin clearance excessively large.	Replace piston and piston pin.
3	Piston ring broken.	Replace piston ring.
4	Piston seized up.	Replace piston.

4-2. Crankshaft

1	Oil clearance excessively large due to worn main bearing metal.	Replace bearing metal.
2	Crankshaft journal worn.	Machine crankshaft or replace.
3	Main bearing metal damaged.	Replace bearing metal and check lubrication system.

4-3. Connecting Rod

1	Oil clearance excessively large due to worn connecting rod bearing metal.	Replace bearing metal.
2	Connecting rod bent.	Correct or replace rod.
3	Crank pin worn.	Machine crank pin or replace.
4	Connecting rod bearing metal damaged.	Replace bearing metal and check lubrication system.

4-4. Miscellaneous

1	Valve clearance incorrect.	Adjust clearance correctly.
2	Crankshaft thrust washer worn.	Replace washer.
3	Engine oil level low.	Add engine oil or disassemble and correct engine.

5. Firing Irregularities

5-1. Ignition System

1	Ignition system wiring connection loose.	Check connection and correct.
2	Spark plug faulty.	Clean spark plug or correct, or replace.
3	Ignition timing incorrect.	Adjust timing.

5-2. Air-fuel Mixture

1	Air-fuel misture too lean.	Clean and adjust carburetor.
2	Carburetor clogged. (or dirty)	Clean and adjust carburetor.
3	Fuel pipe clogged or dirty.	Clean or replace fuel pipe.

5-3. Valves

1	Valve clearance incorrect.	Adjust valve clearance.
2	Valve stuck.	Disassemble valve, and correct or replace.
3	Valve spring weak.	Replace spring.

	Symptom & Possible Cause	Remedy
4	Valve timing incorrect.	Adjust valve timing.

5-4. Cylinder Head

1	Carbon build-up in combustion chamber.	Remove carbon.
2	Cylinder head gasket leaky.	Replace gasket.

6. Incorrect Idle Speed Adjustment

6-1. Carburetor

1	Idle speed adjustment incorrect.	Readjust idle speed.

6-2. Air Entering Fuel Line

1	Air enters carburetor fuel line.	Retighten carburetor mounting bolts.
2	Intake manifold gasket faulty.	Replace gasket.

6-3. Valves

1	Valve clearance incorrect.	Adjust valve clearance.
2	Valve-to-valve seat contact not perfect.	Smooth out valve.
3	Valve stem-to-valve guide clearance excessively large.	Replace valve and valve guide.

6-4. Cylinder Head

1	Cylinder head gasket leaky.	Replace gasket.

7. Engine Runs not Smoothly (when accelerated)

7-1. Carburetor

1	Carburetor acceleration pump circuit clogged.	Disassemble carburetor and correct.
2	Air-fuel mixture lean.	Disassemble carburetor and correct.

7-2. Ignition System

1	Spark plug faulty.	Clean spark plug or replace.
2	High-tension wire faulty.	Replace wire.
3	Distributor point gap adjustment incorrect.	Adjust point gap or replace points.
4	Ignition coil faulty.	Replace ignition coil.

7-3. Engine

1	Valve seized up or adjusted incorrectly.	Readjust or replace.
2	Compression insufficient.	Disassemble engine and adjust.
3	Cylinder head gasket leaky.	Replace gasket.

SATOH TRACTOR

MODEL S-650G

REPAIR MANUAL

CLUTCH SYSTEM

PUBLICATION No.03-B

CONTENTS

CLUTCH SYSTEM

1. General

The clutch for the S-650G is of a dry single plate lever type.

Each component of the clutch is made not to degenerate or be damaged due to the sliding abrasion of the clutch disc in case of connection, moreover, to bear a shock in case of disconnection or a sudden load in case of change in transmission torque.

The operation of the clutch is smooth and secure and provision is made for keeping it from being worn or damaged due to repeated use.

This clutch has the following special systems in order to transmit securely a great torque.

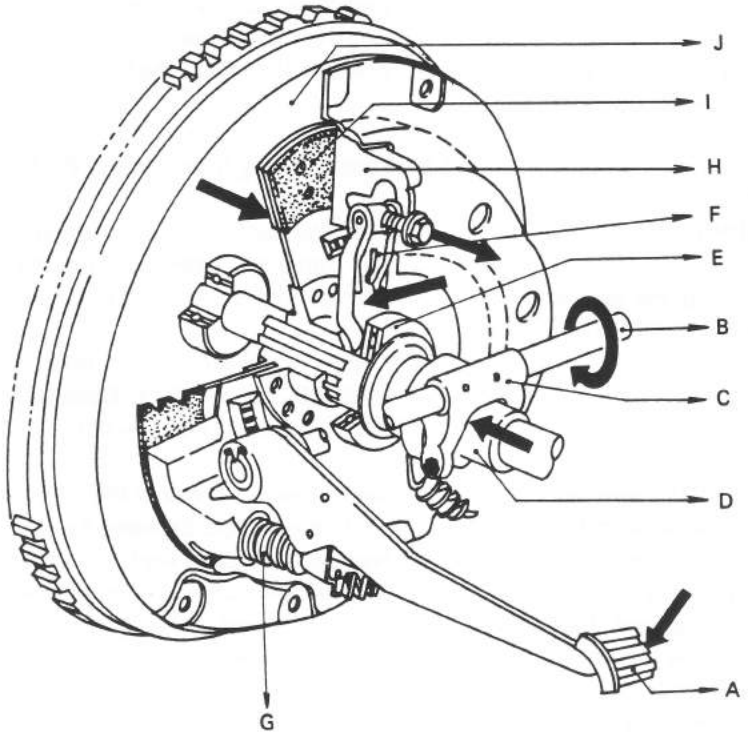
(a) Six pressure springs are used, enabling a high pressure to be applied to the clutch disc to transmit the torque completely and evenly.

(b) For the material of the clutch facing, a wire-reinforced woven fabric whose constant of friction and shape are hardly changed even at a high temperature.

Besides, on the facing there are radial grooves 0.03 in. (0.8 mm) in depth and 0.07 in. (1.8 mm) in width, thus preventing the temperature rise of the facing, incrasing its durability and making it easy for the clutch to be released.

2. Construction

When the clutch pedal (A) is depressed forwards, the shaft (B) is caused to rotate, the fork secured to the shaft with cotter pins slides in the arrow direction to push the thrust bearing carrier (D), forcing the thrust bearing (E) into contact with the release lever (F), the release lever is pushed, the pressure plate is shifted toward the transmission by the pressure of the pressure spring (G), the clutch disc is disengaged, the drive from the engine is cut off.



A clutch pedal
B shaft
C fork
D thrust bearing carrier
E thrust bearing
F release lever
G pressure spring
H pressure plate
I clutch disc
J flywheel

Fig. 1 Clutch Mechanism

3. Disassembling Order

To dismount the clutch assembly from the tractor, there are two methods for it, which to take depending on the facilities of its repair shop.

A Method: Dismounting method when the repair shop has heavy repair tools such as a chain block.

B Method: Dismounting method when the repair shop has light repair tools.

Caution: In dismounting the clutch assembly, it should be done on a broad, firm and flat ground as the transmission is detached at its connection with the engine assembly and each component is very heavy.

3-1. Disassembling Order Using "A" Method

1. In A Method, the front wheel axle and the engine are removed before removing the clutch assembly (see REPAIR MANUAL, ENGINE, 1. Disassembling Order, 1-1. Removal the Engine (No. 1 ~ 21).

2. Support the removed engine with a special tool (0490010 ENGINE STAND) or in other ways.

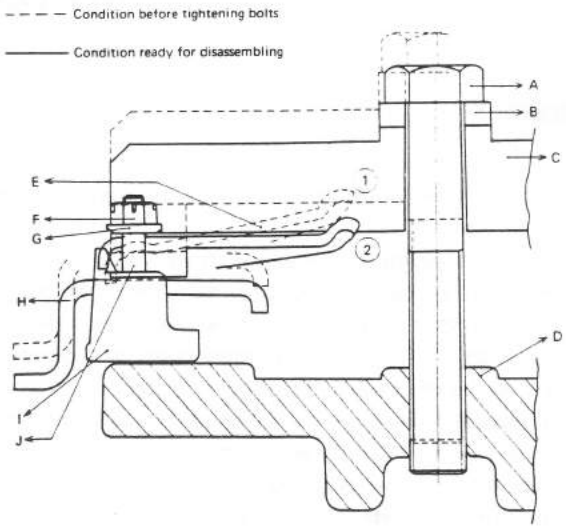
3. Insert a special tool (1102T01 CLUTCH DISC PILOT) into the clutch assembly center and put an alignment mark both on the flywheel and the clutch assembly (to avoid an improper fitting in the case of reassembly).

4. Unscrew four clutch assembly set bolts and two reamer bolts, and remove the clutch assembly together with the disc from the flywheel.

3-2. Clutch Assembly Disassembling Order

1. Attach the clutch cover assembly to the special tool (1102T04 CLUTCH RELEASE LEVER DISASSEMBLY TOOL) (see Fig. 2).

2. Discription of Fig. 2
   The clutch cover assembly taken from the flywheel is as shwon in dotted lines (1), however, under this condition a force which pushes up the clutch cover acts on the lever nut (F) and it is impossible to loosen the lever nut properly.
   So, tighten the bolt (A) of the special tool (1102T04) to lower the clutch cover assembly down to a solid lines (2). Then the release lever (E) is set free and the lever nut can be easily taken out after removing the cotter pin.



A	bolt	F	lever nut
B	washer	G	release washer
C	clutch cover claw	H	clutch cover
D	base	I	pressure plate
E	release lever	J	lever bolt

Fig. 2 Disassembling by use of a Disassembling Tool

3. Tighten the bolt to set the assembly to the position (2) and remove the cotter pin of the lever nut (F) and unscrew three lever nuts (F) and remove the release lever (E) from the lever bolt (J). Slowly loosen the bolt (A) to remove it from the base (D), and remove the clutch cover. Remove six pressure springs and lift up the pressure plate from the base (D).

3-3. Disassembling Order Using "B" Method

1. In B Method, the front wheel axle, the engine and the frame are detached from the clutch housing and the engine fitted place.

2. Follow the procedure, referring to REPAIR MANUAL, ENGINE, 1. Disassembling Order, 1-1. Engine removal (No. 1 ~ 10).

3. Set the jack just below the clutch housing and put a piece of wood between the jack and the clutch housing (to avoid a slip).
   Jack up the clutch housing to keep the tractor rear half horizontal when the front wheel and the engine are detached, but the tractor must not be lifted.

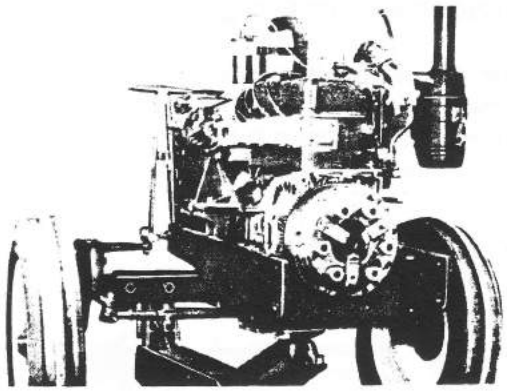


Fig. 3 Front View Detached

4. Drive in a wedge (A) as shown in Fig. 4 to keep the tractor secure.
   The wedge must be a firm piece of wood of about 6 in. (about 150 mm), and see to it that the wedge will not be removed during operation.

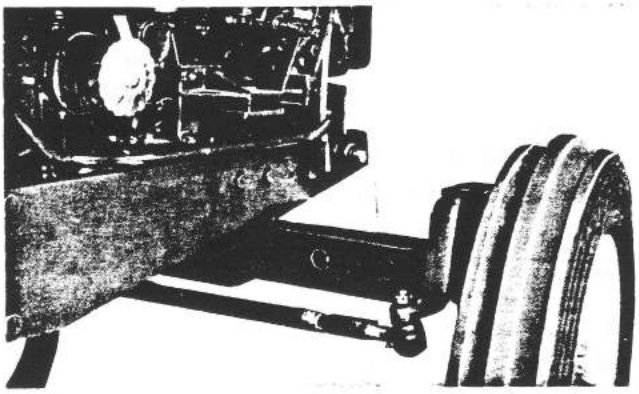
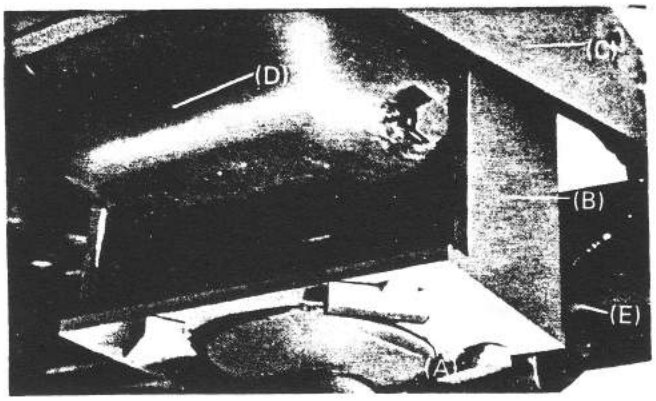


Fig. 4 Wedge (A)

5. To hold the engine oil pan to the garage jack, use a special tool (1102T03 OIL PAN RECEIVER FOR CLUTCH REMOVAL) as shown in Fig. 5.



A Garage jack
B 1102T03
C Chassis
D Oil pan
E Front wheel axle

Fig. 5 Oil Pan Holding

When using the garage jack, the tractor must not be lifted up.

6. Unscrew six nuts (M10) securing the engine and the clutch assembly.
   As both nuts inside the chassis (see Fig. 6) are very hard to be unscrewed, use a special tool (BT-100 DOUBLE OFFSET BOX WRENCH SET).

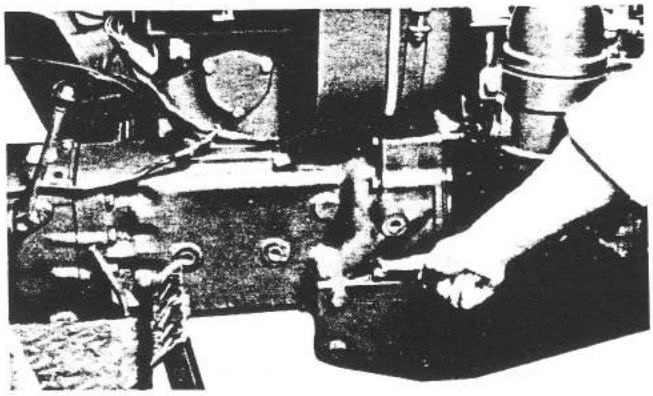


Fig. 6 Positions of Nuts Inside Chassis

7. Take out the starter motor wiring, and loosen two starter motor securing bolts, and remove the starter motor from the engine cylinder block.

8. Loosen eight bolts (M16 x 40) at both sides of the chassis.

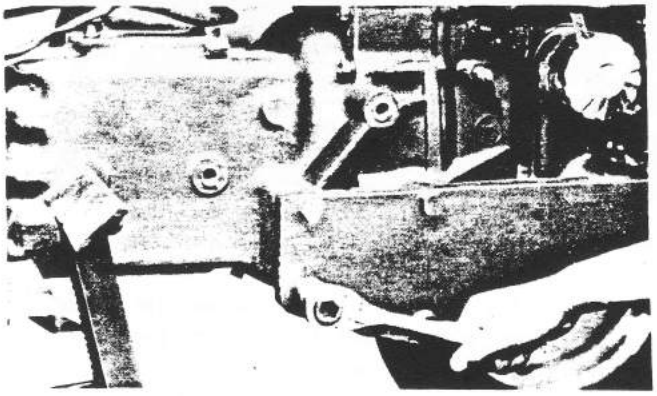
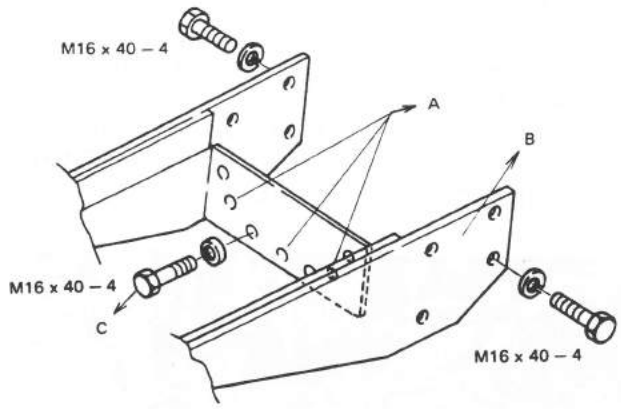


Fig. 7 Removal of Part of Chassis

9. Unscrew four bolts (M16 x 40) (C) shown in Fig. 8.
   Unscrew three rear plate securing screws (M6 x 12) (A) and pull down the rear plate.



A Position of rear plate
B Chassis
C Bottom position

Fig. 8 Installing Bolts of Chassis

10. Now the clutch housing and the engine body are removed, however, if the chassis is not completely pulled off the clutch housing, loosen the nuts (A) at both sides shown in Fig. 9.

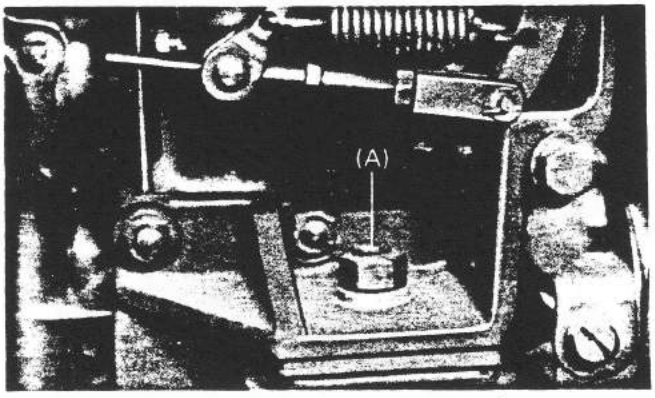


Fig. 9 Nut (A) Position

11. Set up the garage jack a little to keep the tractor horizontal, slide the jack forwards and the tractor is divided into two as shown in Fig. 3.
Note: The engine body for the S-650 is made of alminum. If you treat the tractor roughly when sliding the jack, the stud bolts in the engine body may be twisted, and at last the engine may be damaged, therefore, be very careful.

12. Support the removed tractor rear half with a rigid rack instead of the jack.

13. To remove and disassemble the clutch assembly fitted to the flywheel which has been removed together with the front wheel axle and the engine, refer to 3-1. Disassembling Order Using A Method 3. and 3-2. Clutch Assembly Disassembling Order.

3-4. Clutch Pedal Mechanism Disassembling

1. Remove the spring with pliers and then remove thrust bearing carrier with the thrust bearing from the support snout as shown in Fig. 10.
If the thrust bearing is again used, do not wash it.

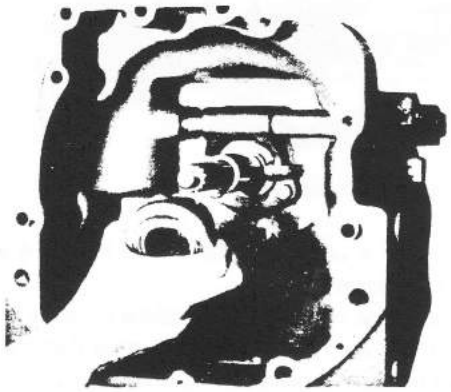
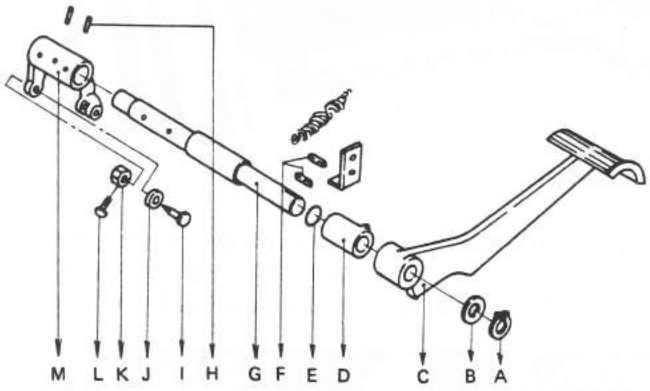


Fig. 10 Removal of Thrust Bearing Carrier

2. Remove the circlip (A), the liner (B), the clutch pedal (C), the spring clutch shifter metal (D), and the "O" ring (E) from the shaft (G) with a special tool (S-O SNAP RING PLIERS).
Then drive out the key (see Fig. 11).



A Circlip
B Liner
C Clutch pedal
D Metal
E "O" ring
F Key
G Shaft
H Taper pin
I Fork pin
J Roller
K Nut
L Cotter pin
M Fork

Fig. 11 Pedal Mechanism

3. Pull out the shaft, referring to Fig. 12.
   To remove the fork from the shaft, pull out two taper pins (H) shown in Fig. 11 with a special tool (1700T03 SPRING PIN INSTALL AND-OUT TOOL), pull out the cotter pin (L), unscrew the nut (K), and remove the roller (J) and the fork pin (I).

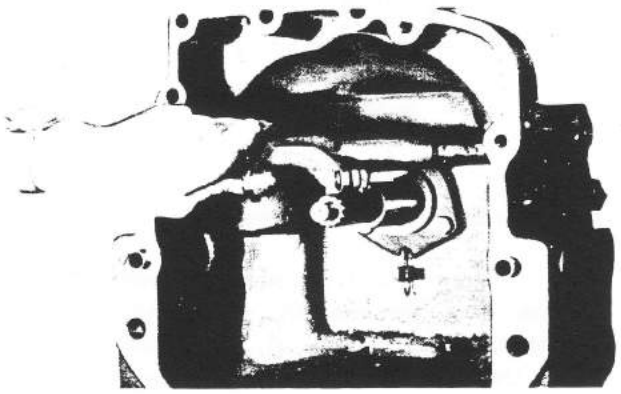


Fig. 12 Removal of Shaft

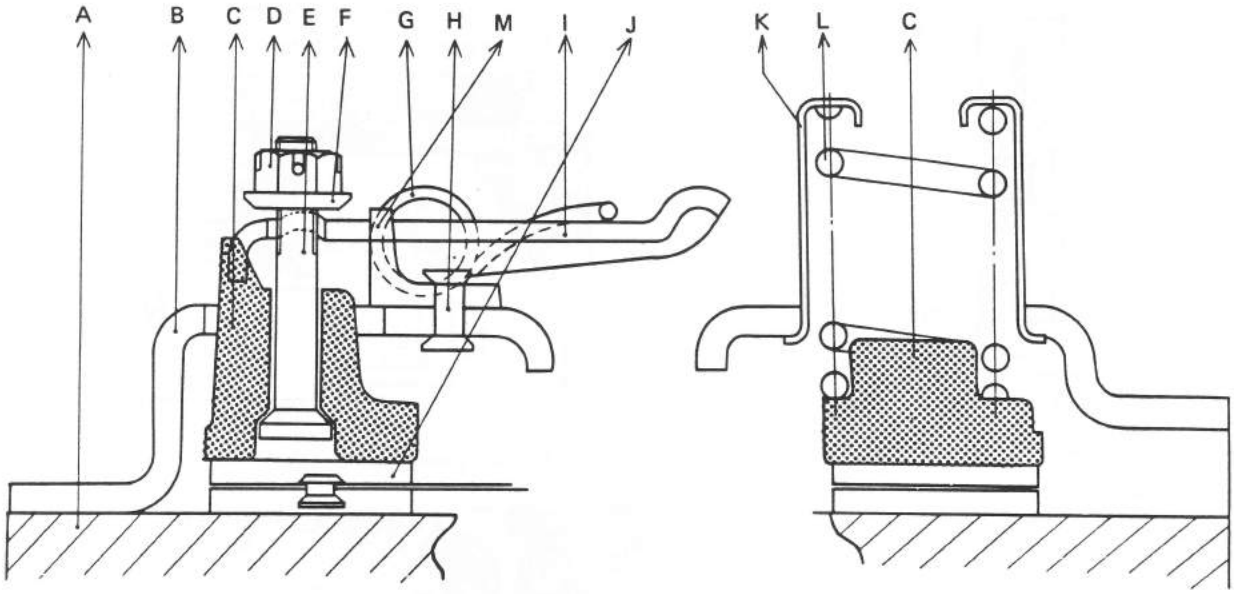
4. Assembling (Adjusting) Order

4-1. Clutch Pedal Mechanism Assembling

1. Follow the reverse procedure of "Clutch Pedal Mechanism Disassembling", seeing Fig. 11. In this case use new taper pins (H).

2. Clean the fork pin (I) and shaft (G) sliding parts and apply grease to them.
   If the snout and thrust bearing carrier sliding parts are considerably worn, correct or replace it.

4-2. Clutch Assembly Assembling and Fitting



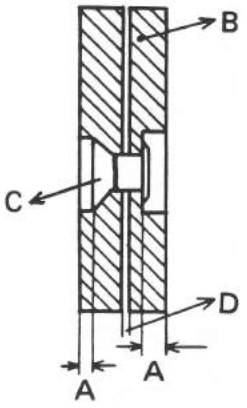
A Flywheel
B Clutch cover
C Pressure plate
D Lever nut
E Lever bolt
F Release washer
G Return spring
H Rivet
I Release lever
J Clutch disc
K Spring cap
L Pressure spring
M Lever seat

Fig. 13 Clutch assembly

1. Before assembling the clutch assembly, check the following.
   Put the pressure spring (L) to a pressure test, and ensure that the spring meets the following requirements.
   a. Spring pressure (length when checking) 146.67 lb. (67.5 kg)
   b. Length when checking the spring 1.58 in. (40.6 mm)
   c. No flow on the pressure plate

2. To reassemble the clutch assembly, follow the reverse procedure of 3-2. Clutch Assembly Disassembling Order with use of a special tool (1102T04 CLUTCH RELEASE LEVER DISASSEMBLING TOOL), however, as for the cotter pin for the lever nut (D), put in the cotter pin after setting the height of the release lever (I).
   Note: A washer may be needed to the pressure spring after grinding the pressure plate. In every case, adjust the total pressure upon the three release levers to be 825.99 lb. (375 kg).

3. See whether oil is attached to the clutch disc (D). When using the removed clutch disc, if the measurement A shown in Fig. 14 becomes over 0.078 in. (0.2 mm), replace it.
   The measurement A of a new clutch disc is 0.039 ~ 0.043 in. (1.0 ~ 1.2 mm).



A 0.078 in. (0.2 mm) C Rivet
B Clutch disc D Cushion plate

Fig. 14 Clutch Disc

4. See whether oil is attached to the flywheel.
   Insert a special tool (1102T01 CLUTCH DISC PILOT) together with the clutch disc into the ball bearing in the center of the flywheel.
   In this case set the clutch disc as shown in Fig. 15.

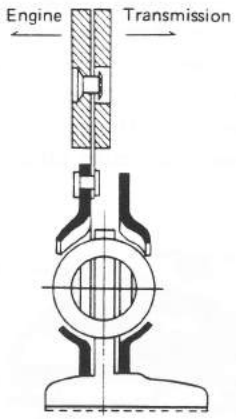


Fig. 15 Front and Back Direction of Disc

5. When fitting the clutch assembly assembled in the flywheel, put the assembly in the right place recorded in the item (3) of 3-1. Disassembling Order Using A Method, especially fit two reamer bolts to their right place and tighten them diagonally at the torque of 13.0 ft-lb. (1.8 kg-m).

6. After fitting the clutch assembly measure the height of the release lever with a special tool (1102T02 CLUTCH RELEASE HEIGHT GAUGE). In this case be sure to turn up and down the release lever several times.
   The adjustment of the release lever can be made with the lever nut (D) shown in Fig. 13, and finally made after putting in the cotter pin.

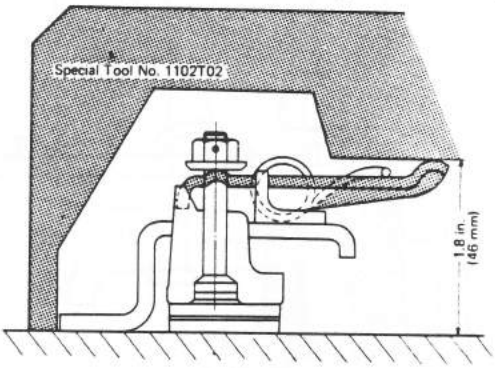


Fig. 16 Release Lever and Gauge

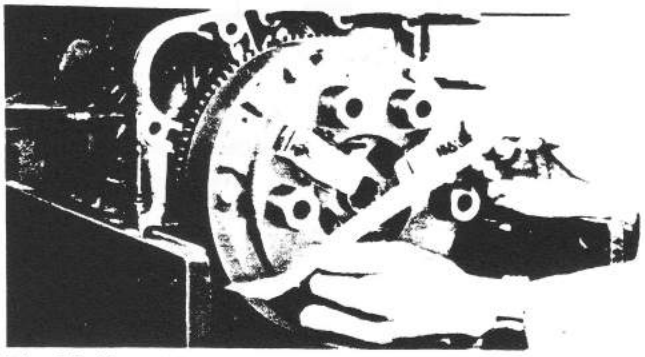
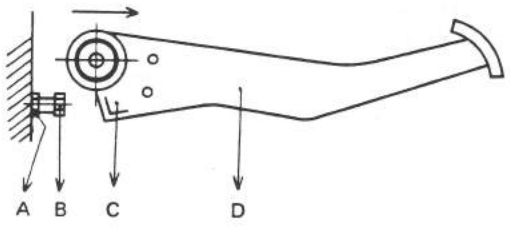


Fig. 17 Use of Gauge

4-3. Overall Assembling

1. After the clutch assembly is fitted to the engine and the clutch pedal mechanism to the clutch housing, fit the engine and the housing, following the reverse procedure of the section 3. Disassembling Order Using A Method or B Method.

2. Then adjust the clutch pedal play.
   This adjustment is important when setting the clearance between the clutch release lever and the thrust bearing.
   Loosen the nut (A) shown in Fig. 18, and fully tighten the adjusting screw (B).
   Pushing the clutch pedal (D) fully to the floor, return the pedal till the adjusting screw (B) gets in contact with the shoulder (C), rotate the pedal by one turn in the arrow direction, and lock it with the nut (A).
   This adjustment serves to control the clutch pressure spring just before the total pressure, and the operating length of the release lever is 0.39 in. (10 mm).



A Nut
B Adjusting screw
C Shoulder
D Clutch pedal

Fig. 18 Adjusting Clutch Pedal

3. As the grease nipple is fitted under the thrust bearing carrier, remove the adjusting cover below the clutch housing and apply grease.
   Then push the clutch pedal several times and check the clutch pedal for normal operation or any strange sound.

5. Inspection, Maintenance and Limit of Modification

	Inspection	Maintenance	Limit of Modification
1	Faulty operation of thrust bearing carrier spring	If trouble lies in bearing carrier, see item 4-1 of 4.	If carrier does not return due to spring load, replace.
2	Wear in clutch disc		If measurement A in Fig. 14 becomes over 0.078 in. (0.2 mm), replace.
3	Hardened clutch disc	Grind.	
4	Oil on clutch disc		Replace.
5	Roll of clutch disc	Rotate and check at disc tip.	If over 0.03 in. (1 mm), replace.
6	Flaw on clutch pressure plate	Grind.	Up to 0.007 in. (0.2 mm). In this case adjust the shim so that the pressure spring total pressure may be 825.99 lb. (375 kg). This pressure also applies in the case of grinding the flywheel.
7	Length and pressure when checking pressure spring	Adjust shim for adjusting pressure.	Length when checking 1.583 in. (40.6 mm). If pressure is within 146.67 lb. (67.5 kg), replace.
8	Height of release lever	Adjust lever nut.	1.81 in. (46 mm) from flywheel. Height allowance of three levers 0.01 in. (0.4 mm)
9	Release lever operating length		If over 0.39 in. (10 mm), trace trouble.
10	Release bearing	**Note:** This can not be washed.	Rotate it with a hand and if any strange sound and irregular rotation are found, replace.
11	Clutch pedal play	Determine the play, using release lever.	Make sure that it is within 1.57 in. (40 mm).

6. Troubleshooting

6-1. Clutch Slips

Caution: If the clutch slips, the engine power deteriorates and the fuel consumption increases.

Trouble	Remedy
No clutch pedal play.	Adjust lever nut of release lever.
Oil on clutch disc.	Replace.
Wear in clutch disc.	Replace.
Irregular height of release lever.	Readjust within allowable limit 0.01 in. (0.4 mm).
Incorrect release lever return.	As lever seat which supports lever is worn and the lever drags, correct it.
Weak pressure spring	If length is less than 1.583 in. (40.6 mm) in the case of 146.67 lb. (67.5 kg), replace. If total pressure is less than 825.99 lb. (375 kg), replace.

6-2. Clutch Drags

Trouble	Remedy
Release lever height exceedingly shorter than the specified.	Readjust it to 1.81 in. (46 mm). If it is due to worn disc, replace disc.
Disc considerably vibrates.	Replace if it exceedingly vibrates, or if vibration exceeds allowable limit 0.03 in. (1 mm).
Rust due to oil shortage in disc spline groove.	Scrape away the rust and apply grease thinly.

6-3. Shudder when Starting

Trouble	Remedy
Hardened disc surface.	Grind it with sandpaper or replace.
Exceeding disc shudder.	Replace.
Release lever height not uniform.	Adjust.
Rust in disc spline groove.	Correct and apply grease.
Loosened or damaged tension spring.	Replace.

6-4. Clutch Overheat

Trouble	Remedy
Burnt release bearing.	Replace.
No clearance between release lever and release bearing.	Adjust release lever height.

7. Specifications

Type	Dry single plate lever type
Clutch disc material	Wire-reinforced woven fabric
Disc dimensions (outer diameter x inner diameter x depth)	7.26 x 5.00 x 0.3 in. (184.2 x 127 x 7.5 mm)
Static transmission torque	100.9 ft-lb. (15.0 kg-m)
Release bearing	Non-lubrication system
Operation	Foot operating system
Pressure spring pressure (when checking)	146.67 lb. (67.5 kg)
Pressure spring length (when checking)	1.583 in. (40.6 mm)
Pressure spring total pressure	826.50 lb. (375 kg)
Number of pressure springs	6
Pressure spring collar	Light blue JAPAN paint 307
Release lever maximum operating length	0.39 in. (10 mm)
Release lever height	1.81 in. (46 mm)
Reamer bolt reamer diameter and number	0.35 in. (9 mm), 2

SATOH TRACTOR

MODEL S-650G
REPAIR MANUAL

STEERING LINKAGE SYSTEM

PUBLICATION No.03-C

CONTENTS

STEERING LINKAGE SYSTEM

1. General

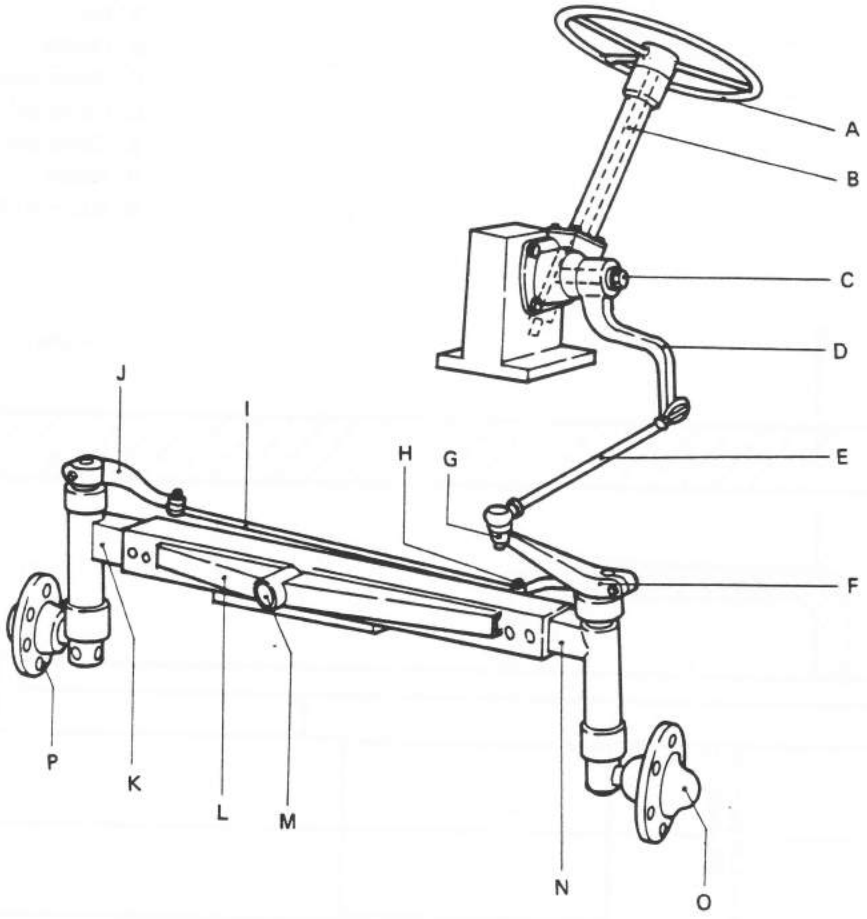
Front Axle and Steering Assembly

Utilizing the center pivot movement system, the front axle moves up and down 8 degrees with the center pin as its pivot. Simple construction of the front wheel axle allows for ease in installing the knuckles; furthermore, the central portion of the front axle is raised basing on the Lumoan construction system.

The worm sector type steering box is installed in the steering assembly. Steering method conforms to Ackerman Steering Gear System.

2. Explanation of Construction

According to Diagram Fig. 1, turning the steering wheel (A) turns the steering mast (B) which transmits the motion to the pitman arm attached to the Pitman Worm Wheel (C), which in turn transmits the motion to the steering lever (J) on the right and to the steering lever (F) on the left by way of the drag ring (E) and tie rod (I) which allows driving in the desired direction when the movement is transmitted to the hub linked to the steering lever (F) and (J).



A Steering wheel
B Steering mast
C Worm wheel
D Pitman arm
E Drag ring
F Steering lever (R. H)
G Ball socket-ass'y "G"
H Ball socket ass'y "H"
I Tie rod
J Steering lever
K Beam extension (L.H)
L Center beam
M Center pin
N Beam extension (R.H)
O Front hub (R)
P Front hub (L)

Fig. 1 Steering Linkage

3. Disassembling Order

3-1. Disassembling the Entire Front Axle

1. As shown by Diagram Fig. 2, place wedges on the upper surface of the center beam and between the chassis from both the right and left side to prevent movement of body of vehicle.

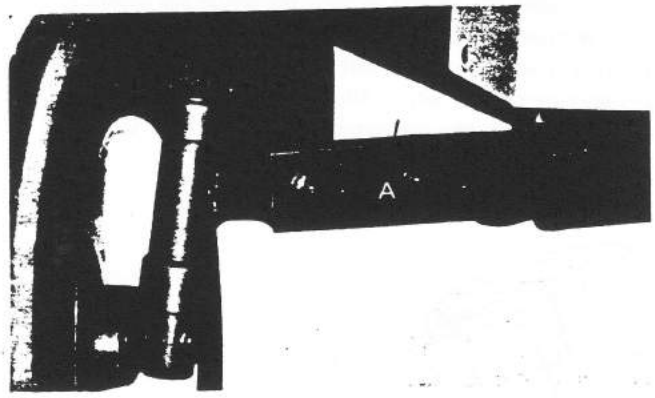


Fig. 2 Wadge

2. Loosen all eight screws from the front hubs (R.L.), slip garage jack underneath, jack front-end up and take front wheels off. Then, place rigid rack beneath frame on both sides and release jack slowly.

3. Pull cotter pin out from ball socket assembly which links steering lever and drag ring, unloosen nut and unloosen ball socket using special tool (TRH-12 TIE-ROD END REMOVER.)

4. Draw downward to pull cotter pin (A) out, as shown in Diagram Fig. 3. Place garage jack in the middle beneath center beam and jack up so top of jack touches the front axle lightly.

A Pin
B Chassis
C Center beam
D Center pin
E Center pin bush
F Nipple
G 0.01~0.03 in. (0.4~1 mm)

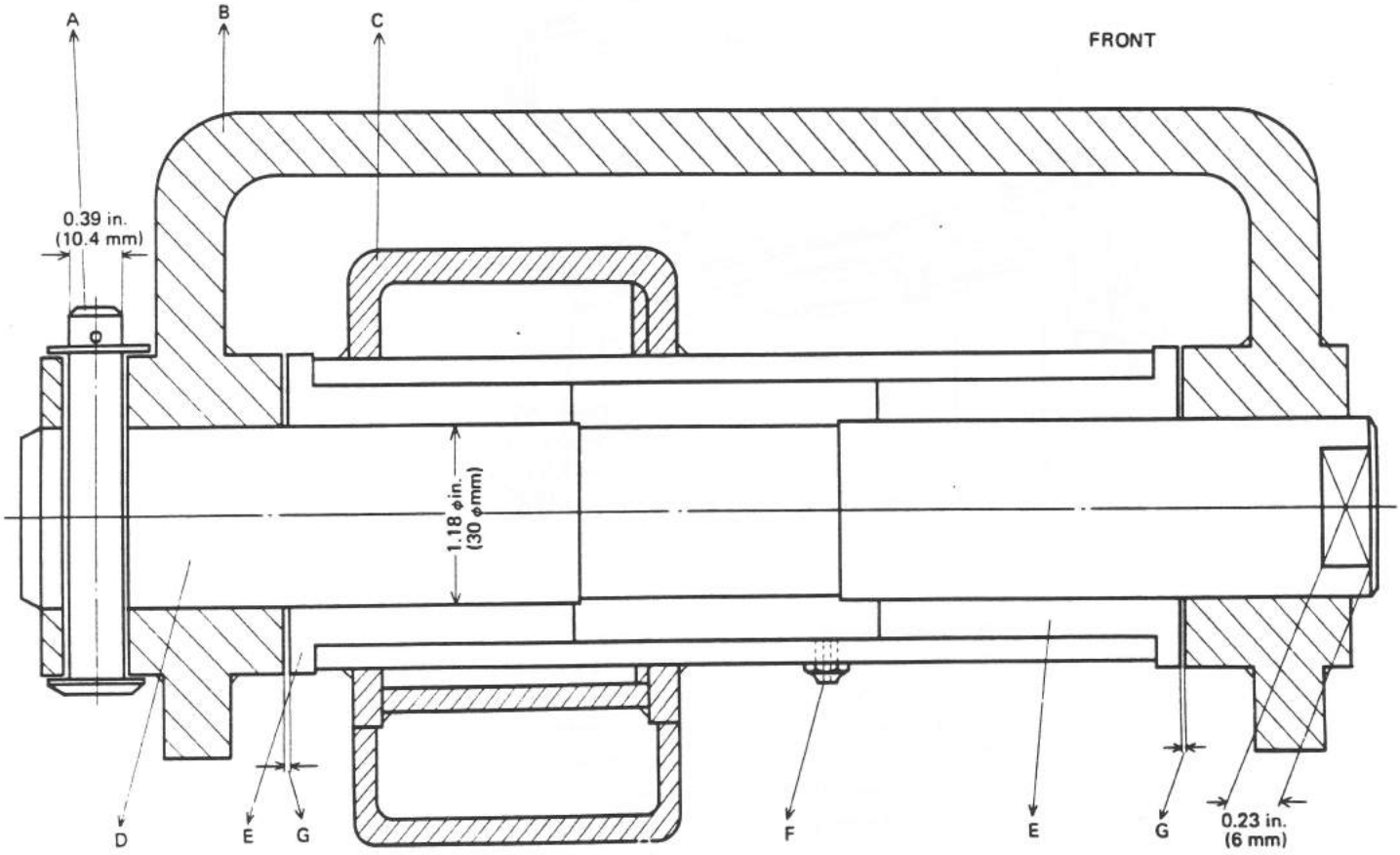


Fig. 3 Center Pin

5. At the forward section of the center pin, there is a groove where an special tool (BT-9 OPEN END WRENCH SET 19 x 21) can be inserted, as shown in Diagram Fig. 4. By manipulating the wrench, right to left, unloosen center pin by pulling forward.
   Caution: When center pin does not dislodge, tap pin lightly from the rear. However, in doing this, be careful not to raise jack too high or let jack down too low; but, have it just right or the pin may not dislodge and the center pin bush may be scratched.

6. As the center pin is withdrawn, the entire front axle will rest on jack. Release jack slowly, simultaneously, pulling forward. This will cause front axle to dislodge from chassis.

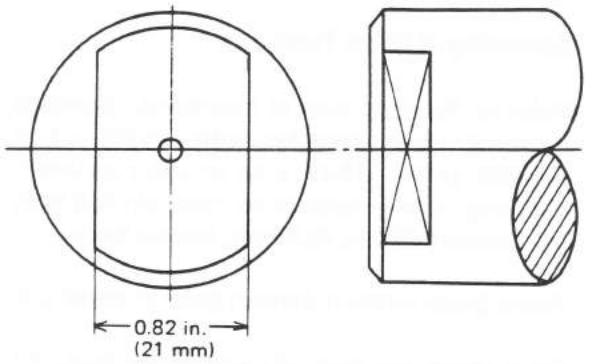


Fig. 4 Center Pin

3-2. Disassembling King Pin and Front Hub

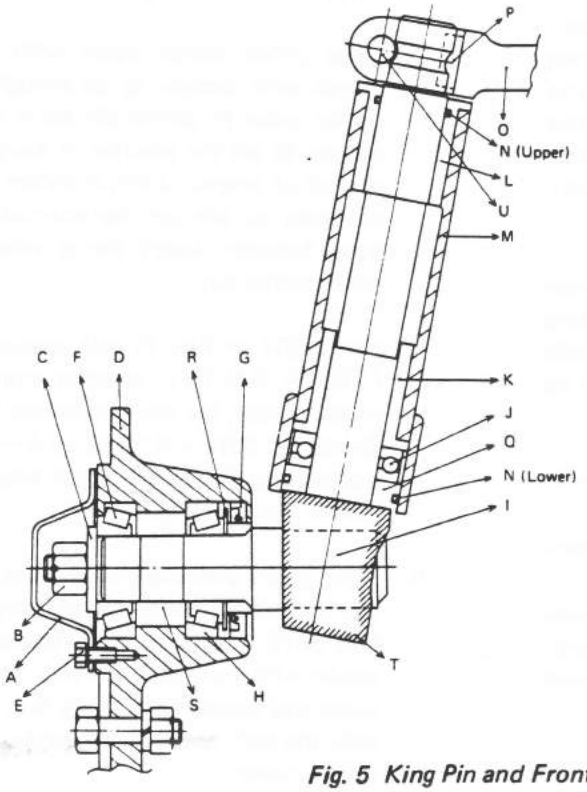
1. Either let front axle rest on rigid rack or have large-size vise hold on to entire front axle.

2. Loosen nut from bolt (M16 x 65), securing beam extension from center beam and unloosen bolt as well as beam extension (R.L.).
   Caution: Because disassembling of parts from both right and left beam extension is the same, except for the steering lever, disassembling instruction for beam extension located on the other side is omitted.

3. With a large-size vise, hold beam extension. Take hub cap (A) off, as shown by Diagram Fig. 5, take slotted nut (B) off and pull the entire front hub (D) off from the king pin (I).

4. Since the top section of the king pin is connected to the steering lever, release and unloosen bolt (M12 x 70) (U), place wedge in opening of steering lever to widen opening, and pull steering lever upward; then, pull key (P) out.
   Caution: When key withdrawn, king pin will fall downward on its own weight; thus, be careful.

5. Place hand beneath king pin and pull downward. King pin will not dislodge with ease when pin not properly lubricated after lengthy use. Tap head of king pin with plastic hammer to dislodge.



A Hub cap
B Slotted nut
C Washer
D Front hub
E Screw
F Taper roller bearing (outer)
G Oil seal
H Taper roller bearing (inner)
I King pin
J Thrust bearing
K Center pin bush
L King pin bush
M Beam extension
N "O" ring (Upper) (Lower)
O Steering lever (R.H)
P Key
Q "O" ring bush
R Oil seal plate
S Grease
T Heel
U Bolt

Fig. 5 King Pin and Front Hub

6. Wash all parts in cleaning solvent. Inspect all parts closely for galling, nicks, etc.

4. Assembling (Adjusting) Order

Though assembling is done in reverse order of disassembling, carefully check and adjust the following points while assembling. Furthermore, refer to Fig. 5 when assembling.

4-1. Assembling Related Parts for King Pin and Front Hub

1. After the inner laces of taper roller bearing (inner and outer) located within the front hub had been washed in cleansing solvent, air dry and thoroughly rub special wheel grease to them.

2. Place taper roller bearing (in) in hub toward king pin, insert oil seal plate, and insert oil seal by applying pressure with special tool (2050T01, FRONT HUB OIL SEAL PRESSURE TOOL). Then grease (S) portion of hub.

3. Rid king pin of dust and apply grease lightly. Replace with new "O" ring to "O" ring bush (Q) and assemble from upper section of king pin and insert oiled thrust bearing. Clamp heel (T) portion of king pin with vise.

4. Bearing. Assembled front hub with oil seal inserted in king pin followed by taper roller bearing (outer) (F), washer (C), and bearing tightened with slotted nut (B). After slotted nut tightened, nut turned counterclockwise 1/16 turn and a new cotter pin inserted tightly and secured. Then, gasket placed prior to replacing hub cap.

5. Relationship between king pin and beam extension (M). When tolerance between king pin and king pin bush (L) and center pin bush (K) exceeds 0.011 in. (0.3 mm), bush or the king pin need be changed; thus, check these parts closely.
   King pin standard measurement:
   1.18 ϕin. (30 ϕmm)
   Bush standard measurement:
   1.18 ϕin. (30 ϕmm)

   When measurement for both king pin and bush meet the standard requirement, apply grease lightly to king pin, place "O" ring bush; then insert thrust bearing.

6. Using special tool (2050T02, BEAM EXTENSION BUSH DRIVER), drive king pin bush (L) and center pin bush (K) into beam extension (M). There is a groove inside the bush of king pin bush (L). Place new "O" ring (N) (up) in it.

7. Assemble set of king pins put together previously from beneath beam extension (M) and drive in key (P), carefully, not to let the king pin drop on its own weight. Insert steering lever (R.L.), link with link bolt (U) and set lock nut into place with special tool (1860 QL, TORQUE WRENCH) at 43.3 ft-lb (6 kg-m).

8. After assembling completed, insert grease through grease nip so grease a pears from the rear section of king pin. Then, check whether or not king pin revolves smoothly right to left.

4-2. Assembling of Entire Front Axle

Refer to Fig. 3 at time of assembling. Standard diametric measurement for center pin (D) is 1.18 ϕin. (30 ϕmm). There is no over-size or under-size; thus, when tolerance for both pin and bush (E) exceeds 0.011 in. (0.3 mm), replace them.

1. Apply grease lightly to contact point of center pin.

2. Drive center pin bush (E) into center beam (C) with special tool (2050T03, CENTER PIN BUSH DRIVER) and apply grease.

3. Raise entire center beam with jack and align chassis with section to be brought together and lightly drive in center pin from the front. Ultimately, to set the position of the center pin, place wrench on wrench catch, as shown in Fig. 4. Align pin hole so pin can be inserted, drive pin (A) from beneath, insert thrust washer, insert and secure cotter pin.

4. Verify (G) in Fig. 3, with special tool (No. 26, FEELER GAUGE), in other words, opening between chassis (B) and center pin bush (E).
   Should be 0.01 ~ 0.03 in. (0.4 ~ 1 mm). Apply grease through grease nipple and be sure grease exudes from space (G).

5. First, insert previously assembled beam extension (L.H.) to both extremes of center beam, insert bolt (M16 x 65), pass spring washer through it and secure with nut (N16). Then, set front wheel in place and secure with front hub screw. Further, lock the lock nut from backside. Lower and pull jack forward.

Should be 0.01 ~ 0.03 in. (0.4 ~ 1 mm). Apply grease through grease nipple and be sure grease exudes from space (G).

5. First, insert previously assembled beam extension (L.H.) to both extremes of center beam, insert bolt (M16 x 65), pass spring washer through it and secure with nut (N16). Then, set front wheel in place and secure with front hub screw. Further, lock the lock nut from backside. Lower and pull jack forward.

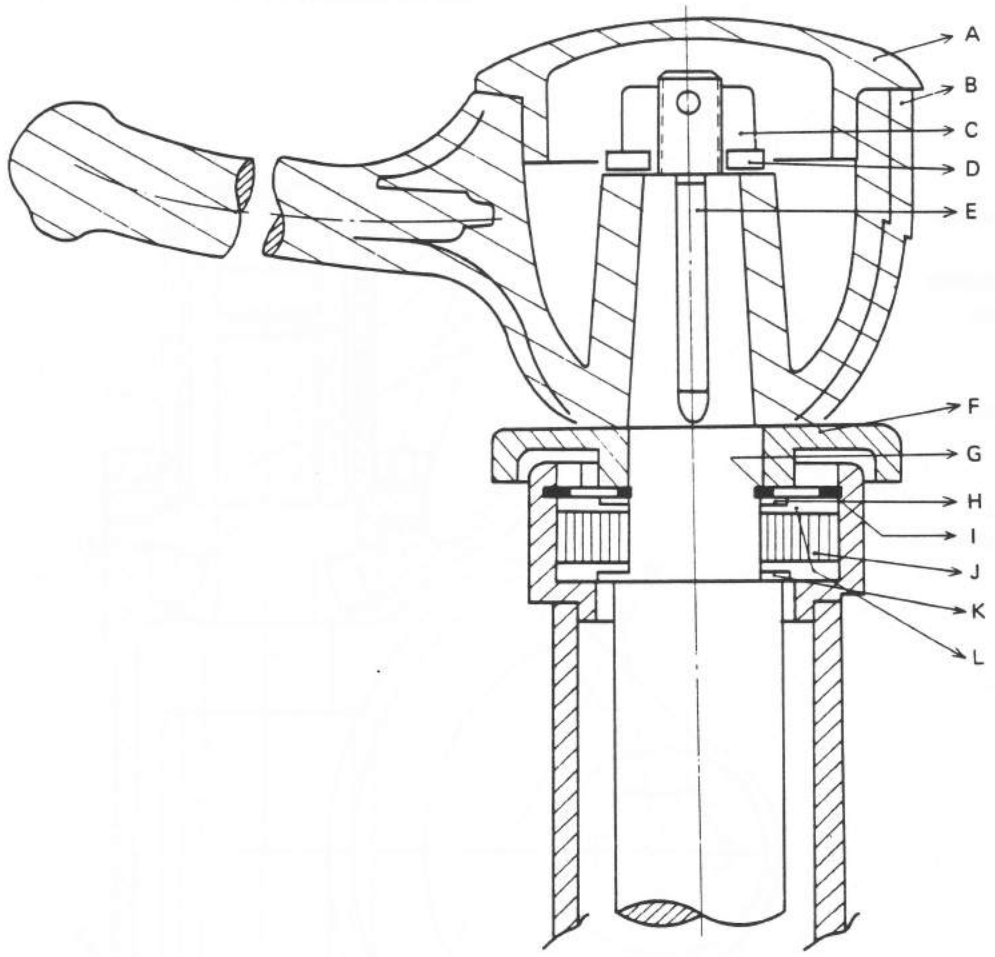
6. Assemble ball socket assembly linking steering lever and drag lug, secure with lock nut, and insert and bend cutter pin.

5. Disassembling Order

5-1. Disassembling Order of Steering

In order to disassemble the entire steering, the following should be adhered to. Refer to Fig. 6, 7.

1. Remove steering wheel cap (A), pull out cotter pin, unbolt slotted nut (C), attach special tool (T-60B, UNIVERSAL STEERING WHEEL PULLER) to steering wheel and remove wheel (B), remove key (E), and remove end cap (F).



A Steering wheel cap	G Circlip
B Steering wheel	H Washer (1)
C Slotted nut	I Circlip
D Washer	J Rubber cushion
E Key	K Washer (1)
F End cap	L Washer (2)

Fig. 6

2. Open bonnet, disengage battery cord (black-yellow) to prevent short-circuit.

3. Drain fuel from fuel tank. After completely draining fuel, disengage fuel line and remove fuel tank.
   Caution: Becuase of inflamability of fuel, precaution is necessary while at the same time, measures must be taken to prevent foreign maters from entering fuel line.

4. From behind the instrument panel, disengage tractor cable and throttle wire, and all electrical wirings such as starter switch, light switch (red/blue, red, red/white), regulator connector, tractor meter lamp socket, and thermometer connections.

5. Remove steering box cover assembly screw (six screws to box M8 and four screws to instrument panel M8). Couple of bands on top side of cover used to secure fuel tank but need not be removed.

6. Remove lever holding steering column support located above instrument panel and remove entire instrument panel.

7. Remove the four screws, M10, securing entire steering box to clutch housing and raise steering box. For this purpose, two dovels emplaced to secure position; thus, entire box should be removed straight upward.

8. After draining oil from steering box, place steering box horizontally in vise.

M Key
N Steering worm gear
O Screw
P Taper roller bearing
Q Flange packing
R Shim
S Steering box
T Taper roller bearing
U Worm wheel
V Pitman
W Groove
X Column support

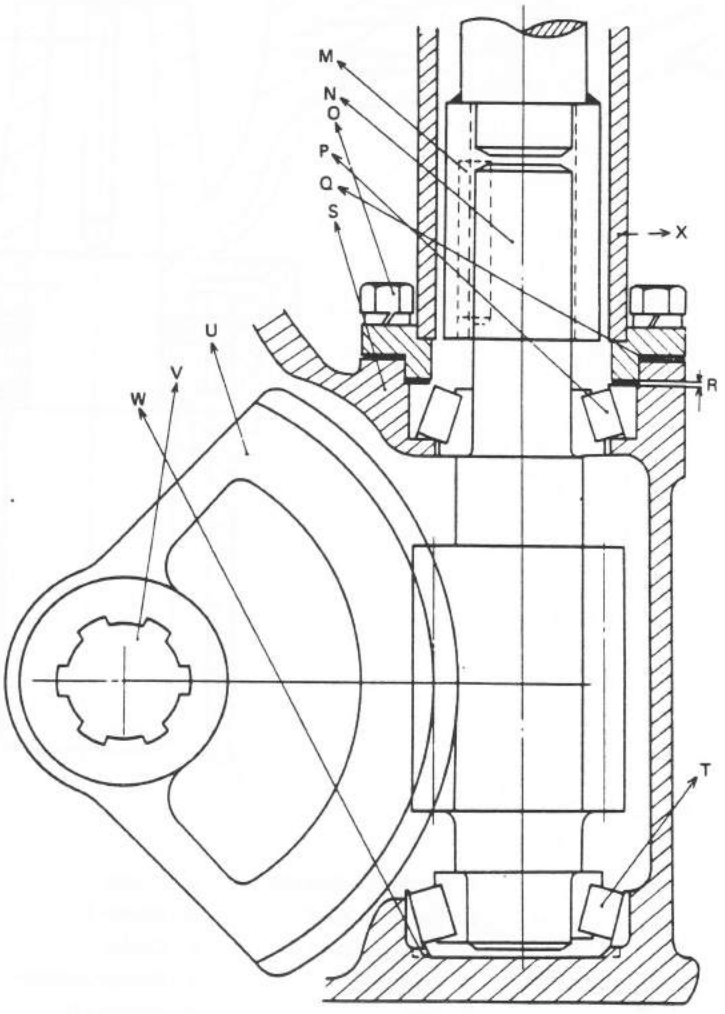
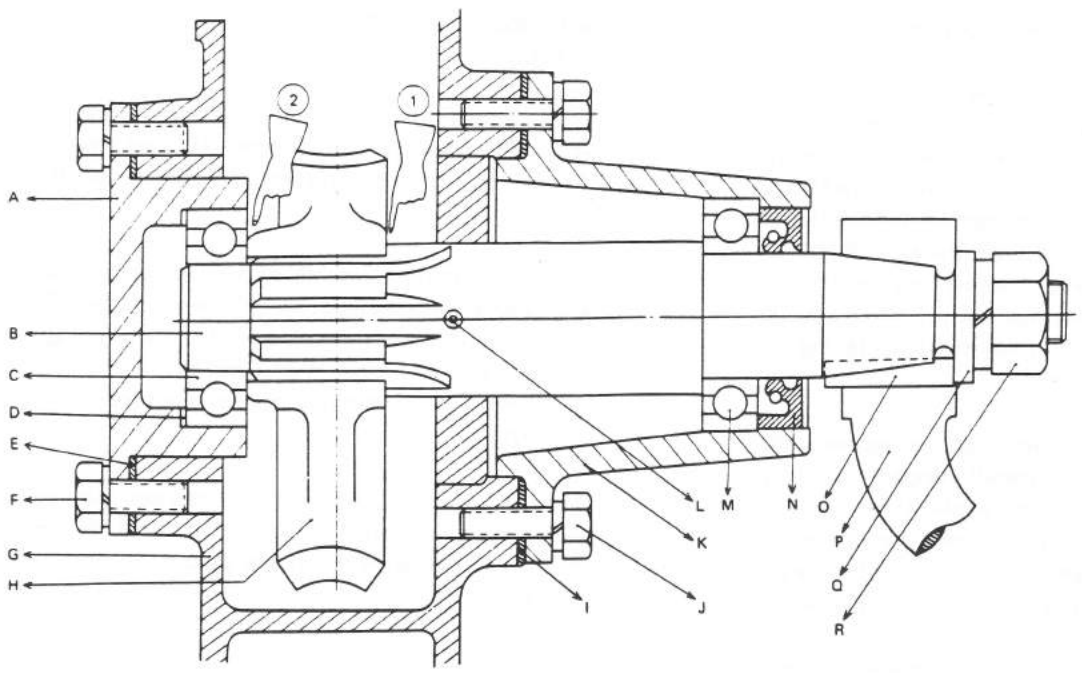


Fig. 7 Steering Box



A Bearing housing
B Pitman
C Taper roller bearing
D Liner
E Gasket
F Screw
G Steering box
H Worm wheel
I Gasket
J Screw
K Bearing housing
L Mark position
M Ball bearing
N Oil seal
O Key
P Pitman arm
Q Washer
R Nut

Fig. 8 Steering Box

9. Referring to Fig. 8, remove three pieces of screws (F) and remove bearing housing (B). Remove four pieces of screws (J) and pull out bearing housing (A). Pitman (B) and pitman arm (P) need not be dismantled at this time. However, if oil seal (N) must be changed, replace seal by removing pitman arm. Remove worm wheel (H) upward.

10. Referring to Fig. 6 and 7, remove four pieces of screws (O) and pull upward to disengage entire column support (X). To disassemble steering mast (L) from column support (X), remove circlip (on side of mast) (G) using special tool (S-0 SNAP-RING PLIER), remove washer (H), remove circlip (on side of column support) (I) with special tool (H-1, SNAPRING PLIER), remove (H) (L) washer (1) (2), remove by pulling upward on rubber cushion (J) and remove washer (K) (1) and (L) (2) to allow removal of steering mast to the rear of column supporter. Then, because steering mast and steering worm bear (N) are attached rather securely, tap steering worm gear (N) with either wood or plastic hammer to separate.

11. Inner lace of taper roller bearing (P.T.) in steering worm gear assembly should be pulled out by using the inner bearing puller.
Attach special tool (2100T04, STEERING TAPER ROLLER BEARING OUTER LACE PULLER) to groove of outer lace (W) to remove outer lace of taper roller bearing (T).

6. Assembling (Adjusting) Order

6-1. Assembling (Adjusting) Order of Steering

Caution: Arrange in order disassembled parts washed in cleaning solvent so they can be assembled at ease. However, do not wash rubber cushion in cleaning solvent.

1. Refer to Fig. 6 and 7 in regard to steering mast. First, apply pressure to insert taper rolling bearing (P.T.) into steering worm gear (N) by using special tool (2100T01, STEERING WORM GEAR T. R. B. INSERTER PLATE). Tap taper roller bearing (T) outer lace into steering gear box with special tool (2100T03, STEERING GEAR BOX T. R. B. TAPPING TOOL). Then, mount gear box on vise

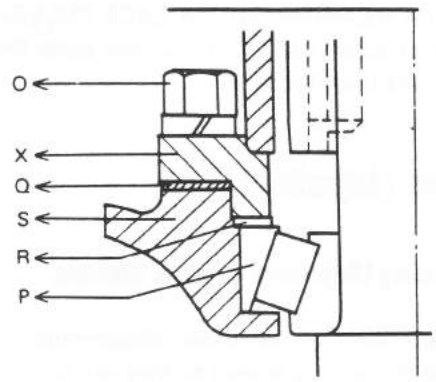
in horizontal position.

2. Tap key (M) into steering worm gear to connect steering mast (L), Insert column support (X) from top section of this unified steering mast and place washer (K) in proper position, press rubber cushion (J) in, insert washer (H) and insert serclip (G) by using special tool (S-0 SNAPRING PLIER). By use of special tool (H-1, SNAPRING PLIER), attach serclip (I) on the side of column support (X). Thereafter, replace and cap (F). So that end cap (F) does not fall off, place key (E) into mast and to prevent key (E) from falling off, secure key with cellotape.

3. Steering mast, worm gear, column support, etc, completely assembled. Install flange packing (Q) to steering mast (do not apply three bond to packing at this time) and assemble with steering gear. Securely tighten with screw (O); then, apply few drops of oil to taper roller bearing to loosen it.

4. When assembling is completed, check to see if taper roller bearing thrust play is 0.003 ~ 0.005 in. (0.1 ~ 0.15 mm). If necessary, insert shim (R) between taper roller bearing (P) and column support (X).

5. When thrust direction play is set, remove screw (O) by tapping at 86.7 ~ 123 ft-lb. (12 ~ 17 kg-m) and secure tightly. Secure with special tool (1800 QL TORQUE WRENCH).



O Screw
P Taper roller bearing
Q Front packing
R Shim
S Steering gear box
X Column support

Fig. 9

6. *Referring to Fig. 8*, press ball bearing (M) into bearing housing (K) from inside and insert oil seal with special tool (2100T03, OIL SEAL PRESS TOOL).

7. Insert pitman (B) with press into bearing housing (K). Insert key (O) into pitman (B), set washer (Q) and spring washer in place and tighten nut (R) slightly.

8. Attach gasket (I) to assembled bearing housing (K) and insert in steering box (G) while inserting pitman wheel (H) into front end of pitman. ponch position (L) on pitman spline and pon 4 location on pitman wheel brought together as shown in Fig. 10.

9. When the ponch is brought into position, secure with screw (J) at torque 86.7 ~ 123 ft-lb. (12 ~ 17 kg-m). Pitman wheel (H) is secured to pitman (B) (1) section.

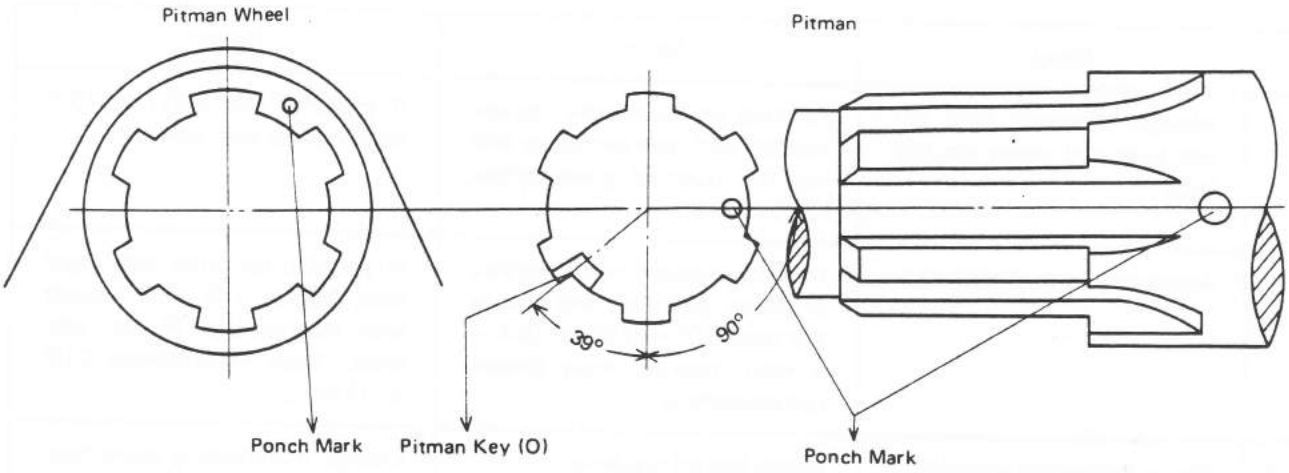


Fig. 10

10. Press ball bearing (C) into bearing housing (A) and attach gasket (E), assemble in steering box so ball bearing (C) and pitman coincides. Then secure with screw (F). Measure space between pitman wheel and pitman at (2) with special tool (No. 26, STANDARD FEELER GAUGE). Space should be 0 ~ 0.011 in. (0 ~ 0.4 mm). If necessary, adjust by placing liner (D) in space.

11. If measurement correct, once again, disassemble bearing housing (A), rub three bond to gasket and put together. Cover screw (J) with tape seal (oil sealing tape) and secure at torque 13 ft-lb. (15 kg-m).

12. After assembling completed, assemble entire box to clutch housing, and after filling 0.704 pt (0.40 ℓ) of oil, replace instrument panel, electrical wiring, etc., according to reverse order of reassembling.

13. Finally, test and adjust, according to Wheel Alignment Data.

7. Method of Inspection, Adjustment and Limit of Repair

	Check	Adjust	Repair
1	Abrasion between king pin and bush and center pin and bush	At time of disassembly, scrape rust off with fine sandpaper and rub fine layer of grease before reassembling.	If tolerance over 0.011 in. (0.3 mm), replace with new part.
2	Abrasion on side of center pin	If space between outer portion of center pin bush and chassis less than 0.01 ~ 0.03 in. (0.4 ~ 1 mm), cleanse, apply grease, and reassemble.	If abrasion on outer side more than 0.58 in. (15 mm), replace with new part or if not, add shim. Shim measurement 0.03 in. (1 mm).
3	Play – ball socket assembly	Grease and oil regularly.	Change if something could happen under operating condition.
4	Wear in rubber cushion		Change when side of entire steering wheel begins making noise.
5	Oil leak from pitman oil seal		Change oil seal.
6	Toe-in	Adjust with tie rod.	0 ~ 0.236 in. (0 ~ 6 mm).
7	Turning angle	Adjust right and left turn angle with drag link.	Inside 53°. Outside 38°.
8	Bolts and nuts	Always check lock nut and cotter pin of steering linkage since weight shifts to front wheels when vehicle in motion.	

8. Troubleshooting

8-1. Front Wheel Shimmy

Cause	Remedy
Deformation of front wheel.	Repair or change.
Loose front wheel screw.	Tighten.
Worn king pin and bush.	Change if tolerance serious.
Play – tie rod or drag link.	Tighten lock nut.
Play – ball socket assembly.	Change.
Loose nut and bolts.	Tighten.

8-2. Hard Steering

Cause	Remedy
Front tires not properly inflated.	Inflate tires, 28 lb/in² (1.97 kg/cm²).
Damaged or worn out bearing within steering box.	Change.
King pin bush.	Change.
Maladjustment of toe-in.	Adjust 0 ~ 0.236 in. (0 ~ 6 mm).
Damaged king pin thrust bearing.	Change.

8-3. Pull to One Side

Cause	Remedy
Worm center pin or bush.	Change.
Loose screw to steering box.	Tighten.
Maladjustment of toe-in.	Readjust.

8-4. Excessive Play on Handle

Cause	Remedy
Worn worm wheel and worm gear.	Change.
Worn ball socket assembly.	Change.

9. Specifications

Model	Lumoan type
Steering system	Ackerman jant method
Size of front wheel	500-15,4 ply
Tire pressure	37 lb/in² (2.6 kg/cm²)
Turning radius	
Minimum with brakes	90.6 in (2.300 mm)
Minimum without brakes	102.4 in (2.600 mm)
Front alignment	
King pin angle	8°
Camber	2.5°
Caster	3°
Toe-in	6 mm
Steering angle	Inside 53°, outside 38°
Front wheel suspension method	Center pivot
Swing	8°
Steering gear type	Worm Sector Type
Gear ratio	15 : 1
Steering wheel size	14.96 φin. (380 φcm)
Oil capacity and type	0.704 pt (0.40 ℓ), gear oil

SATOH TRACTOR

MODEL S-650G

REPAIR MANUAL

TRANSMISSION SYSTEM

PUBLICATION No.03-D

CONTENTS

TRANSMISSION SYSTEM

1. General

The transmission on the S-650G is a six forward, two reverse and two P.T.O. gear type transmission. The transmission case is divided into three parts; the power transmission in the front the differential gear and the differential lock in the center, and the P.T.O. transmission in the rear.

Ahead the case there is a clutch housing where power from the engine is transmitted to the transmission counter shaft by means of the spline of the main shaft.

The axle gear cases are provided at both sides, and the upper cover in which the main transmission lever is installed is fitted to the power transmission, and the hydraulic device is mounted on the differential gear and the P.T.O. transmission.

Well-chosen casting wrought by a machine for its exclusive use is used for the case, thus offering enough strength and accuracy.

The transmission has enough strength and accuracy so that the power may be surely transmitted and that smooth transmission may be operated.

The gears, axles and bearings have also sufficient accuracy to ensure quiet operation.

Various kinds of bearings are used according to the load, featuring high strength and long durability.

2. Construction

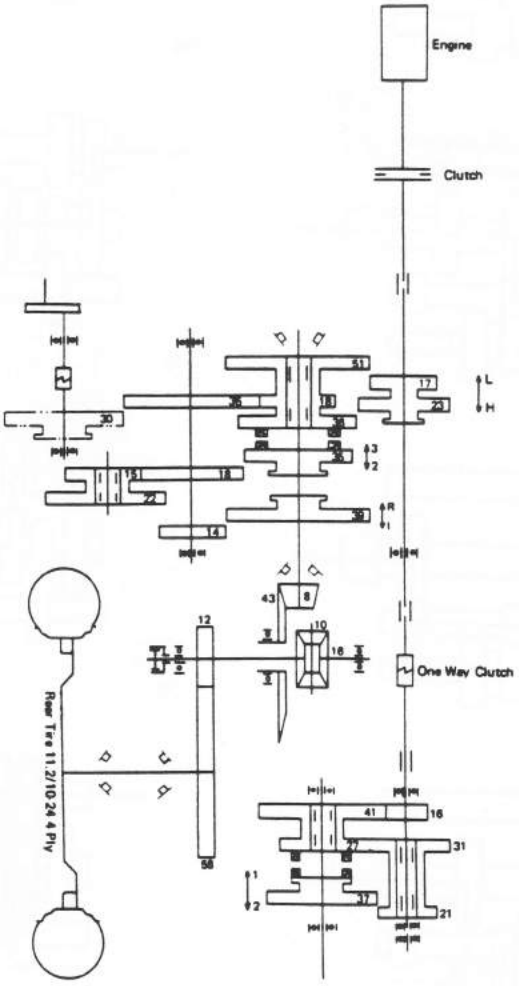
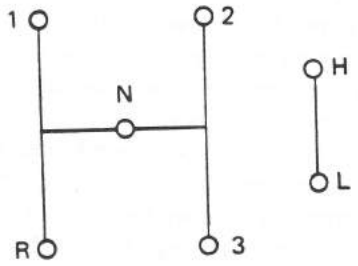


Fig. 1

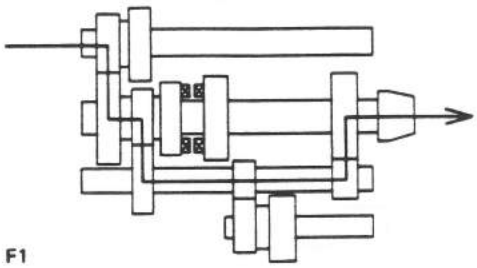
1. The transmission consists of three parts, and the final reduction is provided at either side of the case.

2. The power transmission consists of the range shaft transmission shaft, distributing shaft, reverse shaft, and twelve spur gears, by which the six forward and two reverse speeds are obtained (Fig. 2).
Power from the power transmission is transmitted through the spiral bevel pinion which makes one unit with the transmission shaft to the ring gear in the differential gear, and through the pinion shaft gear to the axle gear.

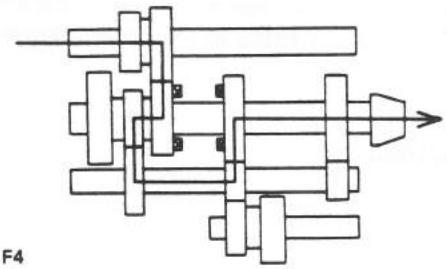


6-Speed Gear Position

Running Position		F1	F2	F3	F4	F5	F6	R1	R2
Lever Position	Range Selector	L		H		L	H	L	H
	Selector	1	2	1	2	3	3	R	R



F1



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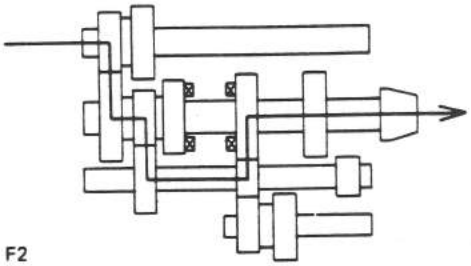
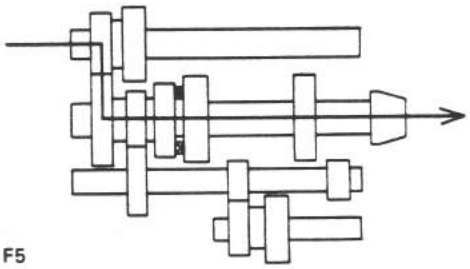
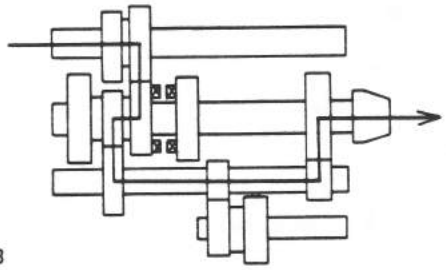


F2



F5



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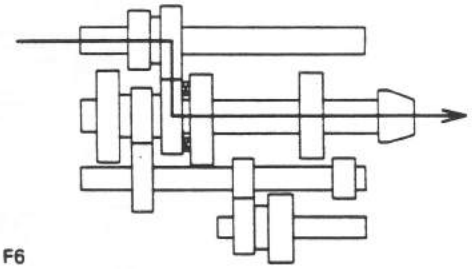
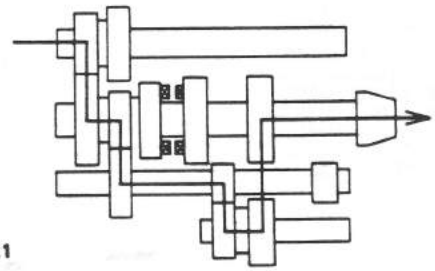
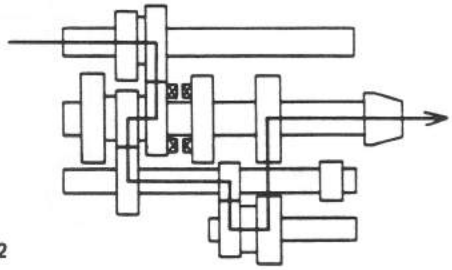


F6



R1

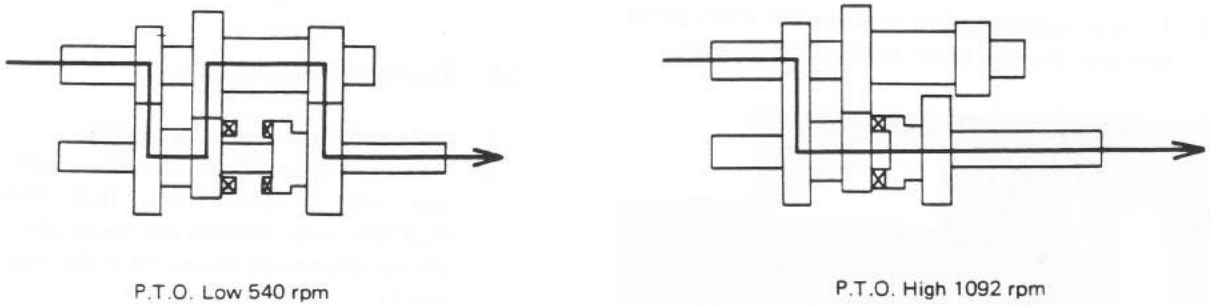


R2

Fig. 2

3. The differential lock is fitted to the right pinion shaft by means of a sleeve which is connected with the foot pedal, and the differential case can be connected with the pinion shaft by depressing the pedal.
   Thus the differential locking is completed and the rear wheels rotate as an unit.

4. Power from the engine is transmitted through the main range shaft one-way clutch to the P.T.O. drive shaft.
   The P.T.O. consists of the P.T.O. drive shaft, P.T.O. shaft, six spur gears, and one set of jaw clutch, and provides two kinds of speed, 540 rpm and 1092 rpm, at the engine rated revolution. The P.T.O. spline meets the SAE standard (Fig. 3).



P.T.O. Low 540 rpm

P.T.O. High 1092 rpm

Fig. 3

5. The one-way clutch is fitted between the range shaft and the P.T.O. drive shaft.
   It is a jaw clutch type, and transmits the power from the engine at right angles.
   It is supported by a spring only, thus preventing a shock to the transmission and the engine.

3. Disassembly

If it is necessary to disassemble the transmission due to a trouble inside, some methods of disassembly are provided according to its condition of the trouble, however, the complete disassembly is discussed here.

Note:

- Pay attention to the disassembly operation as the transmission is very heavy and slippery with oil.
- Use a well-arranged, clean, spacious area, floor of which is hard and flat.

3-1. Transmission Removal

1. Remove the drain plugs under the hydraulic case, the transmission case, and the axle gear case, and drain out the oil in each component (Fig. 4).
   Note: It is advisable to drain out oil when the oil temperature is high after running the engine.

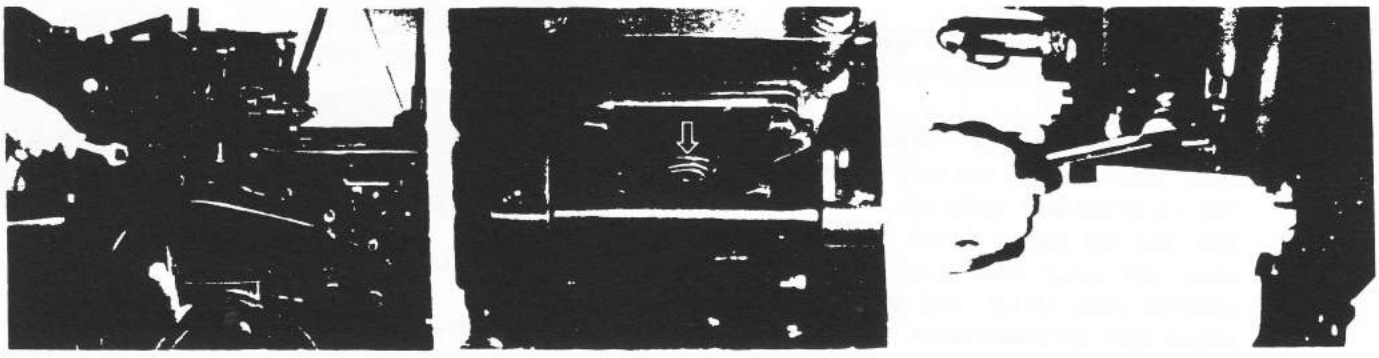


Fig. 4

2. Remove the battery cord from each terminal and lift off the battery case.

3. Remove the operation lamp cord and safety starter cord from the connector and the clip, and arrange it in order at the clutch housing.

4. Remove the three-point linkage.

5. Drive a wooden wedge between the front extension and the axle beam to secure the chassis.

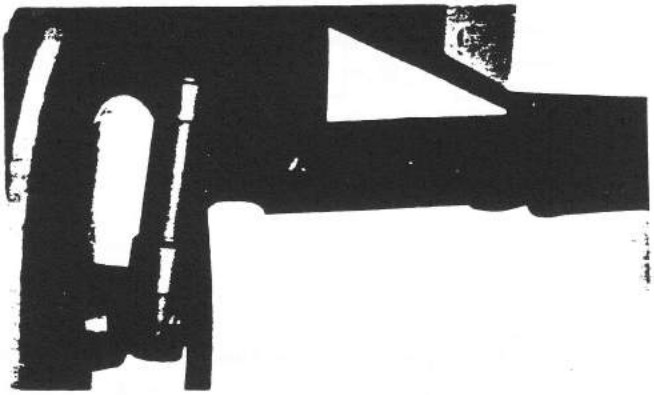


Fig. 5 Wedge

6. Jack up the rear of the transmission, and insert a rigid rack under the axle to suspend the rear of the tractor.
   Lock the brake, loosen the rear tyre tightening nut and remove the wheel.

7. Remove the hydraulic control lever knob, unscrew four (M12) and four (M8) screws.

8. Loosen the screws of the battery case, the tool box and the seat, and remove them.

9. Remove the step and brake pedal assembly.

10. Disconnect the hydraulic pipe (see REPAIR MANUAL, Engine Disassembly 1-1).

11. Place a screw jack or a hydraulic jack under the transmission case (do not jack up the tractor).
    Place a garage jack under the clutch housing (in this case the tractor should not be lifted), unscrew ten clutch housing and transmission case securing bolts (M12), and gently separate the engine from the transmission.
    Replace the jack under the transmission case with a rigid rack.

12. Clean the transmission so that dust may not get into the transmission during disassembly.

13. Unscrew the screws (M10) and remove the hydraulic case assembly and the upper cover.

14. Move them on the work bench by using a chain block.

15. Remove the wheel boss, loosen the bolts (M12) and take off the axle gear case assemblies at both sides.

3-2. Transmission Disassembly

1. **Differential gear unit disassembly**

a. Remove the circlip on the drive shaft at P.T.O. side with a special tool (S-0 SNAP RING PLIERS), push forward the spline joint, and take off the drive shaft by pulling it backward (Figs. 6 and 7).

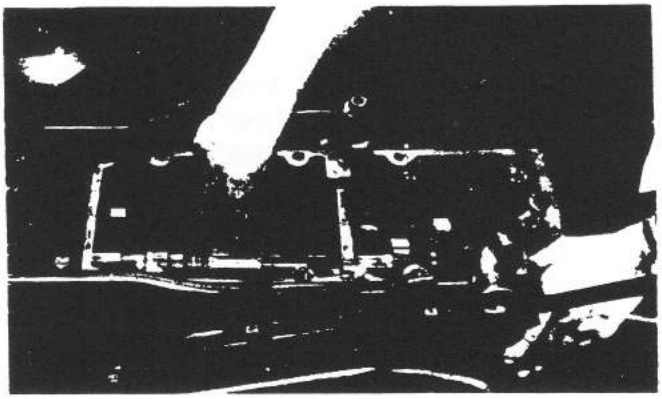


Fig. 6 Removing Circlip

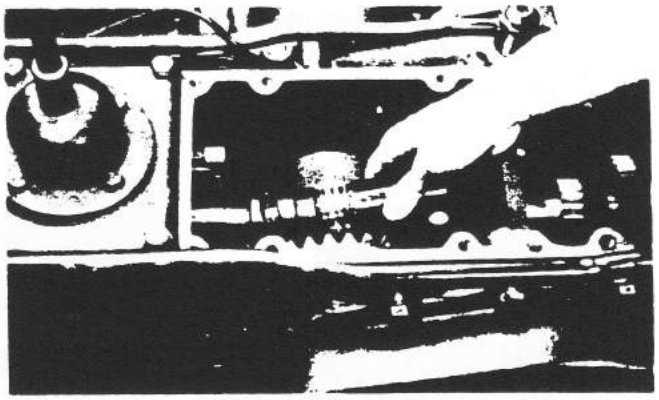


Fig. 7 Pulling One-way Clutch Shaft

b. Straighten the stopper washers and unscrew six bearing holder securing screws (M10) and remove the bearing holders at both sides.
   Note: If the removal is difficult, use a tap.

c. The complete differential gear unit can be taken out by gently tapping it with a tool such as a

screwdriver (−) placed between the final drive case and the ball bearing to the left.

3-3. Power Transmission Disassembly

1. Pull out the spring pins 0.236 in. (6 mm) securing the selector forks (A) and (B) fitted to the selector rods (A) and (B) with a special tool (1700T04 SPRING PIN INSTALL AND-OUT TOOL) (Fig. 8).
   Note: Be careful not to drop the spring pin inside the transmission.

2. Loosen the set screws and take off the selector spring.

3. Unscrew four screws (M8) and pull out the selector rod housing (R.H, L.H) together with the selector rods (A) and (B).
   Remove the selector fork (B) (Fig. 8).
   Note: Be careful not to drop the selector ball inside the transmission.
   As the selector ball is installed in the selector rod housing of the main transmission to prevent gear locker, be careful not to drop it.

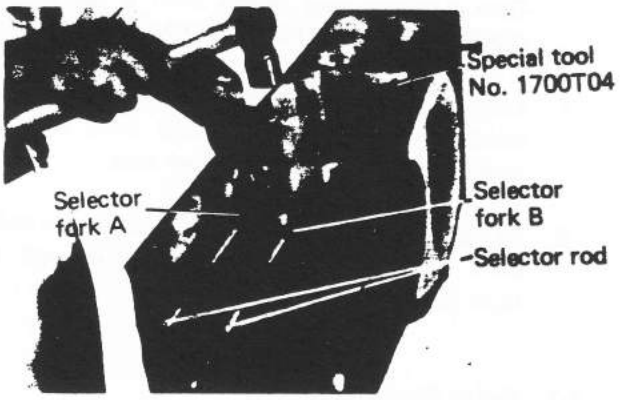


Fig. 8 Remove the Selector Fork

4. Unscrew each shaft end cover securing screws (M8) and remove the covers.
   Push forward the range shaft by gently striking it with a plastic tip hammer from behind, pull out the ball bearing with a special tool (T-60B UNIVERSAL STEERING WHEEL PULLER), and pull backward the range shaft (Fig. 9).

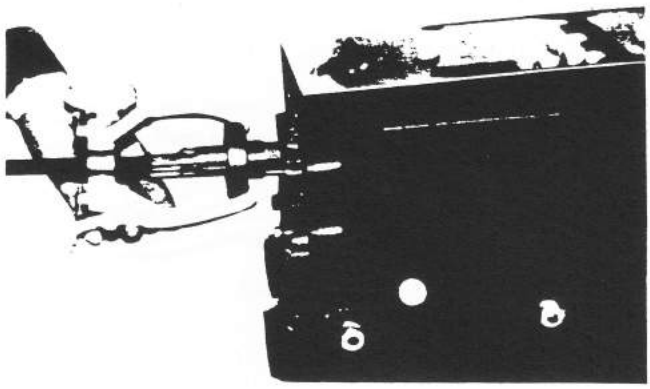


Fig. 9 Range Shaft

5. Remove the safety switch cover and then the switch body and the support.
   Pull out the range lever setting spring pin (6 mm) with a special tool (1700T04 SPRING PIN INSTALL AND-OUT TOOL) and take out the range lever and the range selector.

6. Unscrew four screws (M8) securing the support differential lock pedal and remove the pedal.
   Unscrew the screws securing the range selector rod and remove the rod.
   Note: Be careful not to drop the selector ball and selector pin.
   Take out the selector fork (A) and the range selector fork.

7. Straighten the drive pinion shaft tab washer and loosen the lock nuts with a special tool (1300T19). Remove the lay shaft circlip with a special tool (S-0, SNAP RING PLIERS).
   Unscrew six screws (M8) and remove the end plate from the transmission together with the taper roller bearing.
   Remove the drive pinion shaft circlip with a special tool (S-0, SNAP RING PLIERS) and pull backward the drive pinion shaft and take off each gear from the transmission case.
   Note: Take care of the needle roller bearing, thrust liner insert collar, etc.

8. Remove the lay shaft circlip with a special tool (S-0, SNAP RING PLIERS) and push backward the lay shaft.

9. Remove the reverse shaft circlip with a special tool (S-0, SNAP RING PLIERS).
   Unscrew the transmission case locating bolts and strike the reverse shaft, and the reverse shaft can be pulled backward (Fig. 10).

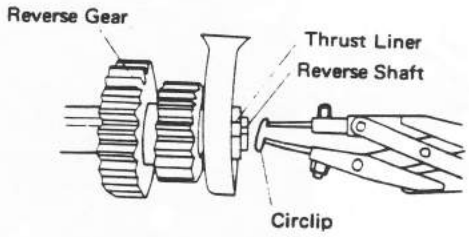


Fig. 10

3-4. Power Take Off Disassembly

1. Straighten the tab washer and loosen the P.T.O. shaft lock nuts with a special tool (1300T17 SOCKET FOR LOCK NUT (For P.T.O. M17).

2. Loosen two screws (M8) and four nuts (M8) securing the end plate.

3. Remove the ball bearings on the P.T.O. drive shaft and on the P.T.O. shaft, and take out the P.T.O. drive shaft circlip with a special tool (S-0, SNAP RING PLIERS).
   Strike the P.T.O. drive shaft and the P.T.O. shaft alternately with a plastic tip hammer, and the shafts can be pulled out.

4. To disassemble the end plate and the P.T.O. shaft, remove the stopper ring circlip with a special tool (S-0, SNAP RING PLIERS) and the ball bearing outer race securing circlip with a special tool (H-1, SNAP RING PLIERS).

5. Loosen the set screws and pull the P.T.O. selector rod.
   Note: Be careful not to drop the selector spring and the selector ball.

6. Pull the P.T.O. selector lever spring pin with a special tool (1700T04 SPRING PIN INSTALL AND-OUT TOOL) and remove the P.T.O. selector arm.
   Loosen two screws (M8) and remove the P.T.O. selector shaft housing.

3-5. Differential Unit Disassembly

a. Remove the ball bearing at the side of the end plate.
   Straighten the stopper washer (A), unscrew eight screws (M10) securing the spiral gear, and take off the spiral gear.
b. Straighten the stopper washer, unscrew eight screws (M8) securing the end plate, and take off the end plate.
c. Hammer gently and remove the center pin, then, the differential pinion, the side gear and the thrust seat can be taken out (Fig. 11).

Fig. 11 Differential

3-6. Final Drive Disassembly

1. Straighten the tab washer and unscrew the lock nuts securing the spur wheel.
   Take out the spur wheel with a special tool (2200T03 SOCKET FOR LOCKNUT).

2. Loosen six screws (M8), remove the oil seal housing and pull out the final drive shaft by knocking it from the spur wheel side.

3. Straighten the stopper washer, unscrew the baffle plate securing screws (M10), and lift off the taper roller bearing outer race.

3-7. Pinion Shaft Disassembly

To disassemble the brake drum, refer to the brake drum disassembly procedures in the chapter of "Brake System".

1. Unscrew six screws (M10) and dismount the brake housing.

2. Remove the pinion shaft from the final drive.

3. Pull out the pinion shaft bearings and the final drive shaft bearings with a special tool (T-60B UNIVERSAL STEERING WHEEL PULLER).

4. Assembling (Adjustment)

Note:

- O To assemble the transmission unit, first assemble the power transmission parts, then the power take off parts, and last the differential gear and one-way clutch parts.
  Be very careful when assembling the transmission because it is one of the most important parts in the tractor.
- O Prior to assembling rotating parts, sliding parts, connecting parts, "O" rings, oil seals, etc., apply lubricant or grease to them.
- O Wash every component and check it for any fault, and if it is faulty, replace it.
- O Pay due attention when checking "O" rings, oil seals, tab washers, etc.
  Gaskets should be generally replaced with new ones.
  Be sure to wind a seal tape on penetrating screws & bolts.

4-1. Power Transmission Assembly

1. Fit stopper washers to the three screws (M10 x 25) and attach the baffle plates.
   Bend the washers and tighten the screws (Fig. 12).
   Tightening torque 43.3 ft-lb (6 kg-m)
   Note: Set the baffle plates with the finished sides toward the case.

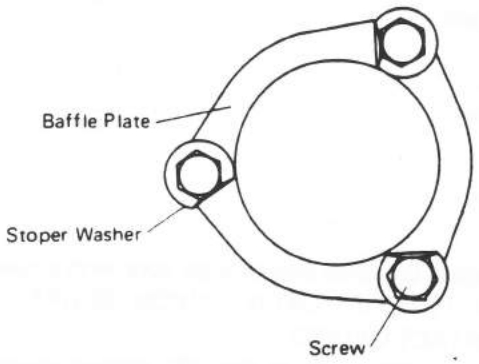
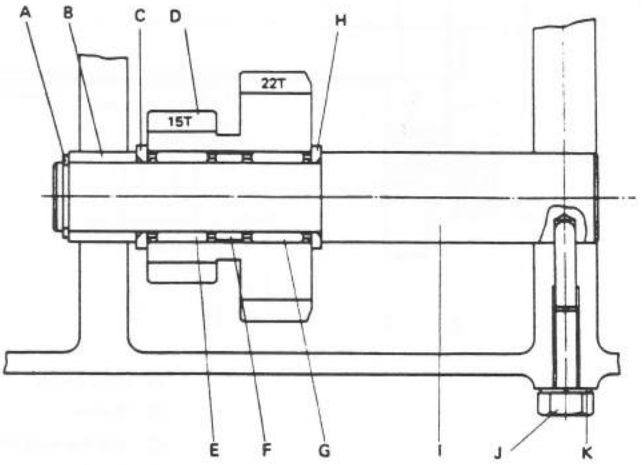


Fig. 12 Fitting Baffle Plate

2. Reverse shaft assembly

a. Insert the reverse shaft from the differential gear side, fit the thrust liner needle roller bearing, insert collar, needle roller bearing, reverse gear, and thrust liner in that order, and push forward the reverse gear.
   Align the tap hole at the left side of the transmission to the reverse shaft hole, wind a seal tape on the locating bolts, and lock the reverse shaft (Fig. 13).
   Tightening torque (13 ft-lb (1.8 kg-m)

3. Insert the bush reverse shaft with a plastic tip hammer and set it with circlips by using a special tool (S-0, SNAP RING PLIERS).



A	Circlip	G	Needle roller bearing
B	Bush, reverse shaft	H	Thrust liner
C	Thrust liner	I	Reverse shaft
D	Reverse gear	J	Locating bolt
E	Needle roller bearing	K	Spring washer
F	Insert collar		

Fig. 13 Reverse Shaft Assembly

Note:

- O Install the reverse shaft and the thrust liner with their inner diameter planed gear free-play in the direction of the thrust may be 0.00394 ~ 0.0118 in. (0.1 ~ 0.3 mm).
  Two kinds of thrust washer, 0.118 in. (3 mm) and 0.116 in. (3.2 mm), are provided. (Fig. 14)

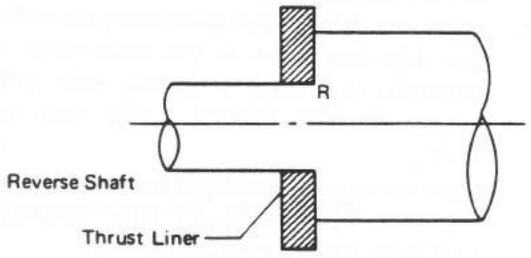
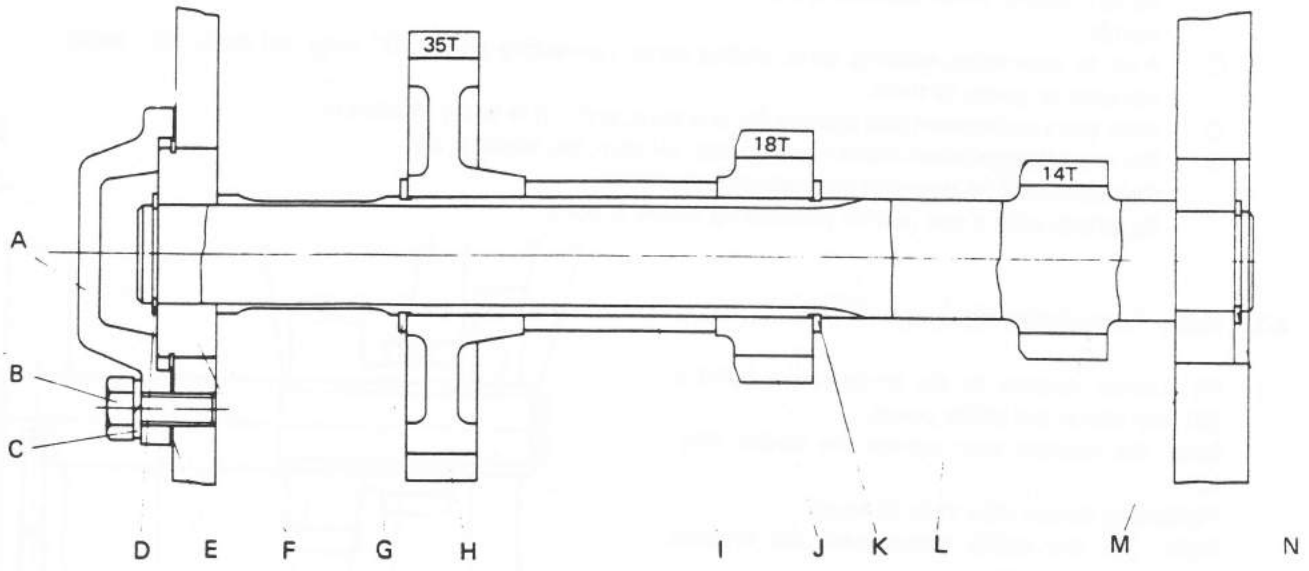


Fig. 14

4. Lay shaft assembly

a. Put the ball bearing (6205) into the lay shaft with a press and set it with circlips by using a special tool (S-0, SNAP RING PLIERS).
Insert the shaft from the differential gear side, fit the lay shaft gear Ⓜ, the distance collar, and the lay shaft gear Ⓛ in that order, and then set them with circlips by using a special tool (S-0, SNAP RING PLIERS) (Fig. 15).



A	End plate	H	Lay shaft gear Ⓛ
B	Screw	I	Distance collar
C	Spring washer	J	Lay shaft gear Ⓜ
D	Circlip	K	Circlip
E	Gasket	L	Lay shaft
F	Ball bearing	M	Ball bearing
G	Circlip	N	Circlip

Fig. 15 Layshaft Assembly

5. Drive pinion shaft assembly

a. Put the taper roller bearing (30308D) into the drive pinion shaft with a press by using a special tool (1300T26 DRIVE PINION SHAFT T.R.B. INSTALLING BASE).
Note: Pay attention to the set direction of the taper roller bearing.

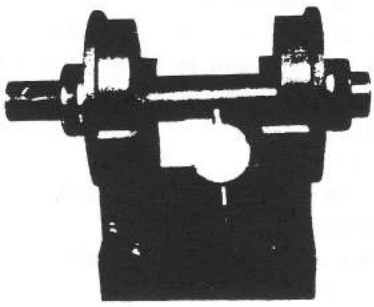
b. Install the taper roller bearing (30205) outer race to the end plate and tighten temporarily four screws (M8) and two dowels.
Install the taper roller bearing (30308D) outer race to the transmission case.

c. Insert the drive pinion shaft from the differential gear side and drive in the taper roller bearing (30205D) by using a special tool (1300T29 DRIVE PINION SHAFT T.R.B. INSTALLING TOOL).
Lock the drive pinion shaft by using a special tool (1300T15 TEMPORARILY TIGHTENING WING NUT FOR DRIVE PINION SHAFT).
Note: Make sure that there is no forward and backward play.

d. Measure the drive pinion shaft core with a special tool (1300T01 DRIVE PINION SHAFT "O" CONTACT GAUGE).
Set the dial gauge of the "O" contact gauge to 4.449±0 in. (113±0 mm).
Remove one centering ring and set the gauge to the transmission case bearing holder fitting hole, taking care so that the dial gauge may not touch the transmission case.
Attach the dial gauge end to the taper roller bearing (30308D), read the scale on the gauge, and calculate the difference between the measured value and 4.449±0 in. (113±0 mm). Insert a proper shim between the taper roller bearing and the baffle plate so that the dimension may be 4.449±0.002 in. (113±0.05 mm). There are shims of the following sizes; 0.00394 in. (0.1 mm), 0.01575 in. (0.4 mm), 0.02362 in. (0.6 mm), and 0.03150 in. (0.8 mm).

Example

1. Standard value
   4.449±0.002 in. (113±0.05 mm)
   Measured value
   4.4851 in. (113.92 mm)



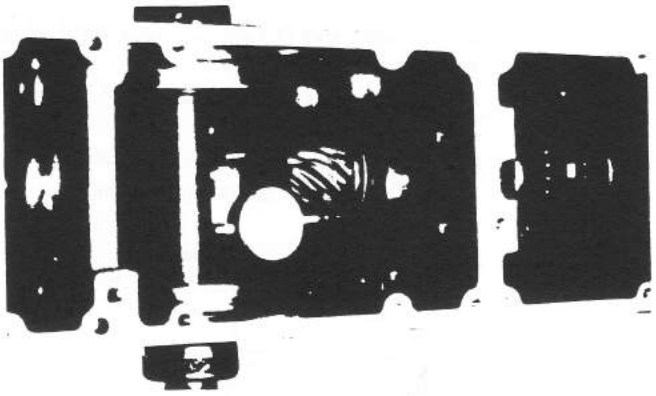
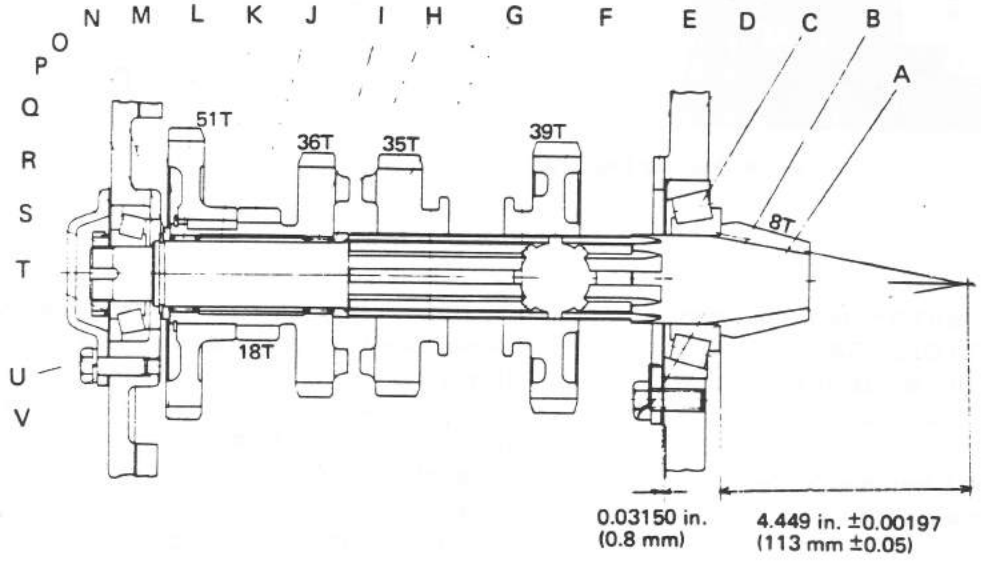


Fig. 16

In this case, to make the measured value equal to the standard value, it is necessary to insert a shim of 0.0362 in. (0.92 mm) however, as there is no shim of that size, use one 0.03150 in. (0.8 mm) shim and two 0.00394 in. (0.1 mm) shims.

6. Remove the drive pinion shaft temporarily tightening nuts and loosen the end plate temporarily tightening screws.
   Remove the end plate together with the taper roller bearing (30305D).
   Remove the drive pinion shaft and the taper roller bearing outer race.

Insert a shim into the baffle plate, install the outer race to its original position.
Fit the shift gear Ⓛ, shift gear Ⓢ, thrust liner Ⓑ, needle roller bearing, insert collar, needle roller bearing, and thrust liner Ⓐ in that order to the drive pinion shaft.
Set them with circlips (Fig. 17).



A Drive pinion shaft
B Stopper washer
C Taper roller bearing (30308D)
D Shim
E Baffle plate
F Shift gear Ⓛ
G Shift gear Ⓢ
H Thrust liner Ⓑ
I Needle roller bearing
J Driven gear ass'y
K Insert collar
L Needle roller bearing
M Circlip
N Thrust liner Ⓐ
O Circlip
P Gasket, end plate
Q Taper roller bearing
R End plate
S Lock nut
T Tab washer
U Screw
V Spring washer
W Screw

Fig. 17 Drive Pinion Shaft Assembly

Note:

- Select a thrust liner (A) in proper thickness so that the clearance between the driven gear assembly and the thrust may be 0.00394 ~ 0.0118 in. (0.1 ~ 0.3 mm).
  There are two kinds of thrust liner, 0.118 in. (3 mm) and 0.1259 in. (3.2 mm) (Fig. 18).
- Pay attention to the thrust liner plane-off direction.
- Make sure that the driven gear (A) and (B) operate smoothly on the drive pinion shaft.

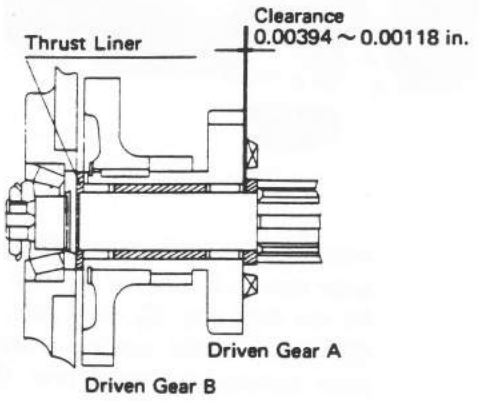
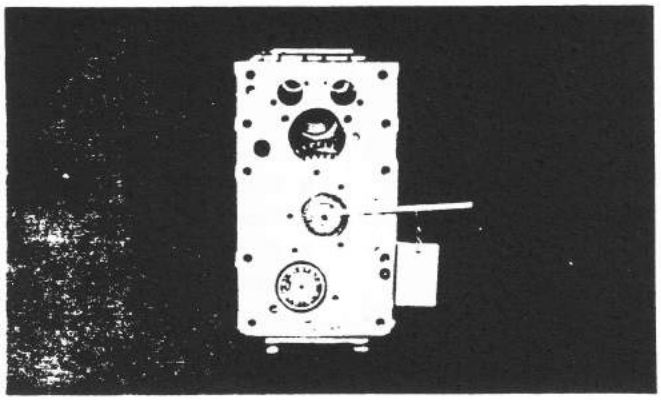


Fig. 18 Driven Gear

7. Align the end plate and the gasket to two dowels, wind a seal tape on six screws (M8), and tighten them. Tightening torque 13 ft-lb (1.8 kg-m). Fit the taper roller bearing to the drive pinion shaft by using a special tool (1350T01), Insert the tab washer and tighten the lock nuts.

8. Pre-load Measurement
   The drive pinion shaft pre-load is 36.1 ft-lb to 57.8 ft-lb (5 kg-m to 8 kg-m), and can be easily measured with a special tool (1300T11 DRIVE PINION SHAFT PRE-LOAD MEASURING TOOL).
   Fit the transmission pre-load measuring tool handle to the lock nut
   Place a weight at (A) and make sure that the drive pinion shaft does not rotate.
   Tighten the nut so that the shaft rotates if the weight is placed at (B), bend the tab washer, and lock it (Fig. 19).
   Note: Measure the pre-load after making sure that the gears on the drive pinion shaft do not mesh or touch with each other and that the shaft rotates smoothly.



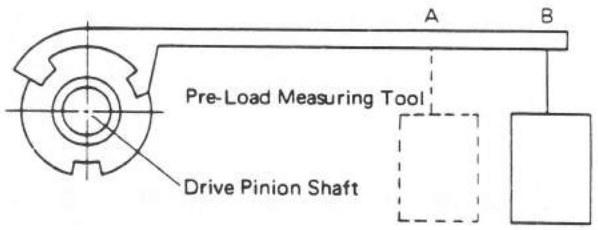
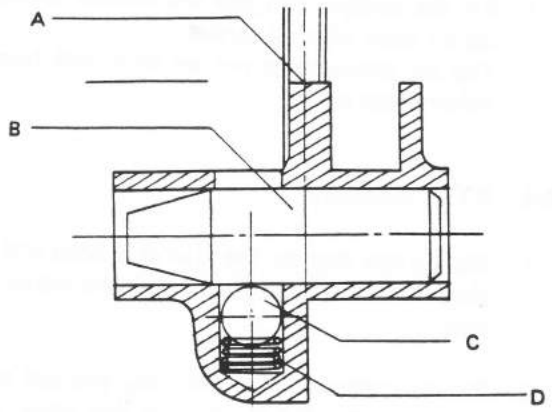


Fig. 19 Pre-load Measurement

9. Install the ball bearing (6205NR) to the lay shaft with a special tool (1300T29 RANGE SHAFT B.B. INSTALLING TOOL) and set it with circlips by using a special tool (S-0, SNAP RING PLIERS FOR SHAFT).
   Fit the gasket and wind a seal tape on the screws (M8 x 25) and install the end plate.

10. Install the selector spring and the selector ball to the range selector fork with a special tool (1700T01 SELECTOR ROD GUIDE).
    Insert the range selector rod from the transmission case front, and assemble the selector fork (Fig. 20).
    From the transmission case right side, fit the set screws with a seal tape on them and lock the range selector rod.
    Note:
    - When fitting "O" rings, apply grease to them and be careful not to damage them.
    - The set screws should not be protruded from the transmission case.



A Range Selector Fork
B Special tool (1700T01 SELECTOR ROD GUIDE)
C Ball
D Shifter Stop Spring

Fig. 20 Installing Shifter Shaft Guide

11. Install the selector forks (A) and (B)
Note: The selector fork (A) curved at the back is set to the right, while the selector fork (B) straight at the back is set to the left.
The spring pin with longer span of the set hole is set to the left.

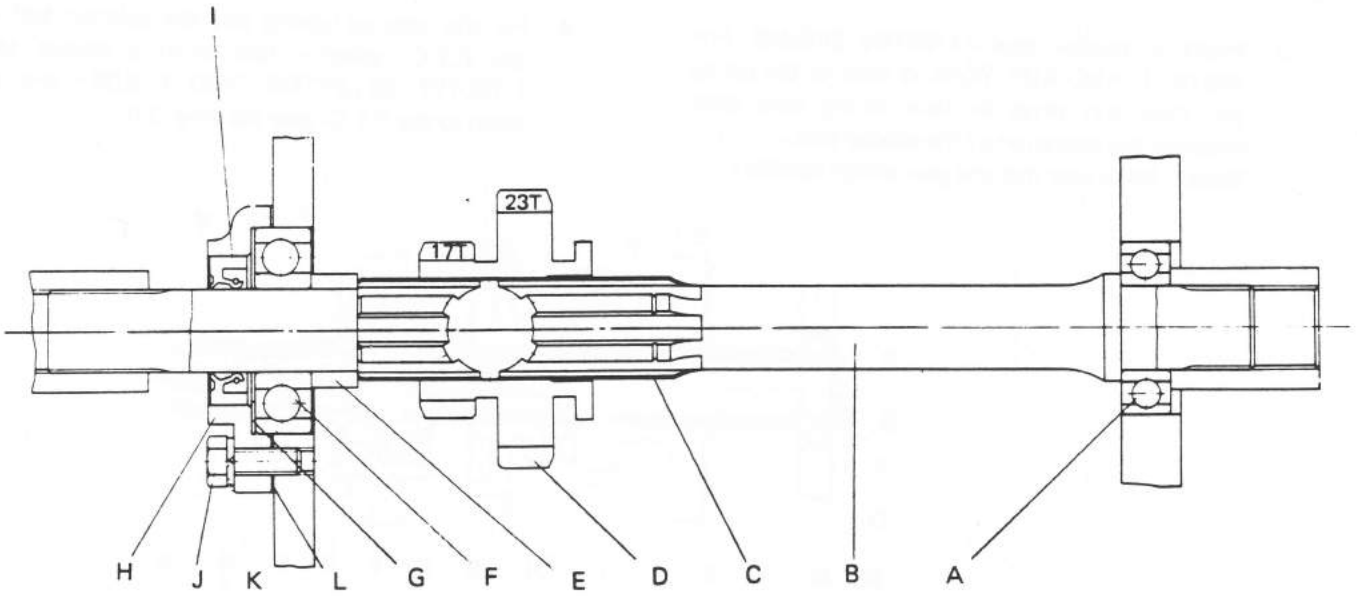
4-2. Range Shaft Assembly

1. Put the ball bearing (6205) into the range shaft differential gear side with a press and insert the shaft with the circlip set in the middle of the shaft using a special tool (S-0, SNAP RING PLIERS FOR SHAFT) from the differential gear side and pass the shaft through the range pinion. Insert the collar range shaft and fit the bearing (6305) with a special tool (1200T03 RANGE SHAFT B.B. INSTALLING TOOL).

2. Fit the shim to the end plate to which the oil seal has been installed and secure the end plate together with the gasket with two screws (M8 x 35) and one screw (M8 x 25) on which a seal tape is wound.

3. Secure the drive pinion shaft end plate and the lay shaft end plate together with the gaskets with five screws (M8 x 25) and one screw (M8 x 35) on which a seal tape is wound.
Tightening torque 13 ft-lb (1.8 kg-m)
Note: Apply some grease to the drive pinion shaft end plate.

4. Fit the "O" ring to the range selector plate and secure it together with the plate gasket with (–) screws (M8 x 6).
Fit the range selector and set the range lever with the spring pin.

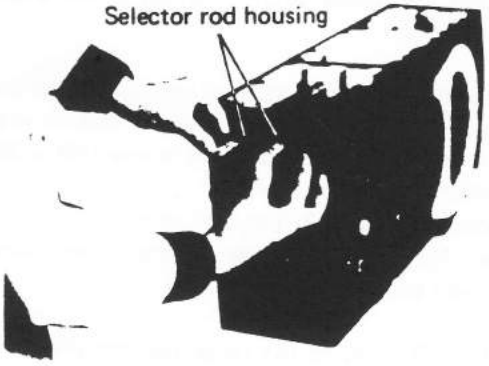


A Ball Bearing (6205)
B Range Shaft
C Circlip
D Range Pinion
E Collar Range Shaft
F Ball Bearing (6305)
G Shim
H End Plate
I Oil Seal
J Screw
K Spring Washer
L End Plate Gasket

Fig. 21 Renge Shaft Assembly

4-3. Selector Unit Assembly

1. Fit the "X" ring to the inside of the selector rod housing (R.H), (L.H), and the "O" ring to the outside with a thin coat of grease on them.
   Align the ball grooves on the selector rods (A) and (B) and insert a ball into each hole.
   Insert the gear locker to each selector rod housing. Pass the selector rods (A) and (B) through the selector forks (A) and (B), and tighten four screws (M8 x 30) with a seal tape on them (Fig. 22).
   Tightening torque 13 ft-lb (1.8 kg-m)



A "O" ring
B Transmission Shifter
C Gear Locker Stopper
D C-type Stopper
E Shifter Shaft Metal

Fig. 22 Selector Unit Assembly

2. Insert a special tool (1700T04 SPRING PIN INSTALL AND-AUT TOOL 6 mm) to the spring pin hole and drive in four spring pins after ensuring the operation of the special tool.
   Note: Make sure that the gear locker operates.

3. Fit the selector ball and the selector spring and secure them with set screws.
   The set screws must not be protruded from the transmission case.

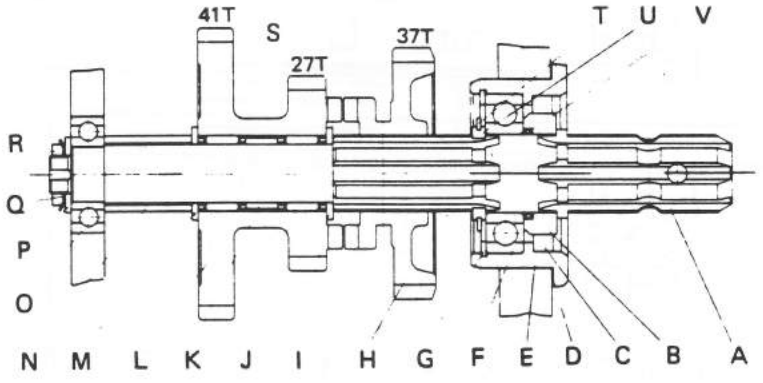
4-4. P.T.O. Assembly

1. Wind a seal tape on the four stud bolts and place them to the taps at the rear of the transmission case.

2. Fit the collar, oil seal, "O" ring, and ball bearing (6207) to the P.T.O. shaft in that order with a press.
   Fit the stopper ring and set it with a circlip by using a special tool (S-0, SNAP RING PLIERS).
   Fit the end plate and set it with a circlip by using a special tool (H-1, SNAP RING PLIERS FOR HOLE).
   Fit the oil seal to the end plate with a special tool (1600T05 P.T.O. SHAFT OIL SEAL INSTALLING TOOL).

3. Insert the P.T.O. shaft to which the end plate is installed, together with the gasket from the transmission case rear, fit the P.T.O. gear Ⓑ, thrust washer, needle roller bearing, collar, needle roller bearing, P.T.O. gear Ⓐ, thrust washer, collar P.T.O. gear Ⓐ in that order, and tighten temporarily the lock nuts.

4. Fit the selector spring and the selector ball to the P.T.O. selector fork with a special tool (1700T01 SELECTOR ROD GUIDE) and set them to the P.T.O. gear (B) (Fig. 23).



A P. T. O. shaft
B Collar, oil seal
C Oil seal
D End plate gasket
E End plate
F Ball bearing (6207)
G Circlip
H P. T. O. gear Ⓑ
I Thrust washer
J Needle roller bearing
K Collar, P.T.O. shaft
L P. T. O. gear Ⓐ
M Thrust washer
N Collar, P.T.O. gear Ⓐ
O Ball bearing (6205)
P Washer
Q Tab washer
R Lock washer
S Needle roller bearing
T Circlip
U Stopper ring
V "O" ring

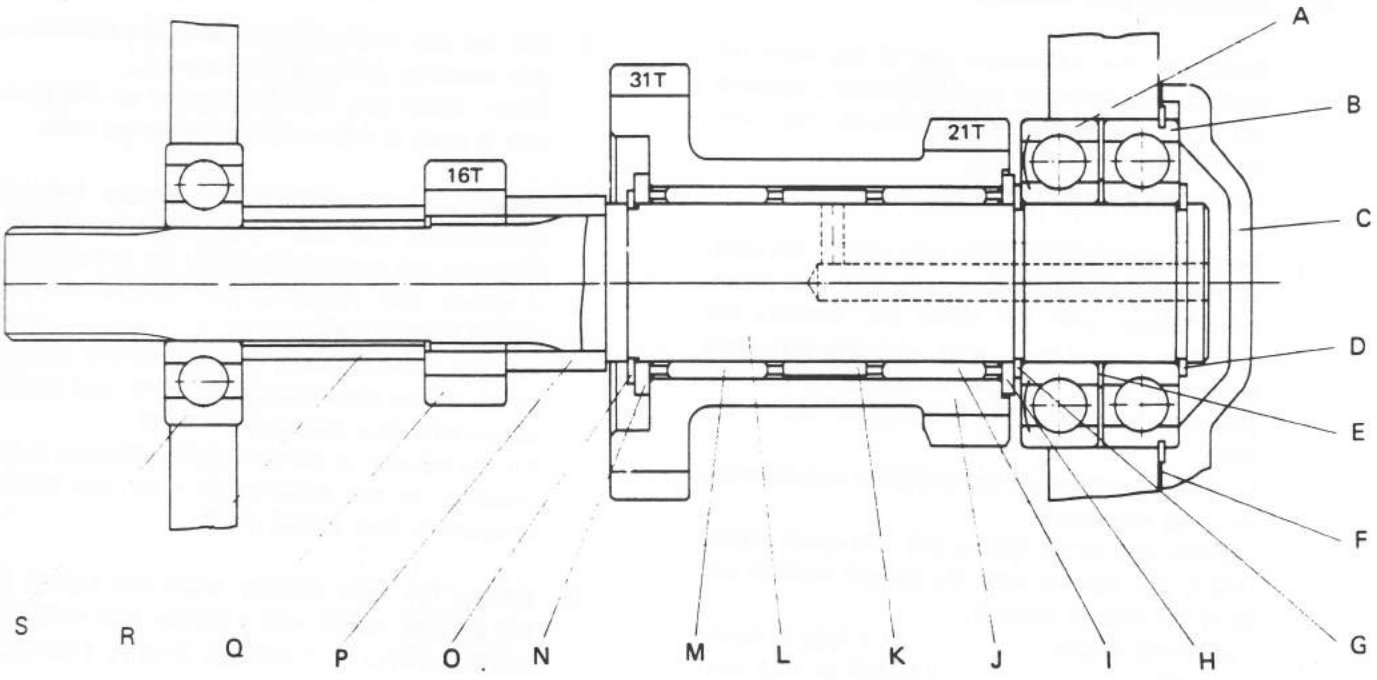
Fig. 23 P.T.O. Assembly

Set the circlip to the P.T.O. drive shaft and fit the ball bearing (6207D), liner and ball bearing (6207NR) with a press.
Insert the shaft from the rear of the transmission case, fit the thrust washer, needle roller bearing, collar, needle roller bearing, counter gear, and thrust washer in that order, and set them with circlips.

5. Align the end plate to the stud bolts and tighten the screws (M8 x 25) with a seal tape on them. To tighten the stud bolts, use four nuts (M8); tightening torque 13 ft-lb (1.8 kg-m).

6. Unscrew the temporarily tightened nuts on the P.T.O. shaft, install the ball bearing (6205) with a special tool (1600T06 P.T.O. SHAFT B.B. INSTALLING TOOL), fit the tab washer, and tighten the lock nuts.
Note: Tighten the nuts so that the clearance between the thrust washer and the counter gear may be 0.00394 ~ 0.0118 in. (0.1 ~ 0.3 mm).

7. Fit the collar Ⓐ, P.T.O. drive gear Ⓐ and collar Ⓑ to the P.T.O. drive shaft, and then the ball bearing (6305) (Fig. 23).
Note: Select a proper thrust washer so that the free-play toward the thrust may be 0.00394 ~ 0.0118 in. (0.1 ~ 0.3 mm).
There are thrust washers of 0.1181 in. (3.0 mm), 0.1259 in. (3.2 mm), and 0.1377 in. (3.5 mm).



A Ball bearing (6207NR)
B Ball bearing (6207D)
C End plate
D Circlip
E Liner
F End plate gasket
G Circlip
H Thrust washer
I Needle roller bearing
J Counter gear
K Collar
L P.T.O. drive shaft
M Needle roller bearing
N Thrust washer
O Circlip
P Collar Ⓐ
Q P.T.O. drive gear Ⓐ
R Collar Ⓑ
S Ball bearing (6305)

Fig. 24 P.T.O. Drive Shaft Assembly

8. Fit the "O" ring to the P.T.O. transmission shifter shaft, apply grease to it, and assemble the P.T.O. selector fork from the rear of the transmission case.
   Secure it with set screws from the side of the transmission case.

9. Fit the "O" ring together with the gasket to the P.T.O. selector shaft housing and tighten the screws (M8 x 20) with a seal tape on them; tightening torque 13 ft-lb (1.8 kg-m).
   Set the P.T.O. selector arm with circlips and the P.T.O. selector lever with spring pins.
   Note: Supply lubricant to the P.T.O. drive shaft ball bearing from over the transmission case.

4-5. Differential Gear Assembly

Note: As the differential gear is the most important component of the transmission, assemble the gear accurately in accordance with the specifications.
Apply thinly oil to the sliding parts.

1. Fit one thrust seat and the side gear to the cage, set the differential pinion seat and the differential pinion with the center pin, measure the side gear up-and-down play with the end plate lower, and select a proper thrust seat so that the play may be 0.00787 ~ 0.01575 in. (0.2 ~ 0.4 mm).
   Do the same thing at the end plate and assemble by using two dowels.
   Tighten one screw (M8 x 30) and seven screws (M8 x 20) together with the stopper washers and bend the stopper wahsers.
   Tightening torque 21.7 ft-lb (3 kg-m)
   Backlash 0.00787 in. (0.2 mm)
   Thrust seat
   Note: When replacing the side gear differential pinion, always replace four pinions.
   Make sure that the end plate dowel is located under the stopper washer.

2. Fit the spiral gear to the cage with two dowels and tighten eight screws (M10 x 20) together with the stopper washers (A).
   Tightening torque 21.7 ft-lb (3 kg-m)
   Before locking with the stopper washer (A), measure the spiral gear vibration with a special tool (1300T21 DIFFERENTIAL SPIRAL GEAR TRANSVERSE WARP MEASURING GAUGE SET).
   The spiral gear vibration limit ranges from 0.00276 ~ 0.00394 in. (0.07 ~ 0.1 mm) and if the measured value is within the limit lock the gear with the stopper washers (A) (Fig. 25).
   Note: Place the dowel under the stopper washer to prevent it from falling.

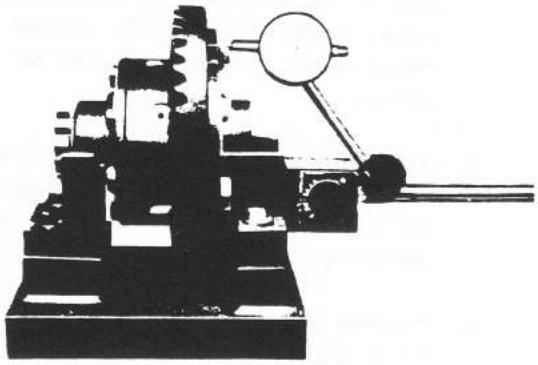


Fig. 25 Differential Spiral Gear Transverse Warp Measuring

3. Put the ball bearing (6213) into the differential gear assembly end plate with a press.
   Note: Make sure that the number on the spiral gear is same as that on the drive pinion shaft.

4. Install the differential gear assembly into the transmission case with the spiral gear to the left.
   Place the ball bearing (6213) to the left side with a special tool (1350T02 DIFFERENTIAL B.B. INSTALLING TOOL).
   Fit the bearing holder collar and the adjuster wheel to the bearing housing (R.H), and tighten temporarily four screws (M10 x 20).
   Fit the adjuster to the left bearing housing (L.H), install it to the transmission case, and tighten temporarily four screws (M10).

5. Loosen the right adjuster wheel and tighten the left adjuster wheel with a special tool (1400T01 DIFFERENTIAL ADJUSTER WHEEL TIGHTENING TOOL).
   Measure the backlash with a magnet-base dial gauge set on the transmission case.
   Rotating the spiral gear, adjust the backlash at three measuring points to 0.00787 ~ 0.00984 in. (0.2 ~ 0.25 mm).
   Tighten the right adjuster wheel, strike the cage several times with a plastic tip hammer, measure the backlash again, tighten the screws (M10 x 20) together with the stopper washers (A), and lock the adjuster wheel (Fig. 26).
   Note:
   1. Backlash 0.00787 ~ 0.00984 in. (0.2 ~ 0.25 mm).
   2. The three measuring points are around the spiral gear.
   3. Make sure that the adjuster wheels and screws are fully locked.

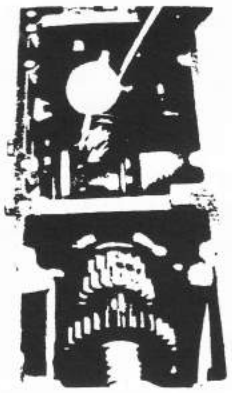


Fig. 26

6. Inspecting the Transmission Shaft and Bevel Gear Teeth Meshing

a. Clean the bevel gear and the transmission shaft pinion gear and apply red lead uniformly to 8 ~ 9 teeth on the bevel gear (Fig. 27).

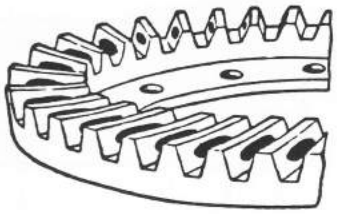


Fig. 27

b. Giving resistance to the bevel gear, rotate the transmission shaft in the forward direction, thus making a pattern on the gear teeth.

c. Check the pattern on the bevel gear teeth, and if the teeth meshing is bad, make the following adjustments.

○ Heel meshing
Increase the thickness of the transmission shaft adjusting liner and allow the pinion to come near the bevel gear.
Keep the bevel gear off the pinion and adjust the backlash (Fig. 28).

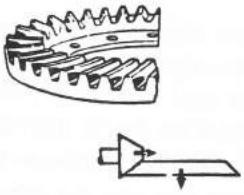


Fig. 28

○ Toe meshing
Decrease the thickness of the transmission shaft adjusting liner and keep the pinion off the bevel gear.
Then allow the bevel gear to come near the pinion and adjust the backlash (Fig. 29).

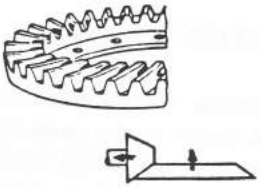


Fig. 29

○ Flank meshing
Make the same adjustment as of toe meshing (Fig. 30).

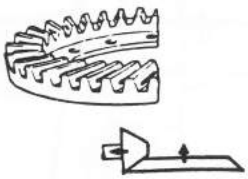


Fig. 30

○ Face meshing
Make the same adjustment as of heel meshing (Fig. 31).

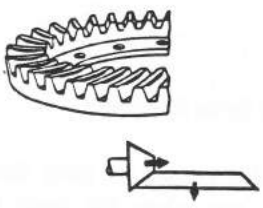


Fig. 31

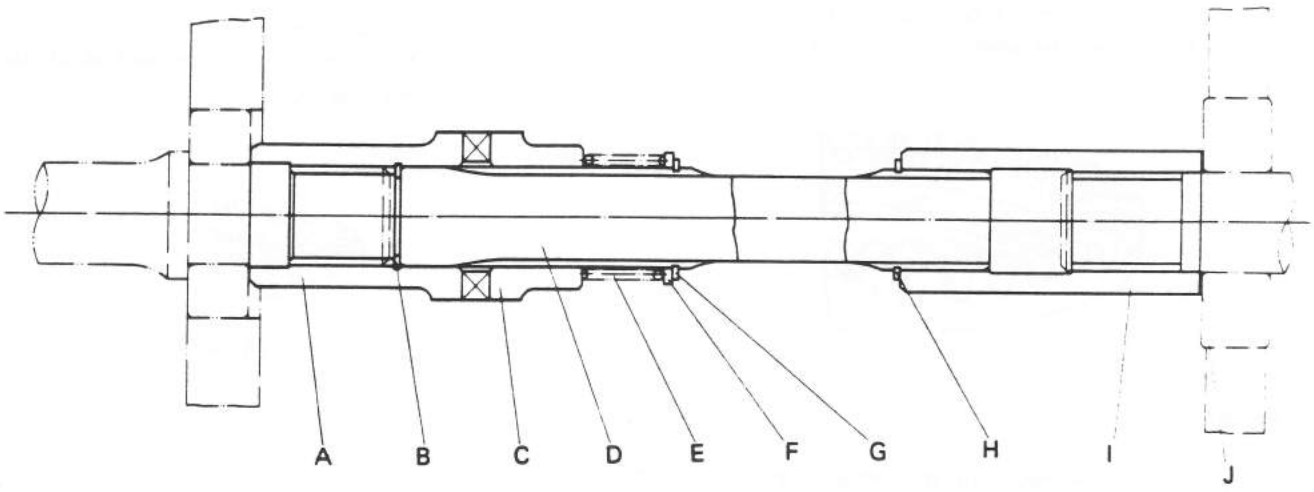
Note: One of the above will never occur independently; usually heel meshing and face meshing combined or toe meshing and flank meshing combined.

d. Repeat the above-mentioned adjustments until good teeth meshing can be obtained.
When the correct teeth meshing is obtained, make sure again of the bevel gear and the transmission shaft pinion backlash.
Backlash 0.00787 ~ 0.00984 in. (0.2 ~ 0.25 mm)
Note: After adjustment, clean the teeth with gasoline.

4-6. One-way Clutch Assembly

1. Fit the circlip to the one-way clutch Ⓐ and install the clutch to the range shaft.
Fit the one-way clutch Ⓑ to the drive shaft and place the spring, one-way clutch and washer in that order and set them with the circlip. Fit the other circlip to the drive shaft and then the coupling sleeve.
Place the one-way clutch assembly between the range shaft and the P.T.O. drive shaft and connect it with the P.T.O. drive shaft by using the coupling sleeve.
Use a proper shim so that the clearance between the coupling sleeve and the ball bearing may be 0.01575 in. (0.4 mm) (Fig. 32).
Note: Make sure that the circlips are rightly fitted to the drive shaft.

2. Check each component for normal operation and make sure there is no trouble.



A One way clutch Ⓐ
B Circlip
C One way clutch Ⓑ
D Drive shaft
E Spring, one way clutch
F Washer
G Circlip
H Circlip
I Coupling, sleeve
J Shim

Fig. 32 One-Way Clutch Assembly

4-7. Final Drive Assembly

1. Fit the collars to both sides of the final drive shaft and place the taper roller bearing with a press and a special tool (1550T01 FINAL DRIVE SHAFT T.R.B. INNER RACE INSTALLING BASE).
Note: Pay attention to the direction of the taper roller bearing and the collar.

2. Install the taper roller bearing to the final drive case, paying attention to its outer race direction. Secure the baffle plate together with the stopper washer with four screws (M10 x 20), bend the stopper washer, and lock it.
Tightening torque 21.7 ft-lb (3 kg-m)

3. Install the final drive shaft to the final drive case and fit the taper roller bearing outer race by using a special tool (1550T04 FINAL DRIVE SHAFT T.R.B. OUTER RACE INSTALLING TOOL).
Measure the depth between the upper part of the final drive case and the taper roller bearing outer race at several measuring points with a depth gauge.

Measure the oil seal housing height and insert a shim which thickness is the difference in dimension plus the gasket thickness 0.01969 in. (0.5 mm) and secure the oil seal housing together with the gasket with six screws (M8 x 25) (Fig. 33).

Tightening torque	13 ft-lb (1.8 kg-m)
Shim thickness	0.00787 in. (0.2 mm)
	0.01575 in. (0.4 mm)
	0.03150 in. (0.8 mm)
	0.00394 in. (0.1 mm)

Fig. 33

4. Fit the collar to the final drive case transmission case side and install the spur wheel and then the washer and the tab washer.
   Tighten the lock nuts, bend the tab washer, and lock it.
   Note: The spur wheel side vibration should be within 0.01378 in. (0.35 mm).
   When the vibration exceeds the limit, replace the collar or change the spline position.

5. Fit the ball bearing (6308NR) to the pinion shaft with a press, apply grease to the "O" ring, press in the collar bushing with a special tool (1300T29 DRIVE PINION SHAFT T.R.B. INSTALLING TOOL).
   Note: Place the ball bearing with the circlip toward the outside.

6. Fit the pinion shaft to the final drive case. Fit the stud with a seal tape on it to the final drive case.

7. Press the oil seal into the brake housing with a special tool (2200T01 BRAKE HOUSING OIL SEAL INSTALLING TOOL).
   Note: Pay attention to the oil seal direction.

8. Place the liner on the ball bearing and install the brake housing together with two dowels and the gasket, and tighten six nuts (M10); tightening torque 43.3 ft-lb (6 kg-m).
   Note: The backlash between the spur wheel and the pinion shaft is 0.005906 ~ 0.009842 in. (0.15 ~ 0.25 mm).

4-8. Differential Lock Assembly

1. Fit the differential lock shifter assembly from inside the final drive case and secure the "O" ring-fitted metal shifter shaft and the gasket with two screws (M6 x 16); tightening torque 13 ft-lb (0.8 kg-m).
   Set the differential lock arm with the spring pin.

2. Fit the shifter pin to the differential lock shifter and install them together with the locking sleeve to the pinion shaft.
   Then fit the return spring.

4-9. Final Drive Case Fitting

1. Fit the spring retainer to the transmission case differential cage end plate.
   Fit two dowels and the gasket to the transmission case.

2. Aligning the final drive case assembly pinion shaft spline to the differential cage side gear spline, secure them with bolts (M12 x 35).
   Note: Seal tape should be wound on two bolts at either side.
   Pay attention to the lower link bracket bolts.

4-10. Transmission Fitting

To fit the transmission, follow the reverse procedure in "3. Disassembly, 3-1 Transmission Removel".

5. Dimensional Data

5-1. Bolt & Nut Tightening Torques

1.	Baffleplate tightening torques	43ft · lb	(6 kg-m)
2.	Spiral/gear and cage tightening torques	21ft · lb	(3 kg-m)
3.	Endplate and cage tightening torques	21ft · lb	(3 kg-m)
4.	Bearing housing (L. H.) (R. H.)	21ft · lb	(3 kg-m)
5.	Brake housing tightening torques	21ft · lb	(3 kg-m)
6.	Baffleplate tightening torques (final drive)	21ft · lb	(3 kg-m)
7.	Final drive case	43ft · lb	(6 kg-m)
8.	Metal shifter shaft	5.7ft · lb	(0.8 kg-m)
9.	M8 screw tightening torques	13ft · lb	(1.8 kg-m)

5-2. End Float

1.	Driven gear assemble	0.0039 ~ 0.0118 in.	(0.1 ~ 0.3 mm)
2.	Reverse gear	0.0039 ~ 0.0118 in.	(0.1 ~ 0.3 mm)
3.	Counter gear	0.0039 ~ 0.0118 in.	(0.1 ~ 0.3 mm)
4.	P. T. O. gear	0.0039 ~ 0.0118 in.	(0.1 ~ 0.3 mm)
5.	One way clutch	0.0157 in.	(0.4 mm)
6.	Diff. side gear	0.0078 ~ 0.015 in.	(0.2 ~ 0.4 mm)
7.	Final drive shaft	0	

5-3. Backlash

1.	Spiral/gear and drive pinion shaft	0.0078 ~ 0.0097 in.	(0.2 ~ 0.25 mm)
2.	Sidegear and differential pinion	0.0078 in.	(0.2 mm)
3.	Spur wheel and pinion shaft	0.0059 ~ 0.0097 in.	(0.15 ~ 0.25 mm)

5-4. Gear Vibration

1.	Spiral/gear	0.0027 ~ 0.0039 in.	(0.07 ~ 0.1 mm)
2.	Spur gear	0.0127 in.	(0.35 mm)

5-5. Others

1.	Pinion shaft center to drive pinion shaft taper roller bearing	4.444 ± 0.0019 in.	(113 ± 0.05 mm)
2.	Drive pinion shaft pre-load	36.1 ft-lb ~ 57.8 ft-lb	(5 kg-m ~ 8 kg-m)

SATOH TRACTOR

MODEL S-650G

REPAIR MANUAL

BRAKE SYSTEM

PUBLICATION No.03-E

CONTENTS

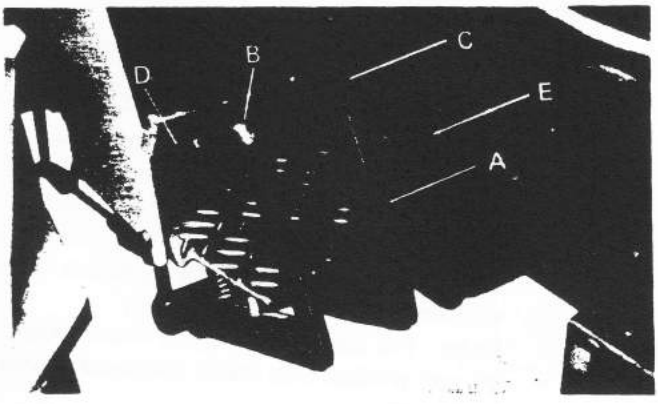
BRAKE SYSTEM

1. General

The brakes on the S-650G use mechanical internal expanding foot brakes. The brakes are operated by means of the left and right separate pedals, and can lock the wheels at one side when the car is making a sharp turn. The parking brake is locked with the left and right pedals depressed. The brakes function effectively by stopping the pinion shaft whose number of rotation is more than that of the axle.
Besides, as they are of the internal expanding type where the two brake linings are applied to the inside of the drums, a powerful braking force both for forward and reverse is obtained. The brake system is provided inside the housing to prevent dust, water or mud from entering the system.

2. Operation

When the brake pedal is depressed, the cross shaft connected with the pedal rotates, the adjusting rod connected with the shaft moves forward, the cam shaft arm connected with the rod turns the brake cam shaft, the shoe and lining expand along the inside of the drum, centering on the shaft (brake shoe fitting), the brake lining is locked against the drum, and the revolution of the wheel is reduced.
To lock the parking brake, lock the locking plate attached to the left brake pedal manually with the pedal depressed.



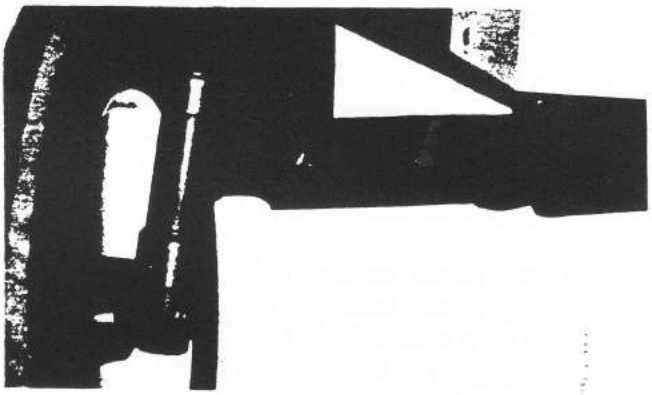
A Ratchet plate
B Locking palte
C Left brake pedal
D Right brake pedal
E Side brake arm

Fig. 1 Brake Pedal

3. Disassembling Order

3-1. Brake Drum Disassembling Order

1. In order to keep the tractor from shaking put a wedge between the front axle center beam and the chassis at either side.

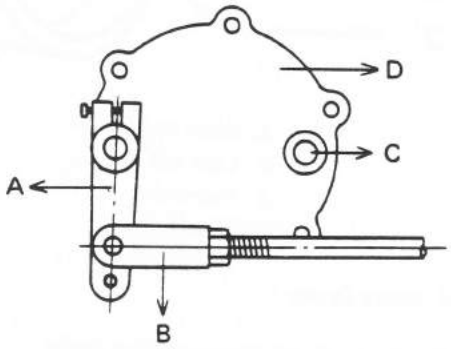


A Wedge B Chassis C Center beam

Fig. 2 Using a Wedge

2. Loosen the rear axle wheel boss nut and jack up the rear.
   Remove the nut and the rear axle.

3. Remove each adjusting rod from the arm bracket cam shaft.



A Arm bracket, cam shaft
B Brake rod joint
C Shaft brake, shoe fitting
D Brake cover

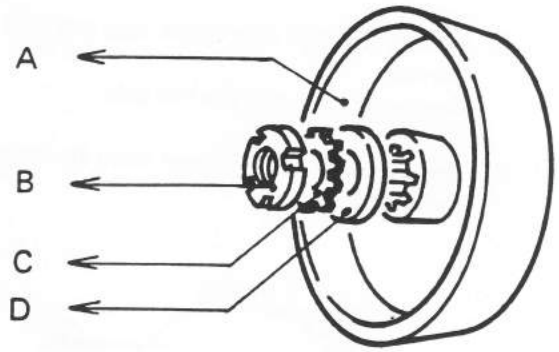
Fig. 3

4. Unscrew six brake cover securing screws (M10), and remove the brake cover from the brake housing.

5. As the brake shoe & lining are expanded by means of the return spring, take off the return spring and remove the brake shoe from the brake cover.

6. As the shaft and the brake shoe fitting are fixed by means of snap rings (c-type), pull them out toward the inside of the brake cover, using a special tool (S-O SNAP RING PLIERS).
   Note: In this case the "O" ring is also pulled out, and if it is damaged or distorted, do not use it again.
   Loosen the arm bracket cam shaft screws, (M10) remove the grease nipple, pull out the arm bracket cam shaft, then, remove the key, and drive out the brake cam shaft toward the inside of the brake cover, and remove the key and the "O" ring.

7. To remove the brake drum, straighten the curved tab washer, loosen the lock nut (B) with a special tool (1300T19 SOCKET FOR LOCK NUT, M25), remove the washer (D) and pull out the brake drum (A), stretching your hand around the inside of the drum.

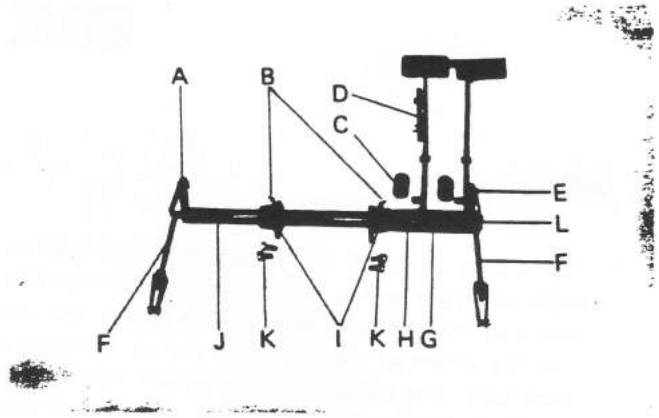


A Brake drum
B Lock nut
C Tab washer
D Washer

Fig. 4 Brake Drum

3-2. Brake Pedal Disassembling Order

1. As the cross shaft (J) is fixed by means of the holders (I) at both sides of the transmission case, unscrew four screws (K), take off two brake springs (C), and remove the brake pedal assembly from the transmission.



A Joint pin	E Joint pin	I Holder (L. H)
B Grease nipple	F Adjusting rod	J Cross shaft
C Brake spring	G Brake pedal (right)	K Screw
D Ratchet plate	H Brake pedal (left)	L Circlip

Fig. 5 Vrake Pedal

2. Mount the brake pedal assembly on a working bench, remove the circlip (L) at the right end of the cross shaft (J) with a special tool (S-0, SNAP RING PLIERS), and pull out the brake pedal (G).
   As the brake pedal (H) is rotated with the cross shaft (J) by means of the key, remove the pedal from the cross shaft (J) by gently tapping the brake pedal side with a hammer.
   Then pull out the holders (I), and the whole disassembly is completed.

4. Assembling (Adjusting) Order

To assemble, follow the reverse procedure of "Disassembling Order".
Following is the outline of inspection, adjustment, and correction.

4-1. Brake Drum

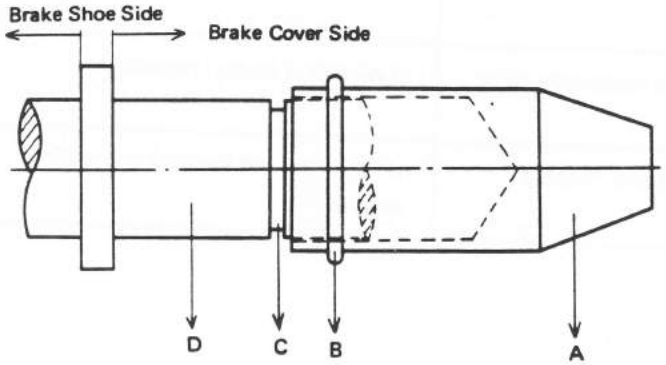
1. Check the brake drum for any flaw on the surface, and if the flaw is so serious that the braking efficiency is reduced, grind the drum surface. If the grinded drum inner diameter exceeds 6.634 in. (158.5 mm), while the standard drum inner diameter is 6.220 in. (158 mm), replace the drum with a new one.
   Note: The inside of the drum must be kept from oil, and grinded with a fine sandpaper in case it is again used.
   Set the drum on the pinion shaft, insert the washer (D) and the tab washer (C) shown in Fig. 4, and tighten the lock nut (B) with a special tool (1300T19 SOCKET FOR LOCK NUT, M25).

2. The surface of the brake lining must be always clean and in even contact with the drum.
   If it is found that the lining is applied to only a part of the drum, find the fault and correct it.
   The lining is 0.196 in. (5 mm) in width, and if it becomes less than 0.147 in. (3.75 mm) due to wear, replace it.
   Note: When replacing any lining, always replace the left and right ones (four).

3. Two "O" rings (M18) are fitted to the brake cam shaft, and one (M18) to the shaft (brake shoe fitting), and if any is damaged or distorted, never fail to replace it with a new one.
   To fit the "O" ring, use a special tool (2200T02 "O" RING INSTALLING GUIDE).
   In this case apply a thin coat of grease to the "O" ring.

4. Fit the shaft and the brake cam shaft to the brake cover, attach the arm bracket to the brake cam shaft, and secure it by screw with the key.
   Fix the shaft (brake shoe fitting) by fitting the snap ring (c-type) with a special tool (S-O SNAP RING PLIERS).

5. Fit the shoe (lining) to the brake cover and secure it with a return spring, attach the parking to the brake cover (use Three Bond), wind a seal tape round the six screws, and tighten the screws to the brake housing.
   Fit the "O" ring to A, slide it to C, and put it on the "O" ring groove.



A Special tool 2200T02
B "O" ring
C "O" ring groove
D Shaft

Fig. 6 "O" ring

Note: Tighten diagonally the six screws at the torque of 21.7 ft-lb. (3 kg-m).

4-2. Brake Pedal

Folow the reverse procedure of 3-2 "Disassembling Order", while paying attention to the following.

1. Clean the area which is in contact with the holder (L, H) on the cross shaft, and apply a thin coat of grease to it.

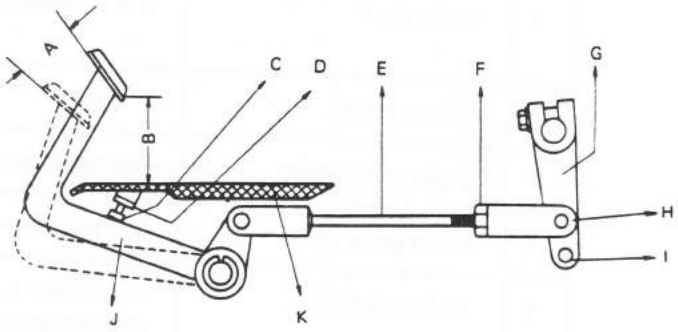
2. Do not use again the cotter pins and circlips, as they always touch mud and water.

3. When completely assembled, supply grease, however, do not lock the adjusting rod lock nut, for the brake adjustment is to be made.

4-3. Adjustment after Assembling

1. Put a wedge between the center beam and the chassis. (see Fig. 2).

2. Jack up the rear wheels to rotate them freely.



A 1.57 in. (40 mm)
B 4.72 in. (120 mm)
C Pedal cushion
D Lock nut
E Adjusting rod
F Lock nut
G Arm bracket
H Standard hole
I Hole for trailer
J Brake pedal
K Step

Fig. 7 Brake Adjustment

3. Fix each brake pedal, adjust the pedal cushion (C) so that the measurement (B) between the step (K) and the brake pedal (J) may be 4.72 in. (120 mm), and lock the cushion with the lock nut (D).

4. Adjust the adjusting rod (E) so that the brake pedal play may be 1.57 in. (40 mm) and each rear wheel may be well braked.

5. Start the engine and rotate the rear wheels at 1,000 r.p.m. at 5th gear, and depress the brake pedal. Make sure that each rear wheel is locked at the same time, and tighten the lock nut (F).
   Note: When making the brake test after jacking-up, pay attention to car's surroundings and rotate the wheels gently.
6. Make sure that the parking brake lock plate operates smoothly.
7. As an overall test make a running test to see whether or not each wheel is braked evenly.

5. Inspection, Maintenance and Limit of Modification

	Inspection	Maintenance	Limit of Modification
1	Wear in brake lining	If wear is within 0.147 in. (3.75 mm), use it again.	If it exceeds 0.147 in. (3.75 mm), replace.
2	Uneven brake lining contact	Correct the trouble and graind the surface.	If it is 0.049 in. (1.25 mm) in width after grinded, replace.
3	Oil on brake lining	If a little oil is attached, correct with a sandpaper.	If a lot of oil is attached, replace each lining.
4	Brake drum	If it is flawed, grind it.	If the drum inner diameter exceeds 6.634 in. (158.05 mm), replace.
5	Return spring		If it is loose, replace.
6	Brake pedal height	Use pedal cushion.	4.72 in. (120 mm)
7	Brake pedal play	Use adjusting rod.	1.57 in. (40 mm)
8	Parking brake	Supply oil to ensure that lock plate operates properly.	
9	Oil leakage in brake	Find the fault, and replace or tighten the screws.	If oil seal is faulty, replace it.
10	Foreign matter in drum	Checking "O" ring and Packing.	If "O" ring and Packing are faulty, replace it.

6. Troubleshooting

6-1. Brakes Insufficient

Trouble	Remedy
Small pedal travel	Adjust with the adjusting rod.
Worn lining	Adjust with the adjusting rod or replace.
Uneven lining contact	Grind with sandpaper.
Burnt lining	Replace.
Oil attached due to oil leak	Replace.

6-2. Brakes Remain ON

Trouble	Remedy
Little pedal play	Adjust with the adjusting rod.
Loose brake spring	Replace.
Loose return spring	Replace.
Cross shaft and holder sticking	Disassemble, correct and supply oil.

6-3. Strange Sound Heard

Trouble	Remedy
Foreign matter in drum	Clear away.
Damaged lining	Replace it.
Loose brake housing securing bolt	Retighten.
Damaged return spring	Replace.

7. Specifications

Type	Mechanical internal expanding dry sealed brake.
Brake pedal	Separate, with interlocking device.
Parking brake	Hand, pedal-lock type.
Parking	Main brake used
Lining material	Miyoshi, No. 5220ABL
Lining dimensions (length x width x depth)	6.69 in. x 1.37 in. x 0.19 in. (170 mm) x (35 mm) x (5 mm)
Number of linings	4
Drum material	FCD 45 (Ductile cast iron)
Drum inner diameter	6.162 in. (158 mm)
Drum depth	0.27 in. (7 mm)

SATOH TRACTOR

MODEL S-650G

REPAIR MANUAL

HYDRAULIC SYSTEM

PUBLICATION No.03-F

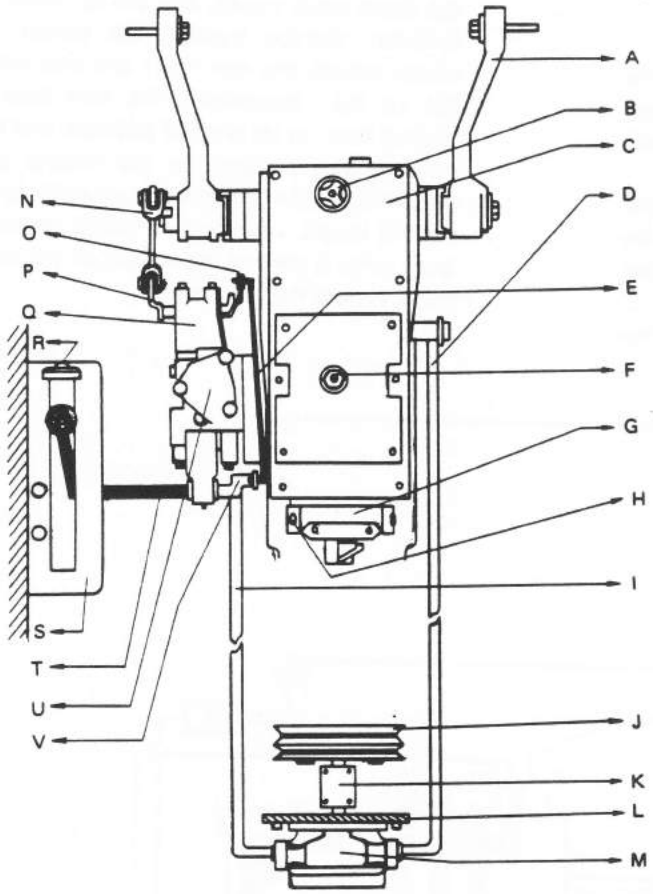
CONTENTS

HYDRAULIC SYSTEM

1. General

This hydraulic mechanism is developed by SATOH, and equipped with a height control (position control), flow control and lift control. The hydraulic pump is of the gear type (Kayaba-Dowty, GP1), and driven directly by the engine crankshaft main pulley. Accordingly, while the engine runs, the oil is constantly delivered.

The oil pressure is regulated by the control lever. When the control lever is moved, the spool valve operates, and then the spool valve causes the unload valve to move, thereby moving the ram piston located in the ram cylinder.



A Ram Arm
B Plug
C Hydraulic Lift Case Cover
D Suction Pipe
E Connecting Rod
F Breather Ass'y
G Adjusting Lever
H Oil Pressure Gauge Adaptor
I Delivery Pipe
J Crankshaft Pulley
K Joint (A & B), Pump
L Pump Bracket
M Pump
N Joint
O Control Arm
P Feed Back Link
Q Control Valve Ass'y
R Lever Stopper
S Quadrant
T Control Lever
U Cover
V Arm Boss

Fig. 1 Hydraulic System

The oil lock valve is of the in-line check valve design. When the oil enters the cylinder, it pushes the lock valve to open. Once the oil enters the cylinder, it forces the lock valve against the seat by means of the pressure generated by the weight of the implement and spring pressure.

Accordingly, the heavier the weight of the implement, the greater the pressure against the lock valve.

While in farming operations, the lock valve opening can be freely adjusted by the lever. This makes it possible to regulate the implement lowering speed ranging from "slow down" (while seeding) to "quick down" (while plowing).

2. Construction

Most conventional type small-size tractors employ the standard control system (ON-OFF system) which is capable of controlling lifting, neutral and lowering, and, as a result, it is difficult to precisely regulate the height of the implement. The height is usually set by the depth wheel on the implement side. (SATOH's S-350 and S-500 tractors employ such system.)
The S-650G adopts the position control system, instead of the standard control system. The position control system is also called "the height control system". In this manual, the latter is used.

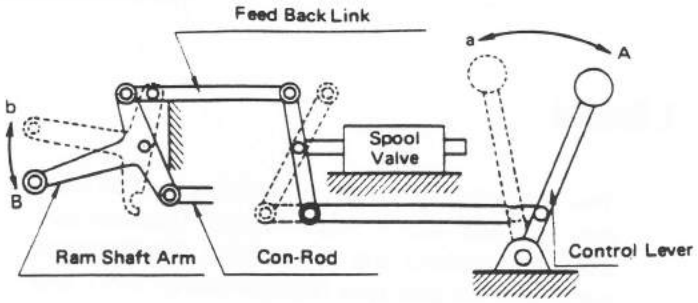


Fig. 2 Standard Control System

2-1. Height Control System

The height of the implement is controlled by the spool valve which is operated by a feed-back system. (Actually, the tilt angle of the ram shaft arm is controlled.)
In this control system, the height of the implement is controlled automatically according to the angle of the control lever which operates the spool valve.
Fig. 2 shows the principle of the control mechanism.

When the control lever is moved from (A) to (a), the spool valve moves, and the oil flows into the cylinder, thereby pushing the piston. As the piston moves, the ram shaft arm also shifts from (B) to (b). Meanwhile, the feed back link is pushed back to its original position, and the spool valve is also restored to the neutral position. Accordingly, the implement can easily be set to a desired height, requiring no depth wheel. At the same time, a part of the weight of the implement shifts toward the rear wheel.

2-2. Neutral Position

Refer to Fig. 3.

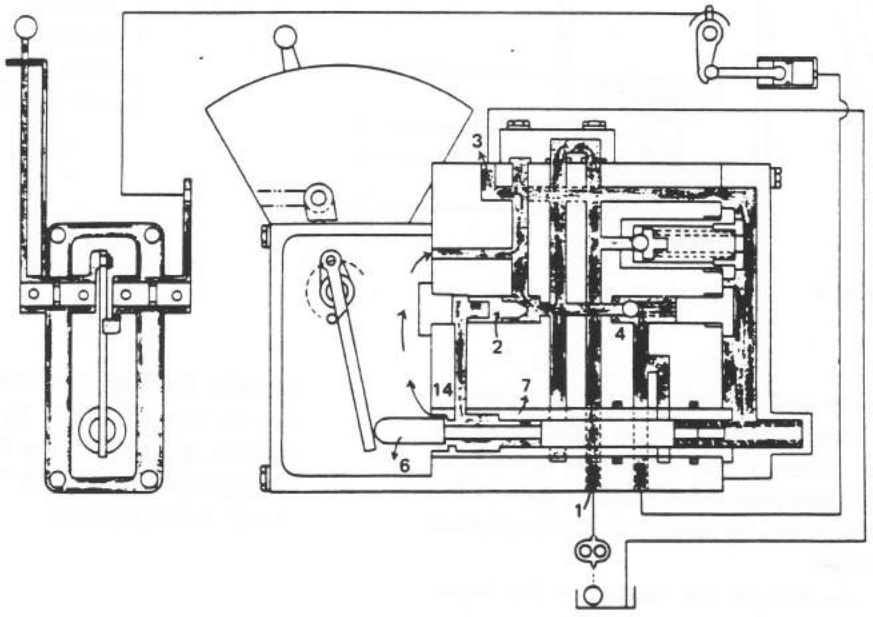


Fig. 3 Neutral Position

The oil, which is delivered from the pump, flows in the direction of the arrow to push up the unload valve (2), and then flows to the tank port (3). Pushing up the unload valve requires a very small amount of pressure, and, as a result, the pump is almost under no-load.

The ram cylinder oil passage is shut from the passage on the tank and pump side by the lap of the check valve (4), spool (6) and sleeve (7), and therefore, has no connection with the implement side.

Note: The unload valve is pushed to open for the following reason. That is, the passage between the spool (6) and the unload valve port (14) is open, and therefore, the pressure from the pump is higher, thus forcing the unload valve (2) to open.

2-3. Lifting Position

Refer to Fig. 4.

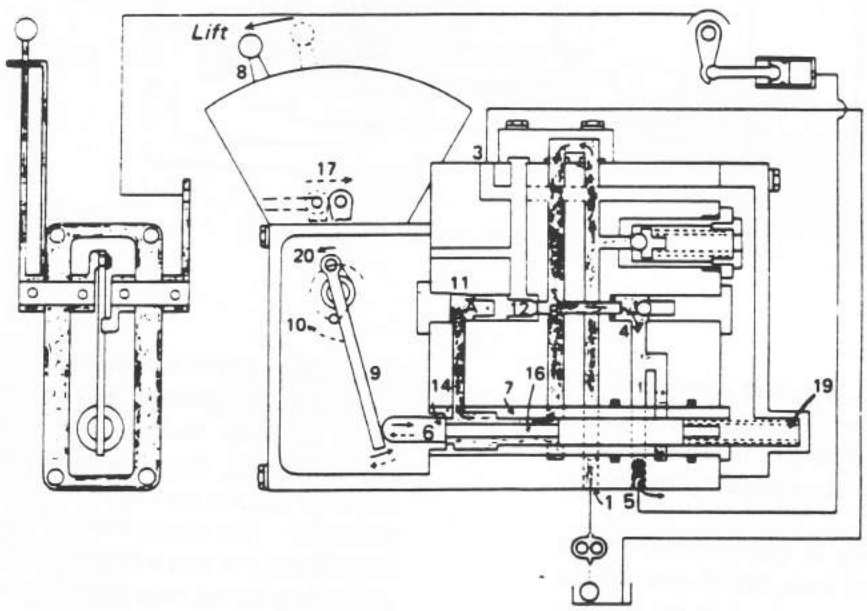


Fig. 4

When the control valve (8) is moved to the lifting position, the link (9) turns around the pin (10) in the direction of the arrow (indicated by full line), and pushes the spool (6) to shut the unload valve passage (14). This causes the pump oil passage to open to the unload valve's rear chamber (11), thereby allowing the oil to flow into the chamber, and the oil pressure forces the unload valve to close. When the unload valve is shut, the pressure of the oil flowing from the pump causes the check valve (4) to open, and the oil further flows to the cylinder port (5), through which it flows into the ram cylinder. Thus, the ram shaft is moved upward.

When the implement begins lifting, this movement is mechanically fed back to the link (17). Then, the link turns in the direction of the arrow (indicated by dotted line), and, simultaneously, the pin (10) also shifts in the direction of the arrow (indicated by dotted line). When the link (9) is moved by the return spring (19) around the pin (20) in the direction of the arrow (indicated by dotted line), the spool is forced out. When the spool moves in proportion to the amount of the movement of the control lever, the implement also moves according to the tilt angle of the control lever. Then, the implement stops its movement, and the pump is placed under no-load.

The unload valve is closed for the following reason:

The oil from the pump flows through the hole (17) into the unload valve.

Force = Pressure x Section area

Because the B section is larger than the A section, the unload valve is pushed by pressure and closes the oil passage to the tank. While the check valve opens and thereby allows the oil to flow into the cylinder.

2-4. Lowering Position

Refer to Fig. 5.

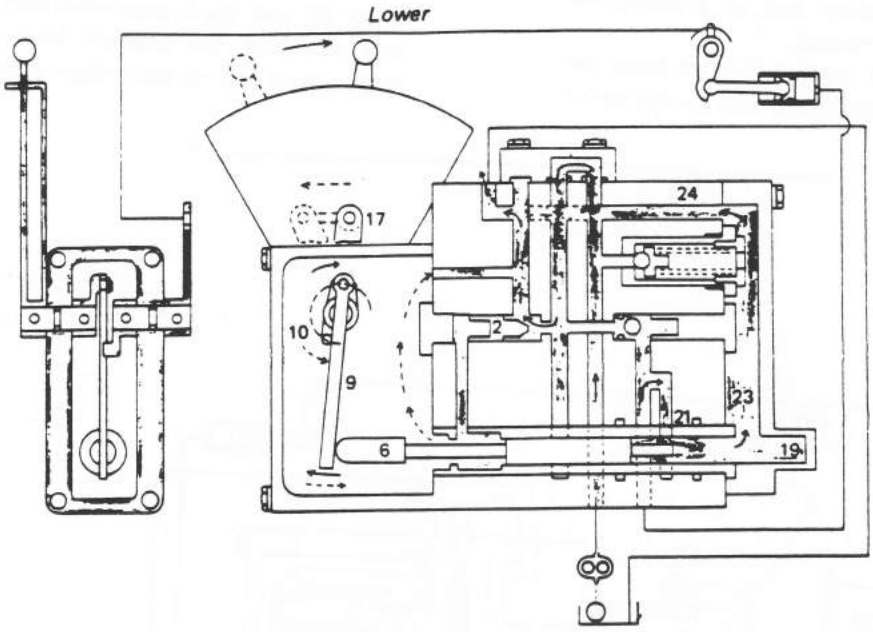


Fig. 5

When the control lever is moved downward, the link (9) turns around the pin (10) in the direction of the arrow (indicated by full line). Simultaneously, the spool (6) is forced out by the return spring (19).

When the spool moves in the direction of the arrow (indicated by full line), the oil also flows in the direction of the arrow and causes the cylinder passage to open to the tank. As a result, the implement begins to lower with its own weight. In this case, the unload valve passage is in the same condition as in the case of the control lever being in the neutral position, and, as a result, the oil pump is under no-load. When the implement begins to lower, the movement is fed back to the link (17), and the pin (10) turns in the direction of the arrow. This causes the link (9) to turn in the direction of the arrow (indicated by full line), and the spool is forced back to its original position. As a result, the spool valve is under no-load, and, at the same time, the implement stops its movement.

2-5. Floating Position

Refer to Fig. 6.

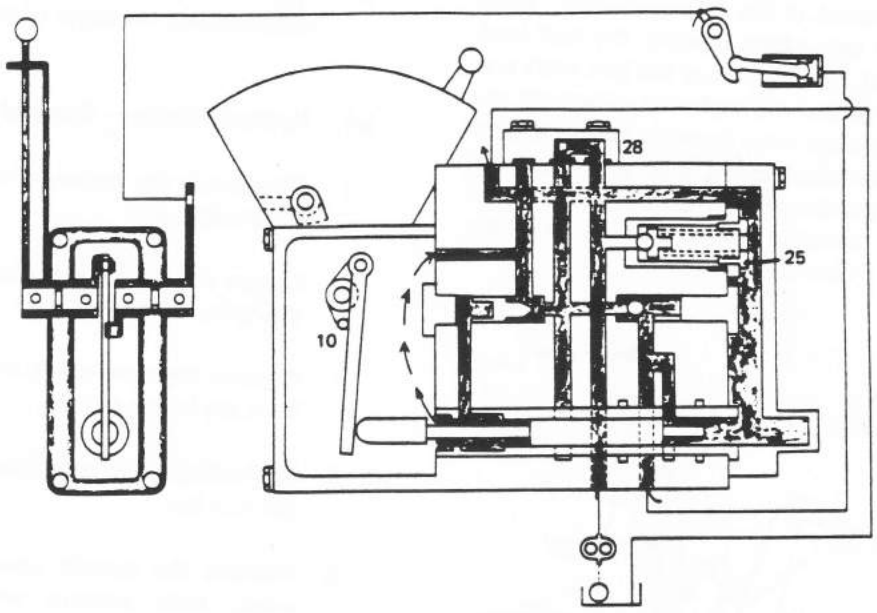


Fig. 6

When the control lever is shifted to the lowering position, the unload valve is placed under height control. If the control lever is further lowered from its maximum lowering position, the unload valve is shifted to the lowering condition. But as the ram cylinder is in the stroke end, it will not move further, and thus no movement is fed back to the link. Accordingly, the pin (10) stays as it is, the spool valve is kept under the lowering condition, the passages are opened through the pump, tank and ram cylinder.

2-6. Control Lever and Link System

In this hydraulic system, a feed back link system is provided in order to feed back the movement of the ram shaft arm and place the control lever in a desired position so that the implement will be properly positioned. That is, the spool valve is automatically pushed back to the neutral position by means of the feed back link. This mechanism is shown in Figs. 7 and 8.

1. Construction
(Refer to Fig. 7.)

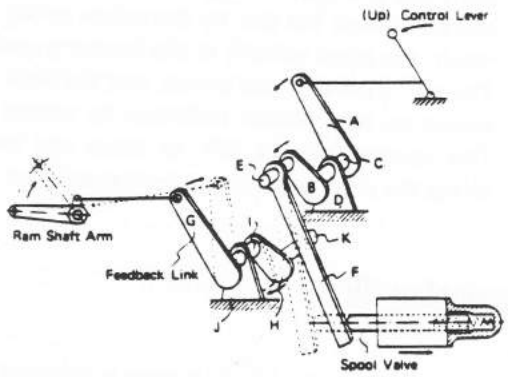


Fig. 7 Link System

The control arm (A) is connected to the control lever by the connecting rod. Both control arm (A) and arm (B) are locked to the shaft (C), and the shaft (C) is supported by the support plate (D) being allowed to rotate freely. The shaft (E) is locked to the arm (B), and the link (H) is mounted on the shaft (E), being allowed to rotate freely. The feed back link (G) is jointed to the ram shaft arm, and both feed back link (G) and arm (H) are locked to the shaft (I).

2. Operation
When the control lever is moved to the lifting position, the link (F) turns around the shaft (K), and the spool valve is forced to the right, thus the valve being placed in the lifting position. When the ram shaft arm moves upward, the feed back link (G) which is connected to the ram shaft arm begins to move and the shaft (K) moves off the link (F). The spool valve is simply pushed toward the link by the return spring, and, as a result, the valve pushes the link (F). When the valve reaches the position indicated by dotted line, and the spool valve is in the neutral position.

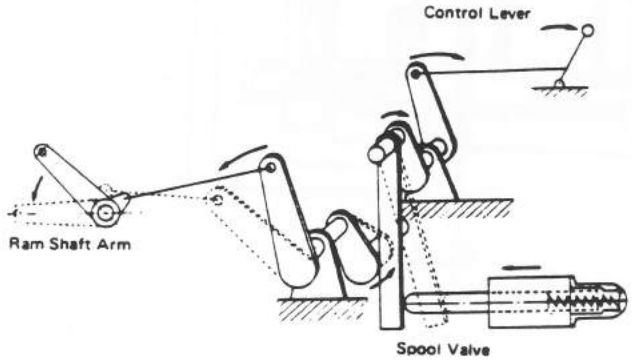


Fig. 8 Operation

Next, when the control lever is moved to the lowering position, the link (F) turns around the shaft (K) as shown in Fig. 8, and the spool valve is pushed toward the link by the return spring. As a result, the spool valve is in the lowering position. The ram shaft arm also lowers, and the shaft (K) is turned to the position indicated by dotted line. This causes the link (F) to move and thereby brings the spool valve in the neutral position.

3. Disassembling Order

In general, the hydraulic system is required to be disassembled or removed in the following cases, although other reasons are also conceivable.

(a) The hydraulic system is in good condition, but the transmission (including the P.T.O. shaft) has trouble. In this case, the hydraulic system must be removed.
(b) The hydraulic system has trouble relating to the ram piston.
(c) The control system is faulty.
(d) The adjusting lever and relating parts are found defective.
(e) The oil pump is found defective. (Refer to the "Oil Pump".)

The disassembling procedures can be divided largely into the following two:

A. The whole part of the hydraulic system is removed and disassembled.
B. The whole part of the control valve is removed and disassembled. (Inclusive of the lock valve)

3-1. Hydraulic System - Removal and Disassembly

1. Disconnect the battery's negative wire from the driver's seat side.

2. Loosen the four screws and remove the seat from the hydraulic case top.

3. Remove the three-point linkage top link support from the hydraulic case.

4. To facilitate the subsequent procedures, remove the tool box.

5. Remove the battery cover, and disconnect the wires, both positive and negative, from the battery, and dismount the battery.

6. Remove the control lever knob, and remove the quadrant from the rear fender.
Note: To prevent dust and dirt from entering the transmission case, clean its exterior and disassembled parts. In particular, the sealing surfaces between the transmission and the hydraulic case should be cleaned carefully.

7. Drain off the oil through the hydraulic case drain plug hole. If the oil is reused, it should be put in a clean container. Exerise care not to allow dust and dirt to enter the container. It is advisable to cover it properly.

8. Remove the delivery pipe and suction pipe from the hydraulic case. Make sure that all "O" rings are in position. The removed "O" rings should not be reused.

9. Remove the ten screws from the transmission case.
Note: Out of these ten screws, the two screws used under the control valve are of M10 x 22 size, and the other are of M10 x 30 size.

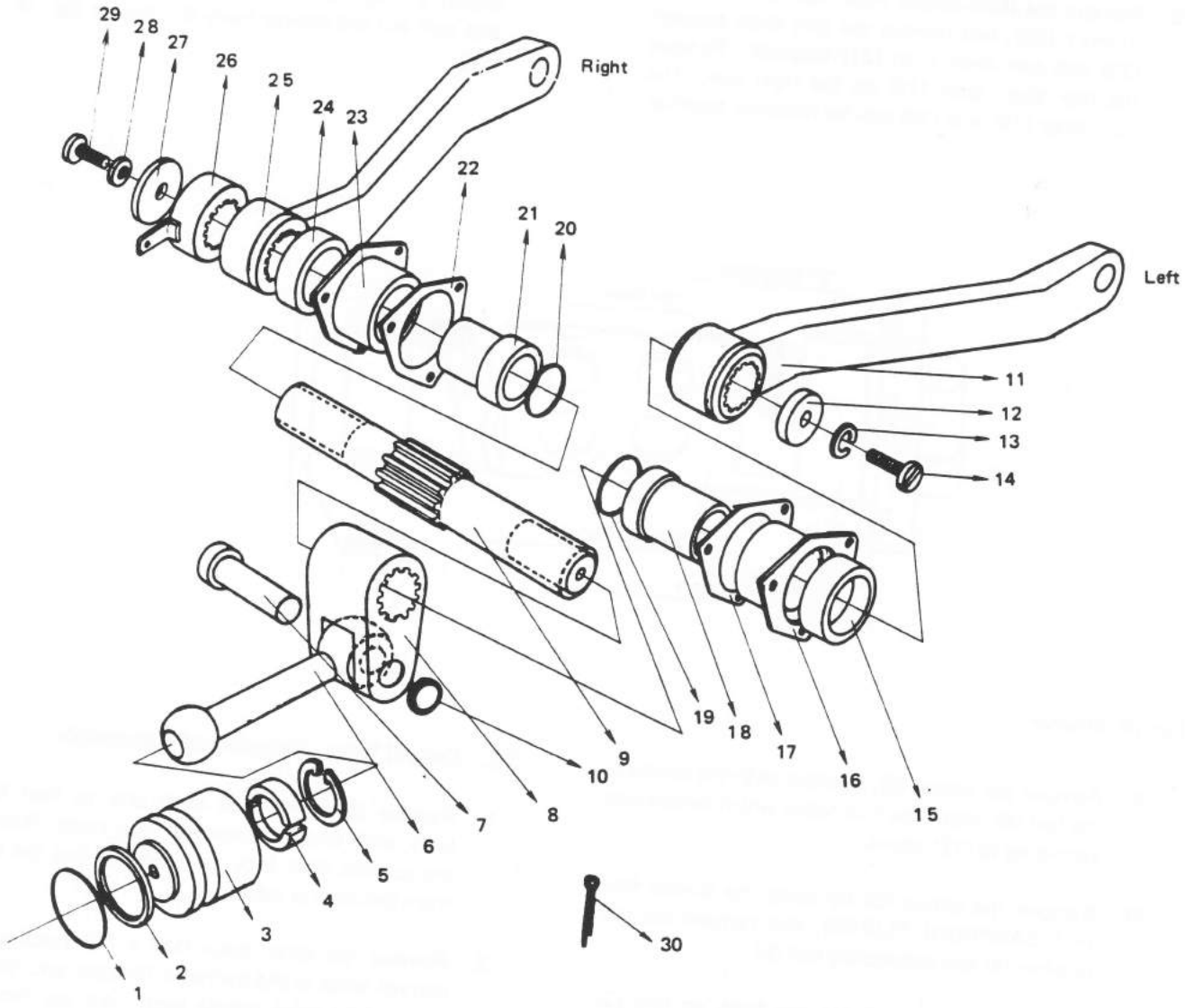
10. Two dowel pins are installed in the contacting surfaces between the hydraulic case and the transmission case. To remove the hydraulic case, place the ram shaft arm in the lowering position, and lightly tap the ram shaft arm. The hydraulic case can easily be removed. The hydraulic case is rather heavy, therefore full care should be taken

when it is removed. Place it on a clean work bench.

Note: When removing the hydraulic case, take care not to drop the dowel pins into the transmission case.

11. Remove the control valve (whole part) from the hydraulic case. To disassemble the control valve, refer to "3-2. Control Valve - Removal and Disassembly". Remove the lift case cover (whole part). Do not reuse the removed gasket.

12. Remove the six screws (M10 x 40) holding the lock valve, and remove the lock valve.
Follow the procedures listed below by making reference to Fig. 9.



1. "O" Ring
2. Back Up Ring
3. Piston
4. Rod Retainer
5. Circlip
6. Con Rod
7. Lift Fork Pin
8. Ram Arm
9. Ram Shaft
10. Washer
11. Ram Shaft Arm
12. Washer
13. Spring Washer
14. Screw
15. Oil Seal
16. Ram Shaft Support
17. Support Gasket
18. Ram Shaft Bush
19. "O" Ring
20. "O" Ring
21. Ram Shaft Bush
22. Support Gasket
23. Ram Shaft Support
24. Oil Seal
25. Ram Shaft Arm
26. Striker Arm Boss
27. Washer
28. Spring Washer
29. Screw
30. Cotter Pin

Fig. 9 Hydraulic Lift

13. Remove the screw (29). Remove the spring washer (28), washer (27) and stricker arm boss (26), and pull out the ram shaft arm (25).

14. Remove the three screws (M8) from the ram shaft support (16). Lightly tap the right end of the ram shaft (9) (take care not to damage the shaft), and drive out the ram shaft with the ram shaft support (16).

15. Remove the three screws (M8) from the ram shaft support (23), and remove the ram shaft support (23) and ram shaft bush (21) together. Remove the ram shaft bush (18) on the right side. The "O" rings (19) and (20) can be removed together with the ram shaft bushes (18) and (21). The removed "O" rings should be discarded. The support gaskets (17) and (22) should be discarded.

16. Remove the cotter pin from the lift fork pin (7), and remove the washer (10). Then pull out the lift fork pin (7) from the ram arm (8) remained in the hydraulic case, and pull out the lift fork pin (7). Remove the ram arm from the hydraulic case.

17. The strainer assembly consists of the parts as shown in Fig. 10. Remove the strainer body A and pull out the strainer body B. Discard the "O" ring.

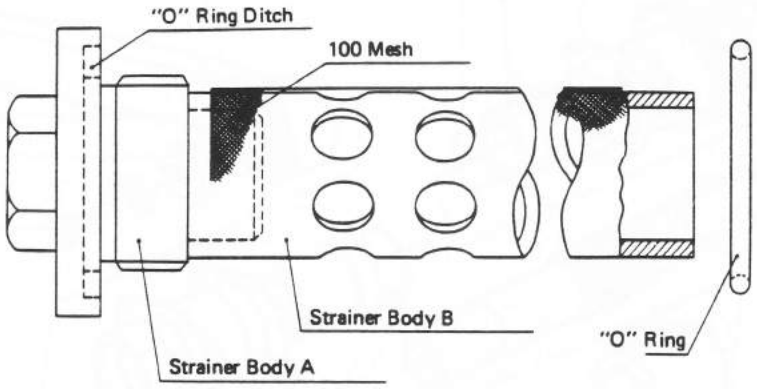


Fig. 10 Strainer

18. Remove the piston (3), together with the connecting rod (6), from the lock valve which is removed according to (12) above.

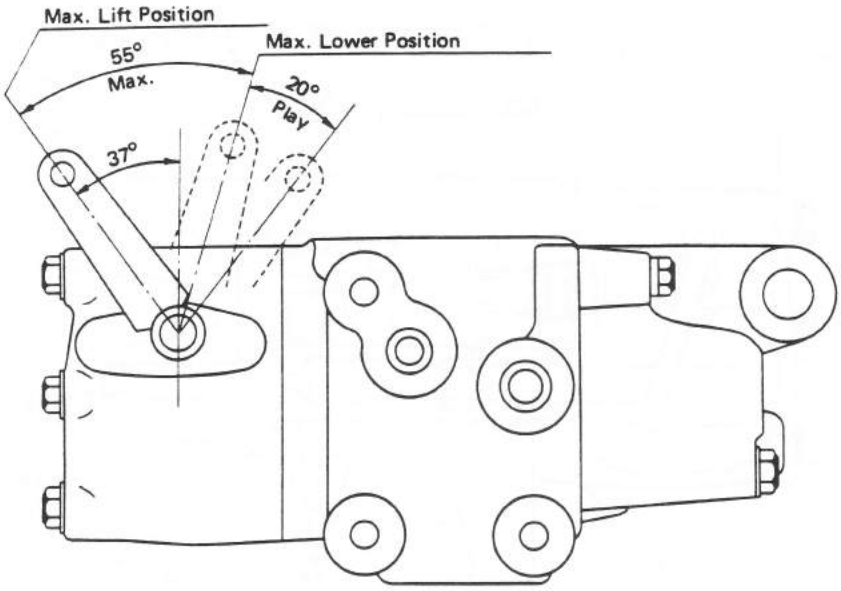
19. Remove the circlip (5) by using the special tool (H-1 SANPRING PLIERS), and remove the rod retainer (4) and connecting rod (6).

20. Remove the "O" ring (1) and back up ring (2) from the piston (3).

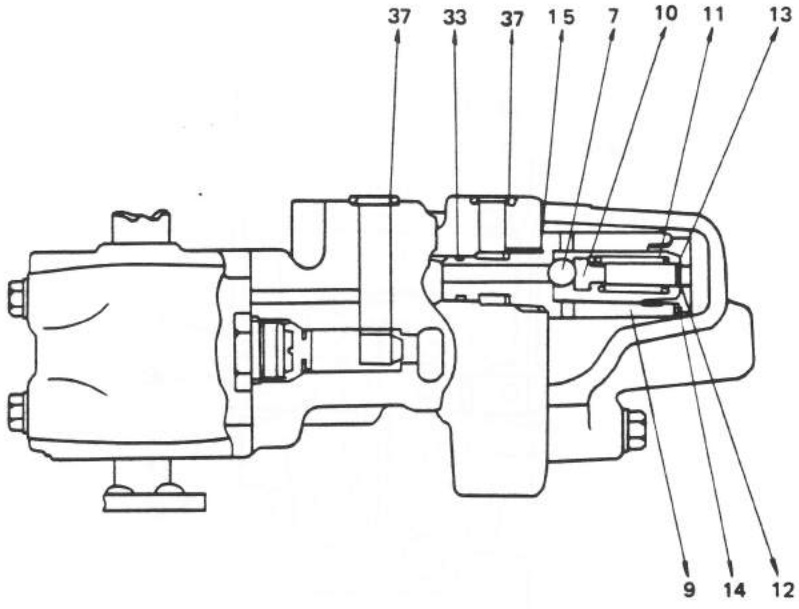
3-2. Control Valve - Removal and Disassembly

1. Remove the joint (ram shaft arm to feed back link), and remove the control lever knob. Remove the control lever lock nut, and pull out the lever from the control valve.

2. Remove the three bolts (M8 x 85) holding the control valve to the hydraulic lift case, and remove the control valve (whole part). All the removed "O" rings should be discarded. Place the removed control valve on a clean work bench.
   Note: When disassembling the control valve, use a clean work bench. Put the removed parts in gasoline so that they are not to be exposed to air. Take care not to allow the valve to contact any metal.
   For this disassembly, refer to Fig. 11, wherein the external view and inside construction are shown. (Figs. 11/1, 11/2, 11/3 and 11/4)


Max. Lift Position
55°
Max.
Max. Lower Position
20°
Play
37°

11/1


37
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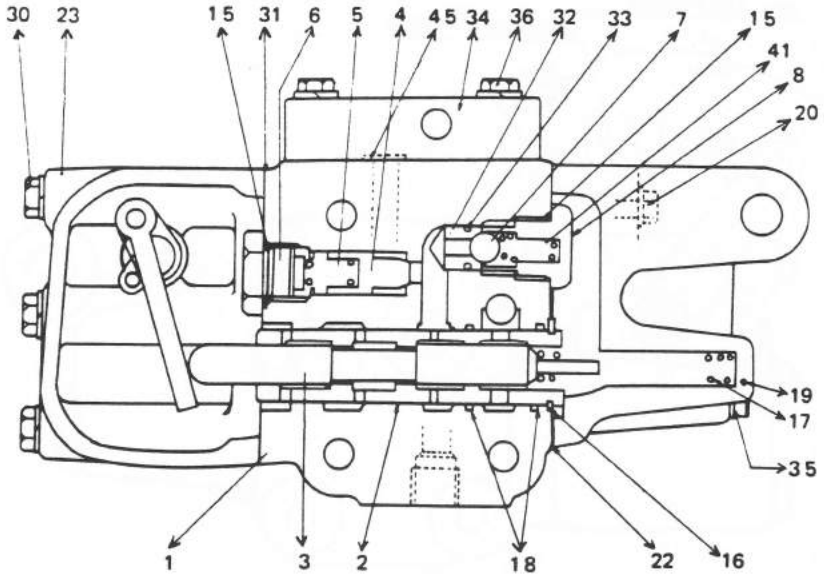
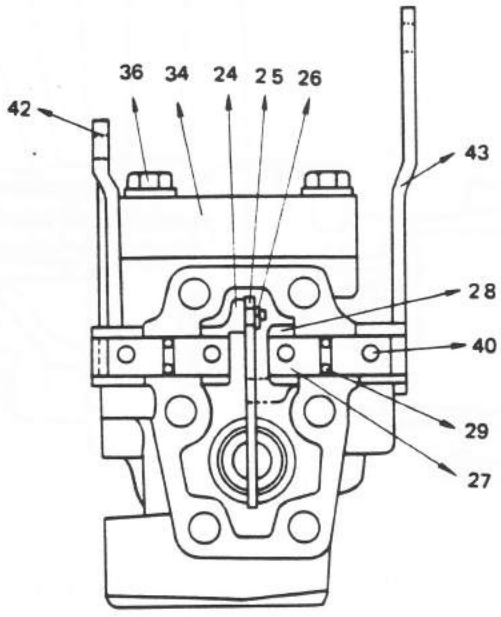
11/2



11/3



11/4

1. Body
2. Sleeve
3. Spool
4. Unload Valve
5. Spring
6. Plug
7. Steel Ball
8. Plug
9. Release Housing
10. Spring Stopper
11. Spring
12. Shim
13. Plug
14. Lock Plate
15. "O" Ring
16. Circlip
17. Return Spring
18. "O" Ring
19. Cap
20. Bolt
21. Bolt
22. Gasket
23. Cap
24. Arm
25. Link
26. Snap Ring
27. Shaft
28. Arm
29. "O" Ring
30. Bolt
31. Gasket
32. Seat
33. "O" Ring
34. Cover
35. Bolt
36. Bolt
37. "O" Ring
40. Spring Pin
41. Spring
42. Link
43. Link
45. "O" Ring

Fig. 11 Control Valve - External View and Inside Construction

3. Remove the bolts (20) and (35), and remove the cap (19). Remove the return spring (17) and spool valve. The gasket (22) should be discarded.

4. Drain off the oil from the cap (23). (The oil flows out through the hole where the spool has been located.) Remove the cap (19) and then remove the bolt (30).
   Remove the bolt (30), and remove the cap (23). Discard the gasket (31).

5. Remove the sleeve (2) from the body by moving it toward the circlip. (Push the sleeve out from the cap (23) side.) The "O" ring should be discarded.

6. Remove the relief valve assembly (consisting of the release housing (9), steel ball (7), spring stopper (10), spring (11), shim (12), plug (13), lock plate (14), "O" ring (15), and "O" ring (33). The "O" rings (15) and (33) should be discarded.

7. Remove the plug (6), and remove the spring (5) and unload valve (4). The "O" ring (15) should be discarded.

8. Remove the plug (8), and take out the spring (41), steel ball (7) and seat (32). The "O" ring (33) should be discarded.

9. Remove the bolt (36), and remove the cover (34). The "O" ring should be discarded.

10. Disassemble the relief valve assembly. (Avoid the disassembly as much as possible.)
    Straighten the lock plate (14), and remove the plug (13), shim (12), spring (11), spring stopper (10) and steel ball (7). The "O" rings (15) and (33) should be discarded.

11. Disassemble the cap assembly. (Avoid the disassembly as much as possible.)

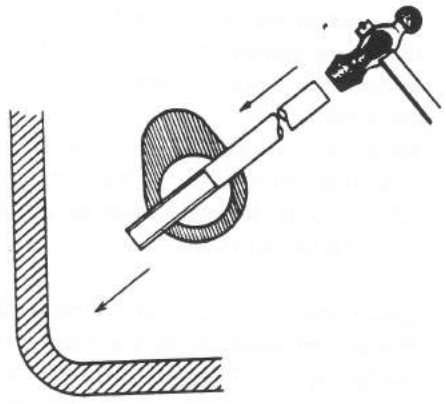
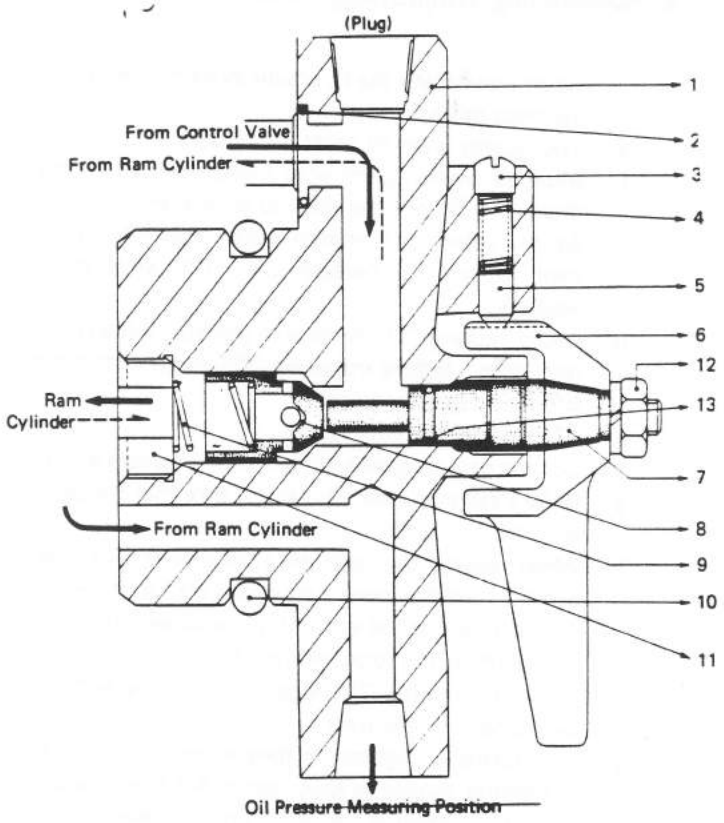


Fig. 12 Spring Pin Out

As shown in Fig. 12, pull out the two springs (40), and the link (42), and link (43) can be taken out, together with the shaft (27). The "O" ring (29) and spring pin (40) should be discarded. The spring pin (40) which connects the links (42) and (43) and shaft (27) should be pulled out only when necessary.

3-3. Lock Valve - Disassembly

1. Unscrew the spring stopper (11) by using a screwdriver (slotted head). (Refer to Fig. 13.)



1. Lock Valve Body
2. "O" Ring
3. Plug
4. Spring
5. Stopper Pin
6. Adjusting Lever
7. Flow rate Adjusting Rod
8. Lock Valve
9. Spring
10. "O" Ring
11. Spring Stopper
12. Nut
13. "O" Ring

Fig. 13 Lock Valve

Pull out the spring (9), and pull out the lock valve (8) from the lock valve body.

2. Remove the plug (3), and remove the spring (4) and stopper pin (5).

3. Remove the nut (12), and remove the adjusting lever. Pull out the flow rate adjusting rod (7) toward the adjusting lever, together with the "O" ring (13).
   Note:
   - O Only when required, the plug as shown in Fig. 13 and the plug in the oil pressure in the oil pressure measuring position should be removed.
   - O Do not measure the oil pressure outside the oil pressure measuring position.

4. Assembling (Adjusting) Order

When assembling the hydraulic system, the following steps must be taken.

a. Thoroughly wash all parts with gasoline.
b. Blow all washed parts with compressed air to dry them off. Do not use cloth to wipe them.
c. As for valves and related parts, they should be kept dipped in Turbine Oil #120 after being washed.
d. Avoid reusing "O" rings and gaskets. Always use new ones. Before installing "O" rings, coat them with good quality grease.
e. Always use new cotter pins.
f. Do not put on gloves while assembling operations.
g. Before starting assembly, make sure that the place is clean.
h. When reusing the used oil after assembly is over, avoid to use the lower part of the oil. Add new oil to make up for the amount of discarded oil (about one-tenth of the total oil amount).
i. Do not stretch "O" rings so that they will not permanently deformed.
j. For details on tightening torque, refer to 4-2. The tightening torque as specified in 4-2 should apply to the assembling of the control valve (whole part).
   Refer to Fig. 11.
   - * Tightening torque for the plugs (6) and (8) is 43 ft-lb (6 kg-m).
   - * Tightening torque for the plug (13) is 21 ft-lb (3 kg-m).
   - * Tightening torque for the bolts (20), (30), (35) and (36) is 13 ft-lb (1.8 kg-m).

4-1. Lock Valve - Assembly

Refer to Fig. 13.

1. Install the "O" ring (13) on the flow rate adjusting rod (7), and install the adjusting rod in the lock valve body (1) by turning it two turns.
2. Install the lock valve (8) in the lock valve body (1), and install the spring (9). Screw in the spring stopper (11), and lock it at two places by using a punch.
3. Install the adjusting lever (6), and install the spring washer. Lightly tighten the nut (12), and install the stopper pin (5) and spring (4). Install the plug (3).
   Note: The position of the adjusting lever should be finally determined while operating the hydraulic system.
   Refer to 4-4, 2.

4-2. Control Valve (Whole Part) - Assembly

Prior to assembling the control valve, refer to Fig. 11 (Control Valve - External View and Inside Construction). The numbers indicating parts are identical with those used in Fig. 11.

1. **Relief valve assembly - assembly**
   Install the steel ball (7) in the release housing (9) so that the ball is in contact with the seat surface. Install the spring stopper (10) and spring (11) over the steel ball and fit the lock plate (14) in the plug (13). Then screw in the plug (13) (not fully). Then install the "O" rings (15) and (33) in the release housing (9).

2. **Cap assembly (23) - assembly**
   Connect the links (42) and (43) to the shaft (27) by means of the spring pin (40). Grease the "O" ring (29), and install it. Install the shaft, to which the link (43) is attached, on the left side of the control valve assembly when viewed from the cap (23), and set the arm (24) with the pin facing downward, by means of the spring pin (40). Install the shaft with the link (42) on the right side, and set the arm (24) with the spring pin. Install the link (25), and set it with the circlip.
   Make sure that the links (42) and (43) are free to move when they are moved by hand. The moving limits are shown in Fig. 11/1. Do not move it beyond the limits; otherwise, the link (25) will be deformed.
   Note: Make sure that the link (25) is correctly positioned in relation to the arm (28). The link (25) must be located closer to you when viewed from the cap surface.

3. Install the "O" ring (15) in the plug (6). Install the unload valve (4) in the body (1), and install the spring (5). Then, screw in the plug (6). (Make sure that the spring is in a vertical position.)

4. Install the "O" ring (33) in the seat (32). Install the "O" ring on the plug (8). Install the seat (32) in the body (1), and install the steel ball (7) and spring (41). Then screw in the plug (8). (Make sure that the spring is held in a vertical position so that the steel ball (7) maintains correct contact with the seat surface.)

5. Install the relief valve assembly (pressure adjustment is complete). (For this, refer to 4-4).

6. Install the "O" rings ((18) 2 pcs) in the body (1).

7. Install the gasket (31) in the body (1), and install the cap (23) on the body by using the bolt (30) and spring washer.

8. Install the circlip (16) on the sleeve (2). Install the sleeve (2) in the body (1), and install the spool (3) in the sleeve (2).

9. Install the gasket (22) in the body. Install the spring in the spring guide of the spool (3), and fasten the cap (19) to the body by means of the bolt (21). Install the "O" ring (37) in the body (1).
Now the control valve (whole part) is ready to be installed in the hydraulic lift case.

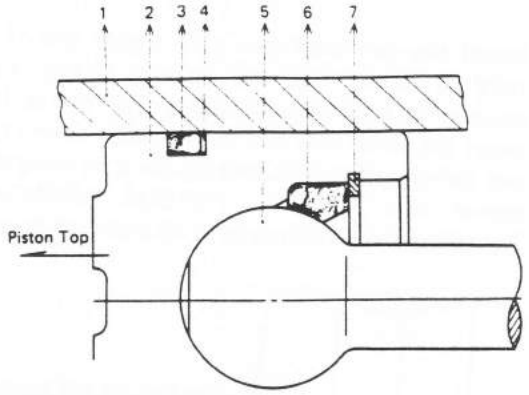
4-3. Hydraulic System - Assembly

Refer to Fig. 9 Ram Shaft Assembly

1. Install the "O" ring (1) and back up ring on the piston (3).
Note: When installing the rings, be sure to install the "O" ring in the top ring groove, and the back up ring in the lower ring groove.
Refer to Fig. 14.

2. Connect the connecting rod (6) to the piston. For this procedure, the rod retainer must be installed so that the machined spherical surface (inner side) is in contact with the connecting rod, as shown in Fig. 14. Lock the circlip (5) by using the special tool (H-1 SNAPRING PLIERS).

3. Put the piston assembly in the cylinder, and connect the ram arm (8) to the connecting rod (6) by the lift fork pin (7). Install the washer (10) and install the cotter pin.



1. Cylinder
2. Piston
3. "O" Ring
4. Back Up Ring
5. Con. Rod
6. Rod Retainer
7. Circlip

Fig. 14 Piston Assembly

4. Install the ram shaft (9) in the ram arm (8) which is installed in the hydraulic lift case. For the position of the spline, match the marks as shown in Fig. 15.

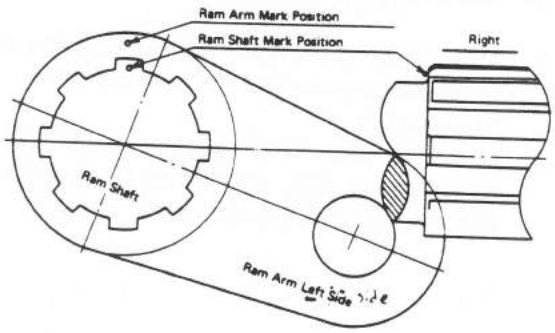


Fig. 15 Setting Position of Ram Shaft and Ram Arm

5. Put the "O" rings (19) and (20) in the ram shaft bushes (18) and (21), respectively. Then install the bushes on the ram shaft while taking care not to damage the "O" rings.

6. Install the oil seals (15) and (24) on the ram shaft supports (16) and (23) by using the special tool (2400T01 RAM SHAFT SUPPORT OIL SEAL INSTALLING TOOL). Install the gasket, and fasten each ram shaft support to the hydraulic lift case by using three screws (M8).
Tightening torque: 13 ft-lb (1.8 kg-m)

7. Install the ram shaft arm (25) (right) and (11) (left) in the ram shaft (9) which is locked. For position of the ram shaft spline, refer to Fig. 16. Insert the screw (14) into the left side washer (12) and spring washer (13), and tighten it by using the special tool (1800QL, TORQUE WRENCH). Tightening torque should be at 40.3 lb-ft (6 kg-m).

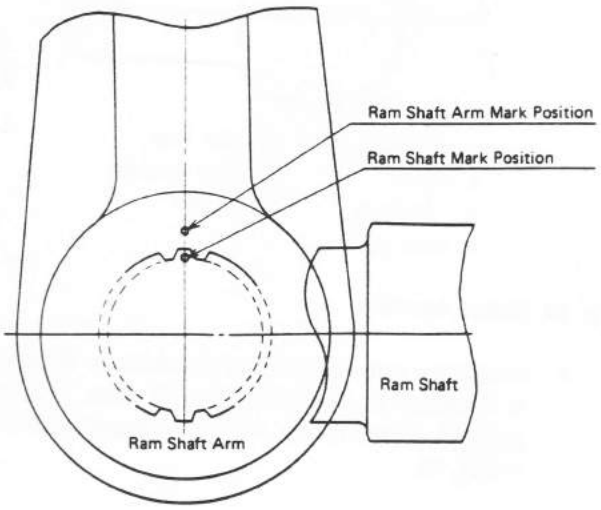


Fig. 16 Position of Ram Shaft and Ram Arm

8. After installing the right side ram shaft arm, install the striker arm boss so as to fit to the spline. (Refer to Fig. 17)
Insert the screw (29) into the washer (27) and spring washer (28), and tighten it. Use the same tightening torque as specified in 7. above.

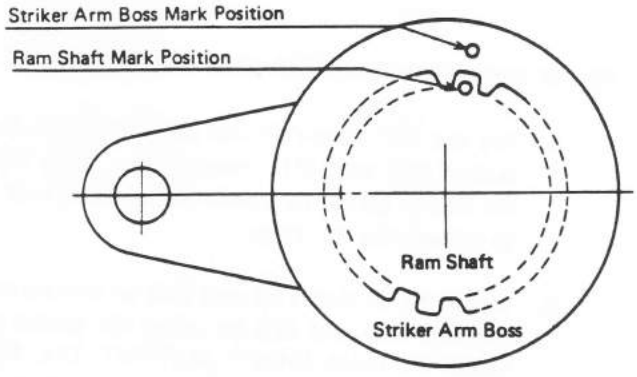


Fig. 17 Position of Striker Arm Boss

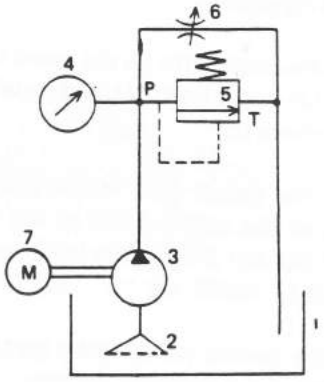
9. Install the strainer (removed according to 3-1, 17 in the hydraulic lift case.

10. For the assembling procedures, follow the instructions from 7 to 12 of "3-1. Hydraulic System - Removal and Disassembly" in reverse order.

4-4. Adjustments

1. **Adjusting the relief valve pressure**
This adjustment will be very difficult without dismounting the relief valve. It is advisable, therefore, that the adjustment be made on a bench stand. The assembly should preferably be replaced with a new one.

a. Pipe lines when adjustment is made on bench stand:



1. Oil Tank
2. Suction Filter
3. Oil Pump
4. Pressure Gauge
5. Relief Valve Requiring Pressure Adjustment
6. Needle Valve
7. Motor

Fig. 18

b. Adjusting the relief valve pressure
As shown in Fig. 19, the jigs are used for performing adjustments.

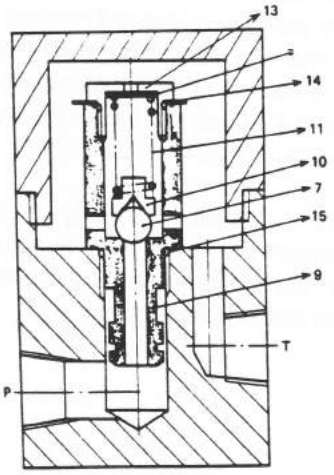


Fig. 19

First, measure the relief valve set pressure without installing the shim (12), and then adjust the pressure to the specified value 1,635±71.10 lb/in² (115±5 kg/cm²). The pressure variation is about 341.36 lb/in² (24 kg/cm²) per shim having a thickness of 0.039 in. (1 mm).
After adjustment, tighten the plug (13) with a torque of 15 lb-ft (2.0 kg-m). Bend the lock plate (14) to lock the plug (13) and the relief housing.

2. **Adjusting the oil lock valve lowering speed**

a. Mount an implement weighing about 1,100 lbs. (500 kg) on the three-point linkage.
b. Start the engine. After the oil temperature rises as specified, shift the control lever to the lifting position.
c. When the implement is raised, shift the control lever to the lowering position and turn the flow rate adjusting rod so that the implement begins to lower. At this point, stop turning the flow rate adjusting rod. When the adjusting lever forms an angle of 45° with the horizontal line on the left side, tighten the nut.

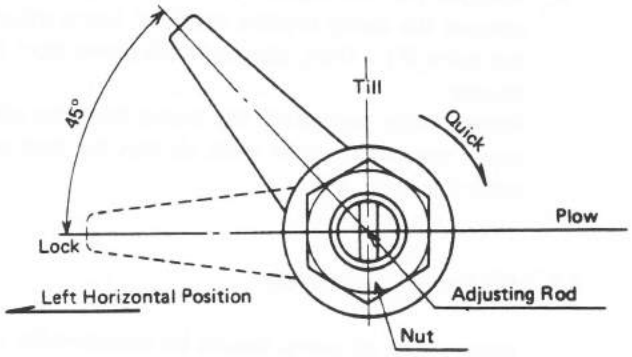
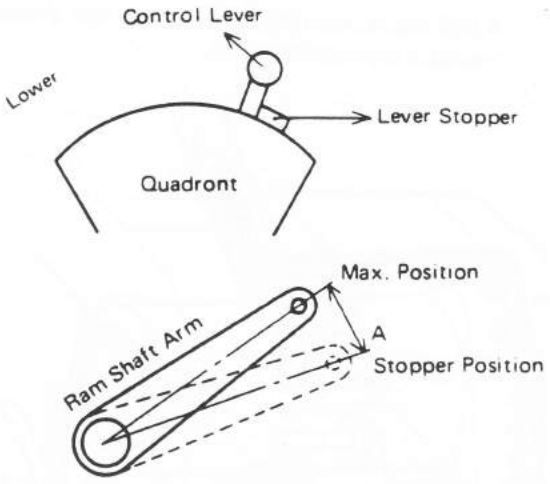


Fig. 20 Lock Position

3. **Adjusting the control lever stopper**

The purpose of control lever stopper adjustment is to stop the control lever so that the ram shaft arm will stop just before the control lever comes to contact with the hydraulic lift case. Otherwise, when the control lever rises to the highest position, the ram shaft arm also reaches the highest position and contact with the hydraulic lift case, thereby causing the relief valve to operate.

a. Raise the ram shaft arm to its highest position by hand, and as shown in Fig. 21, mark the position where the arm end lowers 0.39 in. (10 mm) from the highest position.



A = 0.39 in. (10 mm)

Fig. 21

b. Start the engine, and shift the control lever to the lifting position. When the ram shaft arm lowers to the position as marked in "A" above, stop the control lever. Make the lever stopper contact with the stopped control lever, and tighten the screw (M8 x 20).
c. Again let the control lever to contact with the lever stopper, and make sure that the relief valve will not operate.

5. Oil Pump

5-1. Oil Pump - Construction

This oil pump (Kayaba-Dowty, GP-1) is of the gear type, employing the pressure loading system. The pressurized oil is forced out to bearing bush's rear side, and the minimum clearance is maintained between the gear teeth and the bush to make lubrication, thereby securing a high volumetric efficiency even at high-pressure-low-speed operation. (The bearing bush serves as a pressure loading component and casing at the same time.) The bearing bush is of movable design, and, as a result it is able to maintain a proper clearance whether the bush swells due to heat or is worn due to protracted low-temperature operation.
The bearing bush is designed to be lubricated by low pressure oil which is forced fed, independently of the pressurized oil on the outlet side. This prevents the seizing-up of the bearing and the damage of the oil seal.
As far as the oil is clean, 90 per cent of the specified volumetric efficiency can be secured for a long period. The pump has been tested for

4,000 hours' continuous operation and proven to maintain high-performance.

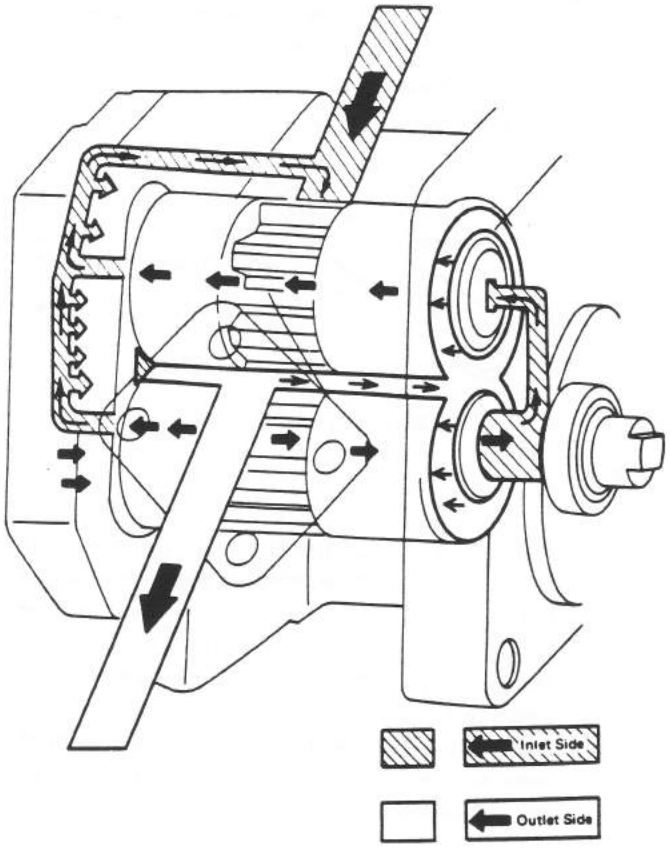


Fig. 22 Pressure Loading System

Note:

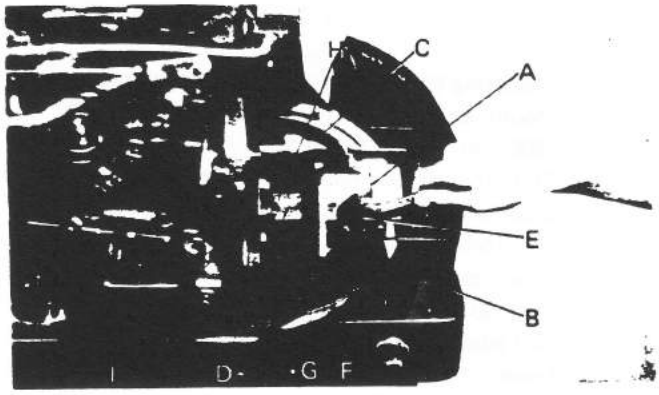
1. The pump oil seal is made of synthetic resin, and therefore, mineral oil should be used for lubrication. Use of acid and alkaline oil kerosene, and high octane vegitable oil is not allowed. Extremely high temperature oil may cause corrosion to the oil seal.
2. The oil should be Turbine oil #120 or equivalent. For details, refer to the Instruction Book.

5-2. Oil Pump Disassembling Order

This oil pump is coupled to the crankshaft pulley by means of a joint, and therefore, before starting the disassembly of the oil pump, it must be dismounted in the following manner.

Oil Pump Removal Order

1. Drain off the oil from the hydraulic system. If the oil is to be used again, keep it in a clean container and keep off the dust from the oil.
2. Disconnect the wires from the head lights, and remove the bonnet from the tractor. Drain th cooling water in the radiator and dismount the radiator.
3. Remove the four bolts (E) connecting the suction pipe, delivery pipe and pump. The "O" rings should be discarded



A Pump
B Delivery Pipe
C Suction Pipe
D Joint (A, B)
E Bolt
F Bolt
G Bracket
H Bolt
I Coupling

Fig. 23 Remove the Oil Pump

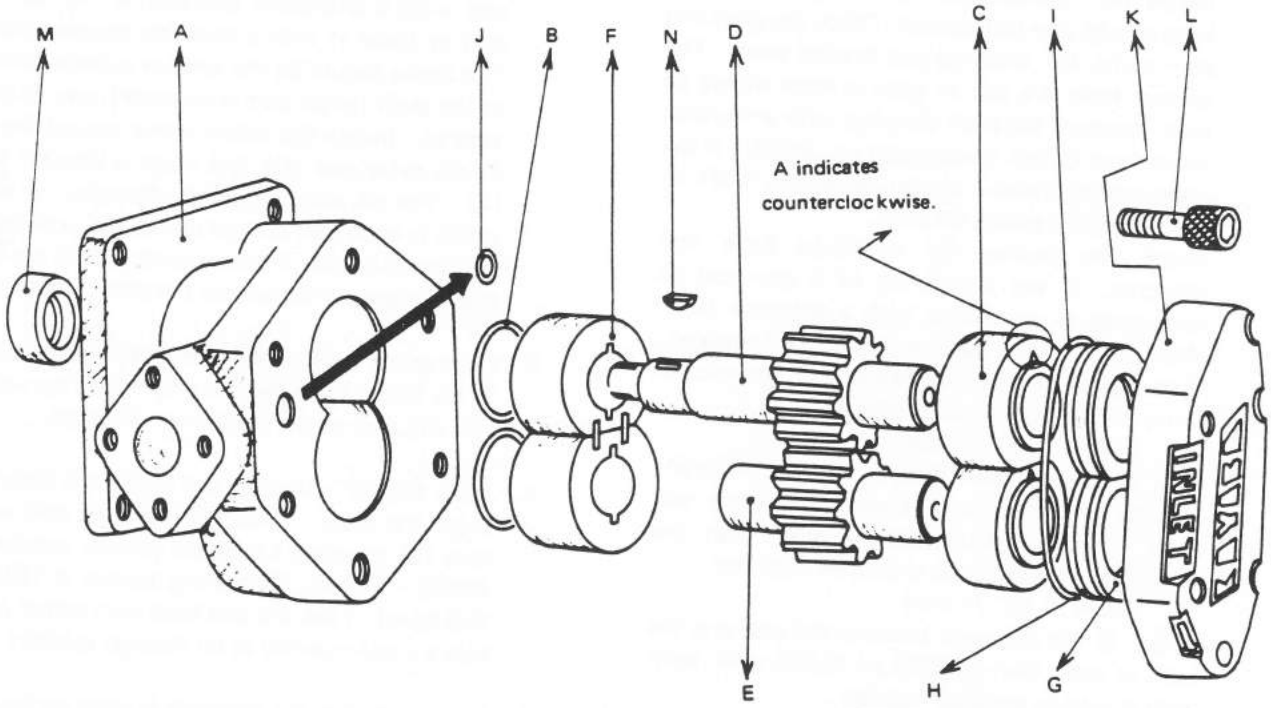
4. Remove the four bolts (H) from the joint (D), and remove the pump bracket and four pump mounting bolts (F). Then, dismount the pump from the tractor.
   Note: After separating the pump from the pipe, cover the pipe's open ends so that no dust will enter the pipe.

5-3. Oil Pump - Disassembly

Note: The oil pump should be disassembled in a clean place, and the tools must be also clean. All disassembled parts are blown with compressed air for drying, after being washed. Do not use rags.
Take care not to damage the body and cover, because they are made of light alloys.
For this disassembly work, refer to Fig. 24.

1. Loosen the bolt (L) with a hexagon hole, and remove the cover (K) and "O" ring (I).
2. Remove the seal element consisting of two sealing rings and support rings (H and G).
   Note: Both sealing ring (H) and support ring (G) are made into one piece assembly, and therefore, they can not be separated.

3. Push the drive gear (D) into the body (A), and the bush (L) can easily be taken out by finger. Remove the bush (C), and remove the gear (D) and driven gear (E). The bush (F) can be taken out together with the "O" ring (B).



A. Body (one)
B. "O" Ring (two)
C. Bush A (one pair)
D. Drive gear (pair with E)
E. Driven Gear (pair with D)
F. Bush C (one pair)
G. Support Ring (two)
H. Sealing Ring (two)
I. "O" Ring (one)
J. "O" Ring (one)
K. Cover (one)
L. Bolt with Hex. Hole (six)
M. Oil Seal (one)
N. Key (one)

Fig. 24 GP1 Gear Pump Disassembled (Counterclockwise Rotation)

The disassembled parts should be arranged in order. As for the shafts and bushes, their positions should be correctly memorized.

When installing bushes, take care not to confuse the bush (C) for bush (F) in relation to their positions. Each bush has a mark (A or B) stamped on its end. A bush having the same character should be installed on the cover side. (e.g. A indicates clockwise rotation, and C denotes counterclockwise rotation) The oil seal (M) should not be removed unless otherwise broken. To pull out the oil seal (M) from the body, take special care not to scratch the housing bore.

5-4. Checking During Disassembling

Replacement of worn or damaged parts should be done with special care. In order to increase pumping efficiency, the gear rotates with its teeth in slight contact with the pump casing. The contact is evidenced on the low pressure side of the pump. After a long period of use, the oil will become dirty, and bush holes and journal bearings will be worn. As a result, the casing wall begins to show wear. If the amount of wear exceeds more than 0.001 in. (0.05 mm), the clearance between the gear teeth and the casing wall will be excessive, and oil leakage will increase. This will reduce the performance of the pump. Replacing the bush will not be effective to improve the performance. The use of a worn bush is not recommended except when the pump is operated under low pressure and with special care.

In general, working parts are subject to wear after a long period of use, and there will be not a big difference in wear between them. It is advisable, therefore, that when any component parts show

an excessive wear, the pump itself should be replaced, instead of replacing worn parts. It will be more economical.

Each part should be washed with kerosene and blown with compressed air. All removed "O' rings should also be replaced. Check the gears and gear shafts for scratches and broken teeth. The contact ratio in a pair of gears in mesh should be even. Measure the shaft diameter with an outside micrometer caliper (special tool No. 25MB). If the measurement shows a smaller value than 0.491 in. (12.598 mm), replace the shaft.

Check the bushes for deformed bore and scratches. If the discoloring of a gear can be considered to be related with a defective bush, check for the relief valve and related oil passages. If the length of a bush is shorter than the value as shown below, it should be replaced.

0.802 in. (20,574 mm)

Any discolored gear should also be replaced. Measure the clearance between the shaft and bush. If the measurement is larger than the following value, the bush should be displaced.

0.006 in. (0.177 mm)

Note: If the clearance between the gear and the bush is more than 0.00019 in. (0.005 mm), both parts should be replaced together.

5-5. Oil Pump Assembly Order

Make sure that all parts are clean. If any oil seal (M) has been replaced, it should be replaced. To install the oil seal, use a press. (The seal lip must face inward.)

1. Place the "O" ring (B) on the bush (F), and coat it with good quality of mineral grease. Insert it in the body (A) and push it in further. A pair of bushes must be at right angles to the bore in order to protect them against scratches.
   Tolerance is allowed for the bush so that it can be smoothly fitted in place without requiring force. If the bush has a scratch on its surface, it will not move smoothly. In this case, pull out the bush and smooth down the raised part with oil stone. Make sure that the surface of the bush is smooth. For this check, use a surface plate. After using oil stone, be sure to wash the bush. Oiling the bore will make it easy to install the bush. Make sure that after installation, the "O" ring is in place.
   The "O" ring must be located between the bush and the body's bottom. The pressure balance type is greatly affected by the result of assembly. Make sure that the escape groove in the bush surface is not inclined. Incorrect assembly will not provide the pressure balance effect, and as a result, the bush in the bore will be deformed by pressure.
2. When inserting the drive gear (D) into the body A, take care not to damage the oil seal with the stepped (machined) part of the gear shaft. To this end, wind a cellophane tape around the machined part or cover it with a specially designed sleeve. The sleeve should be the same in outside diameter as the shaft (larger part in diameter), and its end is tapered. Install this sleeve firmly around the end of the drive gear (D), and insert it into the body (A). The oil seal will not be damaged. If a gear which is once used is to be reinstalled, it should be positioned so that the same contact with the other gear in mesh will be exactly the same as before.
3. Fully grease the bushes (C) in pair, and insert them in the body. Place the seal ring (H) on the support ring (G), and set the position on the bush.
4. Place the "O" rings (I) and (J) on the body, and place the cover. Finally tighten the bolt with a hole (L) by using a hexagon wrench (special tool AW-60 - 6 mm). Tightening torque is 13.0 ft-lb (0.8 kg-m). Lock the bolt head with center punch, feed a small quantity of oil through the port.
5. Make sure that the assembly is done perfectly by turning the drive gear (D) with an open end wrench (special tool BT-9, 8 x 9). If the gear turns smoothly, the assembly is correct. If too tight, correct it.
   Refer to Fig. 25.

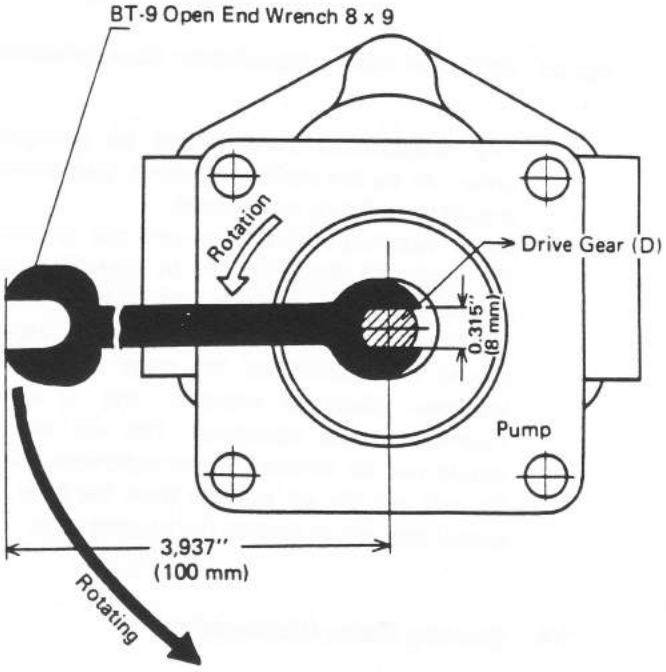


Fig. 25 Checking Pump Rotation after Assembling

5-6. Oil Pump - Installation and Trial Run

1. Installation order
   Install the pump (whole part) on the pump brackets. In this case, do not fully tighten the four bolts (F) as shown in Fig. 23.

2. Install new "O" rings between the section pipe, delivery pipe and pump, and tighten the bolts (E) four each.
   Note: In order to prevent the "O" ring from slipping from position, apply good quality mineral grease to the ring to give lubrication as shown in Fig. 23.

3. Tighten the four bolts (F) so that the runout of the CG type coupling installed side by side with the engine crankshaft pulley will be 0.01 in. (0.3 mm) at maximum as shown in Fig. 23.

4. Install the radiator, bonnet and wiring. Fill with cooling water. The oil (once used) or new oil should be added in the amount of 0.92 gal. (3.5 liters).
   Note: When the used oil is reused, avoid to use the oil on the bottom (about 1/10 of the whole amount of oil). Make up for with new oil.

5. Tests
   Special care should be taken for test run, particularly when bushes, gears and body have been replaced. Test run should be continued at least for 30 minutes. First make sure that the engine oil, cooling water, hydraulic oil, transmission oil and other components of the tractor are all perfect. Run the engine with no-load at idling speed, and when oil temperature rises as specified (engine water 180°F or 82°C), increase the engine speed to increase the pump delivery. Operate the control lever for hydraulic control, and give load to the pump.
   In particular, while operating the pump, check the temperature of the pump. If the temperature is excessively high (about 178°F or 80°C), reduce the engine speed temporarily, and continue no-load operation until working parts are fully broken in.
   Note: The disassembly and reassembly of the pump are relatively easy, but it should not be unnecessarily disassembled because of trouble of the hydraulic system, of which causes are unknown. Avoid to perform disassembly for repair in the field, because it is very difficult to prevent dust and dirt from entering in the pump. Parts may also be scratched. Frequent disassembly will result in leaky oil seals.

6. Sub-Control Valve-Description

This sub-control valve is employed for the S-650G as well as for SATOH's other tractors. It is incorporated in the control valve for height control system in order to control the oil pressure on the implement side (front loader, hydraulic mower, dump trailer, dozer, etc.) by operating the sub-control lever.

6-1. Installation

a. Clean the control valve mounted on the tractor.
b. Lower the ram shaft arm and stop the engine.
c. Remove the three bolts (M8 x 30) as shown in Fig. 26, and remove the cover.

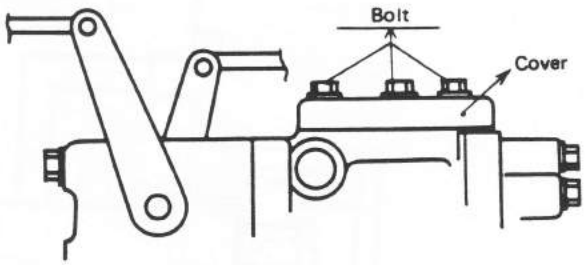


Fig. 26 Bolt Positions

d. Install new "O" rings (two) after removing the cover, and place the sub-control valve on the rings. Then, place the cover (removed before) on the sub-control valve, and install three bolts (M8 x 80). Tighten the bolts with a torque of 15 lb-ft (2.0 kg-m). Refer to Fig. 27.

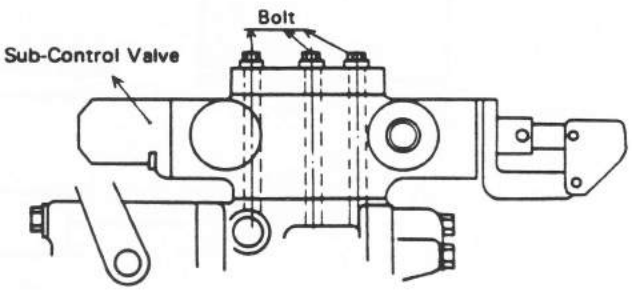


Fig. 27 Sub-control Valve Installation

e. Move up and down the sub-control lever (of the sub-control valve) and make sure that the sub-control valve operates correctly. Then, connect pipes between the sub-control valve and the implement.

6-2. Floating Position

As shown in Fig. 28, the oil discharged from the pump flows in the height control valve and enters the sub-control valve, then passing the cover and sub-control valve's neutral circuit. Finally, the oil flows back to the height control valve. Accordingly, the pump is under no-load operation.

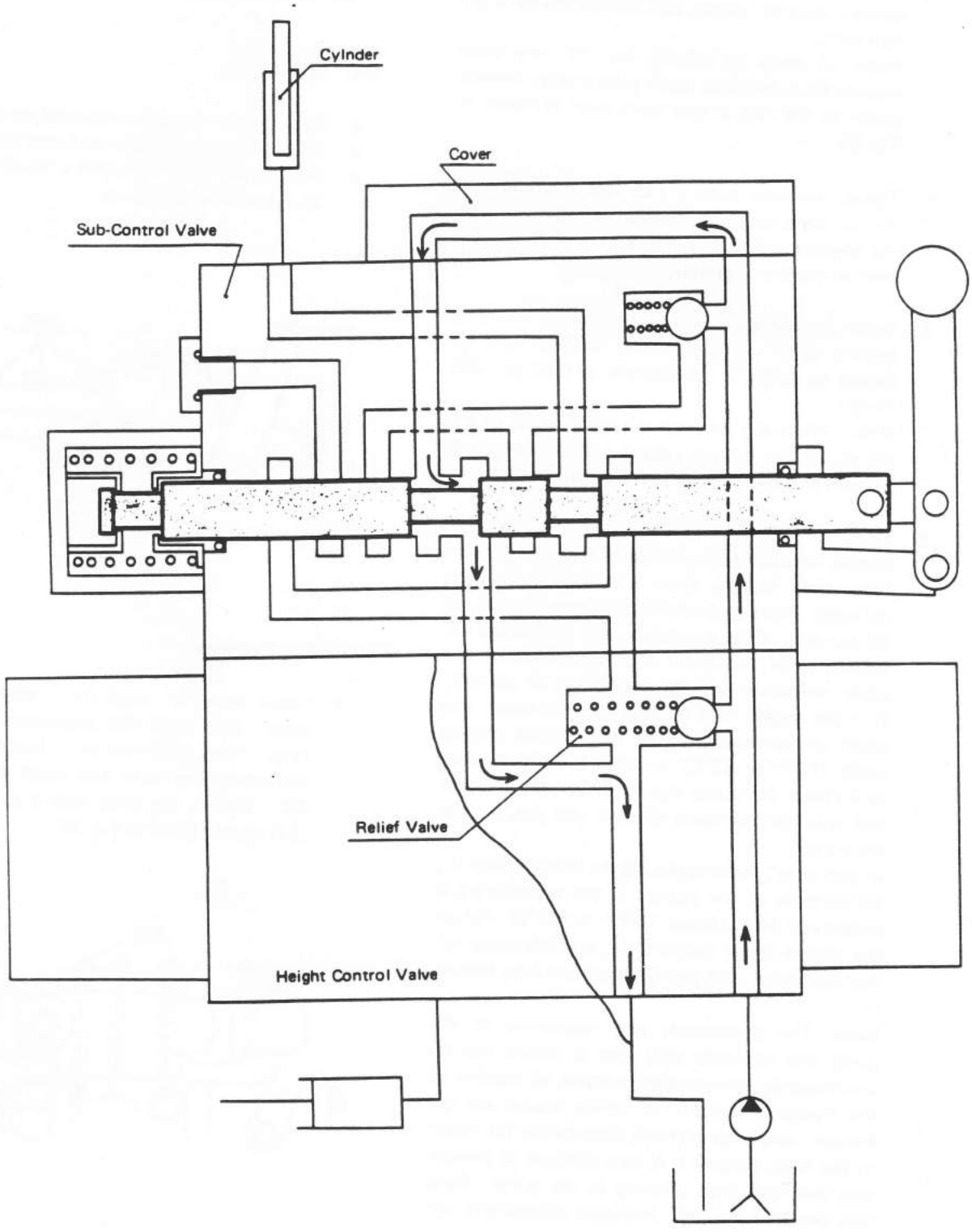


Fig. 28 Floating Position

6-3. Lifting Position

When the sub-control lever is moved up, the oil in the valve flows as shown in Fig. 29. That is, the neutral oil passage is closed, and the oil discharged from the pump flows through the poppet into the cylinder.

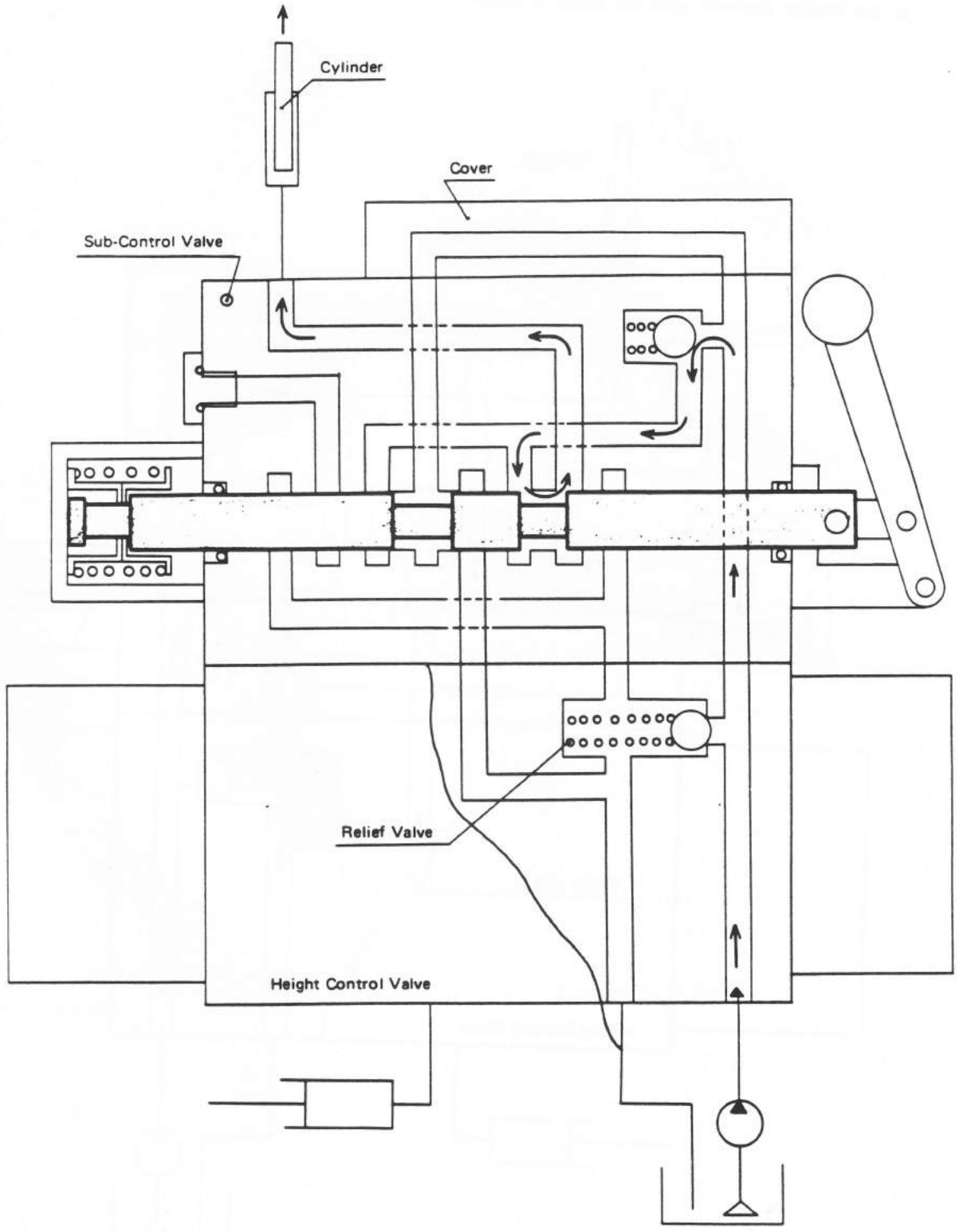


Fig. 29 Lifting Position

6-4. Lowering Position

When the sub-control lever is shifted to the lowering position, the oil in the valve flows as shown in Fig. 30. The oil discharged from the pump flows as in the case of the sub-control lever in the neutral position, and the pump is under no-load. Accordingly, the implement's cylinder circuit is connected to the height control valve circuit, and the weight of the implement, which is affecting the cylinder, forces down the piston.

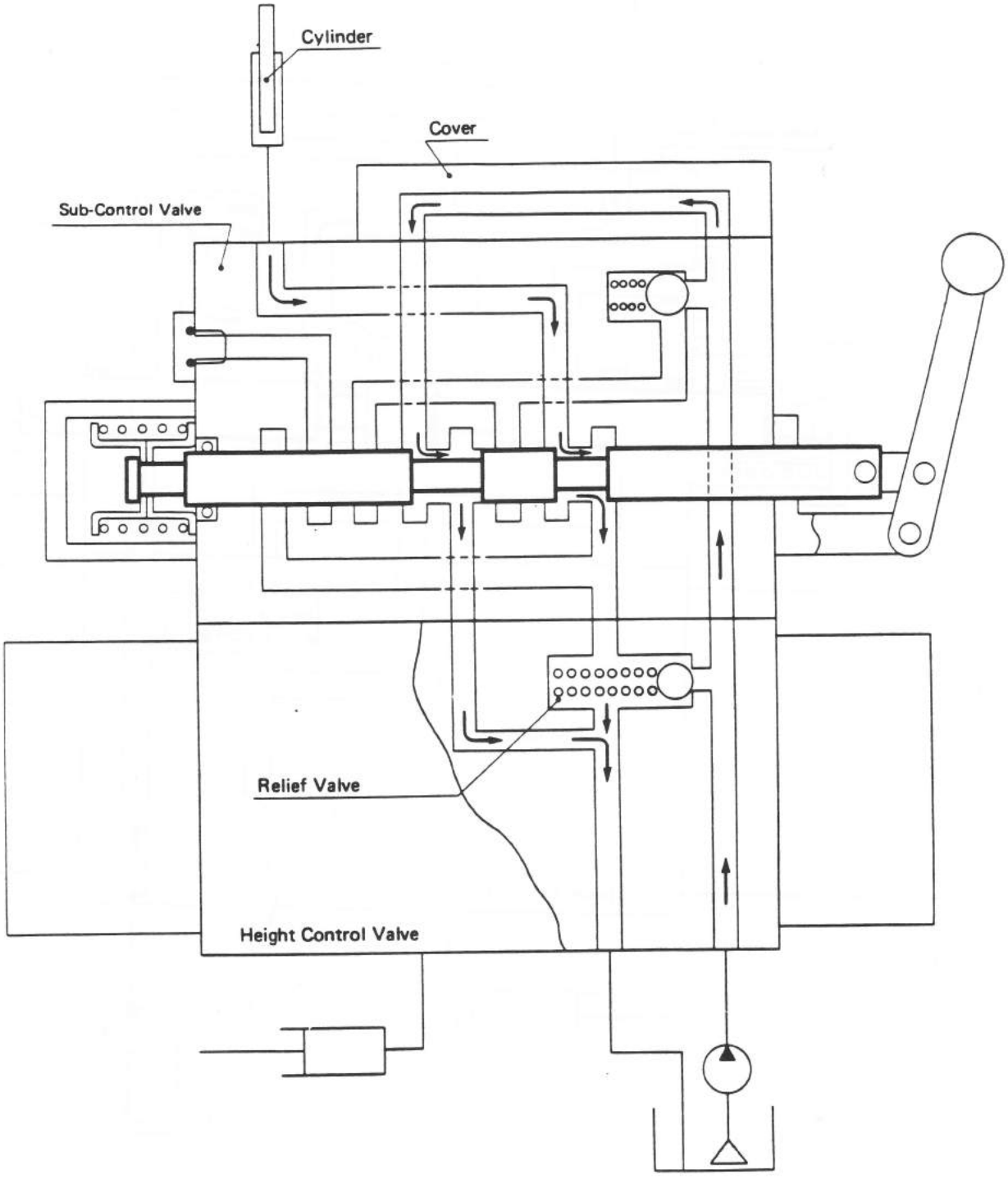


Fig. 30 Lowering Position

6-5. Sub-Control Valve - Disassembly

Refer to Fig. 31.

a. Fully lower the implement, and stop the engine. Clean the sub-control valve and height control valve. Remove pipes connecting the implement to the sub-control valve. Remove the three bolts (M8 x 80) as mentioned in 6-1 above, and remove the sub-control valve. (Refer to Fig. 27).

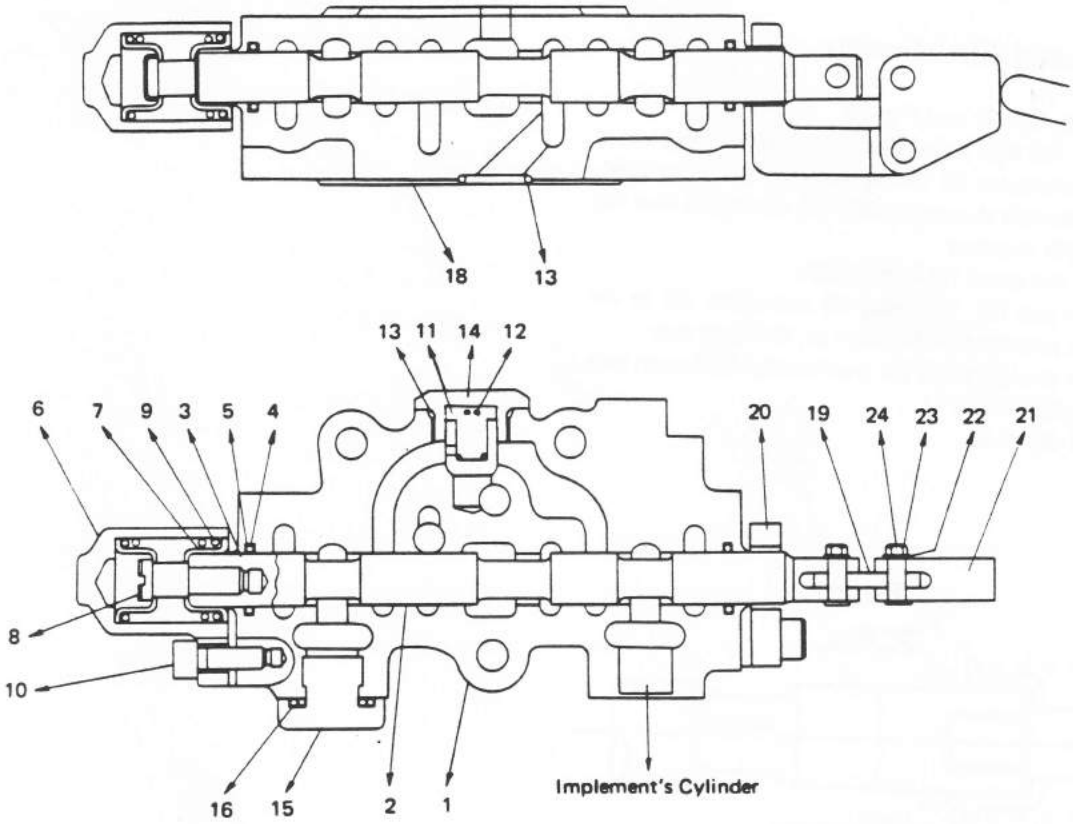
b. Pull out the pin from the lever and remove te lever. Perform this operation on a clean work bench.

c. Remove the four bolts (10), and remove the bracket (20) and cap (6).

d. Take out the "O" ring (4) and wiper (5) (on the lever side) from the body. On the other hand, the "O" ring (4), wiper (5) (on the cap side) and seal plate should be taken out, when the spool (2) is pulled out toward the cap.

e. Remove the cap screw (8), and remove the spring seat (7), spring (9), "O" ring (4) and wiper (5).

f. Remove the plug (14), and take out the poppet (11) and spring (12).



1. Body
2. Spool
3. Seal Plate
4. "O" Ring
5. Wiper
6. Cap
7. Spring Seat
8. Cap Screw
9. Spring
10. Bolt with Hex. Hole
11. Poppet
12. Spring
13. "O" Ring
14. Plug
15. Plug
16. "O" Ring
17. "O" Ring
18. "O" Ring
19. Link
20. Bracket
21. Lever
22. Washer
23. Clevis Pin
24. Cotter Pin

Fig. 31 Sub-Control Valve

6-6. Checking During Disassembling

All disassembled parts should be washed with detergents, and blown with compressed air to remove dust and oil. Then, place them on a clean work bench. When they are stored for a long period, they should be kept in the working oil.

a. Check each part for scratches. If any part is found faulty, replace it as an assembly.
b. Make sure that all working parts and matching parts smoothly move. All oil passages must be free from dust. If any springs are found deformed or broken, replace them. All "O" rings must be replaced with new ones.

6-7. Sub-Control Valve - Assembly

Refer to Fig. 31 and Fig. 32.

a. Install the seal plate (3), "O" ring (4) and wiper (5) in the spool (2) (bring them from the cap side), and assemble the spring seat (7), spring (9) and cap screw (8) together.
b. Install the spool (2) in the body.
Fit the cap (6), "O" ring (4) and wiper (5) in the groove provided in the body on the lever side.
c. Fasten the seal plate (3) and bracket (20) with two bolts (10).
d. Install the lever.

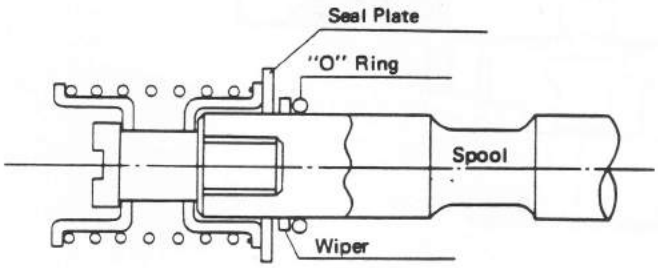


Fig. 32 Spool

7. Trouble-shooting

This trouble-shooting divided into two sections, A and B. The A is applicable to the case of the hydraulic system equipped with only height control, while the B to the case of with sub-control valve.

Section A

7-1. With Control Lever in the lifting position, implement will not move up

Cause	Remedy
The weight of the lower link is heavy at its end (more than 1,025 lb (500 kg)).	Reduce the weight.
Oil pump will not discharge oil. (Drive shaft is broken.)	Replace pump, and check for causes.
Relief valve set pressure is low.	Replace relief valve assembly, or readjust it on a bench stand. Refer to 4-4.
Unload valve will not close.	Make sure that unload valve's slide is not dusty nor scratched. If dusty, wash it carefully. If scratched, give lapping. If the scratch is negligible, smooth if off with oil stone.

7-2. With Control Lever in neutral, implement will show hunching or lowering from the lifted position

Clearance between spool valve and sleeve is too large.	Replace spool valve and sleeve as an unit assembly.
Steel ball seat is scratched.	Replace ball seat.
Spool valve sleeve "O" rings (two), check valve plug "O" rings (two), and control valve and hydraulic lift case "O" ring on the cylinder side are broken.	Replace damaged "O" rings.
Cylinder is leaky in its inside.	Check piston's "O" ring or back up ring. If damaged, replace it.
mmmmmmmmm mmmmmmmm	mmmmmmmmm mmmmmm

7-3. Lifting Speed is slow (Engine Speed 2,800 rpm/min @1,100 lb (500 kg) @1.2 sec.)

Clearance between unload valve and valve body lap is too large.	Replace valve assembly or if impossible, replace defective parts only.
Relief valve seat is scratched and leaky.	Replace relief valve assembly.
Pump's volumetric efficiency is low.	Replace pump.
Suction strainer is clogged.	Wash strainer and replace oil.
Implement is too heavy.	Reduce the weight.

7-4. With Control Lever in the lowering position, implement will not lower

Cause	Remedy
Spool valve is stuck.	Make sure that sleeve and spool valve's lap are not dusty. If found dusty, thoroughly clean. Check valve's contacting surface for scratches.
Return spring is broken.	Replace it.
Lock valve is closed.	Disassemble and clean it.

7-5. Control Valve Lever will not move upward

Spool valve is stuck.	Same as in 6-4.
Return spring is broken.	Same as in 6-4.

7-6. Oil Temperature is too high

Oil pump is seized up.	Replace oil pump. (Check for oil contamination.)
Oil pump's volumetric efficiency is low.	Replace oil pump.
Clearance between unload valve and body's lap is too large.	Replace the assembly. If impossible, replace either of unload valve and body, whichever worn.
Relief valve is under operation.	Check for control valve highest position. Check for stopper. For adjustment, refer to 4-4-3.
Relief valve seat is scratched, causing oil leakage.	Replace relief valve assembly.

7-7. Informal noise

Pump is seized up.	Replace pump.
Pump suction is insufficient..	Check for oil quantity. Check for clogging of suction strainer.
Excessive suction of air.	Check if air is entering the suction pipe. Check if air is entering through pump oil seal.
Hydraulic oil.	Check if the oil is as specified.

Section B

7-8. With Sub-Control Lever in the lifting position, implement will not move upward

Implement's weight is too heavy.	Check for weight.
Oil pump will not discharge oil.	Check for drive system.
Relief valve set pressure is low.	Replace assembly or readjust on a bench stand. Refer to 4-4.

7-9. Lifting speed is slow

Cause	Remedy
Relief valve seat surface is scratched.	Replace seat.
Pump volumetric efficiency is low.	Replace pump.
Suction strainer is clogged.	Replace working oil or clean inside of hydraulic system.
Hydraulic oil.	Replace it with specified oil.

7-10. With Sub-Control Lever in neutral, implement with load will lower

Body and spool working parts are worn.	Replace sub-control valve as an unit. Check for oil.
Hydraulic oil.	Replace it with specified oil.
Inside of the cylinder on the implement side is leaky.	Check for cylinder or replace.
Piping between valve and cylinder is leaky.	Replace leaky parts.

7-11. Sub-Control Lever will not automatically return to neutral

Return spring is broken.	Replace spring.
Body and spool working parts are dusty.	Disassemble and wash dirty parts. If found scratched, smooth it out with oil stone. Replace oil.

8. Specifications

Type of cylinder	One cylinder
Pressure for relief valve setting	1635±71.10 lb/in² (115±5 kg/cm²)
Maximum lift power at lower link	1,102.5 lb (500 kg)
Diameter of ram piston	2.76 in. (70 mm)
Stroke of ram piston	3.15 in. (80 mm)
Material of ram piston	Cast iron FC-25
Type of hydraulic pump	Pressure loading type
Name and model of hydraulic pump	KAYABA-DOWTY, GP-1
Output of hydraulic pump	4.1 gal/min. (17 lit/min.) at 2800 engine rpm W/P/S TEERING G05 W/O-POWER STEERING
Control valve (Height control)	Spool valve, pilot type
Lock valve	In-line non-return valve (Automatic flow control)
Control valve (Sub-control)	Spool valve, 3-way flow change type
Strainer mesh	100 meshes
Hydraulic oil	Turbine oil No. 120 (Capacity 0.92 gal - 3.5 lit)

SATOH TRACTOR

MODEL S-650G
REPAIR MANUAL

ELECTRICAL SYSTEM

PUBLICATION No.03-G

CONTENTS

ELECTRICAL SYSTEM

1. General

The electrical system consists of the battery, alternator, regulator, starter, water temperature warning lamp, charging warning lamp, oil pressure warning lamp, safety switch, fuse, and distributor (including coil, condenser, point, ignition switch, and plug), and the lighting system consists of two head lamps and a flood light.

The lighting switch changes over the optical axes of the tractor lighting equipment and the head lamps, and turns on the rear operation lamp.

The manufacturer of each unit on the S-650G is as follows:

Battery	Yuasa N40L 12V 40AH
Alternator	Mitsubishi AC 2020V
Regulator	Mitsubishi RLB 2220A
Starter	Nippon Denso 2800-269-0
Ignition switch	Yushin Seiki
Water temperature gauge switch and warning lamp	Yushin/Nippon Seiki 12V 3W
Hydraulic pressure gauge and warning lamp	Onishi Seiki/Nippon Seiki 12V 3W
Charging warning lamp	Nippon Seiki 12V 3W
Light switch	Yamaguchi Denki RCS-13
Head lamp	Kubo Seisakysho 12V 25W/25W
Operation lamp	Kubo Seisakusho 12V 25W
Safety starter switch	Yamaguchi Denki BS-152S
Ignition coil	Hanshin Transformer Co. HP5-10E
Distributor	Mitsubishi TVD-4MR
Spark plug	NGKB6E or Nippon Denso W 20EP

Descriptions of the distributor, ignition coil, and spark plug are excluded from the repair manual.

2. Wiring Diagram

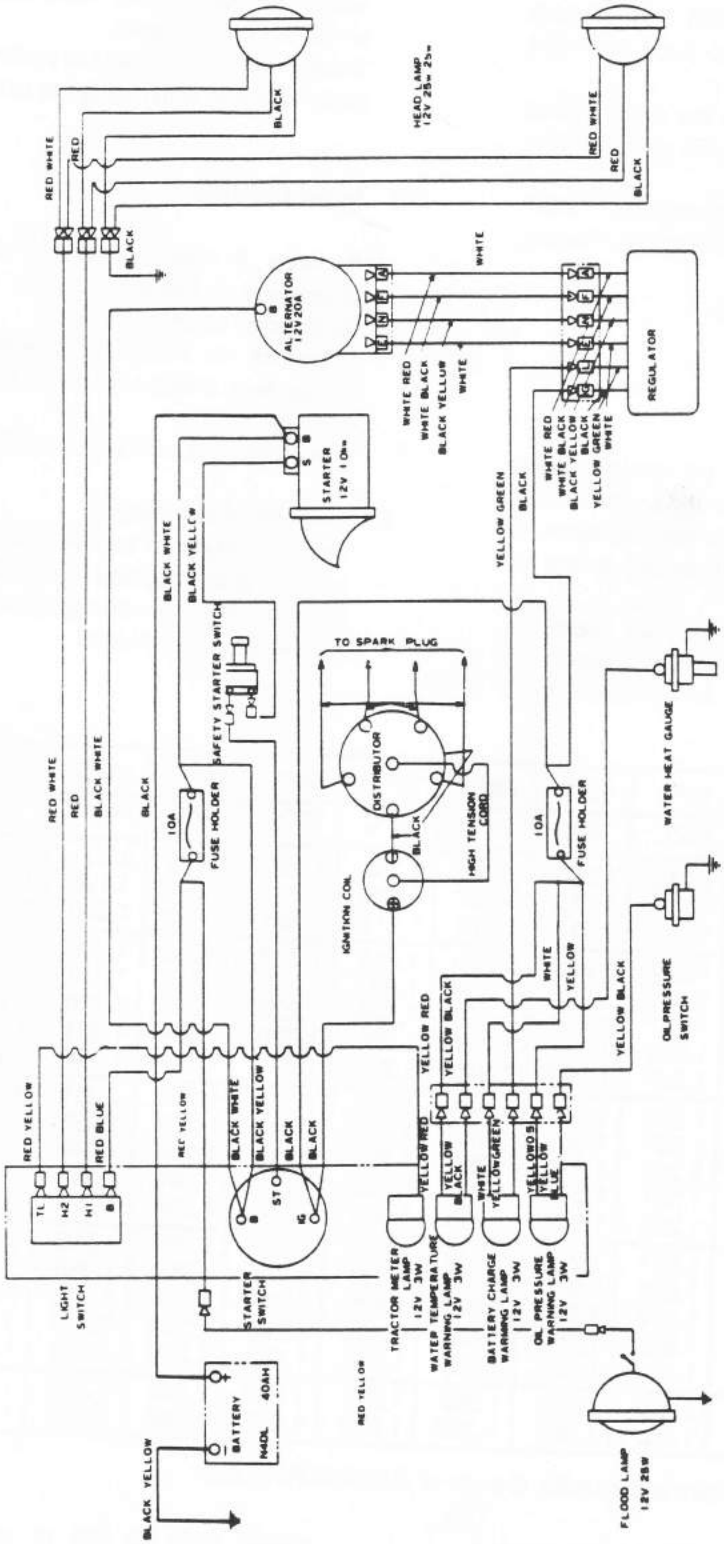


Fig. 1 Diagram

3. Battery

The battery on the S-650G is Yuasa N40L 12V40AH cathode earth type battery.

Note: As the battery on the S-650G is of cathode earth type, care should be taken to place it in right position when replacing or refitting it.

This battery, Yuasa N40L, meets the requirements of the international standard in point of its dimensions and terminal.

As our batteries are always "dry-charged" when shipped abroad, be sure to perform initial charging before starting the engine.

For the initial charging, refer to 3-2.

3-1. Dry Charge

"Dry charge battery" means the directly-usable battery, in which both negative and positive plates are fully charged, plate drying is specially done, so that it may not combine with oxygen in the air when it is stored.

Batteries which are usable only by supplying electrolyte and performing the initial charging are called "dry charge battery" or "directly-usable battery".

The direct usability of the directly-usable battery very gradually deteriorates due to temperature change while it is manufactured and stored. Accordingly, the direct usability performance within six months after manufacture is about 75% of the nominal capacity.

Therefore, it is important to perform the following initial charging when using the battery.

3-2. Initial Charging

Batteries in store cannot be used even if the electrolyte is supplied, as the negative plate is oxidized by oxygen in the air.

Therefore, to restore the negative plate to the sponge lead, charge a relatively low specified direct current.

This charging is called initial charging.

1. **Notes on initial charging**

The electrolyte to be filled first should be dilute sulfuric acid specified by the battery manufacturer, of which specific gravity is nearly that with the battery fully charged.

Sulfuric Acid Weight %	32°F 0°C	41°F 9°C	50°F 10°C	59°F 15°C	68°F 20°C	77°F 25°C	86°F 30°C	95°F 35°C	104°F 40°C	113°F 45°C	Temperature Coefficient
23.0	1.218	1.215	1.212	1.208	1.205	1.202	1.198	1.195	1.191	1.183	
28.5	1.223	1.220	1.217	1.213	1.210	1.207	1.203	1.200	1.196	1.193	
29.1	1.228	1.225	1.222	1.218	1.215	1.212	1.208	1.205	1.200	1.198	0.00067
29.8	1.233	1.230	1.227	1.223	1.220	1.217	1.213	1.210	1.206	1.203	
30.4	1.238	1.235	1.232	1.228	1.225	1.222	1.218	1.215	1.211	1.208	
31.0	1,244	1.241	1.237	1.234	1.230	1.226	1.223	1.219	1.216	1.212	
31.6	1.249	1.246	1.242	1.239	1.235	1.231	1.228	1.224	1.221	1.217	
32.2	1.254	1.251	1.247	1.244	1.240	1.236	1.232	1.229	1.226	1.222	0.00070
32.8	1.259	1.256	1.252	1.249	1.245	1.241	1.238	1.234	1.231	1.227	
33.4	1.264	1.261	1.257	1.254	1.250	1.246	1.243	1.239	1.236	1.232	
34.0	1.269	1.266	1.262	1.259	1.255	1.251	1.248	1.244	1.240	1.237	
34.6	1.274	1.271	1.267	1.264	1.260	1.256	1.253	1.249	1.245	1.242	
35.2	1.276	1.276	1.272	1.269	1.265	1.261	1.258	1.254	1.250	1.247	0.00071
35.8	1.284	1.281	1.277	1.274	1.270	1.266	1.263	1.259	1.255	1.252	
36.4	1.289	1.286	1.282	1.279	1.275	1.271	1.268	1.264	1.260	1.257	
37.0	1.294	1.291	1.287	1.284	1.280	1.276	1.273	1.269	1.265	1.261	
37.5	1.299	1.296	1.292	1.289	1.285	1.281	1.298	1.274	1.270	1.266	
38.1	1.304	1.801	1.297	1.294	1.290	1.286	1.293	1.279	1.275	1.271	0.00072
38.7	1.309	1.305	1.302	1.299	1.295	1.291	1.288	1.286	1.280	1.276	
39.3	1.314	1.311	1.307	1.304	1.300	1.296	1.293	1.289	1.285	1.281	

Fig. 2 Relation between Temperature and Specific Gravity of Dilute Sulfuric Acid

Note: Temperature constant fixes the standard of specific gravity 68°F (20°C), and is the mean value in the chart.

When the electrolyte is filled, its temperature usually rises up due to combining heat, so in summer use the low-temperature electrolyte (in case of N40L, 37.0% at 68°F (20°C), 1.280.

2. Charge the battery usually for 72 hours with a stabilized current one-twentieth the battery capacity.
   In case the battery is stored for more than one year, it is necessary to charge for a longer period than the above.
   If the electrolyte temperature exceeds 113°F (45°C) during charging, decrease the current gradually or stop charging.
   The temperature must be below 113°F (45°C) when the charging is completed.

3. **Completion of charging can be known by the facts outlined below.**

a. You have charged for 72 successive hours with a specified stabilized current.
b. The terminal voltage has risen over 2.50V per one cell, and is stable for several hours.
c. Specific gravity of each cell has risen up to an optimum degree, and is stable for several hours.
d. Gas is vigorously generated from each cell.
   Note: The generated gas, which is combined gas of oxygen and hydrogen, is very explosive, so keep it from fire.

3-3. Auxiliary Charging

The charged battery discharges itself by 0.5 ~ 1.0% of its capacity every day even if it is not used, and the higher its electrolyte temperature is, the more the discharge is.
If the battery keeps discharging for a long time, it does not work well even if it is charged, so it is necessary to perform auxiliary charging.
Once a month perform the auxiliary charging for batteries which are not in use, while perform the charging for those which are in use when the specific gravity is 1.260, 68°F (20°C).

3-4. Handling and Inspection

1. **The battery performance depends on your handling. To inspect the battery, do as follows.**
   See whether something is wrong with the battery on its surface.
   Remove the plug and see whether the electrolyte is properly filled.
   Measure the specific gravity and temperature of each cell with a hydrometer and a thermometer.
   Measure the terminal voltage of each cell or whole cells with a voltmeter.
   Check the charging of the battery with a battery tester.
   Check the battery on the tractor for connection and tightness.

2. **Fluid inspection**
   If the battery fluid is insufficient, replenish refined water up to the specified height.
   In principle, the fluid should remain about 0.39 ~ 0.51 in. (10 ~ 13 mm) above the splash plates.
   Inspect it in the following way.

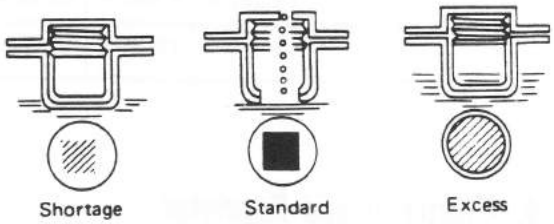


Fig. 3 Fluid Indication

3. **Specific gravity measurement**
   The specific gravity of the electrolyte is in proportion to the discharged quantity, so the battery discharging state can be known by measuring the specific gravity.

a. When measuring the specific gravity, set your eyes at the top of the electrolyte which is raised due to surface tension.
b. The specific gravity depends on the temperature.
   If the temperature is high, the specific gravity is small.
   The specific gravity for this battery fixes the standard of 68°F (20°C).
   Therefore, it is necessary to know the specific gravity in the case of 68°F (20°C).

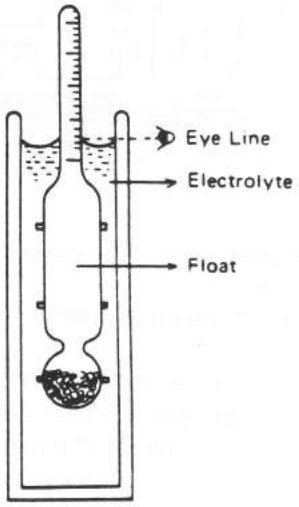


Fig. 4 How to Read Electrolyte

3-5. Specifications

Model	Nominal Capacity (20h CAH)	Outside Dimension (Max.) Length	Width	Height of Electrolytic Bath	Total Height	Weight (including electrolyte) (Approx.)	Capacity of Electrolyte (Approx.)	Normal Charging Current (A)	Plug Type	Connection Diagram
N40L	40	9.282 in.	5.265 in.	8.073 in.	9.048 in.	31.9 lb	0.66 gal	4	A3	⊖ ⊕
		238 mm	135 mm	207 mm	232 mm	14.5 kg	2.5 lit.			

Fig. 5

4. Alternator and Regulator

The alternator and regulator on the S-650G are AC2020V and RLB2220A, respectively, both of which are manufactured by Mitsubishi Electric Co. Ltd.

In this alternator, unlike the DC dynamo, the magnetic pole rotates, around which the stater coil is set, and the three-phase AC current is caused to the coil, and the three-phase AC current is rectified into a DC by the rectifiers (silicon diodes) (+ , − , three each) installed in the end frame.

As the alternator itself controls the maximum current, a current limiter is unnecessary.

A cut-out relay is not needed either because the silicon diode is used as a rectifier.

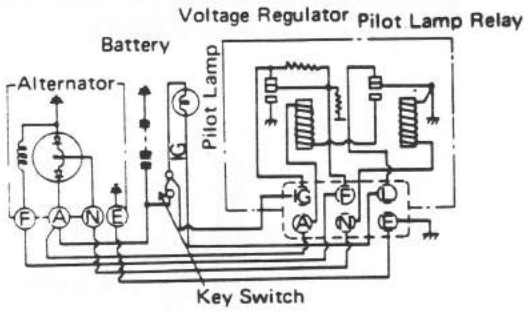


Fig. 6 Alternator Relay Circuit

4-1. Notes on Alternator

1. Even when inspecting the stater, the diode may be damaged if a high voltage tester such as a megger employing a DC dynamo is used.

2. When washing the tractor, be careful not to splash water to the alternator, especially when using a steam cleaner, be very careful not to apply steam directly to the alternator.

3. The alternator does not use a commutator. If oil or dust is attached to the slip ring, there is no continuity between the brush and the slip ring, and no electricity is generated. So when it is dirty, clean it with a cloth.

4. The brush of this alternator has durability several times as much as that of the DC dynamo, however, if it is worn to the wear limit line, replace it with a new one.

5. As the metals of the alternator at both sides use sealed type ball bearings, there is no need of supplying oil, however, if it runs out of oil, replace it with a new one.

6. Be careful when connecting the alternator relay and the battery, especially if the battery is connected in wrong polarity, a high current flows from the battery to the alternator, damaging the diode.

7. While the tractor is in operation, never detach the battery + terminal from the relay A terminal because a high voltage is generated to damage the diode.

8. When quick-charging the battery, be sure to remove one of the battery terminals. If not, the diode may be damaged.

9. As the alternator is designed to be excited by the key switch even after starting the engine, pay attention when changing the wiring.

4-2. Removing the Alternator

To remove the alternator, refer to 1-1 Engine Removal item 14 of REPAIR MANUAL, Engine.

4-3. Inspecting the Alternator

1. Inspecting the starter coil
Check the starter coil for broken circuit and insulation.

a. To inspect the broken circuit, connect the tester's leads to each starter coil, and if there is no continuity, correct the fault or replace.

b. To inspect the insulation, connect the tester's leads between the starter coil lead and the core. If a current flows, it means poor insulation, so correct the fault or replace. (See Fig. 7).

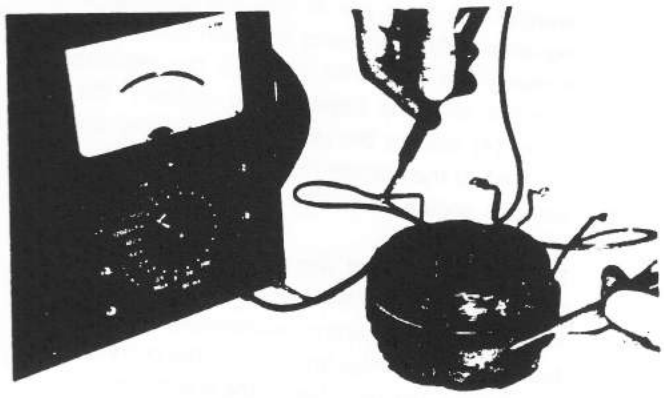


Fig. 7 Inspecting the Starter Coil

2. Inspecting the rotor

a. To inspect the broken circuit in the rotor, connect the tester's leads to the slip ring as shown in Fig. 8, and if the tester shows the resistance of 5 ~ 6 ohms, there is no broken circuit:

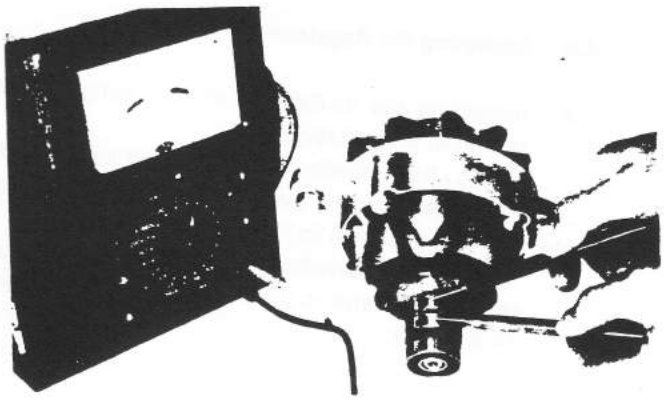


Fig. 8 Inspecting the Rotor

b. To inspect insulation of the rotor, connect the tester's leads to the slip ring and the core, and it is good if there is no continuity.

3. Inspecting the diode
There are two kinds of diode, (+) diode (red) which passes current from the lead wire to the case, and (−) diode (black) which passes current from the case to the lead wire.
To inspect the diode simply, do as follows with a battery and a test lamp.

a. Inspecting the (−) diode
Connect the lamp (2 ~ 10W) between the battery (−) terminal and the alternator as shown in Fig. 9, and then connect the battery (+) terminal to the case, and the lamp is lit.

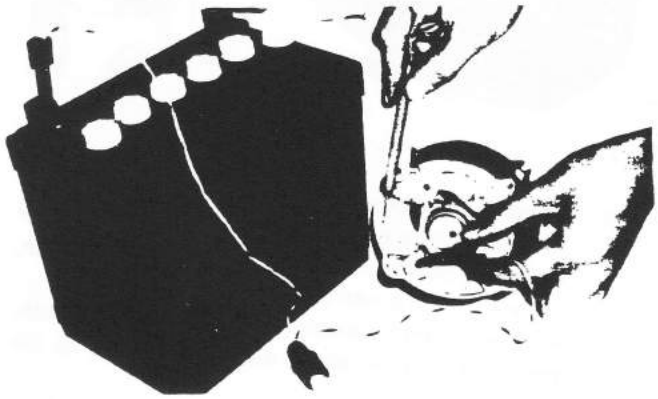


Fig. 9

Make the reverse connection as shown in Fig. 10, and if the lamp is not lit, the (−) diode is good.
If the lamp is lit in either case, the diode is shorted, and if the lamp is not lit in either case, the diode is open.

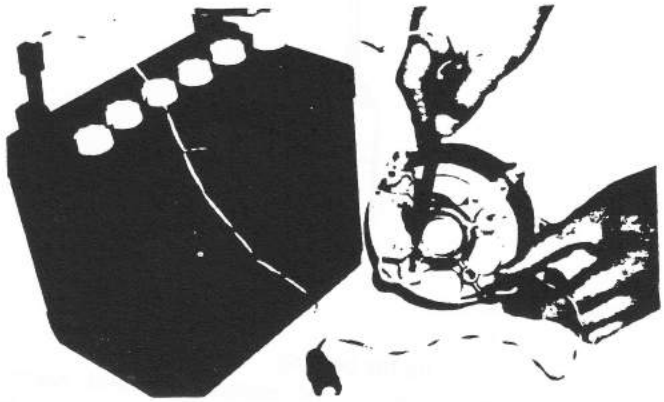


Fig. 10

b. Inspection the (+) diode
Connect the lamp between the battery (−) terminal and the case as shown in Fig. 11, and then connect the battery (+) terminal to the diode,

and the lamp is lit.
Make the reverse connection, and if the lamp is not lit, the (+) diode is good.
If the lamp is lit in either case, the diode is shorted, and if the lamp is not lit in either case, the diode is open.

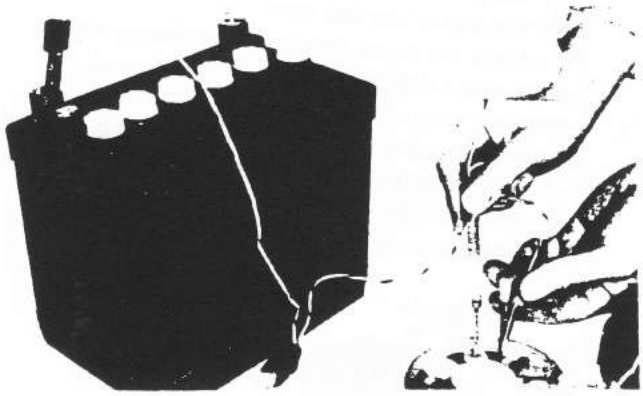


Fig. 11

c. Inspecting the brush
If the brush is worn to the wear limit line (wear limit 0.2756 in. (7 mm)) on the side of the brush, replace it with a new one.
As the exciting current flows through the brush, see to it that no oil or dust be attached to the brush.
The standard tension of the brush spring is 0.71 lb (350 g), and if the brush spring is weak or corroded, replace it.

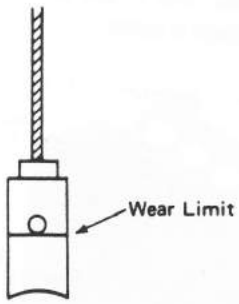


Fig. 12 Wear Limit

d. Inspecting the bearing
The bearing is of sealed type and needs no lubrication, and if it is worn, damaged, or loose due to a long period of use, replace it.

4. Replacing the diode
a. Removing the diode
To remove the diode, support the case or the heat sink with a tool, and pull it out with a press.
Never strike the diode because the diode may be damaged.
Be careful not to damage the diode inserting hole.
b. Fitting the diode
Support the case or the heat sink and insert the diode with a press till the diode lower end touches the upper end of the case or the heat sink.

4-4. Installing the Alternator

To install the alternator, follow the reverse procedure of "removing".

4-5. Inspecting the Charging System

In case charging performance deteriorates or no charging can be performed, do as follows to see whether the fault lies in the alternator or in the regulator before removing the alternator.
a. Remove the lead wire between the regulator A terminal and the battery, and connect the ammeter (+) lead to the regulator A terminal and the (–) lead to the battery (+) terminal.
b. Set the engine to 2,500 r.p.m. and measure the charging current.
Remove the lead at the regulator F terminal and short it to the regulator A terminal.
If the charging current exceedingly increases, the fault lies in the regulator, and if the current shows no increase, the fault lies in the alternator.

Item		Standard value
No-load performance	Terminal voltage (V)	14
Battery (20A) resistance load	Current (A)	16
	Rotation (r.p.m.)	less than 2,300

4-6. Inspecting the Regulator

a. Inspecting the no-load adjustment voltage of the stabilized voltage relay
Use a fully charged battery, and connect the voltmeter between the regulator A terminal and E terminal as shown in Fig. 13.
Increase the alternator rotation up to 4,000 r.p.m., and the regulator is good if the voltage is between 14 and 15V.

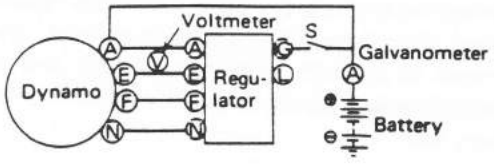


Fig. 13 Inspecting the Regulator

b. Inspecting the pilot lamp relay turning off and lighting voltage
Connect the resistor and the voltmeter as shown in Fig. 14 and turn on the lamp.
Turn gradually the resistor knob to raise the voltage, and measure the voltage when the lamp goes out.
The voltage in this case is a turning off voltage, and is between 4.2 and 5.2V.
Then lower the voltage gradually, and measure the voltage when the lamp is again lit.
This voltage is a lighting voltage and is between 0.5 and 3.0V.

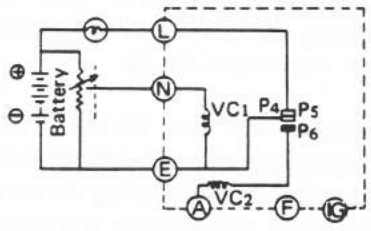


Fig. 14

c. Regulator mechanical dimensions
The mechanical dimensions shown in Fig. 15 which are required to meet the regulator electrical performance are as follows.

Item		Standard value
Voltage relay	air gap	0.027 ~ 0.043 in. (0.7 ~ 1.1 mm)
	point gap	0.010 ~ 0.0016 in. (0.3 ~ 0.4 mm)
	back gap	0.027 ~ 0.043 in. (0.7 ~ 1.1 mm)
Pilot lamp relay	air gap	0.035 ~ 0.047 in. (0.9 ~ 1.2 mm)
	point gap	0.027 ~ 0.043 in. (0.7 ~ 1.1 mm)
	back gap	0.027 ~ 0.043 in. (0.7 ~ 1.1 mm)

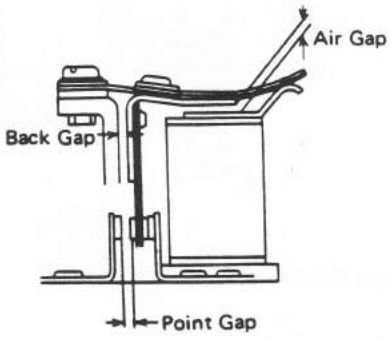


Fig. 15 Regulator Mechanical Dimension

4-7. Specifications

ALTERNATOR

Type	Stabilized type
Nominal output	12V 20A
Polarity	(–) earch
Yoke diameter	4.50 in. (114 mm)
Rotation direction	Clockwise
Weight	Applox. 5.95 lb. (2.7 kg)
Pulley ratio	2.08
Number of polarities	8

REGULATOR

Type	RLB2220A
Voltage regulator adjustment voltage (heated)	14.0 ~ 15.0V
Pilot lamp relay turning off voltage	4.2 ~ 5.2V
Pilot lamp relay lighting voltage	0.5 ~ 3.0W
Weight	1 lb. (0.4 kg)

5. Starter

The starter on the S-650G is the efficient, powerful, economical 28000-269-0 of Nippon Denso, and consists of the overrunning clutch, magnet switch, pinion drive lever, armature yoke and armature shaft.

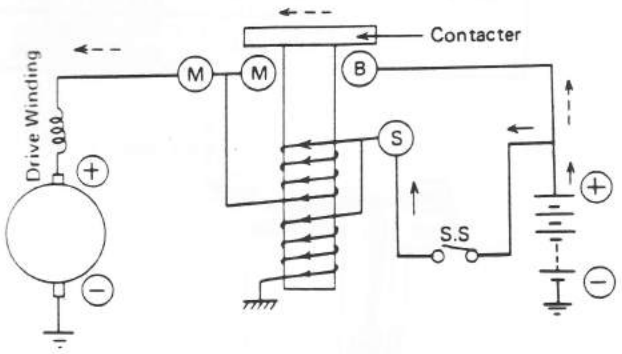


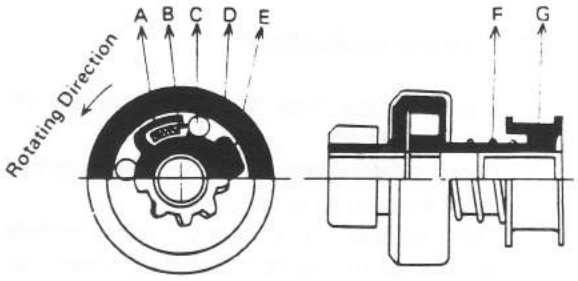
Fig. 16 Starter Connection Diagram

Starter operation

The starter connection diagram is shown in Fig. 16.
When the key switch is turned on, the current from the battery passes through the magnet switch current coil and voltage coil as shown by a solid line and arrows, and the iron core become magnetic and attracts the plunger.
As the end of the lever connected to the plunger is connected to the loose link, the overrunning clutch proceeds along the spline groove on the armature shaft and the pinion meshes with the engine ring gear.
When the plunger is completely attracted and the contactor is attached to the B and M terminals, a large current flows from the battery through the field coil to the armature, and the starter starts the engine with a large starting power.
As the current does not flow through the current coil when the contactor is attached to the B and M terminals, the contactor is attached by the voltage coil only.
When the starter switch is turned off after starting the engine, the current flows through the current coil in the reverse direction, a force is applied whose direction is reverse to that of the voltage coil, the plunger returns to its original position, and the starter stops.

Overrunning clutch operation

The overrunning clutch consists of the thrust spline which is connected to the armature shaft with a spline, the pinion and the roller (see Fig. 17).
The roller is pushed to the narrow end of the wedge by the spring and the spring holder inserted to the thrust spline.
When the engine is started, the roller moves in the reverse rotation direction of the starter, that is, it transmits drive to the pinion and starts the engine as it is pushed to the narrow end of the wedge.
When the engine is started and the roller rotates faster than the starter, the pinion is rotated, the roller moves to the wide end of the wedge, and only the pinion races, thus preventing the starter from rotating very fast.



A Roller spring
B Spring holder
C Roller
D Pinion
E Thrust spline
F Clutch spring
G Loose link

Fig. 17 Overrunning Clutch Operations

5-1. Disassembling the Starter

To disassemble the starter refer to 1-1 Engine Removing item 20 of REPAIR MANUAL, Engine Model, Publication No. 01.

1. Remove the nut from the starter switch terminal and detach the lead wire (A), referring to Fig. 18. Unscrew two screws securing the starter switch (B) to the starter gear housing, and remove the starter switch.
   Remove the Plunger (C) from the drive lever.

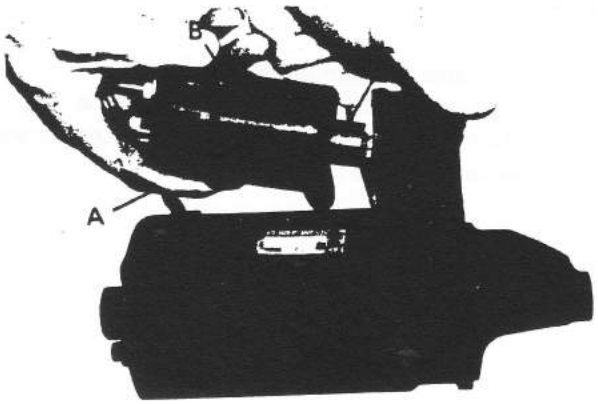


Fig. 18

2. See Fig. 19
Unscrew the screw bolt securing the rear cover (A) to the yoke assembly, and remove the rear cover. Pull out the plane washer (B) and the rubber seal (C) at the rear end of the armature shaft.

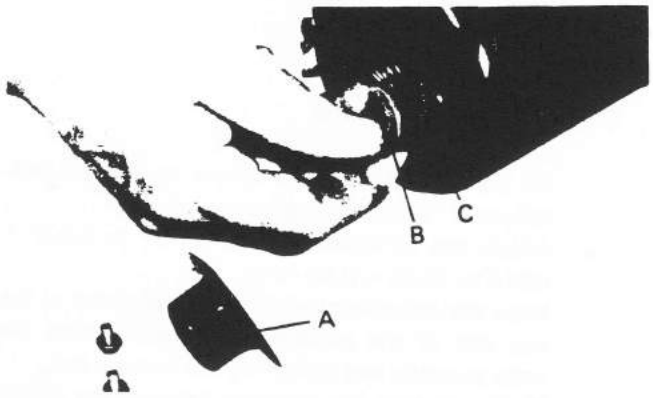


Fig. 19 Disassembling

3. See Fig. 20
Unscrew the through bolt and remove the yoke assembly (A) from the starter gear housing (B).
Remove the spring and the washer from the starter gear housing.

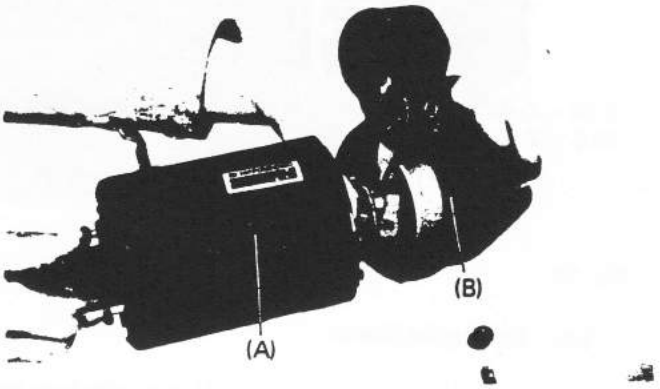


Fig. 20 Disassembling

4. See Fig. 21
Pull the armature (C) together with the overrunning clutch (A) and the drive lever (B) from the starter gear housing.
Remove the stop ring at the end of the armature shaft and pull out the overrunning clutch.

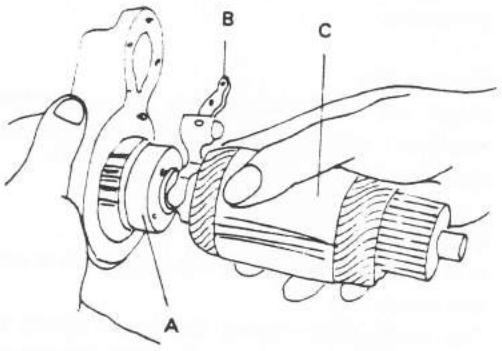


Fig. 21 Disassembling

5-2. Inspecting the Starter

1. Armature
See Fig. 22.
To inspect the insulation of the armature, connect one of the tester leads to the commutator segment and the other to the core or the shaft. See whether there is continuity, and if there is continuity, the insulation is bad, so correct the fault or replace.
To check the rare short, use a glooler tester. Put the armature on the tester, and attach a piece of iron to the core and rotate the armature. If the iron is attracted, it shows rare short.

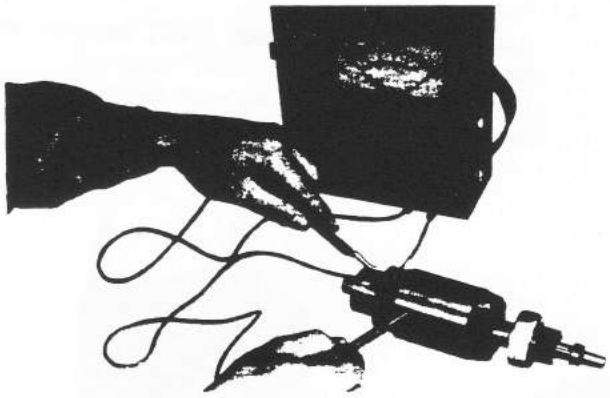


Fig. 22 Armature

2. Commutator
See Fig. 23.
If the commutator is dirty, damaged, burnt or worn, grind it with a sandpaper and wash it with clean abluent.
Undercut it so that the mica is 0.020 ~ 0.031 in. (0.5 ~ 0.8 mm) deep.

3. Field coil
Check the field coil for insulation.
Connect one of the tester leads to the frame and the other to the terminal, and if there is con-

tinuity, the insulation is bad, so correct the fault or replace.

4. Brush holder
Check the brush holder and the end frame for insulation with a tester and if the insulation is bad, replace it.

5. Brush and brush spring
It is advisable to replace the brush if it is worn by one-third.
The worn brush makes the brush spring torque small, and the resistance between the brush and the commutator increases, the torque lowers, and the commutator is burnt.
The brush spring tension is 1.8 ~ 2.4 lb. (0.8 ~ 1.1 kg) and if it is extremely weak, replace it.

6. Wear in bearing
Measure the clearance between the armature shaft and the bush, and if the clearance is too much, replace the bush.

7. Wear in pinion
Check the overrunning clutch pinion gear teeth for wear, and if it is exceedingly worn, replace it.

8. Starter switch
To check the starter switch, make the following three tests and if it is faulty, replace it.

a. Pull-in coil test
Apply a specified voltage (12V) between the starter switch S terminal and MT terminal.
If the plunger is attracted with force, the pull-in coil is good.

Fig. 23 Starter Switch

b. Holding coil test
Earth the MT terminal to the starter switch body, and apply a specified voltage (8V) to the S terminal to attract the plunger.
The holding coil is good if the plunger is being attracted even after the MT terminal earth is removed.
If the plunger returns, it is due to the broken circuit in the coil.

c. Return test
Push the plunger and apply a specified voltage (12V) between the MT terminal and the starter switch body. If the plunger is attracted, it is due to rare short in the coil.

5-3. Assembling the Starter

To assemble the starter, follow the reverse procedure of "disassembling".

a. Adjust the armature shaft end play to 0.002 ~ 0.014 in. (0.05 ~ 0.35 mm).
Make the adjustment with the plane washer at the rear end of the armature shaft after fitting the yoke assembly and tightening the through bolt.

b. Make sure that the clearance between the pinion end and the stop ring is 0.02 ~ 0.08 in. (0.5 ~ 2.0 mm) when the starter is rotated with no load.
If it is faulty, adjust the adjusting washer.

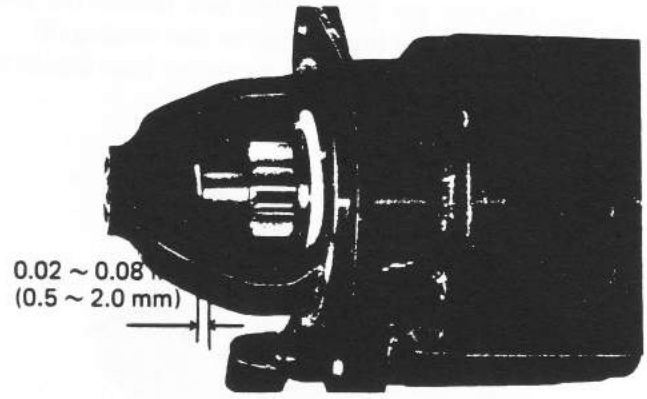


Fig. 24

5-4. Testing the Starter

Perform the following no-load and with-load tests to the removed starter, and if it is faulty, disassemble, inspect and correct the starter.

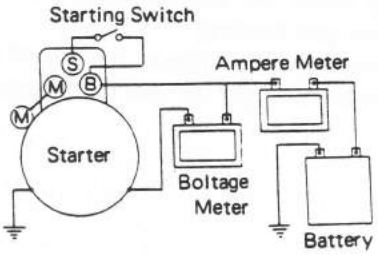


Fig. 25 Circuit Diagram

1. No-load test
   Connect a fully charged 12V battery and an ammeter as shown in Fig. 25 and turn on the starter switch.
   The starter is good if the ammeter reads less than 60A when the engine is rotating at 3,700 r.p.m.

2. With-load test
   Fit the starter to the test bench and test the starter, following the procedure outlined by its manufacturer. The starter is good if the voltage is 7.5V, the current is less than 560A, and the torque is 9.3 ft-lb. (1.3 kg-m).

Test result	Probable cause
Low rotation, large current at no-load	Damaged or worn bearing
	Armature short
	Earth in armature or field circuit
No rotation, large current	Field circuit does not work
	Armature coil does not work
	Burnt commutator
Low torque, current, no-load speed	One field circuit is cut
	High internal resistance
Low torque, high no-load speed	Short in field coil

5-5. Specifications

Type	Nippon Denso 28000-269-0 Electric magnetic pushing type
Winding	Double winding
Nominal output	1.0 kW
Polarity	4
Rotation direction	Clockwise (viewed from pinion side)
Weight	12.79 lb. (5.8 kg)

6. Safety Switch

This safety switch prevents various kinds of accidents due to starting the engine against one's will.
In the conventional starting circuit, current flows to the starter and starts the engine by setting the engine switch to "start" position even if the selector lever or the range lever is not positioned at "neutral", however, this safety switch, if the range lever is not positioned at "neutral", is designed not to flow current to the starter when the engine switch is set to "start ' position.
Therefore, to start the engine, position the range lever at "neutral", and the range lever cam rotates, the steel ball in the safety switch is pushed, and the starting circuit operates.

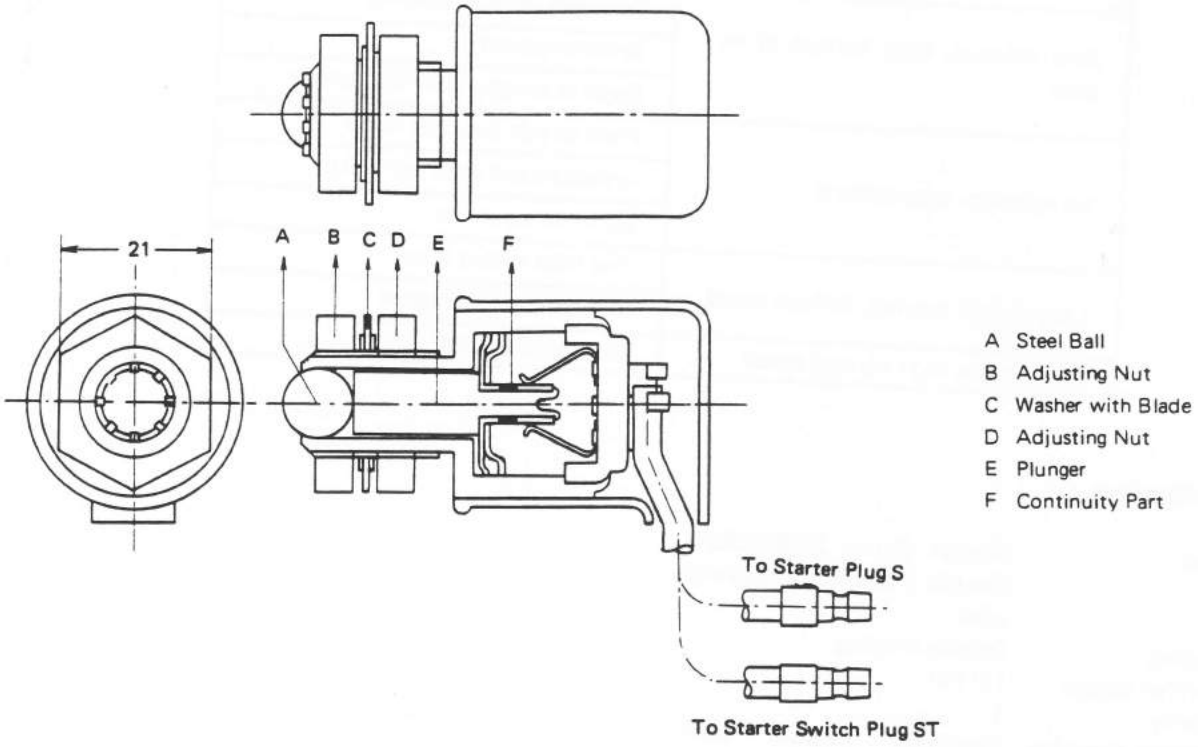


Fig. 26 Safety Switch

6-1. Adjustment

a. Remove two connectors from the wiring.
b. Set the range lever to H position.
Adjust the adjusting nuts (B) and (D) in Fig. 26 with a special tool (1700T05 SAFETY SWITCH SPANNER) so that the clearance between the steel ball (C) and the cam (B) in Fig. 27 is 0.01 in. (0.5 mm).
To measure the clearance, use a special tool (No. 26 STANDARD FEELER GAUGE).
c. After adjustment connect the volt ammeter to the two removed connectors and shift the range lever to H → N → L, and make sure the ON or OFF of the safety switch is rightly indicated on the meter.
d. Connect the connectors and turn on the engine switch and make sure that the safety switch operates normally.
Note: If the safety switch is faulty, replace the safety switch assembly.

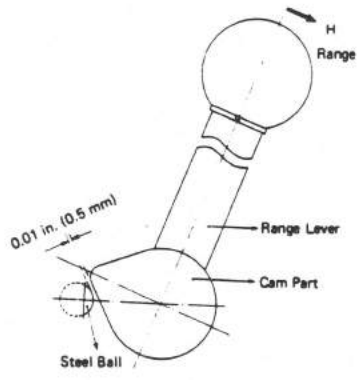


Fig. 27 Clearance

SATOH TRACTOR

MODEL S-650G
REPAIR MANUAL

DRAFT CONTROL

PUBLICATION No. 03-G

CONTENTS

DRAFT CONTROL

1. Outline of Construction

The draft control specifically developed for the use of the Satoh tractor, Model S-650G, comprises a control valve and a sensing unit, and it can be mounted readily enough on any Satoh tractor thus far shipped to the United States by simply replacing only a part of its component parts. Now that this valve has a draft control mechanism and a traction control mechanism assembled in the conventional height control (position control) valve, any one of these mechanisms can be selected readily enough by properly controling the control link for a respectively selected area of operation by means of a single control lever. The draft control is of such construction that the resistance applied on a working equipment is collected by a sensing unit arranged in the rear of a hydraulic case through a top link, and has itself function on the draft link of the control valve, thus putting a spool valve in operation for keeping the tilling depth constant at all time. When the working tractor should come across with some obstacle and strong resistance is thus given birth, the resistance is changed into a motion capable of driving the draft link by means of the sensing unit, thus raising the tractor automatically, and as soon as the tractor has run over the obstacle, it resumes the original tilling depth.

As to the traction control, the simple operations of setting the stopper knob at the connecting rod at the position of "Height" and pushing down the control lever forward in conformity with the mark of a quadrant will be sufficient to move the load on the rear wheels of the tractor and to increase the tractive force of the tractor, thus enabling proper performance to be displayed to best suit the condition of a farming ground no matter how complicated it is.

The three mechanisms of "Height" ("position"), "draft" and "traction" are enclosed in a conventional control valve in a compact manner; and its appearance, dimensions, installation method and so forth remain exactly the same as any former model. This hydraulic mechanism features superb performance, as well as such a simple design as all the phases of its operation can be controled completely with a single control lever by simply changing over the stopper knob of the connecting rod along a groove formed on the control arm.

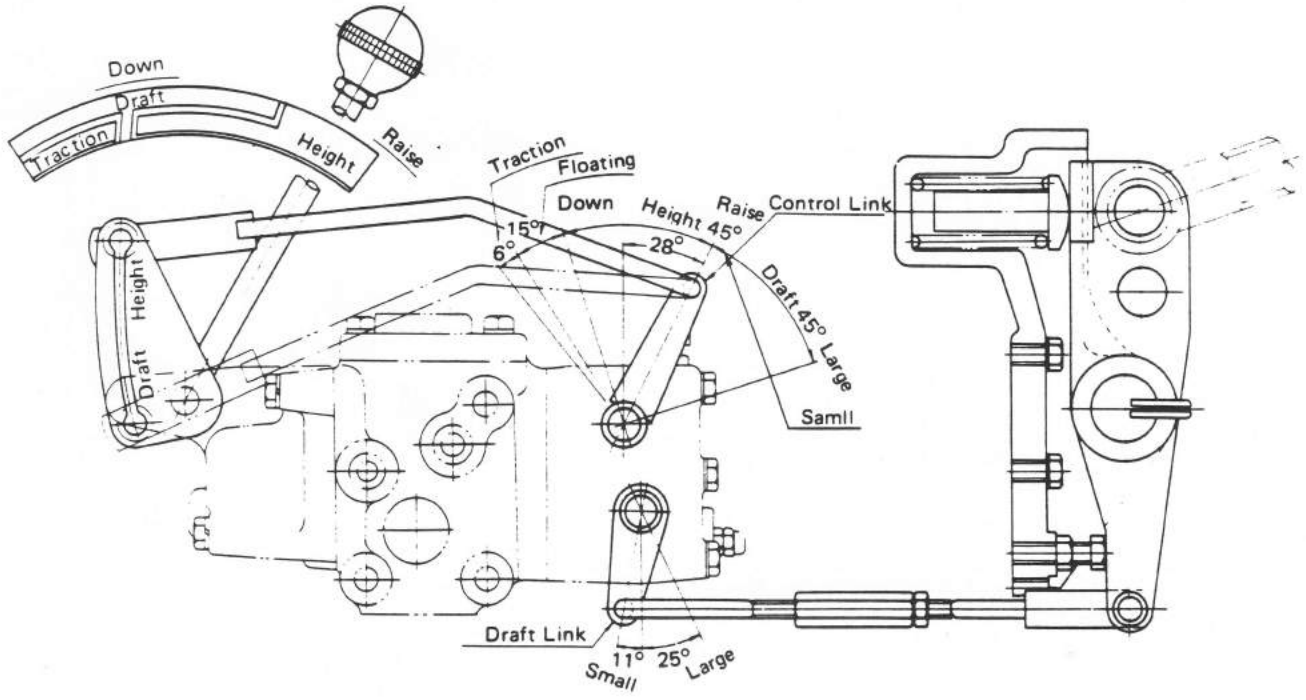


Fig. 1

2. Setting the Draft Control in Place

For setting the draft control in place on your tractor, it is recommended to conduct such operations as set forth below:

1. Take off the magnet plug arranged on the right of the hydraulic case, and drain all the oil.
2. Take off the knob of the control lever, and then take off the quadrant from the fender.
3. Take off feedback link (joint lift arm) – CC24120 – from the striker arm and the position link, and then take off the striker arm.
4. Take off the banjo bolt – CC24340 – that holds the delivery pipe under the control valve, in such a manner as to keep the banjo bolt completely free from being scarred or otherwise damaged. (Since this banjo bolt is eligible for reuse.)
5. Loosen the three bolts and nuts that hold the control valve, and take off the control valve.
6. Take off the top link support – CA31010 – from the hydraulic case.

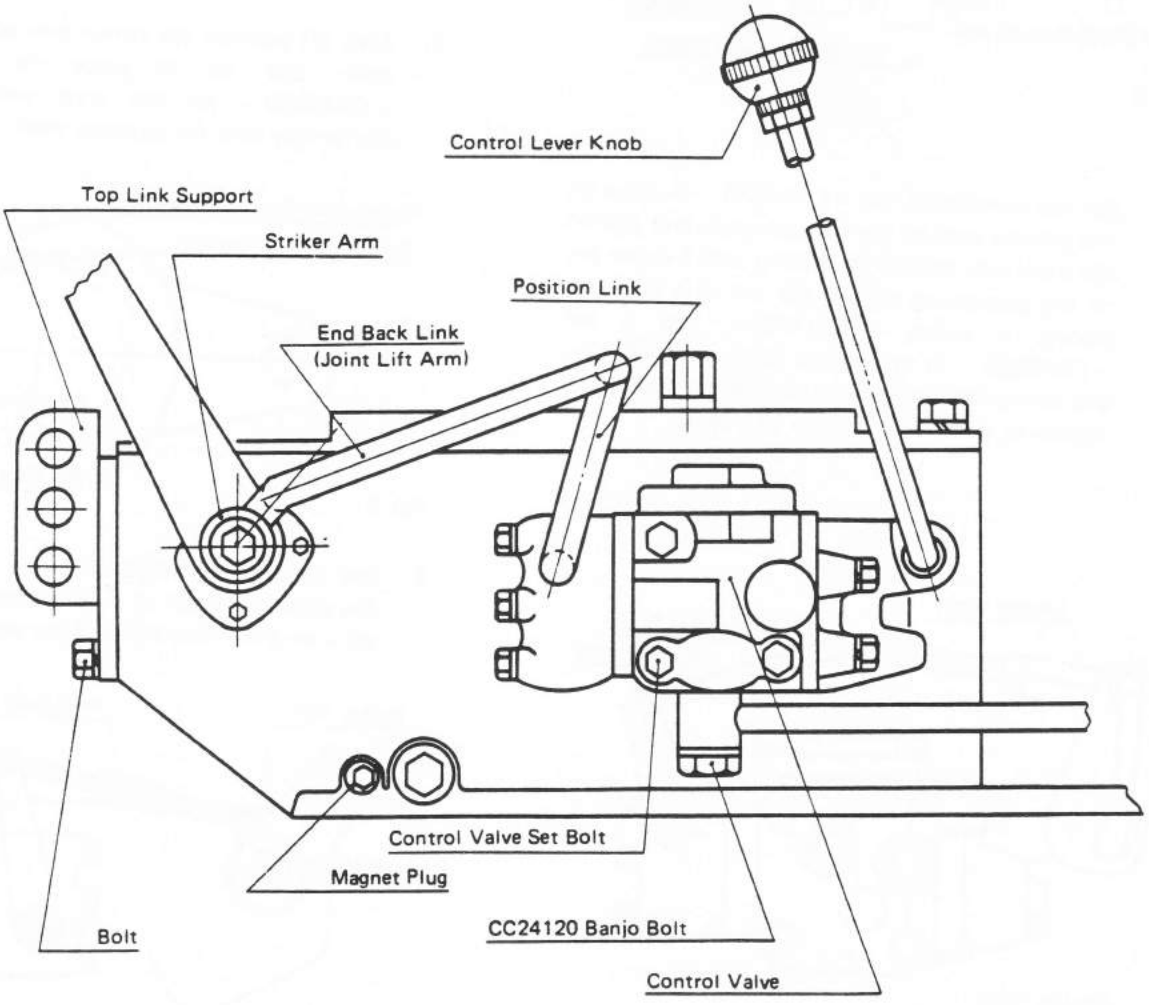


Fig. 2

3. Assembly

1. Set the Bellevill washer – CC24077 – and the control arm – CA48520 – in place on the draft control valve, set in place the control lever – CA48550 – together with a key, set in place the washer – 3501105 –, and tighten in a regular manner by the use of a lock washer. Conduct this tightening so that the tightening load may be 4.4 ~ 6.6 lbs (2 ~ 3 kg) at the tip of the control lever.

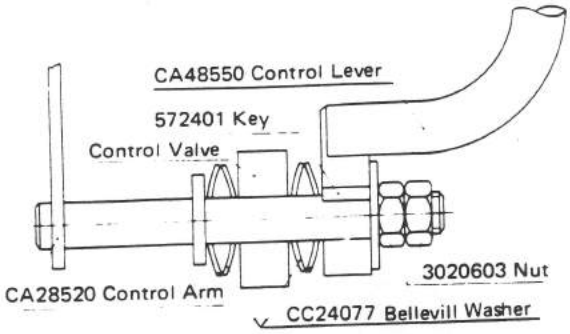
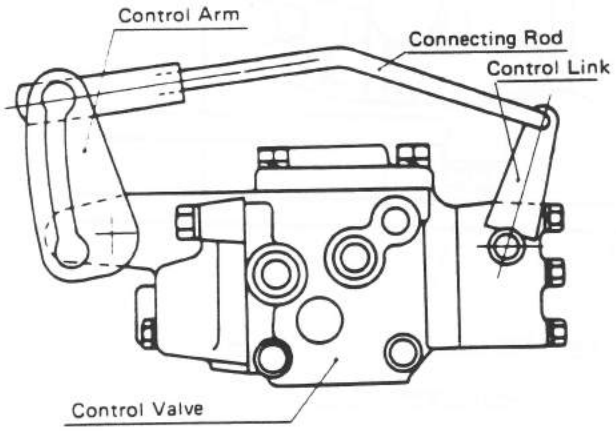


Fig. 3

2. Set the connecting rod – CA48570 – in place on the control link of the control valve, and tighten the front side thereof for setting with a cotter pin on the connecting rod by the use of a nut after placing a spring – CD17070 – and a pin – CD48620 – in the stopper knob – CA48610 – and having the control arm run therethrough. The tightening torque is 0.57 ft-lb (0.8 kg-m).



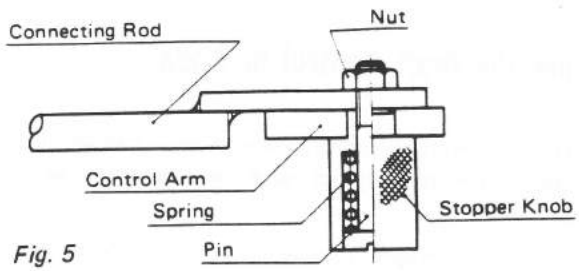


Fig. 5

3. Set the draft control valve in place on the hydraulic lift case by exercising due caution to the "O" ring of the draft control valve. The setting bolt and the spring washer formerly in use therefor will be employed herefor. The tightening torque will be 13.0 ft-lb (1.8 kg-m).

4. Set new "O" rings, – 8310180 – and – 8310240 –, on the banjo bolt – CC24340 – and set the delivery pipe – CA24650 – on the control valve. The tightening torque will be 36.1 ft-lb (5 kg-m).

5. Take off position the striker arm boss of the ram shaft, and set in place the striker arm – CA48680 – for the draft control valve in conformity with the punched mark.

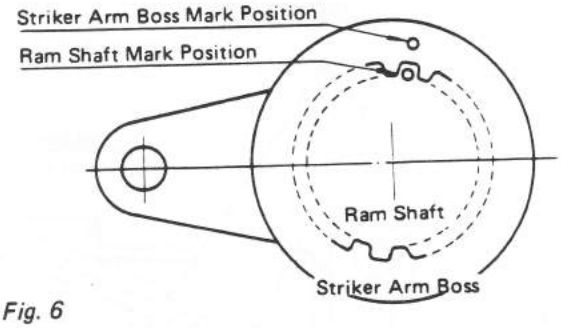


Fig. 6

6. Set in place the feedback link – CA4865A – at the standard length of 4.18 inches (108 mm), and set it on the striker arm and the position link.

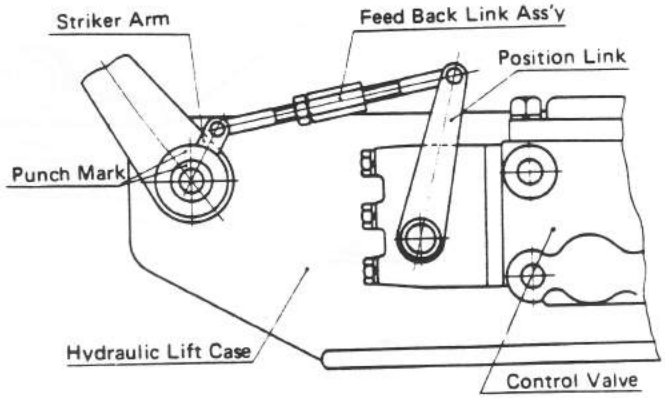


Fig. 7

4. Fabrication of the Sensing Block

1. Set the stopper bolt along with a lock nut under the sensing block (A).

2. Set the sensing block (A) in place on the top link support setting section in the rear of the hydraulic case by the use of 6 pieces of M10 x 30 bolts.

3. Set the spring – CA48740 – and the seat – CA48750 – into the spring setting hole of the sensing block (A).

4. Set a grease nipple on the sensing block (B), and screw a threaded lock securely into the screw of the connecting shaft.

5. Set the sensing block (B) on the sensing block (A) by the use of a center pin – CA48730 –, and set it in place securely enough by the use of the spring pin – 5506028 –.

6. Conduct greasing in a regular manner so as to ensure smooth operation of each section.

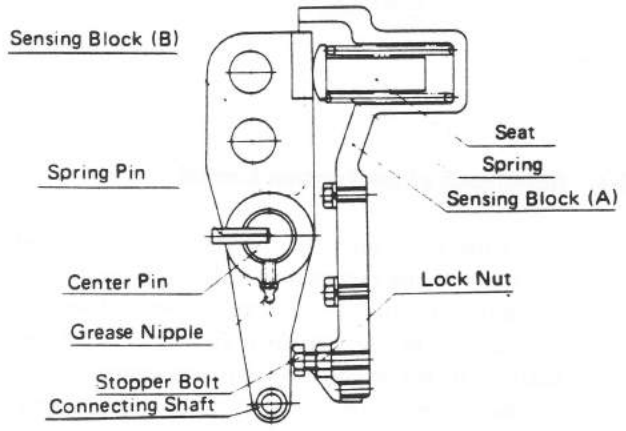


Fig. 8

(Set the draft feedback link later on.)

5. Marking

Take off the old mark of the quadrant, and set in place a new guide mark – CA48930 – securely enough on the quadrant.

6. Adjustment of the Controls

Cautions to be exercised in the course of adjustments of the controls.

1. Feed the hydraulic case with the specified quantity of oil, check that the hydraulic case is completely free from leakage of oil, start the engine, and conduct further checking to ensure that the hydraulic case remains free from leakage of oil under the idling condition.

2. In the case of conducting the adjustment, exercise meticulous caution to the sections above and below the tractor, thus keeping it completely free from an accident taking shape.

6-1. Adjustment of the Height Control

1. Set the knob of the connecting rod at the position of the height control, and set the control lever at the position of "Down". (In this case, exercise meticulous caution to keep the control lever from being set at the position of "Traction".) Set the tractor for the 3-point linkage, and start the engine. Move the control lever softly to the position of "Raise", and adjust the relief valve in such a manner that it reaches the position of the maximum rise and free from operation by the use of the turnbuckle of the feedback link that connects the striker arm for lifting the tractor with the position link of the control valve. Now that the relief valve is put out of operation in case the feedback link is elongated, it is advisable to make the feedback link short in case the lift is rather small. Pull the knob of the connecting rod under this condition, with the control lever kept staying as it is, and set the knob at the position of "Draft". If the tractor is subjected to a vertical move, either upward or downward, at this time, no matter how slight it is, set the control lever at such a position that the height of the control arm and the groove for changing over the draft form an arc in between, with the position for setting the connecting rod of the position link of the control valve selected as a fulcrum, adjust the feedback link once again, and adjust the 3-point linkage so that it can attain to the position of the maximum lift in case changeover from "Height" to "Draft" is conducted, and in such a manner that the tractor is kept free from a vertical move, either upward or downward, then lock the turnbuckle. (In this case, conduct proper adjustment by the use of the turnbuckle of the feedback link in such a manner that the neutral position can be obtained slightly before the stroke end of the piston. Furthermore,

place the lever stopper – CC24210 – behind the control lever, prior to tightening.)

2. The tractor is lowered in case the control lever is moved in conformity with the mark on the quadrant. Set the rubber guide – CA24130 – at such a position properly as the tractor is lowered most.

3. In case the control lever is further moved forward, the traction control is put in operation. (As to the traction control, reference is invited to the traction control sequence.)

6-2. Adjustment of the Draft Control

1. Set the knob of the connecting rod at the position of the height control, set the control lever at the position of "Down", and start the engine.

2. Set the control lever at the position of "Raise", pull the knob of the connecting rod under the condition as the implement is lifted, and set this knob softly at the position of "Draft". (Confirm that the tractor is free from a vertical move, either upward or downward, in case the knob is thus pulled.)

3. Set the control lever at the position of "Down", and loosen the lock nut of the adjuster.
   Now that the relief valve of the control lever is put in operation as the control lever is moved in the direction of "Raise", set the adjuster securely enough in place and set it at the position of "Neutral".
   Set the adjuster securely enough in place like this and make proper adjustment thereof in such a manner that the relief valve is not put in operation, no matter at what position in the operation range of the control lever it is.

4. Conduct proper adjustment by the use of the adjuster in such a manner that the relief valve is kept free from being put in operation, no matter at what position the control lever is; move the draft link of the control valve at the position of the maximum rise of the control lever, and confirm that the relief valve is free from being put in operation, then lock the idler adjuster.
   (In case the relief valve should be put in operation to the contrary, conduct readjustment thereof by the employment of an idler adjuster.)
   The idler adjuster is what is specifically designed for conducting control in the case of the draft control.

5. Set the control lever at the position of "Down", elongate the draft feedback rod over, the standard length of 9.25 inches (235 mm) by approximately 1/4 inch (6.35 mm) by the use of a turnbuckle, and set it on the connecting shaft under the draft link and the sensing block (B).

6. Start the engine, set the control lever at the position of "Raise", turn the turnbuckle of the draft feedback rod in such a manner that the draft feedback rod becomes shorter, turn the same softly until the tractor is lifted to the highest level, and lock the turnbuckle at such a position that the tractor has thus reached the highest level.

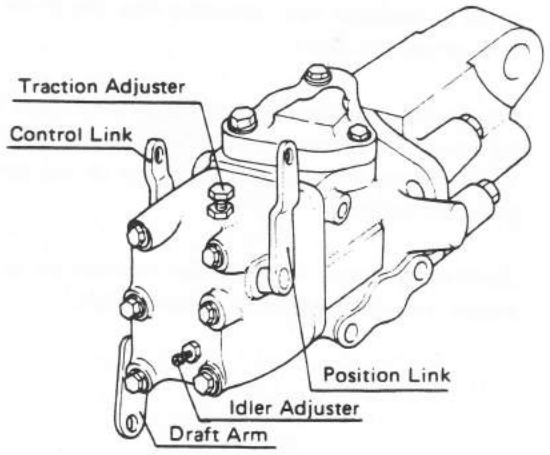


Fig. 9

6-3. Adjustment of the Traction Control

1. As to the adjustment of the traction control, set the knob of the connecting rod at the position of "Height", and start the operation thereof from the position lower by approximately 52° than the position of the maximum lift of the control lever.
   In case extreme deviation from the position thus selected is existent, make proper adjustment of the traction control by the employment of a traction adjuster.
   In case the traction adjuster is tightened, traction slides to the side of "Height", and vice versa.

6-4. Adjustment of the Sensing Units

1. Lock the stopper bolt arranged on the sensing block (A) after loosening the sensing block (B) until no play remains in between. In this case, however, exercise meticulous caution not to loosen excessively until the spring is compressed thereby.

7. Assembly and Disassembly

As to the assembly and the disassembly of the draft control of the Satoh tractor, Model S-650G, reference is invited to "3-2. Control valve – Removal and disassembly" on Page 8, and "4. Assembly (adjusting) sequence" also "4-2. Control valve (integral component part) – Assembly" on Page 12, respecitvely, of the otherwise available "Repair Manual – Hydraulic System" of the Satoh Tractor, Model S-650G, since such are applicable hereto with only slight modifications.

8. Operation

8-1. Explanation of Operation in Height Control (Position Control)

In the case of the height control, set the stopper knob of the connecting rod at the position of "Height" of the control arm.

8-1-1. Neutral Position (See Fig. 11.)

The oil discharged out of the pump flows into the control valve through the port (1) of the pump, pushes the unloaded valve (2) upward, and runs to the port (3) of the tank. Now that the pressure required for thus pushing the unloaded valve (2) upward is only negligible at this time, the pump is virtually placed under an unloaded state.

The cylinder circuit is disconnected with the circuits on the sides of the tank and the pump by the laps of the check valve (5), the spool (6) and the sleeve (7); therefore, the tractor is held always at the constant height.

8-1-2. "Raise" Position (See Fig. 11.)

In case the control lever is moved to the position of "Raise", this control lever moves the control link (8) connected therewith by the connecting rod in the direction of "Raise". The control lever is thus fixed at the position to which the control link has moved, due to the function of friction.

While the pin (9) unified with the control link moves in the direction shown by an arrow, the pin (10) remains under the fixed state; therefore, the tip of the link (11) moves in the opposite direction of the pin (9) with the pin (10) selected as a fulcrum. Accordingly, the spool (6) is pushed by the spring (12) and moves to such a degree as the link (11) has moved, thus disconnecting (16); therefore, the oil running through (1) flows into (17) by passing through (14), (15) and (13), thus shutting unloaded valves. The oil running out of the pump thus opens the check valve (5), runs to the port (4) of the cylinder, and then to the cylinder, and finally raises the tractor.

Once the tractor begins to rise upward, this move is fed back to the position link (18) by the feedback link. Thereby the position link (18) moves in the direction of an arrow (dotted line), and the pin (10) unified therewith also turns in the same direction of the dotted line shown by an arrow, thus pushing the link (11) into the valve; so also pushed into the valve is the spool (6) connected with the link (11). Now, when the spool (6) is pushed back to such a degree as corresponding to the initial move of the control lever, the valve becomes neutral, and the tractor suspends its operation. (As to the height of the tractor, any optional height can be selected corresponding to the angle of the control link (8).)

The neutral state is the same as that set forth above in 8-1-1.

In case the control link (8) remains within the range of the "Height", the pin (19) for the draft does not move the link (11) directly, thus leaving it free, hence nothing to do with the spool (6).

8-1-3. "Down" Position (See Fig. 12.)

In case the control lever is moved to the position of "Down", the pin (9) attached to the control link (8) moves in the direction shown by an arrow. The control link pushes the spool (6) into the valve by thus moving in the direction shown by the arrow. (16) is caused to open as the spool (6) is thus pushed into the valve, and the oil having run through the port (1) of the pump into the valve all runs out to the port (3) of the tank, since the circuit to the unloaded valve is under the same condition as being neutral.

Furthermore, the cylinder circuits, (4), (21), (22) and (14), become open; therefore, the tractor descends by its own weight, and the oil in the cylinder runs to the port (3) of the tank.

Once the tractor begins to descend, this move is fed back to the position link (18) by the feedback link, and the pin (10) moves in the direction shown by an arrow. The spool (6) in direct contact with the pin (10) is pushed by the spring (12) and forced out from the inside of the valve to such a degree as the pin (10) has moved. And the tractor descends corresponding to the degree of moving the control lever, thus falling out into a neutral state, until the tractor suspends its operation.

8-1-4. "Floating" Position (See Fig. 13.)

In case the control lever is moved downward below the position of the maximum descent, the interior of the valve falls out into a descending state; however, now that the cylinder has reached the position of the maximum descent (the stroke end), the tractor descends no more, hence no feedback. Now that the pin (10) does not move any longer, the valve is held in the descending state, thus opening all the ports of the pump, the tank and the cylinder as well.

8-2. Explanation of Operation in Traction Control (See Fig. 14.)

Set the stopper knob of the connecting rod at the position of "Height" of the control arm.
Push downward the control lever (8) further forward, and the control link (8) passes through the floating area and runs into the range of the traction control. The pin (9) revolves in the direction shown by an arrow, and the link (11) is supported by the control bolt (24), then moves in the direction shown by an arrow, completely irrespective of the pin (10) for feedback. Thus the spool (6) is pushed into the valve, shuts (16), and then shuts the unloaded valve. Therefore, oil runs through (14), (22), (21) and (23), then flows into the port (3) of the tank. At this time, the space between (21) and (22) has its area narrowed by the spool (6) and the sleeve (7). Consequently, the pressure in the valve is raised, and pressurized oil runs into the cylinder, thus lifting the tractor slightly; and the move to lift the tractor is transferred to the rear wheels, thus increasing the tractive force.
(The space between (21) and (23) throttled by the spool and the sleeve is fluctuated in accordance with the angle for changing over the control link (8), and the pressure to lift the tractor is fluctuated accordingly. Therefore, highly efficient operation can be ensured to meet multifarious conditions.)

8-3. Explanation of Operation in Draft Control

In the case of the draft control, set the stopper knob of the connecting rod regularly in place at the position of the draft of the control arm.

8-3-1. The Case of Operation to the Side of "Large" Tractive Force (See Fig. 15.)

In case the control lever is pushed downward to the full in conformity with the mark on the quadrant, the control link (8) moves to the side of "large" tractive force, and the tractor descends until the move reaches such a level of the tractive force (the load applied on the top link) as matches the transfer displacement thereof. The flow of oil at this time moves the control link (8), the pin (9) revolves in the direction of the arrow and pushes the spool (6) into the valve, then shows the same circuit as under the descending state of the height control. In the wake thereof, the tractor descends, the link (25) is fed back as the tractive force increases, the pin (19) revolves in the direction shown by an arrow (dotted line), the spool (6) is pushed by the spring (12) to move on, and the tractor suspends its operation in case the spool (6) is moved backward by the degree of move corresponding to the tractive force initially sought. In other words, the valve is thus set at a neutral position, and the circuit of the oil becomes the same as that set forth in 8-1-1 above.

8-3-2. The Case of Operation to the Side of "Small" Tractive Force (See Fig. 15.)

In case the control link (8) is moved to the side of "small" tractive force (the side of "Raise") by the control lever, the tractor is raised to the level of the tractive force thus sought and corresponding to the displacement of the operation. The move of the link within the valve at this time becomes contrary to that set forth in 8-3-1 above, the circuit remains the same as that under the condition the height control is raised, the valve is set at the neutral position when the tractive force thus sought is obtained, and the oil circuit becomes the same as that set forth in 8-1-1 above.

8-3-3. Operation of the Valve in Case the Tractive Resistance has Fluctuated at the Time the Control Link (8) is Placed Under a Fixed Condition at Any Optional Position (See Fig. 16.)

In case the control valve is fixed at any optional position within the operation range of the draft control, such constitutes no problem as far as the resistance applied on the tractor remains constant, however, in case the resistance applied on the tractor is fluctuated or the tractive force of the wheels is subjected to some fluctuation owing to the conditions of the farming ground, the fluctuations in the tractive resistance are seized by the

sensing units through the top link, are fed back into the draft link (25) by the draft control feedback link, and move in the direction shown by the arrow. The pin (19) unified therewith into one entity also revolves concurrently in the direction shown by the arrow, the spool (6) is pushed out of the valve, the valve is placed under the condition for raising the tractor, and the tractor goes on rising upward until such tractive force as is sought by the control link (8) is obtained. Now, in the contrary case, or in case the tractive resistance applied on the tractor is reduced down to a lower level, the portion of the tractive resistance thus reduced is mechanically fed back to the draft link (25). The draft link (25) is moved in the direction shown by an arrow, the pin (19) also revolves concurrently in the direction shown by the dotted line, and the spool (6) is thus pushed into the valve. The valve is placed under the condition for descending, and the tractor descends until the tractive force sought by the control link (8) is obtained.

8-3-4. Operation of the Valve in Case the Tractor is so Operated as to be Raised Up to the Maximum Level Under the Condition of the Draft Control (See Fig. 17.)

The resistance applied on the top link is reduced down to the level of 0 when the tractor becomes free from being subjected to the resistance of the ground and has nothing to bear except its own weight, and even in the case of further raising the tractor, the link (25) is completely free from having anything to be fed back thereinto. In other words, the control link (8) comes to have a free area in the space up to the position for the maximum rise in the height control area over the effective control area of the pin (19) in the operation area of the control link (8). Now, in case the control link (8) is operated in the said free area, no feedback by the tractive resistance results therein as set forth above, the spool (6) is pushed by the spring (12), the oil circuit is maintained intact under the condition with the cylinder kept raised, and the tractor is thus raised up to the position of the maximum lift. When the tractor thus reaches the level of the maximum lift, the position link (18) is fed back as well and moves in the direction shown by the dotted line arrow. So also the pin (10) revolves in the direction shown by the dotted line arrow concurrently; the plate (26) attached to the pin (10) moves along with the pin (10) as a unified entity, pushes the spool head (28) of the disk shape arranged at the tip of the spool (6), pushes the spool (6) until it is placed under a neutral condition, and the tractor is thus placed under a neutral state at such a position as the tractor is raised up to the maximum level. The adjusting bolt (27) does not put the relief valve (29) in operation at the time when the tractor is raised up to the maximum level, but it conducts proper adjustment of the relief valve so that it moves back to the neutral position.

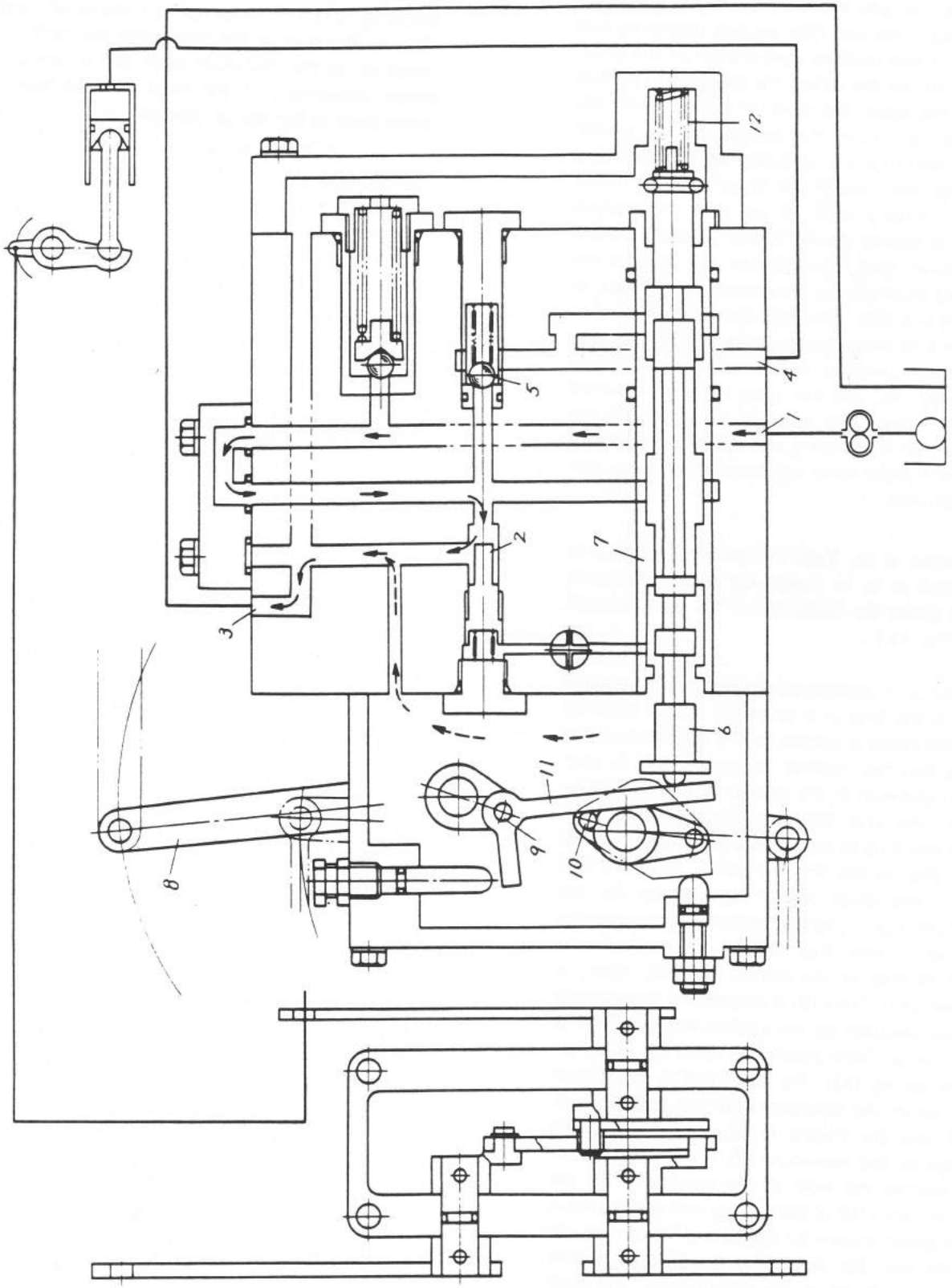


Fig. 10 Neutral State

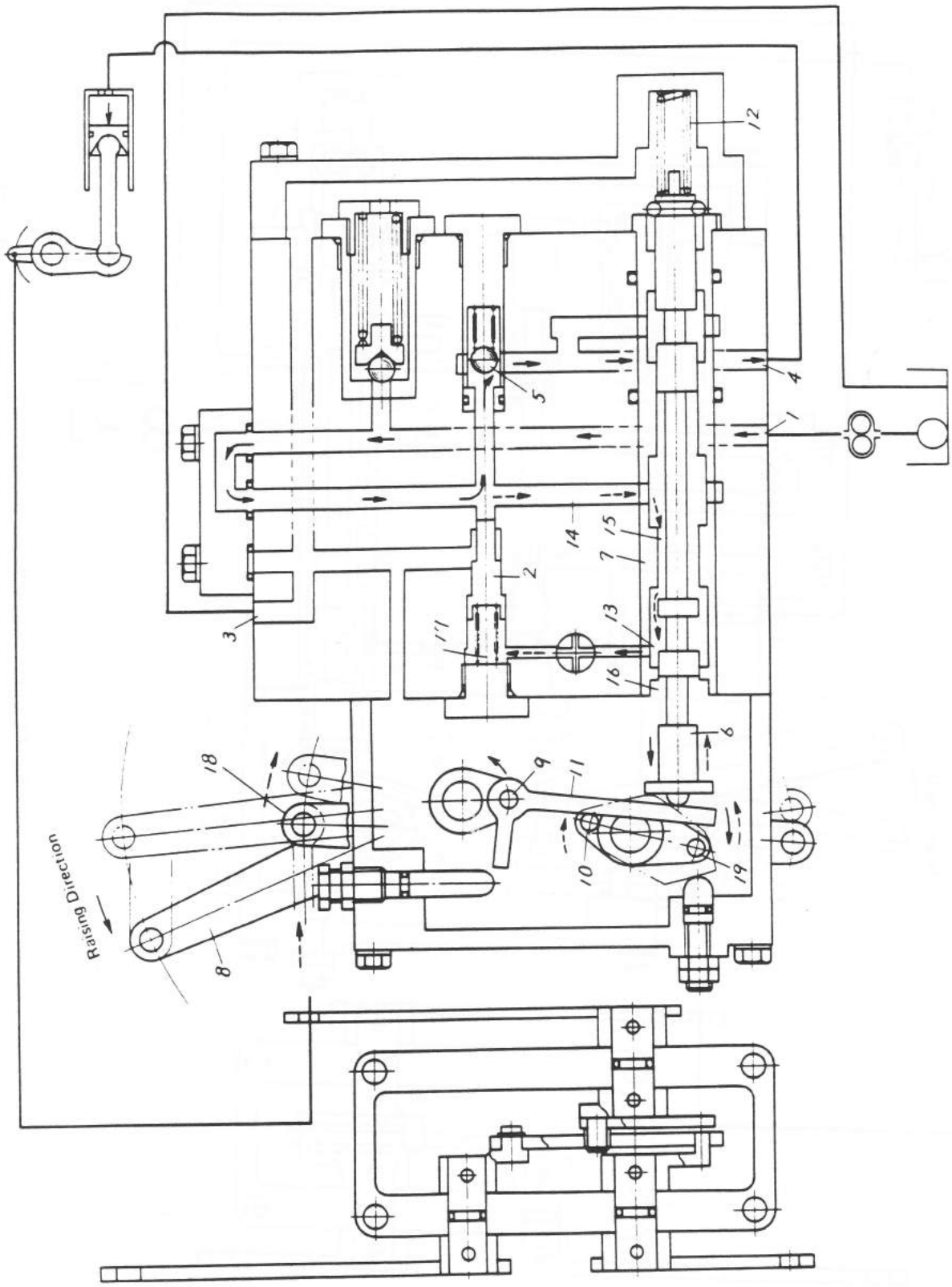


Fig. 11 Raising State

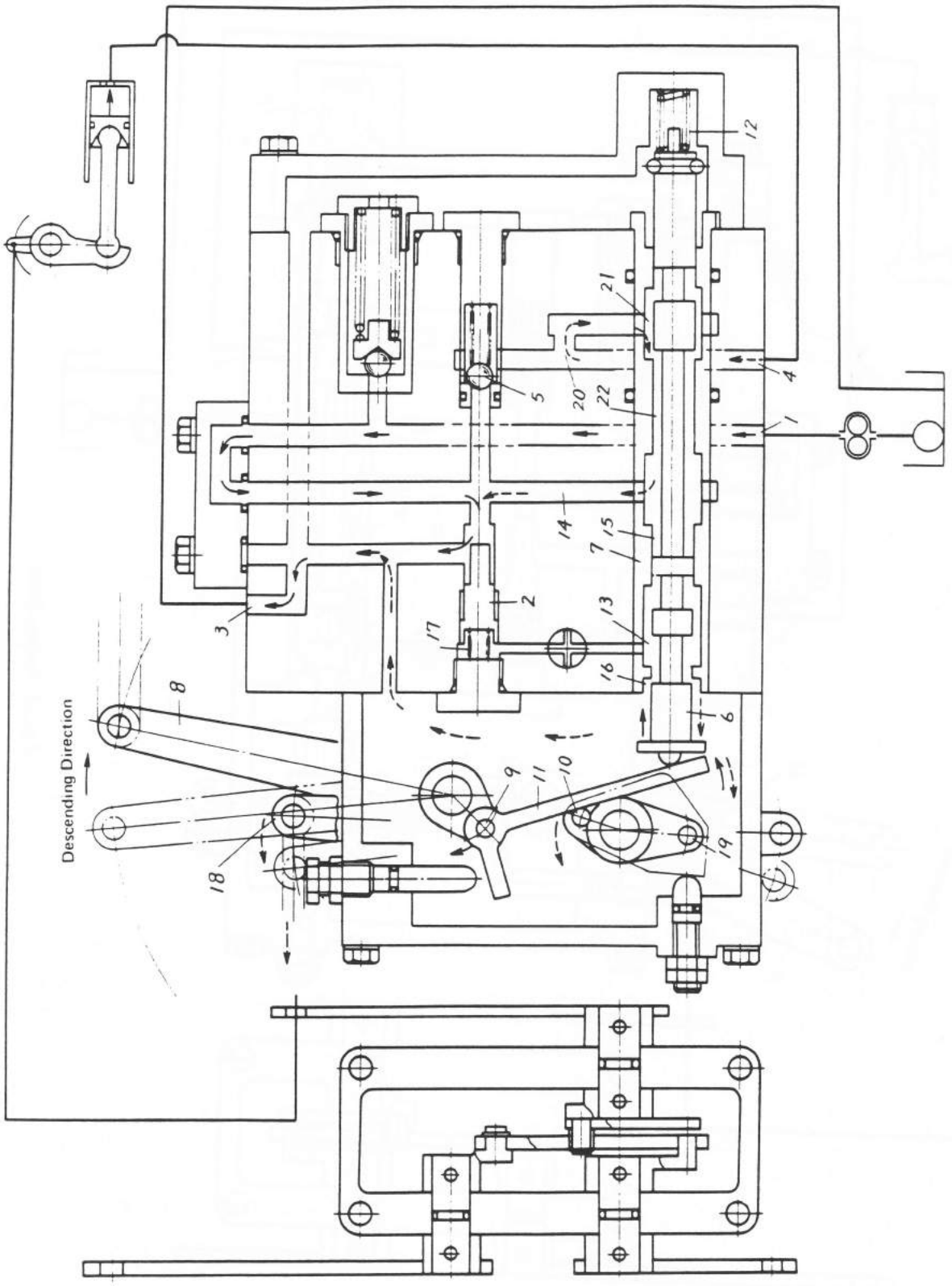


Fig. 12 Descending State

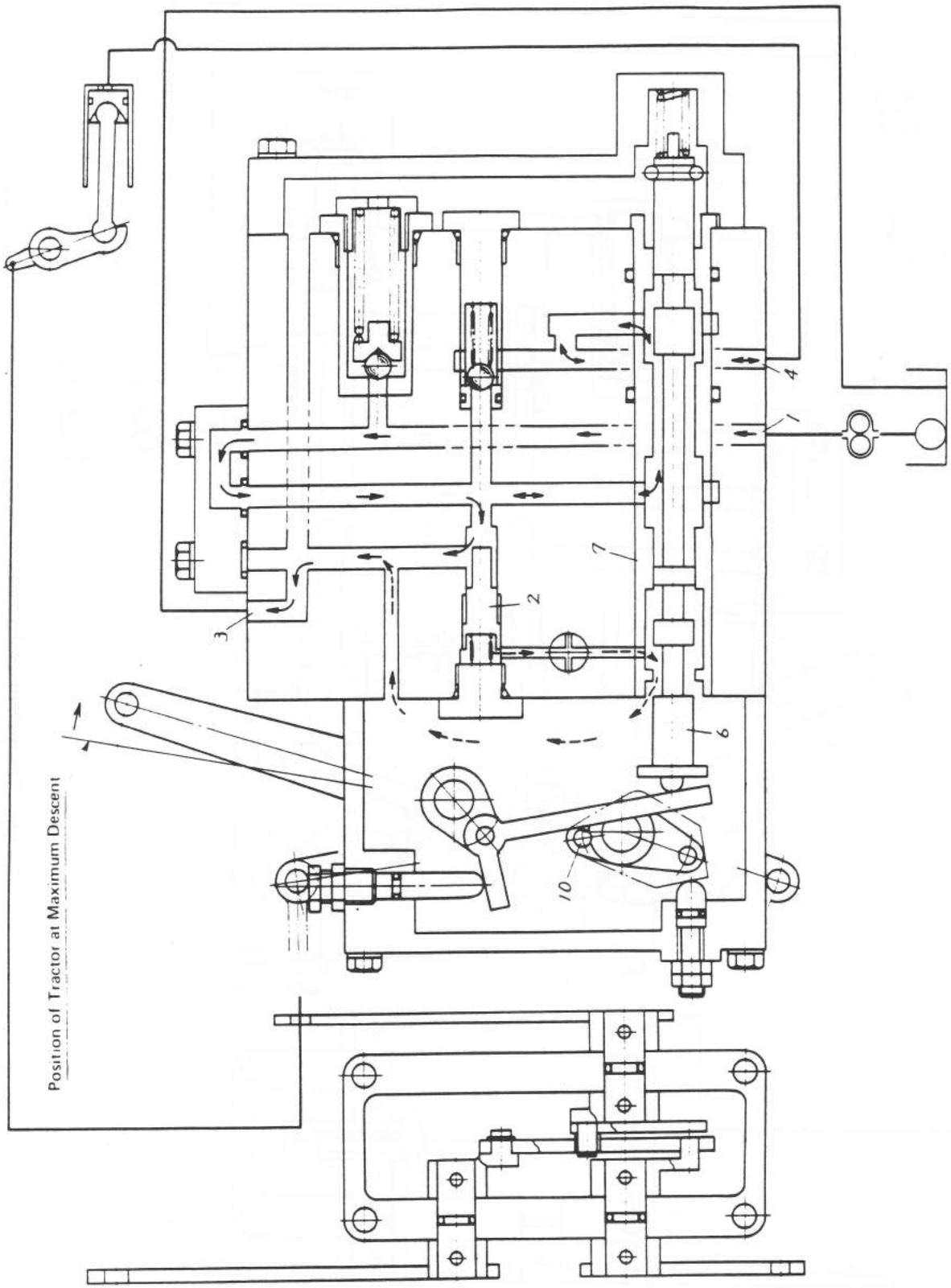


Fig. 13 Floating State

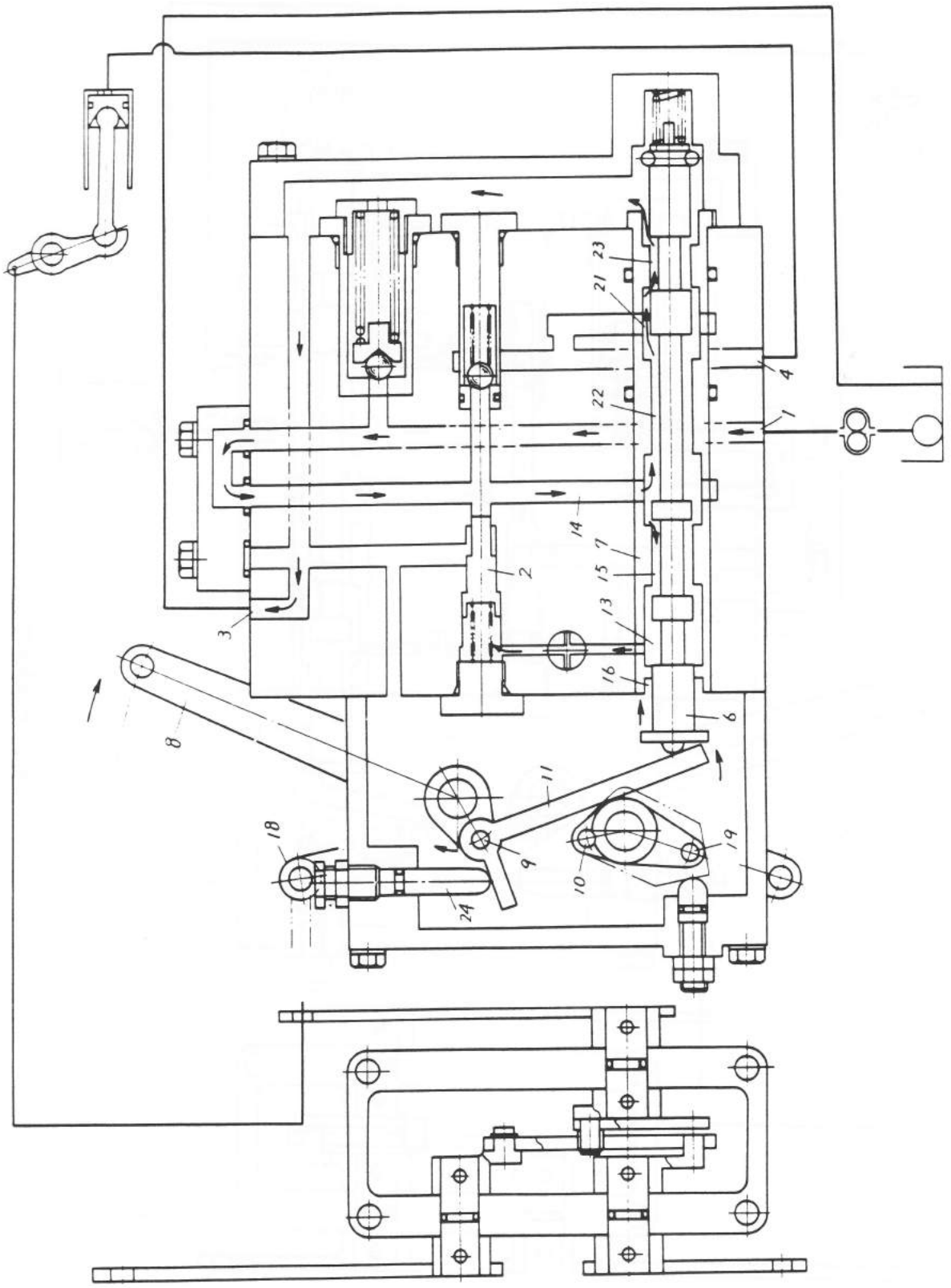


Fig. 14 Operation for Traction

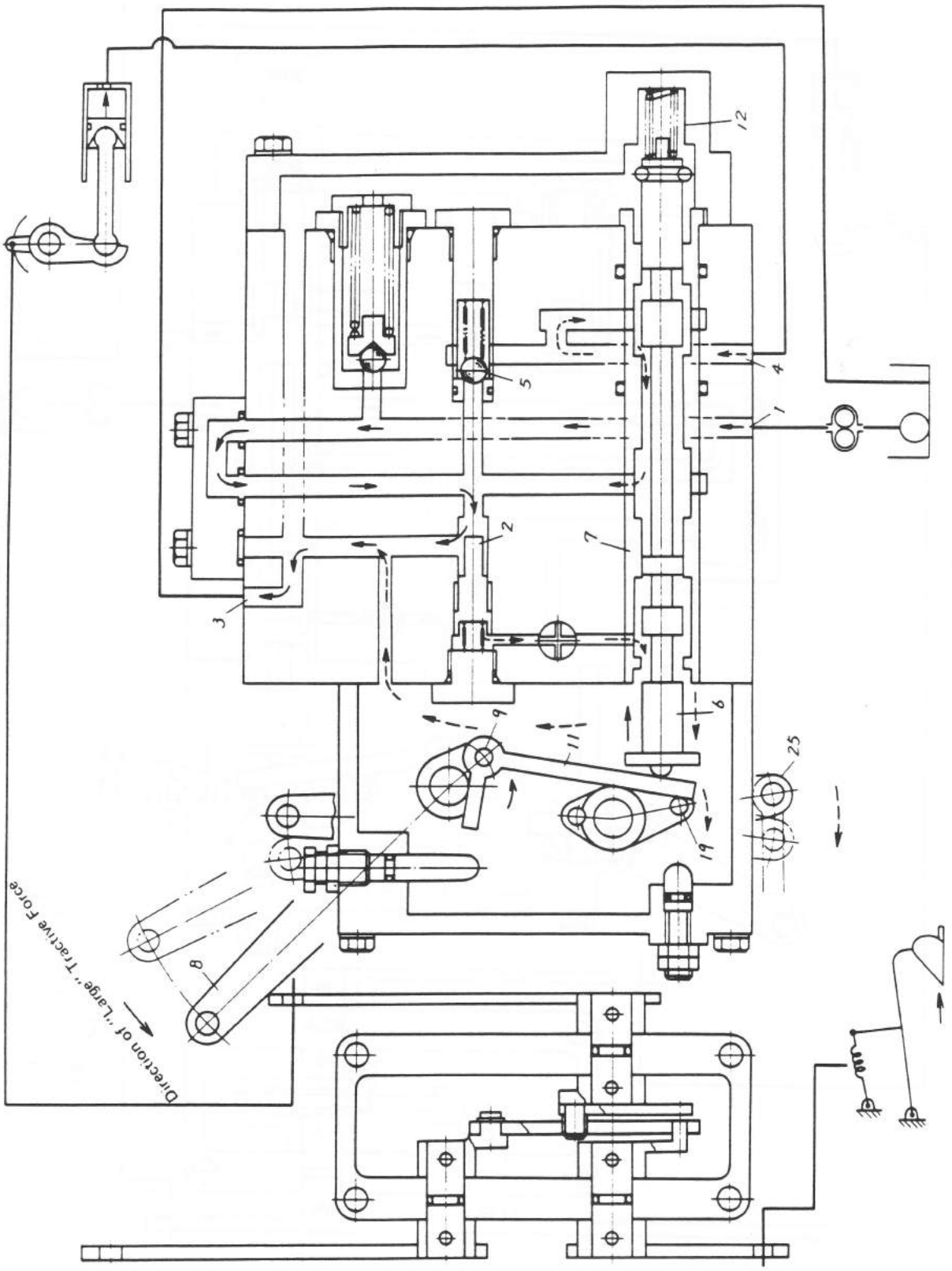


Fig. 15 Case of "Large" Tractive Force

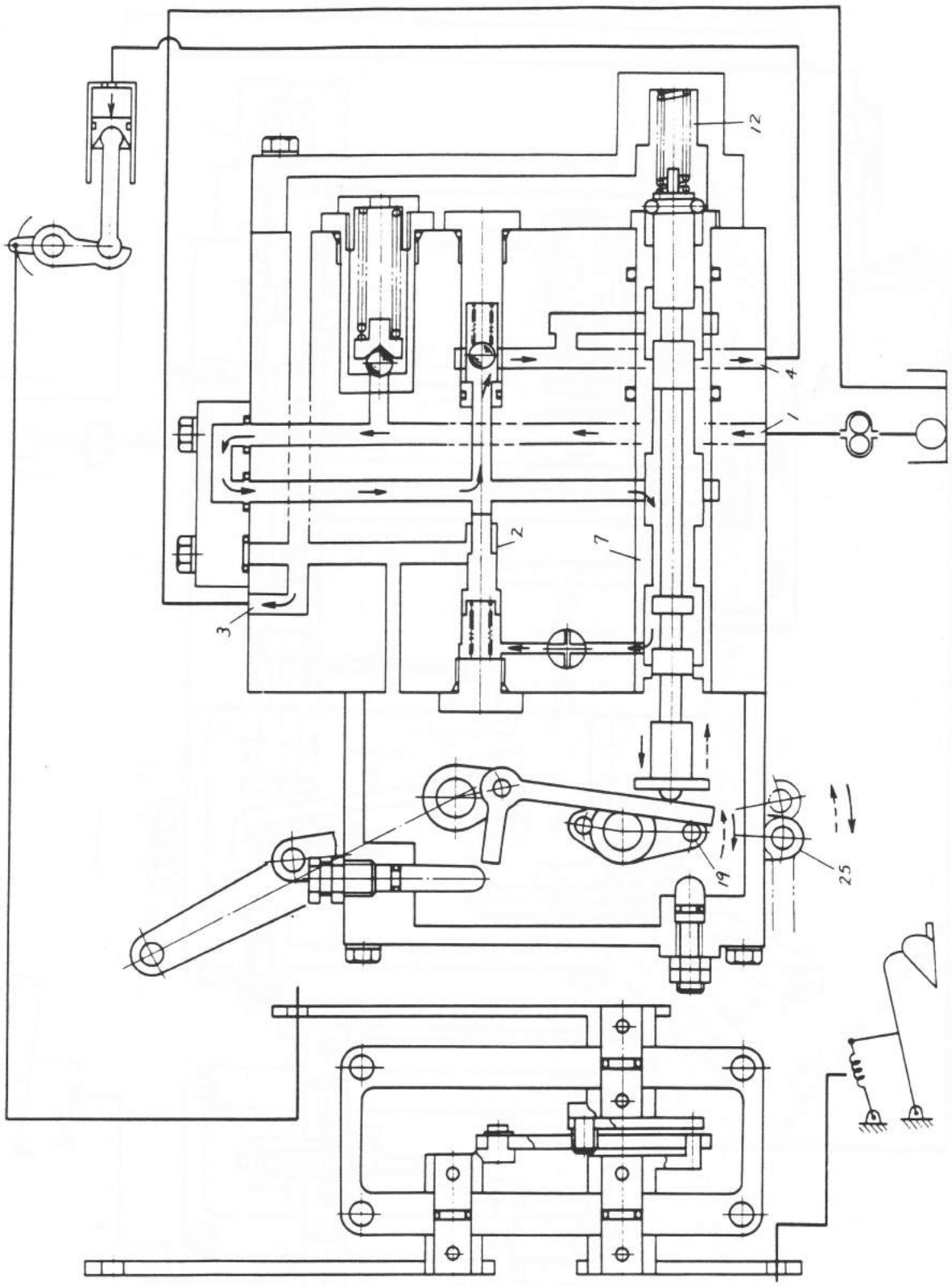


Fig. 16 Tractive Operation with Control Link Fixed in Place
(This figure illustrates the state of the tractive force increased.)

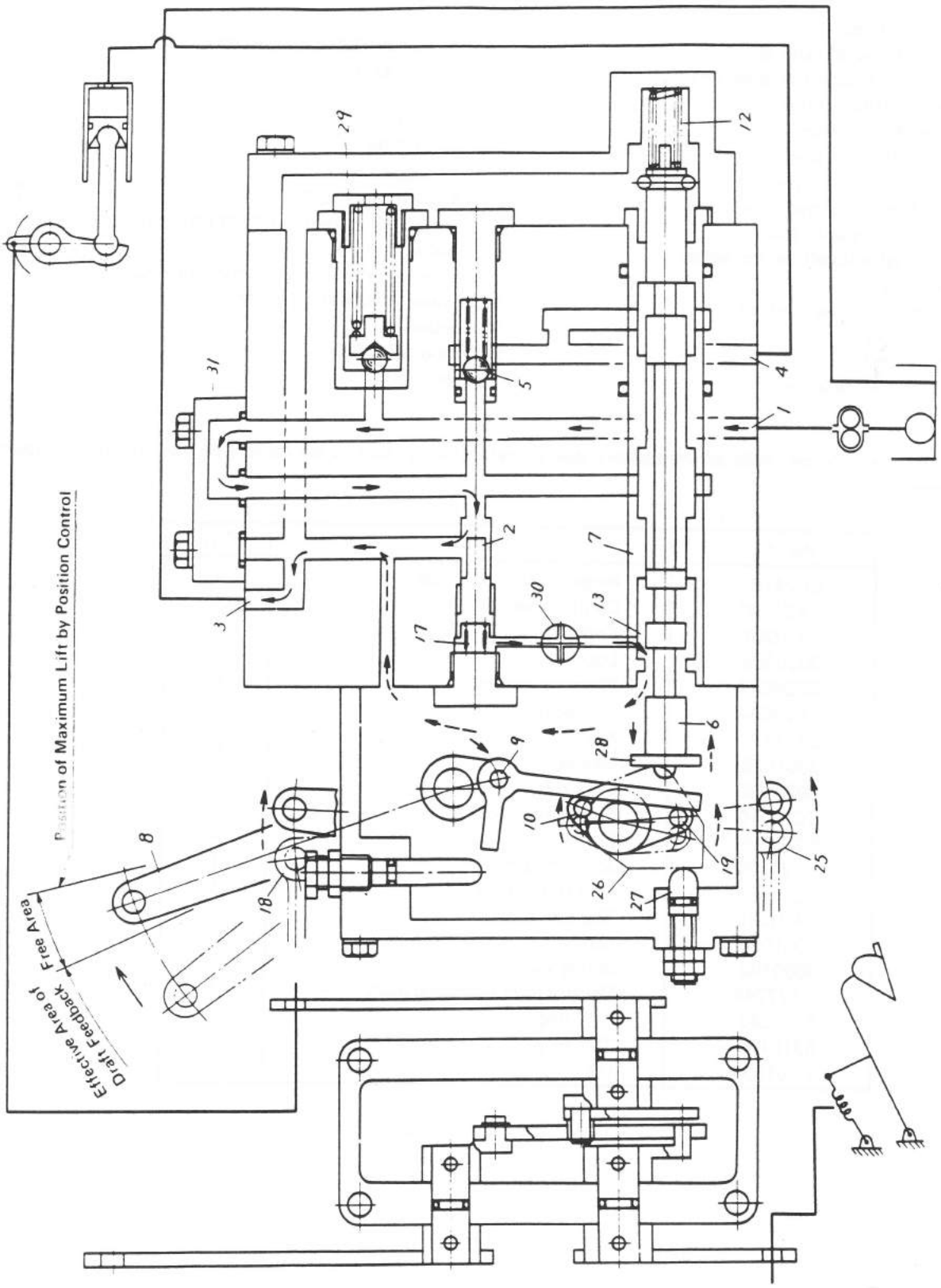


Fig. 17 Draft Position Drawing: Free Area

9. Specifications

1)	Type of cylinder	One cylinder
2)	Pressure for relief valve setting	1706 lb/sq.inch (120 ± 5 kg/sq.cm)
3)	Maximum lift power at lower link	1,102.5 lb (500 kg)
4)	Diameter of ram piston	2.76 in (70 mm)
5)	Stroke of ram piston	3.15 in (80 mm)
6)	Material of ram piston	Cast iron FC-25
7)	Type of hydraulic pump	Pressure loading type
8)	Name & model of hydraulic pump	KAYABA-DOWTY GP-1
9)	Output of hydraulic pump	4.1 gal/min. (17 lit/min.) at 2800 engine r.p.m.
10)	Control valve (Draft control valve)	Spool valve, pilot type
11)	Lock valve	In-line non-return valve (Automatic flow control)
12)	Control valve (Sub control)	Spool valve, 3 way flow change type
13)	Strainer mesh	100 meshes
14)	Hydraulic oil	Turbine oil No. 120
15)	Hydraulic oil capacity	0.92 gal (3.5 lit)

The component parts to be rendered unnecessary due to installation of shaft draft control on your tractor include the following items.

Part No.	Description	Q'ty
CC24220	Height control valve ass'y	1
CA24100	Control lever	1
6900083	Knob	1
3000083	Lock nut	1
CC24077	Belleville washer	4
CC2409A	Arm boss	1
5724010	Key	1
3501025	Washer	1
3020103	Lock nut	2
CC24110	Connecting rod	1
5220015	Cotter pin	4
CC24120	Joint lift arm	1
CC24030	Striker arm boss	1
CA31010	Top link support	1
2001020	Screw	6
3600102	Spring washer	6
CA27240	Control lever operating mark	1
8310240	"O" ring	1
8310180	"O" ring	1
VL01600	"O" ring	2

SATOH TRACTOR

MODEL S-650G
REPAIR MANUAL

POWER ASSISTED STEERING

PUBLICATION No. 03-I

FOREWORD

This manual is applicable to Satoh Power Steering System available as a kit and assembled by Satoh distributors or dealers in US for use on Satoh S-650G Tractors.

It contains instructions for the men who are responsible for the upkeep and availability of tractor on the job. It is requested that this manual be read through in order that you may result in faster, more lasting work without having costly damage to the unit or parts.

CONTENTS

POWER ASSISTED STEERING

Precautions:

Observe the following when installing a Satoh power assisted steering in the field:

1. The most satisfactory service can be expected from a Satoh power steering when the maintenance procedures are based upon a clear understanding of the items described in this manual.
   Before assembling a kit, be sure to read this manual through, in order that you may result in faster, safer and more lasting work.
2. It is essential upon receipt that the entire kit be inspected carefully for missing or damaged parts.
3. If parts are found missing, receive new parts under Claim provisions.
   If missing has been caused during transportation, this must be covered by insurance.

1 Factory Installation:

Factory power steering applications utilizes a different **oil pump, GP1-25**, having a greater capacity. When installing a National Loader on the tractor, refer to page 2.

2 Field Installation:

The oil pump "GP1-25" will also be available through our Parts Department for use on Satoh S-650G tractors in the field.
When placing your order on this pump, use the following part number:
Part No. CA26010 Oil Pump GP1-25

3 Greater Capacity Oil Pump:

The operation of the power steering depends upon a booster arrangement in that a flow divider admits part of oil (1.58 gal/min (6 lit/min) to the booster.
The pump must then be capable of greater capacity to secure oil necessary to operate the ram cylinder.

Note:

1. On tractors with **serial number S-650G 200001** and onward, four tapped holes (M12 x P1.5) are provided for the attachment of the anchor bracket for the pump.
2. On tractors with **serial number S-650G-300201** and up, king pin and steering lever with involuté splines are assembled at the factory. With this arrangement, only thing you must do is to replace the left steering lever CA6186L. For more complete information, refer to the Technical Service Bulletin No. 0005 "Steering".

4 Construction

A hydraulic power-steering system can be installed on all Satoh S-650G tractors with minor modifications and minimum replacement of parts. The unit is a booster type in which hydraulic pressure is used to take over and do most of the work of steering.
The pressure is supplied by the main pump which is common to the power lift of the tractor and is driven directly from the tractor engine at the front.
The assisting action of the unit comes into effect when the steering-wheel is rotated. This admits oil at 1138 lb (80kg/cm^2) (1.58 gal/min) (6 lit/min)) pressure to one side or the other of the divider to assist in the turning effort. The flow divider is of an orifice design. On a left turn (extension), the booster operates at 2205 lb (1000kg) whereas on a right turn (retract), it receives oil at 1545 lb (700 kg).
Thus, even with 2205 lb (1000 kg) load on the front, the system can operate satisfactorily, assuring easier loading/unloading.
Oil passes through the divider into the booster when the engine runs at 1000 rpm. Thus, although the engine runs at idle, most of the work of steering is assisted by the unit.
oil starts to flow to the power lift when the speed of engine exceeds 1000 rpm. It is therefore essential that the engine speed be kept above 1000 rpm when operating the 3-point linkage or front loader. The power steering kit for field installation does not include this larger capacity pump, but it is available as an optional part through our Parts Department.

5 Mounting National Loader

In case where power steering and national loader are mounted on a tractor, follow the instructions given below.

To install a power steering, it is necessary to remove, where used, the loader. Re-install the loader after mounting the power steering.

Your first step is to drill three holes through which bolts are inserted to secure the pump anchor bracket CA6710. See the Instruction Book of national loader, page 7, ref. No. 3 part number 10106 Left Rear Mounting.

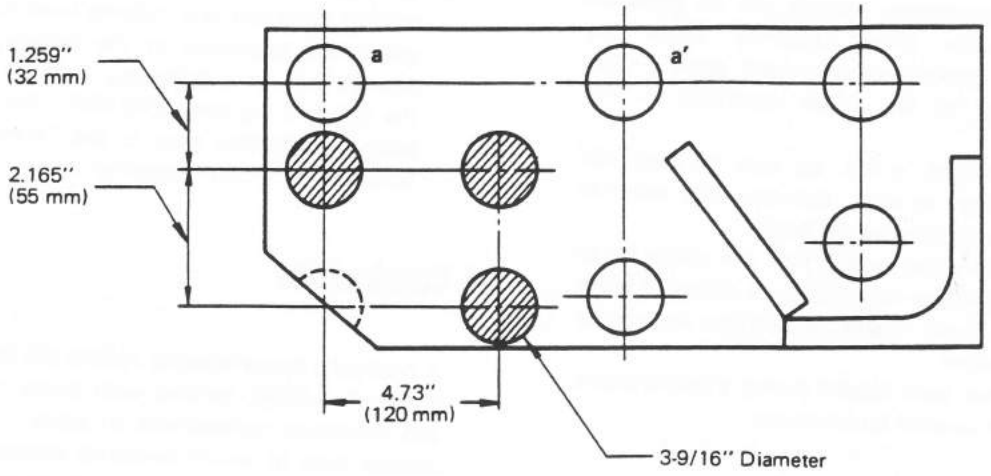


Fig. 1

Draw a line across the centers of the holes "a" and "a'." Drill three holes in the mounting using the line as a reference. The holes are shadowed for identification. The dotted hole at the lower left covers half of the tapped hole in the chassis.

Effective immediately, the loader will be shipped with the pump anchor bracket holes drilled.

Notes:

1. Remove the **spacer CA61740** when the loader is installed together with the power steering.
2. Extend the front tread by 2 inches (50 mm) at the left when the loader and power steering are installed on a tractor. Failure to follow this caution causes the booster to strike the upright stay of the loader.

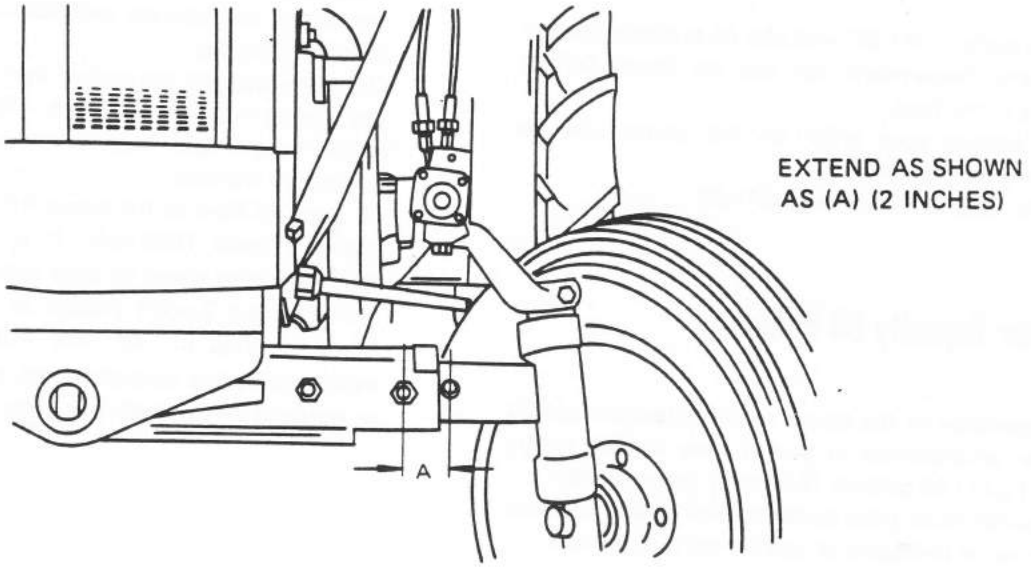


Fig. 2

6 Assembling Power Assisted Steering

6-1 Observe the Following Assembly Notes

1. In removing parts, use care to avoid damaging the parts since some parts are reused.
2. Keep working area clean and wash all removed parts in solvent. Use added care to avoid dust and dirt getting on them, after cleaning. Always replace O-rings and oil seals whenever removed.
3. The following Shows a list of parts which are to be removed for the installation of the power assisted steering. Parts other than those enumerated should be re-used.

Part No.	Discription	Q'ty	Size	Remarks
*CD2067R	King Pin (R.H.)	1		Serial No-S650G-100500 in ward Serial No-S650G-200001 On ward
*CD2067R	King Pin (B.H.)	1		
*CD2067L	King Pin (L.H.)	1		
*CD20710	Steering Lever (R.H.)	1		
CD20720	Steering Lever (L.H.)	1		
5727025	Key	2		
1021270	Bolt	2	M12 x 70	
3020120	Nut	2	M12	
CD2087M	Ball Socket Ass'y (L.H.)	1		
CD2088L	Lock Nut (L.H.) Screw	1		
CA21300	Drag Link	1		
5225020	Cotter Pin	3	M2.5ϕ x 20	
T040628	Oil Seal	2	Tc40628	
5230020	Cotter Pin	2	M3ϕ x 20	
8310490	"O" ring	2	M49	
8310300	"O" ring	2	M30	
CA24617	Suction pipe	1		
CA24657	Delivery Pipe	1		
8350220	"O" ring	2	M22	
8350300	"O" ring	1	M30	
8310220	"O" ring	1	M22	
8310240	"O" ring	1	M24	
8310180	"O" ring	1	M18	
CD20660	King Pin Bush	2		

On tractors with serial number S-650G 300201 and up, the asterisked parts need not be replaced.

6-2 Tapping holes for anchor bracket

This operation should be applied to tractors having serial number S-650G 100200 and inward.
From the accompanying illustration you will see that four tapped holes are drilled in the chassis: A, B, C and D.

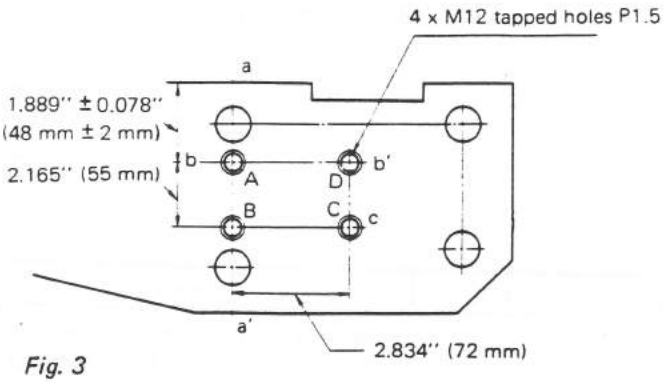


Fig. 3

Using a ruler, draw a line a-a', as illustrated here, across the center of the holes "a" and "a'." Then, draw another line b-b' in parallel with the line a-a' and 1.889" ± 0.078" away from it. This determines the location of hole "A". In like manner as above, determine the holes "B", "C" and "D" as per the instruction given in illustration. Drill 1/2" holes and tap them with 1/2" tap. Use 1/2" x 2.755" bolts to fasten the anchor bracket.

Note:

1. Be sure that the holes "A" and "B" are in alignment with the line a-a'.
2. Use 7T high-tension steel bolts to fasten the anchor bracket.

6-3 Disassembling Work for Mounting Power Assisted steering

1. Remove the battery and tool box; drain oil thoroughly from the oil case.
2. Remove the engine hood, paying attention to the light connector. Dismount the fuel tank.
3. Remove the drag links, tie-rods, under muffler and clutch pedal.
4. Disconnect the suction pipe CA24617 and delivery pipe CA24657.
5. Remove the steering lever and front hub oil seal bushing. Assemble the lever and bushing with new king pin. Refer to Repair Manual, Steering Linkage, Item 3 "Disassembling King Pin and Front Hub." Before assembling, clean all parts in solvent and apply a light coating of grease to them.
6. Remove the upper king pin bushing from the beam extension assembly.
   Install new bushing. Identification of the new bushing is aided by its O-ring groove at the center.
7. Install the new steering lever to the king pin with the punch mark pointing to the rear.

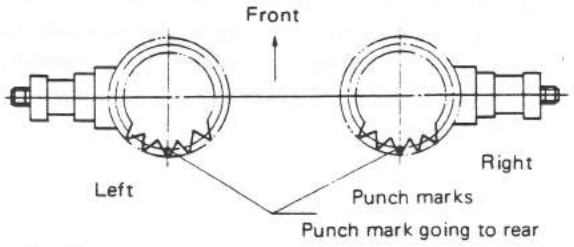


Fig. 4

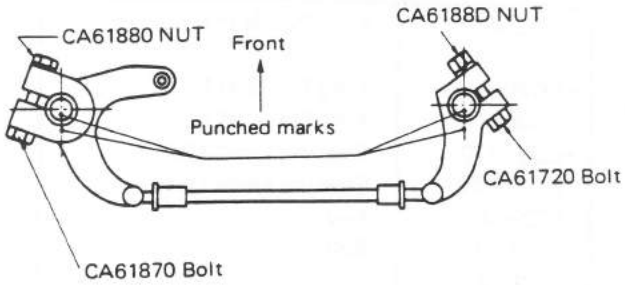


Fig. 5

Note:
On tractors with serial number S-650G 200001 and onward, the beam extension need not be removed from the center beam.
Reuse the existing spring washer.

8. Install the tie-rod and front tire.

6-4 Parts Name

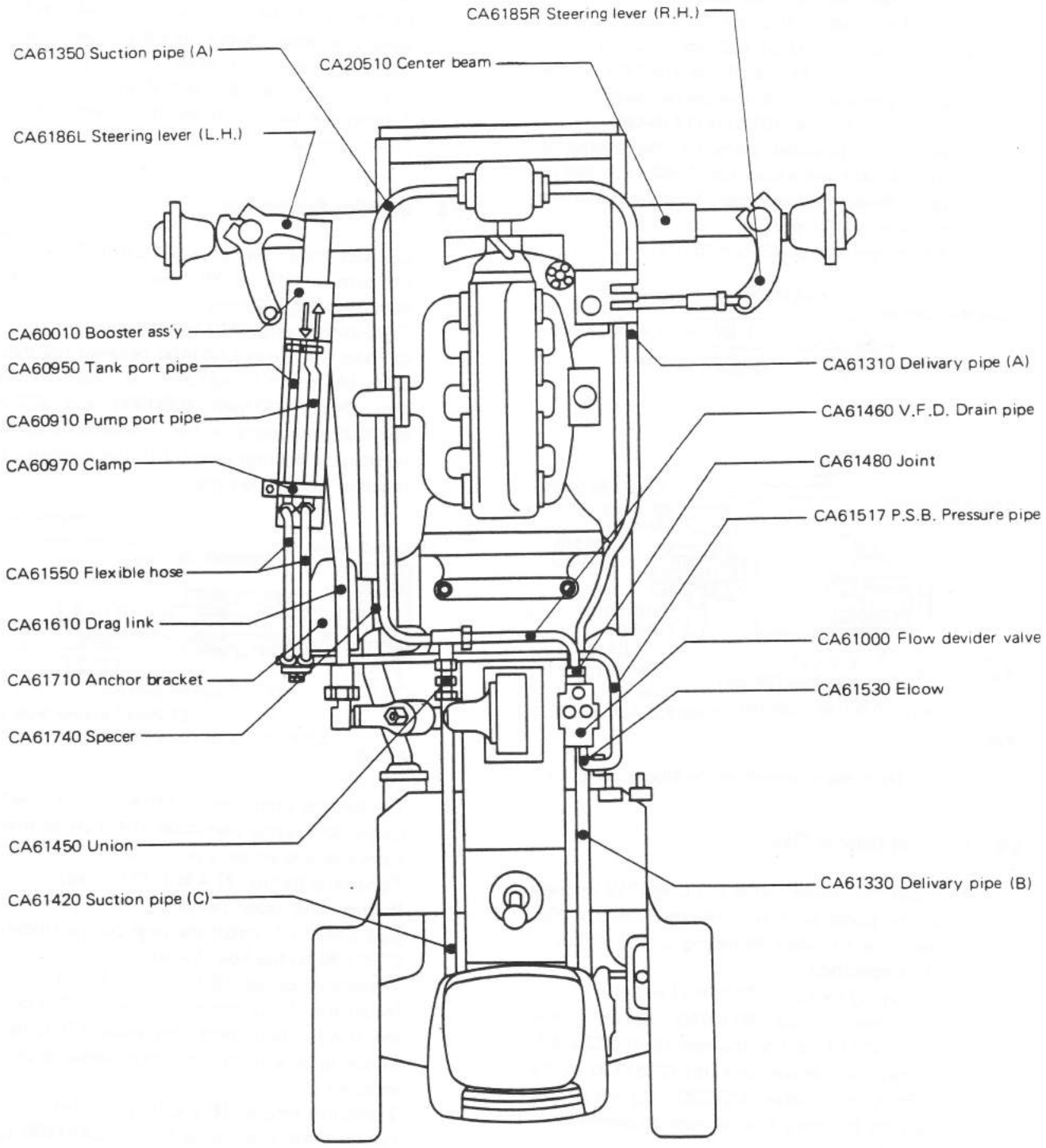


Fig. 6

6-5 Installing Flow Divider Valve

Before assembling, be sure that the working area is clean. Clean all removed parts in solvent and apply a light coating of grease to O-rings.

1. Place O-ring 8310221 (22 mm) in place in the adaptor CA61230; install the assembly on the outlet and inlet of the flow divider valve.
   Tightening torque: 101 lb-ft (14 m-kg)
2. Wrap the threaded parts of the connector CA6147000 and elbow CA61530 with sealing tape. Screw the joint into "T" (tank port), and elbow into "PS" port.
   Tightening torque: 43 lb-ft (6 m-kg)

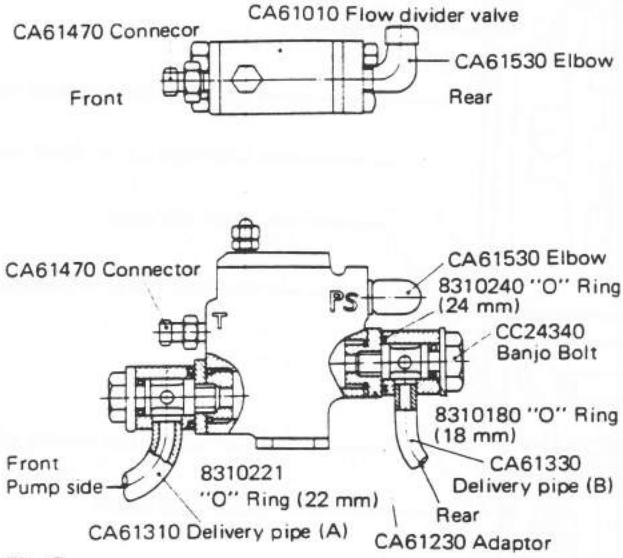


Fig. 7

Note: Note the direction of the elbow. (Fig. 3)

6-6 Installing Delivery Pipe

1. Install the delivery pipe (A) CA61310 in place on the pump with four (4) screw (M6 x 20). Use care to avoid damaging O-ring 8350220 while operation.
   Tightening torque: 7.22 lb-ft (1 m-kg)
2. Put new O-rings 8310240 (24 mm) and 8310180 (18 mm) on the banjo bolt CC24340. Connect the deliver pipe (b) CA61330 to the height control valve CC24220. Do not tighten the pipe (b) more than enough to permit slight movement.
   Tightening torque: 36.1 lb-ft (5 m-kg)

6-7 Installing Flow Divider Valve

Install the flow Divider CA61010 between the delivery pipes (A) and (B) CA61310 and CA61330 by means of the banjo bolt CC24340, with the letter side facing toward the steering gear box.
Use care to avoid damaging O-ring while installing.
Tightening torque: 36.1 lb-ft (5 m-kg)
Tighten the banjo bolt on the deliver pipe (C) as far as it will go.

6-8 Installing Suction Pipe

Connect the suction pipe (A) CA61350 with four (4) screws (M6 x 20), exercising care not to damage O-ring (22 mm).
Tightening torque: 7.22 lb-ft (1 m-kg)
Connect the union CA61450 between the suction pipes (A) and (C) CA61350 and CA61420. Press new O-ring (30 mm) 8350300 and (22 mm) 8310220 into place in the strainer (c) DC24440; tighten the suction pipe (c) to the hydraulic case together with the O-rings.

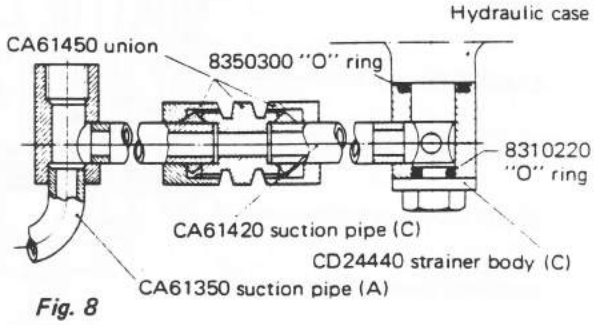


Fig. 8

Tighten the union bolt CA61450 until it will no longer go, paying particular attention so that the taper sleeve is properly positioned.
Tightening torque: 27.4 lb-ft (3.8 m-kg)
Position the taper sleeve on the P.S.B. pressure pipe CA61517; install the pipe on the elbow (PS) CA61530 on the flow divider.
Tightening torque: 18.1 lb-ft (2.5 m-kg)
Install the V.F.D. drain pipe CA61460 in place on the divider tank port connector (T) CA61470. Check to be sure that the taper sleeve is properly installed.
Tightening torque: 18.1 lb-ft (2.5 m-kg)
Connect the drain pipe V.F.D. CA61460 to the suction pipe (A) connector, paying attention that the ferrule is seated on the CA suction pipe (A) connector
Tighting torque: 30.3 lb-ft (4.2 m-kg)

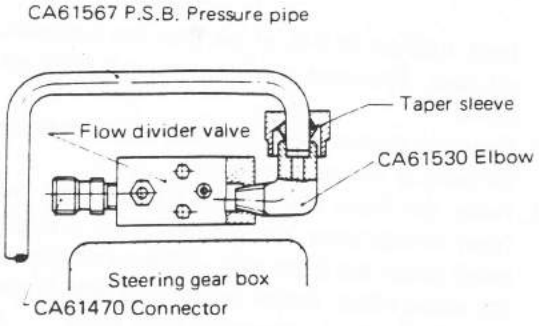


Fig. 9

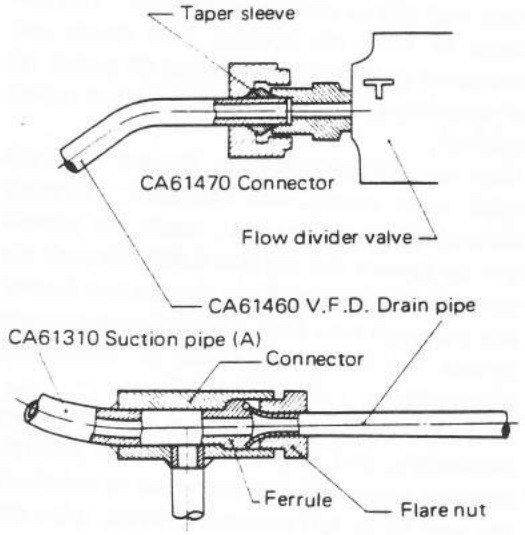


Fig. 10

6-9 Installing Anchor Bracket

Attach the right and left rear mountings (loader) 10103 and 10106 to the tractor.
Put the spring washer M12 on the bolt CA61720.
With ball stud of the anchor bracket CA61710 facing up, position the loader left rear mounting in between. Tighten them to specification.
Tightening torque: 61.4 lb-ft (8 m-kg)

6-10 Installing Booster Cylinder

Connect the pump and tank port pipes CA60910 and CA60950 to the booster assembly as per the instructions given below.
Tightening torque:
Clamp the pipes in place on the booster with the clamp CA60970.

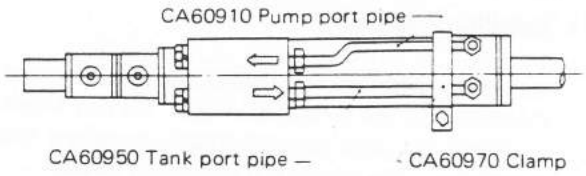


Fig. 11

Install the ball stud at the front end of the booster on the steering lever (L.H.) CA6186L, and at the rear on the anchor braket, and tighten.
Tightening torque: Steering lever 28.9 lb-ft (4 m-kg)
Anchor bracket 123 lb-ft (17 m-kg)

Notes:

1. Wipe clean the taper with a clean, lint-free cloth and apply a light coating of grease before installation.
2. When installing the booster, turn the steering wheel all the way to the right. This is important to minimize air getting into the booster cylinder.

Connect the flexible hose CA61550 to the P.S.B. pressure pipe CA61517. The hose is connected to the booster pump port pipe CA60910.
Connect the flexible hose which is connected to the booster tank port pipe to the P.S.B. drain pipe.
Tightening torque: 36.1 lb-ft (5 m-kg)

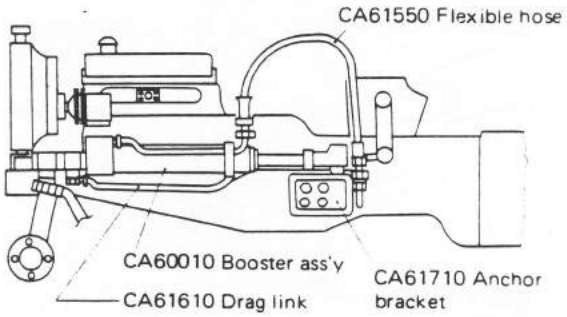


Fig. 12

6-11 Installing Drag Link

Install the ball socket CD2087S to the drag link CA61610 on the pitman arm side. Do not forget to install the lock nut CD2088R to secure the installation. The lock nut is right-hand thread.

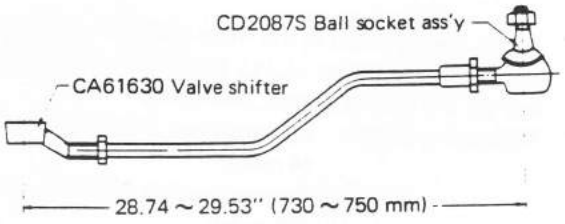


Fig. 13

Check to be sure that the distance between the valve shifter and ball socket is 28.74 to 29.53 in (730 to 750 mm) as shown in sketch above. Connect on the shifter side the drag link to the ball stud at the rear of the booster. Install the ball socket assembly CD2087S to the pitman arm.
Tightening torque: 28.9 lb-ft (4 m-kg)
Tighten the lock nut firmly and adjust toe-in so that it is 0.236 in (6 mm).
Secure the pipes in place on the anchor bracket by means of clamp.

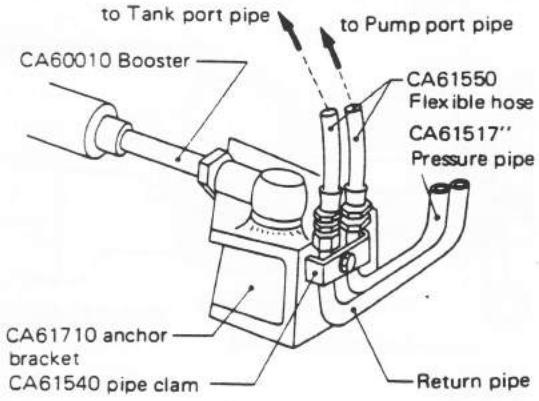


Fig. 14

Install the flexible hoses.
Check all joints or connections for tightness.
Install the following parts removed during previous steps for assembly:
(1) Clutch pedal
(2) Under muffler
(3) Fuel tank
(4) Engine hook
(5) Battery
(6) Tool box

6-12 Inspection and Testing (Air-bleeding)

1. Pour 1.06 gal (4.5 ℓ) of oil into the hydraulic oil case. Specified quantity of oil is 0.92 gal (35 ℓ).
2. Start the engine and run at idle speed, looking for leaks or any other defects.
3. Raise the front end of the tractor until the front wheels clear the ground; place a safety stand under the front axle. Without disturbing the above setup, rotate the steering wheel right and left slowly to actuate the relief valve.
4. Raise the speed of the engine until it runs at 2,300 to 2,500 rpm; rotate the steering wheel right and left as quickly as possible. This will purge air from the booster, flow divider and associated pipings. (Air will not be gotten rid of the system if the steering wheel is not turned quickly).
5. Turn the steering wheel to the left until the relief valve comes into operation. Without disturbing the above setup, return the pitman arm by turning out the bolt CA61730 until the valve stops relieving. Turn out the bolt further one complete turn from the above position and tighten the lock nut firmy to secure the adjustment.
6. After making sure that air has been bled out thoroughly, and that the relief valve will not function when the steering wheel is turned all the way to its left extreme position, drive the tractor at slow speed, looking for any abnormalities by turning the steering wheel right and left.

7 Booster

7-1 General

Satoh S-650G tractors use a linkage type power steering. The purpose of this system is to take over and do most of the work of steering. Unlike ordinary mechanical steering gears in which steering effort is assisted by a gear arrangement, the power steering utlizes hydraulic pressure.

In the hydraulic power steering system, an oil pump supplies hydraulic pressure.

As the steering wheel is rotated, valves are actuated, admitting this hydraulic pressure to the power cylinder by means of the booster.

7-2 Features

(1) Unique valve mechanism keeps front wheels free from swaying motion and provides operational stability for driving.

(2) Simple arrangement with smaller number of components makes service jobs quite easy.

(3) Induction hardened and hard chrome plated piston rod with special rod seal has a high durability.

7-3 Construction

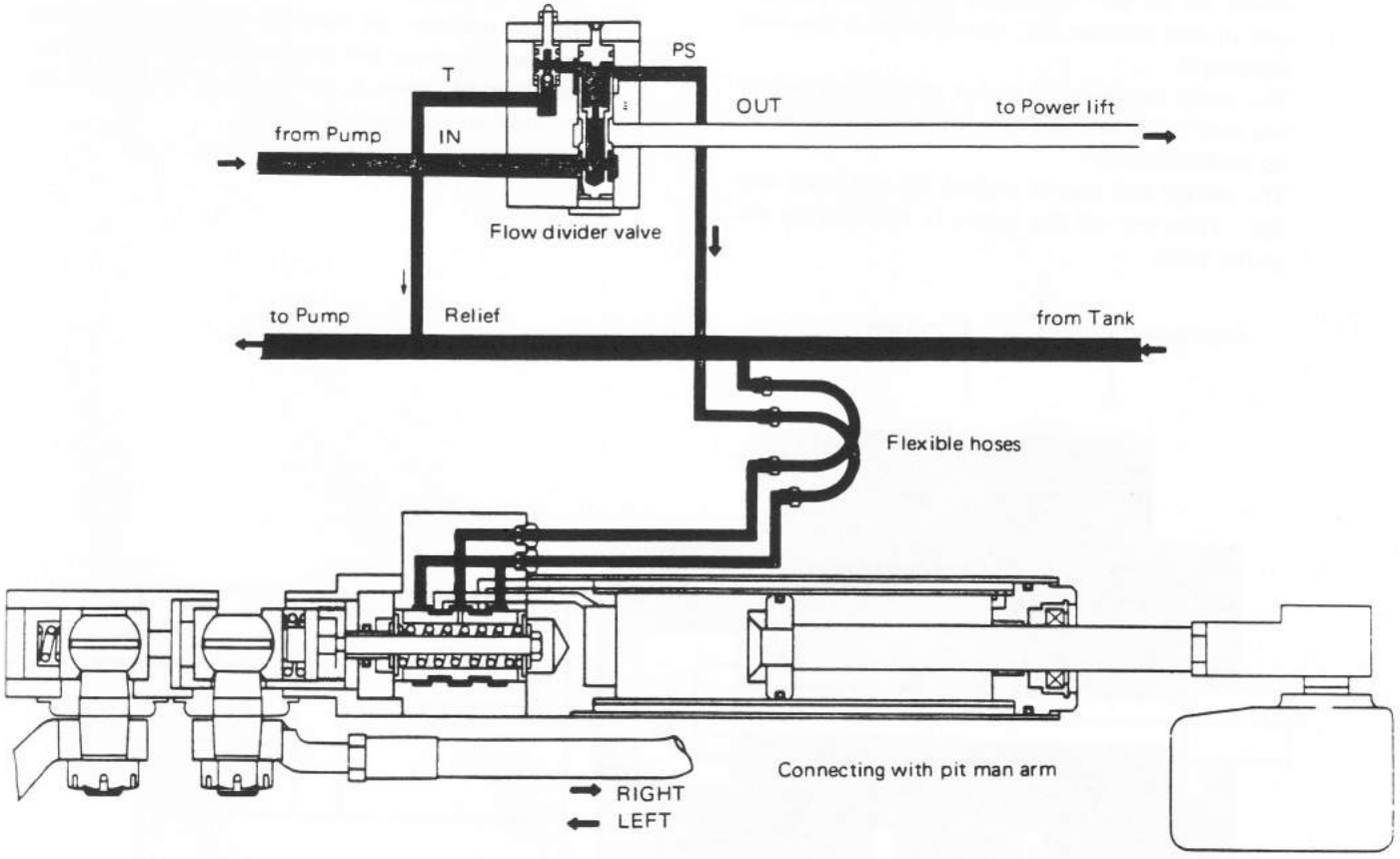


Fig. 15

The ball stud at the end of the piston is attached to the tractor frame through the anchor bracket. Thus, the hydraulic pressure in the power cylinder causes the cylinder itself to move.

The rear ball stud on the shifter connects to the pitman arm through drag link.

The shifter front ball stud is connected to the steering lever. As the steering wheel is turned, the spool valve in the control valve is actuated, directing hydraulic pressure to the power cylinder. Inside the power cylinder, pressure is applied to the head end or rod end of the cylinder. This causes the cylinder to move in the same direction as the control valve.

The valve housing is integrated with the power cylinder. Therefore, the housing is moved together with the cylinder as a unit. In other words, the housing follows the movement of the spool valve.

When the spool valve is moved and is held stationary, further movement of the cylinder closes the oil port leading to the head or bottom end of the cylinder; i.e., the cylinder is also held stationary.

The same sequence of events takes place within the unit to stop or maintain the steering wheel at its applied position.

The shifter ball stud is moved 2.5 mm right and left. (The end of the sleeve is opposed by the shifter wall).

Effort on the steering wheel is transferred to the steering linkage even if the oil pump is defective, provided that the resistance of the front tires is greater than force appeared at the power cylinder.

7-3-1 Control valve

The control valve consists of a housing, spool and centering spring. The housing has three inner grooves whereas the piston incorporates two outer grooves.

The right and left grooves in the housing communicates with the pump port. The center port communicates with the tank port.

The centering spring provides a mechanical means of centering the spool in the valve housing.

7-3-2 Operation

Neutral

During neutral, or straight-ahead, operation, the valve spool is centered in the valve housing by the centering spring.

In this position, oil from the oil pump just flows around the spool and is returned to the oil tank. As a result, there is no tendency for the power cylinder to exercise any action.

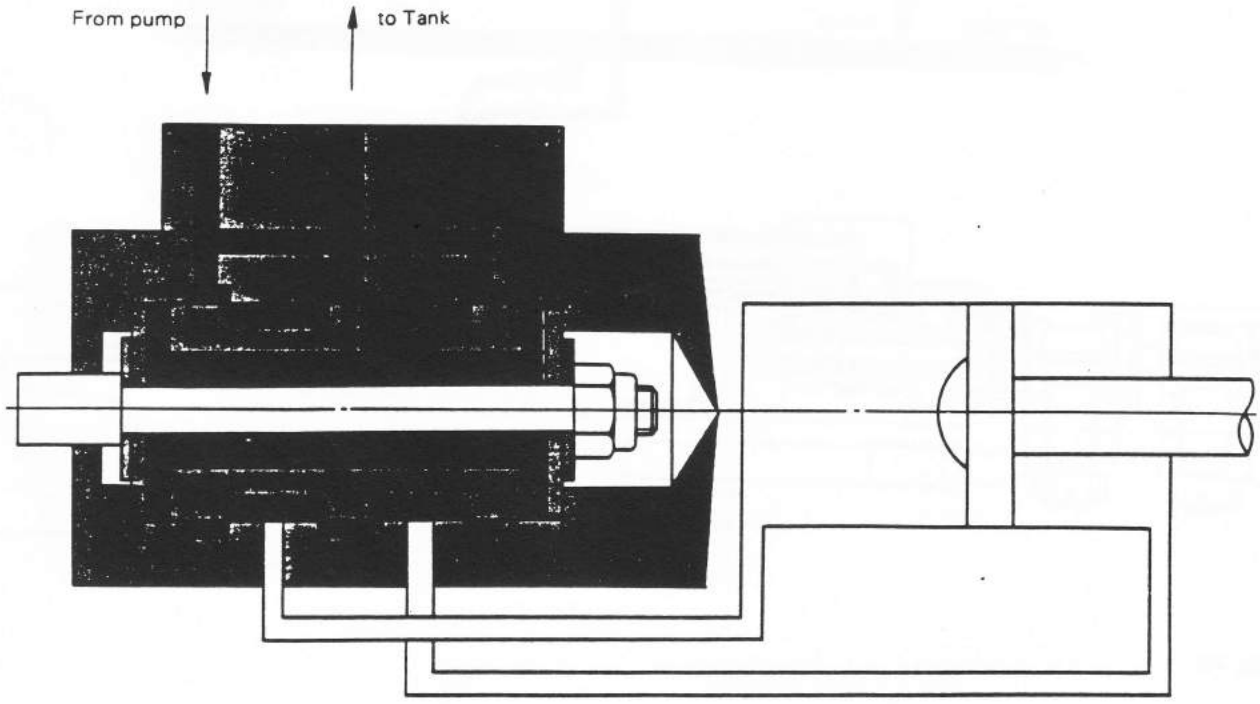


Fig. 16 Neutral Position

Extension (left turn)
When a left turn is made, the pitman arm swings to the left, pulling the spool in the same direction. As this takes place, the spool uncovers the oil port (left port) leading to the head end of the cylinder. Movement of the cylinder in the same direction then occurs, and this movement is transferred to the steering linkage. Speed of movement of the cylinder is setermined by the amount of oil fed from the oil pump.

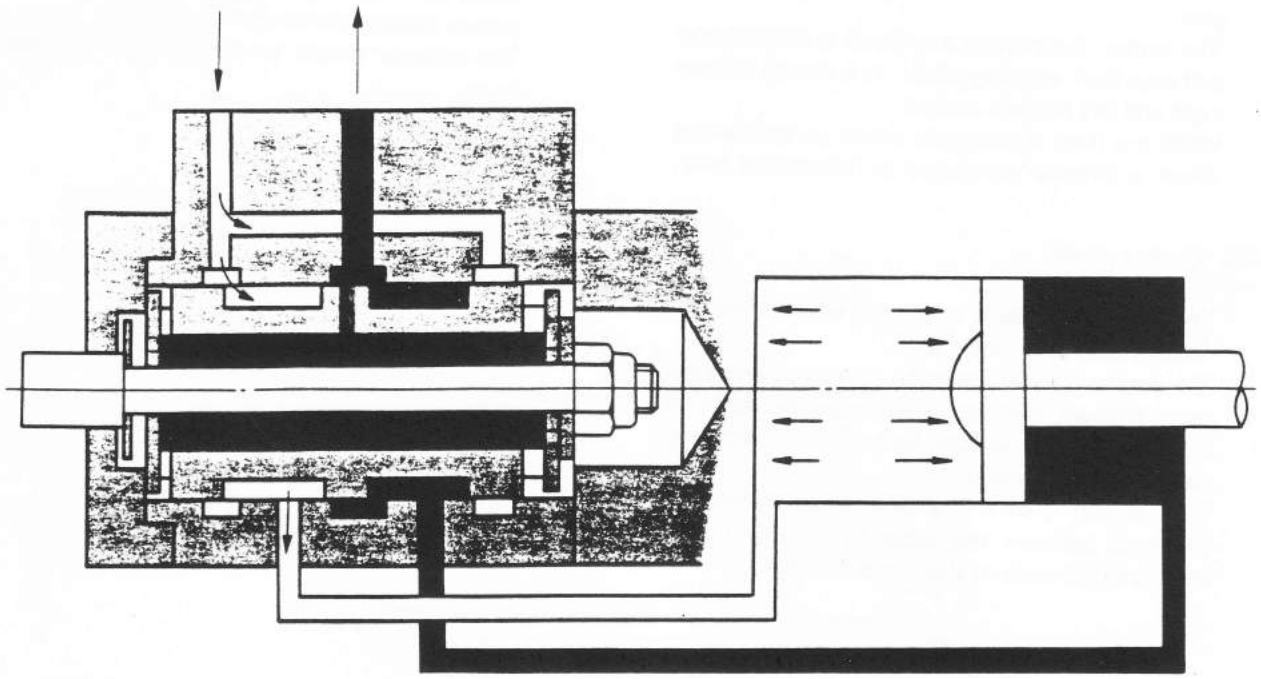


Fig. 17 Extension

Retraction (right turn)
Same sequence of events takes place within the unit as a left turn. However, in this case, oil from the oil pump flows into the right port in the ousing so that the cylinder is moved in the opposite direction.

7-3-3 Centering of spool

The centering mechanism for the spool consists of two rectangular spring seats at both ends and a centering spring inside the spool.
The spool, spring seats and spring are assembled as a unit with washer, bolt and nut.
Outer ends of the seats are flush with the ends of the valve. As the spool is moved to the left, as shown in accompanying sketch below, that side of the seat bears against the end of the valve cap. This allows the valve to center itself as the spool is returned to the neutral position.

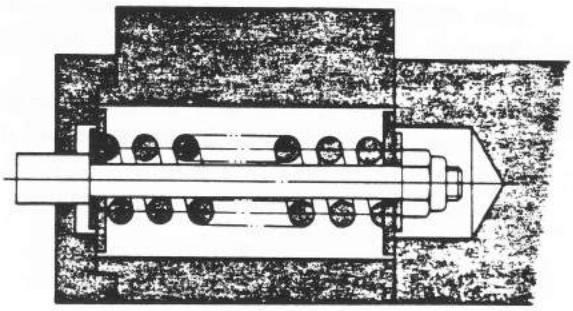


Fig. 18 Reaction of spool valve

7-3-4 Shifter

A shifter sleeve is encased in the shifter housing made of ductile cast iron. It is connected through the spool bolt to the spool. The ball stud seats in a pair of seats which is spring loaded to eliminate play.
The shifter incorporates a dust seal to prevent dust and mud from entering inside. It is moved 2.5 mm right and left through neutral.
When this limit is exceeded, effort on the steering wheel is directly transferred to the steering lever.

7-3-5 Power cylinder

The power cylinder is integrated with the control valve as described previously.
The entire cylinder assembly consists of an induction hardened, chrome plated piston rod, cast-iron piston ring, high quality cast-iron box and long wearing, low friction rod seal.
The cylinder is of a dual tube design in that the clearance between the tubes forms an oil path leading to the bottom end of the cylinder.

7-3-6 End

In the linkage-type power steering system, the power cylinder is not part of the steering gear. Instead, it is attached into the steering linkage.
When installing a power steering system, it is important that the piston end be attached to the anchor bracket on the tractor frame.
The cylinder should be connected to the steering lever.

8 Disassembly of Booster

In disassembling a booster, observe the following disassembly notes:

1. Place removed parts in a part rack so that they can be placed back to their original locations from which they were removed. Also use added care to avoid damaging parts while disassembling.
2. Wash all removed parts in solvent and dry with compressed air. Do not use rags or waste to wipe them clean. Keep parts away from dust and dirt until they can be re-installed. If necessary, apply grease or dip them in clean light oil to prevent rusting.
3. Always replace O-rings and oil seals whenever removed. before installing a new ring or oil seal, apply a light coating of grease to its sliding or sealing surface to provide for initial lubrication.

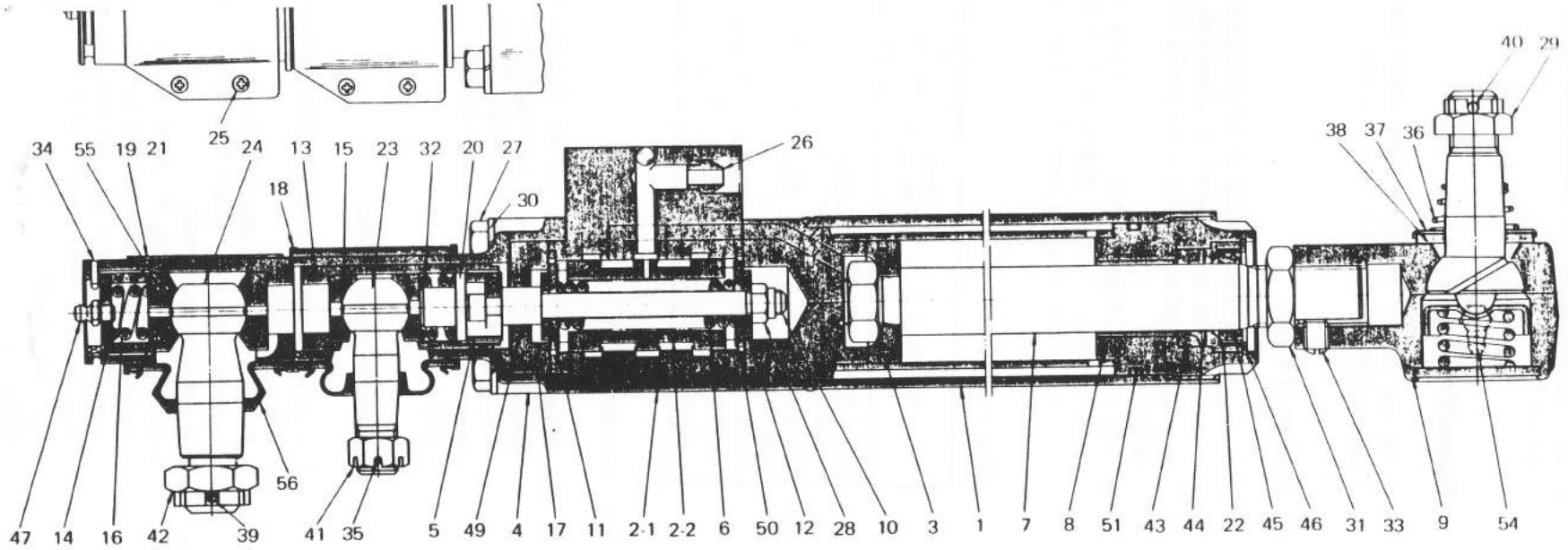
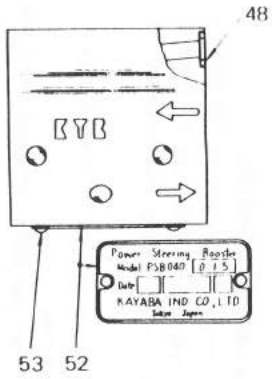


Fig. 19

Ref. No.	Part No.	Part name	Q'ty	Ref. No.	Part No.	Part name	Q'ty	Ref. No.	Part No.	Part name	Q'ty
1	CA60210	Cylinder ass'y	1	19	CA60720	Retainer	2	39	CA60830	Split pin	1
2	CA60020	Valve	1	20	CA60640	Spring sheet	1	40	CA60530	Split pin	1
2-2	CA60030	Valve housing	1	21	CA60730	Retainer	2	41	CA60680	Castle nut	1
2-2	CA60040	Spool valve	1	22	CA60370	Bush	1	42	CA60820	Castle nut	1
3	CA60290	Piston ring	1	23	CA60620	Stud	1	43	CA60350	"U" ring	1
4	CA60610	Shifter housing	1	24	CA60750	Stud	1	44	CA60360	Heel ring	1
5	CA60670	Hanger	1	25	CA60740	Tap screw	4	45	CA60380	Oil seal	1
6	CA60100	Spring	1	26	CA60050	Ferrule	2	46	CA60390	Snap ring	1
7	CA60250	Piston & rod ass'y	1	27	CA60840	Bolt	4	47	CA60800	Grease nipple	1
8	CA60301	Box	1	28	CA60130	Self lock nut	1	48	CA60180	"O" ring	2
9	CA60410	End ass'y	1	29	CA60520	Castle nut	1	49	CA60080	"O" ring	1
10	CA60090	Spool bolt	1	30	CA60850	Washer	4	50	CA60170	"O" ring	2
11	CA60110	Spring sheet	2	31	CA60550	Nut	1	51	CA60340	"O" ring	1
12	CA60120	Washer	2	32	CA60650	Spring	1	52	CA60860	Name plate	1
13	CA60660	Sleeve	1	33	CA60540	Set screw	1	53	CA70870	Tap screw	2
14	CA60790	Screw	1	34	CA60810	Split pin	1	54	CA60470	Tap screw	1
15	CA60630	Sheet	2	35	CA60690	Split pin	1	55	CA60760	Sheet	2
16	CA60770	Spring	1	36	CA60490	Retainer	1	56	CA60780	Dust seal	1
17	CA60070	Cap	1	37	CA60490	Retainer	1				
18	CA60710	Dust seal	1	38	CA60480	Dust seal	1				



8-1 Removal of Booster

1. Remove the flexible hose CA61550
2. Remove the steering lever, valve shifter and nut at the end of the piston. Take out the booster, exercising care not to damage the threaded part of the stud.
3. Remove the clamp and disconnect the pump and tank port pipes.
4. After the booster has been removed from the tractor, place it in soft jaws of a suitable vise. Special wooden pads are available for this purpose.
5. Pry the retainers (19), (21) and (25) and dust seals (18) and (56) off the shifter housing (4) using a thin end of a screwdriver.
6. Loose off a total of four bolts (27); take out the shifter and valve assembly (1) from the power cylinder. Hold the valve housing by hand while removing to prevent it from falling on the ground.
7. Re-install the cylinder in the vise on its front end; loosen off the nut (31) and set screw (33). The end can then be taken out.
8. Using special tool "Wrench" and a soft-faced hammer, drive the box (8) out of the cylinder (1).
   The cylinder tube is staked to the groove in the box. Before removing, break the staked area until the box can be rotated freely. The piston rod seal can be replaced without loosening the box. The seal, however, should be replaced as a kit.

8-2 Disassembly of Box

1. Pry O-ring (51) out of position using a petty knife. Always replace O-ring whenever removed.
2. Using a pair of pliers, remove the snap ring (46); carefully remove the bushing (22), heal ring (44) and U-ring seal (43). The dust seal (45) is press fitted to the bushing (22). Do not disassemble the bearing.

8-3 Disassembly of Shifter

1. Pull out the spool valve (2-2) from the valve housing (2-1). Do not use excessive force or angle the spool since such handling will ruin the spool.
2. Grooves in the valve and housing should be sharply edged. If the edges are dull or rounded, replace the valve as an assembled unit.
   Also discard the valve if the clearance between the spool and housing is excessive too badly beyond use.
3. Withdraw the ferruel and replace with a new one if it is leaky.

8-4 Disassembly of End

1. The end cannot be disassembled except the retainer (37), spring (36) and dust seal (38).

8-5 Assembly of Booster

1. Prior to assembling, dip them all removed parts in clean light oil, and dry with compressed air. Wash clean tools to be used in assembling the booster.
2. After cleaning, inspect all parts for excessive or abnormal wear on their sliding or friction surfaces. If found going over the following limits, discard.

***Wear Limits (mm)**

Part Name	Max. clearance	Max. Allowable Limit
Spool valve and housing diameters	0.015	0.040
Sleeve and shifter housing diameters	0.140	0.300
Piston rod and box diameter	(0.140)	(0.150)
Width of piston reing	1.600	1.549

8-6 Assembly of Box

1. Dip all new U-ring, heal ring and dust seal in clean light oil; apply a light coating of grease to O-ring; secure with the snap ring. Be careful that the snap ring is seated in its groove properly.

8-7 Assembly of Power Steering

1. Place the cylinder in a vise using special wooden pads.
2. Press the piston rod assembly into place in the cylinder. Use tool "Piston Ring Compressor" in installing the assembly.
3. Apply a thin coating of grease to the inside diameter of the outer tube; screw in the box (8) until it will no longer go. Peen over the outer edge of the cylinder against the groove in the box to prevent it from loosening while operation.

8-8 Assembly of Valve Assembly

1. With the valve housing on the bottom, slide the spool (202) into place in the housing by its own weight. Do not use excessive force or angle the spool in installing it.
   Check to be sure that the spool is moved right and left freely in the valve housing.
2. Apply a ligh coating of grease to O-ring (50) install the ring to the end of the housing (201).

8-9 Assembly of Shifter

1. Liberally apply grease to the inside diameter of the shifter housing (4) and ball seats (15) and (55).
2. Temporarily assemble the seat (15), spring (32), spring seat (20) and hanger (5) in place in the sleeve (13) ; install the assembly in the shifter housing (4).
3. Assemble the stud (23). Using a stud guide, tighten the hanger (5) all the way until it will no longer go; turn it out about 10°.
   Stake the sleeve (13) at two places.
4. Enter the seat (55), stud (24) and spring (16) in place. Tighten the screw to the nearest pin slit after resistance is felt. Install the cotter pin (34) to secure the installation.

8-10 Assembly of Valve and Shifter

1. Enter the end of the spool bolt (10) in the hanger (5). Assemble the cap (17) complete with O-ring (49).
2. Install the washer (12), spring seat (11), spool valve (2-2), spring (6), spring seat (11) and washer (12) in the order listed. After the above parts have been installed, tighten the self lock nut (28) to 0.8 m-kg torque using a suitable torque wrench.
   Discard the lock nut after used five times.
3. Make sure that oil hole in the valve housing (2-1) is lined up with that in the cylinder (1); install four bolts (27) with washers (30) under them. Torque the bolts to specification in oriss-cross fashion to exert even pull.
   Tightening torque: 14.4 lb-ft (2 m-kg)
4. Install the dust seals (18) and (56) in their correct positions. Fasten the retainers (19) and (20) with tapped screws (25).

8-11 Assembly of End

1. Screw the end (9) in place on the rod (7); secoure the installation with the set screw (33) and lock nut (31).

9 Flow Divider Valve

9-1 General

The flow divider valve divides oil from the oil pump into two circuits; one for the ram cylinder, and the other for the power cylinder. The valve utilizes a priority design.

The booster circuit includes a relief valve to revent abnormal pressure from being attained in the system. This relief valve also furnishes protection for the power steering circuit.

With this unit incorporated, stable assisting action of the system is assured through constant flow of oil divided into the circuit. It is compact, yet light in weight without power-wasting dead weight. Both the spool valve and relief valve depend on special construction and dumping mechanisms, assuring stable, smooth assist in steering the tractor.

9-2 Construction

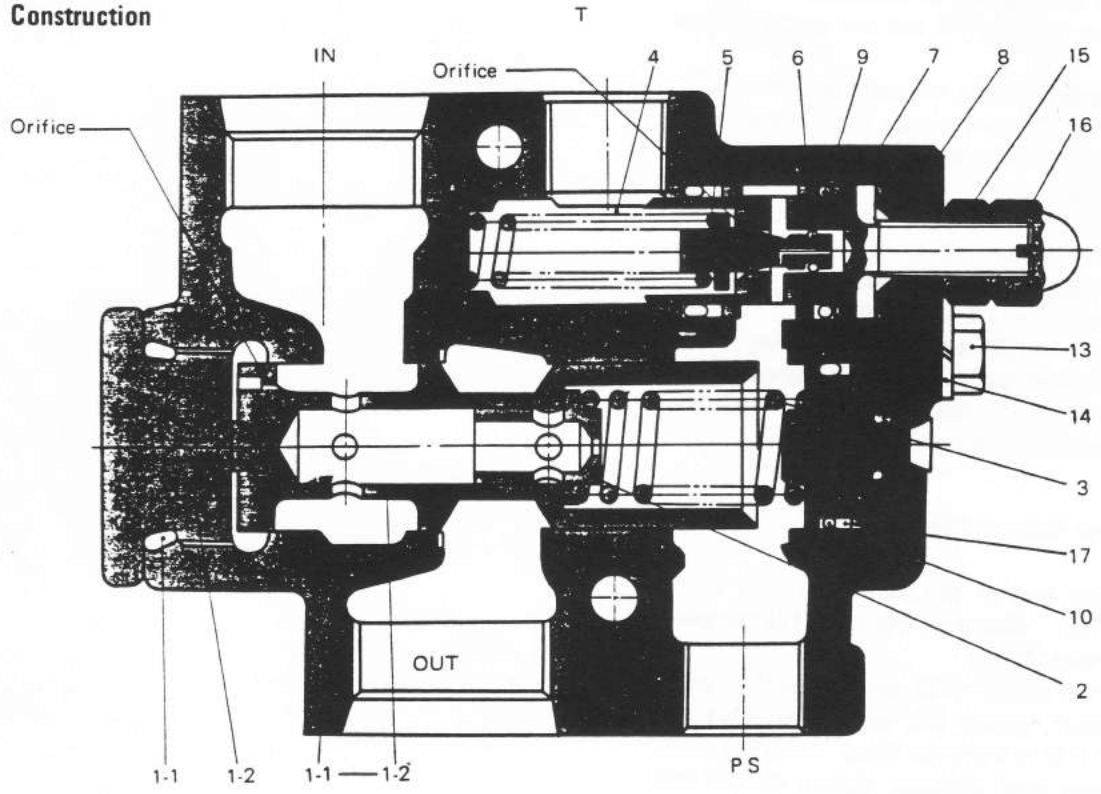
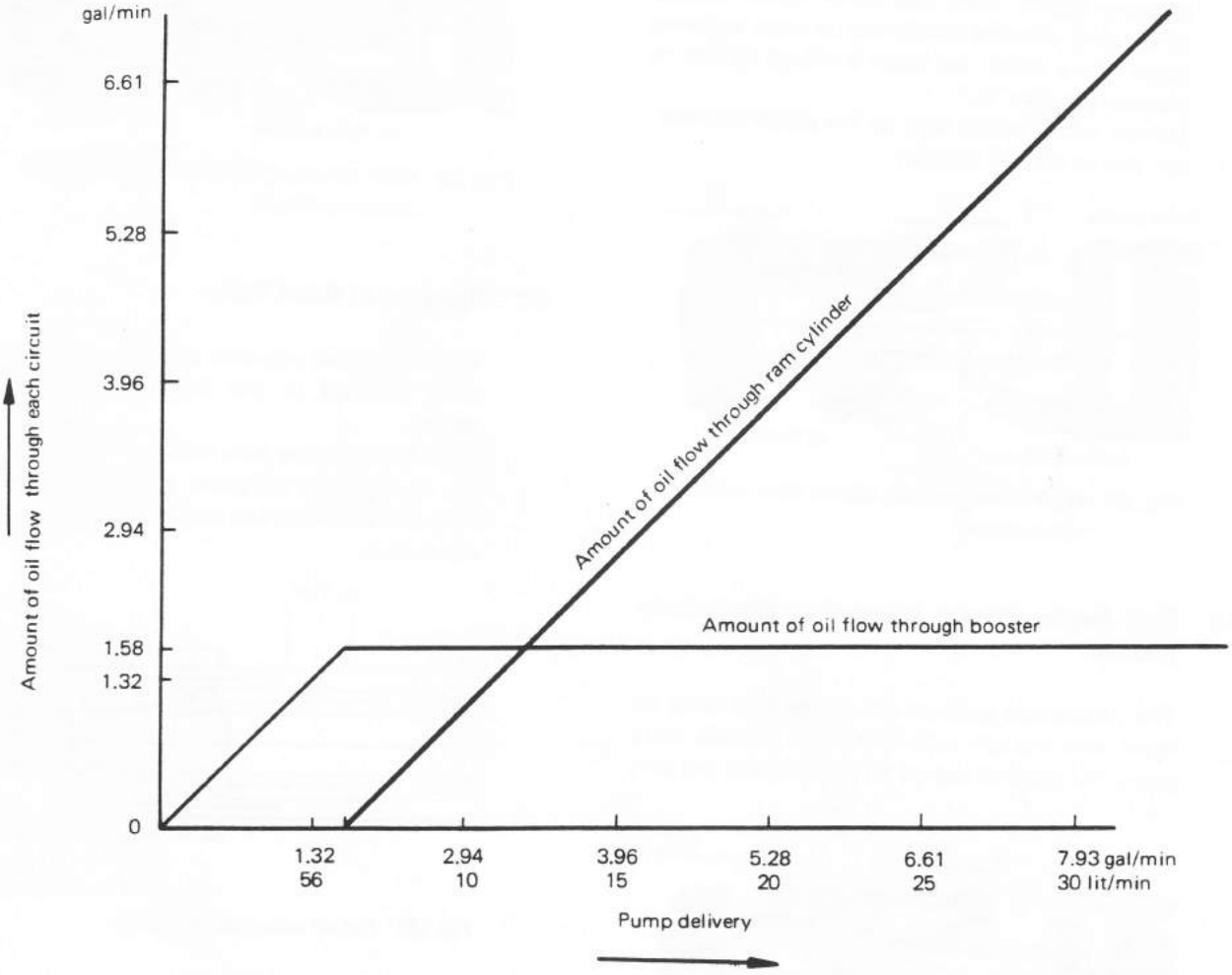


Fig. 20 Construction of flow divider valve

1-1	CA61030 Body	9	CA61130 "O" Ring
1-2	CA61040 Spool valve	10	CA61140 "O" Ring
2	CA61050 Orifice	11	CA61150 "O" Ring
3	CA61060 Spring	12	CA61160 Plug
4	CA61070 Spring	13	CA61170 Bolt
5	CA61080 Valve	14	CA61180 Spring Washer
6	CA61090 "O" Ring	15	CA61190 Nut
7	CA61110 Housing	16	CA61210 Cap
8	CA61120 Plate ass'y	17	CA61220 Back-up Ring

9-3 Performance Curves



9-4 Operation of Spool Valve

The purpose of the spool valve is twofold; 1) to control the amount of oil flowing into the connected circuit, and 2) to regulate the pressure in each circuit.

9-5 With main pressure lower than relief valve setting

Under this condition, oil from the oil pump flows through orifices to one side or the other of the piston in the power cylinder. Differential pressure across the orifices causes the spool to move opposing the tension of the spring. The spool stops moving when an equibrium is reached between the oil pressure and force of the spring.
When the main pressure is lower than the relief valve setting, the port "A" is covered, making all oil available only for the power cylinder. That is, no oil will flow to the ram cylinder.

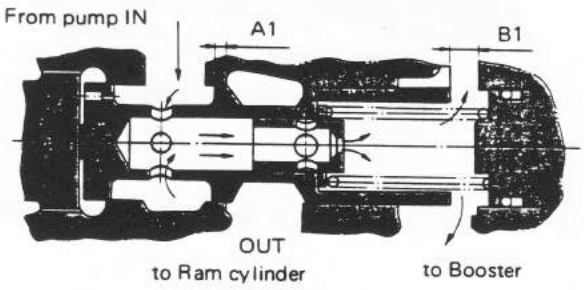


Fig. 21 With main pressure lower than relief valve setting

9-6 With main pressure higher than relief valve setting

When the oil pump brings oil and directs it under pressure higher than the relief valve setting, differential pressure across the orifices becomes larger. As a result, the spool is moved further to uncover the port "A."
The oil will flow not only to the power cylinder, but also to the ram cylinder.

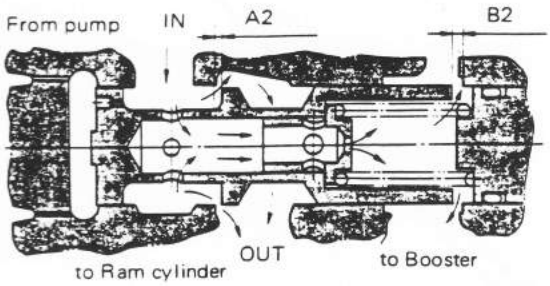


Fig. 22 With main pressure higher than relief valve setting

9-7 With booster pressure higher than ram cylinder pressure

The differential pressure will be lowered since oil flows into the ram cylinder circuit. As this takes place, the spool is moved so as to narrow the port "A".

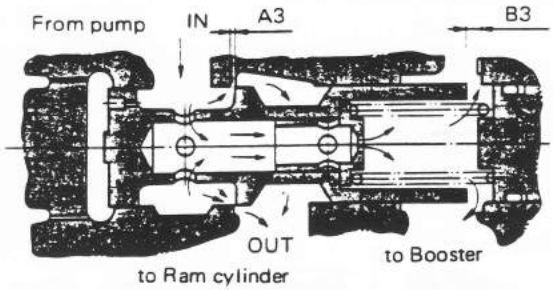


Fig. 23 With booster pressure higher than out circuit pressure

9-8 With booster pressure lower than ram cylinder pressure

Under such a condition, oil tends to flow to the booster circuit, causing the differential pressure to increase. This pushes the spool to the left to narrow the port "B."

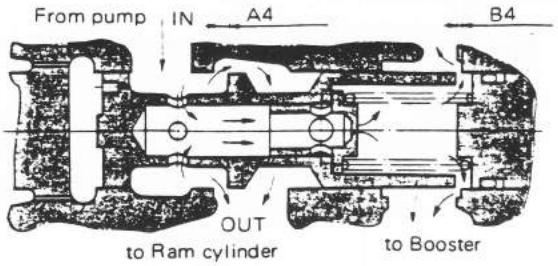


Fig. 24 With booster pressure lower than out circuit pressure

9-9 Operation of Relief Valve

The relief valve prevents abnormal pressure from being attained in the pressure circuits of the system.
When the pressure falls below 1138 psi (80 psc), the oil from the oil pump just flows around the valve and valve seat and is directed directly back to the oil tank.

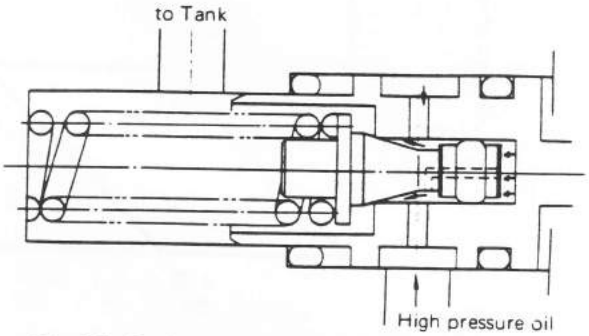


Fig. 25 Relief valve not actuated

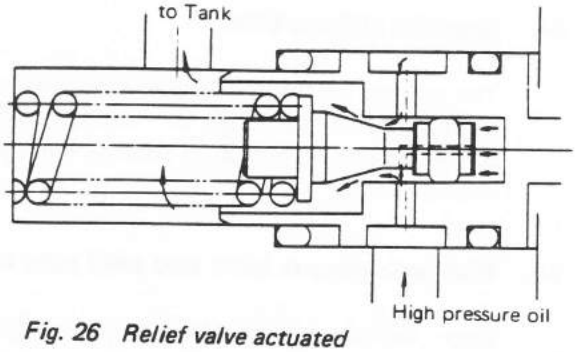


Fig. 26 Relief valve actuated

9-10 Disassembly and Assembly

Prior to disassembling a flow divider valve, observe the following items:

1. Do not disassemble valve unless it is absolutely necessary.
2. Should it become necessary to disassemble a valve, use clean tools and rags.

3. When disassembling and assembling the valve, or before doing any work on it, read this manual through so that you may result in faster, more lasting repair without having costly damage to the equipment or parts.
4. Use wooden pads or soft jaws in placing a valve in a vise. Neglecting this caution would result in damaged valve.

9-10-1 Disassembly (See Fig. 20)

1. Back off bolts (13) and (14) and spring washers under them. This will permit subsequent removal of the housing (7), valve (5), O-rings (6) and (9), nut (15), cap (16) and spring (4) together with the plate assembly (8).
2. Remove the spring (3) and orifice (2); take out the spool (1-2), exercising care not to damage it while operation.
3. Remove the cap (16) and nut (15). The housing (7) can then be taken out from the plate assembly (8). Remove the O-rings (10) and backup ring (17).
4. Loosen off the plug (12) and take out the O-ring (11).

9-10-2 Assembly

Clean all removed parts in solvent and dry with compressed air. To prevent damage to the inner O-ring (9), first apply grease to it and then enter it in the valve body (1-1). Finally assemble the housing (7).

10 Inspection and Repair

1. Check to see if the clearance between the body (1-1) and spool valve is held within the prescribed tolerance. Discard the valve as an assembly if the clearance exceeds 0.0014 in (0.035 mm).
2. The body and spool valve should be handled as a matched set. If any of these parts is found defective, replace all as an assembled unit.
3. Check the valve seat (5) for excessive or abnormal wear.
4. Always replace O-ring when a flow divider valve is disassembled.
5. If the relief set pressure falls below 1138 PSI 980 PSC), remove the cap (16) and turn the housing (7) screw either in or out until correct pressure is obtained. To increase the relief pressure, turn the screw in or out to decrease it. One complete turn of the screw will increase or decrease the relief pressure setting by 335 PSI (25 kg/cm^2).

Notes:

1. Under no circumstances should the relief pressure be allowed to exceed 1138 PSI (80 PSC).
2. The amount of oil flowing through the booster circuit is regulated by orifices and cannot be adjusted.

11 Maintenance and Inspection of Power Steering System

Farming tractors are subject to severe operating conditions. Careful and systematic attention to the following information will add much to performance, economy and long life of the unit.

Item to be inspected	Interval or work	Remedy
Oil leaks	Dialy, check booster and pipings for oil leaks; high pressure hose for signs of damage.	Re-tighten, repair or replace
Lubrication	Every 60 hours, apply grease to steering linkage, shifter and end	Repack grease
Excessive play in steering linkage	Every 200 hours, check linkage for excessive play.	Re-tighten ball stud seat or retighten
Oil	Use the same oil as is used for ram cylinder. Replenish oil if oil level is found to be low. Replace oil with fresh one if found deteriorated.	Add or renew

12 Troubleshooting Guide

The chart that follows lists various power steering complaints, their possible causes, and checks or corrections to be made. As a first step in diagnosing troubles, attempts should be made to determine the exact location of the trouble cause before removing the unit from the tractor.

12-1 Booster

Symptom	Probable cause	Remedy
Steering is heavy	(a) Steering worm gear out of adjustment or sturved	(a) Re-adjust or lubricate
	(b) Booster is lack of power	
	1. Pressure does not rise	1. Measure pressure in divider circuit. If necessary, replace
	2. Piston ring damage or control valve stick damaged.	2. Replace piston ring or control valve as a unit
	3. Steering linkage bending	3. Straighten
	4. Steering linkage joint too tight or sturved	4. Repair or lubricate
	5. Steering column out of alignment	5. Re-align
	6. Air present in booster	6. Bleed air. Refer to relative topic
Tractor is pulled to one side or steering wheel is not returned smoothly	(a) Worn tire or uneven tire pressure1	(a) Replace tire or inflate to specified pressure
	(b) Steering alignment improper	(b) Re-adjust
	(c) Back pressure between booster and tank too high	(c) Replace with proper oil. Check pipe
	(d) Spool and sleeve sticking	(d) Replace as an assembled unit. Lubricate
	(e) Steering gear out of order	(e) Re-adjust
	(f) Sleeve screw and spool bolt loosened (This can be determined by heavy steering when booster is extended)	(f) Remove booster and re-adjust
Excessive steering wheel play	(a) Excessive play in steering linkage connection	(a) Re-tighten
	(b) Steering gear sector out of adjustment	(b) Re-adjust
Noisy operation	(a) In steering	
	1. Oil pump noisy	1. Adjust
	2. Air present in booster	2. Bleed air. Refer to relative topic
	3. Loosenea spool bolt or spool valve excessively worn	3. Re-tighten. Replace valve as a unit
	(b) Metalic noise	
	1. Piston rod lock nut loosened or shifter and end ball stud adjust screw loosened	1. Re-tighten or adjust
	2. Steering linkage joint adjust screw loose or out of adjustment	2. Re-tighten or re-adjust as necessary
Steering wheel is heavy when turned quickly	(a) Air present in booster	(a) Bleed air. See relative topic
	(b) Flow divider divides too little an oil	(b) Inspect; if necessary, replace
	(c) Excessive internal leakage in booster	(c) Replace piston ring or valve as an assembly

12-2 Flow Divider Valve

Symptom	Probable cause	Remedy
Pressure is not built up in high pressure circuit	(a) Spool valve stuck (b) Relief setting too low	(a) Overhaul (Check for fouled oil or damaged valve) (b) Re-adjust
Pressure is not built up in output circuit	(a) Spool valve stuck	(a) Overhaul
Abnormal	(a) Incomplete air-bleeding (b) Spool valve stuck or relief valve O-ring damaged	(a) Continue operating until air is automatically bled out (b) Overhaul. Replace O-ring
Pressure is built up but slowly	(a) Spool valve sticky	(a) Overhaul (damaged spool valve surface or clogged orifice)
Abnormal noises	(a) Relief valve O-ring damaged	(a) Replace O-ring
PS pressure too high	(a) Relief valve out of operation	(a) Overhaul (clogged relief valve orifice)
Amount of oil flow th through PS circuit improper	(a) Spool valve stuck or spring defective tive	(a) Overhaul. Replace spring

13 Specification

1. Type: Bosster type (combained type with linkage) KAYABA made
2. Pressure source: Main pump through flow divider valve

BOOSTER (KAYABA made)	
1. Type of valve	Open center
2. Cylinder bore	1.574 inch (40 mm)
3. Rod diameter	0.866 inch (22 mm)
4. Stroke	7.88 inch (200 mm)
5. Cylinder output	Piston side 2205 lb (1,000 kg) Rod side 1545 lb (700 kg) at 1138 psi (80 psc) of relief valve pressure
FLOW DIVIDER VALVE (KAYABA made)	
1. Type	Flow control orifice type
2. Flow control	1.58 gal/min (6 lit/min)
3. Relief valve pressure	1138 psi (80 psc)
PUMP (Mian pump) KAYABA made	
1. Model	GPL-20 (Field installation)
2. Type	Pressure loading gear type
3. Pump capacity	4.5 gal/min (17 lit/min) at 2.800 engine rpm
PUMP (Factory installation)	
1. Model	GPL-25
2. Type	Pressure loading gear type
3. Pump capacity	5.82 gal/min (22 lit! min) at 2.800 engine rpm

Satoh **SATOH AGRICULTURAL MACHINE MFG. CO.,LTD.**

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