ISO

CHAPTER 5-2
TRANSMISSION SYSTEM

(Hydrostatic Transmission)

5-2

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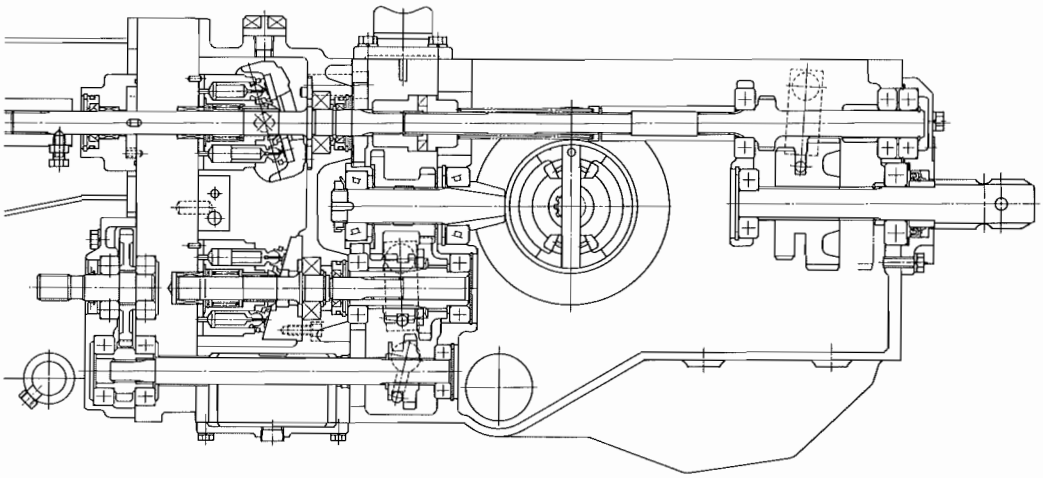
DESCRIPTION

Mitsubishi tractor MT180H/HD is equipped with two types of transmission (hydrostatic transmission and sliding gear type transmission). The hydrostatic transmission (HST) corresponds to the main gear change section in the mechanical type transmission. When changing the gear in the mechanical type transmission, the clutch must be disengaged, but the gear in HST can be changed without disengaging the clutch.
The gear in HST can be set to the stop, forward, and reverse positions with only one lever, and the speed of vehicle can be changed without changing the speed of PTO. The sliding gear type transmission consists of the sub-gear change section (two stages of high and low), differential, final drive, and PTO shaft which is SAE 1-3/8" in size and equipped with PTO overrunning clutch. The employment of HST has facilitated the front loading work, work on mower, etc. in which the gears are frequently changed from forwarding to reverse and vice versa.

NOTE

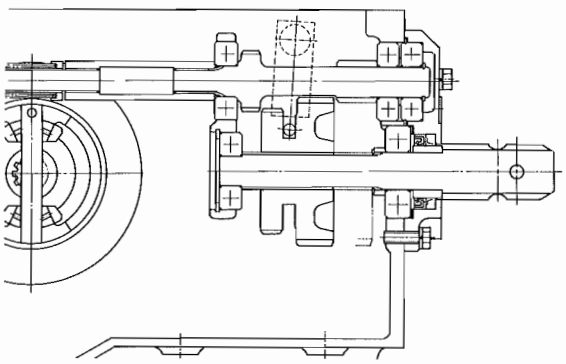
If HST lever is set to the neutral position, and PTO lever to the operating position, PTO shaft continues to rotate. However, if the clutch is disengaged, all the power train is disengaged, and therefore, PTO shaft stops, too.

CONSTRUCTION



Main transmission

This is a stepless hydrostatic transmission (HST). HST does not use gears but use oil to transmit the power of engine to the sub transmission and PTO gear. It is a shuttle transmission with which the forward and reverse positions can be changed easily by moving the lever straight.



The hydraulic circuit of HST is a closed circuit. In the closed circuit, the oil sent out from the cylinders or motors is not returned to the tank but sucked by the pump again.

< Open circuit >

In the open circuit, the oil sent out from the cylinders or motors is returned to the tank, then sucked by the pump.

Function of each section of HST unit and oil flow

(Function of each section)

1. Charge pump

   Althought the circuit is closed, some oil is always lost. This pump supplies the oil by the amount of lost oil. In this HST unit, a trochoid pump is used, which is operated while the engine is running.

2. Low Pressure relief valve

   This is the relief valve of the charge pump. It operates when an excessive load is applied to the charge pump to keep the pressure on

the low pressure side below the specified value and prevent the damage of the charge pump.

3. Cooler

If the temperature of the oil rises, it is deteriorated faster, and the efficiency of HST unit is lowerd. This cooler cools the hydraulic oil to prevent above troubles.

4. Oil filter

The parts of HST are finished accurately, and if dusts (especially metal chips) are mixed into the oil, they are bitten by the valves, etc. and the functions are incomlete. Therefore, the oil must be always cleaned. The oil filter removes the dusts in the hydraulic oil to send clean oil to HST unit.

5. Check valve

This valve prevents the high pressure oil between the pump and the motor from flowing back into the circuit connected to the charge pump to keep the pressure high and protect the charge pump. The oil supplied from the charge pump flows into the main circuit through this valve.

6. High pressure relief valves

Since the high and low pressure sides are changed over as the forward gear and reverse gear are changed, a high pressure relief valve is installed to each circuit. If the load is large and the motor cannot rotate, the high pressure relief valves operate to let the oil flows into the low pressure side and protect the pump and motor from the high pressure.

NOTE

1) In case of a closed circuit, the oil from the relief valve must be sent to the low pressure side. (If that oil is returned to the tank, the charge pump cannot supply the oil sufficiently.)
2) If the high pressure in a closed circuit is relieved, the temperature rises suddenly. Therefore, the load must be released.

7. Neutral valve (Flashing valve)

NOTE

This valve cleans and cools the oil, and called the flashing valve, too.

The high pressure oil flows into the rear of the spool in the neutral valve, and its pressure moves the spool toward low pressure side. The oil sent from the charge pump compensates the lost oil, and the excessive oil flows to the tank through the hole on the housing of the neutral valve.

If the swash plate in the pump is moved from forwarding position to reverse position and vice versa, the spool moves in direction opposite to the direction of pressure application to return the excessive oil to the tank.

(Oil flow)

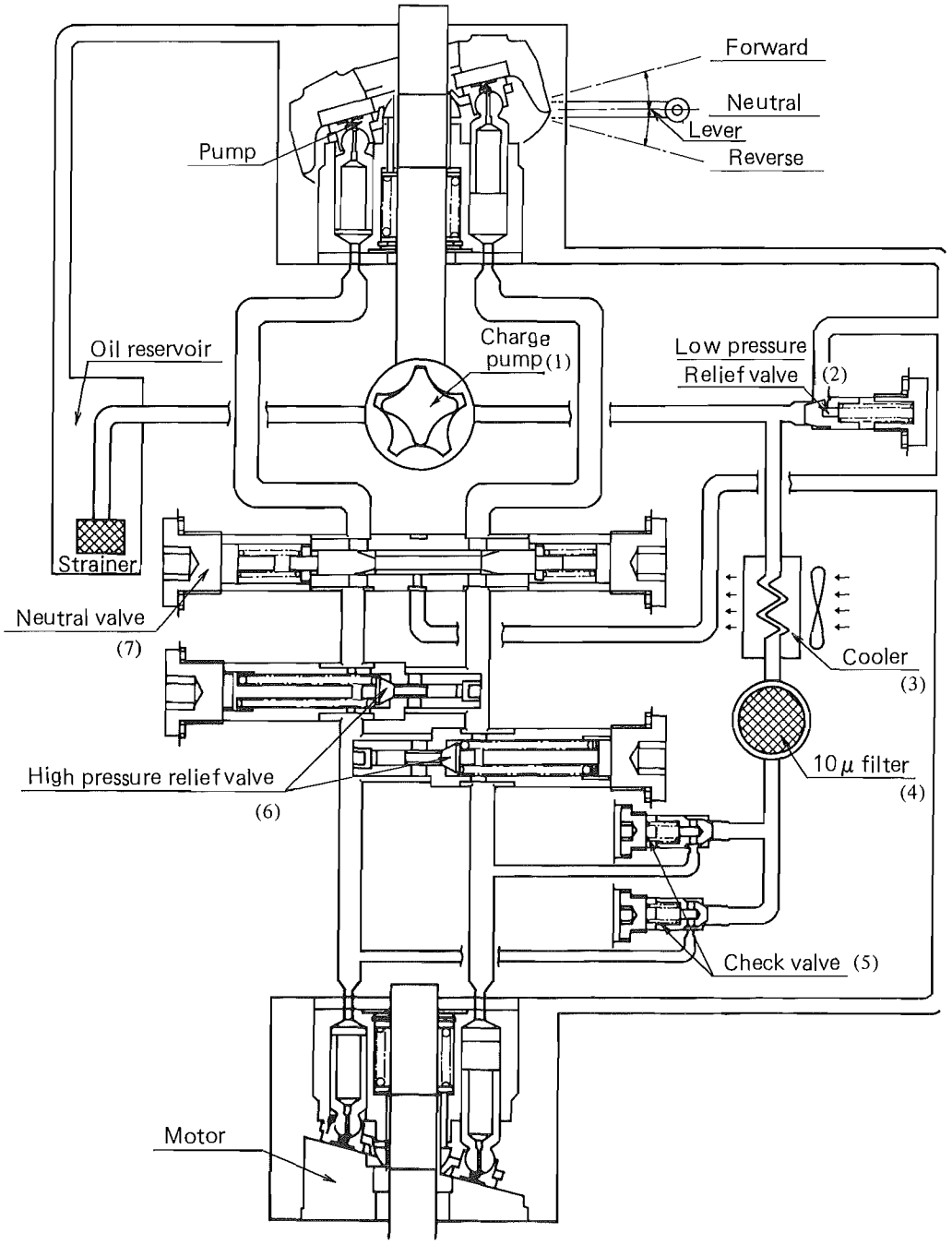
1. If the engine is running (the main clutch is engaged), the charge pump suck the oil in the transmission case through the strainer. The sucked oil flows through the circuit which contains the low pressure relief valve, cooler, and filter, and then, it pushes down the check valve and flows into the low pressure side to compensate the oil lost from the main pump and motor. The check valve on the high pressure side receives the back pressure from the rear, and therefore, the oil does not flow back, and the filter and cooler are not damaged.
2. The oil flowed into the suction side of the pump through the check valve passes the high pressure relief valve next.

A part of this oil is sucked by the main pump, and the rest is returned to the tank through the neutral valve.

(The high pressure relief valve on the low pressure side is a part of the low pressure circuit and becomes a passage when high pressure side is relieved.)

The oil sent out from the charge pump compensates the oil lost from the main pump and motor, and the rest is returned to the tank (in the transmission) through the neutral valve.

3. The pressure of the oil sucked in the pump is raised high by the rotation of the pump, and the oil is sent to the motor. The piston in the motor is pushed down by the oil, and the cylinder block in which the piston is inserted is rotated. As the cylinder block rotates, the shaft is rotated through the spline, and the gears on the shaft transmits the power to move the tractor.
4. If the load on the motor becomes large, the high pressure relief valve operates to let the oil flows into the low pressure side.



Sub transmission

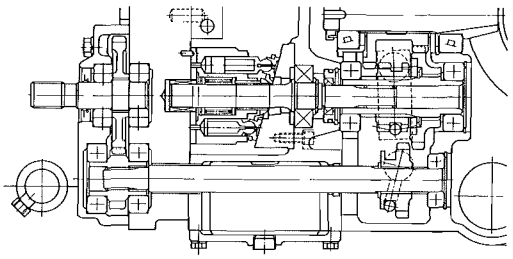
The gears of this transmission are under the pinion shaft of the transmission case. The speed of rotation transmitted from HST unit is changed to low or high speed.

PTO gear

The power from HST unit it transmitted to PTO gear at rear of the differential gear through PTO drive shaft above the differential gear. Using PTO gear, PTO speed can be set to 540rpm or 1,000rpm.

4-Wheel drive gear

4-wheel drive gear is installed uner the counter shaft. It is driven by the slide gear mounted on the lowermost shaft in the transmission case through the idle gear to drive the front axle.



Differential lock

The differential lock consists of a clutch which is located on the right side of differential gear case mounted in the center of diff-housing and a differential lock sleeve which is mounted on the differential right-hand shaft in the rear axle housing. These clutch and sleeve are operated by the differential lock pedal for locking the differential.

GEARSHIFT MECHANISM

HST lever

HST lever is at right rear of the bonnet and right of the throttle lever, Forwarding and reversing are changed-over with this lever.

Sub-gearshift lever

This lever is located on the left side of transmission case. It is guided by the shift guide plate mounted on the transmission case cover. In combination with the HST lever, this lever permits a selection of 2 forward and 2 reverse speeds. In the sub-transmission is built a safety starter switch.

PTO gearshift lever

This lever located on the left side of diff-housing and is ued to select any desired one of 540rpm and 1000rpm.

4-Wheel drive gearshift lever

This lever is located on the left side of transmission case. As this lever is shifted to "ON" position the drive is transmitted to the front axle and the tractor is operated in 4-wheel drive mode.

Rear axle housing

Differential shaft, final drive gears, final shafts and brake system are incorporated in the final drive cases. Differential locking system is housed in the righ-hand final drive case.

REMOVAL AND DISASSEMBLY

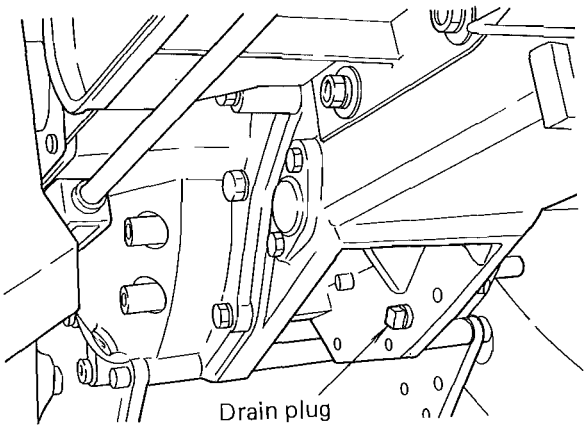
NOTE

a) Complete transmission disassembly is occasioned by two cases: 1) when the transmission case has suffered damage, or 2) when PTO shaft has to be replaced. Partial disassembly will suffice in most cases when a gear, shaft or bearing has suffered damage in the transmission.

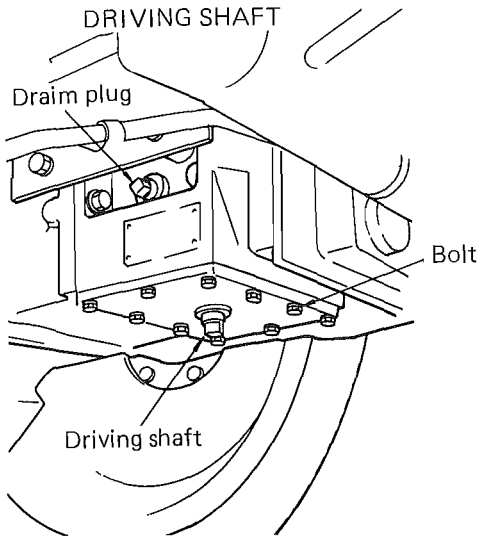
b) To disassemble the transmission partially or completely, it must be taken down from the machine. A sufficient working space should be secured in advance, and all the necessary hand tools and materials should be prepared for ready use. Before starting to disassemble, clean the case thoroughly, removing dirt, grime and greasy matter. The external surfaces of the case are usually greasy and slippery: be sure to handle it carefully upon removing the transmission from the machine.

Removing the transmission

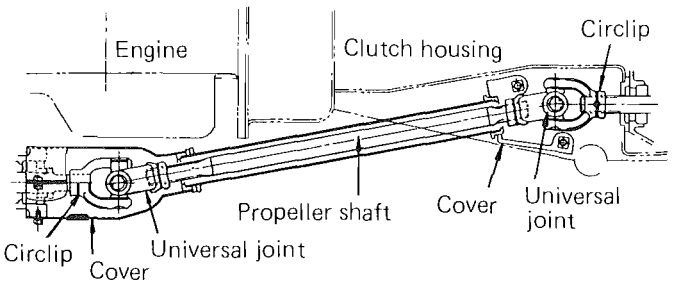
1) Remove drain plugs, right and left, on transmission case at its rear part. Be sure to drain the oil in the case completely.



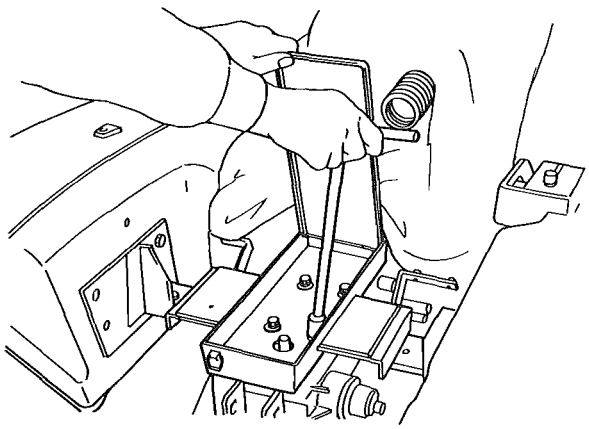
2) Remove the drain plug of HST unit and drain the oil in the unit.



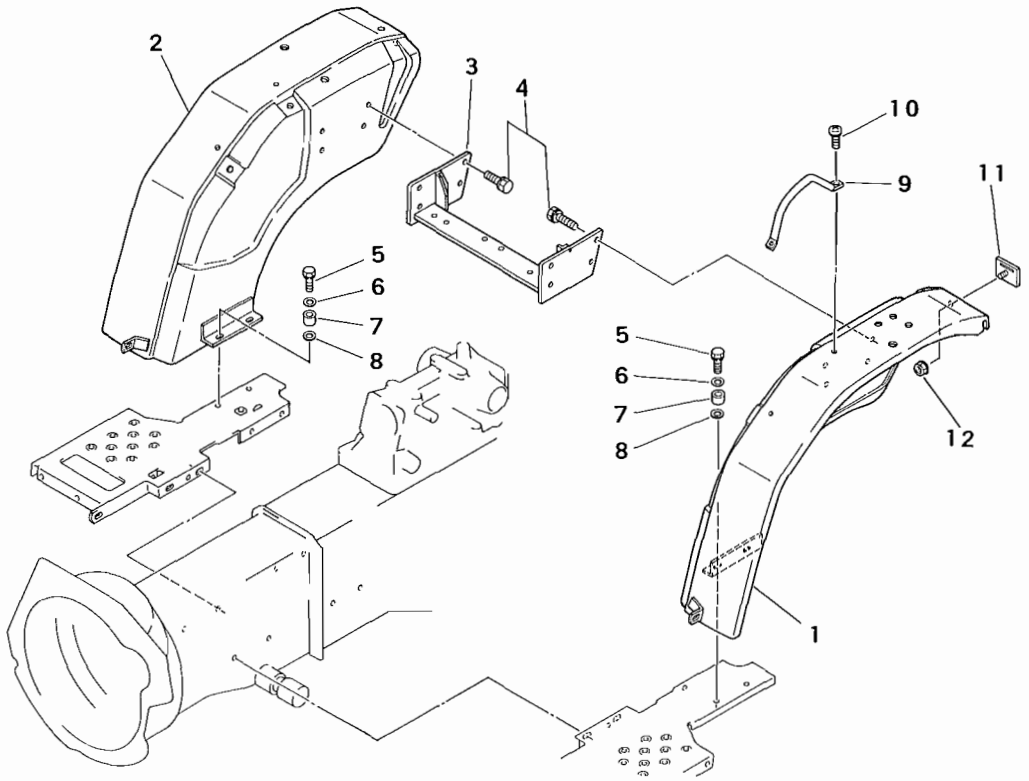
3) Remove bolts securing the covers, front and rear, of 4-wheel drive universal joints, take off the covers, pick out circlips and pins, and remove the joint.



4) Remove the tool box and seat together.

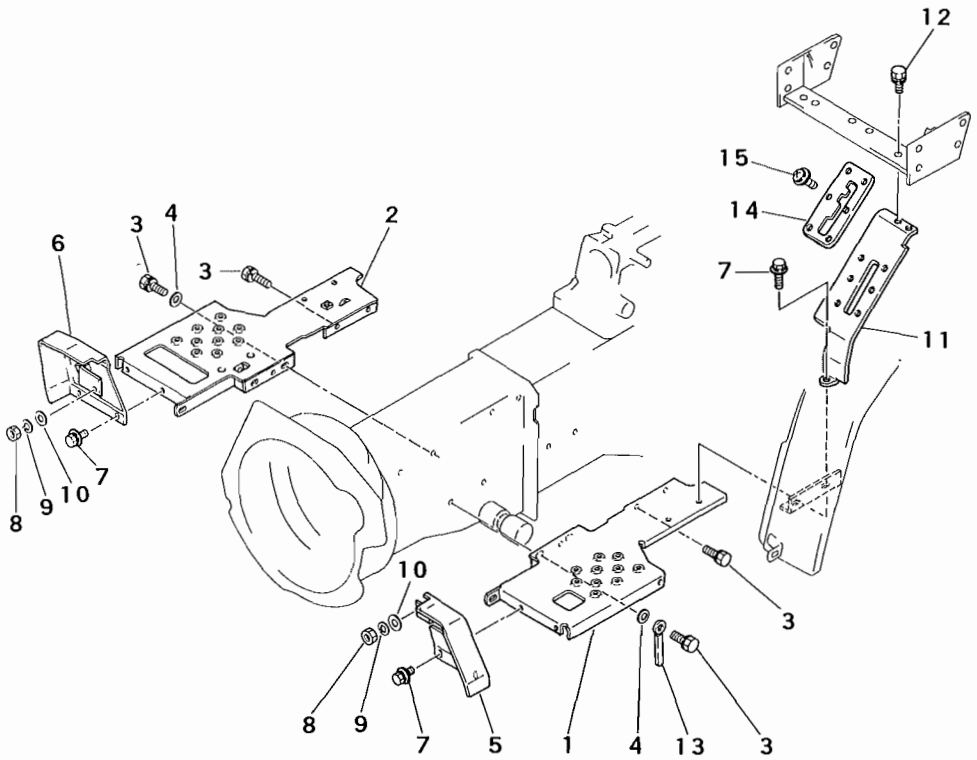


5) Remove the wiring from the fender, and remove the right and left fenders, cover, and fender bracket. At this time, take care not to drop the collar and rubber.



1 Rear fender L.H
2 Rear fender R.H
3 Fender bracket
4 Bolt
5 Bolt
6 Washer
7 Collar
8 Rubber
9 Hand rail
10 Screw
11 Reflector
12 Flange nut

6) Remove the left and right steps.



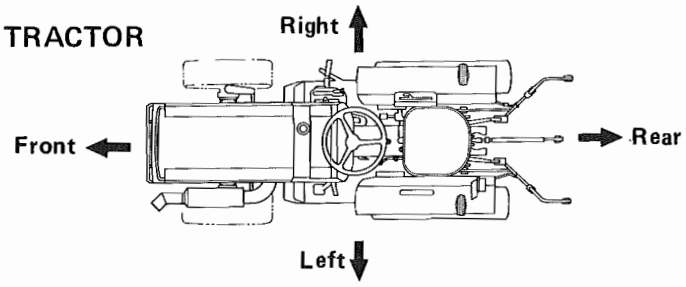
1 Step L.H
2 Step R.H
3 Bolt
4 Washer
5 Foot cover L.H
6 Foot cover R.H
7 Bolt
8 Nut
9 Spring washer
10 Washer
11 Cover
12 Bolt
13 Clamp
14 Plate
15 Screw

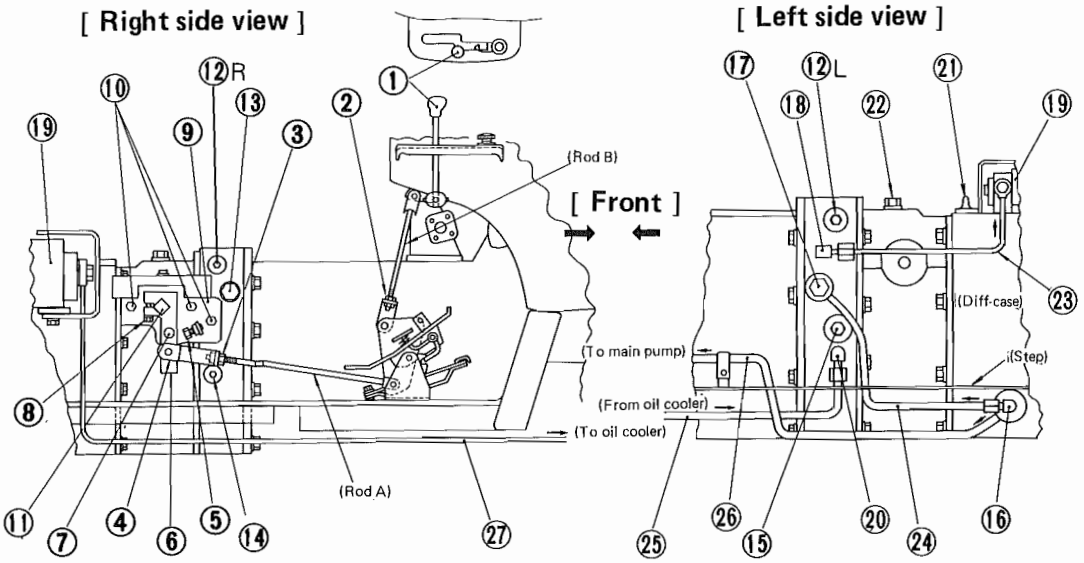
NOTE

Be sure to remove the spring connecting the right step and fifferential lock pedal.

7) Remove the left and right brake rods from the brake.
8) Place a jack under the rear part of transmission case, and take up the weight of the case with the jack. Loosen rear wheel bolts, jack up the rear axle at both ends, and take off the rear wheels.
   Take out the jack supporting the rear part of transmission case.
9) Separate rod A ass'y and HST control lever (6) each other by pulling out the snap pin.
   by pulling out the snap pin.
10) Remove the filter inlet pipe fixing union bolt from HST oil filter (19).
11) Remove filter inlet pipe (23).
12) Remove the union bolt from HST inlet pipe (24), and then, remove HST inlet pipe (24).
13) Remove cooler outlet pipe (25) by loosening the nut on HST unit side.
14) Remove suction pipe (26) from the transmission by removing two bolts.
15) Remove the union bolt securing the pressure pipe on the hydraulic case.

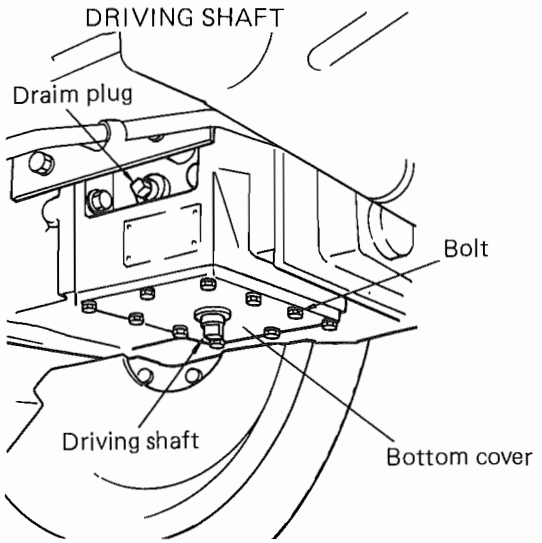
OUTSIDE VIEW of HST TRACTOR



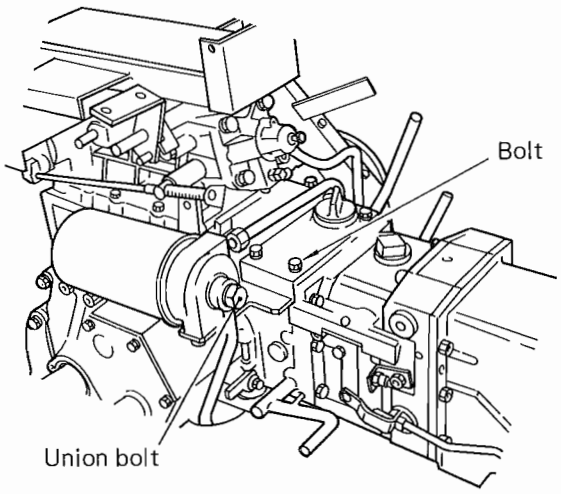


1 HST control hand lever
2 Adjusting point B
3 Adjusting point A
4 Joint
5 Backward speed adjusting stopper
6 HST control lever
7 Poppet ball case
8 HST lever set bolt
9 Neutral position set plate
10 Set plate attaching bolt
11 HST control shaft
12 Neutral valve plug
13 Low pressure relief valve plug
14 High pressure relief valve plug (reverse)
15 High pressure relief valve plug (forward)
16 Oil suction port
17 HST oil inport (to charge pump)
18 Charged oil outport
19 HST oil filter
20 Cooled oil inport (to HST)
21 Oil checking plug
22 Charge oil plug
23 Filter inlet pipe
24 HST inlet pipe
25 Cooler outlet pipe
26 Suction pipe
27 Return pipe

16) Remove the bottom cover from HST unit by removing 10 bolts.



17) Remove the union bolt on HST oil filter (19) of return pipe (27). Remove the cover from the top of the transmission by removing four bolts.



18) Remove 3-point linkage bracket.

19) Place two jacks under the machine to support clutch housing and transmission case, remove 10 bolts securing between clutch housing and HST unit together and seperate them carefully. Then, remove the main shaft and the coupling together.

20) Using a lifting sling and a hoist, lift the transmission out of the machine, and set it on the work stand.

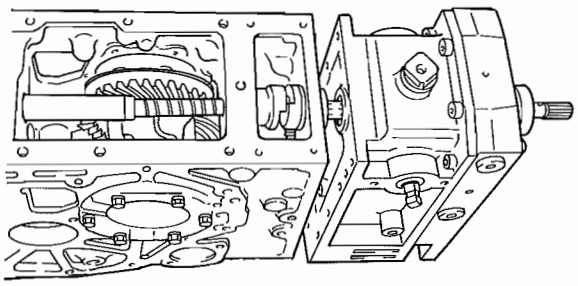
21) Loosen all the bolts securing the hydraulic case on the transmission, and remove the hydraulic case ass'y.

22) Loosen bolts securing each final case to the transmission case, and remove the two cases, right and left.

NOTE

Sealant is used in the joint between transmission case and final case. For this reason, the final cases may not separate easily from transmission case. Driving a chisel-like tool into the joint is sure to damage the case, which is made of an aluminum alloy. A soft-metal hammer may be used on the wheel boss in an attempt to sever it from the transmission case but be careful not to give strong hammer blows to the case.

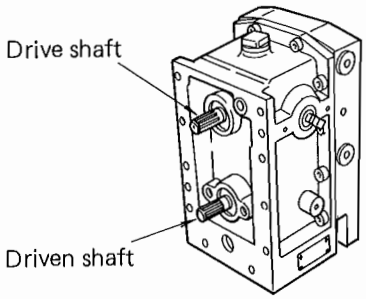
23) Remove 10 bolts, and separate HST unit and the transmission case each other.



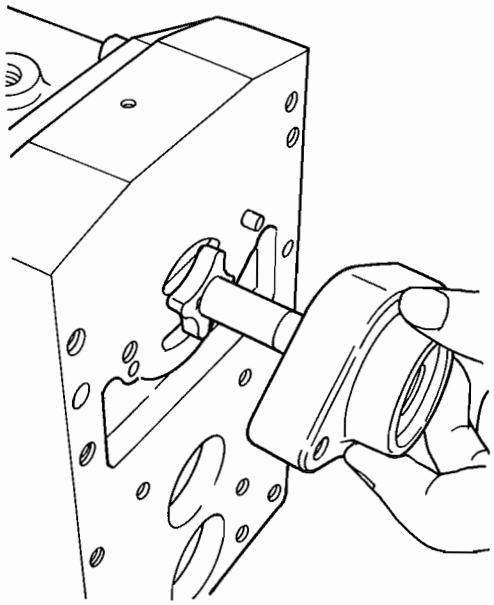
Disassembling the HST unit

Disassemble HST unit according to the following procedure.

1) Remove HST control lever (6) and neutral position set plate (9) by loosening bolts.
2) Remove the set bolts for 4 wheel drive gear case in front of HST unit, and remove the gear, shaft bearing, and gear case an assembly. Now, HST unit was removed.;

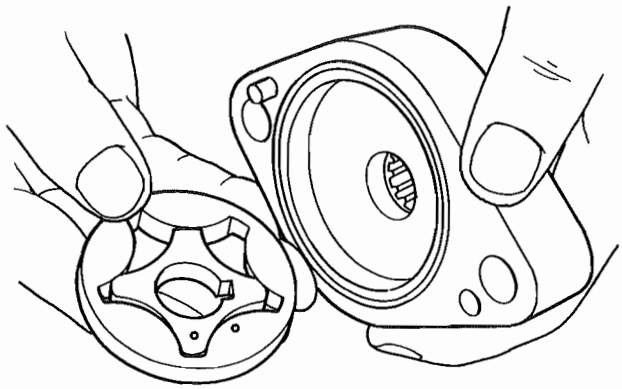


3) Loosen two hexagon socket head bolts from front of HST unit, and remove the casing. At this time, remove the vane and rotor, too.

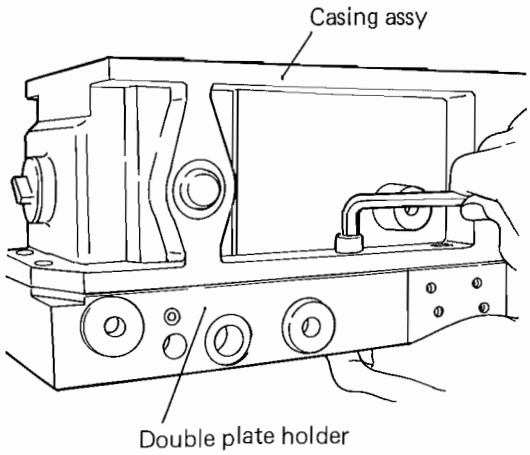


NOTE

Pay attention to the directions and positions of the point marks on the vane and rotor.



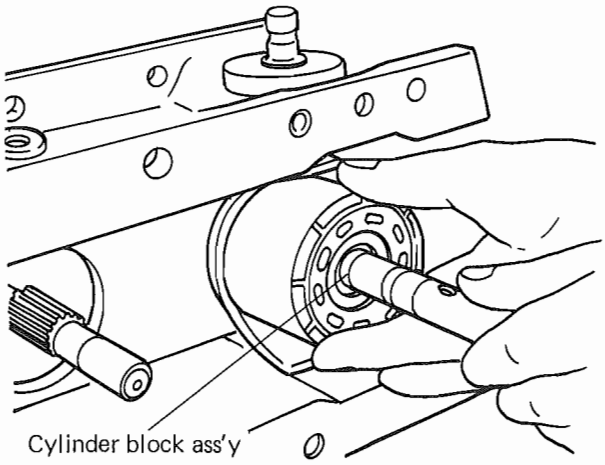
4) Separate the valve plate holder and the casing ass'y by removing 12 hexagon socket head bolts.



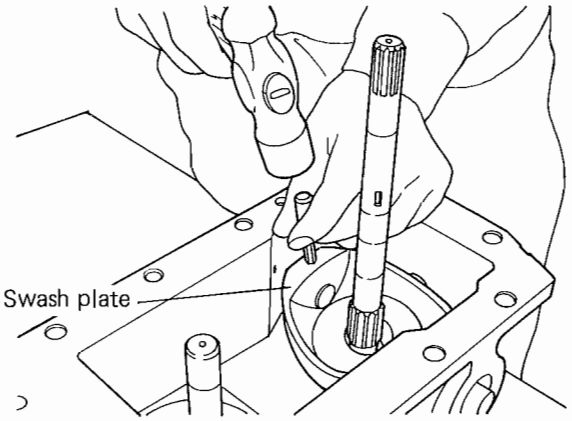
NOTE

The valve plate holder and casing ass'y may not separated easily because the sealing paste is applied on the fitting faces of them. In this case, separate them hitting the casing ass'y with a soft-metal hammer. Remove the sealing paste from the fitting faces of the valve plate holder and the casing ass'y taking care that the fitting faces are not scratched.

5) Remove the cylinder block ass'ies on the pump side and motor side.



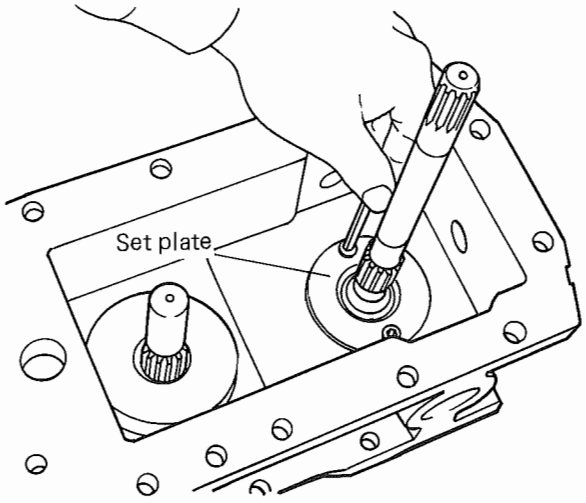
6) Pull out the spring pin of the swash plate, and pull the pin and HST control shaft outward, and then remove the swash plate.



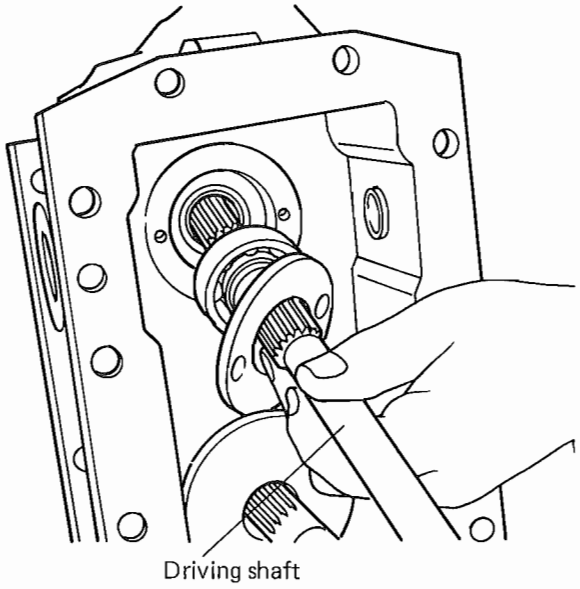
NOTE

Two spring pins are installed on the HST control shaft side.

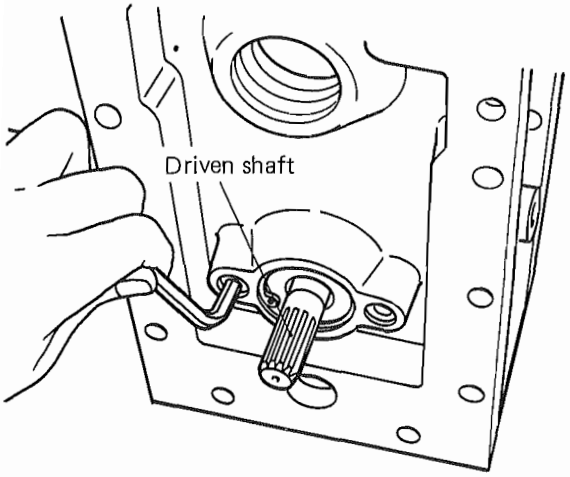
7) Loosen the hexagon socket head bolts securing the set plate on the driving shaft side, and remove the set plate.

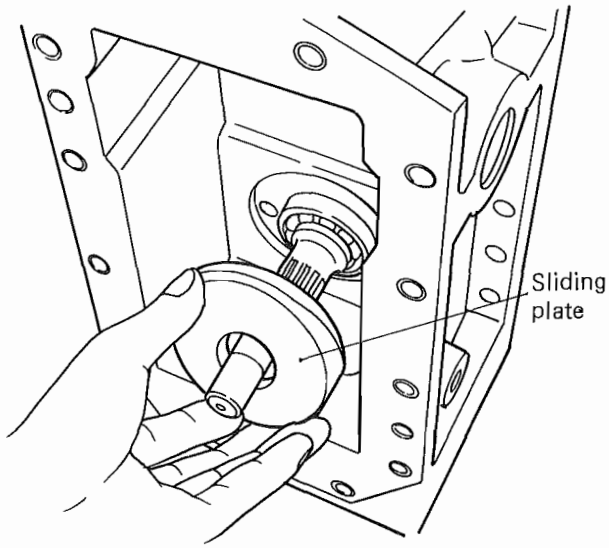


8) Remove the driving shaft together with the ball bearing hitting the driving shaft with a soft-metal hammer from the outside of the casing body.

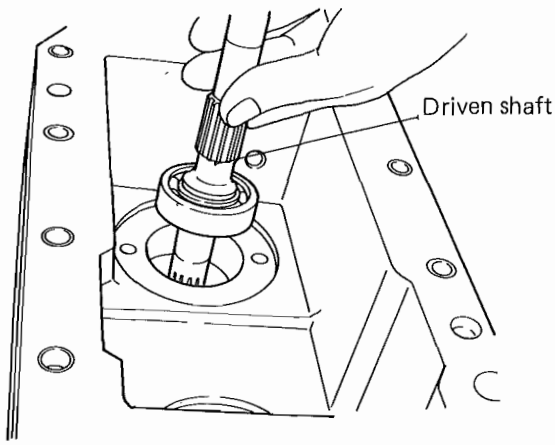


9) Remove the hexagon socket head bolt securing the sliding plate on the casing body, and pull the sliding plate out of the driven shaft.





10) Pull out the driven shaft together with the ball bearing hitting the shaft with a soft-metal hammer from the casing body side.



NOTE

When pulling out the output shaft and driving shaft, take care not to damage the oil seals.

11) When disassembling HST neutral valve assembled in the valve plate holder ass'y, remove either one of neutral valve plug (1) together with seal washer (2).

12) Remove spring (3) and collar (4) in order.

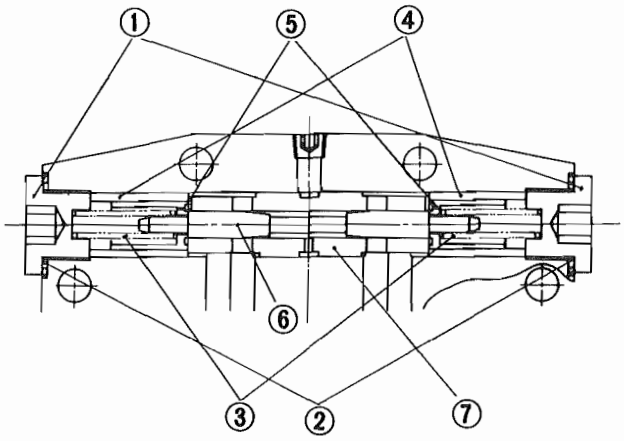
13) Take out plate (5) by using magnet. At this time, hold spool (6) with screw driver or wire so that it does not come out together with plate (5).

NOTE

Particularly be careful because, if the spool comes out, the plate on opposite end may tall into HST circuit.

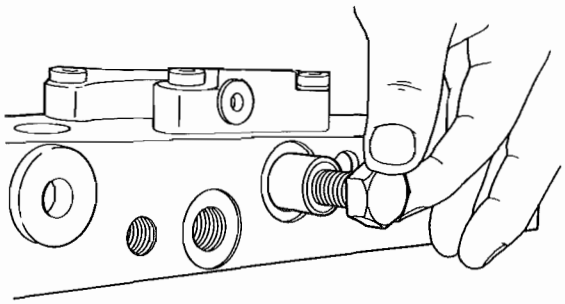
14) Remove neutral valve plug (1) at opposite end.

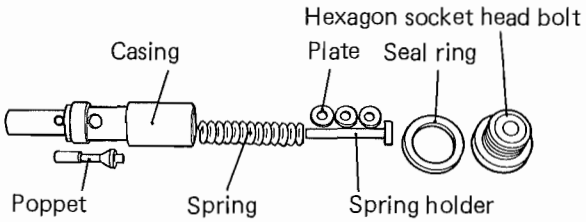
15) Push the spool (6) and neutral valve casing from the end where the neutral valve plug (1) was first removed, to remove them together with spring, collar and plate on opposite end.



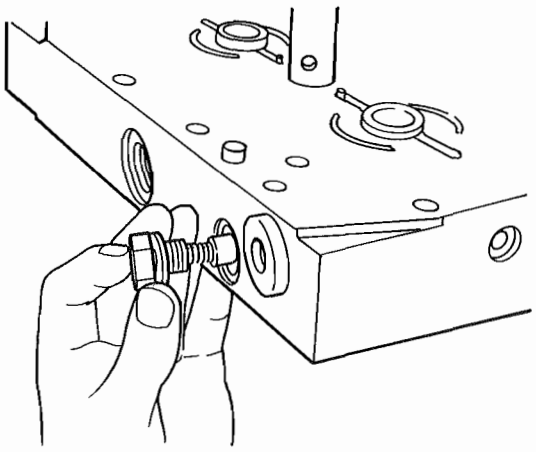
1) Neutral valve plug
2) Seal washer
3) Spring
4) Collar
5) Plate
6) Spool
7) Neutral valve casing

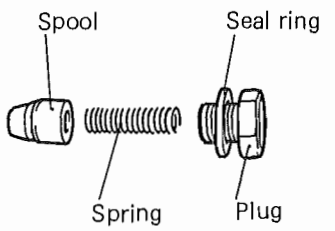
16) Disassemble the left and right high pressure relief valves. Remove the hexagon socket head bolt from the side of the valve plate holder, and take out the seal ring, spring holder, plates, and the spring in order. Then, screw a bolt of M14 x 1.5 into the casing, and pull it out. The poppet can be taken out at this time, too.



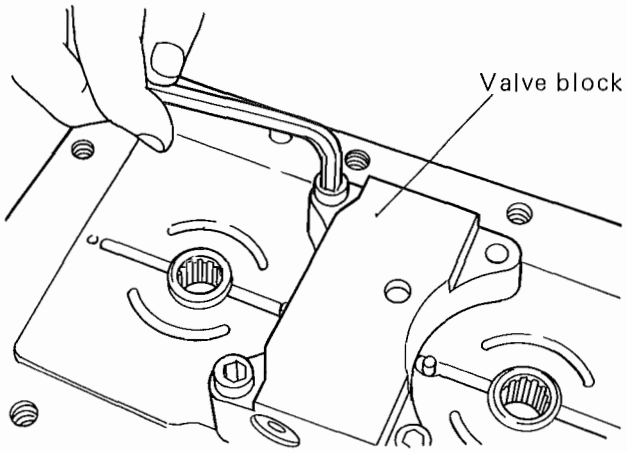


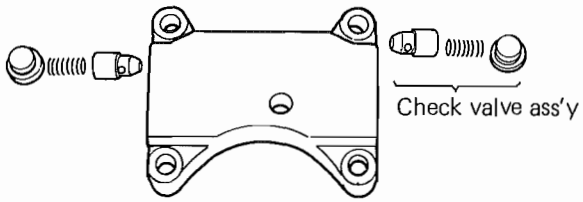
17) Remove the plug of the low pressure relief valve at the side of the valve plate, and remove the low pressure relief valve.





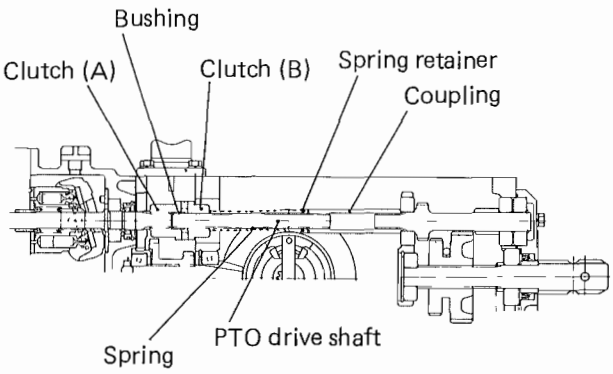
18) Remove four hexagon socket head bolts from the valve block, and remove the valve block. Loosen the plugs, and remove the left and right check valves.





Removing the PTO drive shaft

After removing UST unit, take out clutch (A), bushing, clutch (B), spring, spring retainer, PTO drive shaft and coupling in order.



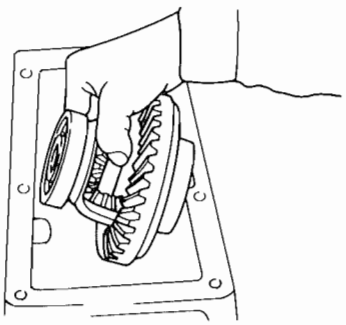
Removing the differential gear assembly

1) Remove bearing holders, right and left, from transmission case. The bolts securing these holders are locked with stopper plates: be sure to straighten these plates and, after loosening the bolts, ease the holder off by putting the tip of a plain screwdriver to the notch formed of the holder.

NOTE

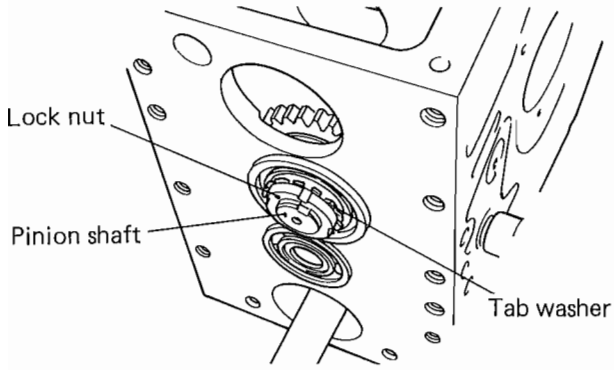
When taking out the differential gear assembly, be sure to recover the shim used for backlash adjustment and to check the shim thickness and the number of shim pieces used. The same shim must be re-used in reassembly if the assembly has not been broken apart and is to be restored in its original condition.

(2) Lift the differential gear assembly out of transmission case.



Removing the pinion shaft

1) Rebend the tab washer securing the lock nut using a plain screw driver. Remove the lock nut at front of the pinion shaft, and remove the tab washer.

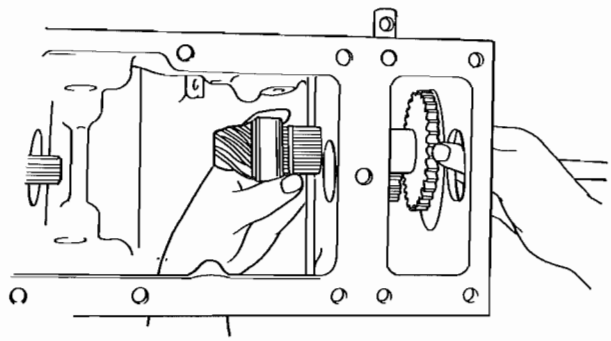


2) Remove the bearing holder together with the ball bearing using two plain screw driver.

NOTE

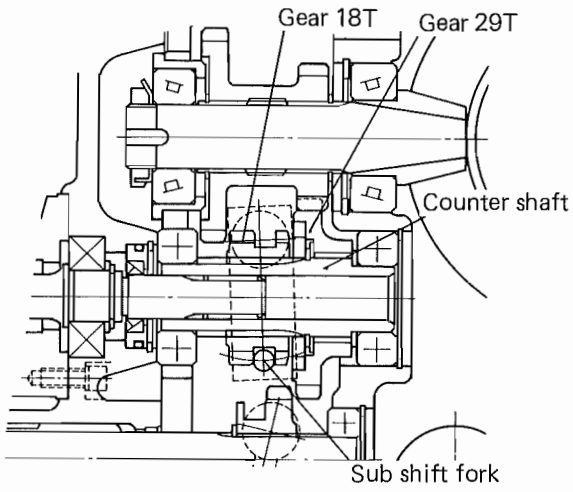
Take care not to damage the bearing holder and transmission case.

3) Remove the circlip (28mm) securing gear 31-20T from the front of the transmission case. Take out the pinion shaft hitting it with a soft-metal hammer from the front of the transmission case. After pulling out the pinion shaft, take out gear 31-20T.



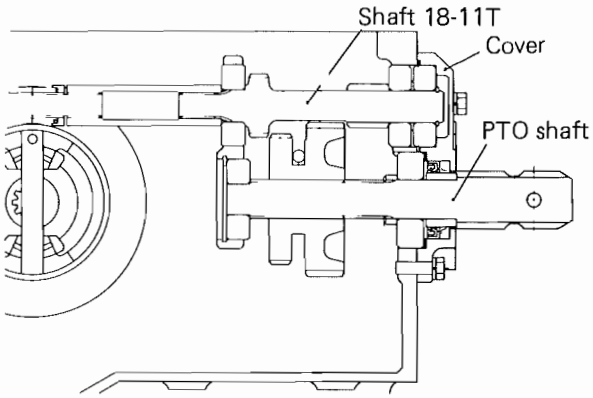
Removing the counter shaft

1) Remove the circlip (52mm) from diff-housing end of the counter shaft. Slide gear 18T forward by setting the sub shift lever to "Low' position. Remove the circlip (30mm) from the groove on the counter shaft, and slide it toward the front of the shaft.
2) Holding gear 18T and gear 29T with hands, hit the counter shaft from the front of the transmission with a soft-metal hammer to push it to rear. Disassemble the sub shift fork, if necessary.



Removing the PTO shaft

1) Remove the cover from rear side which is secured by five bolts.
2) Push out the shaft 18-11T ass'y toword rear side hitting shaft 18-11T with a soft-metal hammer from the diff-housing side.
3) Push out PTO shaft from the diff-housing side in the similar way.



Removing the differential gear assembly

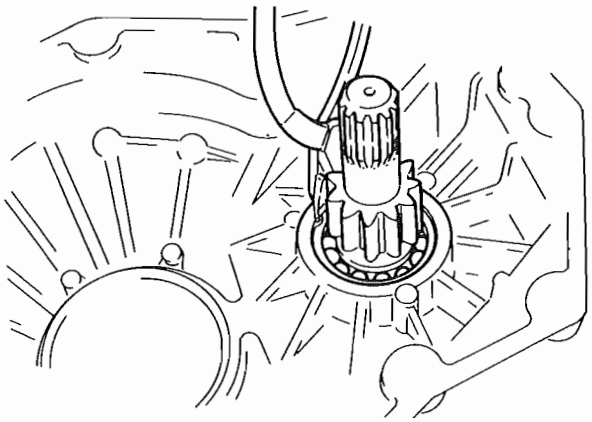
(1) Give match marks to differential gear case and ring gear.
(2) Straighten the lock washers under the heads of bolts securing the ring gear, remove the bolts and take off ring gear.
(3) Pull off locking pin from center pin, draw out the pin, and take out pinion gears, side gears and thrust liners.

Disassembling the final cases

After removing the two final cases from transmission case and detaching brake cover and drum from each, proceed as follows:

<Differential shaft>

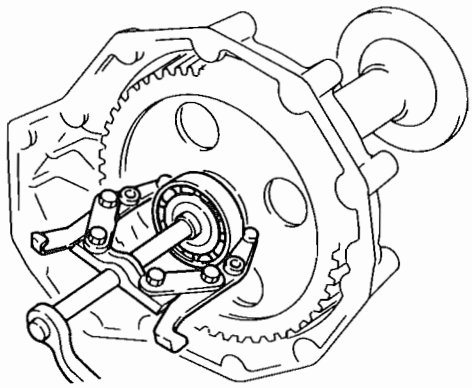
(1) Pick out circlip, remove pinion shaft (it may be necessary to lightly tap on this shaft), and draw out oil seal bushing together with ball bearing.



(2) From the right final case, remove differential lock shifter: loosening the nut allows the shifter to come off.

<Rear wheel shaft>

(1) Draw out ball bearing, and remove collar and final reduction gear.



(2) Pick out two circlips and drive rear wheel shaft out of final case.

Removing the mid PTO shaft

1) Remove the bearing holder, and pull out the mid PTO shaft.
2) Remove 4-wheel drive select shaft ass'y hitting it from the diff-housing side. Remove 4-wheel drive shift fork, if necessary.

REASSEMBLY AND INSTALLATION

(1) Before starting the reassembly work, be sure that all transmission parts are perfectly clean, check to be sure that there is no missing parts, and, when building up sub-assemblies, refer to the specifications and assembly standards to make sure that each sub-assembly is properly built up with respect to gaps, running clearances, plays, backlashes, etc.

(2) Oil or grease sliding surfaces, as necessary, at the time of installing moving parts. Similarly, grease "O" rings, oil seals and the like just before fitting them.

(3) It is advisable but not mandatory that "O" rings, gaskets, packings, oil seals, tab washers and the like be regarded as expendable items and be replaced by new ones upon their removal in disassembly.

(4) Wrap through-bolts with sealing tape just before using them in reassembly.

(5) Have sealant on hand and use it on the mating faces of cases and covers.

(6) Build up the transmission in the following sequence:

(a) Differential gear reassembly

(b) Determination of shim thickness on the basis of pinion shaft cone center measurement

(c) PTO shaft reassembly and installation

(d) 4-wheel drive shaft reassembly and installation

(e) Countershaft reassembly and installation

(f) Pinion shaft installation

(g) Differential gear installation

(h) PTO drive shaft installation

(i) Final case reassembly

(j) Final case installation

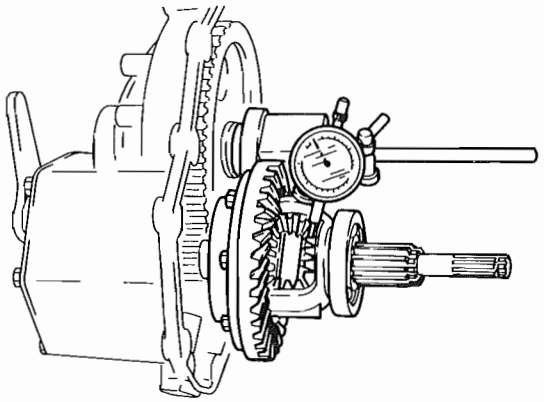
(k) HST unit reassembly and installation

(l) Mid. PTO shaft reassembly and installation

Reassembling the differential gear assembly

(1) Oil thrust liners, fit the liners to the differential gear case, install side gears, position pinion gears in place, together with liners, and insert center pin.

(2) Adjust the thickness of thrust liners, as necessary, to secure a backlash of 0.25 to 0.35 mm (0.010 to 0.014 in.) between pinion gear and side gear.



Backlash	0.25 ~ 0.35 mm (0.010 ~ 0.014 in.)

Shim stock for this backlash adjustment is available in the following thicknesses:

Unit: mm (in.)

Thickness	Part No.
1.2 (0.047)	1135 1408 001
1.4 (0.055)	1135 1409 001
1.6 (0.063)	1135 1411 001

(3) After producing the specified backlash, drive lock pin into center pin to lock the latter pin. Insert differential shaft and rotate the differential by hand to be sure that it rolls smoothly.

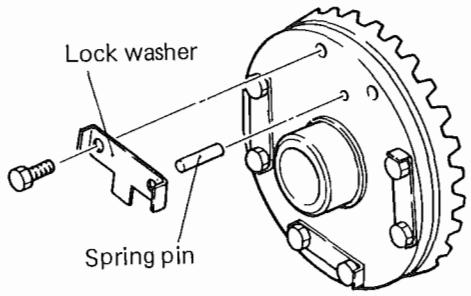
(4) Fit ring gear to the case, as guided by the match marks, setting the gear in its original position, put on lock washers and bolt

the gear to the case, tightening the bolts to this torque value:

Tightening torque	2.5 ~ 3.0 kg-m (18 ~ 22 ft-lb)

NOTE

Lock washer A (Part number 1135 1405 000) has a lug formed as shown. Position this washer in such a way that the lug will cover up the spring pin locking the center spring.



(5) Install ball bearings in the differential case.

Measuring the pinion shaft cone center for shim selection

(1) In the bore provided in the transmission case wall, through which the pinion shaft is to enter, set circlip, and fit the outer race of tapered roller bearing. Be sure to discriminate between the inside end face and the outside end face of this race.

(2) Mount the inner race of tapered roller bearing on countershaft.

(3) Position countershaft in place, install the other tapered roller bearing on the front side, and secure it by tightening sleeve nut. Check to be sure that the pinion shaft so secured has no end play. Remember, cone center measurement with the use of a special tool presumes absence of end play on this shaft. Select the shim thickness, in the manner explained, to obtain this value:

Pinion shaft cone center	77 ± 0.05 mm (3.031 ± 0.002 in.)

How to use the special tool

1) Put the bushing (1982 6011 00X) to the tool A (1135 3905 000).

2) Insert the tool A and bushing together to the transmission housing from the left-hand side of housing.

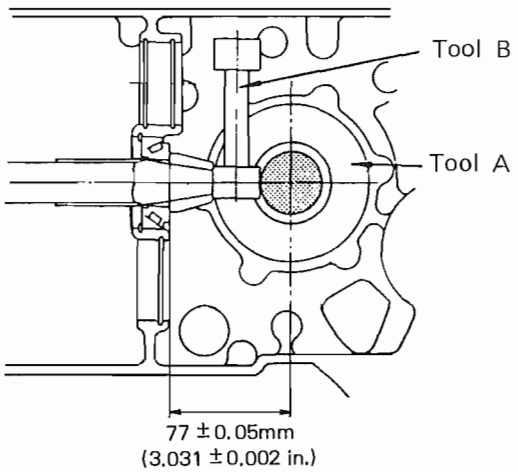
3) Select the shim thickness that permits the small-diameter end of tool B (1135 3908 000) to enter freely and prevents the large-diameter and from etering.
The shim so selected is to be inserted between the outer race of tapered roller bearing and the circlup at the time of reassembling the pinion shaft.

Shim stock for this selection is available in the following thicknesses:

Unit: ,mm (in.)

Thickness	Part No.
0.1 (0.004)	1135 1315 011
0.2 (0.008)	1135 1316 011
0.5 (0.020)	1135 1317 011

The required shim thickness is equal to the clearance which occurs when the small-diameter tool B is placed between pinion gear and tool A.



Ressembling the PTO shaft

1) Set the circlip to the inside wall of the transmission, and assemble the ball bearing.

2) Install the bushing, ball bearing, shims, and collar to PTO shaft from the front, and set them with the circlip.

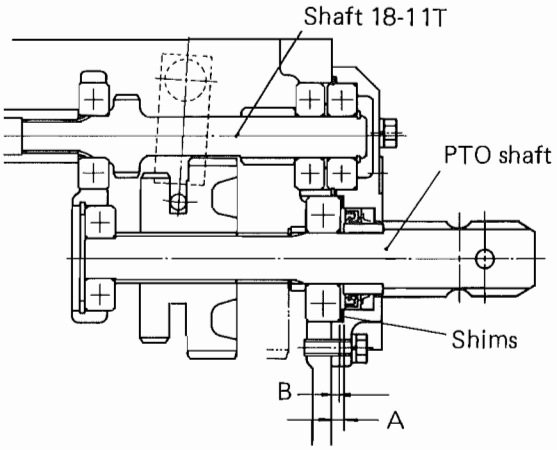
3) Insert the set PTO shaft into the transmission from the rear, and assemble the gear, and then assemble with the bearing.

4) At this time, measure dimensions A and B with slide calipers. A - B = 0.2 (Thickness of shim to be inserted between ball bearing and cover)

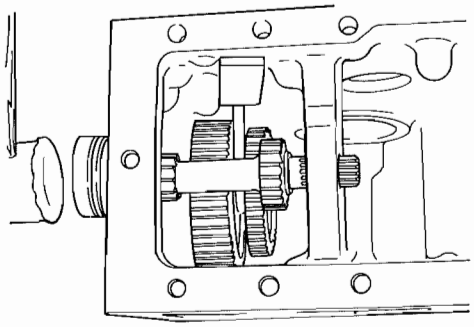
After determining the thickness of shims, reassemble the PTO shaft ass'y with the shims.

Unit : mm (in.)

Thickness	Part No.
Shim set	1021 1318 000
0.15 (0.006)	0730 0006 201
0.40 (0.016)	0730 0006 204
0.80 (0.031)	0730 0006 208



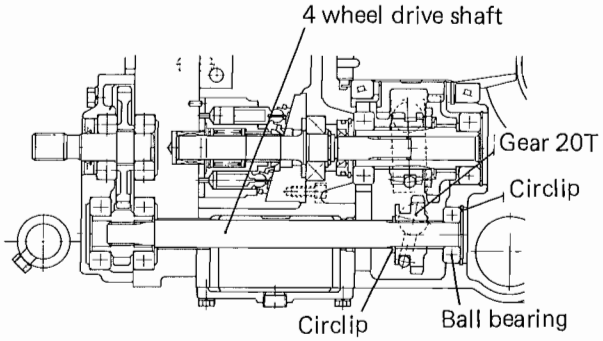
5) After installing shaft 18-11T ass'y, apply liquid packing to the fitting face of the cover, and install the cover to the transmission case.



Reassembling the 4-wheel drive shaft

1) Set the circlip to the inside wall of the transmission on the diff-housing side, and install the ball bearing from the front.

2) Set the circlip to the 4-wheel drive shaft. Set gear 20T to the 4-wheel drive shift fork, and then, install gear 20T and ball bearing in order to the 4-wheel drive shaft.



Reassembling the countershaft

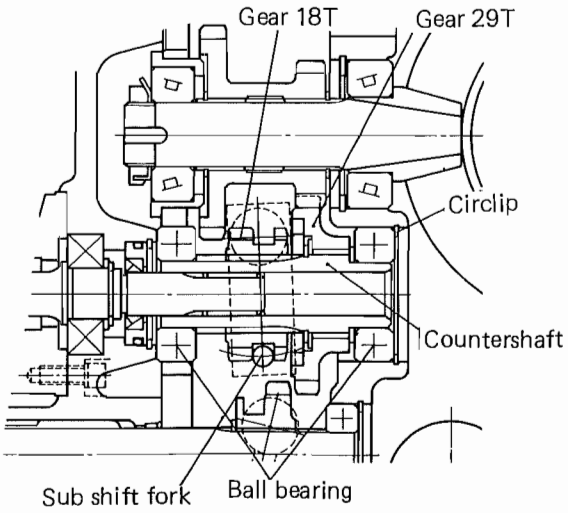
1) Set the circlip to the inside wall of the transmission on the diff-housing side, and install the ball bearing from the front.

2) Set the sub shift lever to low position, and install gear 18T, circlip, liner, gear 29T, bushing, and liner in order from the front. At this point, gear 18T must be installed to the sub shift fork securely. Hit the countershaft into the ball bearing, and set the circlip to the groove of the shaft.

NOTE

If there is the groove on the liner, be sure to set the liner with the grooved face toward the gear.

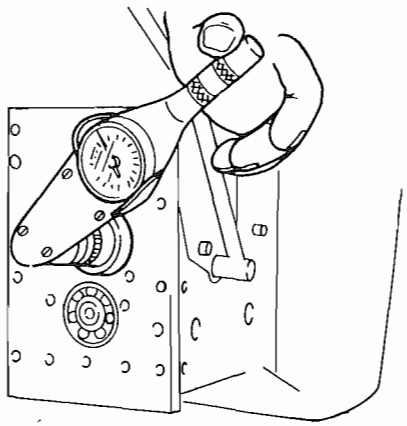
3) Install the ball bearing to the transmission from the front.



Reassembling the pinion shaft

1) Insert the shims (which have been selected on the basis of cone center measurement) between the circlip and the outer race of tapered roller bearing in the wall of transmission case.
2) Insert pinion shaft (to rear end of which tapered roller bearing and cliclip have been mounted) into transmission case through its rear end. At the same time, insert pinion shaft into the gear 31-20T.
3) Set the circlip to the groove on the front portion of the pinion shaft, and secure gear 31-20T.
4) Install the bearing holder, ball bearing, tab washer, and lock nut in order, and adjust the lock nut so that the specified preload on the pinion shaft can be obtained.
   Bend the tab washer to secure the lock nut.

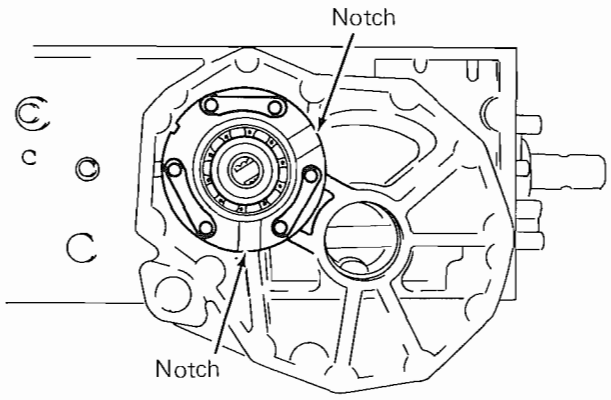
Countershaft preload	0.07 ~ 0.08 kg-m (0.51 ~ 0.58 ft-lb)



Installing the differential gear assembly

(1) The differential gear assembly is already in built-up condition at this stage, complete with the ring gear. Lower it into transmission case, with the ring gear coming on the left side.

(2) Position the two bearing holders (differing in length) in place, seating each holder correctly by matching its notch to the corresponding one formed of case. The long holder comes on the right side, and the short one on the left.



NOTE

Bear in mind that, if the holders are not positioned correctly as dictated by the matching notches, interference occurs between final gear and bearing holder. The final case might break if the case is secured under this condition (interference between holder and gear.)

(3) Tentatively tighten the two bearing holders in place, right and left, on transmission case, making their securing bolts snug-tight. Be sure that stopper washers are used on these bolts.

(4) Using the below-indicated sizes (thicknesses) of shim stock (liner), adjust the ring gear backlash to the specification in the manner hereunder described:

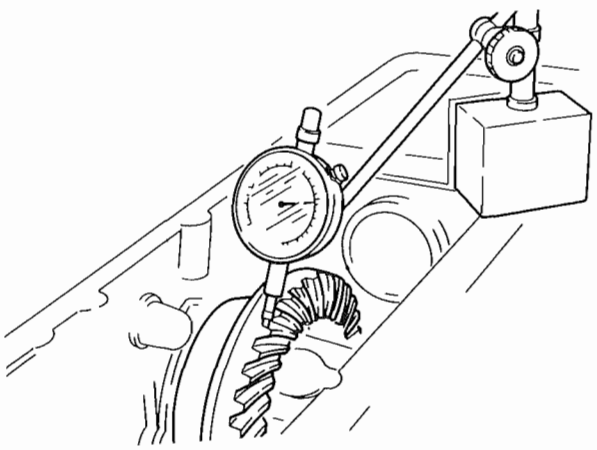
Ring gear backlash	0.25 ~ 0.35 mm (0.01 ~ 0.014 in.)

Shim stock for ring gear backlash adjustment
Unit: mm (in.)

Thickness	Part No.
0.2 (0.008)	1135 1419 000
0.3 (0.012)	1135 1421 000
0.5 (0.020)	1135 1422 000

(a) Insert the liner between transmission case and left-side bearing holder. Be sure that the individual shims (each consisting of one or more sheets) of the liner are equal in thickness. This requirement is met by using the same number of shim sheets. The liner here is tentative and need not be exact in thickness, but make sure that the clearance is filled up uniformly all around.

(b) Tighten the left-side holder (which is now sided by the tentative liner) good and hard, but leave the right-side holder in snug-tight condition. Take a backlash reading, as shown, to see if the backlash is within the specified range indicated above; if not, loosen the left-side holder and increase or decrease the thickness of the liner there.



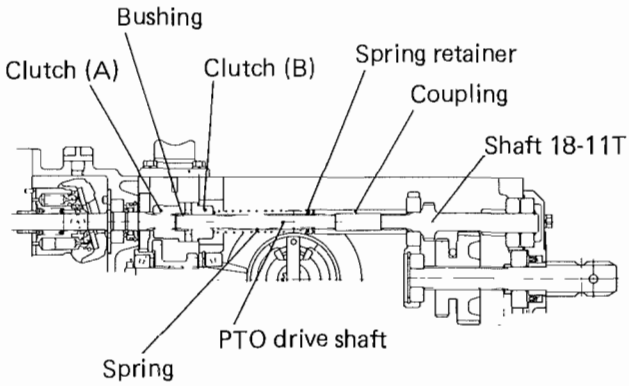
(c) A proper backlash having been secured, measure the clearance between the right-side holder and case, and fill the clearance with another liner equal in thickness to the reading. This liner, too, is to be formed in the same way as above. Put on stopper washers and tighten the right-side holder.

(d) Tap lightly on the differential gear case in place, directing the tapping force leftward and rightward to be sure that this case has no end play. Re-check the backlash and, upon noting that it is within the specified range, lock the bolts securing the bearing holders, right and left, by bending stopper washers sharply. The holder bolts are to be tightened to this torque value:

Tightening torque	2.5 ~ 3.0 kg-m (18 ~ 22 ft-lb)

Installing the PTO drive shaft

Set the circlip to PTO drive shaft, and install the spring retainer, spring clutch (B), bushing clutch (A) in order to PTO drive shaft. Connect PTO drive shaft and shaft 18-11T with the coupling.



Reassembling and installing the final case

(1) Grease oil seals, and fit the seals to those parts of final case admitting differential shaft and final shaft. For the final shaft, however, a washer must be installed before fitting the oil seal.

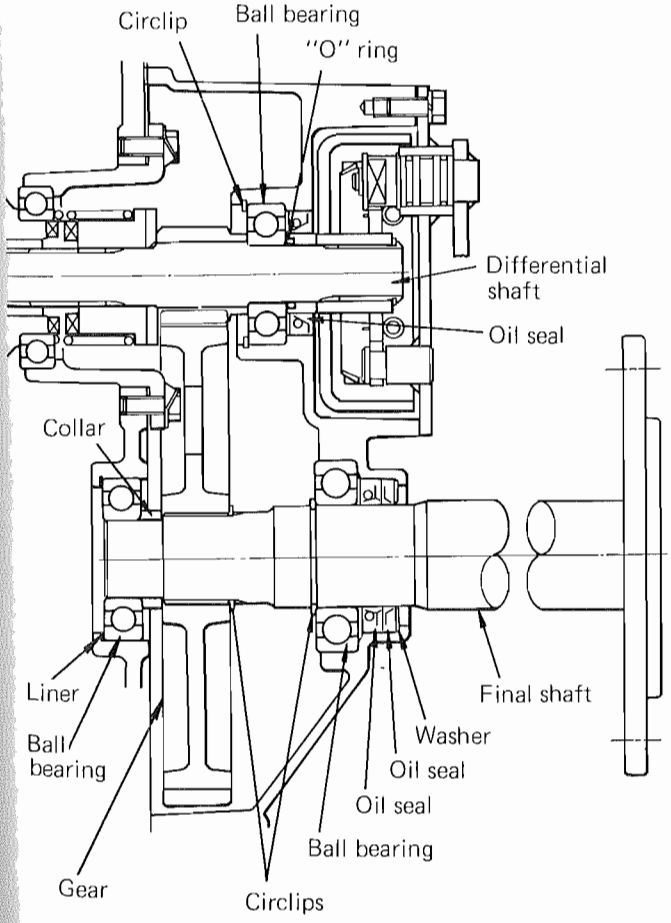
(2) Press ball bearing onto differential shaft. Grease "O" ring and fit it to oil seal collar. Feed the collar onto differential shaft, with its "O" ring coming next to the ball bearing.

(3) Insert differential shaft into final case, and set it in place by fitting circlip.

(4) Position final shaft in final case, fit ball bearing by pressing, and retain the bearing by installing circlip.

NOTE

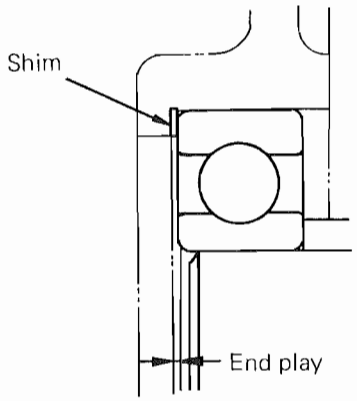
When forcing the bearing in, be sure to apply the push to its inner race.



(5) Install circlip (for final gear stopper) on final shaft, mount final gear and collar, and press in ball bearing.

(6) Take two measurements: 1) height of ball bearing face above the seat formed of transmission case for final case, and 2) distance from transmission case face to ball bearing holder. On the basis of these two measurements, determine the shim (liner) thickness necessary for giving an end play of 0.12 to 0.4 mm (0.005 to 0.016 in.) to final shaft. The liner with the determined thickness is to be used on ball bearing holder.

Final shaft end play	0.12 ~ 0.4 mm (0.005 ~ 0.016 in.)



(7) Apply sealant to the mating face of final case, fit the case to transmission case, and secure it by tightening its bolts to this torque value:

Tightening torque	5.0 ~ 6.0 kg-m (36 ~ 43 ft-lb)

NOTE

The right-side final case must be complete with differential lock shifter and lock sleeve: the shifter must be installed before inserting differential shaft into the case.

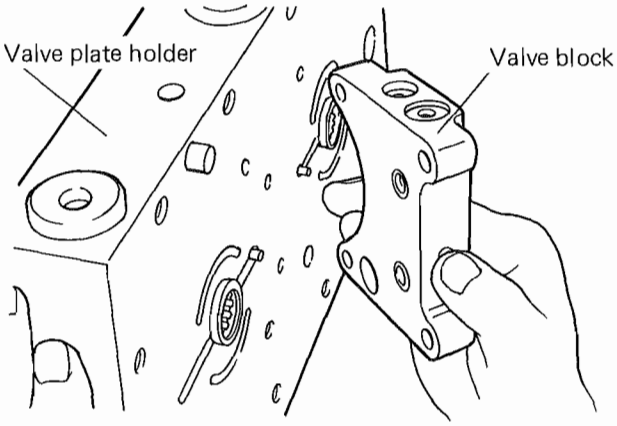
Reassembling and installing HST unit

Assemble and install HST unit according to the following procedure.

NOTE

Before assembling the parts, wash them with cleaning oil. Do not assemble the parts in dirty or dusty place. Assemble them on a clean table.

1) Install the left and right check valves to the valve block, and install the valve block ass'y to the valve plate holder with the hexagon socket head bolts.



NOTE

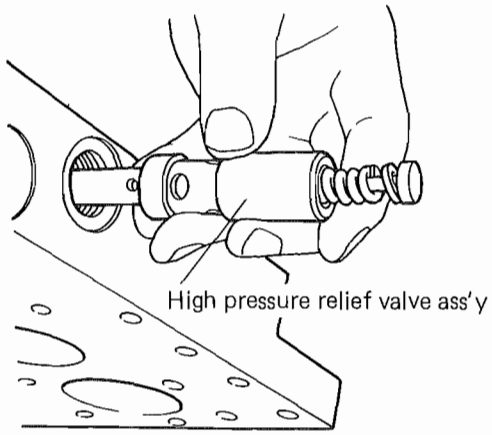
Be sure to install O-ring to the valve block before assembly.

2) Clean disassembled parts of neutral valve. Clean the bore of valve body as well. Spool should move smoothly in the case when installed in it (to the extent that falls down with own weight).
3) Assemble the neutral valve in reverse order of the disassembly procedure.

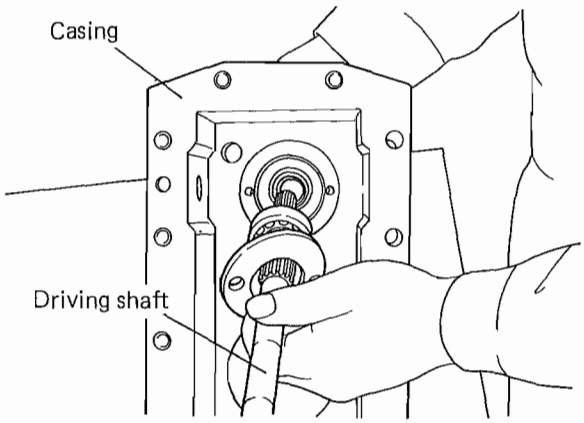
NOTE

Do not insert the plate too deeply but leave it to the extent that collar, spring, etc. will be pushed in when valve plug is tightened. V-groove of plate should come inside.

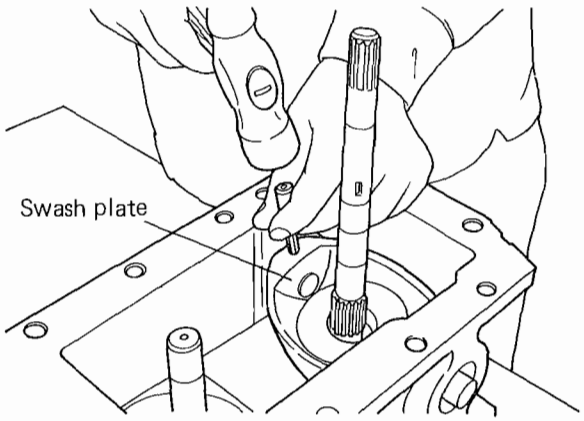
4) Install the low pressure relief valve to the valve plate holder.
5) Assemble the parts into the high pressure relief valve ass'y at first, and then, install the high pressure relief valve ass'y to the valve plate holder.



6) Install the bearing to the driving shaft, and install them to the casing. Install the plate from the inside of the casing with two hexagon socket head bolts.



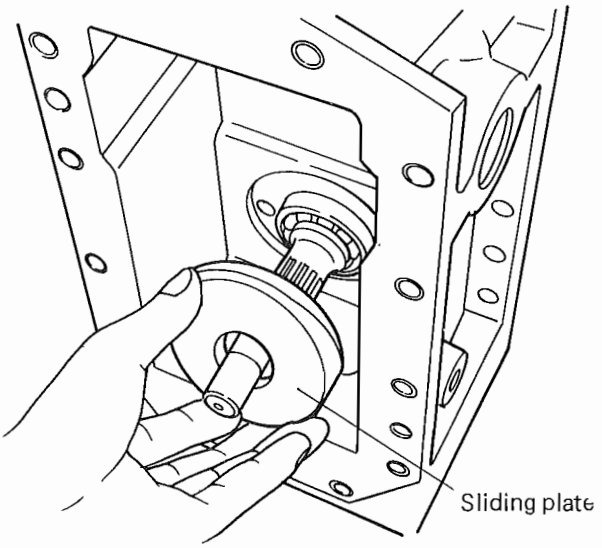
7) Install the pin and HST control shaft from the outside of the casing, and secure the swash plate with spring pin.

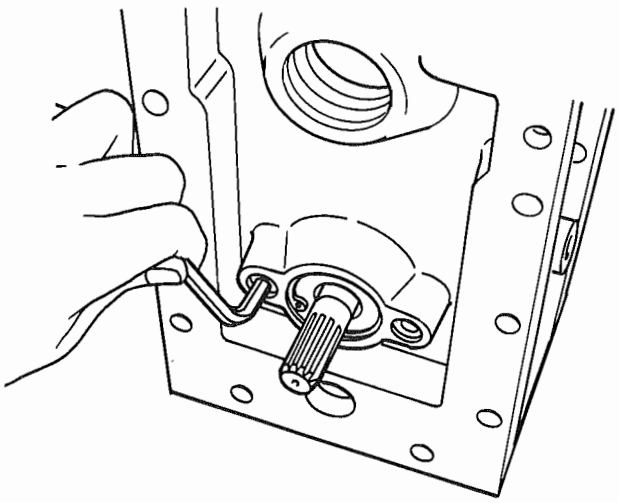


NOTE

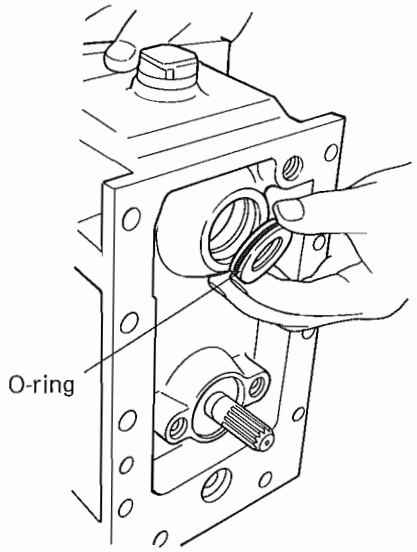
On HST control shaft side, two spring pins are used.

8) Install the bearing to the driven shaft, and install them to the casing body, and then, install the sliding plate. Secure the sliding plate from the outsude of the casing with the hexagon socket head bolts.

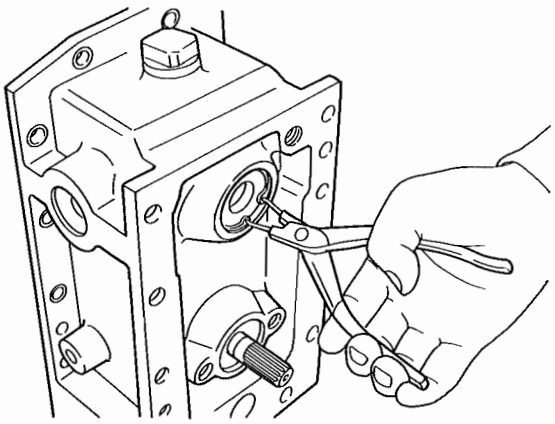




9) Install the oil seal and O-ring to the oil seal holder, and install them to the casing (on both of driving shaft and driven shaft).

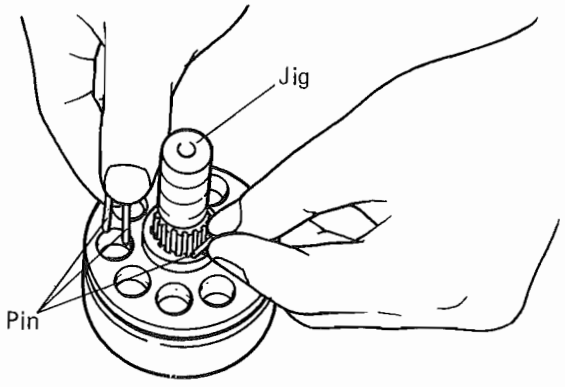


10) Secure the oil seal holder with the circlip (on both of driving shaft and driven shaft).

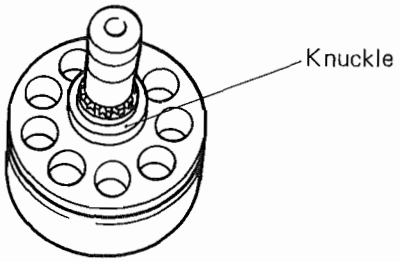


11) Assemble the rotating part assembly.

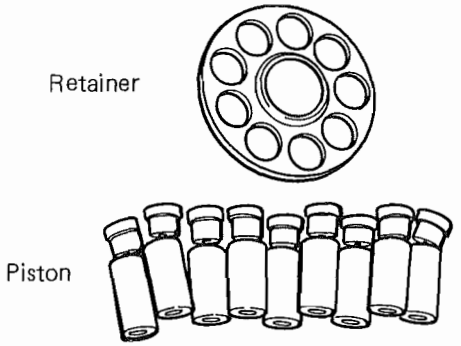
a) Insert the jig into the cylinder block, and push in three pins.

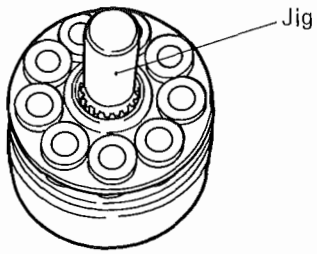


b) Assemble the knuckle.



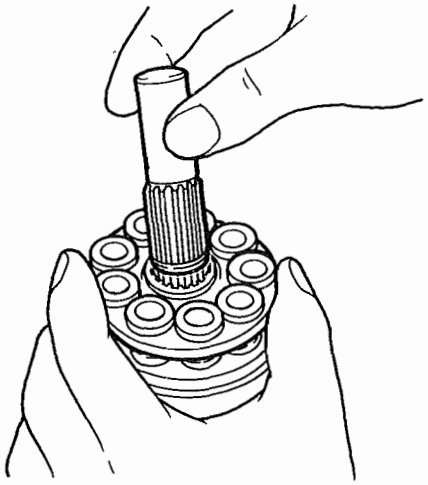
c) Place the piston and retainer.

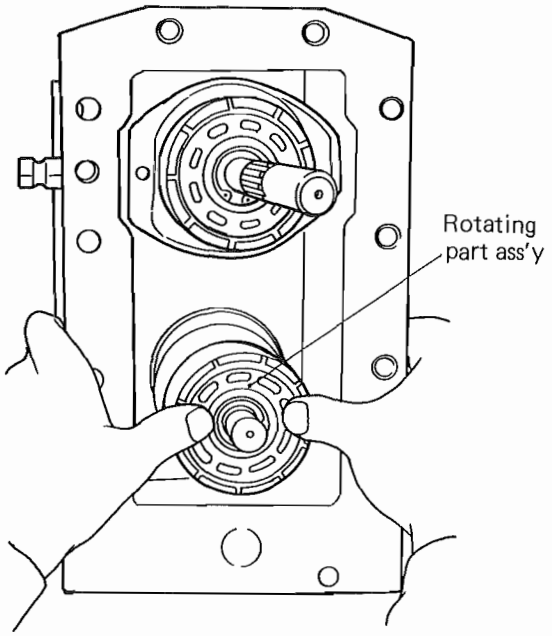




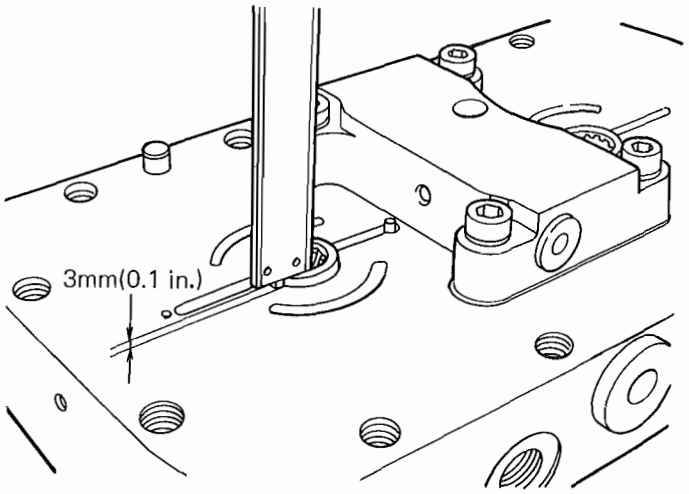
Rotating part ass'y

d) After assembling the rotating part assembly, pull out the jig slowly, and install the rotating part assembly to the driving shaft and the driven shaft.





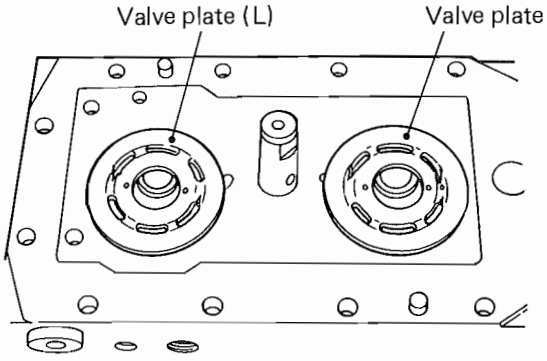
12) Fit the needle bearing to the valve plate holder forcedly.



NOTE

Confirm that the bearing is projected 3mm (0.1 inch) from the surface of the valve plate holder.

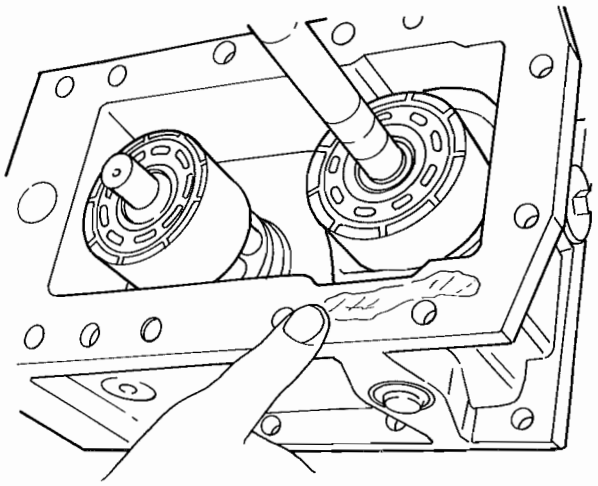
13) Fit the valve plate (L) to the needle bearing on the driving shaft side, and the valve plate to the needle bearing on the driven shaft side.



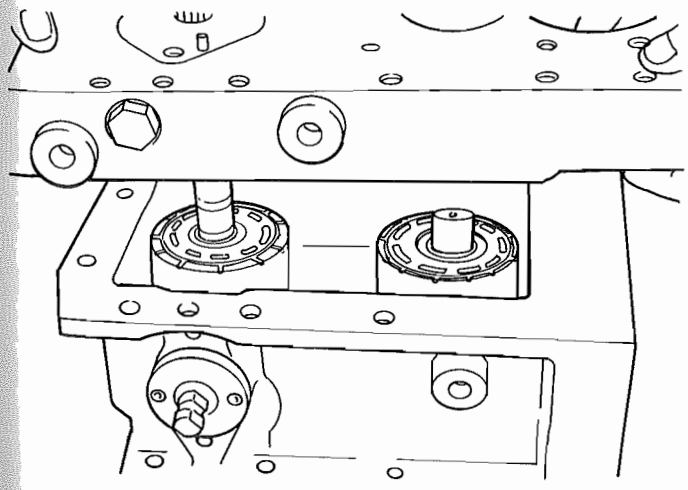
NOTE

Only one side of the valve plate (L) on the driving shaft is notched.

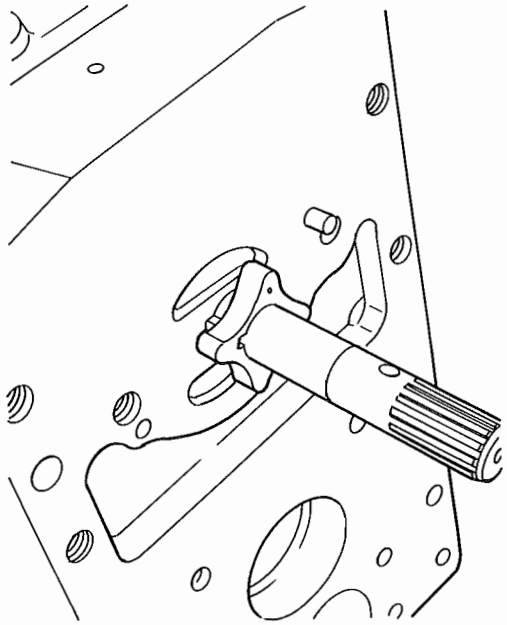
14) Apply sealant to the fitting faces of the casing and valve plate holder.



15) Assemble the valve plate holder ass'y and the casing ass'y.

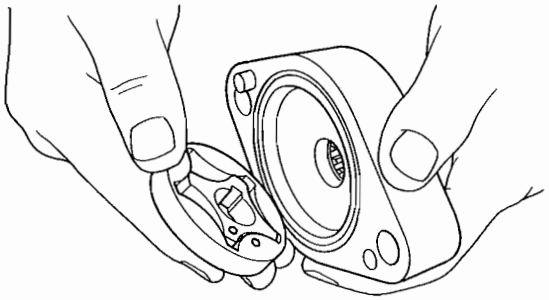


16) Install the vane to the driving shaft.



NOTE

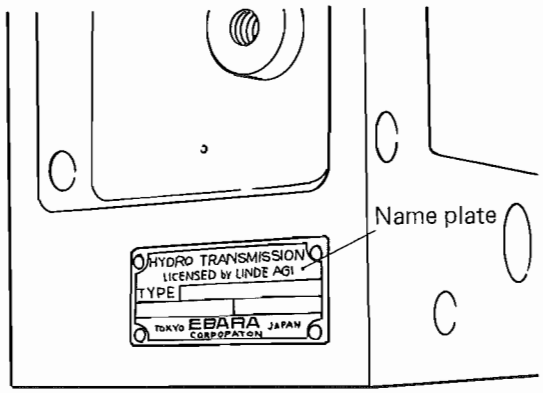
Assemble the vane and rotor with their point marks toward the casing side of the charge pump.



17) Install the oil seal cover, bearing, and rotor to the casign, and isntall them to the driving shaft.

NOTE

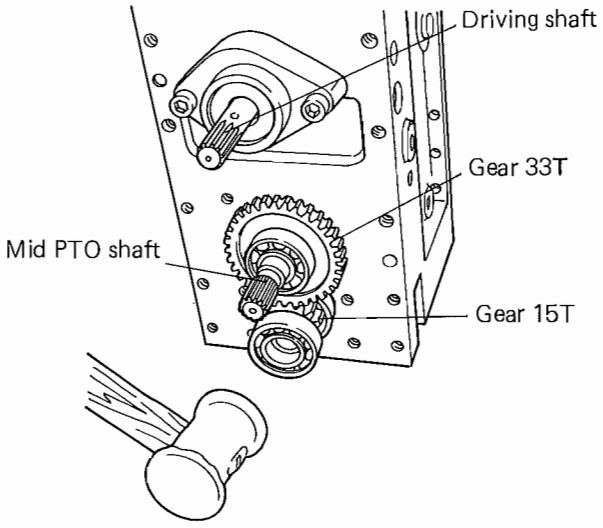
After disassembling and reassembling, take the record of serial No. on the name plate of HST unit.



18) Apply sealant to the fitting faces of HST unit and the transmission case, and assemble them.

Reassembling the mid PTO shaft

Install the ball bearing and gear 15T to the 4-wheel drive shaft in order from the front of HST unit. Install the ball bearing to HST unit. Assemble the mid PTO shaft, and install gear 33T and ball bearing in order to the shaft. Then, install the ball bearing to gear 15T on the 4-wheel drive shaft side, and install the bearing holder, on which the oil seal has been isntalled, with six bolts.



LINK ADJUSTING PROCEDURES FOR NEUTRAL POSITION OF HST

1. With ④ removed, separate the control link and HST control lever ⑥ .
2. Make sure that ball is properly in the neutral position set plate hole ⑨ .
3. Start engine and place sub-shift lever in L. Then gradually raise engine speed from to high speed.
4. If tractor moves forward or backward, return the engine to idling speed and with three bolts ⑩ loosened, move the control shaft lever back and forth, and stop it at approximate center of neutral zone, then tighten three bolts evenly.

NOTE

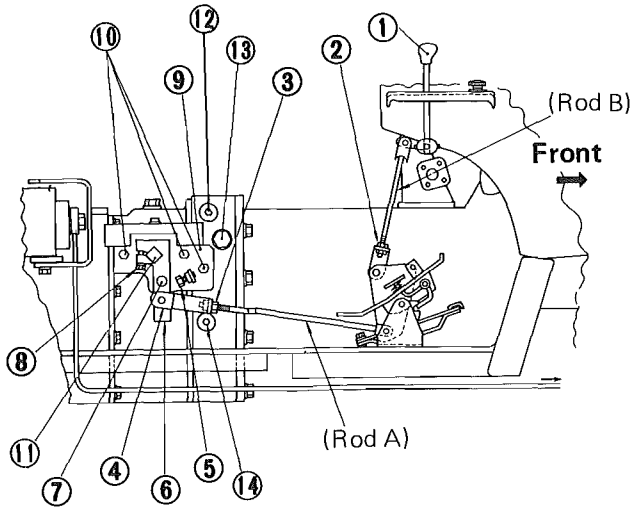
Lever should be operated by hand with the ball properly remaining in plate hole. It should not be operated with excessive force that causes the ball to fall out of the fall.

5. Run the engine at high speed again to make sure that the tractor stands still.
6. If it still moves, repeat adjustment per step (4) above.
7. Place HST foot control pedal in neutral position.
8. Interlock adjust rod A and control shaft lever by means of ④ . Adjust rod length with nut ③ loosened so that rod A has equal amount of play in front and back.
9. For interlocking with hand control lever, place hand lever in neutral position of the lever guide and adjust the length of rod B with the nut ② loosened so that interlocking holes are aligned.

NOTE

External View-Right Side shows the link under manual operation.

Right side view]



1 HST control hand lever
2 Nut
3 Nut
4 Joint
5 Backward speed adjusting stopper
6 HST control lever
7 Poppet ball case
8 HST lever set bolt
9 Neutral position set plate
10 Set plate attaching bolt
11 HST control shaft
12 Neutral valve plug (R.H)

How to measure hydraulic pressure

The qaulity of HST unit can be judged by measuring the hydraulic pressure for the pump in HST unit.

1) Measuring hydraulic pressure in neutral valve

a) When setting HST control lever to the forward position, remove the plug, and install the high pressure gauge [Measuring range to be 0 - 350kg/cm² (4978psi)] to right side of the neutral valve. Install the low pressure gauge [Measuring range to be 0 - 40kg/cm² (568.8 psi)] to left side.

NOTE

When installing the pressure gauges to HST unit, be sure use sealing tape to prevent oil leakage.

When measuring on high pressure side of neutral valve:

i) Apply the parking brake to secure the tractor.

ii) Set the engine speed to 1,000rpm, and move HST control lever toward forward position slowly.

iii) Watch the engine speed, and read the hydraulic pressure when the engine speed starts to lower.

Hydraulic pressure at high pressure side of neutral valve	265 ~ 290 kg/cm² (3769 ~ 4125 psi.)

(Oil temp: 50±5°C/122±41°F)

When measuring on low pressure side of neutral valve:

i) Apply the parking brake to secure the tractor.

ii) Set the sub gear shift lever to neutral, and set the engine speed to 2,600 - 2,700rpm. Read the pressure gauge at this point.

Hydraulic pressure at low pressure side of neutral valve	4 ~ 6 kg/cm² (56.9 ~ 85.3 psi.)

(Oil temp: 50±5°C/122±41°F)

b) When setting HST control lever to the reverse position, the high and low pressure sides are reversed. Therefore, the pressure gauges must be installed in opposite way to the forward position. The hydraulic pressure on the high and low pressure sides can be measured as described in a).

NOTE

The pressure gauges must be set to the correct positions, and HST control lever must be moved correctly.

If the low pressure gauge is set to high pressure side, it may be damaged.

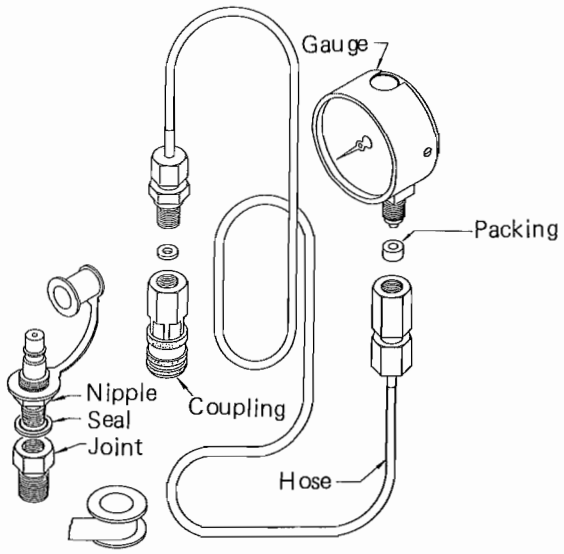
2) Measuring the suction pressure of charge pump.

Remove HST inlet pipe from HST unit. Remove the union bolt, and install the

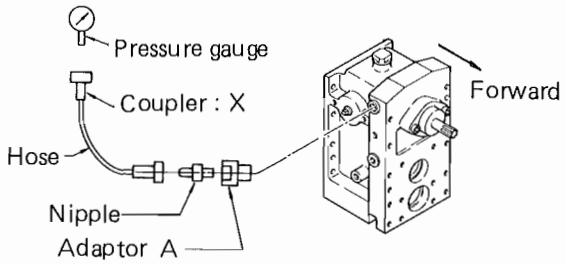
pressure gauge instead using the adapter B (Measuring range to be -1 to 1.5 kg/cm² (-14.2 to 21.3 psi)). Apply the parking brake to secure the tractor, and set the sub gear shift lever to neutral, and then start the engine. Set the engine speed to 2,600 - 2,700rpm, and read the suction pressure.

Suction pressure of charge pump	-0.2 kg/cm² or more (-2.84 psi or more)

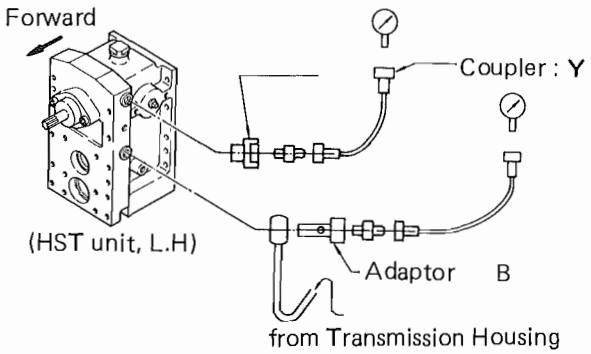
(Oil temp: 50±5°C/122±41°F)



Measuring tools



(HST unit, R.H.)



(HST unit, L.H.)

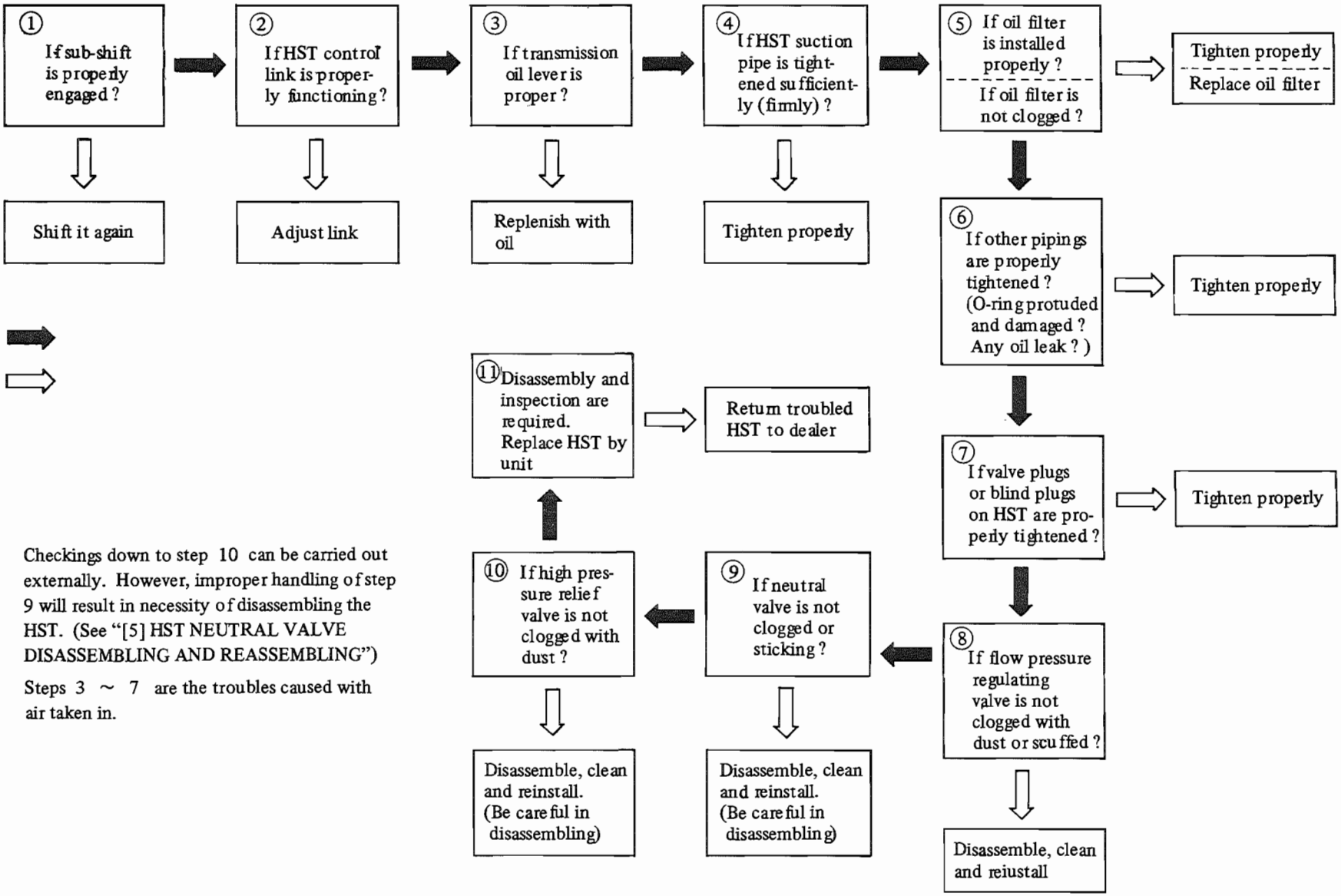
Piping for measuring the hydraulic pressure

[STARTING-UP THE HST TRACTOR AND TROUBLE SHOOTING]

Engine starting and travelling procedures

No.	OPERATION	RESULT
1	Place sub-shift in neutral	Turn on the start safety switch
2	Open throttle fully	Engine gets ready for start (Fuel injection increases)
3	Depress clutch all the way	HST driving load not applied
4	Turn on starter switch	Cranks the engine
5	After engine has started, return throttle lever to 1000 ~ low idling range	(For safety purpose)
6	Slowly return clutch pedal	Drives HST
7	Run the engine as it is for 3 ~ 5 mimutes	Supplys oil to HST circuit and waits for air to escape
8	Disengage clutch and move sub-shift lever to L or H	Power train connected to axle (HST drive is off)
9	Return clytch pedal	(Drive HST)
10	Increase engine speed appropriately	(Secures required drive force)
11	Moving HST lever slowly forward causes the tractor to travel forward. (Vice-versa)	HST power transmitted
12	To bring tractor to stop, return HST lever to neutral. (Returning it suddenly causes jerky stopping)	HST is brought to neutral and stops.
Remark : Stops 6 and 7 may be skipped unless it is immediately after an oil replacement. (Example: After pipe has been removed or filter has been replaced.)		

Checking procedures to follow if tractor does not move



Checkings down to step 10 can be carried out externally. However, improper handling of step 9 will result in necessity of disassembling the HST. (See "[5] HST NEUTRAL VALVE DISASSEMBLING AND REASSEMBLING")

Steps 3 ~ 7 are the troubles caused with air taken in.

Trouble shooting

	TROUBLE	CHECKING PROCEDURE
1.	Operating HST control lever does not cause tractor to move.	Check in accordance with procedures shown in "[2] CHECKING PROCEDURES TO FOLLOW IF TRACTOR DOES NOT MOVE"
2.	Tractor travels but does not again speed.	Is link lever properly tightened ? ⇩ Adjust or retighten. (OK) ⟹ Is link lever deformed ? ⇩ Correct or replace. (OK) ⟹ Is foreign matter in linkage ? ⇩ Remove it. (OK) ⟹ HST control lever shaft loosened ⇩ Retighten.
3.	Does not travel normally (travels and stops against intention).	Check in accordance with steps ② and down shown in
4.	Stops by slight load. * (Engine speed does not drop but HST noise gets greater and stops.)	① Check in accordance with steps ② ~ ⑦ in [2]. ② If OK, check with [2] ⑩⇨⑧⇨⑨, in that order. Note) If adjustment is proper and air has not been taken in, it is highly probable that dust is in the high pressure safety valve.
5.	Travels only in one direction, (forward or reverse)	Check the control link ⇩ Tighten, adjust ⟹ Disassemble and check the spool valve. (for dust or sticking) ⇩ Clean and relative
6.	Even if HST co trol lever is moved slowly tractor makes jerky start only.	Same as above 5.
7.	Does not stop even with HST control lever returned to neutral.	With HST control lever in neutral, is control lever poppet ball on HST case end properly in its hole ? ⇩ (External link adjustment) (OK) ⟹ Remove external link and loosen guide plate of lever on HST end, and adjust. (NO) ⟹ Disassemble and check spool valve. After cleaning and reinstallation, adjust in reversed procedure.
8.	Vibration betwenn charge pump and filter or HST noise is great.	① Check in accordance with steps [2] ② ~ ⑦ . Note) If it has been working normally until just before, clogging of oil filter is suspectable.
9.	Oil temperature increases.	Oil cooler / Radiator } Clogged ⇩ Clean (OK) ⟹ Fan belt loosended or damaged. ⇩ Adjust tension or replace. (OK) ⟹ Oil cooler damaged or clogged. ⇩ Clean or replace. (OK) ⟹ Ask dealer for disassembly and repair of HST.

Remarks: *1. In case setting location of control lever is close to neutral position, travelling speed may fall or tractor may stop due to travelling load. If such is the case, adjust the speed by moving the HST control lever toward the direction where the speed increases. (Change of travelling speed according to load is the characteristics of HST and does not represent any trouble.)

CHAPTER 6
BRAKE SYSTEM

TABLE OF CONTENTS

DESCRIPTION

The brake system for the MITSUBISHI MT160/D, MT180/D and MT180H/HD is of a mechanical internal expansion type.

When the foot pedal is depressed, a cam rotates, the brake lining is pressed against the inside of the brake drum and brake is applied. Brakes are installed in right and left final cases.

Two brake pedals are provided to brake right and left wheels independently. It is an essential requirement for an agricultural tractor that one wheel can be locked completely to make a sharp turn in a confined space or in the corner of the field. Both right and left wheels can be braked at the same time by linking right and left brake pedals with a connecting plate.

The brake drum is installed on the differential shaft which rotates at higher speed than the rear wheels do, to ensure high braking efficiency.

High braking efficiency both in forward and reverse is also provided by its internal expansion type structure where the lining of brake shoe is pressed against the inside of the brake drum by means of the cam.

The brake system is completely enclosed, which eliminates trouble due to water or dust even when the tractor works in paddy fields or very dusty places.

CONSTRUCTION

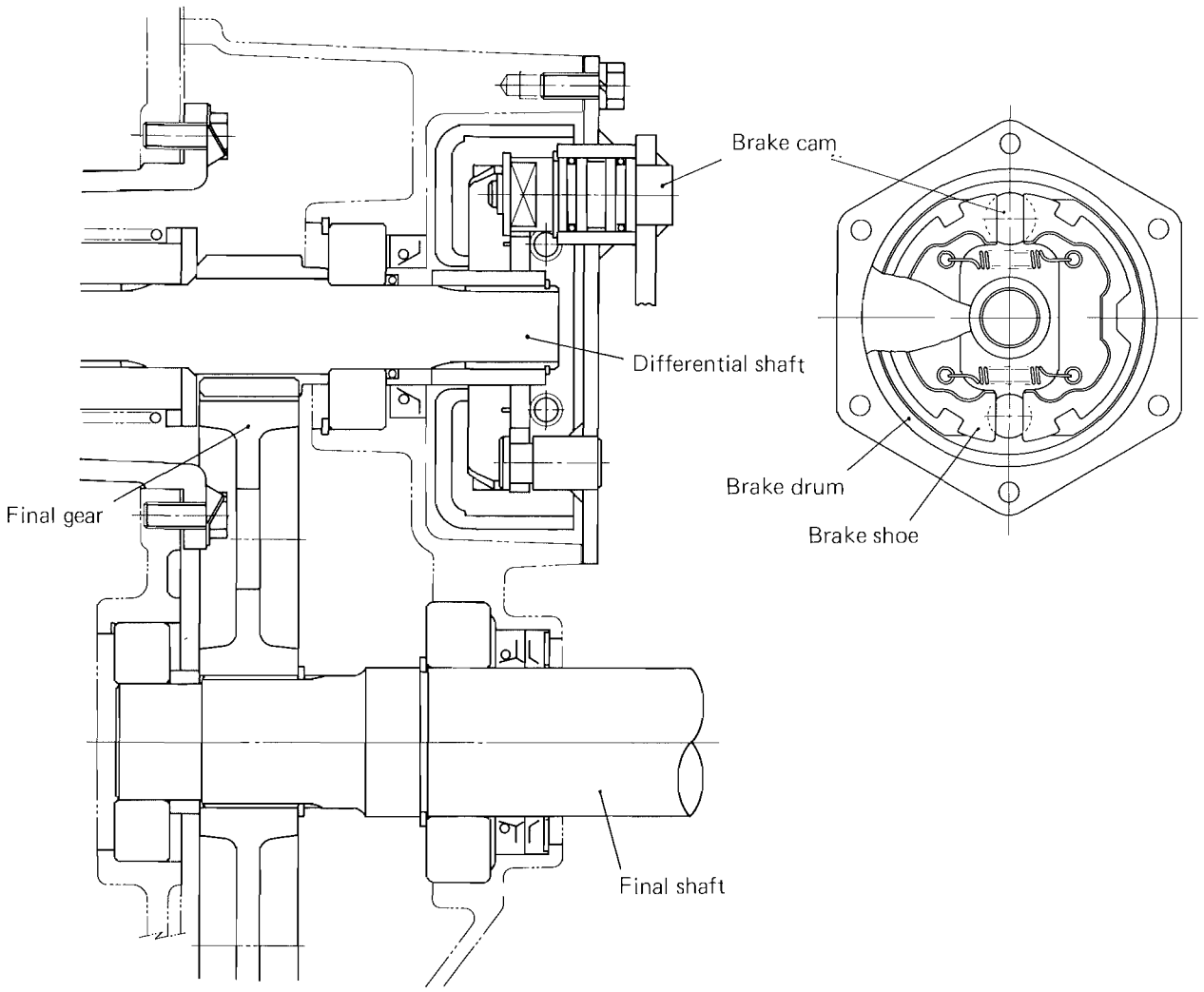
The brake drum is installed at the end of the differential shaft mounted on the differential side gear. In the middle of the shaft, a gear is provided to drive a final shaft.

The brake drum is covered with a brake cover attached to the final case and completely enclosed in the brake cover in which the brake shoe is incorporated.

Anchor pin, cam shaft and brake shoe with a lining are fitted to the brake cover. Brake cam arm is installed in the outside of the brake cover to rotate the cam. The brake pedal is fitted to the cross shaft mounted on the lower part of the clutch housing. Brake cam arm and brake pedal are connected by brake rod and when the pedal is depressed, the cam is rotated via the brake cam arm and the lining is pressed against the brake drum, thus brake is applied.

When the connecting plate is released, right and left wheels can be braked independently and used selectively depending on the work and field conditions.

Parking brake is applied by connecting right and left brake pedals with the connecting plate and lock the brake pedals with the parking brake lever on the clutch housing side.



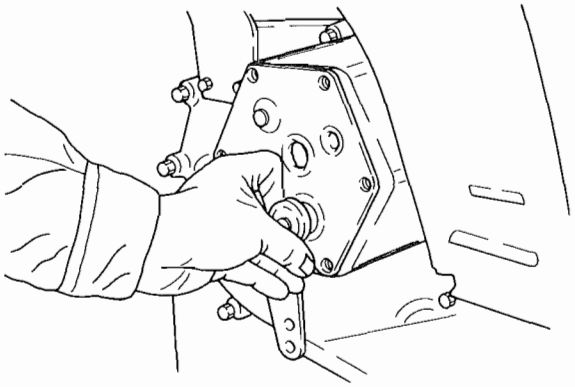
DISASSEMBLY

Disassembling the brake cover and brake drum

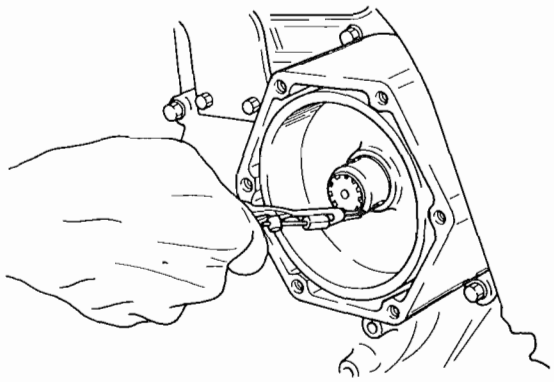
Place a jack under the transmission case and take up the weight of the case with the jack to such an extent that the rear wheels will become slightly airborne. Apply parking brake, and loosen rear wheel bolts; remove the rear wheels and release the parking brake.

(1) Remove brake rod from brake cam shaft.

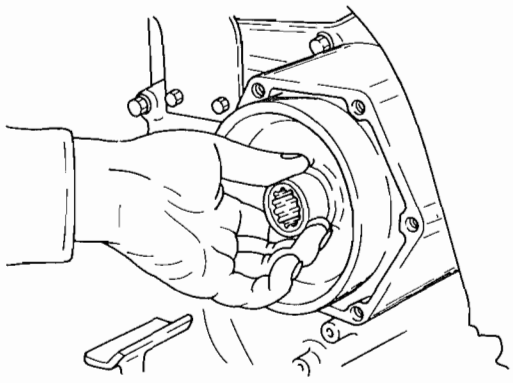
(2) Loosen the six M8 × 20 bolts securing the brake cover, and remove the cover.



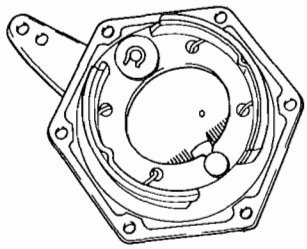
(3) Remove circlip on differential shaft.



(4) Remove brake drum.



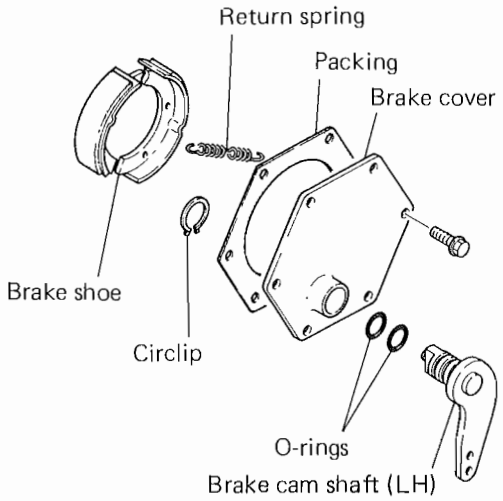
(5) Remove brake shoes from brake cover, as required.



NOTE

To replace differential-shaft oil seals and ball bearings, remove final case from transmission case in order to permit their replacement. How to remove the final case is explained in "Disassembly of the final case."

(6) Remove circlip on cam shaft, and take off cam shaft.

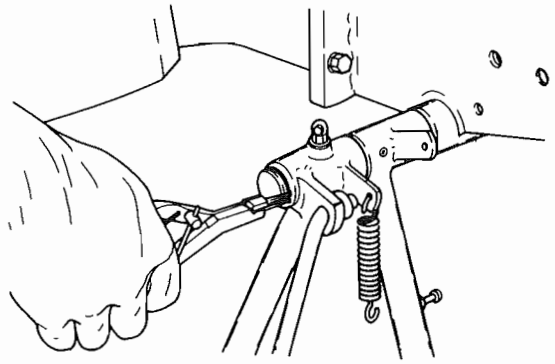


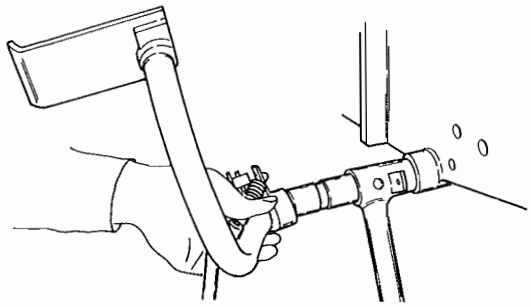
Disassembling the brake pedals

If brake pedals alone have to be removed, it is not necessary to remove both steps, right and left: remove the right-side step only. The left-hand step, too, must be removed if brake cross shaft is to be disassembled.

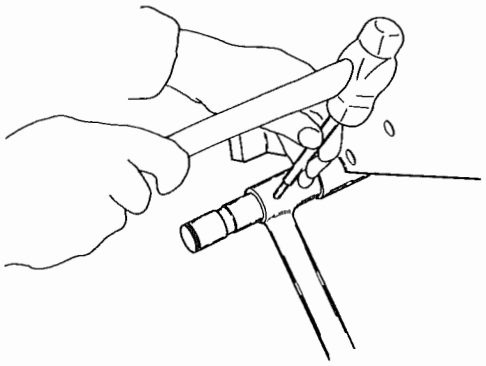
(1) Remove brake cam and brake rod.

(2) Pick out circlip on the right-hand end of brake cross shaft, and remove brake pedal on the right.

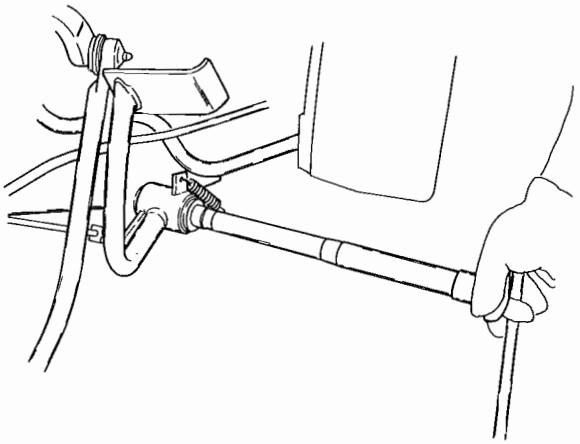




(3) Draw out spring pin from left-hand brake pedal, and remove brake pedal.



(4) Remove brake cross shaft by drawing it out to the left.



INSPECTION AND MAINTENANCE

(1) Check the brake cam shaft O-ring, and if scratched, replace.

(2) If the brake shoe is excessively worn, replace.

(3) Check for oil or grease on the brake shoe.

(4) Check the oil seal for oil leakage.

(5) Check the brake cam shaft for excessive wear.

(6) Check the return spring for fatigue.

(7) Check the brake cross shaft and brake pedal for rust or streaks.

Inspection	Maintenance	Service limit
Worn brake lining	If the thickness of lining is more than 2.5 mm (0.10 in.), use it again.	If it is less than 2.5 mm (0.10 in.), replace.
Uneven brake lining contact	Grind the surface.	If it is 2.5 mm (0.10 in.) in thickness after grinding, replace.
Oil on brake lining	If only a little, correct it with sandpaper.	If a lot of oil is attached, replace the shoes.
Brake drum	If it is scarred, grind it.	If the drum inner diameter exceeds 114.5 mm (4.508 in.), replace.
Return spring		If it is weakened, replace.
Brake pedal free play	Adjust it with brake rod.	20 ~ 30 mm (0.79 ~ 1.18 in.)
Parking brake	Apply oil to ensure that lock plate operates properly.	
Oil leakage in brake	Check it for leaking parts.	If oil seal is faulty, replace it.
Foreign particles in drum	Check "O" ring and packing	If "O" ring and packing are faulty, replace them.

REASSEMBLY

Reassemblying the brake drum and brake cover

(1) Install greased O-ring to the cam shaft, and apply grease to the grease groove. Install the cam to the brake cover, and set it with the circlip.

(2) Hook the spring to the brake shoes and install them to the brake cover.

(3) Install the brake drum to the differential shaft, and set it with the circlip.

(4) Fit packing to brake cover; place the cover on final case, move cam shaft to spread out brake shoes against drum; and, while centering brake cover, tighten bolts to this torque value:

Tightening torque	2.0 ~ 2.5 kg-m (14 ~ 18 ft-lb)

Reassembling the brake pedals

(1) Grease the brake cross shaft mounting boss under the clutch housing, and insert the brake cross shaft into the boss.

(2) Push in the left-side brake pedal, and install the spring pin.

(3) Push in the right side brake pedal, and install the circlip.

(4) Install both right- and left-side brake rods, and set them with cotter pins.

(5) Install the step, and install the return spring.

NOTE

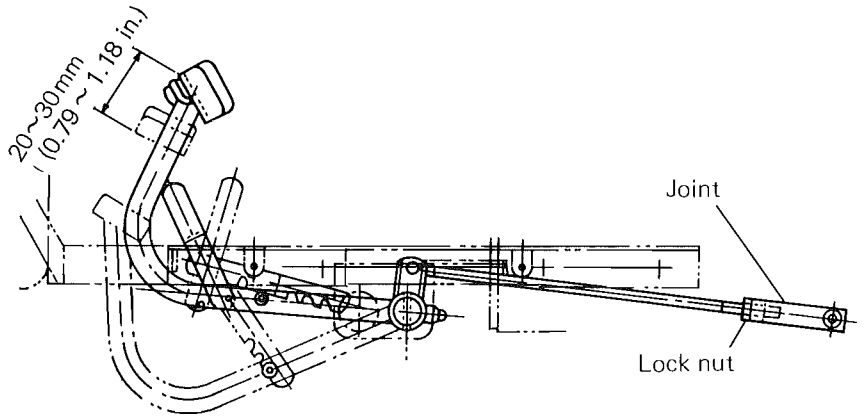
Make sure that brake pedals move smoothly.

ADJUSTMENT

Adjusting the brake pedals

Free play of the brake pedal must be maintained within the correct range, otherwise, accidents may occur or power will be lost.

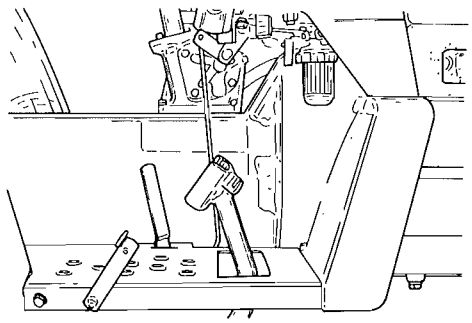
Before the brake on one side becomes unadjustable even by means of brake rod, caused by premature wear of the brake lining due to its more frequent use than the other, periodically interchange the right and left brake shoes. Special care should be taken in the case where the brake on one side only is frequently used.



(1) Loosen lock nut and rotate the joint piece to produce a free play of 20 to 30 mm (0.79 to 1.18 in.) at the brake pedal. With this much play obtained, tighten the lock nut.

(2) Confirm that the right and left brakes operate simultaneously by running the tractor. If not, adjust both of them by means of the brake rod.

(3) Make sure that the parking brake operates correctly.



TROUBLESHOOTING

Poor braking

Possible cause	Remedy
Too much pedal free play	Adjust with brake rod.
Worn brake lining	Adjust with brake rod or replace brake shoes.
Uneven lining contact	Grind with sandpaper.
Burnt lining	Replace brake shoes.
Oil on brake lining	Repair oil leakage and replace brake shoes.

Brakes remain ON

Possible cause	Remedy
Not enough pedal free play	Adjust with brake rod.
Loose brake spring	Replace.
Loose return spring	Replace.
Cross shaft and holder sticking	Disassemble, correct and apply grease.
Brake shoes seized with rusts	Remove rusts.

Abnormal noise

Possible cause	Remedy
Defective brake cover centering	Loosen bolts securing cover, and retighten them while moving cam lever.
Foreign particles in drum	Clear away.
Damaged lining	Replace brake shoes.
Damaged return spring	Replace.
Brake shoes seized with rusts	Remove rusts.

SPECIFICATIONS

Type	Foot operating internal expansion water-proof dry type
Brake pedal	Separate with interlocking device, foot operating type
Parking brake	Main brake used hand operating lock type
Lining material	Specially woven fabric
Lining dimension (length X width X thickness)	119 X 28.5 X 4.0 mm (4.7 X 1.12 X 0.16 in.)
Number of linings	4
Drum inner diameter	114 $^{+0.1}_{0}$ mm (4.49 $^{+0.004}_{0}$ in.)
Braking position	Differential shaft
Brake pedal free play	20 ~ 30 mm (0.79 ~ 1.18 in.)

ISO

CHAPTER 7-1
HYDRAULIC SYSTEM

7-1

TABLE OF CONTENTS

DESCRIPTION

The hydraulic system in MITSUBISHI MT160 and MT160D is simple in construction; its operation is accurately controlled form an easy-to-operate control lever.

For the source of hydraulic pressure, a gear pump of pressure-balanced type is used. The pump is mounted on the timing gear case of the engine, and is driven through gears inside the case. Thus, as long as the engine is running, hydraulic pressure is available.

For the hydraulic actuator to raise and lower the hitched implement, such as the rotary and plow, a single-acting cylinder is used.

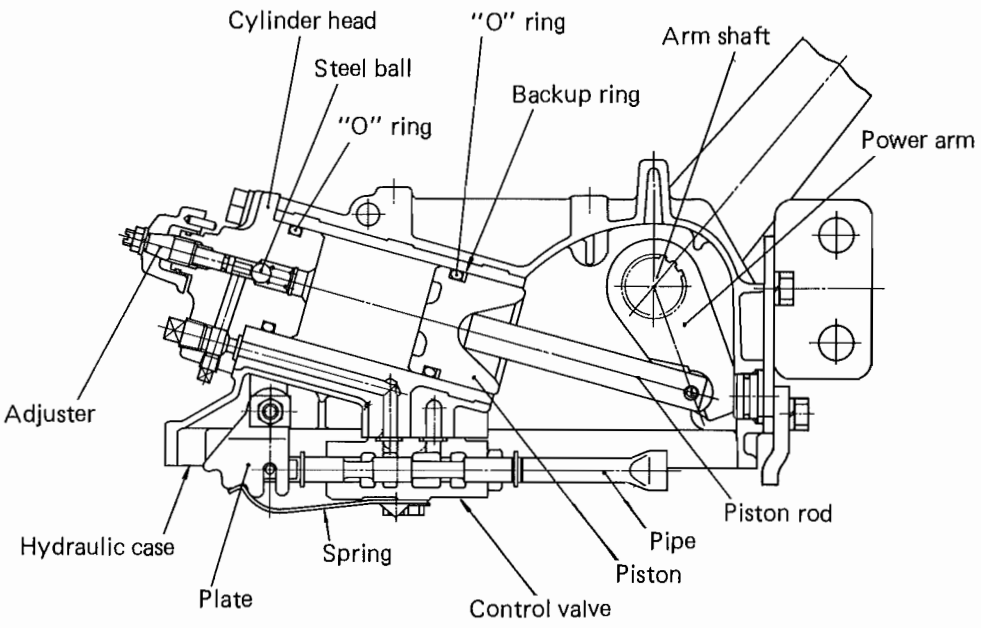
It is the oil in the transmission case that the oil pump draws and delivers to the hydraulic circuit. A high-performance oil filter keeps the oil clean for the hydraulic system. A provision is made in the discharge side of the pump to make the pressurized oil available for driving an external hydraulic device, a feature made possible by the high capacity of the pump.

The hydraulic control valve is a three-way spool valve and, as such, is a precision-machined component. It is a compact unit installed in the hydraulic case. The lowering speed control lever is installed on the cylinder head of the hydraulic case.

The control lever is so linked to the lift arm that, when the hitched implement reaches a certian elevation in lifting action, the lever returns by itself to its neutral position, thereby unloading the pump.

There is no need to drain the transmission in order to permit removal of the hydraulic case.

CONSTRUCTION



Schematic diagram of hydraulic system

The oil pump draws oil in the transmission oil sump through the oil filter. The discharge line of the pump is tied to the oil inlet of the control valve.

In the control valve, oil from the pump is directed to the hydraulic cylinder or to the return line, depending on the position of the spool.

Moving the control lever to "LIFT" position directs the oil to the hydraulic cylinder to push out its piston, whose outward movement is transmitted through piston rod to the lift fork. This fork then rotates the ram shaft to turn up the lift arm, thereby lifting the hitched implement.

As the lift arm rises to a predetermined elevation, another arm (auto-return arm) pulls back the control lever to "NEUTRAL" through a link rod; and when this occurs, the spool traps the oil in the line extending to the hydraulic cylinder, so that the lift arm is prevented from turning down, thereby holding the hitched implement in lifted position.

With the spool in "NEUTRAL," the incoming oil returns to the transmission and the pump runs in no-load condition.

Moving the control lever to "DOWN" position pushes the spool all the way, communicating the hydraulic cylinder to another return line. Consequently, the piston (on which the weight of the implement is acting through the arms) moves inward to force the oil out. The displaced oil flows through the flow control valve and returns to the transmission oil sump. In other words, "DOWN" motion is gravity but "braked" by the flow control valve.

As an optional feature, another control valve may be provided elsewhere, preferably at the hitched implement to drive an additional hydraulic ram.

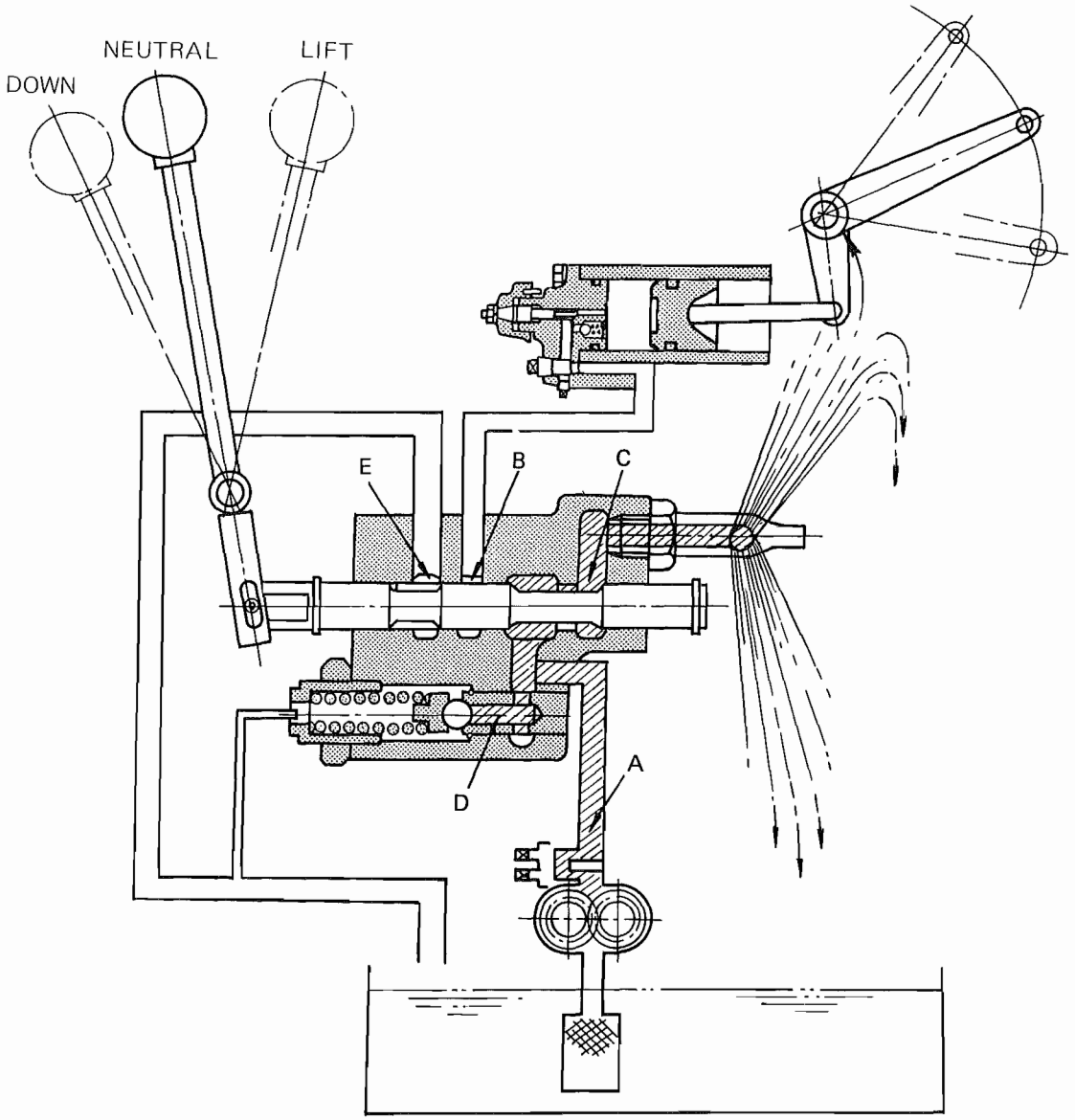
And also an additional single-acting hydraulic ram can be provided and operated from the hydraulic control valve. These are what are referred to as an external service.

OPERATING PRINCIPLES

NEUTRAL

With the spool in "NEUTRAL" position, pressurized oil enters control valve through port A and returns to the transmission case through port C. All return oil is spread from the return line to the piston rod and ram shaft to lubricate them.

Port B is blocked by the spool land, so that the oil in the line to the hydraulic cylinder remains trapped. Thus, the hitched implement is held rigidly in its current vertical position. Needless to say, the pump under this condition supports no load.

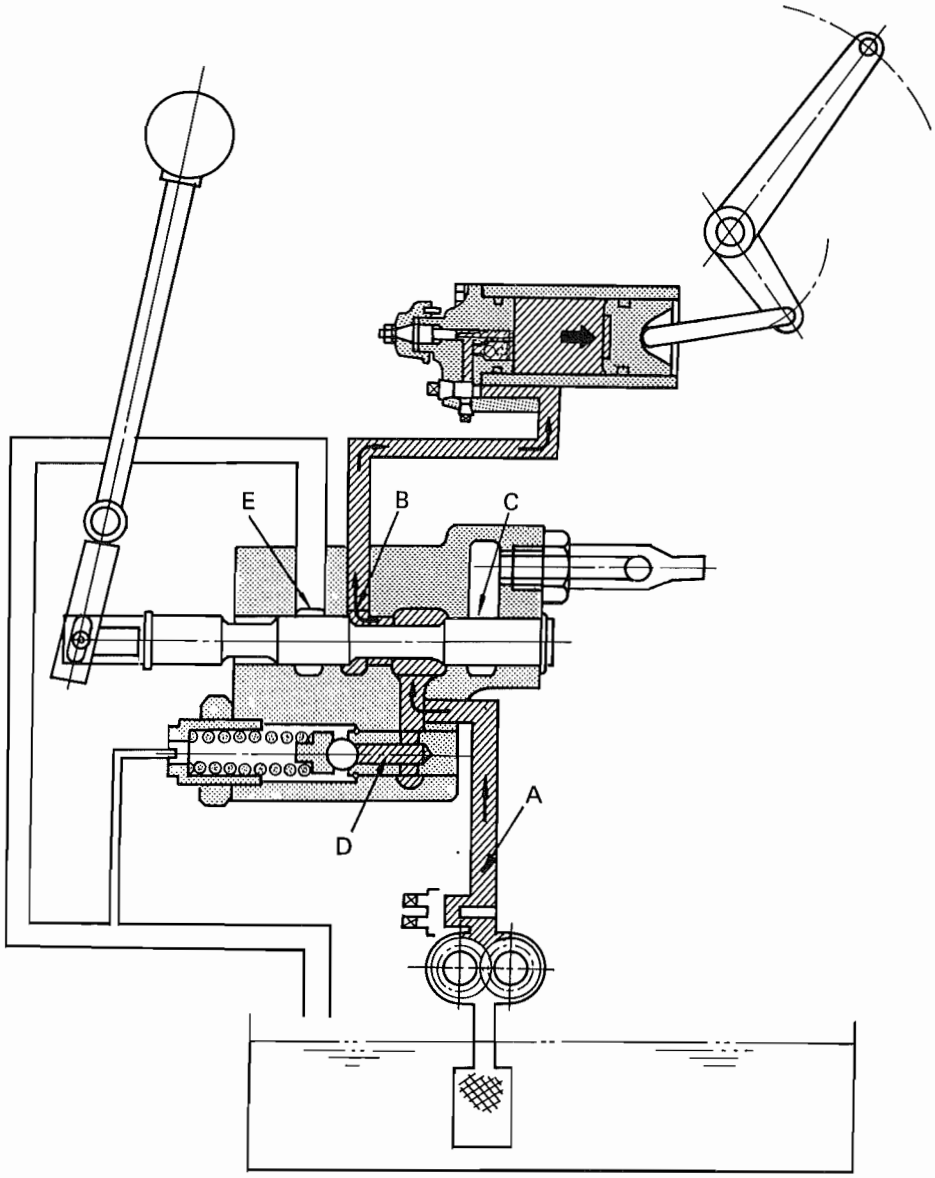


LIFT

With the spool in "LIFT" position, port C is blocked while port B is opened, The oil pushes on the piston in the hydraulic cylinder to do the work already explained.

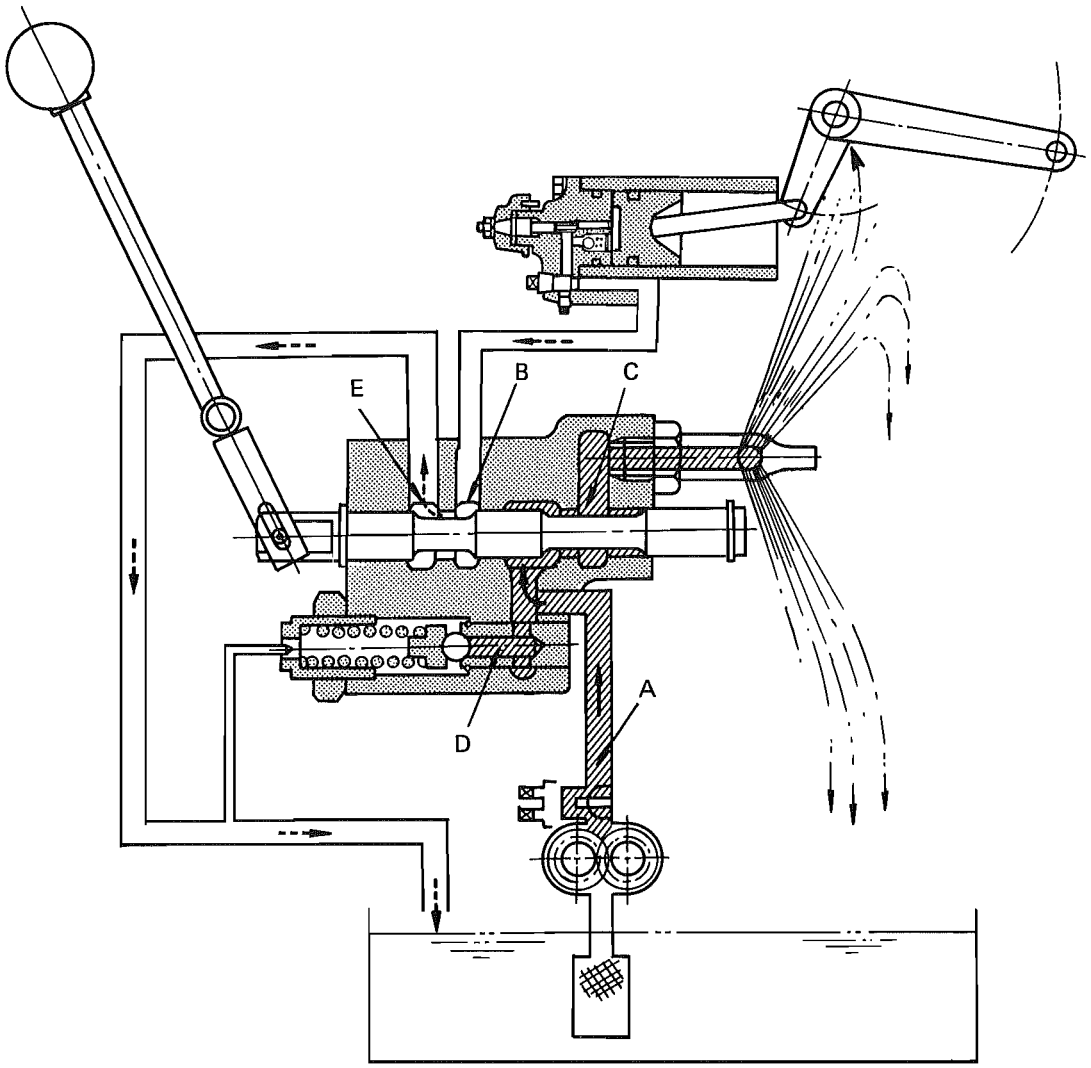
As the hitched implement rises to the limited elevation, the spool gets pulled back by the control lever as actuated through linkage from the auto-return arm, and halts at "NEUTRAL" position.

In the event the hitched implement offers abnormally large resistance to the lifting force, oil pressure in the pump discharge line will build up or peak. In such a case, excess pressure is bled out through port D in the safety valve.



DOWN

Moving the control lever forward, that is, to "DOWN" relocates the spool to communicate port B to port E, keeping port C open to allow the discharged oil to return to the sump in the transmission. As explained previously, the oil flows out of the hydraulic cylinder through the flow control valve (acting like a brake) and returns through port E to the sump, so that the hitched implement goes down by its own weight.

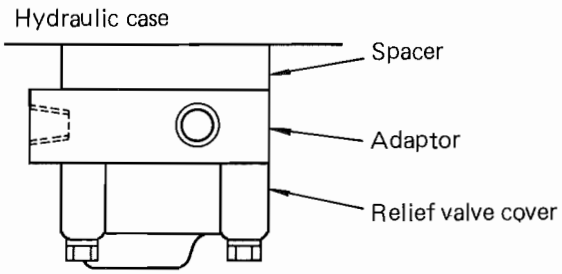


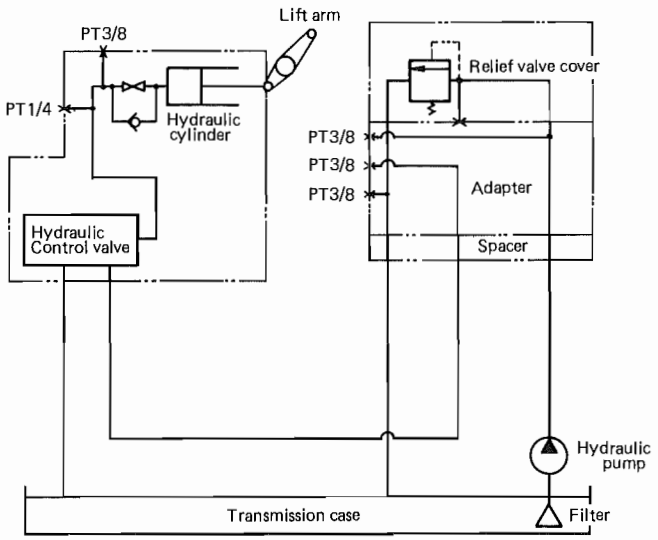
HYDRAULIC POWER TAKE-OFF FOR EXTERNAL SERVICE

There are two ways as under on the hydraulic external service. Select it according to the kind of control valve attached to the implement.

NOTE

External service cannot be done for the machine which is equipped with control valve for use of 3-point linkage of tractor.





Remove the cover (relief valve) on the left side of hydraulic case and secure the spacer, adaptor plate and cover to the hydraulic case. Pass a hose or pipe to IN port of the control valve installed on the implement side from OUT port of the adaptor plate. Pass a hose or pipe to IN port of the adaptor from OUT port of the control valve to make a hydraulic circuit. The implement can be operated by acuating the lever of control valve attached to the implement.

NOTE

1) Thread size of adaptor plate is PT-3/8.;
2) In order to do the hydraulic external service, never use the external port located in the hydraulic cylinder head as it may cause trouble in the hydraulic system.

HYDRAULIC CASE ASSEMBLY

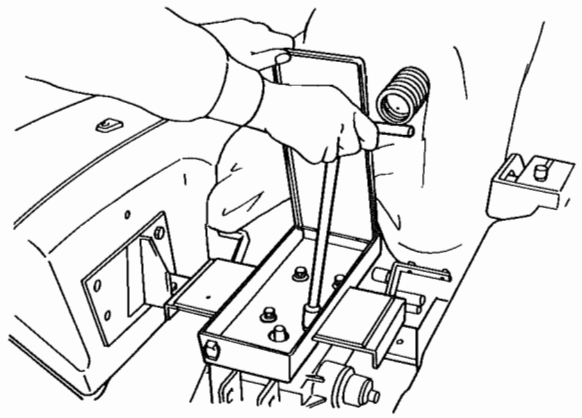
Causes necessitating hydraulic system disassembly may be regarded as occurring in three areas: 1) hydraulic case, in which the control valve is mounted, 2) oil pump, and 3) oil piping inclusive of the oil filter.

Whenever trouble develops, a rough check must be made on each area to pinpoint the suspected part or component. Disassembly of parts and components in sound condition should be avoided and can be avoided by viewing the hydraulic system as consisting of the three groups.

Disassembling the hydraulic case

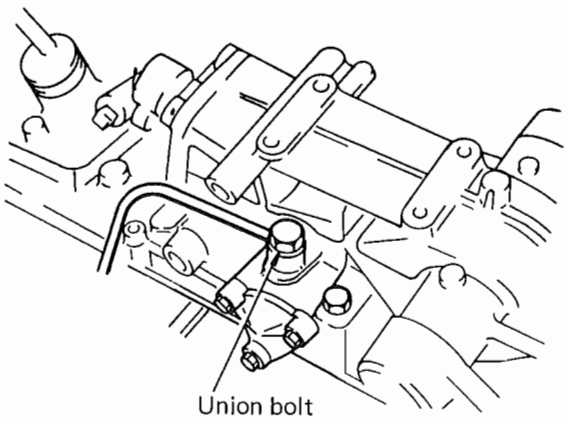
It is not necessary to drain the transmission in order to permit removal of the hydraulic case.

(1) Remove seat and tool box.

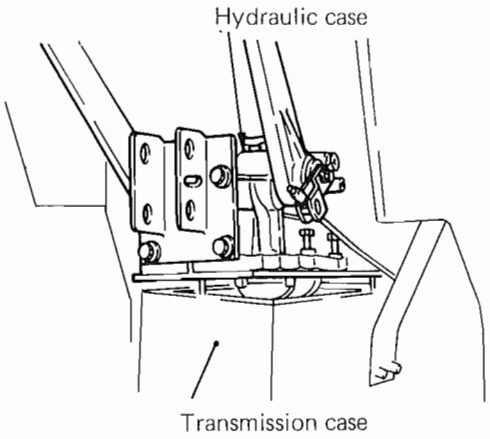


(2) Remove fender bracket and left-had cover.

(3) Remove union bolt securing the pimp pressure pipe to hydraulic case.



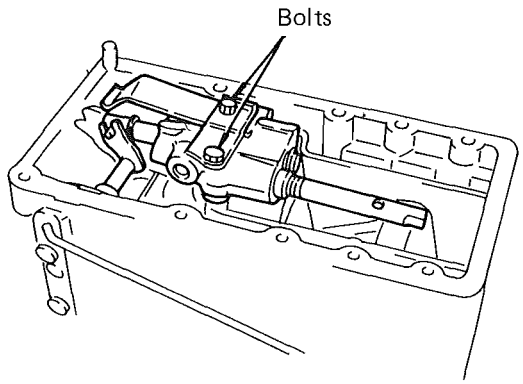
(4) Remove 8 bolts securing the hydraulic case to transmission case, and take off the case.



NOTE

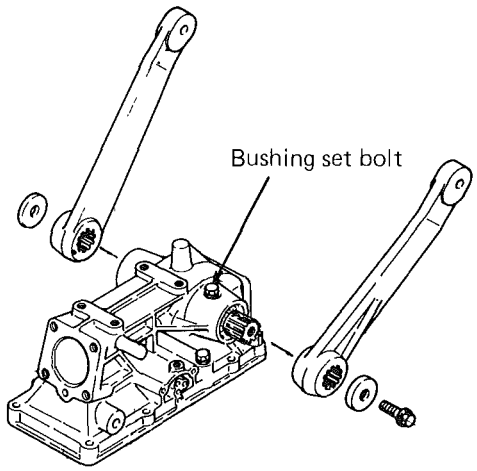
Because of sealant used in the joint of hydraulic case and transmission case, the hydraulic case may not come off easily; if so, loosen the joint by poking with the tip of plain screwdriver, taking care not to damage the case, and remove it by lifting it straight off. Remember, the hydraulic case is made of an aluminum alloy and is not so resistant to shock load as are steel or cast-iron parts.

(5) Straighten the lock plate under the heads of bolts securing the control valve, loosen the bolts and remove the control valve. Be sure to pick out "O" ring.



(6) Pull off cotter pin from the tip of control lever to free the auto-return feedback rod, loosen the bolt on the right-side lift arm, and remove the feedback rod.

(7) Remove right-side lift arm. Loosen the bolt on the left-side lift arm, and remove this arm, too.



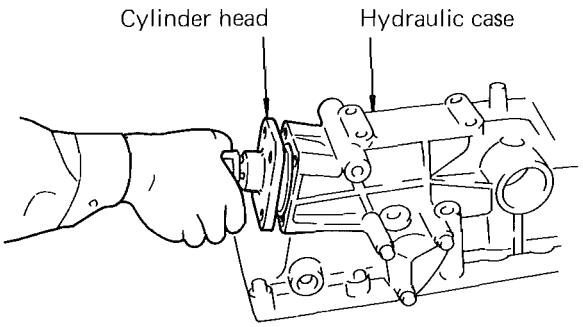
(8) Remove the bushing set bolts, move ram shaft to and fro by driving on its two ends alternately and remove bushings and oil seals. Draw ram shaft out.

NOTE

When pulling ram shaft out, hold the lift fork by hand so that the shaft comes off smoothly.

(9) Remove lift fork and piston rod.

(10) Loosen M10 bolts on cylinder head, and remove the head.



(11) Push piston out into hydraulic case, and take out piston.

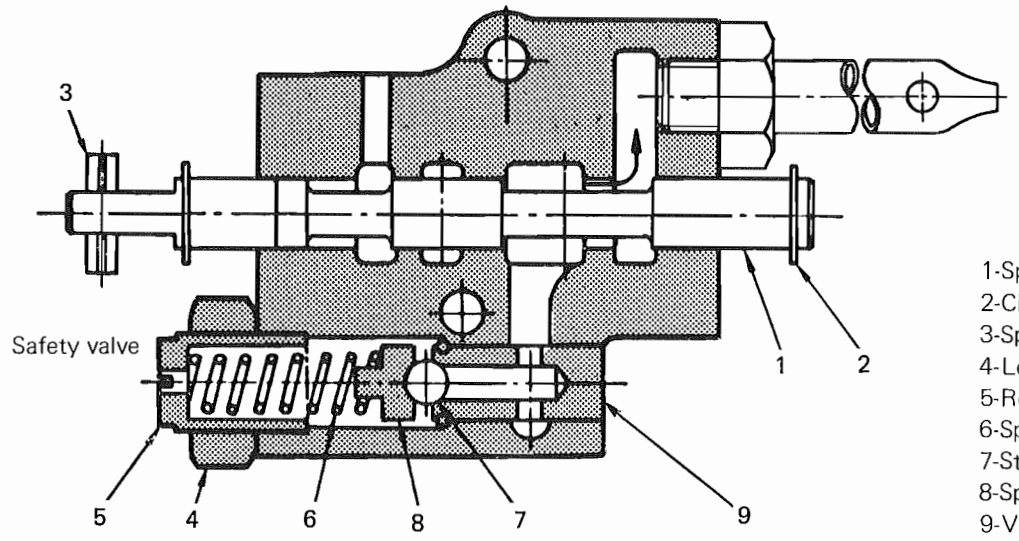
(12) Loosen the nuts on plate and arm by which control lever is held in place, remove the plate and arm, and take off control lever.

Disassembling the control valve

The control valve is a precision-machined component and should not be disassembled in the field unless its disassembly is absolutely necessary. Select a clean place, free from any dust, to perform its disassembly. Upon removal of its spool, exercise utmost care not to damage it even in the slightest way. The bore, too, must be similarly protected. Be sure to adhere to the following instructions:

- If the spool is found in defective condition to require replacement, replace the valve body, too. The spool and body must be handled as a set.

- Do not disassemble the safety valve unless a facility for measuring oil pressure is available. This is because, after its reassembly, it must be tested and set for the specified relieving pressure.



1-Spool
2-Circlip
3-Spring pin
4-Lock nut
5-Relief adjuster
6-Spring
7-Steel ball
8-Spring retainer
9-Valve seat

The disassembling procedure is as follows:

(1) Pick out circlip on that end of spool opposite to the part where spring pin is fitted, and draw the spool out of the body.

(2) Loosen the lock on the lock nut of safety valve, and remove the lock nut.

(3) Loosen relief adjuster, and take out spring, spring retainer and ball.

(4) Drive valve seat off the body by lightly tapping on the seat from outer side.

Inspection of control valve

(1) Inspect valve seat and seating face of steel ball for damage. Be sure that the seat and seating face are both perfectly free of any dent, nick or scratch mark.

(2) Inspect spool and bore for evidence of scuffing, galling, etc.

Reassembling the control valve

Have all parts washed clean and dried. Oil them and reassemble in sequential order which is reverse of disassembling sequence, making sure that no part picks up dust.

The specified relieving pressure for the safety valve is 135 kg/cm² (1920 psi) in full-flow condition.

Disassembling the cylinder head

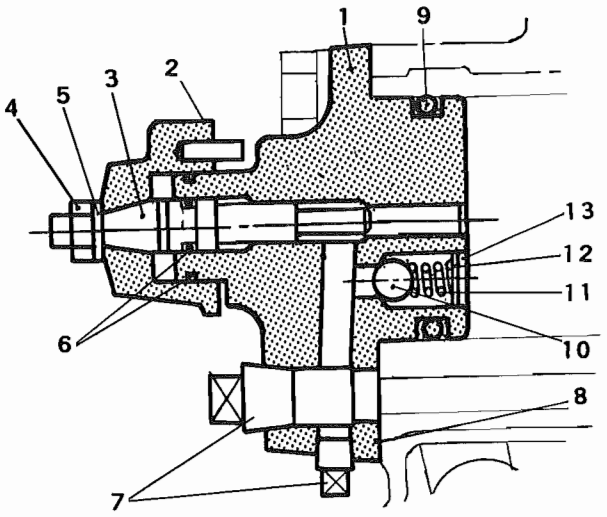
After removing the cylinder head from hydraulic case, proceed as follows:

(1) Remove nut securing the knob, lightly tap on the knob and remove it from the tapered portion of adjuster.

(2) Remove the adjuster.

(3) Pick out circlip, and take out spring and steel ball.

(4) As necessary, remove "O" rings.



1-Cylinder head
2-Grip
3-Adjuster
4-Nut
5-Spring washer
6-"O" ring
7-Plug
8-"O" ring
9-"O" ring
10-Steel ball
11-Spring
12-Washer
13-Circlip

Reassembling the hydraulic case

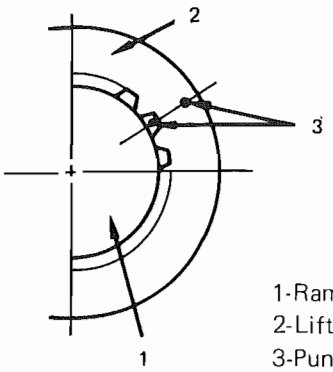
When reassembling the hydraulic case, the following steps must be taken.

- Thoroughly wash all parts with cleaning oil.
- Blow all washed parts with compressed air to dry them. Do not use cloth to wipe them.
- As for valves and related parts, they should be kept dipped in gear oil SAE #80 after being washed.
- Avoid re-using "O" rings, backup ring and gaskets. Always use new ones. Before installing "O" rings, coat them with good quality grease. Apply grease sparingly.
- Always use new cotter pins.
- Do not put on gloves while reassembling operations.
- Before starting reassembly, make sure that the place is clean.
- When re-using the used oil after reassembly is over, avoid using 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).
- Do not stretch "O" rings so that they will not permanently deformed.

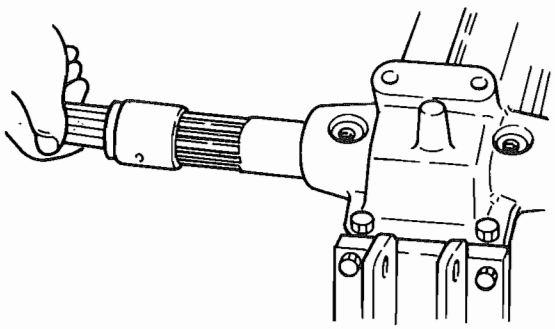
The reassembling procedure is as follows:

(1) Connect the piston rod to lift fork and set with cotter pin.

(2) Place lift fork in hydraulic case, and align the punch mark on ram shaft to the punch mark on lift fork.



1-Ram shaft
2-Lift fork
3-Punch mark



(3) Hold the bushing with its chamfered side facing inward, and put set bolt into bushing while paying attention to the set bolt position.

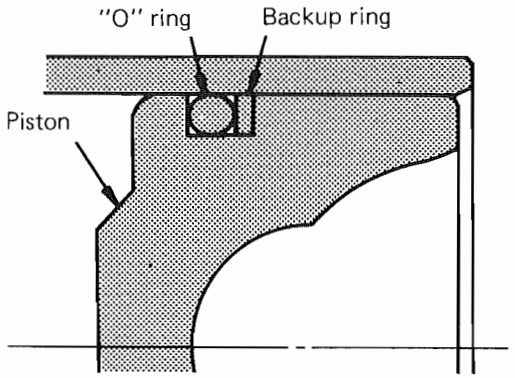
Secure ram shaft by tightening set bolt (around which a seal tape is wound) from the top of the case.

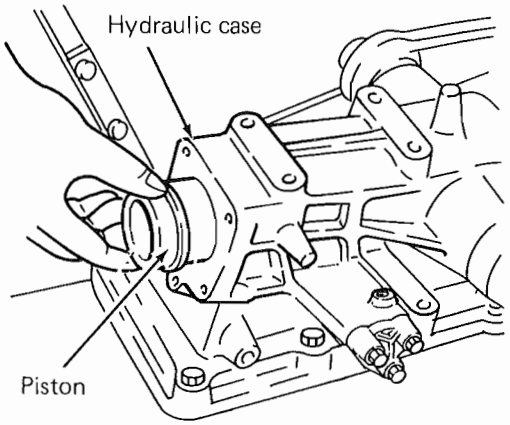
Tightening torque	6.0 ~ 7.0 kg-m (43.3 ~ 50.6 ft-lb)

(4) Grease oil seal, and tap it in until it contacts the bushing.

(5) Install backup ring (fully damped with oil) and "O" ring to the piston.

Oil the cylinder, and install piston.





(6) Reassemble cylinder head as follows:

NOTE

If the plug has been removed, be sure to wrap it with sealing tape or to apply sealant to it before re-fitting. Make certain that neither pieces of sealing tape nor crumby particles of sealant, whichever is the case, will not get into oil.

(a) Grease "O" rings, and fit them to adjuster, setting the rings neatly in the groove.

(b) Run adjuster into cylinder head.

(c) Grease "O" ring, and fit the ring to the front side of culinder head.

(d) Into cylinder head, insert steel ball, followed by spring and washer, and put on circlip.

(e) Grease large "O" ring, and fit it to cylinder head.

(7) Fit small "O" ring to the cylinder head thus far assembled, position it in hydraulic case and secure it by tightening its bolts to this torque value:

Tightening torque	8.5 ~ 9.5 kg-m (61 ~ 68 ft-lb)

(8) Attach the grip, in which spring pin has been inserted, to adjuster, put on spring washer and fasten it down tentatively by tightening its nut snugly.

(9) Grease oil seal and fit it to that part of hydraulic case for holding control lever, and install control lever.

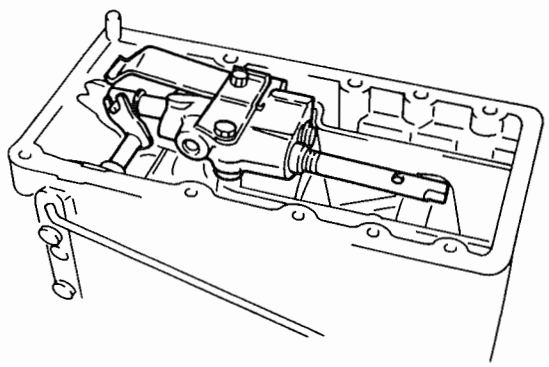
(10) Fit arm, plate and lock washer, in that order, to control lever, and secure them by tightening the nut. Lock the nut.

(11) Fit "O" ring to control valve, insert spool, and position the spool in such a way that the spring pin in the forward end of spool will fit into the notch provided in the arm and plate of control lever.

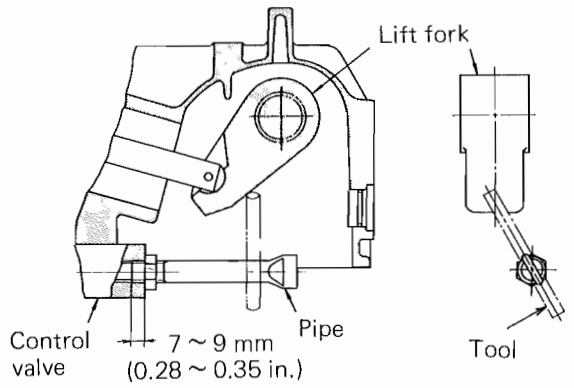
(12) Put on lock plate, taking into account the direction of spring, and secure the control valve by tightening the bolts to this torque value:

Tightening torque	2.5 ~ 3.0 kg-m (18 ~ 22 ft-lb)

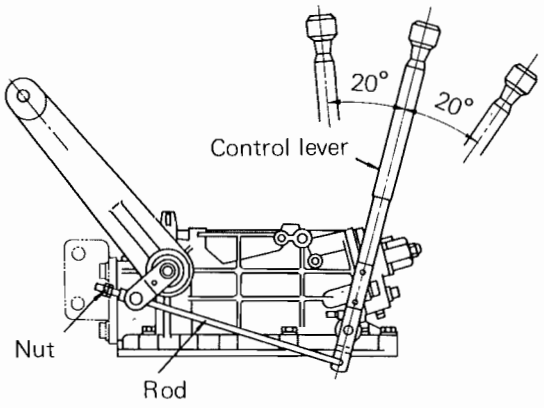
Lock the bolts with lock plate.



(13) If the lube oil pipe for lift forks has been disconnected from the rear end of control valve, reconnect the pipe by running it in about 7 to 9 mm (0.28 to 0.35 in.) or by an amount equal to 5 or 6 threads, and tighten the lock nut with the pipe hole pointing to the lift fork center.



(14) If the lever has been removed from control lever, check to be sure, after installing the lever, that the lever moved to the front and rear meets a stop and that the distances from the "NEUTRAL" position of the lever to the "LIFT" position and to the "DOWN" position are equal.



(15) Install two lift arms, right and left, positioning both arms to align their match marks to the punch marks provided on ram shaft. Attach auto-return arm to the right-side lift arm, and tighten the bolt to this torque value:

Tightening torque	5.0 ~ 6.0 kg-m (36 ~ 43 ft-lb)

(16) Connect auto return rod to control lever and to the arm attached to the right-hand end of ram shaft, and lock the connections by inserting cotter pins. Fit collar and spring to the rear side of rod and make the two nuts snug-tight temporarily.

(17) Fit "O" ring to the plate, position the plate and cap on the left-hand side of hydraulic case, and secure them by tightening to this torque value:

Tightening torque	2.5 ~ 3.0 kg-m (18 ~ 22 ft-lb)

(18) Clean the seat (for hydraulic case) on transmission case, apply the sealant to the cleaned seat, and fit hydraulic case to the seat. Secure the case by tightening its bolts to this torque value:

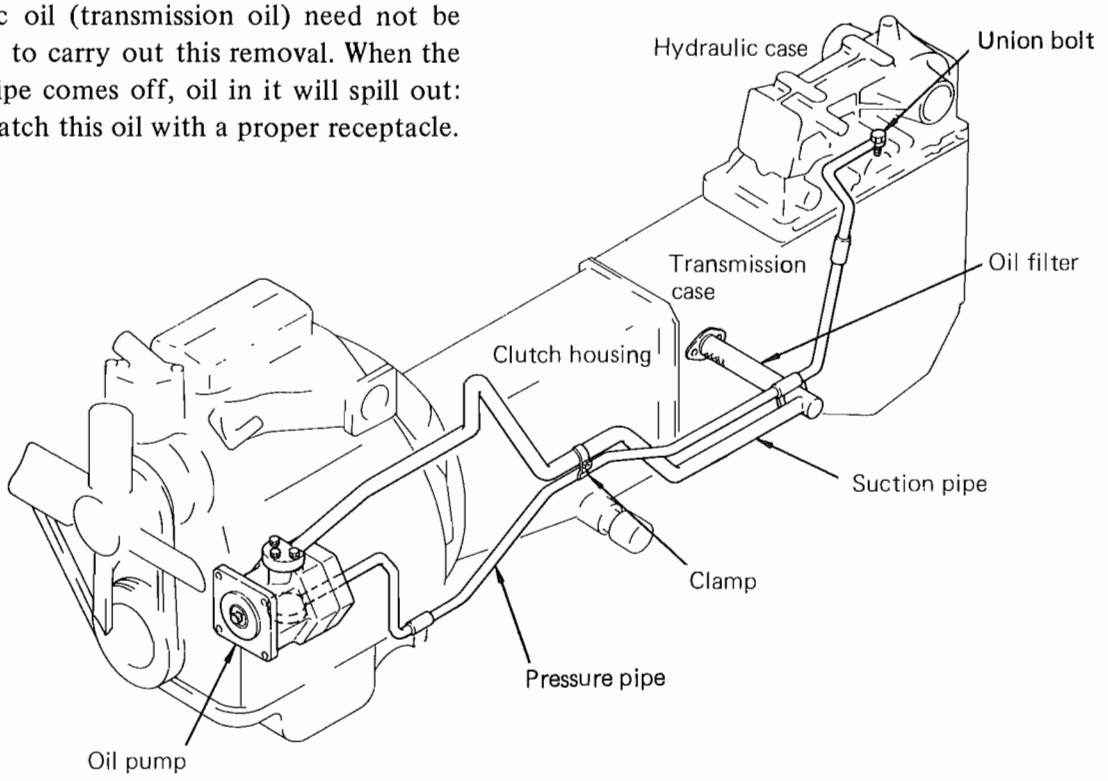
Tightening torque	5.0 ~ 6.0 kg-m (36 ~ 43 ft-lb)

(19) If top link bracket has been removed, install it.

HYDRAULIC PIPES AND OIL FILTER

Removing the discharge pipe

Hydraulic oil (transmission oil) need not be drained out to carry out this removal. When the discharge pipe comes off, oil in it will spill out: be sure to catch this oil with a proper receptacle.



(1) Remove pipe clamp on the left-hand side of clutch housing.

(2) At the same side, loosen union bolt on the left-hand side of hydraulic case and leave it screwed in just a few threads.

(3) Remove 4 bolts securing the pressure pipe to the underside of oil pump. Be sure to pick out "O" ring.

(4) Take off the union bolt mentioned above, and sever pressure pipe. Be sure to recover seal washers.

Removing the suction pipe

It is necessary to drain hydraulic oil, making the transmission empty of oil, in order to carry out this removal. Drain by removing the drain plug on the bottom of transmission case.

(1) Remove step board on the left.

(2) Remove pipe clamp on the left-hand side of clutch housing.

(3) At the same side, remove union bolt on the left-hand side of hydraulic case securing the pressure pipe, and take off seal washers.

(4) Open the bonnet.

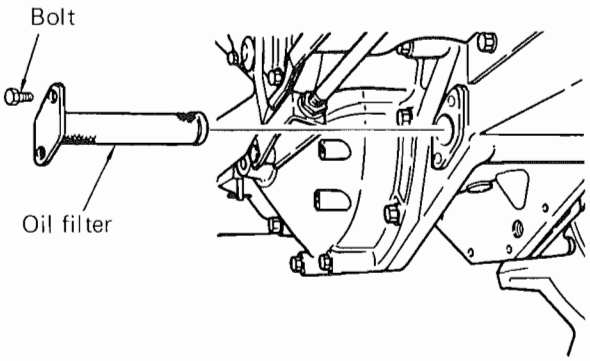
(5) Remove safety cover on the left.

(6) Disconnect suction pipe from the lower left-hand part of transmission case by removing its bolts.

(7) Similarly disconnect suction pipe from the above oil pump.

Removing the oil filter

Have hydraulic oil (transmission oil) drained out, and remove bolts securing the oil filter to transmission case at its lower right-hand part. The oil filter can now be taken out.



Tighten connections to the following torque values:

Suction pipe at pump	1.0 ~ 1.2 kg-m (7.0 ~ 8.7 ft-lb)
Suction pipe at transmission	2.5 ~ 3.0 kg-m (18 ~ 22 ft-lb)
Pressure pipe at pump	1.0 ~ 1.2 kg-m (7.0 ~ 8.7 ft-lb)
Pressure pipe at hydraulic case	4.5 ~ 5.5 kg-m (33 ~ 40 ft-lb)
Oil filter	2.5 ~ 3.0 kg-m (18 ~ 22 ft-lb)

Inspection of oil filter

(1) Do not re-use "O" rings, seal washers and the like that have been removed in disassembly unless they are in perfectly good condition. It is advisable to use new ones when reconnecting the pipes.

(2) Inspect the connecting ends of each pipe and also the full length of pipe. Be sure that pipes are free of any evidence of cracks and their connecting end faces are smooth and free from any damage. Cracked pipes must be replaced. Repair or replace pipes whose ends are in faulty condition.

(3) Inspect the filtering element (gauze-like element) of the oil filter for signs of rupture and, as necessary, replace the element.

Installing the pipes

Before installing a pipe, be sure to have "O" rings and seal washers ready for use if they are needed for the pipe. Some pipe connections need such sealing parts while others do not.

The reconnecting procedure is reverse of the removal procedure for each pipe, and install the pipes, starting with the one last removed.

When positioning the oil filter in place, check to be sure that its forward end is accurately attached to the suction pipe.

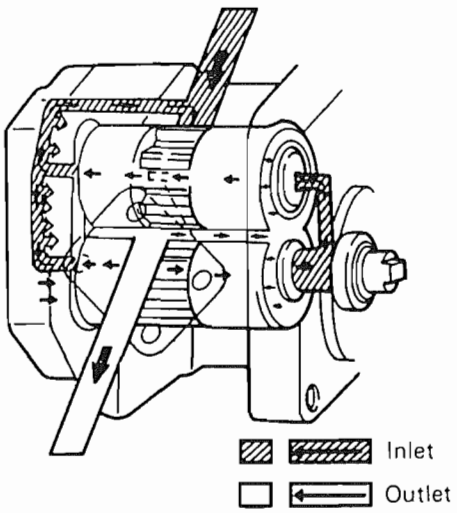
OIL PUMP

Construction

This oil pump [Nachi–GP-3607A] is of the gear type, employing the pressure loading system. The pressurized oil is forced out to the rear side of bearing bushing, and the minimum clearance is maintained between the gear teeth and bushing to minimize internal leakage, thereby securing a high volumetric efficiency even at high-pressure-low-speed operation. (The bearing bushing serves as a pressure loading component and casing at the same time.) The bearing bushing is of movable design, and, as a result, it is able to maintain a proper clearance whether the bushing swells due to heat or is worn due to protracted low-temperature operation.

The bearing bushing 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 percent of the specified volumetric efficiency can be secured for a long period. The pump has been tested for 4000 hours continuous operation and proven to maintain high-performance.



NOTE

a) 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 vegetable oil is not allowed. Extremely high temperature oil may cause corrosion to the oil seal.

b) The oil should be gear oil SAE 80. For details, refer to the Instruction Book.

Removal

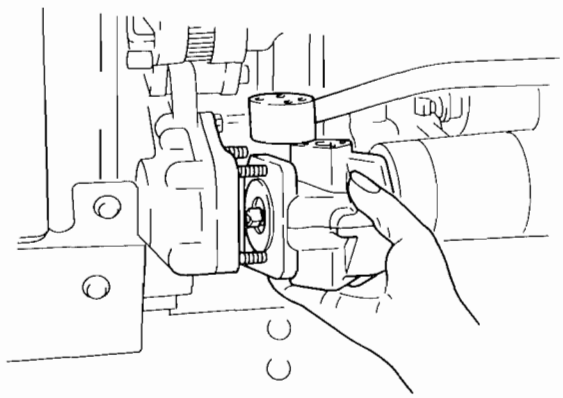
Hydraulic oil (transmission oil) need not be drained out for this removal.

(1) Open the bonnet.

(2) Remove safety cover on the left.

(3) Loosen bolts securing pressure and suction pipe connections. Recover "O" rings.

(4) Loosen nuts securing the pump to timing gear case, and take out the 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 aluminum alloys.

For this disassembly work, refer to the exploded view.

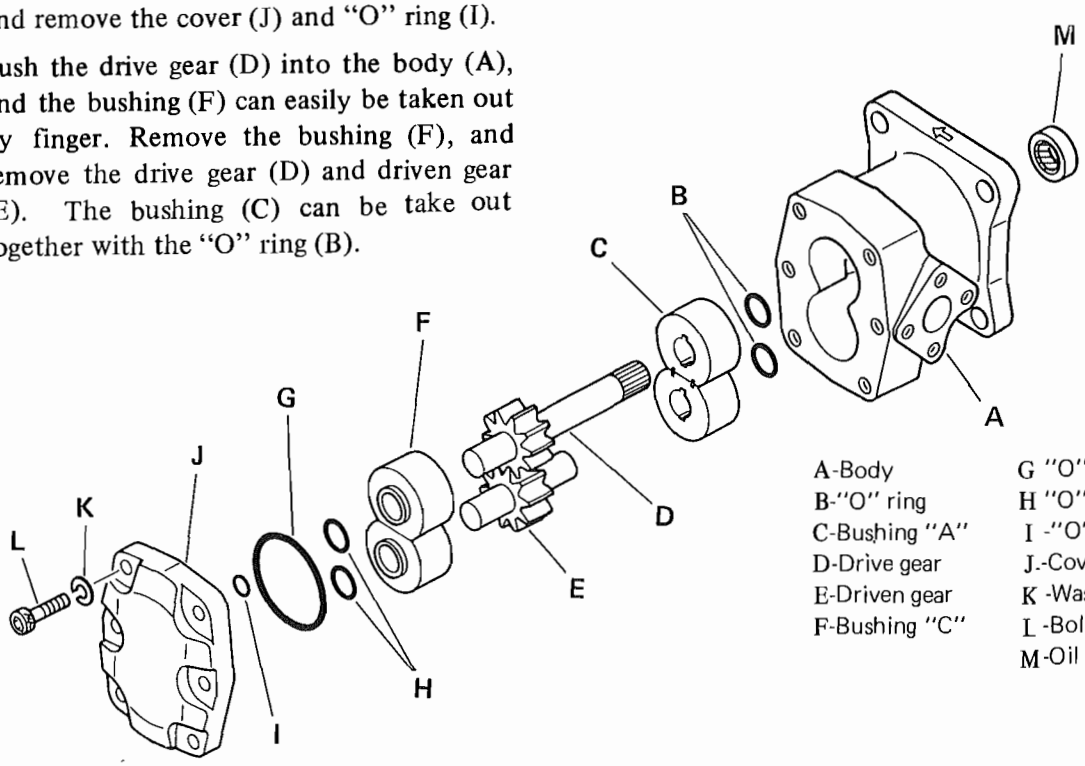
(1) Loosen the bolt (L) with a hexagon hole, and remove the cover (J) and "O" ring (I).

(2) Push the drive gear (D) into the body (A), and the bushing (F) can easily be taken out by finger. Remove the bushing (F), and remove the drive gear (D) and driven gear (E). The bushing (C) can be take out together with the "O" ring (B).

The disassembled parts should be arranged in order. As for the shafts and bushings, their positions should be correctly memorized.

When installing bushings, take care not to confuse the bushing (C) for bushing (F) in relation to their positions.

Each bushing has a mark A or C stamped on its end. A bushing having mark A 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. When pulling out the oil seal (M) from the body, take special care not to scratch the housing bore.



Inspection

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 bushing holes and journal bearings will be worn. As a result, the casing wall begins to show wear. If the amount of wear exceeds 0.05 mm (0.002 in.), 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 bushing will not be effective to improve the performance. The use of a worn bushing 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 calipers. If the measurement shows a smaller value than Nachi – 13.96 mm (0.550 in.) , replace the shaft.

Check the bushings for deformed bore and scratches. If any discoloring of a gear can be considered to be related with a defective bushing, check for the relief valve and related oil passages. If the length of a bushing is shorter than the value as shown below, it should be replaced.

16.80 mm (0.661 in.)

Any discolored gear should also be replaced. Measure the clearance between the shaft and bushing. If the measurement is larger than the following value, the bushing should be replaced.

0.177 mm (0.006 in.)

Reassembly

Make sure that all parts are clean. If the oil seal (M) has been removed, 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 bushing (C), and coat it with good quality of mineral grease. Insert it in the body (A) and push it in further. A pair of bushings must be true and coat it with good quality of oil. Insert it in the body (A) and push it in further. A pair of bushings must be true fitted in place without requiring force. If the bushing has a scratch on its surface, it will not move smoothly. In this case, pull out the bushing and smooth down the raised part with oil stone. Make sure that the surface of the bushing is smooth. For this check, use a surface plate. After using oil stone, be sure to wash the bushing. Oiling the bore will make it easy to install the bushing. Make sure that, after installation, the "O" rings are in place.

The "O" ring must be located between the bushing and the bottom of body. The leading gear type is greatly affected by the result of reassembly. Make sure that the escape groove in the bushing surface is not inclined. Incorrect reassembly will not provide the pressure balance effect, and as a result, the bushing 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. Insert the drive gear (D) and the driven gear (E) into the body (A).

(3) Fully grease the bushings (F) in pair, and insert them in the body. Place the "O" rings (H) on the bushing (F).

(4) Place the "O" rings (G) and (I) on the cover, and place the cover, Finally tighten the bolt (L) with a hole by using a hexagon wrench. Tightening torque is 0.8 kg-m (5.77 ft-lb). Lock the bolt head with center punch and feed a small quantity of oil through the port.

(5) Make sure that the reassembly is done perfectly by turning the drive gear (D) with an open end wrench. If the gear turns smoothly, the assembly is correct. If too tight, correct it.

Installation

(1) Align the pump shaft with the pump drive shaft, and install it to the engine timing gear case.

(2) Set the "O" ring correctly, and install the suction pipe and delivery pipe to the pump.

Test

Special care should be taken for test run, particularly when bushings, 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, 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 82°C or 180°F), 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 80°C or 176°F), reduce the engine speed temporarily, and continue no-load operation until working parts are fully run 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 performing disassembly for repair in the field, because it is very difficult to prevent dust and dirt from entering the pump. Parts may also be scratched.

ADJUSTMENT

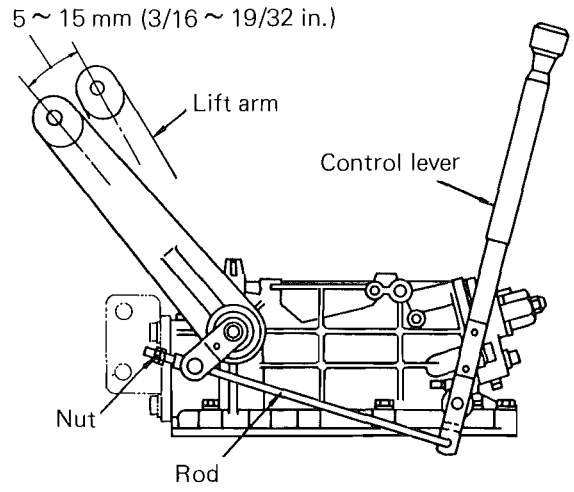
The hydraulic mechanism of BEAVER III and BUCK tractors is so designed that when the implement is moved up to the highest position of full stroke, the hydraulic control lever moves back to the neutral position automatically. If the control lever will not return, as above, after reassembly, adjust as follows:

(1) Disconnect the lift rod from the lift arm.

(2) Turn the flow control grip all the way counterclockwise.

(3) Run in the nut on the auto-return rod until the control lever automatically returns to "NEUTRAL" position and, with the lever in that position, the lift arm has a free play of 5 ~ 15 mm (3/16 ~ 19/32 in.) as measured at the tip of the arm, as shown below.

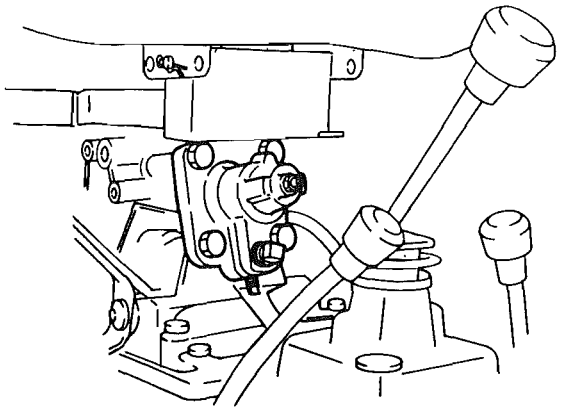
(4) Where it is necessary to limit the end of upward stroke of lift arm to any desired height, run in the nut until the control lever automatically returns to "NEUTRAL" position when the arm reaches the desired height.

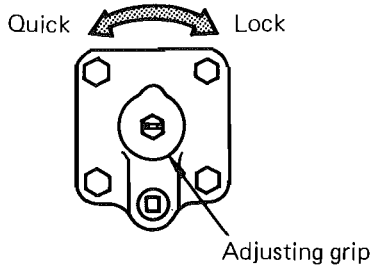


Flow control grip

Loosen nut securing the flow control grip: this nut is in snug-tight condition. Remove the grip, and run in the adjuster all the way by turning it clockwise. Restore the girp, positioning it in such a way that its spring pin meets the clockwise end of the pin guide groove provided in the cylinder head. With the grip so positioned, put on spring washers and secure the grip by tightening the nut.

Start up the engine, and check to be sure that the grip is at locking position when the hitched implement is raised by operating the control lever. With the grip at this position, move the control lever to "DOWN" and see if the hitched implement refuses to go down and stays in its current raised position; if not, that is, if the implement goes down, it means that the adjuster is set improperly and needs to be repositioned further in clockwise direction. The grip is properly set when the hitched implement becomes held up under the above operating conditions.





TROUBLESHOOTING

This paragraph describes the troubleshooting procedures on the hydraulic system used on SATOH BEAVER III and BUCK tractors. It lists the various troubles that might be blamed on the hydraulic system together with their possible causes, the checks to be made, and the corrections needed.

Implement will not lift at all when control lever is placed in LIFT

Possible cause	Remedy
a) Excessive load on ends of lower links	a) Reduce load.
b) Oil pump "O" ring damaged or oil seal slipped out of position	b) Replace.
c) Broken pump drive shaft	c) Replace.
d) Improper relief pressure setting	d) Adjust to 135 kg/cm² (1920 psi). (Full flow)
e) Cracked piping or damaged or weakened "O" ring	e) Replace.
f) Control lever plate to control valve spring pin broken	f) Replace.

Implement is not raised quickly

Possible cause	Remedy
a) Scratched or leaky relief valve seat	a) Replace as an assembly.
b) Pump not delivering enough oil	b) Replace.
c) Suction strainer clogged	c) Wash strainer and replace oil.
d) Implement too heavy	d) Reduce weight.
e) Broken piping or damaged "O" ring	e) Replace.
f) Improper relief pressure setting	f) Adjust to specification

Implement lowers during NEUTRAL

Possible cause	Remedy
a) Broken or leaky "O" ring	a) Replace.
b) Worn spool valve	b) Replace spool and body as a matched set

Implement will not lower when control lever is placed in DOWN

Possible cause	Remedy
a) Flow control valve kept closed due to loosened lock nut	a) Readjust and secure with lock nut positively
b) Flow control lever not properly set	b) Readjust.

Oil temperature is excessively high

Possible cause	Remedy
a) Oil pump seized	a) Replace. (Check for presence of foreign particles in oil)
b) Pump not delivering enough oil	b) Replace.
c) Relief valve at fault	c) Adjust to 135 kg/cm² (1920 psi).
d) Leaking relief valve seat due to damage	d) Replace.
e) Relief valve stuck open	e) Readjust auto-return.

Abnormal noise

Possible cause	Remedy
a) Pump seized	a) Replace.
b) Pump not sucking enough oil	b) Check oil level in tank or clogged suction filter.
c) Air leaking into suction pipe or past oil seal	c) Repair.
d) Deteriorated oil	d) Replace.
e) Clogged strainer	e) Clean.
d) Relief valve stuck open	d) Readjust auto-return.

SPECIFICATIONS

Specification \ Tractor	MT160 and MT160D
Control	3-position control – lift, hold, down and flow control
Type of cylinder	Single action cylinder
Diameter of piston	60 mm (2.36 in.)
Stroke of piston	71 mm (2.80 in.)
Pressure for relief valve setting	135 kg/cm² (1920 psi)
Maximum lift power at ends of lower links	500 kg (1102 lb)
Type of hydraulic pump	Pressure loading gear type
Output of hydraulic pump (at 2700 engine rpm)	12.9 liter/min. (3.4 GPM)
Control valve type	Spool valve 3-port 3-position
Name and model of hydraulic pump	NACHI: GP - 3607A
Oil lock valve	Oil lock valve (adjustable flow control)
Strainer mesh	#42 X 100 mesh
Hydraulic oil	SAE #80 gear oil (same as transmission oil)
External service	PT3/8 tap
Hydraulic adaptor plate	Optional

ISO

CHAPTER 7
HYDRAULIC SYSTEM

(Position Control)

TABLE OF CONTENTS

DESCRIPTION

The hydraulic system in MITSUBISHI MT180/D and MT180H/HD is unique in design, compact in size. Its component parts are built in a single case.

The functions the system provides are position control, flow control and lift lock. By installing sub control valve or adaptor plate, hydraulic pressure can be taken off for external service.

The hydraulic pump is mounted on the timing gear case of the engine, and is driven through gears inside the case. Thus, as long as the engine is running, hydraulic pressure is available for actuating the implement.

It is the oil in the hydraulic case that the pump draws through the strainer and delivers to the control valve.

The lift lock valve is mounted on the front side of hydraulic case. By operating its control lever, the implement can be locked and its lowering speed can be adjusted.

Hydraulic pressure can be taken off for external service by installing the adaptor plate between the hydraulic case cover and relief valve installed on the left side of hydraulic case.

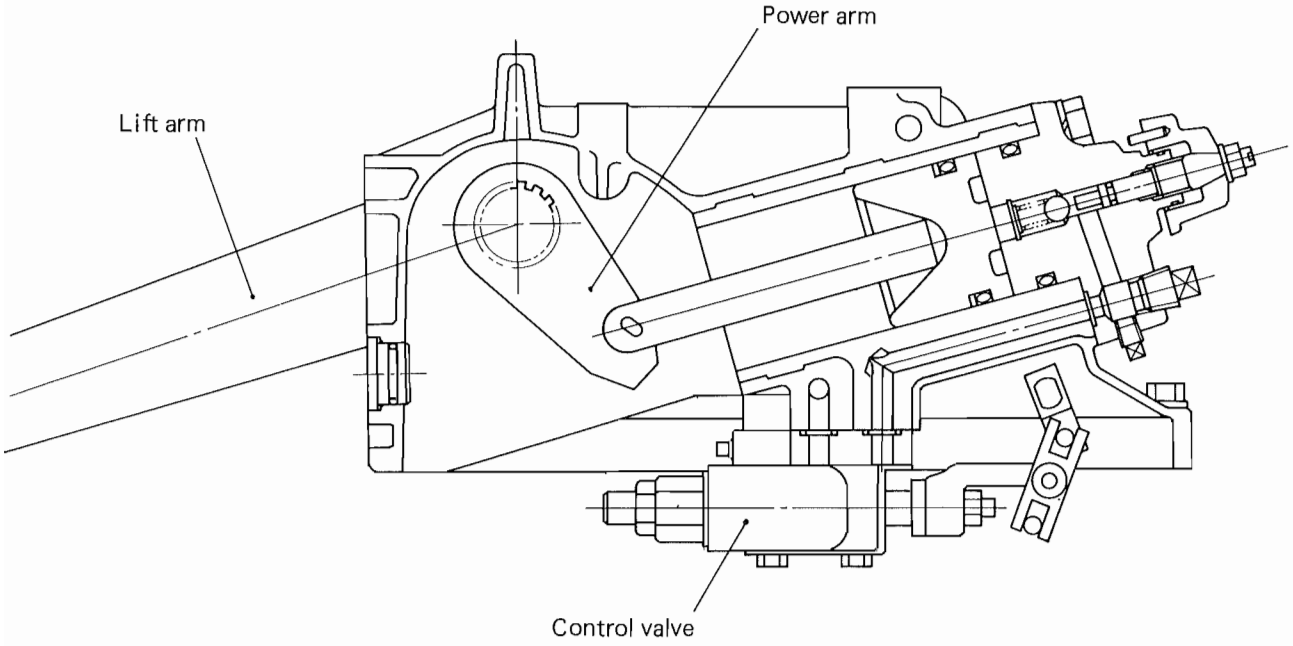
CONSTRUCTION

Hydraulic case

The hydraulic case is made of cast iron which is enough intensive. The cylinder is made of accurately processed steel pipe and of construction capable of being removed.

The cylinder in which piston and connecting rod are built, power arm, ram shaft and control valve are installed in the hydraulic case.

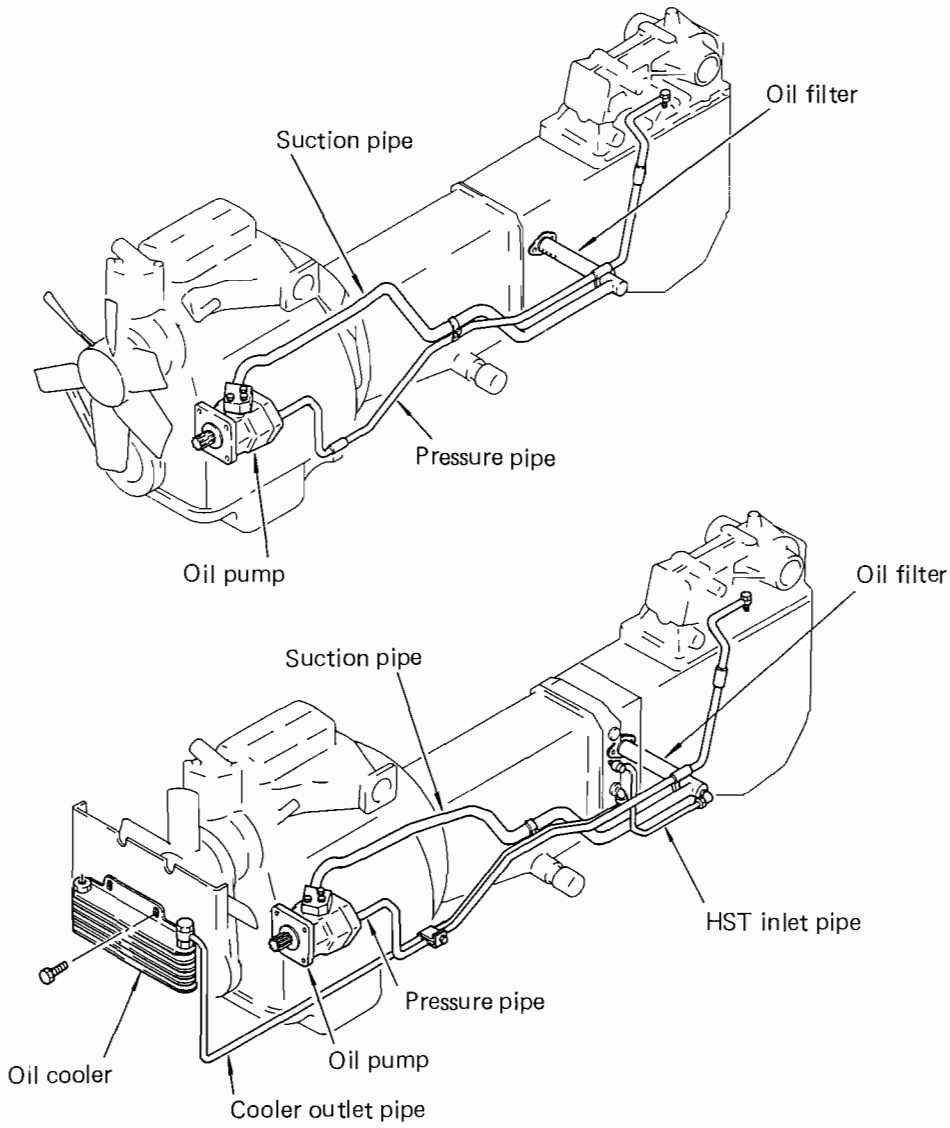
This case is bolted to the top of diff-housing.



Pipe line

The hydraulic pump draws the oil through the strainer and suction pipe and delivers it to the control valve through the high-pressure pipe. Between the pump and control valve is provided a relief valve which protects the pump and piping against overloading. This safety valve is also effective for the external service hydraulic line.

The suction pipe is connected with rubber hose at the center parts. It is easy to remove the pipe by loosening the clamp to slide the rubber hose.



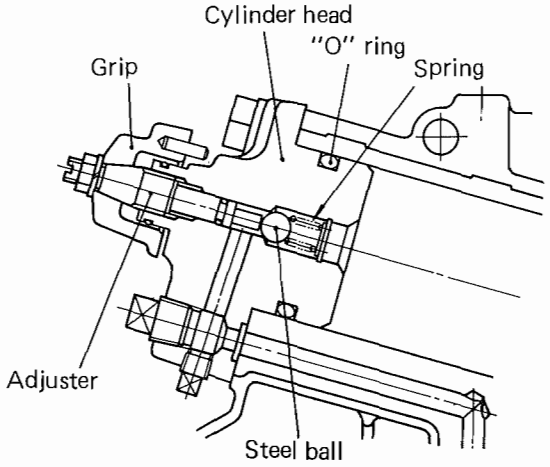
Control valve

The control valve is mounted under the hydraulic lift lock valve and has a linkage connected to the control lever. In this valve are built the spool valves, check valve, unloader valve and poppet.

Lift lock valve

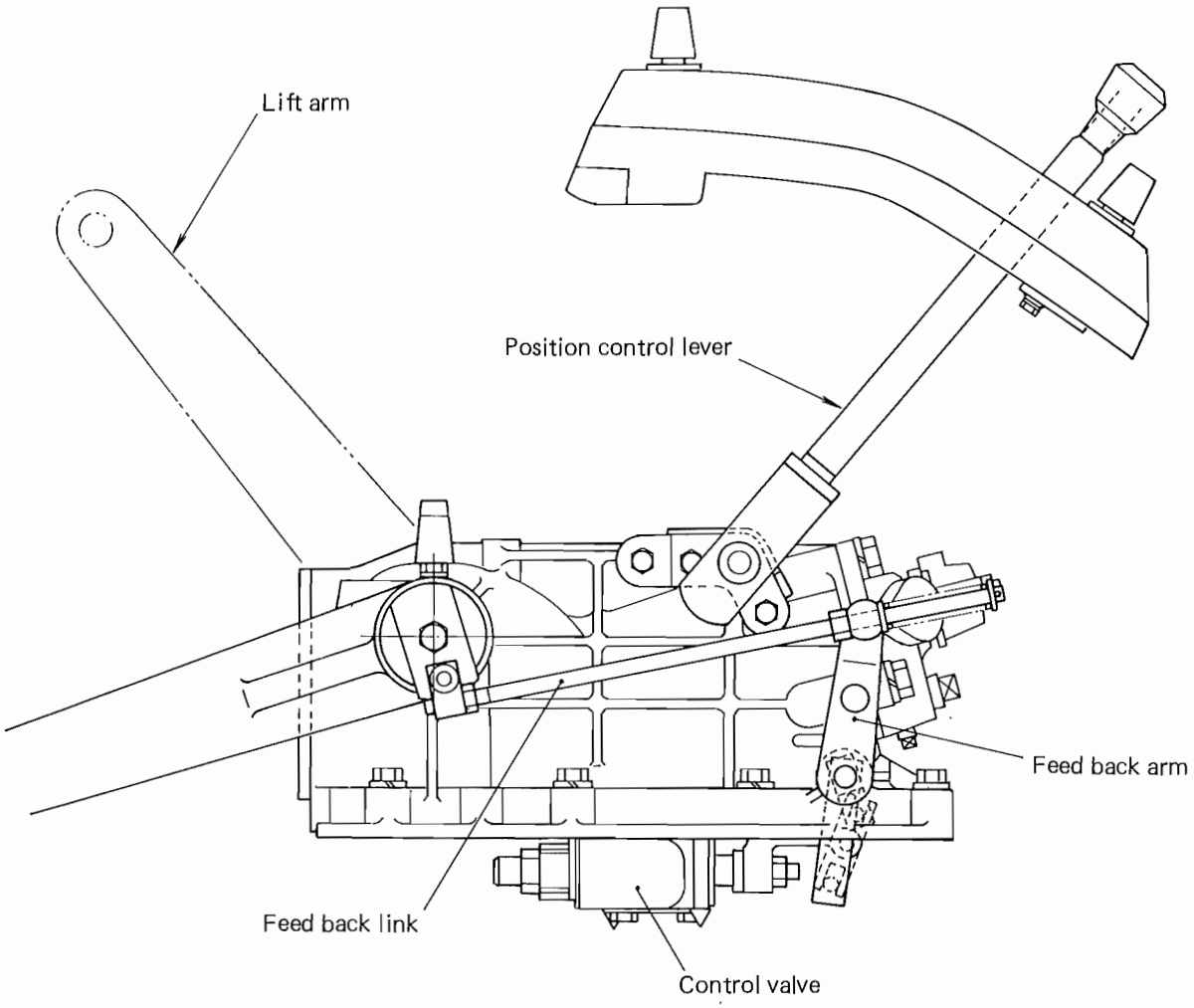
The lift lock valve is an in-line check valve. When the oil enters the cylinder, it pushes the lock valve to open. Once the oil enters the cylinder, it forces the lock valve against the seat by means of the pressure generated by the weight of the implement and spring pressure.

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 easily 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).



Control lever

The control lever is mounted on the right side of hydraulic case. By operating it as guided by the quadrant mounted on the fender, the control linkage is moved to perform control function.



Hydraulic pump

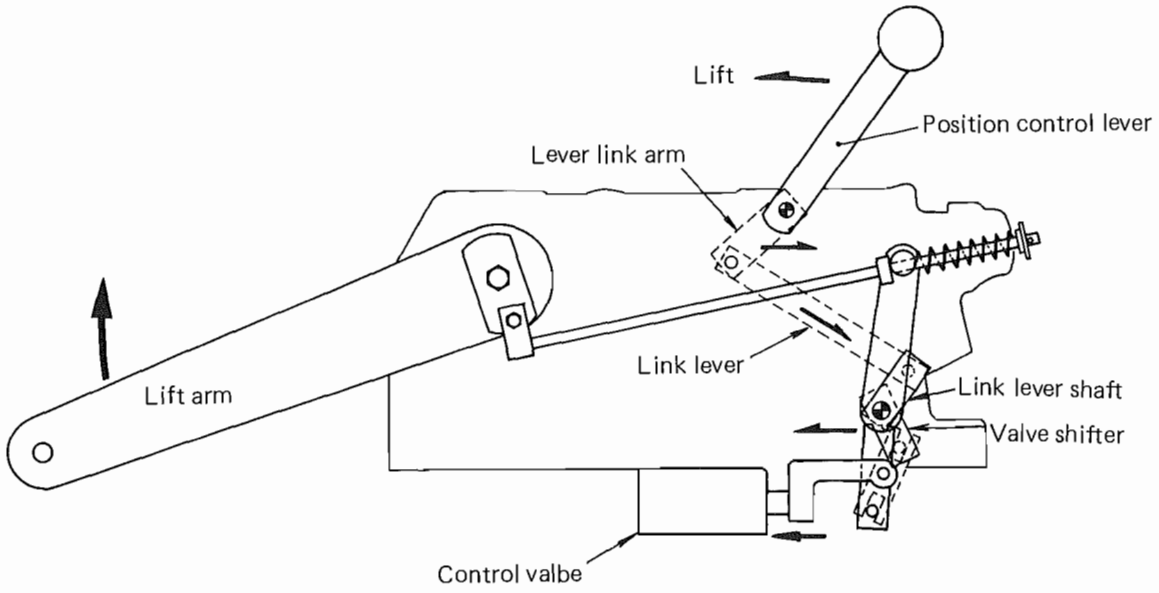
A high-efficiency gear pump of pressure loading gear type is used. The pump is mounted on the engine timing gear case, and, as long as the engine is running, it delivers the oil to the control valve. Thus, the hydraulic system of MITSUBISHI tractor is live type.

OPERATION

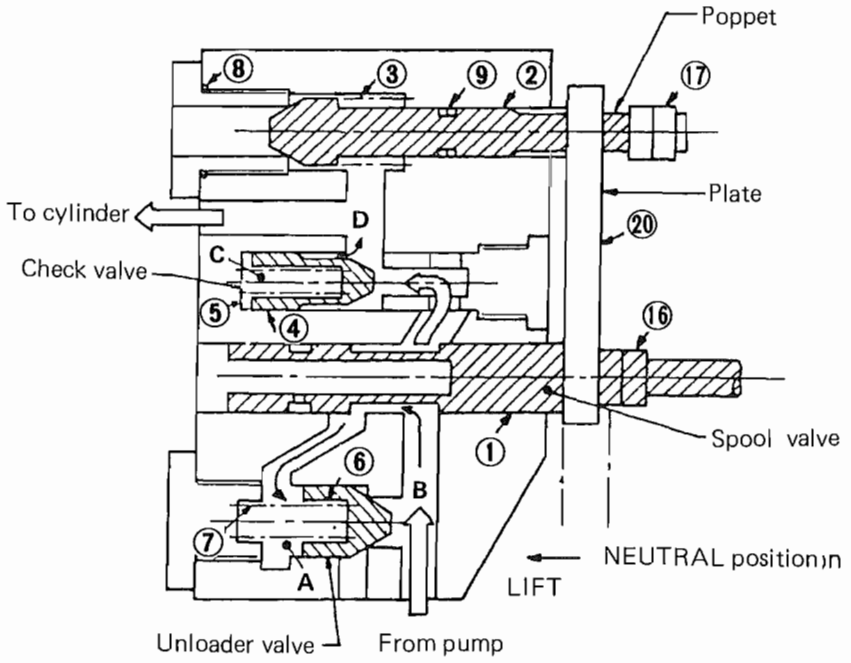
POSITION CONTROL

LIFT

After engine starts, move the position control lever in the direction of raising up, and the spool valve (1) of control valve moves in the direction of raising up by the action of valve shifter fixed at link lever shaft which is connected with link lever on the left side of the hydraulic case.

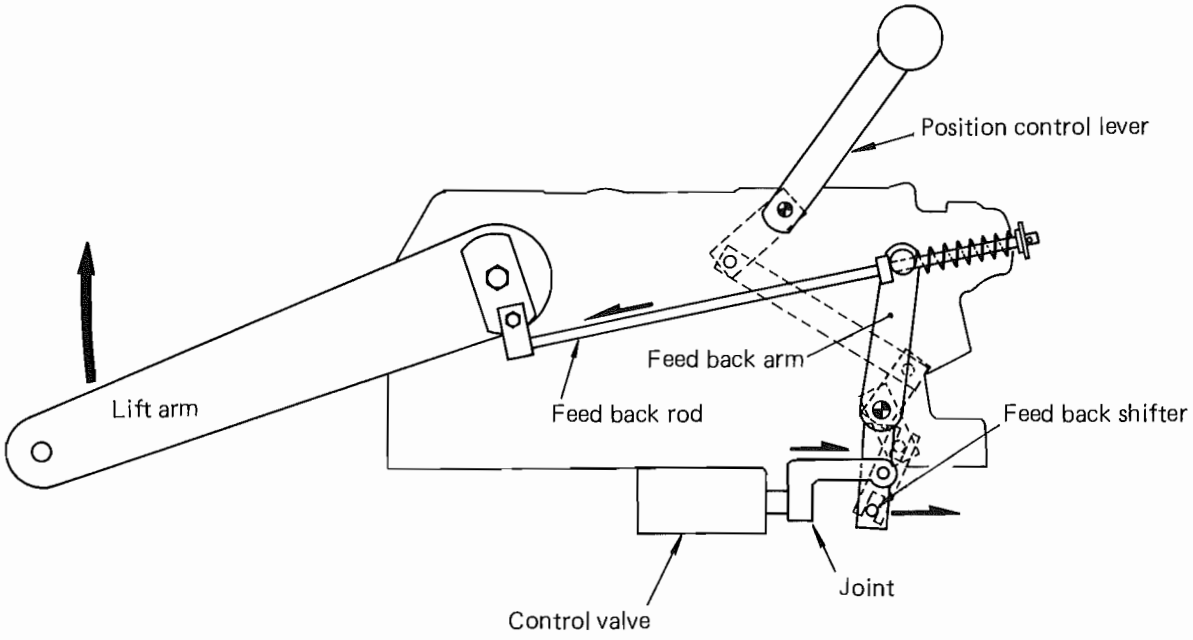


LIFT

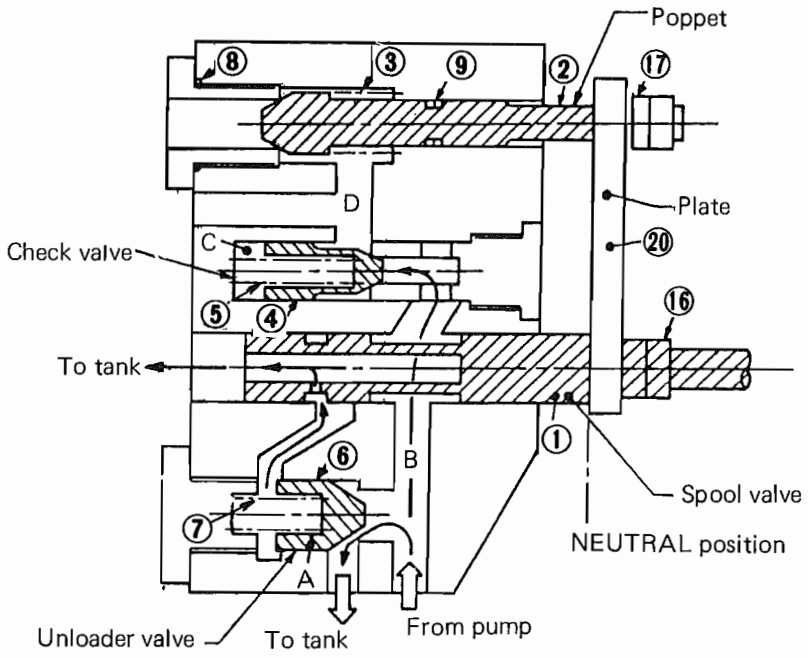


The oil from the pump flows to the rear side (A) of unloader valve (6) through the passage (B). Then the pressure of this oil and the force of spring (7) close the unloader valve (6). Under this condition, the oil pushes down the check valve (4) and enters the circuit (D) leading to the cylinder.

The implement is lifted up by the action of the lift arm as the piston is pushed down by filling the cylinder with oil The spool valve (1) is returned to NEUTRAL position by the action of the feed back shifter through the feed back arm HL which is moved by the feed back HL rod as the arm installed at the lift arm works. Consequently, the implement is held at the position where corresponds to the position of control lever.



NEUTRAL

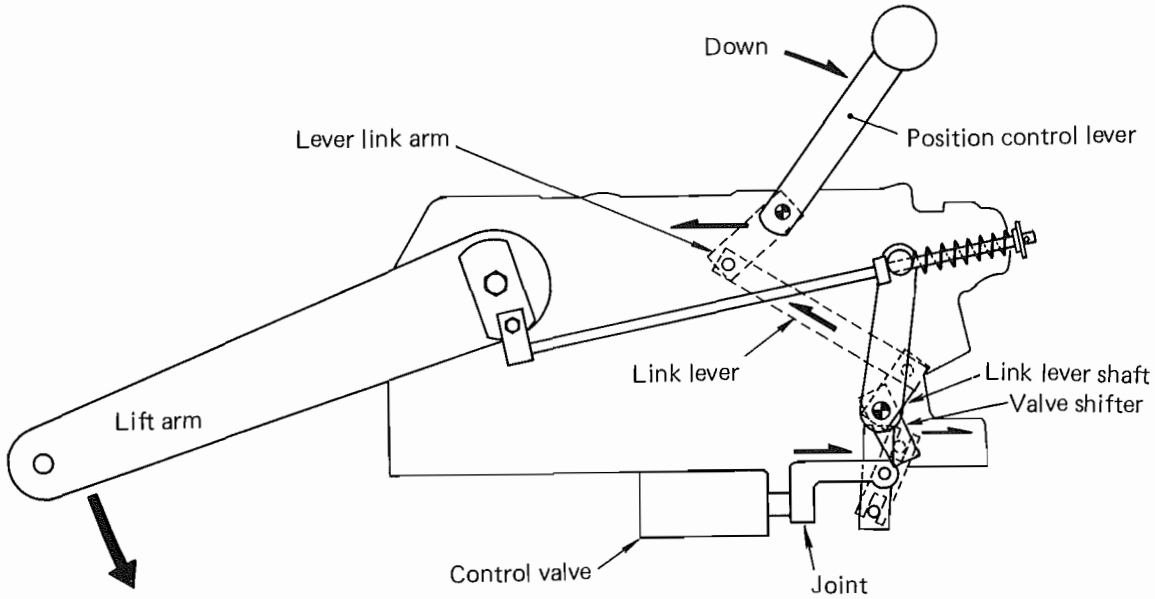


NEUTRAL

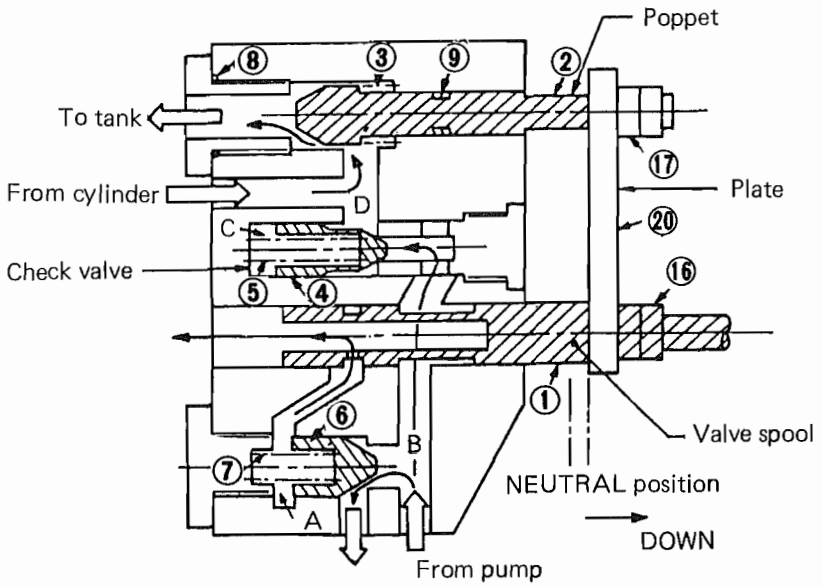
The oil from the pump flows through the passage (B) in the control valve to the unloader valve (6). The check valve (4) is kept in closed position by the force of its spring (5) and the pressure exerted by the weight of implement mounted on the 3-point linkage, which are applied to the rear side (C) of the valve (4). For this reason, the return circuit from the cylinder is blocked to hold the implement. On the other hand, the rear side (A) of unloader valve (6) is connected through the spool valve (1) to the tank, and as the pressure of the oil from the pump is higher than the pressure exerted by the unloader valve spring (7) the oil pushes down unload valve (6) to open the tank port, thus returning the oil to the tank, which makes the pump operate unloaded.

DOWN

In case the control lever is located at the position of DOWN, the spool of unloader valve (6) moves in the direction of opening by the action of valve shifter on the link lever shaft connected with the link lever.



DOWN



Now the poppet (2) is pulled by the plate locked to the spool valve (1) to open the port (D) leading to the tank, causing the oil to flow into the tank port for lowering the implement.

When the implement starts to go down, the spool valve (1) is returned to NEUTRAL position by the action of feed back shifter through the feed back arm which is moved by the feed back rod as the arm installed at the lift arm works.

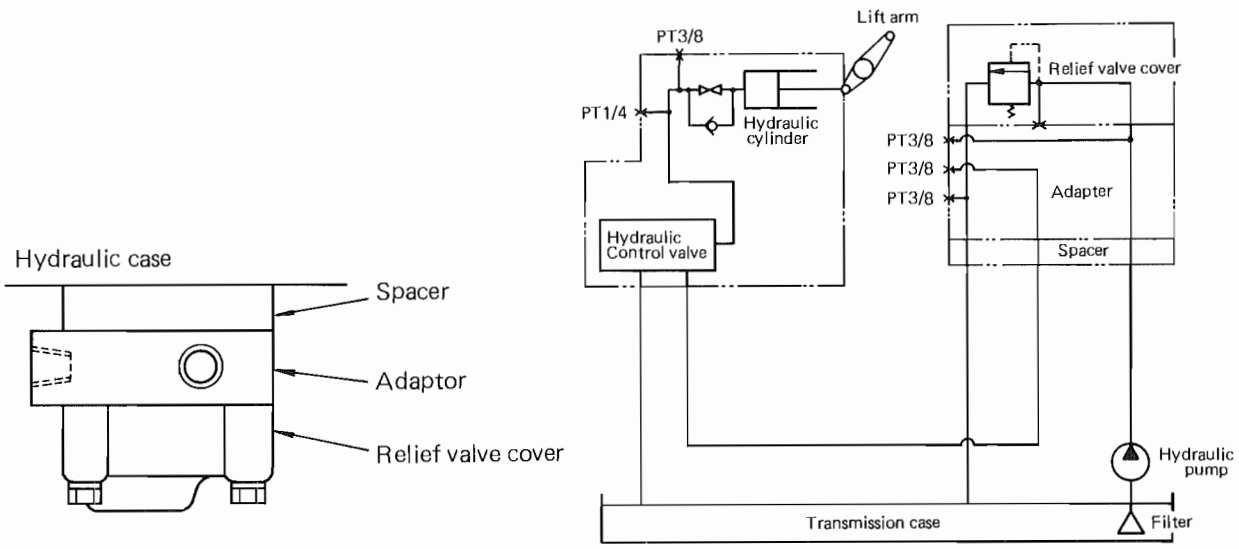
The implement is held at the position where the spool valve is located at NEUTRAL.

Hydraulic external service

There are two ways as under on the hydraulic external service.
Select it according to the kind of control valve attached to the implement.

NOTE

External service cannot be done for the machine which is equipped with control valve for use of 3-point linkage of tractor.



Hydraulic circuit for front loader, etc.

Remove the cover (relief valve) on the left side of hydraulic case and secure the spacer, adaptor plate and cover to the hydraulic case. Pass a hose or pipe to IN port of the control valve installed on the implement side from OUT port of the adaptor plate. Pass a hose or pipe to IN port of the adaptor from OUT port of the control valve to make a hydraulic circuit. The implement can be operated by acuating the lever of control valve attached to the implement.

NOTE

1) Thread size of adaptor plate is PT-3/8.
2) In order to do the hydraulic external service, never use the external port located in the hydraulic cylinder head as it may cause trouble in the hydraulic system.

DISASSEMBLY AND REASSEMBLY

Disassembling the hydraulic system

Causes necessitating hydraulic system disassembly may be regarded as occurring in three areas: 1) hydraulic case, in which the control valve is mounted, 2) oil pump, and 3) oil piping inclusive of the oil filter.

Whenever trouble develops, a rough check must be made on each area to pinpoint the suspected part or component. Disassembly of parts and components in sound condition should be avoided and can be avoided by viewing the hydraulic system as consisting of the three groups.

Disassembling the hydraulic case

It is not necessary to drain the transmission in order to permit removal of the hydraulic case.

(1) Remove the 3-point linkage from tractor.

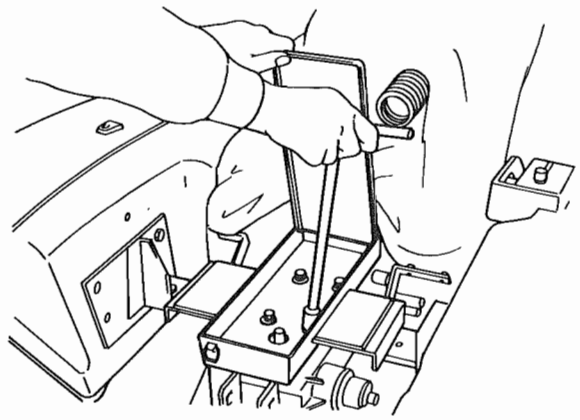
(2) Remove the seat.

(3) Disconnect wirings from each connector.

(4) Remove the knobs from the control lever.

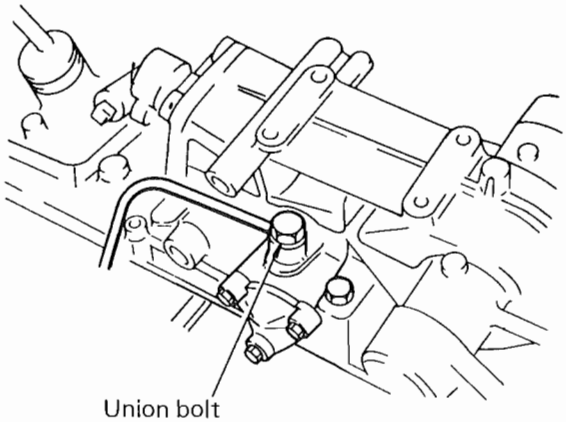
(5) Unscrew bolts both of the left and right that fasten the fender to the step and the cover to the step.

(6) Remove the tool box by means of loosening four tool box fixing bolts.



(7) Remove fenders.

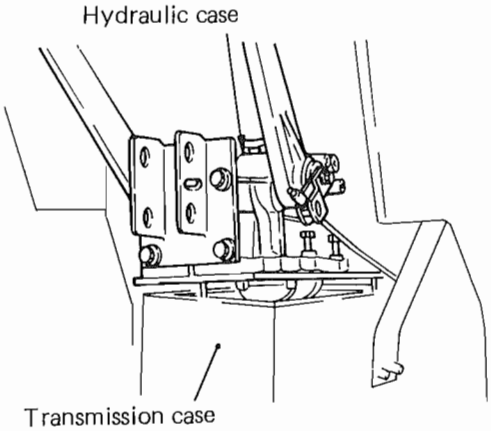
(8) To remove the pipe from the hydraulic case, loosen the union bolt of the pressure pipe.



NOTE

As the union bolt heat is not thick enough, be sure to use socket wrench. Using open wrench will give damage to union bolt head.

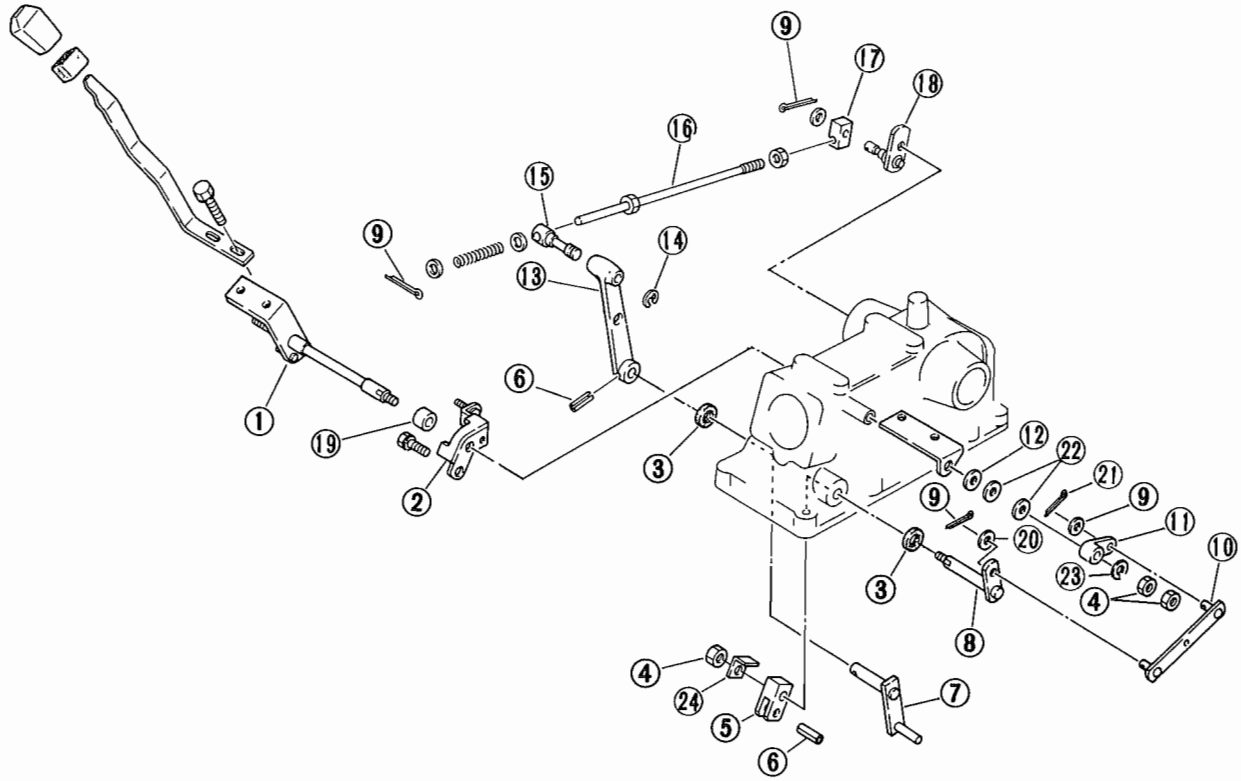
(9) Loosen the bolts securing the hydraulic case to the diff-housing, and remove the hydraulic case assembly.



NOTE

Because of sealant used in the joint of hydraulic case and diff-housing, the hydraulic case may not come off easily; If so, loosen the joint by poking with the tip of plain screwdriver, taking care not to damage the case, and remove it by lifting it straight off.

Disassembling the hydraulic control linkage



1-Control lever
2-Lever bracket
3-Oil seal
4-Lock nut
5-Valve shifter
6-Spring pin
7-Feed back shifter
8-Link lever shaft
9-Cotter pin
10-Link lever
11-Lever link arm
12-Plate
13-Feed back arm
14-E-type circlip
15-Joint pin
16-Feed back rod
17-Joint
18-Plate
19-Collar
20-Washer
21-Disk spring
22-Washer
23-Washer
24-Plate

(1) Loosen the lock nuts (4) at the end of control lever (1) and link lever shaft (8). Remove the assembly of link lever shaft (8), link lever (10) and lever link arm (11).

(2) Pull out the cotter pin (9) of plate (18) at the right side of arm shaft and remove the joint(17).

(3) Pull out the spring pin (6) that connects the feed back arm (13) with feed back shifter (7). Remove the related parts from the feed back rod (16) as required.

(4) Pull out the control lever (1). And remove the assembly of feed back arm (13) and feed back rod (16).

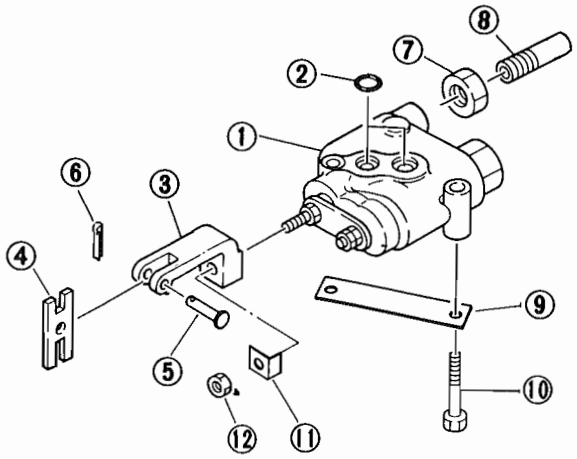
(5) Remove the feed back shifter.

NOTE

Remove the oil seal and other parts from the hydraulic case as required.

Removing the control valve

(1) Pull out the cotter pin (6) of clevis pin (5) which sets the valve link (4) to the fork (3) and then take out clevis pin (5).



1-Control valve	6-Cotter pin	11-Lock washer
2-"O" ring	7-Nut	12-Nut
3-Fork	8-Pipe	13-Taper plug
4-Valve link	9-Spacer	14-Washer
5-Clevis pin	10-Bolt	

(2) Straighten the lock plate (9) under the heads of bolt (10) securing the control valve (1), loosen the bolt (10) and remove the control valve (1). Be sure to pick out "O" rings (2).

(3) Unlock the lock washer (11), loosen nut (12) and remove fork (3).

Removing the power arm

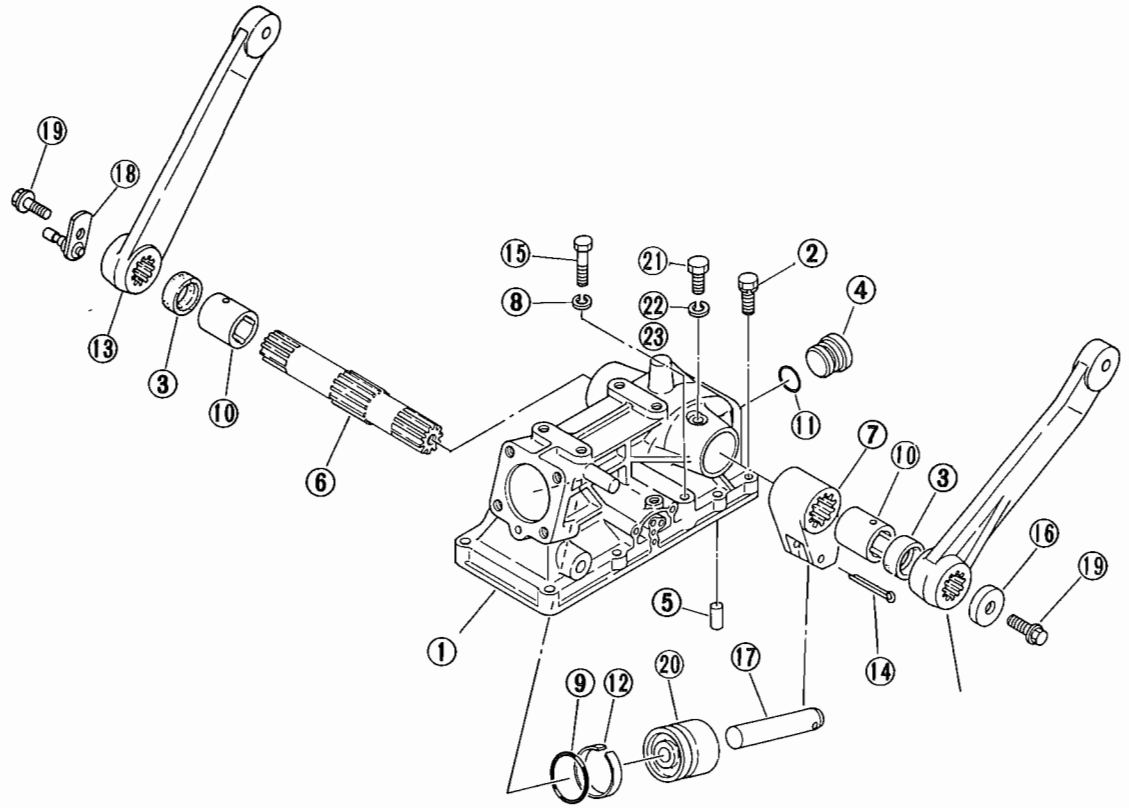
(1) After loosening bolts (19) of lift arms (13), remove both lift arms(13) and washers (16).

(2) Loosen bushing set bolts (21), and then remove oil seals (3) and bushings (10).

(3) Remove the ram shaft (6).

(4) Remove the power arm (7) keeping it incorporated a piston rod (17).

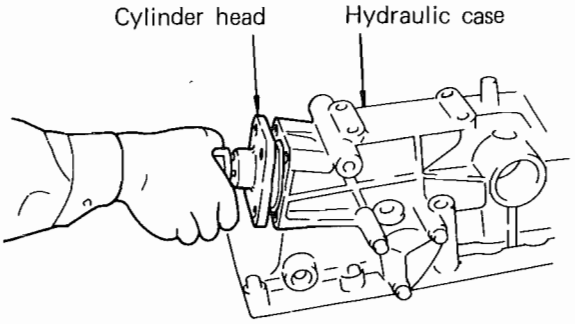
(5) Remove the piston rod (17) from the power arm (7) as required.



1-Hydraulic case
2-Bolt (M10 x 45) w/washer
3-Oil seal
4-Plug
5-Dowel pin
6-Ram shaft
7-Power arm
8-Spring washer
9-O-ring
10-Bushing
11-"O" ring
12-Back up ring
13-Lift arm
14-Cotter pin
15-Bolt (M10x100)
16-Washer
17-Piston rod
18-Plate
19-Bolt w/spring washer (M10x25)
20-Cylinder
21-Bushing set balt
22-Washer
23-Seal washer

Removing the lift lock valve

(1) Loqsen M12 bolts on cylinder head, and remove the head.

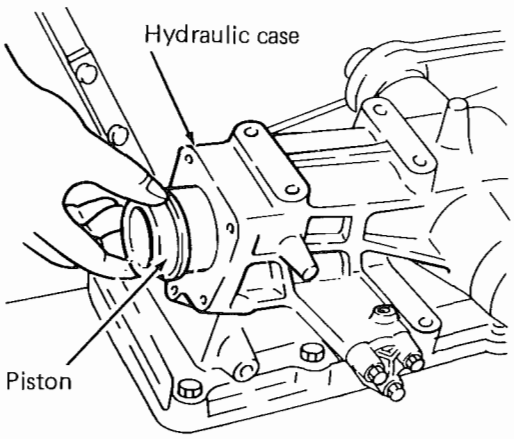


(2) Push piston out into hydraulic case, and take out piston.

(3) Remove the lift lock valve as required.

Disassembling the cylinder

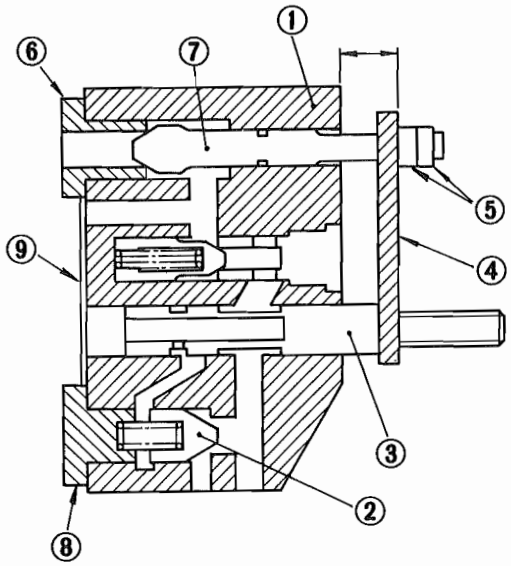
Remove the hydraulic cylinder from hydraulic case while paying attention to "O" rings.



Disassembling the control valve

The hydraulic system including the control valve is almost trouble-free if the oil filter is cleaned and the oil is changed at the specified intervals.

Should the control valve become defective, disassemble it in a clean place in a careful manner.



1-Body
2-Unloader valve
3-Spool valve
4-Plate
5-Nut
6-Valve seat plug
7-Poppet
8-Valve seat plug

NOTE

Before disassembling the control valve, measure the body and plate, and make a note of the measurements which will be used when reassembling the control valve.

- **Disassembling**

Remove the control valve from the hydraulic case, and proceed as follows:

(1) Remove nut (5) and the valve seat plug (6) with 26 mm socket.

(2) Remove valve seat plug (8) and plate (9).

(3) Pull out the spool valve (3) and poppet (7) to the left hand side.

NOTE

As the plug and seat head is not thick enough, be sure to use box wrench. Using open wrench will give damage to plug and seat head.

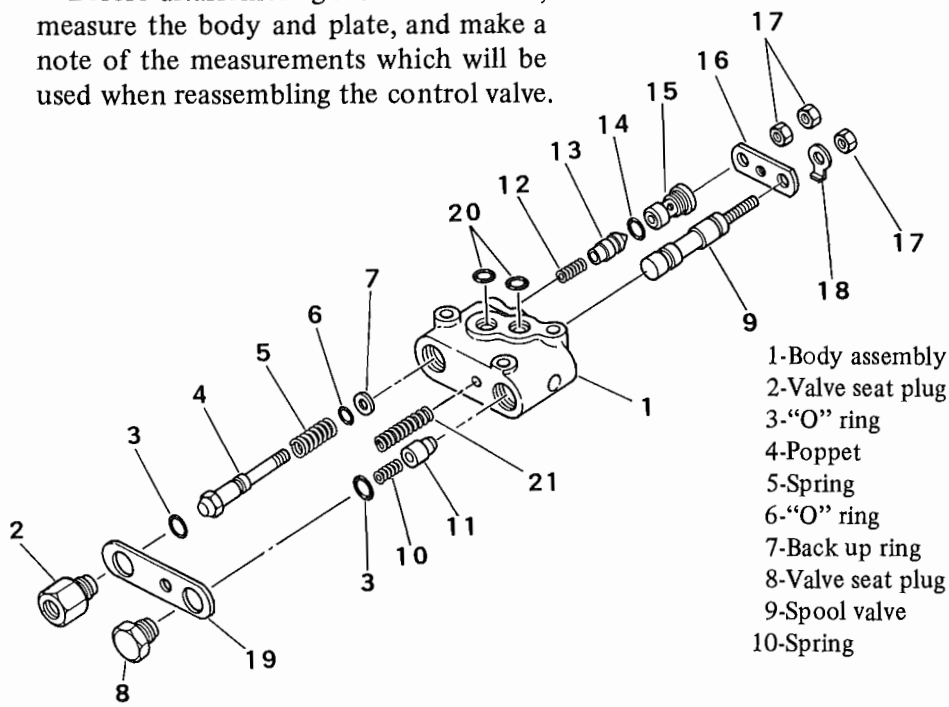
- **Inspection**

(1) Wash the disassembled parts in cleaning oil and dry them with air. Correct or replace defective parts with scratches or damages.

(2) Be sure to replace the body and spool as a set. All the other parts can be replaced as a single piece each.

- **Assembling**

Be sure to replace "O" rings with new ones. When assembling, apply clean oil and assemble carefully. Pay a special attention to the inclination of the spring and movement of each valve.



1-Body assembly
2-Valve seat plug
3-"O" ring
4-Poppet
5-Spring
6-"O" ring
7-Back up ring
8-Valve seat plug
9-Spool valve
10-Spring
11-Unloader valve
12-Spring
13-Check valve
14-"O" ring
15-Seat plug
16-Plate
17-Nut
18-Stopper plate
19-Plate
20-"O" ring
21-Return spring

(1) Fit an "O" ring and back-up ring to the poppet and install the poppet to the body together with a spring. Fit an "O" ring to the seat and install it to the body with plate (21). Install the "O" ring to the poppet side and back-up ring to the screw side.

Tightening torque	7 ~ 9 kg-m (50.6 ~ 65.0 ft-lb)

(2) Fit an "O" ring to the check valve seat. Install the spring first and then check valve and fasten with a seat plug. Lock the seat plug after punching.

Tightening torque	5 ~ 7 kg-m (36.1 ~ 50.6 ft-lb)

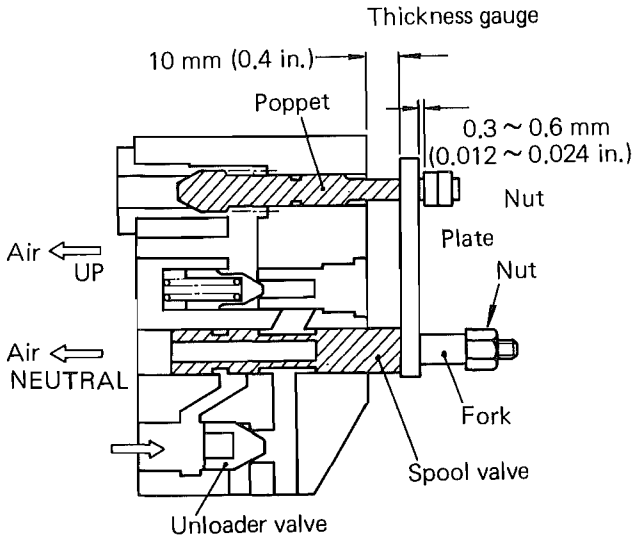
(3) Install the plate to the spool valve, install a stopper plate and fork fasten with a nut.

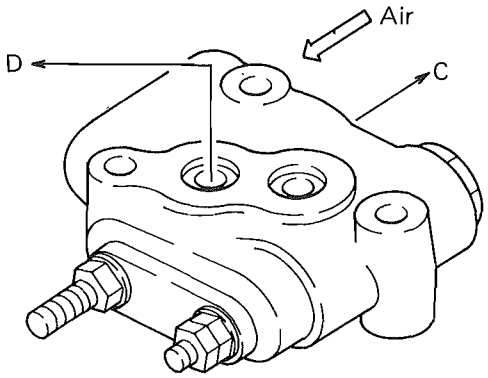
Tightening torque	1.2 ~ 2.2 kg-m (8.684 ~ 15.9 ft-lb)

(4) Insert the spool valve into the body, and install the plate to the poppet. Set the body and plate according to the measurements taken before disassembly, and tighten the nut.

(5) Install the unloader valve.

- **Control valve adjustment**





(1) With the unloader valve installed, blow air into the unloader plug hole.

(2) Insert the thickness gauge, as shown in figure between the plate and the double nut, and confirm the followings:

(a) When inserting the thickness gauge of 0.3 mm (0.1 in.), air comes out of the hole C of the spool valve – at NEUTRAL position.

(b) When inserting the thickness gauge of 0.6 mm (0.2 in.) air comes out of the pump port D, or no air leakage is noticed anywhere – at UP position.

(3) If such a case is not applicable, loosen the double nut and adjust it so as to meet the requirement shown by the item (a) and (b).

(4) In case of adjusting, punch the outer nut for preventing looseness after finishing adjustment.

(5) Insert the spring into the unloader valve and tighten the plug with "O" ring.

Tightening torque	7 ~ 9 kg-m (50.6 ~ 65.0 ft-lb)

Pump relief valve (cover)

Pump relief valve is installed in the pipe line connected to the pump and control valve. It has been designed to operate properly even when a sub control valve is installed.

- **Relief valve (disassembling the cover)**

When the relief valve is disassembled completely, pressure should be adjusted. Never disassemble it without special reason.

After removing the hydraulic case, proceed as follows:

(1) Remove the plug, and take out the shim, "O" ring, spring seat, spring, poppet and valve seat.

(2) Pressure can be adjusted by changing the thickness of the shims.

Relief set pressure	135 kg/cm² (1920 psi)

- **Inspection**

Wash the components in cleaning oil and inspect it carefully for damages. Replace with new one if a remarkable flaw is found. Especially check the poppet and seat face carefully.

- **Assembling**

Wash components cleanly to remove dust or dirt. Check to see that no damage is involved, apply oil and assemble carefully.

Be sure to replace "O" rings with new ones, and apply grease thinly before assembly.

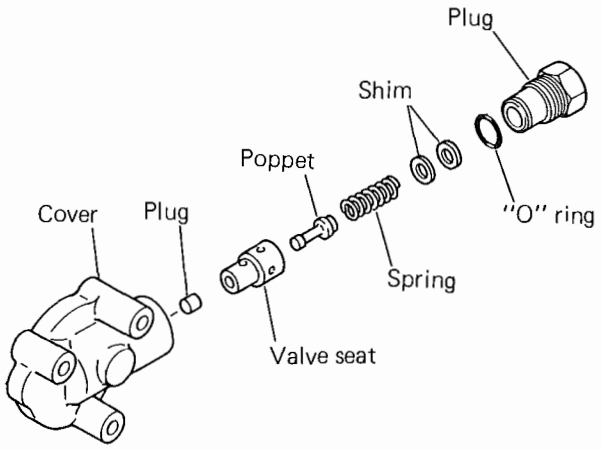
Fit an "O" ring to the plug, install a seat, poppet and then spring to the body. Install a spring seat to the plug and mount it to the cover.

- **Relief set pressure adjustment**

If the relief set pressure is less or more than the specified, or the cover is disassembled, it is necessary to measure the relief pressure. If no measuring facilities are available, measurement can be taken with the valve installed. For measurement, proceed as follows:

(1) Install a compression gauge to the 1/8 tap of the hydraulic case cover.

(2) Start the engine, move the control lever over the finger guide toward LIFT so that the relief valve is actuated. Read the pressure gauge. If the pressure is high, decrease the thickness of the shim. If low, increase the shim thickness. Pressure will change.



Reassembling the hydraulic case

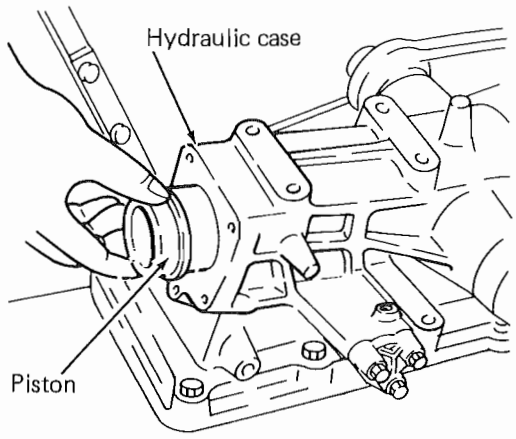
When reassembling the hydraulic case, the following steps must be taken.

- Thoroughly wash all parts with cleaning oil.
- Blow all washed parts with compressed air to dry them. Do not use cloth to wipe them.
- As for valves and related parts, they should be kept dipped in gear oil SAE 80 after being washed.
- Avoid re-using "O" rings, back-up ring and gaskets. Always use new ones. Before installing "O" rings, coat them with good quality grease. Apply grease sparingly.
- Always use new cotter pins.
- Do not put on gloves while reassembling operations.
- Before starting reassembly, make sure that the place is clean.
- When re-using the used oil after reassembly is over, avoid using 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).
- Do not stretch "O" rings so that they will not permanently deformed.

Assembling the cylinder

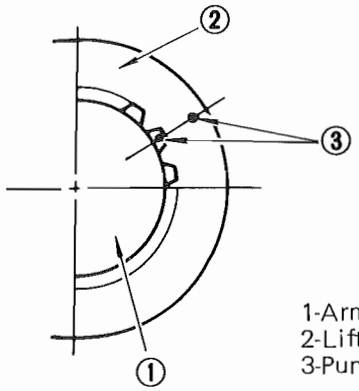
(1) Apply the oil to the "O" ring, and install this "O" ring to "O" ring groove.

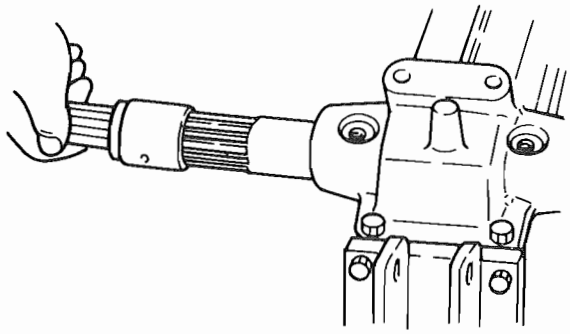
(2) Install the cylinder to the hydraulic case.



Assembling the ram arm and lift arm

Fix the piston rod to the power arm with a cotter pin.





(1) Install the power arm to the hydraulic case.

(2) Install the ram shaft to suit punch mark of the power arm.

(3) Install bushings coated with oil on both sides of the ram shaft. Put bushing set bolts into bushings while paying attention to the bushing set bolt position. And then tighten them.
Set oil seals coated with grease to both sides of the ram shaft.

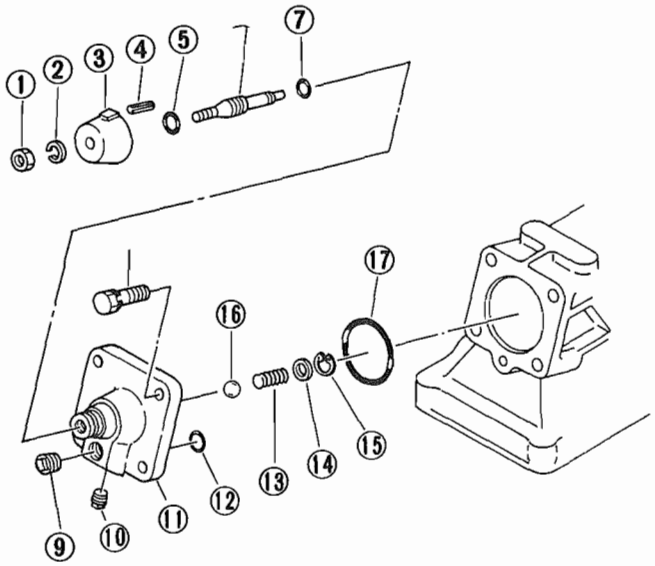
(4) Install the lift arm to suit punch mark of the ram shaft, and set it with a bolts.

NOTE

Make sure that the ram shaft arm moves smoothly.

Assembling the cylinder head

(1) Wash each parts cleanly before assembling.



1-Nut
2-Spring washer
3-Grip
4-Spring pin
5-"O" ring
6-Adjuster
7-"O" ring
8-Bolt w/washer (M12x45)
9-Taper plug(PT=3/8)
10-Taper plug (PT=1/8)
11-Cylinder head
12-")" ring
13-Spring
14-Washer
15-Circlip
16-"O" ring
17-Steel ball

(1) Grease "O" rings (5) (6), and fit them to adjuster (6), setting the rings (5) (6) neatly in the groove.

(2) Run adjuster (6) into cylinder head (11).

(3) Grease "O" ring (12), and fit the ring (12) to the front side of cylinder head (11).

(4) Into cylinder head (11), insert steel ball (17), followed by spring (13) and washer (14), and put on circlip (15).

(5) Grease large "O" ring (16), and fit it to cylinder head (11).

NOTE

(1) If the plugs (9), (10) have been removed, be sure to wrap them with sealing tape or to apply sealant to them before re-fitting. Make certain that neither pieces of sealing tape nor crumby particles of sealant, whichever is the case, will not get into oil.

(2) Adjustment of flow control valve must be done after completing assembly or installing of both hydraulic case and diff-housing.

Assembling the hydraulic control linkage

(1) Apply thin grease to oil seals (3) and set each of them to the hydraulic case.

(2) Install a lever bracket (2) on the hydraulic case.

(3) Set a collar (19) to the control lever (1), and install the shaft coated with oil on the hydraulic case.

(4) Install link lever (10) on both link lever shaft (8) and lever link arm (11).

(5) Install the feed back shifter (7) from the inside of hydraulic case.

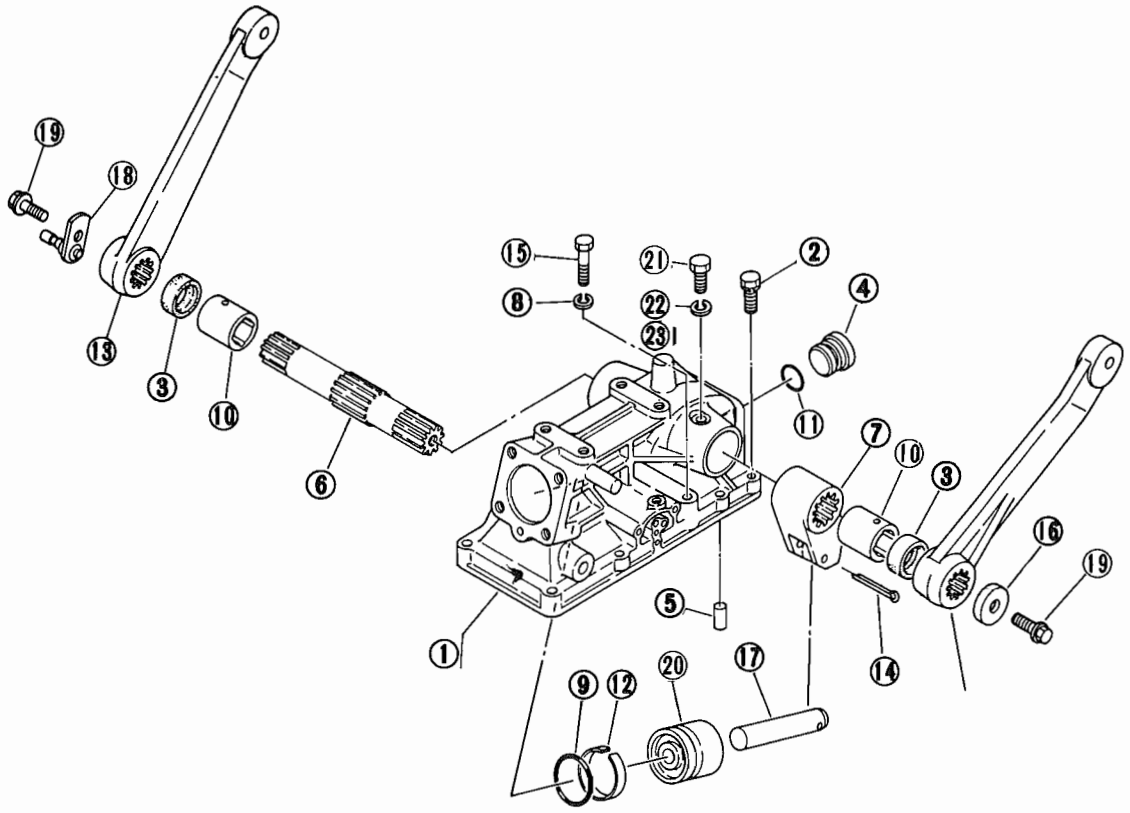
(6) Install the feed back arm (13) on the shaft of the feed back shifter (7), and set it with a spring pin (6).

(7) Set a washer (22) and disk springs (21) to the control lever (1). Then install the link lever shaft (8) on the hydraulic case, and do the lever link arm (11) on the control lever (1).

(8) Install a washer (23) on the tip of control lever, and fasten it with double nuts (4) so that correct torque can be obtained.

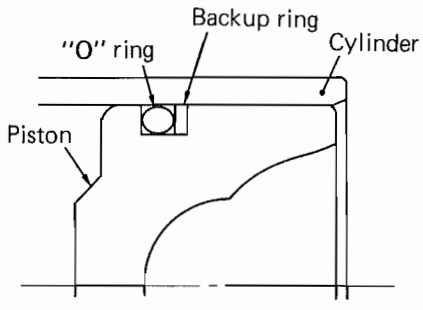
Starting torque of position control lever	5 ~ 6 kg (11 ~ 13.2 lb)

(9) Put a spring pin (6) into the valve shifter (5), install the valve shifter (5) on the tip of link lever shaft (8) together with the plate (24), and fasten them with a nut (4). Lock the nut (4) with a plate (24).

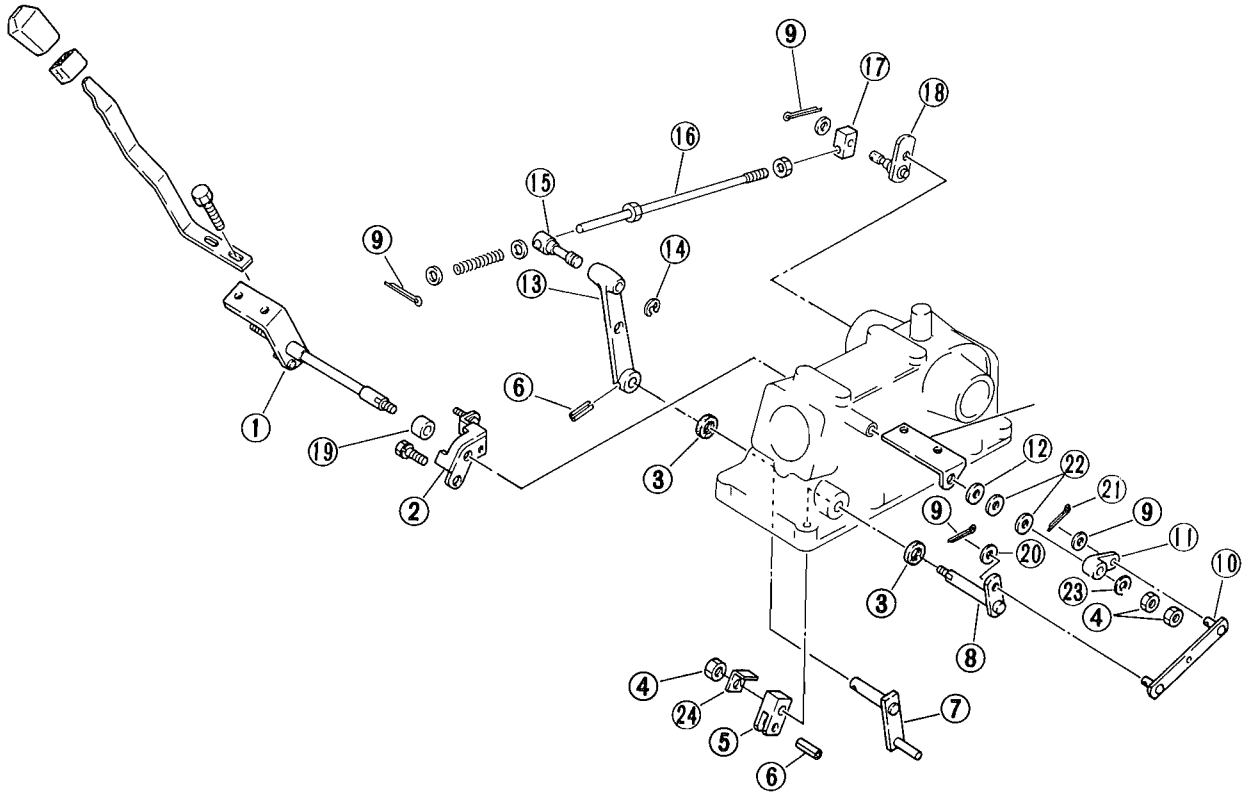


1-Hydraulic case
2-Bolt (M10 x 45) w/washer
3-Oil seal
4-Plug
5-Dowel pin
6-Ram shaft
7-Power arm
8-Spring washer
9-O-ring
10-Bushing
11-"O" ring
12-Back up ring
13-Lift arm
14-Cotter pin
15-Bolt (M10x100)
16-Washer
17-Piston rod
18-Plate
19-Bolt w/spring washer (M10x25)
20-Cylinder
21-Bushing set balt
22-Washer
23-Seal washer

(5) Apply the oil to the back-up ring and "O" ring, and install these rings to the piston.



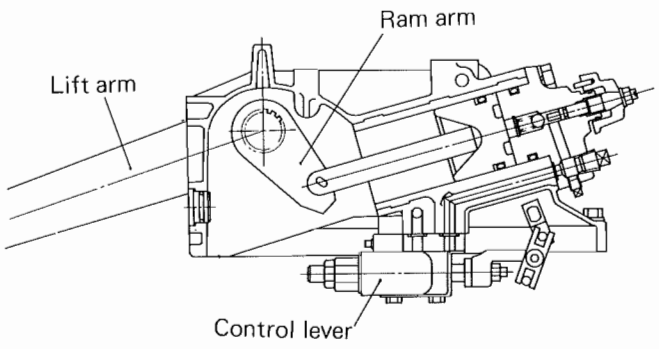
(6) Apply the oil to the cylinder, and install the piston to cylinder.



1-Control lever
2-Lever bracket
3-Oil seal
4-Lock nut
5-Valve shifter
6-Spring pin
7-Feed back shifter
8-Link lever shaft
9-Cotter pin
10-Link lever
11-Lever link arm
12-Plate
13-Feed back arm
14-E-type circlip
15-Joint pin
16-Feed back rod
17-Joint
18-Plate
19-Collar
20-Washer
21-Disk spring
22-Washer
23-Washer
24-Plate

Installing the control valve

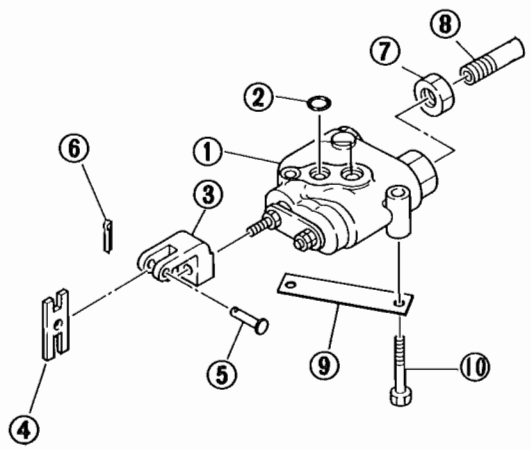
(1) Install a pipe for lubricating power arm with nut on the correctly adjusted control valve.



(2) Install valve link on the tip of fork by the use of pin and set it with cotter pin.

(3) Install the fork equipped with the valve link on the tip of spool valve and fasten it with lock plate nut.

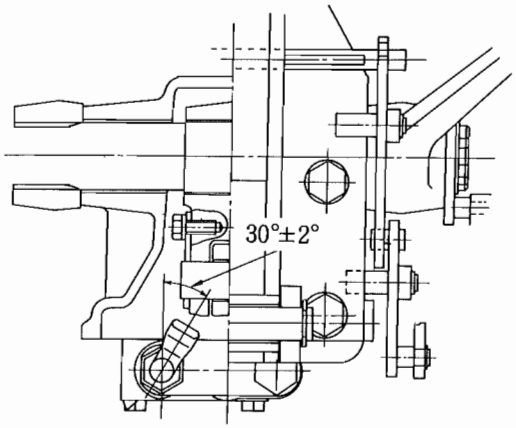
(4) Clean mating surface of the control valve and install "O" rings applied with oil on the control valve to fit the hydraulic case with it.



1-Control valve
2-"O" ring
3-Fork
4-Valve link
5-Clevis
6-Cotter pin
7-Nut (M14)
8-Pipe
9-Lock plate
10-Bolt (M8 x 45)

NOTE

Correctly set the valve link to the valve shifter and lever.



(5) After fixing the lock plate, tighten the control valve to the hydraulic case to secure it with lock plate.

Tightening torque	2.5 ~ 3.0 kg-m (18.1 ~ 21.7 ft-lb)

Removing the hydraulic pipings

(1) Place (a) jack under the rear part of axle housing and take up the weight of the housing with lack.

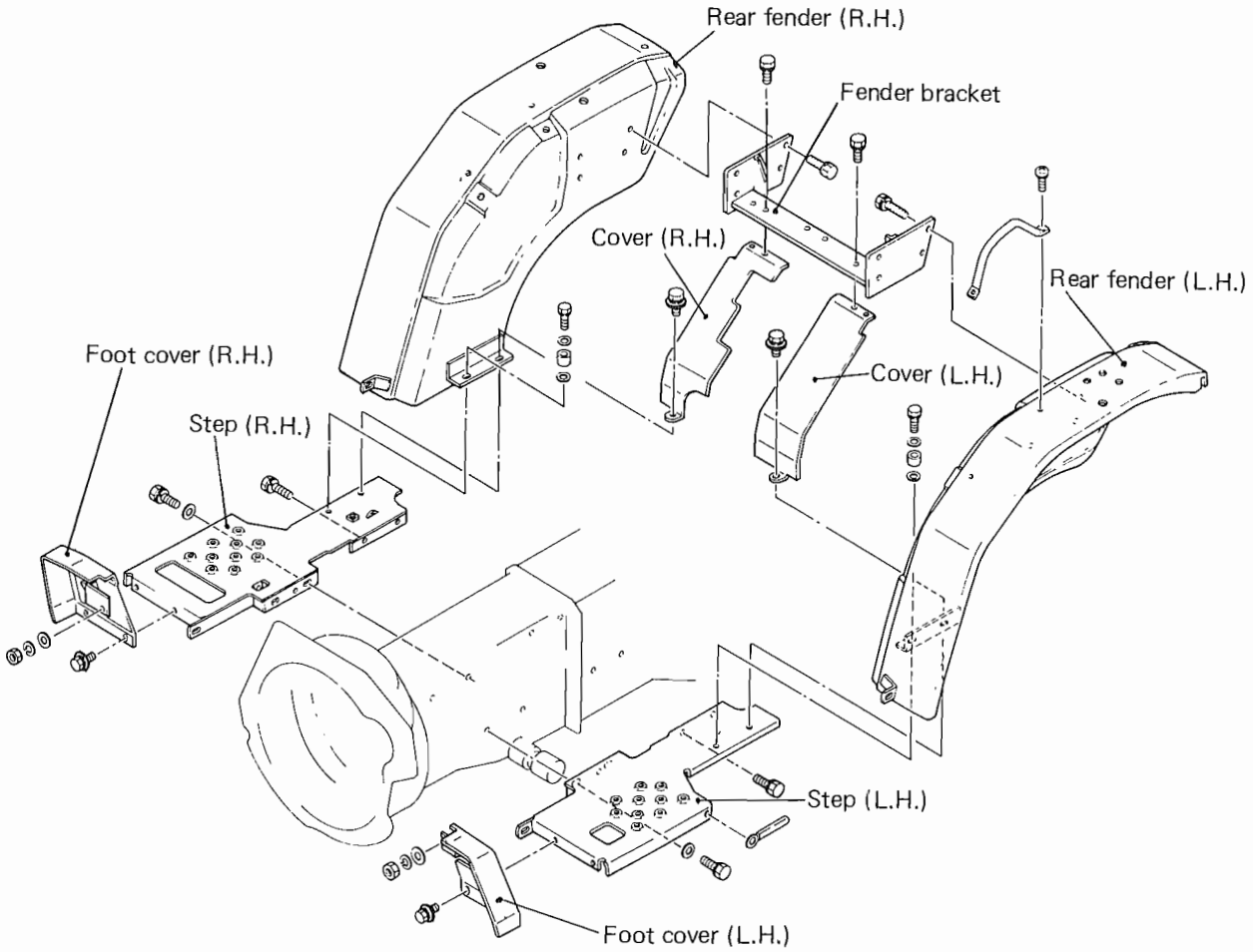
(2) Loosen rear wheel bolts, jack up the rear axle at left side, and tack of the rear wheel.

(3) Take out the lack supporting the rear part of axle housing.

NOTE

Apply the parking brake or shifting gear.

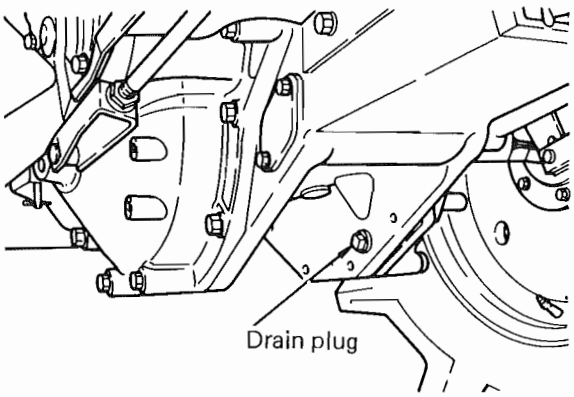
(4) After removing the fenders and covers, remove the left hand step and left hand foot cover.



(5) After opening the bonnet cover, remove left hand safety covers.

NOTE

Dust or impurities will be discharged more easily if the oil is drained while it is warm after operation.

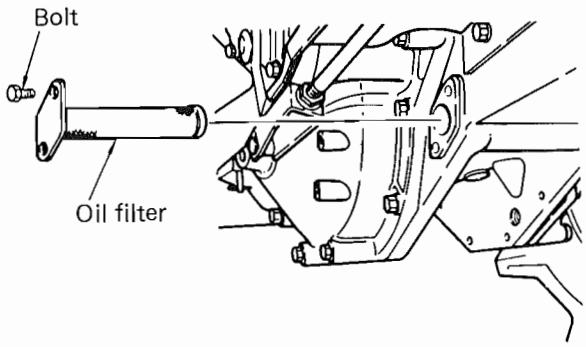


(6) Remove drain plugs at bottom of transmission case and diff-housing to allow oil flow out completely.

NOTE

Dust or impurities will be discharged more easily if the oil is drained while it is warm after operation.

(7) Remove oil filter at right bottom side of transmission case.



NOTE

Remove brake rod as required.

(9) To remove the pipe from hydraulic case, loosen the union bolt of the pressure pipe.

NOTE

As the union bolt heat is not thick enough, be sure to use socket wrench. Using open wrench will give damage to union bolt head.

(10) Loosen bolts securing suction pipe and remove the suction pipe from the left bottom side of diffhousing case.

(11) Loosen the nut securing the oil pump and remove the oil pumps from the engine timing gear case.

NOTE

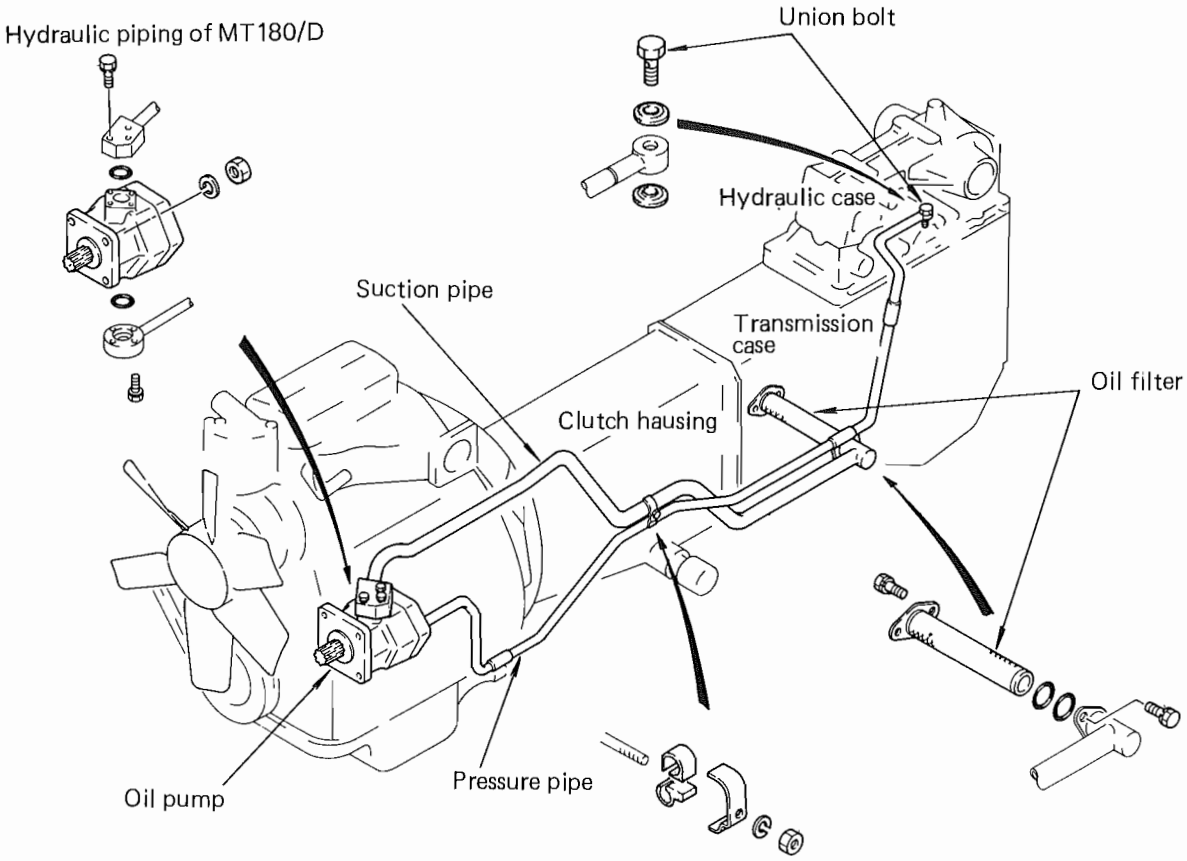
It is not necessary to remove the pipes, not to drain the oil when removing the oil pump only.

(12) Take out the suction pipe and pressure pipe in the front side.

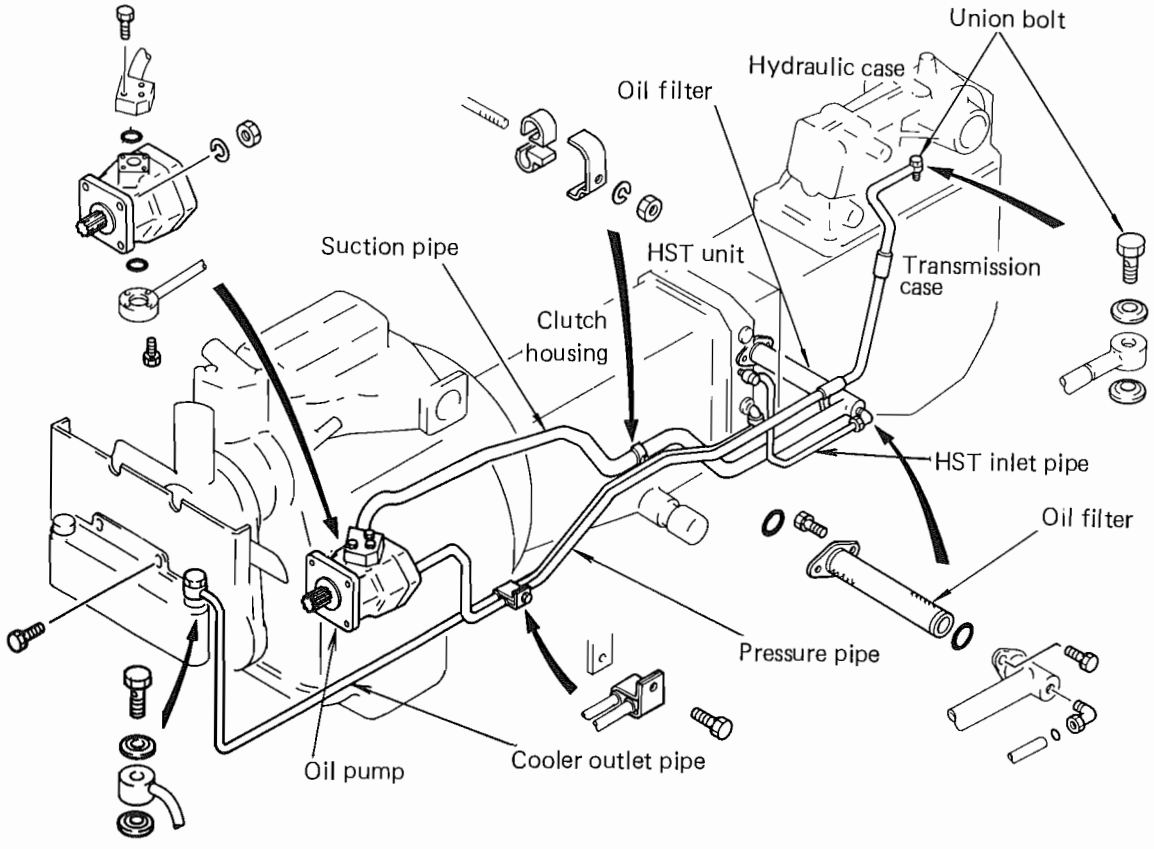
NOTE

Remove clutch return spring as required.

Hydraulic piping of MT180/D



Hydraulic piping of MT180H/HD



Installing the pipings and pump

NOTE

Be sure to replace "O" rings with new ones. When assembling, apply clean oil and assemble carefully.

The procedure of re-installing the pipings and pump is reverse of the foregoing removal procedure.

Item		Tightening torque
Pup Pump side	Suction pipe	1.0 ~ 1.2 kg-m (7.2 ~ 8.7 ft-lb)
	Pressure pipe	1.0 ~ 1.2 kg-m (7.2 ~ 8.7 ft-lb)
Transmission case side	Suction pipe	2.5 ~ 3.0 kg-m (18.1 ~ 21.7 ft-lb)
Hydraulic case	Union bolt	4.5 ~ 5.5 kg-m (32.5 ~39.8 ft-lb)
Oil Filter	Bolt	2.5 ~ 3.0 kg-m (18.1 ~21.7 ft-lb)

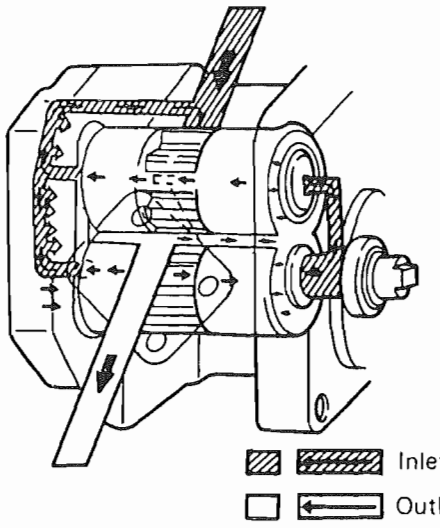
OIL PUMP

Construction

This oil pump [Nachi–GP-3607A] is of the gear type, employing the pressure loading system. The pressurized oil is forced out to the rear side of bearing bushing, and the minimum clearance is maintained between the gear teeth and bushing to minimize internal leakage, thereby securing a high volumetric efficiency even at high-pressure-low-speed operation. (The bearing bushing serves as a pressure loading component and casing at the same time.) The bearing bushing is of movable design, and, as a result, it is able to maintain a proper clearance whether the bushing swells due to heat or is worn due to protracted low-temperature operation.

The bearing bushing 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 percent of the specified volumetric efficiency can be secured for a long period. The pump has been tested for 4000 hours continuous operation and proven to maintain high-performance.



NOTE

a) 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 vegetable oil is not allowed. Extremely high temperature oil may cause corrosion to the oil seal.

b) The oil should be gear oil SAE 80. For details, refer to the Instruction Book.

Removal

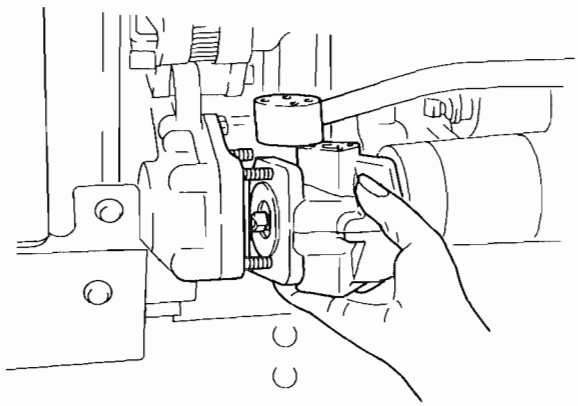
Hydraulic oil (transmission oil) need not be drained out for this removal.

(1) Open the bonnet.

(2) Remove safety cover on the left.

(3) Loosen bolts securing pressure and suction pipe connections. Recover "O" rings.

(4) Loosen nuts securing the pump to timing gear case, and take out the 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 aluminum alloys.

For this disassembly work, refer to the exploded view.

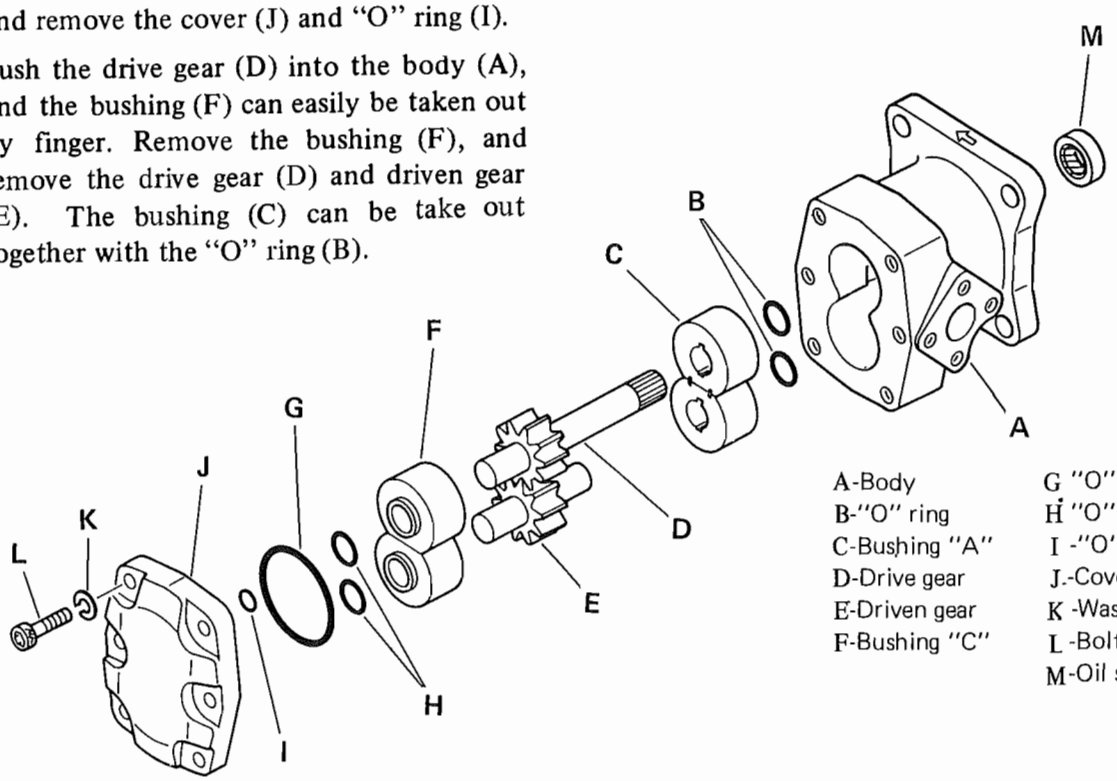
(1) Loosen the bolt (L) with a hexagon hole, and remove the cover (J) and "O" ring (I).

(2) Push the drive gear (D) into the body (A), and the bushing (F) can easily be taken out by finger. Remove the bushing (F), and remove the drive gear (D) and driven gear (E). The bushing (C) can be take out together with the "O" ring (B).

The disassembled parts should be arranged in order. As for the shafts and bushings, their positions should be correctly memorized.

When installing bushings, take care not to confuse the bushing (C) for bushing (F) in relation to their positions.

Each bushing has a mark A or C stamped on its end. A bushing having mark A 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. When pulling out the oil seal (M) from the body, take special care not to scratch the housing bore.



A-Body
B-"O" ring
C-Bushing "A"
D-Drive gear
E-Driven gear
F-Bushing "C"
G "O" ring
H "O" ring
I -"O" ring
J.-Cover
K -Washer
L -Bolt
M-Oil seal

Inspection

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 bushing holes and journal bearings will be worn. As a result, the casing wall begins to show wear. If the amount of wear exceeds 0.05 mm (0.002 in.), 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 bushing will not be effective to improve the performance. The use of a worn bushing 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 calipers. If the measurement shows a smaller value than Nachi – 13.96 mm (0.550 in.) , replace the shaft.

Check the bushings for deformed bore and scratches. If any discoloring of a gear can be considered to be related with a defective bushing, check for the relief valve and related oil passages. If the length of a bushing is shorter than the value as shown below, it should be replaced.

16.80 mm (0.661 in.)

Any discolored gear should also be replaced. Measure the clearance between the shaft and bushing. If the measurement is larger than the following value, the bushing should be replaced.

0.177 mm (0.006 in.)

Reassembly

Make sure that all parts are clean. If the oil seal (M) has been removed, 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 bushing (C), and coat it with good quality of mineral grease. Insert it in the body (A) and push it in further. A pair of bushings must be true and coat it with good quality of oil. Insert it in the body (A) and push it in further. A pair of bushings must be true fitted in place without requiring force. If the bushing has a scratch on its surface, it will not move smoothly. In this case, pull out the bushing and smooth down the raised part with oil stone. Make sure that the surface of the bushing is smooth. For this check, use a surface plate. After using oil stone, be sure to wash the bushing. Oiling the bore will make it easy to install the bushing. Make sure that, after installation, the "O" rings are in place.

The "O" ring must be located between the bushing and the bottom of body. The leading gear type is greatly affected by the result of reassembly. Make sure that the escape groove in the bushing surface is not inclined. Incorrect reassembly will not provide the pressure balance effect, and as a result, the bushing 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. Insert the drive gear (D) and the driven gear (E) into the body (A).

(3) Fully grease the bushings (F) in pair, and insert them in the body. Place the "O" rings (H) on the bushing (F).

(4) Place the "O" rings (G) and (I) on the cover, and place the cover, Finally tighten the bolt (L) with a hole by using a hexagon wrench. Tightening torque is 0.8 kg-m (5.77 ft-lb). Lock the bolt head with center punch and feed a small quantity of oil through the port.

(5) Make sure that the reassembly is done perfectly by turning the drive gear (D) with an open end wrench. If the gear turns smoothly, the assembly is correct. If too tight, correct it.

Installation

(1) Align the pump shaft with the pump drive shaft, and install it to the engine timing gear case.

(2) Set the "O" ring correctly, and install the suction pipe and delivery pipe to the pump.

Test

Special care should be taken for test run, particularly when bushings, 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, 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 82°C or 180°F), 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 80°C or 176°F), reduce the engine speed temporarily, and continue no-load operation until working parts are fully run in.

NOTE

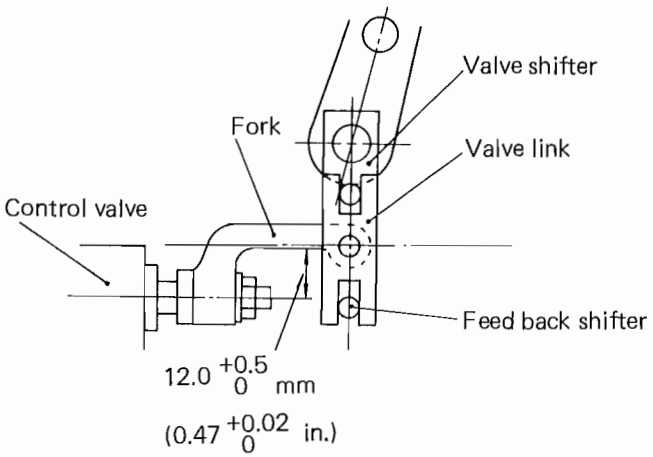
The disassembly and reassembly of the pump are relatively easy, but it should not be unnecessarily disassembled because of trouble of the hydraulic system, of which causes are unknown. Avoid performing disassembly for repair in the field, because it is very difficult to prevent dust and dirt from entering the pump. Parts may also be scratched.

ADJUSTMENT

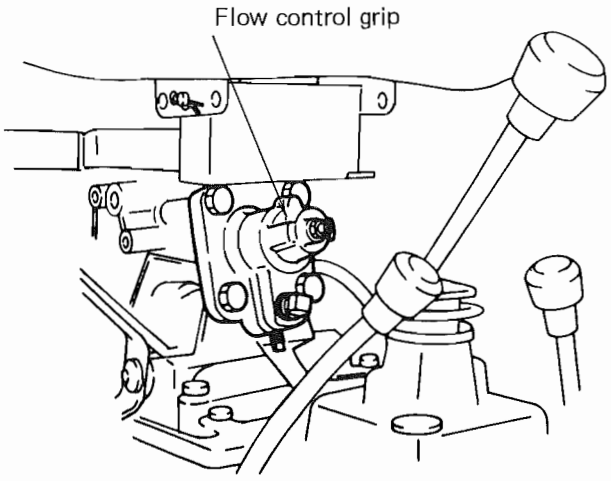
Adjusting the control valve fork

It is required to adjust the fork so as to position it correctly because hole diameter is bigger than that of the tip of spool valve.

Make valve link vertical by means of position control lever. Loosen nut at the tip of spool valve, and adjust fork by moving up and down so that both upper part of the link pin and lower part of valve link set pin come to $12.0\ ^{+0.5}_{0}$ mm ($0.47\ ^{+0.02}_{0}$ in.). After adjusting it to the prescribed dimension, tighten nut, secure the fork and lock it with lock plate.



Adjusting the flow control grip



(1) Attach implement to 3-point linkage and place position control lever in lower position.

(2) Start engine, lift up implement and stop the engine.

(3) Loosen nut on the tip of flow control grip.

(4) Turn the position control lever to LOWER position, and make sure the implement is held.

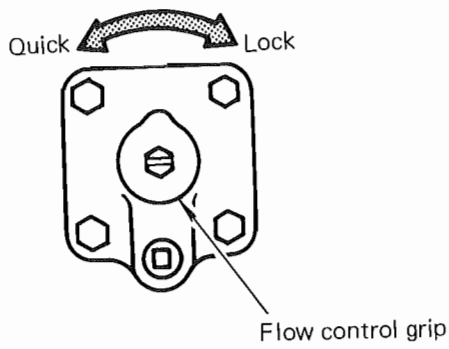
NOTE

In case the implement is apt to be lowered, turn the adjusting screw more clockwise. Start the engine again, turn the control lever to RAISE position. Then turn the control lever to RAISE position, stop the engine and lower the control lever to make sure that the implement is held to the full.

(5) Turn the pilot screw slowly counterclockwise and move it to the position where the implement starts to be lowered. Turn the pilot screw clockwise to the position where the implement is stopped.

Lock the flow control grip with nut.

(6) Start the engine again and turn the control lever to RAISE position. Then make sure that the implement is stopped at the position where the flow control grip is turned clockwise while the implement is lowered rapidly by turning the stopper lever counterclockwise.



Setting of flow control grip

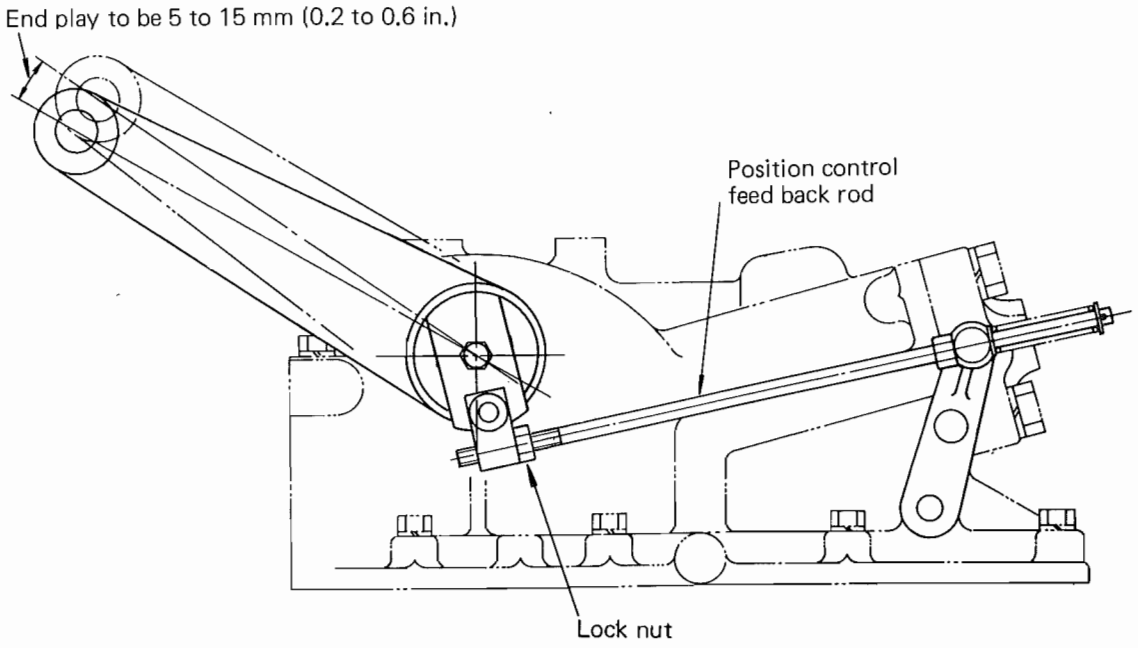
Adjusting the position control

(1) Remove the lift rod from lift arm.

(2) Start engine and locate the control lever at RAISE position.

(3) In case the end play is more than 5 to 15 mm (0.2 to 0.6 in.) on the lift arm.

Loosen lock nut of the feed back rod and extend the feed back rod by turning the rod counterclockwise.



(4) In case there is no play on the tip of lift arm and relief valve is worked.

Loosen lock nut of the position control feed back rod. Then screw the feed back rod into the lift arm side and adjust it so as to obtain the prescribed end play.

TROUBLESHOOTING

Trouble	Possible cause	Remedy
Implement does not move up even when the control lever is set to the lifting positions.	a) Weight of the implement exceeds lifting capacity	Check the weight of the implement
	b) Gear pump discharges no oil (damaged drive shaft)	Replace the gear pump
	c) Air is mixed in the pipe line	Bleed air from the pipe line Refer to the items, "Oil filter" and "Notes," bleed air from the pipe line.
	d) Shortage of hydraulic oil	Check the level of hydraulic oil and supply if not sufficient
	e) Clogged oil filter element	Clean the oil filter element
	f) Dropped set pressure of the pump relief	Readjust the relief pressure: $135\ ^{+5}_{0}$ kg/cm^2 ($1920\ ^{+71}_{0}$ psi) or replace with new one
	g) Unloader valve or poppet does not close	Disassemble and clean the unload valve and correct flaw. Then, confirm smooth operation of the unload valve.
	h) Defective assembly of control valve	Adjust properly
The implement set in neutral shows hunting while the engine is running.*	a) Flaw or dust on the poppet and seat surface	Correct, clean or replace
	b) Flaw or dust on the check valve and seat surface	Correct, clean or replace
	c) Flaw or defect on the "O" ring	Check and replace the "O" ring if defective
	d) Oil leakage from the piston and cylinder	Check for the cause and repair defective parts
	e) Oil leakage from passage between control valve and cylinder	Check the "O" ring and replace if defective
	f) Hydraulic oil	Replace with proper hydraulic oil
Lifting speed of the implement is found slower than the standard.	a) Flaw or dust on the unloader valve seat surface	Clean or replace Replace the unloader valve or the body. When replacing the body, replace the spool valve at the same time.
	b) Oil leakage due to flaw on the relief seat surface	Correct or replace the relief valve poppet
	c) Leakage inside the cylinder	Check, correct or replace the cylinder and piston Check the "O" ring

Trouble	Possible cause	Remedy
The implement set in neutral shows hunting while the engine is running.	a) Inferior power volumetric efficiency of the pump	Replace the pump (Check for the oil leakage)
	b) Clogged strainer	Wash the oil filter
		Check the oil for contamination
		Replace the oil if contaminated
Defective operation of the control lever	a) Dust between the body and spool	Remove and clean the valve
	b) Sticking in the spool valve	Correct or replace the spool valve
		Replace the spool valve and body at the same time.
	c) Sticking in the link system	Disassemble and correct the defective part
		Replace if correction is impossible
Temperature of hydraulic oil is too high	a) Relief valve is operating always	Readjust the relief valve
		Readjust the link system
		Check and adjust the weight of the implement
		Check and correct improper assembling and the control valve.
		Check the oil for contamination
	b) Lower pump volumetric efficiency	Replace the pump
		Check the oil for contamination
	c) Flaw on the unloader valve, body and seat surface	Replace the body and unloader valve
		Replace the body and spool valve as a set
		Check the oil for contamination
	d) Oil leakage due to flaws on the relief valve seat surface	Correct or replace the relief valve
	e) Oil leakage from the cylinder or piston	Check and correct the defective parts
	f) Sticking in the pump	Replace the pump
Abnormal sound	a) Sticking in the pump	Replace the pump
	b) Insufficient suction of the pump	Clean the oil filter element
		Check the oil for contamination
	c) Air is sucked in.	Check "O" rings of each joint for tightening
		Bleed air from pipe line
		Refer to the items, "Oil filter" and "Notes," bleed air from the pipe line.
	d) Air suction from the pump oil seal	Check, correct or replace
	e) Improper hydraulic oil in use	Replace with proper one

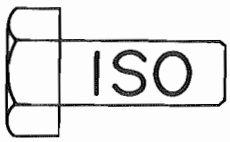
Trouble	Possible cause	Remedy
Implement lowers naturally when the engine stops	Follow the steps described in the * marked item, which has the same cause.	
Implement lowers naturally while traveling	a) Control lever moves toward lowering direction during running	Use a stronger friction spring to prevent the control lever from moving
	b) Insufficient set pressure of cylinder relief valve	Adjust the pressure to be as specified

Pump

Trouble	Possible cause	Remedy
Oil leakage	a) Damage of shaft oil seal	Replace with new one
	b) Damage of gasket	Replace with new one
Noise		
Cavitation	a) Clogged strainer	Clean the strainer
	b) Low oil temperature	Raise the temperature
	c) Unsuitable oil	Replace with a proper one
Air is mixed	d) Insufficient oil	Supply oil up to the specified level
	e) Air entered from the suction side pipe line or joint	Repair the defective parts
	f) Damage of the shaft oil seal	Replace with new one
Discharge amount is decreased and discharge pressure is not increased	a) Damage of the bearing gear and body due to foreign matters mixed	Replace the hydraulic oil and clean the oil strainer and pipe line
	b) Damage of the bearing gear and body due to exhaustion of oil	Replace the bearing gear and body or replace the working oil and clean the oil strainer and pipe line.
	c) Insufficient oil	Supply oil up to the specified level
	d) Damage of bearing, gear and body due to overload	Adjust the pressure of the pump relief valve as specified
	e) Damage of halfeight gasket	Replace with new one

SPECIFICATIONS

Specification \ Tractor	MT180/D	MT180H/HD
Type of cylinder	Single action cylinder	
Diameter of piston	60 mm (2.36 in.)	
Stroke of piston	71 mm (2.80 in.)	
Maximum lift power at the end of lower link	500 kg (1103 lb)	
Pressure for pump relief valve setting	135 kg/cm² (1920 psi)	
Type of hydraulic pump	Pressure loading gear type	
Model of hydraulic pump	Nachi: GP–3607A	
Output of hydraulic pump (at 2700 engine rpm)	12.9 liter/min (3.4 GPM)	
Control valve type	2 spool valve with unload valve	
Oil lock valve	In-line non return valve automatic flow control valve	
Strainer mesh	#42 x 100 mesh	
Hydraulic oil	Gear oil SAE #80	
Oil capacity	18 liters (4.74 U.S. gallon) [same as transmission oil]	
Control	Position control, flow control and lift lock	
External service	PT3/8 tap	
Hydraulic adaptor plate	Optional	



CHAPTER 8
ELECTRICAL SYSTEM

TABLE OF CONTENTS

DESCRIPTION

The electrical system of the MITSUBISHI MT160/D, MT180/D and MT180H/HD operates on 12 volts and consists of an alternator, voltage regulator, starter, glow plugs, headlamps, pilot lamps, switches and a 12-volt battery. Its ground polarity is negative (–).

Generator and voltage regulator

The generator supplies current to keep the battery in charge state, replacing the energy consumed by the starter motor and lamps. The generator charging rate is controlled by a voltage regulator which controls the generator output, thereby maintaining a charging rate, and prevents the battery from overcharging under varying temperatures and operating conditions.

Starter switch and starter circuit

The starter switch is actually a "heat and start switch" and permits current to flow from the battery to the glow plugs in its "H" position and to the starter in "S" position. The starter circuit is equipped with a safety starter switch which is mounted on the sub shift mechanism. This switch closes only when the sub shift lever is in neutral position to permit the current to flow to the starter. This is for preventing the tractor from jerking accidentally when the engine is started.

Glow plugs

Three sheathed type glow plugs, one for the combustion chamber of each cylinder, are used. The glow plug indicator mounted on instrument panel glows red when the plugs are energized.

Pilot lamps

The water temperature pilot lamp, engine oil pressure pilot lamp and battery charge pilot lamp are clustered in one and mounted on the instrument panel. These pilot lamps are connected to their respective sensing switches.

"Polymion" battery (perfector type)

Manufactured and sold under the trade name of "Polymion" battery by JAPAN STORAGE BATTERY CO., LTD., this 12-volt, 45-ampere-hour perfector type battery Model NX100-S6L (S) is standard on MT160/D, MT180/D and MT180H/HD. This battery features its extra thin separators which are in base material polyolefin; they are homogeneously porous to permit electrolyte to freely circulate between cell plates. The "Polymion" battery, because of such separators, gains an advantage over an ordinary battery in capacity per size. In other words, this battery is capable of far more power than an ordinary battery of like size. Thus, it is not advisable to substitute this battery with any other type of battery of like size.

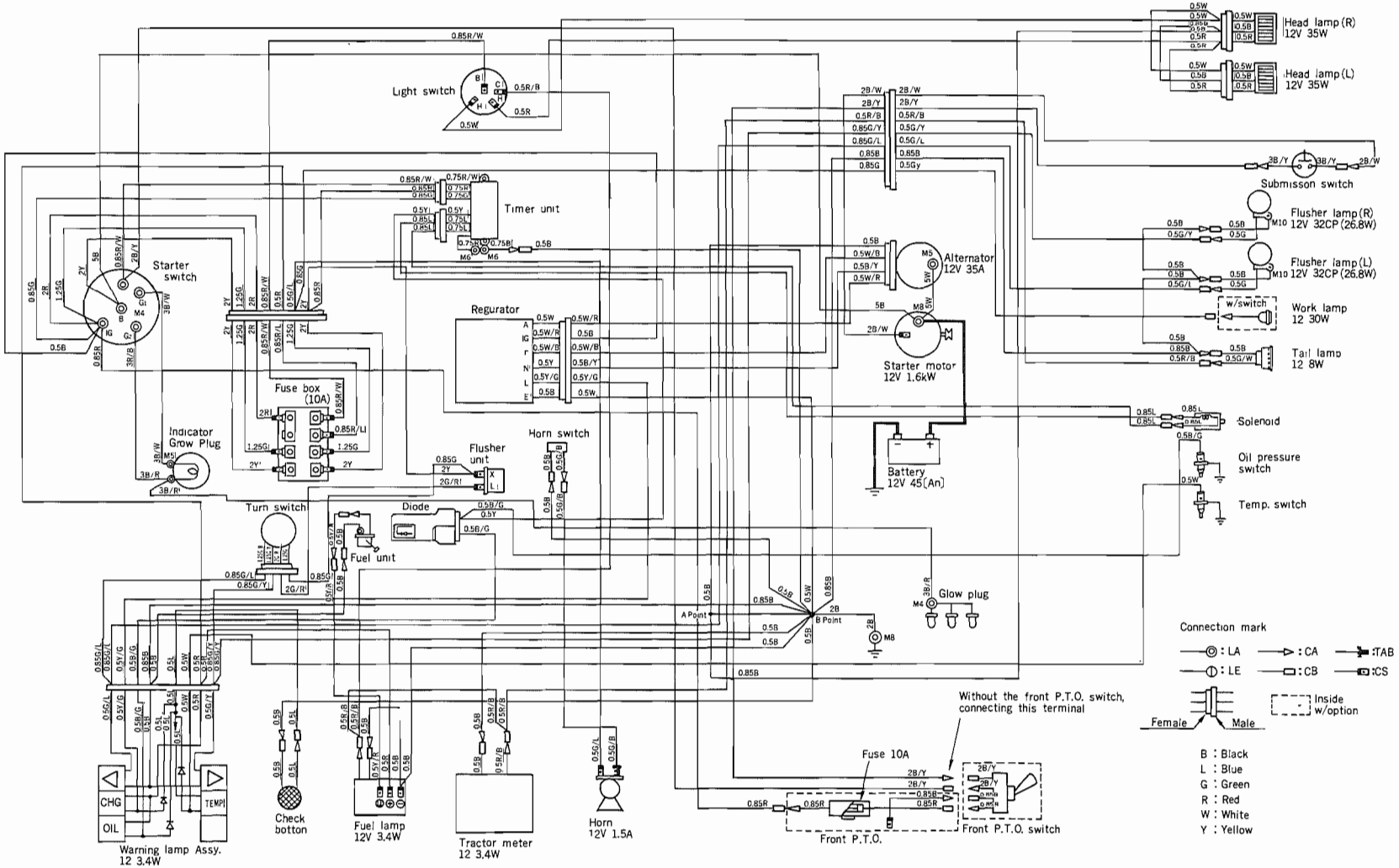
Following are the standard items of electrical equipment mounted on MT160/D, MT180/D and MT180H/HD:

Battery	NX100-S6L(S) 12 volts, 45 ampere-hours
Starter motor	MITSUBISHI M002T50371, 1.6 kilowatts, 12 volts
Alternator	MITSUBISHI AH2053M4, 12 volts, 35 amperes
Indicator lamps	Water temperature pilot lamp, engine oil pressure pilot lamp, battery charge pilot lamp
Water temperature pilot lamp switch	
Engine oil pressure pilot lamp switch	
Glow plugs	Sheathed type, 10.5 volts, amperes
Glow plug indicator	Red-heat type, 30 amperes
Voltage regulator	MITSUBISHI RQB2220D1

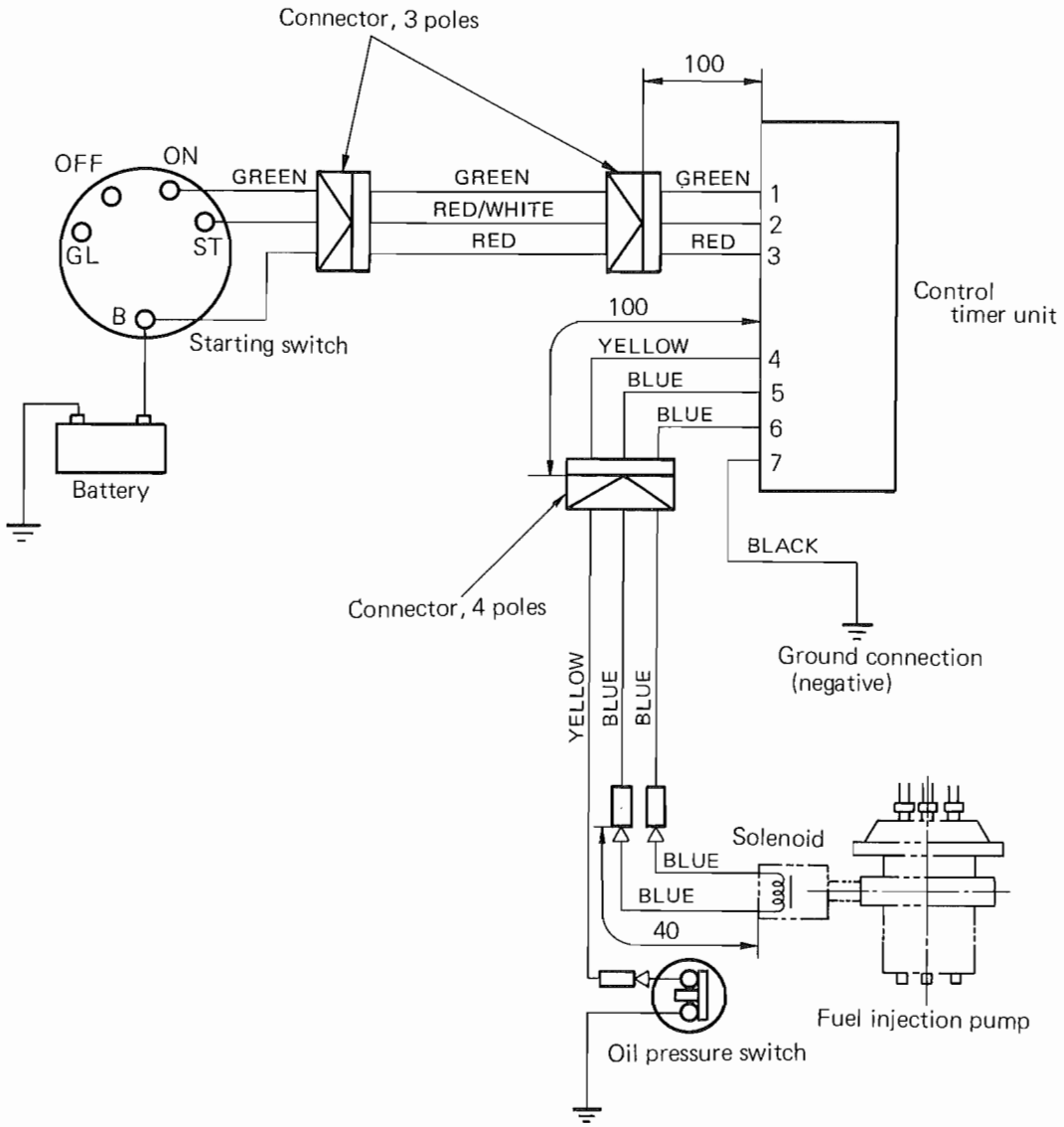
Engine ON-OFF key switch	
Lighting switch	
Safety starter switch	
Headlamps	Stanley 12 volts, 25 watts/25 watts
• Two flashing lamps with turn signal	
• Tail lamp	
• Horn	
Fuse holder	Box type with 4 pieces of 10A cartridge type fuse

Following are the optional items of electrical equipment:

Working lamp


Light switch
Starter switch
Timer unit
Regurator
Fuse box (10A)
Indicator Grow Plug
Flusher unit
Horn switch
Turn switch
Diode
Fuel unit
Alternator 12V 35A
Starter motor 12V 1.6kW
Battery 12V 45(An)
Head lamp (R) 12V 35W
Head lamp (L) 12V 35W
Submisson switch
Flusher lamp (R) 12V 32CP (26.8W)
Flusher lamp (L) 12V 32CP (26.8W)
w/switch
Work lamp 12 30W
Tail lamp 12 8W
Solenoid
Oil pressure switch
Temp. switch
Glow plug
A Point
B Point
Connection mark
: LA
: CA
: TAB
: LE
: CB
: CS
Inside w/option
Female
Male
B : Black
L : Blue
G : Green
R : Red
W : White
Y : Yellow
Without the front P.T.O. switch, connecting this terminal
Fuse 10A
Front P.T.O.
Front P.T.O. switch
CHG
OIL
TEMP
Warning lamp Assy. 12 3.4W
Check botton
Fuel lamp 12V 3.4W
Tractor meter 12 3.4W
Horn 12V 1.5A

Wiring diagram of electric shut-off system



Description	Control timer unit and oil pressure switch
Ambient temperature	–30 to 80°C (–22 to 176°F)
Acceleration of VIB	10G (at 3000 rpm)

BATTERY

HANDLING THE PERFECTOR TYPE BATTERY

This battery is of a perfector type and as long as plugs are properly sealed, the battery will operate considerably long. For caution's sake, however, give it an initial charging before use. As the initial charging to this battery, a quick charging is allowable unless the specific gravity of its electrolyte is considerably dropped. In freezing weather, warm up electrolyte before pouring it into the battery.

Following are the basic rules to be followed in handling this battery:

(1) Take sealing tapes off filler plugs and remove the plugs.

(2) About 2.8 liters (3 quarts) of electrolyte will be required to fill the battery up to level. The specific gravity should be 1.260 as corrected to 20°C (68°F).

(3) When filling the battery with electrolyte, make sure that the electrolyte temperature is not higher than 30°C (86°F).

(4) After filling the battery, leave it for a while until the electrolyte level goes down; then, replenish it to the upper level.

(5) The battery will self-discharge if it is kept out of service for long periods of time, or if cell plates are left exposed to the air due to poorly sealed plugs. Such a battery will not deliver the amount of current enough to cause the starter to crank the engine properly even if it is filled with electrolyte up to the upper level. In such a case, remove the battery from the tractor and recharge it.

(6) Where the tractor is stored with its battery filled with electrolyte up to level, check the specific gravity of electrolyte and recharge the battery when the specific gravity is below the specified value.

NOTE

For measuring the specific gravity, be sure to confirm the gravity value obtained in filling in electrolyte for the first time.

(7) If the specific gravity of electrolyte is found below 1.200, charge the battery slowly at the current of 5.0 amperes. Never make a quick charging.

CHARGING THE BATTERY

Slow charging

To recharge the battery which has been left out of service over long periods of time:

(1) The charging current should not exceed 1/20 of the battery capacity; it is normally 2 to 2.5 amperes.

(2) The length of time required for charging is 10 to 20 hours.

Regular charging

To recharge the battery which is discharged in normal service:

(1) The charging current should not exceed 1/10 of the battery capacity; it is normally 4 to 4.5 amperes.

(2) The length of time required for charging is 1.2 to 1.5 times of the value obtained by dividing the rate of discharge (ampere-hour) (presumed) by the charging current.

Quick charging

To charge the battery by using a quick charger:

(1) The charging current should not exceed the battery capacity.

(2) The length of time required for charging is 30 to 60 minutes.

The charging should be continued until the battery is gassing freely and there is no rise in the specific gravity of electrolyte. In fully charged battery, a charging voltage of higher than 15 volts will be noted at each cell and a specific gravity of 1.260 as corrected to 20° C (68°F) will be read.

PRECAUTIONS FOR CHARGING

When recharging the battery (removed from the tractor), observe the following rules:

(1) A battery that is being charged gives off highly explosive gases. Never light a match or a cigarette near such a battery.

(2) If battery temperature rises above 45°C (113°F) during charging, stop charging and have a wait for a while to permit the battery to cool down, or reduce the charging current to 1/2.

(3) In cold weather, a rapid voltage rise will occur in a battery being charged, resulting in an undercharged battery. In such a weather, charge a battery in a warm place.

(4) Remove the battery from the tractor, and remove vent plugs (if equipped) to improve ventilation.

(5) When connecting or disconnecting the leads from a charger to the battery, turn off the switch on the charger, making sure that no charging current is flowing into the battery.

(6) To charge the battery on the tractor with an external charger, be sure to take off the grounded-terminal cable clamp and make good connection of the charger with the battery by clamping the positive (+) lead of the charger on the positive (+) terminal of the battery and the negative (–) lead on the negative (–) terminal.

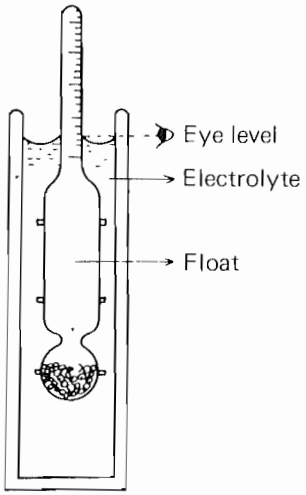
(7) Never use a battery tester on a battery that is being charged. This will allow sparks, resulting in accident.

CARE OF THE BATTERY

Checking the specific gravity of electrolyte

(1) As the battery discharges, the electrolyte gradually loses its specific gravity. Check the specific gravity to determine the state of charge of the battery.

(2) To check the specific gravity, use a battery hydrometer, and take the reading at eye level.



How to read hydrometer

(3) The specific gravity varies with temperature. This effect is due to the fact that as a liquid cools it becomes thicker and gain gravity. As a liquid warms it becomes thinner and loses gravity. The same is true of electrolyte. Thus, temperature should be considered when a gravity reading is taken. Make a correction if the electrolyte temperature is above or below 20°C (68°F) standard.

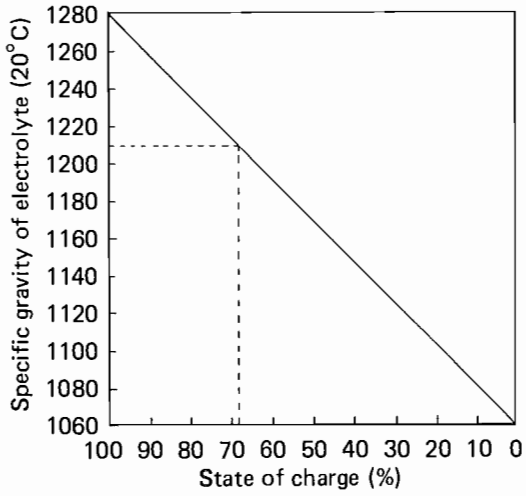
Conversion table of specific gravity of electrolyte

Sulfuric acid weight %	0°C (32°F)	5°C (41°F)	10°C (50°F)	15°C (59°F)	20°C (68°F)	25°C (77°F)	30°C (86°F)	35°C (95°F)	40°C (104°F)	45°C (113°F)	Temperature coefficient
28.0	1.218	1.215	1.212	1.208	**1.205**	1.202	1.198	1.195	1.191	1.188	
28.5	1.223	1.220	1.217	1.213	**1.210**	1.207	1.203	1.200	1.196	1.193	0.00067
29.1	1.228	1.225	1.222	1.218	**1.215**	1.212	1.208	1.205	1.201	1.198	
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	0.00070
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	1.233	1.229	1.226	1.222	
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	0.00071
34.6	1.274	1.271	1.267	1.264	**1.260**	1.256	1.253	1.249	1.245	1.242	
35.2	1.279	1.276	1.272	1.269	**1.265**	1.261	1.258	1.254	1.250	1.247	
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	0.00072
37.5	1.299	1.296	1.292	1.289	**1.285**	1.281	1.278	1.274	1.270	1.266	
38.1	1.304	1.301	1.297	1.294	**1.290**	1.286	1.283	1.284	1.275	1.271	
38.7	1.309	1.306	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	

Conversion formula

$$\text{Specific gravity at } 20^\circ C\ (68^\circ F) = \text{Hydrometer reading} + \text{Temperature coefficient} \times \left(\text{Electrolyte temperature } (^\circ C) - 20^\circ C\right)$$

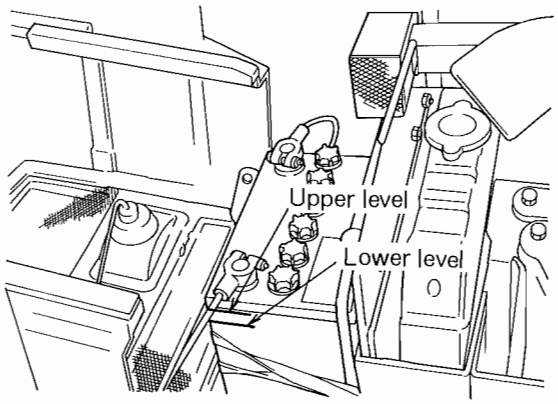
(4) Electrolyte (dilute sulfuric acid) specific gravity varies in relation to the discharge. Accordingly the remaining level of the battery is obtained by measuring the specific gravity.



It is required to adjust the electrolyte specific gravity of the battery to be 1.260 ±0.01 (20°C = 68° F).

Checking the electrolyte level

The battery case is made of transparent synthetic resin. The electrolyte level can be checked at a glance.



Other services

(1) Apply vaseline or grease to terminal posts.

(2) Always keep the top of the battery clean and dry. After refilling, tighten the plugs good and hard and wipe off spilled electrolyte. Once in a while, check to make sure that the cables are clean and tightly clamped to the terminals.

SAFE BATTERY HANDLING

(1) Battery electrolyte, sulfuric acid, is very corrosive and can destroy most things it touches.

- Be careful not to drip electrolyte on the tractor or on yourself; it will ruin the paint on the tractor or eat holes in your clothes.
- If you get electrolyte on your skin, flush it off at once with water. Continue to flush for at least 5 minutes. Put baking soda (if available) on the skin. This will neutralize the acid. If such a soda is not available, wash with soap and water.
- If you get electrolyte in your eyes, flush your eyes out with water, over and over again. Get to a doctor at once! Do not wait!
- A battery is unknown to children. Keep children away from a battery that is being charged. Store the battery out of their reach. There was a child who sucked electrolyte through a straw. This could happen again.

(2) Do not check the state of charge by placing a metal object across the terminals.

EMERGENCY STARTING
(Use of booster battery and jumper cables)

In emergency starting, particular care should be used when connecting a booster battery in order to prevent sparks. Following are the rules to be followed in jump starting:

(1) Shut down the engine.

(2) Connect the ends of RED jumper cable to the positive (+) terminal of each battery.

(3) Connect one end of BLACK jumper cable to the negative (–) terminal of the "good" battery. Then connect the other end of the cable to the engine block on the tractor being started (not to the negative (–) terminal of battery) as apart from the battery as possible.

(4) Start the engine of the tractor being started.

(5) Having made sure that the engine is idling, disconnect the cables by following the reverse of steps 2 and 3 above.

BATTERY DIAGNOSIS

External failures

Failure	Possible cause
Cracked case	• Excessively loose or tight hold-down clamps • Freezing • Oil or gasoline spilled over battery • Flying stones • Attacking of chemicals • Explosion due to clogged vent holes
Bulged case	• Abnormal temperature rise due to excessive charging current • Excessively tight hold-down clamps • High temperature • High voltage due to improper regulator setting
Corroded terminals and cable clamps	• Spilling of electrolyte due to high level • Passage of leak current • Buildup of corrosion around terminals
Burned terminals and clamps	• Excessive discharge current • Excessive resistance due to corrosion around terminals • Spark due to falling metal objects

Internal failures

Tester	Condition	Possible cause
Hydrometer	Electrolyte gravity low in all cells	• Undercharge due to defective charging system • Overdischarge due to excessive loads • Leakage, buildup of corrosion around terminals, or high electrolyte level
	Electrolyte gravity low in one or more cells (variation: more than 0.04)	• Impurities in electrolyte • Separators shorted or continuity between cells
	Electrolyte gravity high	• Low electrolyte level • Sulfuric acid was added where distilled water should have been poured in

Tester	Condition	Possible cause
Hydrometer	No electrolyte	• Overcharge • Electrolyte level low
	Electrolyte gravity is normal, but battery will not deliver current	• Cable clamps loose on terminal posts • Terminals and clamps burned
Battery tester	GREEN zone (battery is normal)	• Cable clamps loose on terminal posts
	YELLOW/RED zone	• Battery discharged. Cable clamps loose on terminal posts • Battery dead • Battery has aged

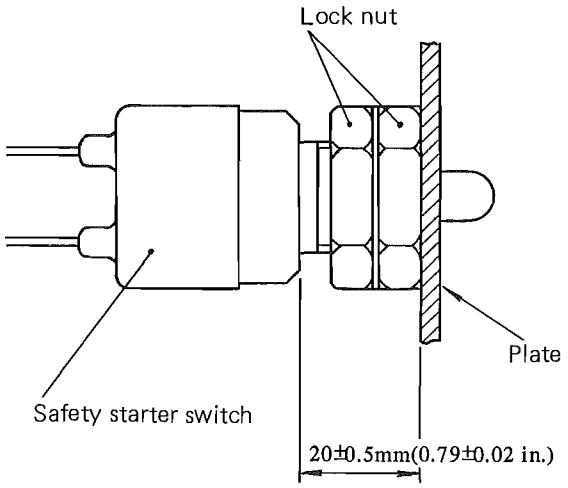
Hydrometer Battery tester	Specific gravity / Battery tester	1.220, min (variation: 0.04, max)	1.220, max (variation: 0.04, max)	Variation: 0.04, min
	GREEN	O.K. Use without charging	O.K. but recharge	Recharge to correct gravity Re-test
	YELLOW/RED	Dead? Cable clamps loose on terminal posts or burned	Recharge Re-test	Dead Replace

SAFETY STARTER SWITCH

HOW IT WORKS

This switch is, as described previously, a safety means of preventing the tractor from accidentally jerking when the engine is started. Working as a "circuit breaker" for the circuit between the starter switch and starter motor, this safety switch is governed by the sub shift lever. It keeps the circuit open as long as the lever is being placed to "NEUTRAL" position, even if the starter switch (key) is turned to the start position; it closes the circuit when the switch is turned to the start position with the sub shift lever depressed placed to "High" or "Low" position. Thus, safe engine starting is assured for both operator and tractor.

ADJUSTMENT



What to be checked and adjusted for this switch is the interval from the plate to the switch end as shown in figure. This interval is specified to be 20 ± 0.5mm (0.79 ± 0.02 in.) as measured with the sub shift lever placed to "Neutral" position.

If not, adjust it to the specification by means of the lock nuts. Upon complection of adjustment, tighten the lock nuts good and hard, and test to be sure that the starter motor will not rotate when the sub shift lever is being placed to "Low" or "High" positions even if the starter switch is turned for cranking the engine. And then, make sure that the starter motor will rotate when placing the sub shift lever to "Neutral" position.

FUSE

A 15-ampere fuse is in a cylindrical holder located below the dash panel. When this fuse is blown, replace it with a new one of the specified amperage.

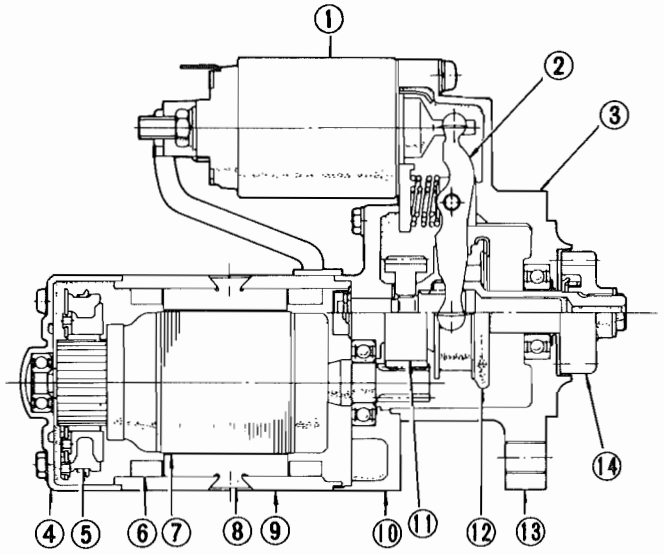
NOTE

Do not attempt to use a fuse of any amperage other than is specified (15 amperes).

STARTER

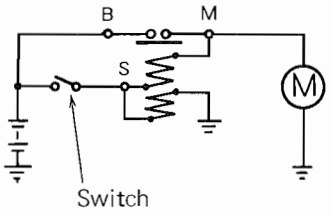
CONSTRUCTION

This starter, because of its built-in reduction gears, is called "internal reduction starter." The motor proper is compact in size and is capable of higher speeds for faster engine cranking.



1-Magnetic switch
2-Shift lever
3-Front bracket
4-Rear bracket
5-Brush
6-Field coil
7-Armature
8-Pole piece
9-Yoke
10-Center bracket
11-Reduction gears
12-Overrunning clutch
13-Front bracket
14-Drive pinion

Starter



Wiring diagram

Following are the design features of this starter entirely different from those of an ordinary starter:

- In an ordinary starter, drive pinion slides on and along motor (armature) shaft. In this starter, it slides on its shaft separated from the motor shaft.
- Armature rotation or drive is transmitted from motor shaft, through reduction gears, to pinion shaft.
- Pinion shift mechanism (Bendix drive) is totally enclosed to keep dirt out, lubricating grease in. This design minimizes pinion seizure due to hardened or deteriorated grease.
- Ends of motor shaft are supported by ball bearings (in "antifriction" fashion). This means far less friction to the shaft rotation than in an ordinary starter.

The pinion shift lever, magnetic switch, overrunning clutch and internal circuitry are basically the same as those of an ordinary starter.

The major functional parts of this starter are as follows:

- Motor: The source of drive
- Overrunning clutch: Is operated by shift lever to shift drive pinion into mesh with the flywheel ring gear. After the engine starts, it allows the pinion to spin independently of, or

"overrun," the armature (the motor).

- Reduction gears: Consist of large driven gear on the clutch (pinion) shaft and small drive gear on the armature (motor) shaft. The gear ratio between the two shafts provides a high cranking torque for starting.
- Magnetic switch: When the key of starter switch is to START position, the winding in this switch is connected to the battery; now, the magnetism is produced in it to pull shift lever actuating plunger. This closes the contacts in the switch to operate the motor. After the engine starts, and the driver takes his hand off the switch key, the key is spring-back to ON position. This opens the magnetic-switch winding circuit to move back the plunger and, at the same time, to open the contacts. Now, the starter circuit is opened, and the starter stops cranking.

TESTING THE STARTER ON THE TRACTOR

There are three basic starter troubles:

(a) The starter does not turn over.

(b) The starter turns over slowly, but the engine does not start.

(c) The starter turns over and cranks the engine at normal speed, but the engine does not start.

These troubles cannot necessarily be blamed on the starter. There is some problem in the switch or battery, or the engine, that prevents starting. Before removing the starter for repair, check to be sure that:

Starter circuit

(a) The battery is in good condition, with its cell plates showing no evidence of "sulfation" or any other faulty condition, and is fully charged.

(b) The battery cables are clean and tight on terminal posts.

(c) The starter terminal connections are tight.

(d) The wires are securely connected to terminals, and are free of any damage, there being no signs of grounding or breaking.

(e) The starter is properly grounded.

(f) The starter switch closes and opens the circuit positively at each position.

(g) The safety starter switch is in sound condition.

REMOVAL

(1) Open the bonnet, and remove the left-hand safety guard.

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

(3) Disconnect the leads from the terminals "B" and "S" on the starter.

(4) Remove the starter by loosening its mounting bolts.

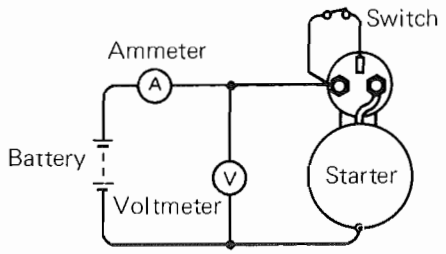
TESTING A REMOVED STARTER

No-load test

Connect the starter to the battery according to the test setup shown. Close the switch to run the starter in no-load condition to check the speed and current. The starter is in good condition if it runs smoothly and meets the following specifications at a battery voltage of 11.5 volts:

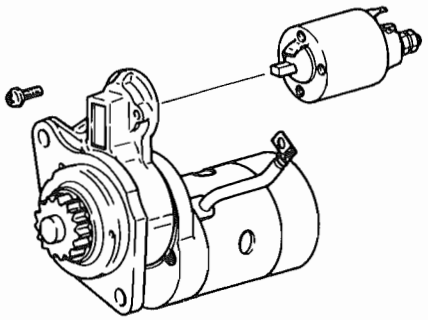
- Current . . . . 90 amperes, max.
- Speed . . . . . 3600 rpm, min.

If the starter is found defective in this test, disassemble it and check the motor parts as outlined in INSPECTION, which follows.



No-load test setup

INSPECTION



Magnetic switch removed from starter

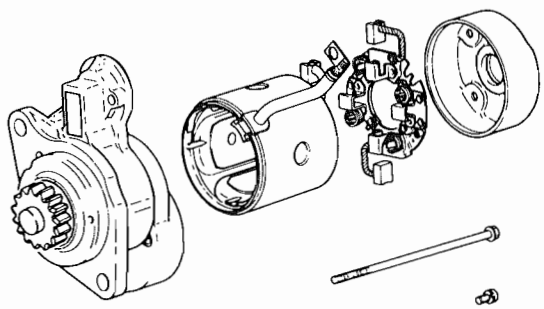
Brushes and brush holders

(1) Check each brush for wear. Replace a brush worn beyond the wear limit line. (See SPECIFICATIONS.)

(2) Check each brush spring for tension with the brush holder installed in place on commutator. Replace a spring weakened or fatigued beyond the service limit.

(3) Check for continuity across positive (+) side brush holder and holder base. Replace the brush holder assembly if any continuity is noted.

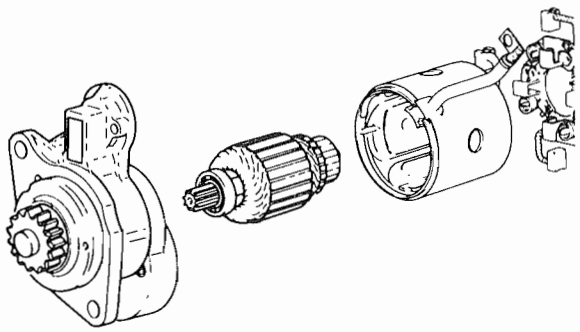
(4) Check each brush holder for installation.



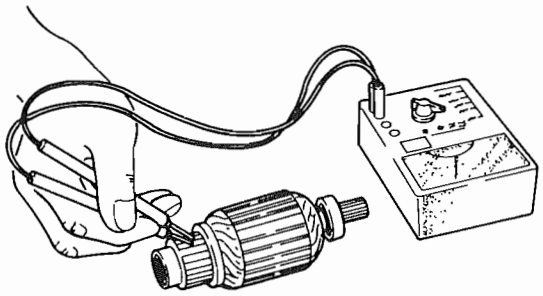
Brush assembly remove from motor

Armature

(1) Test the armature for short circuits on the growler. Also test for ground by placing one test point on the lamination and the other on the commutator. Replace a shorted or grounded armature.



Disassembled view of armature



Commutator inspection

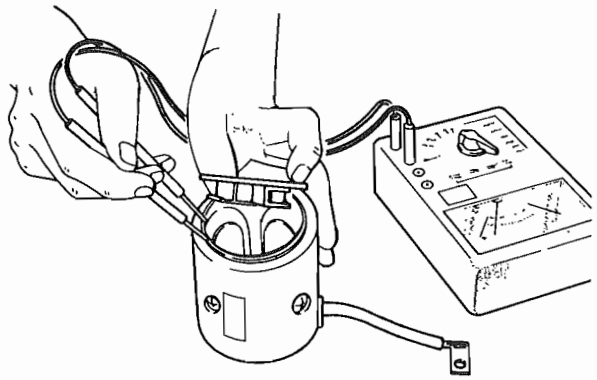
(2) Measure the commutator diameter and undercutting of commutator Repair it if the repair limit is reached. The commutator sometimes becomes covered with a film of dirt or gum. This can be cleaned off by polishing with No. 300 to 400 sandpaper.

Field coil

(1) Using a tester, check for continuity across both ends of the coil (brushes). If no continuity is noted, it is an indication that the coil is open-circuited. In such a case, replace the yoke assembly.

(2) Similarly check for continuity across connector and yoke. If continuity is noted, it is an indication that the coil is grounded; check for insulation and, if defective beyond repair, replace the yoke assembly.

(3) Check the pole shoes and coil for installation, making sure that they are installed securely.



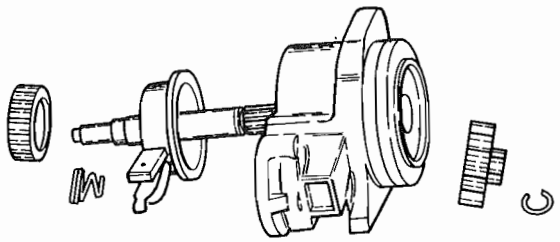
Field coil inspection

Magnetic switch

Check for continuity across the terminals "S" and "M" on one hand and across the terminal "S" and body on the other. Any continuity means that the switch is in sound condition.

Overrunning clutch

Check the drive pinion for badly worn or broken teeth. Replace the pinion if damaged.



Disassembled view of overrunning clutch

Reduction gears

Replace the gears if badly worn or damaged.

Front bracket

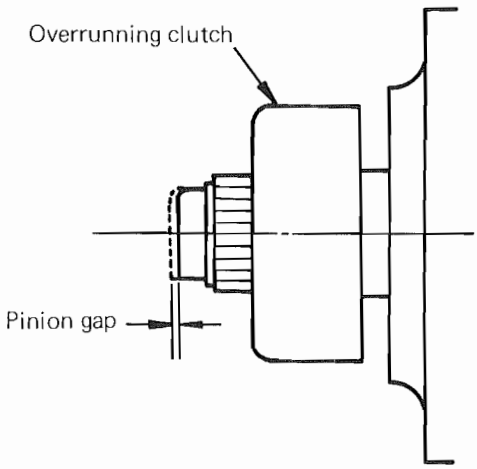
Check the ball bearing and bushing for wear. Replace the bracket assembly if any of them is badly worn.

Pinion gap

(1) Disconnect connector from terminal "M" on magnetic switch.

(2) Connect the starter to the battery (with the positive (+) cable of the battery connected to the terminal "S" of magnetic switch and the negative (−) terminal to the starter) to shift the drive pinion out. Under this condition, slightly push the pinion back toward the armature, and measure the gap.

If the gap is out of specification, increase or decrease the number of washers used between magnetic switch and front bracket to adjust it. Increase in the number of washers will decrease the gap, and vice versa.



Pinion gap inspection

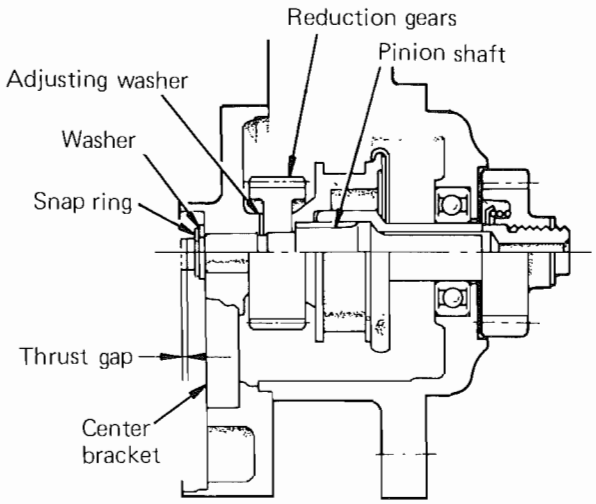
NOTE

a) In this test, never operate the starter for periods longer than 20 seconds to avoid overheating the switch coil.

b) Too large or too small a pinion gap may also be caused by improperly installed shift lever or defective magnetic switch. Check the lever and switch, too.

Pinion shaft

Check the shaft for thrust gap (axial play). The gap should be less than 5 mm (0.20 in.). If the gap is out of adjustment, put adjusting washer into between the center bracket and reduction gear.



Thrust gap (axial play) inspection

(1) To put adjusting washer with the pinion off pinion shaft, proceed as follows:

Place reduction gear on pinion shaft. Pass the shaft through center bracket and secure it in place with washer and snap ring. Move the shaft in axial direction to measure the gap. Adjust the gap by putting the washer.

(2) To put adjusting washer with the pinion on pinion shaft, proceed as follows:

Pass pinion shaft complete with reduction gear through front and center brackets. Tighten bolt and measure the gap by moving the shaft in axial direction. Adjust the gap by putting the washer.

NOTE

When measuring thrust gap with the pinion installed, be sure to remove lever spring.

Magnetic switch

(1) Pull-in action

Apply the battery voltage across the terminals "S" and "M" of the magnetic switch to see if the plunger gets pulled in to shift the pinion; if not, the pull-in coil is open-circuited or the overrunning clutch is defective.

(2) Hold action

With the battery voltage applied across the terminal "S" and the body of the switch, pull out the pinion by hand to the stopper. Release the pinion in this condition to see if the pinion moves back; if not, then the holding coil is in sound condition.

(3) Return action

With the battery voltage applied across the terminal "M" and the body of the switch, pull out the pinion by hand to the stopper. Release the pinion in this condition to see if the pinion moves back; if it does move back promptly, then the coil is in sound condition.

NOTE

In any test outlined above, never apply battery voltage for periods longer than 10 seconds.

INSTALLATION

(a) When installing the starter, clean the mounting flange of starter and the mounting seat on crankcase off oily substance, rust and other foreign matter.

(b) Even a starter which has been tuned up properly will not operate satisfactorily if leads or wires are not of the types or sizes called for, or if connections are poor. Be sure to use leads and wires of the types and sizes called for and tighten terminals good and hard.

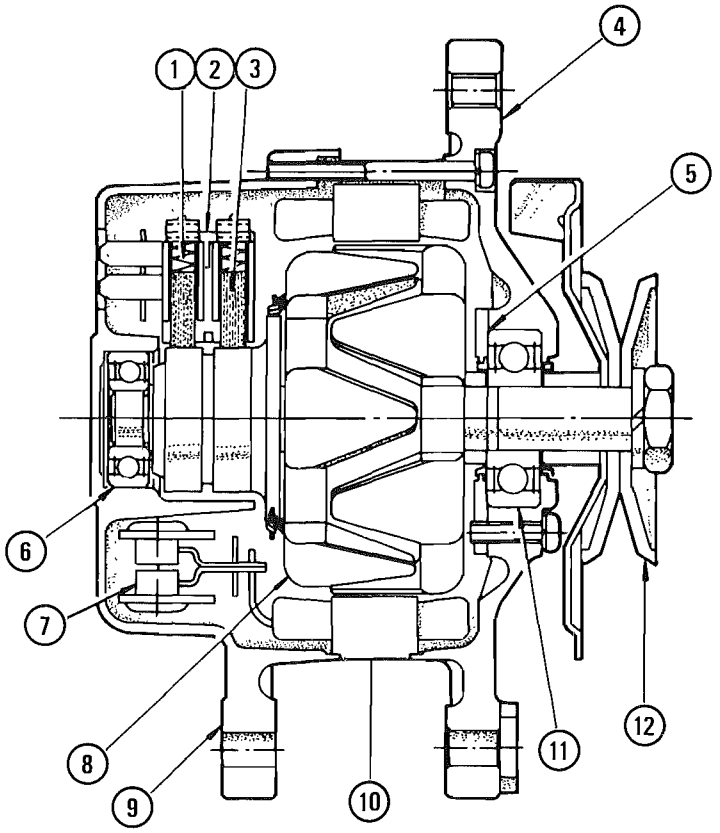
ALTERNATOR

CONSTRUCTION

The alternator consists essentially of a three-phase generator and a silicon-diode rectifier unit for converting the AC output of the generator into a DC power.

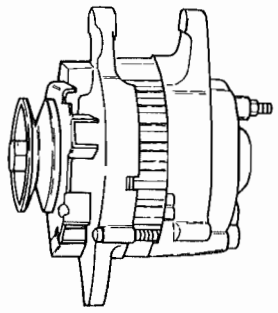
Referring to the longitudinal cross section, rotor assembly (8) is supported by ball bearings (6) (11), bearing (6) being fitted to rear bracket (9) and bearing (11) to front bracket (4). 6-diode rectifier (7) is mounted in a metal bracket called a "heat sink" which takes heat from the diodes during operation.

The rotor shaft carries two slip rings, on which brushes (3) are resting. Excitation current is supplied through the slip rings and brushes to the field coil. Pulley and fan assembly (12) is mounted on the extended portion of the rotor shaft.

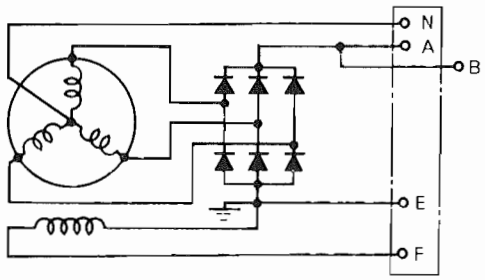


1-Brush spring
2-Brush holder
3-Brush
4-Front bracket
5-Bearing retainer
6-Rear ball bearing
7-Diode rectifier
8-Rotor assembly
9-Rear bracket
10-Stator
11-Front ball bearing
12-Pulley and fan assembly

Alternator — Sectional view



Alternator assembly



Alternator wiring diagram

REMOVAL

(1) Open the bonnet, and remove the left-hand safety guard.

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

(3) Disconnect leads from the terminals on the alternator.

(4) Remove the alternator by removing its mounting bolts.

TESTING AND ADJUSTMENT

NOTE

a) Never use a hign-voltage tester such as a megger; the use of such a tester will be the sure way of rupturing the diodes.

b) When the engine is running at high speed, do not attempt to undo the terminal "A" of the regulator. A sudden rise of the alternator output voltage will rupture the diodes.

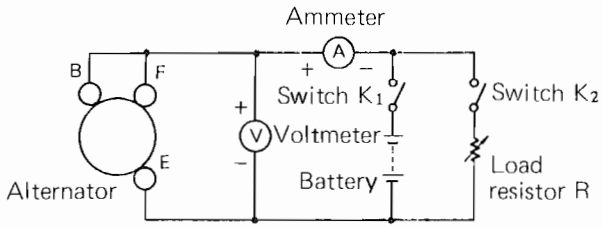
c) Never attempt to start the engine with the lead disconnected from the terminal "B" of the alternator; otherwise the voltage coil of the regulator will be damaged.

d) When charging the battery by means of a quick charger, be sure to disconnect the grounded–terminal cable clamp from the battery for protection of the diodes.

e) When using a steam cleaner, take care not to direct a blast of steam to the alternator.

Alternator output test

Take down the alternator and set it up on the test bench. Connect the battery (14 volts) to the alternator, with a voltmeter and an ammeter inserted as shown, to form a test setup.



Alternator output test setup

Couple the alternator to a variable-speed drive source capable of picking speed up to over 3000 rpm. Close switch K_1 : this energizes the alternator field. Start up the drive source and raise the alternator speed gradually until reverse current no longer flows in the field coil, that is, until the ammeter pointer indicates 0 (zero). When a zero-ampere (0 A) reading is obtained, open switch K_1 to allow the alternator field to draw excitation current from the armature.

With the alternator now running in self-excited condition, raise the speed until the voltmeter shows 14 volts and read the speed right then. If this speed is under 1300 rpm, the field circuit of the alternator is in sound condition.

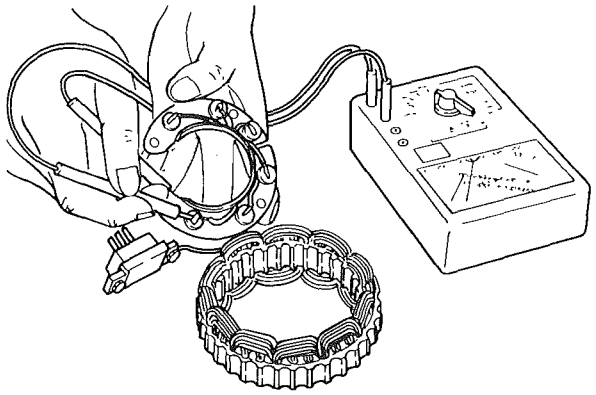
Set the load resistance for the highest resistance value (so that little or no load current would flow), and close switches K_1 and K_2 ; raise the speed gradually while slowly decreasing the setting of the load resistance to increase load current. Under this condition, bring the alternator to a state in which its output voltage (as read on the voltmeter) is 14 volts and the load current is 15 amperes. Read the speed right then; this speed should be under 2500 rpm.

The alternator is in good operating condition when it meets the two requirements stated above: self-exciting speed of 1300 rpm maximum and rated output speed of 2500 rpm maximum. These two are servicing standards.

Bench testing of rectifier diodes

The diodes should be checked for "open" and "short." What is meant by "open" is obvious enough. An "open" diode does not pass any current; its internal circuit is broken somewhere. A "shorted" circuit is that which has its junction ruptured or pierced so that it readily passes current in either direction and thus does not serve as an electronic check valve.

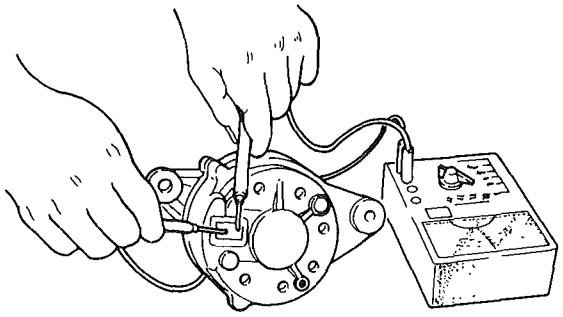
Of the six diodes, three are on the positive side (connected to output terminal A) of the rectifier and the remaining three on the negative side (connected to ground terminal E). The neutral point of the three windings (star-connected) of the alternator is connected to neutral terminal N.



Diode inspection

(1) Checking for "short"

Use a circuit tester and check the positive-side diodes for continuity in the two directions, normal and reverse, with the tester knob set in the ohmic zone. Put the plus (+) probe pin to terminal A and the minus (−) pin to terminal N: the tester should indicate continuity. Exchange the probe pins, putting positive pin to N and minus pin to A: the tester should indicate no continuity. The second trial is important; if continuity is noted, it means that one or more of the three positive-side diodes are ruptured. If this happens to be the case, remove the rectifier and check individual diodes.



"Short" inspection

NOTE

The circuit tester has a built-in battery. Turning its selector knob to the ohmic (resistance) zone connects the battery to the probe pins, making the positive (+) pin minus (−) and the negative (−) plus (+).

The three negative-side diodes of the rectifier can be checked similarly for "short." In this case, the probe pins are to be put to terminals N and E (as if N were terminal A and E were terminal N in the above check).

(2) Checking for "open"

Remove the rectifier and check each

diode individually. This check can be accomplished by checking it for continuity in normal direction.

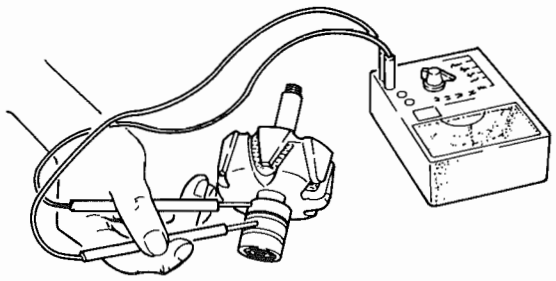
Checking the stator coils for condition

Disconnect the three leads of the stator coil from the rectifier and the neutral lead from terminal N. Check each winding for continuity by putting one probe pin to lead wire N and the other pin to each of the three leads.

Next, check the windings for ground by putting one probe pin to the core and the other pin to each of the three leads. There should be no evidence of continuity. If any continuity is noted, replace the stator.

Checking the field coil for condition

When the field coil is at normal temperature 20°C (68°F), it has an ohmic resistance of about 7.9 ohms as checked at the slip rings. Set the selector knob at the lowest range and put the probe pins to the slip rings. If a reading is much less than 7.9 ohms, it is likely that there is a short-circuit between coil turns; a much higher reading means that some part of the field circuit is nearly broken.



Field circuit inspection

INSTALLATION

NOTE

When connecting the alternator, regulator and battery, be sure to match the polarity signs. A failure to follow this precaution will cause large current to flow from the battery to the alternator, resulting in costly damage to diodes or other parts.

- Install the alternator on the left upper part of the gear case. Put distance piece into between the rear face of gear case and the rear bracket and insert shims so that there is no clearance between the case and bracket. Tighten the bolts on the case temporarily.
- Wrap the drive belt around each pulley and adjust its tension. Secure the alternator brace and tighten the bolts on the case good and hard.

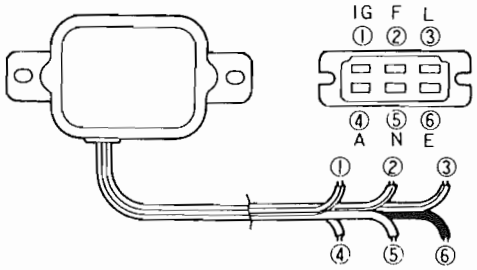
REGULATOR

HOW IT WORKS

The regulator is of two-element type consisting of a voltage relay and a pilot lamp relay. In the view of the regulator with its cover removed, note that the two relays look alike, each being composed of a coil wound around a core, a spring armature carrying a contact point, a frame for supporting the coil, armature and stationary contact points.

The voltage relay is a means of maintaining the alternator output voltage at constant level regardless of the alternator speed. In operation, it limits the alternator field current as necessary to prevent excess alternator voltage.

The pilot lamp relay has its coil connected to the terminal "N" and operates with half the output voltage of the rectifier to merely make or break the pilot lamp circuit. Going out of this lamp signifies that voltage is available from the alternator.



1-White/red lead
2-White/black lead
3-Yellow/white lead
4-White lead
5-Yellow lead
6-Black lead

Color identification of regulator leads

NOTE

When the regulator connector is replaced, adhere to the lead color identification to avoid misconnection.

TESTING AND ADJUSTMENT

NOTE

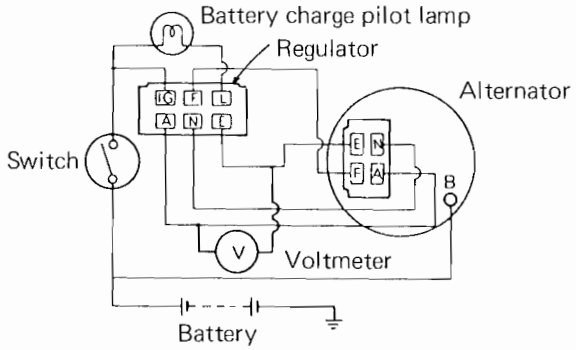
a) Do not connect the terminals "F" and "IG" the wrong way round; otherwise the wire harness or points will be burned.

b) When testing the regulator on the tractor, be sure to turn the starter (key) switch to OFF position and disconnect the lead from terminal "IG" to avoid burning the wire harness and points.

c) Do not break cachet of the regulator. This will release Satoh from any guarantee.

Testing for no-load regulated voltage

Have a voltmeter connected across terminals "A" and "E." Run the engine at idle speed and, while so operating the engine, disconnect the lead from terminal "B" to run the alternator in no load condition. Under this condition, increase the alternator speed up to 4000 rpm and check voltmeter indication. The regulator is in good condition if the voltage read on the voltmeter is 14 to 15 volts.



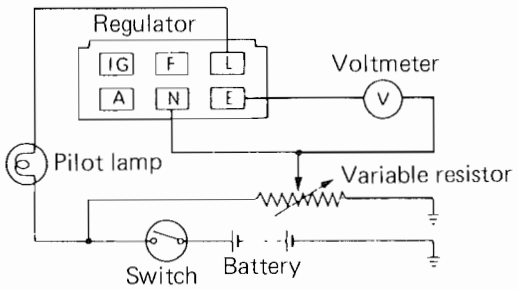
Regulator test setup

Testing for pilot lamp lighting voltage

(1) Connect the pilot lamp and regulator to the battery as shown, with the voltmeter, switch and variable resistor in between.

(2) With the pilot lamp lighted, gradually raise the voltage by changing the setting of the resistor to see if the lamp goes out at anywhere between 4.2 and 5.2 volts.

(3) Gradually lower the voltage to see if the lamp lights up at anywhere between 0.5 and 3.0 volts.



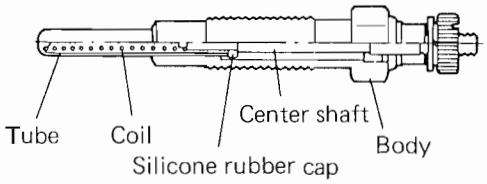
Regulator test setup for checking pilot lamp lighting voltage

Item	Standard
Pilot lamp goes out at	4.2 ~ 5.2V
Pilot lamp lights up at	0.5 ~ 3.0V

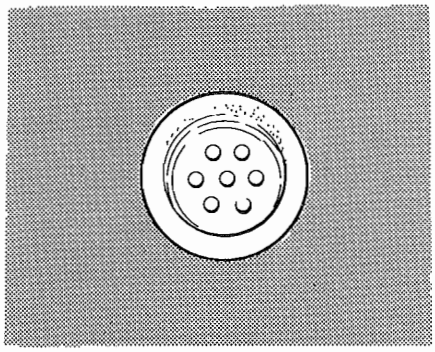
GLOW PLUGS AND GLOW PLUG INDICATOR

HOW THEY WORK

The glow plugs are of sheathed type and constructed as shown. The glow plug indicator simulates the operation (energization) of the plugs.



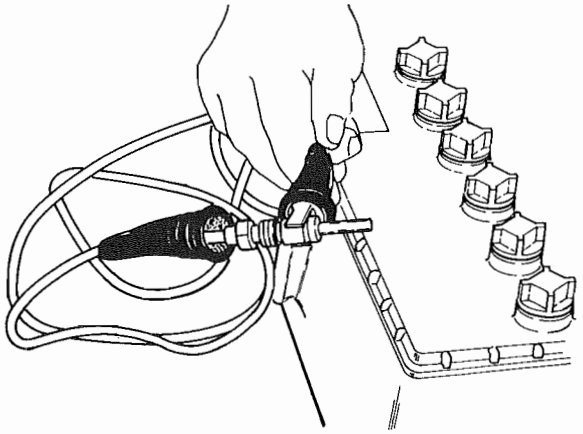
Glow plug



Glow plug indicator

TESTING

- Connect the positive (+) lead of the battery to the terminal of glow plug and the negative (–) lead to the body of the plug. The plug is in good condition if it glows red when it is so connected to the battery.
- The glow plug indicator should glow red within 25 seconds. If it will not glow within 25 seconds, it is an indication that any one of three glow plugs (within the engine) is shorted.



Glow plug inspection

SOLENOID SWITCH

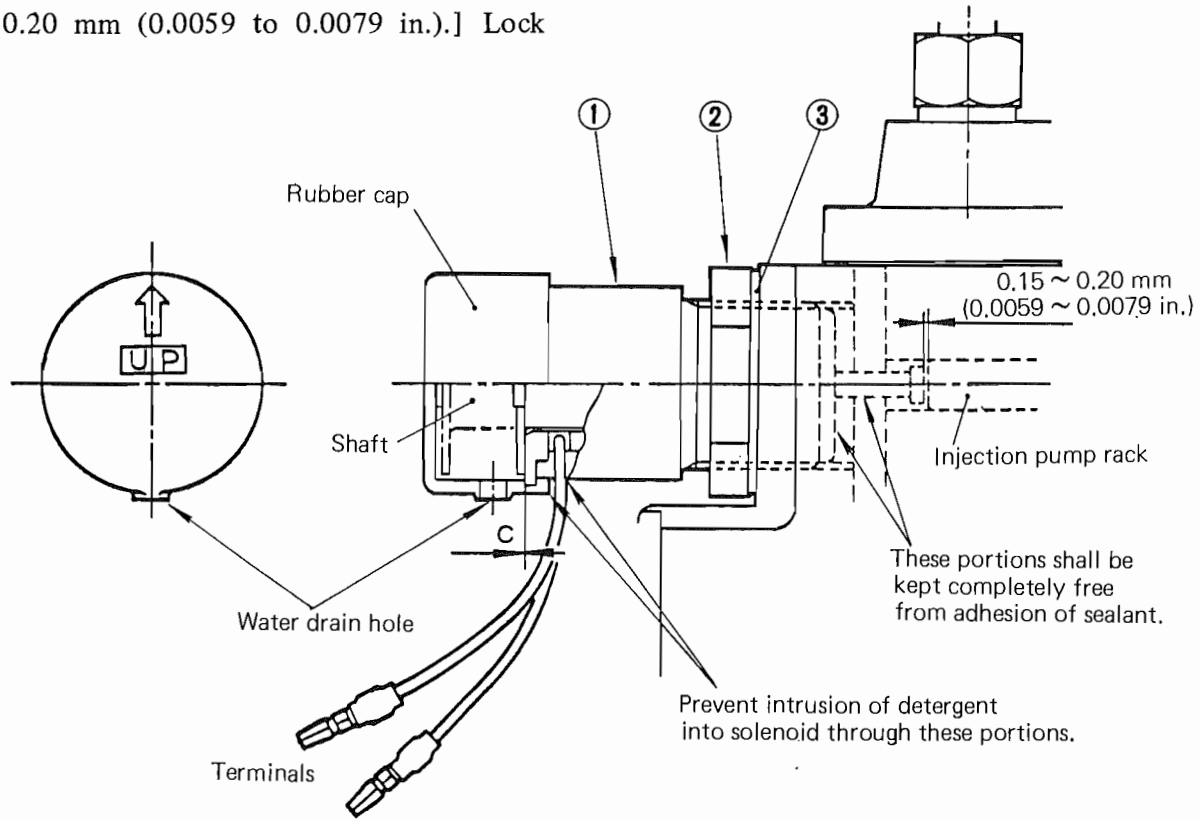
(1) Temporarily install the solenoid (1), nut (2) and gasket (3) to the crankcase. (Coat the effective thread portion of the solenoid with sealant, Three-Bond 1212 or 1211.)

(2) Turn in the solenoid so that clearance "C" becomes zero at the injection pump rack position "zero."

(3) Turn back the solenoid 30° to 45°. [The rack to shaft clearance will become 0.15 to 0.20 mm (0.0059 to 0.0079 in.).] Lock the solenoid at that position with the nut. [Nut tightening torque: about 5 kg-m (36.2 ft-lb)]

(4) Confirm that MS is reset securely when the shaft is pushed fully.

(5) Finally, install the rubber cap with its arrow mark facing upward. (The water drain hole comes to the bottom of the cap.)



Installing solenoid switch

CAUTION

Be sure to prevent intrusion of detergent into the solenoid terminals and the inside of solenoid (cord and shaft).

ENGINE STOP SYSTEM

This system uses a solenoid switch which acts, when the engine starting switch key is turned to OFF, on the fuel injection pump control rack to push it to the "non-injection" position to stop the engine.

Combinations of switch positions

State of engine	Key switch	Oil pressure switch	Electro-magnetic solenoid	Fuel injection pump control rack	Function
Start	ON	ON	ON	STOP	MS resetting
	START	OFF	OFF	MS	Automatic increase of fuel injection quantity for engine start
Running	ON	OFF	OFF	(SS)	Nomal operation
	ON	ON	ON	STOP	Emergency stop caused by an lowering of oil pressure
	OFF	OFF	ON.	STOP	Stopping the engine with key switch turned to OFF

Function

(1) MS resetting

When starting the engine, turning the key switch to ON will close a circuit through which current flows to the oil pressure switch. This will cause transistors Tr5 and Tr4 to become conductive, thus allowing current to flow from terminal B of the key switch to transistors Tr3, Tr2 and Tr1. As the solenoid is excited, the control rack of fuel injection pump is placed in the MS reset position.

(2) Automatic increase of fuel injection quantity for engine start

When the engine starting key switch is turned to START, a short-circuit current will flow to the condenser C1 from ST terminal of the switch. Since the timer function is accelerated, the action of the solenoid will be terminated instantaneously and the fuel injection pump control rack will be set to the MS position automatically.

(3) Normal engine operation

After the engine starts, increase of oil pressure will turn the oil pressure switch to OFF, thus opening the oil pressure switch circuit. Transistors Tr5 and Tr4 will become non-conductive (no current flows from the key switch terminal B to the transistors Tr3, Tr2 and Tr1), thus preventing the solenoid from acting.

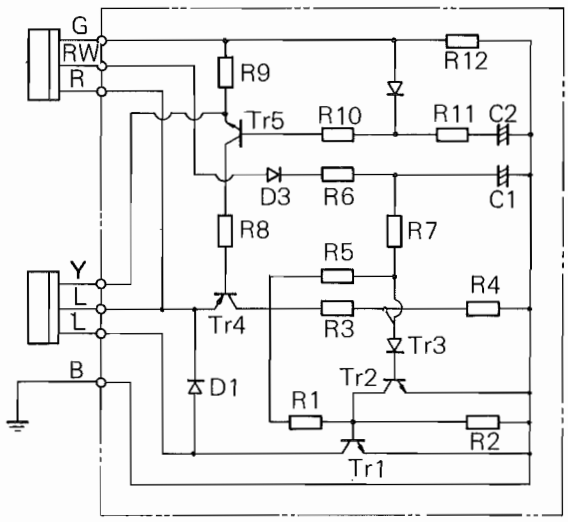
(4) Stopping the engine with key switch turned to OFF

When the key switch is turned to OFF, discharge current of the condenser C2 which has been charged during engine operation will make the transistors Tr5 and Tr4 conductive. Resulting current flow from terminal B of the key switch to the transistors Tr3, Tr2 and Tr1 will excite the solenoid to stop the engine.

(5) Emergency stop caused by an excessive lowering of oil pressure

If oil pressure lowers excessively during engine operation, the oil pressure switch will be turned on to close a circuit through which current flows from terminal B of the key switch to the transistors Tr3, Tr2 and Tr1. As the result, the solenoid will be excited to stop the engine.

After the engine stopped, all transistors are kept in non-conductive condition and no current flows in the timer circuit.



Reference: Tr1 - Tr4 Transistors
D1 - D3 Diodes
C1 - C2 Condensers
R1 - R12 Resistors

Control timer circuit diagram

Checking the system for proper operation

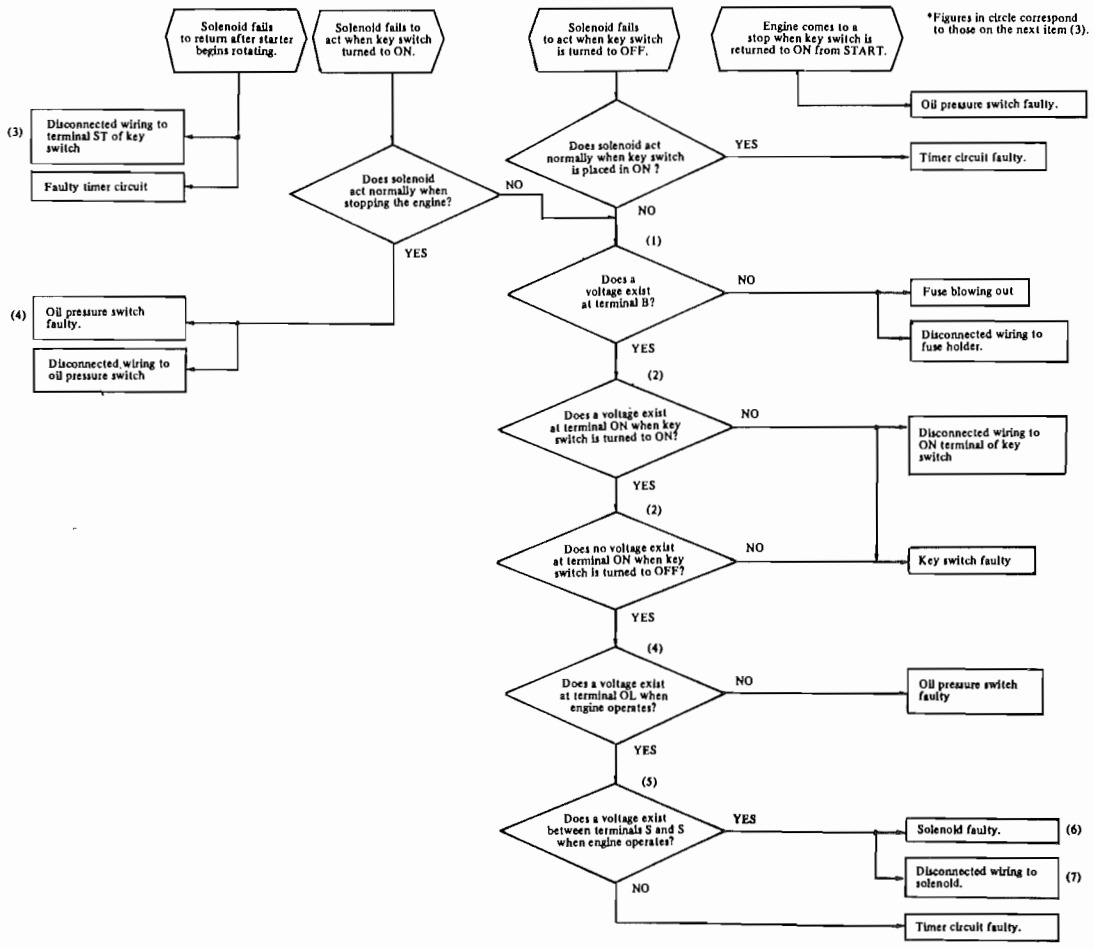
(1) Make the wiring of this system in accordance to with the wiring diagram.

(2) Remove the tie-rod cover to give access to the fuel injection pump control rack. Turn the starting switch key to ON and check to see that the solenoid comes into action, causing the control rack to move accurately to the MS resetting position.

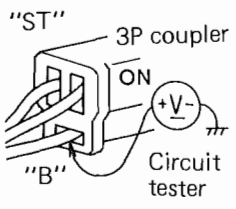
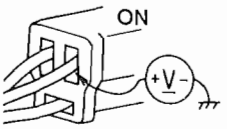
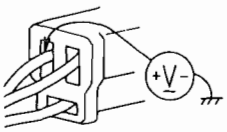
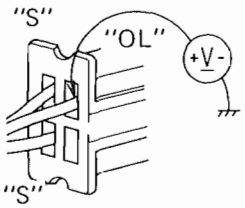
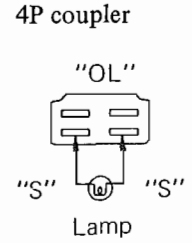
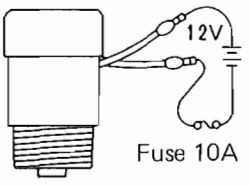
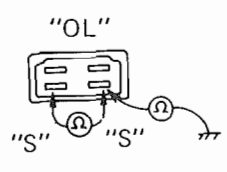
(3) Turn the starting switch key to OFF and reinstall the tie-rod cover. Turn the key from OFF to START, through the ON position, and confirm that the solenoid comes into action at the ON position and the action stops at the START position.

Troubleshooting

If the system becomes malfunctional, find out the cause of trouble using the diagnostic chart below.



TESTING PROCEDURES

No.	Check item	Sketch	Criterion	Testing tool	Testing procedure
1	Voltage at terminal B (Lead wire: red)		Approx. 12V DC	Circuit tester	Connect voltmeter to terminal B of 3P coupler.
2	Voltage at terminal ON (Lead wire: green)		ON: Approx. 12V DC OFF: 0V	Circuit tester	(1) Connect voltmeter to terminal ON of 3P coupler. (2) Read voltmeter each time when key switch is turned to ON and OFF.
3	Voltage at terminal ST (Lead wire: red/white)		ON: Approx 12V DC OFF: 0V	Circuit tester	(1) Connect voltmeter to terminal ST of 3P coupler. (2) Read voltmeter each time when starter is rotated and stopped.
4	Voltage at terminal OL (Lead wire: yellow)		When stopped: 0V When operated: Approx. 12V	Circuit tester	(1) Connect voltmeter to terminal OL of 4P coupler. (2) Read voltmeter each time when engine is stopped and operated.
5	Output of solenoid (Lead wire: blue)		Lamp lights for 7 to 15 seconds	A lamp of 3W or lower rating	(1) Remove 4P coupler and connect lamp between terminals S and S. Keep terminal OL free from connection. (2) Turn key switch to ON and, after waiting for a few seconds, turn the switch to OFF. Lamp will go on and maintain lighting for 7 to 15 seconds.
6.	Action of solenoid		It is normal if plunger of solenoid is attracted..	Battery Fuse (10A)	Connect a battery to solenoid terminals and check for normal movement of plunger. Test should not be continued for more than 10 seconds.
7	Wiring to solenoid (Lead wire: blue)		Approx. 1.7Ω Resistance to body: ∞	Circuit tester	(1) Remove 4P coupler and connect ohmmeter to terminals S and S to read resistance between terminals. Be sure to remove coupler without fail. (2) Measure resistance between ground and each terminals with ohmmeter.

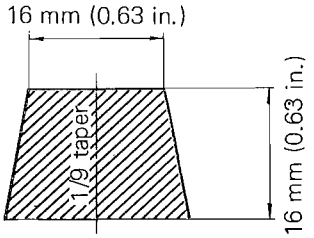
The following parts are not to be repaired for reuse; they should be replaced as an assembly:

(1) Tractor meter
(2) Fuel gauge
(3) Starter switch
(4) Engine ON-OFF solenoid
(5) Water temperature gauge unit
(6) Oil pressure switch
(7) Flasher unit
(8) Glow plug indicator
(9) Combination flasher/turn signal switch
(10) Lighting switch
(11) Safety starter switch
(12) Control timer unit

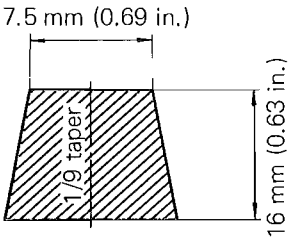
SPECIFICATIONS

Starter	Type			Magnetic shift
	Model			Mitsubishi M002T50371
	Output – voltage		kW – V	1.6 – 12
	Direction of rotation			Clockwise as viewed from drive pinion side
	No-load characteristics	Terminal voltage	V	11.5
		Current	A	90, max.
		Speed	rpm	3600, min.
	Brush length		mm (in.)	17 (0.67) [wear limit: 11.5 (0.45)]
	Brush spring tension		kg (lb)	1.5 (3.3) [service limit: 0.7 (1.5)]
	Pinion gap		mm (in.)	0.5 ~ 2.0 (0.02 ~ 0.08)
	Thrust gap (pinion shift)			0.5 (0.02), max.
Alternator	Type			Three-phase, with built-in silicon-diode rectifier
	Model			Mitsubishi AH2053M4
	Output – current		V – A	12 – 35
	Direction of rotation			Clockwise as viewed from pulley side
	No-load characteristics	Terminal voltage	V	14
		Current	A	0
		Speed	rpm	1100, max.
	Load characteristic	Voltage – current	V – A	14 – 30, min.
		Speed	rpm	2500
Regulator	Type			Tirrill, two-element
	Model			Mitsubishi RQB2220D1
	Regulated voltage		V	14.8
	Pilot lamp switch opening voltage			4.2 ~ 5.2
	Pilot lamp switch closing voltage			0.5 ~ 3.0
Glow plugs	Type			Sheathed
	Voltage – current		V – A	10.5 – 30
	Resistance		Ω	1 ~ 1.2
Glow plug indicator	Type			Red heat
	Rated current		A	30
	Voltage across terminals		V	0.9 ~ 1.1 (at 30A)

Battery	Model and type		NX100–S6L (S)
	Capacity	V ~ Ah	12 ~ 45
	Dimensions (length X width X height)	mm (in.)	238 x 129 x 203 (9.37 x 5.08 x 8)
	Weight	kg (lb)	14 (30.9) including electrolyte
	Electrolyte capacity	liter (qt)	2.8 (3)
	Standard specific gravity of electrolyte		1.260 ± 0.010 at 20°C (68°F)
	Size of terminals		



Negative: 1/9 tapered



Positive: 1/9 tapered

CHAPTER 9
OTHERS

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MITSUBISHI ROTARY TILLER (Model 2PR-1110S)

DESCRIPTION

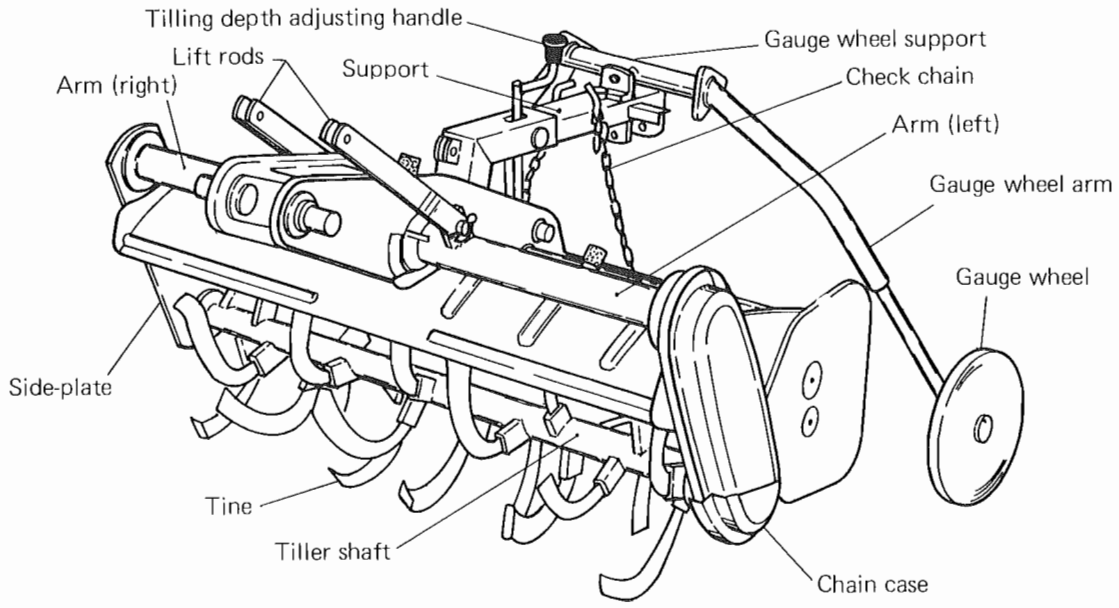
NOTE

This rotary tiller is for MT160/D, MT180/D and MT180H/HD.

Model 2PR-1110S is a high-performance rotary tiller of side-chain-drive type, built compact, light in weight, and durable. It is designed for MITSUBISHI Tractor with the best of what MITSUBISHI has gained in engineering and manufacturing know-how through long years of research and manufacture in the area of farm implements and power machines.

In the 2PR-1110S, as in other MITSUBISHI-made machines, choice materials are used, with each part worked and machined under strict quality control in the MITSUBISHI plant equipped with modern production tools and facilities. Each tiller unit receives close and detailed attention while it is being built, and comes out of the production line to get inspected individually.

- The tiller is easy to hitch to and unhitch from MITSUBISHI tractor: a special bracket mechanism for hitching is used. It is well balanced with the tractor: an ample ground clearance is preserved.
- Tilling width is so large as 1100 mm (43.3 in.), and is covered by so many tines as 28.
- Drive is taken from the tractor's PTO to the side-chain through reduction gearing.
  PTO speeds are matched to the travel speeds of the tractor to ensure the high-performance rotary plowing and other tillage operations.
- Tine mounting holders are angled backward relative to the tiller shaft in order to smoothen the plowing action and to prevent the tiller from getting fouled up with tangling stalks.
- The tines, made of high-grade durability material, are designed for effective plowing in all types of soil with a high degree of efficiency under a wide range of soil conditions, and to make maximized use of drive taken from the PTO.
- Tilling depth can be freely adjusted with a handle by the operator at the wheel.
- Optional equipment is available: The ridger for making ridges, and the puddling rotor which replaces the tiller shaft and others to condition rice paddies prior to rice transplanting.



2PR-1110S side-drive rotary tiller

Compact and light in weight, the 2PR-1110S rotary tiller is designed for bracket hitching to the tractor. Because of the special bracket mechanism, it takes no more than just one person to connect it to and disconnect it from the tractor. All one has to do is just to push the shafts (mounted on the tiller frames) into the "U"-shaped part of the hitching bracket installed on the rear side of the transmission case of the tractor, fit sleeves and then set the shafts by pinning.

Vertical positioning of the tiller is accomplished hydraulically, that is, by utilizing the hydraulic pressure available from the tractor. Controls for this positioning are the two lift rods, right and left.

Drive from the tractor PTO flows into the tiller through the universal joint and gearbox. The spiral bevel gearing of this gear box changes the direction of drive flow in order to transmit drive to the chain inside the chain case attached to the left side of the tiller. The chain drives the tiller shaft to thrust its tines into soil to plow in a turning up and crushing manner. The rear cover serves the purpose of leveling.

The frames, right and left, have hitching pins at the forward end. To the middle parts of these frames are connected the lift rods for raising or lowering the tiller. The support, which carries the gauge wheels and tilling depth adjusting handle, is pinned to the rear parts of these frames.

The tilling depth adjusting mechanism is a crank handle having screw threads. It is by turning this handle that the gauge wheels are raised or lowered for the depth adjustment.

The center cover above the universal joint is a safety guard. Safety features are provided at places of danger to prevent personal injuries. Rotating parts are protected against rain and dust for improved durability.

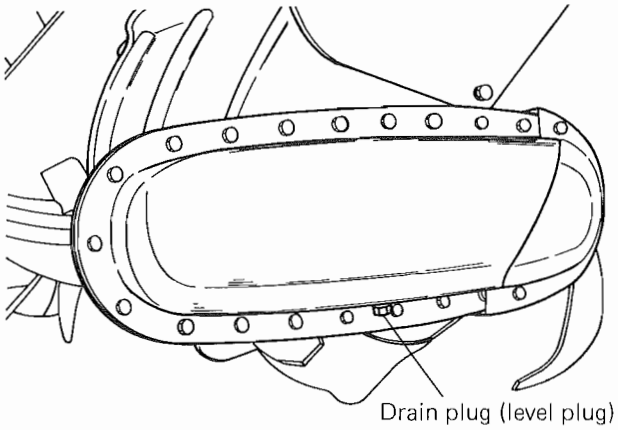
Provisions are made in the rear portion of the support to allow the ridger (optional) to be hitched to it. The tiller shaft, to which tines are secured, is simple in construction and can be easily removed. The puddling rotor or similar optional attachment available for MITSUBISHI tractors (MT160/D, MT180/D and MT180H/HD) can be substituted for the tiller shaft assembly.

DISASSEMBLY

Disassembling the tiller

Prior to disassembly, the tiller must be cleaned by washing with water: never attempt to disassemble the tiller in dirty condition.

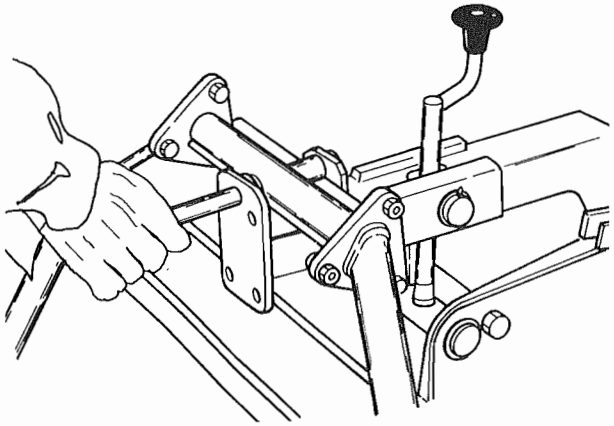
(1) With the tiller hitched in the normal manner to the tractor, remove drain plug on chain case to drain out the oil. Unhitch the tiller from the tractor.



Chain case drain plug

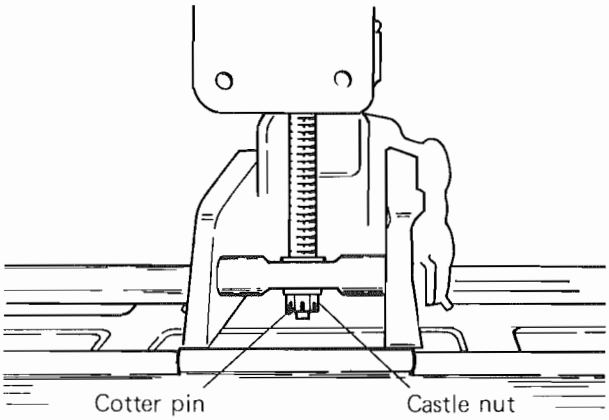
(2) Remove drain plug on gearbox, and drain out the oil.

(3) Pull off set pin on gauge wheel support, and take out the gauge wheel assembly.



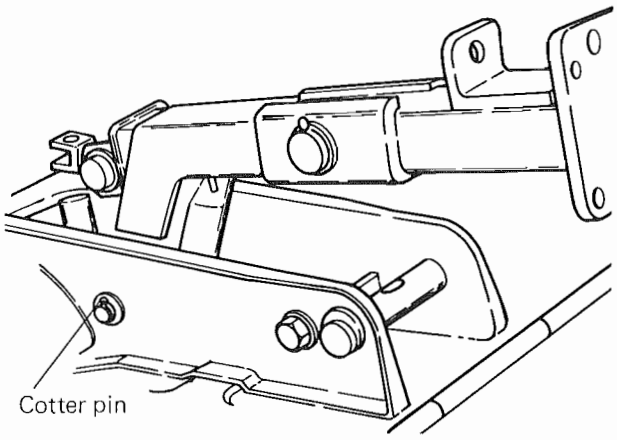
Removing gauge wheel assembly

(4) Pull cotter pin off the castle nut on the end of depth adjusting handle, and remove the nut.



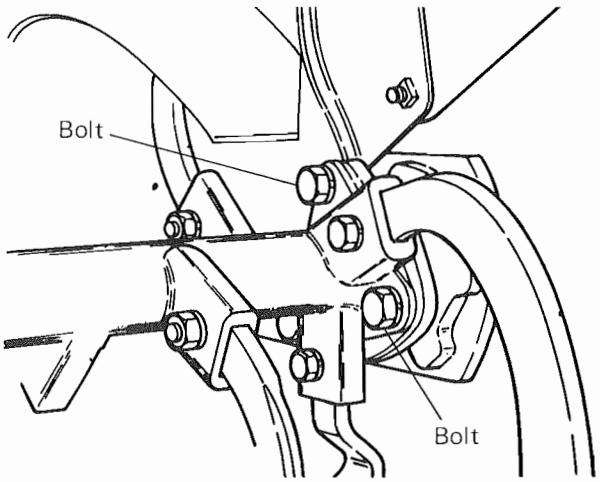
Removing castle nut

(5) Pull cotter pin off the shaft, on which the support and frames pivot, and draw out the shaft while holding the support. The support can now be taken out.



Removing support

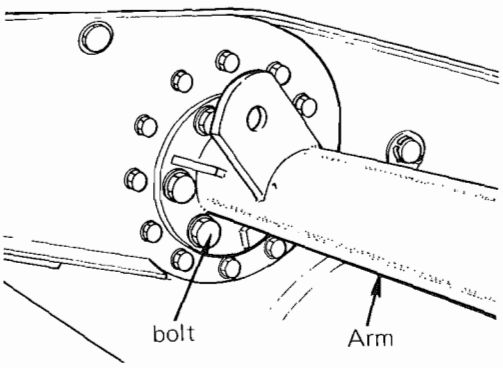
(6) Remove rotary pipe: this is accomplished by removing the bolts, right and left, securing the rotary pipe.



Bolts securing rotary pipe

(7) Remove bolts securing covers to frames, chain case and side-plate and take down the covers.

(8) Loosen bolts securing frames, right and left, to gearbox, and remove the frames. The bolts have been coated with "thread-lock."



Frame securing bolts

(9) Remove bolts securing chain case cover, and take off the cover.

(10) Pull cotter pin off tension spring, and remove the spring.

(11) Pick out circlip at the left end of drive shaft. Straighten tab portion of sleeve nut on rotary shaft, loosen sleeve nut, and remove the upper and lower sprockets, complete with the chain.

(12) Remove bolts securing left-hand arm to chain case, and detach the case. Draw out ball bearing supporting drive shaft.

(13) Remove bolts securing right-hand arm to sub-frame, and detach the side-plate.

NOTE

This step should be omitted unless sub-frame or right-hand arm has to be replaced.

(14) Remove bolts securing arms, right- and left-hand, to gearbox, and remove left-hand arm.

(15) After picking out circlip at right end of drive shaft, draw out drive shaft and left-hand arm from gearbox: the shaft has to be driven out of the box by delivering blows to its right-hand end. Take out bevel gear.

(16) Remove bolts securing gearbox to pinion bearing case, and take out the case. Be sure to cover the liners.

Disassembling the pinion bearing case

Remove rubber cap; straighten tab portion of sleeve nut loosen sleeve unit; and take out pinion gear. As necessary, remove oil seal, ball bearing and tapered roller bearings.

Disassembling the rotary shafts

These shafts can be disassembled in place, with the tiller hitched in the normal manner to the tractor.

(1) Remove rotary pipe and chain case cover. Remove sprockets, complete with chain, and draw out left-hand rotary shaft. It may be necessary to tap but lightly on the shaft so that it will come out. Ball bearing and oil seal need not be removed unless they have to be replaced.

(2) Remove bolts securing the bearing holder to the side-plate, take out the bearing holder. After picking out circlip on right-hand rotary shaft, draw out right-hand rotary shaft.

REMOVAL

Removing the gauge wheels

Remove seal caps. Pick out circlips. This allows the gauge wheels to be removed.

INSPECTION

(1) Inspect the roller chain surfaces. If the surfaces are badly pitted or if the chain as a whole is distorted excessively or if the bushings are cracked, replace the chain.

(2) Inspect oil seal for wear. Check each ball bearing for smoothness of rotation, wear and damage.

REASSEMBLY

Reassembling the tiller

(1) Wash all parts clean with a washing fluid. Inspect each cleaned part for wear, damage or any other malcondition and repair or replace it if necessary. Be sure that all parts to be used in reassembly are in satisfactory condition.

(2) The oil seals, "O" rings, gaskets, circlips and cotter pins that were removed in disassembly should be replaced unless they are in perfectly good condition. It is a good practice to use new oil seals, gaskets, circlips and pins.

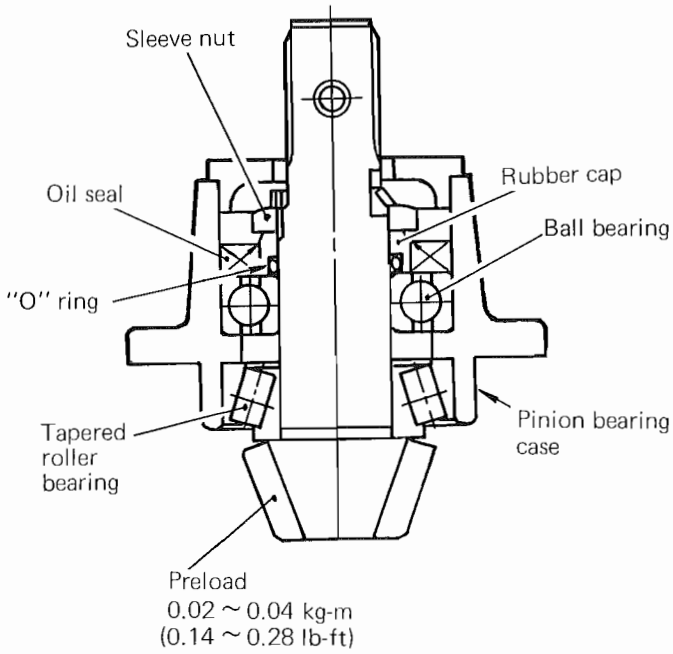
(3) Be sure that each ball bearing is capable of smooth rotation, without evidence of rattle or brinelling.

(4) Rubber parts should be inspected for deterioration, that is, for cracks, swelling, etc., and replace them as necessary.

(5) Distorted or bowed rotary shafts must be repaired or replaced.

(6) During disassembly, surfaces in sliding or rotary contact must be oiled or greased. When positioning each part in place, be sure that the dimensional specification, if any, is met.

Reassembling the pinion gear case



(1) Mount tapered roller bearing on pinion shaft. Be sure to position the bearing correctly, discriminating its inner end from outer end.

(2) Fit the ball bearing to pinion bearing case.

(3) Insert pinion shaft, complete with ball bearing into the pinion bearing case, giving a push to the bearing.

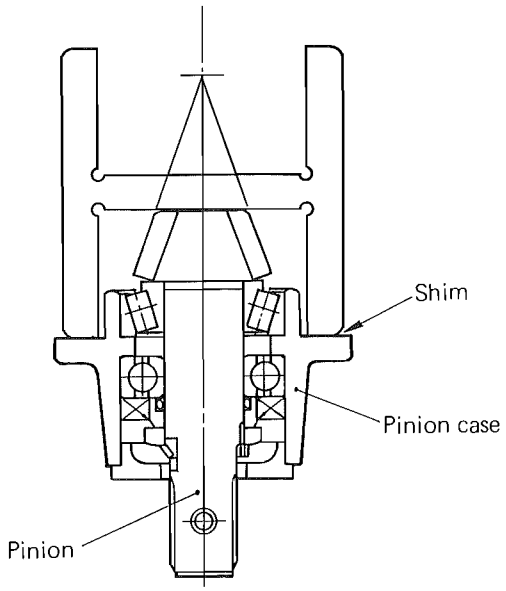
(4) Position oil seal bushing and push in greased oil seal. Secure the oil seal in place by tightening sleeve nut.

Preload	0.02 ~ 0.04 kg-m (0.14 ~ 0.28 ft-lb)

(5) With the bearings properly preloaded, lock the sleeve nut by bending tab portion of sleeve nut sharply.

(6) Select the liner that will give 75 ± 0.5 mm (2.95 ± 0.002 in.) to the cone center of pinion shaft, as measured by using the special tool.

Pinion shaft cone center	75 ± 0.05 mm (2.953 ± 0.002 in.)



Checking cone center

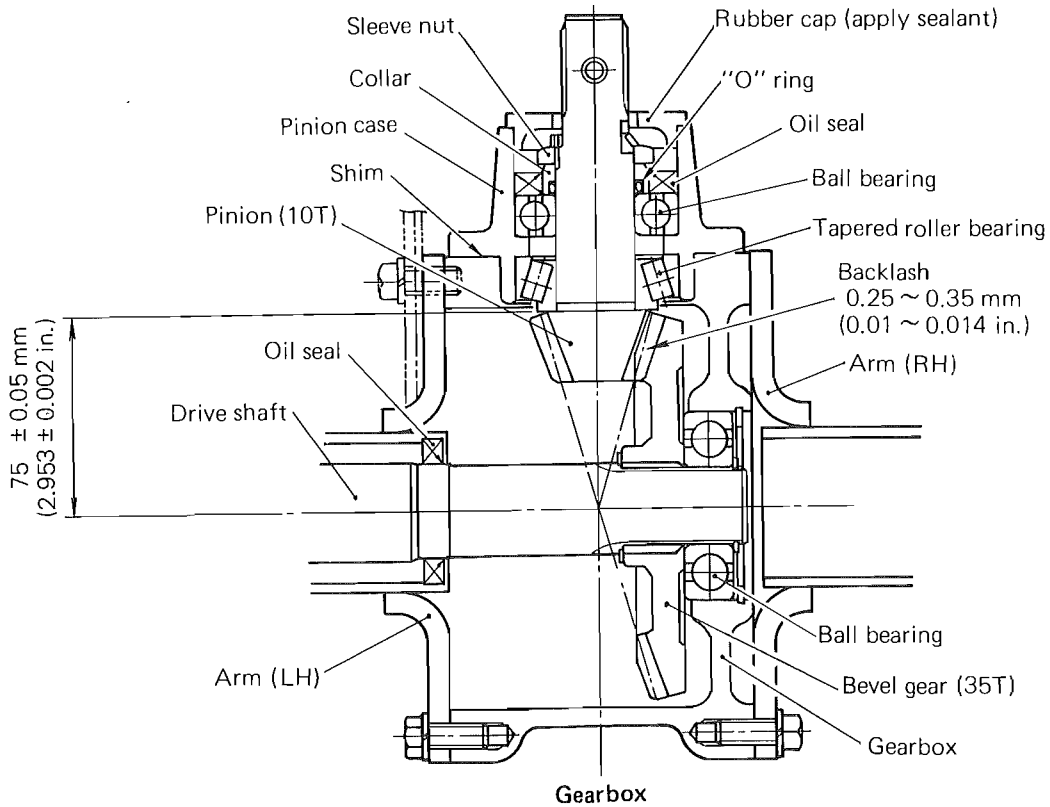
Rest the special tool on the pinion gear, and measure the clearance between forward end of special tool and the face of pinion bearing case, as shown. Select a liner whose thickness is equal to the clearance reading just taken. Insert this liner between the pinion bearing case and the gearbox when fitting the former to the box.

Liner stock is available in these thicknesses:

Thickness	Part No.
0.1 mm (0.004 in.)	1136 3011 000
0.2 mm (0.008 in.)	1136 3012 000
0.4 mm (0.016 in.)	1136 3013 000

Tightening torque for pinion gear case	4.0 ~ 4.6 kg-m (29 ~ 33 ft-lb)

Reassembling the gearbox



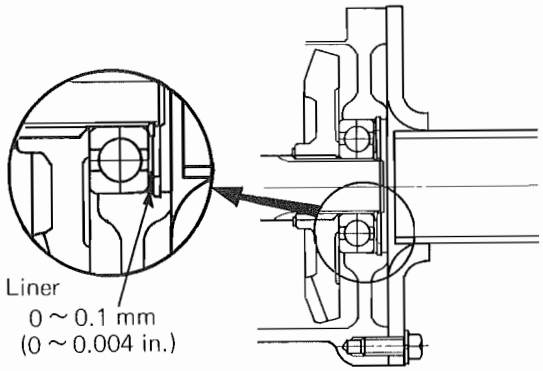
Gearbox

(1) After fitting circlip, insert drive shaft into the left side of gearbox. And bevel gear to the shaft. From the right side, fit the other ball bearing to the shaft.

(2) For the right side, insert a liner at right side of ball bearing and fit circlip tentatively. This liner is a tentative one.

(3) Check the backlash of bevel gear in place. On the basis of backlash reading, select the liner that will produce a backlash of anywhere between 0.25 and 0.35 mm (0.01 and 0.014 in.), and replace the tentative inserted liner by this liner.

Bevel gear backlash	0.25 ~ 0.35 mm (0.01 ~ 0.014 in.)



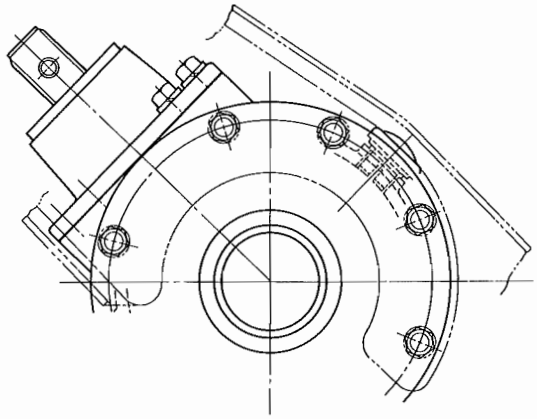
Liner stock for this adjustment is available in the following thicknesses:

Thickness	Part No.
0.2 mm (0.008 in)	69582-00711
0.3 mm (0.012 in)	69582-00712
0.5 mm (0.02 in)	69582-00713

(4) Having determined the liner to be used, fit greased oil seal to left-hand arm. Coat its flange face with sealant, and secure the arm to gearbox.

(5) Put left-hand arm to gearbox so that oil feed pipe is located as shown below, and secure the arm in place with bolts and reamer bolts.

Tightening torque	5.0 ~ 6.0 kg-m (36 ~ 43 ft-lb)



(6) Coat the face of right-hand arm flange with sealant, and secure it to gearbox.

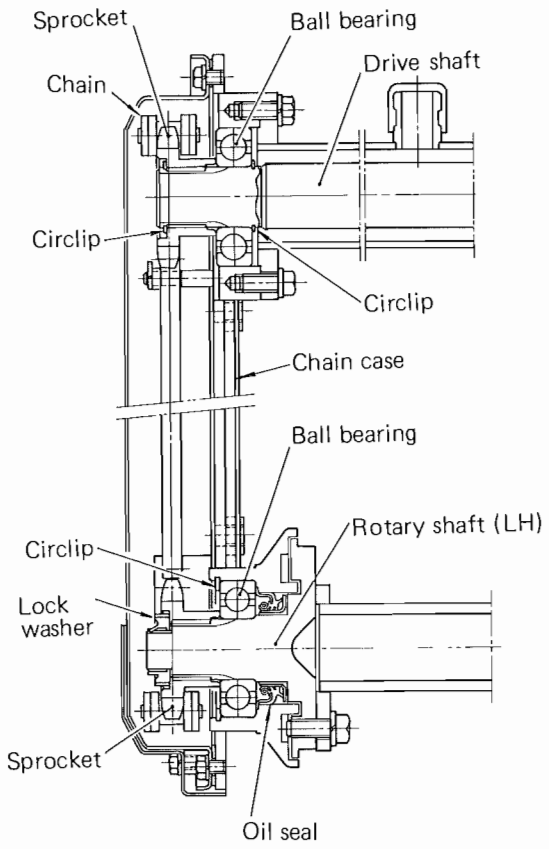
When installing the arm, be sure that it is aligned with the lift rod mounting plate of left-hand arm.

Tightening torque	4.9 ~ 5.7 kg-m (35 ~ 41 ft-lb)

(7) After tightening the arm securing bolts to the specified torque value, re-check bevel gear backlash to be sure that it is within the specified range. If the backlash is noted off the range, remove the two arms, right and left, and replace the liners by the ones that will satisfy the backlash specification.

(8) Fit circlip to the end of drive shaft.

Reassembling the chain case



(1) Grease oil seal, and fit the seal carefully to the lower hole of chain case. Position ball bearing in place by pushing it in, and retain it by installing circlip.

(2) Position left-hand rotary shaft in chain case.

(3) Coat the face of left-hand arm flange with sealant, attach chain case to it, and tighten the securing bolts to this torque value:

Tightening torque	4.9 ~ 5.7 kg-m (35 ~ 41 ft-lb)

(4) Fit ball bearing to drive shaft.

(5) Put chain over two sprockets, and fit the sprockets to drive shaft and rotary shaft. The boss of each sprocket comes on inner side. Make sure that the sprockets go in smoothly onto the splined shaft ends.

(6) Retain the sprocket on drive shaft by fitting circlip. Secure the sprocket on rotary shaft by tightening sleeve nut and locking the nut by bending its tab portion sharply.

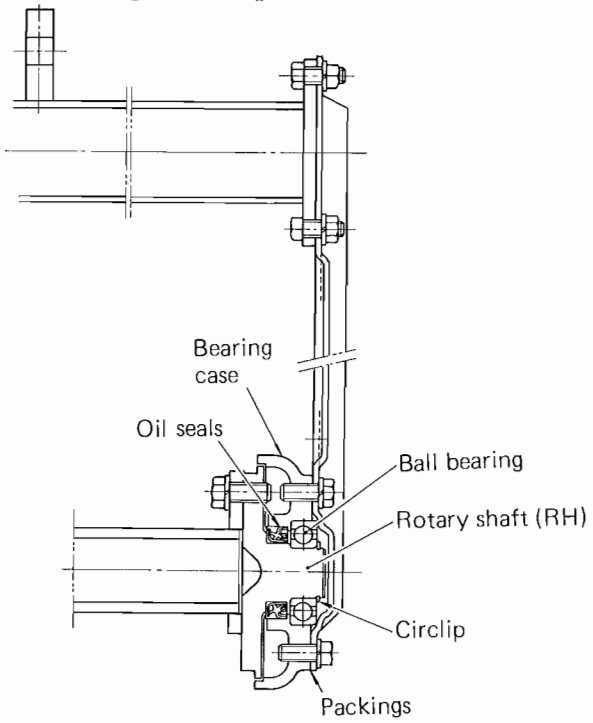
Tightening torque for sleeve nut	15.0 ~ 20.0 kg-m (108 ~ 145 ft-lb)

(7) Install chain tensioning spring and set it by inserting cotter pin.

(8) Secure chain case cover to chain case by tightening cover securing bolts. Before fitting the cover, be sure to coat both faces of the packing with sealant and position the packing neatly on chain case face.

Tightening torque for chain cover securing bolt	1.5 ~ 2.0 kg-m (11 ~ 14 ft-lb)

Reassembling the side-plate



(1) Push greased oil seals into bearing holder at the lower part of side-plate. Insert right-hand rotary shaft into the bearing holder, push in ball bearing, and retain the bearing by putting on circlip.

(2) Apply sealant to both faces of bearing holder and side-plate, and attach the holder to side-plate.

(3) Fill the holder with grease. Secure the cover to side-plate by tightening securing bolts to this torque value:

Tightening torque for cover	4.9 ~ 5.7 kg-m (35 ~ 41 ft-lb)

(4) Secure side-plate to right-hand arm.

Tightening torque for side-plate	4.9 ~ 5.7 kg-m (35 ~ 41 ft-lb)

INSTALLATION

Installing the rotary cover

Some of cover securing bolts on the chain case side are through-bolts. Wrap these bolts with sealing tape. Secure the covers to chain case, tightening the bolts temporarily.

Installing the frames

(1) Using bolts coated with "thread-lock," secure frames to gearbox. Position support in place, and lock it by inserting cotter pins. After installing drive shaft and others, secure the frame by tightening its securing bolts. Be sure to lock the frames by the plate.

Tightening torque for frame	4.9 ~ 5.7 kg-m (35 ~ 41 ft-lb)

(2) Install bolts for fastening rotary cover to frames, and tighten cover securing bolts good and hard.

Others

(1) One end of rotary pipe is marked "L-····, by punching. Position the pipe with its marked end brought to chain case side, and secure it by tightening the bolts to this torque value:

Tightening torque for rotary pipe	7.9 ~ 9.2 kg-m (57 ~ 67 ft-lb)

(2) Fill up gearbox and chain case with the prescribed oil.

(3) After installing rotary pipe, turn it by hand to be sure that it is capable of smooth rotation.

(4) Put the castle nut on the tip of depth adjusting handle; make sure that it moves smoothly; and lock the nut by inserting cotter pin.

(5) Mount the gauge wheel support on the support.

(6) Assemble the gauge wheels by reversing the disassembling procedure.

SPECIFICATIONS

Model				2PR-1110S	
Type				Side drive type rotary tiller	
Applicable tractor				MT160/D, MT180/D and MT180H/HD	
Mounting method				Special 2-point hitch	
Dimensions	Overall length		mm (in.)	1210 (47.64)	
	Overall width			1230 (48.41)	
	Overall height			800 (31.50)	
	Weight		kg (lb)	136 (299.8)	
Tilling tines	Tilling width		mm (in.)	1100 (43.31)	
	Tilling depth			150 (5.91)	
	Diameter			450 (17.7)	
	Number of tines			28	
	Drive system			Universal joint spiral bevel gear, chain side drive	
	Depth control			Lifting and lowering of tail wheels with a handle	
	Tilling shaft revolution at rated engine rpm	C-1	rpm	178	173 Incase of MT180H
		C-2		263	339
		C-3		430	
	Holder pitch		mm (in.)	46.5 (1.8)	
	Tilling pitch	F-1 C-1		112 (4.6)	
		F-1 C-2		168 (3.1)	
		F-1 C-3		280 (1.9)	
		F-2 C-1		76 (7.0)	
		F-2 C-2		114 (4.8)	
		F-2 C-3		189 (2.9)	
		F-3 C-1		46 (11.9)	
		F-3 C-2		70 (8.1)	
		F-3 C-3		116 (4.9)	
Oil capacities	Gear case oil		liter (pint)	0.4 (0.85) SAE# 80 ~ 90 gear oil	
	Chain case oil			0.7 (0.65) SAE# 80 ~ 90 gear oil	

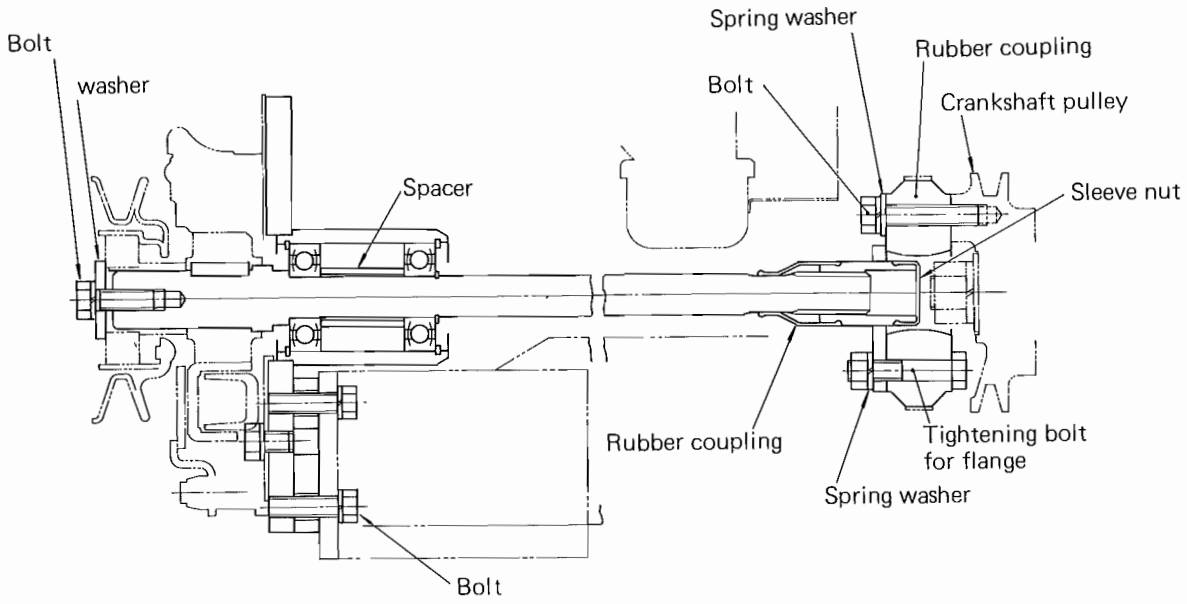
These specifications are subject to change without notice.

FRONT POWER TAKE-OFF (PTO) KIT

This PTO kit also can be installed on MITSUBISHI tractor (MT160/D, 180/D, and 180H/HD).
The only alteration required for installing the kit is to reposition the flange piece in place by reversing.

Description

This PTO is for making power available at the front end of the tractor from its engine through the CG rubber coupling provided on crankshaft pulley. With the front PTO kit installed, such an implement as a mower, sweeper, snow blower or the like can be driven from the engine.



Front PTO kit

Disassembly

(1) If the kit includes an electromagnetic clutch, remove the guard and undo the electric cord connection. Slacken "V" belt tensioning pulley, and remove the "V" belt. Loosen lock nut with washer; remove base securing bolts; and take down the clutch.

(2) Remove bolts securing the mounting bracket to chassis, and take down the front PTO.

(3) Pick out circlip, and draw the shaft out. The shaft may have to be tapped on lightly to make it come out: use a plastic hammer in such a case.

(4) Remove ball bearings, circlips and collar from the bracket.

Reassembly

(1) After fitting circlip to the front end of bracket, insert ball bearing into the bracket.

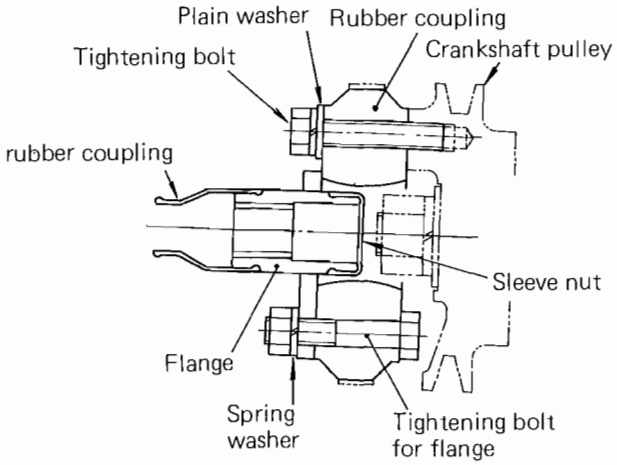
(2) Fit ball bearing collar and ball bearings to the PTO shaft. Insert it into the bracket and retain it in place by putting on circlip.

(3) Fit it to the bracket.

NOTE

When installing the front PTO, never loosen the nut on engine crankshaft.

(4) Mount the flange together with cap on rubber coupling, bringing its boss to outer side, and secure it to the coupling by tightening three bolts and nuts.



(5) With the flange secured as shown above, install the coupling on crankshaft pulley by tightening its mounting bolts to this torque value:

Tightening torque for coupling	4.0 ~ 4.5 kg-m (29 ~ 33 ft-lb)

NOTE

a) When installing rubber coupling to crankshaft pulley, be careful not to tighten it together with flange. In other words the flange is to be secured to the coupling and tighten with three sets of bolts and nuts, and the coupling is to be secured to crankshaft pulley and tightened with other three pieces of bolts.

b) The new rubber coupling comes with a steel band strapped around it. Remove this band after installing and securing the new coupling.

(6) Grease the splines cut in the rear end of PTO shaft, and insert this splined end of it with boot into the splined flange piece secured to rubber coupling. Keeping PTO shaft level with crankshaft, secure its bracket to chassis by tightening the bracket mounting bolts to this torque value:

Tightening torque for bracket	4.0 ~ 4.5 kg-m (29 ~ 33 ft-lb)

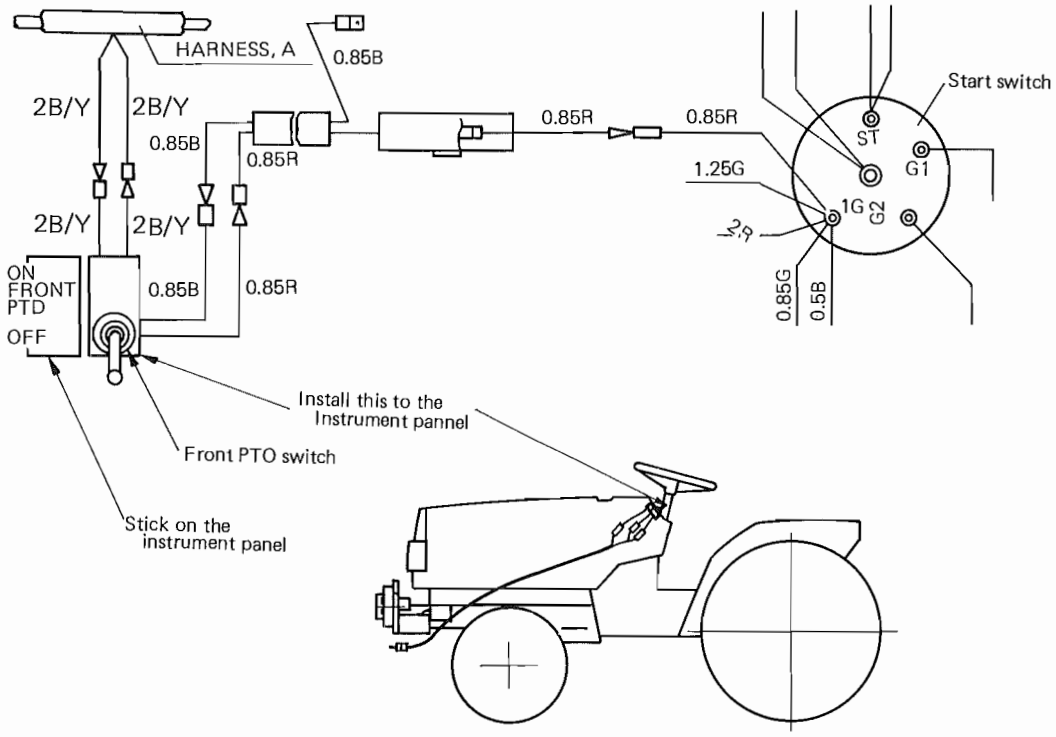
Install the electromagnetic clutch in the order that is reverse of its removal.

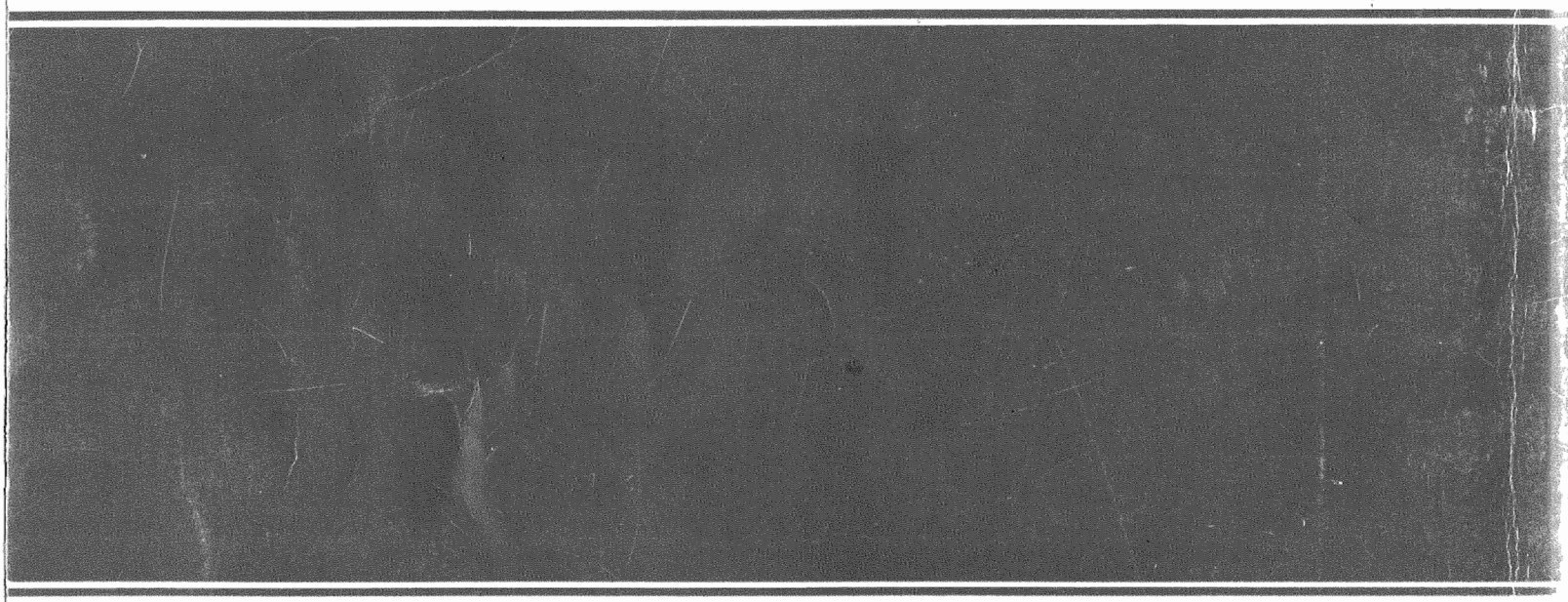
NOTE

When installing the pulley and magnetic clutch, the core might interfere with the clutch drum being positioned in place. In such case, eliminate the interference by loosening bolts securing the magnetic clutch base in place and displace the base out of the way for the drum. Be sure that the radial clearance between core and drum is uniform all around.

The axial clearance, too, must be uniform all around. To obtain a proper axial clearance, insert a liner between clutch drum and shoulder formed of PTO shaft.

Electrical wiring for Front PTO kit





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