

WATEROUS COMPANY
South St. Paul, Minnesota 55075

“REVISED”

FORM T-333

OVERHAUL INSTRUCTIONS
WATEROUS MODEL TFA (Flywheel PTO)

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DESCRIPTION

The flywheel PTO is a power transfer device that is installed between the engine flywheel housing and the front mounting flange of an Allison automatic transmission. The PTO shaft is engaged and disengaged by means of a hydraulic clutch. Power from the engine to the automatic transmission is through a one-piece shaft in the flywheel PTO. The front end of this shaft connects to a drive plate attached to the engine flywheel. The rear end of the shaft simulates the engine crankshaft and attachment to the automatic transmission is by means of a flexplate in a manner similar to when attached to the engine.

Power to the PTO shaft is transmitted by a chain drive from the one-piece shaft. The chain drive, PTO shaft clutch, and clutch bearings are pressure lubricated. Other bearings are lubed by splash from the pressure lube system.

A simple built-in two-position valve controls the clutch. Actuation of this valve is via a linear motion actuator furnished and installed by the vehicle builder, controlled from the chassis cab. A double acting air cylinder with suitable controls is ideal for this.

NOTE

Refer to applicable Service Parts List included with pump manual for location of parts noted in this instruction by reference number.

The flywheel PTO is sandwiched between the engine and the automatic transmission of the vehicle. Repairs to the main PTO shaft will require removal of the flywheel PTO from the chassis.

Repairs required to the clutch and output shaft, or the oil pump of the flywheel PTO can be done without removal of the PTO from the vehicle, provided access to the top of the flywheel PTO is possible by removal of walkways, seating and body panels in this area.

Preliminary work required on vehicle to allow work on the flywheel PTO in or out of the vehicle:

1. Make sure the vehicle engine is de-activated to prevent start up during work on the flywheel PTO.
2. Remove walkways, seats, decking and body panels as necessary to gain access to the top of the flywheel PTO.
3. Remove drive shaft between the PTO and the pump or whatever it is driving.
4. Remove plug (54) and drain the oil.

NOTE

The PTO has an oil supply separate from that of the engine and transmission.

**REMOVAL OF THE AUTOMATIC TRANSMISSION
AND THE PTO FROM THE VEHICLE**

1. Proceed with preliminary work to prepare for removal as noted above.

NOTE

- A. If sufficient working room exists, the vehicle's automatic transmission and the PTO may be removed as a unit and the automatic transmission later detached from the PTO.
 - B. The instruction here to remove the PTO covers removal of the automatic transmission from the PTO and then the removal of the PTO from the engine.
 - C. Depending on the model of the PTO (TFA-1, TFA-2, or TFA-3) and make of vehicle chassis, the PTO case may or may not be supported in the chassis by brackets from the PTO to the chassis frame rails, or crossmember.
2. Disconnect oil line from PTO oil pump to the oil filter.
 3. Disconnect cable control or linkage from end of PTO shift lever (8).
 4. Disconnect PTO output drive shaft from PTO.
 5. Disconnect drive line from the rear of the Allison transmission.
 6. Disconnect all cooling lines and any mechanical linkage between the engine and the Allison transmission. Plug open end of cooling lines temporarily to avoid excessive oil leakage from lines.
 7. If the Allison transmission has a rear support, disconnect it from this rear support.
 8. Remove access cover (2) from bottom of PTO housing by removing six cap screws (22).
 9. Through the opening in PTO housing, remove screws (or nuts) that fasten torque converter to the flexplate.

CAUTION

If rear of the engine is supported by brackets between the frame and the PTO case or the automatic transmission case, support the rear of the engine by blocking or other means before removal of the automatic transmission and the PTO.

10. Support automatic transmission with suitable hoist from above or by a transmission jack or other means from below the transmission. If there are brackets between the frame and the transmission case, remove the bolts attaching brackets to the case.

11. Remove 12 cap screws fastening the transmission to the PTO case.
12. Pull transmission away from PTO and remove from chassis.

WARNING

Keep rear of transmission lower than front to keep the torque converter assembly from sliding out of the transmission and falling to the floor. Secure the converter assembly to the transmission as soon as possible with wire to keep it in place.

13. If the rear of the engine is partially or wholly supported via brackets from the PTO to the chassis frame or crossmember, support the rear of the engine from beneath by blocking and then disconnect the brackets to the PTO.
14. Remove flexplate attached to the rear of the main shaft (66) of the PTO. This can be done later if desired, however it will be easier at this time as the engine compression will aid in keeping the shaft from rotating when the cap screws (68) are removed.
15. Support the PTO with a suitable hoist.
16. Remove the 12 screws fastening the PTO to the engine flywheel housing and pull the PTO away from the engine housing until the spline on shaft (66) disengages from the drive plate attached to the flywheel and the shaft end is beyond the face of the flywheel housing. Lower the PTO to the floor.

REMOVAL OF THE MAIN SHAFT FROM THE PTO

NOTE

Two styles of main shafts have been used in these units (TFA-1 and TFA-2 only). The early units have 2 ball bearings in the main case which support the shaft. Beginning 11/83, the main shaft is supported by one bearing in the main case and one bearing in the engine flywheel. Some units made prior to 11/83 have been retrofitted to the later style. Considerations should be given to update any older style unit, under repair, to the new style shaft and bearing arrangement. Consult Waterous Company Service Department.

1. Remove the PTO case cap and disconnect the chain as described in this instruction under **REMOVAL OF CLUTCH ASSEMBLY**.
2. Remove lock nut (39) and lock washer (40) from shaft (66).

3. Stamp or otherwise mark alignment of engine adapter (67) and PTO main case (60) to each other. Remove the cap screws (24) fastening the engine adapter (67) to the PTO main case (60) and pull the adapter from the case. As this is being done, the adapter will pull off the outer race of bearing (36) on units with two bearings in the case, or spacer (109) on shaft (66) and may bind on these unless it is pulled evenly.
4. Remove the 8 cap screws (23), attaching housing (10) to main case (60), and tap shaft (66) and related parts toward front end of the PTO.

NOTE

Once housing (10) is free of its fit with the main case (60), the complete shaft can then be removed.

DISASSEMBLY OF MAIN SHAFT

1. Remove the shaft as described in this instruction under **REMOVAL OF MAIN SHAFT**.
2. Support sprocket (63) on face between sprocket and housing (10) and press shaft out of the sprocket. When this is done the oil seal sleeve (5), bearing (36) on units with two bearings in the case, or spacer (109), and spacer (4) at the spline end of shaft (66) will be pushed off the shaft by the sprocket.
3. Remove key (64).
4. Remove snap ring (108) (used on new style shafts only).
5. Support the housing (10) on its face that bolts to the main case and press shaft (66) towards the housing to remove bearing (36) at housing end from the shaft.
6. Press oil seal (31) from housing (10).

REMOVAL OF CLUTCH ASSEMBLY
(Flywheel PTO In or Out Of Vehicle)

1. Disconnect linkage from end of lever (8).
2. Remove cotter pin (41), lock nut (49) and slide end yoke (48) from the shaft.
3. Remove cover (15), if so equipped. (TFA-1 early Model only.)
4. Disconnect suction hose (80) from the oil pump (12) at swivel fitting (94). Disconnect pump discharge line at the pump on nearest breakable connection between oil pump and oil filter.
5. Disconnect steel tube oil lines (86), (87) and (88) from housing (16).
6. Remove oil pump assembly (106) by removing cap screws (24) which fasten the pump assembly to bearing housing (13).

7. Loosen lower cap screws (24) fastening housings (13) and (16) to the PTO case and remove the upper cap screws (24) at each end that fasten these housings to the case cap.
8. Remove cap from the case (60) by removing the cap screws (24) that fasten the cap to the case and pushing cap off its positioning dowels by using 2 screws (24) as jacking screws in the tapped jack screw holes in the flange of the cap.
9. Clamp clutch together. **(See Figure #1.)**
10. Remove lower screws (24) (previously loosened) holding housing (13) (at pump end) to case (60) and remove housing (13).

NOTE

When removing housing (13), retain clutch assembly from axial movement, keep clamp in place and use blocking as shown in Figure #1.

11. Disconnect chain. **(See Figure #2).**
12. Unwrap chain (61) from upper sprocket (62) and either remove the chain or tie each end in place with wire.
13. Remove lower screws (24) (previously loosened) holding housing (16) to case (60). Lift clutch assembly (19) and related parts from the case (60). Keep clamp in place to hold clutch together.
14. Pull oil seal sleeve (18) from spline end of the clutch shaft.
15. Remove housing (16) by pulling it off of the clutch shaft bearing (107) and past the end of the clutch shaft. Remove O-ring (29) from the housing.

DISASSEMBLY OF CLUTCH ASSEMBLY

1. Remove clamp holding the sprocket and drum assembly (62) in place.
2. Slide the sprocket and drum assembly (62) off the clutch (19) and tangs of the clutch plates. Note the arrangement of the spacers and needle bearings under the sprocket so they are reinstalled in the same arrangement. When the sprocket and drum assembly (62) has been removed, a needle thrust bearing and two thrust washers will either be in place on a large journal on the shaft or may have slipped off this journal and may be hanging on the smaller journal the sprocket and drum needle bearings fit to. Remove this needle thrust bearing and washers.
3. With bearing puller, removing bearing (107) from the shaft.

NOTE

No further disassembly of the clutch is recommended unless the clutch and shaft have been damaged or internal problem with the clutch is suspected. If the clutch must be completely disassembled, it should be returned to Waterous for repair or replacement.

DISASSEMBLY OF OIL PUMP

1. Remove cap screws fastening the pump end cover and internal rotor to pump housing (12) and pull end cover from housing . The only part that will remain in housing (12) will be bushing (58) and this can now be pressed out of the housing (12), if desired.

NOTE

Bushing (58) should only be removed if damaged or new oil pump components are to be installed.

2. Slip pump drive rotor shaft out of mesh with the teeth on the idler gear on the pin in the cover.

DISASSEMBLY OF VALVE & STEM (7) FROM HOUSING (16)

1. Unhook spring (56), remove pin (42) fastening lever (8) to stem (7).
2. Turn the valve stem (7) in a counterclockwise rotation and this will screw the stem and valve (7) out of housing (16). Remove O-ring (26).

REASSEMBLY

MAIN SHAFT ASSEMBLY

1. Install oil seal (31) and bearing (36) in housing (10). If bearing (36) was retained in the housing with a snap ring (108), reinstall the snap ring. Slip housing assembly, oil seal end first, over spline of shaft (66) until bearing (36) contacts its journal on the shaft. Square up bearing with the shaft and press on the inner race of the bearing until it seats against shoulder at the flange end of the shaft.
2. Install key (64) and press on sprocket (63) until tight against bearing (36) in housing (10).
3. Install spacer (4). Install spacer (109) if shaft is new style or press on bearing (36) if shaft is old style. Press it tight up against spacer (4).
4. Press on oil seal sleeve (5) tight up against bearing (36) or spacer (109).

CLUTCH, SHAFT AND HOUSING ASSEMBLY

1. Press bearing (107) on spline end of shaft.
2. Support shaft in vertical position with spline end down and line up tangs of clutch plates.
3. Install thrust bearing washer on the shaft and onto the shoulder protruding from the plate end of the clutch. Position washer against the clutch. Install needle thrust bearing and another thrust washer.

NOTE

Make sure these thrust washers and bearing do not slip off this shoulder and down onto smaller portion of the shaft.

4. Install insert (3) in end of driven sprocket and drum assembly (19) lining up hole in insert with that in sprocket and install pin (38). Remove any burrs that may result from installing the pin.
5. Press bearing (36) on sprocket.
6. Install on the shaft of the clutch the following in this order. Needle bearing, two spacers, needle bearing, then one spacer.
7. Check alignment of tangs of clutch plates. Check again to make sure needle thrust washers and bearings installed per 3 above are still properly positioned. Slip sprocket and drum assembly (62) over bearings installed in 6 above and guide drum into engagement with tangs on clutch plates until the drum is in full engagement with the clutch plates. The sprocket and drum assembly (62) should now turn freely on the shaft.
8. With the assembly still in a vertical position, clamp the sprocket and drum assembly (62) to the other portion of the clutch to prevent these from separating which would allow the needle bearing and thrust washer to slip out of position. **(See Figure #1.)**
9. Inspect and make sure the 3 small piston rings are not damaged in the grooves in the shaft between the bearing (36) and the spline at the spline end of the shaft.
10. Install O-ring (26) on valve stem (7). Thread the valve stem into bearing housing (16) until hole in valve stem (7) lines up with the port in bearing housing (16). At this location of the valve stem (7), it should be rotatable 360° without bottoming of the stem threads. Back out stem as necessary to avoid bottoming. Install lever (8), pin (42) and spring (56).

NOTE

Proper assembly of lever (8) to stem (7) results in a closed port in housing (16) when lever is rotated clockwise to a position against its stop pin.

11. Install O-ring (29) on bearing housing (1) and oil seal (30) in the housing.

12. Install bearing housing (16) on spline end of clutch shaft and fit onto bearing (107). Install sleeve (18) on same end of shaft.

MISCELLANEOUS ASSEMBLY

- A. If oil spray tube (11) was removed, reinstall and safety wire cap screw (93) together.
- B. Assembly of oil pump.

If all original oil pump components except the gasket are to be reused and bushing (58) was not removed from housing (12), proceed as follows:

1. Mesh idler gear and rotor together on idler pin in cover.
2. Slip new .015" thick gasket onto cover and install cover assembly in housing (12) positioning notch on O.D. of cover flange between ports in housing (12). **(See Figure #3.)** Install and tighten the 6 cover screws. After tightening the screws, rotate pump via tang shaft. Pump should rotate without binding.

If any component except the gasket of the original pump assembly is replaced or the bushing (58) was removed from housing (12), reassemble the oil pump as noted in **Figure #3**.

- C. Press oil seal (31) into engine adapter (67).
- D. Install O-ring (29) on bearing housing (13).

FINAL ASSEMBLY

1. Apply light coat of Super 300 Permatex to face of main housing (60) that gasket (20) fits to. Install gasket (20). Apply light coat of Permatex sealant to other face of gasket.
2. Install the main shaft (66) and components previously assembled to this shaft in main housing (60). Seat pilot diameter of bearing housing (10) into bore in the main housing (60). Apply coat of Permatex sealant to threads on cap screws (23) and fasten bearing housing (10) to inside face of the main housing (60) using these cap screws with lock washers.
3. Apply coat of Permatex sealant to engine end of main housing (60).
4. Install engine adapter (67) to face of main housing (60). Line up holes between the two parts and install cap screws (24) and (89) (with threads coated with Permatex sealant) and lock washers and tighten being sure alignment between the main housing (60) and engine adapter (67) is the same as original before installation of fasteners and tightening.
5. Install main shaft lock washer (39) and lock nut (40). Tighten securely and bend at least one tab on the washer into a slot in the lock nut.

6. Install chain (61) in main case (60) and around sprocket (63) and secure both ends of the chain from falling back into the main case by tying in place with wire.
7. Take clutch shaft and housing assembly previously assembled and position to top of main housing (60) so housing fits into the half bore in the top of the main case (60). Be careful not to cut or otherwise damage the O-ring seal (29) on housing (16). Temporarily install and snug up the two lower cap screws (24) to keep housing (16) in place. Be sure the clamp holding clutch together stays in place.
8. Install chain (63) around driven sprocket and drum assembly (62) and connect ends of the chain. **See Figure #2.**
9. Install bearing housing (13) over bearing (36) on driven sprocket and drum assembly (62). Be careful not to cut O-ring (29) on housing (13).
10. Install two lower cap screws (24) in housing (13) and tighten finger tight.
11. Remove clamp holding clutch assembly together. Check to see that everything turns freely.
12. Install dowels (65) in face of main case the cap fastens to and apply coat of Permatex sealant to this face.
13. Install cap and fasten in place with cap screws (24).
14. Remove lower cap screws (24) previously installed in housing (13) and (16) and coat threads with Permatex sealant. Reinstall both upper and lower cap screws (24), coating all threads with sealant, and tighten.
15. Install gasket (6) on pilot diameter on end of oil pump. Line up tang on oil pump shaft with slot in insert of clutch assembly. Install oil pump assembly to housing (13) making sure the ports are facing the same direction as before removal of the oil pump. Fasten in place with cap screw (24) coated with Permatex sealant.

NOTE

Depending on engine, chassis and if equipped with turbo charger, the oil pump is factory installed with suction and discharge ports pointing to either the right or left side of the vehicle. When the pump assembly is reinstalled to the flywheel PTO, the discharge port is the upper port when the ports are pointing towards the driver side of the vehicle. When installed pointing towards the passenger side, (pump rotated 180°) the discharge port is the lower port.

16. Install adapter (94) to suction port of oil pump if adapter was removed.
17. Install and reconnect steel tube oil lines (86), (87) and (88) and oil hose (80) from case sump to oil pump.

18. Install end yoke (48) on clutch shaft. Install lock nut (49) and securely tighten, lining up slot in nut with hole in shaft. Install cotter pin (41) and secure.
19. Install pressure regulator (51) if it was removed. Be sure gasket (105) is in place.
20. Install any remaining small parts and fittings that were removed.
21. Position flexplate to flange end of shaft (66). Then position scuff plate to the flexplate .

NOTE

One hole is oddly spaced in these parts. Make sure holes are lined up.

Install class 8 cap screws and torque to following Specs.

Model TFA-1	75 lb. ft.
Model TFA-2, 2A	180 lb. ft.
Model TFA-3	125 lb. ft.

INSTALLATION IN VEHICLE

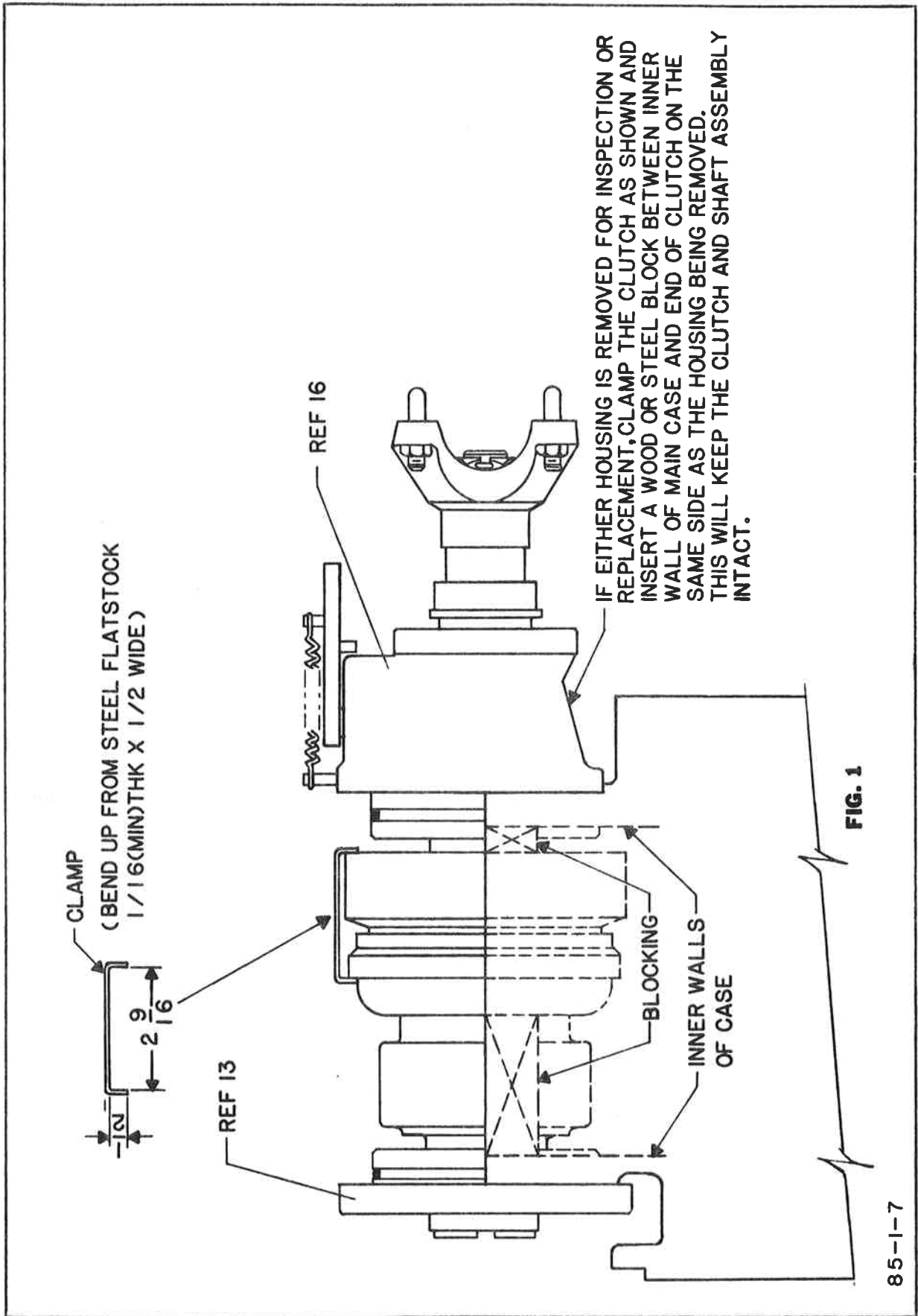
1. Install PTO to engine.
2. Install automatic transmission to PTO.
3. Reconnect oil line from oil filter (75) to PTO.
4. Connect flexplate at rear of PTO to torque converter of the transmission. If any of these fasteners are replaced, make sure any replacements are SAE Grade 8 fasteners.
5. Reconnect drive line between PTO shaft and pump or whatever it is driving.
6. Reconnect cooling lines and control rods to the automatic transmission.
7. Replace access cover plate (2) at bottom of PTO.
8. Reconnect drive line between automatic transmission and rear axle.
9. Recheck for fasteners that may have been overlooked.
10. Reconnect control mechanism to lever (8) on the PTO.
11. Fill PTO with automatic transmission fluid to center of sight glass (52) or to oil level plug (43).
12. If automatic transmission was drained or oil was lost during removal and installation, refill with or add automatic transmission fluid.

13. Again review complete reinstallation and assure that everything is in order to allow start of engine.
14. Place automatic transmission in neutral and PTO in disengage position. Set vehicle brakes. Start engine.

WARNING

Whenever the engine is running, the PTO output shaft may rotate, even with the clutch in the disengaged mode, due to fluid viscous drag between the disengaged clutch plates. As the PTO warms up, this drag may diminish sufficiently that rotation may cease.

15. With engine at idle speed of at least 700 RPM and PTO in disengaged position, check for oil leaks at all tubing joints, connection from oil filter, at valve stem connected to control lever, and cooling lines of automatic transmission. If leak is detected, shut down engine before tightening any connection.
16. Restart engine and let run at idle speed for about 5 minutes. Again check for leaks and also recheck oil level in the automatic transmission. Add oil as needed.
17. While engine is still running, engage PTO and again check for oil leaks. Take corrective steps to eliminate leaks. Make sure PTO is disengaged and engine is shut down while correcting any leaks.
18. Check oil level in PTO and add oil as needed to replenish that absorbed by filter and tube lines.
19. Again start engine and engage PTO. Make sure any previous oil leak has been stopped. Again check oil level in automatic transmission and add oil if necessary.
20. Reinstall all sheet metal panels and walkways.



TO DISCONNECT CHAIN

- 1) REMOVE SPRING PIN AT CLUTCH DRUM SIDE OF CHAIN.
- 2) PULL LONG CONNECTING PIN FROM CHAIN OVER TOP OF BEARING.
- 3) WITH A BENT PIECE OF STIFF WIRE PUSH THE SHORT CONNECTING PIN OUT OF CHAIN UNTIL IT PROTRUDES ENOUGH TO GRIP WITH A PLIERS AND WITHDRAW FROM CHAIN.

TO CONNECT CHAIN

- 1) INSTALL ONE SPRING PIN IN THE LONG CONNECTING LINK.
- 2) WRAP BOTH ENDS OF CHAIN AROUND THE SPROCKET INTO THE TEETH AND MESH ENDS OF CHAIN TOGETHER.
- 3) INSERT THE SHORT CONNECTING PIN A SHORT DISTANCE INTO THE CHAIN WITH CONVEX SURFACE TOWARDS END OF CHAIN.
- 4) INSERT THE LONG CONNECTING PIN INTO CHAIN WITH CONVEX SURFACE TOWARDS CONVEX SURFACE OF THE SHORTER PIN, TAP BOTH CONNECTING PINS THRU THE CHAIN UNTIL THE SPRING PIN IN THE LONG CONNECTING PIN CONTACTS THE OUTER LINK OF THE CHAIN.
- 5) INSTALL SPRING PIN IN THE HOLE IN THE OTHER END OF THE LONG CONNECTING PIN.

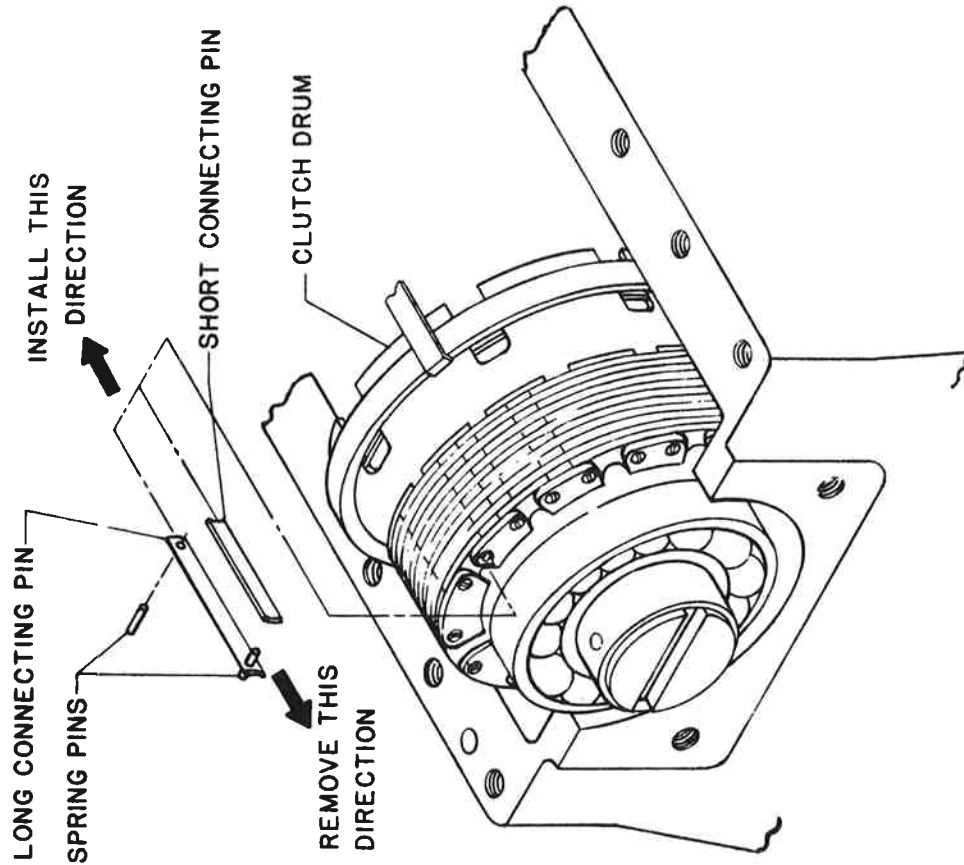


FIG. 2