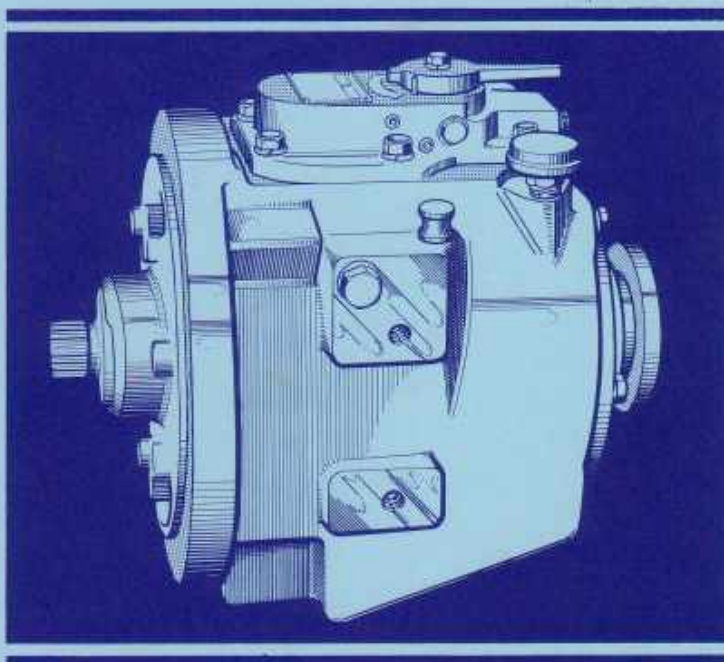
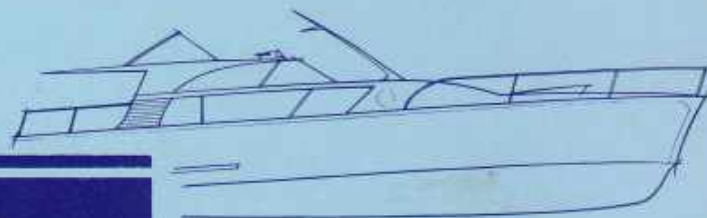
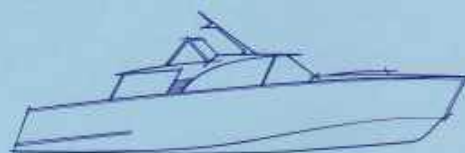


SERVICE MANUAL

FOR
HYDRAULIC
REVERSE GEARS



MODEL HF7

Paragon[®]
REVERSE & REDUCTION GEARS

PARAGON GEAR WORKS INC., TAUNTON, MASS., U.S.A.

Price \$1.50

FOREWORD

This service manual covers the HF7 hydraulic reverse gear. This manual covers only the reverse gear portion of a unit since the reduction gear portion is covered in a separate service manual. However, coverage is extended through the reduction adapting material as well as covering the direct drive models.

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PARAGON HYDRAULIC TRANSMISSION - MODEL "HF7"

DESCRIPTION

The Paragon hydraulic transmission, model HF7, is a self contained unit, independent of the engine lubricating oil and oil pressure system. The unit consists of a pressured oil system, a hydraulically actuated multiple disc clutch for the forward drive and a hydraulically actuated reverse band which clamps a planetary reverse gear train for the reverse drive. Cooling is provided by an external oil cooler which utilizes the engine water for cooling.

OPERATION

Pressured oil for the operation of the transmission is provided by an internal gear type pump mounted inside of the transmission. The internal gear type pump or oil pump is driven continuously by the engine thus providing pressured oil for the operation of the transmission during any running of the engine. From the pump, the pressured oil is delivered through the external oil cooler to the relief valve and to the control valve where, depending upon the control valve setting, the pressured oil can be directed either to the forward drive or to the reverse drive.

The pressured oil is maintained at a constant pressure by means of a relief valve. At engine speeds over 1000 RPM, the pressured oil will be approximately 125 P. S. I. and at idle speeds the pressure may be as low as 60 P. S. I. Pressure slightly above or below these values may be encountered, due to variance in the relief valves.

By shifting the control lever to the forward position, the pressured oil is directed to the multiple disc clutch piston. This clamps the multiple disc clutch and the planetary reverse gear case together as a solid coupling, which rotates in the same direction as the engine rotates.

The reverse band is clamped by shifting the control lever to the reverse position which directs the pressured oil to the reverse piston, thus engaging the reverse band around the planetary gear case. This causes the planetary gears to rotate, driving the output shaft or propeller shaft opposite to engine rotation.

With the control lever in the neutral position, the pressured oil is prevented from entering either the multiple disc clutch piston or the reverse band piston. Therefore the planetary gears run idle and the propeller shaft remains stationary.

ROTATION DESIGNATION

Since there are several methods used to designate the rotation of an engine, the following explanation shall be used to determine the rotation of an engine SO FAR AS ALL Paragon hydraulic transmissions are concerned.

Regardless of whether the transmission is attached to the flywheel end or the anti-flywheel end of the engine, ALWAYS view the transmission and/or engine from the transmission or output end. Therefore, when viewed from the transmission end, an engine that rotates "clockwise", "standard" or "right hand"

will be known as a Right hand rotating engine and an engine that rotates "counter-clockwise", "opposite" or "left hand" will be known as a Left hand rotating engine.

It is important when assembling the HF7 transmission to properly determine the rotation of the engine. Notes taken during disassembly as to the location of the reverse band adjusting screw, the position of the reverse band linkage and direction of the arrow and location of the rotation note on the front end plate will be very useful when reassembling the transmission. Remember, ALWAYS VIEW THE TRANSMISSION AND ENGINE FROM THE TRANSMISSION END.

The right hand and left hand sides of the transmission are also determined in the above manner. That is, they are determined when viewing the unit from the output end.

PART NUMBERS AND ORDERING

The parts list accompanying the exploded views are intended only to identify the parts in regards to disassembly and assembly following this service manual and are not intended to identify parts by number. To order parts, refer to the key number and name as given in the parts list, the figure number referred to and which service manual found in. Example: Key No. 2 - Gear Case - Figure 5 - HF7 Service Manual. Model HF7B2-4C1235. ALWAYS GIVE MODEL NUMBER AND SERIAL NUMBER OF TRANSMISSION WHEN ORDERING PARTS.

The reduction gear portion of a transmission is covered in the "Reduction Gear Service Manual". Therefore, refer to that service manual for service instructions.

TROUBLE SHOOTING

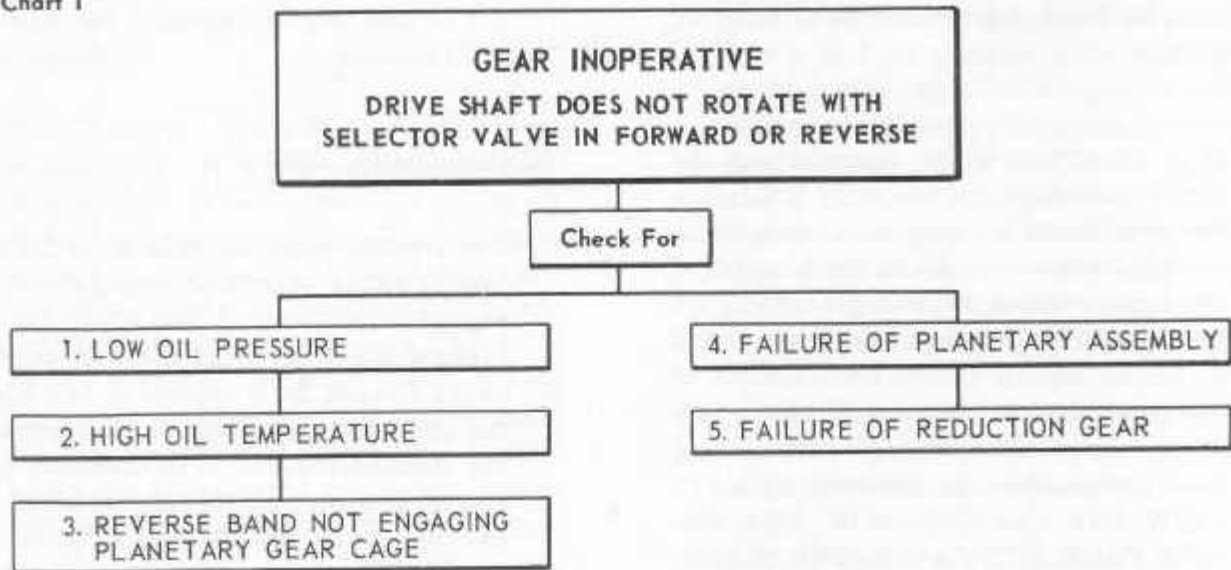
The trouble shooting charts on the following pages should be studied and the suggestions carried out prior to any disassembly, to determine as best as possible what the trouble may be. Also, the exploded views and the accompanying discussions should be carefully read and understood, so that any or all of the service work as indicated from the trouble shooting charts may be carried out properly.

It is desirable to start the engine with the transmission in neutral, thus avoiding moving the boat in either direction. Should the engine stall during shifting or in forward or reverse, return the control lever to the neutral position before restarting the engine.

It is not necessary to race the engine to obtain good shifting characteristics, as the design of the transmission is such that the operation of the forward and reverse drive is nearly instantaneous with the moving of the control lever, even at very low engine speeds. It is recommended that shifting be done at speeds below 1000 RPM and preferably in the 800 RPM range, to prolong the life of the engine, transmission, and of the boat. While NOT recommended as a continuous method, EMERGENCY shifts may be made at higher engine speeds.

TROUBLE SHOOTING CHART

Chart 1



REMEDY

1. Check the following items:

- a. Low oil supply. Add oil, refer to lubrication.
- b. Faulty oil gauge. Replace gauge. Oil gauge slow to register, air or obstruction in oil gauge line. Clean and bleed oil gauge line.
- c. Plugged oil lines or passages. Clean lines or passages.
- d. Oil pressure relief valve scored and sticking. Remove relief valve. Clean valve and valve bore in control valve housing with crocus cloth to free valve, or replace.
- e. Defective pistons and oil distributor seal rings. Replace seal rings.
- f. Defective oil pump. Check for wear, and replace if necessary.

2. Check the following items:

- a. Low oil supply. Add oil, refer to lubrication.
- b. Low water level in cooling system. Add water, and check for leaks.
- c. Plugged raw water inlet screen. Clean screen.

- d. Collapsed or disintegrated water inlet hose. Replace hose.
- e. Air leak in cooling water suction line. Replace suction line.
- f. Raw water pump impeller worn or damaged. Replace impeller.
- g. Clogged or dirty oil cooler element. Remove and clean.

3. Check the following items:

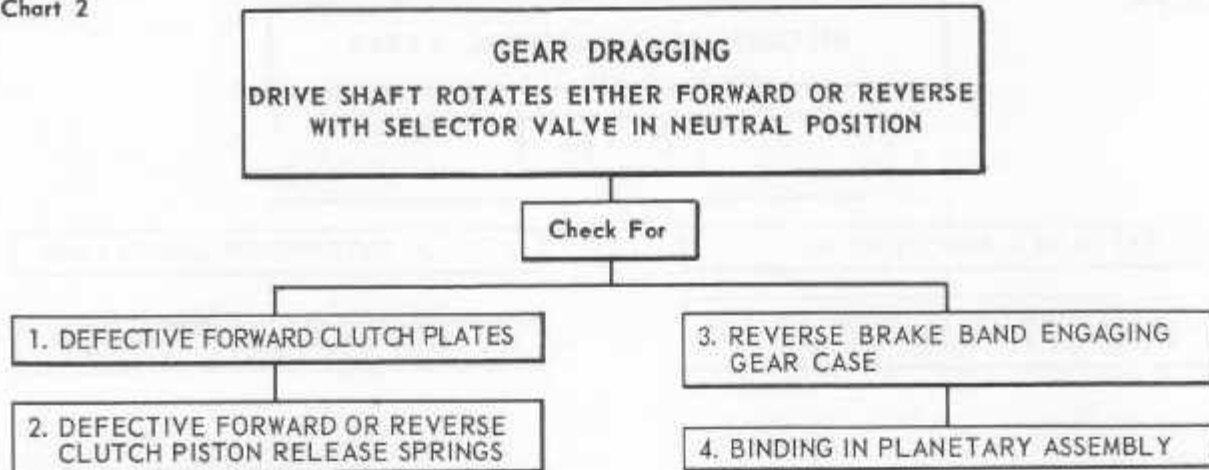
- a. Improper reverse band adjustment. Adjust reverse band as outlined under adjustment.
- b. Reverse band lining worn out. Replace lining.
- c. Defective reverse piston "O" ring. Replace "O" ring.

4. Remove gear case assembly, and check for defective or damaged parts. Replace defective or damaged parts.

5. Remove reduction gear assembly and check for defective or damaged parts. Replace defective or damaged parts.

TROUBLE SHOOTING CHART

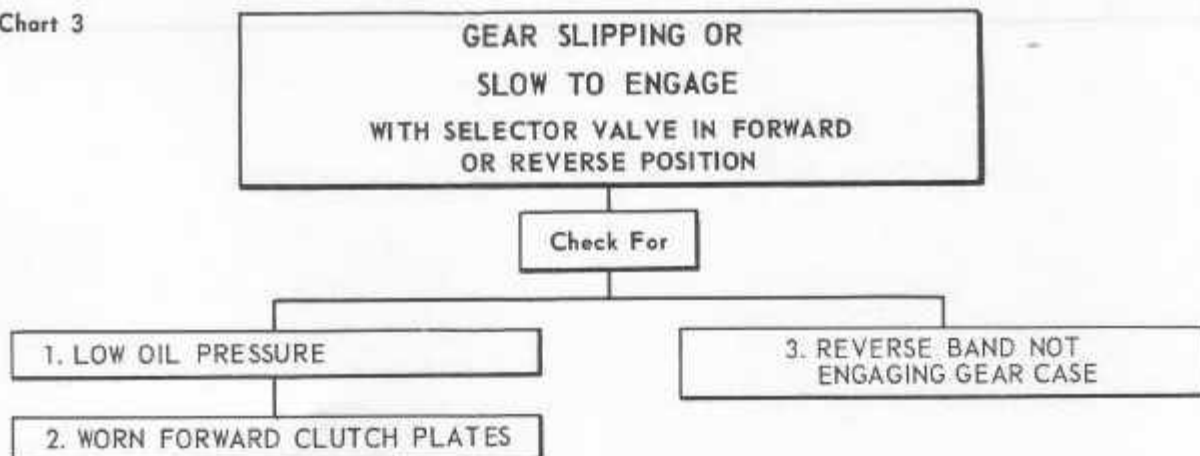
Chart 2



REMEDY

1. Forward clutch plates warped and sticking. Remove clutch plates and replace.
2. Forward and reverse clutch piston release springs broken or weak. Replace springs.
3. Improper reverse band adjustment. Adjust reverse band, refer to adjustment.
4. Check the following items:
 - a. Bearings and gears worn excessively in gear case. Replace necessary parts.
 - b. Input shaft bearings worn excessively, causing misalignment of input shaft. Replace necessary parts.

Chart 3

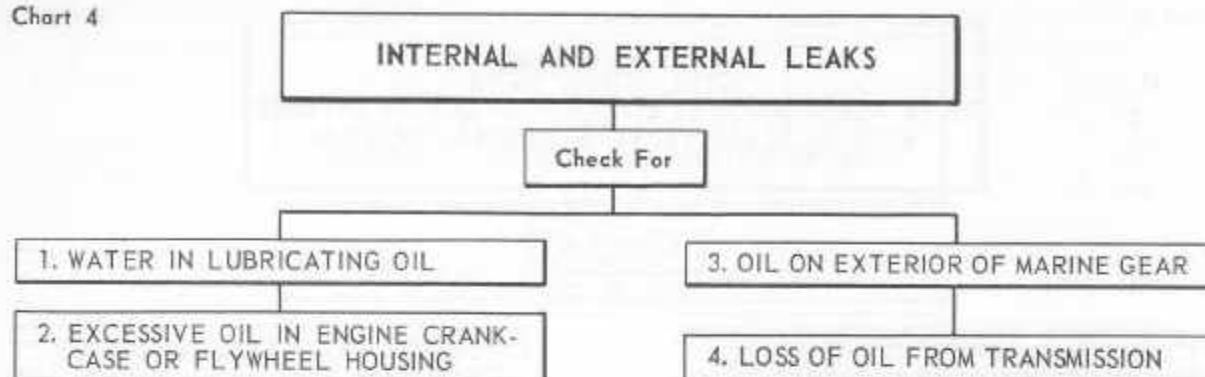


REMEDY

1. Low oil pressure. See Chart 1, item 1.
2. Remove forward clutch plates and check for wear. If worn excessively, replace clutch plates.
3. Reverse band not engaging gear case. See Chart 1, item 3.

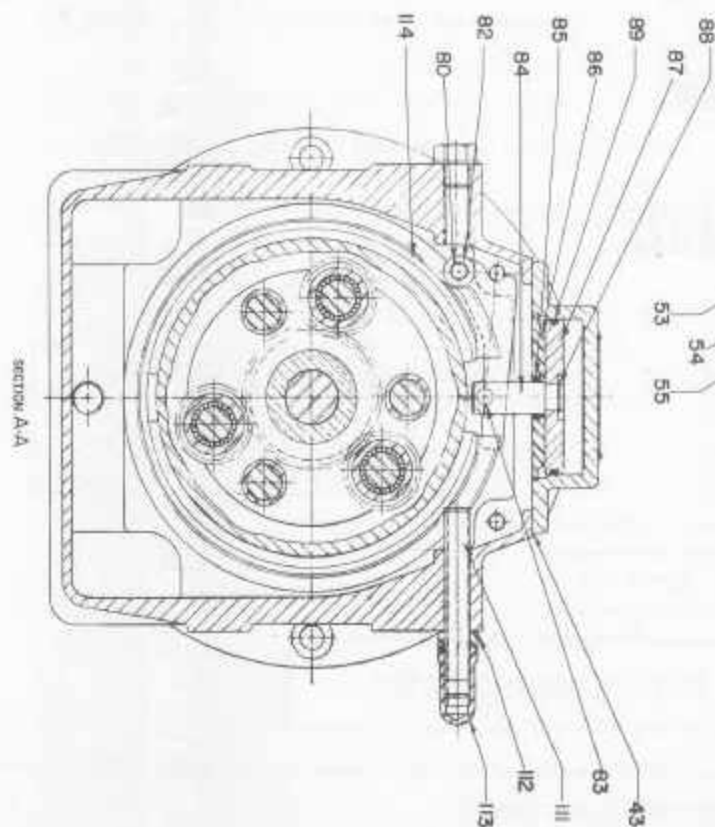
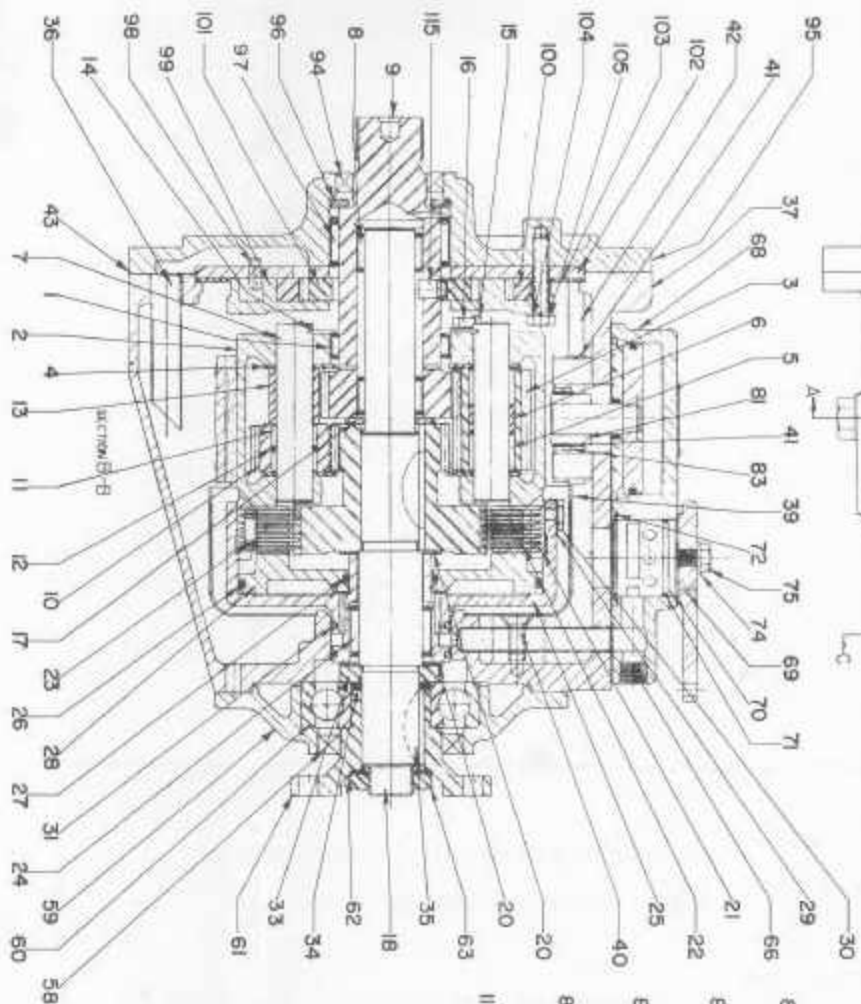
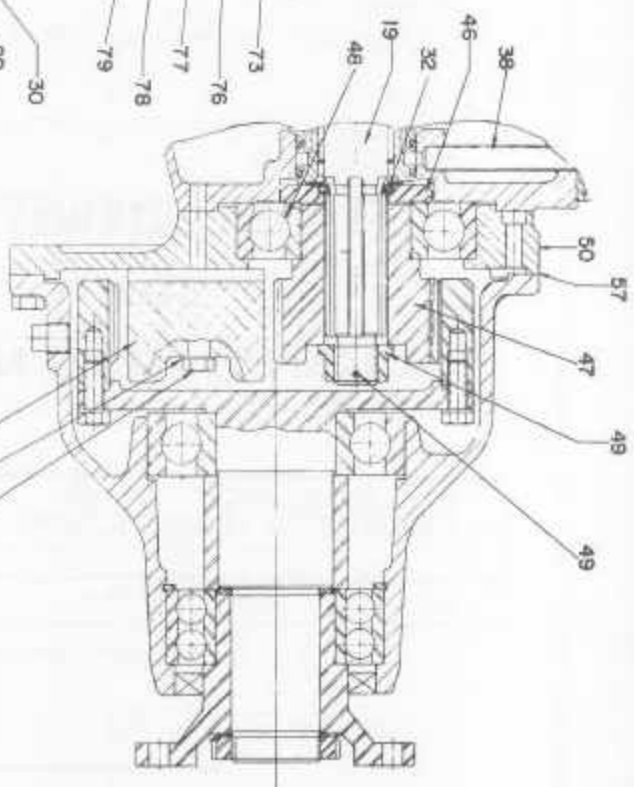
TROUBLE SHOOTING CHART

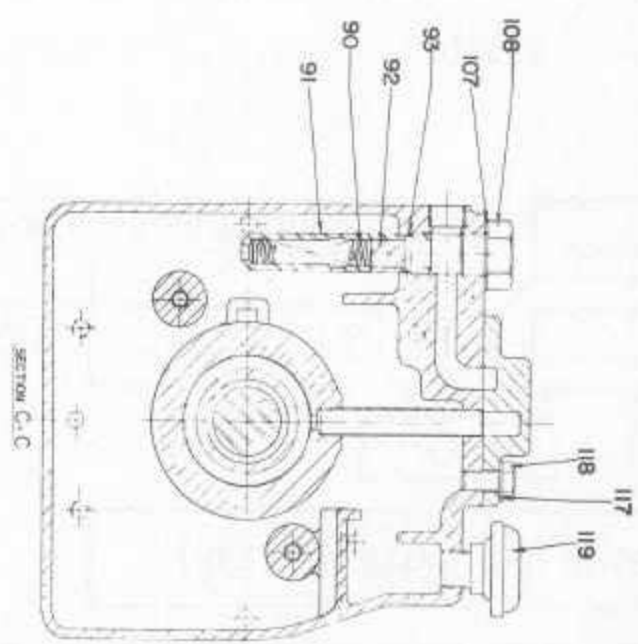
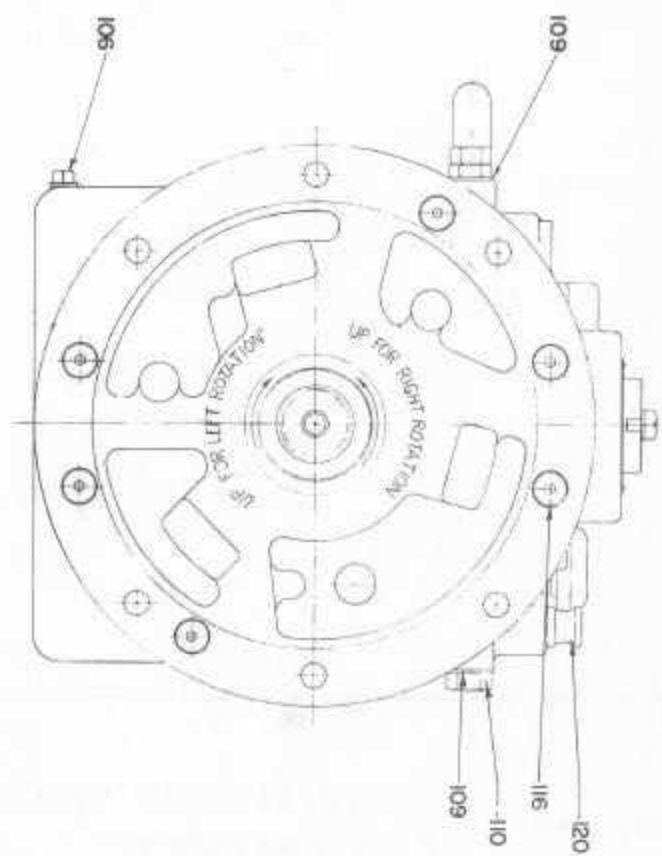
Chart 4



REMEDY

1. Check the following items:
 - a. Hole in oil cooler element permitting water to seep into oil compartment. Replace oil cooler element.
 - b. Oil cooler gaskets. Check gaskets and replace.
2. Defective front end plate oil seal. Replace oil seal.
3. Check for damaged gaskets. Replace gaskets.
 - a. Oil seeping from breather. Check for too high oil level.
 - b. Defective rear end oil seal. Replace oil seal.
4. a. See Chart 4, Item #1.
b. Check for defective gaskets and seal.





LUBRICATION

The model HF7 transmission is a self contained unit, independent of the engine lubricating systems. The unit is lubricated by pressure and by splash from its own oil. The type of oil recommended is "Transmission Fluid, Type A", commonly used for automatic transmissions in automobiles.

The quantity of oil depends upon the angle of installation, as well as the reduction model. The level must be maintained at the high mark on the dipstick and should be checked periodically to ensure satisfactory operation.

When filling for the first time or refilling after an oil change, check the level after running for a few minutes to make certain that the oil cooler and the various passages are full. If necessary, refill to the high mark on the dipstick to ensure proper operation of the transmission.

The oil in the transmission should be changed every 100 hours, or each season under normal conditions. However, the number of hours that can be run between oil changes varies with the oper-

ating conditions. Drain plugs are located at the bottom of the reverse gear housing and the reduction gear housing.

MODEL AND SERIAL NUMBERS

Each reverse gear has a model number and a serial number. These numbers are on the name plate, located on the cover of the transmission. These numbers are also duplicated on the periphery of the planetary gear case, located on the forward end. A reverse gear which has a reduction unit attached has two model and serial numbers. The reverse gear numbers are located as above. The reduction gear model and serial numbers are on the name plate of the reduction unit, located on the upper side of the reduction gear housing. Unless the transmission has been altered after it has left the factory, the serial number on the reduction gear is the next consecutive number. For example, the reverse gear serial number may be 4B-1234 and the reduction gear serial number will be 4B-1235. Thus a direct drive reverse gear or transmission has one serial number and a transmission with a reverse gear and a reduction gear has two serial numbers.

The model and serial numbers for a direct drive may appear as **HF7D-R 4C-1234**.

The model and serial numbers for a reduction drive unit may appear as **HF7B2-R 4C-1235** on the reverse gear and **RB20-R 4C-1236** on the reduction gear.

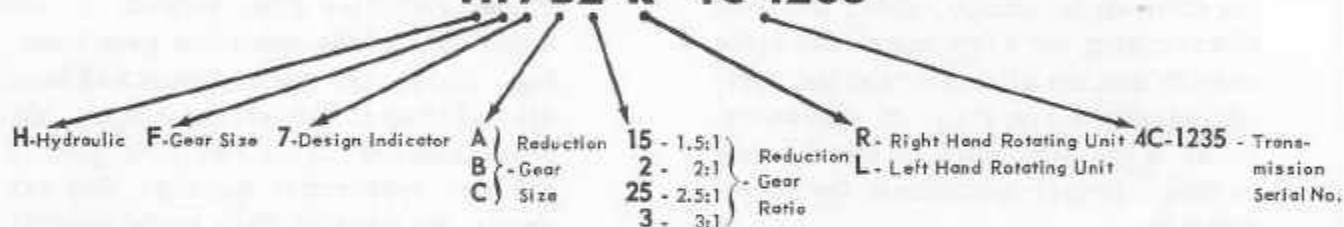
DIRECT DRIVE MODEL AND SERIAL NUMBERS

HF7D-R 4C-1234



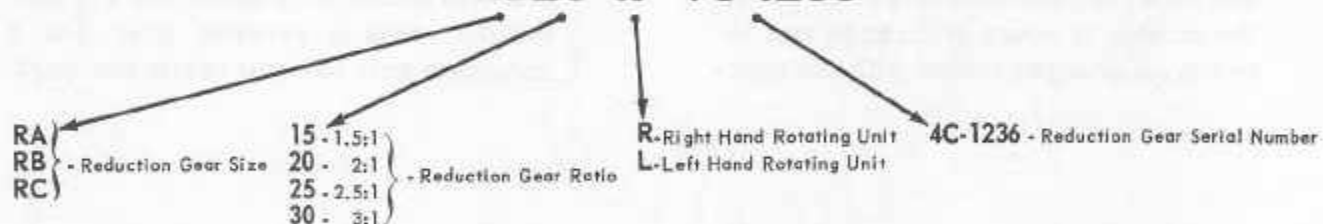
REVERSE GEAR MODEL AND SERIAL NUMBERS

HF7B2-R 4C-1235



REDUCTION GEAR MODEL AND SERIAL NUMBERS

RB20-R 4C-1236



Transmissions that have R after the model number are intended for right hand rotating engines and transmissions that have L after the model number are intended for left hand rotating engines. For example, **HF7B2-R** is intended for right hand rotation and **HF7B2-L** is intended for left hand rotation.

To determine the rotation of an engine, refer to section on "ROTATION DESIGNATION".

DISASSEMBLY OF TRANSMISSION

As in any servicing operation, cleanliness is a must and all rules for good workmanship apply. Some of these rules are as follows:

1. Use only clean fluid in any cleaning or washing of parts.
2. Use only clean oil, preferably Transmission Fluid, Type A, when pressing parts together.
3. Never press a ball bearing so that the force is carried through the balls.
4. Never use a hammer to drive ball bearings, needle roller bearings or oil seals in place.
5. Use only properly sized wrenches in removing or securing nuts and capscrews.
6. Replace gaskets and "O" rings with new material.
7. Work on a clean bench and protect gear teeth and oil seal surfaces from nicks and scratches.
8. Lubricate the lips of new oil seals with clean, light grease applied with a soft brush before installing on the running surface.

Before removing the transmission from the engine, disconnect all control cables, and oil lines to the cooler. The propeller half coupling should be disconnected and slid back approximately 4 inches. Remove the dipstick from the housing and drain all of the lubricating oil before removing the transmission to avoid spilling the oil in the boat.

DISASSEMBLY NEED BE CARRIED OUT ONLY AS FAR AS IS NECESSARY TO CORRECT THOSE DIFFICULTIES WHICH INTERFERE WITH PROPER FUNCTIONING OF THE TRANSMISSION.

REMOVAL OF REDUCTION GEAR ASSEMBLY FROM THE REVERSE GEAR ASSEMBLY

NOTE: To facilitate removal of the transmission from the engine, it is easier to remove the reduction gear assembly first. Make certain that all of the oil is removed from the reverse and reduction units before removal is attempted.

1. Remove capscrews and lockwashers around flange of reduction gear housing.
2. Strike gear half coupling flange with a soft mallet to break reduction gear unit from the reduction adapter plate. Slide entire reduction unit straight back approximately 3 inches until reduction unit clears reduction drive gear and lift reduction unit clear of reverse gear assembly.

NOTE: Refer to Reduction Gear Service Manual for disassembly and assembly of reduction unit.

REMOVAL OF COMPLETE TRANSMISSION ASSEMBLY FROM ENGINE

1. Remove six bolts and washers from around flange of reverse gear housing.
2. Slide entire reverse gear assembly straight back approximately 3 inches until transmission is clear of engine.

DISASSEMBLY OF COVER

FIGURE 7

1. Remove six capscrews (118) and seal washers (117) around flange and cover.
2. Lift cover (68) from top of reverse gear housing assembly by rotating slightly. This will leave the reverse piston (87) and assembled linkage remaining on the reverse gear housing assembly.
3. Remove reverse band adjusting screw nut (113) and back out reverse band adjusting screw (111) approximately 1 inch.
4. Lift reverse piston (87) and assembled linkage from top of reverse gear assembly.

NOTE: Make notation of position of linkage, i.e. to which side levers (81) are attached.

5. Remove reverse piston "O" ring (89) from groove in reverse piston (87).
6. Remove retaining ring (88) in counterbore of reverse piston using tool T-4727 and remove reverse piston from reverse piston shaft (84). Remove piston back-up plate (86) from reverse piston shaft and remove "O" ring (85) from groove in bore in piston back-up plate.
7. Remove retaining ring (41) from end of reverse piston shaft pin (83) and remove reverse piston shaft pin (83) from reverse band lever (81) and reverse piston shaft. Remove retaining ring (41) from other end of reverse piston shaft pin.
8. Remove retaining ring (41) from end of reverse band roll pin (80) and remove reverse band roll pin from levers (81)

and reverse band roll (82). Remove retaining ring (41) from other end of reverse band roll pin.

9. Remove capscrew (79) and seal washer (78) from cover (68) and remove detent spring (77) and remove ball detent (76).
10. Remove control valve retaining ring (72) from counterbore on under side of cover (68).
11. Remove assembled control valve from top of cover by pulling on control lever (73).
12. Remove capscrew (75) and lockwasher (74) from control lever (73) and remove control lever from control valve (70).
13. Remove control valve "O" ring (71) from groove in control valve (70).
14. It is not necessary to remove control lever pin (69) in control valve for further servicing. However, if control valve pin has become damaged and needs replacing, it may be removed by gripping with a plier and twisting.
15. Unless damaged, it is not necessary to remove control lever pins (69) and pipe plugs (67 and 66) from cover.

DISASSEMBLY OF FRONT END PLATE AND PUMP

FIGURE 9

1. Remove six flat-head socket capscrews (116) around flange of front end plate assembly.

NOTE: To assure proper assembly, make notation of direction of cast arrow on front end plate before removing front end plate.

2. Place assembly tool T-4689 over splined end of engine gear (9) to protect oil seal during removal of front end plate.
3. Lift front end plate assembly, figure 10, from housing assembly taking care not to damage front oil seal in front end plate.
4. Remove pump drive key (115) from engine gear (9).
5. Remove six capscrews (105) and six lockwashers (104) from pump housing (99), figure 9.
6. Remove pump port plate (102) from front end plate. Care must be taken not to damage pump housing pins (98).
7. Remove pump port plate (102) from pump housing and remove inner pump gear (101) and outer pump gear (100) from cavity in pump housing.

NOTE: Care must be taken not to damage port plate seal (103) during disassembly.

8. It is not necessary to remove two pump pins (98) from pump housing (99) for further servicing. However, if pump housing pins have become damaged and require replacing, they may be removed by gripping with a plier and twisting.
9. Unless damaged and they require replacing, do not attempt removal of roller bearing (97) and front end plate thrust washer (96) from front end plate.
10. Unless damaged and it requires replacing, do not attempt removal of oil seal (94) from front end plate. If necessary to remove oil seal for replacement, take care not to damage roller bearing (97) and front end plate thrust washer (96).

REMOVAL OF GEAR CASE ASSEMBLY FROM REVERSE GEAR HOUSING - Reduction Gear Models

FIGURE 6

1. Remove reverse band (114) from gear case inside reverse gear housing.
2. Remove cotter pin (56) from reverse gear tailshaft (19) and remove reverse gear tailshaft nut (49).
3. Support reverse gear housing face down so that gear case may drop free approximately 3 inches.
4. Press on reverse gear tailshaft until tailshaft is free of reduction drive gear.
5. Lift reverse gear housing straight up from gear case assembly until housing clears tailshaft.
6. Remove capscrews (55) and lockwashers (54) and remove crescent (53).
7. Remove capscrews (51) that secure reduction adapter plate (50) to reverse gear housing and remove reduction adapter plate (50), ball bearing (48) and reduction drive gear (47) assembly from reverse gear housing (37).
8. Press ball bearing (48) and reduction drive gear (47) from reduction adapter plate (50) and press ball bearing from reduction drive gear.
9. Remove thrust washer (46) from counterbore in rear of reverse gear housing (37).
10. Unless damaged and in need of replacing, do not remove oil suction tube (36), oil distributor tube (38), baffle (39), reverse band housing pins (42), pipe

plug (106), capscrew (110) and brass washer (109) or hex. nut (112) from housing. If necessary to replace, make note of location of each to aid reassembly.

11. Remove all old gaskets from reduction adapter plates, cover and housing.

REMOVAL OF GEAR CASE ASSEMBLY FROM REVERSE GEAR HOUSING - Direct Drive Models

FIGURE 6

1. Bend tang of lockwasher (62) away from locknut (63) and remove locknut from reverse gear tailshaft (18) while holding gear half coupling (61) with spanner wrench.
2. Support reverse gear housing face down so that gear case may drop free approximately 3 inches.
3. Press on reverse gear tailshaft until tailshaft is free of gear half coupling. Lift reverse gear housing straight up until housing clears tailshaft.
4. Remove capscrews (65) and seal washers (64) that secure direct drive plate (59) to reverse gear housing (37) and remove direct drive plate (59), ball bearing (60) and gear half coupling (61) from reverse gear housing.
5. Press gear half coupling (61) from ball bearing (60) and press ball bearing (60) from rear end plate (59).
6. If necessary to replace, remove oil seal (58) from direct drive plate.
7. Unless damaged and in need of replacing, do not remove oil suction tube (36),

oil distributor tube (38), baffle (39), reverse band housing pins (42), pipe plug (106), capscrew (110) and brass washer (109), reverse band adjusting screw (111), or hex. nut (112) from housing. If necessary to replace, make note of location of each to aid reassembly.

DISASSEMBLY OF GEAR CASE

FIGURE 5

1. ON DIRECT DRIVE MODELS ONLY. Remove Woodruff key (35), tailshaft seal washer (34) and thrust washer (33) from end of tailshaft (18).

ON REDUCTION MODELS ONLY. Remove tailshaft retaining ring (32) from tailshaft (19) using tool T-4726.

2. Remove screw collar thrust washer (20) from end of tailshaft.
3. If necessary to replace, remove oil distributor seal rings (31) from ring grooves in screw collar (25).
4. Bend sides of screw collar clip (29) away from head of lock screw (30) and remove lock screw and clip from screw collar (25).
5. Using spanner wrench T-4391, remove screw collar (25) from end of gear case (2) while clamping gear case.
6. Remove forward piston (28) from screw collar by tapping open face of screw collar on wooden surface.
7. Remove "O" rings (26) and (27) from outside and inside diameters of piston.

8. If necessary to replace, remove screw collar needle bearing (24) from screw collar.
9. Lift clutch plates (21) and (22) and clutch springs (23) from end of gear case.
10. Remove propeller gear thrust washer (20) from end of tailshaft.
11. Remove tailshaft assembly (19 or 18) from gear case (2). Remove engine gear thrust washer (17) from end of tailshaft assembly. Note: Washer may retain inside gear case (2).
12. Bend sides of case clip (15) away from head of cap screw (16) and remove cap screw (16), case clip (15) and pinion shaft locking tab (14) from gear case (2).
13. Drive pinion shaft (7) from one of short pinions (10) from threaded end of gear case approximately 1/2 inch. Push pinion shaft on through with dummy shaft T-4725 until dummy shaft is centered in short pinion. Remove short pinion and dummy stud from gear case (2). Remove pinion shaft and short pinion spacer (13) from gear case.
14. Replace dummy shaft with pinion shaft (7) and remove remaining short pinions.
15. Remove engine gear (9) from inside gear case (2).
16. Remove long pinions (3) from gear case, using T-4724 as in #13 above. Remove thrust pads (4) from inside gear case.
17. Do not remove engine gear roller bearings (8) unless damaged and replacement is necessary.
18. Do not remove gear case needle bearing (1) unless necessary to replace.

DISASSEMBLY OF RELIEF VALVE

FIGURE 8

1. Remove relief valve cap screw (108) and relief valve seal (107) from reverse gear housing (37).
2. Using tool T-4608, remove relief valve assembly from reverse gear housing.
3. Hold relief valve body in vise with threaded end up. Depress relief valve plug (92) with screwdriver until relief valve pin (93) may be removed from side of relief valve body.
4. Remove relief valve plug (92) and relief valve spring (90) from relief valve body.

REASSEMBLY OF TRANSMISSION

INSPECTION

All parts should be thoroughly cleaned before inspection. Parts showing excessive wear should be replaced.

1. Ball and roller bearings should be examined for indications of corrosion and pitting on balls or rollers and races.
2. Long and short pinion roller bearings should be examined for wear.
3. Pinion shafts should be examined for wear or "brinelling" (wear on pinion shaft caused by rollers).
4. Long and short pinion thrust pads, roller spacers and short pinion spacers should be examined for wear.
5. Long and short pinion bore diameter should be examined for wear.

6. All gear teeth should be examined for "pitch line pitting", uneven wear pattern or excessive wear.
7. All shafts should be examined for wear on splines and shoulders.
8. Clutch plates should be examined for flatness, roughness, indication of excessive heating and wear or peening of driving lugs.
9. Clutch plate carrier should be examined for wear and peening of involute splines.
10. Examine all "O" rings for cuts, flattening or evidence of rolling.
11. Examine all oil seals for rough or charred lips.
12. Oil pump parts should be examined for wear.
13. Reverse band links, pins and adjusting screw should be examined for wear or bending.
14. Reverse band lining should be examined for wear.

NOTE: Lining should be replaced before rivets come in contact with gear case.

15. Gear case should be examined for wear from reverse band lining, short or long pinions wearing into inside face or wear in clutch plate slots on threaded end.
16. Oil distributor seal rings should be examined for wear on outside diameter and on side away from pressure.
17. Screw collar should be examined for

wear where oil distributor seal rings run.

18. All retaining rings should be examined for burrs or deformities.
19. All old gaskets should be replaced.
20. All oil passages should be checked to make certain that they are clear.
21. All external oil lines, water lines and oil coolers are furnished by the engine builder. Check recommendations before attempting to clean any of this equipment.
22. Engine gear should be examined for wear on oil seal surface, roller bearing races and gear teeth for pitch line pitting, uneven wear or excessive wear.
23. Vibration dampers should be checked at springs and splines for wear.
24. Check relief valve plug and relief valve body for scoring or burrs.

ASSEMBLY OF GEAR CASE

DIRECT AND REDUCTION MODELS

FIGURE 5

1. Press gear case needle bearing (1) into gear case (2), using bearing assembly tool T-4602.
2. Assemble long pinions (3) and roller bearings (5) and thrust pads (4) etc., as follows:
 - (a) Place long pinion (3) on one end on thrust pad (4) and insert dummy shaft T-4724 into long pinion.

- (b) Insert four roller bearings (5) equally spaced around dummy shaft to center shaft in pinion; then assemble remaining rollers in first row. Thirty-two roller bearings complete one row. Install long pinion bearing spacer (6) over dummy shaft next to first row of roller bearings, then assemble second row of roller bearings.

NOTE: Smear dummy shaft with cup grease to prevent rollers from dropping out. Use extreme care when handling assembled pinions to prevent roller bearings from dropping out during assembly, into gear case.

- (c) Lay gear case (2) on side and insert long pinion (3) with dummy shaft and roller bearings in gear case from threaded end of case. Long pinion should align with one hole in outer row of pinion shaft holes. Insert thrust pad (4) between long pinion and front wall of gear case. Note that each thrust pad aligns with one hole on outer row and one hole on inner row of pinion shaft holes and that the curvature of thrust pad follows curvature of gear case.

- (d) Insert pinion shaft (7), plain end first, into unthreaded end of gear case and push through thrust pad and pinion as far as rear wall of gear case, forcing out dummy shaft.

- (e) Remove dummy shaft, insert second thrust pad (4) between long pinion and rear wall of gear case and start pinion shaft into rear wall of gear case. Do not drive pinion shaft all the way into gear case until all shafts are inserted.

- (f) Assemble remaining long pinions into gear case.

3. Press first engine gear roller bearing (8) into engine gear (9) using bearing assembly tool T-4603. Install second engine gear roller bearing into engine gear using T-4670.

4. Install engine gear (9) with assembled engine gear roller bearings into gear case (2) from threaded end of gear case, meshing teeth on engine gear and long pinions already assembled into gear case. The splined end of the engine gear should protrude from the front end of the gear case.

5. Assemble short pinion (10) and roller bearings (11) etc., as follows:

- (a) Place short pinions (10) on one end on flat surface and insert dummy shaft T-4725 into short pinion.

- (b) Insert four roller bearings (11) equally spaced around dummy shaft to center shaft in pinion; then assemble remaining rollers in first row. Thirty-two roller bearings complete one row.

Insert short pinion bearing spacer (12) over dummy shaft next to first row of roller bearings, then assemble second row of roller bearings.

NOTE: Smear dummy shaft with cup grease to prevent rollers from dropping out. Use extreme care when handling assembled pinion to prevent roller bearings from dropping out during assembly into gear case.

- (c) Line up thrust pad (4) already in gear case and insert pinion shaft (7), plain end first, into unthreaded end of gear case, through thrust pad so that pinion shaft protrudes approximately one inch into gear case. Place short pinion spacer (13) over end of protruding pinion shaft.
 - (d) Smear ends of roller bearings with cup grease.
 - (e) Insert short pinion assembled with roller bearings, etc., into gear case, meshing teeth on short pinion and long pinion already in gear case. Line short pinion over pinion shaft and short pinion spacer already in gear case and push pinion shaft through short pinion as far as rear wall of gear case, forcing out dummy shaft.
 - (f) Remove dummy shaft, line up second thrust pad (4) already in gear case and start pinion shaft into rear wall of gear case. Do not drive pinion shaft all the way into gear case until all shafts are inserted.
 - (g) Assemble remaining short pinions into gear case.
6. Align slots in each pair of pinion shafts so that slots face each other and are parallel. Insert pinion shaft locking tab (14) into slots in pinion shaft. Make certain that the pinion shafts and pinion shaft locking tabs are seated against gear case. Place case clip (15) over top of pinion shaft locking tab lining up holes with threaded holes in gear case and formed end of case clip over edge of locking tab toward center of gear case. Install capscrew (16) and secure tightly. Bend pre-formed end of case clip up around head of capscrew.

7. Install engine gear thrust washer (17) over smaller end of tailshaft assembly (18) or (19).

NOTE: Tailshaft assembly (18) is for direct drive and tailshaft assembly (19) is for reduction drive.

8. Install tailshaft assembly into gear case from the threaded end of the gear case meshing the gear teeth on the tailshaft assembly with the short pinions already in the gear case. Make certain that tailshaft assembly is seated properly and rotates freely without any apparent binding.
9. Install propeller gear thrust washer (20) over end of tailshaft assembly seating against propeller gear on tailshaft.
10. Install steel clutch plates (21) clutch springs (23) and bronze clutch plates (22) in clutch plate cavity in threaded end of gear case as follows:
- (a) Place one steel clutch plate (21) with lugs in notches of gear case and place one bronze clutch plate (22) over teeth on clutch plate carrier on tailshaft.
 - (b) Place second steel clutch plate (21) next to bronze clutch plate in clutch plate cavity in gear case so that holes in lugs of second steel clutch plate do not line up with holes in lugs of first steel clutch plate.
 - (c) Install remaining bronze clutch plates (22) and steel clutch plates (21) alternating bronze and steel until all but one steel clutch plate (21) is in place. Make certain that the holes in the lugs of these last steel clutch plates line up with holes in second steel plate.

- (d) Install clutch springs (23) in holes of steel clutch plates. Place remaining steel clutch plate next to last bronze clutch plate so that holes in lugs do not line up with holes in preceding steel clutch plates so that clutch springs (23) will not come out.

NOTE: Make certain that all clutch plates ride freely on their respective lugs and that no binding is apparent during assembly.

11. Press screw collar needle bearing (24) into screw collar (25) using bearing assembly tool T-4671.
12. Install "O" rings (26) and (27) to outside diameter and inside diameter of forward piston (28).
13. Install forward piston with "O" rings into screw collar (25). Lubricate "O" ring surfaces of screw collar with light oil before installing forward piston into screw collar.

NOTE: Use care in installing forward piston as not to roll or damage "O" rings on internal threads in screw collar.

14. Clamp gear case in vise with engine gear protruding down. Place screw collar with assembled forward piston and screw collar needle bearing over tailshaft and screw down screw collar using spanner wrench T-4391. Screw collar should be tightened until threaded holes in periphery of screw collar line up with drilled holes in gear case.

15. Line up screw collar clip (29) over one threaded hole in screw collar with lip over edge of screw collar. Install lock-screw (30) and tighten until two sides of lock-screw head are parallel with sides of clip. Bend pre-formed sides of clip up around head of lock-screw. Add second lockclip and lock-screw.

16. Install two oil distributor seal rings (31) in ring grooves of screw collar.

NOTE: Use care in expanding oil distributor seal rings when installing so as not to break rings.

17. Up-end gear case assembly and place on end of engine gear. Place screw collar thrust washer (20) over end of tailshaft making certain that it rests flat against screw collar.
18. ON REDUCTION MODELS ONLY. Install tailshaft retaining ring (32) in groove in tailshaft (19) next to screw collar thrust washer (20) using retaining ring expander T-4726. Make certain that retaining ring seats properly in groove.

ON DIRECT DRIVE MODELS ONLY. Place tailshaft thrust washer over end of tailshaft (18) next to screw collar thrust washer (20) making certain that tailshaft thrust washer (33) seats properly against shoulder on tailshaft (18). Place tailshaft seal washer (34) over tailshaft next to tailshaft thrust washer and install woodruff key (35) in keyway in tailshaft.

ASSEMBLY OF GEAR CASE IN REVERSE GEAR HOUSING

REDUCTION DRIVE MODELS

FIGURE 6

1. Assemble oil suction tube (36) in hole in flange of reverse gear housing (37) using suction tube assembly tool T-4672.
2. Insert oil distributor tube (38) in hole in top of reverse gear housing, making certain that tube is seated in bottom of hole and is below top surface of reverse gear housing.
3. Install baffle (39) into reverse gear housing (37) until back side rests on bosses in back of reverse gear housing. Fasten with flat head socket capscrews (40).
4. Assemble retaining ring (41) to reverse band housing pin (42) and install reverse band housing pin (42) into drilled bosses on inside housing near elongated slot in top. There are two pins, one for each side.
5. Place new gaskets (43), (44) and (45) on reverse gear housing (37). Note that front gasket (43) holds reverse band housing pin (42) in place in housing.
6. Place reverse gear housing (37) on side with cover opening up. Turn oil distributor seal rings (31) in screw collar (25) so that gaps of rings are together and are facing up.
7. Place gear case assembly, figure 5, in reverse gear housing with tailshaft protruding through bore in rear of reverse gear housing.
8. Hold gear case by end of tailshaft and by end of engine gear. Start screw collar into bore in rear of reverse gear housing. Ease oil distributor seal rings into chamfer on bore of reverse gear housing with gentle up-and-down rocking motion. Do not force rings into housing or rings may break. Lubricate bore in housing before assembly to ease installation.
9. Up-end reverse gear housing and gear case with reverse gear tailshaft up, using care that oil distributor seal rings do not slip from housing bore and place entire assembly on end of engine gear.
10. Place thrust washer (46) with counter-bored side down over reverse gear tailshaft so that counterbore goes over retaining ring on tailshaft. Make certain that screw collar thrust washer (20) is seated properly on screw collar.
11. Press reduction drive gear (47) into ball bearing (48).
12. Press reduction drive gear and ball bearing on reverse gear tailshaft until ball bearing is seated against thrust washer. Thread on reverse gear tailshaft nut (49).
13. Press reduction gear adapter plate (50) over ball bearing. Install four socket head capscrews (51) in reduction adapter plate (50). Use two reduction adapter plate seals (52) in two uppermost holes under head of capscrew.
14. Place reduction gear crescent (53) on reduction adapter plate and fasten with lockwashers (54) and capscrews (55).
15. Check oil circulation holes, one at bottom of crescent and one at approximately 10 o'clock, to be certain that they are clear into reverse gear housing.

16. Tighten all capscrews. Tighten reverse gear tailshaft nut (49) until cotter pin (56) can be installed through castellation in nut and hole in reverse gear tailshaft.
17. Install cotter pin (56) and bend ends around sides of nut and NOT over end of shaft to provide clearance with reduction unit.
18. Place new gasket (57) on reduction adapter plate.

ASSEMBLY OF GEAR CASE IN REVERSE GEAR HOUSING

DIRECT DRIVE MODELS

FIGURE 6

1. Follow steps #1 through #8 as in Assembly of Gear Case in Reverse Gear Housing - Reduction Drive Models, above.
2. If removed for replacement, press new oil seal (58) into direct drive plate (59). Oil seal should be pressed in from the small end or outside of direct drive plate. Press ball bearing (60) into direct drive plate.
3. Place direct drive plate, oil seal and ball bearing assembly on suitable support and press gear half coupling (61) into oil seal and ball bearing until gear half coupling is seated properly against ball bearing. Care must be taken not to damage oil seal during assembly.
4. Up-end reverse gear housing and gear case with reverse gear tailshaft up, using care that oil distributors seal rings do not slip from housing bore and place entire assembly on end of engine gear.
5. Make certain that screw collar thrust washer (20) is seated against screw collar (25) and that thrust washer (33) is seated against shoulder on tailshaft (18).
6. Place direct drive plate and gear half coupling assembly over reverse gear tailshaft with keyway in gear half coupling lined up with key in reverse gear tailshaft and press together until ball bearing is seated against thrust washer (33).
7. Place lockwasher (62) over reverse gear tailshaft with tang on lockwasher in keyway in gear half coupling and thread locknut (63) on reverse gear tailshaft.
8. Install six seal washers (64) and six capscrews (65) in holes in direct drive plate and bolt to reverse gear housing.
9. Tighten all capscrews. Tighten locknut (63) and bend up one tang on lockwasher (62) over locknut.

COVER ASSEMBLY

FIGURE 7

1. Install pipe plugs (66) and (67) into cover (68). Install two control lever pins (69) into top of cover (68).
2. Assemble one control lever pin (69) to top of control valve (70).
3. Assemble control valve "O" ring (71) to groove at top of control valve (70).
4. Place control valve lever (73) over control valve lever pin on control valve.

5. Install lockwasher (74) and capscrew (75) in hole in control lever (73) and into threaded hole in control lever.
 6. Install assembled control valve into cover (68) from top side of cover, so that the handle of the control valve lever is aft. Lubricate bore of cover before installing control valve to aid in installing. Care must be taken not to damage "O" ring during assembly. Assemble control valve retaining ring (72) to control valve from underside of cover.
 7. Make certain that control lever and control valve rotate freely.
 8. Install ball detent (76) into hole in side of cover and rotate control valve until ball detent drops into detent in control valve.
 9. Install detent spring (77) on top of ball detent in cover. Install seal washer (78) and capscrew (79) and tighten capscrew. Rotate control valve to make certain that ball detent operates smoothly in forward, neutral and reverse.
 10. NOTE: The following items may be assembled together at this time; however, DO NOT assemble into cover at this time.
 11. Assemble retaining ring (41) to one end of reverse band roll pin (80). Install reverse band roll pin through hole in short leg of one reverse band lever (81). Place reverse band roll (82) over end of reverse band roll pin and install second reverse band lever (81) over end of reverse band roll pin (80). Make certain that both levers are installed so as to line up. Install retaining ring (41) over end of reverse band roll pin.
 12. Assemble retaining ring (41) to end of reverse piston shaft pin (83). Install reverse piston shaft pin through hole in long leg of one reverse band lever (81), through hole in reverse piston shaft (84) and through hole in long leg of second reverse band lever (81). Assemble retaining ring (41) to end of reverse piston shaft pin (83).
 13. Install piston backup plate "O" ring (85) into groove in bore of piston backup plate (86). Install reverse piston shaft (84) and assembled links into piston backup plate (86) using tool T-4688 to avoid damaging "O" ring. Chamfered side of piston backup plate (86) should be opposite linkage.
 14. Install reverse piston (87), with counterbored side up, over end of reverse piston shaft (84) and assemble reverse piston retaining ring (88), using assembly pliers T-4727, into groove in reverse piston shaft so that retaining ring (88) is seated properly in counterbore of reverse piston.
 15. Install reverse piston "O" ring (89) into groove in O.D. of reverse piston (87).
- NOTE: DO NOT assemble into cover at this time.

RELIEF VALVE ASSEMBLY

FIGURE 8

1. Place relief valve spring (90) in relief valve housing (91). Place relief valve plug (92) on top of spring in relief valve housing (91).
2. Clamp relief valve housing (91) in vise with relief valve plug up. Depress relief valve plug with screwdriver until

relief valve pin (93) can be pushed through holes in relief valve housing (91).

3. Install relief valve pin (93) in relief valve housing (91) and relax pressure on relief valve plug until plug holds pin in place.

FRONT END PLATE AND PUMP ASSEMBLY

FIGURE 9

1. Press oil seal (94) into front end plate (95) from front face or outside face of front end plate.
2. Press front end plate thrust washer (96) into front end plate, using assembly tool T-4673 until properly seated against bottom of bore.
3. Press roller bearing (97) into front end plate using assembly tool T-4602.
4. Install two pump housing pins (98) into pump housing (99).
5. Install outer pump gear (100) into cavity of pump housing (99).
6. Install inner pump gear (101) into cavity of pump housing (99) meshing teeth with outer pump gear.
7. Place pump port plate (102) over pump housing (99) with unchamfered side toward pump housing, lining up over pump housing pins (98) already in pump housing, and press together.
8. Line up pump housing pins (98) protruding through pump port plate (102) with holes in front end plate and bolt together using six lockwashers (104) and six capscrews (105).
9. Place port plate seal (103) over pump port plate (102). Port plate seal should be cemented in place with shellac or gasket cement. Port plate seal goes on side of port plate without chamfers.

TRANSMISSION ASSEMBLY

FIGURE 10

1. Install pipe plug (106) into drain hole of housing. Drain hole is located on the righthand side near the bottom of the housing.
2. Install relief valve assembly (figure 8) into reverse gear housing, using assembly tool T-4608. Make certain that relief valve is seated properly. Assemble relief valve seal (107) and relief valve capscrew (108) and tighten securely.
3. After final adjustments have been made, install breather (119) and dipstick (120).
4. FOR RIGHTHAND ROTATION. See Figure 4 and Figure 10: Install brass washer (109) and capscrew (110) to threaded-through hole in pad on left-hand side of housing. Install reverse band adjusting screw (111), brass washer (109) and hex. jam nut (112) to threaded hole in pad on righthand side of housing. DO NOT assemble reverse band adjusting screw nut (113) until adjustments have been made after final assembly.

FOR LEFTHAND ROTATION. See Figure 3 and Figure 10. Install brass washer (109) and screw (110) to threaded-through hole in pad on right-hand side of housing. Install reverse band adjusting screw (111), brass

washer (109) and hex. jam nut (112) to threaded hole in pad on lefthand side of housing. DO NOT assemble reverse band adjusting screw nut (113) until adjustments have been made after final assembly.

NOTE: Refer to notes taken during disassembly.

5. Assemble reverse band (114) to gear case inside housing so that lugs on reverse band are up and in line with reverse band adjusting screw. Position reverse band adjusting screw so that lug on reverse band can rest against it.
6. Install pump drive key (115) in hole in engine gear. Line up sides of pump drive key with engine gear.
7. Place assembly tool T-4689 over splined end of engine gear to protect oil seal during front end plate assembly.
8. Line up keyway in inner pump gear in front end plate assembly (figure 9) with pump drive key in engine gear. Slide front end plate assembly over engine gear until front end plate is seated properly against housing, engaging pump drive key with keyway in inner pump gear.
9. Rotate front end plate assembly to line up six bolt holes with reverse gear housing. Note that front end plate assembly can be located in one of two positions; i.e., up for right rotation or up for left rotation. Refer to notes taken during disassembly and figures 1 and 2 to properly orientate front end plate assembly.
10. Install six flat-head socket capscrews (116) to front end plate assembly and reverse gear housing and tighten securely.

11. Install assembled reverse piston and linkage (figure 7) into opening in top of reverse gear housing as follows:

- (a) Back off reverse band adjusting screw (111) until reverse band can be rotated past end of reverse band adjusting screw.
- (b) Rotate reverse band until reverse band roll on assembled linkage can pass between lug on reverse band and reverse band housing pin in housing.
- (c) Slip reverse band roll over squared end of lug on reverse band and hook notches of reverse band lever over reverse band housing pin in housing.
- (d) Insert screwdriver through opening in top of housing and rotate reverse band lug against reverse band roll. This will cause the reverse piston and piston back-up plate to drop down against the top of the housing.

NOTE: On righthand rotation, hook reverse band lever on reverse band housing pin on lefthand side of housing; and on lefthand rotation, hook reverse band lever on reverse band housing pin on righthand side of housing. Refer to notes taken during disassembly and figures 3 and 4.

- (e) Tighten reverse band adjusting screw until reverse band is snug.
12. Place cover and assembled control valve (figure 7) over reverse piston assembled to reverse gear housing, and line up bolt holes in cover with those in reverse gear housing.

13. Press down on cover, engaging reverse piston in cavity in cover. Care must be taken not to damage "O" ring on reverse piston during assembly. Lubricate bore in cover prior to assembly with light oil.
14. Install six seal washers (117) and six capscrews (118) in cover and tighten securely.

ASSEMBLY OF COMPLETE TRANSMISSION ASSEMBLY TO ENGINE

1. Install two studs in opposite side holes in engine adapting plate on engine so studs protrude approximately 3-1/2 inches.
2. Start reverse gear assembly over studs and slide entire assembly up against engine, engaging spline on engine gear in splined hole of vibration damper on engine.
3. Install four attaching bolts and washers (furnished by engine builder) in holes around flange of reverse gear housing.
4. Remove studs and install remaining two bolts and washers.

ASSEMBLY OF REDUCTION GEAR ASSEMBLY TO REVERSE GEAR ASSEMBLY

NOTE: Refer to reduction gear service manual for assembly of reduction unit.

1. Install two studs 3-1/2 inches long in two opposite holes in reduction adapter plate.
2. Position reduction gear assembly over studs with oil drain plug at bottom and slide onto reduction drive gear. It may be necessary to rotate reduction ring

gear slightly to properly mesh gear teeth.

3. Install lockwashers and capscrews around flange of reduction gear housing and tighten uniformly.

ADJUSTMENTS

With transmission secured to the engine, replace all oil lines, etc. Before securing the propeller half coupling to the gear half coupling, check to make certain that the couplings do not run out more than .002 inches with respect to each other.

The transmission should be filled with new oil as specified under "Lubrication".

The forward clutch is direct acting and has sufficient travel to compensate for wear. Therefore, there are no adjustments for the forward drive.

The adjustment for neutral and reverse is accomplished in a single procedure. To make the proper adjustment, the engine must be running at idle speed and the control lever must be in the neutral position. Remove the reverse band adjusting screw nut (113) from the reverse band adjusting screw (111) and

justing screw IN firmly until tight. Gear will now be reversing. Loosen adjusting screw just enough to get a good neutral. Loosen an additional 1/4

Then back OFF the adjusting screw 1/2 turn, tighten the locknut and replace the acorn nut. This adjustment is necessary ONLY at the time of original installation and periodically to compensate for wear of the lining of the reverse band.

TO CHANGE ROTATION OF TRANSMISSION

To change the transmission to another rotation (i.e., from a righthand turning engine to a lefthand turning engine, or a lefthand turning engine to a righthand turning engine) the transmission oil pump and reverse band and its linkage must be changed to fit the desired rotation.

With transmission removed from engine, remove six flat-head capscrews (116) from front end plate (95). Rotate front end plate 180°. See figures 1 and 2 to properly orientate front end plate assembly.

Remove cover assembly as outlined under "Disassembly of Cover", steps 1 through 4.

Change location of reverse band adjusting screw (111), etc. as outlined under "Transmission Assembly" step 4. Replace reverse piston and cover assembly as outlined under "Transmission Assembly" steps 11 through 14.

Refer to figures 3 and 4 for further details.

Figure 1
Left Hand

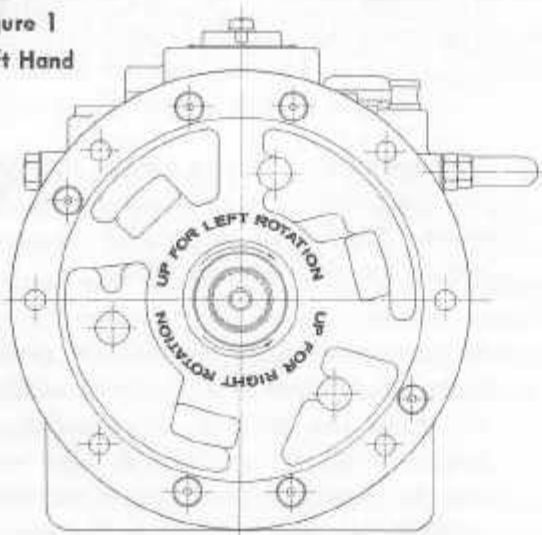


Figure 2
Right Hand

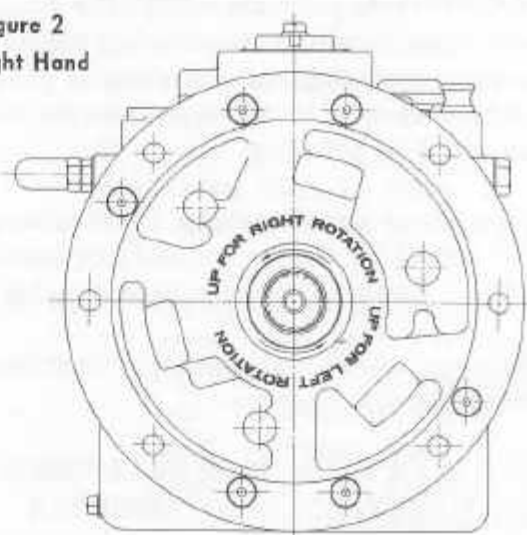


Figure 3
Left Hand

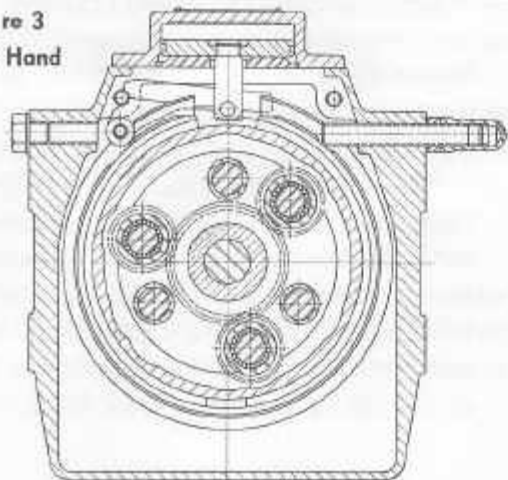
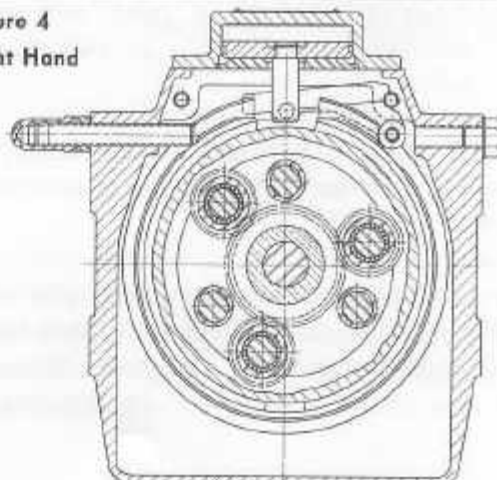


Figure 4
Right Hand



ALL VIEWS ARE SHOWN FROM FRONT OF TRANSMISSION

PARTS LIST AND EXPLODED VIEWS

PARTS LIST

KEY NO.	DESCRIPTION	KEY NO.	DESCRIPTION
1	Gear Case-Needle Bearing	34	Tailshaft Seal Washer
2	Gear Case	35	Woodruff Key
3	Long Pinion	36	Oil Suction Tube
4	Thrust Pad	37	Reverse Gear Housing
5	Roller Bearing	38	Oil Distributor Tube
6	Long Pinion Bearing Spacer	39	Baffle
7	Pinion Shaft	40	Flat Head Socket Capscrew
8	Engine Gear-Roller Bearing	41	Retaining Ring
9	Engine Gear	42	Reverse Band Housing Pin
10	Short Pinion	43	Front Gasket
11	Roller Bearing	44	Cover Gasket
12	Short Pinion Bearing Spacer	45	Rear Gasket
13	Short Pinion Spacer	46	Thrust Washer
14	Pinion Shaft Locking Tab	47	Reduction Drive Gear
15	Case Clip	48	Ball Bearing
16	Capscrew	49	Reverse Gear Tailshaft Nut
17	Engine Gear Thrust Washer	50	Reduction Gear Adapter Plate
18	Tailshaft Assembly-Direct Drive	51	Socket Head Capscrew
19	Tailshaft Assembly-Reduction Drive	52	Reduction Adapter Plate Seal
20	Thrust Washer	53	Reduction Gear Créscent
21	Steel Clutch Plate	54	Lockwasher
22	Bronze Clutch Plate	55	Capscrew
23	Clutch Spring	56	Cotter Pin
24	Screw Collar-Needle Bearing	57	Reduction Adapter Plate Gasket
25	Screw Collar	58	Oil Seal
26	Forward Piston "O" Ring-outer	59	Direct Drive Plate
27	Forward Piston "O" Ring-inner	60	Ball Bearing
28	Forward Piston	61	Gear Half Coupling
29	Screw Collar Clip	62	Lockwasher
30	Lockscrew	63	Locknut
31	Oil Distributor Seal Rings	64	Seal Washer
32	Tailshaft Retaining Ring	65	Capscrew
33	Tailshaft Thrust Washer	66	Pipe Plug

GEAR CASE ASSEMBLY

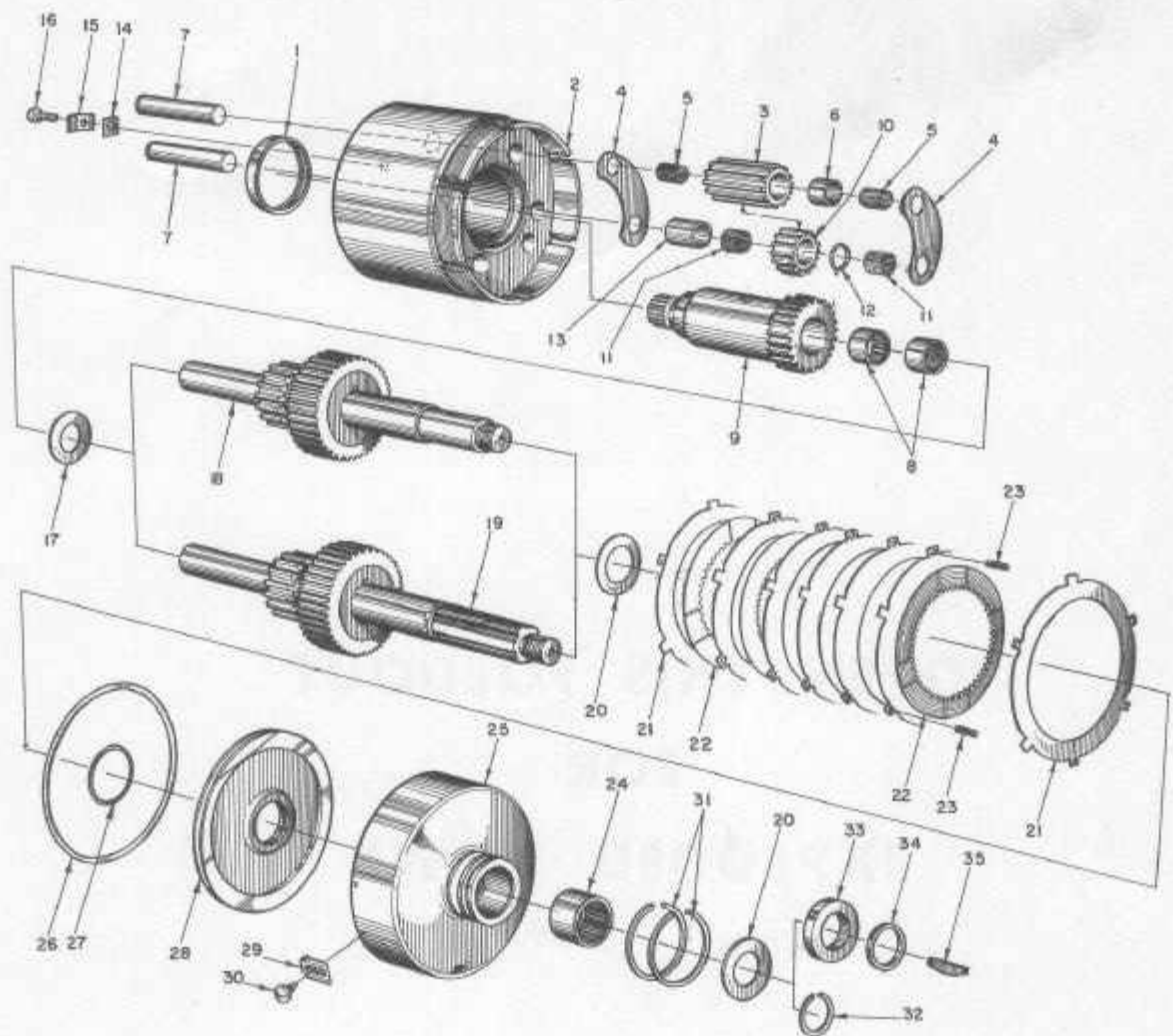


Figure 5

COVER ASSEMBLY

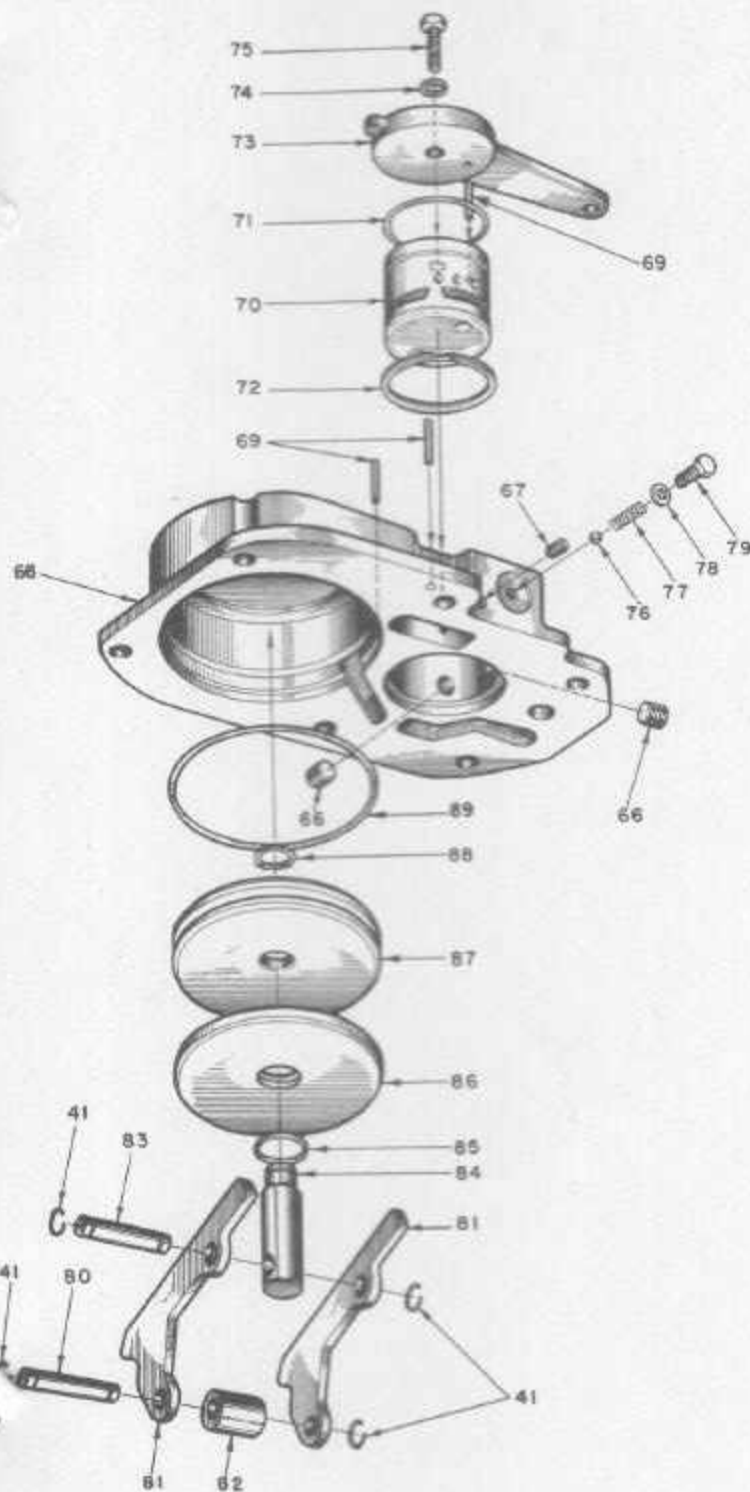


Figure 7

RELIEF VALVE ASSEMBLY

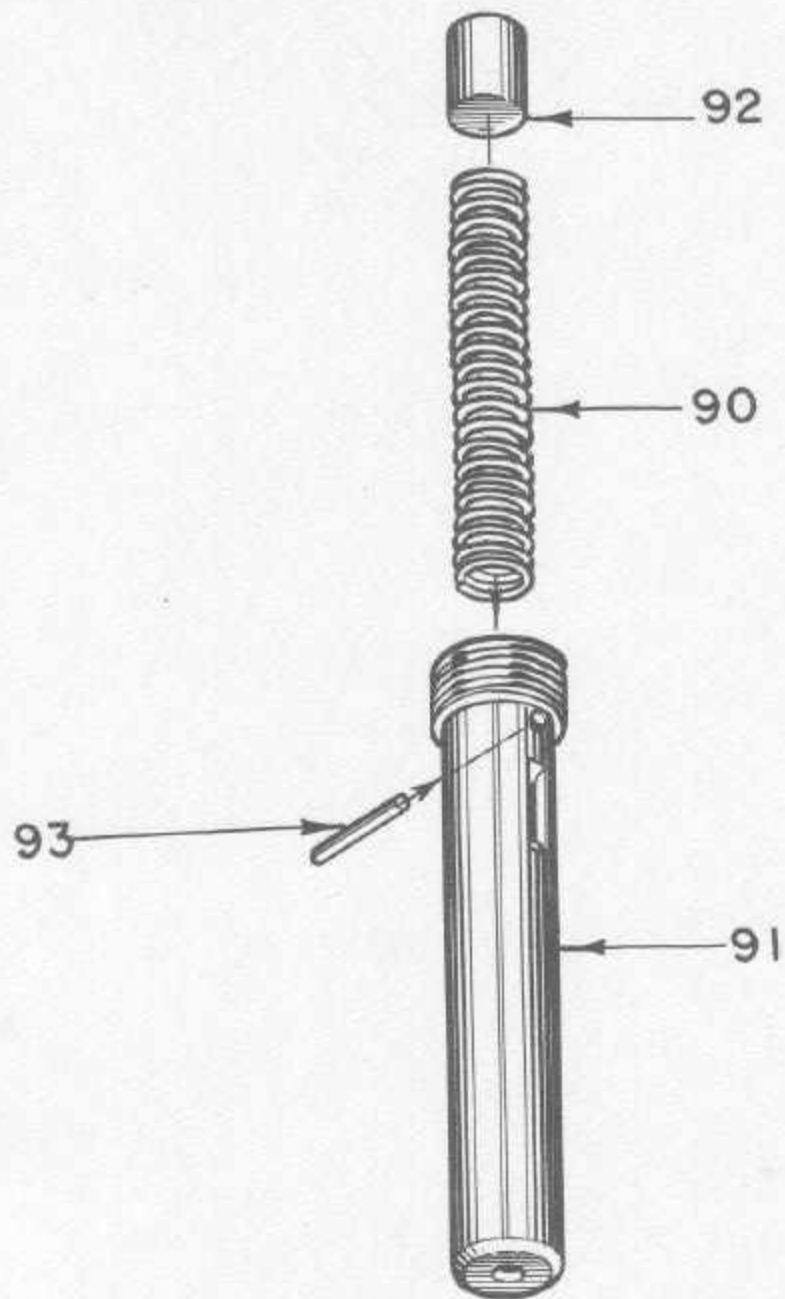


Figure 8

REVERSE GEAR HOUSING ASSEMBLY

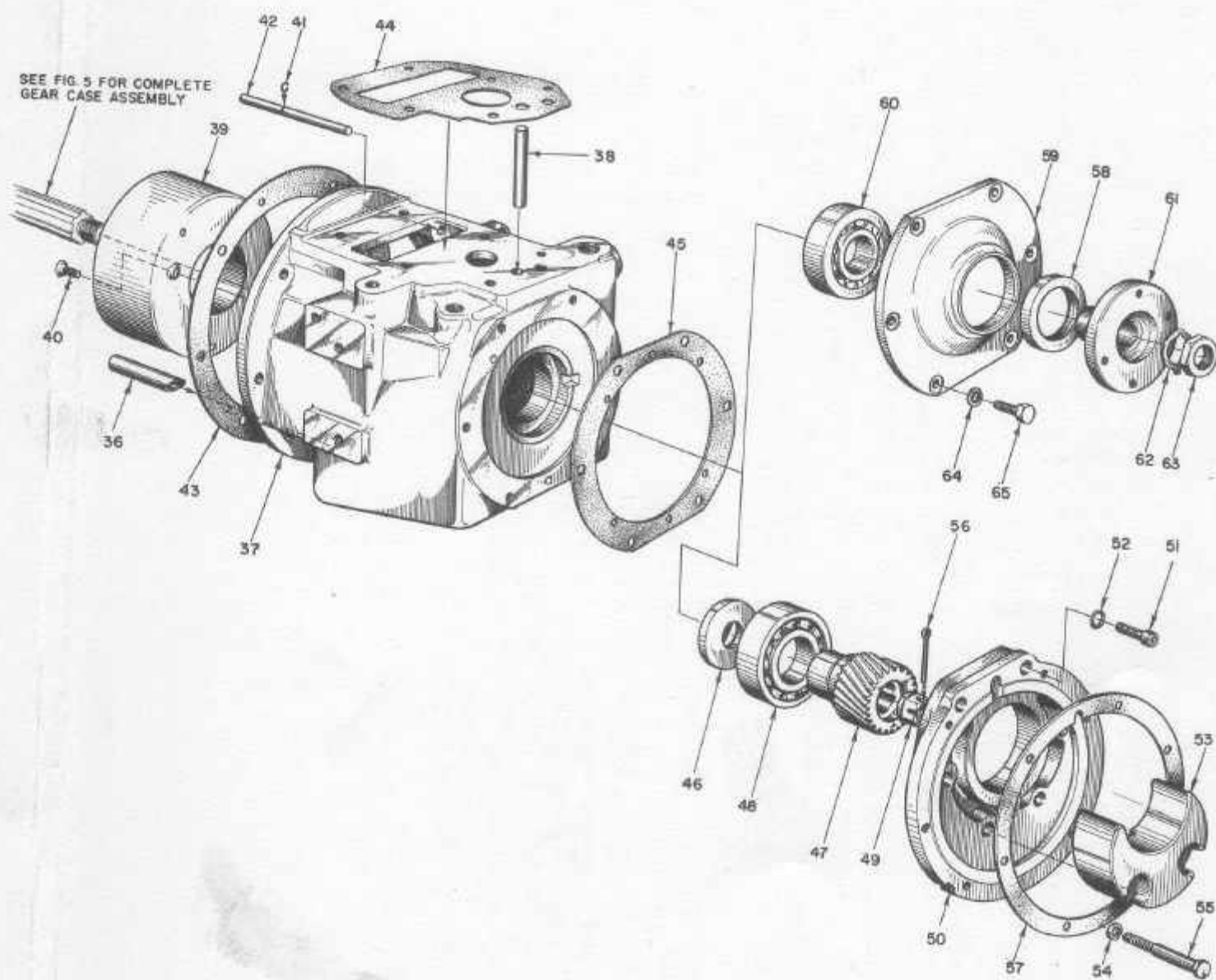


Figure 6

FRONT END PLATE AND PUMP ASSEMBLY

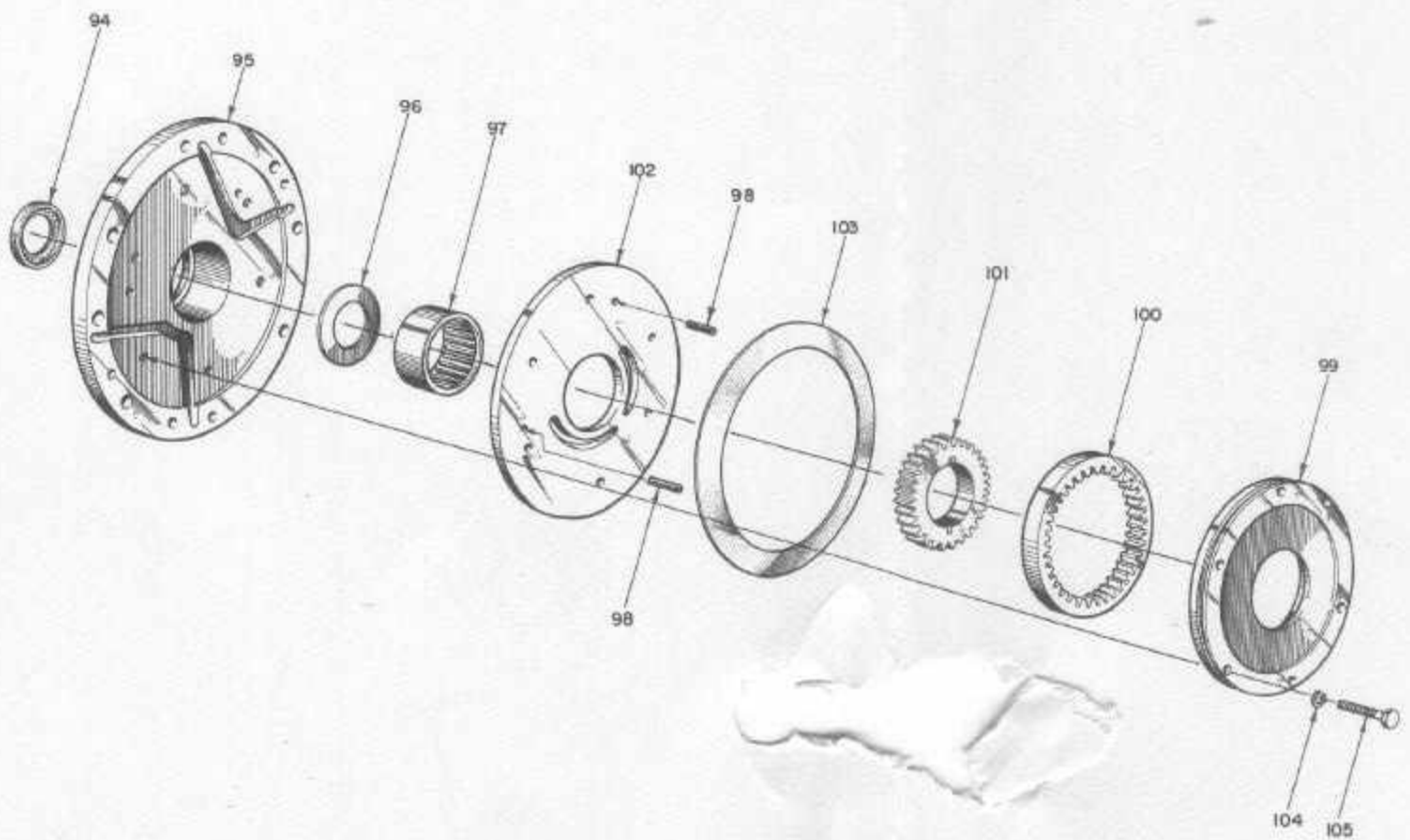


Figure 9

COMPLETE ASSEMBLY

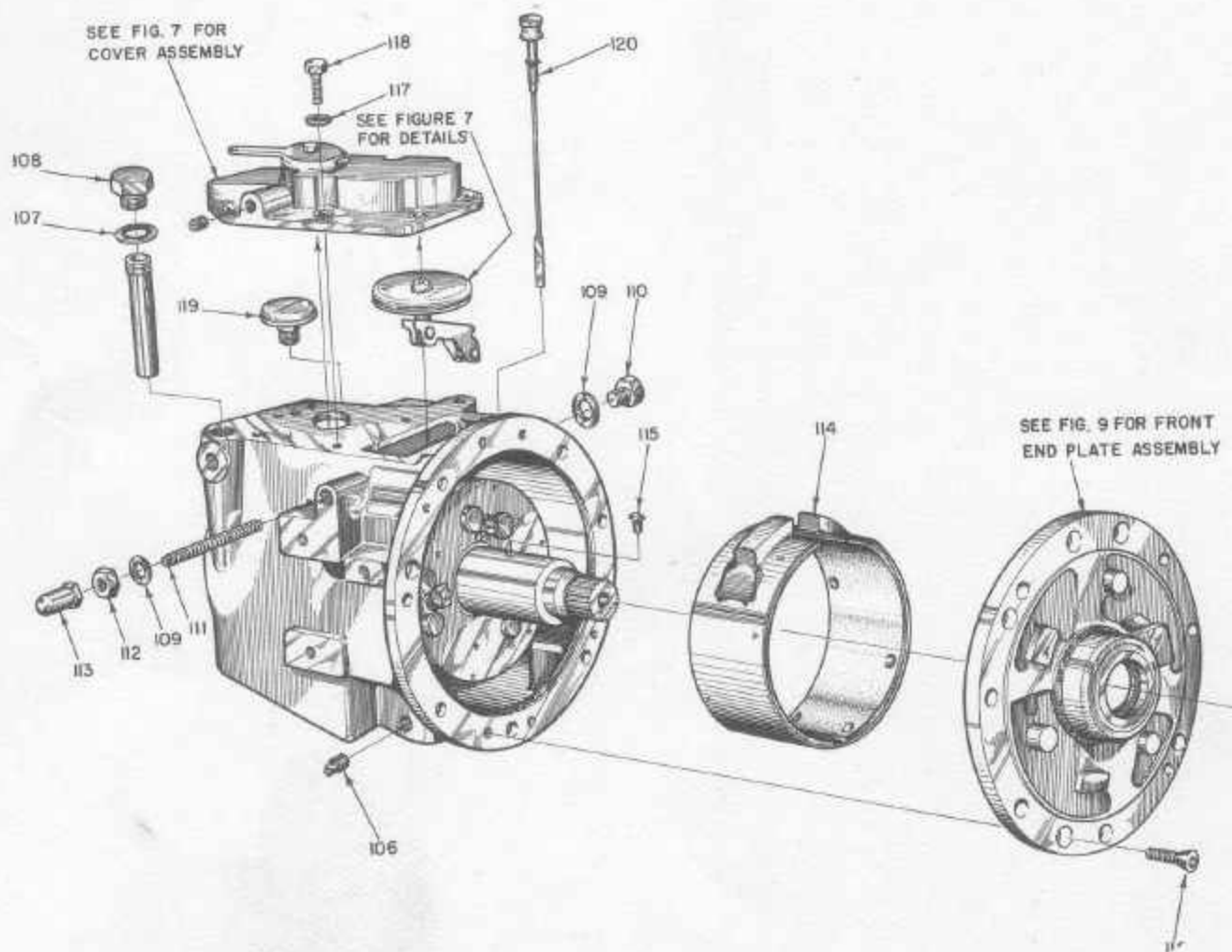


Figure 10

