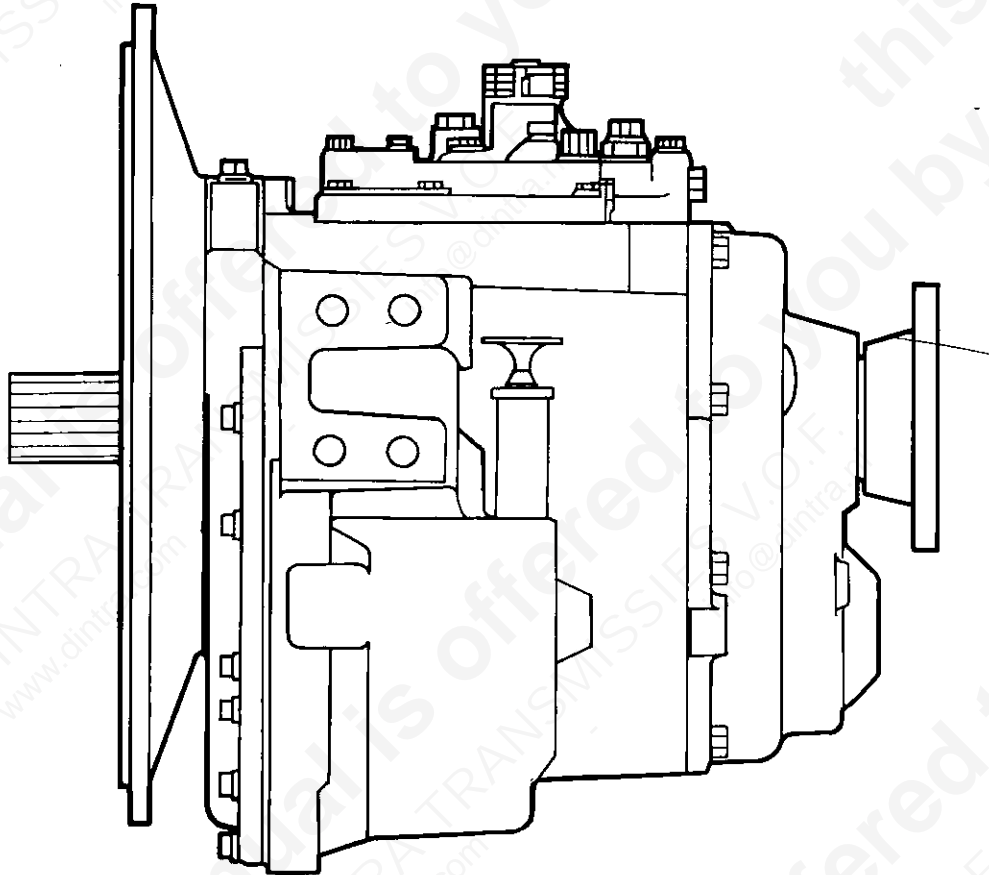


# Velvet Drive® Marine Transmission Service Manual

## Series 7000

Original Rev-0 9/84  
Rev-1 12/86

**Price \$6.00**



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## SERIES 7000 HYDRAULIC MARINE TRANSMISSIONS FEATURES AND BENEFITS

The Series 7000 (Fig. 1) is a part of the Velvet Drive family of hydraulic marine transmissions. Backed by more than a quarter century of marine transmission leadership, it is available now from Velvet Drive distributors worldwide. Now more boat builders and owners can take advantage of the broad range of features and benefits enjoyed by nearly a half-million Velvet Drive transmission buyers. The Series 7000, with its 500 hp diesel rating, is a totally new design, compatible with the world's most popular mid-range marine diesels.

The Series 7000 Hydraulic Marine Transmission features helical gearing for quiet, smooth-running operation; an in-line configuration that is compatible with popular engine/hull combinations. An added advantage is six gear ratios that are adaptable to a broad range of performance requirements. The 7000 series is also full-reversing which will allow the use of engines of the same rotation in twin engine applications. A wide range of adapters, dampers, and propeller shaft couplings compatible with most popular diesel engines in the rated horsepower range is an additional advantage.

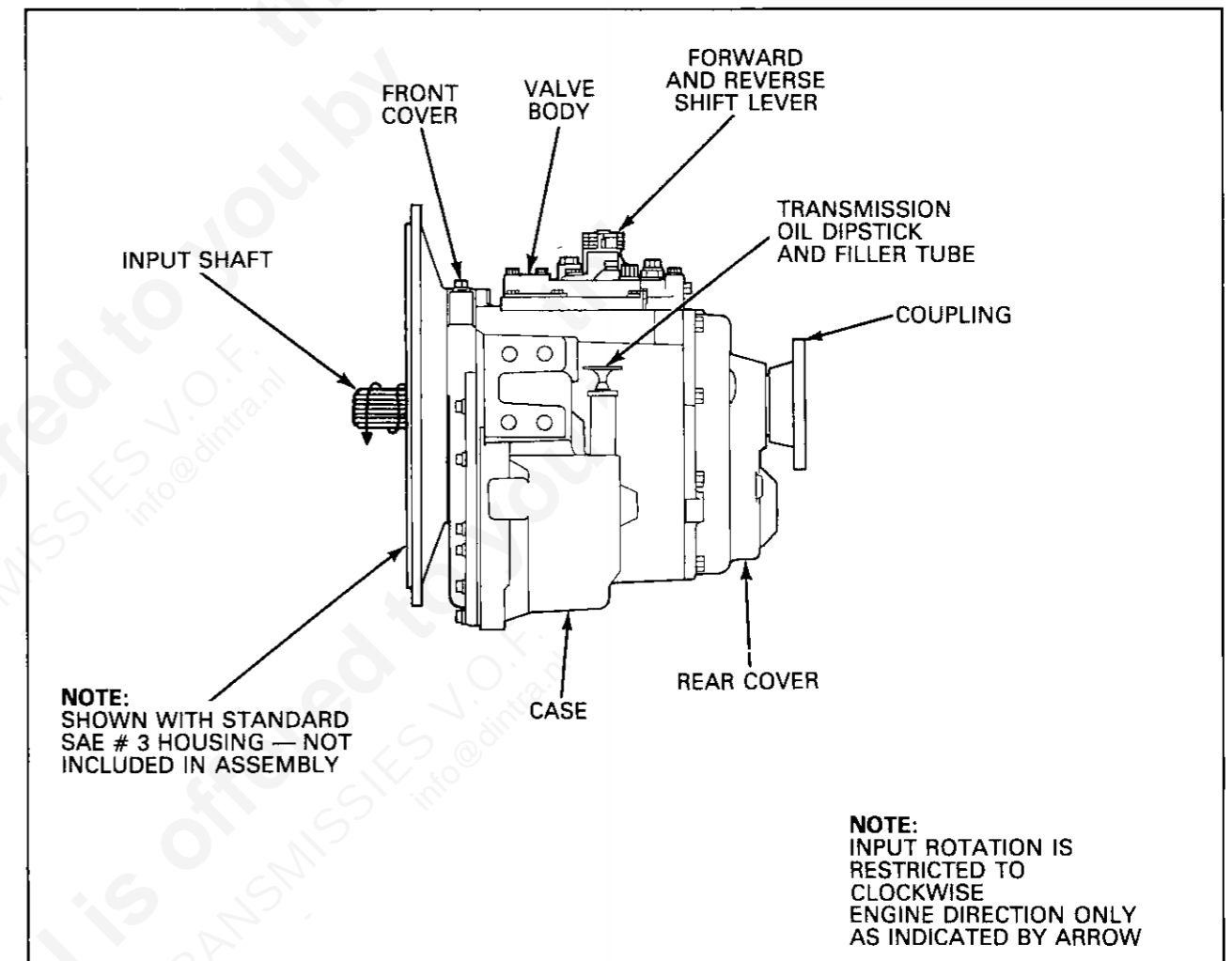


FIG. 1 SERIES 7000 HYDRAULIC MARINE TRANSMISSION

## SECTION I OWNERS GUIDE

This section should be read by anyone who plans to operate a boat equipped with a Series 7000 Velvet Drive. The operator is responsible for the safety of all persons on board. Read the Coast Guard rules for safe boating. Know the Federal and State operating rules of the road before moving the boat from the dock. Do not operate any electrical device, including switches, when fuel vapors are present.

### STARTING THE ENGINE

Perform the recommended daily checks before starting the engine. Place the selector lever into neutral before starting the engine. Follow the engine manufacturer's recommendations for starting the engine. The throttle lever should not be positioned more than 1/3 open. Be prepared to return the throttle to idle or shut off the engine immediately if a problem exists.

### OPERATING THE TRANSMISSION

The transmission may be shifted from any selector position to any other position providing the engine speed is 1000 RPM or less. Shifts at higher engine speeds should only be made in an emergency, and then at the lowest feasible speed. Shifting at higher engine RPM can cause severe damage to the transmission, as well as a risk to the safety to the occupants of the boat.

Move the selector lever to the desired position. Wait until the engagement is felt before adding throttle. Throttle back in time to ensure that the boat will slow down or stop before a collision occurs. Some boats will stop quickly while others move forward for a short distance. Get the feel of the equipment in open water. Do not wait until you are in close quarters to attempt a maneuver only to find out you misjudged the response time.

### FREEWHEELING

Freewheeling is permissible for output shaft speeds of 1000 RPM or less. This speed will not normally be exceeded when freewheeling, while towing the boat at safe speeds.

### WARRANTY AND CLAIM PROCEDURES

Velvet Drive distributors or their dealers should be contacted to make adjustments, answer your questions, handle warranty claims, or make repairs. You should be aware that repairs under warranty performed by anyone other than an authorized distributor or one of their dealers may not be fully covered under the warranty policy.

The name plate located on top of the transmission (Fig. 2) will provide the model and serial number of the unit. It is suggested that the name plate be located and the information recorded in the space provided below.

Model Number  
Serial Number  
Date of Purchase  
From Whom Purchased  
Ratio

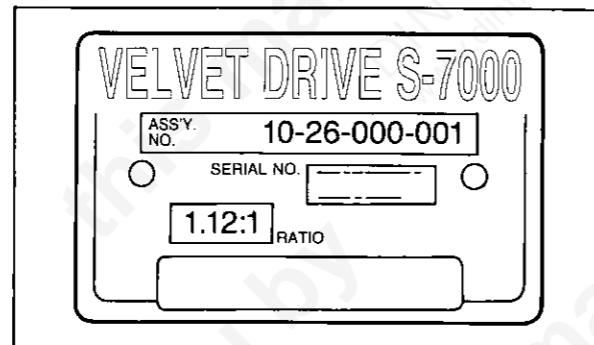


FIG. 2 NAMEPLATE

When calling or writing, it is important that this information be provided, otherwise service questions may not be able to be answered.

### MAINTENANCE

Many daily checks can be made by the owner. It is recommended that anything which the owner does not know about or has not been instructed in, other than the simple daily checks, should only be made by authorized personnel. Proper care and maintenance will ensure long service with a minimum of operating expense. The owner should carefully read the sections in this manual covering operation and maintenance before attempting to operate the equipment. A maintenance record is provided so that a permanent record of all service can be kept. A permanent record of the type and date of service that was performed should be kept.

READ THE OWNERS MANUAL BEFORE OPERATING YOUR BOAT.

### PREVENTATIVE MAINTENANCE

Preventative maintenance is performed to reduce the possibility of problems. Many of the preventative maintenance procedures are checks to determine if everything is in good condition. Daily checks should be performed before operation of the boat.

### DAILY CHECKS

1. Check oil level and add oil as required. Low oil level may indicate a leak. Check transmission fluid level with engine in neutral. **Warning: Transmission fluid will be hot. Use caution when handling dipstick.**
2. Look for signs of leaks and correct.
3. Visually check for worn or kinked hoses and repair.
4. Check for loose bolts and tighten to specified torque.

5. Listen for unusual noises. Have an authorized mechanic check the unit if you cannot determine the cause of the noises.

### GENERAL CHECKS

1. Check that the shift linkage accurately positions the shift lever in relation to the poppet ball position; Engine, Neutral, Opposite.
2. Propeller shaft alignment should be checked every time the boat is removed from the water. The propeller shaft bolts should always be removed prior to removing the boat from the water. Check alignment and replace bolts only after the boat has been placed in the water. Seasonal checks are recommended even though the boat is not removed from the water.
3. Learn the function of each gauge and check occasionally to determine if the gauges are reading within the specified limits.
4. Check the neutral start switch and wiring. Repair or replace defective wires to Coast Guard specifications. The starter should operate only when the selector is positioned in neutral. If starter will operate in any position other than neutral, replace the switch or look for damaged wiring.

### SEASONAL MAINTENANCE

1. Change the oil once per season in pleasure boats. Depending on application, commercial use boats should have the oil changed after each 250-500 hours of operation. Oil should be changed anytime it becomes contaminated, changes color, or becomes rancid-smelling.

The oil may be drained by placing a suitable container under the oil drain plug. Remove the drain plug and oil screen from the unit. Allow the oil to drain. A pump may also be used to pump the oil from the transmission by inserting the pump suction hose through the dipstick opening.

2. Automatic transmission fluids (ATF) which meet the Detroit Diesel Allison C-3 specification or the Caterpillar TO-2 specification are preferred when refilling unit. Do not mix different brands.
3. Tighten all exposed bolts to the recommended torque once per season.
4. Prior to cold weather, the boat should be winterized. This should include draining the transmission oil cooler and cooler lines unless the system contains anti-freeze in a closed system. The antifreeze, if used, in the transmission cooler circuit should be changed every other season.

**NOTE:** Antifreeze must not be allowed to enter transmission sump.

5. Keep the outside of the engine and transmission clean. This will enhance the general appearance as well as help prevent fires.

### PAINTING

The cast iron transmission should be painted to prevent rusting. The procedure will be similar to that used on the engine.

Care must be taken to keep paint away from areas which have precision dimensions. Masking tape or grease should be used to prevent paint from sticking.

Paint must be kept from the following areas:

1. Mounting faces and pilot diameter
2. Input shaft splines
3. Face of couplings
4. Detent ball and spring
5. Nameplate

## SECTION II TRANSMISSION OPERATION

The Series 7000 units are the largest of the Velvet Drive Marine Transmissions. These units have full torque capacity in both forward and reverse gear. Engines which crank clockwise from in front or counterclockwise from behind the engine can only be used to power Series 7000 units.

**CAUTION:** The pump cannot be changed from factory setting. The arrow located at top of pump housing must always point to the right when facing the pump.

Two multiple disc clutches are used to obtain engine crankshaft or opposite engine crankshaft rotation of the output shaft. One clutch cylinder is riveted to the input shaft. This clutch pack, when applied, drives the output shaft in the direction of engine rotation. The input shaft clutch cylinder also drives the opposite engine clutch cylinder through a gear mesh (Fig. 3).

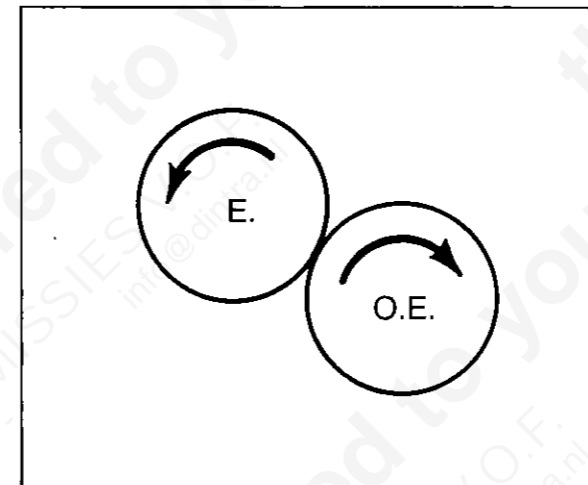


FIG. 3 ENGINE AND OPPOSITE ENGINE CLUTCH ARRANGEMENT

"E" will be used to designate the clutch which drives the output shaft in the direction of engine crankshaft rotation.

"OE" will denote the clutch which drives opposite engine crankshaft rotation.

Arrows show direction of clutch cylinder rotation when viewed from behind unit (facing engine).

A countershaft is used to transmit power from the clutch pack to the output shaft. A gear is located at the front end of the countershaft which engages the clutch gears. The clutch gears are assembled into the two clutch packs and one is driven by the engine rotation clutch and the other is driven by the opposite engine rotation clutch.

### POWER FLOW — ENGINE ROTATION CLUTCH APPLIED (Refer to Fig. 4).

The engine rotation ("E") clutch drives the engine rotation clutch gear ("A") at engine RPM in the direction of engine rotation. This clutch gear drives the front countershaft gear ("C") which is splined to the front end of the countershaft. The countershaft and both countershaft gears rotate at the same speed, but in a direction opposite to engine crankshaft rotation. The rear countershaft gear ("D"), drives the output shaft in the direction of engine rotation at a speed reduction ratio which depends upon the gears used in the unit.

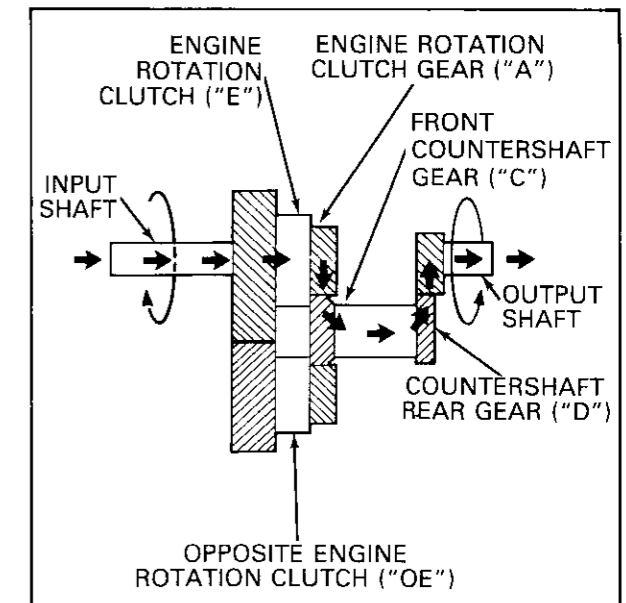


FIG. 4 POWER FLOW — ENGINE ROTATION CLUTCH APPLIED

**POWER FLOW — OPPOSITE ENGINE ROTATION CLUTCH APPLIED (Refer to Fig. 5).**

The applied opposite engine clutch ("OE") is driven at engine RPM by the teeth on the outside diameter of the engine rotation clutch, but in a direction opposite to engine rotation, Figure 5. The "OE" clutch drives the opposite engine rotation clutch gear at the same RPM as the engine, but in a direction opposite to engine rotation. The opposite engine rotation clutch gear ("B") drives the countershaft front gear, the countershaft, and the countershaft rear gear, in the direction of engine rotation. The countershaft rear gear drives the output gear and shaft in a direction opposite to engine rotation and at a reduction speed ratio which depends upon the gears used in the unit.

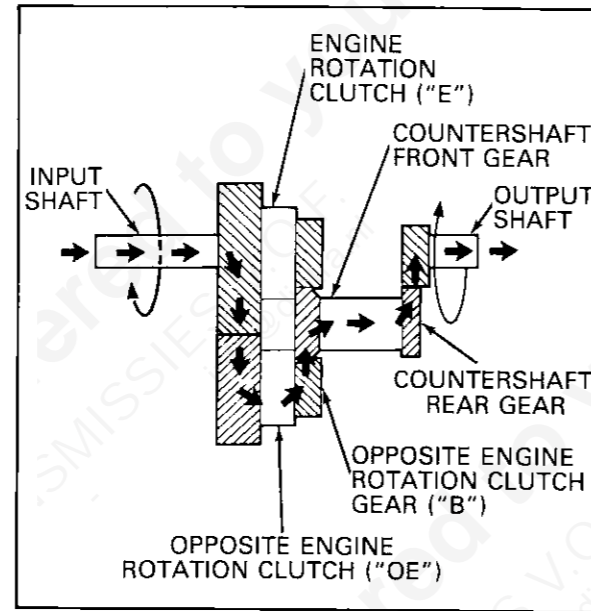


FIG. 5 POWER FLOW — OPPOSITE ENGINE ROTATION CLUTCH APPLIED

**CHART SHOWING NUMBER OF GEAR TEETH AT EACH GEAR LOCATION**

| ASSEMBLY      | A  | B  | C  | D  | E  | GEAR RATIO |
|---------------|----|----|----|----|----|------------|
| 10-26-000-001 | 30 | 30 | 41 | 45 | 37 | 1.12       |
| 10-26-000-002 | 25 | 25 | 46 | 45 | 37 | 1.51       |
| 10-26-000-003 | 30 | 30 | 41 | 29 | 42 | 1.98       |
| 10-26-000-004 | 25 | 25 | 46 | 29 | 42 | 2.66       |
| 10-26-000-005 | 30 | 30 | 41 | 22 | 49 | 3.04       |
| 10-26-000-007 | 25 | 25 | 46 | 22 | 49 | 4.10       |

**DESCRIPTION OF HYDRAULIC CIRCUIT**

The pump consists of a pump housing, oil seal, drive gear, and driven gear. The drive gear is driven at engine RPM by a key located in a keyway in the groove of the input shaft. The driven gear is driven at approximately 83% of engine speed by the drive gear. The two gears separate as they approach the pump suction port. The space between gears and teeth are filled with oil from the suction port. The crescent shaped portion of the pump housing traps oil between pump teeth as the gears rotate and this oil is delivered to the pressure port. The gear teeth move back into mesh as gears rotate past the pressure port. There is no

longer any space between the gear teeth, therefore the oil is forced out into the case passage under pressure from the pump.

The main line pressure passage directs oil to the regulator valve, selector valve and cooler-lube orifice, see Fig. 6. The cooler-lube orifice feeds oil to cooler and to the end of the cooler bypass valve. The cooler bypass valve will remain closed until the force from the oil on the end of the valve exceeds spring force at which time the valve opens and the excess oil is fed into the lube circuit. Mainline pressure on the end of the regulator valve causes a force which will move the regulator valve when this force exceeds

spring force. The regulator valve will then feed the excess oil into the cooler circuit. The selector valve may be moved to any one of three positions. Neutral position blocks line oil pressure to the clutches and exhausts oil from both clutches. When engine or opposite engine clutch feed is selected, the other clutch circuit will be exhausted.

Cooler oil is fed to the external cooler and is returned to the lube circuits to lube the clutch assemblies. The lube relief valve consists of a ball and spring which controls the lube oil pressure by returning oil to pump suction.

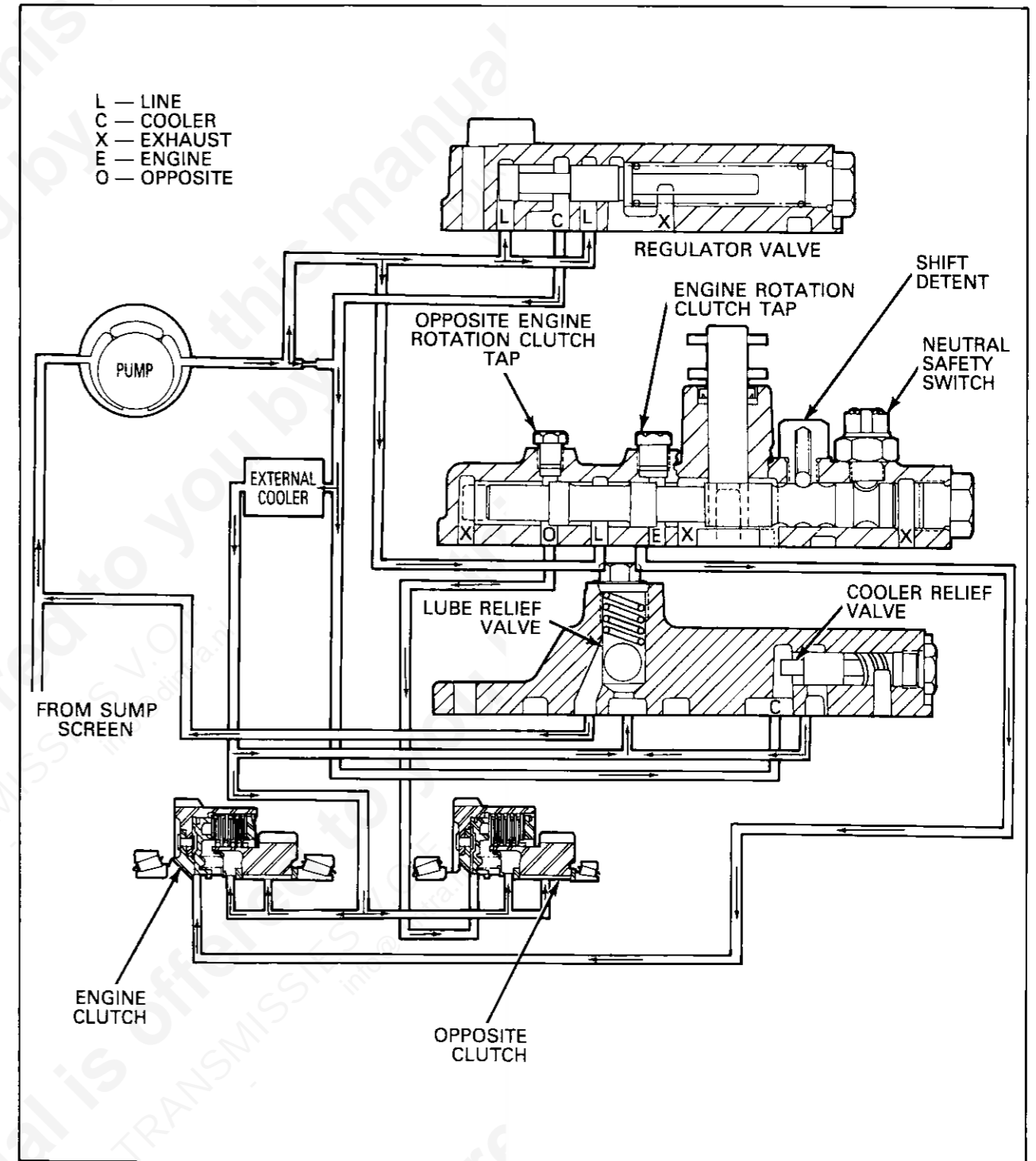


FIG. 6 HYDRAULIC CIRCUIT

## SECTION III INSTALLATION MANUAL

**NOTE:** For more detailed information on unit selection, transmission installation, propeller shaft couplings, coolers and installation, and dampers and installation, refer to Velvet Drive Marine Installation Manual, Form 1131.

tributor or BWA-TS to suggest a suitable unit. The Series 7000 units should only be used with engines which crank clockwise from in front of (or counterclockwise from behind) the engine.

**DO NOT ATTEMPT TO CHANGE PUMP FROM THE ORIGINAL FACTORY SETTING ON ANY SERIES 7000 UNIT.** These units have full reversing capabilities; therefore opposite engine crankshaft rotation is not needed.

### SELECTION OF A UNIT

Refer to the technical specifications given in this manual for available ratios, ratings and other data. You may want to fill out an application sheet to allow a Velvet Drive dis-

**CHART SHOWING DAMPER ASSEMBLIES**

| DAMPER ASSEMBLY NUMBER | MAXIMUM FT. LBS. (N·m) WORKING TORQUE |               |              |              |                |              |              |              |
|------------------------|---------------------------------------|---------------|--------------|--------------|----------------|--------------|--------------|--------------|
|                        | GASOLINE ENGINES                      |               |              |              | DIESEL ENGINES |              |              |              |
|                        | 8 Cyl.                                | 6 Cyl.        | 4 Cyl.       | 1-3 Cyl.     | 8 Cyl.         | 6 Cyl.       | 4 Cyl.       | 1-3 Cyl.     |
| 10-26-650-001          | 680<br>(922)                          | 638<br>(865)  | 553<br>(750) | 468<br>(635) | 595<br>(807)   | 510<br>(691) | 425<br>(576) | 340<br>(461) |
| 10-26-650-002          | 680<br>(922)                          | 638<br>(865)  | 553<br>(750) | 468<br>(635) | 595<br>(807)   | 510<br>(691) | 425<br>(576) | 340<br>(461) |
| 10-26-650-003          | 840<br>(1139)                         | 788<br>(1068) | 683<br>(926) | 578<br>(784) | 735<br>(997)   | 630<br>(854) | 525<br>(712) | 420<br>(569) |

The dampers listed in the above chart are available from Velvet Drive distributors. The dampers listed are shown for guidance purposes only and are not to be interpreted as recommendations. Each engine has its own characteristics of vibration and inertia. The application engineer must select a specific damper most suitable for the particular model of engine. BWA-TS does not assume the responsibility for recommending the proper engine flywheel and damper assembly for the installation of our transmission. BWA-TS will supply information to permit a total system torsional analysis.

tach the damper to the engine flywheel. Torsional reversals tend to cause the damper to shift out of alignment when common bolts are used. The damper should be aligned with respect to the bore of the adapter within 0.010 inch (0.25 mm) total indicator reading.

The splines of the input shaft of the transmission must make full engagement with the splines in the damper hub. **CAUTION: The damper hub should not bottom against the shaft. This can cause end thrust to the input shaft which can damage the transmission.**

**NOTE:** Body fit bolts should be used to at-

### SELECTION OF AN ENGINE TO TRANSMISSION ADAPTER

Adapters are available from Velvet Drive distributors. Select the proper adapter which will adapt the transmission to the engine.

### SELECTION OF A TRANSMISSION OIL COOLER

Long transmission life and good efficiency will be obtained if the transmission sump temperature is maintained between 140° and 190°F (60°-80°C). Select a cooler that will maintain the temperature within this range.

### ASSEMBLY OF TRANSMISSION ADAPTER TO ENGINE

Assemble the adapter to the engine. Tighten the mounting bolts to the torque specified. Use a dial indicator to check the bore and face runout with respect to the crankshaft. The indicator reading should not exceed ± 0.010 inch (0.25 mm) total indicated reading for the bore or face of the adapter. This check is made to ensure proper crankshaft to adapter alignment.

**NOTE:** Some bolts which attach the flywheel housing adapter to the front cover are also used to attach the front cover to the case.

When installing a new adapter, omit the throw-away type washers supplied with the adapter bolts. Tighten the adapter bolts to specified torque.

### ASSEMBLY OF THE TRANSMISSION TO ADAPTER

Remove flywheel housing adapter from the engine. Lubricate the splines of the input shaft prior to installing the transmission to the adapter. Two dowel studs should be assembled into holes on opposite sides of the flywheel so the transmission can be posi-

tioned on these dowels and moved straight into position against face of housing. **DO NOT PERMIT SPLINES OF INPUT SHAFT TO SUPPORT THE TRANSMISSION.** This can cause damage to the damper. Install and tighten the transmission to adapter bolts, then remove the two dowels and install the bolts into these two holes. Tighten all bolts to the specified torque.

### INSTALLATION OF THE TRANSMISSION OIL COOLER

Mount the cooler with the oil outlet located at the highest point on the cooler. This will allow the air to be forced out above the oil and make the system self-purging. The maximum cooling will be realized when the water flows in the direction opposite to the flow of the oil. Use hydraulic hose which has a minimum inside diameter of 13/32 inch (10.3mm). The hose should be able to withstand at least 200 PSI (1379 kPa). Use hose fittings that have the maximum sized passages available.

The cooler circuit can have a direct bearing on cooler pressure. High cooler pressure may indicate restrictions in the cooler circuit. The line or cooler size may need to be changed to lower the cooler pressure if required. Cooler pressure will range from 25 to 115 PSI (172-793 kPa) in a normal unit.

Water fed directly to the Velvet Drive cooler will provide the maximum amount of cooling. A larger cooler will be required when warm water is used to cool the transmission. For maximum cooling, direct water flow to the oil cooler of the transmission and then onto the exhaust manifold of the engine.

### PROPELLER SHAFT COUPLING

Two optional methods for fastening the coupling to the propeller shaft are used. One method uses a pilot hole drilled through one side only. The shaft and other side of the coupling must be drilled with the

coupling in position on the shaft. Use a 15/64 inch drill and ream to 0.25-0.256 inch (6.35-6.50 mm).

Install two 1/2-13UNC-2B set screws that are used to retain the coupling.

The propeller shaft must have a 0.3135 to 0.3155 inch (7.96-8.0 mm) wide keyway cut to permit installation of a drive key.

It is common for a boat to slightly change shape with age or load. An alignment check should be made at the beginning of each season. Alignment should only be checked with the boat afloat and loaded with a typical load.

Misalignment of the propeller shaft coupling to the transmission can cause vibration, gear noise, loss of RPM, and premature oil seal and bearing failure. The propeller shaft is usually fixed in the boat structure. Alignment is achieved by adjusting the engine mounts or changing engine shims.

**COUPLING BOLTS SHOULD BE REMOVED AND COUPLING HALVES SEPARATED PRIOR TO REMOVING THE BOAT FROM THE WATER.**

Check coupling alignment with all coupling bolts removed. Hand-hold couplings together with the snap fit engaged. When the couplings touch at any point, a feeler gauge thicker than 0.003 inch (0.08 mm) should not fit between the two couplings at any other point. Rotate one coupling 90° and check the clearance and repeat at 90° intervals for each coupling half until both coupling halves have been rotated separately for one complete revolution.

**CAUTION: Do not lift or pry against the coupling, as this can distort the couplings.**

#### FLEXIBLE COUPLINGS

Borg-Warner Automotive, Transmission Systems strongly recommends the use of flexible couplings with the Series 7000 transmission. Flexible couplings reduce noise, dampen vibrations, and absorb damaging torsional forces. They may also adjust for some flexing conditions of the boat hull and engine supports.

First, properly align the system. Then, connect the flexible coupling between the transmission and propeller shaft couplings.

## SECTION IV OVERHAUL PROCEDURE

### TROUBLESHOOTING

#### GENERAL

The most common cause of transmission failure is lack of oil. Oil level should be checked before troubleshooting procedures are undertaken.

Pressure gauges are of no value unless they are accurate. They should be checked periodically against a master gauge or a dead weight tester and should be adjusted or discarded when found to be inaccurate. Gauges should have a 0-200 (0-1379 kPa) or a 0-300 p.s.i. (0-2068 kPa) range.

High pressure can be caused by a regulator valve that is stuck or restrictions in the hydraulic circuit. Low pressure can be caused by leaks, stuck valves, low oil level, a faulty pump, or restrictions such as a dirty oil screen. The lack of any pressure can be caused by low oil level or no oil, a defective pump, broken pump drive tang or a large leak. All pressure checks should be made at normal operating temperature.

#### CLUTCH PROBLEMS

Faulty clutch parts or low pressure can cause a clutch to fail to apply. Shift to apply the other clutch. If the other clutch applies, then the pump and regulator are operating

and the problem is mechanical. Install a pressure gauge to check for line pressure when both clutches fail to apply. Slipping clutches will usually squeal. A clutch which has been permitted to slip will usually overheat and the plates may warp or can become welded together. A warped or welded clutch pack will cause a tie-up condition in the transmission when other clutch is applied.

#### NOISE

Shift into each selector position to determine exactly when the noise occurs. Careful observation will help pinpoint the operating conditions causing the noise. Compare the moving parts which are rotating when the noise occurs and try to pinpoint the cause.

Valve buzz or hydraulic noise can be caused by air in the hydraulic system, low oil level, a restricted oil screen or restricted passages, sticky valves, or an air leak on the suction side of the pump.

Transmission and flywheel housing alignment may be responsible for noise problems. Make an alignment check to determine that both the bore and face are within 0.010 inch (0.25 mm) total indicator reading with respect to the crankshaft.

## TROUBLE ANALYSIS CHART

| PROBLEM                    | POSSIBLE CAUSE   | CORRECTION  |
|----------------------------|--|---|
| NO FORWARD OR REVERSE      | Low oil level<br>Oil pump not functioning<br>Low oil pressure due to leakage<br>Shift valve incorrectly positioned<br>Broken shafts (input or output)<br>Cavitation of propeller<br><br>Broken propeller | Fill to proper level<br>Repair pump or drive key<br>Find and repair leak<br>Adjust shift linkage<br>Replace broken parts<br>Use slower engine speed or change prop<br>Repair or replace |
| NO FORWARD                 | Shift valve incorrectly positioned<br>Forward clutch failed<br>Leakage in forward clutch circuit<br>Reverse clutch not releasing   | Adjust linkage<br>Repair or replace<br>Find and repair leak<br>Repair or replace  |
| NO REVERSE                 | Shift valve incorrectly positioned<br>Reverse clutch failed<br>Leakage in reverse clutch circuit<br>Forward clutch not releasing   | Adjust linkage<br>Repair or replace<br>Find and repair<br>Repair or replace   |
| NO NEUTRAL                 | Shift valve incorrectly positioned<br>Reverse clutch not releasing<br>Forward clutch not releasing   | Adjust linkage<br>Repair or replace<br>Repair or replace  |
| VALVE BUZZ OR NOISE        | Air in hydraulic system<br><br>Low oil level<br>Air leak on suction side of pump<br>Restriction in oil passages<br>Restricted oil screen<br>Sticking valves  | Normal transmission operation will remove air<br>Add oil to full mark<br>Find and repair<br>Remove restrictions<br>Clean and replace<br>Clean valve body and add clean oil              |
| UNIT OVERHEATS             | Cooler oil restricted<br>Cooler oil restricted in lines<br>Cooler water restricted<br>Cooler too small   | Reverse flush cooler<br>Reverse flush lines<br>Reverse flush cooler and lines<br>Replace with a larger cooler   |
| NOISY IN FORWARD & REVERSE | Misalignment of flywheel housing or damper with transmission or engine<br>Damaged gear   | Align flywheel housing<br>Replace damaged gear  |
| NOISY IN NEUTRAL ONLY      | Oil level low  | Fill to correct oil level   |

## INSPECTION AND GENERAL INSTRUCTIONS

Bearings which are pressed into position should be inspected in position and removed only if replacement is required. Always press on the inner race which has the name or other miscellaneous markings. Inspect bearings, thrust faces, and journals for scuffing, pits, or for other abnormal wear conditions. Replace all damaged parts.

Clutch plates should be flat. Slipping clutch plates will show discoloration by heat damage. They should be carefully inspected for wear and warpage. Never replace clutch plates as a single unit but rather in sets of steel or friction or both steel and friction plates. Gears should be checked for pits, scuffs, broken or cracked teeth. Check thrust washers for wear or damage.

Pumps are built to very close tolerances and pump gears are matched to the pump housing at the factory. Except for the oil seal, it is necessary to replace the pump as an assembly if the pump is found to be damaged.

Check gaskets, "O" rings, and cast iron sealing rings before they are removed. Information may be gained, which if analyzed, may give the answer for a failure. Damaged sealing rings permit leakage which can cause a clutch to slip and fail.

Wash and air dry all parts. Do not use rags or a paper towel to wipe parts as this will leave lint that can clog the oil screen. Do not apply excessive amounts of sealant. Oil passages may be restricted or fully closed off by excess sealant. Use Gasket Eliminator Loctite 515 which will dissolve in oil rather than clog the screen.

Tighten all bolts and screws alternately and evenly to the recommended torque.

Be sure all mating surfaces are clean and free of all traces of former gasket or sealing material. Use a new valve body gasket except where otherwise noted.



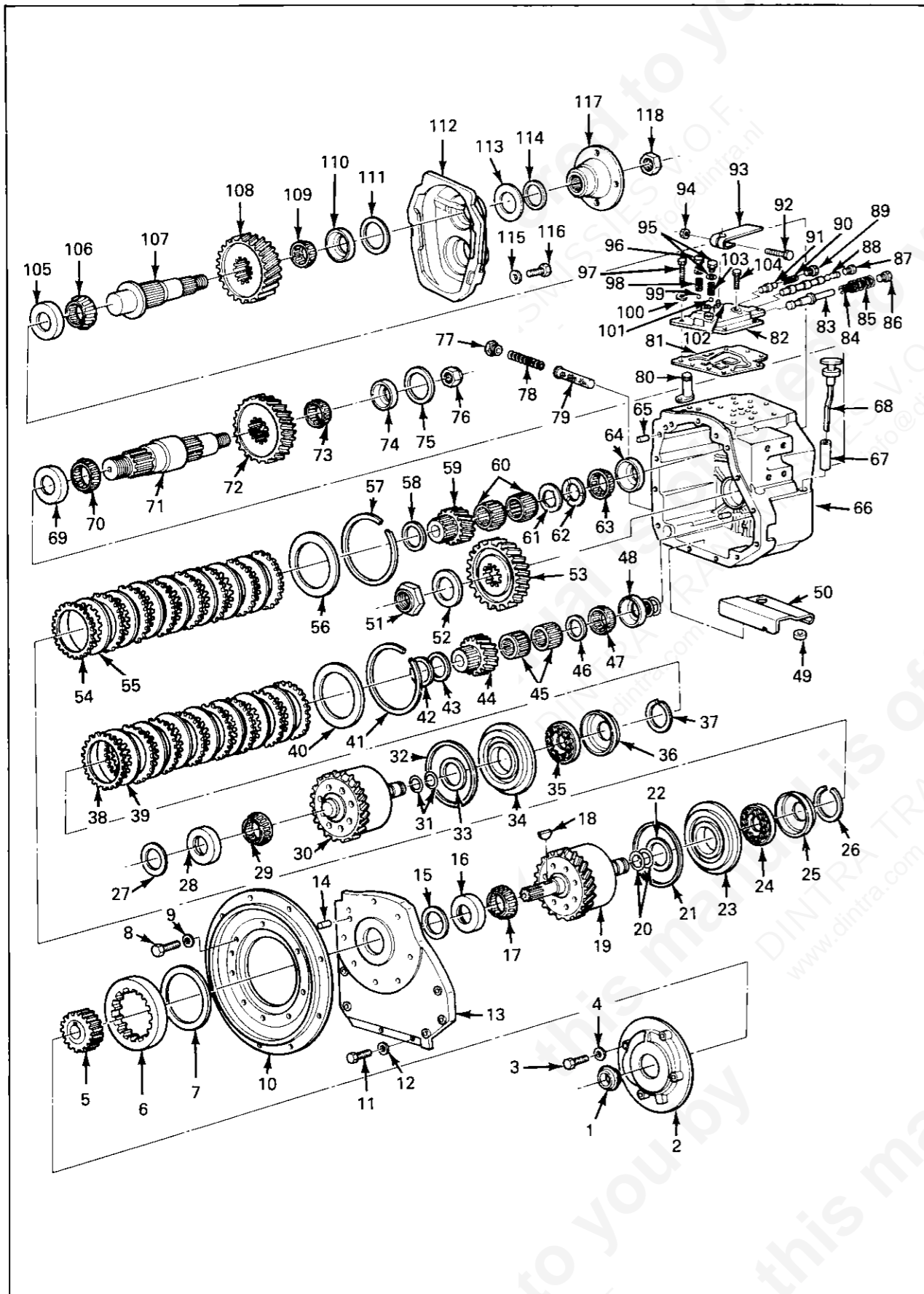


FIG. 7 SERIES 7000 TRANSMISSION — EXPLODED VIEW

| INDEX NUMBER | BORG-WARNER PART NUMBER | PART NAME OR DESCRIPTION   | 10-26-000- |     |     |     |     |     |  |
|--------------|-------------------------|--|------------|-----|-----|-----|-----|-----|--|
|              |                         |  | 001        | 002 | 003 | 004 | 005 | 007 |  |
| N1           | 10-26-508-002           | PUMP ASSEMBLY  | 1          | 1   | 1   | 1   | 1   | 1   |  |
| 1            | 10-00-044-031           | OIL SEAL   | 1          | 1   | 1   | 1   | 1   | 1   |  |
| 2            | ORDER ASS'Y             | PUMP HOUSING   | 1          | 1   | 1   | 1   | 1   | 1   |  |
| 3            | 10-00-183-021           | 5/16-18 x 1-3/8 HEX HEAD BOLT  | 4          | 4   | 4   | 4   | 4   | 4   |  |
| 4            | 10-00-047-029           | 5/16 OIL SEAL BOLT WASHER  | 4          | 4   | 4   | 4   | 4   | 4   |  |
| 5            | ORDER ASS'Y             | PUMP DRIVE GEAR  | 1          | 1   | 1   | 1   | 1   | 1   |  |
| 6            | ORDER ASS'Y             | PUMP DRIVEN GEAR   | 1          | 1   | 1   | 1   | 1   | 1   |  |
| 7            | 3-61                    | PUMP GASKET  | 1          | 1   | 1   | 1   | 1   | 1   |  |
| 8            | 0000179868              | 7/16-14 x 2-1/2 HEX HEAD BOLT  | 4          | 4   | 4   | 4   | 4   | 4   |  |
| 9            | 000103322               | 7/16 LOCKWASHER  | 7          | 7   | 7   | 7   | 7   | 7   |  |
| 10           |                         | FLYWHEEL HOUSING ADAPTER   |            |     |     |     |     |     |  |
|              | 10-26-712-001           | SAE #3 FLYWHEEL HOUSING USAGE  |            |     |     |     |     |     |  |
|              | 10-26-712-002           | SAE #3 FLYWHEEL HOUSING USAGE — CATERPILLAR 3208 ENGINES WITH REAR ENTRY STARTER                   |            |     |     |     |     |     |  |
|              | 10-26-712-003           | SAE #3 FLYWHEEL HOUSING USAGE — CUMMINS V-504, V-555M, AND VT-555M ENGINES WITH REAR ENTRY STARTER |            |     |     |     |     |     |  |
|              | 10-26-712-004           | SAE #3 FLYWHEEL HOUSING USAGE — DETROIT DIESEL 8.2L ENGINES WITH REAR ENTRY STARTER                |            |     |     |     |     |     |  |
|              | 10-26-712-005           | SAE #2 FLYWHEEL HOUSING USAGE — CUMMINS V-903 ENGINES WITH REAR ENTRY STARTER                      |            |     |     |     |     |     |  |
|              | 10-26-172-001           | USE WITH FLYWHEEL HOUSING ADAPTER, 10-26-712-001 TO ADAPT SAE #2 FLYWHEEL HOUSING                  |            |     |     |     |     |     |  |
| 11           | 0000179841              | 3/8-16 x 1-1/4 HEX HEAD BOLT   | 8          | 8   | 8   | 8   | 8   | 8   |  |
| 12           | 0000103321              | 3/8 LOCKWASHER   | 8          | 8   | 8   | 8   | 8   | 8   |  |
| 13           | 10-26-607-002           | FRONT COVER ASS'Y  | 1          | 1   | 1   | 1   | 1   | 1   |  |
| 14           | 0000141281              | DOWEL PIN  | 4          | 4   | 4   | 4   | 4   | 4   |  |
| 15           | 10-00-037-017           | 0.010 INCH (0.254 mm) SHIM   | *          | *   | *   | *   | *   | *   |  |
|              | 10-00-037-018           | 0.014 INCH (0.356 mm) SHIM   | *          | *   | *   | *   | *   | *   |  |
|              | 10-00-037-019           | 0.018 INCH (0.457 mm) SHIM   | *          | *   | *   | *   | *   | *   |  |
|              | 10-00-037-020           | 0.022 INCH (0.559 mm) SHIM   | *          | *   | *   | *   | *   | *   |  |
|              | 10-00-037-021           | 0.026 INCH (0.660 mm) SHIM   | *          | *   | *   | *   | *   | *   |  |
|              | 10-00-037-022           | 0.030 INCH (0.762 mm) SHIM   | *          | *   | *   | *   | *   | *   |  |
|              | 10-00-037-023           | 0.034 INCH (0.864 mm) SHIM   | *          | *   | *   | *   | *   | *   |  |
| 16           | 10-00-133-001           | BEARING CUP  | 1          | 1   | 1   | 1   | 1   | 1   |  |
| 17           | 10-00-133-002           | BEARING CONE   | 1          | 1   | 1   | 1   | 1   | 1   |  |
| 18           | 4873                    | PUMP DRIVE KEY   | 1          | 1   | 1   | 1   | 1   | 1   |  |
| 19           | 10-26-689-001           | CLUTCH CYLINDER AND INPUT SHAFT ASS'Y  | 1          | 1   | 1   | 1   | 1   | 1   |  |
| 20           | 4806C                   | SEALING RING   | 2          | 2   | 2   | 2   | 2   | 2   |  |
| 21           | 10-00-016-013           | PISTON SEALING RING  | 1          | 1   | 1   | 1   | 1   | 1   |  |
| 22           | 4804FF                  | "O" RING   | 1          | 1   | 1   | 1   | 1   | 1   |  |
| 23           | 10-26-124-001           | PISTON   | 1          | 1   | 1   | 1   | 1   | 1   |  |
| 24           | 10-21-540-001           | SPRING AND RETAINER ASSEMBLY   | 1          | 1   | 1   | 1   | 1   | 1   |  |
| 25           | 10-21-040-002           | SPRING RETAINER  | 1          | 1   | 1   | 1   | 1   | 1   |  |
| 26           | 14-00-139-020           | SNAP RING  | 1          | 1   | 1   | 1   | 1   | 1   |  |
| 27           | 10-00-037-024           | 0.010 INCH (0.254 mm) SHIM   | *          | *   | *   | *   | *   | *   |  |
|              | 10-00-037-025           | 0.014 INCH (0.305 mm) SHIM   | *          | *   | *   | *   | *   | *   |  |
|              | 10-00-037-026           | 0.018 INCH (0.356 mm) SHIM   | *          | *   | *   | *   | *   | *   |  |
|              | 10-00-037-027           | 0.022 INCH (0.406 mm) SHIM   | *          | *   | *   | *   | *   | *   |  |
|              | 10-00-037-028           | 0.026 INCH (0.660 mm) SHIM   | *          | *   | *   | *   | *   | *   |  |

\* Selective shim

FIG. 8 SERIES 7000 TRANSMISSION — PARTS LIST

| INDEX NUMBER | BORG-WARNER PART NUMBER | PART NAME OR DESCRIPTION                | 10-26-000- |     |     |     |     |     |  |
|--------------|-------------------------|---|------------|-----|-----|-----|-----|-----|--|
|              |                         |   | 001        | 002 | 003 | 004 | 005 | 007 |  |
| 27           | 10-00-037-029           | 0.030 INCH (0.762 mm) SHIM              | *          | *   | *   | *   | *   | *   |  |
|              | 10-00-037-030           | 0.034 INCH (0.864 mm) SHIM              | *          | *   | *   | *   | *   | *   |  |
|              | 10-00-037-031           | 0.038 INCH (0.965 mm) SHIM              | *          | *   | *   | *   | *   | *   |  |
| 28           | 10-00-133-040           | BEARING CUP                             | 1          | 1   | 1   | 1   | 1   | 1   |  |
| 29           | 10-00-133-027           | BEARING CONE                            | 1          | 1   | 1   | 1   | 1   | 1   |  |
| 30           | 10-26-594-001           | O.E. CLUTCH CYLINDER AND SHAFT ASSEMBLY | 1          | 1   | 1   | 1   | 1   | 1   |  |
| 31           | 4806C                   | SEALING RING                            | 2          | 2   | 2   | 2   | 2   | 2   |  |
| 32           | 10-00-016-013           | PISTON SEALING RING                     | 1          | 1   | 1   | 1   | 1   | 1   |  |
| 33           | 4804FF                  | "O" RING                                | 1          | 1   | 1   | 1   | 1   | 1   |  |
| 34           | 10-26-124-001           | PISTON                                  | 1          | 1   | 1   | 1   | 1   | 1   |  |
| 35           | 10-21-540-001           | SPRING AND RETAINER ASS'Y               | 1          | 1   | 1   | 1   | 1   | 1   |  |
| 36           | 10-21-040-002           | SPRING RETAINER                         | 1          | 1   | 1   | 1   | 1   | 1   |  |
| 37           | 14-00-139-020           | SNAP RING                               | 1          | 1   | 1   | 1   | 1   | 1   |  |
| 38           | 10-26-666-001           | FRICTION PLATE                          | 8          | 8   | 8   | 8   | 8   | 8   |  |
| 39           | 10-26-166-001           | STEEL PLATE                             | 7          | 7   | 7   | 7   | 7   | 7   |  |
| 40           | 10-26-062-001           | PRESSURE PLATE                          | 1          | 1   | 1   | 1   | 1   | 1   |  |
| 41           | 10-00-139-020           | SNAP RING                               | 1          | 1   | 1   | 1   | 1   | 1   |  |
| 42           | 10-00-193-011           | STEEL THRUST WASHER                     | 1          | 1   | 1   | 1   | 1   | 1   |  |
| 43           | 10-00-193-009           | VESPEL THRUST WASHER                    | 1          | 1   | 1   | 1   | 1   | 1   |  |
| 44           | 10-26-080-007           | CLUTCH HUB GEAR — 30 TEETH              | 1          |     | 1   |     | 1   |     |  |
|              | 10-26-080-008           | CLUTCH HUB GEAR — 25 TEETH              |            | 1   |     | 1   |     | 1   |  |
| 45           | 10-00-132-051           | NEEDLE BEARING                          | 2          | 2   | 2   | 2   | 2   | 2   |  |
| 46           | 10-00-193-007           | STEEL THRUST WASHER                     | 1          | 1   | 1   | 1   | 1   | 1   |  |
| 47           | 10-00-133-026           | BEARING CONE                            | 1          | 1   | 1   | 1   | 1   | 1   |  |
| 48           | 13-51-133-002           | BEARING CUP                             | 1          | 1   | 1   | 1   | 1   | 1   |  |
| 49           | 4915                    | MAGNET                                  | 1          | 1   | 1   | 1   | 1   | 1   |  |
| 50           | 10-26-036-001           | OIL BAFFLE                              | 1          | 1   | 1   | 1   | 1   | 1   |  |
| 51           | 10-00-149-021           | COUNTERSHAFT FRONT NUT                  | 1          | 1   | 1   | 1   | 1   | 1   |  |
| 52           | 10-00-047-023           | WASHER                                  | 1          | 1   | 1   | 1   | 1   | 1   |  |
| 53           | 10-26-070-014           | COUNTERSHAFT FRONT GEAR — 41 TEETH      | 1          |     | 1   |     | 1   |     |  |
|              | 10-26-070-015           | COUNTERSHAFT FRONT GEAR — 46 TEETH      |            | 1   |     | 1   |     | 1   |  |
| 54           | 10-26-666-001           | FRICTION PLATE                          | 8          | 8   | 8   | 8   | 8   | 8   |  |
| 55           | 10-26-166-001           | STEEL PLATE                             | 7          | 7   | 7   | 7   | 7   | 7   |  |
| 56           | 10-26-062-001           | PRESSURE PLATE                          | 1          | 1   | 1   | 1   | 1   | 1   |  |
| 57           | 10-00-133-020           | SNAP RING                               | 1          | 1   | 1   | 1   | 1   | 1   |  |
| 58           | 10-00-193-008           | THRUST WASHER                           | 1          | 1   | 1   | 1   | 1   | 1   |  |
| 59           | 10-26-080-007           | CLUTCH HUB GEAR — 30 TEETH              | 1          |     | 1   |     | 1   |     |  |
|              | 10-26-080-008           | CLUTCH HUB GEAR — 25 TEETH              |            | 1   |     | 1   |     | 1   |  |
| 60           | 10-00-132-051           | NEEDLE BEARING                          | 2          | 2   | 2   | 2   | 2   | 2   |  |
| 61           | 10-00-193-011           | STEEL THRUST WASHER                     | 1          | 1   | 1   | 1   | 1   | 1   |  |
| 62           | 10-00-193-009           | VESPEL THRUST WASHER                    | 1          | 1   | 1   | 1   | 1   | 1   |  |
| 63           | 10-00-133-029           | BEARING CONE                            | 1          | 1   | 1   | 1   | 1   | 1   |  |
| 64           | 10-00-133-011           | BEARING CUP                             | 1          | 1   | 1   | 1   | 1   | 1   |  |
| 65           | 0000141281              | DOWEL PIN                               | 4          | 4   | 4   | 4   | 4   | 4   |  |
| 66           | 10-26-065-002           | TRANSMISSION CASE                       | 1          | 1   | 1   | 1   | 1   | 1   |  |
| 67           | 10-26-034-002           | DIPSTICK TUBE                           | 1          | 1   | 1   | 1   | 1   | 1   |  |
| 68           | 10-06-559-001           | DIPSTICK                                | 1          | 1   | 1   | 1   | 1   | 1   |  |
| 69           | 10-00-133-023           | BEARING CUP                             | 1          | 1   | 1   | 1   | 1   | 1   |  |

\*Selective shim

FIG. 8 SERIES 7000 TRANSMISSION — PARTS LIST (CONT.)

| INDEX NUMBER | BORG-WARNER PART NUMBER | PART NAME OR DESCRIPTION          | 10-26-000- |     |     |     |     |     |  |
|--------------|-------------------------|-----------------------------------|------------|-----|-----|-----|-----|-----|--|
|              |                         |                                   | 001        | 002 | 003 | 004 | 005 | 007 |  |
| 70           | 10-00-133-031           | BEARING CONE                      | 1          | 1   | 1   | 1   | 1   | 1   |  |
| 71           | 10-26-067-001           | COUNTERSHAFT                      | 1          | 1   | 1   | 1   |     |     |  |
|              | 10-26-067-003           | COUNTERSHAFT                      |            |     |     |     | 1   | 1   |  |
| 72           | 10-26-070-001           | COUNTERSHAFT REAR GEAR — 29 TEETH |            |     | 1   | 1   |     |     |  |
|              | 10-26-070-011           | COUNTERSHAFT REAR GEAR — 45 TEETH | 1          | 1   |     |     |     |     |  |
| 73           | 10-00-133-030           | BEARING CONE                      | 1          | 1   | 1   | 1   | 1   | 1   |  |
| 74           | 10-00-133-023           | BEARING CUP                       | 1          | 1   | 1   | 1   | 1   | 1   |  |
| 75           | 10-00-037-032           | 0.010 INCH (0.254 mm) SHIM        | *          | *   | *   | *   | *   | *   |  |
|              | 10-00-037-033           | 0.012 INCH (0.305 mm) SHIM        | *          | *   | *   | *   | *   | *   |  |
|              | 10-00-037-034           | 0.014 INCH (0.356 mm) SHIM        | *          | *   | *   | *   | *   | *   |  |
|              | 10-00-037-035           | 0.016 INCH (0.406 mm) SHIM        | *          | *   | *   | *   | *   | *   |  |
|              | 10-00-037-036           | 0.018 INCH (0.457 mm) SHIM        | *          | *   | *   | *   | *   | *   |  |
|              | 10-00-037-037           | 0.020 INCH (0.508 mm) SHIM        | *          | *   | *   | *   | *   | *   |  |
|              | 10-00-037-038           | 0.022 INCH (0.559 mm) SHIM        | *          | *   | *   | *   | *   | *   |  |
| 76           | 10-00-149-020           | COUNTERSHAFT REAR NUT             | 1          | 1   | 1   | 1   | 1   | 1   |  |
| 77           | 10-00-552-006           | DRAIN AND OIL SCREEN ACCESS PLUG  | 1          | 1   | 1   | 1   | 1   | 1   |  |
|              | 10-00-552-017           | USED WITH A4867HN KIT             | 1          | 1   | 1   | 1   | 1   | 1   |  |
| 78           | 10-21-156-003           | OIL SCREEN SPRING                 | 1          | 1   | 1   | 1   | 1   | 1   |  |
| 79           | 10-21-238-001           | OIL SCREEN                        | 1          | 1   | 1   | 1   | 1   | 1   |  |
| 80           | 10-26-514-004           | INTERNAL SHIFT LEVER              | 1          | 1   | 1   | 1   | 1   | 1   |  |
| 81           | 10-26-045-004           | VALVE BODY GASKET                 | 1          | 1   | 1   | 1   | 1   | 1   |  |
| 82           | 10-26-236-002           | VALVE BODY                        | 1          | 1   | 1   | 1   | 1   | 1   |  |
| N1           | 10-26-736-002           | VALVE BODY ASSEMBLY               | 1          | 1   | 1   | 1   | 1   | 1   |  |
| 83           | 10-26-237-003           | REGULATOR VALVE                   | 1          | 1   | 1   | 1   | 1   | 1   |  |
| 84           | 10-26-156-006           | INNER SPRING                      | 1          | 1   | 1   | 1   | 1   | 1   |  |
| 85           | 10-26-156-005           | OUTER SPRING                      | 1          | 1   | 1   | 1   | 1   | 1   |  |
| 86           | 10-00-552-009           | PLUG AND "O" RING ASSEMBLY        | 1          | 1   | 1   | 1   | 1   | 1   |  |
| 87           | 10-00-552-009           | PLUG AND "O" RING ASSEMBLY        | 1          | 1   | 1   | 1   | 1   | 1   |  |
| 88           | 10-26-239-002           | SELECTOR VALVE                    | 1          | 1   | 1   | 1   | 1   | 1   |  |
| 89           | 10-00-552-004           | PLUG AND "O" RING ASSEMBLY        | 1          | 1   | 1   | 1   | 1   | 1   |  |
| 90           | 10-26-156-003           | SPRING                            | 1          | 1   | 1   | 1   | 1   | 1   |  |
| 91           | 10-26-237-002           | COOLER RELIEF VALVE               | 1          | 1   | 1   | 1   | 1   | 1   |  |
| 92           | 0000181343              | 5/16-24 x 1-1/2 HEX HEAD BOLT     | 1          | 1   | 1   | 1   | 1   | 1   |  |
| 93           | 10-26-098-002           | OUTER SHIFT LEVER                 | 1          | 1   | 1   | 1   | 1   | 1   |  |
| 94           | 0000103025              | 5/16 NUT                          | 1          | 1   | 1   | 1   | 1   | 1   |  |
| 95           | 10-00-552-008           | PLUG AND "O" RING ASSEMBLY        | 1          | 1   | 1   | 1   | 1   | 1   |  |
| 96           | 10-00-552-004           | PLUG AND "O" RING ASSEMBLY        | 1          | 1   | 1   | 1   | 1   | 1   |  |
| 97           | 0000179826              | 5/16-18 x 2 HEX HEAD BOLT         | 4          | 4   | 4   | 4   | 4   | 4   |  |
| 98           | 68C-269                 | COOLER RELIEF VALVE SPRING        | 1          | 1   | 1   | 1   | 1   | 1   |  |
| 99           | 0000453593              | 7/16 INCH STEEL BALL              | 1          | 1   | 1   | 1   | 1   | 1   |  |
| 100          | 0000103320              | 5/16 LOCKWASHER                   | 10         | 10  | 10  | 10  | 10  | 10  |  |
| 101          | 10-00-109-001           | 1/4 INCH STEEL BALL               | 1          | 1   | 1   | 1   | 1   | 1   |  |
| 102          | T90A-108                | OIL SEAL                          | 1          | 1   | 1   | 1   | 1   | 1   |  |
| 103          | 10-21-156-004           | POPPET SPRING                     | 1          | 1   | 1   | 1   | 1   | 1   |  |
| 104          | 0000179818              | 5/16-18 x 1 HEX HEAD BOLT         | 6          | 6   | 6   | 6   | 6   | 6   |  |
| 105          | 10-00-133-005           | BEARING CUP                       | 1          | 1   | 1   | 1   | 1   | 1   |  |
| 106          | 10-00-133-006           | BEARING CONE                      | 1          | 1   | 1   | 1   | 1   | 1   |  |
| 107          | 10-26-171-001           | OUTPUT SHAFT                      | 1          | 1   | 1   | 1   | 1   | 1   |  |

\*Selective shim

FIG. 8 SERIES 7000 TRANSMISSION — PARTS LIST (CONT.)

| INDEX NUMBER | BORG-WARNER PART NUMBER | PART NAME OR DESCRIPTION     | 10-26-000- |     |     |     |     |     |   |
|--------------|-------------------------|------------------------------|------------|-----|-----|-----|-----|-----|---|
|              |                         |                              | 001        | 002 | 003 | 004 | 005 | 007 |   |
| 108          | 10-26-070-003           | OUTPUT SHAFT GEAR — 42 TEETH |            |     | 1   | 1   |     |     |   |
|              | 10-26-070-010           | OUTPUT SHAFT GEAR — 49 TEETH |            |     |     |     |     | 1   | 1 |
|              | 10-26-070-013           | OUTPUT SHAFT GEAR — 37 TEETH | 1          | 1   |     |     |     |     |   |
| 109          | 10-00-133-034           | BEARING CONE                 | 1          | 1   | 1   | 1   | 1   | 1   | 1 |
| 110          | 10-00-133-003           | BEARING CUP                  | 1          | 1   | 1   | 1   | 1   | 1   | 1 |
| 111          | 10-26-037-001           | 0.010 INCH (0.254 mm) SHIM   | *          | *   | *   | *   | *   | *   | * |
|              | 10-26-037-002           | 0.012 INCH (0.305 mm) SHIM   | *          | *   | *   | *   | *   | *   | * |
|              | 10-26-037-003           | 0.014 INCH (0.356 mm) SHIM   | *          | *   | *   | *   | *   | *   | * |
|              | 10-26-037-004           | 0.016 INCH (0.406 mm) SHIM   | *          | *   | *   | *   | *   | *   | * |
|              | 10-26-037-005           | 0.018 INCH (0.457 mm) SHIM   | *          | *   | *   | *   | *   | *   | * |
|              | 10-26-037-006           | 0.020 INCH (0.508 mm) SHIM   | *          | *   | *   | *   | *   | *   | * |
|              | 10-26-037-007           | 0.022 INCH (0.559 mm) SHIM   | *          | *   | *   | *   | *   | *   | * |
| 112          | 10-26-039-003           | REAR COVER                   | 1          | 1   | 1   | 1   | 1   | 1   |   |
| 113          | 10-00-044-017           | OIL SEAL                     | 1          | 1   | 1   | 1   | 1   | 1   |   |
| 114          | 10-00-053-016           | SPACER                       | 1          | 1   | 1   | 1   | 1   | 1   |   |
| 115          | 0000103321              | 3/8 INCH LOCKWASHER          | 8          | 8   | 8   | 8   | 8   | 8   |   |
| 116          | 0000179841              | 3/8-16 x 1-1/4 HEX HEAD BOLT | 8          | 8   | 8   | 8   | 8   | 8   |   |
| 117          | 4914                    | COUPLING                     | 1          | 1   | 1   | 1   | 1   | 1   |   |
| 118          | 4775T                   | 1-1/4-18 COUPLING HEX NUT    | 1          | 1   | 1   | 1   | 1   | 1   |   |

\*Selective shim

FIG. 8 SERIES 7000 TRANSMISSION — PARTS LIST (CONT.)

## TRANSMISSION DISASSEMBLY

**NOTE:** To aid in disassembly and assembly, refer to the exploded view and nomenclature parts list as shown in Figs. 7 and 8.

1. Remove all damper housing to transmission bolts and remove the damper housing from transmission (Fig. 9).

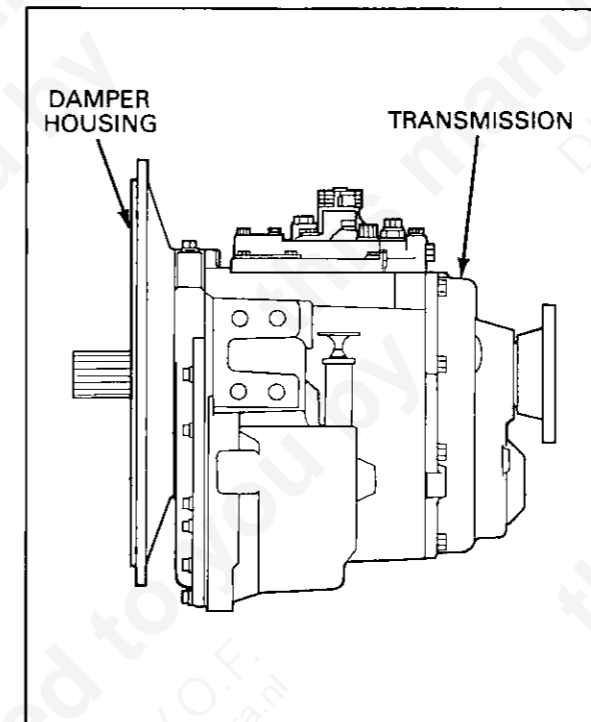


FIG. 9 DAMPER HOUSING REMOVAL

2. Remove valve body to case bolts. Remove valve body and gasket.
3. Remove the pump to case bolts. Lift the pump housing from the front cover. Remove pump housing gasket. Remove the pump drive gear and driven gear from pump housing. Remove the pump key located on the input shaft.
4. Using suitable supports, position the transmission case so that the front cover faces up.

5. Remove the front cover to case bolts. Insert a screwdriver in the pry slot and remove the front cover from the transmission. It may be necessary to remove the dowels (Fig. 10).

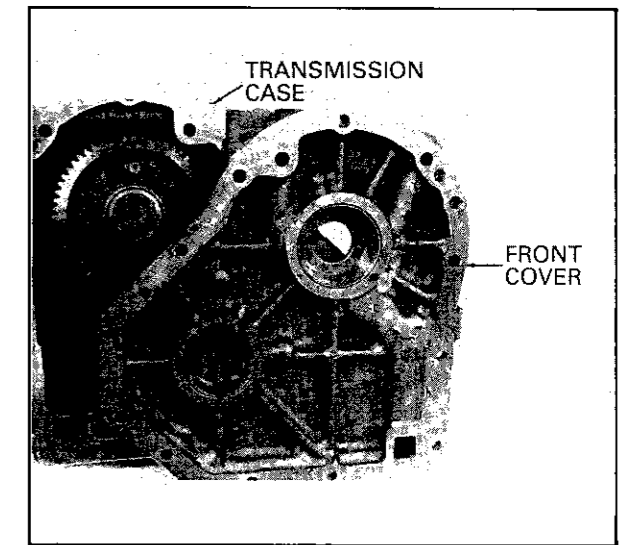


FIG. 10 FRONT COVER REMOVAL

6. Lift straight up on the input shaft to remove the engine rotation clutch along with the input shaft from the transmission (Fig. 11).

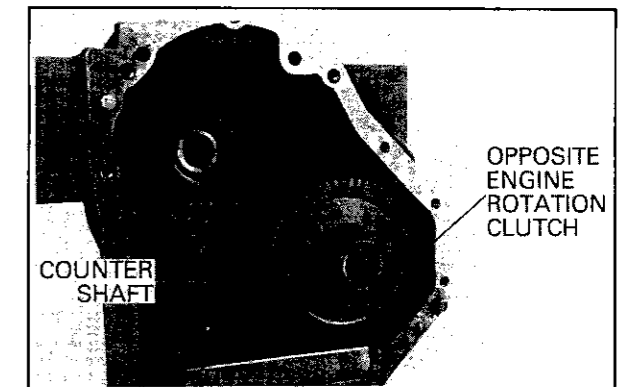


FIG. 11 ENGINE ROTATION CLUTCH REMOVAL

7. Lift the opposite engine clutch and shaft from the transmission.
8. Fabricate a holding tool by cutting a 5 inch bevel gear in half (Fig. 12).

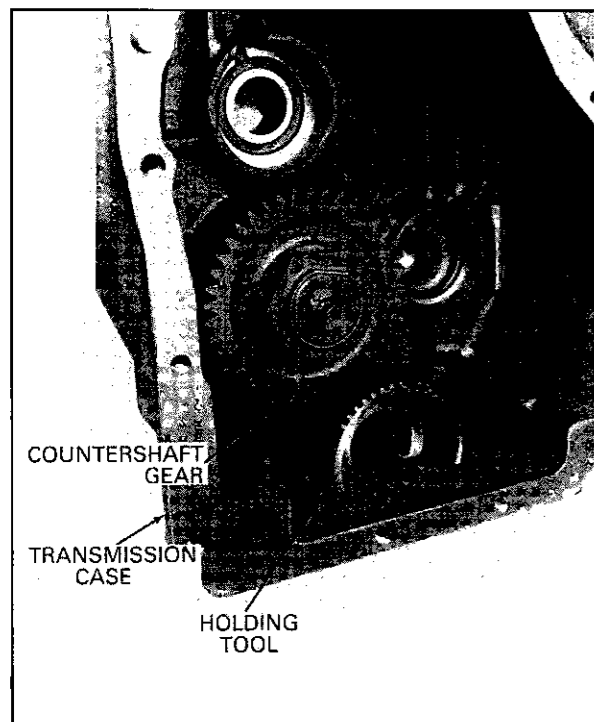


FIG. 12 HOLDING TOOL INSTALLATION

9. Place the holding tool on the floor of the case and mesh the holding tool with the countershaft front gear.
10. While holding the holding tool in mesh with the countershaft gear, carefully reposition the transmission case so that the rear cover is facing up.
11. Remove the nut and output flange.
12. Remove the rear cover to case bolts. Using a screwdriver inserted in the pry slot, remove the rear cover.
13. Lift the output shaft, gear and bearing assembly from the transmission case (Fig. 13).

14. Turn the transmission case over so that the front of the case faces up.

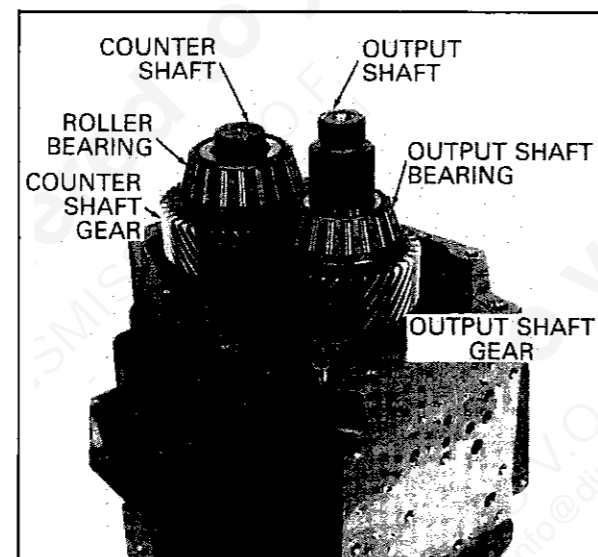


FIG. 13 OUTPUT SHAFT, GEAR AND BEARING REMOVAL

15. Keeping the holding tool in mesh with the front countershaft gear, remove the nut and washer from the front end of the countershaft and slide the gear off of the splines of the shaft. Remove the countershaft.

#### DISASSEMBLY OF THE SUBASSEMBLIES

**NOTE:** Read Inspection and General Instructions before any Disassembly of the subassemblies is attempted.

#### BEARING AND BEARING CUP REMOVAL

16. Remove the bearing cups from the bores of the case and also from the front and rear case covers.
17. Press the bearings from all the shafts and remove the gear and thrust washers from each shaft.

#### CLUTCH PACK DISASSEMBLY

**NOTE:** Except for the location and size of the thrust washer, both the engine rotation clutch and opposite engine rotation clutch are identical. This disassembly procedure is the same for both. The only difference is the location of thrust washer installation.

18. Remove the needle bearings from the engine rotation clutch and from the opposite engine rotation clutch. Note the location of each thrust washer for reassembly. Remove the thrust washers from both clutches.
19. Remove the snap ring located in front of the pressure plate of both clutches (Fig. 14).

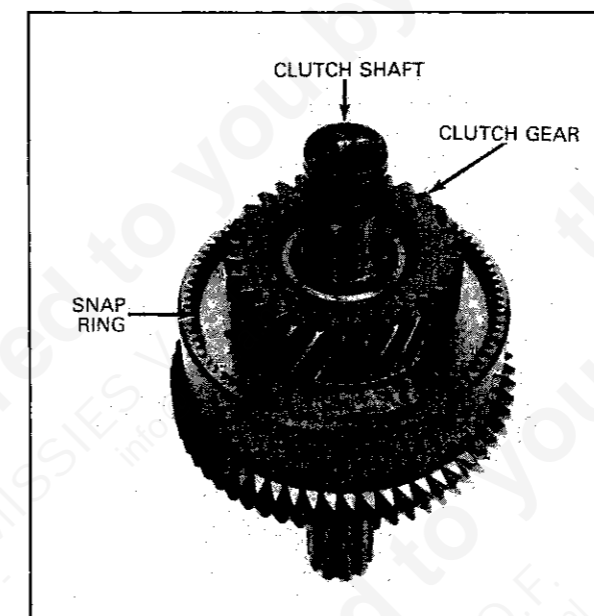


FIG. 14 PRESSURE PLATE SNAP RING REMOVAL

20. Remove the pressure plate along with the friction and separator plates from both clutches (Fig. 15).

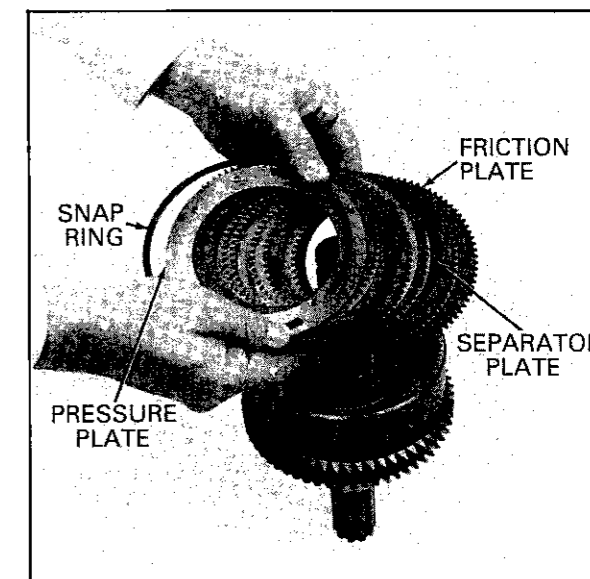


FIG. 15 PRESSURE PLATE AND CLUTCH PACK REMOVAL

21. Using a suitable tool, compress the clutch spring and remove the snap ring from above the spring retainer. Slowly release the clutch spring and remove the spring retainer and springs and retainer assembly (Fig. 16). Dimensions for the retainer holding tool are shown in Fig. 17.

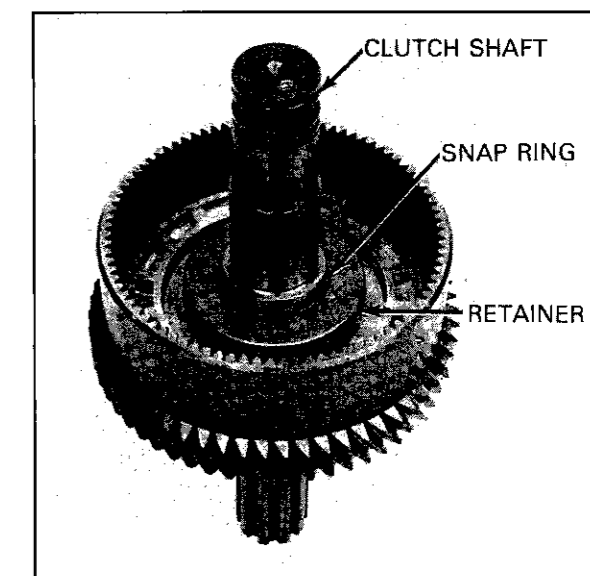


FIG. 16 RETAINER SNAP RING REMOVAL

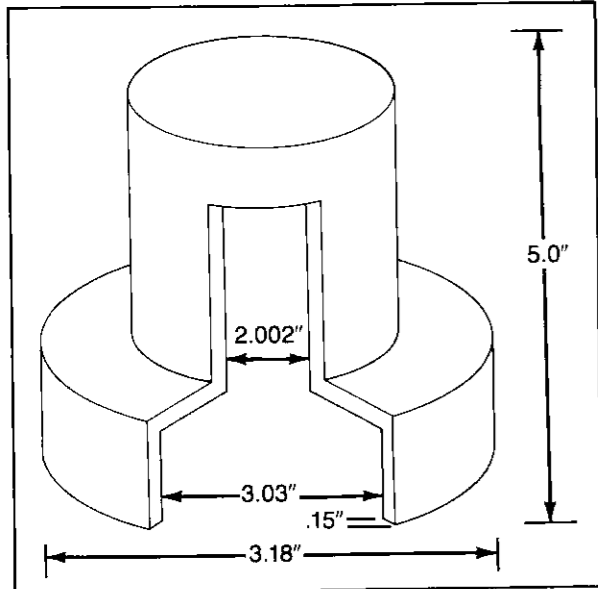


FIG. 17 RETAINER HOLDING TOOL

22. Use low pressure compressed air to remove the pistons from both clutch cylinders. Remove and inspect the sealing rings. If they have been damaged, discard and replace during reassembly.

#### VALVE BODY DISASSEMBLY (Refer to Fig. 18)

23. Remove the cooler line fitting from the cooler outlet of the valve body.

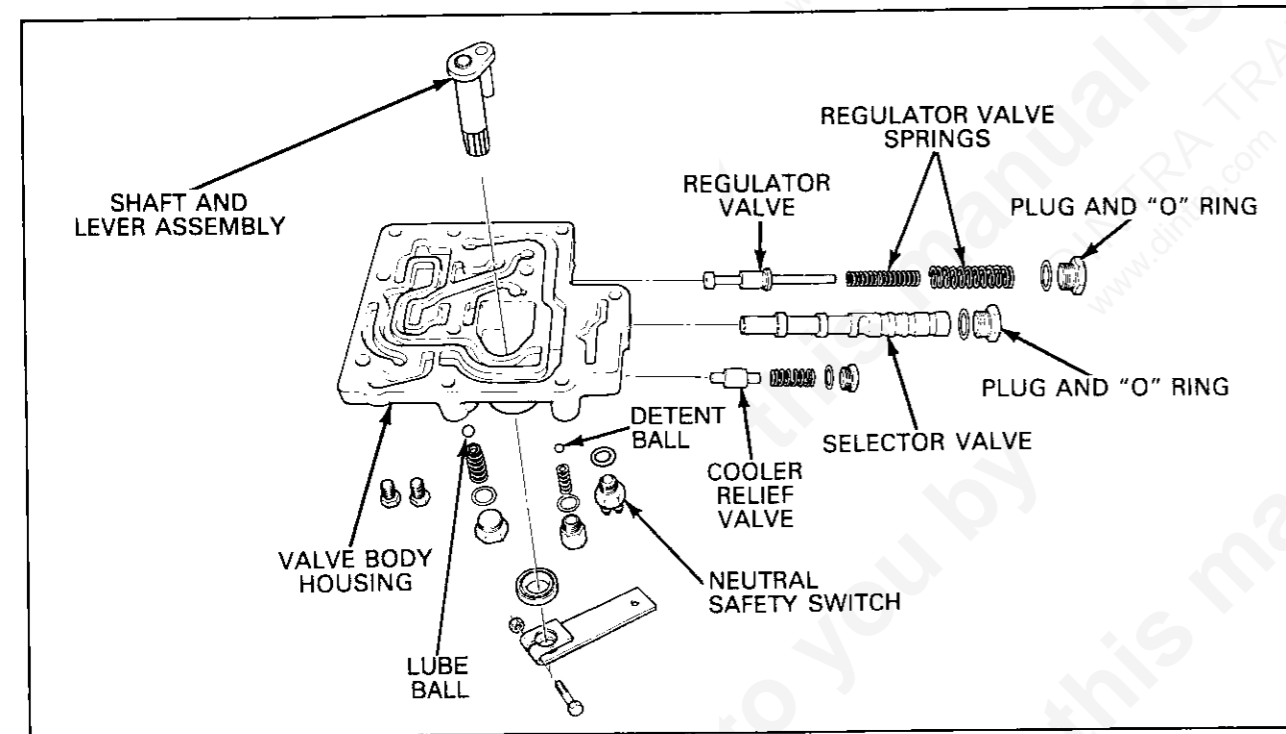


FIG. 18 VALVE BODY — EXPLODED VIEW

24. Remove the neutral start switch.
  25. Remove the two 1/8 inch pipe plugs from the clutch pressure taps.
  26. Remove the outer shift lever from the shifter shaft.
- NOTE:** It may be helpful to scribe a line from the top of the shifter shaft to the outer shift lever. This will aid in repositioning during reassembly.
27. Remove the selector shaft, lever and pin assembly out of the valve body.
  28. Remove the lube relief plug, spring, and ball from the valve body.
  29. Remove the plug from the selector valve bore and remove the spring and poppet ball out of the valve body.
  30. Remove the selector valve.
  31. Remove the cooler bypass valve spring and plug.
  32. Remove the two regulator valve springs along with the regulator valve.

#### TRANSMISSION ASSEMBLY

**NOTE:** Prior to assembly, lubricate all internal components with the specified transmission fluid.

#### VALVE BODY ASSEMBLY (Refer to Fig. 18)

**NOTE:** Before assembly of the valve body, be sure that all valves are free of burrs and nicks. If any burrs or nicks are found, remove with a crocus cloth or replace the valve.

1. Assemble the regulator valve, with stem end out, into bore of valve body.
2. Install the two regulator valve springs. The smaller diameter spring is installed inside of the larger spring.
3. Assemble a new "O" ring over the threaded end of the plug. Tighten plug to specified torque.
4. Assemble the cooler valve and spring into the bore of the valve body. Install the "O" ring and plug assembly. Tighten the plug to specified torque.
5. Slide the selector valve into the selector bore of the valve body. Align the neutral (middle) poppet notch with the hole for the poppet ball and spring (Fig. 18). Assemble the poppet ball, spring, and plug with "O" ring. Tighten plug to the specified torque.
6. Install the plug with the "O" ring into the selector valve bore of the valve body.
7. Install the selector shaft, lever, and pin assembly into the valve body. The pin should be assembled in the groove of the selector valve.
8. Use a sleeve over the exposed knurled section of the selector shaft to protect the oil seal as it is assembled into the counterbore of the valve body. The seal should be flush with the face of the valve body.

9. Assemble the outer shift lever over the exposed splines of the shifter shaft. Assemble the bolt and nut. Tighten the nut to 30-35 pounds-feet (41-48 N·m). It is recommended the outer shift lever be installed in the position marked during removal.

10. Assemble the two 1/8 inch pipe plugs in the clutch pressure taps. Tighten these plugs to 7-12 pounds-feet (10-16 N·m).

11. Install the neutral start switch and tighten to 20-30 pounds-feet (27-41 N·m) (Fig. 19). Install the lube relief check ball, spring and plug (Fig. 19).

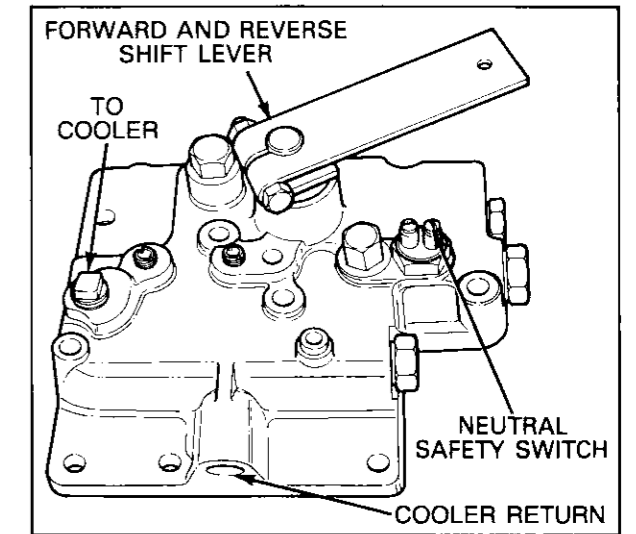


FIG. 19 NEUTRAL START SWITCH INSTALLATION

12. Assemble the cooler line fitting into the cooler outlet of the valve body. If unit is to be stored, plug the outlet.

#### REASSEMBLY OF THE CLUTCH PACKS

**NOTE:** Both clutch packs are identical. This procedure applies to both clutch packs. The only difference is the position of thrust washer installation and the size of the thrust washers. The thrust washers are not interchangeable between clutches. They must be repositioned as noted in step 18 under CLUTCH PACK DISASSEMBLY.

13. Press a tapered bearing cone over the face of the gear on each clutch shaft (Fig. 20).

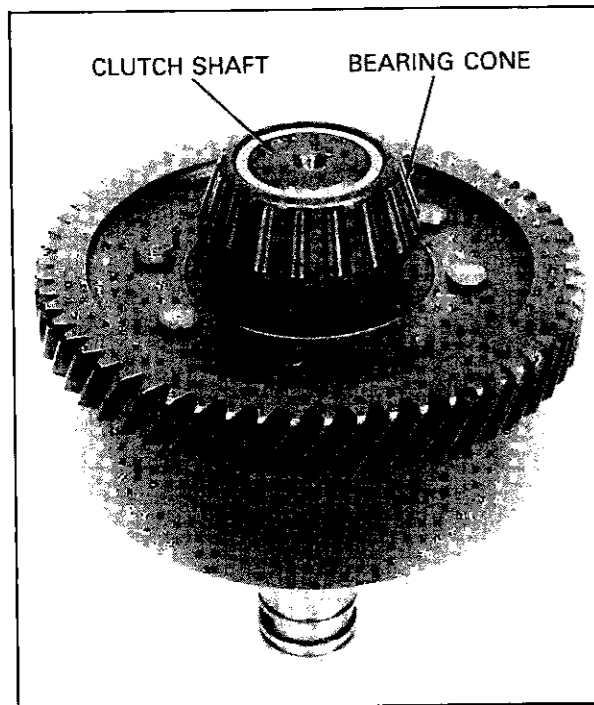


FIG. 20 BEARING CONE INSTALLATION

14. Lubricate the two "O" rings with petroleum jelly. Assemble one ring into the groove of each clutch shaft (Fig. 21).

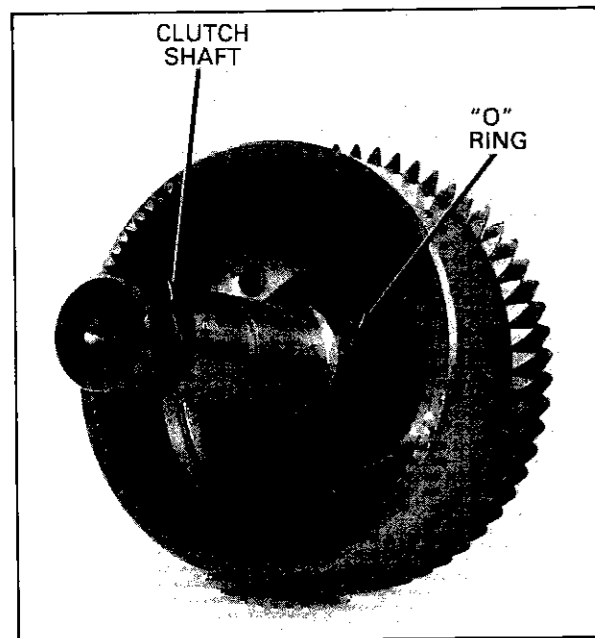


FIG. 21 "O" RING INSTALLATION

15. Lubricate and assemble the clutch piston sealing ring into each piston. The lip of these sealing rings should point toward the flat side of the piston.

16. Using a tapered cylindrical tool as shown, install the piston and seal into each clutch cylinder (Fig. 22). A piece of shim stock, 0.004 inch (0.1 mm) thick or less which is 3 inches (76 mm) wide and 16 inches (406 mm) long, may be wrapped around the inside of the clutch cylinder to guide the lip of the seal into the cylinder if a special tool is not available.

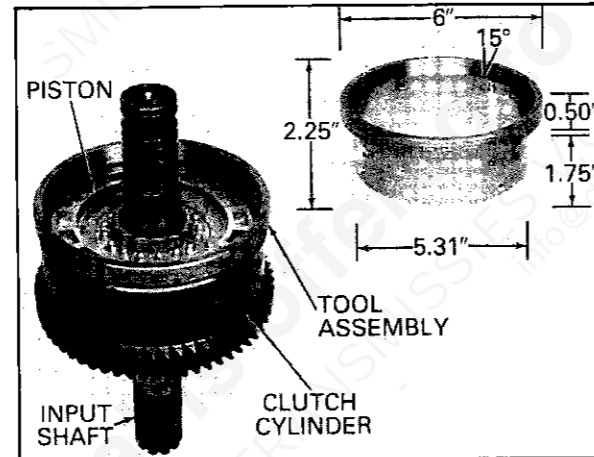


FIG. 22 CLUTCH PISTON INSTALLATION

17. Seventeen clutch release springs are permanently attached to the spring retainer. Check to determine that each spring is securely attached to the retainer. Position each spring over one of the spherical bosses on the face of the piston.

18. Place the spring retainer over the spring and retainer assembly (Fig. 23).

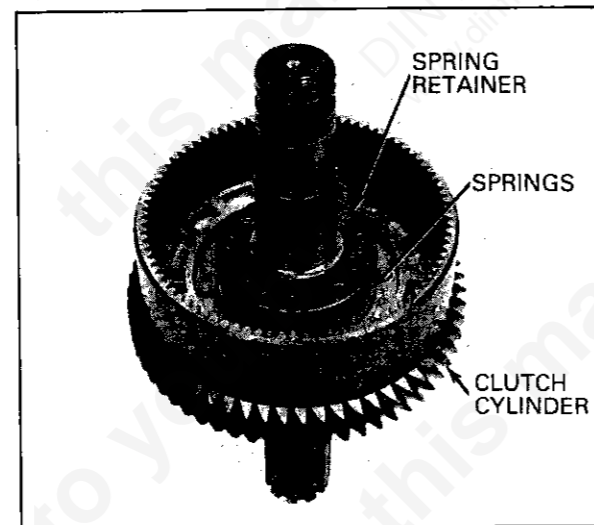


FIG. 23 SPRING RETAINER INSTALLATION

19. Using a suitable tool as shown in Fig. 17, compress the clutch springs and install the snap ring into the groove of the clutch shaft (Fig. 24).

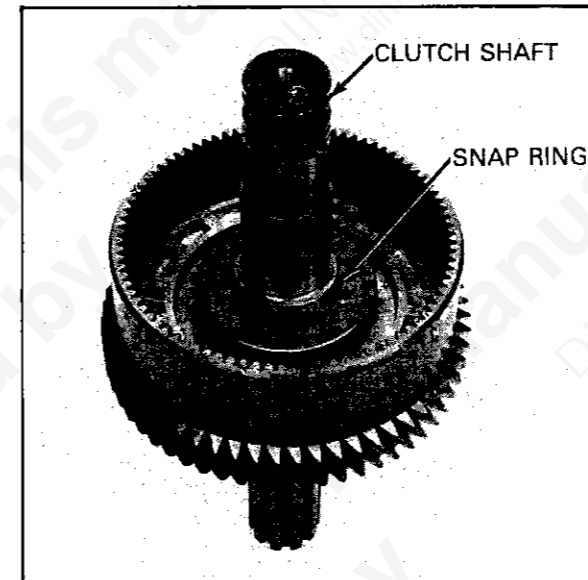


FIG. 24 RETAINER SNAP RING INSTALLATION

20. Assemble a friction plate followed by a separator plate and alternate friction and separator plates until eight friction and seven separator plates are assembled into the clutch cylinder (Fig. 25).

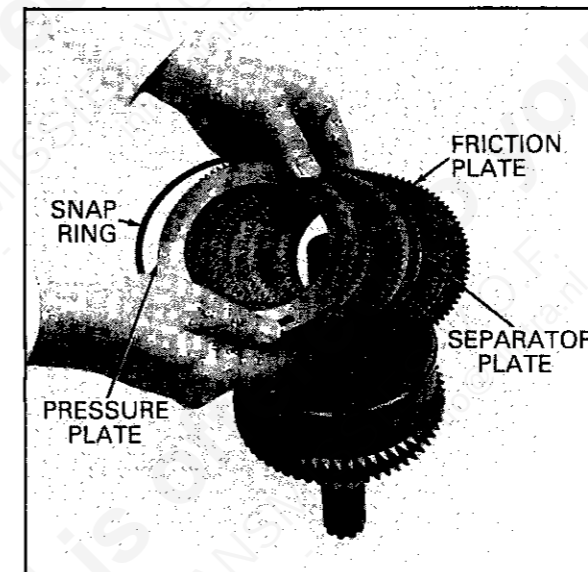


FIG. 25 CLUTCH PACK INSTALLATION

21. Assemble the pressure plate into the clutch cylinder (Fig. 26).

22. Install a snap ring into the groove above the pressure plate (Fig. 26).

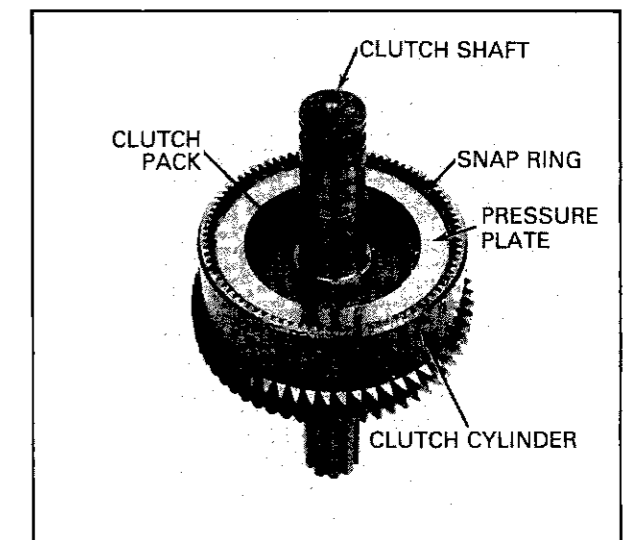


FIG. 26 PRESSURE PLATE INSTALLATION

23. Check clutch pack clearance to ensure the plates are free. Pack clearance should be from 0.0905 to 0.1785 inch (2.30-4.53 mm). Drag between the clutch gear and shaft when in a horizontal position should not exceed 30 inch pounds (3.39 N·m).

24. Assemble a steel thrust washer over the engine rotation clutch shaft and position against the shoulder of the shaft (Fig. 27). Install a steel and then a vespel thrust washer for the opposite engine rotation clutch.

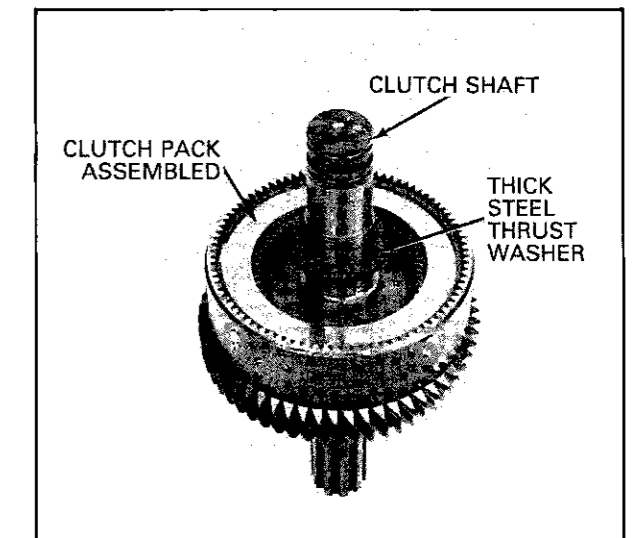


FIG. 27 THRUST WASHER ON CLUTCH SHAFT INSTALLATION

25. Assemble the clutch gear over the shaft to rest against the thrust washer. It will be necessary to rotate the clutch gear to engage the splines of the gear with the teeth of the clutch plates (Fig. 28).

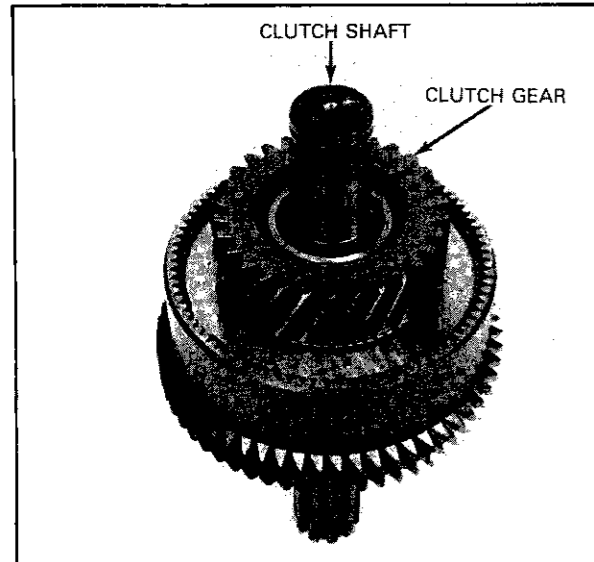


FIG. 28 CLUTCH GEAR INSTALLATION

26. Assemble both needle bearings into the bore of the gear (Fig. 29).

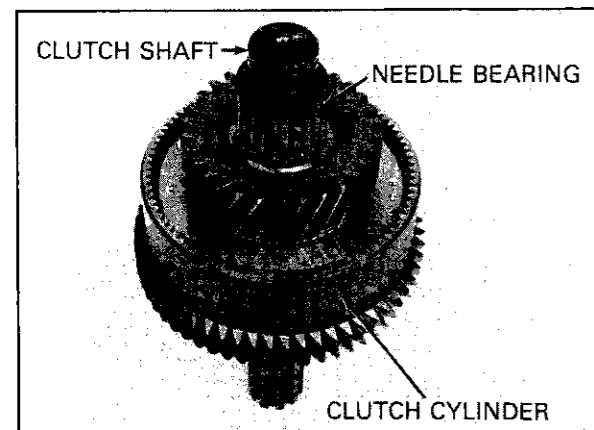


FIG. 29 NEEDLE BEARINGS AND SPACER INSTALLATION

**NOTE:** Each needle bearing has twenty-two caged needles. Be sure all bearings are in place before installation.

27. Install a vespel and then a steel thrust washer against the engine rotation clutch gear.

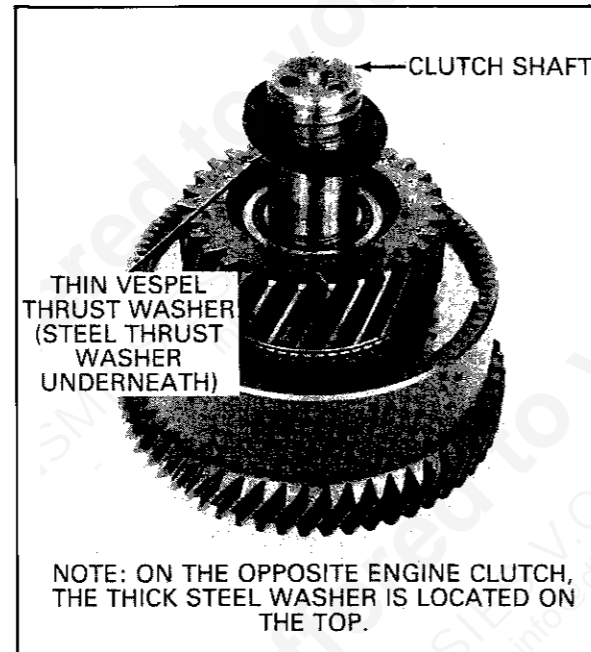


FIG. 30 THRUST WASHER INSTALLATION

Install the clutch gear over the opposite engine clutch shaft. Rotate the clutch gear to engage the splines of the gear with the teeth of the clutch plates. Assemble the needle bearings into the bore of the gear. Install a thick steel thrust washer against the face of the opposite engine clutch gear.

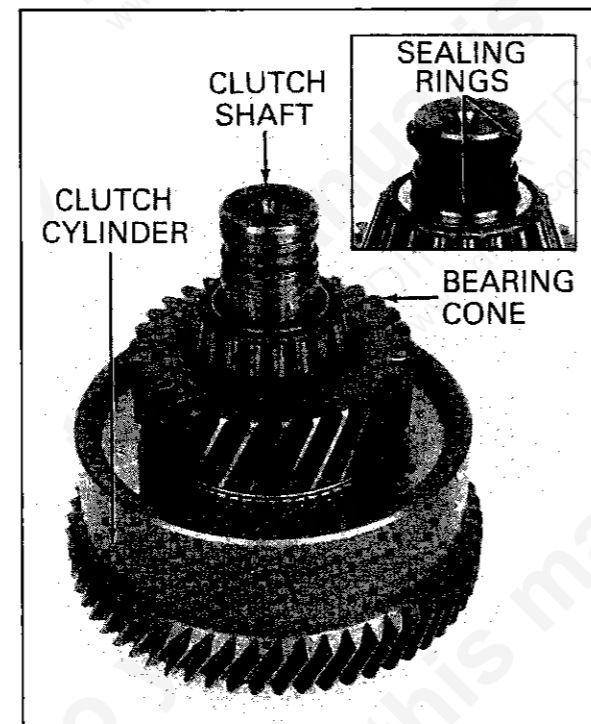


FIG. 31 CLUTCH SHAFT BEARING CONE INSTALLATION

28. Press on the inner race of the bearing cone while installing the bearing cone onto the shaft. Seat the bearing cone on the shaft shoulder. The clutch gear should have from 0.003 to 0.016 inch (0.07-0.41 mm) end play after the bearing is pressed against the shaft (Fig. 31).

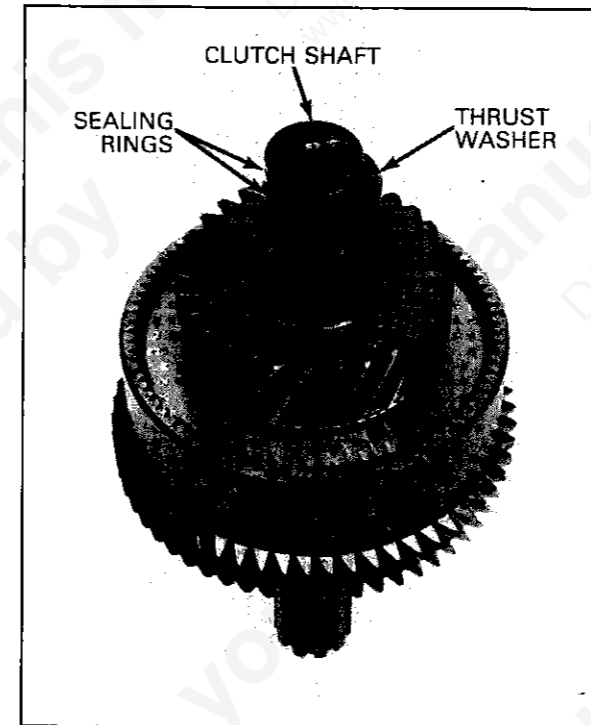


FIG. 32 CLUTCH SHAFT SEALING RING INSTALLATION

29. Assemble the two sealing rings into the grooves of the shaft. Use petroleum jelly to lubricate sealing rings (Fig. 32). Hook the ends of the rings together.

### ASSEMBLY OF THE OUTPUT SHAFT AND COUNTERSHAFT INTO THE CASE

30. Replace the four dowels, if removed, in the holes provided in the case. These dowels should stick out of the case from 0.37 to 0.39 inch (9.4-9.9 mm).

31. Press the countershaft rear bearing cone over the countershaft and into contact with the face of the gear.

**NOTE:** Press the countershaft rear bearing cone and front bearing cone on the inner race only.

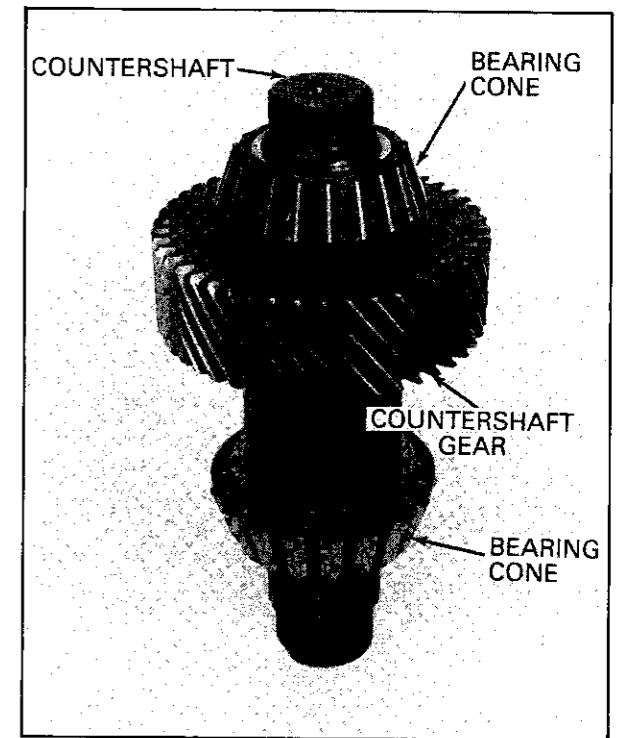


FIG. 33 COUNTERSHAFT FRONT BEARING CONE INSTALLATION

32. Press the countershaft front bearing cone over the countershaft and seat against the shoulder of the countershaft (Fig. 33).

33. Assemble the countershaft front bearing cup into the lower bore of the case (Fig. 34).

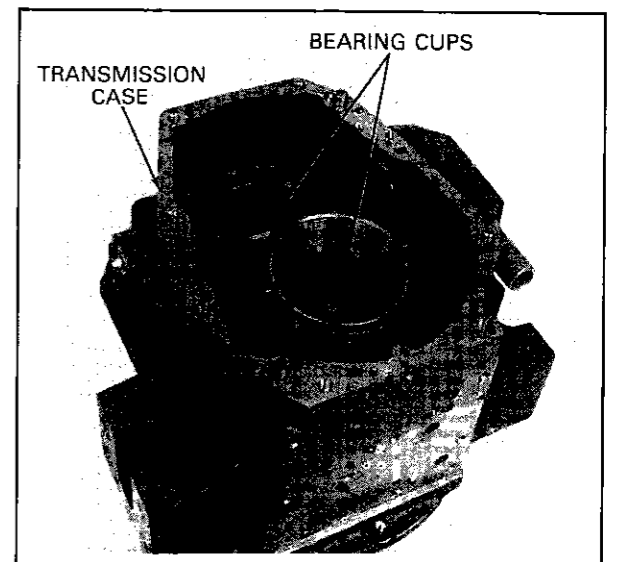


FIG. 34 COUNTERSHAFT FRONT CUP INSTALLATION

34. Hold the countershaft and attached components in position with the front bearing cone rested in the cup.

35. Slip the splines of the front countershaft gear over the splines of the countershaft. The longer end of the gear hub of this gear should be assembled toward this bearing (Fig. 35).

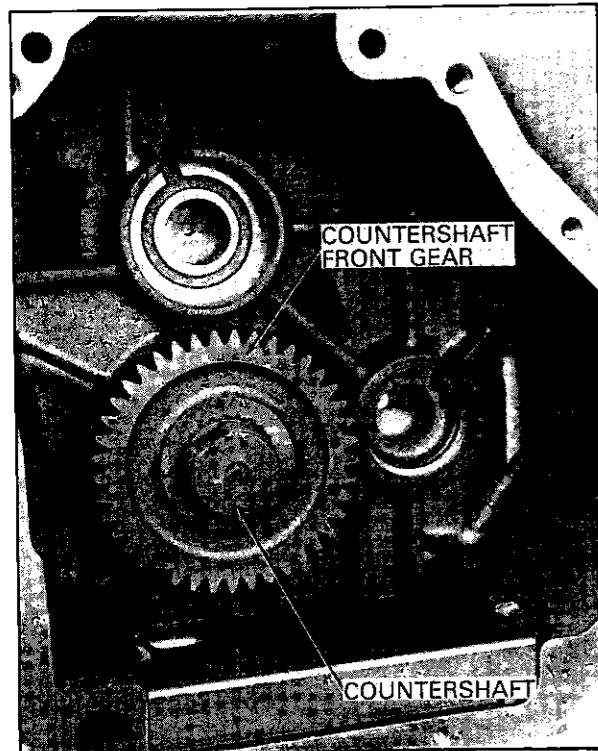


FIG. 35 COUNTERSHAFT FRONT GEAR INSTALLATION

36. Position the holding tool in mesh with the front countershaft gear and install the flat washer and nut (Fig. 36). Tighten the nut to 500-550 pounds-feet (678-746 N·m). Drive the thin section of the nut down against the flat on shaft to retain nut to shaft.

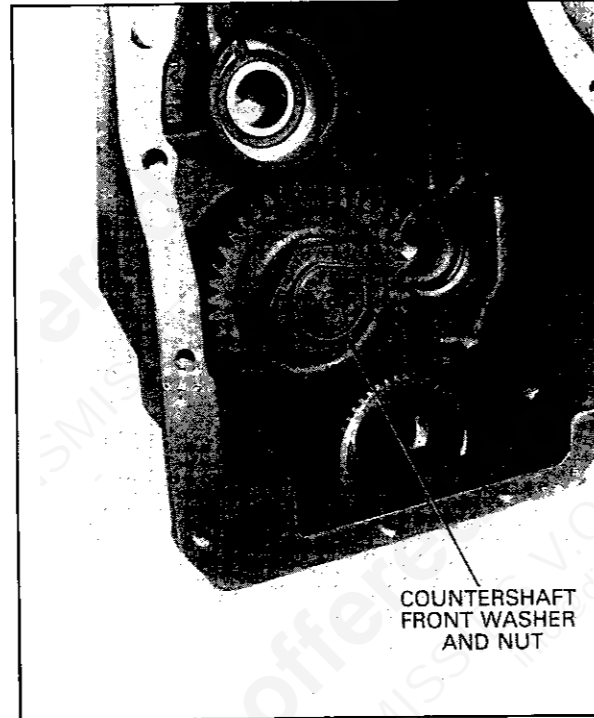


FIG. 36 COUNTERSHAFT FRONT NUT INSTALLATION

37. Position the case on its front face and install the output shaft bearing cup into the bore of the case (Fig. 34).

38. Install the output shaft gear splines over the splines of the output shaft. The counterbore of the gear should be located toward the front end of the shaft.

39. Press the output shaft front and rear bearings over the shaft and seat against the shoulder of the output shaft (Fig. 37).

**NOTE:** Press the output shaft bearings on the inner race only.

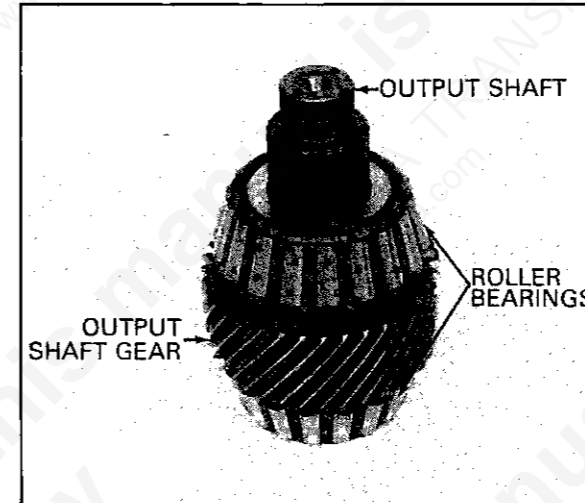


FIG. 37 OUTPUT SHAFT BEARINGS INSTALLATION

40. Position the output shaft front bearing cone in the bearing cup in the case as the output shaft, gear and bearing assembly is installed into the case (Fig. 38).

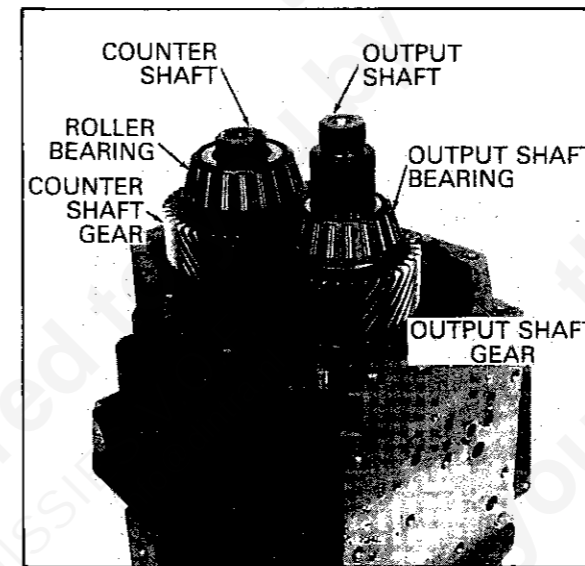


FIG. 38 OUTPUT SHAFT INSTALLATION

#### SHIM PACK SELECTION — OUTPUT SHAFT AND COUNTERSHAFT

41. There are two methods for shim pack selection for the output shaft and countershaft. The first method for selecting the shim packs is accomplished by placing a 0.060 inch (1.5 mm) shim pack in position for one of the shafts. Install the rear case cover, which should be held above the face of the case because the shim pack will be too thick. Use three sets of feeler gauges having equal blade

thickness. Place the feeler gauge blades between the two faces. The three feeler gauge blades should just slip into position at three equally spaced locations. Ensure that the two faces are parallel to each other. Subtract the thickness of the feeler gauge blade from the 0.060 inch (1.52 mm) thickness of the shim pack. This will give the thickness of a shim pack which should allow zero end play. It is permissible to use a shim pack which is 0.004 inch (0.10 mm) more than the zero end play shim pack. Repeat for the other shaft.

42. An alternate shim pack selection method is to assemble the bearing cups without shims over each bearing cone. Assemble the case cover over the output shaft and countershaft and position against the rear face of the case. Do not use sealing compound on the face of the case at this time. Assemble and tighten two cover to case bolts to retain cover to case. Use a dial indicator against the end of each shaft to determine the total amount of end play for each shaft. Record the amount of end play for each shaft. Remove the case rear cover. Use the recorded value of end play to select a shim pack which is 0.000-0.004 inch (0.00-0.10 mm) more than this value. The shaft should then have 0.000-0.004 inch (0.00-0.10 mm) preload.

#### REAR CASE COVER TO CASE ASSEMBLY

43. Press a new seal into the case rear cover. This seal should be pressed to the bottom of the seal bore in the case (Fig. 39).

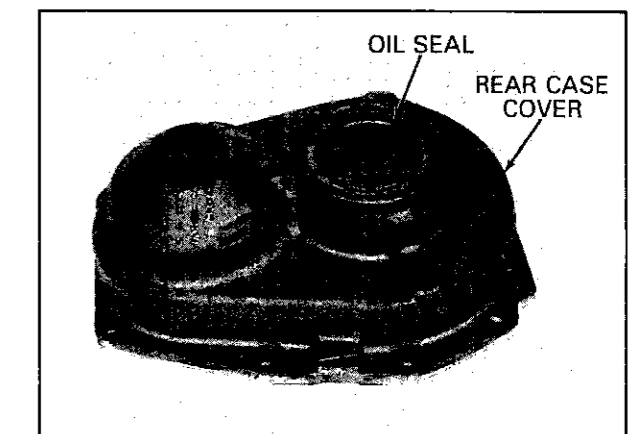


FIG. 39 REAR CASE COVER AND OIL SEAL



44. Assemble shims for the countershaft and output shaft into their respective bores in the case rear cover (Figure 40). Apply petroleum jelly to the bearing cups to prevent them from sliding out of their bores. Assemble each cup into the respective bore.

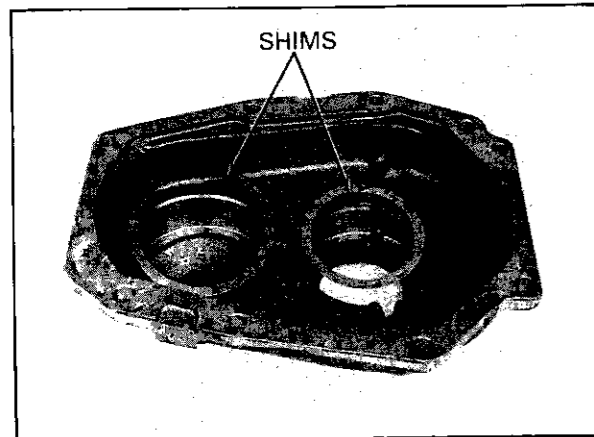


FIG. 40 REAR COVER SHIM INSTALLATION

45. Apply a  $\frac{1}{16}$  inch (1.6 mm) bead of Loctite Number 515 sealing compound to the face of the case. Place the case cover onto the face of the case. Install the attaching bolts and tighten to 32-37 pounds-feet (43-50 N·m) (Fig. 41).

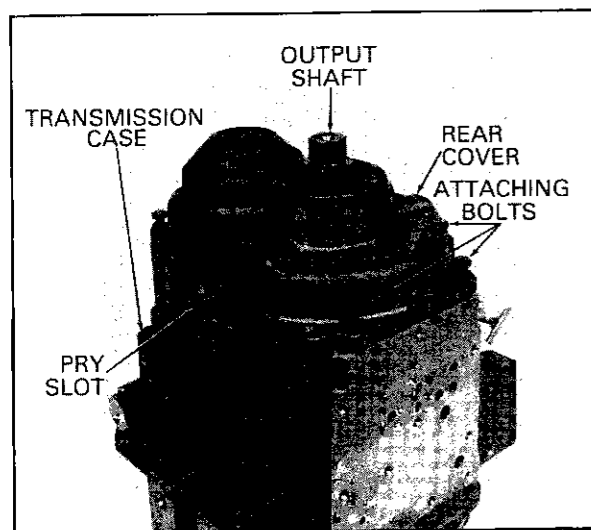


FIG. 41 REAR COVER INSTALLATION

46. Assemble the spacer against the rear face of the output shaft bearing.

47. Using the holding tool to hold the countershaft front gear, assemble output flange and nut to the output shaft (Fig. 42). Tighten the coupling nut to 200-250 pounds-feet (271-340 N·m).

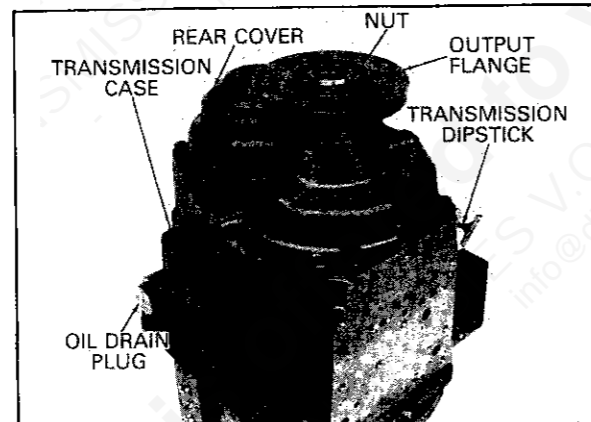


FIG. 42 OUTPUT FLANGE INSTALLATION

48. With a torque wrench placed on the coupling nut, check the torque required to rotate the output shaft at a constant speed. It should take approximately 8 to 10 foot pounds (11.0-13.6 N·m) of torque to rotate the coupling. If the torque required to rotate the coupling exceeds these values, check for bearing preload or check bearing end play.

#### CLUTCH PACKS INTO CASE ASSEMBLY

49. Position the case with the front of the case facing up. Use suitable supports to hold the case in position.

50. Lower each clutch assembly into position with the rear bearing cone seated in the bearing cup. Place the front bearing cup over each shaft. Center the two clutch assemblies in a vertical position (Fig. 43).

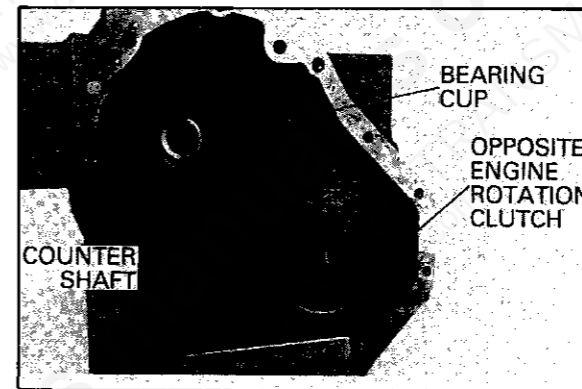


FIG. 43 OPPOSITE ENGINE ROTATION CLUTCH INSTALLATION

51. If the oil baffle and magnet have been removed, reassemble into case.

#### CLUTCH SHAFT END PLAY CHECK

52. Measure and record the dimension from the face of the bearing cup to the front face of the case for each clutch pack.

Measure and record the dimension from the face of the case front cover to the bottom of each bearing bore.

Subtract the dimension found in first step from the value found in the second step. Select a shim pack which will give from 0.000-0.004 inch (0.0-0.10 mm) preload when front case cover is in position.

|  | E. Clutch | O.E. Clutch |
|--|-----------|-------------|
| Example  |           |             |
| Face of cover to bottom of bearing bore          | 0.817"    | 0.861"      |
| Face of case to bearing cup                      | -0.800"   | -0.841"     |
| Shim pack required to obtain 0.000 inch end play | .017"     | .020"       |
| Plus   | 0.004"    | 0.004"      |
| Shim pack required to obtain 0.004 inch preload  | 0.021"    | 0.024"      |

53. Apply a continuous  $\frac{1}{16}$  inch (1.6 mm) bead of Loctite Number 515 sealing compound to the face of the case (Fig. 44).

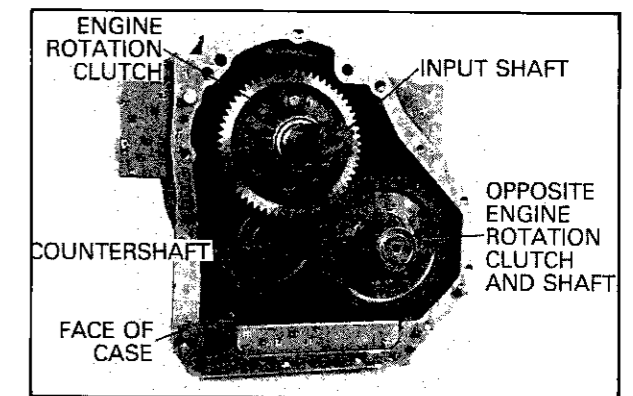


FIG. 44 FRONT OF TRANSMISSION

54. Assemble shims and bearing cups into the respective bores. Use petroleum jelly to hold cups in position (Fig. 45).

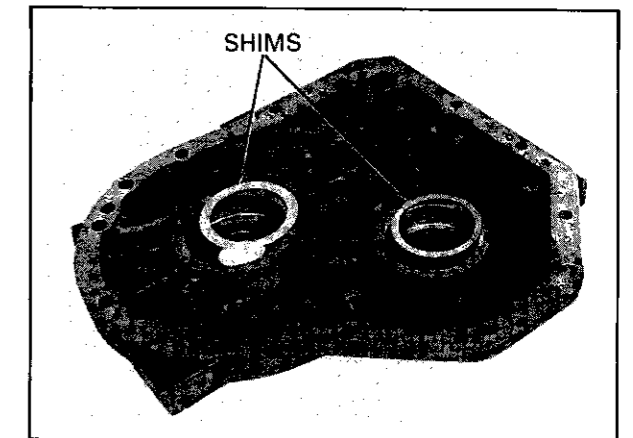


FIG. 45 FRONT COVER SHIM INSTALLATION

55. Lower the front cover against the face of the case. Insert and tighten the cover to case bolts to 36-41 pounds-feet (49-56 N·m) (Fig. 46). Check the end play of the input shaft to be certain it is from 0.000 to 0.004 inch (0.0-0.10 mm).

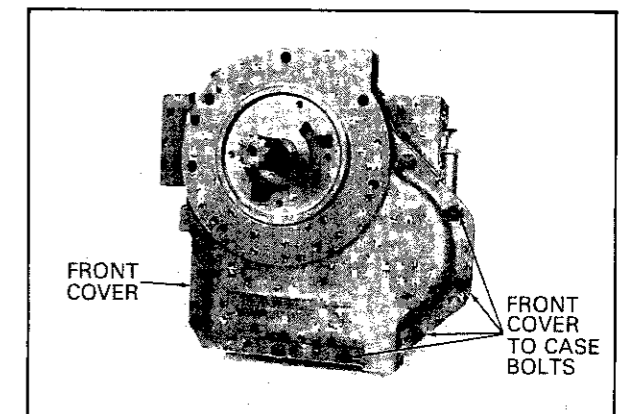


FIG. 46 FRONT COVER INSTALLATION

## PUMP ASSEMBLY

56. Press an oil seal into the pump housing. Position the seal to where the front face of the seal is flush with the front face of the pump (Fig. 47).

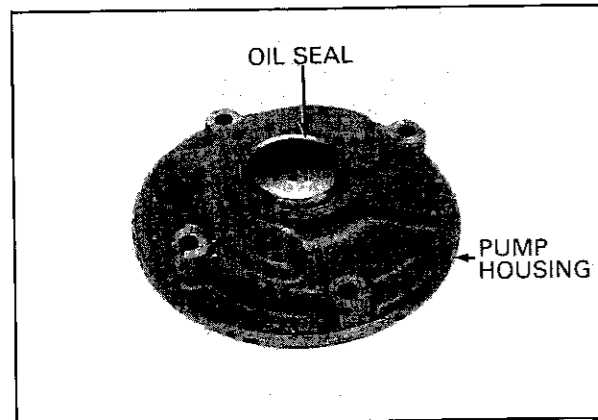


FIG. 47 PUMP OIL SEAL INSTALLATION

57. Assemble the driven gear into the pump housing (Fig. 48).

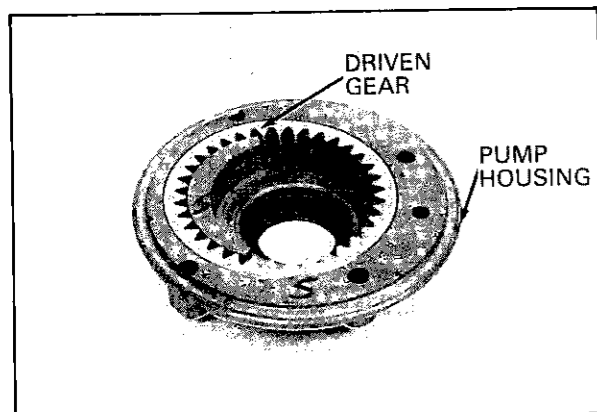


FIG. 48 PUMP DRIVEN GEAR INSTALLATION

58. Install the pump key into the keyway of input shaft (Fig. 49).

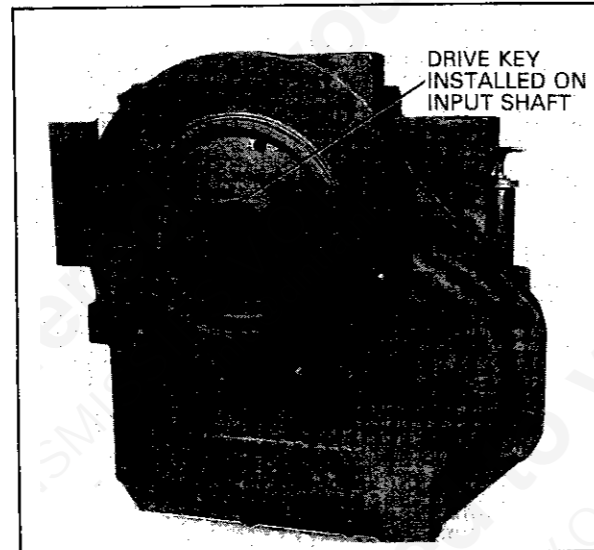


FIG. 49 PUMP KEY INSTALLATION

59. Install the pump drive gear over the shaft and key (Fig. 50).

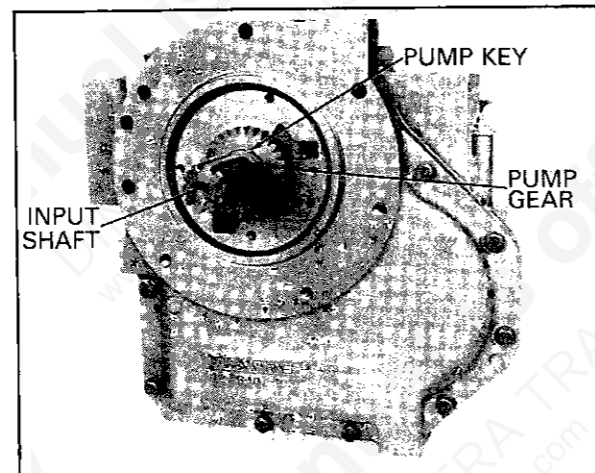


FIG. 50 PUMP DRIVE GEAR INSTALLATION

60. Assemble the pump gasket into pump bore of case cover.

61. Assemble the pump housing and drive gear to front face of the case front cover. Locate the pump housing so that the pump bolt holes are aligned with bolt holes in the adapter and the arrows which are located at the bottom and also at the top of the pump housing are pointing to the right when assembling the pump (Fig. 51).

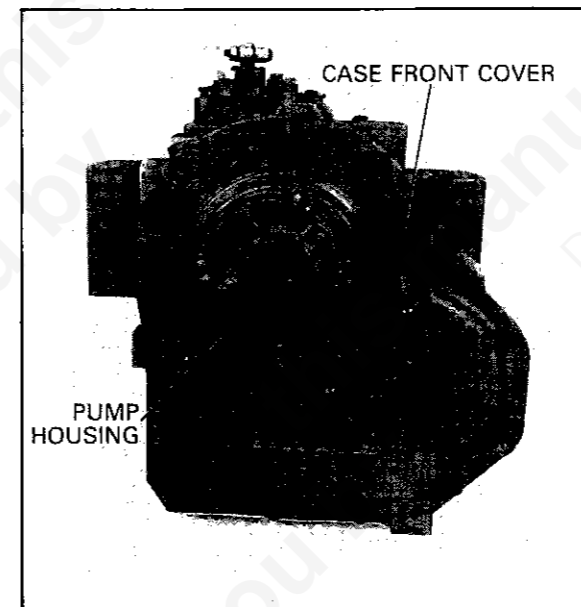


FIG. 51 PUMP HOUSING INSTALLATION

62. Assemble pump bolts and oil seal washer (Fig. 52) and tighten to 15-20 pounds-feet (20-27 N·m).

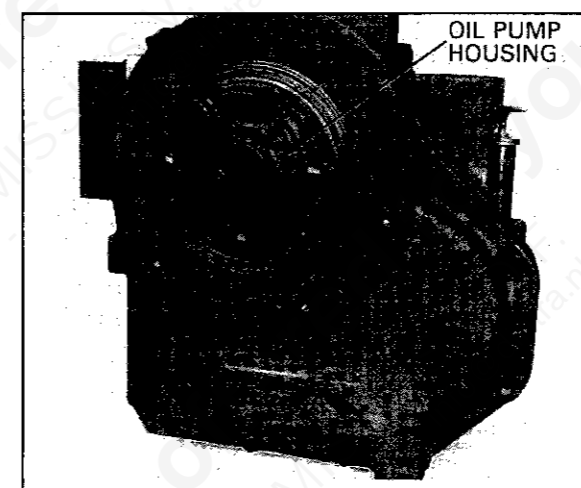


FIG. 52 PUMP HOUSING BOLT INSTALLATION

## VALVE BODY TO CASE ASSEMBLY

63. Place the valve body gasket on the case.

64. Place the valve body over the gasket (Fig. 53). Install and tighten valve body bolts (Fig. 54) to 15-20 pounds-feet (20-27 N·m).

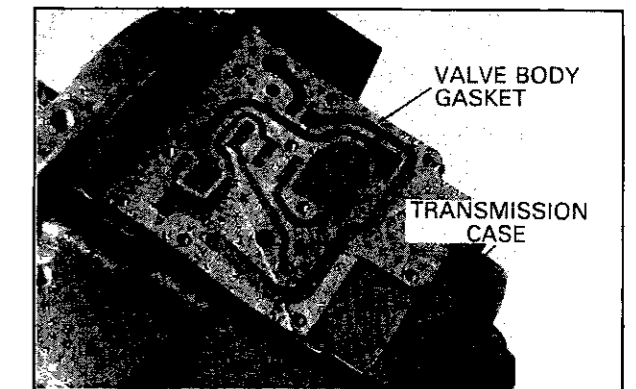


FIG. 53 VALVE BODY GASKET INSTALLATION

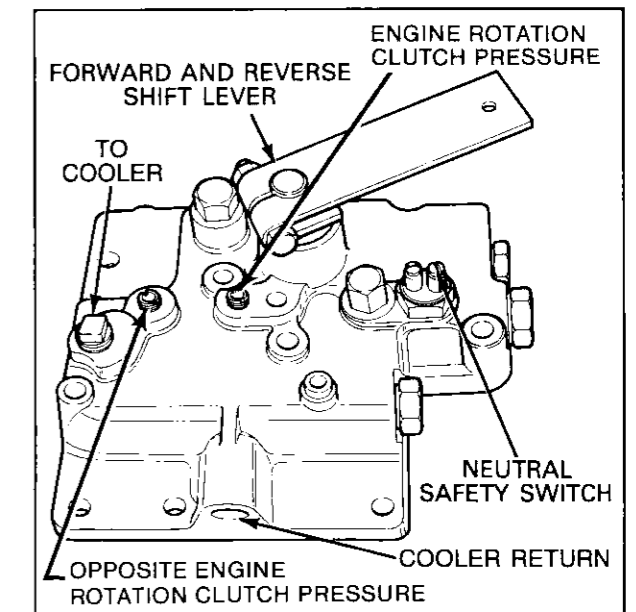


FIG. 54 VALVE BODY INSTALLATION

65. Remove the dipstick and fill the case with 5 quarts (4.7 liters) of the specified transmission fluid. Install the dipstick. Additional fluid will be required for the cooler and cooler lines.

### BOLT TORQUE SPECIFICATIONS

| PART NUMBER   | PART DESCRIPTION             | WHERE USED OR DESCRIPTION  | BOLT TORQUE SPEC. |             |
|---------------|------------------------------|----------------------------|-------------------|-------------|
|               |                              |                            | POUNDS-FEET       | N·m         |
| 0000444577    | 1/4-18 Pipe Plug             | Case                       | 12-20             | 16.3-27.1   |
| 10-00-552-006 | 1-5/16-12 Plug & "O" Ring    | Drain                      | 44-49             | 59.7-66.4   |
| 10-00-552-004 | 9/16-18 Plug & "O" Ring      | Valve Body Bore            | 20-30             | 27.1-40.7   |
| 0000179841    | 3/8-16 x 1-1/4 Hex Hd. Bolt  | Front & Rear Cover to Case | 32-37             | 43.4-50.2   |
| 0000179821    | 5/16-18 x 1-3/8 Hex Hd. Bolt | Pump to Adapter            | 15-20             | 20.3-27.1   |
| 10-00-149-020 | 1-9/16-18 Hex Nut            | Countershaft Rear Nut      | 160-200           | 135.6-203.4 |
| 10-00-149-021 | 1-3/4-18 Hex Nut             | Countershaft Front Nut     | 500-550           | 678-746     |
| 10-00-640-004 | 1/2 NPTF-Switch              | Neutral Switch             | 20-30             | 27.1-40.7   |
| 0000179860    | 7/16-14 x 1-1/4 Hex Hd. Bolt | Damper Housing to Case     | 36-41             | 48.8-55.6   |
| 0000179868    | 7/16-14 x 2-1/2 Hex Hd. Bolt | Front Cover to Case        | 36-41             | 48.8-55.6   |
| 0000179818    | 5/16-18 x 1" Hex Hd. Bolt    | Valve Body to Case         | 15-20             | 20.3-27.1   |
| 0000179826    | 5/16-18 x 2" Hex Hd. Bolt    | Valve Body to Case         | 15-20             | 20.3-27.1   |
| 4775T         | 1-1/4-18 Hex Nut             | Output Shaft Nut           | 200-250           | 271.2-339.6 |
| 0000103025    | 5/16-24 Hex Nut              | Shift Lever to Shaft       | 30-35             | 40.7-47.5   |
| 10-00-552-009 | 3/4-16 Plug & "O" Ring Assy. | Valve Body Bore            | 25-35             | 33.9-47.45  |
| X1516H        | 1/8-27 Pipe Plug             | Valve Body                 | 7-12              | 9.5-16.3    |
| 10-00-552-008 | 1/2-20 Plug & "O" Ring       | Valve Body                 | 18-23             | 24.4-31.2   |
| 00-00-181-343 | 5/16-24 x 1-1/2 Bolt         | Lever Clamp Bolt           | 18-23             | 24.4-31.2   |

### SERIES 7000 MAINTENANCE RECORD

| DATE | DAILY CHECKS          |           |            |                | GENERAL CHECKS |               |                           |                | SEASONAL CHECKS      |            |              |                    |                       |                       |
|------|-----------------------|-----------|------------|----------------|----------------|---------------|---------------------------|----------------|----------------------|------------|--------------|--------------------|-----------------------|-----------------------|
|      | Maintenance Performed | Oil Level | Leak Check | Bolt Tightness | Noises         | Shift Linkage | Propeller Shaft Alignment | Gauge Readings | Neutral Start Switch | Oil Change | Bolt Tighten | Boat Winterization | Transmission Painting | Transmission Cleaning |
|      |                       |           |            |                |                |               |                           |                |                      |            |              |                    |                       |                       |
|      |                       |           |            |                |                |               |                           |                |                      |            |              |                    |                       |                       |
|      |                       |           |            |                |                |               |                           |                |                      |            |              |                    |                       |                       |
|      |                       |           |            |                |                |               |                           |                |                      |            |              |                    |                       |                       |
|      |                       |           |            |                |                |               |                           |                |                      |            |              |                    |                       |                       |
|      |                       |           |            |                |                |               |                           |                |                      |            |              |                    |                       |                       |
|      |                       |           |            |                |                |               |                           |                |                      |            |              |                    |                       |                       |
|      |                       |           |            |                |                |               |                           |                |                      |            |              |                    |                       |                       |
|      |                       |           |            |                |                |               |                           |                |                      |            |              |                    |                       |                       |
|      |                       |           |            |                |                |               |                           |                |                      |            |              |                    |                       |                       |
|      |                       |           |            |                |                |               |                           |                |                      |            |              |                    |                       |                       |
|      |                       |           |            |                |                |               |                           |                |                      |            |              |                    |                       |                       |
|      |                       |           |            |                |                |               |                           |                |                      |            |              |                    |                       |                       |
|      |                       |           |            |                |                |               |                           |                |                      |            |              |                    |                       |                       |
|      |                       |           |            |                |                |               |                           |                |                      |            |              |                    |                       |                       |
|      |                       |           |            |                |                |               |                           |                |                      |            |              |                    |                       |                       |
|      |                       |           |            |                |                |               |                           |                |                      |            |              |                    |                       |                       |
|      |                       |           |            |                |                |               |                           |                |                      |            |              |                    |                       |                       |
|      |                       |           |            |                |                |               |                           |                |                      |            |              |                    |                       |                       |
|      |                       |           |            |                |                |               |                           |                |                      |            |              |                    |                       |                       |
|      |                       |           |            |                |                |               |                           |                |                      |            |              |                    |                       |                       |
|      |                       |           |            |                |                |               |                           |                |                      |            |              |                    |                       |                       |
|      |                       |           |            |                |                |               |                           |                |                      |            |              |                    |                       |                       |
|      |                       |           |            |                |                |               |                           |                |                      |            |              |                    |                       |                       |
|      |                       |           |            |                |                |               |                           |                |                      |            |              |                    |                       |                       |
|      |                       |           |            |                |                |               |                           |                |                      |            |              |                    |                       |                       |
|      |                       |           |            |                |                |               |                           |                |                      |            |              |                    |                       |                       |
|      |                       |           |            |                |                |               |                           |                |                      |            |              |                    |                       |                       |
|      |                       |           |            |                |                |               |                           |                |                      |            |              |                    |                       |                       |
|      |                       |           |            |                |                |               |                           |                |                      |            |              |                    |                       |                       |
|      |                       |           |            |                |                |               |                           |                |                      |            |              |                    |                       |                       |
|      |                       |           |            |                |                |               |                           |                |                      |            |              |                    |                       |                       |
|      |                       |           |            |                |                |               |                           |                |                      |            |              |                    |                       |                       |
|      |                       |           |            |                |                |               |                           |                |                      |            |              |                    |                       |                       |
|      |                       |           |            |                |                |               |                           |                |                      |            |              |                    |                       |                       |
|      |                       |           |            |                |                |               |                           |                |                      |            |              |                    |                       |                       |
|      |                       |           |            |                |                |               |                           |                |                      |            |              |                    |                       |                       |
|      |                       |           |            |                |                |               |                           |                |                      |            |              |                    |                       |                       |
|      |                       |           |            |                |                |               |                           |                |                      |            |              |                    |                       |                       |

NOTES

**APPLICATION WORK SHEET**

**SERIES 7000 MARINE TRANSMISSION WARRANTY**

Seller warrants to engine manufacturers and to Seller's distributors only that all Series 7000 marine transmissions manufactured or furnished by Seller shall be free from defects in material and workmanship under normal use and service for a period of twenty four months or 4000 hours, whichever occurs first, from date placed into operation by the original owner/operator provided that this warranty period shall not extend any longer than thirty-six months from date of shipment from Seller.

This warranty shall not apply to any product or part which has been subjected to misuse, negligence, damage in handling or shipment, modification or alteration, improper maintenance, or use beyond the product's rated capacity or in any other improper manner.

Seller's obligation under this warranty is expressly limited to the repair or replacement, at its option, of Series 7000 marine transmissions which are returned f.o.b. Seller's factory, Muncie, Indiana, and which are determined by Seller to be defective.

**THIS IS THE SOLE AND ONLY WARRANTY OF SELLER AND NO OTHER WARRANTY IS APPLICABLE, EITHER EXPRESSED OR IMPLIED, IN FACT OR BY LAW, INCLUDING ANY WARRANTY AS TO MERCHANTABILITY OR FITNESS FOR A PARTICULAR USE OR PURPOSE. SELLER SHALL NOT BE LIABLE FOR ANY CONSEQUENTIAL, INCIDENTAL, OR PUNITIVE DAMAGES RESULTING FROM ANY BREACH OF THIS WARRANTY.**

BORG-WARNER AUTOMOTIVE, INC.  
TRANSMISSION SYSTEMS  
MUNCIE, INDIANA

EFFECTIVE DATE  
FEBRUARY 1, 1986

**BOAT**

Make/Model \_\_\_\_\_ Year \_\_\_\_\_  
Length \_\_\_\_\_ Beam \_\_\_\_\_ Weight \_\_\_\_\_  
Twin Screw \_\_\_\_\_ Single Screw \_\_\_\_\_  
Hull Type \_\_\_\_\_ Maximum Speed \_\_\_\_\_

**POWER**

Make/Model \_\_\_\_\_  
Rated for \_\_\_\_\_ Hp Maximum at \_\_\_\_\_ rpm  
Gasoline \_\_\_\_\_ Diesel \_\_\_\_\_ Turbo \_\_\_\_\_

**PROPELLER**

Diameter \_\_\_\_\_ Pitch \_\_\_\_\_ Number of Blades \_\_\_\_\_

What is maximum engine rpm at wide open throttle? \_\_\_\_\_

**CURRENT TRANSMISSION (Repower)**

Make/Model \_\_\_\_\_ Ratio \_\_\_\_\_  
Prop shaft coupling:  
Make/Model \_\_\_\_\_ Flexible \_\_\_\_\_ Rigid \_\_\_\_\_  
Prop shaft bearing:  
Single \_\_\_\_\_ Double \_\_\_\_\_  
Prop shaft length \_\_\_\_\_ Diameter \_\_\_\_\_ Material \_\_\_\_\_

**OPERATION**

Classification: Pleasure \_\_\_\_\_ Charter \_\_\_\_\_ Light duty commercial \_\_\_\_\_ Workboat \_\_\_\_\_  
Average usage: \_\_\_\_\_ hours per year \_\_\_\_\_  
High speed cruising \_\_\_\_\_ % @ \_\_\_\_\_ rpm  
Normal cruising \_\_\_\_\_ % @ \_\_\_\_\_ rpm  
Low speed \_\_\_\_\_ % @ \_\_\_\_\_ rpm

Name \_\_\_\_\_ Date \_\_\_\_\_  
Firm name \_\_\_\_\_ Phone \_\_\_\_\_  
Street Address \_\_\_\_\_  
City \_\_\_\_\_ State \_\_\_\_\_ Zip \_\_\_\_\_

Use the following chart to compare series 7000 transmission pressures. Transmission oil temperatures should be in the 160°-180°F (71-82 c) range when pressures should fall within the range given in the chart. Higher oil temperatures will lower transmission pressures & lower oil temperature will cause oil pressure to be higher.

## SERIES 7000 PRESSURE CHART

| ENGINE<br>RPM | MAIN LINE WITH<br>NEUTRAL SELECTED |     |      |      | FORWARD OR REVERSE CLUTCH<br>& MAIN LINE WITH EITHER<br>CLUTCH SELECTED |     |      |      | TO COOLER |     |      |     | COOLER FLOW |     |     |     |
|---------------|------------------------------------|-----|------|------|---|-----|------|------|-----------|-----|------|-----|-------------|-----|-----|-----|
|               | PSI                                |     | k Pa |      | PSI   |     | k Pa |      | PSI       |     | k Pa |     | gal/min     |     | L/S |     |
|               | MIN                                | MAX | MIN  | MAX  | MIN   | MAX | MIN  | MAX  | MIN       | MAX | MIN  | MAX | MIN         | MAX | MIN | MAX |
| 600           | 140                                | 205 | 965  | 1413 | 110   | 200 | 758  | 1379 | 2         | 8   | 14   | 55  | 1           | 3   | .06 | .19 |
| 1000          | 160                                | 220 | 1103 | 1517 | 150   | 220 | 1034 | 1517 | 6         | 35  | 41   | 241 | 1           | 7   | .06 | .44 |
| 2000          | 160                                | 220 | 1103 | 1517 | 150   | 220 | 1034 | 1517 | 20        | 80  | 138  | 552 | 3           | 10  | .19 | .63 |