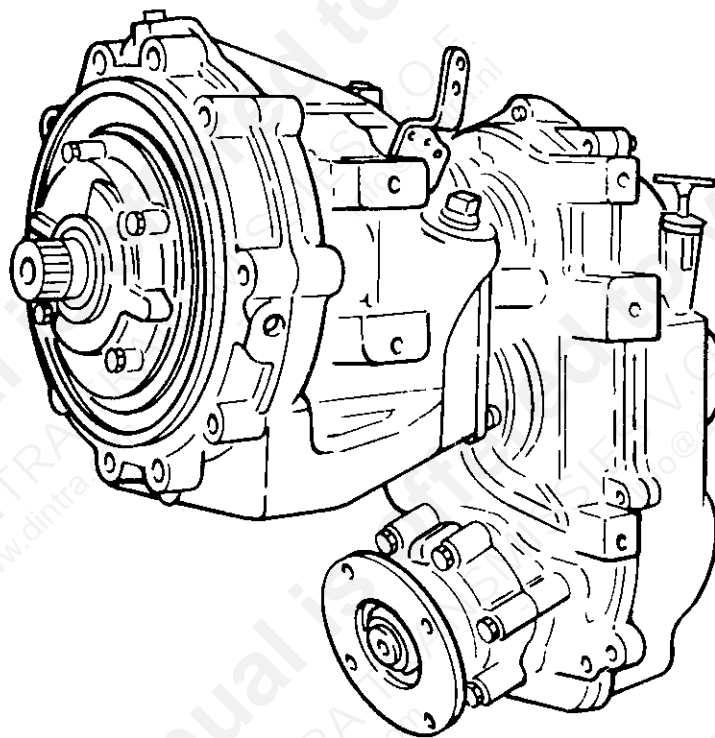

**71C-72C V-Drive
(All Ratios)**



FOREWORD

PURPOSE. This service manual presents maintenance instructions for the Velvet Drive® V-Drive marine transmissions. The next page contains a model chart listing the part numbers covered in this manual. Be sure one of these assembly part numbers is on the transmission identification plate before using these instructions.

SCOPE. This service manual presents information of value to maintenance personnel familiar with hydraulic transmissions. The information is organized as shown in the Table of Contents.

INTERNATIONAL SYMBOLS. The following international symbols are used in this service manual. These symbols are printed in red to emphasize their importance.



WARNING: THIS SYMBOL WARNS OF POSSIBLE PERSONAL INJURY.



CAUTION: This symbol warns of possible damage to the transmission.

ABBREVIATIONS. The following symbols and abbreviations are used:

- OEM - Original Equipment Manufacturer (Boat/Engine Manufacturer).
- SAE - Society of Automotive Engineers.
- RPM - Revolutions Per Minute.
- ATF - Automatic Transmission Fluid

UNITS OF MEASURE. United States standard units of measure are used in this manual. The metric equivalent follows in (). The following terms are used:

Foot-Pounds (FT-LB)	Newton Meters (Nm)
Inch-Pounds (IN-LB)	Newton Meters (Nm)
Pounds per Square Inch (PSI)	Kilopascal (kPa)
Pounds (lbs)	Kilograms (K)
Inches (in.)	Millimeters (mm)
Fahrenheit (F)	Centigrade (C)

IMPROVEMENTS. A Reader's Comment Card is located in the back of this manual. Please take a moment to answer the questions and return the card.

71C MODEL CHART

TRANSMISSION ASSEMBLY *	TRANSMISSION PORTION	V-DRIVE GEAR BOX	RATIO (in fwd.)
10-04-000-002	10-04-410-001	13-08-410-002	1.99:1
10-04-000-003	10-04-410-001	13-08-410-003	1.98:1
10-04-000-004	10-04-410-001	13-08-410-004	2.50:1
10-04-000-005	10-04-410-001	13-08-410-005	2.49:1
10-04-000-006	10-04-410-001	13-08-410-006	3.10:1
10-04-000-007	10-04-410-001	13-08-410-007	3.14:1
10-04-000-008	10-04-410-001	13-08-410-008	0.97:1
10-04-000-009	10-04-410-001	13-08-410-009	0.96:1
10-04-000-010	10-04-410-001	13-08-410-010	1.53:1
10-04-000-011	10-04-410-001	13-08-410-011	1.51:1
10-04-000-012	10-04-410-001	13-08-410-012	1.21:1
10-04-000-013	10-04-410-001	13-08-410-013	1.21:1

72C MODEL CHART

TRANSMISSION ASSEMBLY *	TRANSMISSION PORTION	V-DRIVE GEAR BOX	RATIO (in fwd.)
10-05-000-002	10-05-410-001	13-08-410-002	1.99:1
10-05-000-003	10-05-410-001	13-08-410-003	1.98:1
10-05-000-004	10-05-410-001	13-08-410-004	2.50:1
10-05-000-005	10-05-410-001	13-08-410-005	2.49:1
10-05-000-006	10-05-410-001	13-08-410-006	3.10:1
10-05-000-007	10-05-410-001	13-08-410-007	3.14:1
10-05-000-008	10-05-410-001	13-08-410-008	0.97:1
10-05-000-009	10-05-410-001	13-08-410-009	0.96:1
10-05-000-010	10-05-410-001	13-08-410-010	1.53:1
10-05-000-011	10-05-410-001	13-08-410-011	1.51:1
10-05-000-012	10-05-410-001	13-08-410-012	1.21:1
10-05-000-013	10-05-410-001	13-08-410-013	1.21:1

* This part number appears on transmission identification plate.

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DESCRIPTION

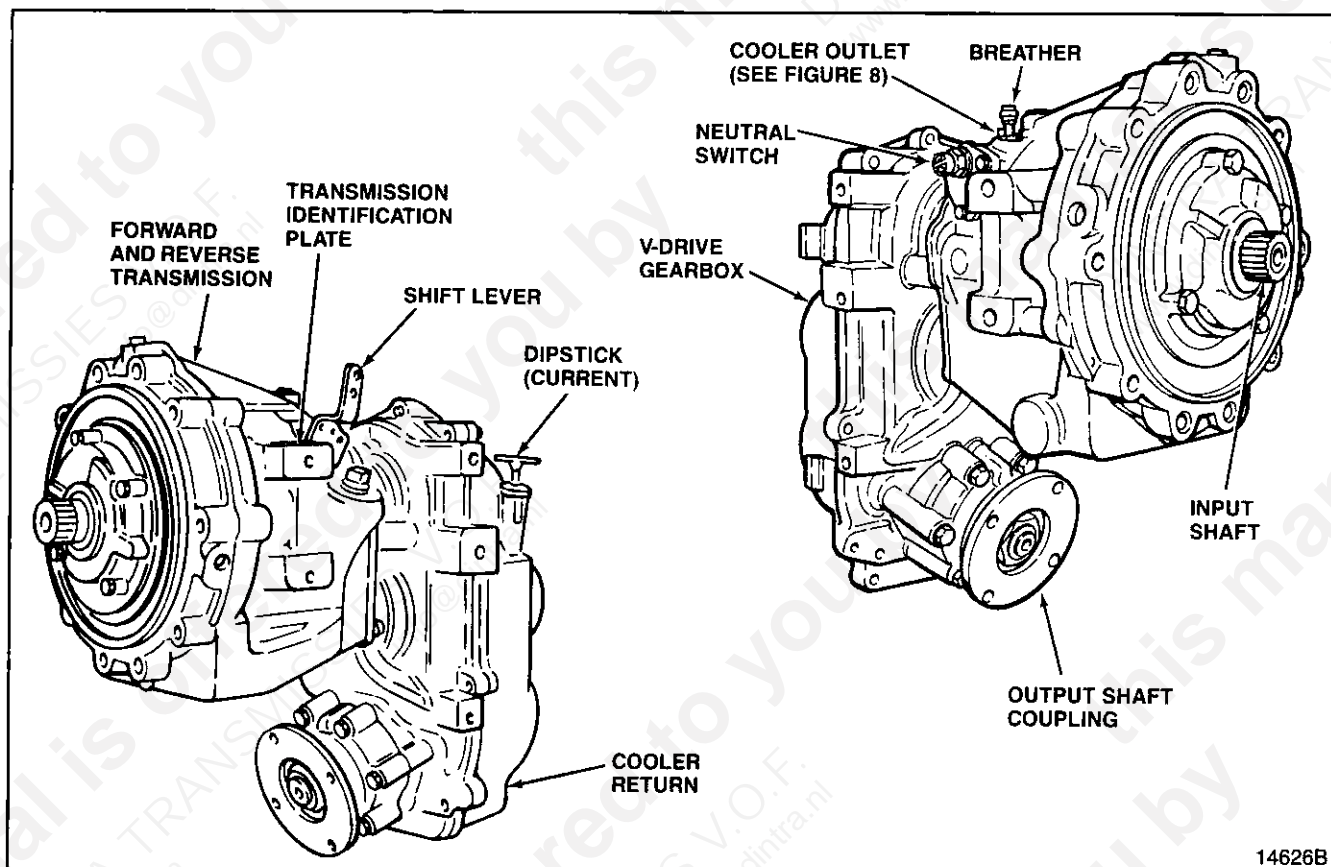


Figure 1. 71C and 72 C V-Drive Transmission Assembly

Table 1. Technical Specifications

DESCRIPTION	MODEL 71C	MODEL 72C
Speeds	One Forward One Reverse	One Forward One Reverse
Dry Weight (Approximate)	190 lb. (86 kg)	203 lb. (92 kg)
Maximum Operating Temperature	190 Degrees F (88 Degrees C)	190 Degrees F (88 Degrees C)
Type of Hydraulic Oil	Automatic Transmission Fluid (ATF) meeting the requirements of C-3 specification.	Automatic Transmission Fluid (ATF) meeting the requirements of C-3 specification.
Effective Downangle	15°	15°

A. INTRODUCTION (See Figure 1).

The 71C and 72C V-Drive transmissions consist of a planetary gear set and multiple disc clutches.

Hydraulic pressure is provided by a crescent type pump. The pump is driven at engine speed by the input shaft. Oil from the pump is sent to the control valve. The control valve positions are forward-neutral-reverse. An internal regulator valve controls system pressure. Oil discharged by the regulator valve is sent to the oil cooler.

The V-Drive gearbox contains a set of spiral bevel gears and drive gears (or drive chain).

B. DIRECTION OF ROTATION (See Figure 2).

Gear Drive. The output shaft on all V-Drives with gear drive turns the same direction as engine rotation with the shift lever placed in the forward position.

Chain Drive. The output shaft on all V-Drives with chain drive turns the opposite direction of engine rotation with the shift lever placed in the forward position.

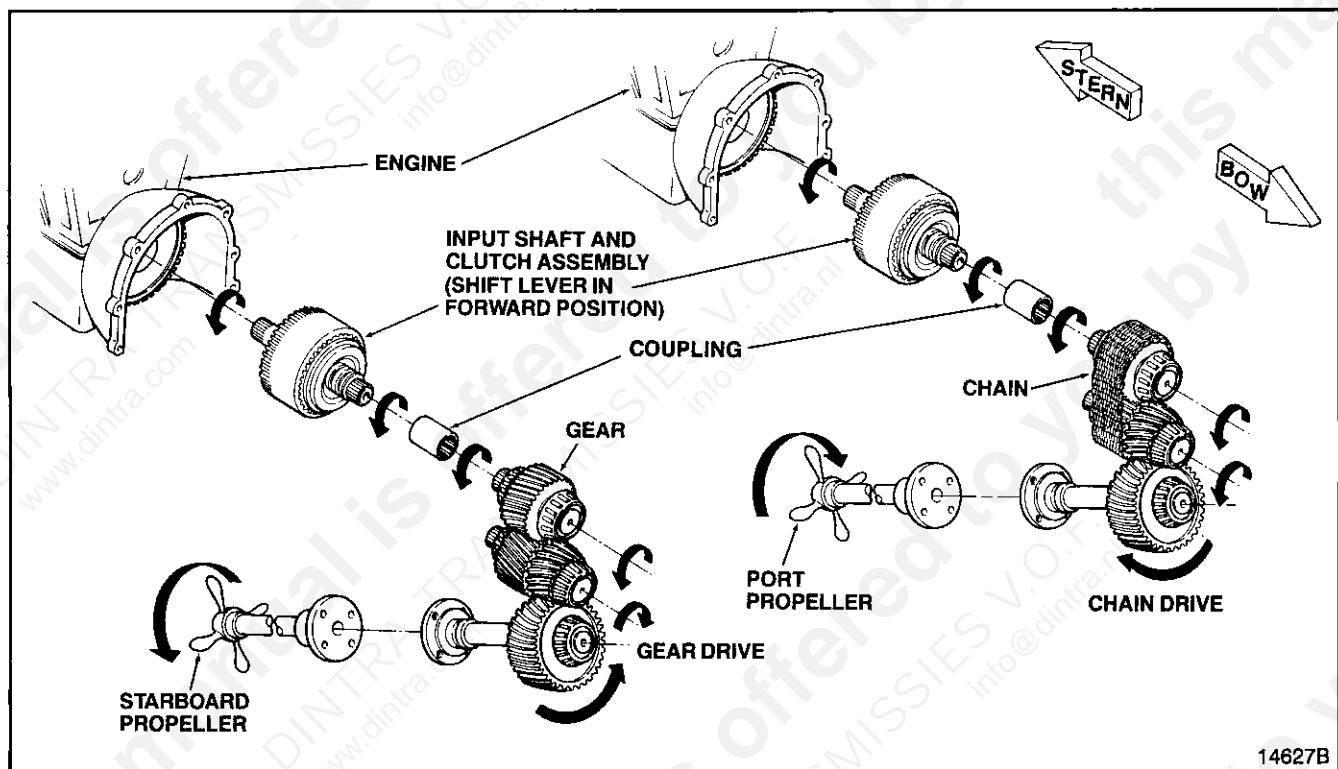


Figure 2. Direction of Rotation for Typical Installation

C. THEORY OF OPERATION.

The following information is for the forward and reverse transmission only. Refer to page 37 for details of operation of V-Drive gearbox.

Forward is direct drive. A planetary gear set (1.0 to 1.0 ratio for 71C, and 1.1 to 1.0 ratio for 72C) is used to obtain reverse.

The transmission oil pump is driven by the input shaft. It supplies oil pressure to operate the clutch packs, lubricate parts, and provide cooling.

A damper plate is bolted to the engine flywheel. The damper plate is splined to connect to the input shaft. The damper plate reduces torsional vibrations to the transmission from the engine (See Figure 3).

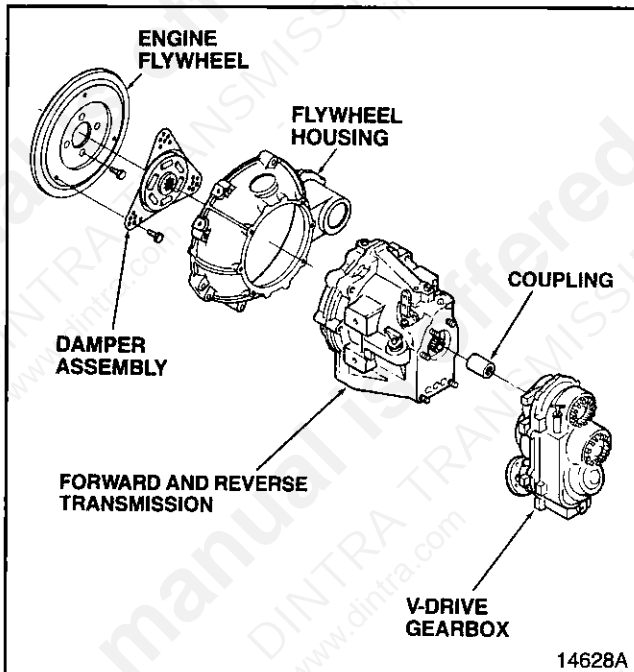


Figure 3. Typical Installation

Forward. The forward clutch is applied hydraulically when the shift lever is placed in the forward position. This connects the input shaft to the output shaft. The transmission then transmits power at a 1 to 1 speed ratio in the same direction of rotation as the engine (See Figure 4).

Reverse. The reverse clutch is applied hydraulically when the shift lever is placed in the reverse position. The applied clutch holds the ring gear. The input shaft and sun gear, drive the pinion gears, which drive the carrier output shaft. The output shaft turns opposite to engine rotation at a 1 to 1 speed ratio for 71C models, and 1.1 to 1 speed ratio for 72C models (See Figure 4).

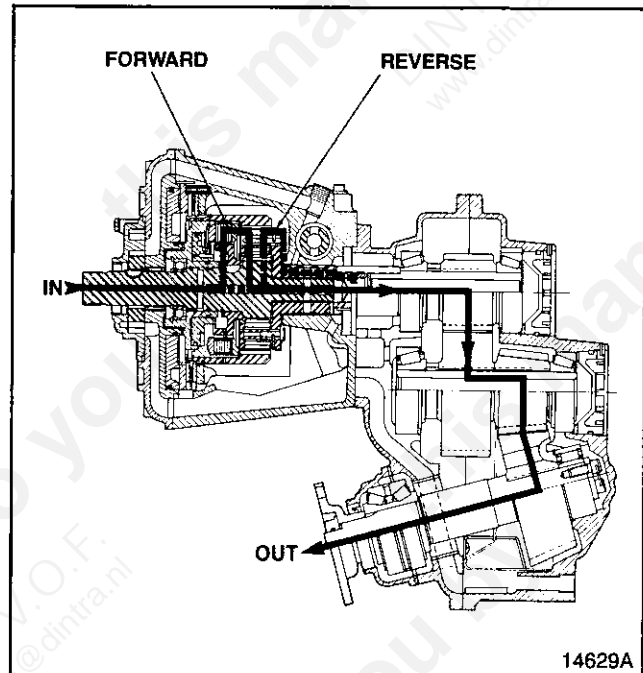


Figure 4. Transmission Power Flow

Hydraulic Circuit. Oil from the V-Drive sump enters the pump suction passage and is directed to the pump. The pump supplies oil under pressure through passages to the control and regulator valves (See Figure 5).

Oil pressure on the end of the regulator valve moves the valve, compressing the spring. This movement allows oil to flow to the cooler.

Selector Valve. The selector valve shifts the transmission from neutral to forward or reverse. When selector valve is placed in the forward position, oil is directed to the forward clutch. When selector valve is placed in reverse position, oil is fed to the reverse clutch. When one clutch is engaged the other is exhausted by a slot in the selector valve.

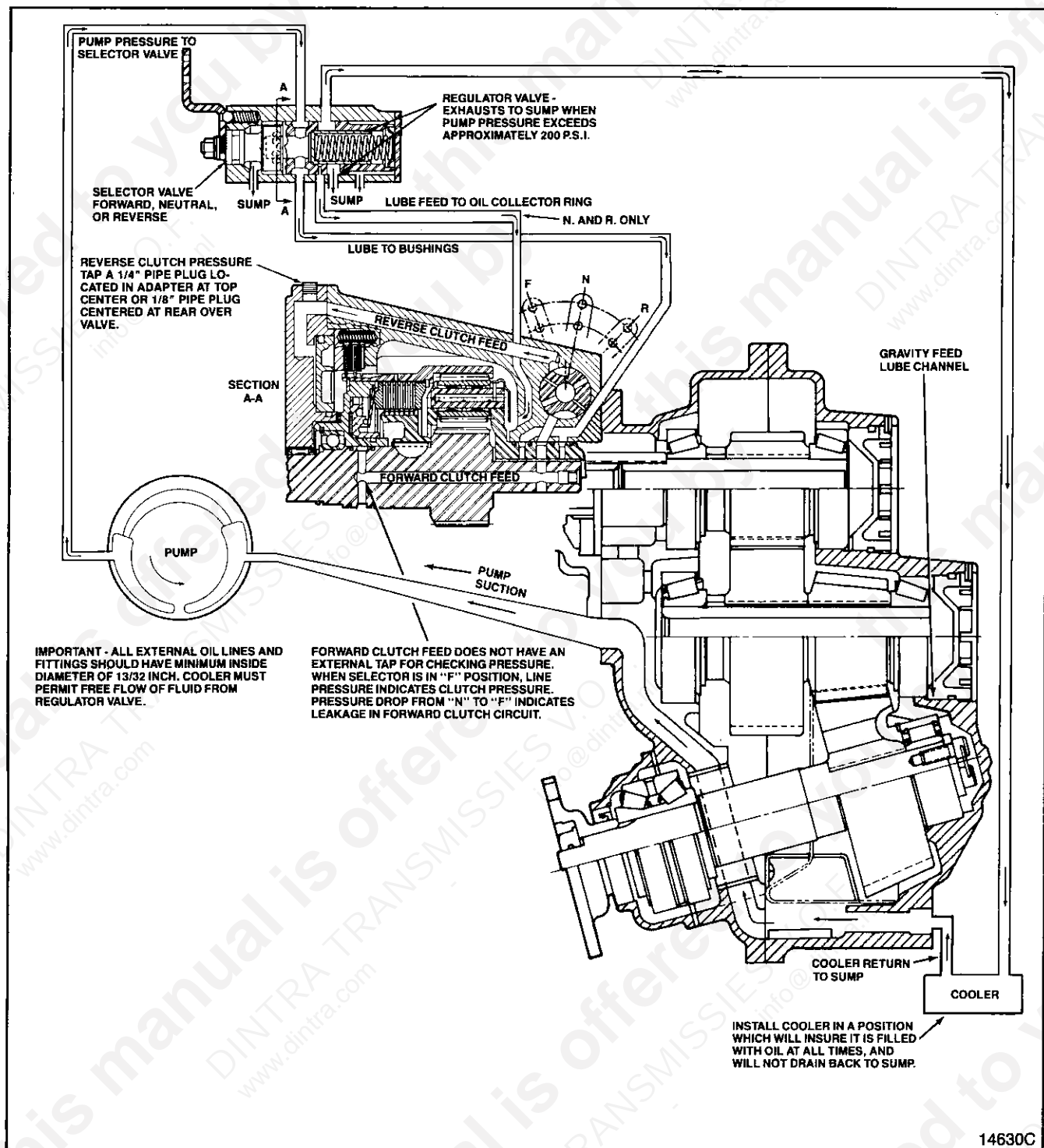


Figure 5. Hydraulic Circuit Schematic

INSPECTION

A. GENERAL.

The transmission, cooler, cooler lines, and control linkage should be inspected at regular intervals. Regular inspections will ensure proper operation and help detect minor problems that can be corrected before they cause a transmission failure.

B. SCHEDULED INSPECTION (See Table 2).



WARNING: FAILURE TO PERFORM THESE INSPECTIONS AT REQUIRED INTERVALS CAN RESULT IN INJURY TO PERSONNEL OR PREMATURE FAILURE OF TRANSMISSION.

The following recommended inspection intervals are based on normal operating conditions. Intervals should be adjusted for extremes of temperature or other severe operating conditions. Inspection intervals are defined as follows:

WEEKLY - Once a week before transmission is operated.

PERIODIC - Once a month or 100 hours, whichever comes first.

SAFETY - Annually or 1,000 hours, whichever comes first.

Table 2. Scheduled Inspections

INSPECTION TASK	INSPECTION INTERVAL		
	WEEKLY	PERIODIC	SAFETY
CAUTION: If transmission temperature has exceeded 190 degrees or alarm sounds, oil in transmission, cooler, and cooler lines must be replaced.			
Check oil level. Add oil to proper level. See page 6 for details.	X		
Remove dipstick. Check oil for signs of water or other contaminants. Check (smell) for signs of burnt oil (overheating). If found, replace oil. See page 6 for details.	X		
Change oil in transmission, cooler, and cooler lines. See page 6 for details.			X
Inspect control linkage and shift lever for operation. There should be no sticking, binding, or looseness.		X	
Inspect cooler, lines, and connections for leakage, damage, or looseness.		X	X
Inspect transmission for signs of leakage around housings and bolts.		X	X
Inspect breather. Check movement of cap. If no movement replace breather.		X	
Check mounting bolts for tightness. If loose, tighten to torque specified in OEM manual.			X

MAINTENANCE

A. GENERAL.

Transmission maintenance normally requires performing the following tasks.

- Checking Oil level. The proper oil level can prevent damage to the transmission.
- Changing Oil. Regular scheduled oil changes are an important part of transmission maintenance.



WARNING: SHIFT LINKAGE MUST BE ADJUSTED FOR PROPER OPERATION OF TRANSMISSION.

- Adjusting control lever and shift linkage. For details refer to page 29 or the OEM manual.
- Tightening transmission mounting bolts. Tighten only to torque specified in OEM manual.

B. LUBRICATION.

Type of Oil.

Any automatic transmission fluid (ATF) which meets the C-3 oil specification is recommended. Do not mix different brands. If engine doesn't exceed 3,000 RPM, a premium grade 30 weight engine oil is acceptable. SAE 40 weight and multi-viscosity oils are not recommended.

Oil Level Check.

Due to the various installation angles and oil cooler set-ups, it may be necessary to adjust the transmission oil level. Transmission oil level can be checked either warm or cold using the following procedures.

Always clean around dipstick with a lint-free cloth to remove dirt and grease. Small particles of dirt can damage internal components and cause valves to stick.

Warm Oil Level Check.



WARNING: DO NOT REMOVE DIPSTICK WITH ENGINE RUNNING. HOT OIL CAN CAUSE BURNS.

Before making a warm oil level check note the following.

- Place control lever in neutral.
- Start engine and let transmission reach normal operating temperature (190 degrees F max). Oil expands when heated and will change the oil level reading.
- Check oil level immediately after engine shut-down. Oil drains into transmission from cooler and cooler lines, and will change the oil level reading.
- Shut-down engine. Remove dipstick, wipe end with a lint-free cloth.
- Immediately install dipstick in transmission until seated, then remove it.
- Read oil level on dipstick. Oil level should be at dipstick mark.
- Add or remove oil if necessary. If required, repeat this checking procedure until oil is at dipstick mark.

Cold Oil Level Check.

A cold oil level mark can be added to the dipstick for ease in checking oil level before starting the engine.

Use the following procedure to mark cold oil level on dipstick.

- Set oil level according to Warm Oil Level Check (page 6).
- Let boat sit overnight.
- Remove dipstick and wipe end with a lint-free cloth.
- Install dipstick in transmission until seated, then remove it.
- Mark dipstick at the cold oil level reading.
- Install dipstick in transmission.

Use the cold oil level mark to check oil before starting engine. If oil level adjustment is needed, add oil to the new mark.

Changing Oil.



WARNING: DO NOT REMOVE DIPSTICK WITH ENGINE RUNNING. HOT OIL CAN CAUSE BURNS.

- Place control lever in neutral. Run engine for five minutes at 1500 RPM. Shut-down engine.

- Clean area around cooler line with a lint-free cloth.
- Remove cooler line from transmission. Drain oil from transmission, cooler, and cooler lines into a suitable container.
- Check oil for the following foreign matter. Note the following.

Metal Particles. A few small particles are normal. However, large metal chips are an early sign of transmission failure. The transmission should be disassembled and inspected for internal damage.

Rubber Particles. These indicate cooler line wear. Each line should be inspected for cracks or fraying. Damaged lines should be replaced.

- Install cooler line in transmission.

NOTE: The amount of oil will vary based on length of cooler lines. Use an amount equal to about three-fourths the quantity removed.

- Fill transmission with new oil.
- Install dipstick. Remove dipstick and check against cold level mark. Add oil to the proper level.

NOTE: If a cold oil level mark is not shown use the procedure described in Warm Oil Level. Check to set oil level.

- Start engine and allow to idle. Check transmission, cooler, and cooler lines for leaks.

TROUBLESHOOTING

A. GENERAL.

Before troubleshooting the transmission, check the following:

- Oil level and condition of oil. See page 6 for details.
- Transmission, cooler, and cooler lines for damage or leakage. Correct any problem.
- Engine, damper plate, or drive train alignment. Refer to page 29, OEM manual, or Velvet-Drive Installation manual (Form No. 1131) for drive train alignment requirements.

B. GUIDELINES.

Perform all pressure checks at normal operating temperature. Refer to page 53 for details. Pressure gages used should have a range of 0-200 or 0-300 psi and must be accurate.

Shift into each selector position to determine when noise or problem occurs. Determine which parts are moving. This will help pinpoint the cause. Use the following information as a guide to common problems.

Damper Plate. Some transmission problems are damper plate related. Check and/or replace damper plate when the following problem occurs.

- Transmission “knocks” at idle or low RPM, then stops at 1,000 RPM or higher.

NOTE: If the damper plate springs are too soft the sides of the windows will wear. If the springs are too hard the splines will wear. Consult engine OEM for damper plate recommendations.

Clutches. Check and/or replace clutches if the following problem occurs.

- Excessive engine RPM (over the rated RPM). This can indicate a slipping clutch. The slipping clutch will usually squeal.



WARNING: DO NOT OPERATE TRANSMISSION IF THE FOLLOWING CONDITION IS SUSPECTED BECAUSE TRANSMISSION CAN NOT BE DISENGAGED.

- Transmission overheating with squealing clutch. A slipping clutch will normally overheat. This can result in warped clutch plates. In severe overheating clutch plates can weld together. This will cause a tie up condition in the transmission when the other clutch is applied.

Table 3. Troubleshooting

PROBLEM	CAUSE	CORRECTION
LEAKS:		
1. At pump or output shaft seal.	Faulty seal. Misalignment. Rough shaft.	Replace seal. Correct alignment. Replace shaft.
2. Between seal and bore.	Rough housing bore.	Polish bore and replace seal.
3. At gasket(s)	Loose bolts. Damaged gaskets. Face(s) not flat.	Tighten bolts to proper torque. Refer to Table 4 (page 52). Replace damaged gaskets. Replace damaged parts.

Table 3. Troubleshooting (Continued)

PROBLEM	CAUSE	CORRECTION
LEAKS: (Cont.)		
4. Loss of oil with no trace of missing oil.	Oil leaking from cooler or cooler lines.	Replace damaged cooler or cooler lines.
5. Oil out of breather.	Oil has been overheated. (Lost anti-foam additive.)	Replace oil.
	High or low oil level.	Correct oil level.
	Water in oil.	Change oil.
	Cooler too small.	Replace cooler with larger cooler.
	Cooler lines not properly connected.	Connect cooler lines to correct ports. (Refer to page 29.)
	Incorrect oil.	Replace oil with correct type.
MALFUNCTION IN BOTH FORWARD AND REVERSE:		
1. Low oil pressure.	Regulator valve jammed. Internal leakage.	Clean and polish valve. Replace damaged sealing rings.
	Low oil level.	Add oil.
	Pump damaged.	Replace pump.
2. No oil pressure.	Regulator valve jammed.	Clean and polish.
3. High oil temperature.	Regulator valve jammed.	Clean and polish.
4. Damper plate noise.	Worn or incorrect damper plate.	Replace damper plate.
5. No line pressure.	Heavy weight oil.	Replace oil with correct type.
6. Noise in Forward and Reverse.	Misalignment of damper plate with engine, or misalignment of output shaft coupling.	Align drive train components.
7. Hydraulic noise or buzz.	Low oil level or air in hydraulic circuit.	Check oil level. Fill if low. Run engine in neutral at 1200 RPM to remove air.
	Regulator valve sticking.	Clean and polish regulator valve.
8. Gear noise in forward and/or reverse.	V-Drive bevel gears not properly meshed or gear tooth damage.	Check tooth contact pattern. Shim as required to obtain proper mesh or replace damaged parts.

Table 3. Troubleshooting (Continued)

PROBLEM	CAUSE	CORRECTION
MALFUNCTION IN FORWARD OR REVERSE:		
1. Clutch drags or does not release.	Warped clutch plate. Mechanical Failure. Tight pack clearance.	Replace damaged parts. Replace damaged parts. Increase clearance to specification.
2. Clutch does not apply.	Low pressure. Damaged parts.	See low oil pressure . Replace damaged parts.
3. Harsh engagement.	High pressure - regulator valve sticking. Engine idle too fast. Linkage binding or misadjusted.	Clean and polish valve. Adjust engine idle. Repair as required and adjust to OEM measurement.
4. Soft engagement.	Low pressure.	See low oil pressure .
5. Won't move or sluggish.	Forward clutch seized. Worn or broken sealing rings.	Replace damaged parts. Replace damaged parts.
MALFUNCTION IN NEUTRAL:		
1. Drives in forward direction.	Broken sealing rings or bushings. Warped forward clutch plates or mechanical failure of clutch.. Exhaust blocked in control valve. Shift linkage improperly adjusted.	Replace damaged parts. Replace damaged parts. Clean control valve. Adjust shift linkage.
2. Drives in reverse direction.	Warped reverse clutch plates or mechanical failure of clutch. Exhaust blocked in control valve. Shift linkage improperly adjusted.	Replace damaged parts. Clean control valve. Adjust shift linkage.
3. Noisy in neutral only.	Low oil pressure - Pump gears worn. Low oil level.	Replace pump. Add oil.

Table 3. Troubleshooting (Continued)

PROBLEM	CAUSE	CORRECTION
TRANSMISSION OVER-HEATING:	<p>Oil level high.</p> <p>Oil level low.</p> <p>Cooler or lines too small.</p> <p>Low oil pressure - Pump gears worn.</p> <p>Clutches slipping.</p> <p>Internal leakage bypassing cooler.</p> <p>Temperature sensor damaged</p> <p>Incorrect type oil.</p> <p>Poor quality oil</p> <p>Regulator valve sticking.</p>	<p>Adjust oil level.</p> <p>Adjust oil level.</p> <p>Replace with larger cooler and/or cooler lines. Lines should have a minimum 13/32" I.D.</p> <p>Check pump pressure. If low, inspect pump. Replace pump if worn or damaged.</p> <p>Check sealing rings. Replace if damaged.</p> <p>Locate and fix leak.</p> <p>Replace sensor.</p> <p>Drain, flush, and replace with correct type oil.</p> <p>Clean and polish.</p>

OVERHAUL

A. GENERAL.



WARNING: KEEP WORK AREA, TOOLS, AND TRANSMISSION CLEAN. WIPE UP ANY SPILLED TRANSMISSION OIL TO PREVENT ACCIDENTS. AS REQUIRED, WEAR SAFETY GLASSES, SAFETY SHOES, AND A HARD HAT TO PREVENT PERSONAL INJURY.

Before removal and disassembly, review the following procedures. Use the proper hand tools, slings, or hoists for the job.

Refer to the OEM manual for specific removal procedures.

Refer to page 37 for overhaul of V-Drive gearbox.

B. DISASSEMBLY.

- The transmission can be disassembled following the order of index numbers on the exploded-view (page 31).
- Do not remove suction tube or bearings unless replacement or cleaning is required.
- Do not disassemble pressed parts unless replacement of parts is required.
- Remove O-rings, sealing rings, and oil seals carefully to prevent damage if they must be reused. It is recommended these parts be replaced with new parts during assembly.
- Keep matched parts and sets together. Do not reverse or mix them.

C. CLEANING.



WARNING: CLEANING SOLVENTS CAN BE TOXIC, FLAMMABLE, AN IRRITANT TO THE SKIN, OR GIVE OFF HARMFUL FUMES. AVOID PROLONGED CONTACT, INHALATION OF VAPORS, OR SMOKING.

- Rinse all metal parts in cleaning solvent to remove dirt, grease, and transmission oil.
- Take special care to remove cleaning solvent from all internal passages and cavities.
- Air dry clutch plates.
- If O-rings, sealing rings, and oil seals are to be reused, air dry them.

D. INSPECTION.

- Inspect case for cracks. Check sealing surfaces for nicks, scratches, or burrs that can cause leaks. Inspect output shaft bores for signs of wear on one side. This can indicate misalignment of drive train components.
- Inspect gears for unusual wear patterns, chipped, cracked or broken teeth.
- Inspect bearings for chips, cracks, galling, or missing bearings. Check for signs of discoloration due to overheating.
- Inspect threaded parts for stripped, damaged threads, or burrs.
- Inspect springs for distortion, cracks, or other damage. Check dimensions of each spring. Refer to Table 5 (page 52) for details.

E. REPAIR.

- Remove minor scratches, burrs, or surface defects with very fine emery cloth.
- Retap threaded holes using the same size tap. Do not make the hole larger.
- If parts cannot be repaired, they must be replaced.

F. ASSEMBLY OF FORWARD AND REVERSE TRANSMISSION.



CAUTION: Threaded parts, screws, bolts, and coupling nuts must be tightened to the torques shown in Table 4 (page 52) to prevent premature failure of transmission.

NOTE: The following procedures are correct for most transmissions. Minor differences may be found on some models.

- A new coupling nut must be used at assembly.

- Prior to assembly, dip or coat internal parts with transmission oil. Let excess oil drain off.
- Inspect assemblies pressed together for proper fit and position.
- Check that each snap ring is fully engaged in groove.
- Assemble the transmission using the following procedures. Refer to Figure 10 (page 31) for an exploded-view of the transmission. Numbers in () refer to item numbers on the exploded-view. If V-Drive gearbox was disassembled refer to page 37 for assembly details.



CAUTION: Transmissions manufactured prior to September 1978 used bushings instead of sealing rings. If bushings were removed from the case, they must be installed before assembly of transmission. Refer to Figure 6 for details.

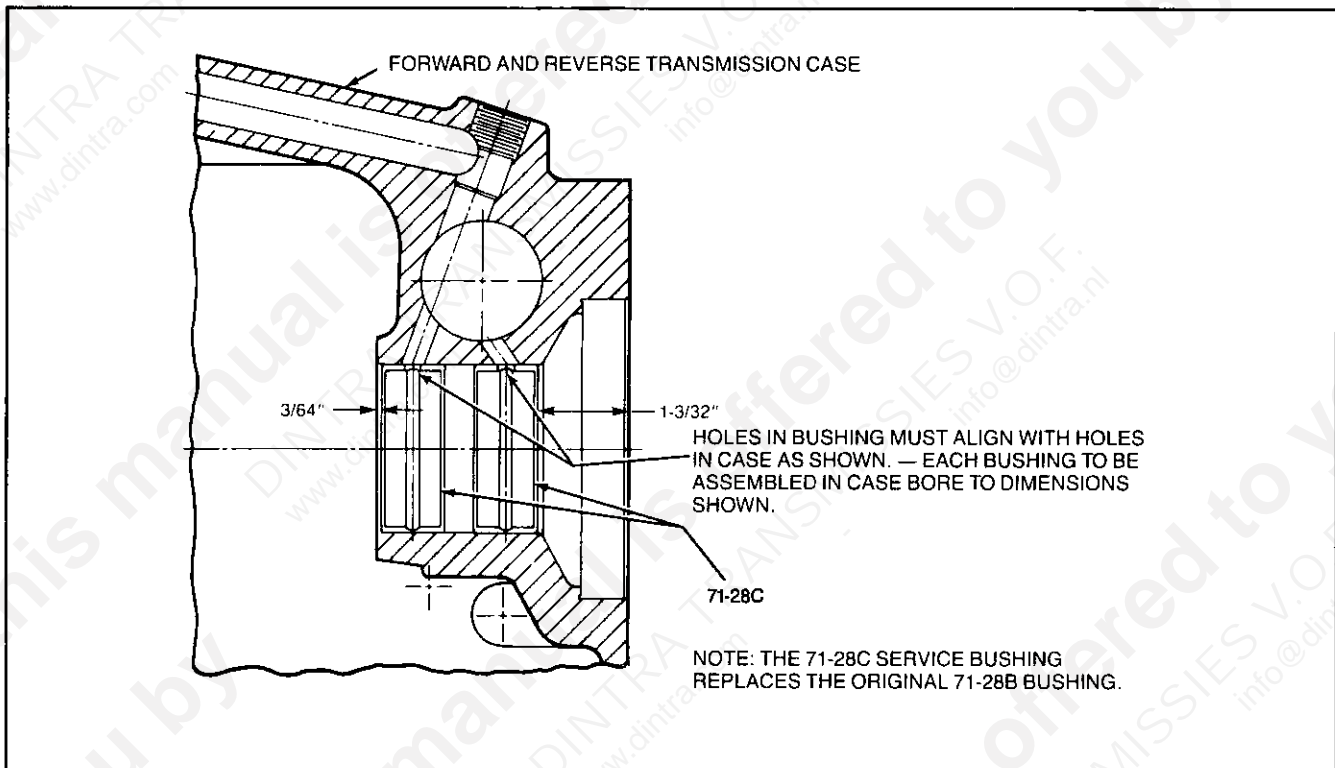


Figure 6. Bushing Installation

STEP 1. If removed, install the following parts in case (81). Tighten threaded parts to torque shown in Table 4 (page 52).

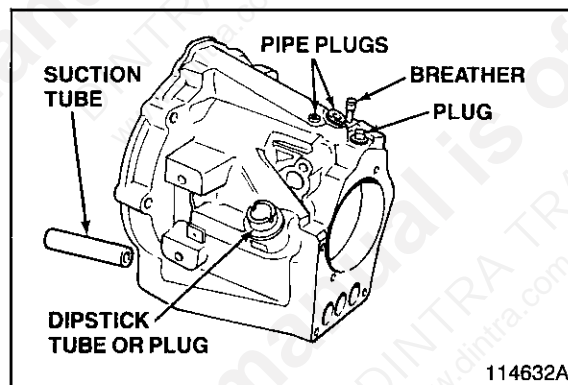
Install breather (72) into top of case (81).

Press suction tube (71) into case (81).

Apply loctite #92, or equivalent, to threads of pipe plugs (74, 75, and 76) and thread into top of case (81).

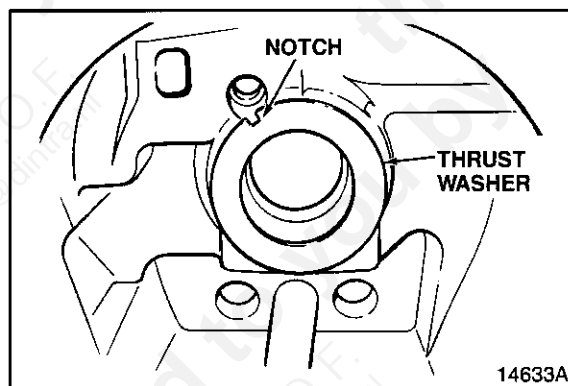
On early models: Apply loctite #592, or equivalent, to threads of dipstick tube (2) and thread into side of case (81). This is used instead of pipe plug (76).

NOTE: The plastic shipping plug (73) should be installed hand-tight.



Case Assembly

STEP 2. Place thrustwasher (70) on face of bearing bore. Notch in thrustwasher (70) must align with notch in case (81).

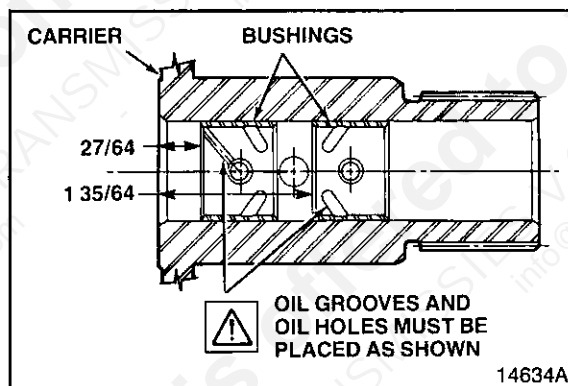


Thrustwasher Installation

STEP 3. If removed, press bushings (68) into pinion carrier (69).



CAUTION: Do not block pressure holes in pinion carrier with bushings.

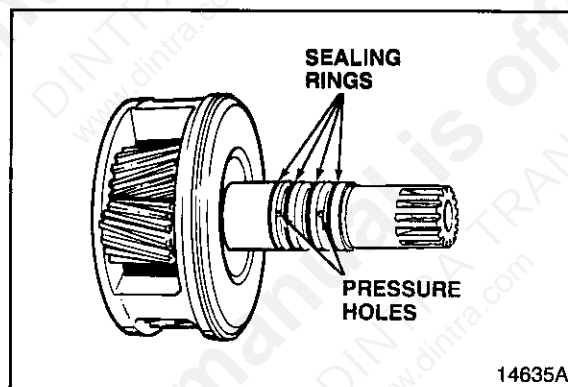


Bushing Installation

STEP 4. Lubricate sealing rings (67) and bushings (68) with vaseline.

Install sealing rings (67) in grooves of pinion carrier (69). Compress each sealing ring (67) until it locks in place.

Install pinion carrier (69) in case (81).



Pinion Carrier Assembly

STEP 5. Install pressure plate (58) in ring (60). Late production ring gears for 72C transmissions have 3 large oil drain holes 120° apart. Early production ring gears have 4 small 3/16 holes 90° apart. Either ring gear can be used successfully in marine applications.

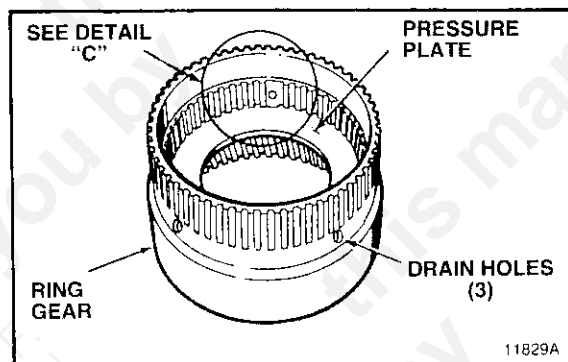
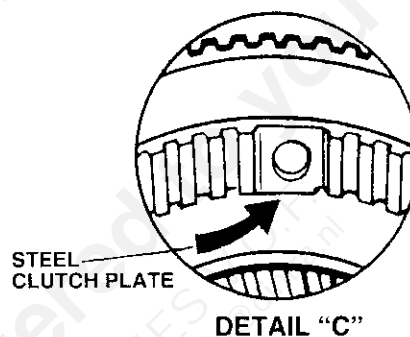


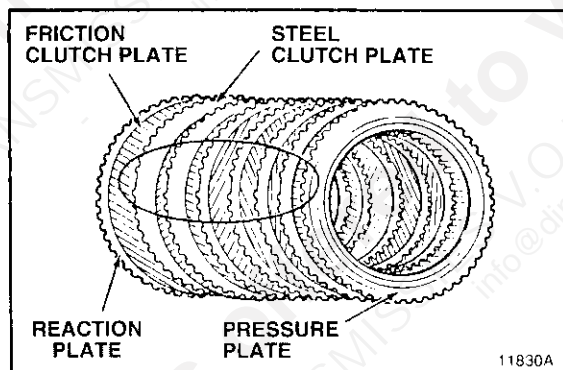
FIGURE "A"



STEP 6. Starting with a friction clutch plate (57), alternately stack friction clutch plates (57) and steel clutch plates (56).

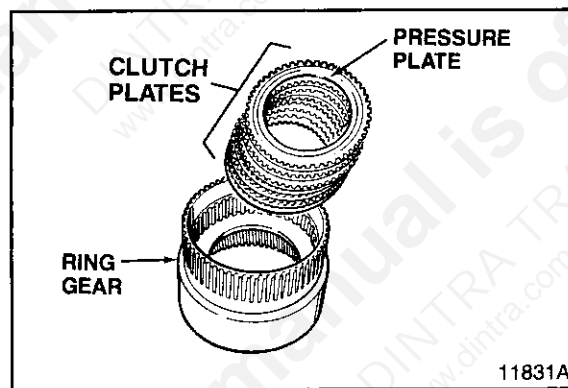
Friction clutch plates are now designed with 3 missing teeth 120° apart. When installed in a late designed ring gear, they should be installed with the missing teeth aligned with the 3 large drain holes as shown in detail "C".

Early and late friction plates can be mixed indiscriminately when installed in an early 72C ring gear or in any 71C ring gear.



**Forward Clutch Pack Arrangement
FIGURE "B"**

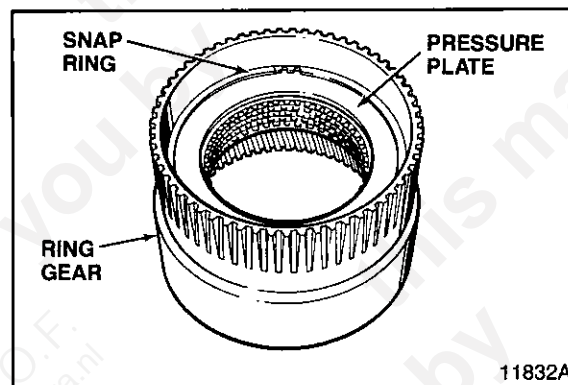
STEP 7. Install clutch plates (56 and 57) and pressure plate (55) in ring gear (60).



Forward Clutch Pack Assembly

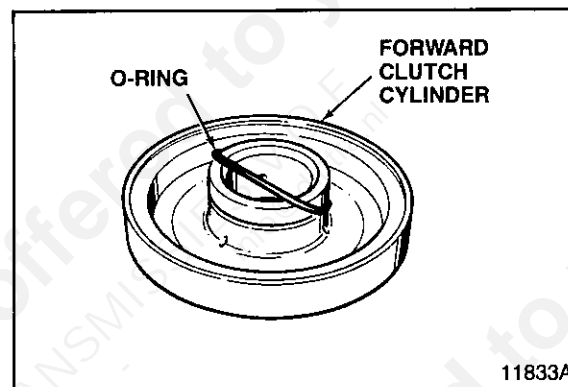
STEP 8. Install snap ring (54) in ring gear (60).

NOTE: Snap ring will locate on top of internal teeth. Do not attempt to seat snap ring in undercut relief groove.



Snap Ring Installation

STEP 9. Lubricate O-ring (50) lightly with vaseline and install in groove of forward clutch cylinder (48).



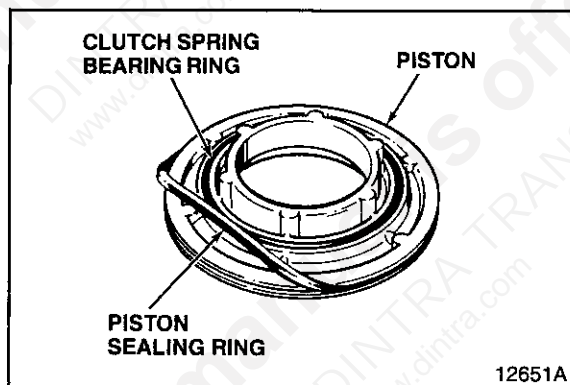
O-Ring Installation

STEP 10. Lubricate clutch spring bearing ring (52) and piston sealing ring (51) with vaseline.

Install clutch spring bearing ring (52) in groove on piston (49) face.

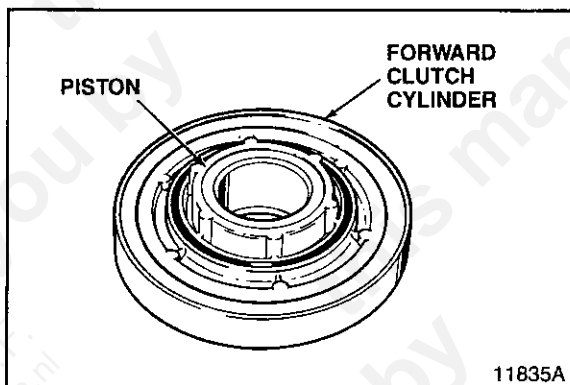
Install piston sealing ring (51) in outer groove of piston (49).

NOTE: Check that piston sealing ring is not twisted, cut, or deformed. Replace if damaged.



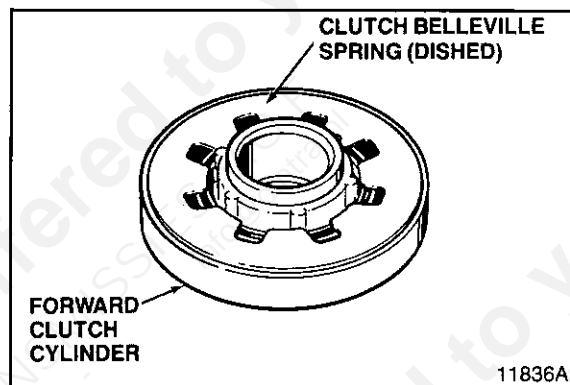
Clutch Rings Installation

STEP 11. Install piston (49) in forward clutch cylinder (48).



Piston Installation

STEP 12. Place clutch belleville (dished) spring (53) inside rim of forward clutch cylinder (48). Spring is dished. The inside of the spring should be lower than the outside.



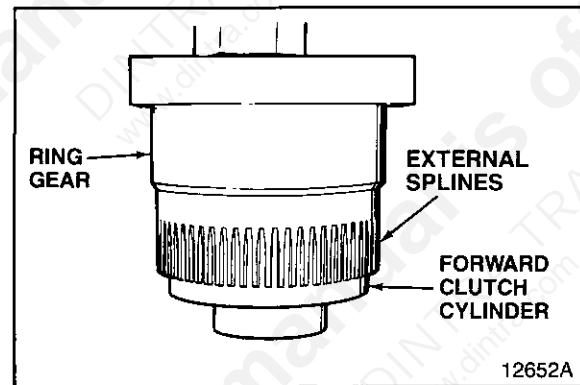
Clutch Spring Assembly

STEP 13. Install ring gear (60) over forward clutch cylinder (48), with piston (49) and spring (53) facing up.

Press ring gear (60) down over forward clutch cylinder (48). Remove clutch assembly from press.



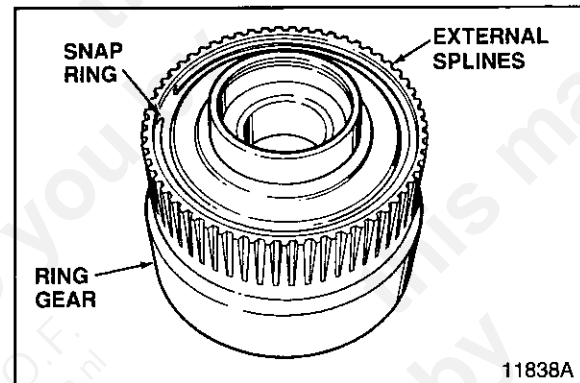
CAUTION: Check to see that clutch spring bearing ring is still seated in groove of clutch piston.



Forward Clutch Cylinder Installation

STEP 14. Install snap ring (59) in groove of ring gear (60).

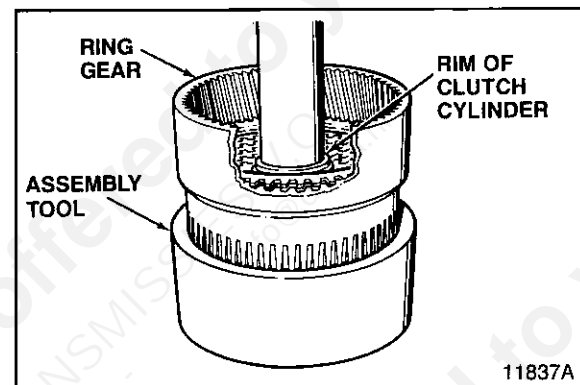
NOTE: Several different snap rings are used to assemble clutch group. They have different thicknesses. Be sure correct snap ring is used.



Snap Ring Installation

STEP 15. Place ring gear (60) in press with external splines facing down. Press forward clutch cylinder (48) against snap ring (59). Remove clutch assembly from press.

NOTE: Assembly tool should support the ring gear only. The forward clutch cylinder should not be touching the assembly tool.



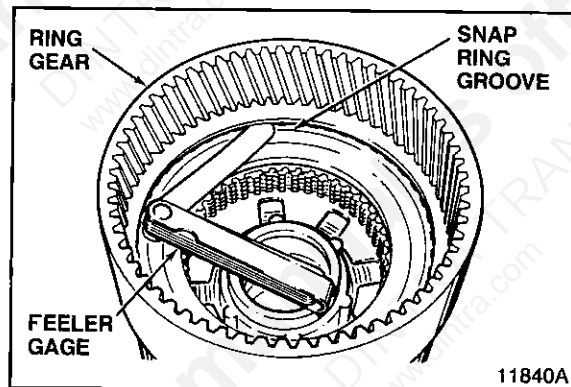
Compressing Clutch Pack

STEP 16. Push down, by hand, on clutch plates. Measure snap ring gap. Select proper thickness snap ring (59) or combination of snap rings (59) to set clutch pack clearance. Refer to chart below. More than one snap ring may be required.

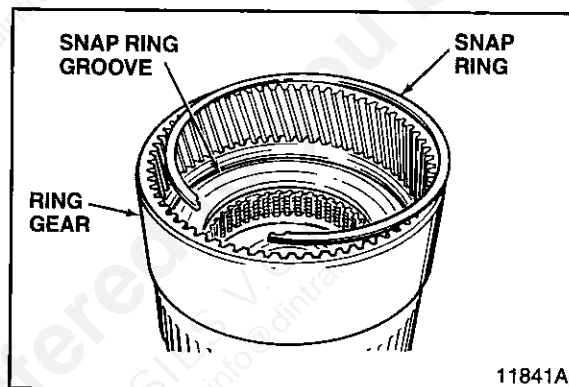
10-04 bronze pack clearance: 0.018 - 0.053 in.
(0.46 - 1.35 mm)
10-05 bronze pack clearance: 0.035 - 0.055 in.
(0.89 - 1.40 mm)
10-04 paper pack clearance: 0.018 - 0.053 in.
(0.46 - 1.35 mm)
10-05 paper pack clearance: 0.021 - 0.046 in.
(0.53 - 1.17 mm)

PART NUMBER	SNAP RING THICKNESS	
	inch	mm
4768	0.050 - 0.054	1.3 - 1.4
4768A	0.074 - 0.078	1.9 - 2.0
4768B	0.096 - 0.100	2.4 - 2.5
10-00-139-018	0.062 - 0.066	1.6 - 1.7
10-00-139-048	0.033 - 0.037	0.84 - 0.94
10-00-139-049	0.050 - 0.054	1.27 - 1.37

STEP 17. Install selected snap ring(s) (59) in groove of ring gear (60).



Snap Ring Selection



Snap Ring Assembly

STEP 18. If removed, install woodruff key (65) in drive gear assembly (66). Slide forward clutch hub (64) on drive gear assembly (66) and align with woodruff key (65). Press forward clutch hub (64) on drive gear assembly (66) and against shoulder.

Install snap ring (63) in groove of drive gear assembly (66).

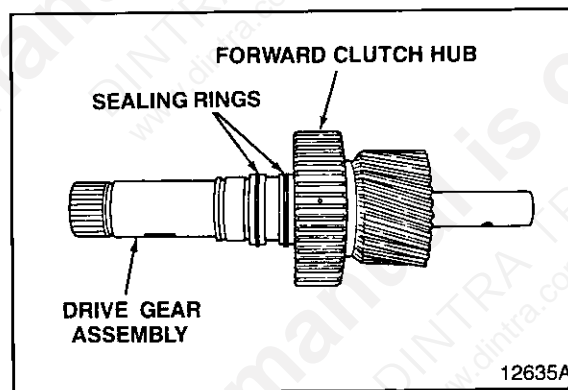
Lubricate sealing rings (62) with vaseline and install in grooves of drive gear assembly (66).

Compress each sealing ring (62) until it locks in place.

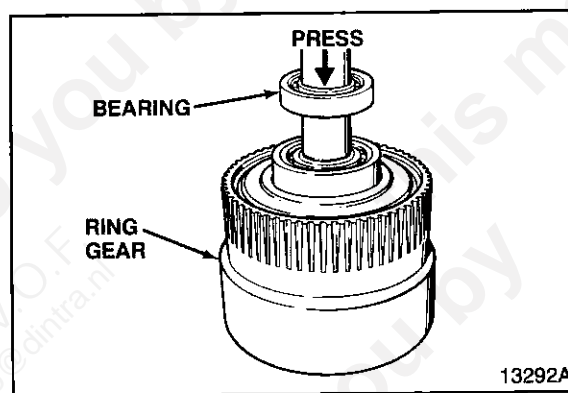
STEP 19. Install drive gear assembly (66) in clutch assembly. Slide bearing (47) down drive gear assembly (66).

Place complete assembly in press. Press bearing (47) into drive gear assembly (66) until seated against shoulder.

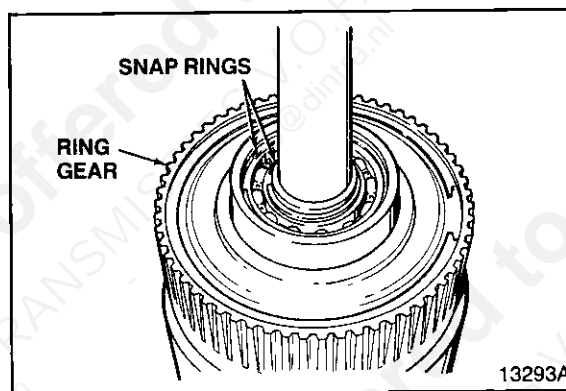
STEP 20. Install snap rings (45 and 46) in grooves of drive gear assembly (66) and forward clutch cylinder (48).



Sealing Ring Installation

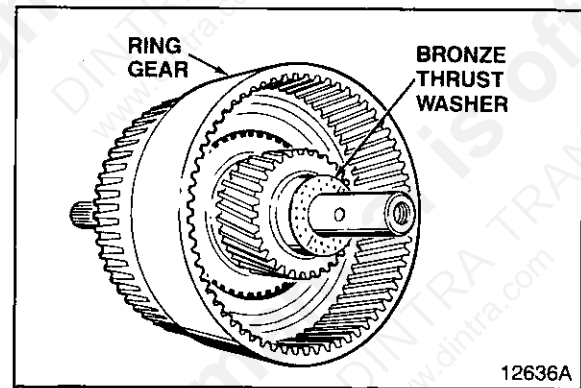


Bearing Installation



Snap Ring Installation

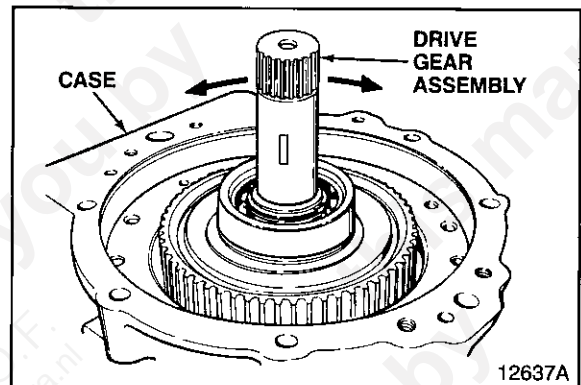
STEP 21. Apply vaseline to bronze thrust washer (61). Install over end of shaft and against face of gear.



Thrustwasher Assembly

STEP 22. Install clutch and drive gear assembly in case (81).

Rotate clutch and drive gear assembly back and forth to engage ring gear teeth with pinion teeth.



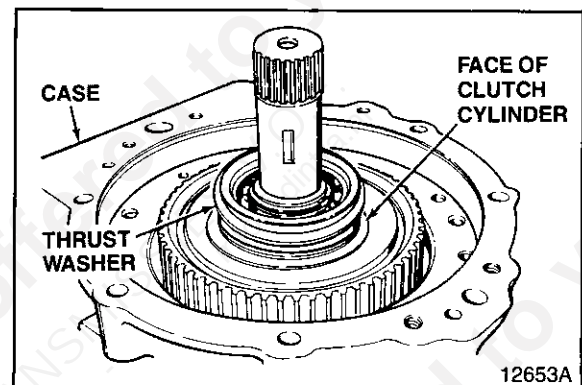
Clutch and Drive Gear Installation

STEP 23. Install thrustwasher (43) on face of clutch cylinder. Check clearance as follows:

Position case (81) vertically as shown. Measure from face of case (81), without gasket (33), to face of clutch cylinder.

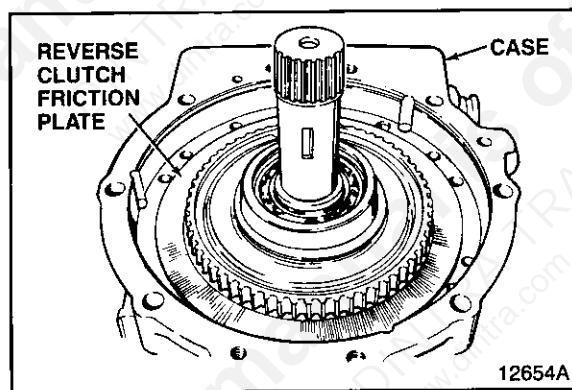
When dimension is 0.433 inch (11.0 mm) or less, use 71-15B thrustwasher.

When dimension is greater than 0.433 inch (11.0 mm), use 10-16-193-001 thrustwasher.



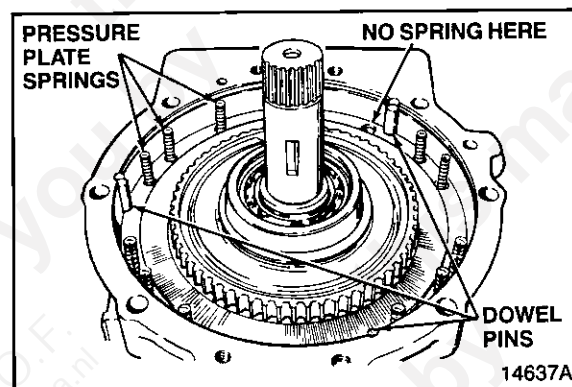
Thrustwasher Installation

STEP 24. Install one bronze reverse clutch friction plate (40) in case (81).



Friction Plate Installation

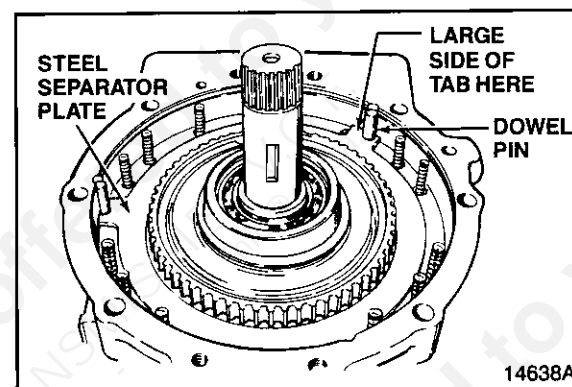
STEP 25. Install three dowel pins (42) and eleven pressure plate springs (41) in case (81).



Spring and Dowel Pin Installation

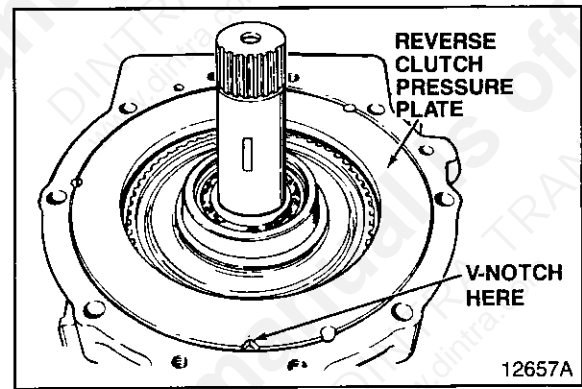
STEP 26. Install one steel clutch plate (39) in case (81) with large part of tab to left of dowel pin (42).

Alternately stack remaining friction clutch plates (40) and steel clutch plates (39) in case (81).



Reverse Clutch Pack Installation

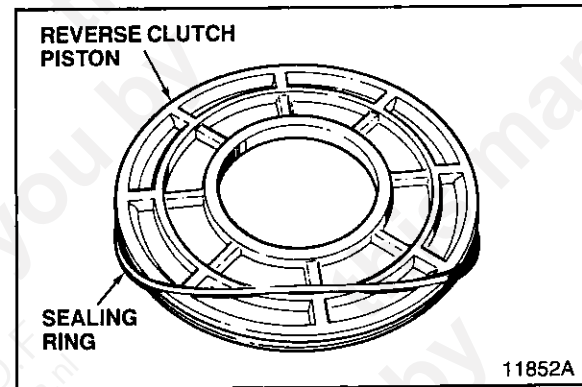
STEP 27. Install clutch pressure plate (38) in case (81) with three half moons aligned with dowel pins (42). Be sure all pressure plate springs (41) are seated in their holes.



Pressure Plate Installation

STEP 28. Lubricate sealing ring (36) with vaseline and install in groove of reverse clutch piston (35).

NOTE: Be sure sealing ring is not twisted, cut, or distorted. Replace if damaged.



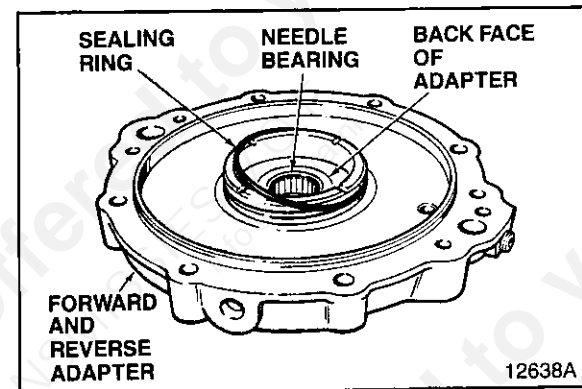
Sealing Ring Assembly

STEP 29. If removed, press needle bearing (31) into adapter (29). **Needle bearing (31) must be installed flush (even) with back face of adapter (29).**

Lubricate O-ring (37) with vaseline and install in groove of adapter (29).

NOTE: Be sure O-ring is not twisted, cut, or distorted. Replace if damaged.

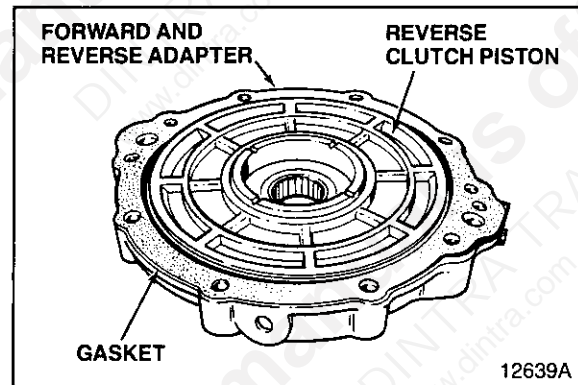
If removed, install dryseal plug (34) in adapter (29). Tighten plug (34) to torque shown in Table 4 (page 52).



Sealing Ring Installation

STEP 30. Install reverse clutch piston (35) in adapter (29).

Lightly coat gasket (33) with vaseline and place on adapter (29).

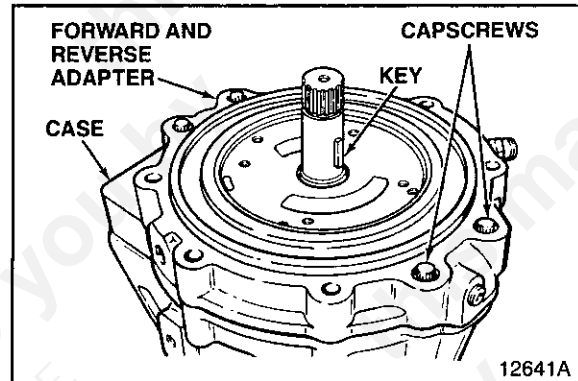


Reverse Clutch Piston Assembly

STEP 31. Install adapter (29) on case (81) and align bolt holes.

Thread four capscrews (30) into case (81). Tighten capscrews (30) in a criss-cross pattern to final torque specified in Table 4.

Lightly tap woodruff key (28) into place in drive gear with a soft-faced mallet.

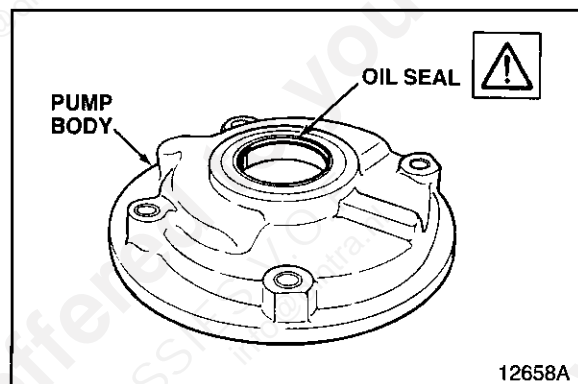


Adapter Installation

STEP 32. Press oil seal (26) into pump body.



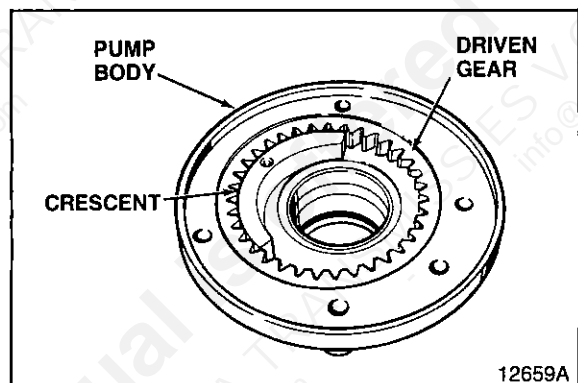
CAUTION: Oil seal must be installed dry on the outside diameter. Lubricants can damage rubber coating.



Oil Seal Installation

STEP 33. Install driven gear in pump body.

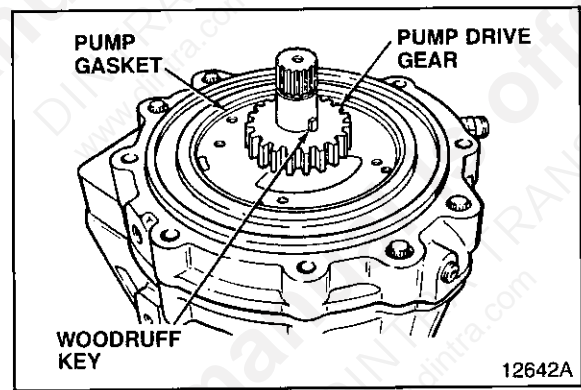
NOTE: Pump gear should be installed the same side down as removed.



Pump Driven Gear Assembly

STEP 34. Lubricate pump gasket (27) with vaseline and install in groove of adapter (29).

Install pump drive gear onto drive gear assembly (66). Check that pump drive gear locates freely on woodruff key (28) and drive gear assembly (66).



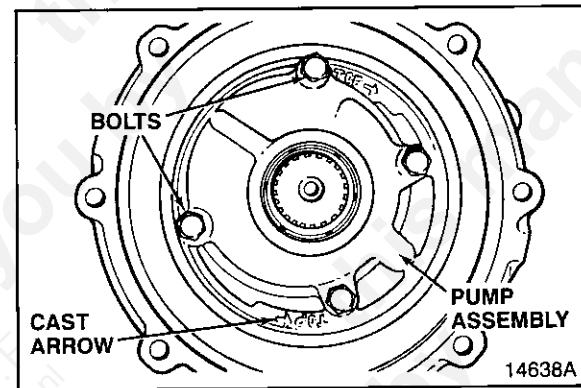
Pump Gasket Installation

STEP 35. Install pump assembly (24) on top of adapter (29) and align bolt holes.

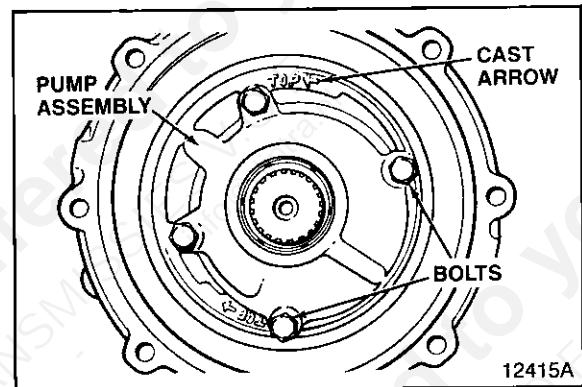


CAUTION: Position pump housing with cast arrow at top pointing in the same direction as engine rotation.

Thread four bolts (25) into adapter (29). Tighten bolts (25) in a criss-cross pattern to final torque specified in Table 4 (page 52).



**Pump Assembly Installation
(Automotive rotation engine)**

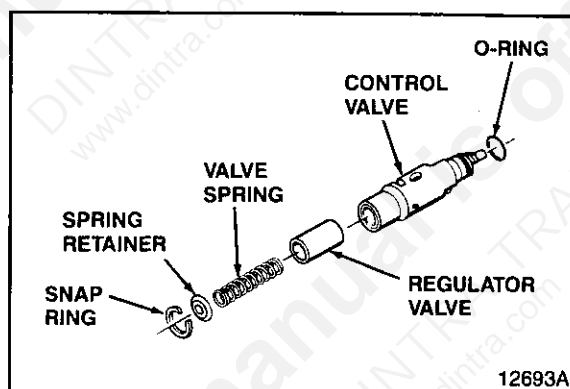


**Pump Assembly Installation
(Non-automotive rotation engine)**

STEP 36. Assemble control valve assembly (17).

Lubricate O-ring (22) with vaseline and install on end of control valve assembly (17).

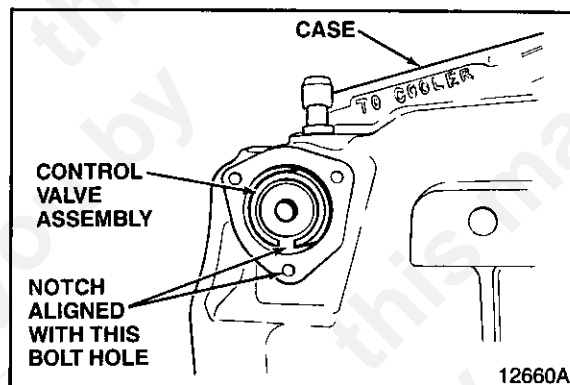
NOTE: Gap in snap ring must be aligned with notch in control valve.



Control Valve Assembly

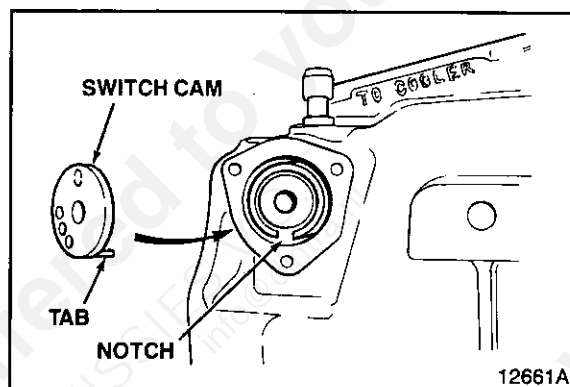
STEP 37. Lightly lubricate O.D. of control valve assembly (17) with vaseline.

Slide control valve assembly (17) into side of case (81).



Control Valve Assembly Installation

STEP 38. Install switch cam (15) on end of control valve assembly (17). Be sure tab on switch cam (15) sets in notch of control valve assembly (17).



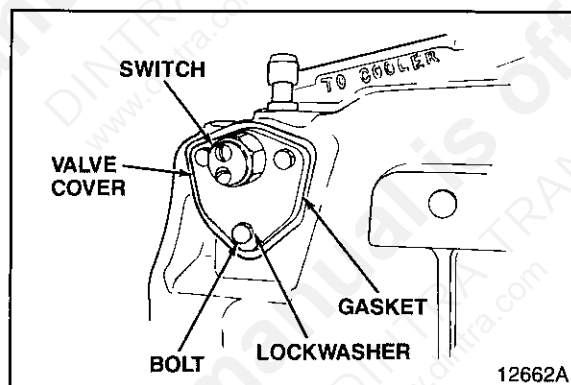
Switch Cam Installation

STEP 39. Install valve cover (12) as follows:

Position gasket (16) on case (81). Place valve cover (12) over gasket (16) and align bolt holes.

Thread three bolts (13) with lockwashers (14) into case (81). Tighten bolts (13) in a criss-cross pattern to final torque specified in Table 4 (page 52).

If removed, lubricate O-ring (11) with vaseline and install in groove of neutral switch (10). Thread neutral switch assembly (9) into valve cover (12). Tighten neutral switch assembly (9) to torque specified in Table 4 (page 52).



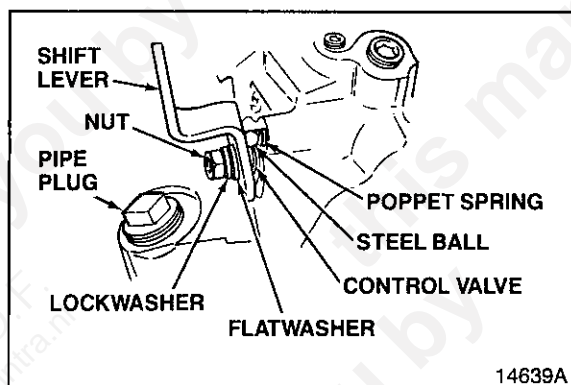
Valve Cover Installation

STEP 40. Install shift lever (3) as follows:

Lubricate poppet spring (8) and hole in case (81) with grease, Shell Alvania #2, or equivalent. Place poppet spring (8) and steel ball (7) in case (81).

Slide shift lever (3) over end of control valve assembly (17) and against steel ball (7). Rotate shift lever (3) to engage steel ball (7) in hole of shift lever (3).

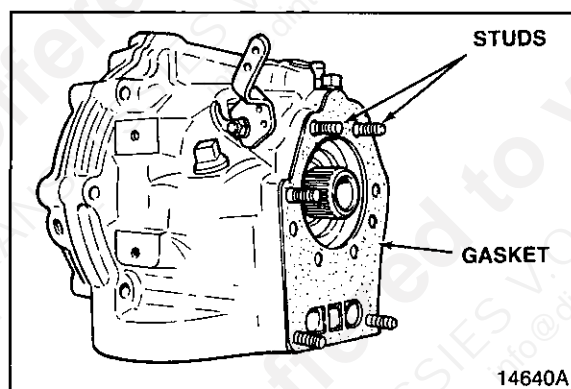
Hold shift lever (3) against steel ball (7). Install washers (5 and 6) and thread nut (4) on control valve assembly (17). Tighten nut (4) to torque specified in Table 4 (page 52).



Shift Lever Assembly

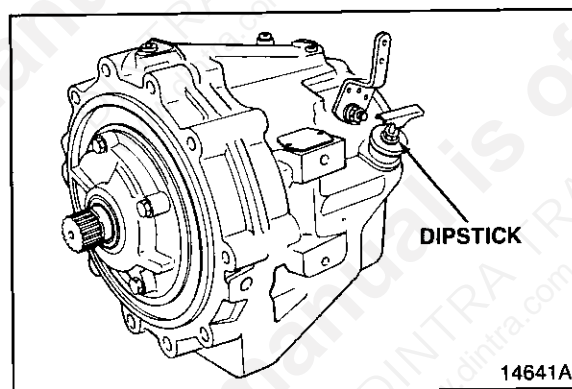
STEP 41. If removed, apply loctite #270 to threads of studs (78). Thread studs (78) into back of case (81). Tighten studs (78) to torque specified in Table 4 (page 52).

Lubricate gasket (79) with vaseline and install on back of case (81) over studs (78).



Stud Installation

STEP 42. On early models, install dipstick (1) in side of case (81). Turn handle until snug. Do not overtighten.



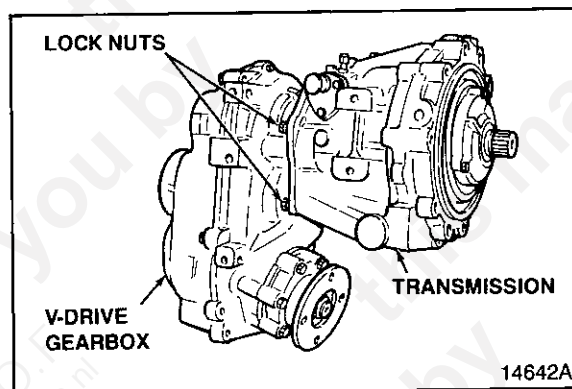
Dipstick Installation

STEP 43. Slide coupling (80) onto output shaft of transmission.

Align splines of coupling (80) with input shaft of V-Drive and slide V-Drive against back of transmission.

Thread new nuts (77) onto studs (78). Tighten nuts (77) in a criss-cross pattern to final torque specified in Table 4 (page 52).

Rotate V-Drive coupling several times to be sure coupling (80) is not binding.



V-Drive Installation

INSTALLATION



CAUTION: After a transmission failure the cooler and cooler lines must be flushed to remove contaminated transmission oil and metal/rubber particles. Failure to comply can result in premature wear or failure of overhauled transmission.

- Align input shaft spline with damper plate.
- Assemble transmission to engine, and then install bolts. Do not use bolts to draw transmission against engine.



WARNING: CHECK THE SHIFT LEVER POSITION AT THE HELM TO SEE THAT FORWARD POSITION IS ALSO FORWARD POSITION AT THE TRANSMISSION SHIFT LEVER. (TRANSMISSION SHOULD NOT BE RUNNING IN REVERSE WHEN BOAT IS GOING FORWARD.)

- Adjust shift cable so holes in shift lever are centered over the detent ball at each selector location (See Figure 7).
- For complete installation instructions refer to OEM manual. Installation literature is available from Borg-Warner Automotive Systems. Request Form No. 1131.
- Connect oil line to oil cooler outlet (See Figure 8).

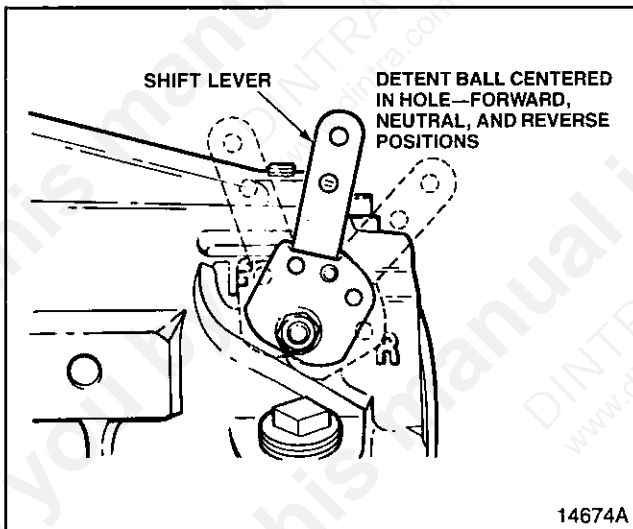


Figure 7. Shift Cable Adjustment

- Connect propeller shaft to gearbox. Check alignment of coupling halves (See Figure 9).

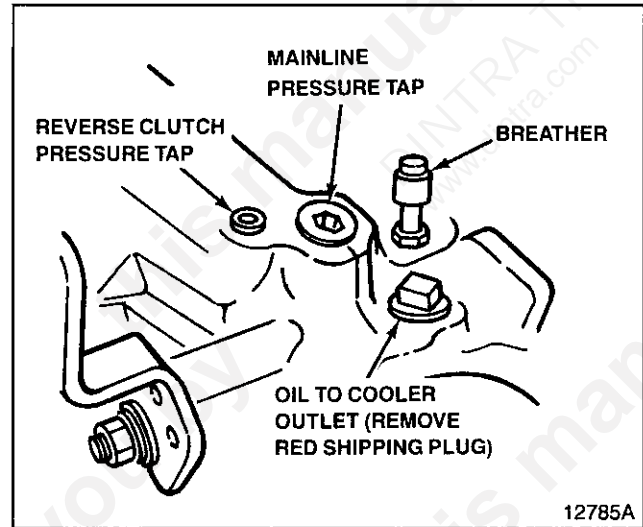


Figure 8. Oil Outlet to Cooler

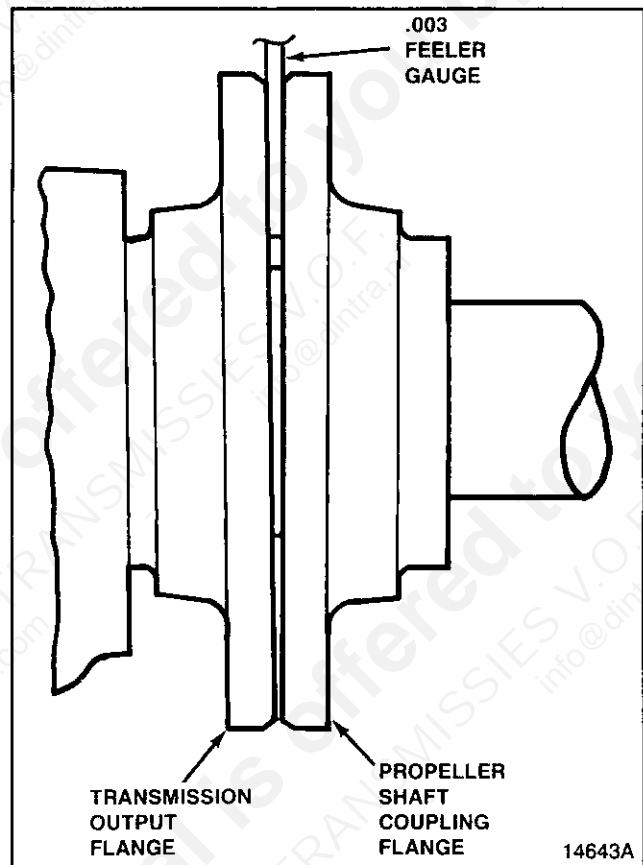


Figure 9. Coupling Alignment

ILLUSTRATED PARTS LIST

A. GENERAL.

The Illustrated Parts List is a breakdown of assemblies, subassemblies, and detail parts of the 71C and 72C transmission.

Explanation of columns in illustrated parts list:

INDEX NUMBER COLUMN: The index numbers key the parts list to the related illustration. The index numbers are arranged in sequence and reflect the order of disassembly. An index number followed by a letter indicates a multiple listing of that item.

PART NUMBER COLUMN: This column contains the Borg-Warner Automotive part number for each item. When "NO NUMBER" appears in this column it indicates the item is not serviced separately (NSS). It is only available as part of the Next Higher Assembly or a service kit. Service kits and special notes are listed at the end of the parts list.

DESCRIPTION COLUMN: This column identifies the items being listed. The assemblies, detail

parts, and attaching parts are indented to show their relationship to the assembly. Parts unique to a specific model will have this information noted in (), such as: (10-04 ONLY). Symbols appearing in this column are explained at the end of the parts list.

QTY COLUMN: This column indicates the number of parts required for assembly. Some parts, such as shims and snap rings, are used as required to obtain the proper fit or clearance.

B. ORDERING DATA.

Obtain the index number assigned to the item(s) required from the illustration. Refer to the illustrated parts list for the name and part numbers. Be sure to check if any of the parts are contained in a service or repair kit. Always reference the model and serial numbers on the transmission identification plate. This will help ensure the correct parts are supplied for the transmission.

NOTE: The illustrated parts list for the V-Drive gearbox is on page 48.

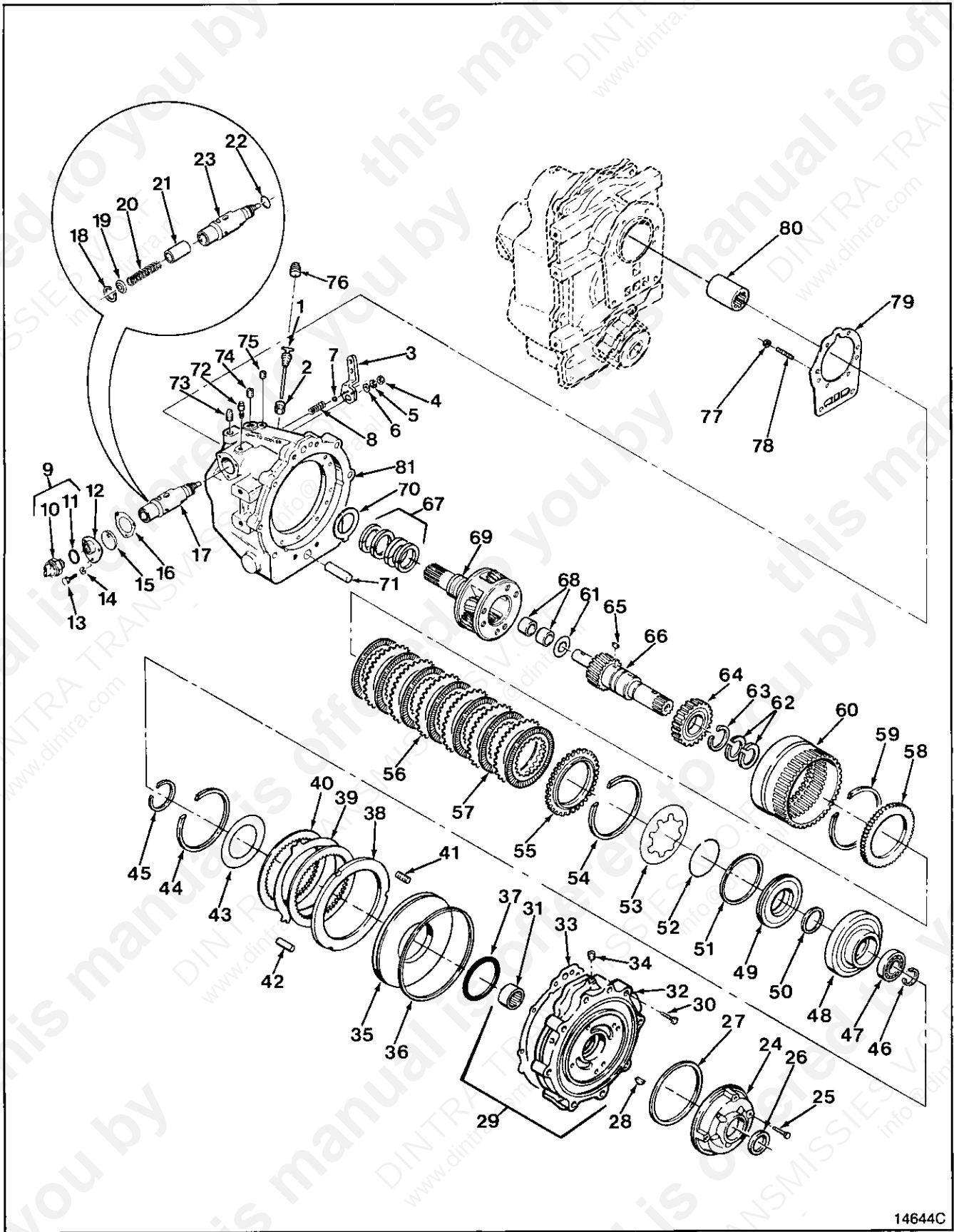


Figure 10. 71C and 72C V-Drive Transmission Assembly

INDEX NO.	PART NUMBER	DESCRIPTION	QTY
Fig. 10	10-04-000- *	TRANSMISSION ASSEMBLY (MODEL 71C)	
	10-05-000- *	TRANSMISSION ASSEMBLY (MODEL 72C)	
1	10-06-559-001	• DIPSTICK (EARLY)	1
2	10-04-034-002	• DIPSTICK TUBE (EARLY)	1
3	71-79B	• SHIFT LEVER	1
4	9418892	• HEX NUT (5/16-24)	1
5	0000108579	• LOCKWASHER (5/16)	1
6	0000103340	• FLATWASHER (5/16)	1
7	0000453632	• STEEL BALL (5/16)	1
8	71-42	• POPPET SPRING	1
9	10-00-640-004	• NEUTRAL SWITCH ASSEMBLY	1
10	NO NUMBER	•• NEUTRAL SWITCH (NSS)	1
11	10-00-141-046	•• O-RING	1
12	10-16-039-001	•• VALVE COVER	1
13	0000179796	• HEX HEAD BOLT (1/4-20 X 1/2)	3
14	0000103319	• LOCKWASHER (1/4)	3
15	10-16-099-001	• SWITCH CAM	1
16	71-14	• VALVE COVER GASKET	1
17	71-A244A	• CONTROL VALVE ASSEMBLY (CURRENT)	1
17A	10-04-739-001	• CONTROL VALVE ASSEMBLY (EARLY)	1
18	4821	•• SNAP RING	1
19	71-246	•• SPRING RETAINER	1
20	71-242	•• VALVE SPRING (BLACK - CURRENT)	1
20A	72N-242	•• VALVE SPRING (WHITE - EARLY)	1
21	71-243	•• REGULATOR VALVE	1
22	4804H	•• O-RING	1
23	71-244A	•• CONTROL VALVE	1
24	71C-A60	• PUMP ASSEMBLY	1
25	10-00-183-021	• HEX HEAD BOLT (5/16-18 X 1-3/8)	4
26	10-00-044-014	•• OIL SEAL	1
27	3-61	• PUMP GASKET	1
28	4873	• WOODRUFF KEY	1
29	71C-A8	• FORWARD AND REVERSE ADAPTER ASSY	1
30	4911	• CAPSCREW (3/8-16 X 1-1/4)	4
31	4840D	•• NEEDLE BEARING	1
32	NO NUMBER	•• FORWARD AND REVERSE ADAPTER (NSS)	1
33	71-144B	• GASKET	1
34	0000444858	• PIPE PLUG (1/4)	1
35	71-35	• REVERSE CLUTCH PISTON	1
36	4805A	• CLUTCH SEALING RING	1
37	4804G	• O-RING	1
38	71-71	• REVERSE CLUTCH PRESSURE PLATE	1
39	72-176	• STEEL CLUTCH PLATE (10-04 ONLY)	1
39A	72-176	• STEEL CLUTCH PLATE (10-05 ONLY)	2
40	72-A66B	• FRICTION CLUTCH PLATE (10-04 ONLY)	2
40A	72.A66B	• FRICTION CLUTCH PLATE (10-05 ONLY)	3
41	71-97	• PRESSURE PLATE SPRING	11
42	R6-177	• DOWEL PIN (0.312 DIA X 0.621 LONG) (10-04 ONLY)	3
42A	4622E	• DOWEL PIN (0.312 DIA X 0.875 LONG) (10-05 ONLY)	3

INDEX NO.	PART NUMBER	DESCRIPTION	QTY
43	71-15B	• THRUSTWASHER +	1
43A	10-16-193-001	• THRUSTWASHER +	1
44	4822	• SNAP RING	1
45	R6A-7-1/2	• SNAP RING (10-04 ONLY)	1
45A	4766B	• SNAP RING (10-05 ONLY)	1
46	4734	• SNAP RING (10-04 ONLY)	1
46A	4559A	• SNAP RING (10-05 ONLY)	1
47	B107A	• BEARING (10-04 ONLY)	1
47A	B108A	• BEARING (10-05 ONLY)	1
48	71-70	• FORWARD CLUTCH CYLINDER (10-04 ONLY)	1
48A	72-70	• FORWARD CLUTCH CYLINDER (10-05 ONLY)	1
49	10-16-124-001	• FORWARD CLUTCH PISTON	1
49A	71-45	• FORWARD CLUTCH PISTON	1
50	5M-122	• O-RING	1
51	5L-36	• PISTON SEALING RING	1
52	5C-33	• CLUTCH SPRING BEARING RING	1
53	3-37	• CLUTCH BELLEVILLE SPRING	1
54	4755	• SNAP RING	1
55	5C-175A	• CLUTCH PRESSURE PLATE	1
56	1016-166-001	• STEEL CLUTCH PLATE (10-04 ONLY)	4
56A	1016-166-001	• STEEL CLUTCH PLATE (10-05 ONLY)	6
57	5C-A66A	• FRICTION CLUTCH PLATE (10-04 ONLY)	5
57A	5C-A66A	• FRICTION CLUTCH PLATE (10-05 ONLY)	7
58	5L-67	• CLUTCH PRESSURE PLATE	1
59	10-00-139-048	• SNAP RING (0.033 - 0.037 THICK) (10-04 ONLY)	1
59A	10-00-139-049	• SNAP RING (0.050 - 0.054 THICK) (10-04 ONLY)	1
59B	4768	• SNAP RING (0.050 - 0.054 THICK) (10-05 ONLY)	1-2
59C	4768A	• SNAP RING (0.074 - 0.078 THICK) (10-05 ONLY)	1
59D	4768B	• SNAP RING (0.096 - 0.100 THICK) (10-05 ONLY)	1
59E	10-00-139-018	• SNAP RING (0.062 - 0.066 THICK) (10-05 ONLY)	1
60	71-6	• RING GEAR (10-04 ONLY)	1
60A	1016-162-001	• RING GEAR (10-05 ONLY)	1
61	71-17	• THRUSTWASHER	1
62	4806J	• SEALING RING	2
63	4495	• SNAP RING	1
64	71-40	• FORWARD CLUTCH HUB (10-04 ONLY)	1
64A	10-16-179-001	• FORWARD CLUTCH HUB (10-05 ONLY)	1
65	0000218211	• WOODRUFF KEY (10-04 ONLY)	1
65A	0000124553	• WOODRUFF KEY (10-05 ONLY)	1
66	71C-3A16	• DRIVE GEAR ASSEMBLY (10-04 ONLY)	1
66A	72C-2A16	• DRIVE GEAR ASSEMBLY (10-05 ONLY)	1
67	4806B	• SEALING RING	4
68	NO NUMBER	• BUSHING ▲	3
69	10-17-659-020	• PINION CARRIER ASSEMBLY (10-04 WITH SEALING RINGS)	1
69A	71-1A2A	• PINION CARRIER ASSEMBLY (10-04 WITH BUSHINGS)	1
69B	10-18-659-014	• PINION CARRIER ASSEMBLY (10-05 WITH SEALING RINGS)	1

INDEX NO.	PART NUMBER	DESCRIPTION	QTY
69C	72-1A2A	• PINION CARRIER ASSEMBLY (10-05 WITH BUSHINGS)	1
70	71-159	• THRUSTWASHER (CASE WITH BUSHINGS)	1
70A	10-17-193-001	• THRUSTWASHER (CASE WITHOUT BUSHINGS)	1
71	10-04-034-001	• SUCTION TUBE (10-04 ONLY)	1
71A	10-05-034-001	• SUCTION TUBE (10-05 ONLY)	1
72	A4740G	• BREATHER	1
73	10-00-191-002	• SHIPPING PLUG (3/8-18)	1
74	0000444866	• PIPE PLUG (3/8-18)	1
75	0000444687	• PIPE PLUG (1/8-27)	1
76	0000444592	• PIPE PLUG (3/4-14) (CURRENT)	1
77	0009419506	• HEX NUT (7/16-20)	6
78	10-00-146-001	• STUD	6
79	13-08-045-002	• GASKET	1
80	13-08-089-001	• COUPLING †	1
81	10-04-565-005	• CASE ASSEMBLY ◆ (10-04 WITH SEALING RINGS)	1
81A	10-04-565-002	• CASE ASSEMBLY ■ (10-04 WITH BUSHINGS)	1
81B	10-05-565-012	• CASE ASSEMBLY ◆ (10-05 WITH SEALING RINGS)	1
81C	10-05-565-002	• CASE ASSEMBLY ■ (10-05 WITH BUSHINGS)	1
	A4867VV	• CASE BUSHING KIT ‡	1

NSS - NOT SERVICED SEPARATELY, BUY NEXT HIGHER ASSEMBLY.

* CHECK MODEL NUMBER ON IDENTIFICATION PLATE AND MATCH WITH MODEL CHART IN THE FRONT OF THIS MANUAL.

+ USE AS REQUIRED TO OBTAIN PROPER AMOUNT OF END PLAY.

▲ ORDER A4867DD KIT WHICH CONTAINS TWO PRESIZED BUSHINGS (71-9C).

◆ ASSEMBLY INCLUDES CASE, SUCTION TUBE, AND STUDS.

■ ASSEMBLY INCLUDES CASE, SUCTION TUBE, BUSHINGS, AND STUDS.

† COUPLING IS NOT SUPPLIED WITH TRANSMISSION OR V-DRIVE GEARBOX AND MUST BE ORDERED SEPARATELY.

‡ KIT CONTAINS TWO PRESIZED BUSHINGS (71-28C) FOR SERVICE.

NOTE: The following kits are available for the 10-04 and 10-05 transmissions. Index numbers shown match the index numbers on the exploded-view, Figure 10 (page 31).

INDEX NO.	PART NUMBER	DESCRIPTION	QTY
	A4867AE	FORWARD CLUTCH PACK KIT (10-04 ONLY)	
55	5C-175A	• CLUTCH PRESSURE PLATE	1
56	1016-166-001	• STEEL CLUTCH PLATE	4
57	5C-A66A	• FRICTION CLUTCH PLATE	5
58	5L-67	• CLUTCH PRESSURE PLATE	1

INDEX NO.	PART NUMBER	DESCRIPTION	QTY
55	A4867AB	FORWARD CLUTCH PACK KIT (10-05 ONLY)	1
56A	5C-175A	• CLUTCH PRESSURE PLATE	6
57	1016-166-001	• STEEL CLUTCH PLATE	7
58	5C-A66A	• FRICTION CLUTCH PLATE	1
	5L-67	• CLUTCH PRESSURE PLATE	

INDEX NO.	PART NUMBER	DESCRIPTION	QTY
--	10-04-420-052	NEUTRAL SWITCH KIT	1
9	10-04-539-001	• SWITCH AND BODY ASSEMBLY	1
12	10-00-640-004	• NEUTRAL SWITCH ASSEMBLY	1
13	10-16-039-001	• VALVE COVER	3
14	0000179796	• HEX HEAD BOLT (1/4-20 X 1/2)	3
15	0000103319	• LOCKWASHER (1/4)	1
16	10-16-099-001	• SWITCH CAM	1
	71-14	• VALVE COVER GASKET	1
	OF1340	• INSTRUCTION SHEET	1

INDEX NO.	PART NUMBER	DESCRIPTION	QTY
	10-95-410-002	SNAP RING SERVICE KIT	1
18	4766	• RETAINING RING	1
44	4821	• SNAP RING	1
45	4822	• SNAP RING	1
45A	R6A-7-1/2	• SNAP RING (10-04 ONLY)	1
46	4766B	• SNAP RING (10-05 ONLY)	1
46A	4734	• SNAP RING (10-04 ONLY)	2
54	4559A	• SNAP RING (10-05 ONLY)	1
59	4755	• SNAP RING	1
59A	10-00-139-048	• SNAP RING (.033-.037 THICK) (10-04 ONLY)	1
59B	10-00-139-049	• SNAP RING (.050-.054 THICK) (10-04 ONLY)	1
59C	4768	• SNAP RING (.050-.054 THICK) (10-05 ONLY)	2
59D	4768A	• SNAP RING (.074-.078 THICK) (10-05 ONLY)	1
59E	4768B	• SNAP RING (.096-.100 THICK) (10-05 ONLY)	1
63	10-00-139-018	• SNAP RING (.062-.066 THICK) (10-05 ONLY)	1
	4495	• SNAP RING	1
	4756D	• SNAP RING	1
	4756E	• SNAP RING	1
	4816	• SNAP RING	1
	4766A	• SNAP RING	1

V-DRIVE GEARBOXES

A. DESCRIPTION.

The V-Drive gearbox is mounted on the back of a 71C or 72C transmission. The gearbox is either gear or chain driven and provides various ratios. (See Figure 2, page 2.) The V-Drive gearbox is splash lubricated.

B. ASSEMBLY.

Refer to page 12 for general maintenance procedures on V-Drive gearboxes. Before starting disassembly, review the exploded-view shown in Figure 12 (page 48). The V-Drive can be disassembled by following the index numbers shown in Figure 12. The following procedures are correct for most V-Drives. Minor differences may be found. Numbers in () refer to item numbers on the exploded-view.

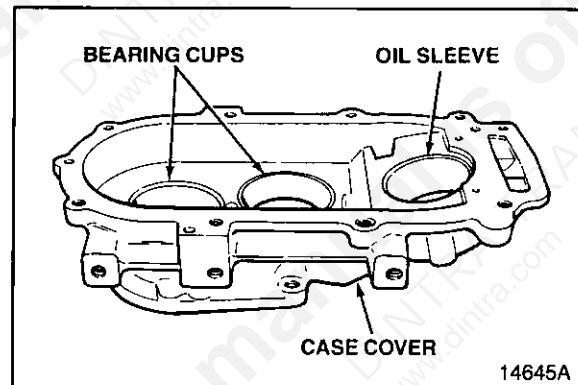


CAUTION: Threaded plugs, screws, bolts, and coupling nut must be tightened to torque shown in Table 4 (page 52) to prevent premature V-Drive failure.

- A new coupling nut must be used at assembly.
- Bearing cups and cones, bevel gears, and case/cover are matched sets. If one is damaged both must be replaced.
- Multi-piece bevel gears are no longer available. They can be replaced with the one piece bevel gear and shaft. See illustrated parts list for details.
- The dipstick has been changed to increase oil capacity in the gearbox. Old style dipsticks (part number 10-06-559-001) should be replaced with the new dipstick. See illustrated parts list for details.

STEP 1. Install bearing cups (17 and 27) in case cover (11).

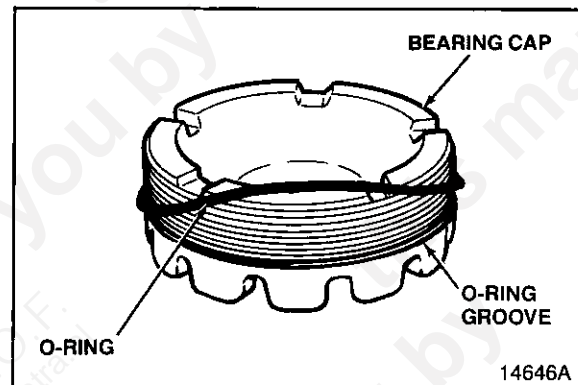
If removed, press oil sleeve (38) in case cover (11).



Bearing Cup Installation

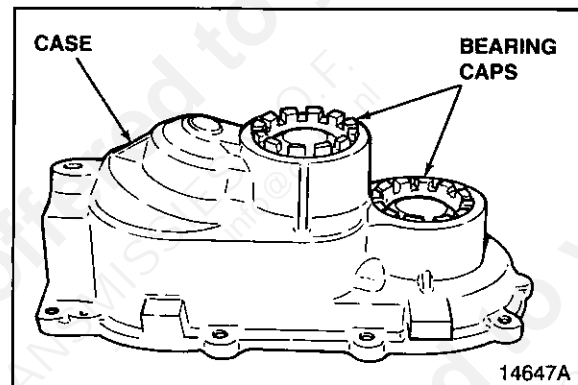
STEP 2. Lubricate O-rings (45) with vaseline. Install O-rings (45) in groove of bearing caps (43).

NOTE: Check that O-ring is not twisted, cut, or deformed. Replace if damaged.



O-Ring Installation

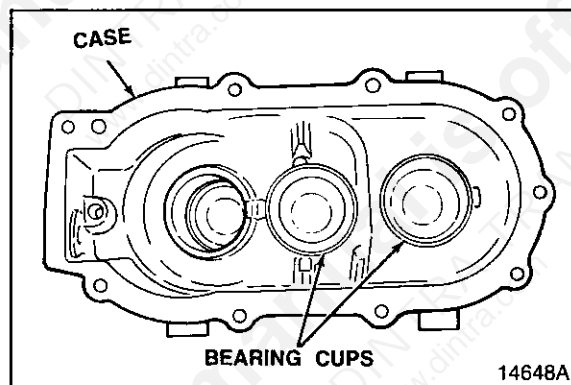
STEP 3. Thread bearing caps (43) into case (11) until flush with outer edge of case (11).



Bearing Caps Installation

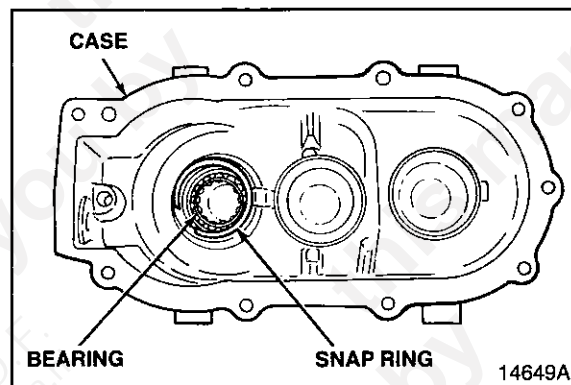
STEP 4. Install bearing cups (24 and 33) in case (11).

NOTE: Do not install shims under bearing cup.



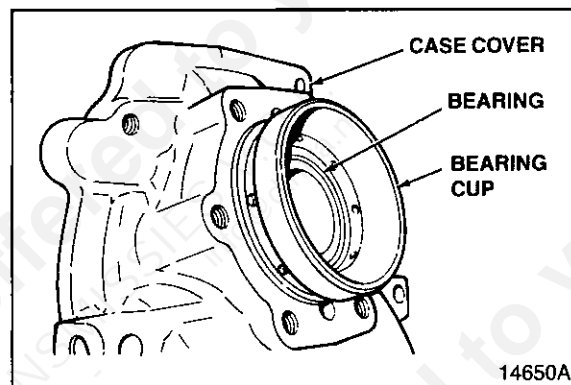
Bearing Cups Installation

STEP 5. Install bearing (42) and snap ring (41) in case (11).



Bearing and Snap Ring Installation

STEP 6. Install one bearing cone and bearing cup (10) in case cover (11).



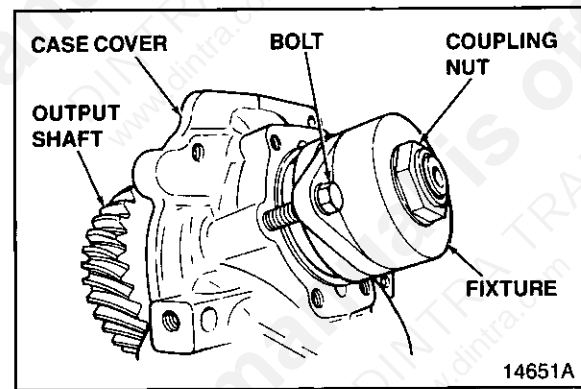
Bearing and Cup Installation

STEP 7. Slide output shaft (40) through bearing cone and bearing cup (10) in case cover (11).

NOTE: See Figure 13 (page 51) for instructions on local manufacture of fixture.

Hold output shaft (40) and install fixture using two bolts (7).

Install old coupling nut (3) on end of output shaft (40) and tighten.



Fixture Installation

STEP 8. Determine amount of shims required on output shaft (40) as follows:

(a) Measure dimension "A" from machined face of case cover (11) to ground face of bevel gear (Measure to the nearest 0.001 inch).

(b) Multiply etched dimension on the end of bevel gear by 0.001 inch.

(c) If dimension etched on end of bevel gear has a plus (+) in front of it, add the dimension in step (b) to measurement obtained in step (a). If dimension etched on end of bevel gear has a minus (-) in front of it subtract the dimension in step (b) from measurement obtained in step (a).

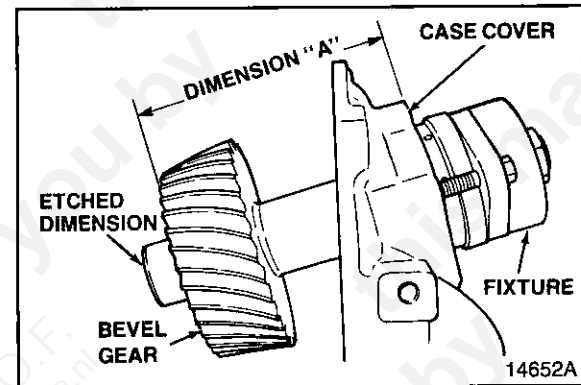
(d) Add dimension from step (c) to 14.375 inch.

(e) Subtract dimension obtained in step (d) from 20.9343 inch. The difference is the amount of shims required to locate the output shaft bevel gear.

Remove old coupling nut (3) from end of output shaft (40).

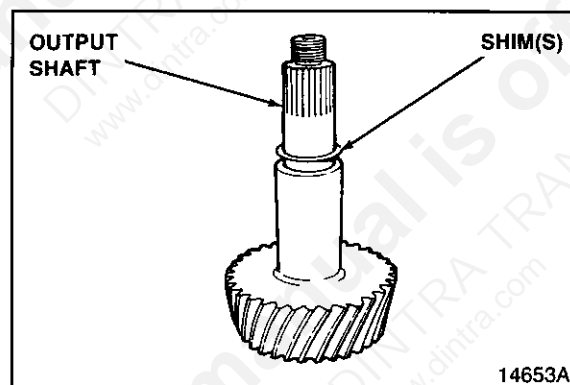
Remove output shaft (40) from bearing cone and bearing cup (10) in case cover (11).

Remove fixture from case cover (11).



Shim Selection

STEP 9. Install selected shims (39) on output shaft (40).

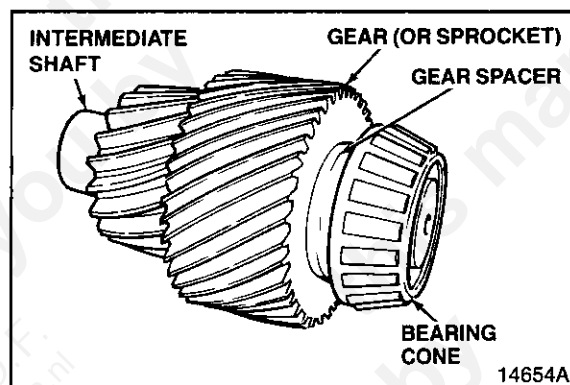


Shim Installation

STEP 10. If removed, install gear or sprocket (30) on intermediate shaft (31).

If removed, install gear spacer (29) and press bearing cone (28) on end of intermediate shaft (31).

NOTE: Do not install bearing cone on other end of intermediate shaft at this time.



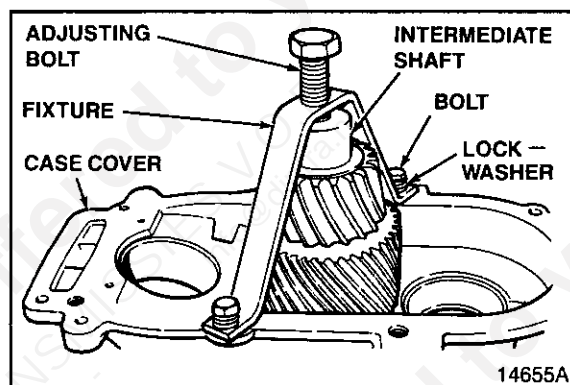
Gear and Bearing Installation

STEP 11. Install intermediate shaft (31) in case cover (11).

NOTE: See Figure 14 (page 51) for instructions on local manufacture of fixture.

Install fixture on case cover (11) using two bolts (12) and lockwashers (13). Tighten bolts (13) snug.

Tighten bolt on fixture so intermediate shaft (31) does not move.



Intermediate Shaft Installation

STEP 12. Determine amount of shims (35) required on intermediate shaft (31) as follows:

(a) Measure dimension "A" from machined face of case cover (11) to ground face of bevel gear (Measure to the nearest 0.001 inch).

(b) Multiply etched dimension on the end of bevel gear by 0.001 inch.

(c) If dimension etched on end of bevel gear has a plus (+) in front of it, add the dimension in step (b) to measurement obtained in step (a). If dimension etched on end of bevel gear has a minus (-) in front of it subtract the dimension in step (b) from measurement obtained in step (a).

(d) Add dimension from step (c) to 14.472 inch.

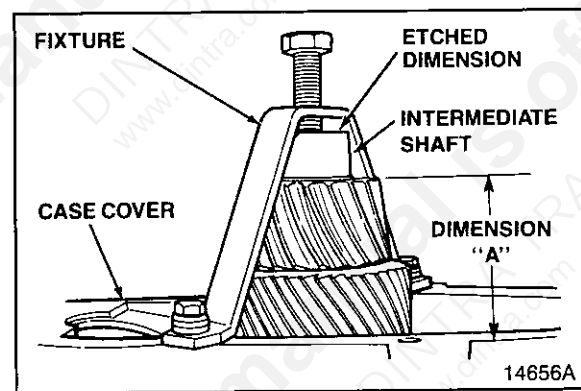
(e) Subtract dimension obtained in step (d) from 17.8141 inch. The difference is the amount of shims required to locate the intermediate shaft bevel gear.

Remove bolts (12), lockwashers (13), and fixture from case cover (11).

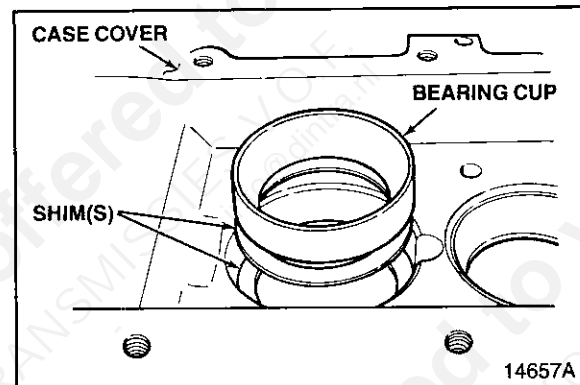
Remove intermediate shaft (31) from case cover (11).

STEP 13. Remove bearing cup (27) from case cover (11).

Install selected shims (35) and bearing cup (27) in case cover (11).

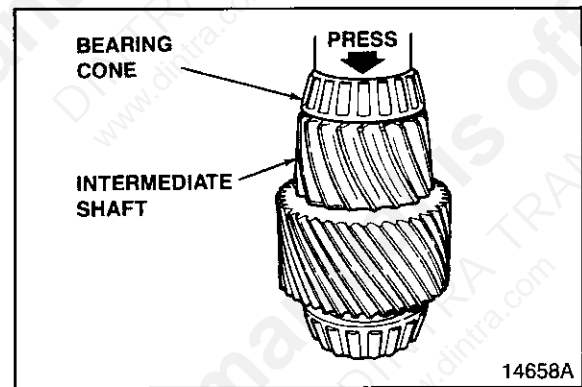


Shim Selection



Shim Installation

STEP 14. Press bearing cone (34) on intermediate shaft (31).

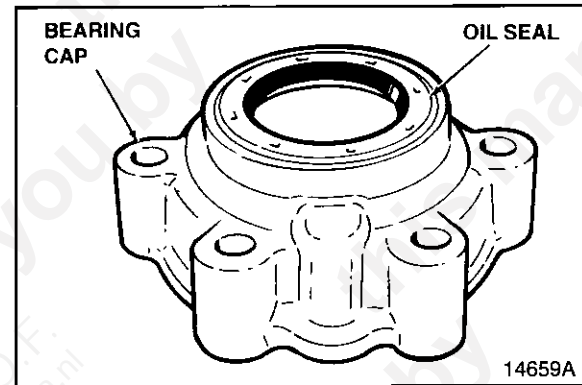


Bearing Cone Assembly

STEP 15. Install oil seal (5) in bearing cap (6).

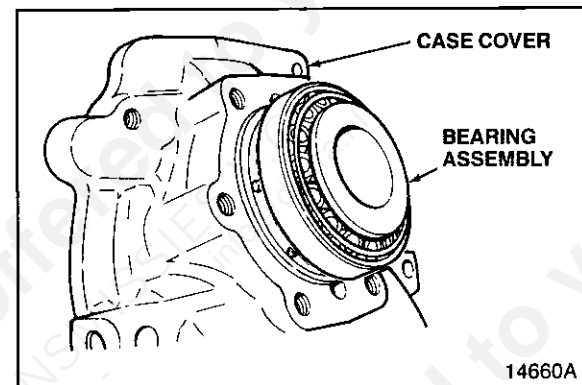


CAUTION: Oil seal must be installed dry on outside diameter. Lubricants can damage rubber coating.



Oil Seal Installation

STEP 16. Install bearing assembly (10) in case cover (11).

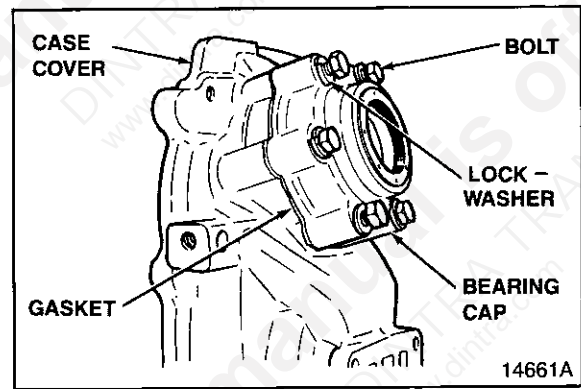


Bearing Installation

STEP 17. Lightly coat gasket (9) with vaseline and position on case cover (11).

Place bearing cap (6) on case cover (11) and align bolt holes. Be certain oil channel in bearing cap (6) is aligned with oil channel in case cover (11).

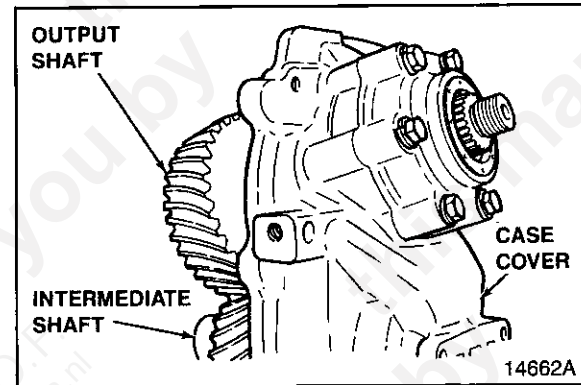
Thread bolts (7) with lockwashers (8) into case cover (11). Tighten bolts (7) to torque shown in Table 4 (page 52).



Bearing Cap Installation

STEP 18. Install intermediate shaft (31) and output shaft (40) in case cover (11).

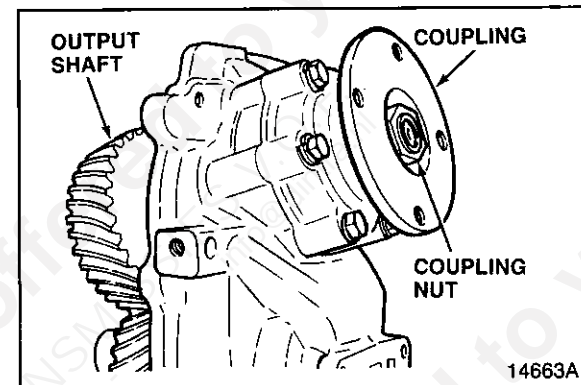
NOTE: Be sure shims are installed on output shaft.



Shaft Installation

STEP 19. Hold output shaft (40) and install coupling (4) on end of output shaft (40).

Thread old coupling nut (3) onto end of output shaft (40). Tighten coupling nut (3) to torque shown in Table 4 (page 52).



Coupling Nut Installation

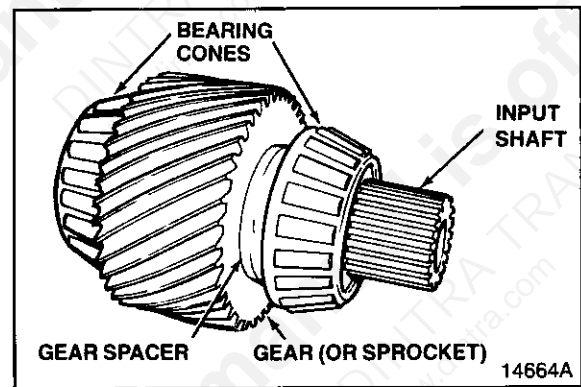
STEP 20. If required assemble input shaft as follows:

Install gear or sprocket (21) on input shaft (20).

Slide gear spacer (19) onto input shaft (20).

Press bearing cones (17 and 25) on input shaft (20).

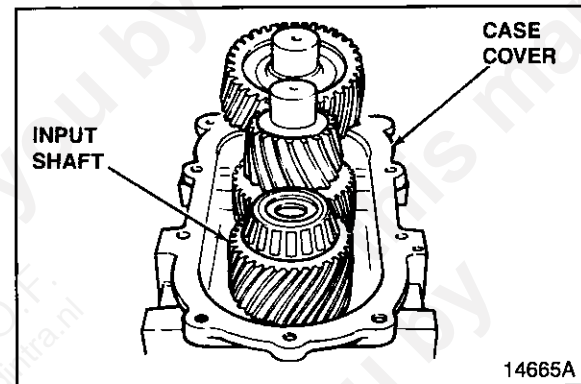
NOTE: On chain drives if sprocket is smaller than bearing cone, chain must be installed on sprocket before pressing bearing cone on input shaft.



Bearing Assembly

STEP 21. Install input shaft (20) in case cover (11).

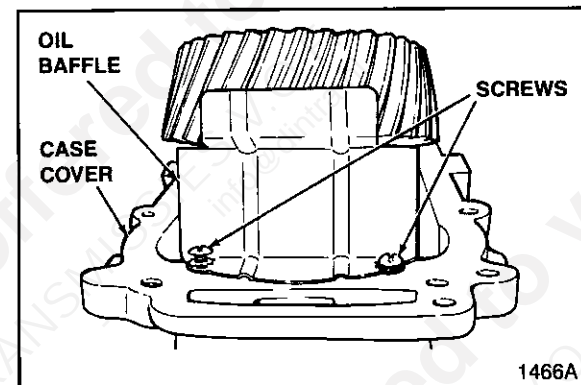
NOTE: Gear drive shown. For chain drive units, chain should be installed on the sprockets.



Input Shaft Installation

STEP 22. Install oil baffle (36) on case cover (11).

Install screws (3) and tighten to torque shown in Table 4 (page 52).



Oil Baffle Installation

STEP 23. Check contact pattern of bevel gears (31 and 40) as follows:

Coat teeth of bevel gears (31 and 40) with red dykem or gear paint.

Complete assembly of case cover (11) to case (11). Refer to STEP 24.

Rotate coupling (4) several times to develop a contact pattern.

Remove case cover (11) from case (11). Check contact pattern. If not correct, adjust using the following procedures.

TOE CONTACT: Remove shims (35) from intermediate shaft (31).

HEEL CONTACT: Add shims (39) to intermediate shaft (31).

If more than 0.010 inch of adjustment is required in intermediate shaft shim pack for proper tooth pattern, complete the adjustment in the output shaft shim pack.

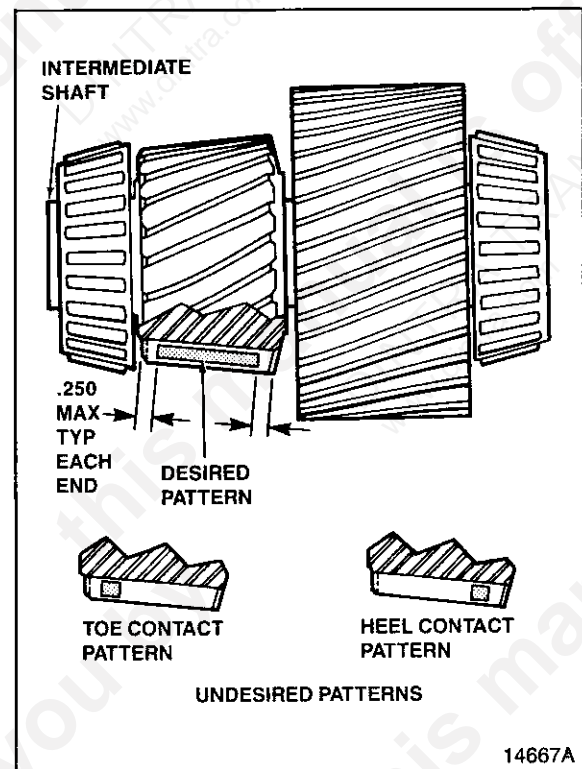


CAUTION: After contact pattern is correct apply a bead of RTV sealant to back of a new coupling nut. Thread coupling nut onto output shaft and tighten to torque shown in Table 4 (page 52).

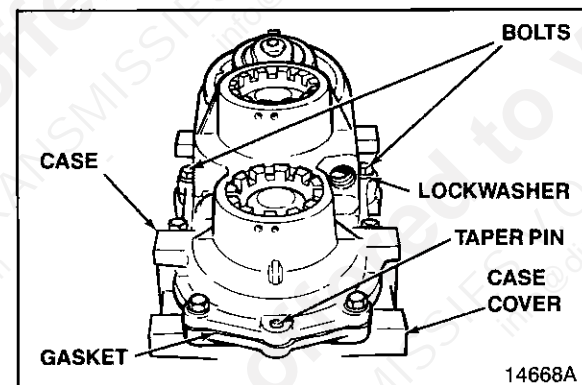
STEP 24. Lightly coat gasket (14) with vaseline and position on case (11). Place case cover on case (11) and align holes.

Insert taper pins (15) through case cover and into case (11).

Coat threads of bolts (12) with locktite #92, or equivalent. Thread bolts (12) with lockwashers (13) into case (11). Tap ends of taper pins (15) to set them in case (11). Tighten bolts (12) in a criss-cross pattern to final torque shown in Table 4 (page 52).



Tooth Contact Patterns



Cover Installation

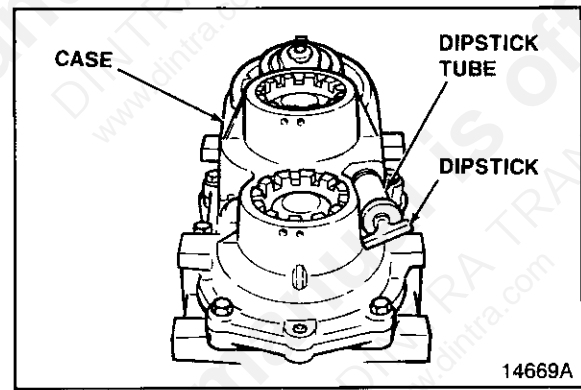
STEP 25. Coat threads of dipstick tube (2) with loctite #592, or equivalent.

Thread dipstick tube (2) into case (11). Tighten dipstick tube (2) to torque shown in Table 4 (page 52).

Install dipstick (1) in dipstick tube (2). Turn handle until snug, do not overtighten.

NOTE: Early transmissions had dipstick tube and dipstick mounted in transmission.

If removed, coat threads of plug (46) with loctite #92, or equivalent. Thread plug (46) into case (11) and tighten to torque shown in Table 4 (page 52).



Dipstick Installation

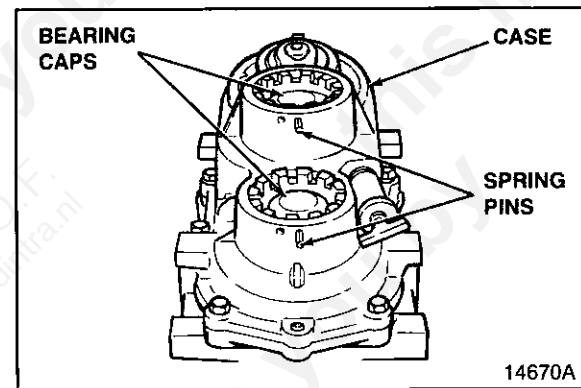
STEP 26. Tighten upper bearing cap (43) to seat bearings. Loosen upper bearing cap (43).

Tighten lower bearing cap (43) to seat bearings. Loosen lower bearing cap (43).

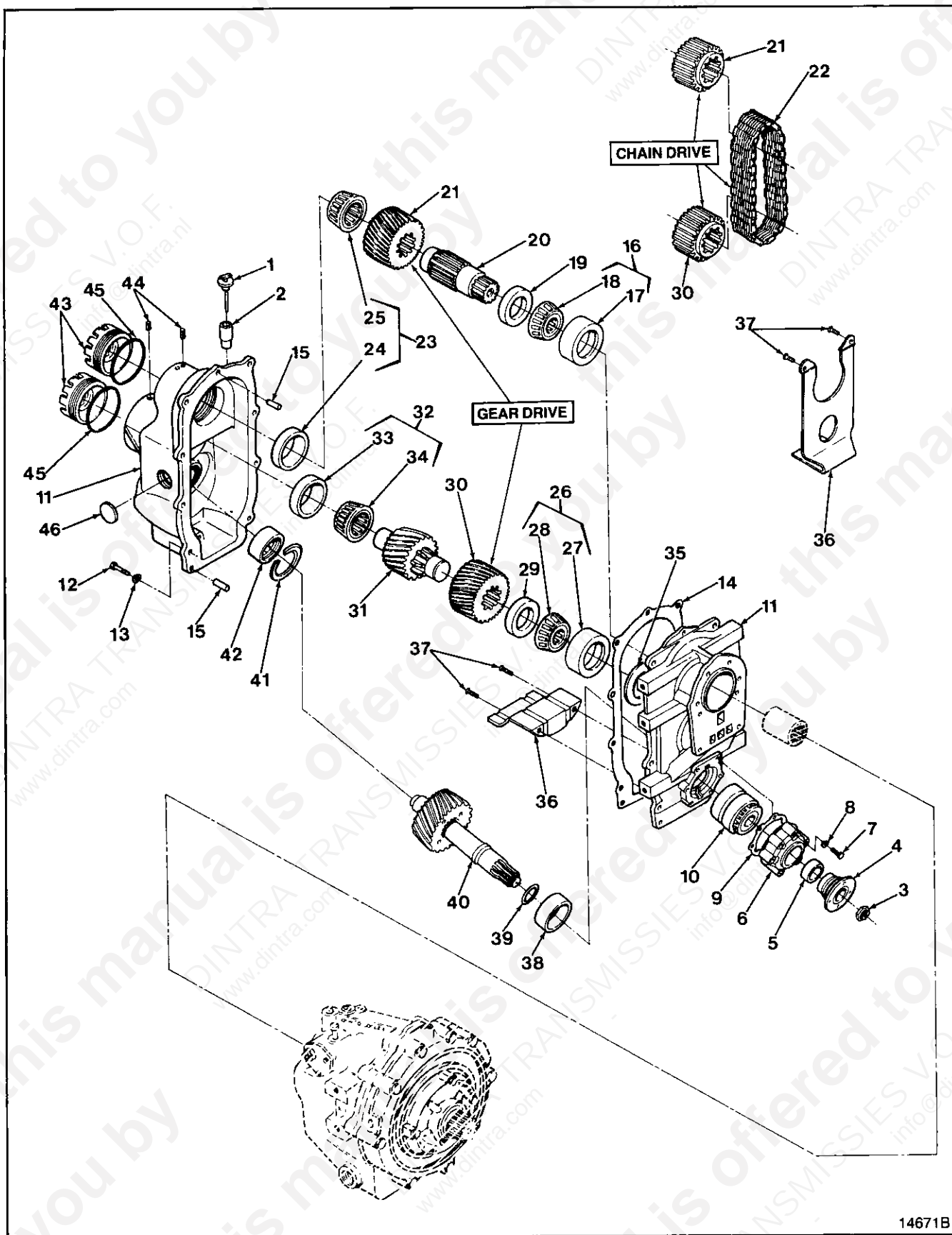
Tighten bearing caps (43) to torque shown on Table 4 (page 52).

Install spring pin (44) in nearest notch of each bearing cap (43).

Drive spring pins (44) into case (11) until flush.



Spring Pins Installation



14671B

Figure 12. V-Drive Assembly

INDEX NO.	PART NUMBER	DESCRIPTION	QTY
Fig 12	13-08-410-*	V-DRIVE ASSEMBLY	
1	10-05-559-001	• DIPSTICK +	1
2	13-08-034-001	• DIPSTICK TUBE	1
3	10-00-149-034	• OUTPUT SHAFT NUT	3
4	4912	• COUPLING	1
5	71C-110	• OIL SEAL	1
6	13-08-027-001	• BEARING CAP	1
7	0000179866	• HEX HEAD BOLT (7/16-14 X 2)	6
8	0000103322	• LOCKWASHER (7/16)	6
9	13-08-045-003	• GASKET	1
10	4920	• BEARING ASSEMBLY	1
11	13-08-565-015	• CASE ASSEMBLY ▲ (1.51, 1.53, 1.98, AND 1.99 RATIOS)	1
11A	13-08-565-018	• CASE ASSEMBLY ▲ (ALL OTHER RATIOS)	1
12	4853E	• HEX HEAD BOLT (7/16-14 X 1-1/4)	8
13	0000103322	• LOCKWASHER (7/16)	8
14	13-08-045-001	• GASKET	1
15	0000100360	• TAPERED PIN	2
16	10-00-633-001	• BEARING ASSEMBLY	1
17	NO NUMBER	• BEARING CUP (NSS)	1
18	NO NUMBER	• BEARING CONE (NSS)	1
19	13-08-053-001	• GEAR SPACER (GEAR DRIVE ONLY)	1
20	13-08-189-002	• INPUT SHAFT	1
21	13-08-070-001	• GEAR (34 TEETH)	1
21A	13-08-070-002	• GEAR (39 TEETH)	1
21B	13-08-070-003	• GEAR (30 TEETH)	1
21C	13-08-070-004	• GEAR (43 TEETH)	1
21D	13-08-070-005	• GEAR (26 TEETH)	1
21E	13-08-070-006	• GEAR (47 TEETH)	1
21F	13-08-144-007	• SPROCKET (29 TEETH)	1
21G	13-08-144-008	• SPROCKET (33 TEETH)	1
21H	13-08-144-009	• SPROCKET (25 TEETH)	1
21I	13-08-144-010	• SPROCKET (36 TEETH)	1
21J	13-08-144-011	• SPROCKET (23 TEETH)	1
21K	13-08-144-012	• SPROCKET (41 TEETH)	1
22	13-08-143-003	• DRIVE CHAIN (1.21:1, 1.53:1, 1.98:1, AND 2.50:1 RATIOS ONLY)	1
22A	13-08-143-004	• DRIVE CHAIN (.97:1 AND 3.10:1 RATIOS ONLY)	1
23	10-00-633-001	• BEARING ASSEMBLY	1
24	NO NUMBER	• BEARING CUP (NSS)	1
25	NO NUMBER	• BEARING CONE (NSS)	1
26	10-00-633-002	• BEARING ASSEMBLY	1
27	NO NUMBER	• BEARING CUP (NSS)	1
28	NO NUMBER	• BEARING CONE (NSS)	1
29	13-08-053-001	• GEAR SPACER (GEAR DRIVE ONLY)	1
30	13-08-070-001	• GEAR (34 TEETH)	1
30A	13-08-070-001	• GEAR (39 TEETH)	1

INDEX NO.	PART NUMBER	DESCRIPTION	QTY
30B	13-08-070-002	• GEAR (30 TEETH)	1
30C	13-08-070-003	• GEAR (43 TEETH)	1
30D	13-08-070-004	• GEAR (26 TEETH)	1
30E	13-08-070-005	• GEAR (47 TEETH)	1
30F	13-08-144-007	• SPROCKET (29 TEETH)	1
30G	13-08-144-008	• SPROCKET (33 TEETH)	1
30H	13-08-144-009	• SPROCKET (25 TEETH)	1
30I	13-08-144-010	• SPROCKET (36 TEETH)	1
30J	13-08-144-011	• SPROCKET (23 TEETH)	1
30K	13-08-144-012	• SPROCKET (41 TEETH)	1
31	13-08-410-014	• BEVEL GEAR AND SHAFT ◆	1
32	10-00-633-001	• BEARING ASSEMBLY	1
33	NO NUMBER	•• BEARING CUP (NSS)	1
34	NO NUMBER	•• BEARING CONE (NSS)	1
35	13-08-037-012	• SHIM (0.050 INCH THICK)	■
35A	13-08-037-013	• SHIM (0.040 INCH THICK)	■
35B	13-08-037-014	• SHIM (0.030 INCH THICK)	■
35C	13-08-037-015	• SHIM (0.020 INCH THICK)	■
35D	13-08-037-016	• SHIM (0.010 INCH THICK)	■
35E	13-08-037-017	• SHIM (0.005 INCH THICK)	■
35F	13-08-037-018	• SHIM (0.004 INCH THICK)	■
35G	13-08-037-019	• SHIM (0.003 INCH THICK)	■
36	13-08-036-001	• OIL BAFFLE (GEAR DRIVE)	1
36A	13-08-036-003	• OIL BAFFLE (CHAIN DRIVE)	1
37	0000188488	• MACHINE SCREW (1/4-20 X 1/2)	2
38	13-08-036-002	• OIL SLEEVE	1
39	10-13-037-002	• SHIM (0.005 INCH THICK)	■
39A	10-13-037-004	• SHIM (0.009 INCH THICK)	■
39B	10-13-037-009	• SHIM (0.020 INCH THICK)	■
40	13-08-410-014	• BEVEL GEAR AND OUTPUT SHAFT ◆	1
41	T86-7-1/2	• SNAP RING	1
42	10-00-134-001	• ROLLER BEARING	1
43	13-08-027-003	• BEARING CAP	2
44	9422345	• SPRING PIN (3/16 X 9/16 LONG)	2
45	10-00-141-235	• O-RING	2
46	10-00-113-004	• EXPANSION PLUG (SOME MODELS ONLY)	1

NSS - NOT SERVICED SEPARATELY, BUY NEXT HIGHER ASSEMBLY.

* MATCH PART NUMBER ON IDENTIFICATION PLATE WITH PART NUMBER ON MODEL CHART.

+ REPLACES DIPSTICK 10-06-559-001.

▲ MATCHED SET. INCLUDES FRONT COVER AND CASE.

◆ MATCHED SET. INCLUDES BEVEL GEARS AND SHAFTS.

■ USE AS REQUIRED TO OBTAIN PROPER CONTACT PATTERN.

SPECIAL TOOLS

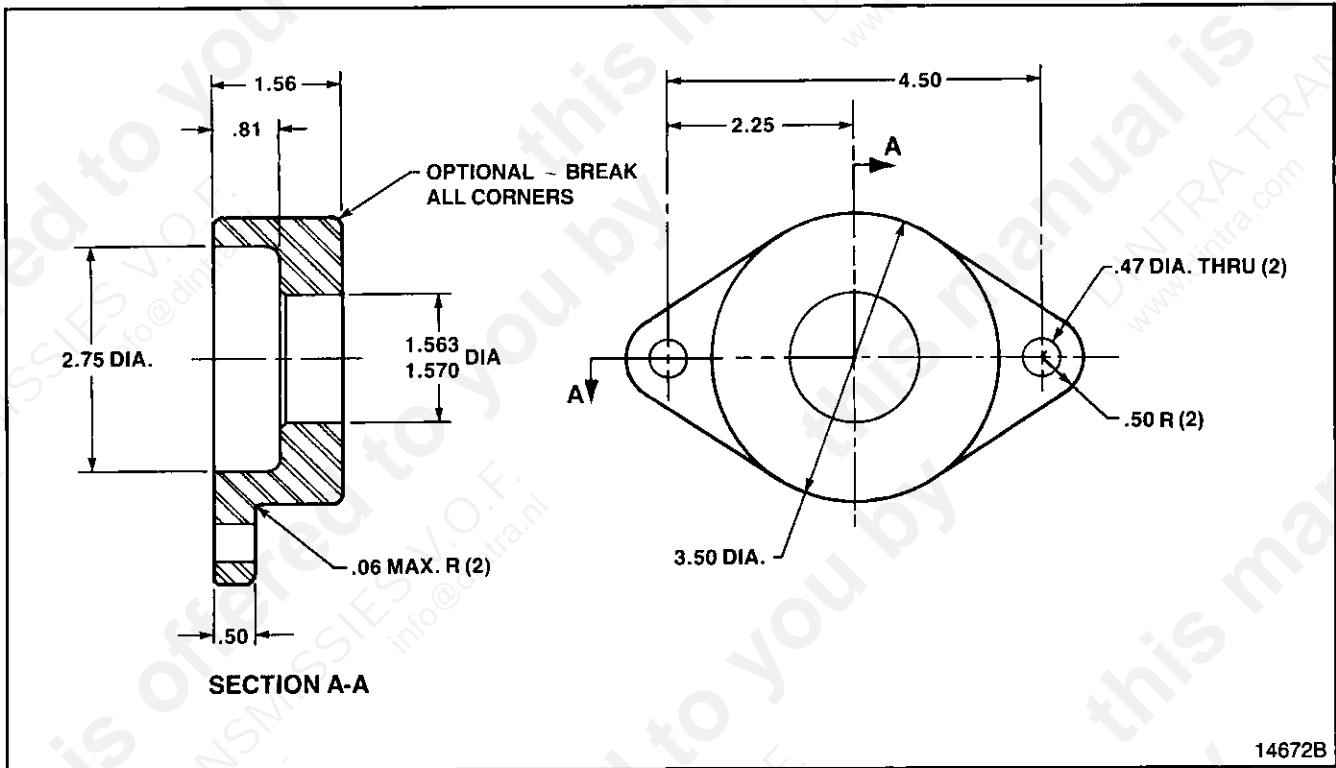


Figure 13. Output Shaft Shim Fixture

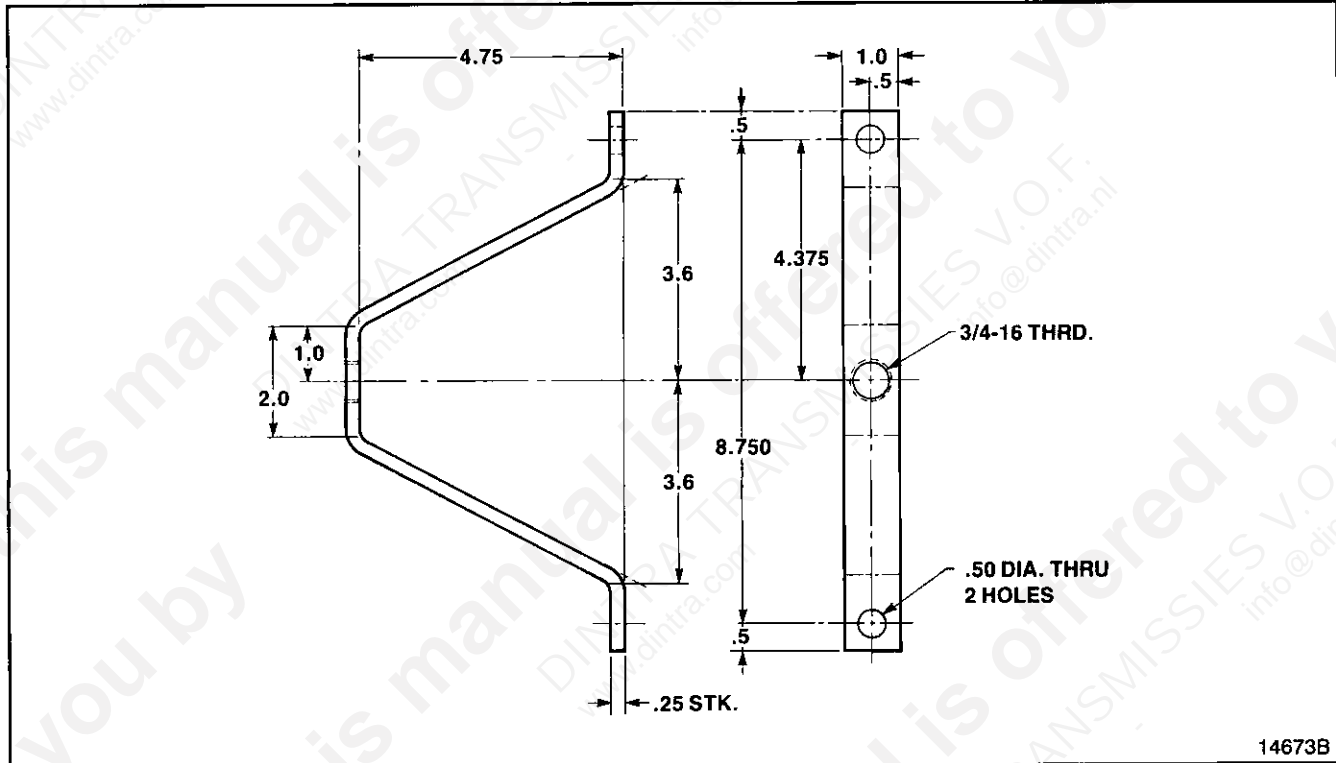


Figure 14. Intermediate Shaft Shim Fixture

SPECIFICATIONS



CAUTION: Threaded plugs, screws, bolts, and coupling nuts must be tightened to torque shown in this table to prevent premature failure of transmission or V-Drive.

Table 4. Bolt and Fastener Torques

PART NUMBER	DESCRIPTION	FT-LB	Nm
9418892	Shift Lever Nut (5/16-24)	8-11	11-15
0000179796	Hex Head Bolt (1/4-20 x 1/2)	8-11	11-15
4775L	Coupling Nut	160-260	217-353
10-00-149-034	Output Shaft Nut	220-260	298-352
0000179864	Hex Head Bolt (7/16-14 x 1-3/4)	42-50	57-68
10-04-034-002	Dipstick Tube	10-40	14-55
13-08-034-001	Dipstick Tube	10-40	14-55
10-00-183-021	Hex Head Bolt (5/16-18 x 1)	17-22	23-30
4911	Capscrew (3/8-16 x 1-1/4)	27-37	37-50
0000444592	Pipe Plug (3/4-14)	10-20	14-28
0000444860	Pipe Plug (1/4-20)	8-11	11-15
0000444866	Pipe Plug (3/8-18)	17-27	23-37
0000444687	Pipe Plug (1/8-27)	7-12	9-16
10-00-640-004	Switch Assembly (9/16-18)	20-30	28-42
4853E	Hex Head Bolt (7/16-14 x 1-1/4)	42-50	57-68
0000179840	Hex Head Bolt (3/8-18 x 1-1/8)	27-37	37-50
10-00-146-001	Stud (7/16-20 x 1-3/4)	50-55	68-75
0009419506	Hex Lock Nut (7/16-20)	50-55	68-75
0000188448	Machine Screw (1/4-20 x 1/2)	8-11	11-15
13-08-027-003	Bearing Cap	125 IN-LB	14

Table 5. Spring Dimensions

PART NUMBER	WHERE USED	APPROX. FREE LENGTH		APPROX. O.D.		DIAMETER OF WIRE		NO. OF ACTIVE COILS
		in.	mm	in.	mm	in.	mm	
71-242	Control Valve +	2.66	67.6	0.78	19.8	0.14	3.6	12
72N-242	Control Valve + +	2.69	68.3	0.78	19.8	0.13	3.3	11
71-42	Poppet	1.0	25.4	0.29	7.4	0.04	1.0	6
71-97	Pressure Plate	1.25	31.8	0.31	7.9	0.05	1.3	11

+ Black Spring used in current production.

+ + White spring used in early production.

Table 6. Test Pressures

PRESSURE TAP	ENGINE RPM	TYPICAL RANGE		TYPICAL RANGE	
		PSI	PSI	kPA	kPA
USE THIS PORTION FOR UNITS WITH BLACK SPRING IN CONTROL VALVE					
Neutral Line	500 2000	115 NOT USED	135 NOT USED	793 NOT USED	931 NOT USED
Reverse Clutch	500 2000	115 125	135 160	793 862	931 1,103
Forward Clutch	500 2000	115 125	135 160	793 862	931 1,103
USE THIS PORTION FOR UNITS WITH WHITE SPRING IN CONTROL VALVE					
Neutral Line	500 2000	90 NOT USED	120 NOT USED	621 NOT USED	827 NOT USED
Reverse Clutch	500 2000	90 100	120 125	621 689	827 862
Forward Clutch	500 2000	90 100	120 125	621 689	827 862

NOTE: Pressures shown are typical at an oil temperature of 140 degrees F (60 degrees C). Variations can occur due to plumbing, fittings, and cooler differences.

NOTE: The forward clutch feed does not have an external tap for checking pressure. When selector is in "F" position, line pressure indicates clutch pressure. Pressure drop from "N" to "F" indicates leakage in forward clutch circuit.

Table 7. Cooler Flow

	RPM	GPM	GPM	LPM	LPM
Reverse Cooler Flow	600 2000	0 3.5	1.8 6.5	0 13.25	6.8 24.6
Forward Cooler Flow	600 2000 3500	0 3.5 6.0	1.8 8.0 10.5	0 13.25 22.7	6.8 30.3 39.7