



ES46-5 & ES56-5

*Service Manual*

*Bulletin No. 2377*

2002



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## Gear Ratios

Gear	ES43-5		ES53-5	
	Ratio	% Step	Ratio	% Step
Rev.	6.77		6.77	
1st	7.25		7.25	
		82%		82%
2nd	3.98		3.98	
		78%		78%
3rd	2.23		2.23	
		55%		73%
4th	1.44		1.29	
		44%		29%
5th	1.00		1.00	

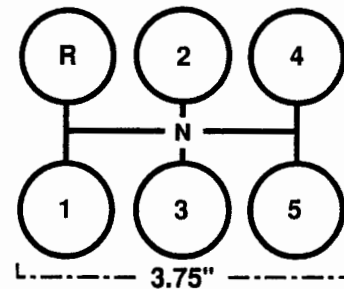
## General Application Guidelines On-Highway Use

	ES43-5	ES53-5
GVW:	35,000 lbs.	50,000 lbs.
HP Range:	180 HP	210 HP
RPM Range:	2,200 - 3,000	
Engine Types:	5 - 9 Liter Diesel	

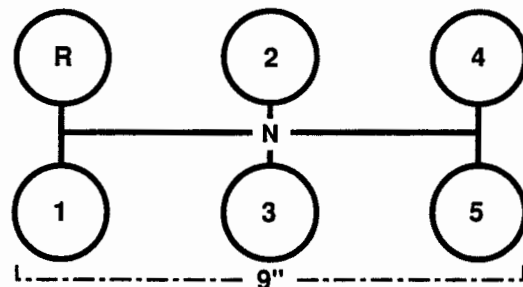
## Specifications

- Torque Capacity . . . ES43-5, 430 lbs. ft. (582 nm)  
ES53-5, 530 lbs. ft. (718 nm)
- Ratio Coverage . . . 7.25:1
- Synchronized . . . . . Gears 2 - 5
- Gearing . . . . . All helical, constant mesh
- Weight . . . . . 325 lbs. (148 kg)
- Length . . . . . 27.05" (clutch housing mounting  
face to washer seat face)
- Lube Capacity . . . . 12 pints (5.7 liters)
- Output . . . . . 2" 38-involute spline
- Input Shaft . . . . . ES43-5: 1 3/8" or 1 1/2"  
10 spline  
ES53-5: 1 1/2" or 1 3/4"  
10 spline
- Clutch Housing . . . SAE No. 2, apron front available  
for gas
- Clutch . . . . . Spicer 13" or 14" single or  
2-plate push or pull
- Power Take-Off . . . 6-bolt right & left standard,  
countershaft rear optional  
A-Ratios: 48% eng. speed,  
6-pitch, 32 teeth  
D-Ratios: 48% eng. speed,  
6-pitch, 34 teeth
- Speedometer . . . . . Specify mechanical or electronic

## Gimbal Tower Shift Pattern



## Standard Tower Shift Pattern




TORQUE SPECIFICATIONS FOR NUTS AND CAP SCREWS				
Nom. Size (Dia.) Inches    mm		Part Name	Wrench Torque (ft. lbs.) Min.        Max.	
<b>Cap Screws</b>				
.375	10	Oil trough (16 x .750)	25	41
.375	10	Rear shift bar support (16 x 1.00)	25	41
.375	10	Front mainshaft bearing cap (16 x 1.00)	25	41
.375	10	Rear mainshaft bearing cap (16 x 1.125)	25	41
.375	10	Rear countershaft bearing cap (16 x 1.125)	25	41
.375	10	Clutch housing to main case (16 x 1.25)	25	41
.375	10	Front shift bar support (16 x 2.250)	25	41
.438	11	Rear mainshaft brake cap (14 x 1.25)	40	56
1.062	27	Shift tower trunnion	100	125
<b>Miscellaneous</b>				
.875	23	Backup light switch	40	40
1.250	32	Mainshaft output	300	325
.375	10	6 bolt PTO (16 x .750)	25	41



## Synchronizer Information

A synchronized transmission helps the driver make clash-free shifts. These transmissions are not synchronized in first and reverse gears because these gears are normally selected when the vehicle is stationary. No synchronizing of engine speed and road speed is required to get in gear from a stop. In fact, a synchronizer could cause hard shifting in these two gear positions because a synchronizer needs a gear rotation to do its job. To use the synchronizer properly and receive the benefits of clash-free shifts, you should understand how it works.

When a shift is required, the operator declutches and moves the lever toward the desired gear. When the synchronizer ring makes contact with the desired gear, the blockers automatically prevent the shift collar from completing the shift until the gear and mainshaft speeds are matched. At that time, the blocker neutralizes automatically and the clash free shift is the result. It must be noted that a steady pressure on the shift lever helps the synchronizer do its job quickly. When synchronized, the lever moves into gear smoothly and easily.

 **Do not jab at the synchronizer or “tease” it by applying pressure and releasing pressure.** The synchronizer won't be able to do its job. It takes a second or two to match speeds and constant pressure—not stabbing—assures faster synchronizer action. It is possible to override a blocker if the lever is “forced” into gear. However, this defeats the purpose of the synchronizer and can cause gear clash which can damage the unit.

## Driver Instructions

Depress the clutch. Wait for complete clutch release, then move the shift lever into 1st gear. Accelerate to an RPM that will allow enough momentum to select the next higher gear and still have vehicle acceleration after completing the shift into 2nd gear. This is using the progressive shift technique. It saves fuel. There is usually no reason to go all the way to the governor before you shift to second. This method can vary depending on the GVW of the vehicle, road condition, and type of service.

When second speed is desired, declutch and move the lever towards second gear. Keep a steady pressure on the lever. The synchronizer will pick up 2nd gear and synchronize its speed to the mainshaft speed. When synchronized, the lever moves easily into 2nd. Continue in the same manner to top road speed. Notice as you approach the top speed, you must accelerate closer to the governed speed before you allow the engine to drop to the next gear shift point to have good performance. This is because air resistance at higher speeds requires more of the available horsepower to get adequate performance. You receive maximum performance and horse power at governed speed.

When you downshift, the same procedure for shifting the transmission will be used, except that the engine RPM will be raised to the governor as the clutch is engaged after completing the shift. In top gear as you approach the shift point (normally the shift starts about 100 RPM over the shift point), declutch and move the shift lever with a steady even pressure toward 4th gear. The synchronizer will pick up 4th gear and speed it up to vehicle speed. This allows a clash free shift from 5th speed gear to 4th.


After the shift, reengage the clutch. At the same time, accelerate the engine to keep the vehicle moving at the desired speed. If further downshifts are required, continue in a similar manner. Remember that when downshifting into 1st gear, 1st gear is not synchronized and will require a double clutch operation to complete a clash-free shift.

You can double clutch on all shifts if desired. This only helps the synchronizer to its job by manually matching the engine speed and road speed.

## Replacement Parts

The exploded views of subassemblies which are incorporated in this manual are for the mechanic's convenience and show the latest material. The parts are arranged in their correct order and may also be used as a reference for assembly or disassembly of this unit.

## Lubrication

 **To insure proper lubrication and operating temperatures in this unit, the proper lubricants must be used.** Correct oil levels must be maintained. Spicer recommends using only lubricants produced by reputable, well-known suppliers. If you want to use a lubricant not specified below, please contact your local truck dealer to determine whether the lubricant is suitable for your purposes.

### Recommended Lubricants

The lubricants listed below are recommended for use in all Spicer mechanical transmissions, auxiliaries, and transfer cases.

### Oil Changes

Spicer recommends an initial oil change and flush after the transmission is placed in actual service. At the time of first engine oil change, the transmission should also be serviced. In off-highway use, the change should be made after 24 hours—but before 100 hours—of service have been completed.


Many factors influence the following oil change periods. Therefore, a definite mileage interval is not specified here. In general, a drain and flush should be scheduled at 50,000 mile

or one-year intervals. Off-highway uses usually require an oil change every 1,000 hours. The oil level in the transmission should be checked every 5,000 miles (8045 km) on-highway, or every 40 hours in off-highway operation. When it is necessary to add oil, Spicer recommends that types and brands of oil not be mixed. The correct oil level in this transmission is established by the filler plug opening.


### Refill

First, remove all dirt around the filler plug. Then refill the transmission with new oil. Use the grade recommended for the existing season and prevailing service. The lubricant should be level with the oil fill plug located on the right side of the transmission case.

### Overfilling

 **Do not overfill the transmission.** This usually results in oil breakdown due to excessive heat and aeration from the churning action of the gears. Early breakdown of the oil will result in heavy varnish and sludge deposits that plug up oil ports and build up on splines and bearings.

TEMPERATURE	GRADE	TYPE
Above 0°F (-18°C) Below 0°F (-18°C)	SAE 30 or 40 SAE 30	Heavy duty engine oil meeting MIL-L-2104 D or MIL-L-46152 B, API-SF, or API-CD (MIL-L-2104 B & C, or 46152 are also acceptable)
Above 0°F (-18°C) Below 0°F (-18°C)	SAE 90 SAE 80	Straight mineral gear oil R & O type API-GL-1
All	CD SAE 50 CD SAE 30	Synthetic engine oil meeting MIL-L-2104 D or MIL-L-46152 B, API-SF or API-CD

 **Do not use extreme pressure additives such as those found in multi-purpose or rear axle type lubricants.** These additives are not required for this unit and may, in some cases, create transmission problems. Multi-purpose oils, as a group, have relatively poor oxidation stability, a high rate of sludge formation, and a greater tendency to react on or corrode the bronze parts in this transmission.

## Important Procedure

To locate and correct unit power or auxiliary transmission troubles, a systematic procedure should be followed.

Road test whenever possible. Mechanics usually get second- or third-hand reports of trouble experienced with the unit. These reports do not always accurately describe the actual conditions. Sometimes symptoms seem to indicate trouble in the transmission, while actually the problem is with the axle, driveshaft, universal joints, engine or clutch. This is especially true of noise complaints. Therefore, before removing the transmission or related components to locate trouble, road test to check the possibility of trouble in other closely associated units. Road testing is most effective when the mechanic drives the vehicle. However, riding with the driver can be very informative.

## Check Functioning Prior to Disassembly

If a remote control is used, a careful check of the remote and connecting linkages (and their adjustment) must be made. The remote unit must be in good working order if the transmission is expected to shift satisfactorily.

Many times, the answer to the trouble is apparent when the unit is inspected prior to disassembly. But this evidence is often lost when the parts are separated. If possible, check the unit prior to disassembly. Bear in mind that a careful inspection of the unit should be made as each disassembly step is performed.

## Inspect Thoroughly During Disassembly

It is poor practice to disassemble a unit or the complete transmission as quickly as possible without examining the parts. The mechanic may completely disassemble a unit and fail to find the cause of the trouble, unless he examines the parts. After the transmission is disassembled, check the lubricant for foreign particles. This is a source of trouble often overlooked during the disassembly.

## Repair or Replace Worn Parts

Many times the parts or critical adjustments causing the trouble are not replaced or corrected because the mechanic only inspects and replaces parts that have failed completely. All pieces should be carefully examined because broken parts are often just the result—not the cause—of the problem. All parts that are broken or worn and no longer meet specifications should be replaced.

Also, parts that are worn to the extent that they do not have a long service life remaining should be replaced. Replacing these parts now will avoid another teardown on the unit in the near future. Also at this time, make the recommended changes or modifications to bring the transmission up to date and increase the service life of the unit.

**!** Read this section before starting the detailed disassembly procedures. Follow each procedure closely in each section, making use of both text and pictures.

## Rebuild Facilities

A suitable holding fixture or overhaul stand with a hole for the input shaft is desirable.

For easier working conditions, table height should be 28 - 30 inches. A light chain hoist should be used to handle the mainshaft and countershafts during removal and reassembly procedures.

## Cleanliness

Transmissions should be steam cleaned prior to disassembly. Seal all openings before steam cleaning to prevent entry of dirt and water which can damage serviceable parts.

Dirt is abrasive and will cause premature wear of bearings and other parts. Spicer suggests that mechanics have a wash tank available to clean parts just prior to reassembly.

## Bearings

When a transmission is removed at relatively low mileage, bearings should be removed with pullers designed for this purpose. Wrap the bearings to keep out dirt. Clean, inspect, and lubricate all bearings just prior to reassembly. If accumulated mileage is over 150,000 miles, we suggest that all bearings be replaced. If bearings are worn or damaged, always replace them regardless of mileage.

## End Yokes and Flanges

**⊘** Do not hammer on end yokes and flanges to remove or install them. It is not only destructive to the yoke or the flange itself, but can also cause serious internal damage. Hammering destroys or mutilates the pilot diameters and warps or bends the flange. Hammering on end yokes will close-in the bearing bores or misalign yoke lugs. This will result in early failures of journal needle bearings.

Serious damage can be done internally to bearings, thrust faces and washers, pilot bearings, etc., by hammering on external parts. In most designs, when the yoke/flange locknuts are tightened and secure, the internal bearings and gears are in proper location. When the yoke/flange is driven on the shaft, however, two conditions can exist.

- (a) If the bearing fit is tight on the shaft, usually the bearings will brinell as they must absorb the pounding force.
- (b) If the bearing fit is loose, the shaft will keep moving inward until it is stopped by the internal parts such as the pilot bearing thrust washers.

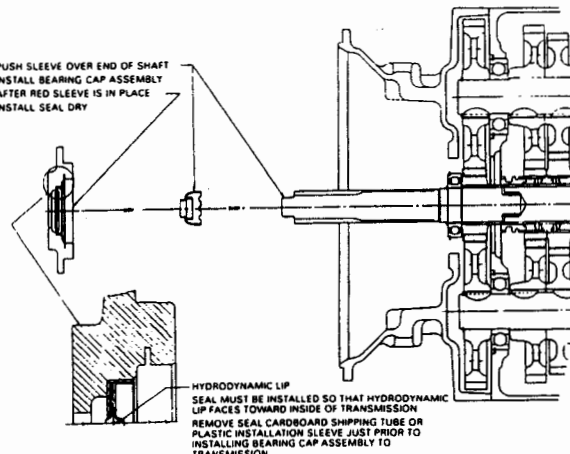
## Power Take-Offs

Refer to your owner's manual and installation procedures when installing any PTO on your transmission.

## Front Bearing Retainer & Seal

**!** When installing the front bearing retainer and seal in the transmission, use the red plastic sleeve to prevent serious damage to the oil seal. Failure to use the seal sleeve will void the seal warranty.

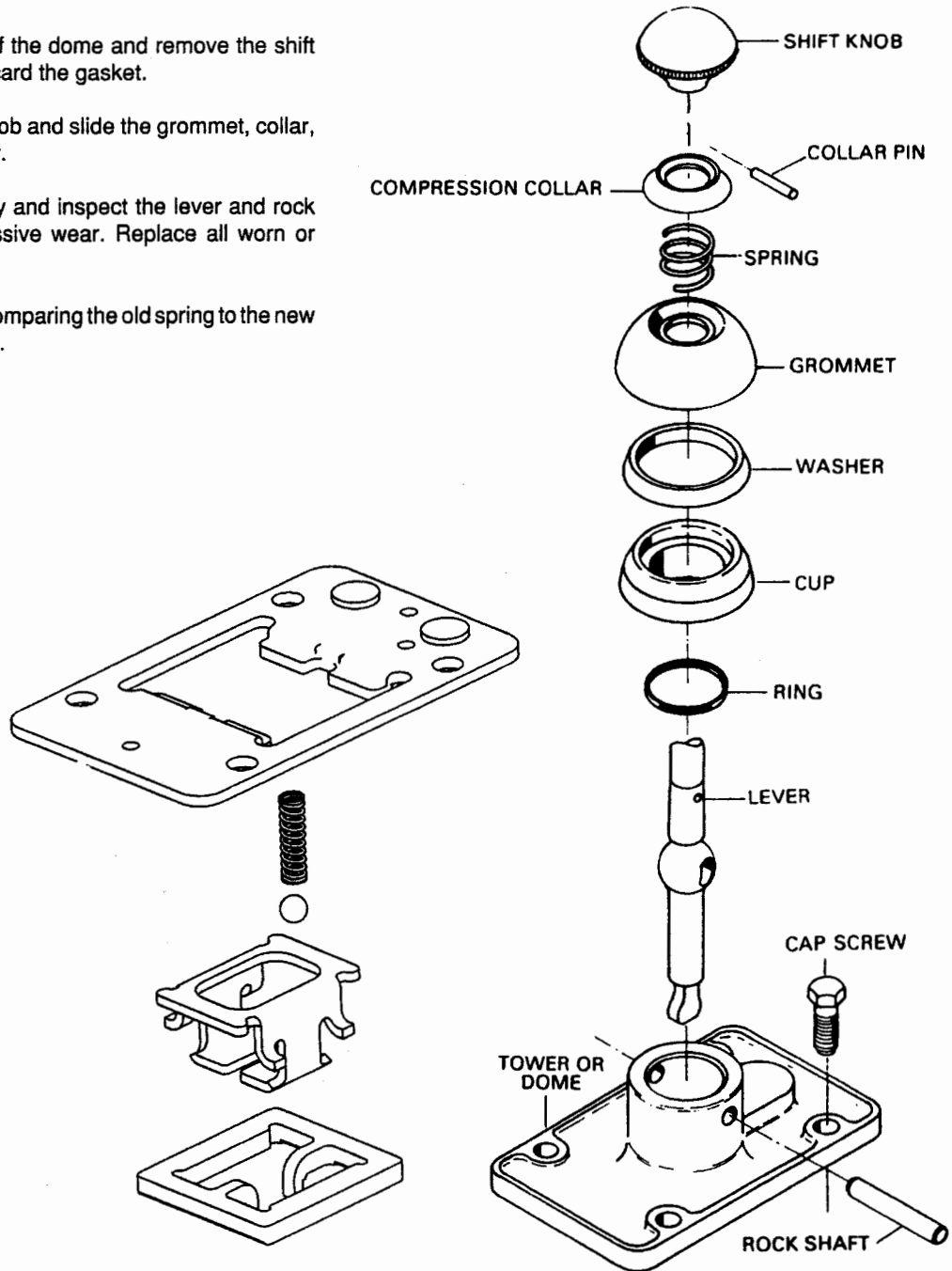
PUSH SLEEVE OVER END OF SHAFT  
INSTALL BEARING CAP ASSEMBLY  
AFTER RED SLEEVE IS IN PLACE  
INSTALL SEAL DRY



HYDRODYNAMIC LIP  
SEAL MUST BE INSTALLED SO THAT HYDRODYNAMIC  
LIP FACES TOWARD INSIDE OF TRANSMISSION  
REMOVE SEAL CARDBOARD SHIPPING TUBE OR  
PLASTIC INSTALLATION SLEEVE JUST PRIOR TO  
INSTALLING BEARING CAP ASSEMBLY TO  
TRANSMISSION

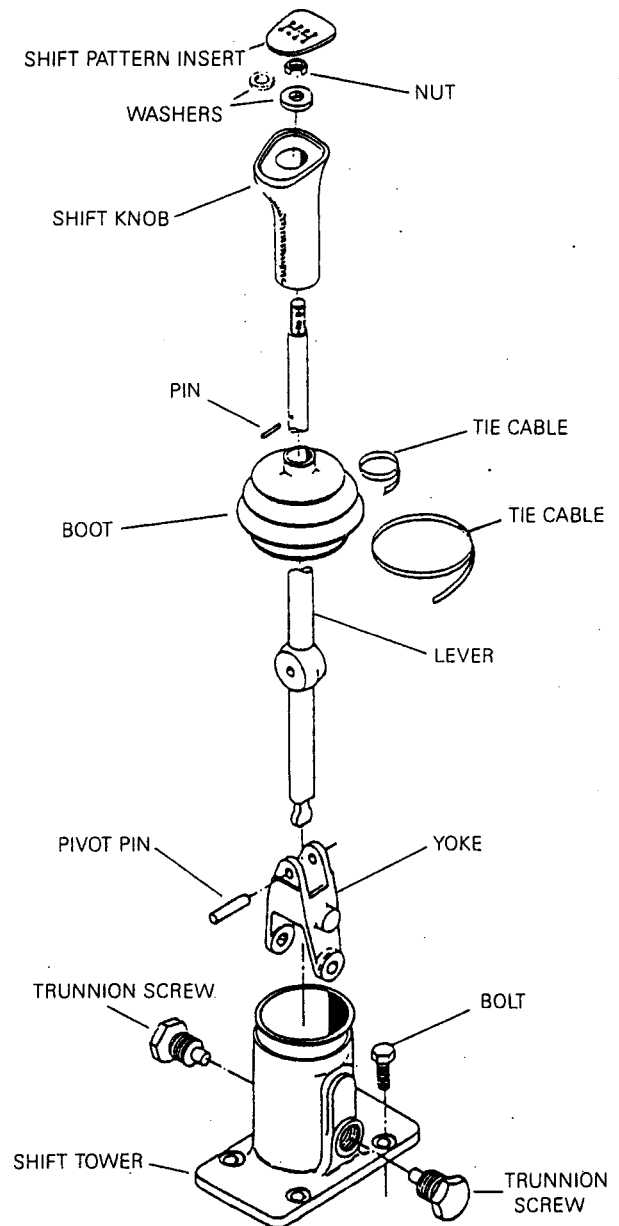
## Standard Shift Tower

1. Remove the retaining cap screws and lock washers.
2. Position the shift lever dome on edge in a vise.
3. Pull up the grommet. Press the collar against the spring, then remove the lock pin.
4. Slide the compression cup up the shift lever and remove the rock shaft snap ring.
5. Tap the rock shaft free of the dome and remove the shift lever. Now remove and discard the gasket.
6. Remove the shift lever knob and slide the grommet, collar, spring, and cup off the lever.
7. Wash all parts thoroughly and inspect the lever and rock shaft cross holes for excessive wear. Replace all worn or damaged parts.
8. Check spring tension by comparing the old spring to the new one. Replace it if necessary.



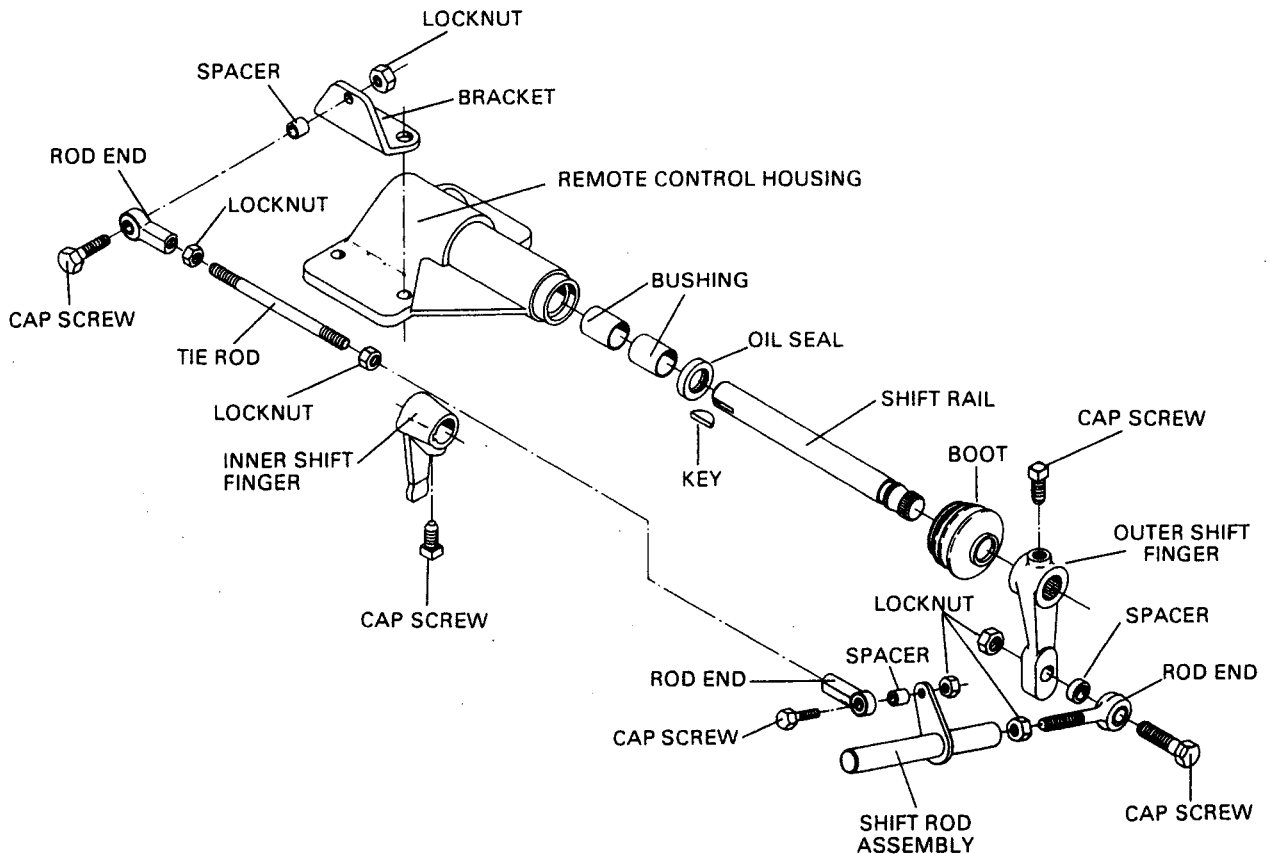
## Gimbal Shift Tower

1. Begin disassembly by cutting the two tie cables which secure the boot.
2. Slide the boot off the shift lever.
3. Remove the two trunnion screws.
4. Lift the lever from the tower.
5. To remove the shift yoke from the lever, simply press out the pivot pin.
6. Wash all parts. Inspect them thoroughly for damage. Replace all worn or damaged parts.

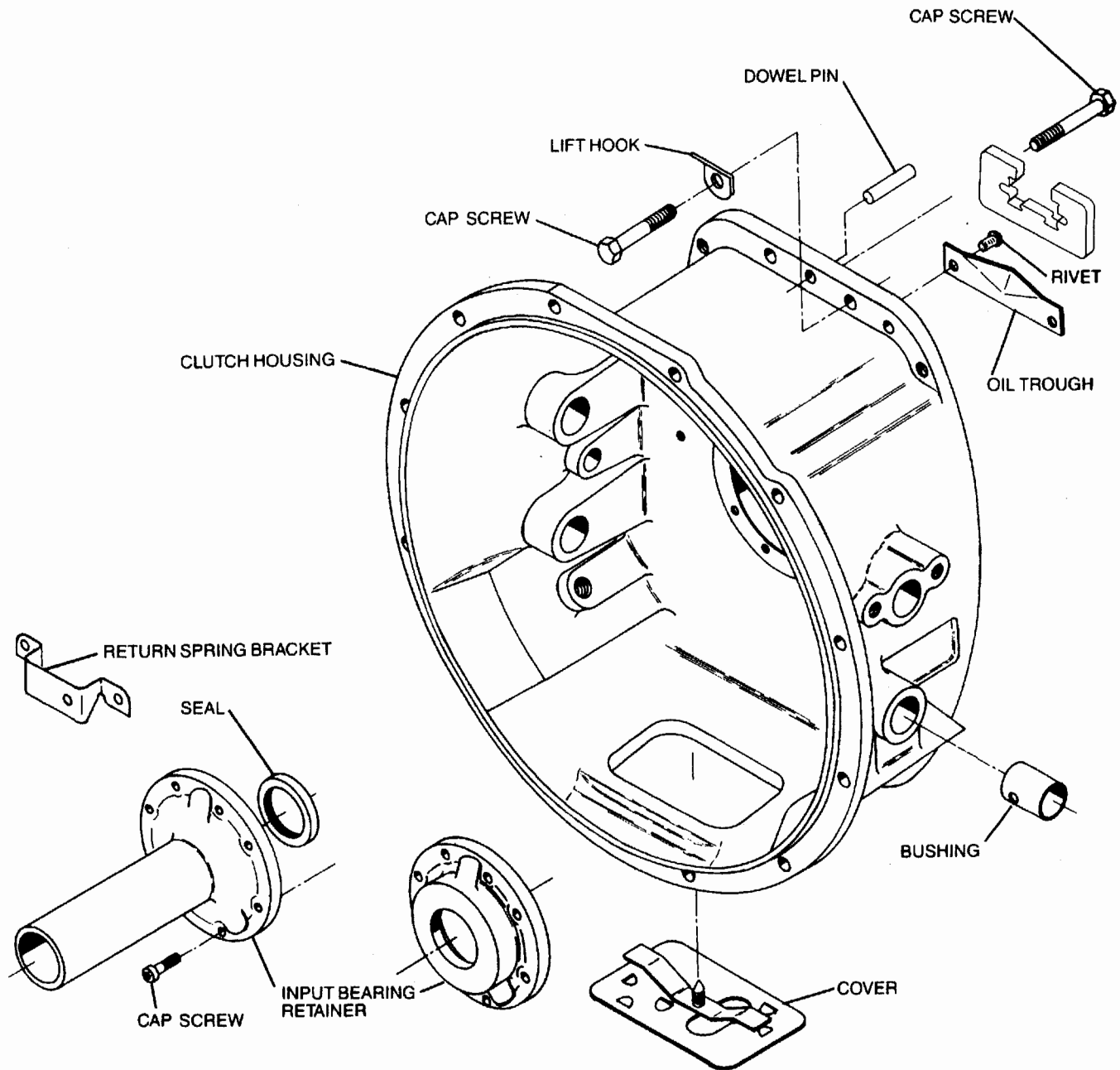


## Remote Control

1. Remove the cap screws and separate the remote control from the shifter housing.
2. Remove all retaining cap screws and locknuts from the rod ends.
3. Continue to disassemble the remote housing subassembly, if necessary.
4. Remove the lock wire from the rubber boot.
5. Remove the inner shift finger, cap screw, shift finger, and key.
6. The shift rail subassembly may now be removed.
7. After removing the cap screw, the outer shift finger can be removed.
8. The oil seal and internal bushings are all that remain.

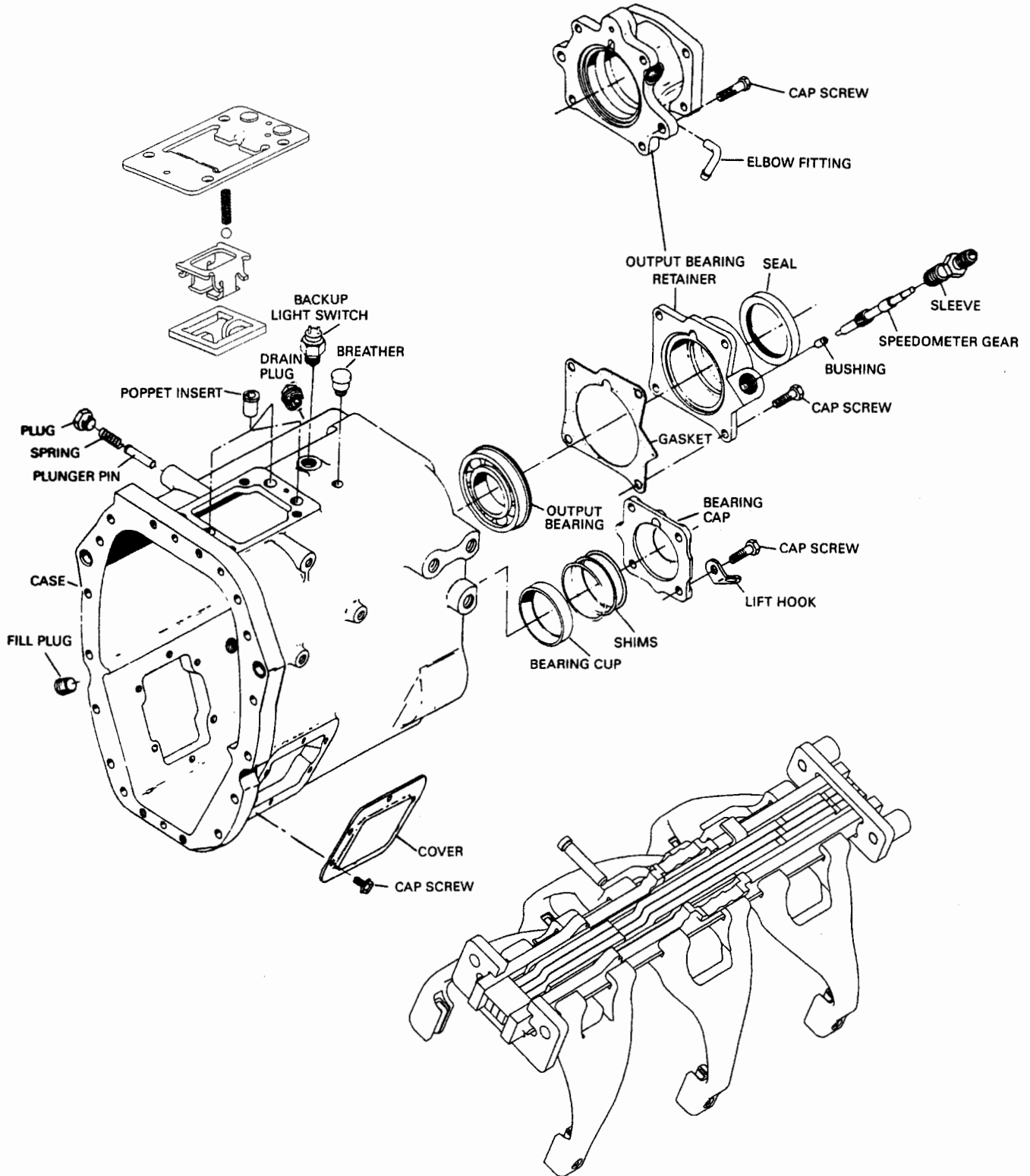


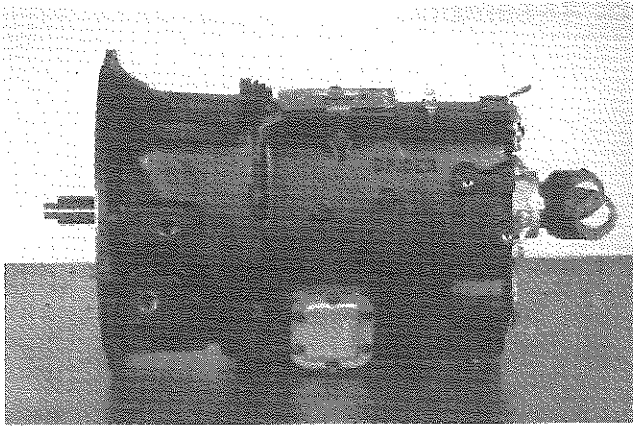
**Clutch Housing**




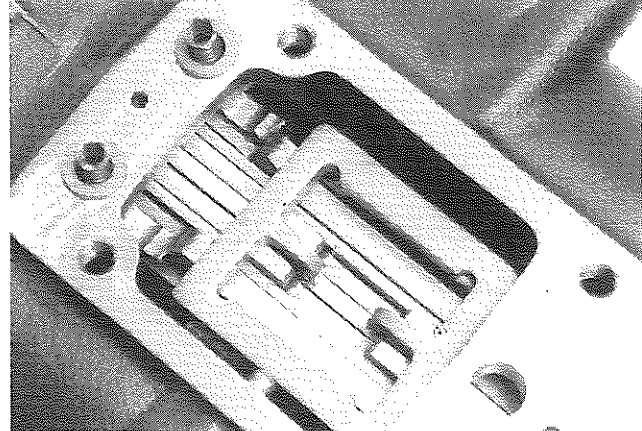


**Case Group & Fork Assembly**

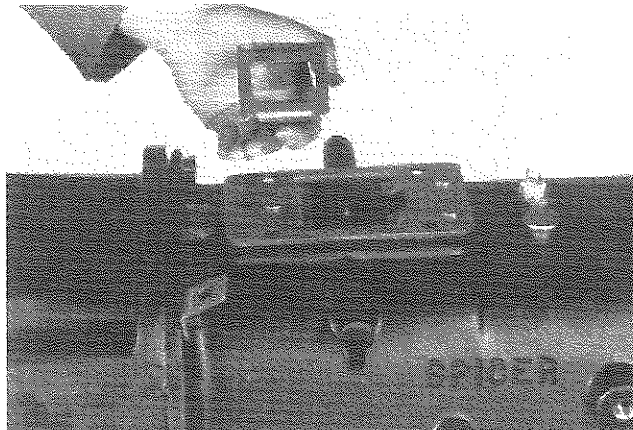




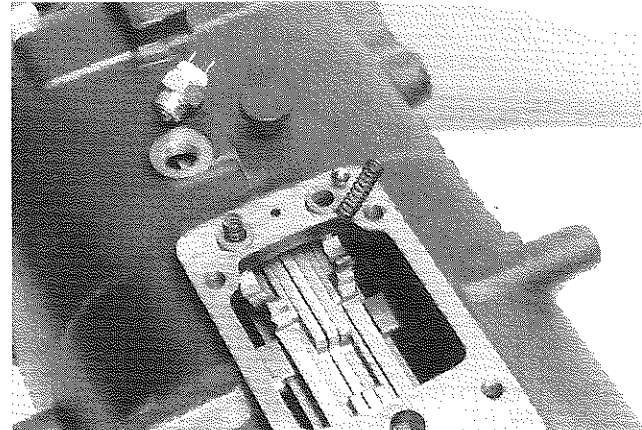
1. After removing the unit from the vehicle, let the transmission cool down before draining the fluid.  This will help protect you against possible burns.



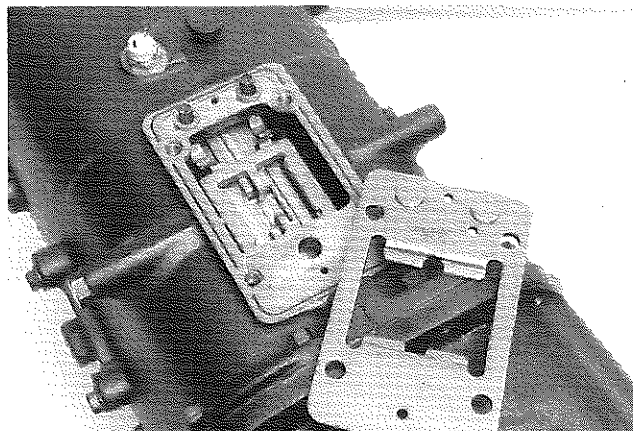
4. Remove inner interlock slide.



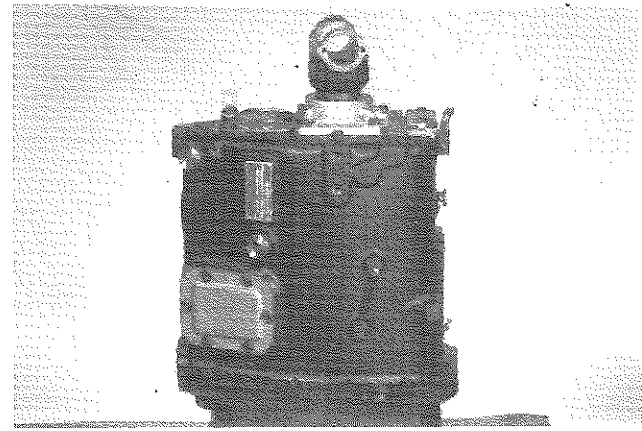
2. Remove the interlock.



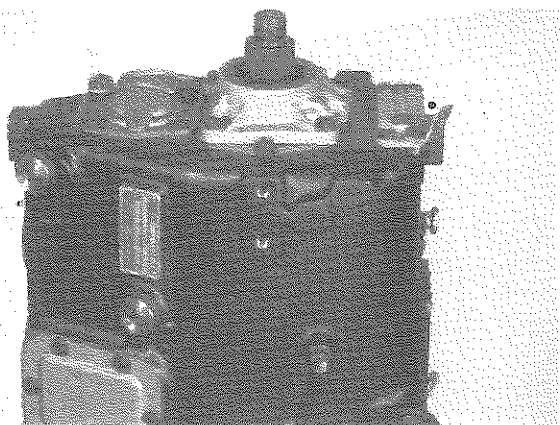
5. Remove the two poppet springs and balls. If they are worn or damaged replace them during reassembly. Also remove the backup light switch.



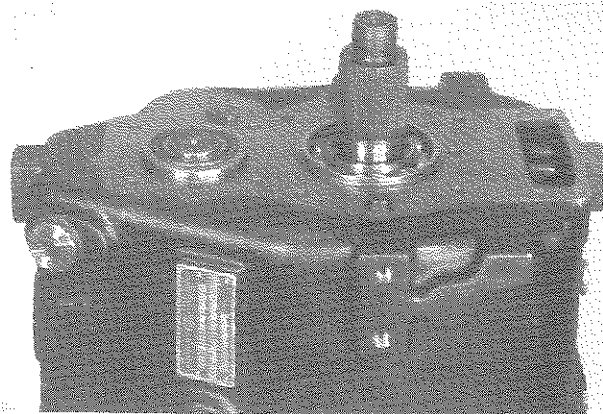
3. Remove the interlock retaining plate and gasket. The two drive pins securing this plate are required during initial manufacturing only. Not for service rebuilds.



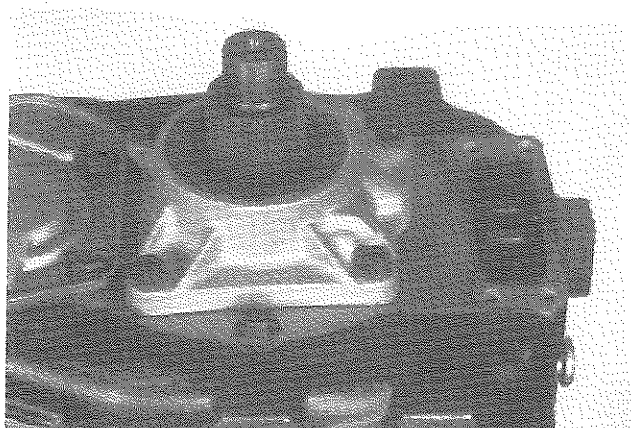
6. Using a chain hoist, stand the transmission on a suitable workbench.



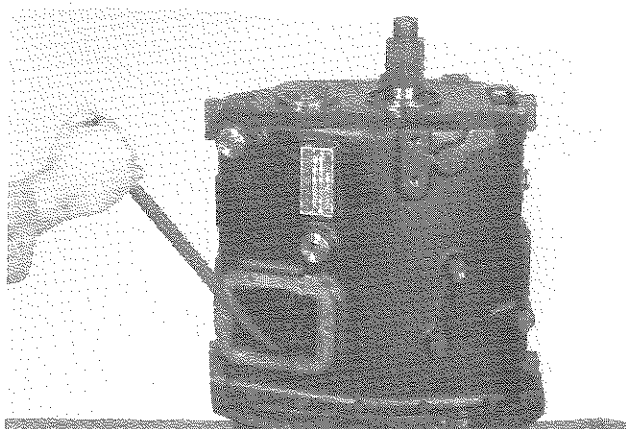
7. Remove the nut, washer, and end fitting.



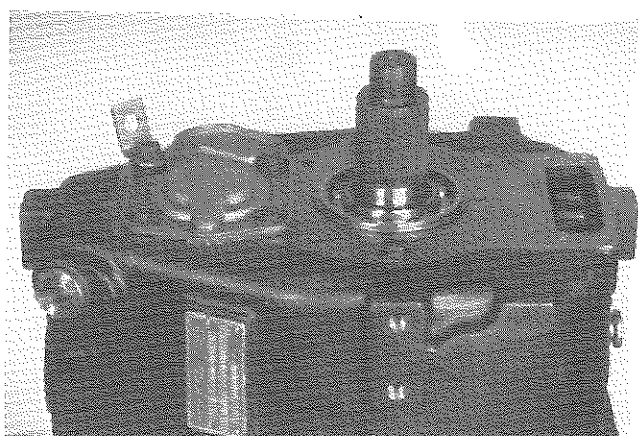
10. Remove the rear countershaft bearing cap and shims.



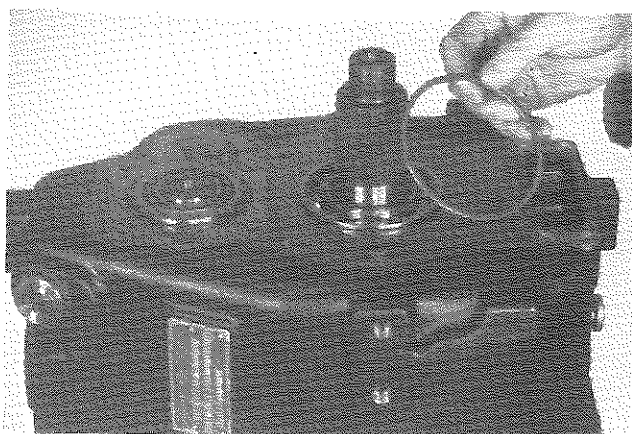
8. Remove the rear shift bar support cap.



11. Remove the PTO aperture cover and use a pry bar to gently lift up on the countershaft gear. This will make the next step easier.



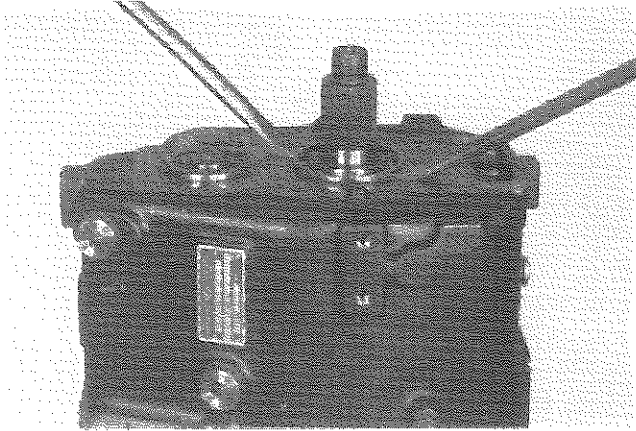
9. Remove the output bearing cap, gasket, and speedometer gear.



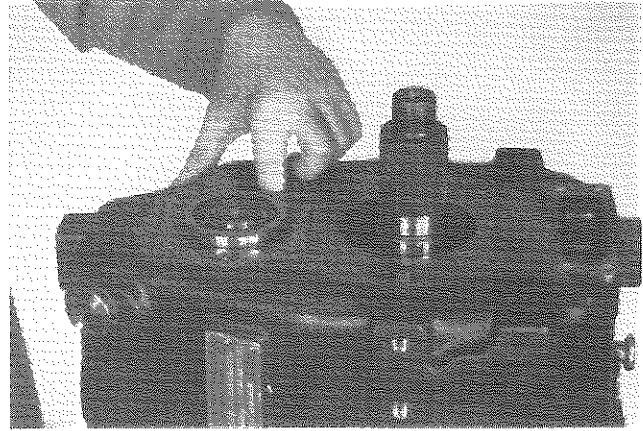
12. **Wearing safety glasses, continue by removing the output bearing snap ring.**



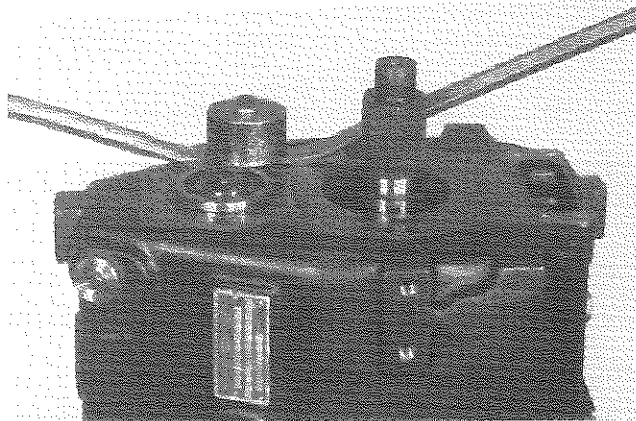




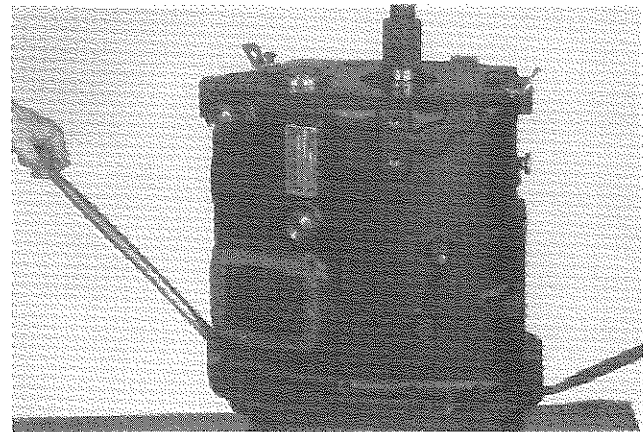
13. Use either a puller or pry bars in the snap ring groove to remove the output bearing. **Do not pry on the top of the countershaft.** If you do, it will damage the countershaft bearing race.



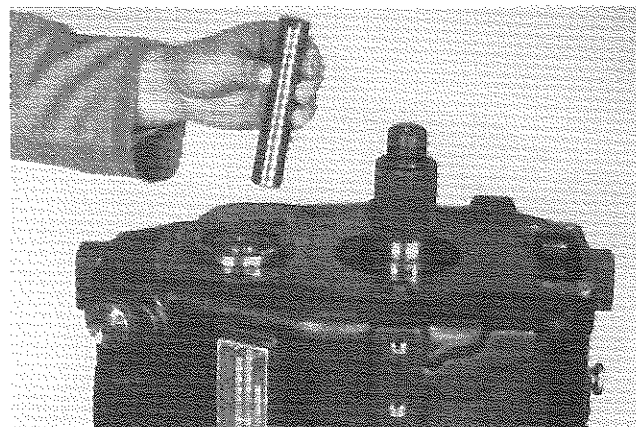
16. Remove the clutch housing-to-case cap screws. Then use your finger or a screwdriver to move reverse idler gear to the side of the case.



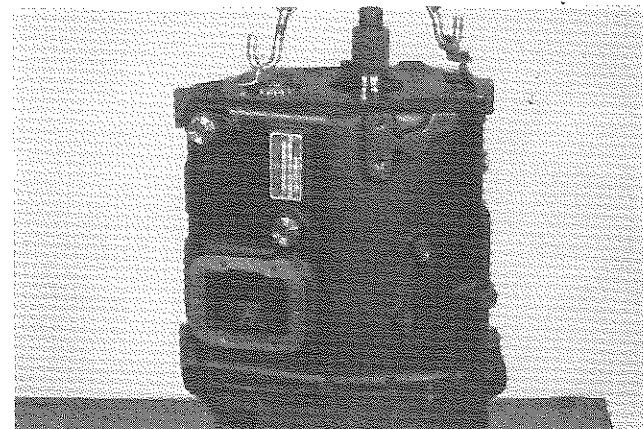
14. Insert a 3/8" bolt with a prying fixture into the reverse idler shaft as shown here.



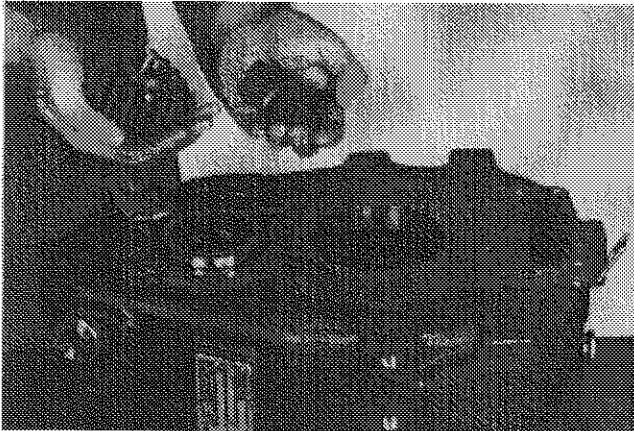
17. Use pry bars in the milled case slots to break the housing seal.



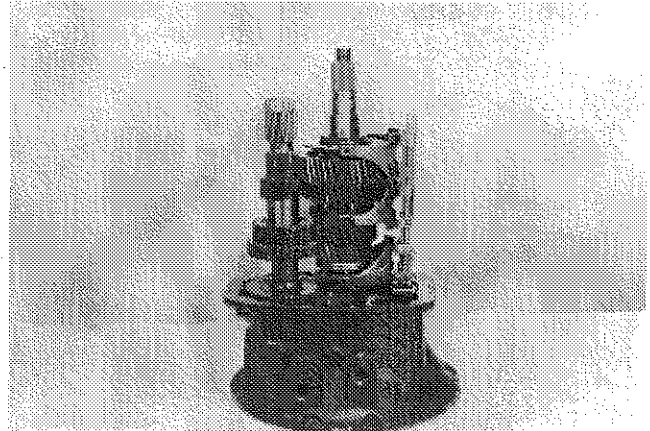
15. Remove the reverse idler shaft.



18. **Using a chain hoist, remove the case from the clutch housing.** Be careful when lifting the case. The reverse idler gear rests loosely on a ledge in the housing and could fall out.



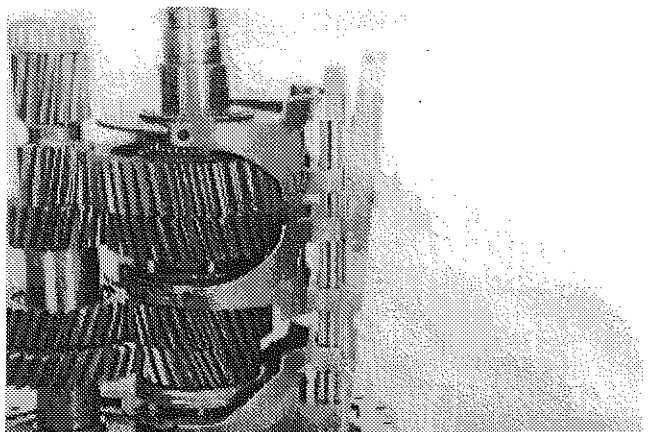
19. Remove the reverse idler gear from the case. Remove the two caged needle bearings and the spacer from the gear.



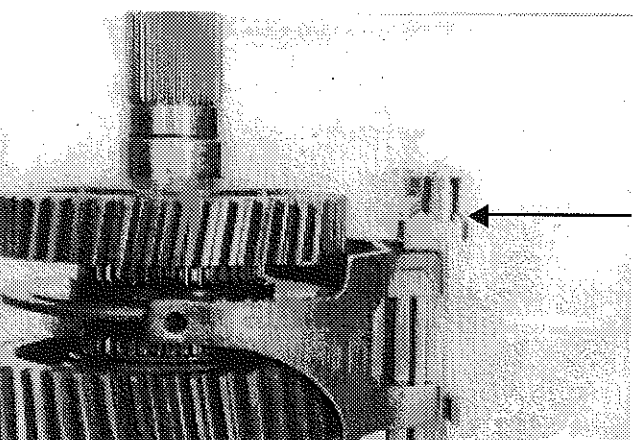
22. Remove the thrust washer, reverse gear and bearing.



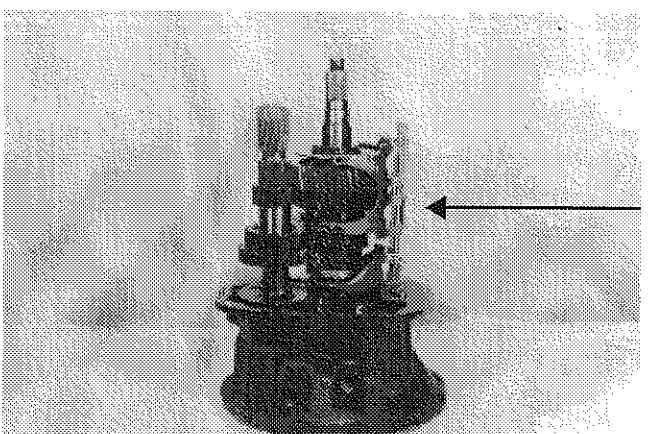
20. Remove the rear countershaft bearing race. The easiest way to do this is to tap it out from the inside of the case. Use a brass punch.



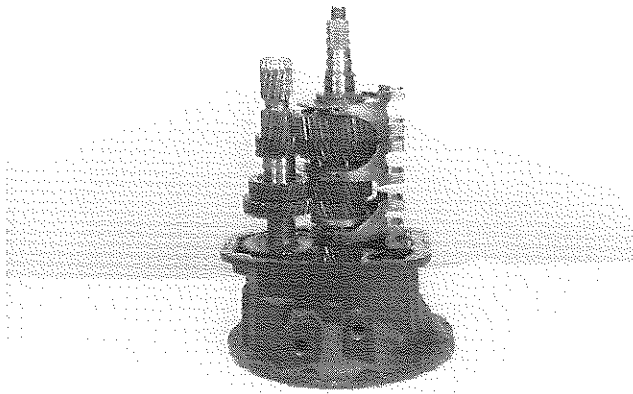
23. Remove the three shift rails and two half rails from welded shift rail assembly.



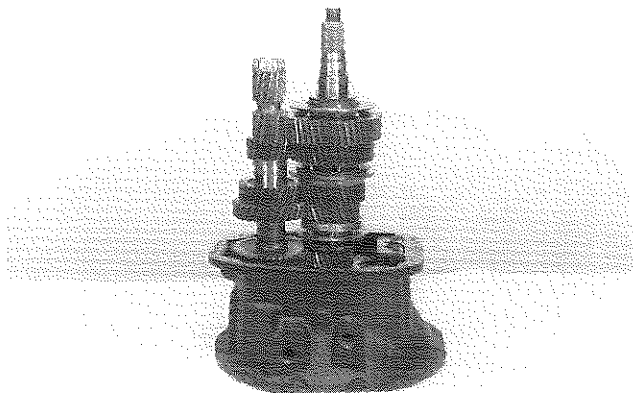
21. Remove the rear shift bar support bracket.



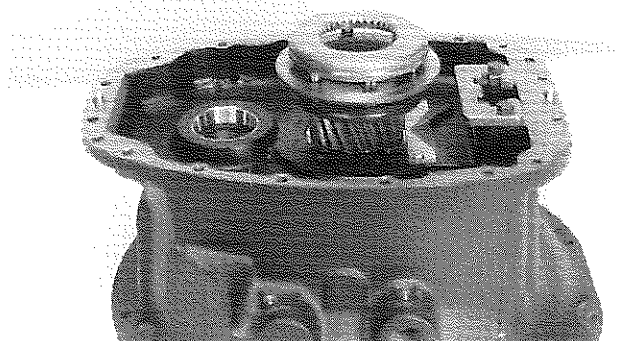
24. Remove the welded shift rail assembly. Install the welded shift rail assembly.



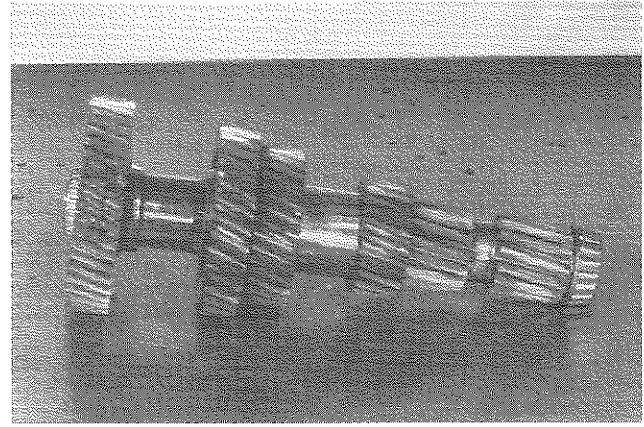
25. Remove three shift forks.



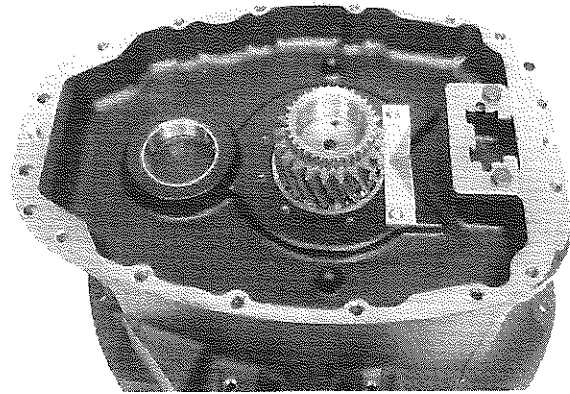
26. Using a lifting fixture and chain hoist, lift the mainshaft sub assembly from the 4th and 5th speed synchronizer.



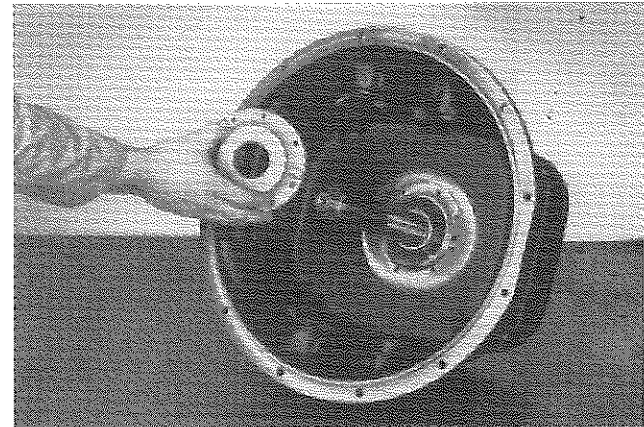
27. Remove the countershaft sub assembly using a chain hoist.



28. Remove the snap ring, then press the gears off the countershaft starting with the drive gear. Any time you use a press, consider placing a shield between you and the press. The countershaft uses rolled involute splines instead of woodruff keys to secure the gears.



29. Remove the 4th and 5th speed synchronizer assembly. The front shift bar support bracket and the front countershaft bearing race can stay in the case unless they are damaged and need to be replaced. Replace the front counter shaft bearing race if the bearing case is replaced.

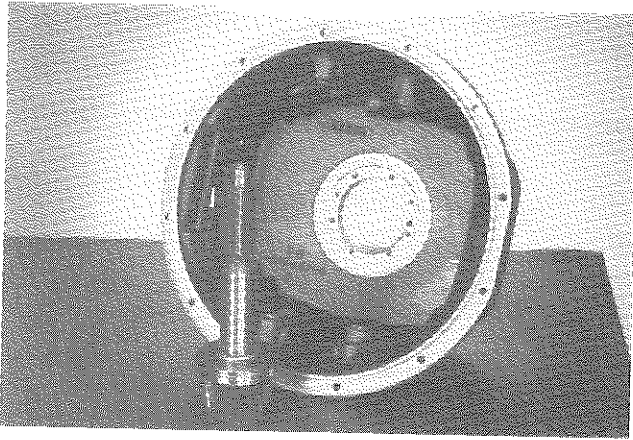


30. Remove the input bearing cap. If it sticks, tap on the side of the cap with a rubber mallet to loosen it.

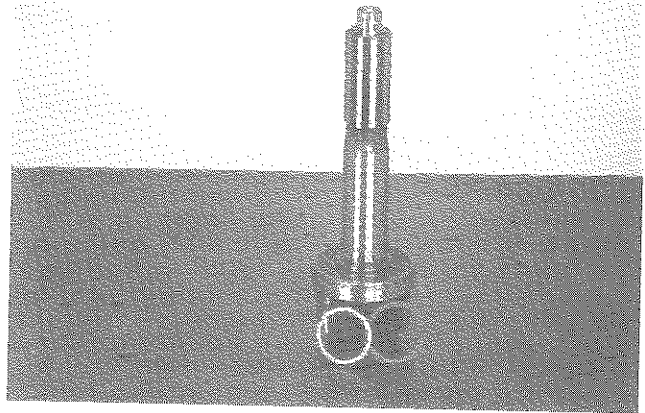


# CASE DISASSEMBLY

# SECTION IV



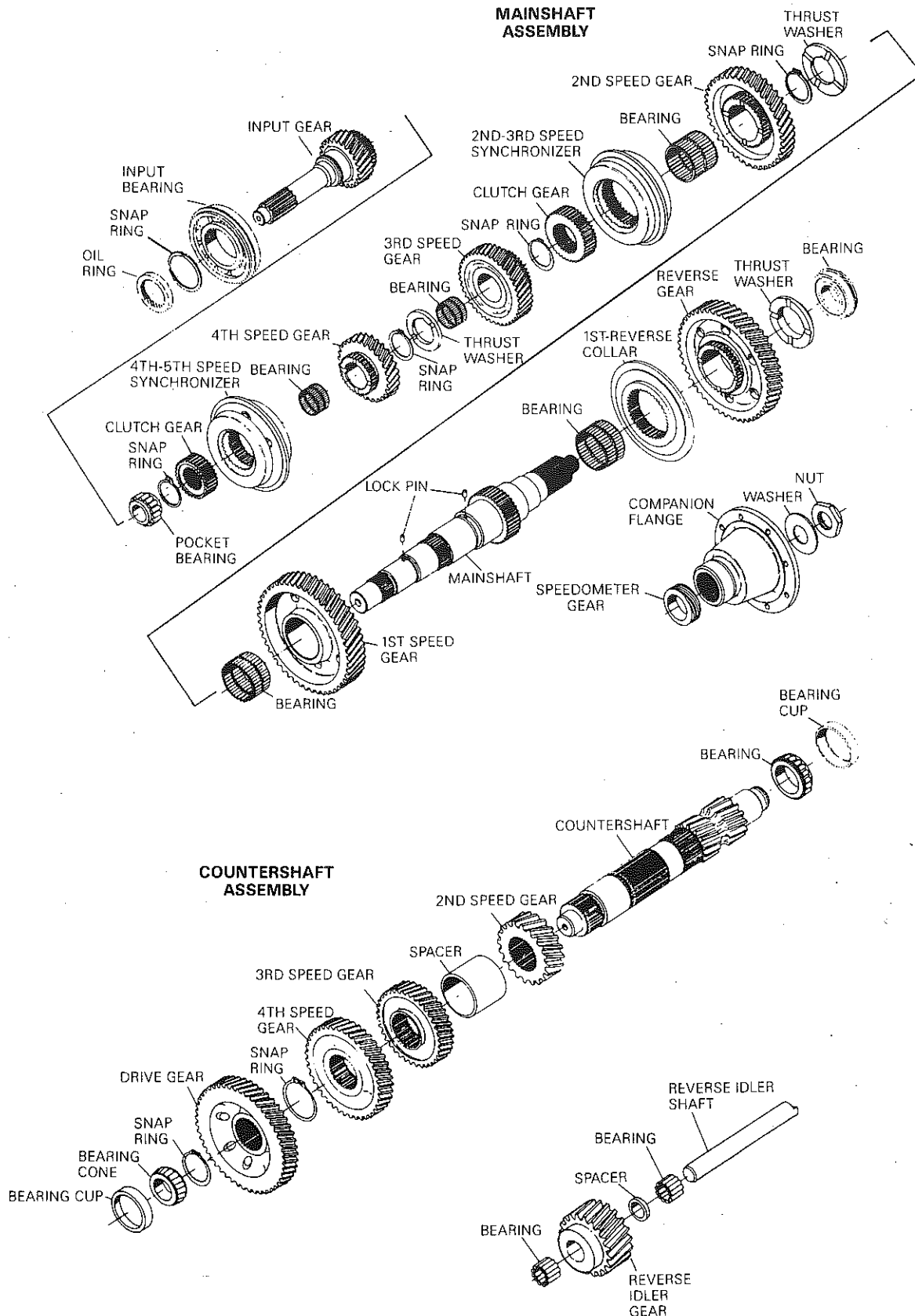
31. Remove the input gear by tapping it with a rubber mallet.



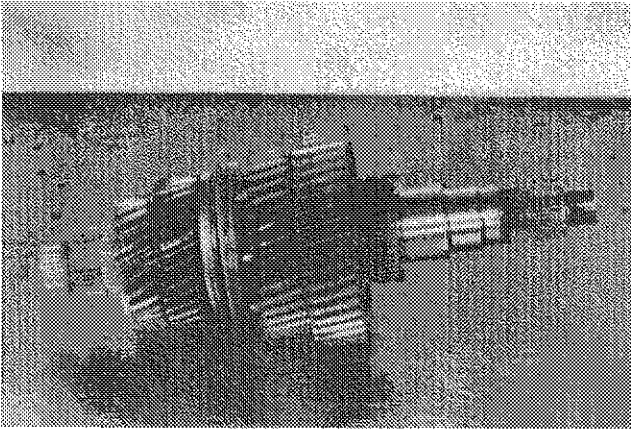
32. **Wearing safety glasses, remove the oil sling and snap ring. Then press the shaft through the bearing.** Case disassembly is now complete.



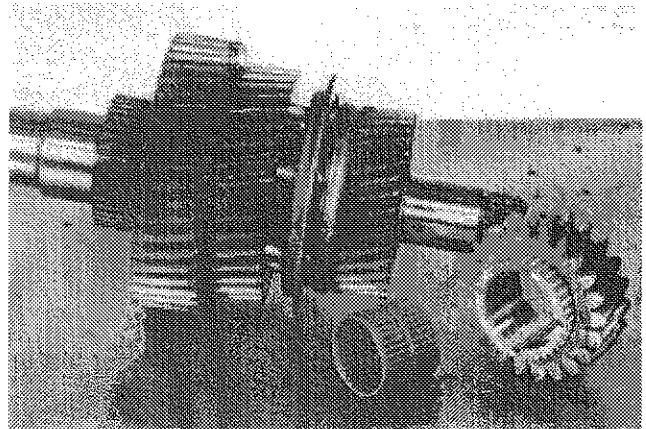
## Gear Group



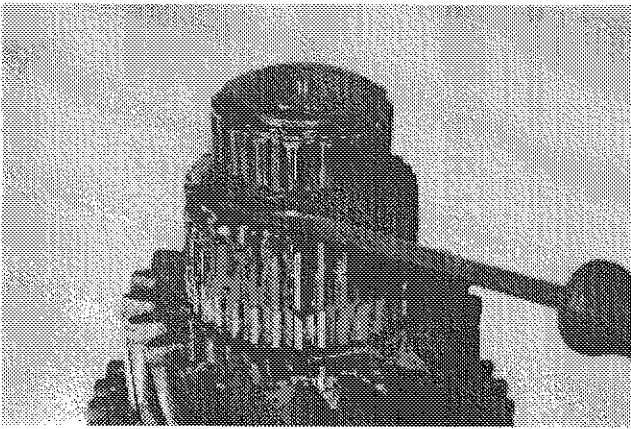




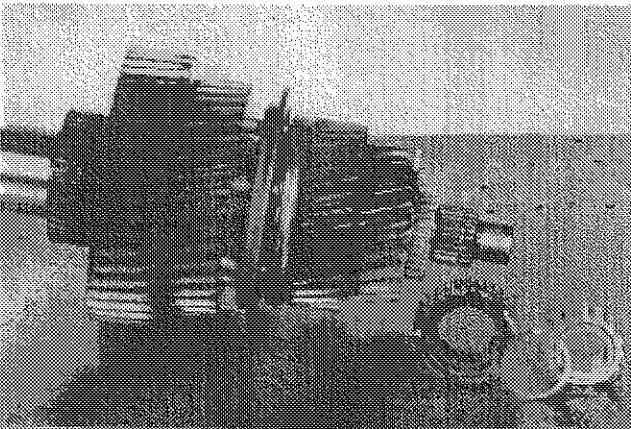
1. Place the mainshaft subassembly on a bench.



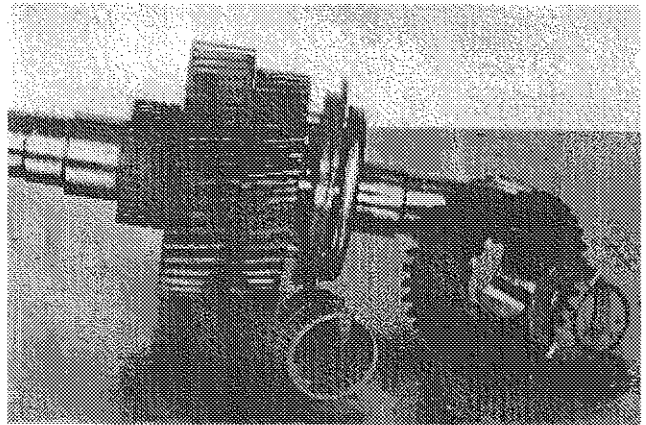
4. Remove the 4th speed gear and caged needle bearing.



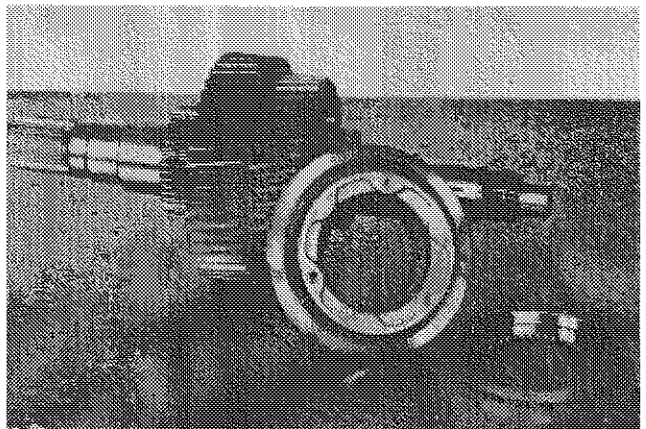
2. **Wearing safety glasses, remove the spiral snap ring from the groove.** The easiest way to do this is to place a screwdriver under one end and work it around the snap ring.



3. Next attach a puller to the 4th - 5th speed clutch gear. Remove the pocket bearing, spiral snap ring, and clutch gear together.



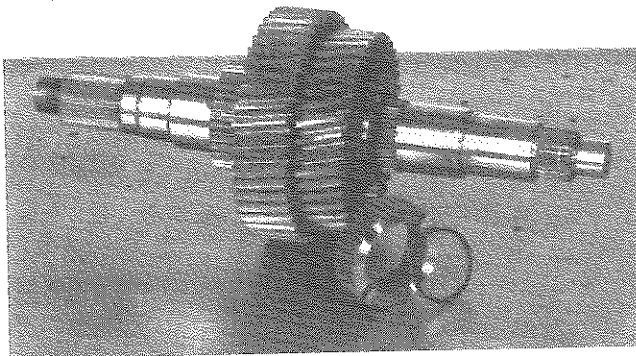
5. Next remove the snap ring, thrust washer, lock pin, 3rd speed gear, and the caged needle bearing.



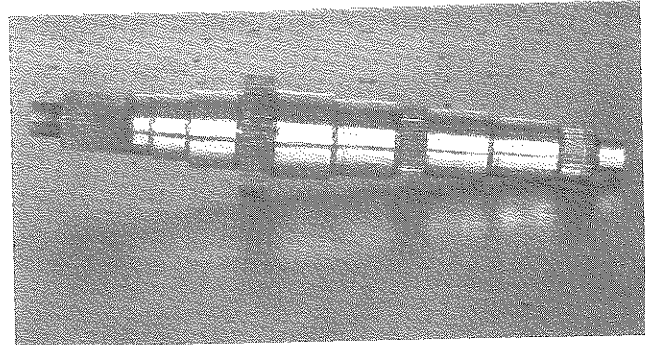
6. Remove the 2nd - 3rd speed synchronizer.

# MAINSHAFT DISASSEMBLY

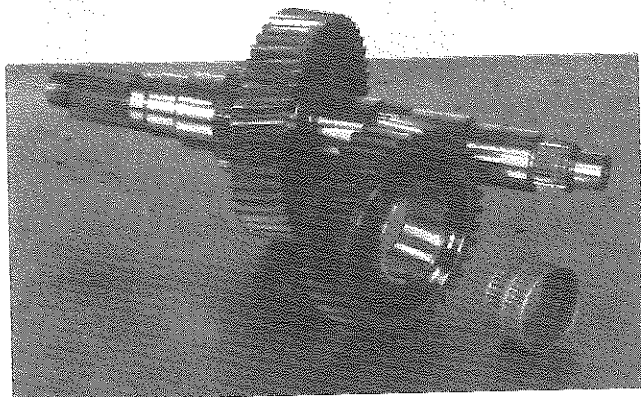
# SECTION V



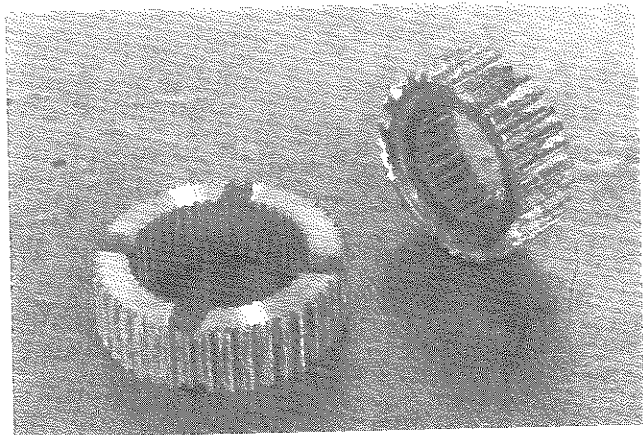
7. Remove the snap ring and 2nd - 3rd speed clutch gear.



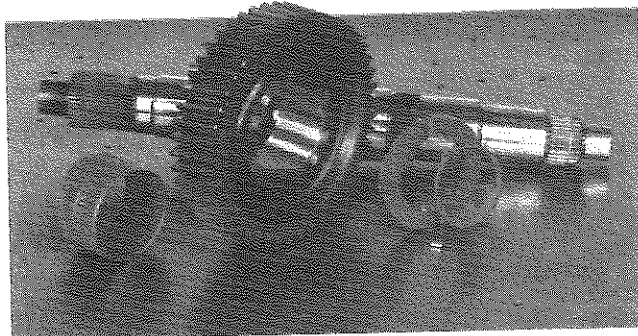
10. The mainshaft uses caged needle bearings under all gears.



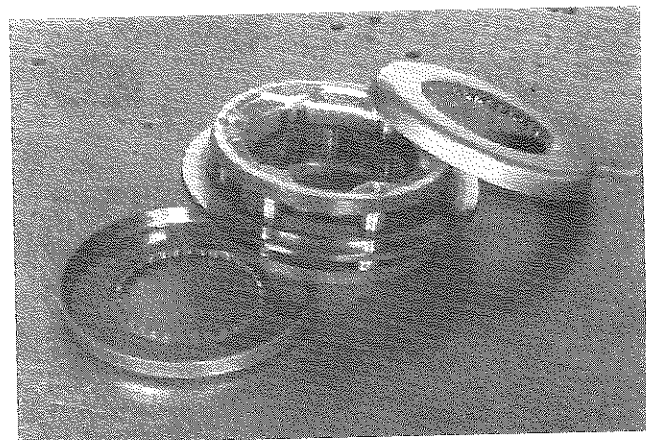
8. Remove 2nd speed gear and the caged needle bearing from the mainshaft.



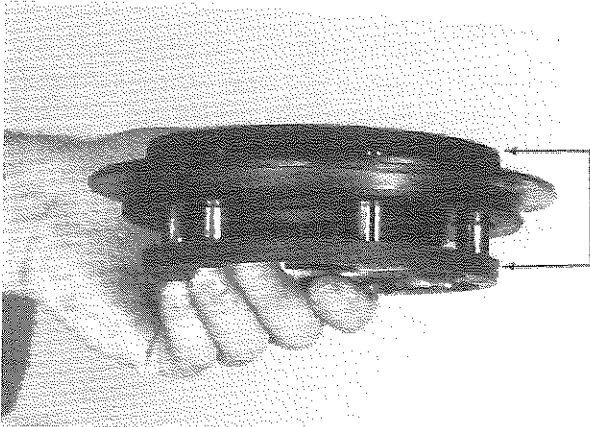
11. The clutch gears — not the mainshaft — contain the gear locks. The only exception to this is the 1st-reverse mainshaft clutch gear which contains gear locks.



9. Remove the snap ring, thrust washer, lock pin, 1st speed gear, and the caged needle bearings. Remember to wear safety glasses during service.



12. The synchronizers have separate clutching rings.





13. The brass synchronizer outer race diameters are coated with GYLON® friction material for smoother shifting.




## Cleaning

Prior to reassembly, wash all parts thoroughly.

 **Use a petroleum-based solvent.** Refer to the solvent manufacturer's safety precautions to prevent personal injury or transmission damage.

 **Do not use water or steam to clean internal components.** If you do, it could cause corrosion of these components.

 **Do not use gasoline to clean parts.** Gasoline can explode, causing serious physical injury.

Dry the parts immediately with compressed air. Coat them with lubricant if they are to be reassembled immediately. If the parts are to be stored, coat them with a rust inhibitor and wrap them to keep contamination out.

Inspect parts thoroughly for wear or damage. Parts damaged or worn from previous service must be replaced to insure maximum rebuild life. Suggested inspection procedures include the following.

## Inspection

### Clutch Collars

Both the internal and external teeth must have sharp edges. Check for chipped or broken teeth, or teeth with rounded corners. Also, examine fork slots for wear. Replace collars if any of these conditions exist.

### Gears

Examine for broken or cracked operating and clutching teeth. Also check for any unusual wear patterns. If any of the preceding exists, replace the gear. If a gear must be replaced, also remember to replace its mating gear.

## Thrust Washers

Check for flatness, excessive face wear, cracks, scoring, or signs of heat damage. Replace if any one of these conditions exists.

## Snap Rings

New snap rings are recommended with every rebuild.

## Mainshaft

Check for signs of twisting or misalignment, and for worn or damaged splines. Also check for brinnelled bearing journals and any discoloration due to excessive heat. Replace the shaft if any of these conditions exists.

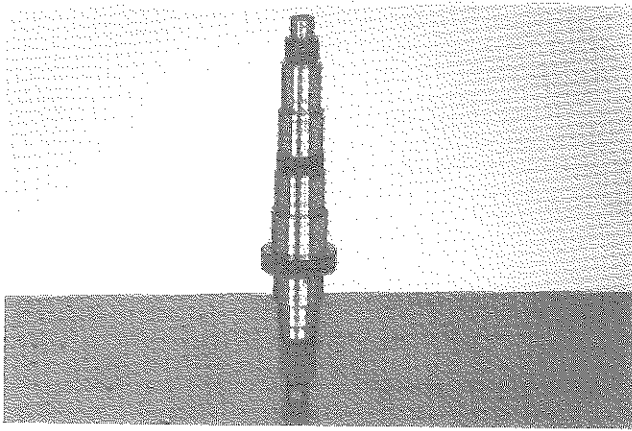
## Bearings

New bearings are recommended with every rebuild. (See "*General Disassembly—Bearings*" for further information.)

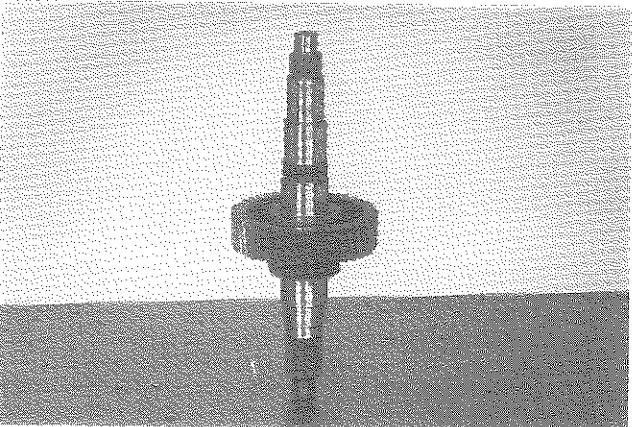
## Housings

Inspect the housing sections for cracks. If cracks exist, replace that section of the housing. Also inspect the shift bar support bracket for cracks or worn slots. Replace if either of these conditions exists.

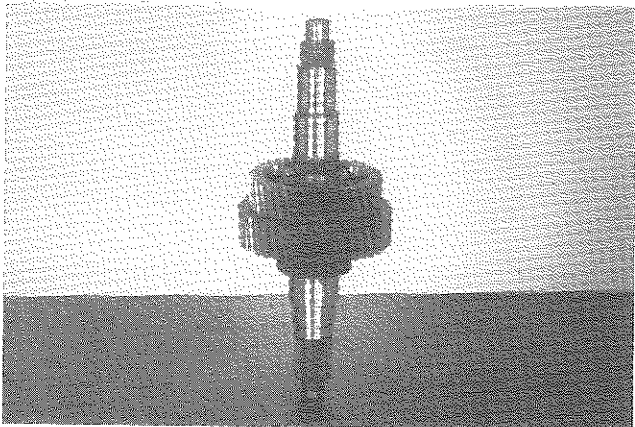




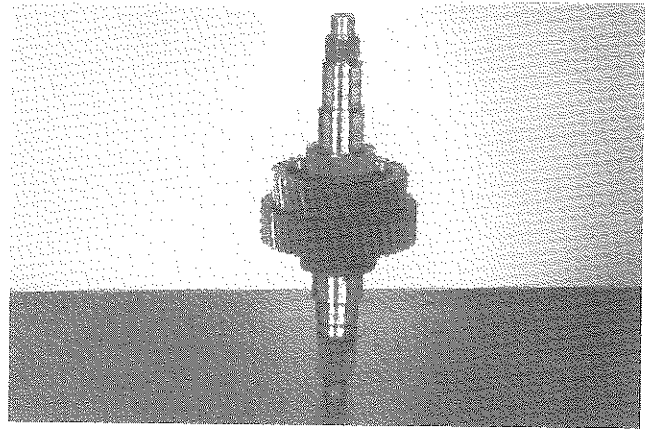
1. Begin reassembly by placing the mainshaft in an upright position. **Also at this time, coat all bearings (inside diameters and outside diameters) with Moly #2 grease.** This will help protect them the first time the unit is placed back in service.



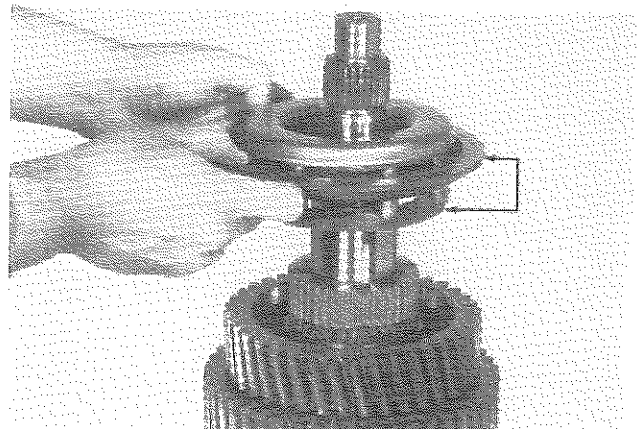
2. Assemble the lubricated caged needle bearing, 1st speed gear (clutching teeth down), lock pin, and lubricated thrust washer. Secure them with a snap ring with the flat side against the washer. **Remember to wear safety glasses.**



3. Place the lubricated caged needle bearing and 2nd speed gear onto the shaft. The clutching teeth should face up.



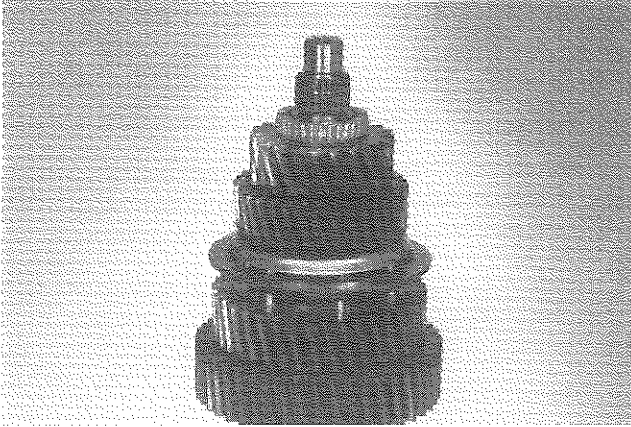
4. Lubricate both sides of the reversible 2nd - 3rd speed clutch gear, then install it. **Secure it with a snap ring.** The flat side of the snap ring should face the gear.



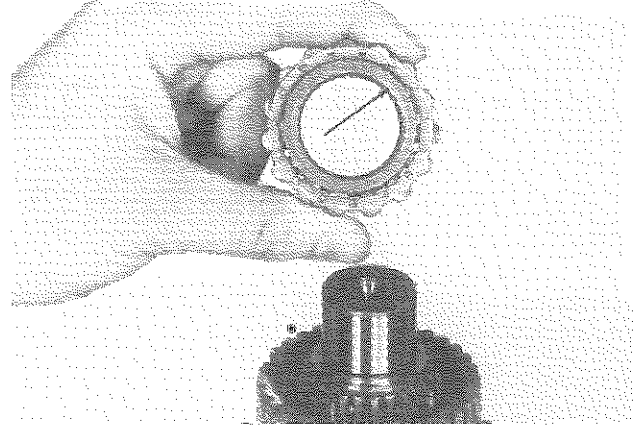
5. Place oil on the synchronizer outer diameters. Then install the synchronizer. **The longest synchronizer side should face 2nd gear when the synchronizer is in neutral (see photo).**



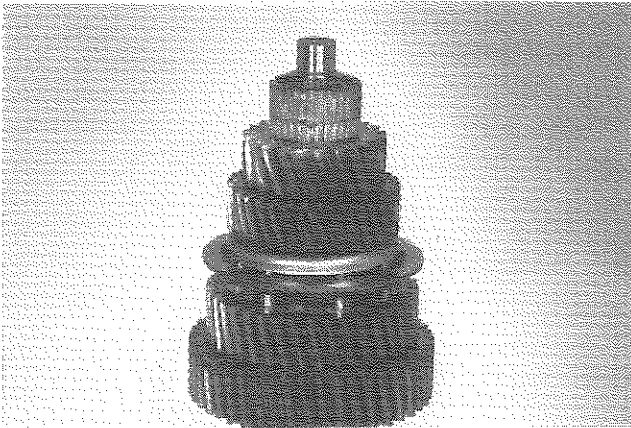
6. Install the caged needle bearing, 3rd speed gear (clutching teeth down), lock pin, and lubricated thrust washer. **Secure them with the snap ring.** The flat side of the snap ring goes against the thrust washer.



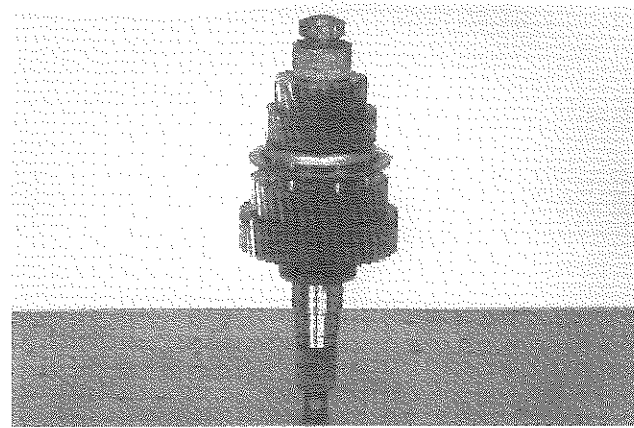
7. Next install the lubricated caged needle bearing and 4th speed gear (clutching teeth up).



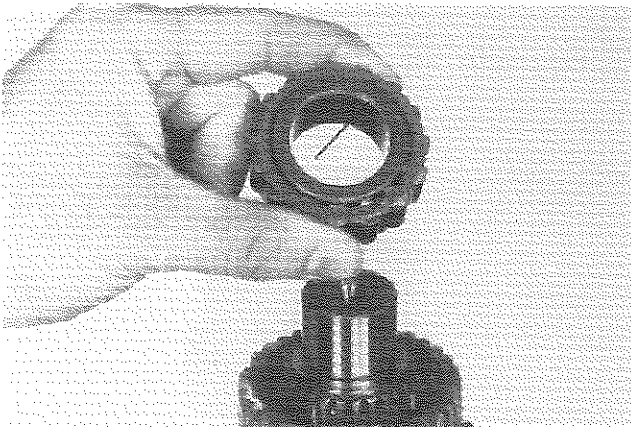
10. The other side has a larger "rolled" area.



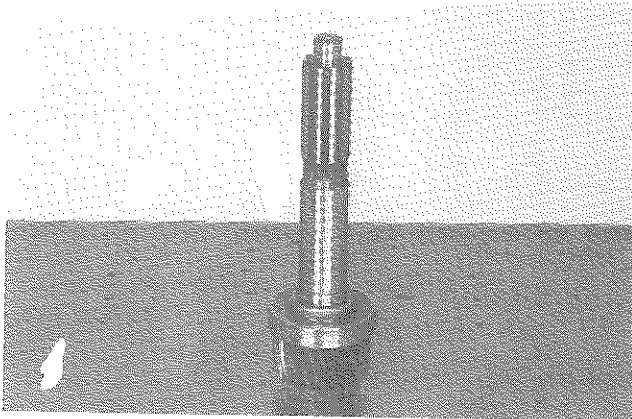
8. Lubricate the mating face of the 4th - 5th speed clutch gear, then slide it onto the mainshaft. Secure it with a spiral snap ring.



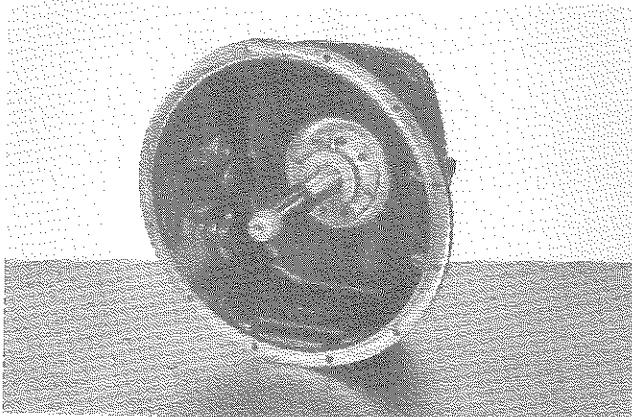
11. Use a suitable driver to install the pocket bearing with the chamfered inner diameter up. Then pack the bearing with Moly #2 grease. This completes mainshaft reassembly.



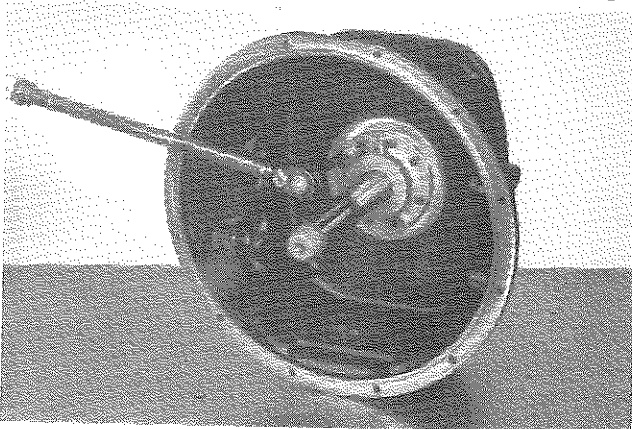
9. Prepare to install the pocket bearing. One side has a small, chamfered inner diameter.



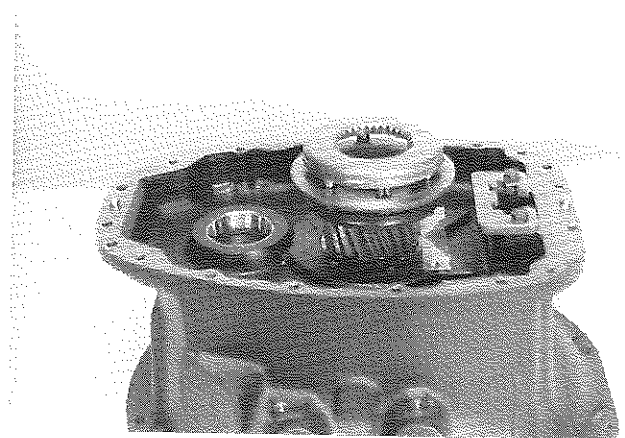
1. Wearing safety glasses, press the bearing onto the input shaft. Secure it with a snap ring. **Position the oil slinger, then lightly press it into place by tapping it with a brass hammer.** This will keep oil in the pocket bearing and help prevent component damage.



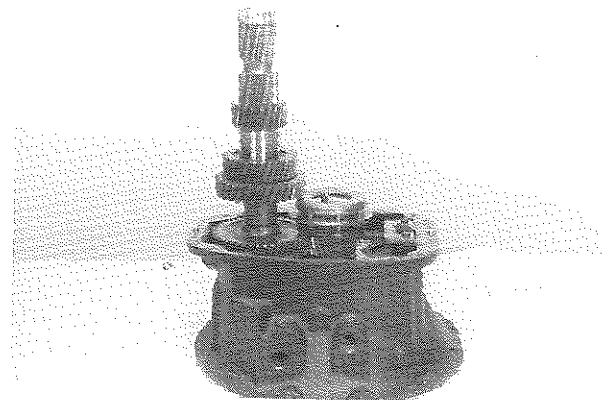
2. **Place the protective sleeve over the shaft to prevent oil seal damage during installation.** Next, coat the input bearing cap with purple Loctite 515® or the equivalent. Install the input bearing cap, making sure the oil return slot in the cap lines up with the oil hole in the clutch housing.



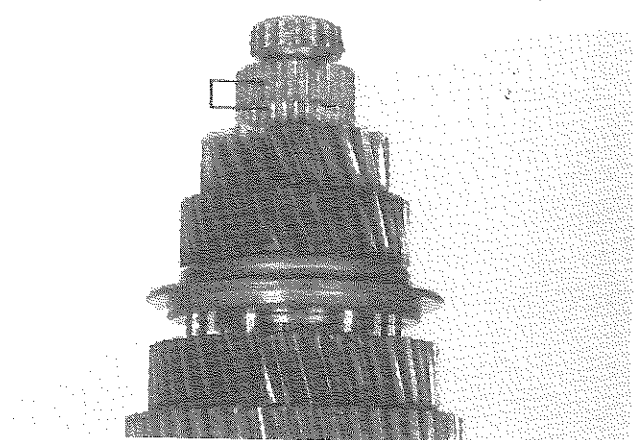
3. Torque the input bearing cap Allen head cap screws to 25 - 41 ft. lbs. **Remove the protective shaft sleeve now.**



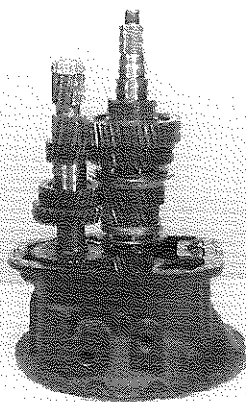
4. Place the 4th and 5th synchronizer onto the input gear.



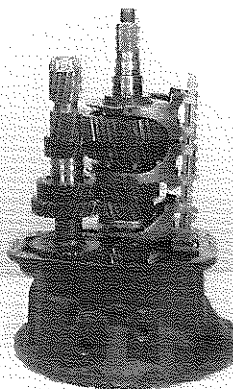
5. Lubricate the front countershaft bearing race with Moly #2 grease. Then set the countershaft subassembly in the clutch housing.



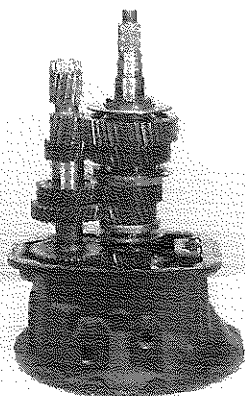
6. Align the 4th - 5th speed clutch gear splines with the 4th speed gear clutching teeth. Keeping them aligned when you lower the mainshaft subassembly into place will make installation easier and will help prevent pocket bearing damage.



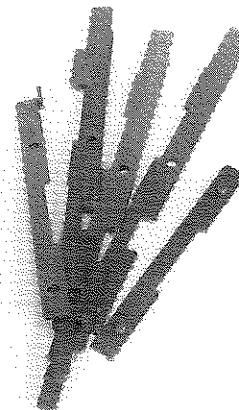
7. Using a chain hoist, lift the mainshaft subassembly into position.



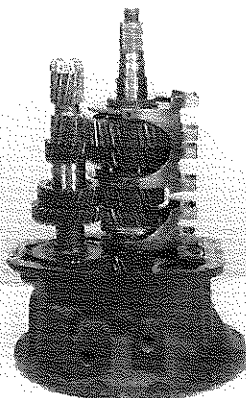
10. Install the welded shift rail assembly.



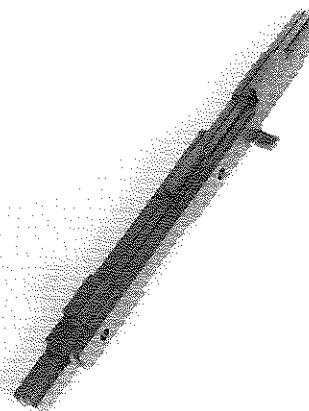
8. Install the 1st — reverse clutch collar.



11. Assemble the three shift rails and two half shift rails as shown in picture.

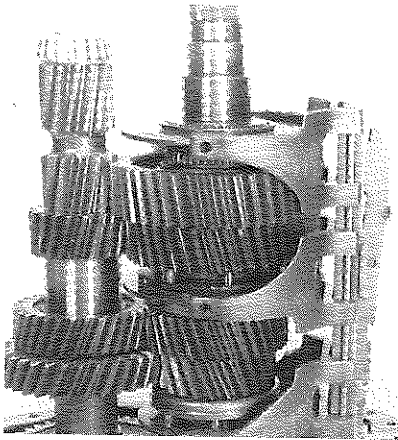


9. Install the three shift forks as shown in picture.



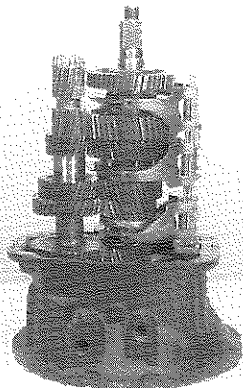
12. Finished assembly should look like above picture.



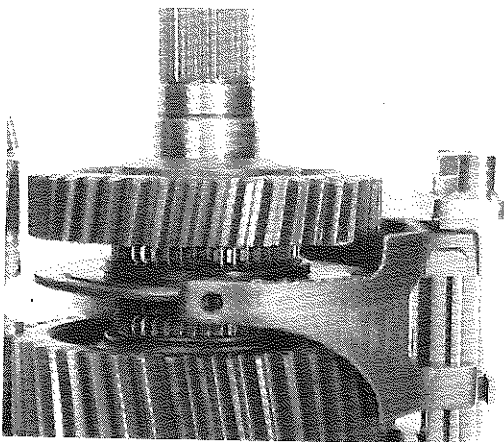


13. Install the shift rail assembly into the weld shift rail assembly, making sure the shift rail tangs align with their respective shift fork.

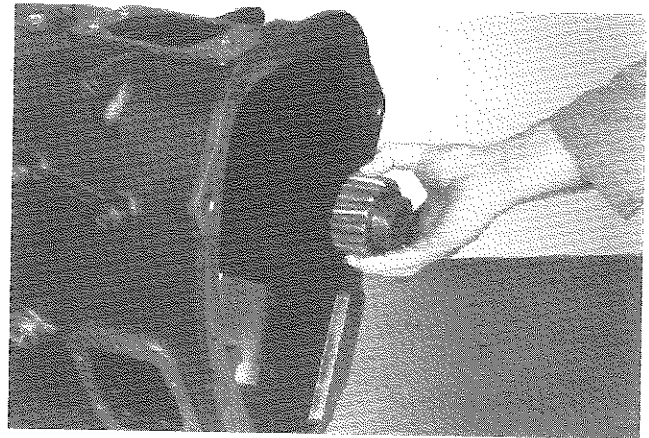
*Inset* — When shift rail is assembled correctly they will look like the picture with the highest notch towards the rear and right of the transmission when installed in the vehicle.



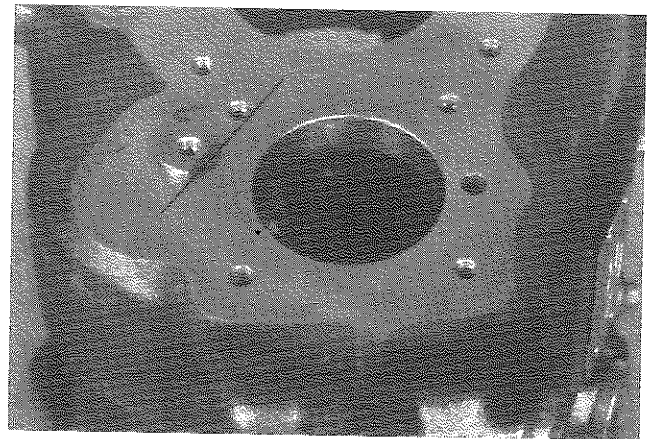
14. Install the lubricated caged needle bearing, reverse gear and lubricated thrust washer (flat side against reverse gear). Shift all forks into neutral.



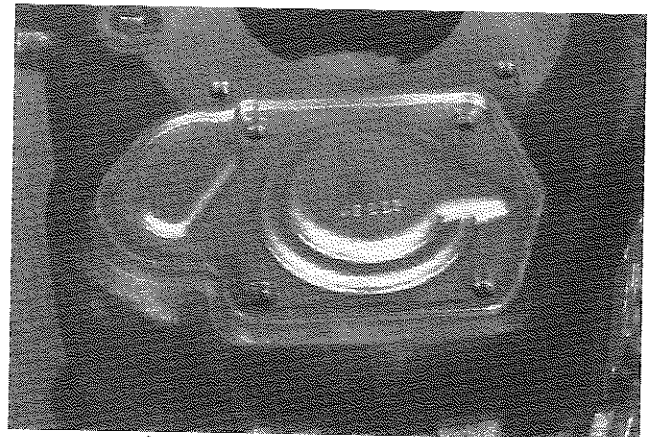
15. Place the rear shift bar support into position before lowering the case over the gear assembly. Otherwise, the case might not fit into place or the unit will not shift properly.



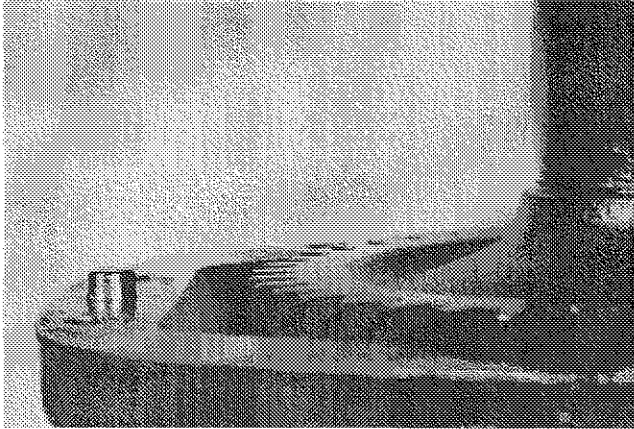
16. Lubricate the reverse idler gear caged needle bearings and spacer with Moly #2 grease. Place the bearing, spacer, and bearing into the reverse idler gear. Install the gear into the housing with the longer hub facing the clutch housing.



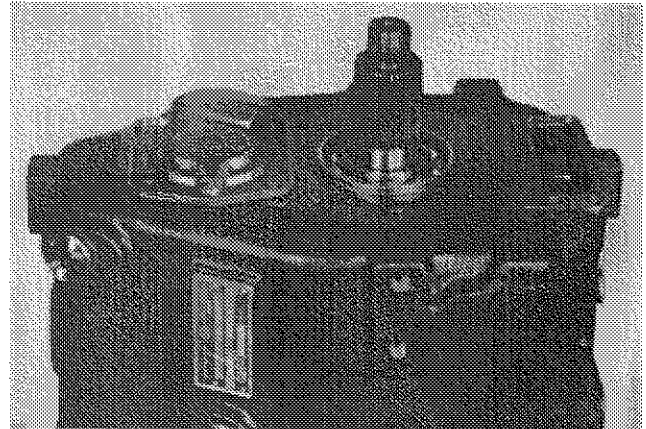
17. Next, use a rubber mallet to tap the reverse idler shaft into place. The shaft notch should align with the bearing cap hole shown in the photo. The notch in the shaft should be just below the case surface when installed correctly.



18. Set the rear countershaft bearing cap into place without securing it. The cap bolt holes should align with the bolt holes in the transmission case. If they don't, recheck the reverse idler shaft to make sure it is aligned properly and is tapped down far enough.



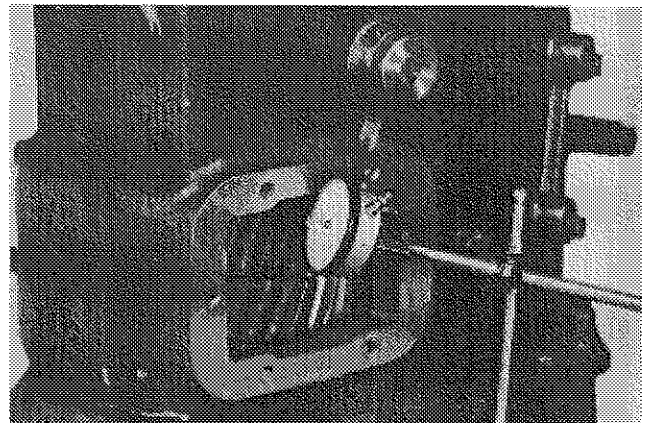
19. Make sure the two dowel pins are in place on the clutch housing. **They should extend above the clutch housing no more than 1/4"**. Then install the case. Secure it with bolts torqued to 25 - 41 ft. lbs.



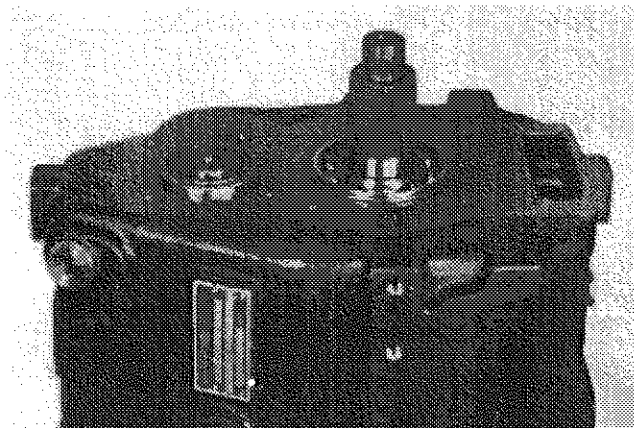
22. Secure the rear countershaft bearing cap snugly into place with at least two bolts. **Do not seal the cap yet.**



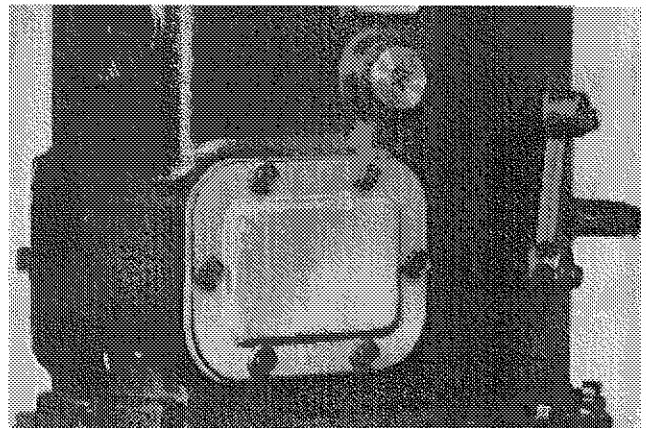
20. Coat the rear countershaft bearing race with Moly #2 grease. Install it using a proper driver. Install the shims.



23. Now check countershaft end play through the PTO aperture by gently lifting up on a countershaft gear. End play must be set between .001 - .008 inches. If it isn't correct, make adjustments by either adding or removing shims under the rear countershaft bearing cap.

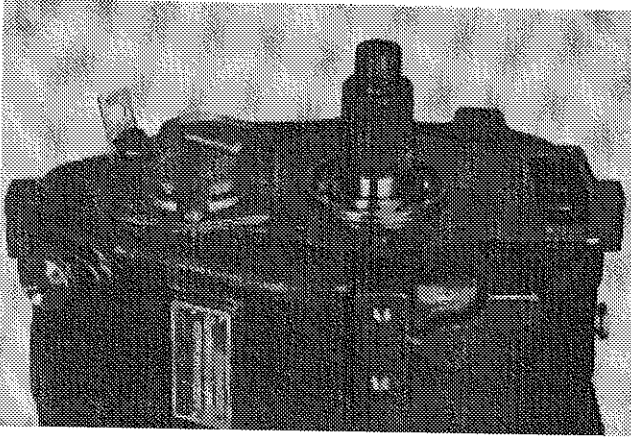


21. Install the output shaft bearing next. Use a proper driver.

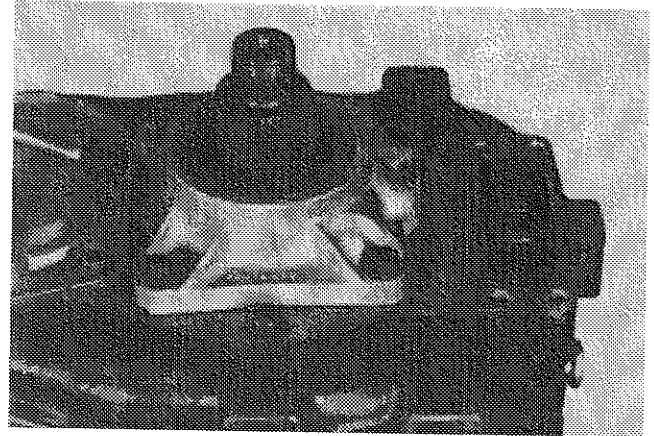


24. When finished, coat the PTO aperture cover with purple Loctite 515® or the equivalent. Install the cover and torque to 25 - 41 ft. lbs.





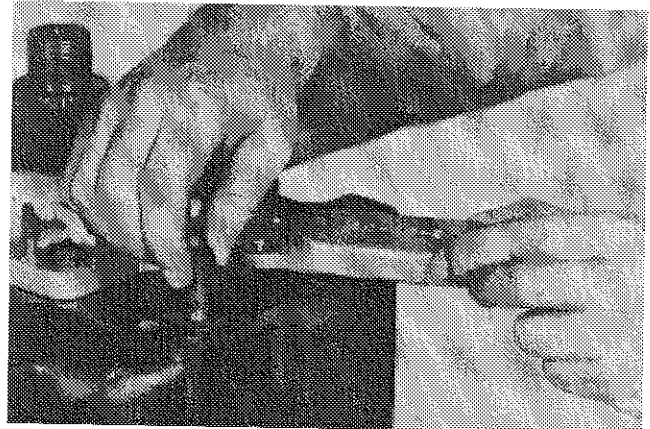
25. Apply purple Loctite 515® or the equivalent to the rear countershaft bearing cap. Torque the bolts to 25 - 41 ft. lbs.



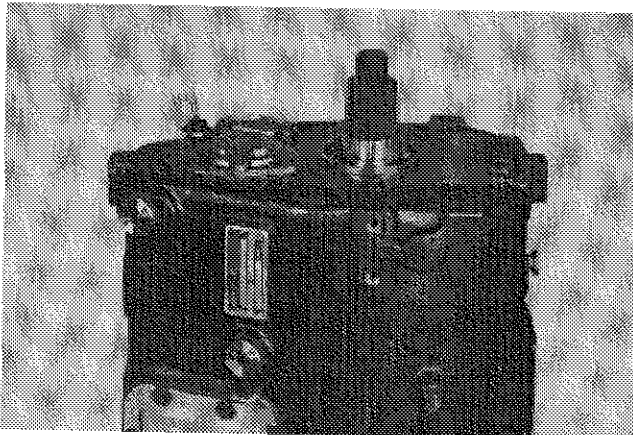
28. Install the gasket and output bearing cap. Torque the bolts to 25 - 41 ft. lbs.



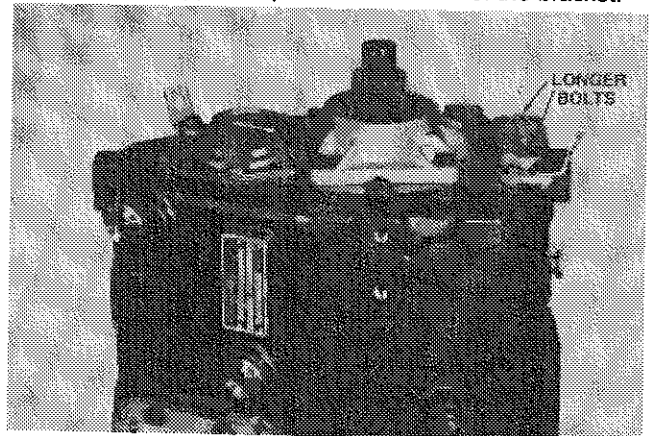
26. Notice that there are two spacers under the lift hook. These allow the hook to extend above the lip of the bearing cap.



29. Coat the rear shift bar support cap with purple Loctite 515® or the equivalent. Then install a long bracket bolt in one end of the rear shift bar support bracket. Lift up on it to raise the bracket to its proper position. Hold it while attaching the rear shift bar support cap to the other end of the bracket.



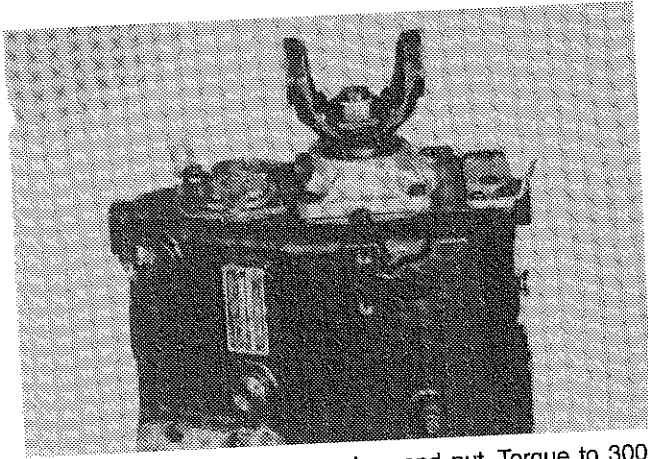
27. Install the speedometer gear.



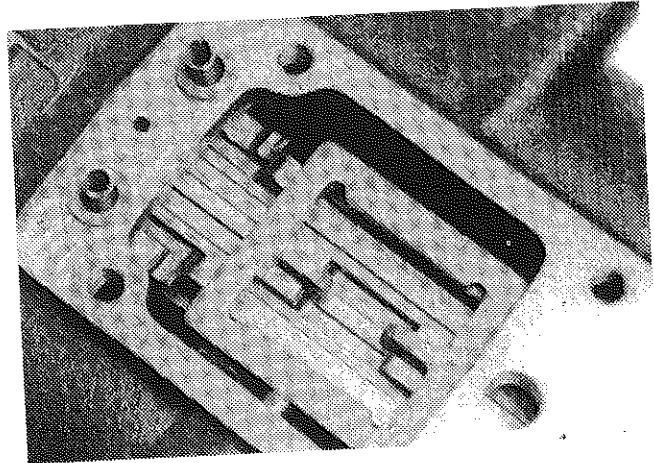
30. Remove the first rear shift bar support bracket bolt. Secure the other end of the shift bar support cap to the bracket using the bolt you just removed. Secure the support cap using the remaining four shorter bolts. Torque the bolts to 25 - 41 ft. lbs.

# CASE REASSEMBLY

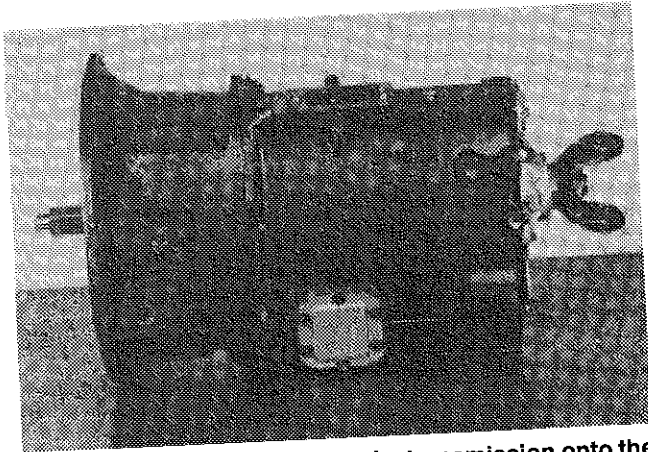
# SECTION VIII



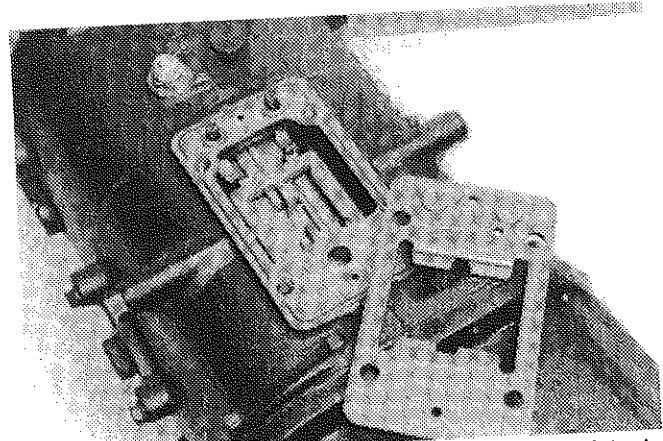
31. Attach the end fitting, washer, and nut. Torque to 300-325 ft. lbs.



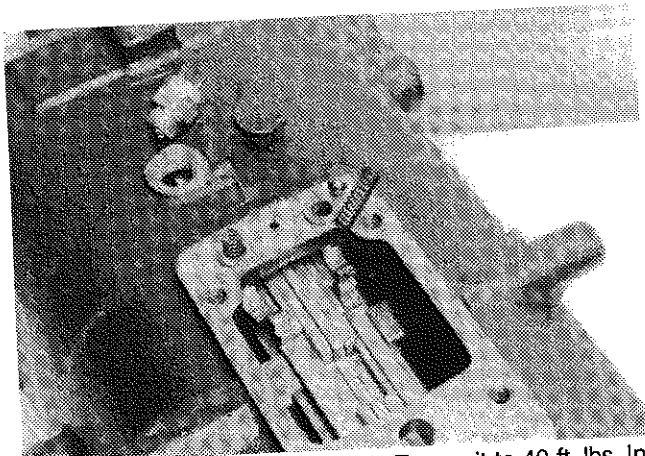
34.



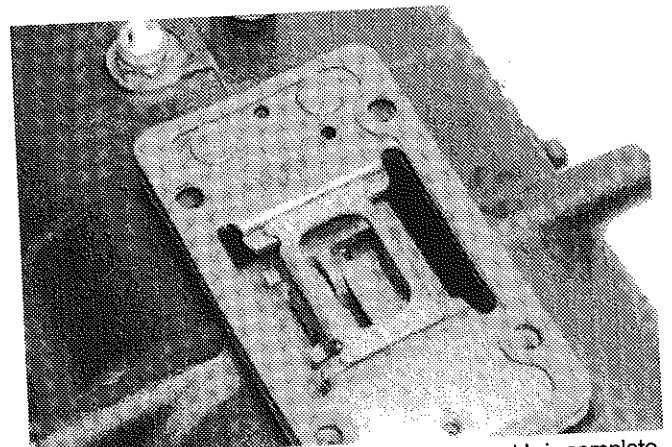
32. Use a chain hoist to lower the transmission onto the bench. Bench shift the unit to make sure it is working properly.



35. Install the gasket and retaining plate. The two detents on the plate must fit over the two poppet springs. This helps ensure proper tension on the shift bar.



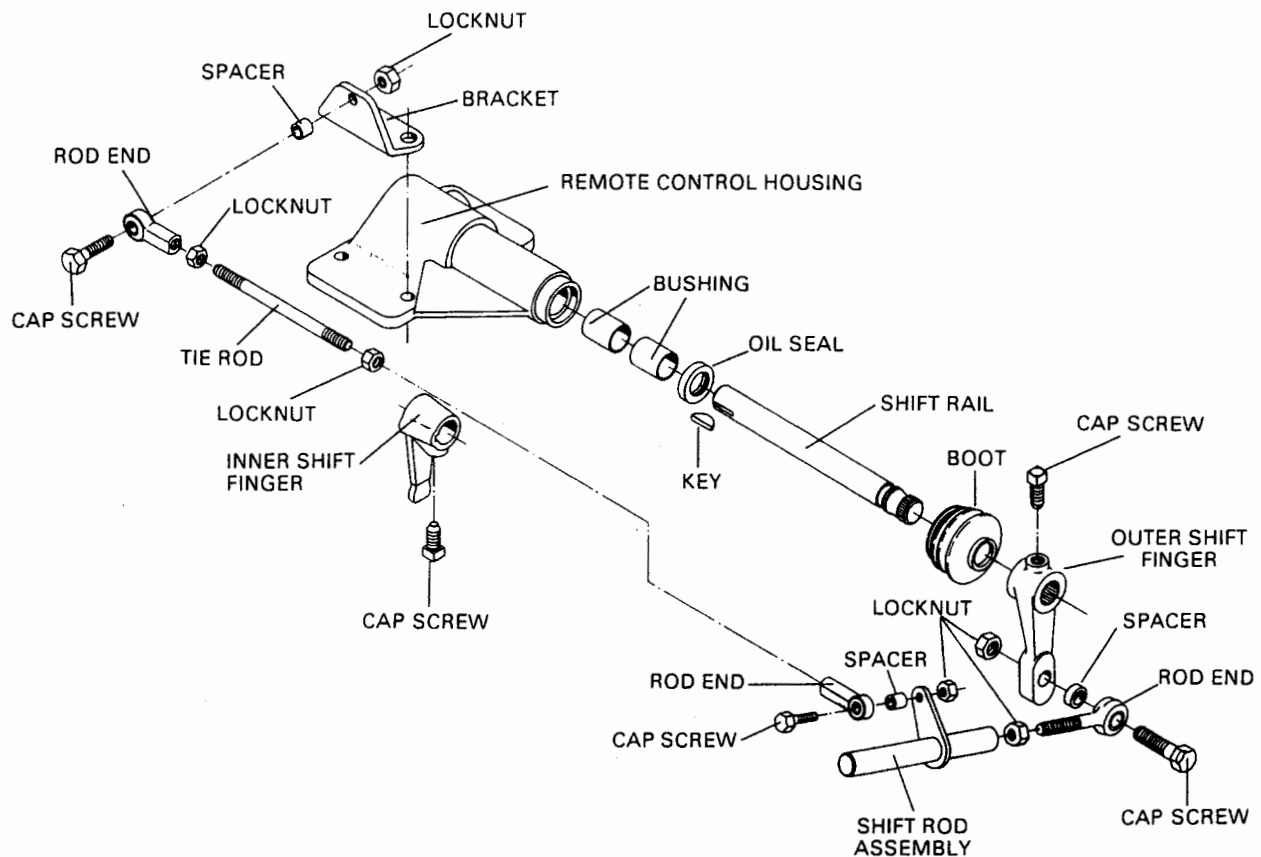
33. Install the backup light switch. Torque it to 40 ft. lbs. Install the two poppet balls and springs now.



36. Install the interlock and top gasket. Reassembly is complete.

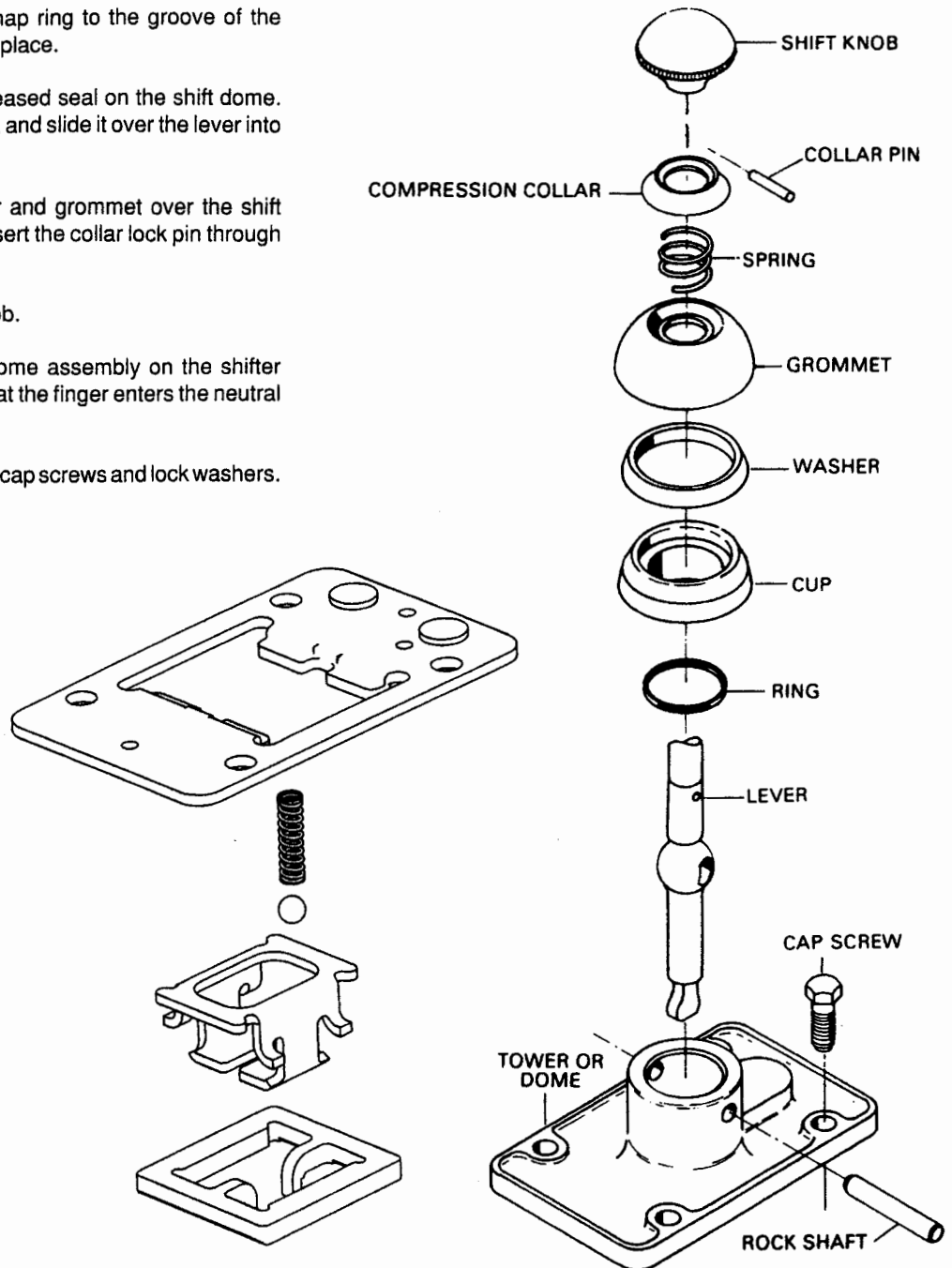
## Remote Control

1. Press the two bushings and the oil seal into the remote control housing.
2. Press the shift rail through the outer finger and secure the assembly with a cap screw.
3. Install the rubber boot. Then insert the shift rail subassemblies into the remote housing.
4. Next install the key and the inner finger, securing them with a cap screw.
5. Secure the boot with a lock wire.
6. Continue by installing all cap screws and locknuts through the rod ends.
7. With the bracket, secure the remote control to the transmission shifter housing. The shift finger enters the neutral position notches.



## Standard Shift Tower

1. Position the shift lever dome on edge in a vise.
2. Hold the shift lever so the lever cross hole aligns with the rock shaft cross hole in the dome.
3. Insert the rock shaft through the holes in the dome and shift lever.
4. Assemble the rock shaft snap ring to the groove of the dome, locking the rock shaft in place.
5. Next place a new, lightly greased seal on the shift dome. Grease the inner wall of the cup, and slide it over the lever into position on the dome.
6. Assemble the spring, collar and grommet over the shift lever. Depress the collar and insert the collar lock pin through the hole in the lever.
7. Assemble the shift lever knob.
8. Place the shift lever and dome assembly on the shifter housing with a gasket, noting that the finger enters the neutral position notches.
9. Secure the assembly with the cap screws and lock washers. Torque to 25-41 ft. lbs.



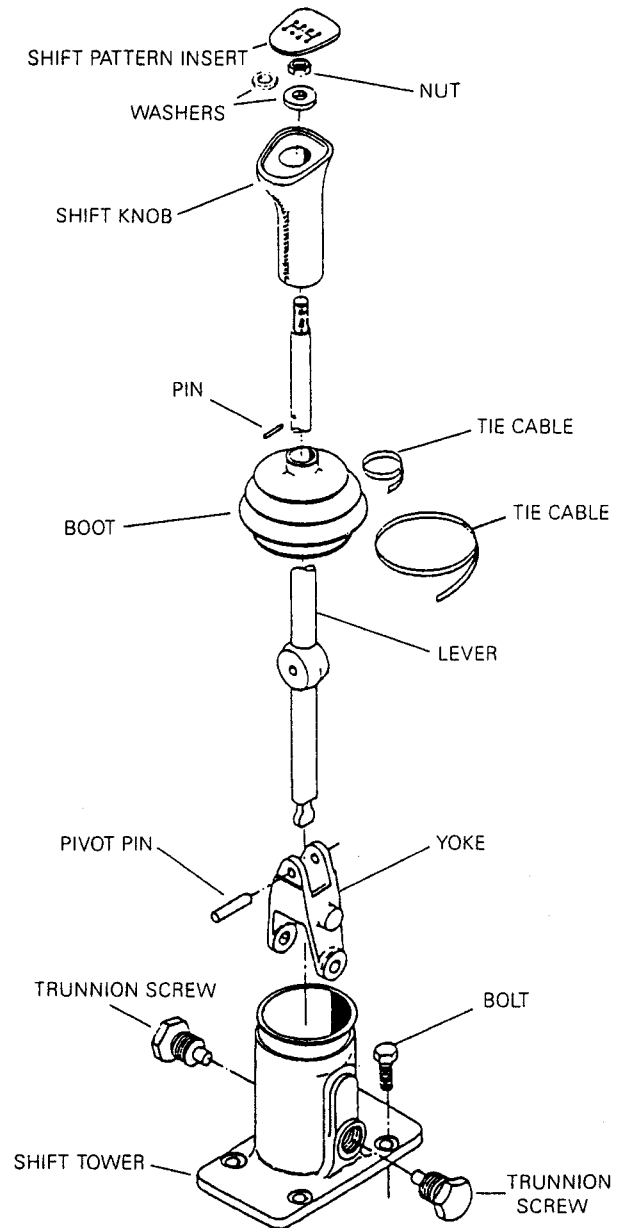
## Gimbal Shift Tower

1. Position the yoke onto the shift lever. Secure the yoke by pressing the pivot pin into position.

2. Place the lever assembly into the tower housing. **The raised boss on the yoke must be placed next to the side of the tower that contains the casting number stamp.**

3. Install the two trunnion screws. Torque to 100 - 125 ft. lbs.

4. Slide the boot into place. Secure it with two tie cables, being careful not to cut into the boot.



## Noisy Operation

Noise is usually a very elusive problem, and is generally not the fault of the transmission. Mechanics should road test the vehicle to determine if the driver's complaint of noise is actually in the transmission.

In numerous instances where drivers have insisted noise was coming from the transmission, investigations revealed it was caused by one of the following conditions:

- (a) Fan out of balance or blades bent.
- (b) Defective vibration dampers.
- (c) Crankshaft out of balance.
- (d) Flywheel out of balance.
- (e) Loose flywheel mounting bolts.
- (f) Rough engine idle producing rattle in gear train.
- (g) Clutch assembly out of balance.
- (h) Loose or broken engine mounts.
- (i) Power take-off engaged.
- (j) Worn universal joints.
- (k) Driveshaft out of balance.
- (l) Universal joint angles out of phase or at excessive angles.
- (m) Center bearings in driveline dry, not mounted properly.
- (n) Wheels out of balance.
- (o) Tire treads humming or vibrating at certain speeds.
- (p) Air leaks on suction side of induction system, especially with turbo-chargers.

Mechanics should try to locate and eliminate noise by means other than a transmission removal or an overhaul. However, if the noise appears to be in the transmission, try to determine what position the gear shift lever is in when the noise occurs. If the noise is evident in only one gear position, the problem is generally traceable to the operating gears. Next, try to categorize the noise into the following classifications:

- (a) *Growling, humming and grinding.* These noises are caused by worn, chipped, rough or cracked gears. As gears continue to wear, the grinding noise will be noticeable particularly in the gear position that throws the greatest load on the worn gear.

A lack of lubricant or use of improper lubricant can also result in growling and grinding noises. This is because there is insufficient lubricant to cool and cover the gears, which allows metal-to-metal contact.

- (b) *Hissing, thumping and bumping.* Hissing noises can be caused by bad bearings. As bearings wear and retainers start to break up, the noise could change to a thumping or bumping.

- (c) *Gear whine.* This is usually caused by lack of backlash between mating gears. Improper PTO shimming is the big offender here.
- (d) *Vibration.* Today's improved highways mean entire power trains are cruising at higher RPMs. These higher speeds mean damage caused by driveline vibration is more obvious than in the past.

When the maximum RPM of a shaft is reached, it begins to bow. A resonant hum can be heard, and a vibration will be set up. This type vibration can cause gear seizures, broken synchronizer pins, bearing failures, brinelling and corrosion.

During acceleration and deceleration, the shaft may pass through half-critical vibration (half the maximum RPM of the shaft). A whine or boom may be heard at this point.

- (e) *Metallic rattles.* These noises within the transmission usually result from a variety of conditions. Engine torsional vibrations are transmitted to the transmission through the clutch. In heavy duty equipment, clutch discs with vibration dampers are not used, so a rattle - particularly in neutral - is common with diesel equipment.

In general, engine speeds should be 600 RPM or above to eliminate objectionable rattles and vibration during the idle. A defective or faulty injector would cause a rough or lower idle speed, and possibly a rattle in the transmission. A rattle can also be caused by excessive backlash between the PTO input gear and the transmission output gear.



## Noise in Neutral

### Possible Causes:

- (a) Misalignment of transmission.
- (b) Worn flywheel pilot bearing.
- (c) Worn or scored countershaft bearings.
- (d) Sprung or worn countershaft.
- (e) Excessive backlash in gears.
- (f) Scuffed gear tooth contact surface.
- (g) Insufficient lubrication.
- (h) Use of incorrect grade of lubricant.

## Noise in Gear

### Possible Causes:

- (a) Rough, chipped, or tapered sliding gear teeth.
- (b) Noisy speedometer gears.
- (c) Excessive end play of countershaft gears.
- (d) Refer to conditions listed under Noise in Neutral.

## Oil Leaks

### Possible Causes:

- (a) Oil level too high.
- (b) Wrong lubricant in unit.
- (c) Seals defective, wrong type or omitted from bearing cap.
- (d) Transmission breather omitted or plugged internally.
- (e) Capscrews loose, omitted or missing from remote control, shifter tower, bearing caps, PTO or covers.
- (f) Oil drain-back openings in bearing caps or case plugged with varnish or dirt.
- (g) Gaskets shifted or squeezed out of position, broken gaskets with pieces still under the shift tower.
- (h) Cracks or holes in castings.
- (i) Loose drain plug.
- (j) Oil leakage from engine.
- (k) Loose speedometer adaptor or connections.

## Walking or Jumping Out of Gear

If the units are walking out of gear, it could be caused by:

- (a) External interference, such as the floorboard opening, preventing full engagement, or
- (b) An internal malfunction, such as worn clutching teeth, allowing the transmission to shift out of position.

If a remote control is being used, make sure it is functioning properly before the transmission is blamed for the problem. Note whether the unit walks out of gear under drive while pulling a load, or on a coast load. Also, notice whether the gear hop occurs on smooth roads or only on rough roads. Items that would prevent full engagement of gears are:

- (a) Improperly positioned forward remote control which limits full travel forward and backward from the remote neutral position.
- (b) Improper length shift rails or linkage that limits travel of forward remote from neutral position.
- (c) Loose bell cranks, sloppy ball and socket joints.
- (d) Shift rails, cables, etc., too spongy or flexible, or not secured properly at both ends.
- (e) Worn or loose engine mounts if forward unit is mounted to frame.
- (f) Forward remote mount too flimsy, or loose on the frame.
- (g) Setscrews loose at remote control joints, on shift forks inside remote.
- (h) Shift fork pads or groove sliding gear or collar worn excessively.
- (i) Transmission and engine out of alignment either vertically or horizontally.

A few items which could move the gear or shaft out of proper position, particularly on rough roads are:


- (a) Use of heavy shift lever extensions.
- (b) Broken shift rail poppet springs.
- (c) Worn shift rail poppet notches.
- (d) Bent or sprung shift rails.
- (e) Excessive end-play in drive gear or countershaft, caused by worn bearings or retainers.
- (f) Worn or missing thrust rings.

## Hard Shifting

An improperly operating clutch will interfere with the proper shifting of gears in any transmission. It is also important that the hydraulic, air or similar release mechanism is in proper working order. If full and complete clutch release is being made, the following could be a few of the possible causes for hard shifting complaints:

- (a) No lubricant in remote control unit. (Note: The forward remote is isolated and is often overlooked. Many remote controls used on transmissions and auxiliaries require separate lubrication.)
- (b) No lubrication in, or grease fittings on, u-joints or swivels of remote controls.
- (c) Lack of lubricant or wrong lubricant used, causing buildup of sticky varnish and sludge deposits on splines of shaft and gears.
- (d) Badly worn or bent shift forks.
- (e) Improper adjustment on shifter linkage.
- (f) Sliding clutch gears tight on splines of shaft.
- (g) Clutch teeth burred over, chipped or badly mutilated because of improper shifting.
- (h) Binding or interference of shift lever with other objects or rods inside the cab or near the remote control island.
- (i) Clutch dragging.
- (k) Free running gears seized or galled on either the thrust face or diameters.

## Sticking in Gear

- (a)  Clutch not releasing. Also check remote units such as hydraulic or air assist. Note: On some units employing a full air control for clutch release, air pressure of approximately 60 lbs. or more must be secured before the clutch can be released. **Do not leave these vehicles parked in gear.**
- (b) Sliding clutch gears tight on splines.
- (c) Chips wedged between or under splines of shaft and gear.
- (d) Improper adjustment, excessive wear or lost motion in shifter linkage.

## Bearing Failures

The service life of most transmissions, main and auxiliary, is governed by the life of the bearings. The majority of bearing failures can be attributed to vibration and dirt. Some other prominent reasons for unit bearing failures are:

- (a) Fatigue of raceways or balls.
- (b) Wrong type or grade of lubricant.
- (c) Lack of lubricant.
- (d) Broken retainers, brinelled races and fretting caused by vibration.
- (e) Bearings set up too tight or too loose.
- (f) Improper installation resulting in brinelled bearings.
- (g) Improper fit of shafts or bore.
- (h) Acid etching due to water in lube.
- (i) Vehicle overload or too large an engine for the transmission resulting in overload.

## Dirt

More than 90% of all ball bearing failures are caused by dirt, which is always abrasive.

Dirt may enter the bearings during assembly of units, or may be carried into the bearing by the lubricant while in service. Dirt also may enter bearings through seals, the breather or even dirty containers used for addition or change of lubricant.

Softer material, such as dirt or dust, usually forms abrasive paste or lapping compounds within the bearings. The pressure between the balls and raceways makes a perfect pulverizer: the rolling motion tends to entrap and hold the abrasives. As the balls and raceways wear, the bearings become noisy. The lapping action tends to increase rapidly as the fine steel from the balls and rollway adds to the lapping material.

Hard, coarse material, such as metal chips, may enter the bearings during assembly from tools such as hammers, drifts, and power chisels. It may also be created within the unit during service from raking teeth. These chips produce small indentations in balls and races. When these hard particles jam between the balls and races, it may cause the inner race to turn on the shaft, or the outer race to turn in the housing.

## Fatigue

All bearings are subject to fatigue and must be replaced eventually. Your own operating experience will dictate mileage replacement of bearings showing only normal wear.

## Corrosion

Water, acid and corrosive materials formed by deterioration of lubricant, will produce a reddish-brown coating and small etched holes over outer and exposed surfaces of the race. Corrosive oxides also act as lapping agents.

## Shaft Fits

Bearing fits on rotating shafts are usually specified as tight. Excessive looseness - even .001" - under a load, produces a creeping or slipping of the inner race on the rotating shaft. The result is that surface metal of the shafts scrub or wear off. The force causing the inner race to rotate disappears when the bearing fits properly.

## Installation and Removal of Bearings

Improper installation or removal of bearings, especially hammering the bearing on the shaft with off-center blows, can result in brinelling. Since such damage is seldom visible, it does not become known until after failure or complete disassembly. The correct drivers (preferably under an arbor press) and pullers should be used.

Removing bearings is more difficult than installing them. In most cases, it is necessary to remove the bearing by pulling on the outer race, which can damage the balls or races. Therefore, it is a good idea to replace bearings during an overhaul, to prevent problems. However, if a bearing is not going to be replaced, avoid removal during low mileage rebuilds.

## Interchangeability

All ball bearings, whether manufactured here or abroad, are interchangeable in regard to standardized dimensions, tolerances, and fits. However, for a given shaft size there are standard bearings for light, medium, and heavy duty service.

Numbers and symbols stamped on inner and outer races of bearings designate size and type. Note that the numbering systems of different bearing manufacturers have not been standardized. Consult interchangeable tables and use the proper bearings for replacement parts.

## Clutch Troubleshooting

Faulty clutch operation interferes with proper shifting of gears in any transmissions. The two following paragraphs describe the most common problems encountered with clutches.

- (a) If the clutch slips or does not engage properly, first check the internal clutch adjustment. If adjustment does not remedy the situation, check for weak pressure springs, lack of free pedal, and worn or oily clutch facings and binding release mechanism.
- (b) If the clutch drags or does not release properly, check the internal clutch adjustment. Some other causes for clutch drag are: an intermediate plate sticking on drive pins or drive lugs; the pressure plate not retracting; a distorted or warped driven disc; worn splines on the main drive gear of the transmission; a damaged clutch release bearing; or the bushing in the release sleeve dragging on the transmission drive gear.



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