

MODELS
ES52-7B
ES56-7B
ES066-7B
7 SPEED
TRANSMISSION



Service Manual
Bulletin No. 2366
Revised August 2002



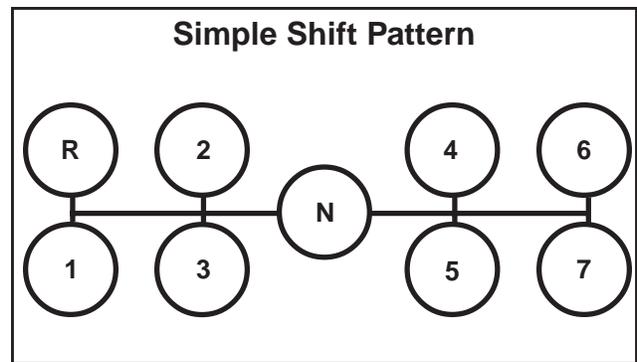
Technology in Motion®

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Gear Ratios			
	ES52-7B ES56-7B	ES066-7B	
Gear	Ratio	Ratio	% Step
Rev.	8.99	6.66	
1st	10.09	7.48	—69—
2nd	5.98	4.43	—61—
3rd	3.72	2.76	—45—
4th	2.56	1.90	—41—
5th	1.81	1.34	—34—
6th	1.35	1.00	—35—
7th	1.00	.074	

General Application Guidelines On-Highway Use		
	ES56-7B	ES066-7B
GVW:	50,000 lbs.	65,000 lbs.
HP Range:	155 - 210 HP	185 - 250 HP
RPM Range:	1,800 - 3,000	
Engine Types:	5 - 9 Liter Diesel	



Specifications

Torque Capacity ES52-7B - 520 lbs. ft. (704 nm)
 ES56-7B - 560 lbs. ft. (758 nm)
 ES066-7B - 660 lbs. ft. (894 nm)

Ratio Coverage 10:1

Synchronized Gears 2-7

Length 35" (clutch housing mounting face to washer seat face)

Weight 454 lbs. (206 kg)

Clutch Housing SAE No. 2

Clutch 13" or 14" single or 2-plate push or pull

Input Shaft 1 3/4" - 10-spline or 1 1/2" - 10-spline

Lube Capacity 22 pints (10.4 liters)

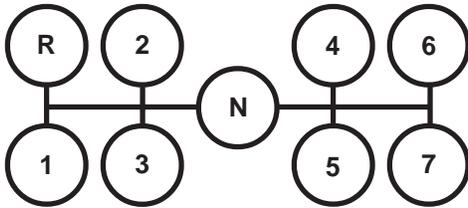
Speedometer Provision for mechanical and electronic

Power Take-Off 6-bolt right & left, countershaft rear
 34 tooth 18° right-hand helix
 17.50° pressure angle

PTO Speeds: % of engine RPM ES52-7B, 48.8%
 ES56-7B, 48.8%
 ES066-7B, 65.8%

TORQUE SPECIFICATIONS FOR NUTS AND CAP SCREWS				
Nom. Size (Dia.)		Part Name	Wrench Torque (ft. lbs.)	
Inches	mm		Min.	Max.
.375	10	Oil trough (16 x .750)	25	41
.375	10	Intermediate shift bar support (16 x 1.00)	25	41
.375	10	Front mainshaft bearing cap (16 x 1.00)	25	41
.375	10	Overdrive linkage (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
.375	10	6-bolt PTO aperture cover	25	41
1.250	32	Mainshaft output nut	300	325
2.548	65	Intermediate mainshaft (spanner) nut	300	325
.875	23	Backup light switch	40	40

How to Shift the Spicer Easy-Shift 7-Speed Transmissions



Synchronizer Information

The purpose of a synchronizer is to simplify shifting and help deliver clash-free shifts. Only 1st and reverse gears aren't synchronized.

To shift, the driver depresses the clutch and moves the lever toward the desired gear. When the synchronizer ring makes contact with the desired gear, "blockers" automatically prevent the shift collar from completing the shift until the gear and mainshaft speeds are matched. When the speeds are matched, the synchronizer allows the shift to be completed without clashing.

Steady pressure on the shift lever helps the synchronizer do its job. When speeds are synchronized, the lever moves into gear smoothly and easily. If the driver jabs or "teases" the synchronizer, the synchronizer can't do its job. It is possible to override a blocker if the lever is forced into gear. However, this defeats the purpose of the synchronizer and can shorten the life of the transmission.

Driver Instructions

Upshifting

To drive a vehicle containing this transmission, first depress the clutch and wait for complete release. Next, move the shift lever into 1st gear and engage the clutch. 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 known as the progressive shift technique. Using this shift technique saves fuel. There is usually no reason to go all the way to the governor before you shift to

2nd gear. This method can vary depending on the GVW of the vehicle, road conditions, and type of service.

When 2nd gear is desired, declutch and move the shift lever toward that gear. The synchronizer will pick up 2nd gear and synchronize its speed to the mainshaft speed. When synchronized, the lever moves easily into 2nd gear.

Continue in the same manner to top road speed. Notice that as you approach top road speed you must accelerate close to the governed speed before allowing the engine to drop to the next gear shift point. This is because air resistance at higher speeds requires more of the available horsepower to get adequate performance. Maximum performance and horsepower are achieved at governed speed.

Downshifting

To begin downshifting from top gear, declutch and move the shift lever steadily toward 6th gear and speed it up to the vehicle speed. This will allow a clash-free shift from 7th to 6th gear. After the shift, reengage the clutch while accelerating the engine to keep the vehicle moving at the desired speed. If further downshifts are required, continue in a similar manner.

Remember that 1st gear isn't synchronized. Therefore, shifting into gear will require a double clutch operation to complete a clash-free shift.

Towing



Do not tow vehicles without first pulling the axles or disconnecting the driveshaft. If you tow the vehicle without doing this, you can damage drive train components because the system lubrication is inadequate when the vehicle is towed.

Lubrication



To insure proper lubrication and operating temperatures in this unit, the proper lubricants must be used. Correct oil levels must be maintained. TTC 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

For off highway use, TTC recommends that the oil be changed after the first 24 hours of service, 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 miles, or one-year intervals. If synthetic oil is used, a drain and flush should be scheduled at 500,000 miles, or 5 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, TTC 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 additive 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.

Tool Reference

This Spicer transmission can be repaired with ordinary mechanic's tools. However, if your transmission has a mainshaft intermediate nut rather than a snap ring, vehicle downtime can be minimized with the use of this special socket. It is available through Sealed Power Corporation, part number OEM6599. To order, contact:

OTC Division
Sealed Power Corporation
O.E.M. Sales
655 Eisenhower Drive
Owatonna, MN 55060
Phone: (800) 533-6127
Fax: (800) 283-8665

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 replaced 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 countershaft 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. TTC 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.

- If the bearing fit is tight on the shaft, usually the bearings will brinell as they must absorb the pounding force.
- 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.

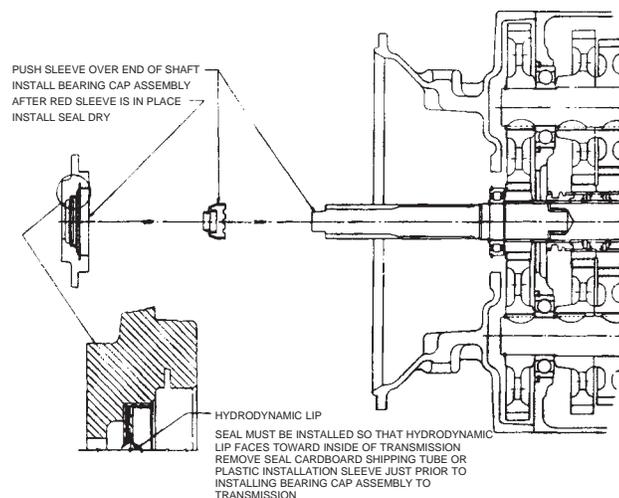
Power Take-Offs

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

Front Bearing Retainer & Seal

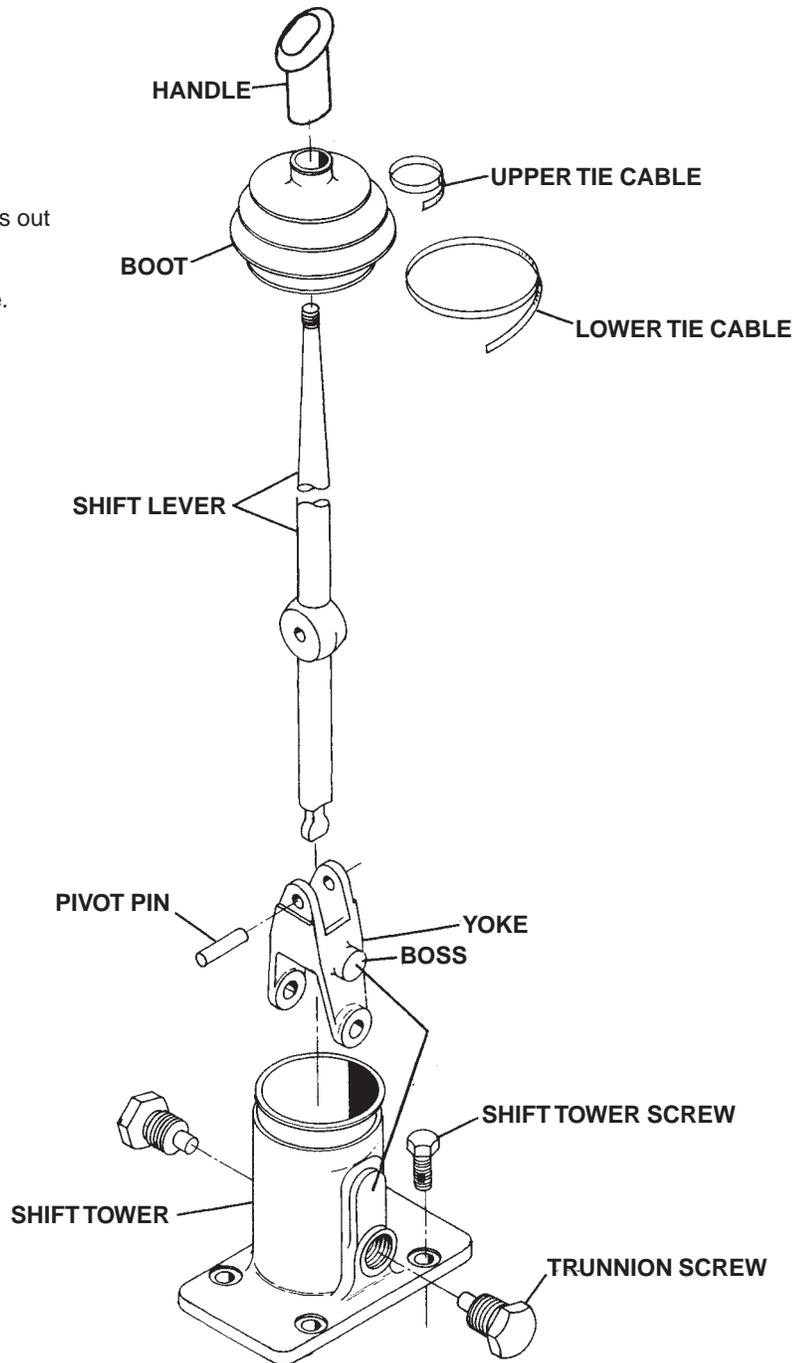


When installing the front bearing retainer and seal in the transmission, use the red plastic sleeve to prevent serious damage to the oil seal. Failure to use the seal sleeve will void the seal warranty.

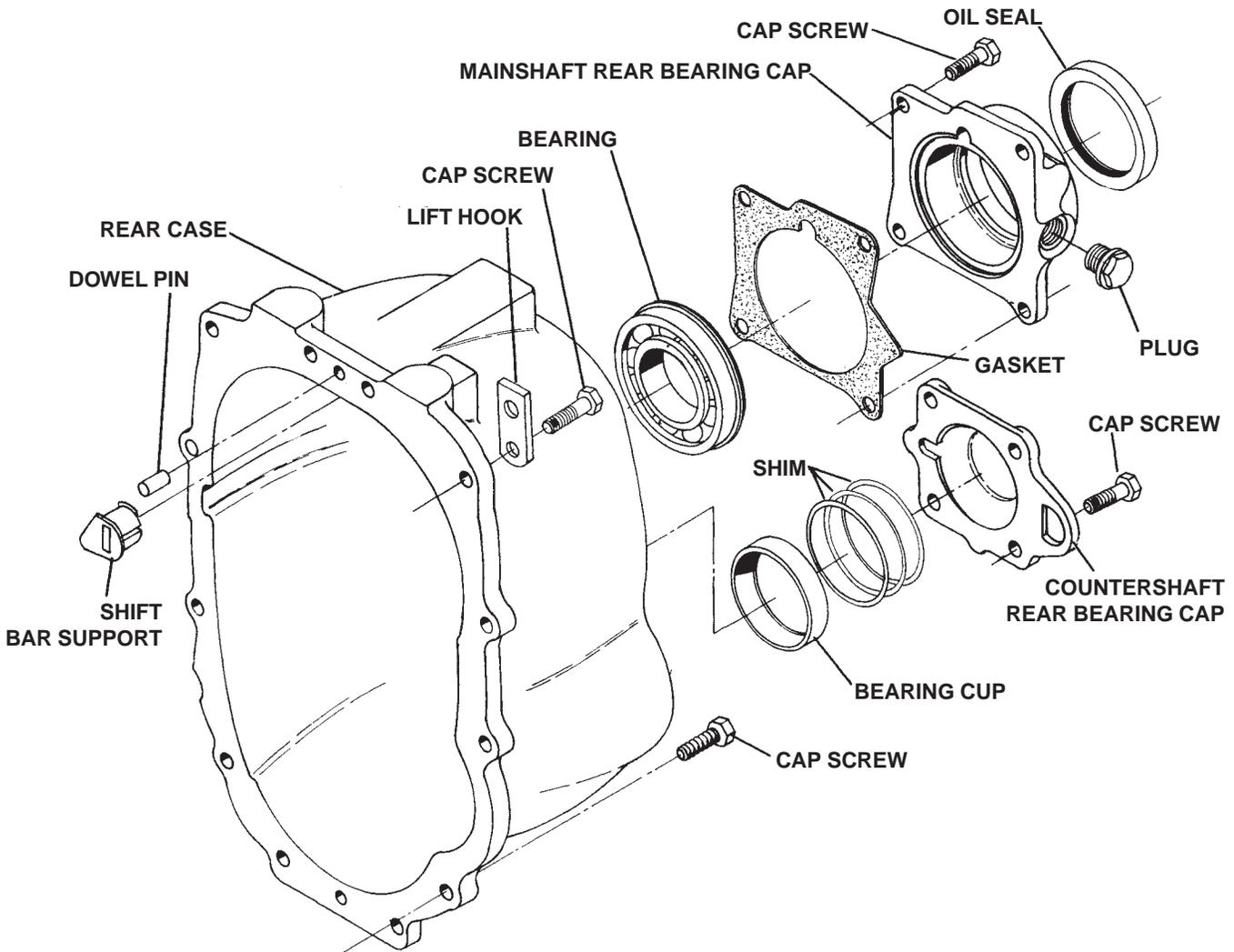


Shift Tower Disassembly

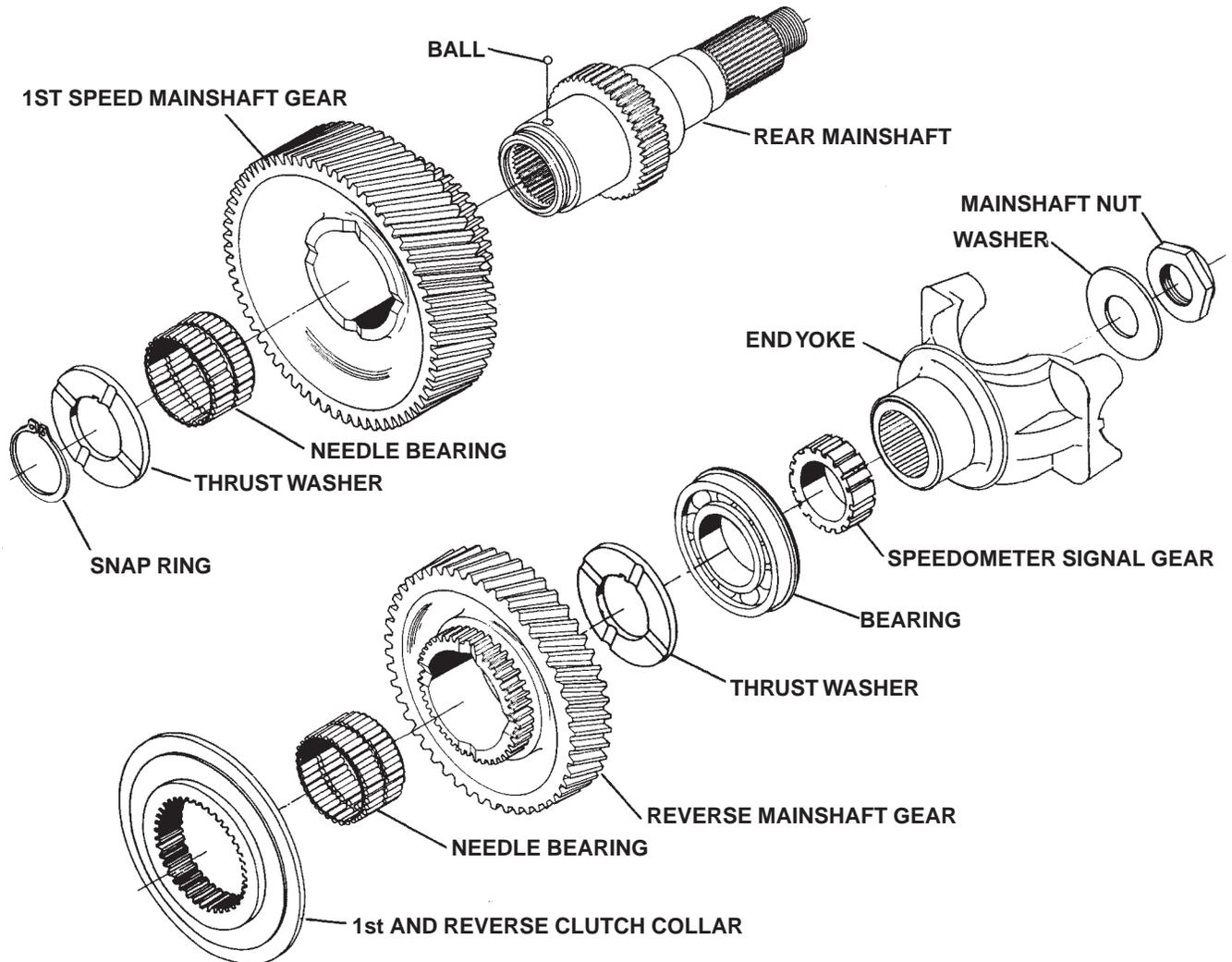
1. Begin disassembly by cutting the two tie cables which secure the boot.
2. Slide the boot off the shift lever.
3. Remove the two trunnion screws.
4. Lift the lever from the tower.
5. To remove the shift yoke from the lever, simply press out the pivot pin.
6. Wash all parts. Inspect them thoroughly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



Rear Case Exploded Drawing

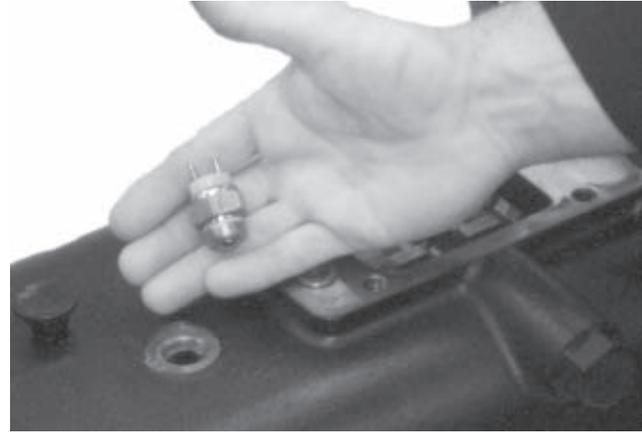


Rear Case Gears Exploded Drawing





1. After removing the transmission from the vehicle, drain the oil. **Let the unit cool down first.** Otherwise, hot transmission fluid could cause burns.



4. The backup light switch can be removed if it is going to be replaced. Otherwise, it does not have to be removed during servicing.



2. Remove the interlock retaining drive screws. Next remove the gaskets and interlock retainer plate.



5. If the driver has experienced shifting problems, check the crossgate plunger and spring at this time. Replace them if they are worn or damaged. If no problems have occurred, it is not necessary to remove the plunger and spring.



3. The four springs and plungers should be removed now. If the reason for the teardown was a shifting problem, closely examine the springs and plungers for wear or damage. Replace them if they are worn or damaged.

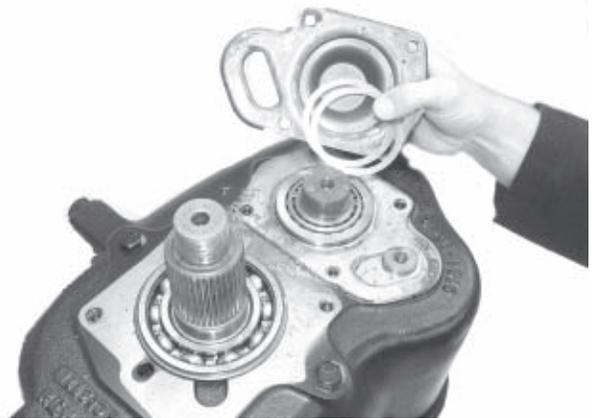


6. Attach a bracket or lift hooks to the rear case. Secure with bolts, which are at least hand-tightened. **Lift the transmission with a hoist**, and set it on end on a workbench that contains a hole for the drive gear.





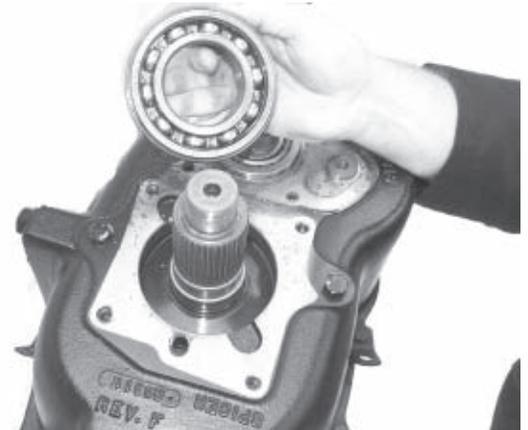
7. Remove the nut, washer, and end yoke or flange.



10. Remove the countershaft bearing cap and shims.
Note: Some models have a rear countershaft PTO option. In this situation, the countershaft will come out with the rear case when it is removed.



8. Remove the output bearing cap and gasket.



11. Using pullers in the milled slots, remove the rear mainshaft bearing.



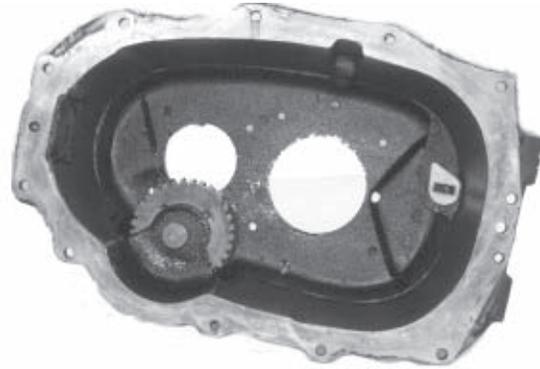
9. Next remove the speedometer signal gear.



12. Remove bolts from housing.



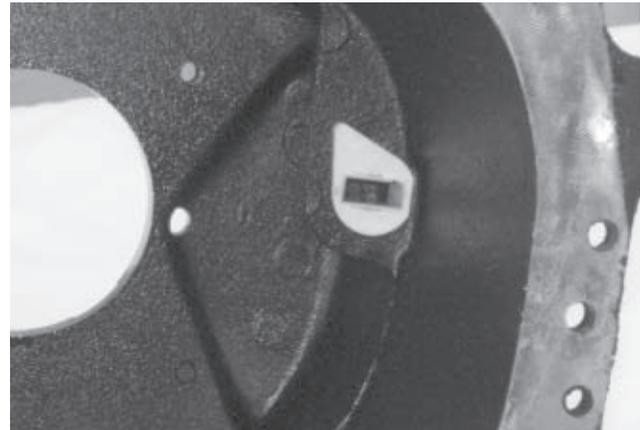
13. Next, place pry bars in the slots provided in the rear case. Break the seal.



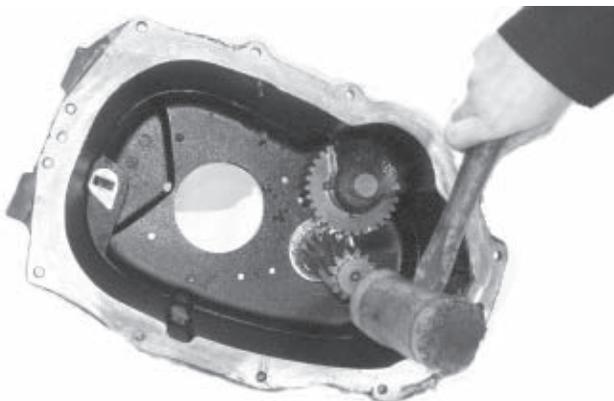
16. The reverse idler shaft and gear stay in the housing.



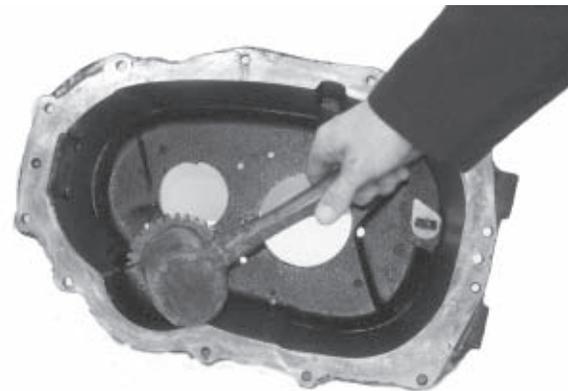
14. Then use a chain hoist to remove the rear housing.



17. Notice that the 1st/reverse shift fork support bracket also stays in the housing. This bracket should not be removed unless it is broken and is going to be replaced.



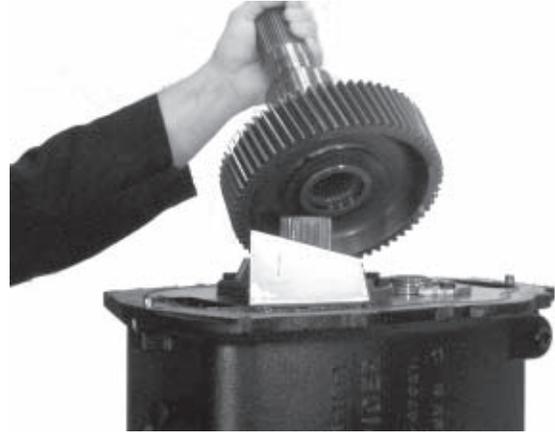
15. Using a plastic mallet, tap the rear countershaft out of the rear of the case.



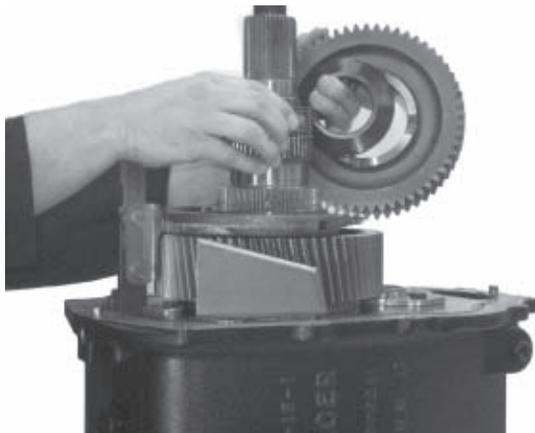
18. Tap the reverse idler shaft out of the housing.



19. Remove the reverse idler gear and bearings.



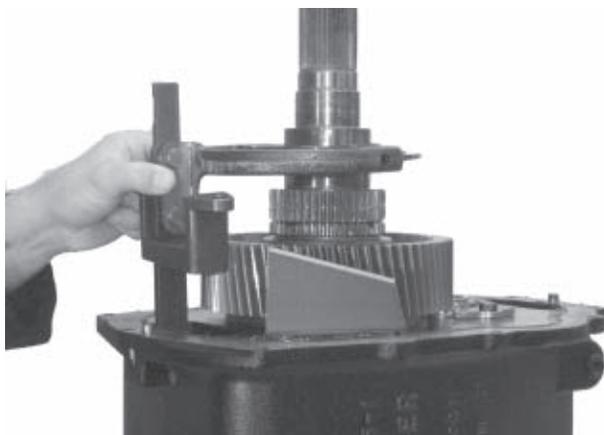
22. Next, remove the rear mainshaft.



20. Continue by removing the thrust washer, reverse gear, and the caged needle bearings.



23. To remove 1st gear from the mainshaft, first remove the snap ring. **Always wear safety glasses to protect your eyes when servicing transmissions.**



21. Unbolt the rear shift bar support bracket. Lift the 1st/ reverse fork and collar assembly from the housing.



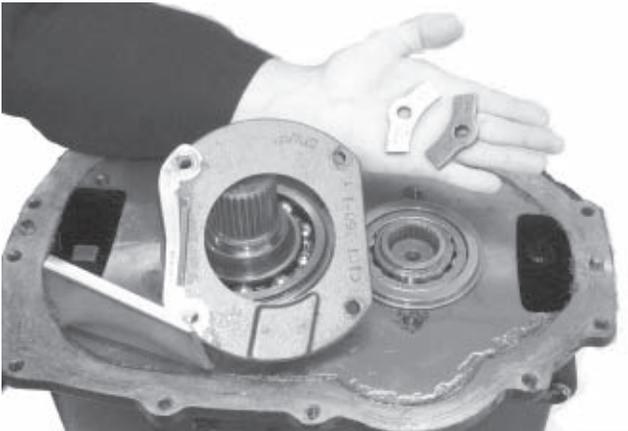
24. Remove the thrust washer and lock ball next.



25. Remove 1st gear and the bearing from the shaft. The clutch gear is a part of the shaft.



27. Lock the transmission into two gears. Remove the snap ring or mainshaft intermediate nut, depending on which component your unit contains. If your unit contains the mainshaft intermediate nut, the easiest way to remove it is to use the special socket pictured on the tool reference page.



26. Continue by removing the two intermediate bearing caps. The large oil trough connected to the housing doesn't have to be removed.



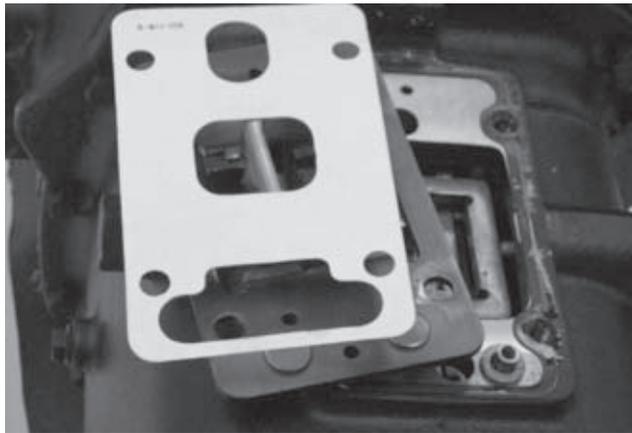
28. Use pry bars to remove the mainshaft and countershaft bearings.



1. After removing the transmission from the vehicle, drain the oil. **Let the unit cool down first.** Otherwise, hot transmission fluid could cause burns.



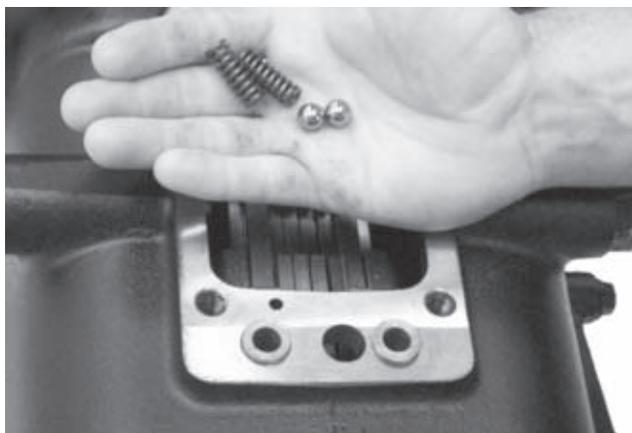
4. The backup light switch can be removed if it is going to be replaced. Otherwise, it does not have to be removed during servicing.



2. Remove the interlock retaining drive screws. Next remove the gaskets and interlock retainer plate.



5. If the driver has experienced shifting problems, check the crossgate plunger and spring at this time. Replace them if they are worn or damaged. If no problems have occurred, it is not necessary to remove the plunger.



3. Remove the detent springs and detent balls.

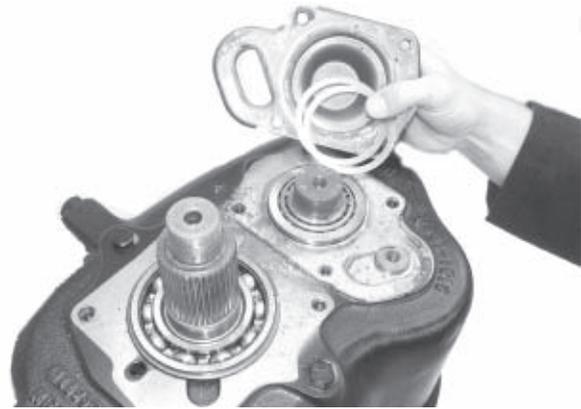


6. Attach a bracket or lift hooks to the rear case. Secure with bolts, which are at least hand-tightened. **Lift the transmission with a hoist**, and set it on end on a workbench that contains a hole for the drive gear.





7. Remove the nut, washer, and end yoke or flange.



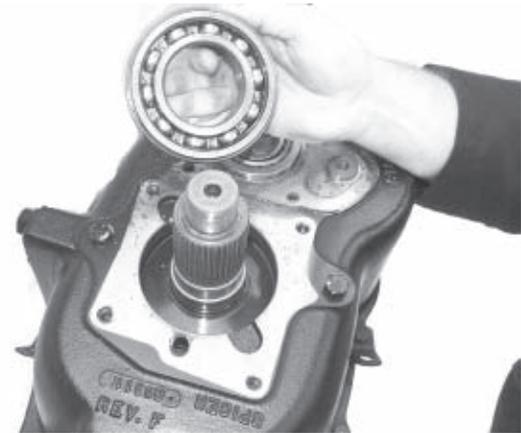
10. Remove the countershaft bearing cap and shims.



Note: Some models have a rear countershaft PTO option. In this situation, the countershaft will come out with the rear case when it is removed.



8. Remove the output bearing cap and gasket.



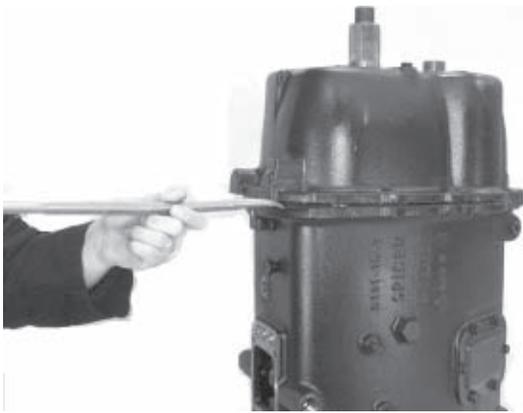
11. Using a puller in the milled slots, remove the rear mainshaft bearing.



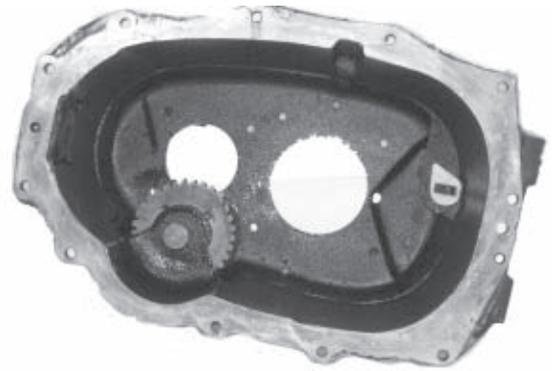
9. Next remove the speedometer signal gear.



12. Remove bolts from housing.



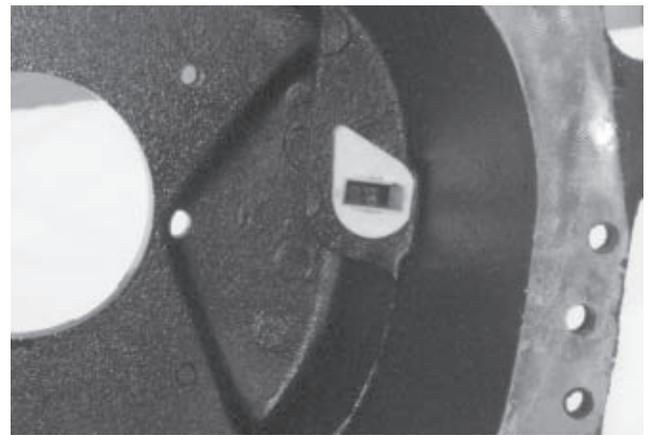
13. Next, place pry bars in the slots provided in the rear case. Break the seal.



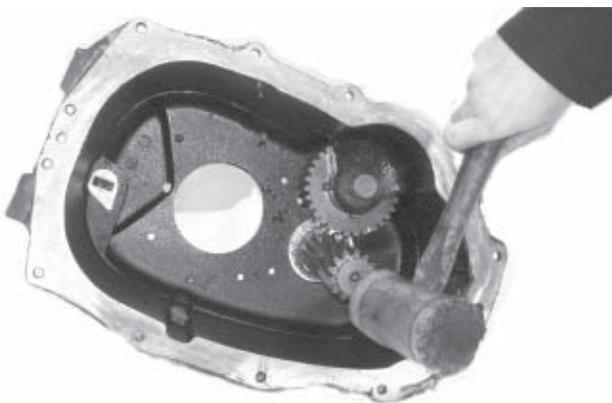
16. The reverse idler shaft and gear stay in the housing.



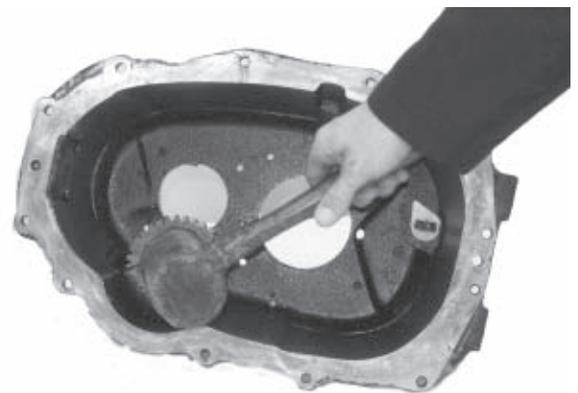
14. Then use a chain hoist to remove the rear housing.



17. Notice that the 1st/reverse shift fork support bracket also stays in the housing. This bracket should not be removed unless it is broken and is going to be replaced.



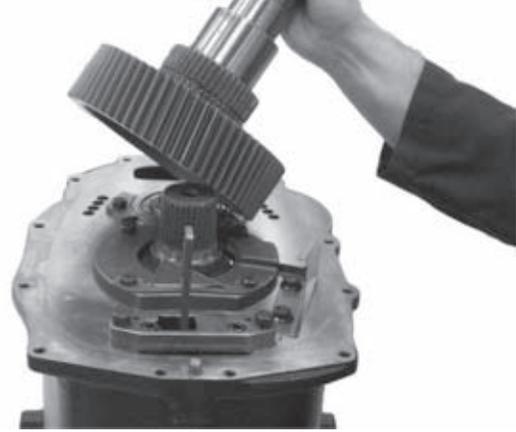
15. Using a plastic mallet, tap the rear countershaft out of the rear of the case.



18. Tap the reverse idler shaft out of the housing.



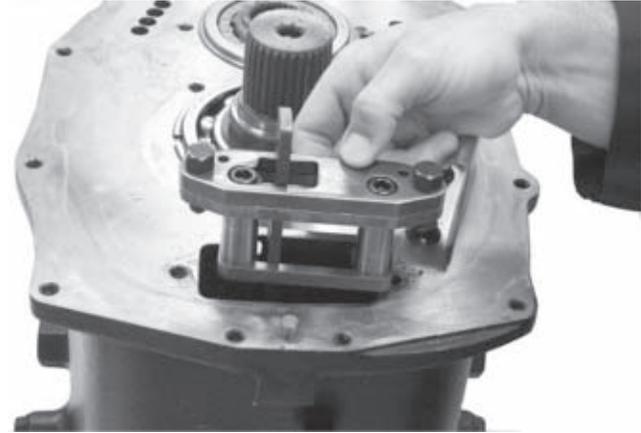
19. Remove the reverse idler gear and bearings.



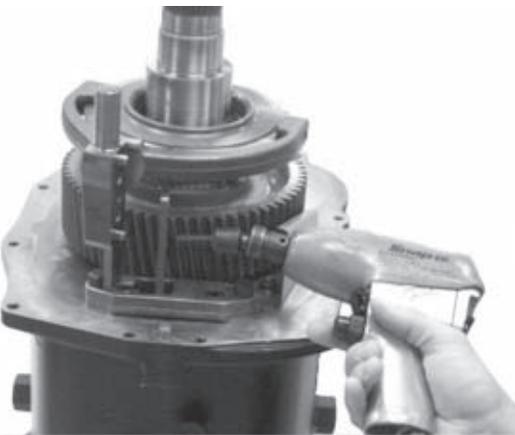
22. Remove rear mainshaft assembly.



20. Continue by removing the thrust washer, reverse gear, and the caged needle bearings.



23. Remove retaining bolts and rear shift bar support.



21. Remove retaining bolt from 1st/reverse shift fork. Remove 1st/reverse shift fork and collar from output shaft.



24. To remove 1st gear from the mainshaft, first remove the snap ring. **Always wear safety glasses to protect your eyes when servicing transmissions.**

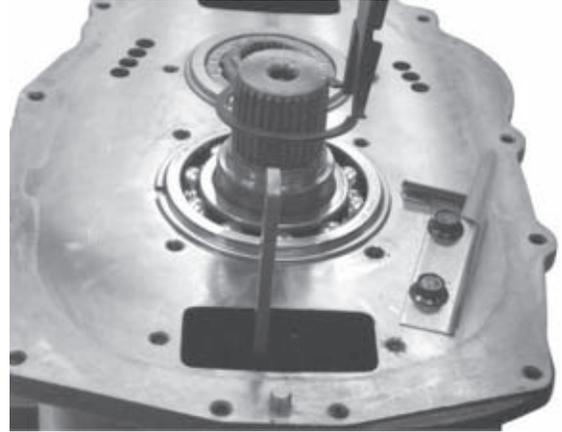




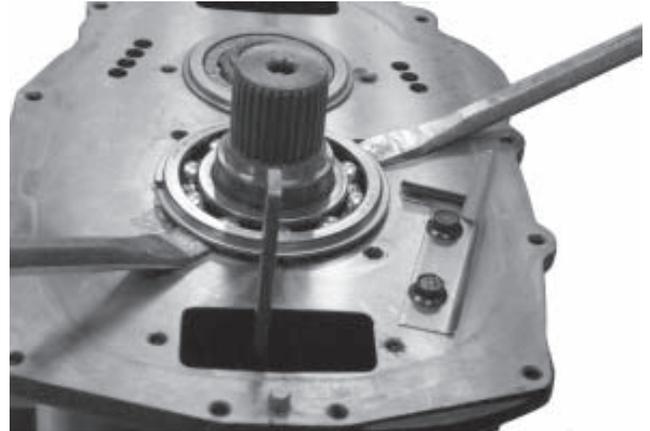
25. Remove the thrust washer and lock ball next.



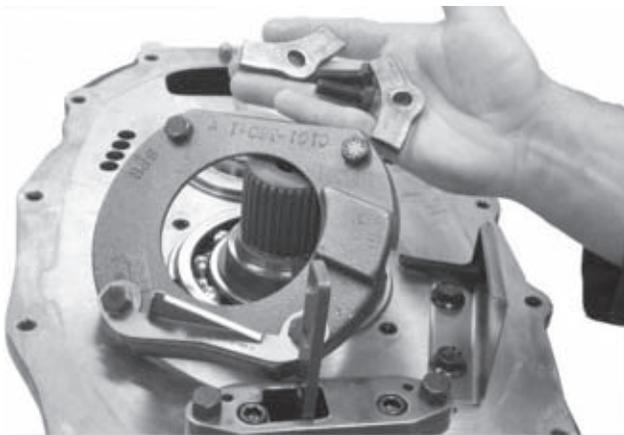
26. Remove 1st gear and the bearing from the shaft. The clutch gear is a part of the shaft.



28. Lock the transmission into two gears. Remove the snap ring or mainshaft intermediate nut, depending on which component your unit contains. If your unit contains the mainshaft intermediate nut, the easiest way to remove it is to use the special socket pictured on the tool reference page.



29. Use pry bars to remove the mainshaft and countershaft.

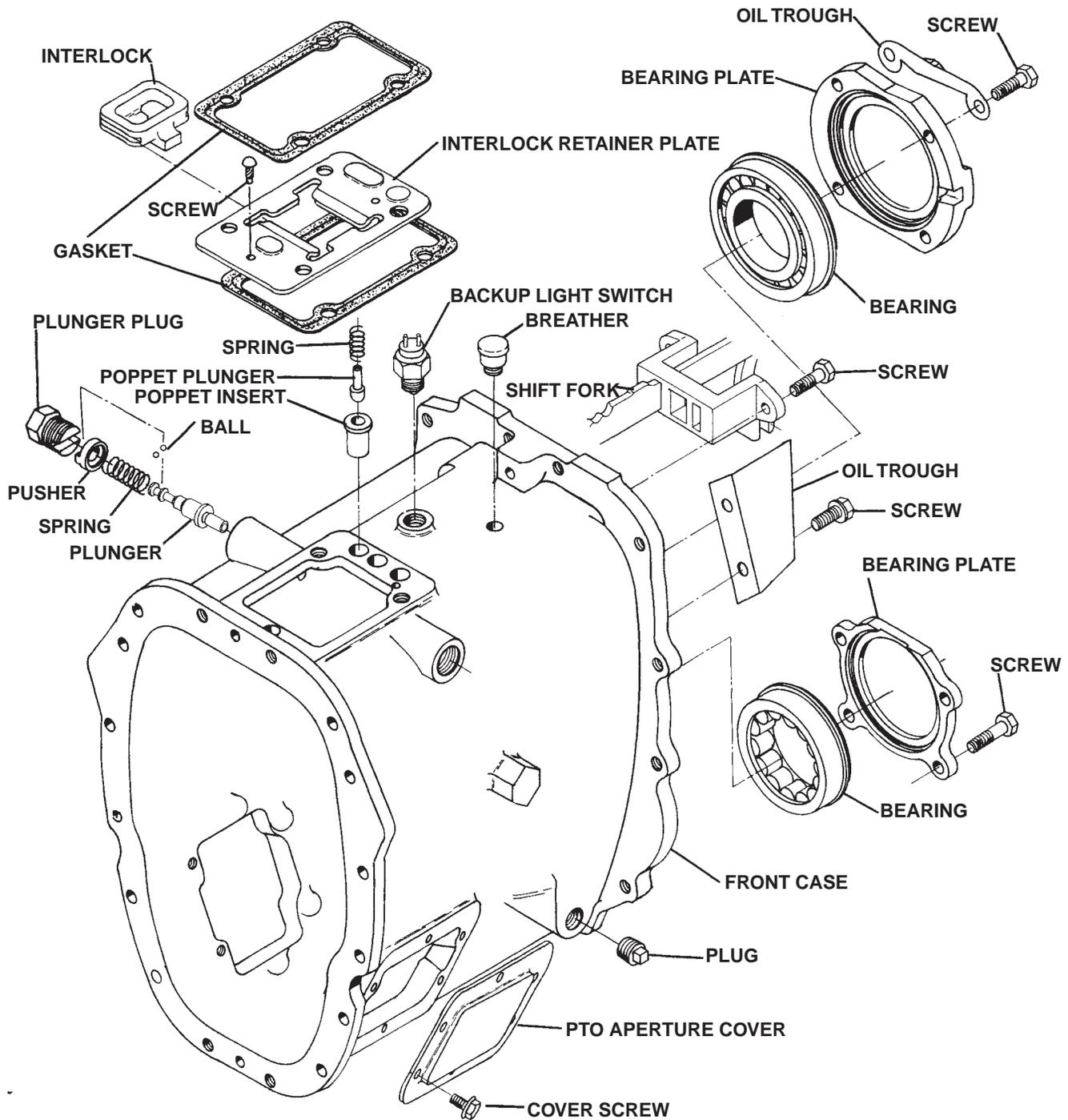


27. Continue by removing the two intermediate bearing caps. The large oil trough connected to the housing doesn't have to be removed.

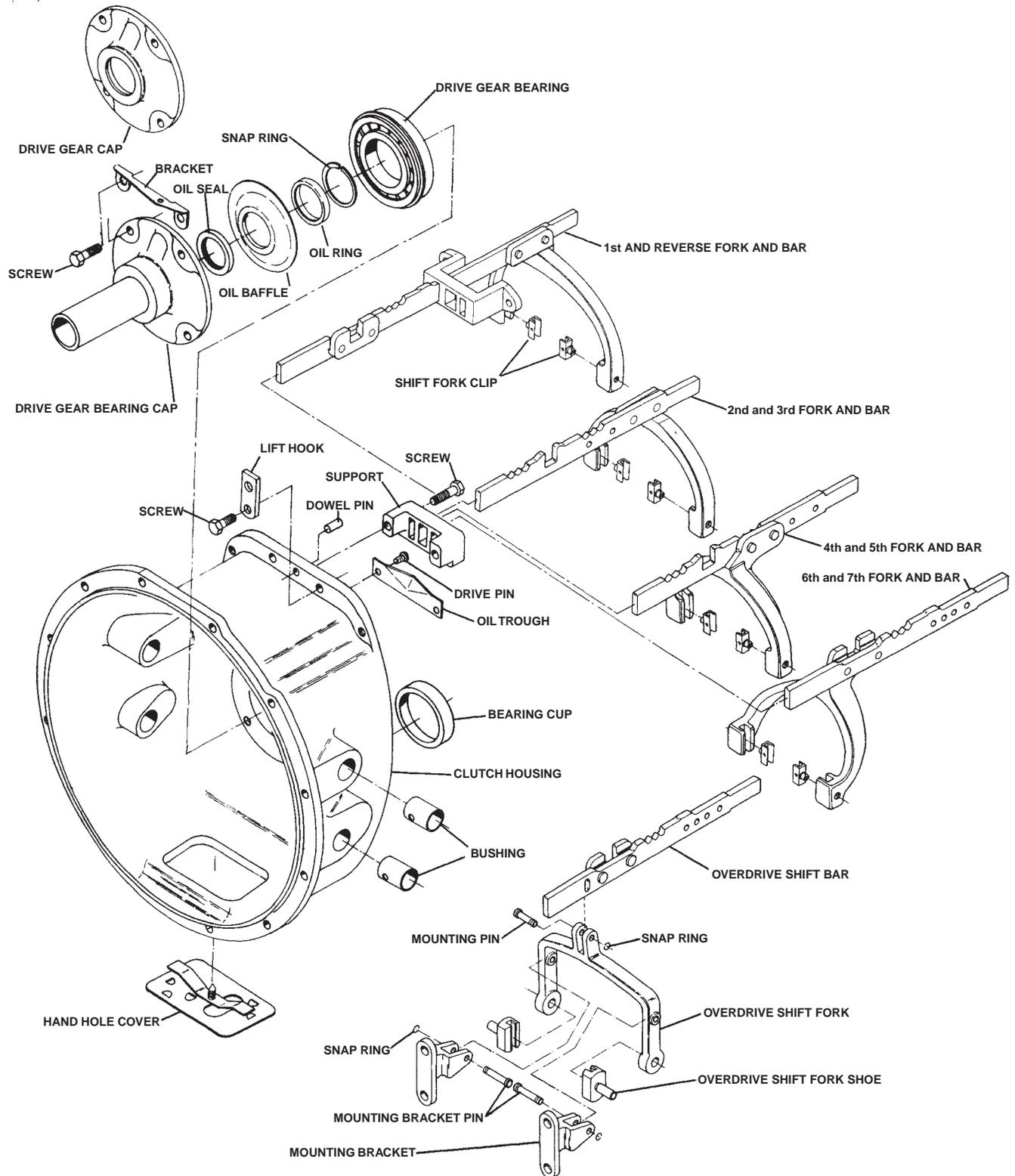
MAIN CASE DISASSEMBLY

SECTION VI

Main Case Exploded Drawing

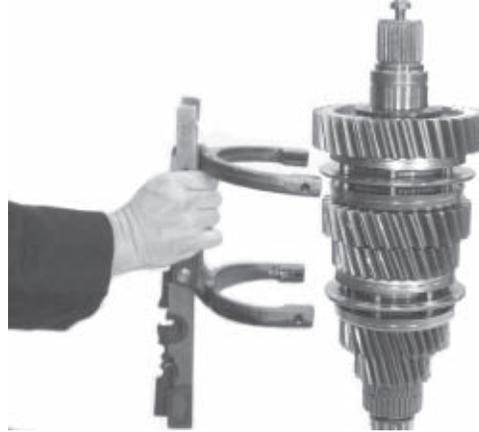


Clutch Housing & Shift Forks Exploded Drawing





1. Remove case bolts.



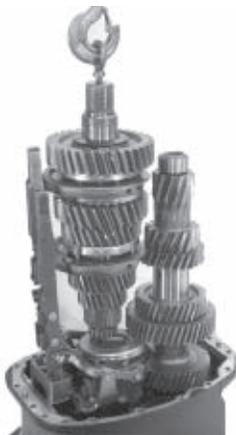
4. Remove the forks from the mainshaft.



2. Begin main case disassembly by removing the housing.
Use a chain hoist.



5. Tilt the countershaft and lift it from the housing.



3. **Lift the mainshaft from the case with the help of a hoist.**



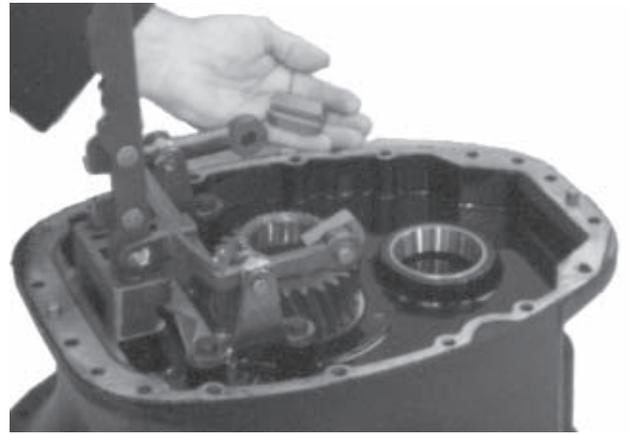
It may be necessary to tilt the countershaft to the side for clearance. Note that the 2nd/3rd and 4th/5th speed forks lift out of the housing with the mainshaft.



6. Slide the synchronizer away from the fork clips.



7. The overdrive fork is pictured here. It is not necessary to remove this fork, although the technician may wish to do so.



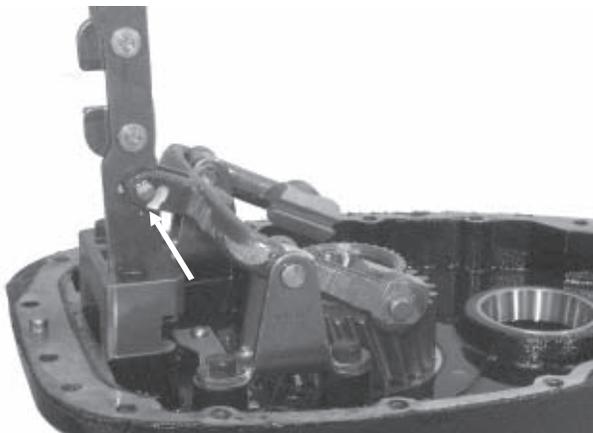
10. If the overdrive shift fork clips or the direct drive shift fork shoes are worn, they must be removed and replaced.



8. The direct shift fork, shown at left, also could be removed at this time.



11. Next, tip the clutch housing up. Remove the four drive gear bearing cap capscrews.



9. If the overdrive shift bar is worn, simply remove the snap ring and pin. Replace the bar, and secure it with the shift fork mounting pin and snap ring.



12. Use the milled slot to pry the bearing cap away from the housing.



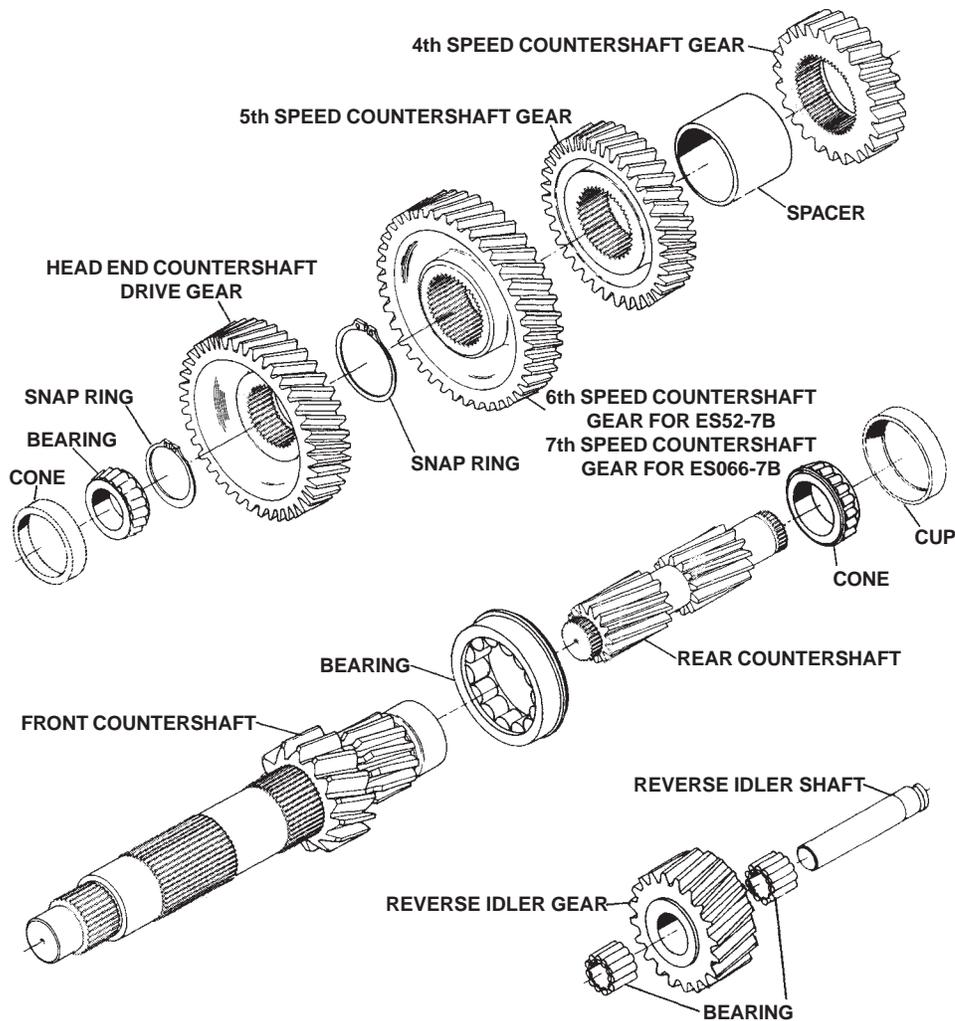
13. Remove the cap and oil baffle. Then tap the drive gear out of the clutch housing.



14. Continue by removing the snap ring and oil ring. Also remove the bearing.



Countershaft Exploded Drawing





1. Remove case bolts.



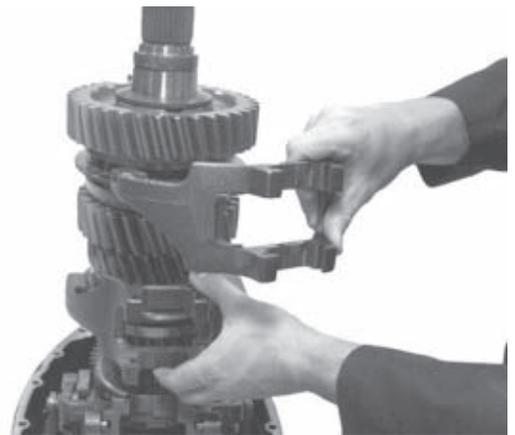
4. Remove rail channel from shift forks and front bar support.



2. Begin main case disassembly by removing the housing.



Use a chain hoist.



5. Remove 2nd/3rd shift fork, 4th/5th shift fork. (Overdrive models) remove shift fork assembly retaining bolts from clutch housing. (Direct models) remove 6th/7th shift fork.



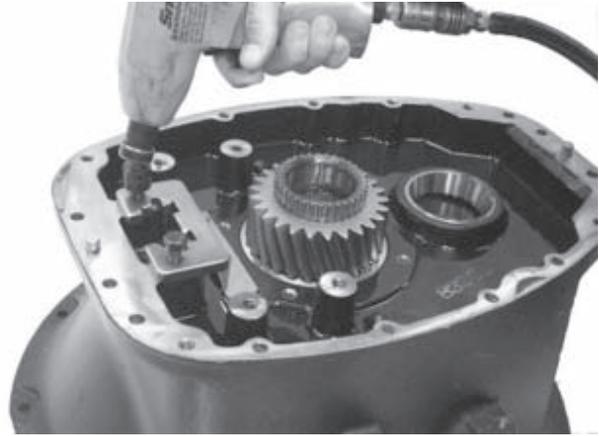
3. Remove shift rails from rail channel.



6. Remove 2nd speed gear assembly and 2nd/3rd synchronizer.



7. Remove main shaft.



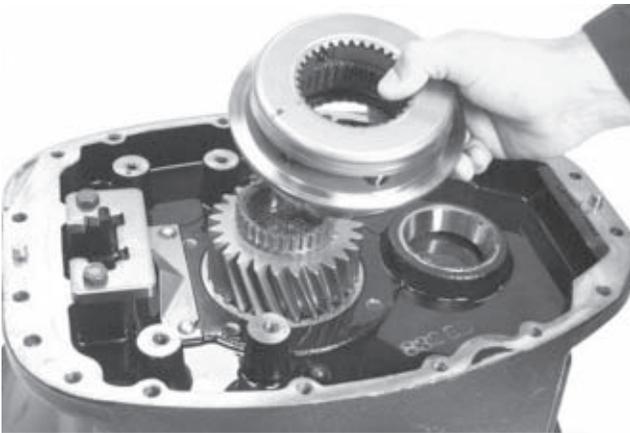
10. Remove retaining bolts and front shift bar support.



8. Remove countershaft (tilting the countershaft is the easiest way to do this).



11. Next, tip the clutch housing up. Remove the four drive gear bearing cap capscrews.



9. Remove 6th/7th synchronizer.



12. Use the milled slot to pry the bearing cap away from the housing.



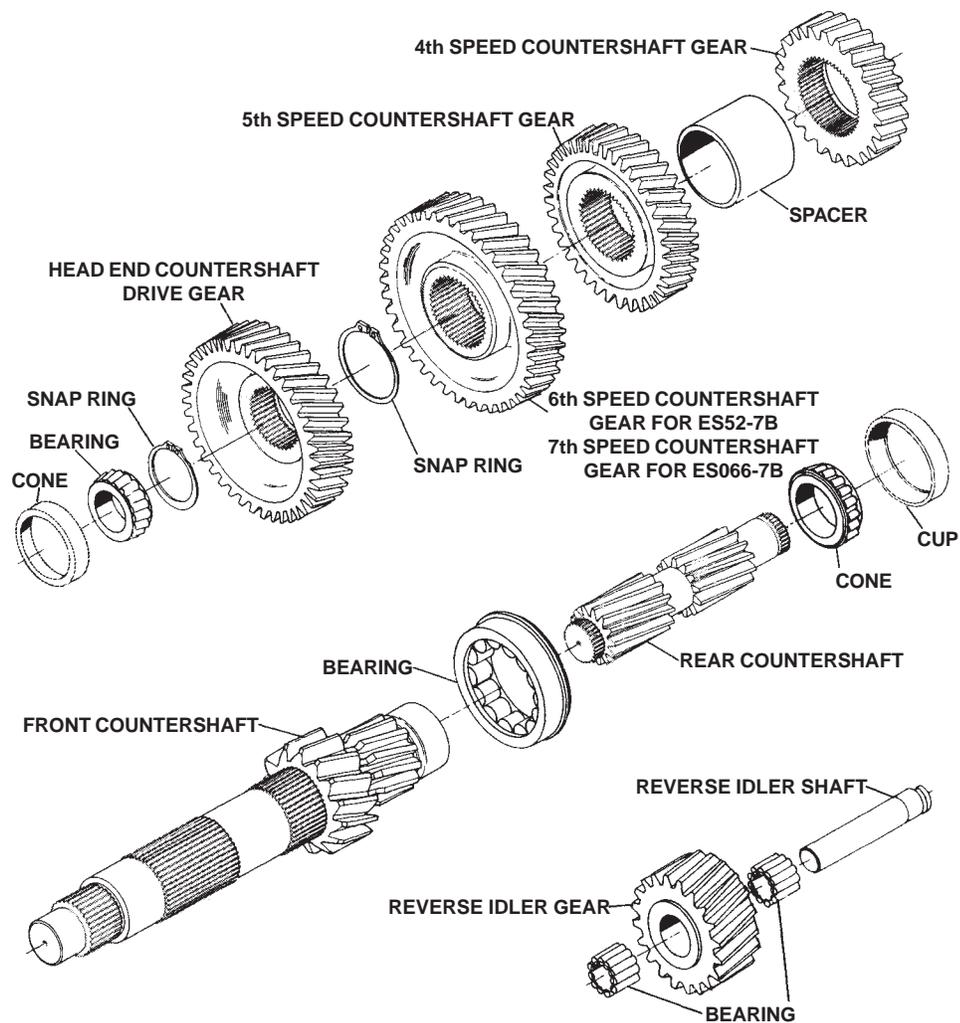
13. Remove the cap and oil baffle. Then tap the drive gear out of the clutch housing.



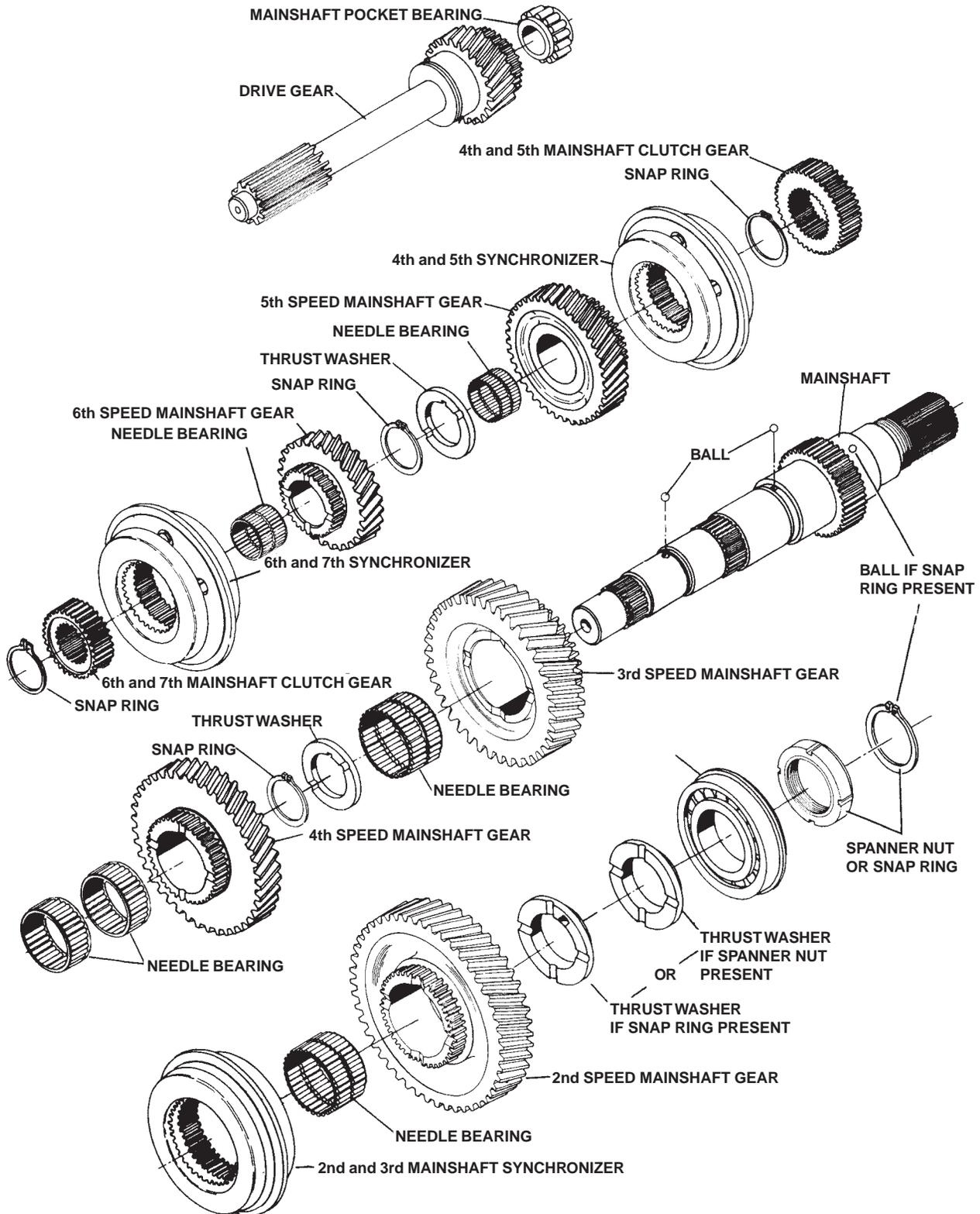
14. Continue by removing the snap ring and oil ring. Also remove the bearing.



Countershaft Exploded Drawing



Mainshaft Exploded Drawing





1. Place the shaft in a vise with protective jaws, or a holding fixture.



4. Next remove the overdrive gear in an overdrive unit, or 6th speed gear in a direct drive unit. There are two caged needle bearings in the gear.



2. 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.



5. Remove the snap ring, thrust washer, and lock ball. (The lock ball prevents the thrust washer from turning on the shaft.) Also remove 5th speed gear, and the two caged needle bearings.



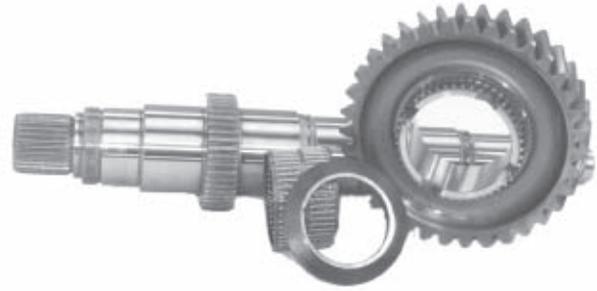
3. Attach a puller to the 6th/7th speed clutch gear. Remove the gear and the drive gear bearing together.



6. Remove the 4th/5th speed synchronizer from the shaft.



7. **Wearing safety glasses, remove the snap ring and 4th/5th speed clutch gear.** Also remove 4th speed gear and the two caged needle bearings. Notice that one bearing is wider than the other. This will be important during reassembly.



10. Then remove the thrust washer, 2nd speed gear, and the caged roller bearing.



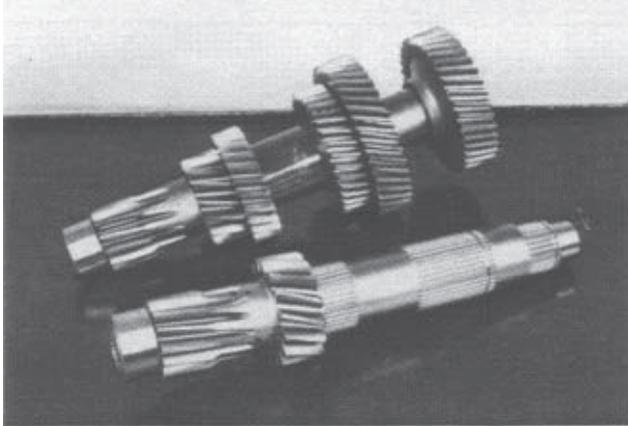
8. **The snap ring, thrust washer, and lock ball can be removed.** Also remove 3rd speed gear and the caged needle bearing.



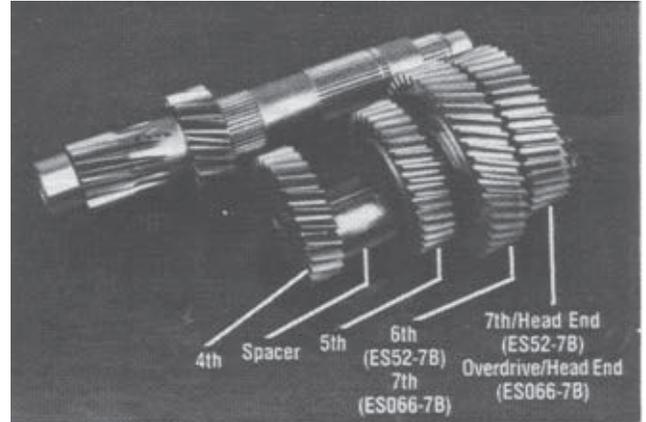
11. Disassembly of the mainshaft is complete.



9. Remove the 2nd/3rd speed synchronizer.



1. The countershaft gears are easily pressed off and on this shaft. The rolled involute splines provide increased torque capacity.



2. When assembling this countershaft, make sure the gears are positioned correctly:

- 4th speed gear recessed ID faces 3rd gear (3rd gear is part of the shaft)
- Spacer
- 5th speed gear
- Overdrive gear (or 6th speed gear on a direct shift unit). Part number faced 5th speed gear
- 7th speed gear hub faces overdrive gear (or 6th speed gear on a direct shift unit)

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. Also check for worn or damaged splines. 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. Lubricate all bearings with oil before beginning reassembly. Continue by placing the caged needle bearing and 2nd speed gear (hub toward clutch gear) on the shaft. Position the thrust washer on the shaft, then press the bearing race into place.



2. Place the assembly in a vise or holding fixture.



3. Lubricate the 2nd/3rd speed synchronizer with oil, then slide it onto the shaft. Shift it into 2nd gear.



4. Place the caged needle bearing and 3rd speed gear onto the shaft. The gear hub should point toward 2nd/3rd speed synchronizer. Position the lock ball into the shaft and slide the thrust washer into place.



5. Note that the lock ball keeps the thrust washer from rotating on the shaft. **Wearing safety glasses,** Continue by installing the snap ring with the rounded side toward the thrust washer.



6. Continue by placing two caged needle bearings (wider one first) on the shaft. Slide 4th speed gear on the shaft with the clutching teeth up. Also install 4th/5th speed clutch gear. **Secure it with a snap ring.** The rounded side of the snap ring should face the clutch gear.





7. Lubricate then Install the 4th/5th speed synchronizer.



9. Install two caged needle bearings and either the overdrive gear (for the overdrive version) or the 6th speed gear (for the direct version). The clutch teeth should face up. Install the 6th/7th speed clutch gear, and secure it with the spiral snap ring.



8. Next, install the two caged needle bearings and 5th speed gear. The gear hub should face the synchronizer. Put the lock ball into place. **Then install the thrust washer and snap ring.**

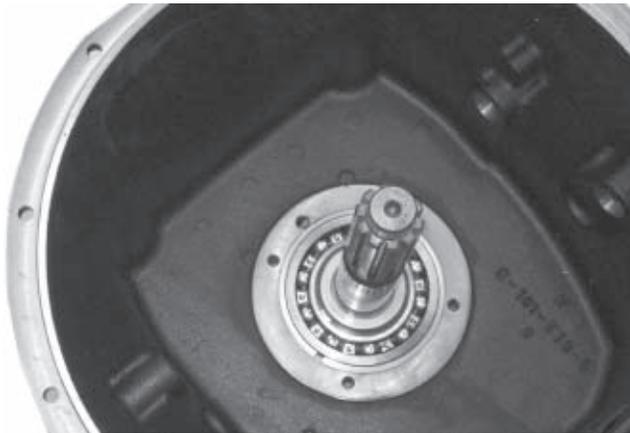


10. **Press the bearing onto the end of the shaft.** The chamfered side of the bearing should face the 6th/7th speed clutch gear.

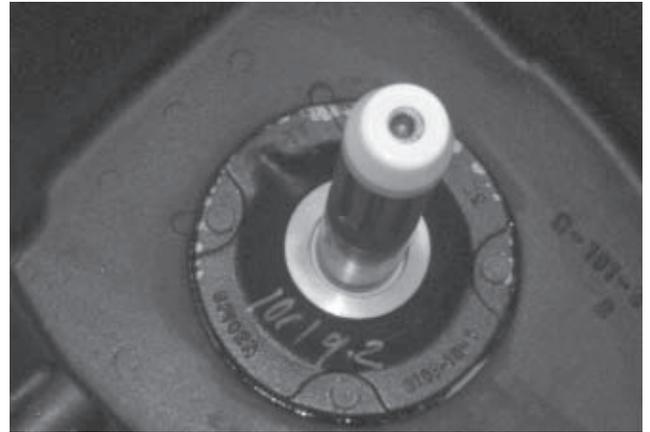




1. **Press the bearing into place and install snap ring.** Then use a suitable press to push the oil ring into place. A brass hammer can also be used for this procedure.



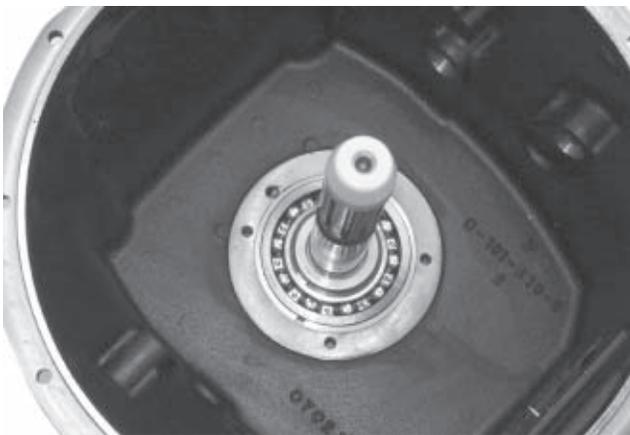
2. Install the drive gear into the clutch housing.



4. Install the oil baffle. Then coat the drive gear bearing cap with purple Loctite 515 or the equivalent, aligning the lubrication holes. Torque the cap screws to 25 - 41 ft. lbs.



5. Place the clutch housing, drive gear face down, on the workbench.



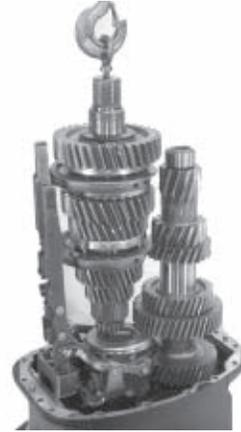
3. **Place a protective sleeve over the shaft before installing the bearing cap.** (See the warning on the inside front cover of this manual.) Also notice the position of the lubrication hole. The bearing cap lubrication hole must be aligned with this housing lubrication hole.



6. Install the overdrive fork if it was removed earlier. Secure it with bolts. Torque the bolts to 25 - 41 ft. lbs. If working on a direct-drive model, install the 6th/7th speed fork.



7. Next lubricate then install the 6th/7th speed synchronizer. Shift it down toward the drive gear. This will aid alignment.



10. Oil the pocket bearing race, then slide the mainshaft assembly into place. It may be necessary to tip the countershaft away from the mainshaft to do this. Make sure the shift bars line up with the shift bar support in the case.



8. The countershaft is installed next. Tilting the countershaft toward the mainshaft is the easiest way to do this. Notice that there aren't any timing marks on the gears. There is no need to time the countershaft to the mainshaft.



11. Coat the clutch housing sealing surface with purple Loctite 515 or the equivalent. **Lower the case into place with the help of a chain hoist.** Secure it with bolts. Torque to 25 - 41 ft. lbs.

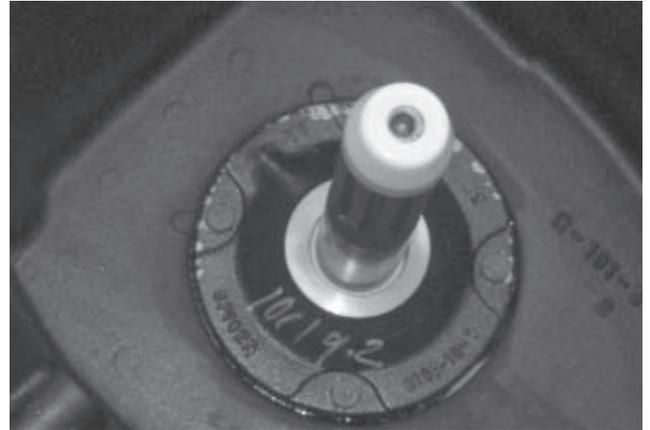


9. **Lift the mainshaft with a hoist.** While it is in the air, install 2nd/3rd and 4th/5th speed forks into place.

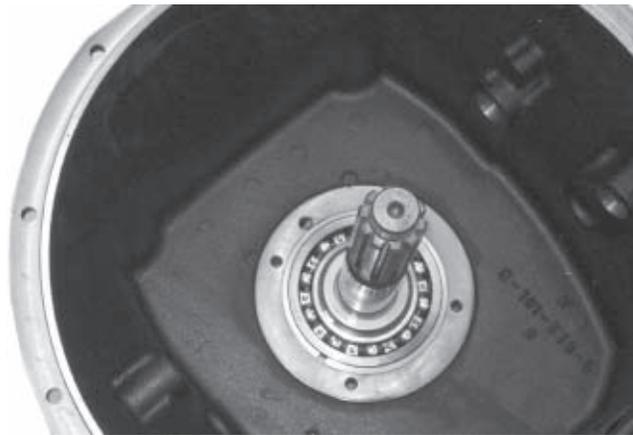




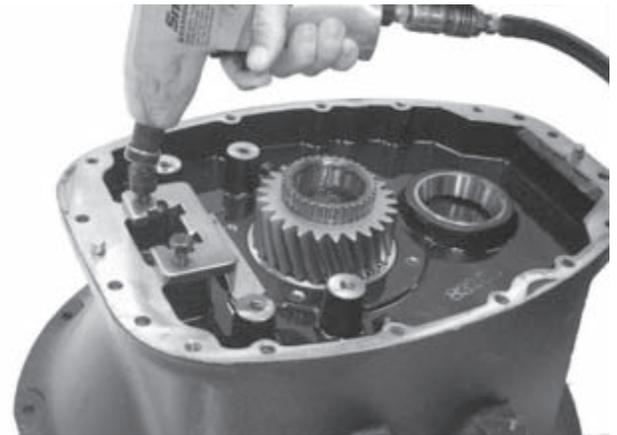
1. **Press the bearing into place and install snap ring.** Then use a suitable press to push the oil ring into place. A brass hammer can also be used for this procedure.



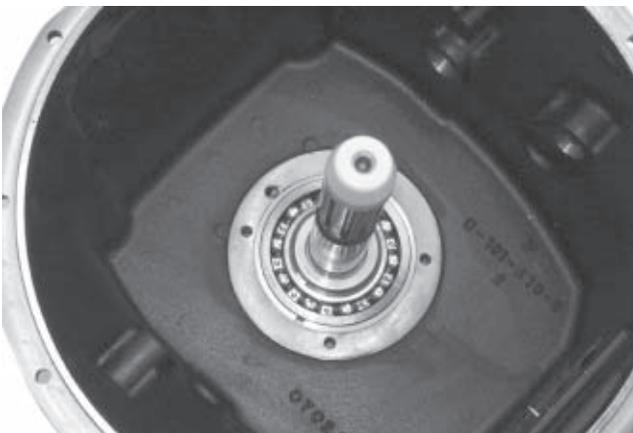
4. Install the oil baffle. Then coat the drive gear bearing cap with purple Loctite 515 or the equivalent, aligning the lubrication holes. Torque the cap screws to 25 - 41 ft. lbs.



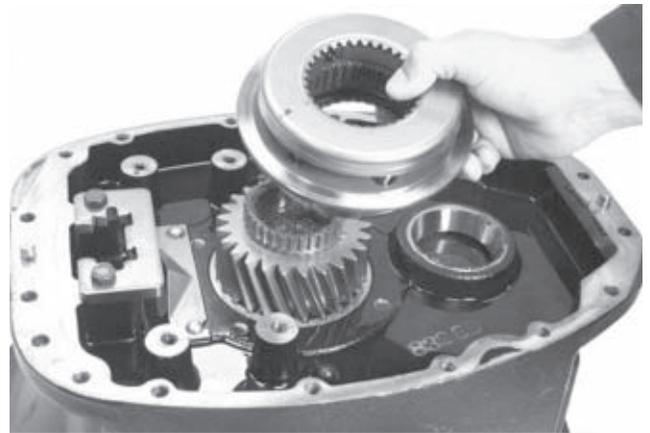
2. Install the drive gear into the clutch housing.



5. Place the clutch housing, drive gear face down, on the workbench and install front bar support, secure with bolts and torque to 25 - 41 ft. lbs.



3. **Place a protective sleeve over the shaft before installing the bearing cap.** (See the warning on the inside of this manual.) Also notice the position of the lubrication hole. The bearing cap lubrication hole must be aligned with this housing lubrication hole.



6. Next lubricate then install the 6th/7th speed synchronizer. Shift it down toward the drive gear. This will aid alignment.



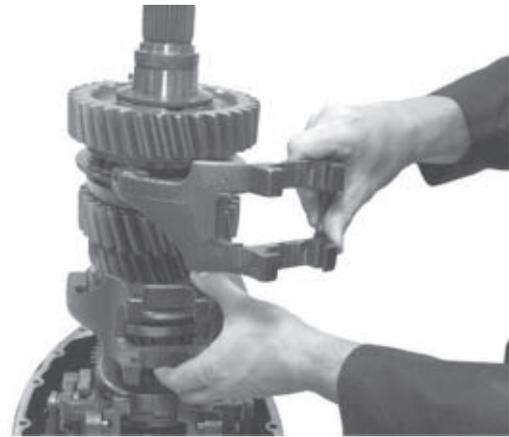
7. The countershaft is installed next. Tilting the countershaft toward the mainshaft is the easiest way to do this. Notice that there aren't any timing marks on the gears. There is no need to time the countershaft to the mainshaft.



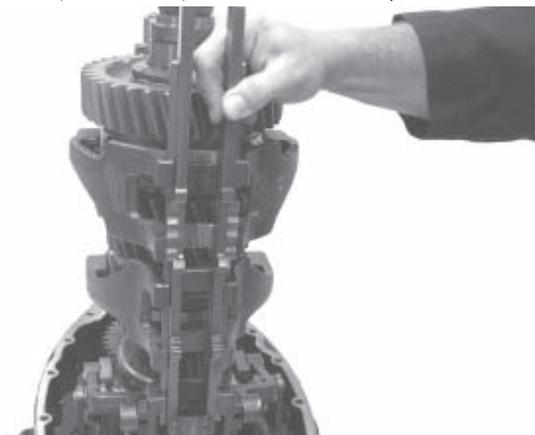
8. Oil the pocket bearing race, then slide the mainshaft assembly into place. It may be necessary to tip the countershaft away from the mainshaft to do this.



9. Lubricate the 2nd/3rd synchronizer with oil, then slide it onto the shaft. Continue by placing the caged needle bearing and 2nd speed gear (hub toward synchronizer) on the shaft. Position the thrust washer on the shaft.



10. Slide the 2nd/3rd shift fork onto the 2nd/3rd synchronizer. (The part #101-66-14 stamped on shift fork should be facing up). Slide the 4th/5th shift fork onto the 4th/5th synchronizer (The part #101-66-17 stamped on shift fork should be facing down). Slide the 6th/7th shift fork onto the 6th/7th synchronizer. (The part #101-66-16 stamped on the shift fork should be facing up). (Overdrive) Attach the 6th/7th shift fork assembly to the clutch housing, torque bolts to 25 - 41 ft. lbs. (On direct models) slide 6th/7th shift fork onto synchronizer.



11. Install the rail channel from the top through the shift forks and down into the front bar support.



12. Gather all 4 shift rails and put them in order from left to right (1st/reverse, 2nd/3rd, 4th/5th, and 6th/7th).



13. Slide the shift rails into the front bar support and in place between the rail channel. When properly installed in the rail-channel, the tabs on the bottom of the shift rails will line up with the appropriate shift fork. Also, there are indentations on rails 2/3, 4/5, and 6/7. If the rails are installed properly, the indentations will descend from left to right. After insuring proper installation, temporarily secure shift rails with a zip tie.

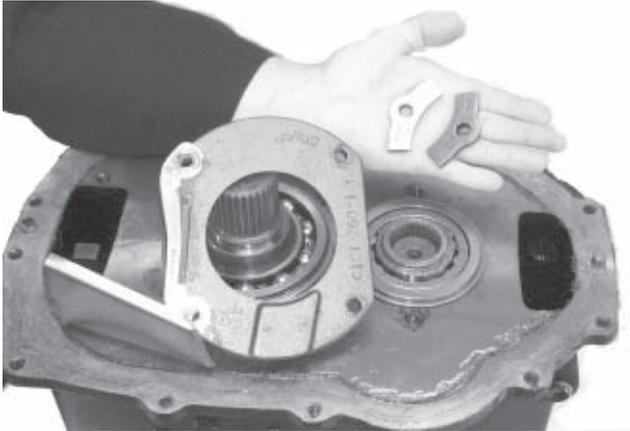


14. Coat the clutch housing sealing surface with purple Loctite 515, or equivalent. **Lower the case into place with the help of a chain hoist.** Secure it with bolts. Torque to 25 -41 ft. lbs.





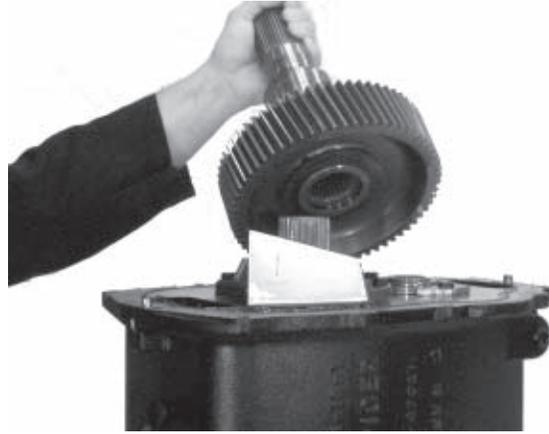
1. **Install the snap rings on the intermediate bearings.** Lock the transmission into two gears. If the unit is to be secured by a snap ring, lift up on 4th gear to expose the snap ring groove. Install the snap ring. If the unit is secured with a nut, install the nut on the mainshaft using the special socket listed in the tool reference. Torque the nut to 300 - 325 ft. lbs.



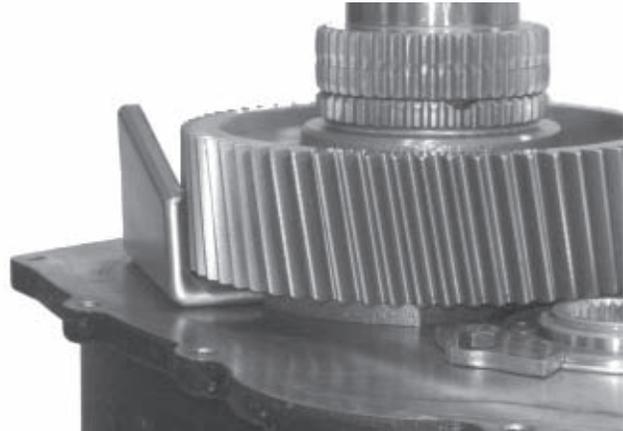
2. Install the intermediate bearing caps. The mainshaft bearing cap has a groove that lines up with the lubrication hole in the housing. **Do not use gaskets or sealing compounds on either cap because it could prevent proper lubrication to the unit.** Torque the cap capscrews to 25 - 41 ft. lbs.



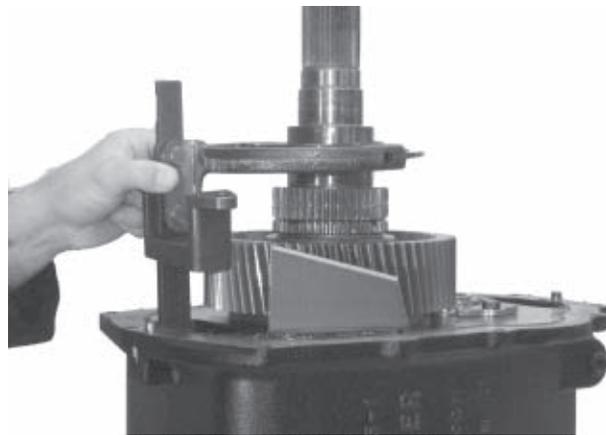
3. Next install the bearing and 1st gear onto the rear mainshaft. **Also install the lock ball, thrust washer, and snap ring.**



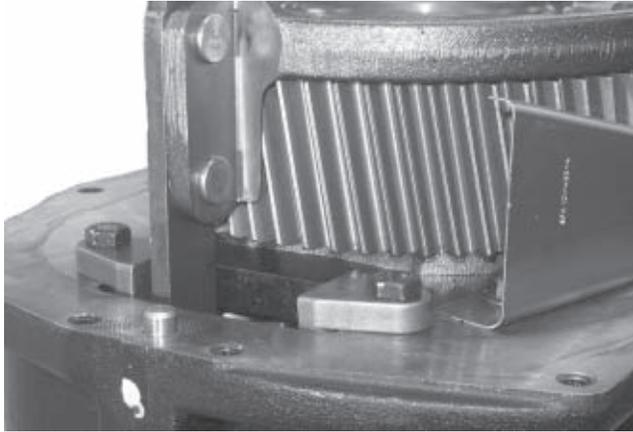
4. Use Moly #2 lubricant to coat the mainshaft splines. Then install the rear mainshaft.



5. If the trough was removed earlier, check now to make sure there is proper clearance between it and 1st gear.



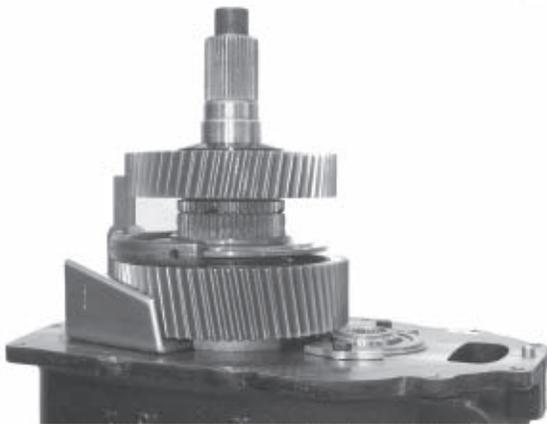
6. Install the fork and 1st/reverse shift collar. When the shift bar won't drop further, push in on the fork bars at the shift tower opening while pushing the fork bar bracket down. This will aid alignment.



7. Secure the bracket with cap screws. Torque the cap screws to 25 - 41 ft. lbs.



10. The straight edge on the end of the idler shaft must be positioned as shown here. Tap it into the case so the top portion of the shaft is flush with the case, or not more than .030" below the case surface. The lower portion of the idler shaft will extend about 1/4" above the case.



8. Next install the caged bearing and reverse gear. The gear hub should face the bearing. Also install the thrust washer, with the tapered side up.



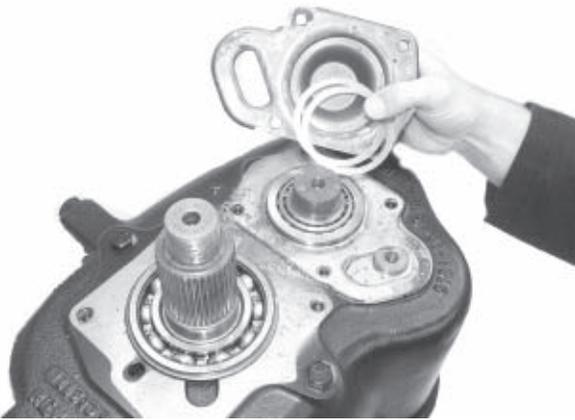
11. Coat the case sealing surface with purple Loctite 515 or the equivalent. **Then install the rear case with the aid of a chain hoist.** Secure with capscrews. Torque them to 25 - 41 ft. lbs. If a new 1st/reverse shift bar support was installed in the rear case, make sure the 1st/reverse bar is shifting properly.



9. Assemble the bearings and gear onto the idler shaft and install the assembly. Make sure the bearings are packed with Moly #2 lubricant.



12. Next install the rear mainshaft bearing, using the proper driver to avoid bearing damage. Also install the countershaft and the countershaft bearing race.



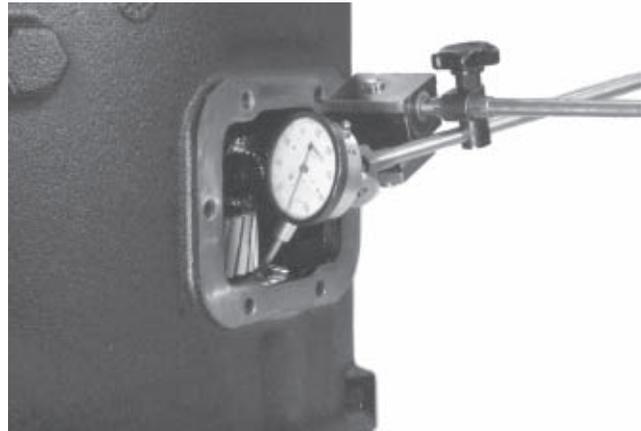
13. Coat the countershaft bearing cap with purple Loctite 515 or the equivalent. **Do not put sealant in the oil groove because it could prevent proper unit lubrication.**



16. Secure the bearing cap with cap screws. Torque them to 25 - 41 ft. lbs.



14. Secure the cap with cap screws. Torque them to 25 - 41 ft. lbs.



17. Remove the PTO cover and position a dial indicator as shown. Use a pry bar to lift up on a gear. End play should measure between .001"-.008". If end play is correct, replace the PTO cap and torque the cap screws to 25 - 41 ft. lbs. If end play is not correct, add or subtract shims under the rear countershaft bearing cap.



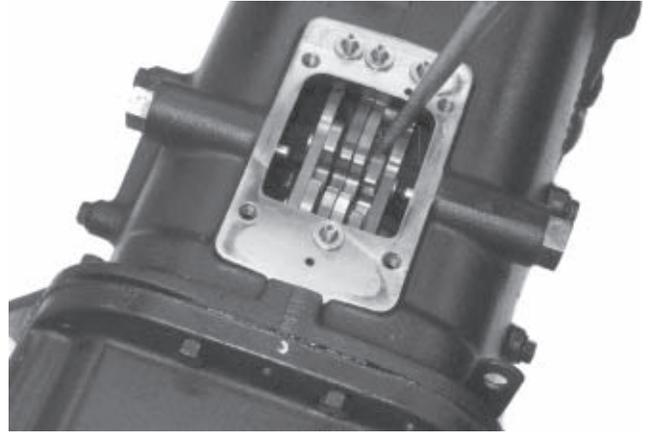
15. Install the signal gear and the mainshaft bearing cap and gasket. Make sure the bearing cap oil passage lines up with the oil passage in the transmission housing.



18. Install the flange or yoke. Secure with a nut. Torque to 300 - 325 ft. lbs.



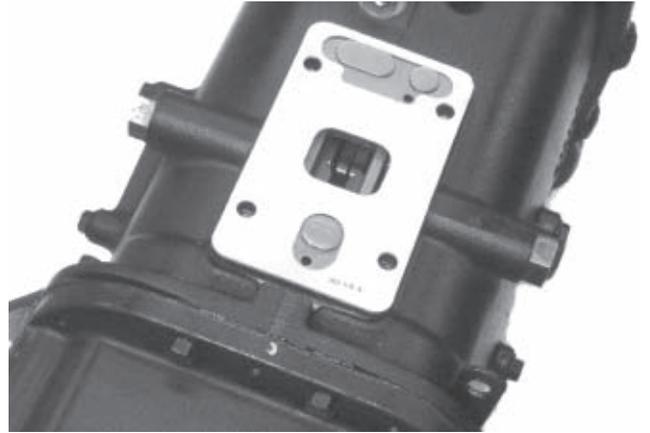
19. Set the transmission in normal operational position.



22. Bench shift the unit to make sure all forks are shifting properly.



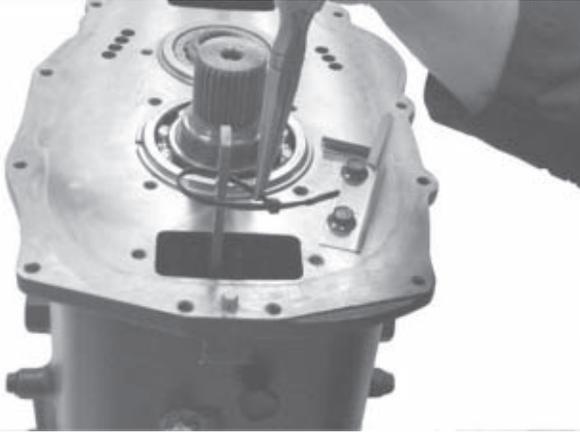
20. Install the backup light switch if it was removed earlier. Torque it to 25 - 41 ft. lbs.



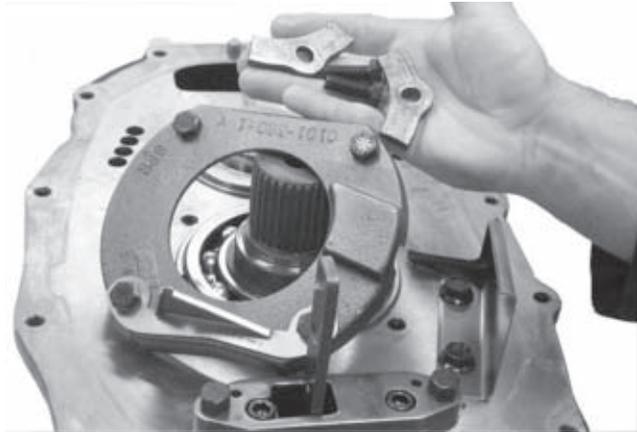
23. Install a gasket, the interlock plate, and the final gasket. Note the position of the interlock plate. This photograph shows its correct position. Next, shift into direct and install the transmission into the vehicle. Install the shift tower. Secure it with cap screws torqued to 25 - 41 ft. lbs.



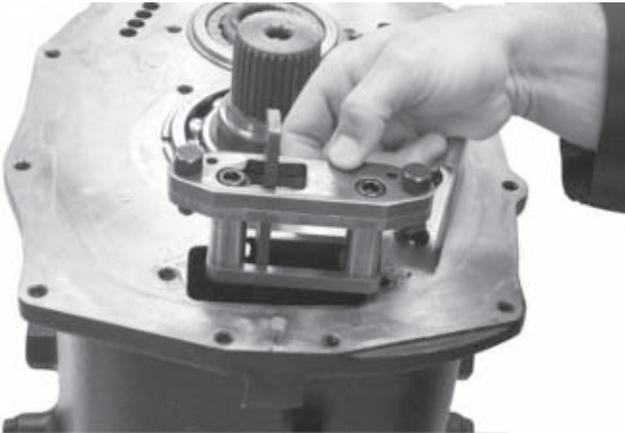
21. Next install the plungers and springs.



1. Remove zip tie with needle nose pliers and discard.



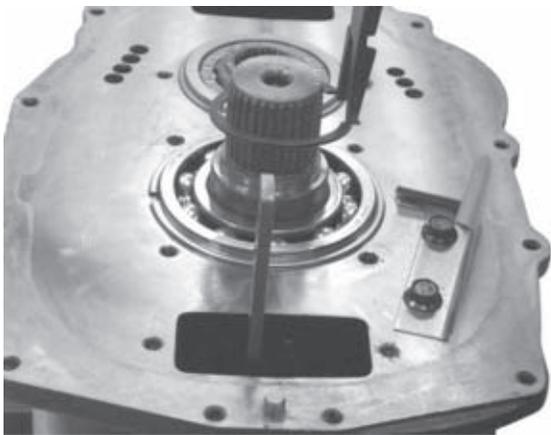
4. Install the intermediate bearing caps. The mainshaft bearing cap has a groove that lines up with the lubrication hole in the housing. **Do not use gaskets or sealing compounds on either cap because it could prevent proper lubrication to the unit.** Torque the cap screws to 25 - 41 ft. lbs.



2. Slide rear support on to the end of the rail channel, secure with bolts. Torque to 21 - 45 ft. lbs.



5. Next install the bearing and 1st gear onto the rear mainshaft. **Also install the lock ball, thrust washer, and snap ring.**



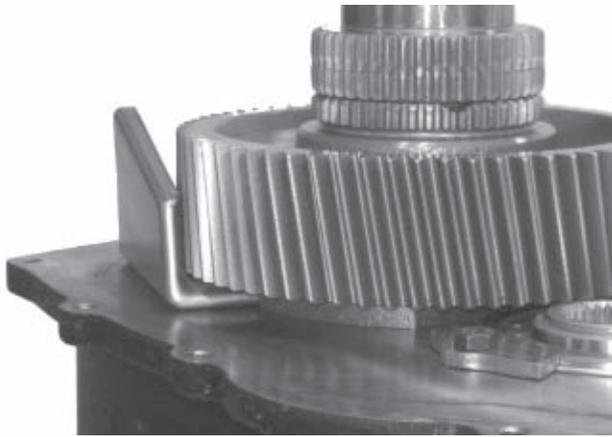
3. **Install the snap rings on the intermediate bearings.** Lock the transmission into two gears. If the unit is to be secured by a snap ring, lift up on 4th gear to expose the snap ring groove. Install the snap ring. If the unit is secured with a nut, install the nut on the mainshaft using the special socket listed in the tool reference. Torque the nut to 300 - 325 ft. lbs.



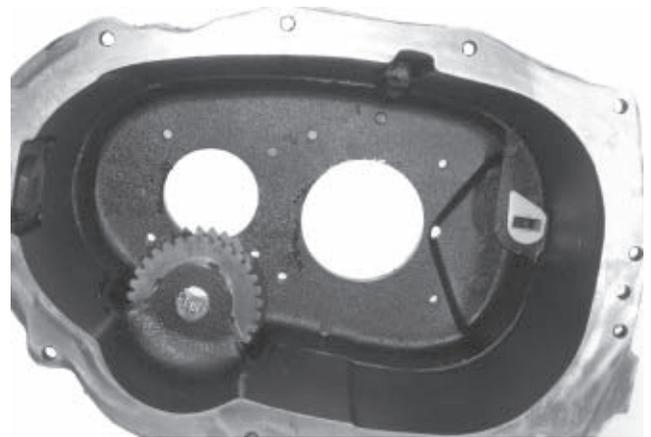
6. Use Moly #2 lubricant to coat the mainshaft splines. Then install the rear mainshaft.

REAR CASE REASSEMBLY (OPTI-RAIL)

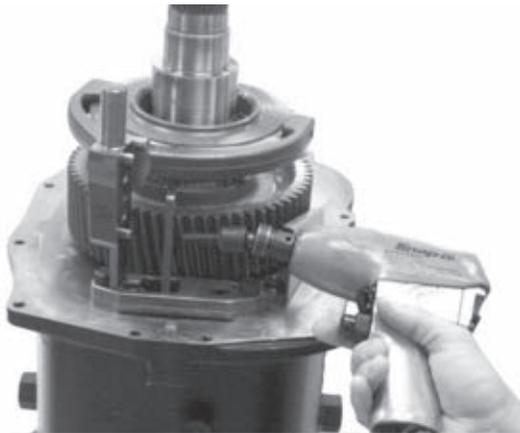
SECTION XII



7. If the trough was removed earlier, check now to make sure there is proper clearance between it and 1st gear.



10. Assemble the bearings and gear onto the idler shaft and install the assembly. **Make sure the bearings are packed with Moly #2 lubricant.**



8. Attach 1st/reverse fork to shift rail and torque bolt to 21 - 45 ft. lbs.



11. The straight edge on the end of the idler shaft must be positioned as shown here. Tap it into the case so the top portion of the shaft is flush with the case, or not more than .030" below the case surface. The lower portion of the idler shaft will extend about 1/4" above the case.



9. Next install the caged bearing and reverse gear. The gear hub should face the bearing. Also install the thrust washer, with the tapered side up.



12. Coat the case sealing surface with purple Loctite 515 or the equivalent. **Then install the rear case with the aid of a chain hoist.** Secure with cap screws. Torque them to 25 - 41 ft. lbs. If a new 1st/reverse shift bar support was installed in the rear case, make sure the 1st/reverse bar is shifting properly.

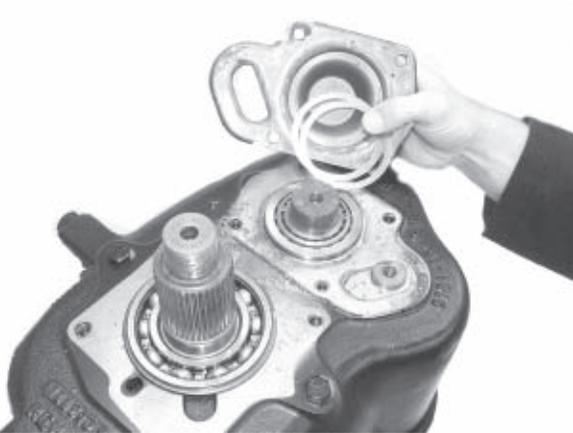




13. Next install the rear mainshaft bearing, using the proper driver to avoid bearing damage. Also install the countershaft and the countershaft bearing race.



16. Install the signal gear and the mainshaft bearing cap and gasket. Make sure the bearing cap oil passage lines up with the oil passage in the transmission housing.



14. Coat the countershaft bearing cap with purple Loctite 515 or the equivalent. **Do not put sealant in the oil groove because it could prevent proper unit lubrication.**



17. Secure the bearing cap with cap screws. Torque them to 25 - 41 ft. lbs.



15. Secure the cap with cap screws. Torque them to 25 - 41 ft. lbs.



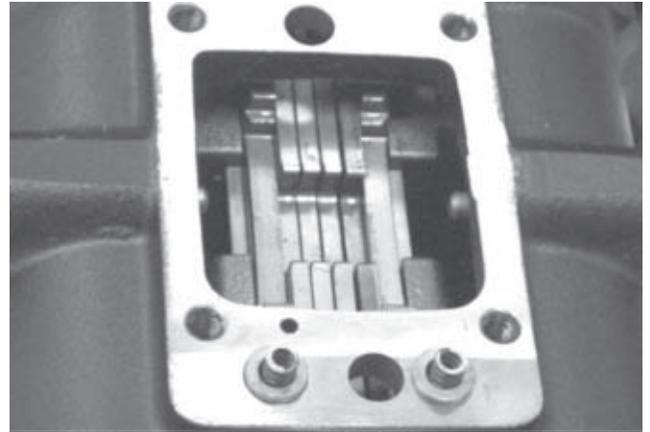
18. Remove the PTO cover and position a dial indicator as shown. Use a pry bar to lift up on a gear. End play should measure between .001"-.008". If end play is correct, replace the PTO cap and torque the cap screws to 25 - 41 ft. lbs. If end play is not correct, add or subtract shims under the rear countershaft bearing cap.

REAR CASE REASSEMBLY (OPTI-RAIL)

SECTION XII



19. Install the flange or yoke. Secure with a nut. Torque to 300 - 325 ft. lbs.



22. Check the alignment of the shift rails and shift rail channel.



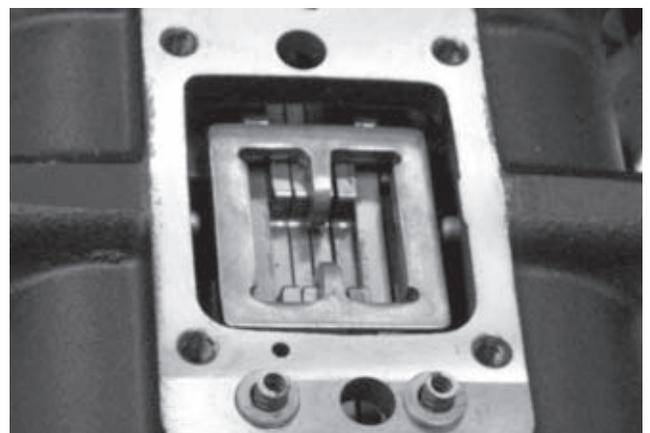
20. Set the transmission in normal operational position.



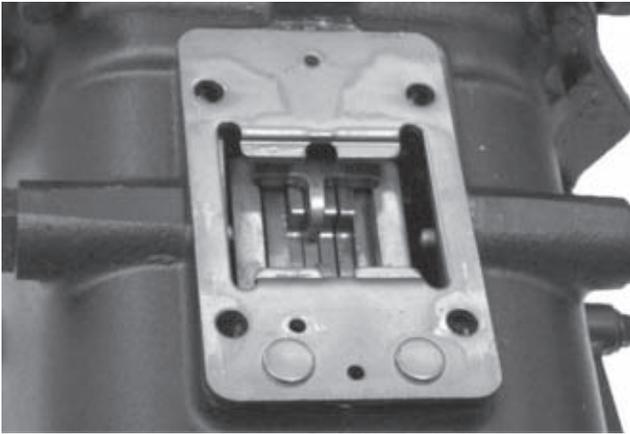
23. Install detent ball and detent springs.



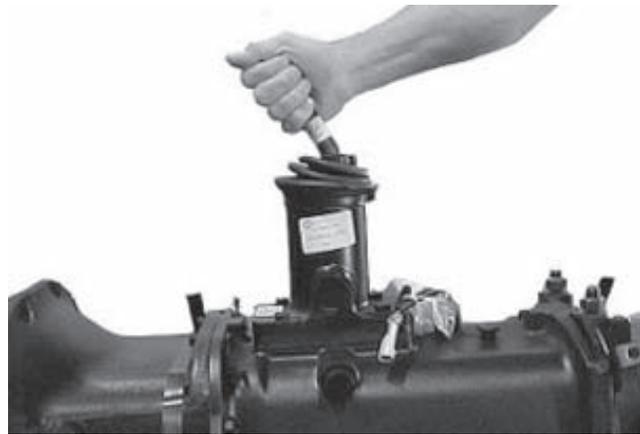
21. Install the backup light switch if it was removed earlier. Torque it to 25 - 41 ft. lbs.



24. Install cross slide between the shift rails making sure all 4 rails are aligned in neutral and the cross slide is sitting flat.



25. Install gasket and interlock retaining plate.



28. Temporarily install the shift tower and bench shift the unit to make sure all forks are shifting properly. **Before removing shift tower assembly, shift the transmission into direct gear.** This will aid in the installation of transmission into the vehicle.



26. Install the interlock on top of interlock retaining plate. Top surface of interlock should be flush with the retaining plate.



27. Install final gasket and note the position of the interlock plate. This photograph shows the correct position.

SHIFT TOWER REASSEMBLY

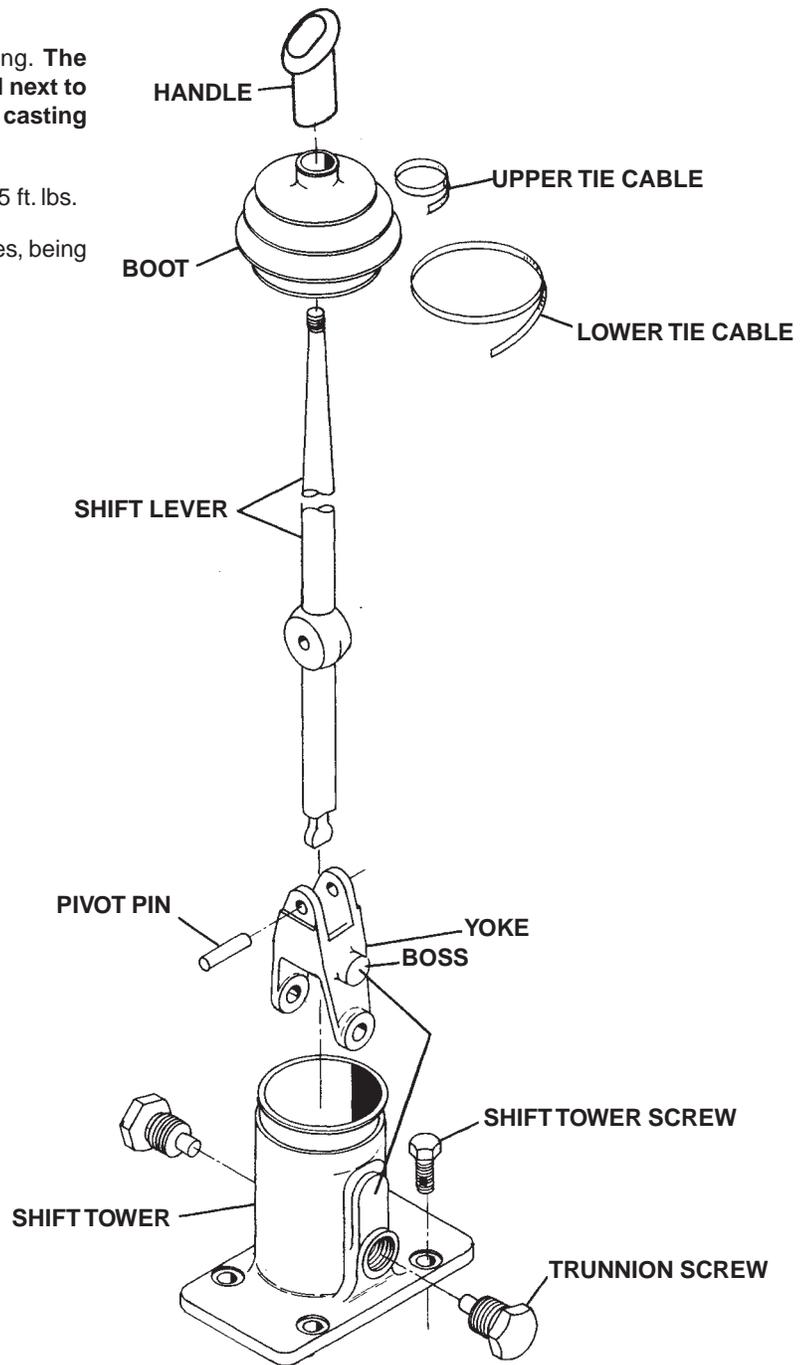
SECTION XIII

1. To reassemble the tower, first position the yoke onto the shift lever. The yoke has a boss which must align with the tower side that has boss clearance. 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 bearing 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 fork
- (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.
- (j) 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 of 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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