



ES62-5 & ES67-5

Service Manual

Bulletin No. 2371

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SAFETY FIRST

Carefully read this service manual before beginning any work on your Spicer transmission.

Throughout this literature, you will see symbols that warn of potential personal injury or property damage if the accompanying instructions aren't followed. Here are the symbols and their meanings.



This symbol indicates a potentially hazardous situation.



This symbol indicates that you must do something in order for the transmission to function properly. For example, you must use only one gasket underneath the shift tower. If it is eliminated, or more than one gasket is used, binding can occur. This would prevent proper shifting of the transmission and could damage the unit.



This symbol indicates that you must NOT do something in order to avoid damaging the transmission. For example, you must not use sealant underneath the shift tower. Using sealant underneath the tower will prevent proper interlock functioning and could damage the unit.

Be sure you understand all procedures and instructions in this manual before you begin working on your Spicer Transmission. If you have any questions, contact your Spicer Transmission representative.

General Safety Precautions



WARNING: Use a hoist whenever lifting the transmission or shaft assemblies. Using a hoist can help prevent muscle strain or other possible injuries.



WARNING: Always wear safety glasses when working on the transmissions to help prevent possible eye injury due to small parts (such as snap rings) or metal chips that may fly up unexpectedly during a teardown or rebuild.



WARNING: Be careful when picking up gears or other sharp components. If you aren't careful, you could cut your hands. Consider wearing heavy cloth gloves or covering sharp objects with shop towels before picking them up.



WARNING: When draining the transmission prior to working on it, be careful to let the unit cool down first. Otherwise, hot transmission fluid could cause burns.

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GENERAL INFORMATION

SECTION I

General Application Guidelines On-Highway Use	
GVW:	Up to 65,000 lbs.
HP Range:	175 - 250 HP
RPM Range:	2,200 - 3,600
Engine Types:	Mid-range diesel and big gas

PTO Specifications		
Model	Speed*	Chelsea® Application Page
ES62-5A ES67-5A	490	SPR-128
ES62-5C ES67-5C	490	SPR-128
ES62-5D ES67-5D	490	SPR-130

*Per 1000 RPM of engine speed.

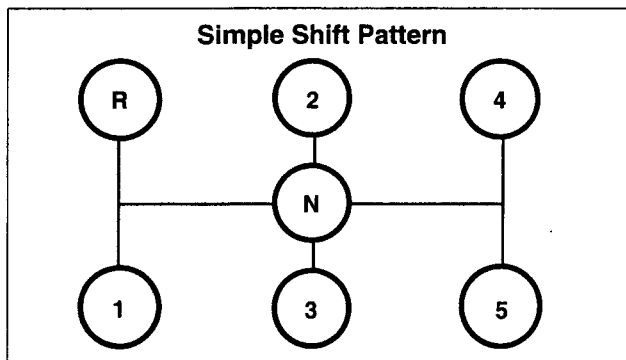
Specifications

- Torque Capacity ES62-5—620 ft. lbs.
ES67-5—670 ft. lbs.
- Speeds 5 forward, 1 reverse
- Length 24.7" (627 mm) from clutch housing facing to end of splines on output shaft
- Weight 362 lbs. (164.3 kg)
- Clutch Housing SAE No. 2 or 3
- Clutch 13" or 14" push or pull, single or 2-plate
- Input Shaft 1.50" or 1.75"
- Yokes and Flanges 1480, 1550, 1610, and 1710 series
- Lube Capacity 17 pints (8 liters)
- Speedometer Provision will be made in the rear bearing cap for installation
- Power Take-Off Standard 6-bolt left side, standard 8-bolt right side, countershaft rear PTO mount optional

Gear	ES62-5A & ES67-5A		ES62-5C & ES67-5C		ES62-5D & ES67-5D	
	Ratio	% Step	Ratio	% Step	Ratio	% Step
1	7.17	85	7.17	70	7.17	85
2	3.88	62	4.21	66	3.88	84
3	2.39	65	2.54	75	2.11	64
4	1.45	45	1.45	45	1.29	29
5	1.00		1.00		1.00	
R	7.17		7.17		7.17	

TORQUE SPECIFICATIONS FOR NUTS AND CAP SCREWS							
Nom. Thread Size (Dia.)		Part Name	Wrench Torque (ft. lbs.)				
			NON-LOCKING TYPE		LOCKING TYPE (Bonded Nylon Patch)		
Inches	mm		Min.	Max.	Min.	Max.	
.250 .312 .375 .438 .500 .562 .625 .750 1.250 1.375 1.750	6	Cap Screw or Nut	7	10	10	13	
			13	17	20	24	
	10		25	32	34	41	
			40	50	52	62	
	12				60	80	
			60	80	78	98	
	14				80	100	
			90	115	112	137	
			120	150	150	180	
			200	250	240	290	
			Nut			400	450
						550	600
						550	600
		PTO Aperture Cover Caps Screws					
		Cap Screw	10	15	16	24	
		Cap Screw with Gasket 97-324-2	20	25	36	41	
		Cap Screw with Gasket 22P22	20	25	29	34	

Driver Instructions



Synchronizer Information

The purpose of a synchronizer transmission is to simplify shifting and to help the driver get a clash free shift. To receive these results, however, it is important to understand how the synchronizer works.

When a shift is required, the operator declutches and moves the shift lever toward the desired gear. When the synchronizer ring makes contact with the 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 automatically neutralizes. The lever moves smoothly and easily into gear.

It takes one or two seconds to match speeds. Steady pressure on the shift lever helps the synchronizer do its job quickly. If the lever is "forced" into gear, it is possible to override a blocker. This defeats the purpose of the synchronizer, however, and can cause gear clash.

Finally, remember that this transmission is 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.

! **CAUTION: Always start in first gear.** Starting in any other gear may cause hard shifting and internal transmission damage. This is because a synchronizer needs gear rotation to do its job.

Shifting

To begin shifting, first depress the clutch and wait for complete release. Move the shift lever into 1st gear. Next, accelerate to an RPM that will allow enough momentum to select the next higher gear while still allowing vehicle acceleration after the shift has been completed. There is usually no reason to go all the way to the governor before you shift to second. The progressive shift technique helps save fuel. This method can vary depending the GVW of the vehicle, road condition, and type of service.

When 2nd gear is desired, declutch and move the lever toward 2nd, keeping steady pressure on the lever. The synchronizer will pick up the gear and synchronize its speed to the mainshaft speed. The lever will move into gear easily.

Continue in the same manner to top road speed. Notice that to have good performance as you approach top road speed, you must accelerate closer to the governed speed before you allow the engine to drop to the next gear shift point. This is because air resistance at higher speeds requires more horsepower. You receive maximum horsepower and performance at governed speed.

When you downshift, use the same procedure. However, the engine must be raised to the governor as the clutch is engaged after completing the shift. To downshift from top gear, declutch as you approach the shift point (about 100 RPM above the shift point) 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, allowing a clash free shift. After the shift, reengage the clutch while accelerating to keep the vehicle moving at the desired speed. If further downshifts are required, continue in the same manner.

When downshifting, remember that 1st gear is not synchronized. Double clutching is required to complete a clash free shift. You can double clutch on all other shifts as well. This only aids the synchronizer in doing its job by manually helping to match the engine speed and road speed.

⊘ CAUTION: Do not tow vehicles equipped with Spicer transmissions without first pulling the axle shafts or disconnecting the driveshaft. Lubrication of the internal gear train is inadequate when the vehicle is towed.

⊘ CAUTION: Do not pull or roll start vehicles in first or reverse gears.

Lubrication

! **CAUTION: To ensure proper lubrication and operating temperatures in this unit, the proper lubricants must be used.** Correct oil levels must be maintained. All lubricants should be backed by the reputation of a well-known supplier. If you want to use a lubricant not specified below, please contact your local truck dealer.

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

⊘ **CAUTION: 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. Oil overflow escapes onto the clutch or parking brakes, causing additional trouble.

TEMPERATURE	GRADE	TYPE
Above 0°F (-18°C) Below 0°F (-18°C)	SAE 30, 40, or 50 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

⊘ **CAUTION: 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 Procedures

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.



CAUTION: Read this section before starting the detailed disassembly procedures. Follow procedures closely to ensure proper transmission operation.

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



CAUTION: 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 transmission 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 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.

These conditions must be prevented.

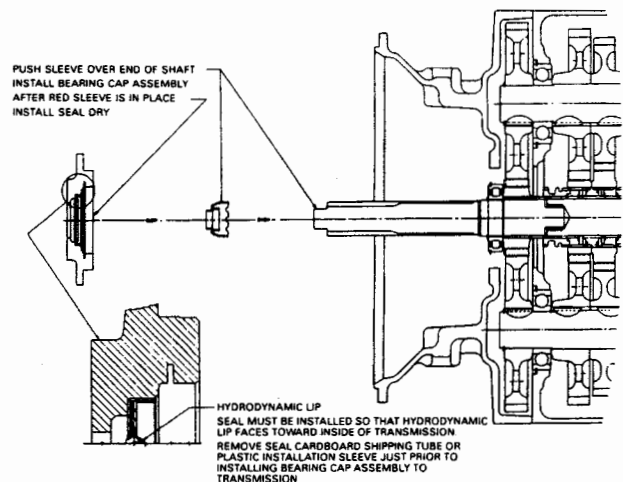
Power Take-Offs

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

Front Bearing Retainer & Seal

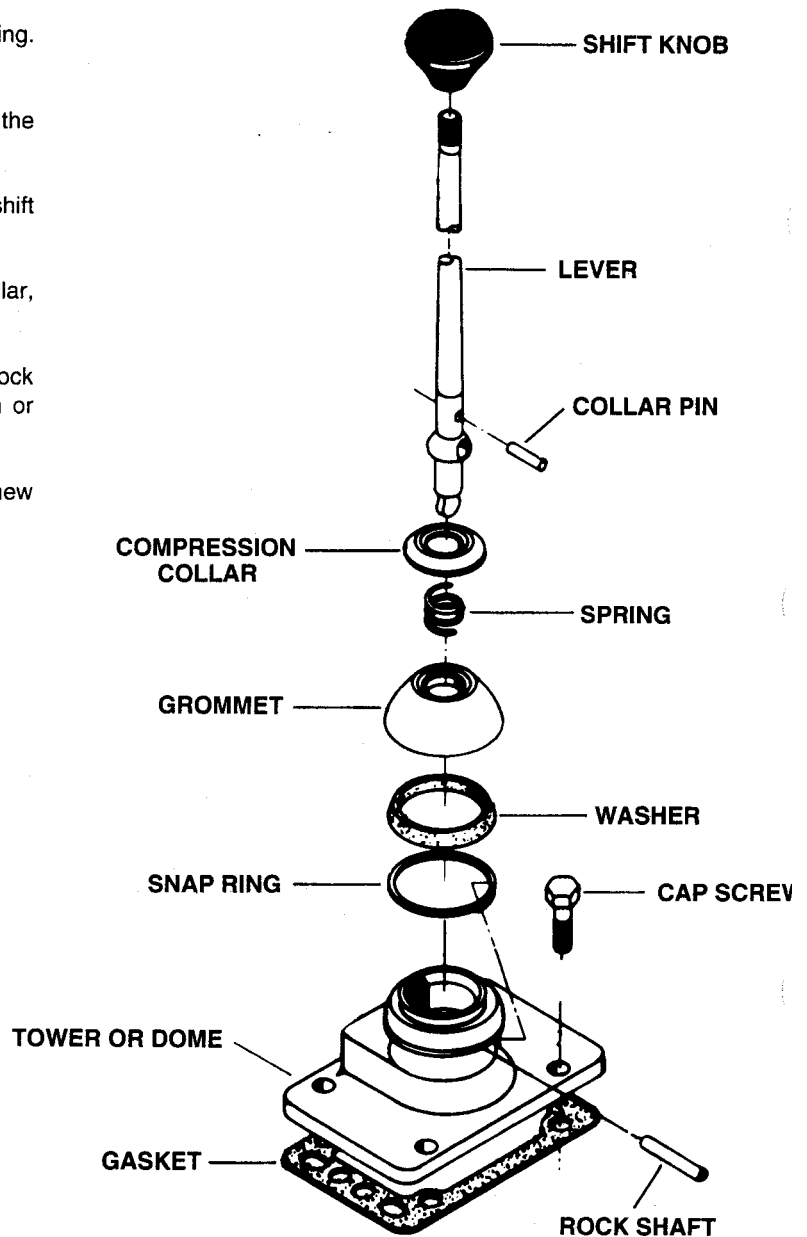


CAUTION: When installing the front bearing retainer and seal in the transmission, use the red plastic sleeve to prevent serious damage to the oil seal. Failure to use the seal sleeve will void the seal warranty.



Shift Tower Disassembly

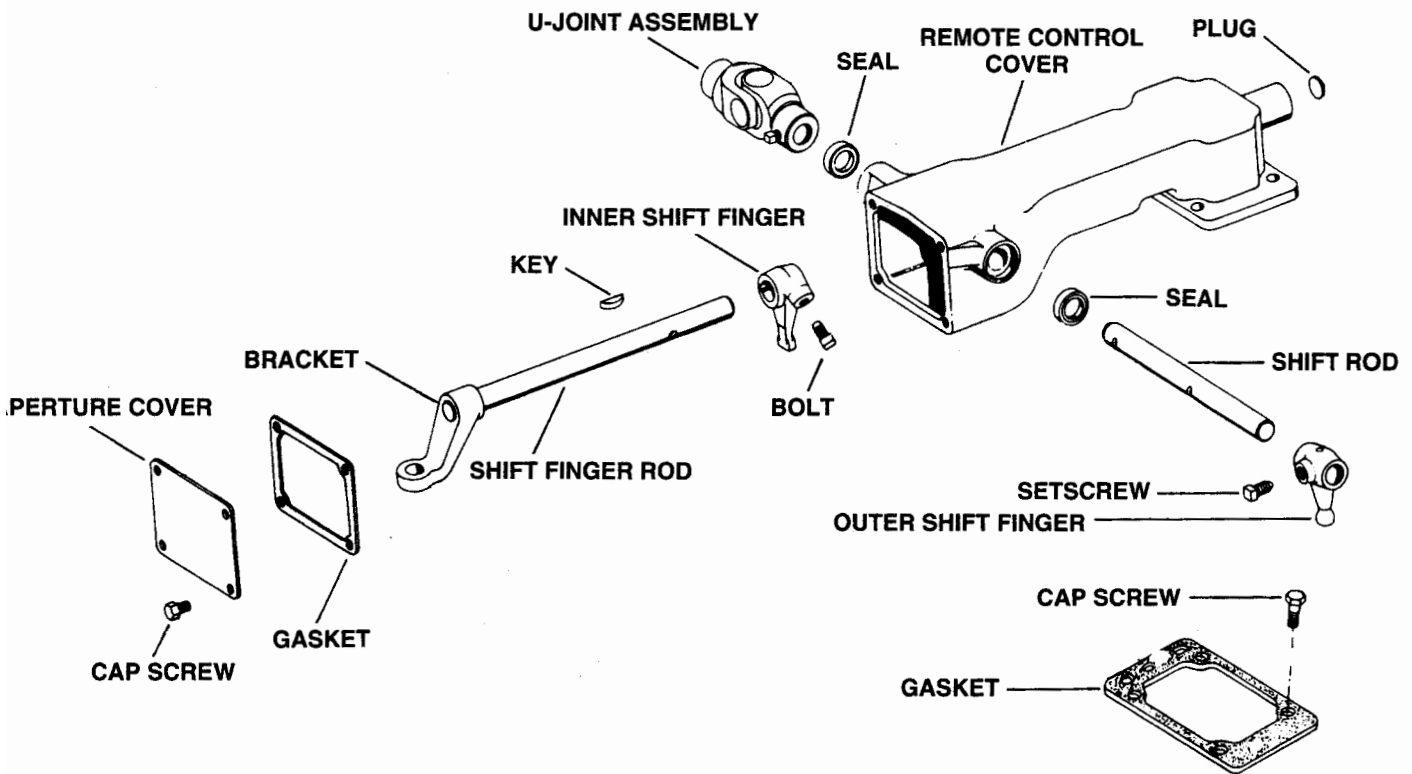
1. Remove the six retaining cap screws and lockwashers. Separate the dome from the shifter housing and gasket. Lift it straight up.
2. Position the shift lever dome on edge in a vise.
3. Pull up the grommet. Press the collar against the spring. Remove the lock pin.
4. Slide the compression cup up the shift lever and remove the rock shaft snap ring.
5. Tap the rock shaft free of the dome and remove the shift lever. Remove and discard the gasket.
6. Remove the shift lever handle. 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 if necessary.



Remote Control Disassembly

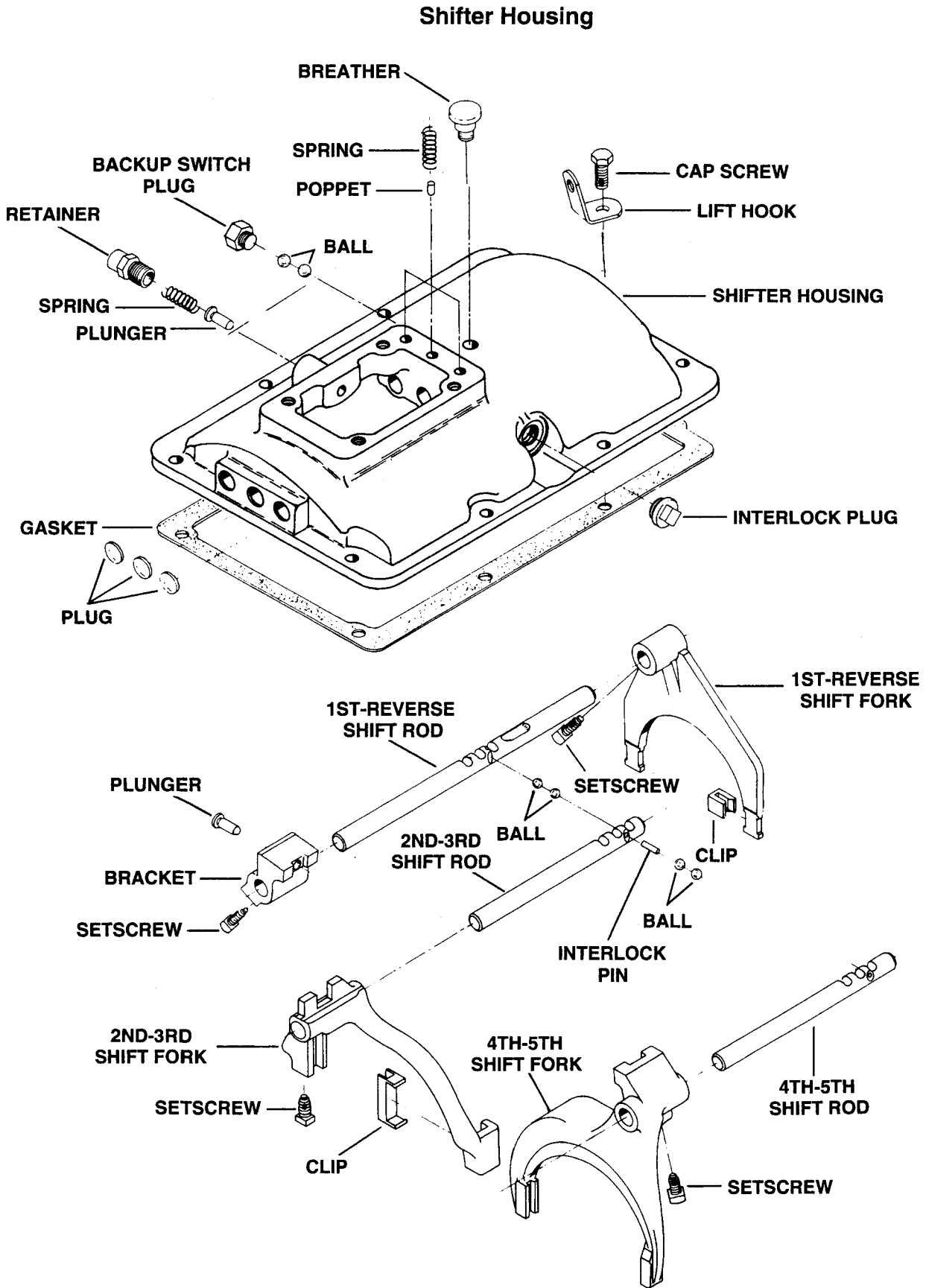
1. Remove the six cap screws and lock washers. Separate the remote control from the shifter housing.
2. Remove the setscrew from the universal joint assembly. Pull the universal joint from the rod.
3. Remove the four cap screws and lock washers that hold the end cover and gasket in place.
4. Remove the setscrew from the joint shift rod finger. Tap the rod through the cross holes in the housing.

5. Remove the finger from the housing.
6. Remove the setscrew from the inner shift finger.
7. Slide the rod and bracket assembly from the inner shift finger. Be careful not to lose the key.
8. Remove the seals from the cross holes in the housing.
9. Check the shift fingers for excessive wear. Also check all bores and rods for excessive wear or scuffing. Clean all parts thoroughly, and apply a light coat of grease to the pivot points when reassembling.



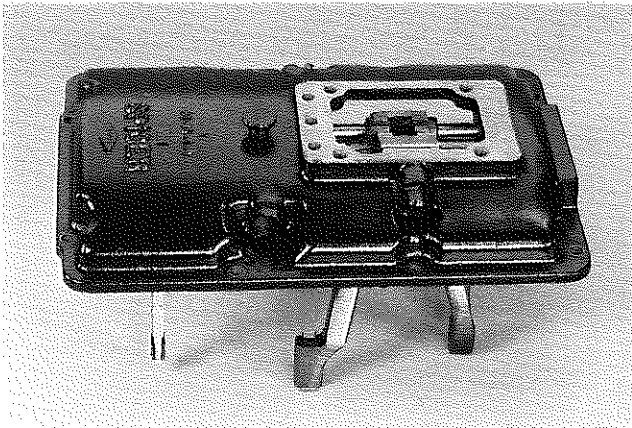
SHIFTER HOUSING DISASSEMBLY

SECTION IV

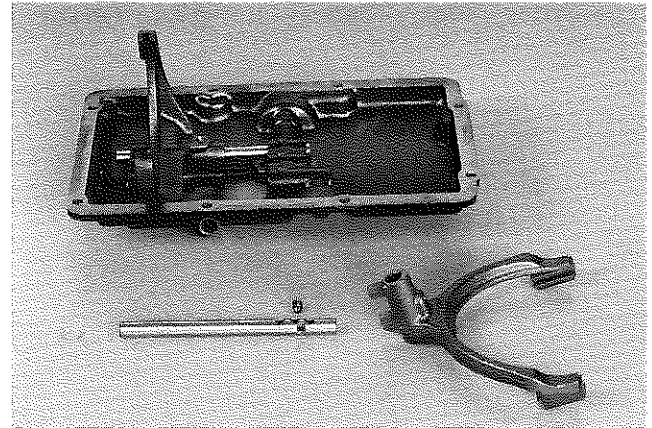


SHIFTER HOUSING DISASSEMBLY

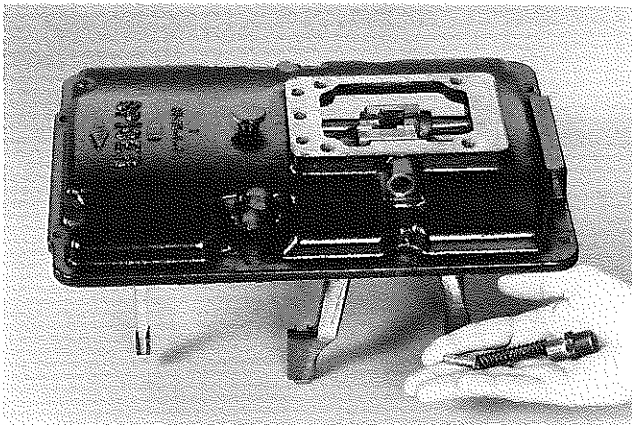
SECTION IV



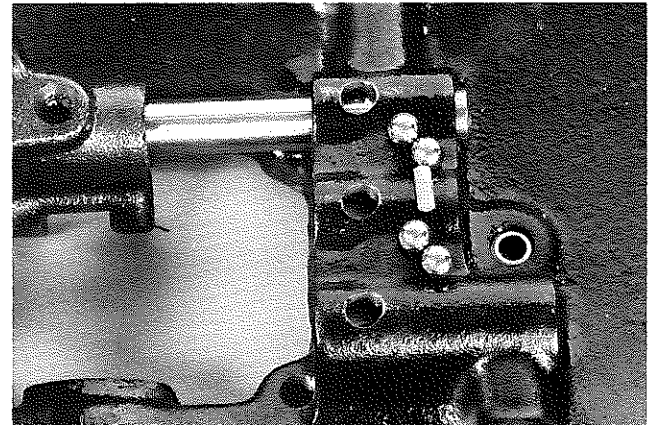
1. Remove the shifter housing and place it on a bench.



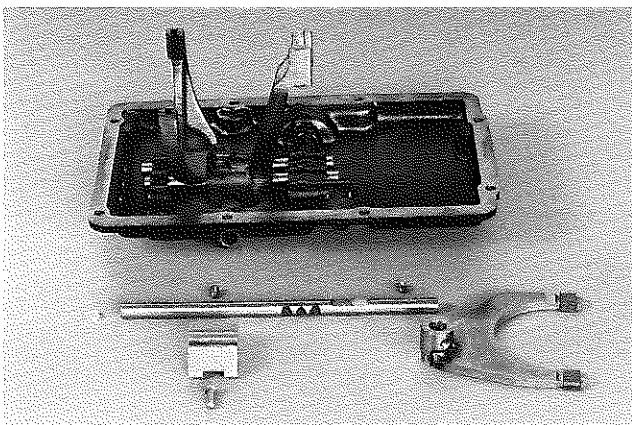
4. Remove the allen screw to disassemble the 2nd-3rd speed shift fork. Tap the shaft and plug through the housing.



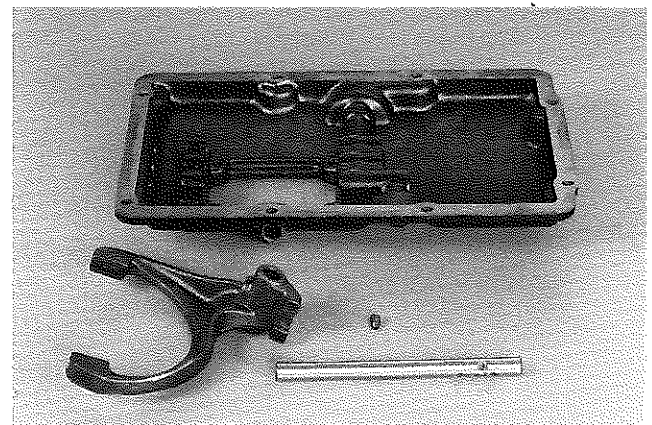
2. Remove the retainer, spring, and plunger. Remove the backup light switch if the cover has one.



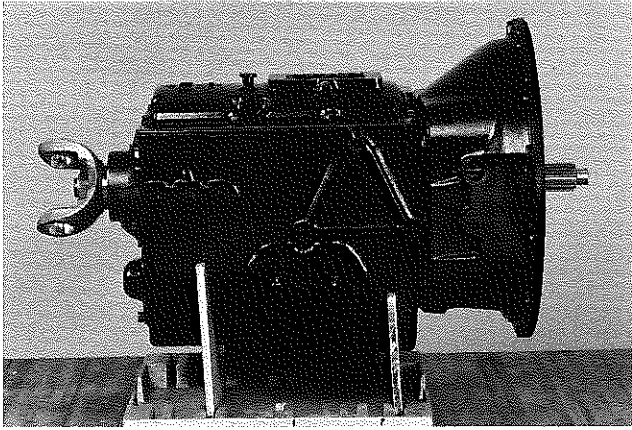
5. There are two poppet balls and an interlock pin in the housing bore between 1st-reverse and 2nd-3rd speed shift rods. There are also two balls in the housing bore between 2nd-3rd and 4th-5th speed shift rods.



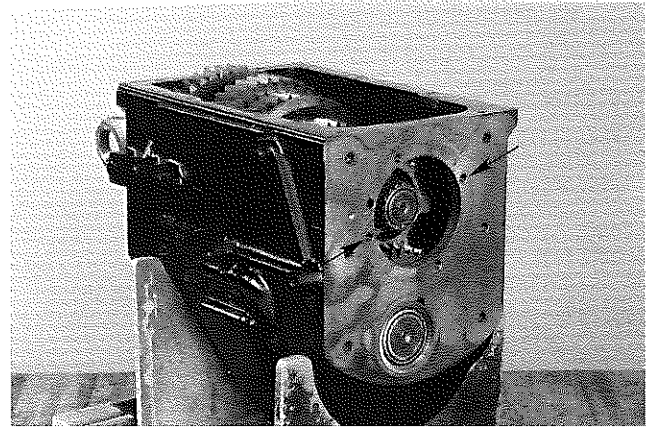
3. Remove the allen screws from the shift fork and bracket. Use a drift and rubber mallet to tap the shaft through the fork, bracket, and housing with a drift and rubber mallet. A case plug will be tapped out with the shaft.



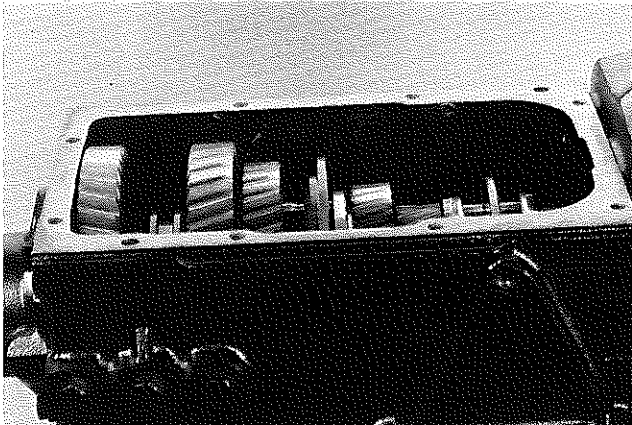
6. Remove the allen screw from the shift fork. Tap the shaft through the fork and housing. A case plug will be tapped out with the shaft. If the unit has a backup light switch, there will be a pin in this shift rod. Examine all components for wear or burring. Replace worn or damaged components.



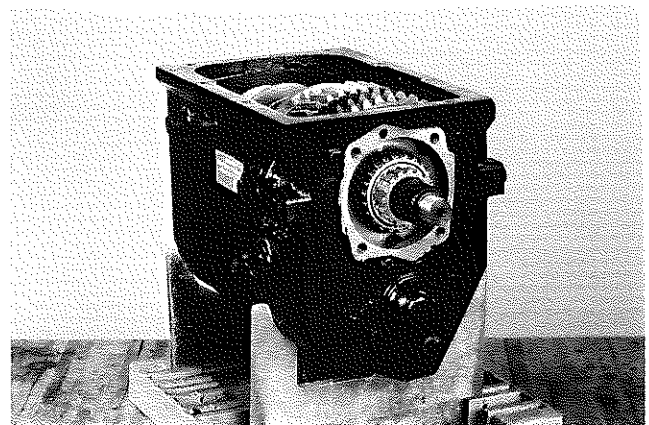
1. Begin disassembly by removing the shift tower.



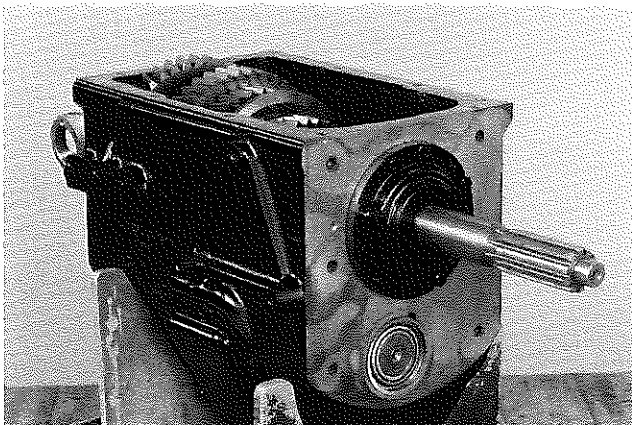
4. Remove the four input bearing cap bolts. Place two of the bolts in the holes highlighted in the photograph. Tightening them will help draw the cap from the transmission case. Also remove the bearing cap gasket and the input shaft.



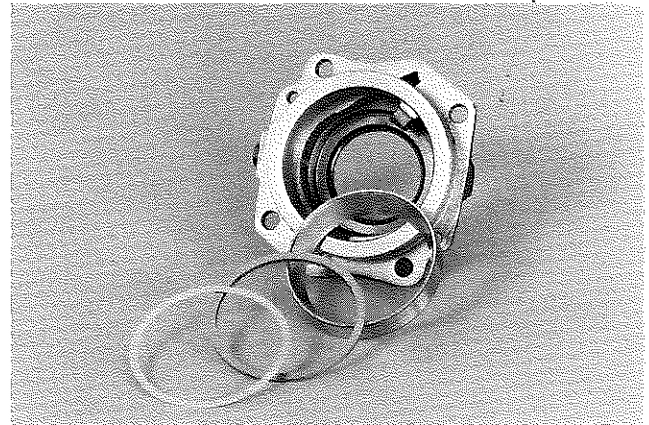
2. Remove the springs and poppet balls from the shifter housing so you don't lose them. Then remove the shifter housing.



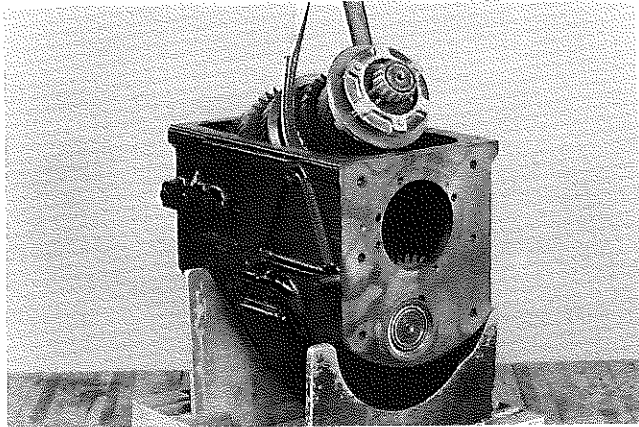
5. Remove the end yoke, bearing cap, and gasket next. Tightening 3/8" bolts in the special holes will help separate the cap from the transmission case.



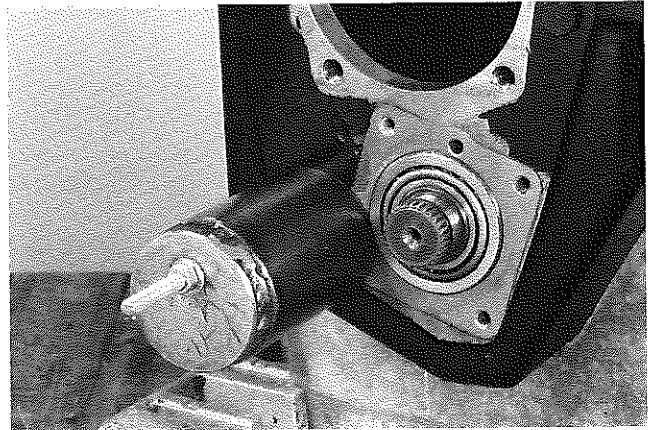
3. Remove the six clutch housing bolts. **WARNING: Remove the clutch housing with the help of a chain hoist to prevent possible injury.** It may be helpful to tap the clutch housing with a rubber mallet to loosen it from the case.



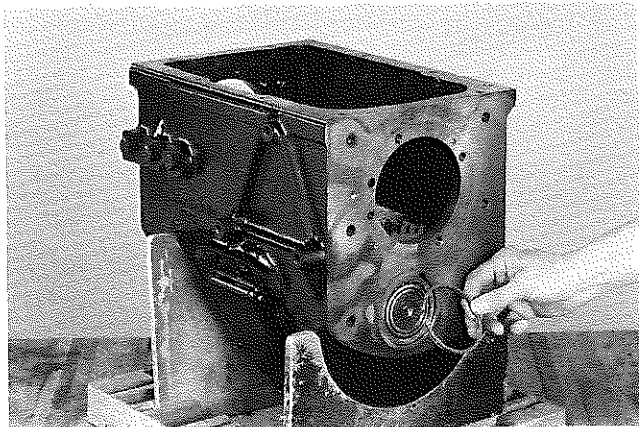
6. Remove the output bearing cap, bearing race, and gasket next. Note that mainshaft end play is adjustable through a spacer and shims in this output bearing cap.



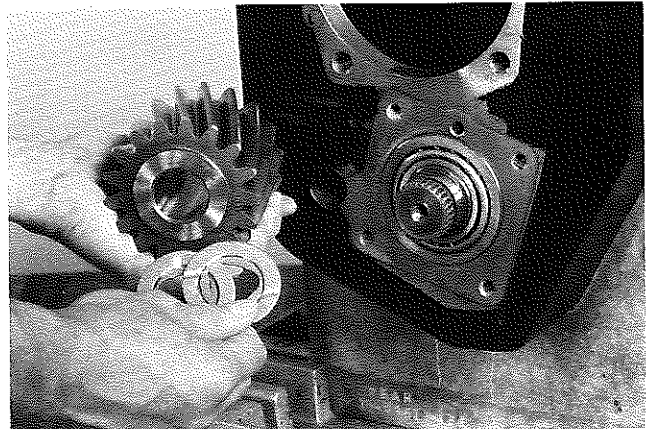
7. **WARNING:** Using a chain hoist to help prevent injury, lift the mainshaft from the case.



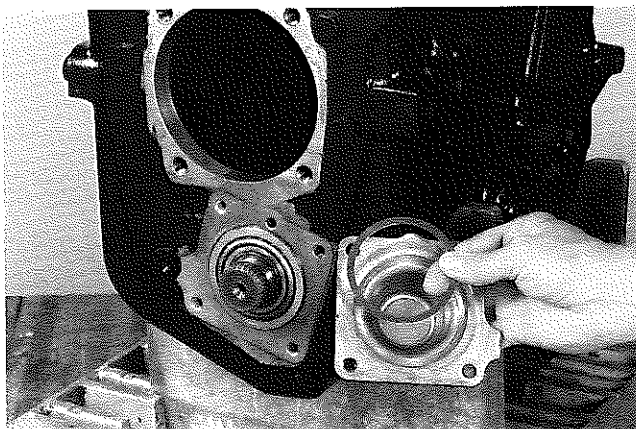
10. The reverse idler shaft may be removed. Kent Moore puller J28668-A is recommended.



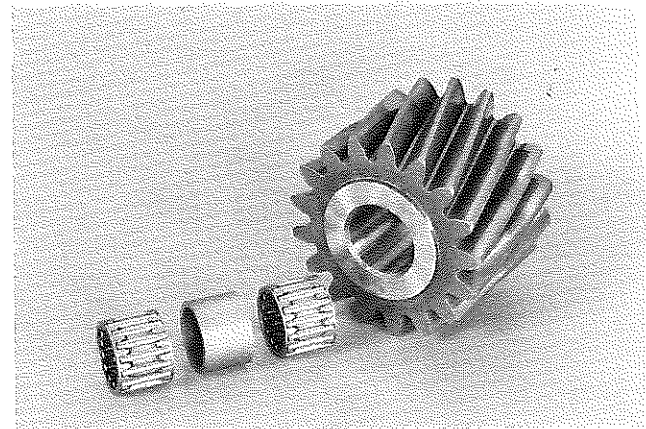
8. Remove the countershaft lubrication spacer from the case bore.



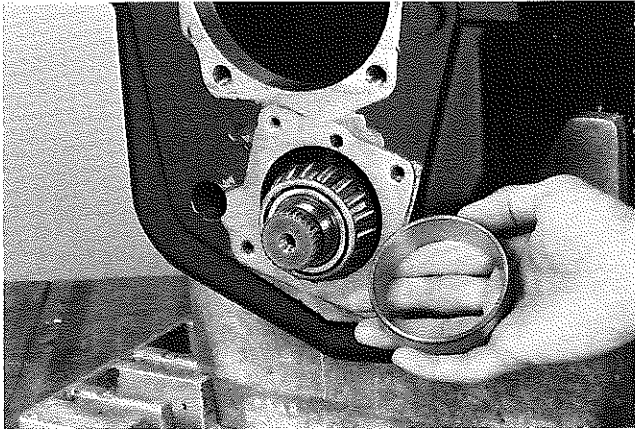
11. Lift the reverse idler gear and thrust washers out of the case.



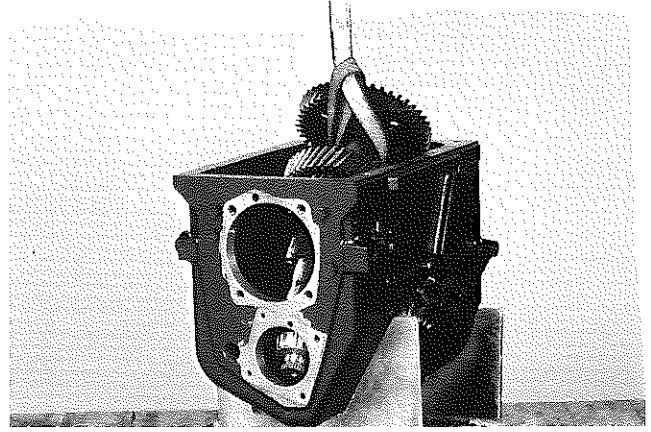
9. Remove the countershaft rear bearing cap and shims.



12. The idler gear contains two bearings and a spacer in its bore. Inspect them and replace if worn or damaged.



13. Tapping the input side of the countershaft with a rubber mallet, drive the rear countershaft bearing race out of the case.

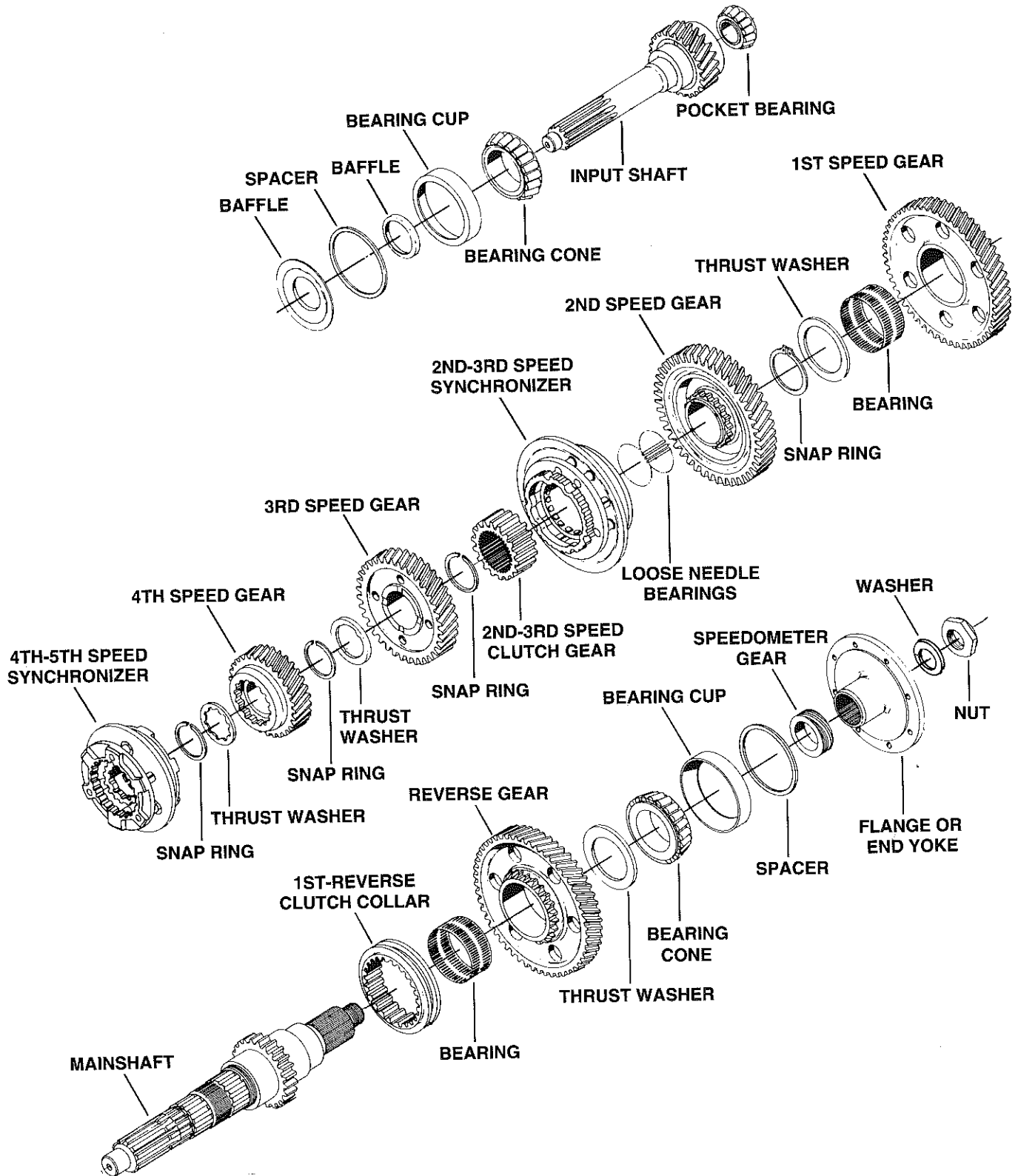


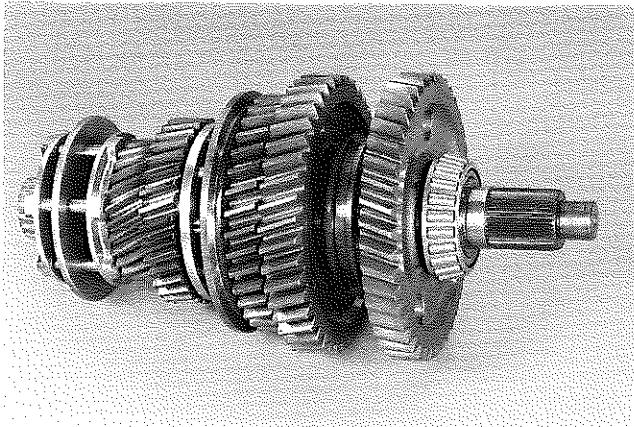
14. **WARNING:** Using a hoist to help prevent injury, remove the countershaft from the case. The input bearing race can also be removed now. Inspect and clean all reusable parts.



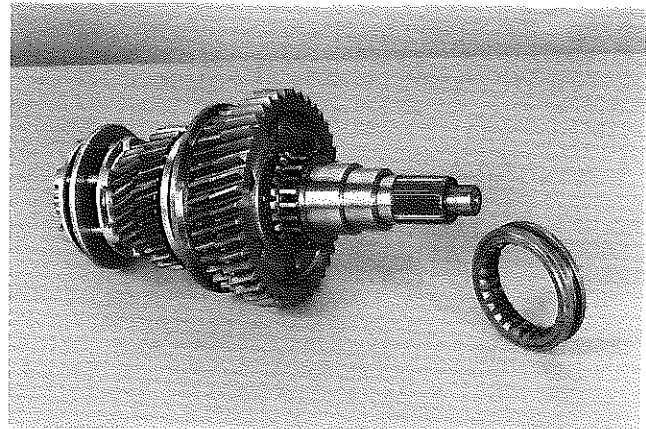
Inspect and clean all reusable parts.

Mainshaft & Gears

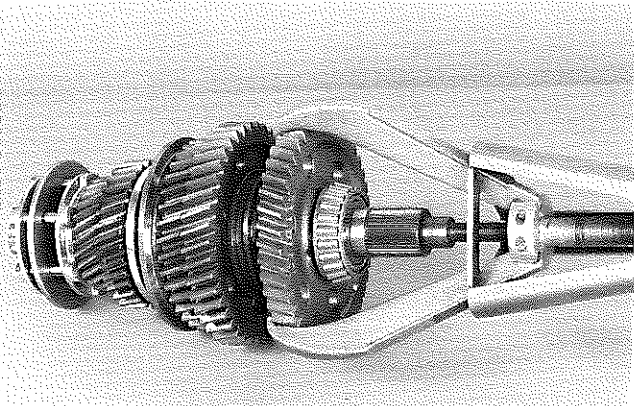




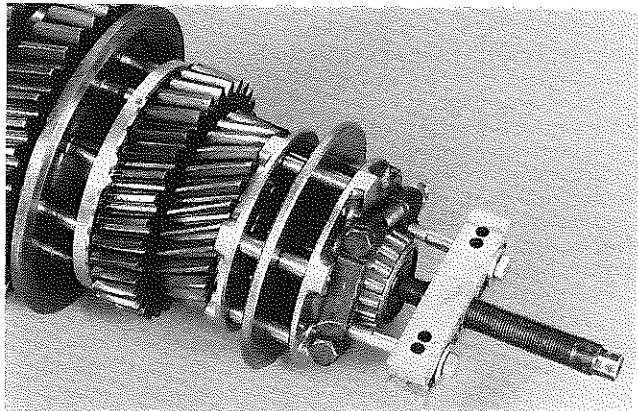
1. Place the mainshaft on a bench.



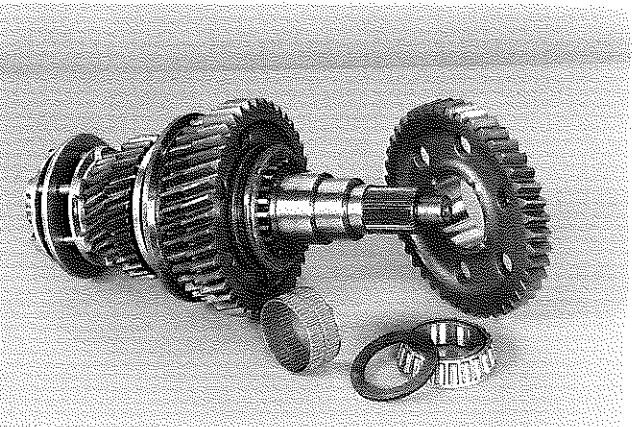
4. Remove 1st-reverse clutch collar.



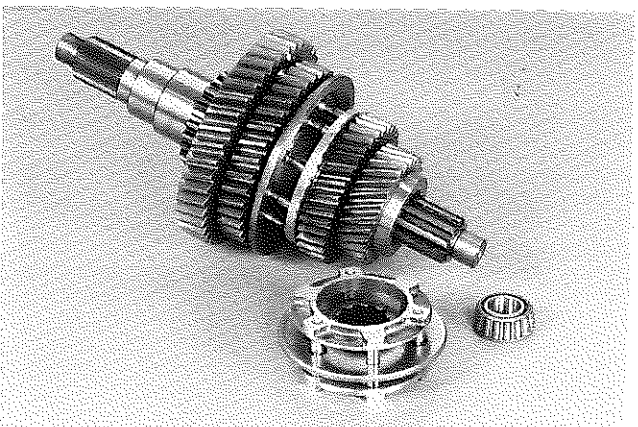
2. Use a suitable puller to remove the output bearing.
WARNING: Always wear safety glasses when pulling components off (or pressing or driving components onto) a shaft. Glasses will help protect your eyes from any flying metal pieces.



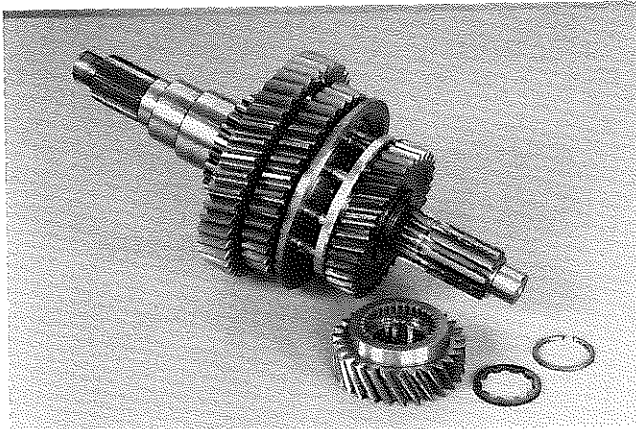
5. Use a suitable puller to remove the pocket bearing.
CAUTION: Do not pull on the synchronizer to remove the bearing. Doing so could damage the synchronizer and cause shifting problems in the unit.



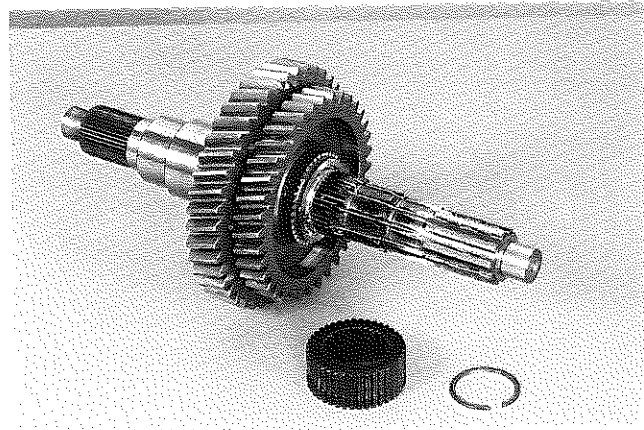
3. Remove the bearing cone, thrust washer, reverse gear, and bearing.



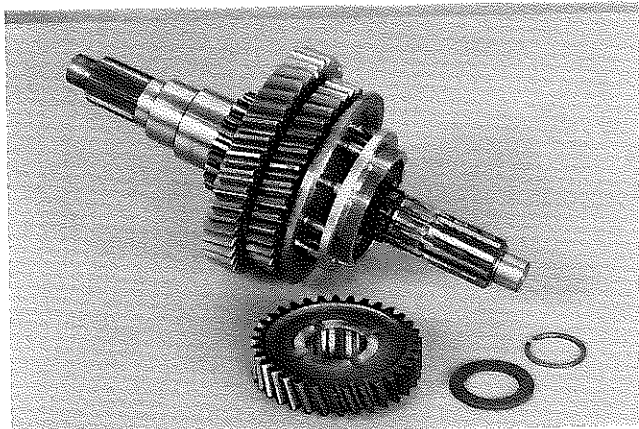
6. Next, remove the 4th-5th speed synchronizer.



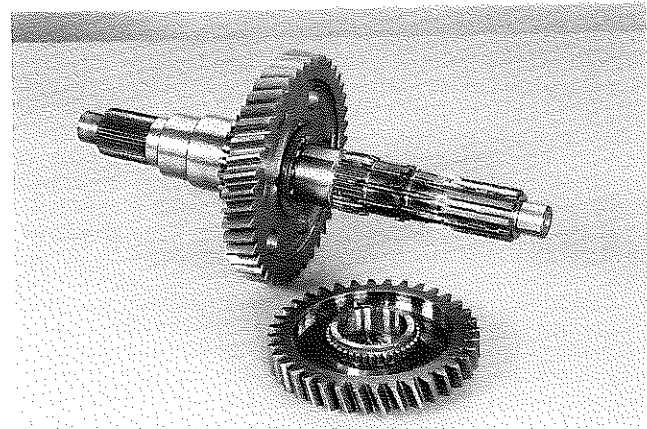
7. Remove the snap ring, 4th speed gear, and the washer from the mainshaft.



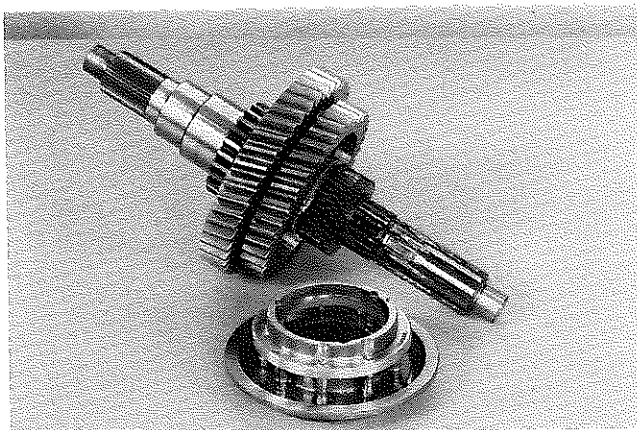
10. Remove the snap ring and 2nd-3rd speed clutch gear.



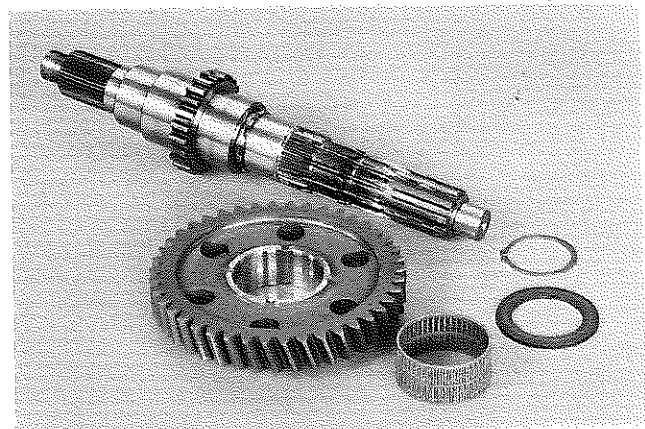
8. Remove 3rd speed gear, thrust washer and snap ring.



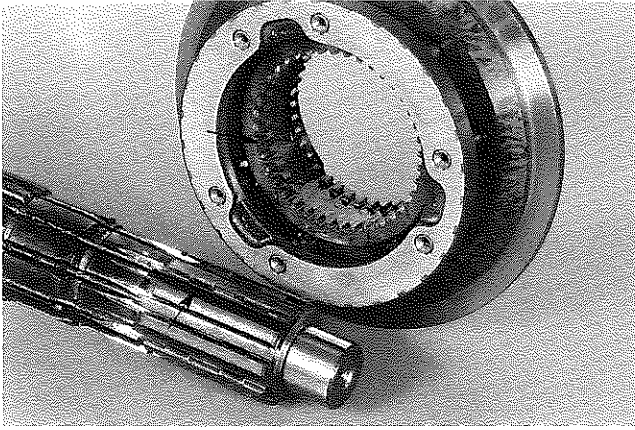
11. Next remove 2nd speed gear and the loose needle bearings that rest in the gear bore.



9. Remove the 2nd-3rd speed synchronizer next.



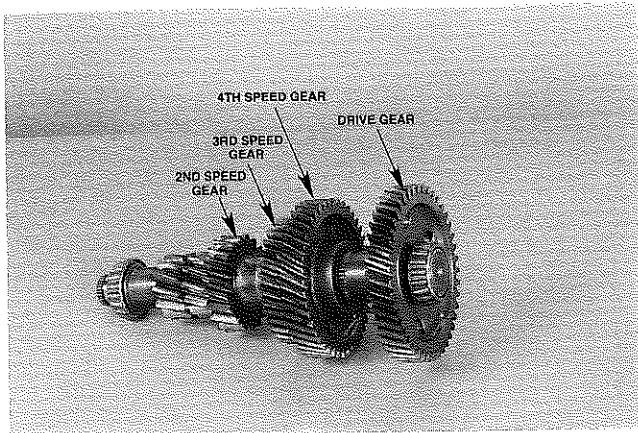
12. Remove the snap ring, 1st speed gear, thrust washer and caged needle bearing.



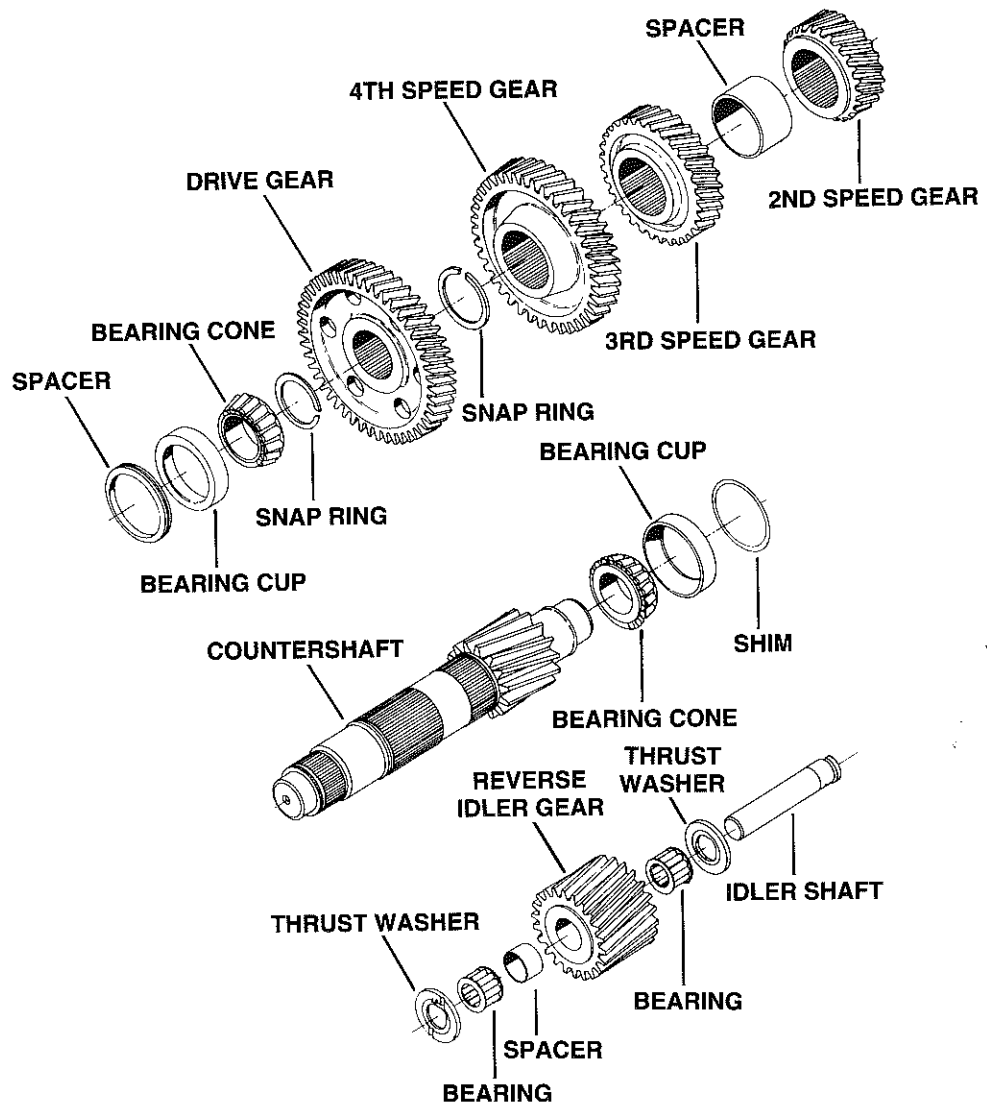
13. Examine all parts for wear or damage. Inspect mainshaft gearlocks and synchronizer clutching teeth for excessive wear that could produce gear jumping. Clean all reusable components before reassembly.

COUNTERSHAFT DISASSEMBLY & REASSEMBLY

SECTION VII

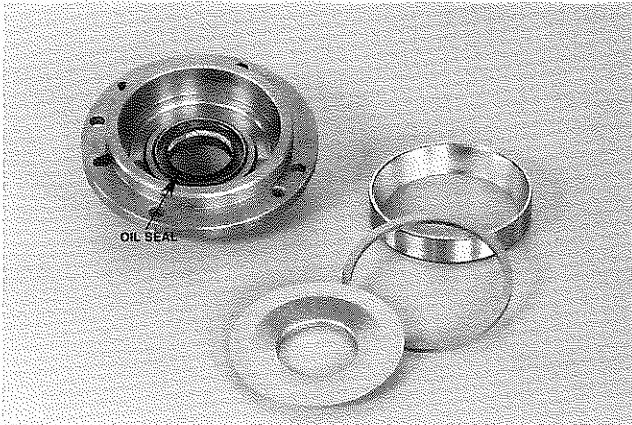


1. The countershaft gears are pressed onto the shaft.

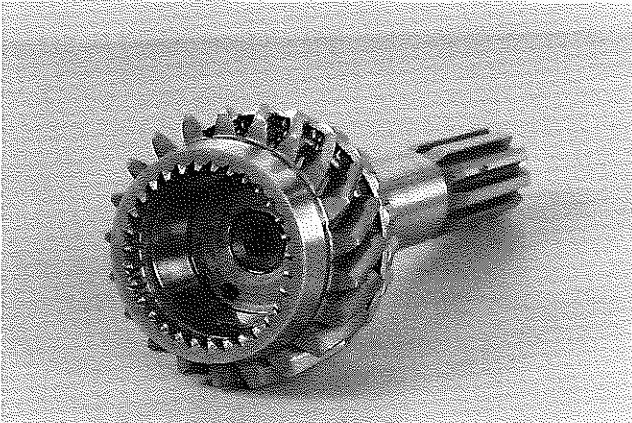


INPUT SHAFT DISASSEMBLY & REASSEMBLY

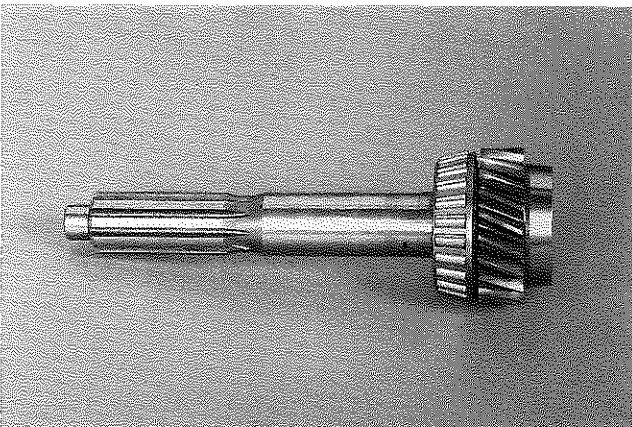
SECTION VIII



1. After removing the bearing cap from the transmission, place it on a workbench with the open side down. Tap the edges of the cap with a rubber mallet until the bearing race falls out. Remove the spacer and oil baffle. Also remove the oil seal and replace it with a new one.

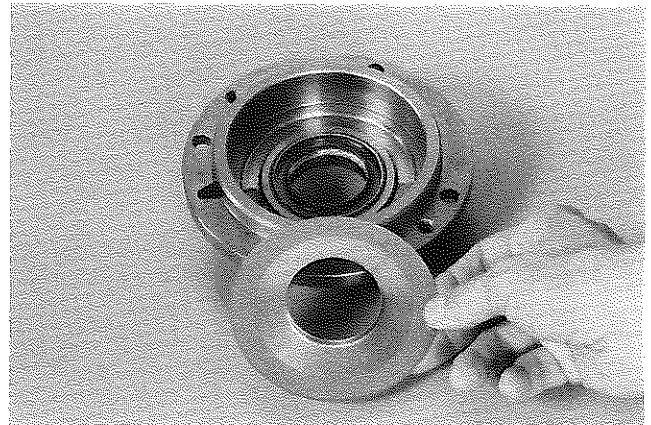


2. Remove the input shaft. The hole in the center allows lubricant to flow to the pocket bearing. Make sure it is free from contaminants and other obstructions.

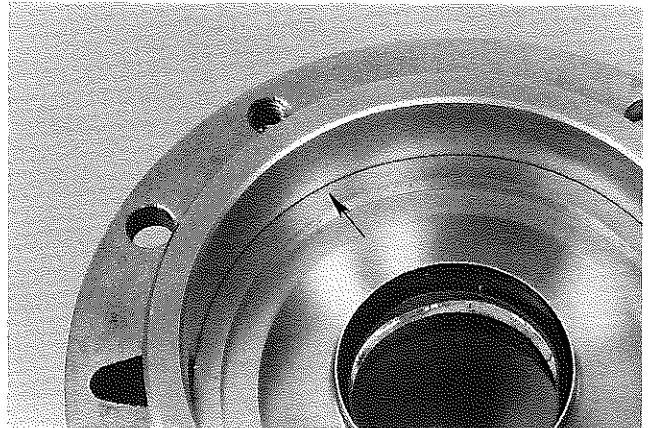


3. Press the bearing off the shaft and replace it with a new one.

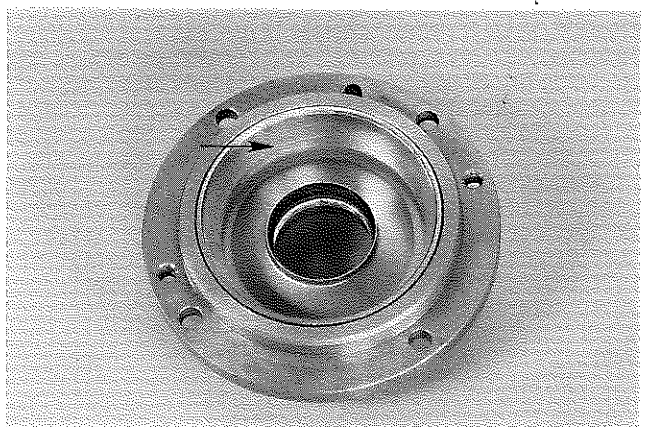
WARNING: Always wear safety glasses when pulling components off (or pressing or driving components onto) a shaft. Glasses will help protect your eyes from any flying metal pieces. It is good practice to always replace bearings during service.



4. To reassemble the input bearing cap, place the baffle into the cap.



5. Install the spacer.



6. Finally, install the bearing race with the tapered edge down, as shown in the photograph.

Cleaning

Prior to reassembly, wash all parts thoroughly.



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



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



WARNING: 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 is replaced, also replace the mating gear.

Thrust Washers

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

Remote Control

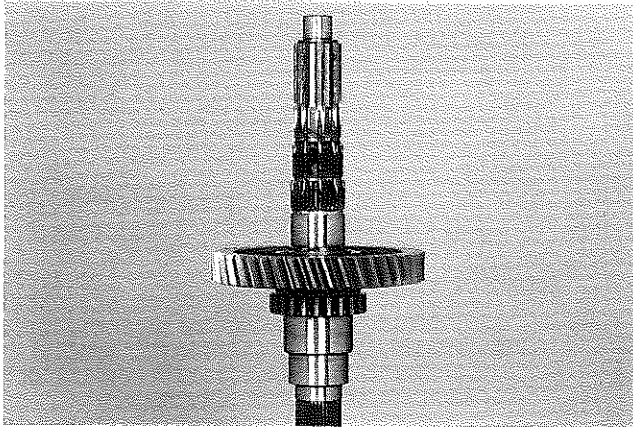
Check the shift fingers, bushing bores and rods for excessive wear or scuffing. Replace springs, bearing races, boots and seals. Clean all reusable parts thoroughly and apply a light coat of grease to the pivot points when reassembling.

Bearings

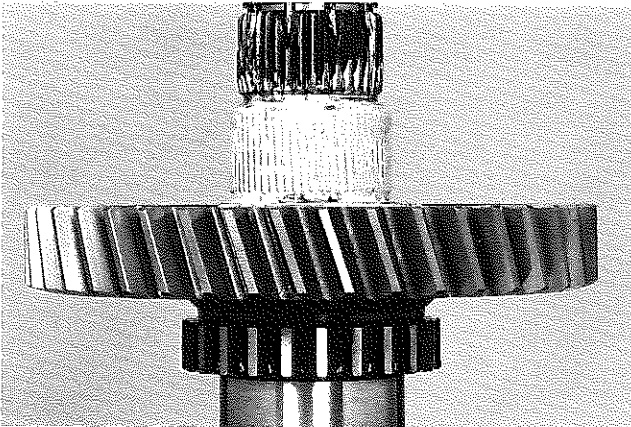
New bearings are recommended with every rebuild. (See "*General Disassembly—Bearings*" for further information.)

Housings

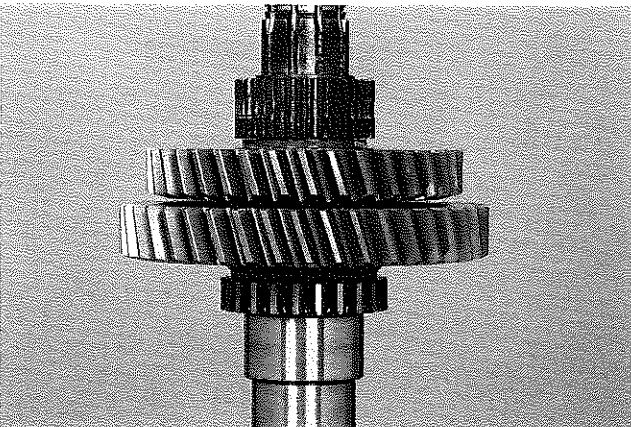
Inspect the housing sections for cracks. If cracks exist, replace that section of the housing. Also inspect the shift bar support bracket for cracks or worn slots. Replace if either of these conditions exists.



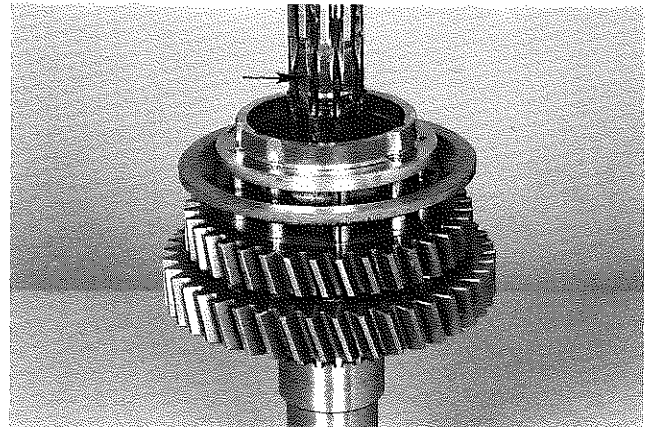
1. Place 1st speed gear and a thrust washer on the shaft. Secure them with a snap ring. **WARNING: Always wear safety glasses when installing or removing snap rings or bearings.** Safety glasses will help protect your eyes if metal parts unexpectedly fly up.



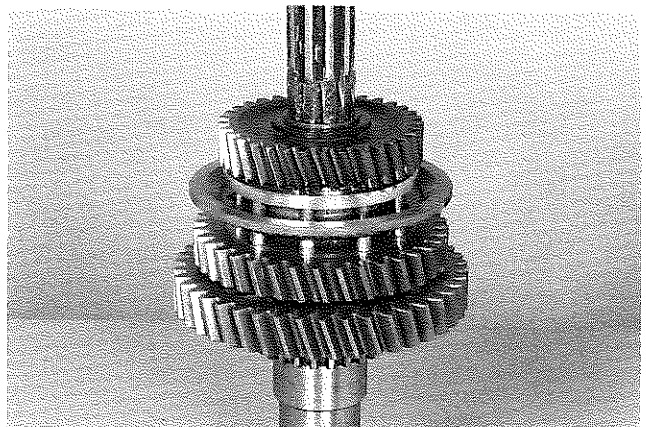
2. Place Moly #2 lubricant on the shaft, then install the loose needle bearings around the shaft diameter.



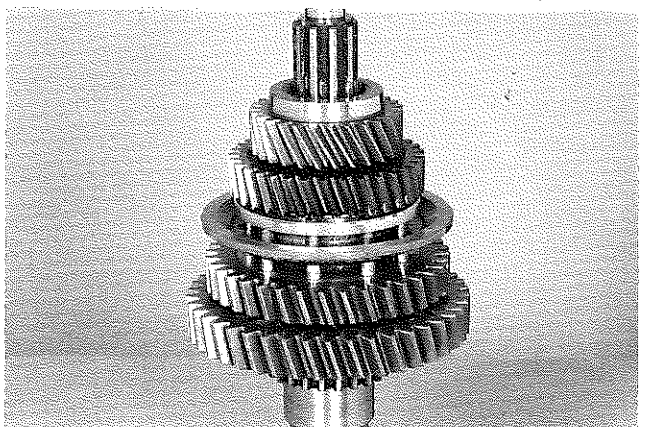
3. Place 2nd speed gear on the shaft. Install the 2nd-3rd speed clutch gear and secure it with a snap ring.



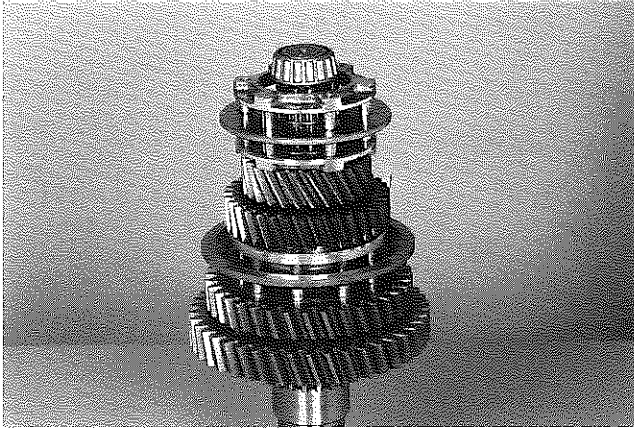
4. Lubricate the fluted shaft diameters with Moly #2 lubricant. Then install the 2nd-3rd speed synchronizer.



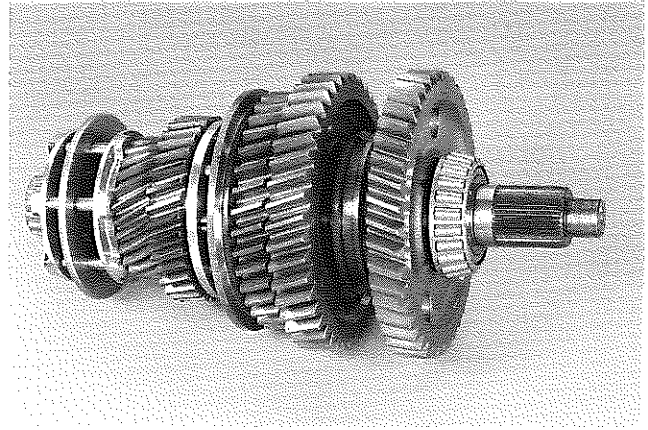
5. Place Moly #2 lubricant on the fluted diameters. Then install 3rd speed gear and thrust washer on the shaft. Secure them with a snap ring.



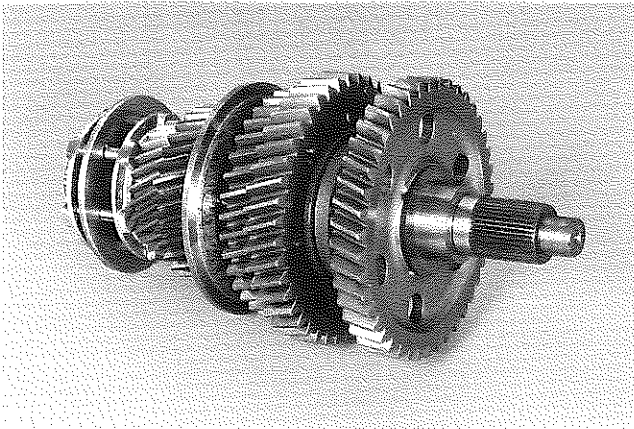
6. Install 4th speed gear and thrust washer on the shaft. Secure them with a snap ring.



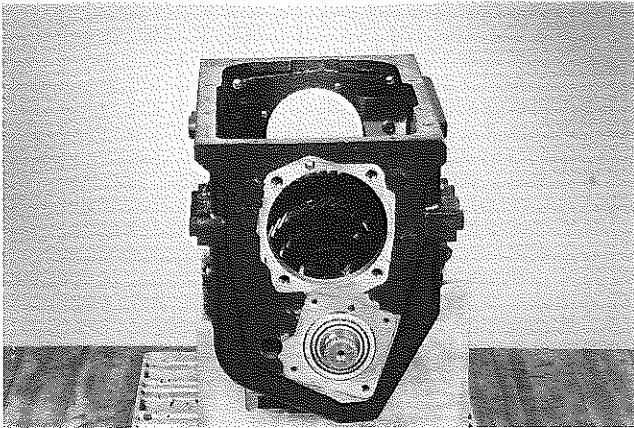
7. Next, place 4th-5th speed synchronizer on the mainshaft. Use a suitable driver to install the pocket bearing.



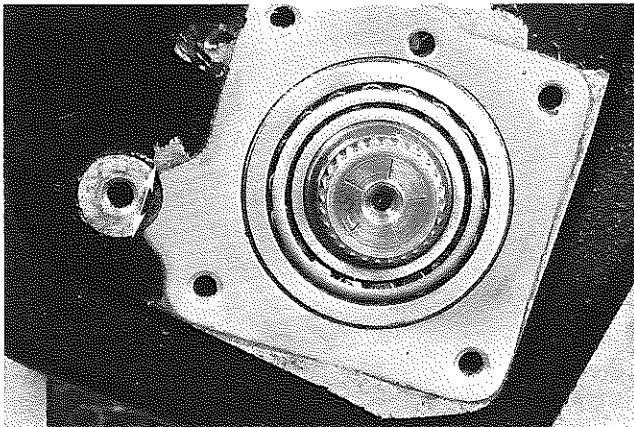
9. Use a suitable driver to install the output bearing. This bearing must be firmly seated against the thrust washer to prevent the washer from moving.



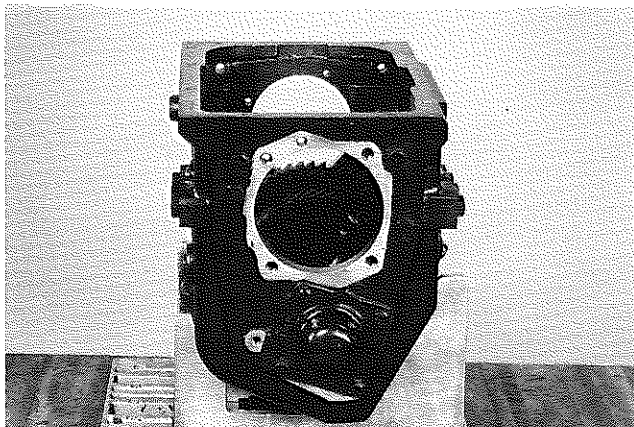
8. Set the mainshaft on the bench. Install 1st-reverse clutch collar, needle bearing, reverse gear, and washer.



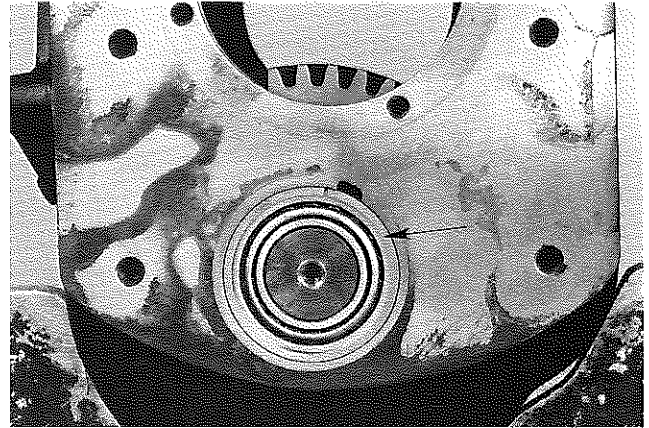
1. **WARNING:** Using a hoist to help prevent injury, install the countershaft assembly into the case. Use the proper driver to install the front and rear countershaft bearing races.



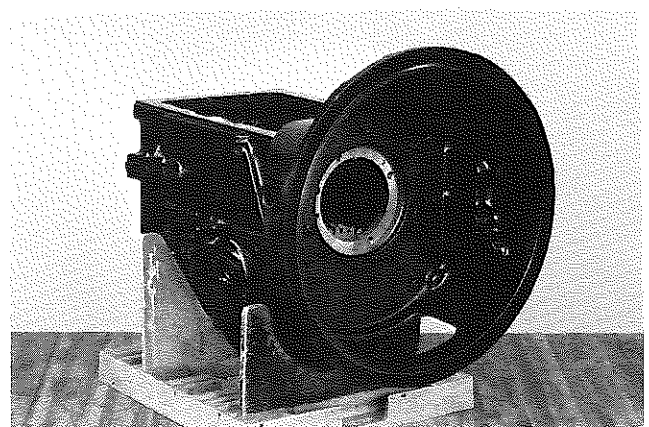
2. Position the reverse idler gear and thrust washers in the case. Next, use a rubber mallet to install the idler shaft with the flat side facing the bearing cap.



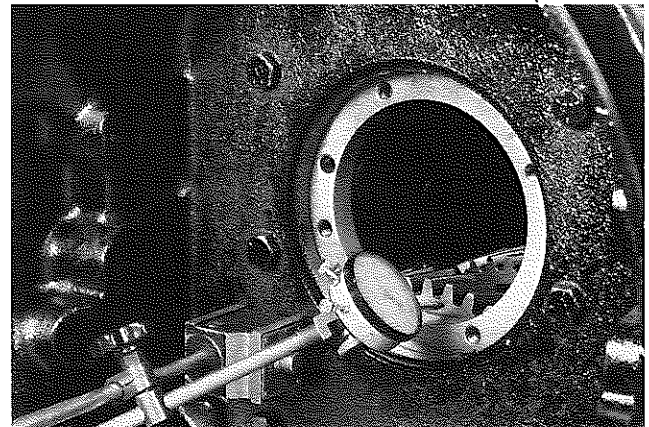
3. Assemble the countershaft rear bearing cap and shims, but do not apply an anaerobic sealant until after end play is checked. Notice how the idler shaft and bearing cap align.



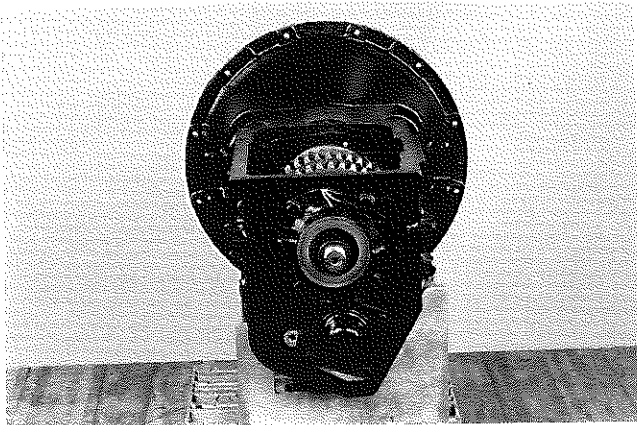
4. Install the lubrication spacer into the countershaft front bearing bore.



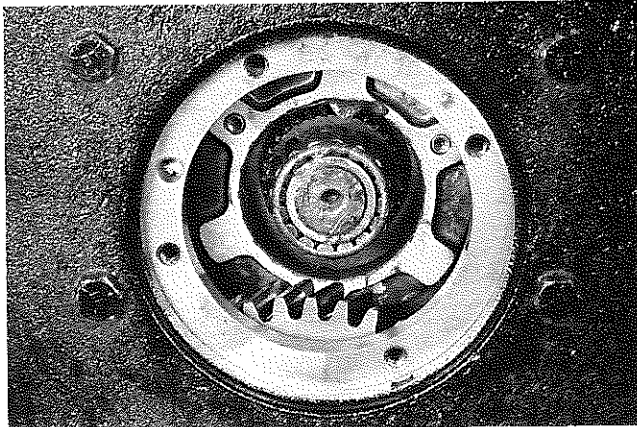
5. Install the clutch housing and gasket. Secure with cap screws. Torque to 120 - 150 ft. lbs.



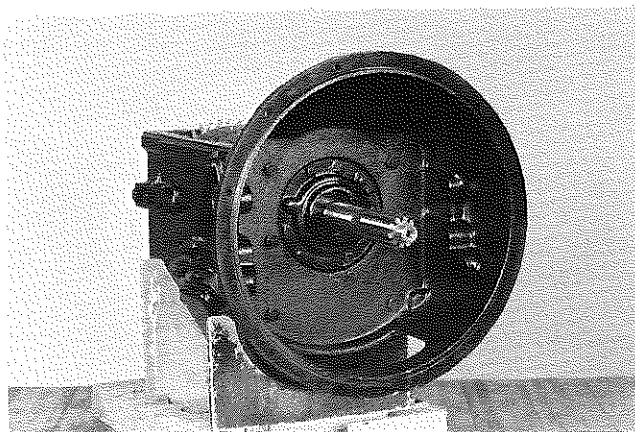
6. Check countershaft end play. It must be set between .001" - .008" for proper unit functioning. Adjustments can be made by re-shimming if necessary. Also reinstall the rear countershaft bearing cap using purple Loctite® 515 or the equivalent. Secure with cap screws. Torque to 60 - 80 ft. lbs.



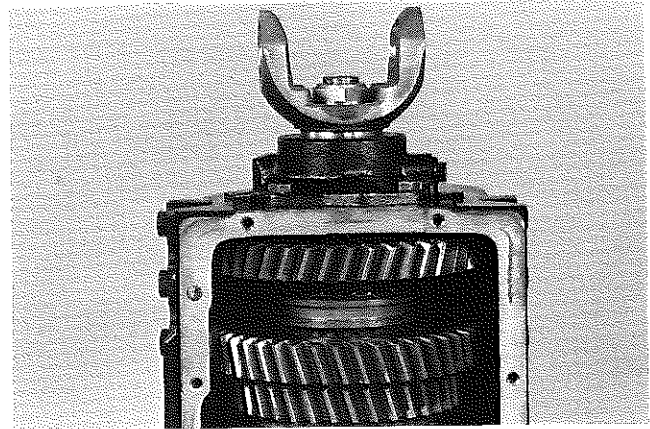
7. **WARNING:** Using a chain hoist to help prevent injury, lift the mainshaft assembly into the case. Install the bearing cap and gasket, making sure to align the oil passages with those in the case. Secure with cap screws. Torque to 60 - 80 ft. lbs.



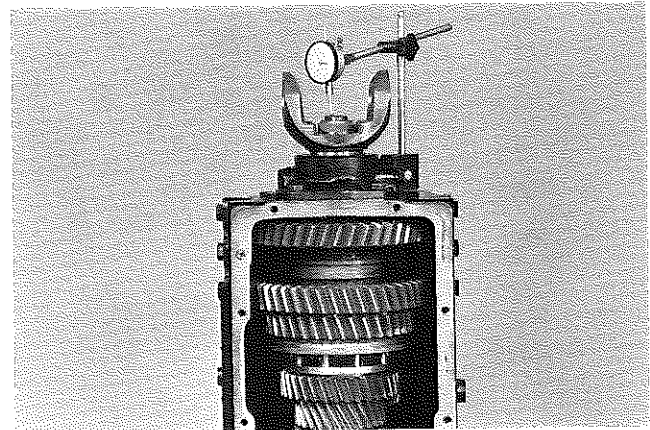
8. Lubricate the pocket bearing with Moly #2 lubricant.



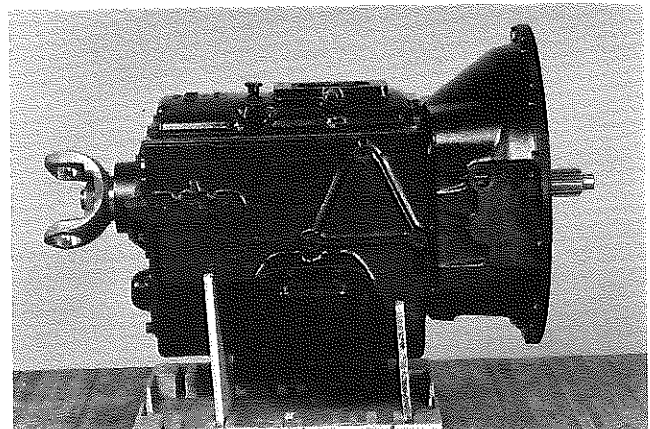
9. Install the input shaft, bearing cap, and gasket. **CAUTION:** Make sure a protective sleeve is used to protect the bearing cap seal when sliding the cap over the shaft. Secure with cap screws. Torque to 34 - 41 ft. lbs.



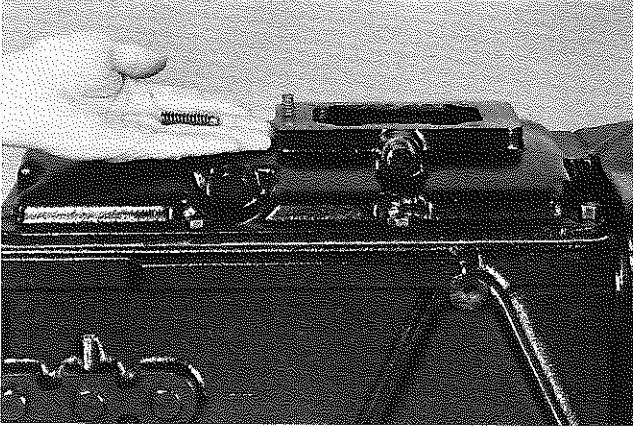
10. Install the end yoke, washer, and nut. Torque to 500 - 600 ft. lbs.



11. Rotate the mainshaft to properly seat the bearings. Place a dial indicator on the output end of the shaft and lift the shaft with pry bars. End play must be between .003" - .008" to help ensure proper unit functioning. If necessary, re-shim the output bearing cap to achieve proper end play.



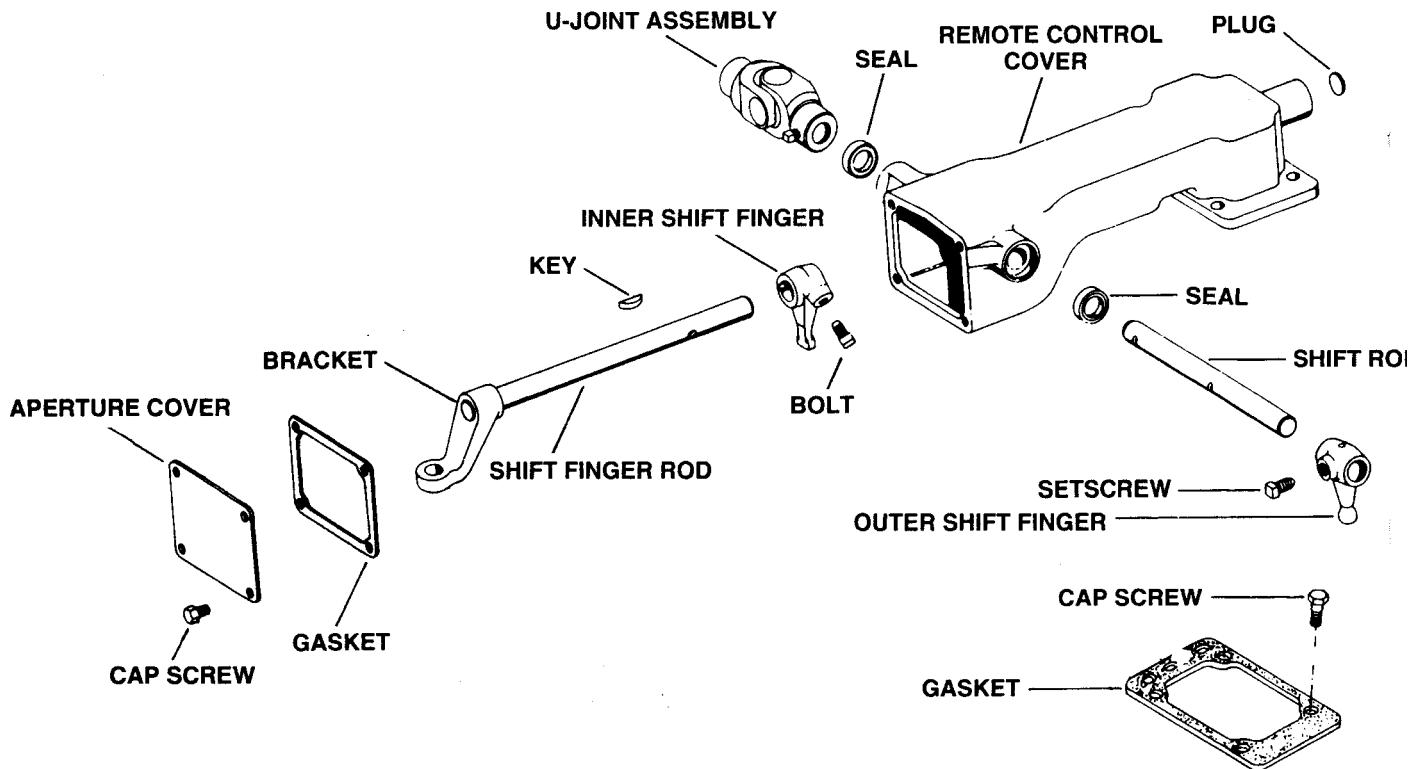
12. Place all shift collars in neutral. Install the shift cover and gasket. Secure them with cap screws. Torque to 20 - 30 ft. lbs.



13. Insert the poppet balls and springs into the shift cover.

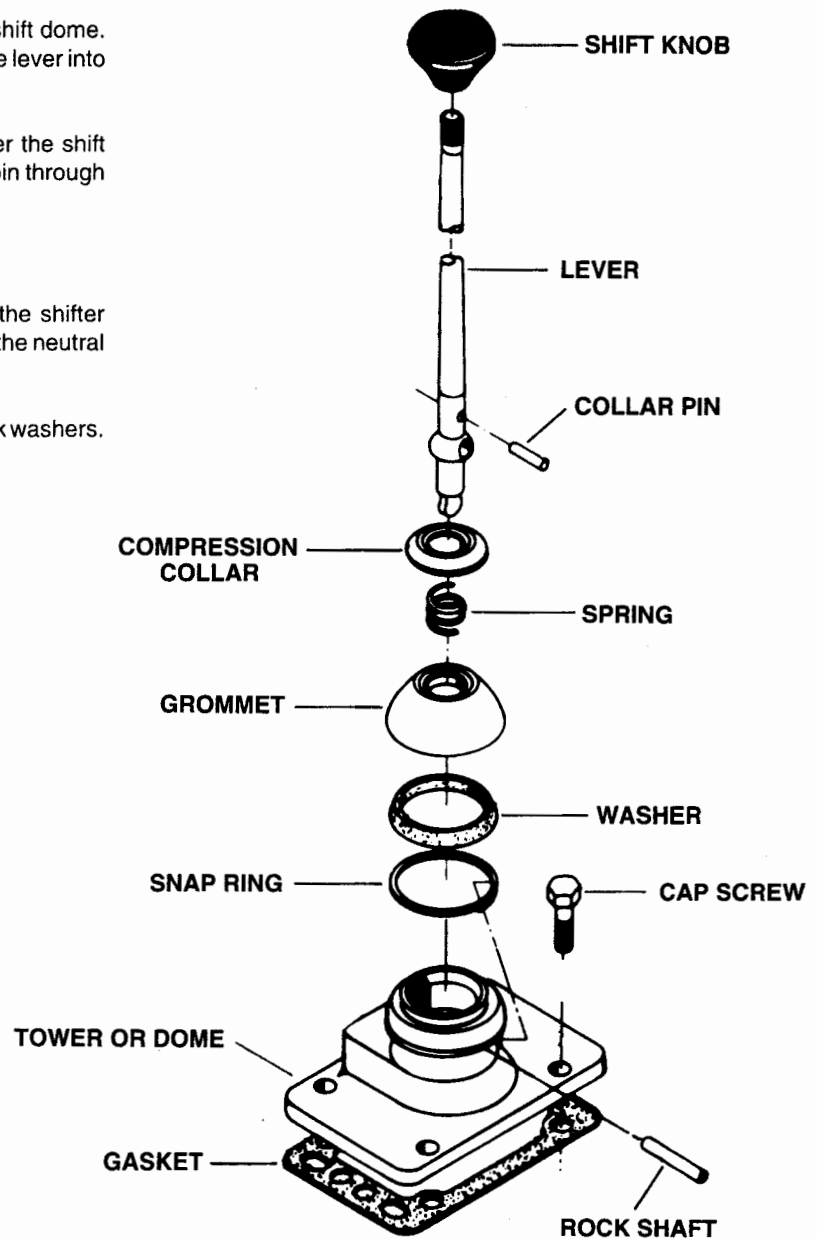
Remote Control Reassembly

1. Install a key in the rod and bracket assembly.
2. Install the unit into the remote housing, sliding the inner shift finger on the end of the rod.
3. Line up the setscrew holes and install the setscrew. Torque to 40 - 50 ft. lbs.
4. Install the joint shift rod through the cross holes and the outer finger. Make sure the finger is inserted into the bracket.
5. Align the setscrew holes and install the setscrew. Torque to 40 - 50 ft. lbs.
6. Install the end cover. Secure it with the four cap screws and lock washers. Torque to 25 - 41 ft. lbs.
7. Install two new oil seals in the joint shift rod bores.



Shift Tower Reassembly

1. Position the shift lever dome on edge in a vise.
2. Hold the shift lever so that 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 handle.
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.



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 turbochargers.

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, etc., 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) Cap screws 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.
- (j) 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.



WARNING: Do not leave these vehicles parked in gear. If the vehicle is started in gear, the truck may lurch forward and injure passersby.

- (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.

Backup Lights

If the backup lights do not function, check the following:

- (a) Continuity of the switch with the ball fully depressed
- (b) Electrical plug connection
- (c) Wiring



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