

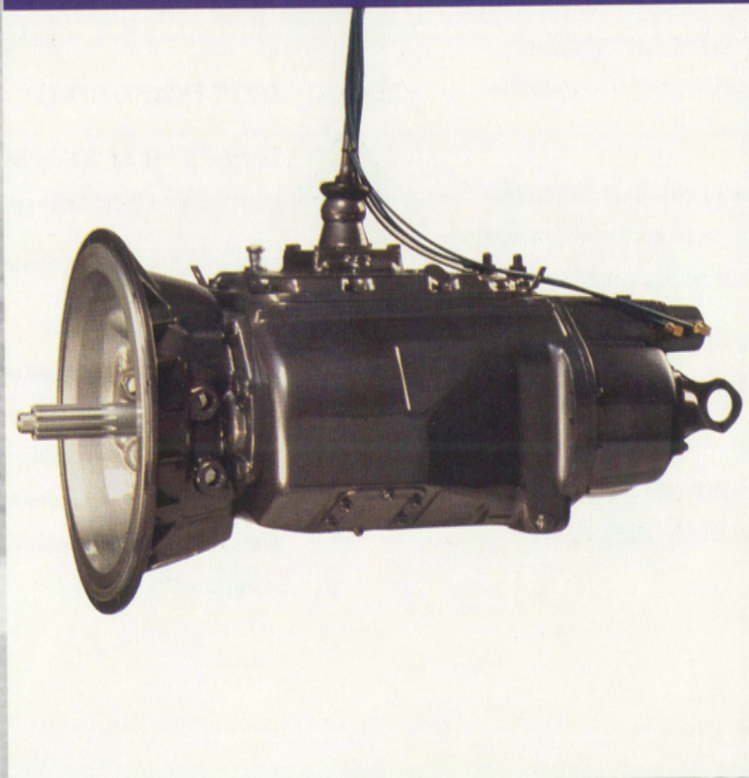
SERVICE MANUAL

SPICER 16-SPEED AND
18-SPEED TRANSMISSIONS

SPICER[®]



TRANSMISSION



INTRODUCTION

SAFETY FIRST

Carefully read this troubleshooting guide before beginning any work on your Spicer transmission.

Throughout this literature, you will see symbols that warn of potential physical dangers or product damage if the accompanying instructions are not followed. Here are the symbols and their meanings:



This symbol indicates a potentially hazardous situation. If the instructions aren't followed, the result could be death or serious injury.



This symbol indicates that you must do something in order for the transmission to function properly.



This symbol indicates that you must NOT do something in order to avoid damaging the transmission.

Be sure you understand all procedures and instructions in this guide before you begin working on your Spicer transmission. If you have any questions, contact your Spicer transmission representative or call the Spicer Support Line (800-666-8688).

GENERAL SAFETY PRECAUTIONS



Be sure to set air brakes before beginning any transmission troubleshooting procedure.



Never shift automated gears while the engine is running.



Do not tow vehicles equipped with Spicer transmissions at high speeds or for long distances without removing the semi-axles or disconnecting the driveshaft. Lubrication of the gear train is insufficient when the vehicle is being towed.

The information in this guide was current at the time of publication.

The Spicer Support Line (800-666-8688) can advise you of any changes or updates.

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GENERAL INFORMATION

SPECIFICATIONS

MODEL NO.	TORQUE CAPACITY	GVW/GCW*
PSO150-16B	1,500 lb. ft.	120,000 lbs.
PSO165-16B	1,650 lb. ft.	140,000 lbs.
PSO175-16B	1,750 lb. ft.	140,000 lbs.
PSO175-16M	1,750 lb. ft.**	140,000 lbs.
PSO165-18A	1,750 lb. ft.	140,000 lbs.
PSO175-18A	1,750 lb. ft.	140,000 lbs.
PSO175-18M	1,750 lb. ft.	140,000 lbs.

	16 SPEED	18 SPEED
Ratio Coverage	17.7:1	16.92:1
Length	34.81"	34.81"
Weight	796 lbs.	796 lbs. (811 lbs.-M Series)
Input Shaft	2" x 10" Spline	2" x 10" Spline
Output Shaft	2.596" x 20-Spline	2.596" x 20-Spline
Clutch Housing	SAE No. 1 or 2	SAE No. 1 or 2
Clutch	Spicer 14" or 15-1/2"	Spicer 14" or 15-1/2"
Lube Capacity	30 Pints	30 Pints
Speedometer	Specify Mech., Elect.	Specify Mech., Elect.

* All other applications require Spicer Engineering approval.

** M ratios include internal lube pump. External pump available on all others.

TOTAL REDUCTION

16 SPEED WITH 14.52 1ST GEAR		18 SPEED WITH 14.21 1ST GEAR	
AXLE RATIO	TOTAL REDUCTION	AXLE RATIO	TOTAL REDUCTION
2.9	42.1:1	2.9	41.2:1
3.06	44.1:1	3.06	43.5:1
3.21	46.6:1	3.21	45.6:1
3.42	49.7:1	3.42	48.6:1
3.55	51.5:1	3.55	50.4:1
3.73	54.2:1	3.73	53.0:1
3.90	56.6:1	3.90	55.4:1
4.10	59.5:1	4.10	58.3:1
4.33	62.9:1	4.33	61.5:1
4.44	64.5:1	4.44	63.1:1
4.56	66.2:1	4.56	64.8:1
4.63	67.2:1	4.63	65.8:1
4.88	70.9:1	4.88	69.3:1
5.29	76.8:1	5.29	75.2:1
5.86	85.1:1	5.86	83.3:1

POWER TAKE-OFF APPLICATIONS

PTO GEAR DATA

6-Bolt Right, 8-Bolt Bottom Left
 Hand Valve Position 1 & 3 - 43% Engine Speed
 Hand Valve Position 2 & 4 - 52% Engine Speed
 56 Tooth, 20 Degree Pressure Angle

GEAR RATIOS

GEAR	RATIO	% STEP	GEAR	RATIO	% STEP
16 SPEED			18 SPEED		
1st	14.52		1st	14.21	19%
2nd	11.97	21%	2nd	11.97	18%
3rd	9.96	20%	3rd	10.13	19%
4th	8.21	21%	4th	8.53	14%
5th	6.81	21%	5th	7.46	19%
6th	5.61	20%	6th	6.28	18%
7th	4.67	21%	7th	5.32	19%
8th	3.85	22%	8th	4.48	15%
9th	3.15	21%	9th	3.89	18%
10th	2.60	20%	10th	3.27	19%
11th	2.16	21%	11th	2.77	19%
12th	1.78	22%	12th	2.33	19%
13th	1.46	22%	13th	1.96	18%
14th	1.20	20%	14th	1.65	18%
15th	1.00	22%	15th	1.40	19%
16th	0.82		16th	1.18	18%
			17th	1.00	19%
			18th	0.84	
Rev. 1	14.52		Rev. 1	14.20	
Rev. 2	11.97		Rev. 2	11.97	
Rev. 3	9.96		Rev. 3	10.13	
Rev. 4	8.21		Rev. 4	8.53	

TOP-GEARED AVERAGE MPH

ENGINE GOVERNED RPM								
AXLE RATIO	1400	1500	1600	1700	1800	1900	2000	2100
3.06	64							
3.21	61	65						
3.42	57	61	65					
3.55	55	59	63	67				
3.73	52	56	60	64	67			
3.90	50	54	57	61	65	68		
4.10		51	55	58	61	65	68	
4.33			52	55	58	61	65	
4.44				50	54	57	60	66
4.56					52	55	58	64
4.63						51	54	60
4.88							52	57
5.29								50
5.86								

With tires @ 517 revolutions per mile

GENERAL INFORMATION

TORQUE SPECIFICATIONS FOR NUTS AND BOLTS

NOM. THREAD SIZE (DIA.)		PART NAME	WRENCH TORQUE (FT. LBS.)				
			NON-LOCKING TYPE		LOCKING TYPE (Bonded Nylon Patch)		
			MIN.	MAX.	MIN.	MAX.	
.250	6	Bolt or Nut	7	10	10	13	
.312			13	17	20	24	
.375	10		25	32	34	41	
.438			40	50	52	62	
.500			60	80	78	98	
.562			90	115	112	137	
.625			120	150	150	180	
.750			200	250	240	290	
1.250			Nut			500	550
1.375						550	600
1.750					550	600	
		PTO Aperture Cover Bolts					
		Bolt	10	15	19	24	
.375		Bolt	20	25	32	37	
		Setscrews	For Lockwire				
		Setscrews	25	32	34	41	
.375			40	50	52	62	
.438							

GENERAL INFORMATION

INSTALLING SPICER 16- or 18-SPEED TRANSMISSION

Before installing the transmission in the vehicle, check the condition of the clutch. This will avoid a possible repair in the near future. If a new clutch is installed, be sure a transmission shaft or other device is used to align the disk.

1. Place the transmission on a jack suitable for transmission installation. Before putting the transmission under the vehicle, be sure that all the accessories are installed. These accessories include the clutch brake, temperature sensor, reverse switch, clutch release shafts, etc.
2. Once the transmission is under the vehicle, raise the jack to get proper alignment with the engine (Figure 1). Insert the input shaft into the clutch hub and push on the transmission to insert the shaft into the disk hub.

To facilitate insertion of the shaft into the hub of the clutch disks, place the transmission in any gear in order to "feel" the disk hub while turning the output yoke.

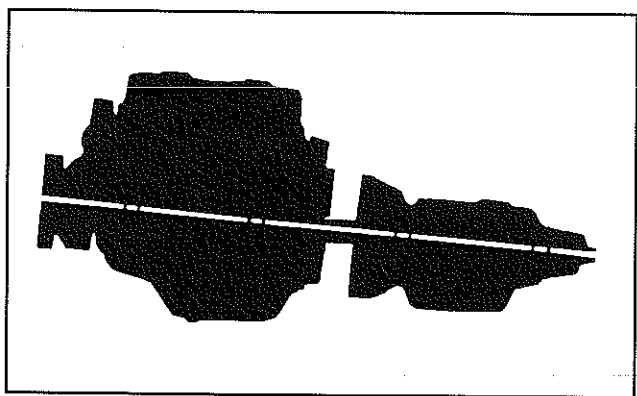


Figure 1

⊘ Do not move the transmission up or down once the shaft has entered the hub of the clutch disks. Doing so will cause internal parts of the transmission to break and clutch disks to twist or crack, preventing them from working properly.

3. Before the transmission is completely connected to the engine, check to see that the shift fork disengagement is assembled correctly on the clutch collar.

After verifying this, attach the transmission to the engine and alternately tighten the screws to 60 - 80 ft. lbs.

4. Install the rear transmission support to the vehicle chassis. Remove the jack supporting the transmission and continue installing the other components (driveshaft, clutch rod, shift lever, etc.).
5. Install the pneumatic system hoses as shown in Figure 2.

GENERAL INFORMATION

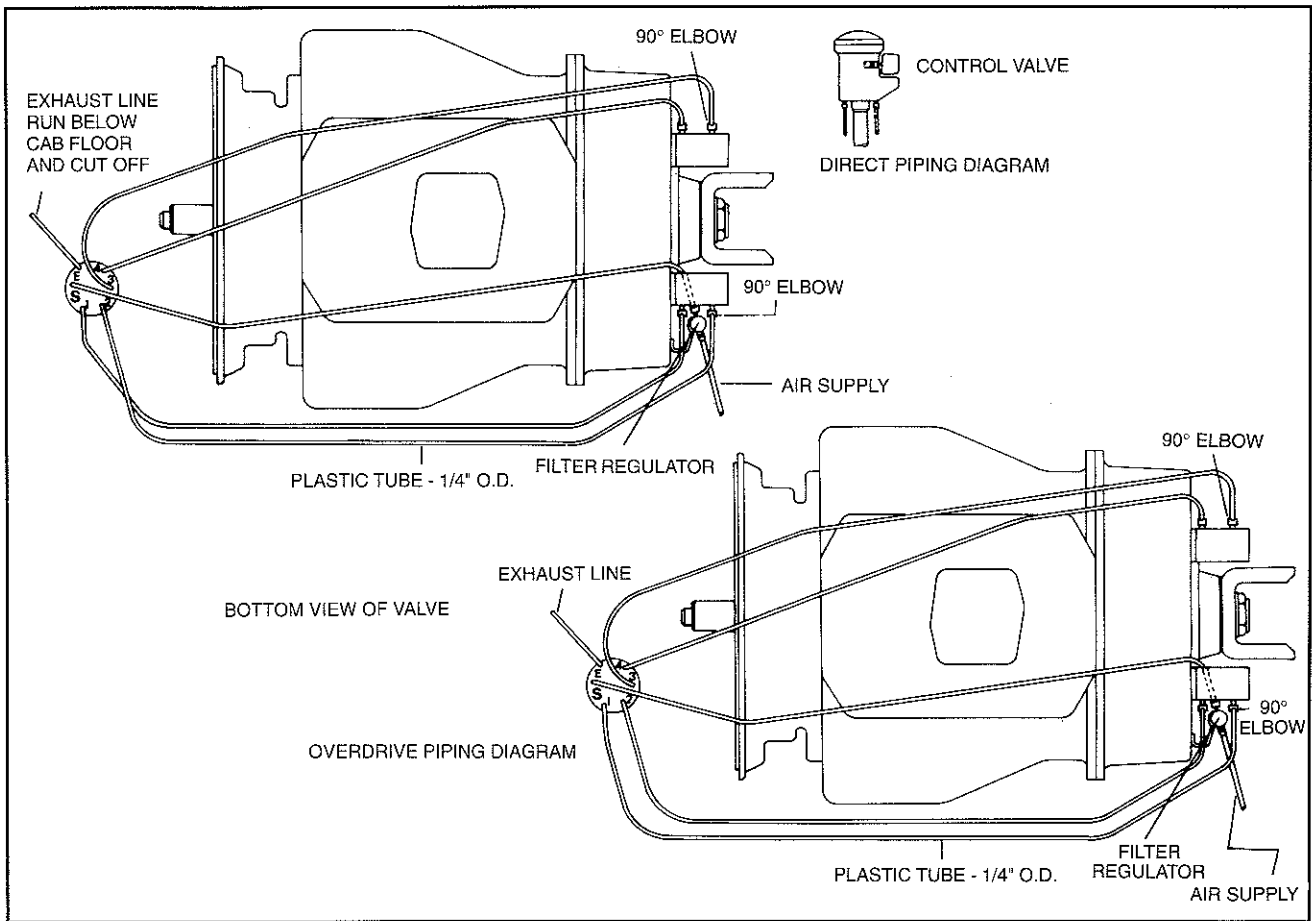


Figure 2

6. Use high quality oil that meets Spicer specifications (See lubrication information, page 7) and verify the oil level (Figure 3). On a level terrain, 15 quarts (14.2 liters) of oil should be in the transmission. If you are using a pump and oil cooler for the transmission, let the pump run briefly to fill the tubes and cooler to establish the oil level.
7. Check the clutch adjustment.
8. Test drive the vehicle before taking it on the road.

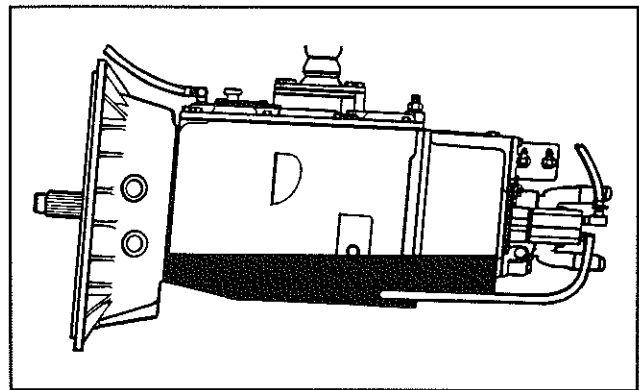


Figure 3

GENERAL INFORMATION

SHIFTING INSTRUCTIONS FOR 16-SPEED MODEL

The Spicer 16-speed transmission was designed to be used with conventional/performance engines (2,100/2,000 rpm governed and 1,200 rpm peak torque) for performance, on/off highway and specialty hauling applications. It is a close stepped (20-22%) transmission with maximum versatility and driver ease. The air system provides the muscle to shift the splitter and range sections. All 16 gears are obtained from a single lever with a standard shift pattern. The gear ratios are shown in Figure 4.

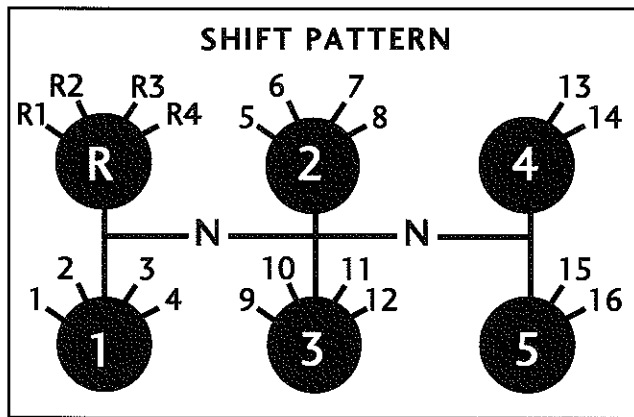


Figure 4

Clash-free shifts are made when the engine and driveline speeds are matched. Double clutching is recommended when the shift lever is moved either up or down in shift sequence.

Clutch Brake

The clutch brake used with this unit is designed for stopping gears to get into 1st and reverse gears. The last 1" of clutch pedal travel activates the clutch brake. On shifts other than first or reverse gear from a stop, depress the clutch pedal only enough to release the clutch. Depressing the pedal to the floorboard will activate the clutch brake and could cause gear hangup or hard shifting.

To start the vehicle if a butt tooth condition exists, gradually release the clutch. The drive gear can then roll over to align teeth to complete the shift.

Upshifting

Normal shift sequence is shown in the shift pattern (Figure 4). When the lever is moved, use normal double clutch techniques. When the shift is desired, depress the clutch pedal and move the lever to neutral. Engage the clutch, allowing the engine to drop (330-380 rpm) so engine and driveline speeds are matched. Depress the clutch pedal and move the lever into gear. Engage the clutch and accelerate as conditions permit.

On splitter shifts (1 to 4, 5 to 8, 9 to 12, 13 to 14 and 15 to 16), do not move the lever from its position. With torque on the driveline, merely select the air control and use a single clutch application just enough to break torque. Then let the engine speed drop (330-380 rpm). Engage the clutch and apply the throttle. The shift from the 2nd to 3rd air position on the control is a double shift. Both the splitter and range are shifting, so the shift will take slightly longer.

When the shift requires both splitter and lever position change (4 to 5, 8 to 9, 12 to 13 and 14 to 15), select the splitter just as the shift lever enters neutral. Complete a normal double clutch operation. The air shift will be completed automatically as the lever is moved to the next gear position.

GENERAL INFORMATION

Downshifting

On a splitter shift, do not move the lever. With torque on the driveline, select the splitter and break torque with a single clutch application while simultaneously increasing engine speed toward the governor. The air system will complete the downshift quickly and smoothly. When lever movement is required, the double clutch technique is used. As the engine approaches the shift point (start the downshift 50-100 rpm above the shift point), select the splitter with torque on the driveline, depress the clutch and move the lever to neutral. Engage the clutch and raise the engine (300-350 rpm) until the engine rpm and driveline speed are equal. Depress the clutch and move the shift lever into the next lower gear. Engage the clutch.

GENERAL INFORMATION

SHIFTING INSTRUCTIONS FOR 18-SPEED MODEL

The Spicer 18-speed transmission was designed to be used with performance engines (1,800-2,100 rpm governed and 1,200 rpm peak torque) for performance, on/off highway and specialty hauling applications. It is a close stepped (18-19%) transmission with maximum versatility and driver ease. The air system provides the muscle to shift the splitter and range sections. All 18 gears are obtained from a single lever with a standard shift pattern. The gear ratios are shown in Figure 5.

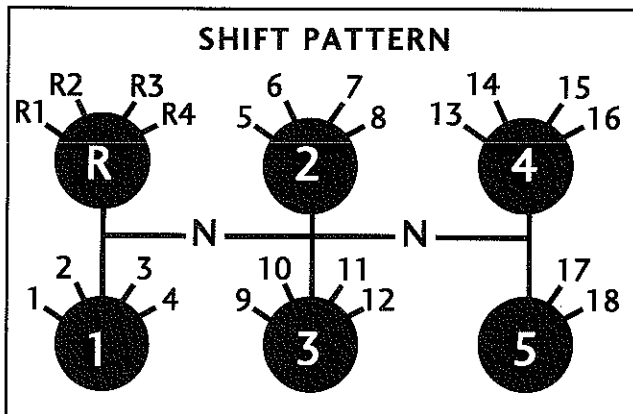


Figure 5

Clash-free shifts are made when the engine and driveline speeds are matched. Double clutching is recommended when the shift lever is moved either up or down in shift sequence.

Clutch Brake

The clutch brake used with this unit is designed for stopping gears to get into 1st and reverse gears. The last 1" of clutch pedal travel activates the clutch brake. On shifts other than first or reverse gear from a stop, depress the clutch pedal only enough to release the clutch. Depressing the pedal to the floorboard will activate the clutch brake and could cause gear hangup or hard shifting.

To start the vehicle if a butt tooth condition exists, gradually release the clutch. The drive gear can then roll over to align teeth to complete the shift.

Upshifting

Normal shift sequence is shown in the shift pattern (Figure 5). When the lever is moved, use normal double clutch techniques. When the shift is desired, depress the clutch pedal and move the lever to neutral. Engage the clutch, allowing the engine to drop (300-350 rpm) so engine and driveline speeds are matched. Depress the clutch pedal and move the lever into gear. Engage the clutch and accelerate as conditions permit.

On splitter shifts (1 to 4, 5 to 8, 9 to 12, 13 to 16 and 17 to 18), do not move the lever from its position. With torque on the driveline, merely select the air control and use a single clutch application just enough to break torque. Then let the engine speed drop (300-350 rpm). Engage the clutch and apply the throttle. The shift from the 2nd to 3rd air position on the control is a double shift. Both the splitter and range are shifting, so the shift will take slightly longer.

When the shift requires both splitter and lever position change (4 to 5, 8 to 9, 12 to 13 and 16 to 17), select the splitter just as the shift lever enters neutral. Complete a normal double clutch operation. The air shift will be completed automatically as the lever is moved to the next gear position.

GENERAL INFORMATION

Downshifting


On a splitter shift, do not move the lever. With torque on the driveline, select the splitter and break torque with a single clutch application while simultaneously increasing engine speed toward the governor. The air system will complete the downshift quickly and smoothly. When lever movement is required, the double clutch technique is used. As the engine approaches the shift point (start the downshift 50-100 rpm above the shift point), select the splitter with torque on the driveline, depress the clutch and move the lever to neutral. Engage the clutch and raise the engine (275-325 rpm) until the engine rpm and driveline speed are equal. Depress the clutch and move the shift lever into the next lower gear. Engage the clutch.

BASIC MAINTENANCE

LUBRICATION

To assure the correct lubrication and operating temperature of the transmission, it is very important to maintain the proper oil level and use appropriate lubricants.

Recommended Lubricants

 Do not use additives such as those found in all-purpose lubricants for extreme pressure or for differential cases. These additives are not necessary for Spicer transmissions and, in some cases, can cause transmission problems. In general, multigrade lubricants tend to form sludge, have a relatively low resistance to oxidation, and are likely to corrode steel and bronze parts.

Oil Changes

Because there are several applications for this transmission, exact oil change intervals are not specified, but a schedule is suggested.

Drain and change the oil after the first 3,000 miles (5,000 km), and before 4,800 miles (8,000 km). Not changing the oil during this time will cause premature problems with the transmission bearings. After the first oil change, it is recommended that the oil be drained and changed every 100,000 miles (160,000 km) or every year for normal highway use.


For off-road use, change the oil after 24 hours and before 100 hours of service. After that, it is suggested that the oil be changed every 1,000 hours.

Lubricants for Non-Synchronized Transmissions

(Exclusively for Mexico or countries with similar climates)

TYPE	VISCOSITY
HEAVY DUTY MOTOR OIL According to specifications MIL-2104D or MIL-L-46152B, API SF/CD (MIL-2104B and C or 46152 are also acceptable)	SAE 50
PURE MINERAL OILS FOR GEAR TYPES R and O Contains corrosion and oxidation inhibitors API-GL-1	SAE 90
* EP TYPE GEAR OIL (light) According to specifications MIL-L-2105 or API-GL4	SAE 90
SYNTHETIC MOTOR OIL According to specifications MIL-L-2104D or MIL-L-46152B, API-SF/CD	CD SAE 50
* SYNTHETIC GEAR OIL According to specifications MIL-2105D 75W90 or API-GL5	EP/SAE EP/SAE

* The EP (extreme pressure) type of gear oils are not recommended when the operating temperature of the lubricant is over 230°F (110°C) or when oil coolers are used for the transmission, since in some cases they can attach to the material from which they are made.

 Do not tow a vehicle equipped with a Spicer transmission at high speeds or for long distances without removing the drive axles or disconnecting the driveshaft. Lubrication of the gear train is insufficient when the vehicle is being towed.


BASIC MAINTENANCE

The use of synthetic oils in Spicer transmissions is recommended and also extends the period of time between oil changes. For highway applications, we suggest oil changes every 250,000 miles (490,000 km) / 3 years, and for off-road use, every 1,000 hours of service. (Off-road use is when a vehicle operates more than 10% of the time off paved roads).

Refilling Oil

When it is necessary to add oil, do not mix oil types or brands because they may be incompatible. In all transmissions, the proper oil level is defined by the oil fill hole.

Overfilling Oil

 Do not overfill the transmission. Oil loses its lubricating qualities under excessive heat and aeration caused by the agitation of the gears. The degradation and premature failure of the oil will cause the formation of varnish and sludge deposits. This plugs the oil ports, accumulating in the bearing tracks and splines of the main shaft. In some cases, excess oil escapes onto the clutch, causing additional problems.

Oil Temperature

Operating temperature of transmission oil under normal conditions is 220°F to 250°F (104°C to 121°C). In some cases, such as use on steep inclines, oil temperature may reach a maximum of 325°F (163°C). Operation above these temperatures will require an oil cooler to prevent long-term damage and maintain the integrity of the transmission.

BEARINGS

Bearing life depends mainly on the lubricant. Use specified oil and change it at the recommended intervals to maximize bearing and transmission performance.

GEARS AND COLLARS

Normally, gears and collars last a long time, and only unusual conditions cause premature failure. Gears and collars are affected by proper and improper operator techniques, and operational mistakes directly influence the life of gears and collars. Parts that suffer the most damage from operation problems are the curvic collars of the pneumatic system. When these begin to wear, gears and shift forks are damaged. These problems are best resolved with proper operator training.


BASIC MAINTENANCE

AIR FILTER REGULATOR

The air filter regulator has an essential role in the proper functioning of the transmission. It filters and regulates the air that operates the transmission. It controls the air flow to a pressure of 50 - 55 lbs./sq. in. However, air pressure can decrease and produce flat or slow shifts if oil and pollutants reach the filter element.

To properly maintain the air filter regulator (Figure 1):

1. Clean or replace the filter element (7) every 6 months or when you notice shifting is slow.
2. If you detect poor functioning of the air filter regulator and the filter has been cleaned, replace the entire unit.
3. To service the filter section, disconnect the air supply, unscrew the body (1), and remove the o-ring seal (2), the stud (4), the baffle (5), the o-ring seal (6), the filter element (7) and the lower seal (8) of the stud.

 Do not dismantle the regulator section (9); if this is done, it will nullify the guarantee.

4. Wash and inspect the parts.
5. Apply air pressure to the filter element (7) from the inside to the outside.
6. Assemble the element with all its parts and tighten the stud to 5 - 10 ft. lbs. Apply synthetic grease to all o-ring seals and screw the body to 10 - 15 ft. lbs.
7. Verify the output pressure of the filter with a manometer. It should be 50 - 55 lbs./sq. in.

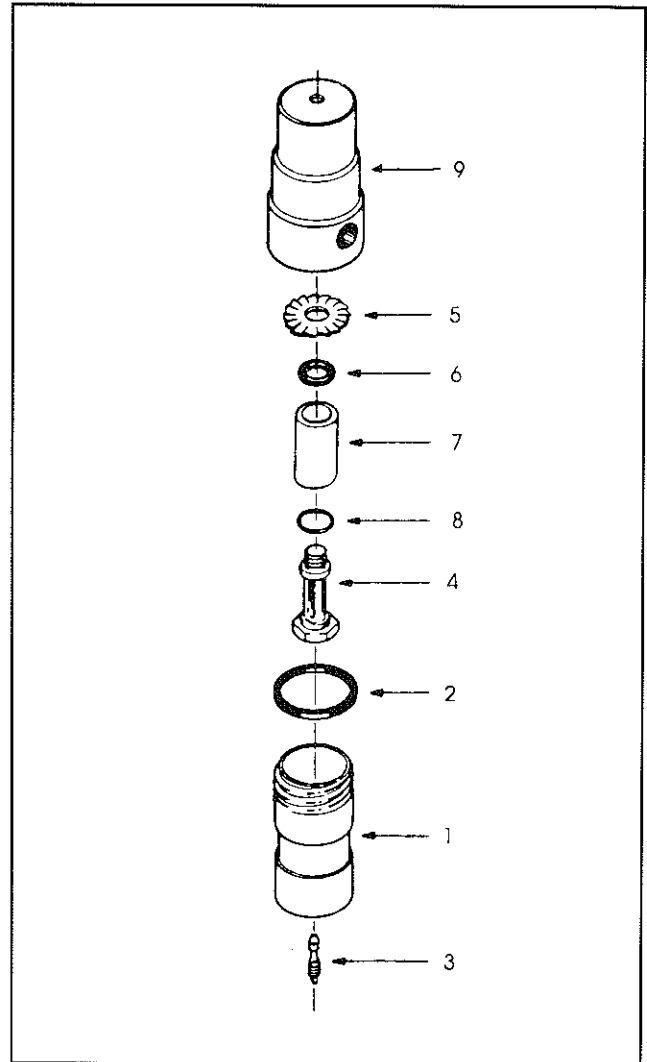
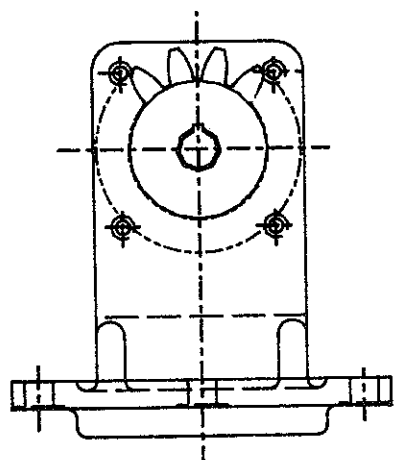


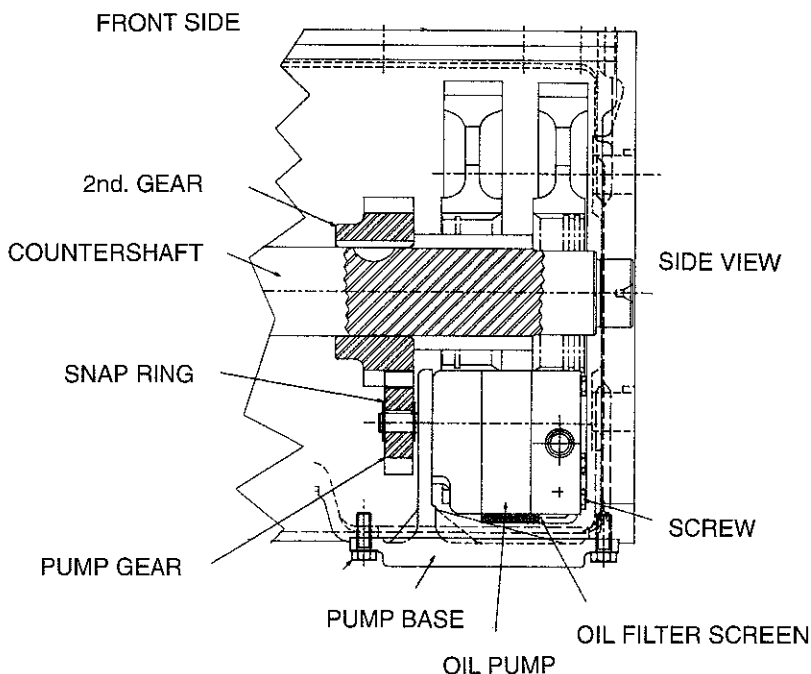
Figure 1

BASIC MAINTENANCE

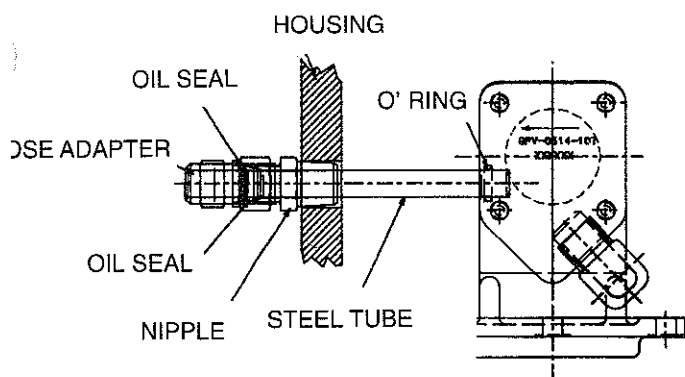
LUBE PUMP INSTALLATION DIAGRAM



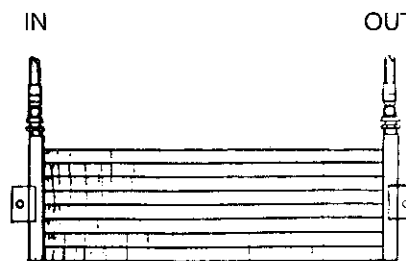
PUMP FRONT VIEW



OIL PUMP



PUMP REAR VIEW



OIL COOLER

Normally the Spicer transmissions do not require oil or lube cooler; however, there are applications where we recommend using it:

- ◆ For all the direct transmissions, used with engines of 450 HP or more.
- ◆ For all the overdrive transmissions, used with engines of 400 HP or more.
- ◆ Applications where the GVW / GCW is bigger than 90,000 pounds.

- ◆ Whenever the truck shape or configuration limits the air flow through the transmission.
- ◆ Any application where the vehicle is working at low speed, or where the transmission is continuously working above 250°F (121°C).
- ◆ In mountain regions with high temperatures.
- ◆ Applications with power take off.
- ◆ When the exhaust tube is close to the transmission.

GENERAL DISASSEMBLY

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.

INSPECTION 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.

INSPECTION 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 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 update the transmission and increase the service life of the unit.



CAUTION: Read the following 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 chain hoist should be used to handle the mainshaft and countershafts during removal and reassembly procedures.

GENERAL DISASSEMBLY

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 end yokes and flanges to remove or install them. It is not only destructive to the yoke or the flange itself, but hammering 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 that must be prevented can exist.

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

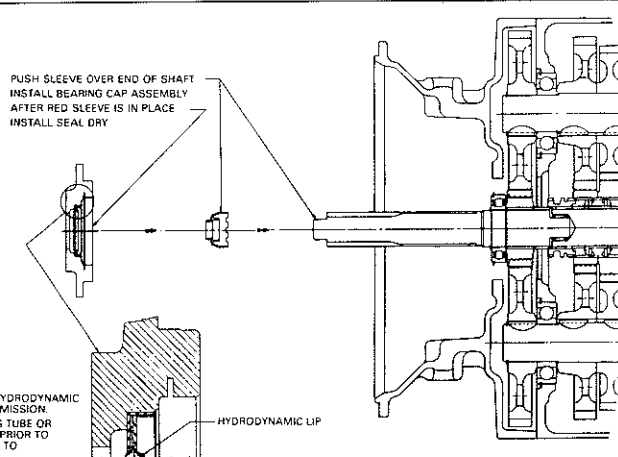
POWER TAKE-OFFS

Refer to your owner's manual for installation procedures and safety precautions when installing a 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.

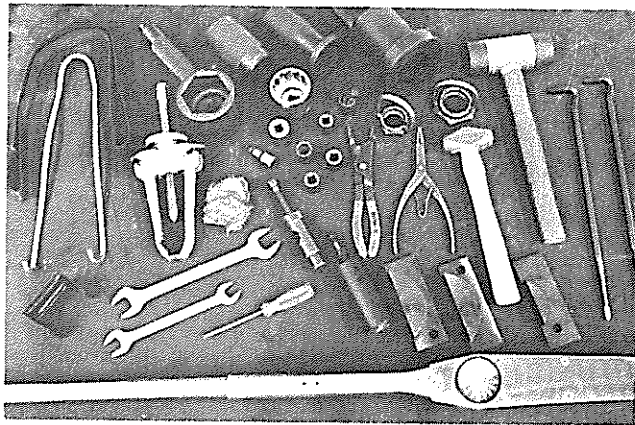
SEAL MUST BE INSTALLED SO THAT HYDRODYNAMIC LIP FACES TOWARD INSIDE OF TRANSMISSION
REMOVE SEAL, CARDBOARD SHIPPING TUBE OR PLASTIC INSTALLATION SLEEVE JUST PRIOR TO INSTALLING BEARING CAP ASSEMBLY TO TRANSMISSION



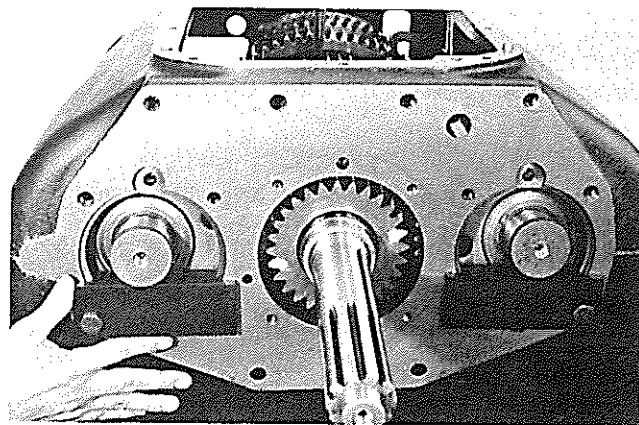
TOOL REFERENCE

To reduce maintenance costs and vehicle downtime, the tools shown here are recommended. Spicer Transmissions can be repaired with common shop tools, but using such

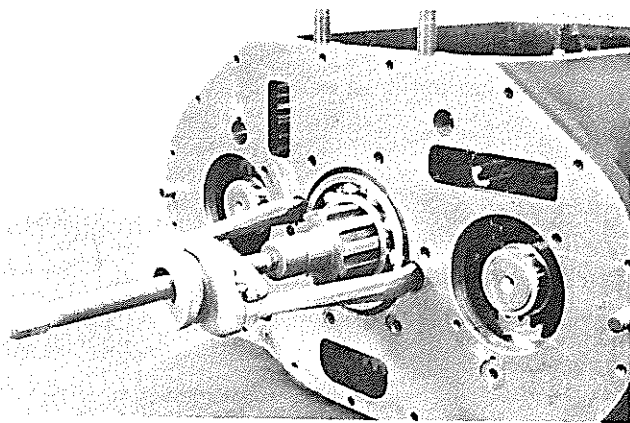
tools can be time consuming and can damage parts that could otherwise be reused.



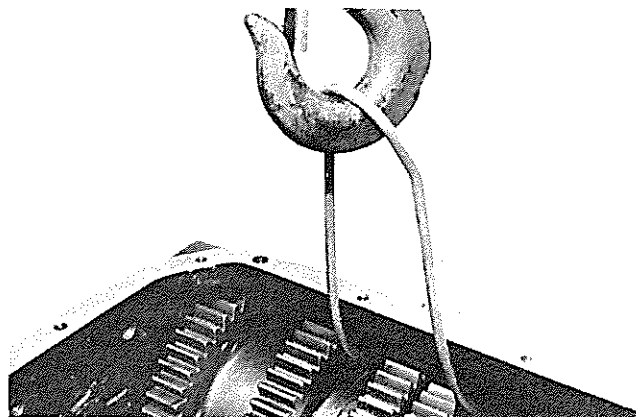
1. Suggested alignment tools, pullers and devices.



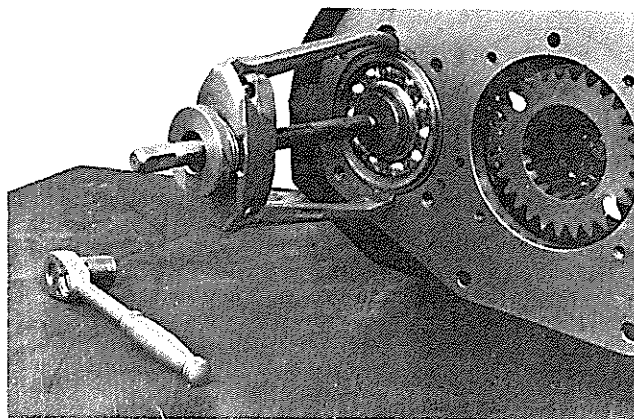
4. Supports for the countershaft to permit alignment of the main shaft when positioning the input shaft cover.



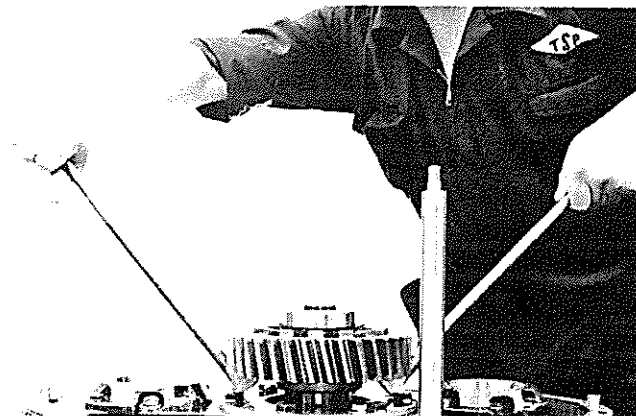
2. A puller for rear and side front bearings (SNAP-ON GC-270).



5. A hook to raise and center the countershaft. This allows the shaft to be raised and centered while the front and rear bearings are installed.



3. Another view of the puller (GC-270).



6. A pry bar (SNAP-ON 1650) to use as a substitute for an puller in some cases.

SHIFT TOWER DISASSEMBLY AND REASSEMBLY

DISASSEMBLY

1. If the upper controls are intact on the cover, shift the transmission to neutral before disassembling.
2. Remove the four bolts (Q-3) and washers (Q-5). Separate the tower (P-12) from the case and the gasket (Figure 1).
3. Place the shift lever tower (P-12) on edge in a vise.
4. Take off the cap (P-6), push the collar against the spring (P-9) and remove the pin (P-7).
5. Raise the compression cup (P-10) over the lever (P-4), and remove the retainer (P-14) from the pivot pin.
6. Tap the pin (P-13) to remove it from the tower (P-12) and remove the lever (P-4). Remove the seal (P-11) and discard it.
7. Remove the shift knob (P-5) and take it off the lever (P-4), the cap (P-6), the collar (P-8), the spring (P-9) and the cup (P-10).

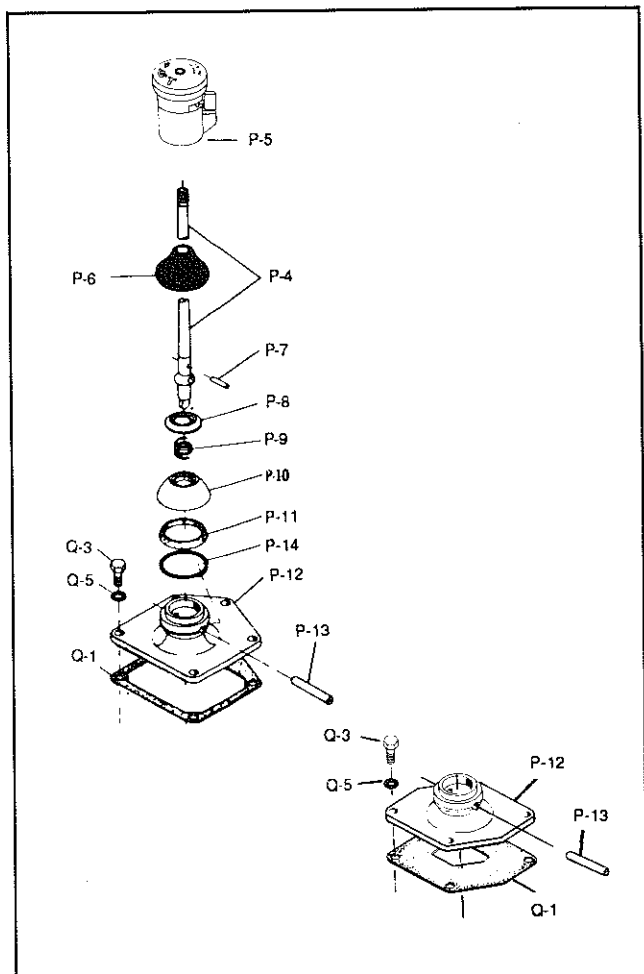


Figure 1

INSPECTION

Carefully wash all parts and inspect for wear on the crosshole of the lever (P-4) and the pivot pin (P-13).

Inspect for excessive wear on the end of the lever. The original contour is shown in Figure 2.

Test the spring tension by comparing it to a new part.

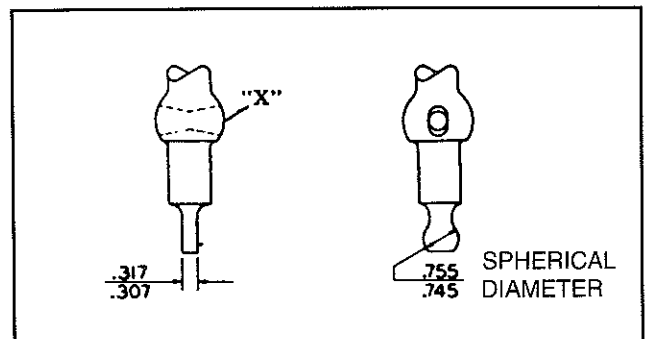


Figure 2

SHIFT TOWER DISASSEMBLY AND REASSEMBLY

REASSEMBLY

1. Place the tower (P-12) on edge in a vise.
2. Holding the lever (P-4), align the crosshole with the drill hole of the cover.
3. Insert the pin (P-13) through the hole of the lever cover.
4. Mount the pivot pin retainer (P-14) in the groove of the tower to keep the pin in place.
5. Lightly grease a new seal (P-11) and place it on the tower. Grease the interior of the cup (P-10) and slide it through the lever to its position over the tower.
6. Assemble the spring (P-9), collar (P-8) and cap (P-6) over the lever. Push the collar (P-8) and insert the pin (P-7) through the hole in the lever.
7. Place the shift knob on the lever.

INSTALLATION

1. Shift the transmission to neutral to align the notches of the shift forks and supports.
2. Apply a light coat of gasket cement to the new gasket (Q-1) and place it on the opening of the cover.
3. Place the lever and tower assembly on the shift cover. Make sure the end of the lever fits in the notches of the neutral position.
4. Secure it with four bolts and washers (Q-5 and Q-6).

REMOTE CONTROL DISASSEMBLY AND REASSEMBLY

DISASSEMBLY

Remove the four screws and washers and separate the remote control from its housing on the shift cover.

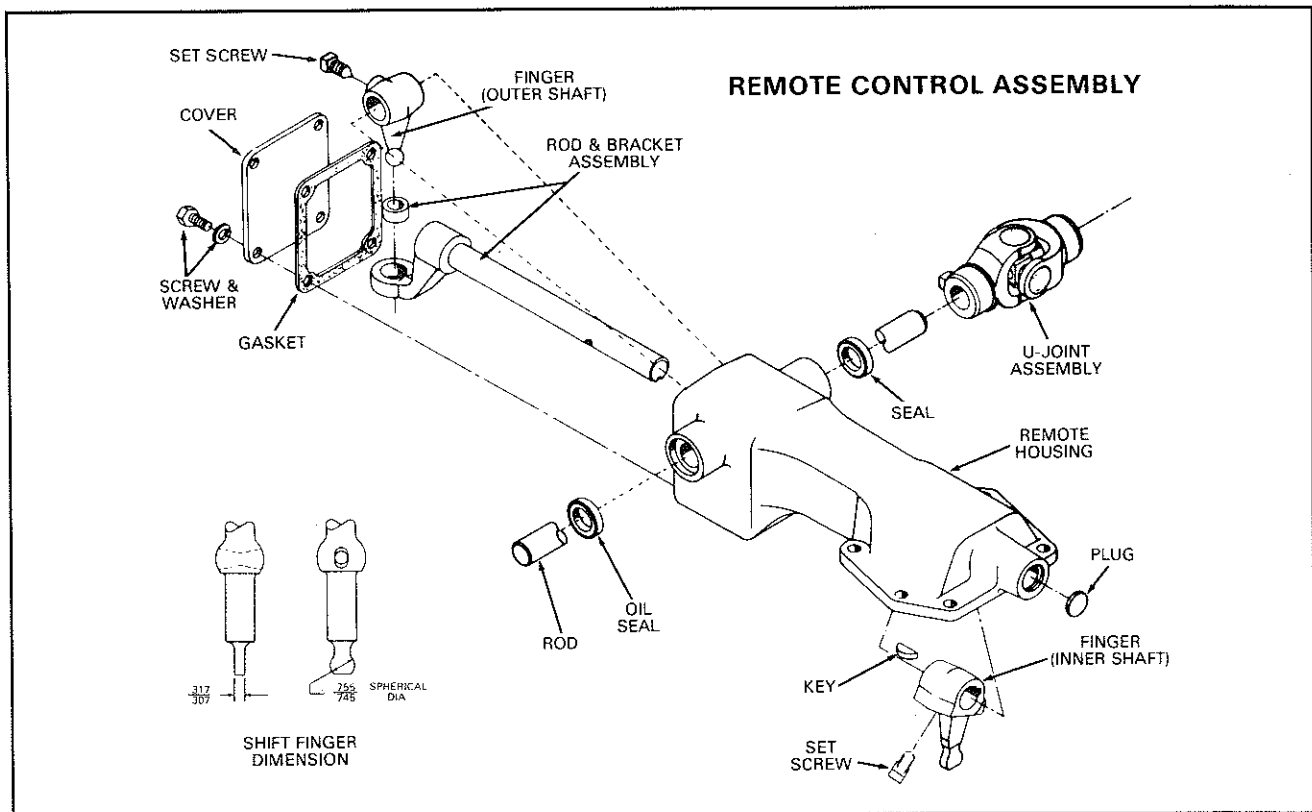
1. Remove the universal joint setscrew and separate it from the exterior rod.
2. Remove the four screws and washers that support the cover to the gasket.
3. Remove shifter setscrew or exterior finger of the shift bar. Slide the exterior rod through housing holes.
4. Take the exterior finger out of the housing.
5. Remove the shifter setscrew from the interior finger.
6. Slide the arm rod separating it from the interior shift finger.
7. Be careful not to lose the shift bar key or interior finger.
8. Remove the seals from the crossholes of the housing.

INSPECTION

Verify that the shifters or fingers of all rods do not have cracks or excessive wear. Thoroughly clean all parts. Apply a coat of grease to all support points before reassembling.

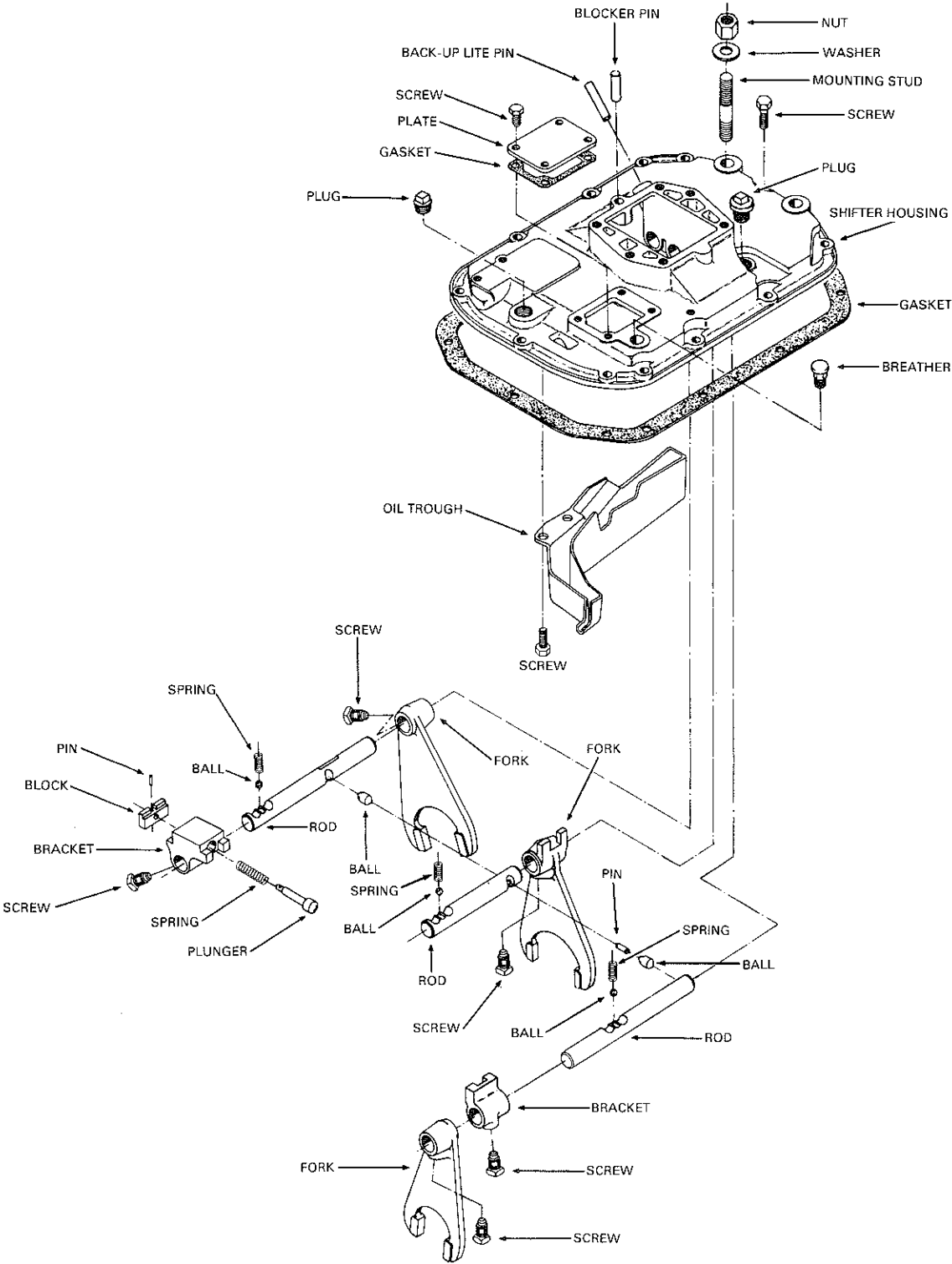
REASSEMBLY

1. Install a key in the arm bar assembly and place on the case by sliding the interior finger on the end of the rod.
2. Align holes, install setscrew and tighten to 40 - 50 ft. lbs.
3. Install the connecting rod through the crossholes and the exterior finger. Make sure that the exterior finger is inserted into the bracket.
4. Align holes, install setscrew and tighten to 40 - 50 ft. lbs.
5. Install the cover with the washers and screws.
6. Install two new seals in the holes of the connecting rod.
7. Install the universal joint assembly and secure setscrew.



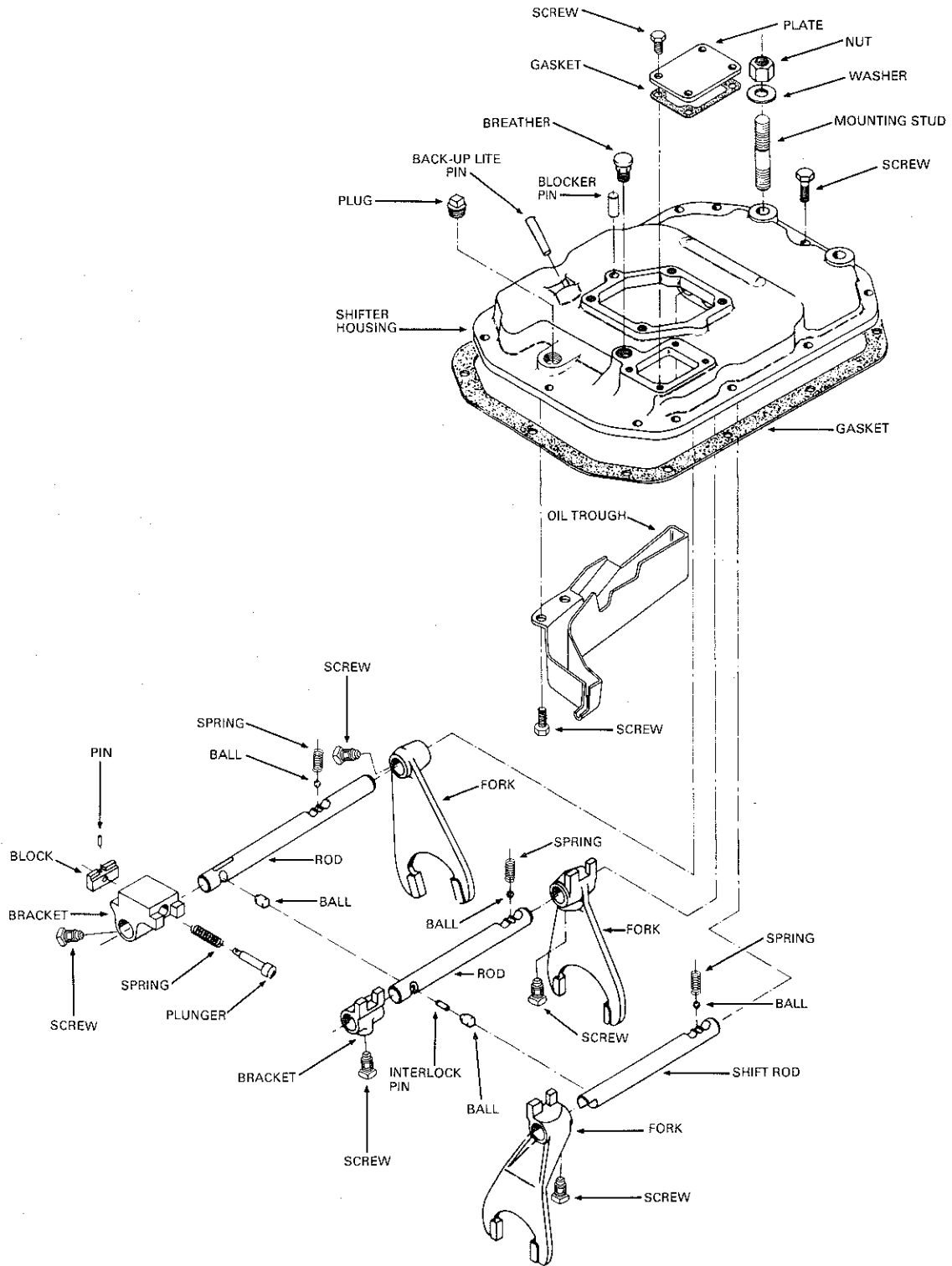
SHIFTER HOUSING DISASSEMBLY

CENTER CONTROL SHIFTER HOUSING

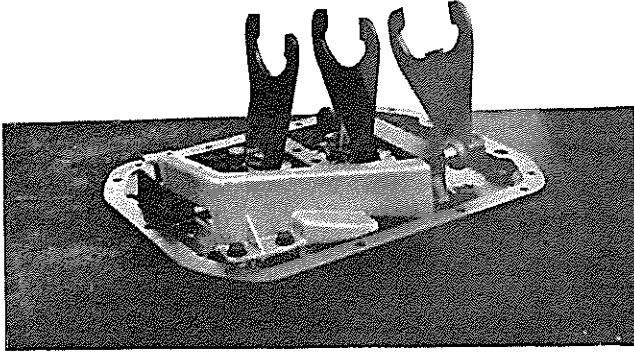


SHIFTER HOUSING DISASSEMBLY

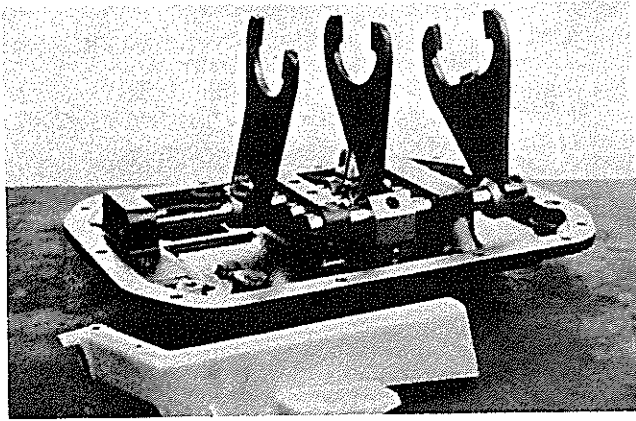
FORWARD CONTROL SHIFTER HOUSING



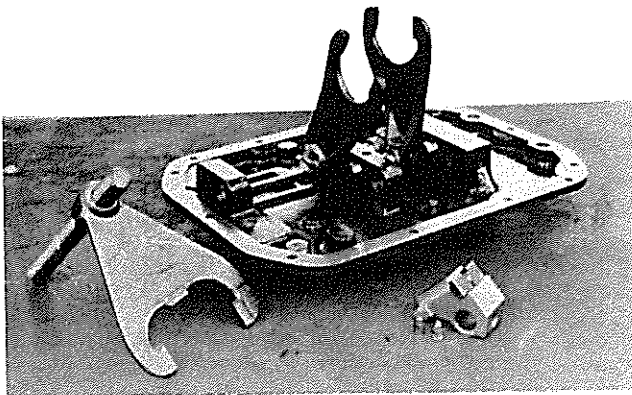
SHIFT COVER DISASSEMBLY



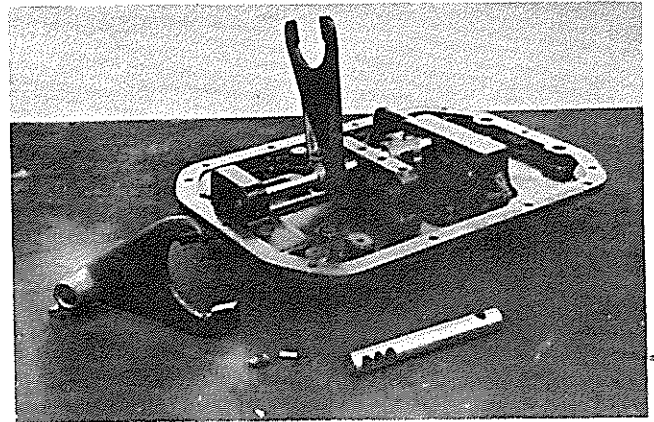
1. Remove the shift cover and place it on a work table with the shift forks up and in the neutral position.



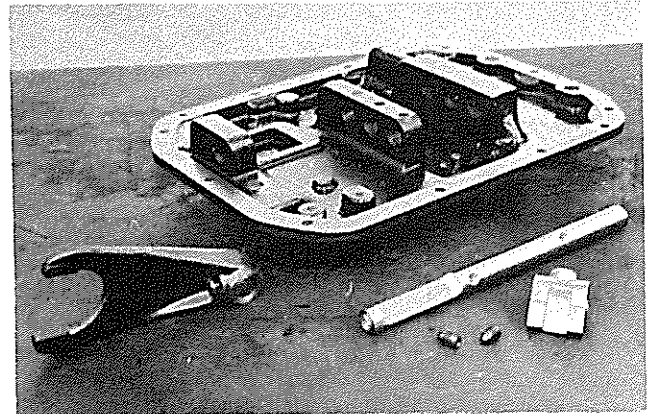
2. Remove the screws from the oil trough and remove the trough to make disassembly of the cover easier.



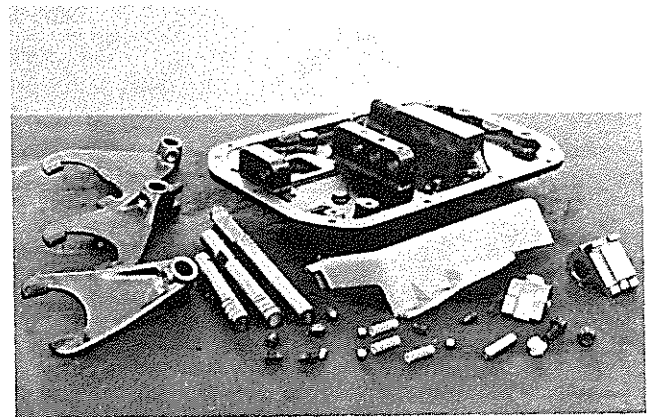
3. Remove the setscrews from the 1st to 4th and reverse shift fork and its bracket. Slide the rod back, being careful not to lose the ball and spring.



4. Remove the setscrew from the 5th to 12th shift fork. Slide the rod back and remove the ball and spring, being careful not to lose the interlock and the interlock that is inside the bar.

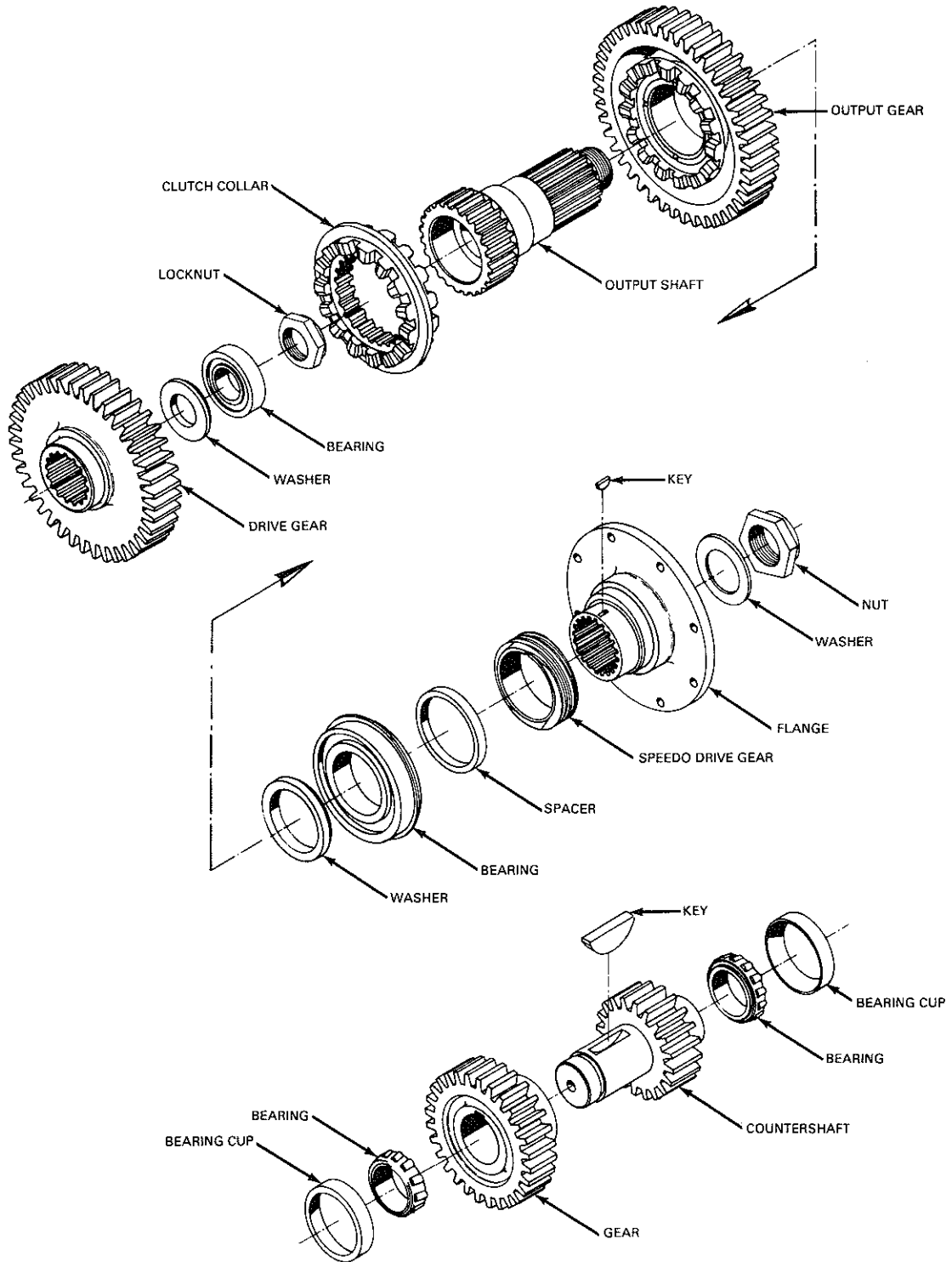


5. Remove the setscrews from the last fork and its bracket. Slide the rod to extract it and take the ball and spring.

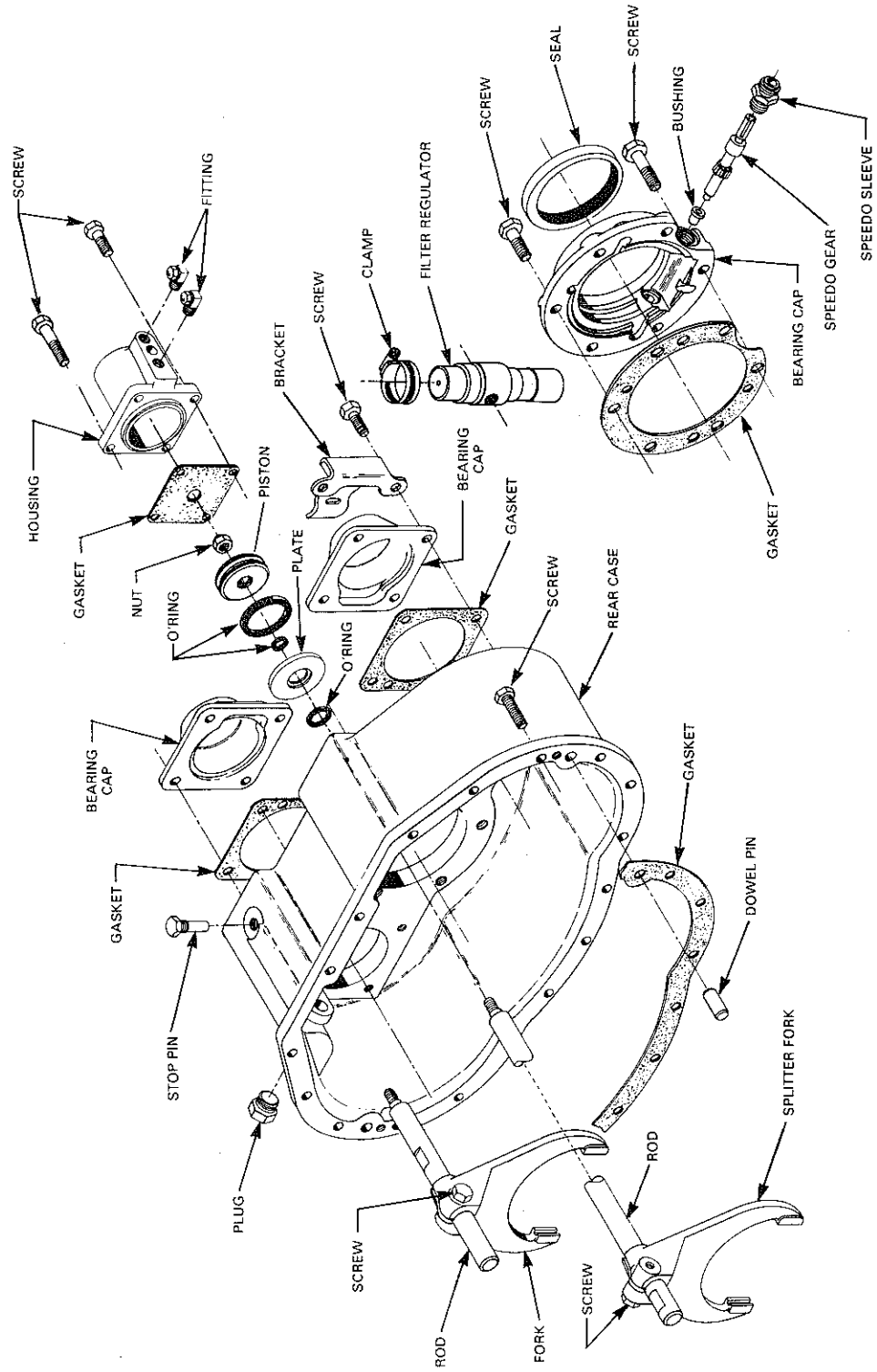


6. Inspect all the parts for wear, cracks or fractures. Verify that the shift fork pads do not have scales or deep wear. If they do, replace them.

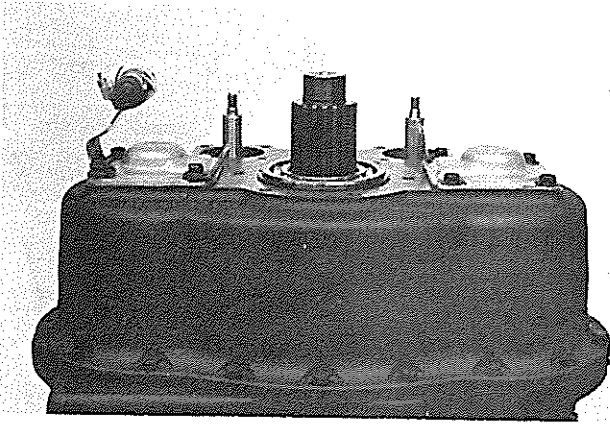
AUXILIARY SECTION DISASSEMBLY



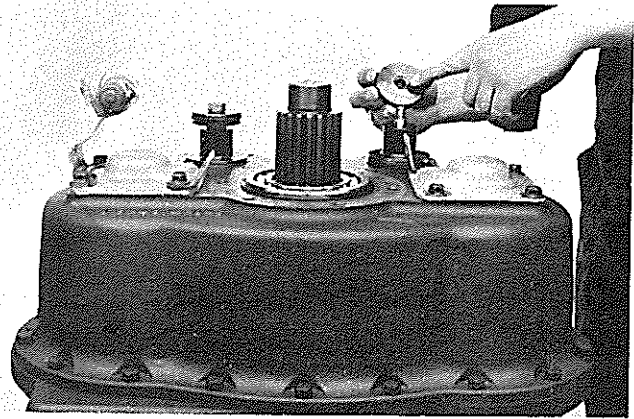
REAR CASE SUBASSEMBLY



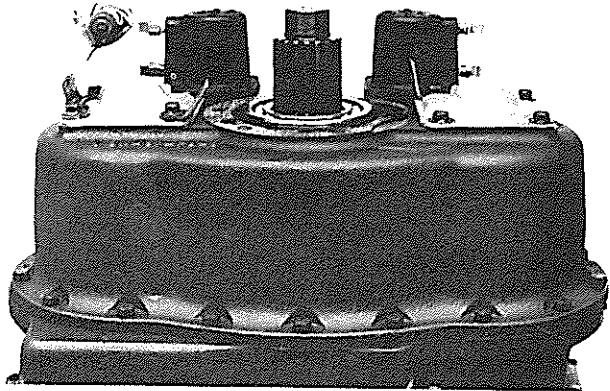
AUXILIARY SECTION DISASSEMBLY



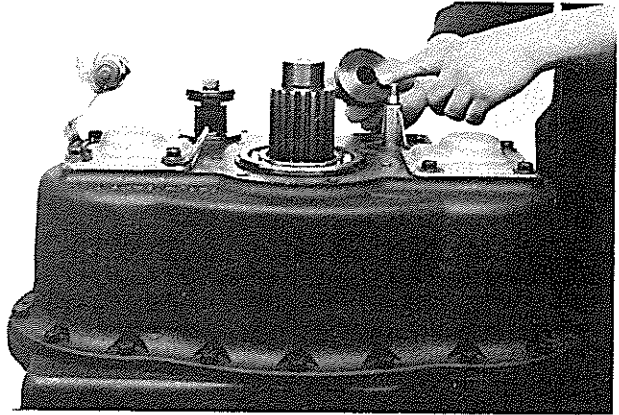
1. Place the transmission upright, loosen the yoke nut and remove the washer and yoke. Remove the speedometer gear and spacer.



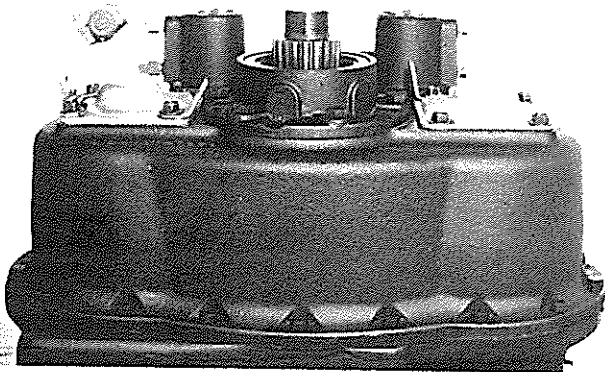
4. Loosen the nuts and remove the pistons with an $\frac{1}{16}$ " wrench. Inspect the condition of the o-ring seals. It is recommended that o-rings be changed with each repair.



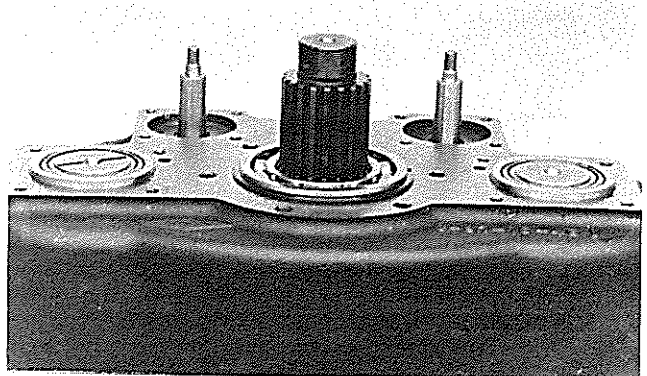
2. Remove the output bearing cover and seal using a $\frac{3}{4}$ " wrench to remove the screws.



5. Take off the piston stops and inspect the o-ring seals.

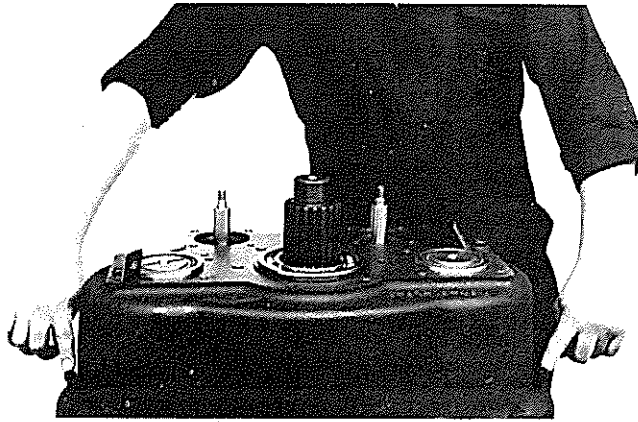


3. Remove the two range piston housings.

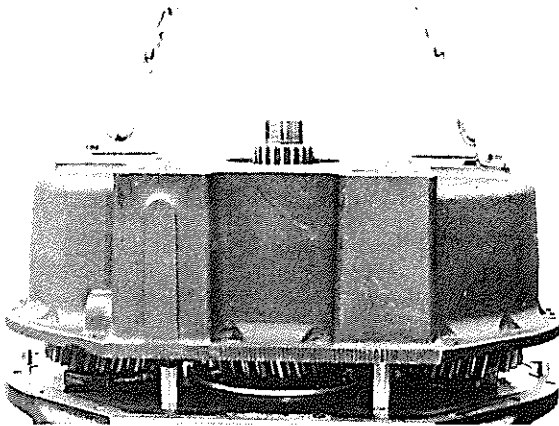


6. Remove the bearing covers from the countershafts by first removing the screws with a $\frac{9}{16}$ " wrench.

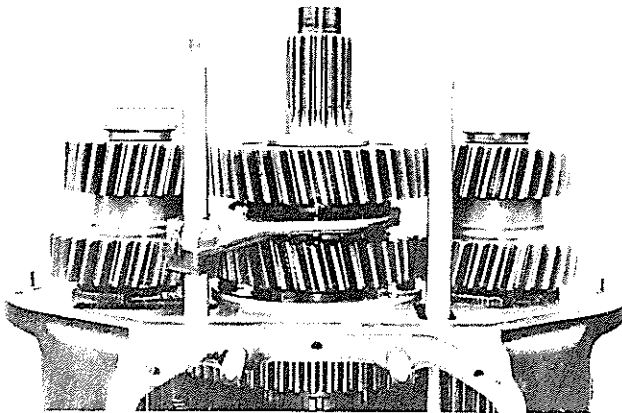
AUXILIARY SECTION DISASSEMBLY



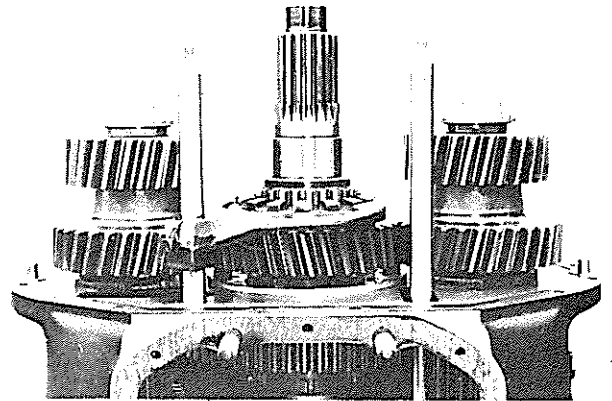
7. Remove the screw that fastens the auxiliary to the main case. Place two bolts in the threaded holes and alternately tighten them to help with the removal of the case and the output bearing.



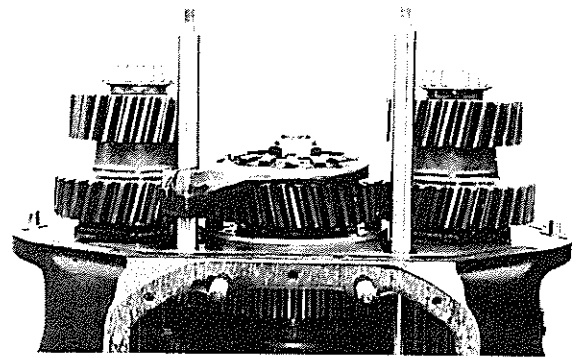
8. Lift the auxiliary case of the transmission. Tap the output shaft so it will stay in place and remove the output bearing.
▲ Use a chain hoist to lift the case.



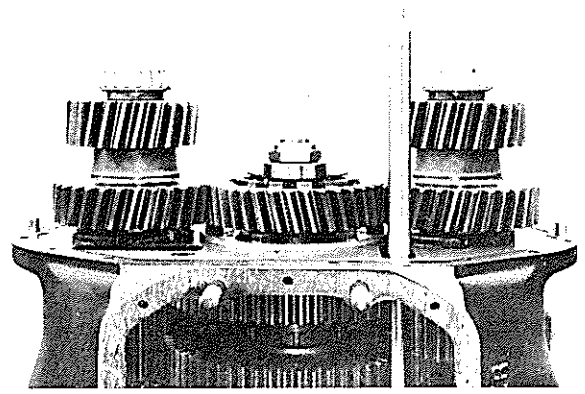
9. The low and high range gears, auxiliary countershafts, shift fork and the rod with the curvic range collar are shown. Notice the locator pins that align the auxiliary case with the main case.



10. Remove the washer and the low range gear with its needle bearing.

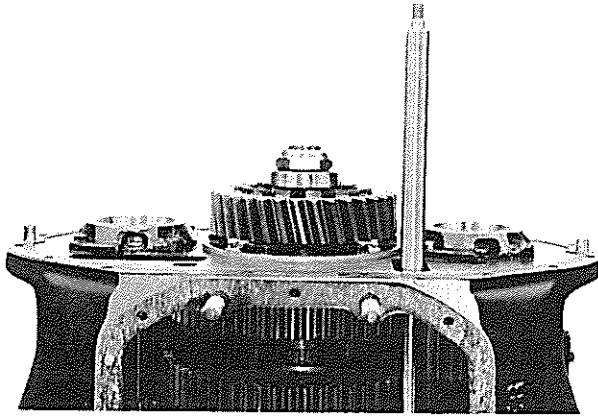


11. Remove the output shaft.

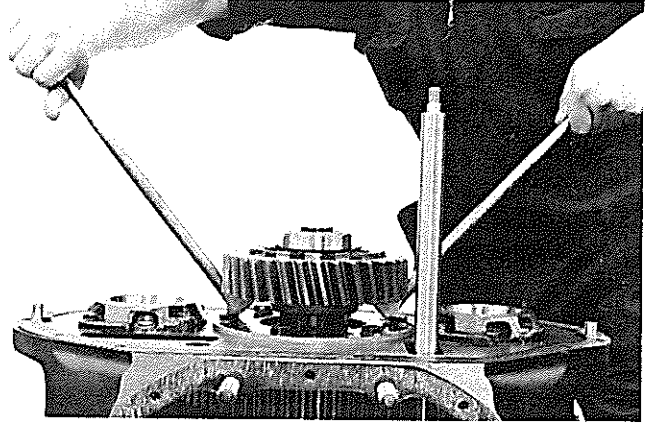


12. Remove the shift fork and range curvic clutch collar.

AUXILIARY SECTION DISASSEMBLY

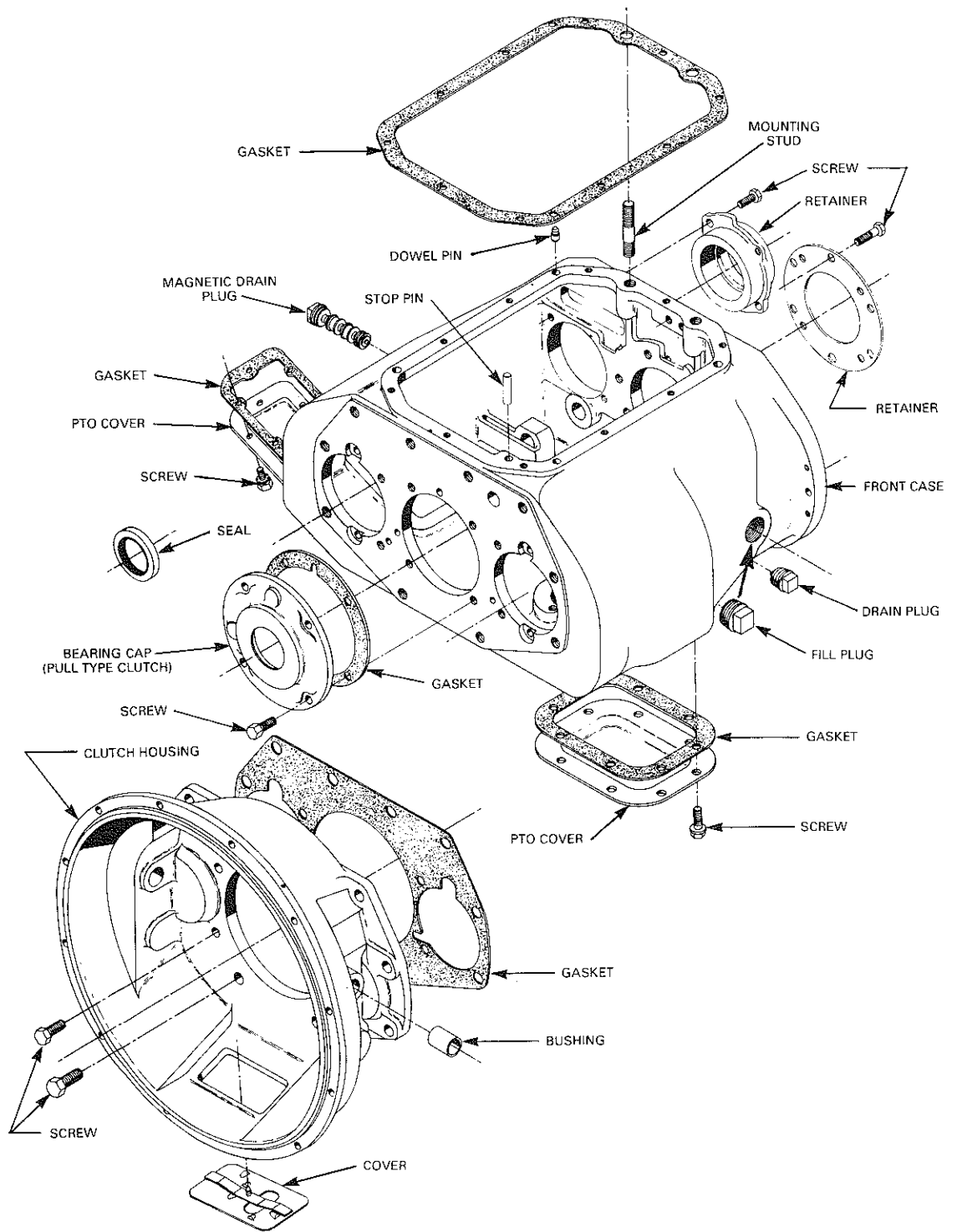


13. Remove the auxiliary countershafts. These are similar except for a groove in the left shaft. The groove drives the oil pump on units equipped with a cooler. Loosen the main shaft nut.

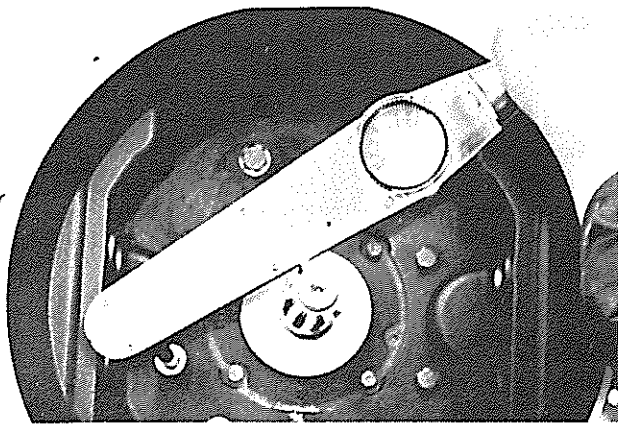


14. With the help of two pry bars under the high gear, remove the bearing, washer and gear.

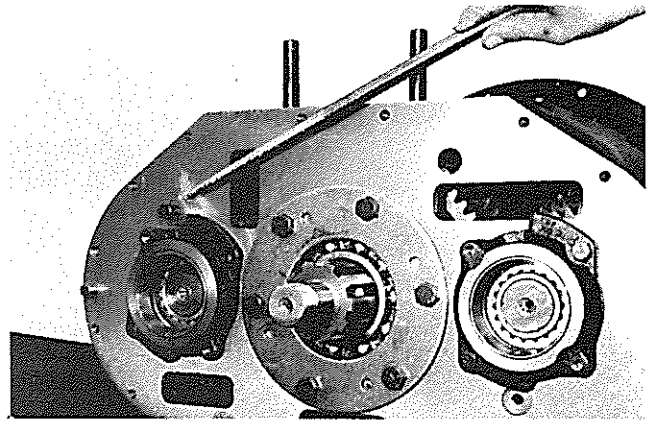
MAIN CASE DISASSEMBLY



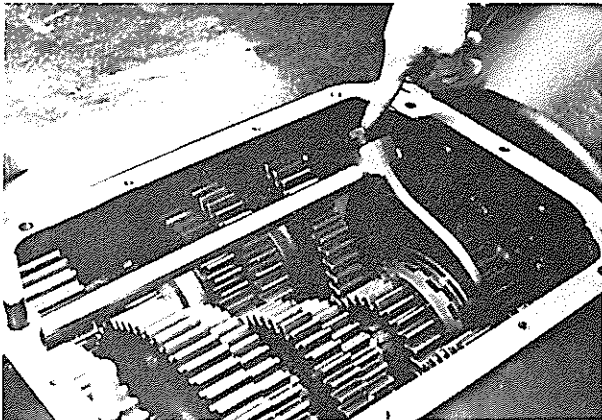
MAIN CASE DISASSEMBLY



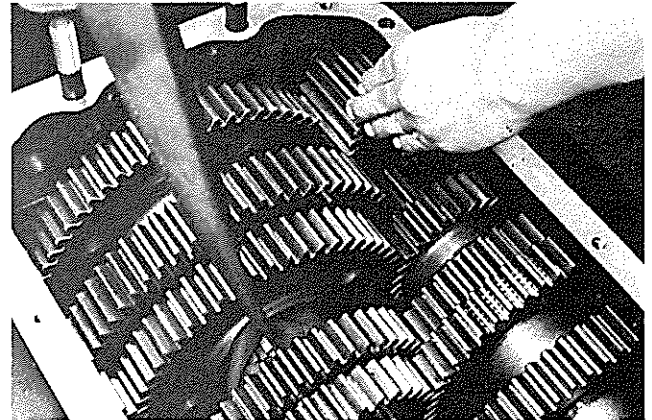
1. Place the transmission in a horizontal position on a work bench and remove the clutch housing.



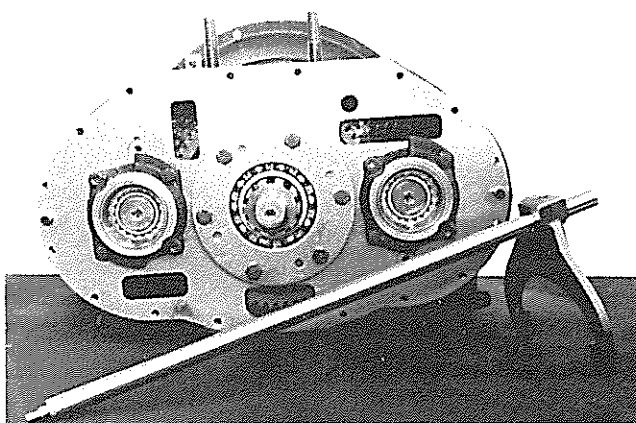
4. Remove screws from the rear bearing retainers, rotate clockwise and remove the reverse idler shaft. Do not lose the lock ball that prevents the shaft from turning. Do not remove the retainers.



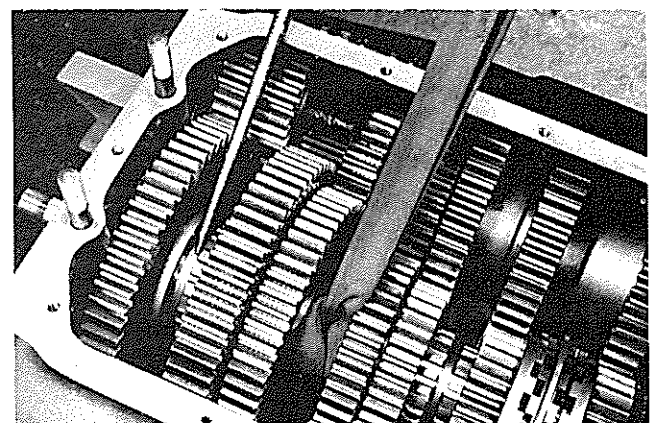
2. Cut the safety wire from the splitter shift fork screw and remove it.



5. Once the shaft is separated from the reverse idler gear, roll it toward an edge of the case.

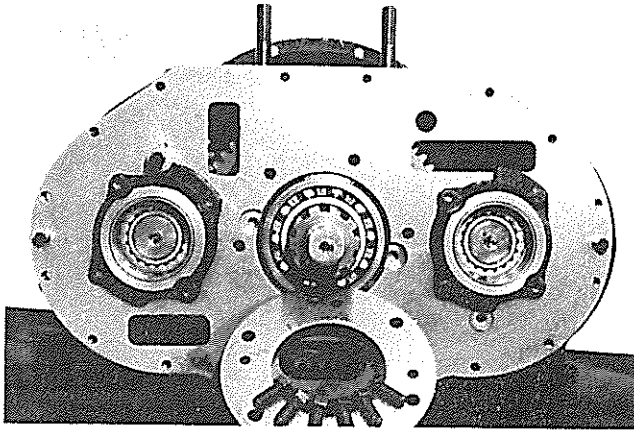


3. Remove the rod and splitter shift fork.

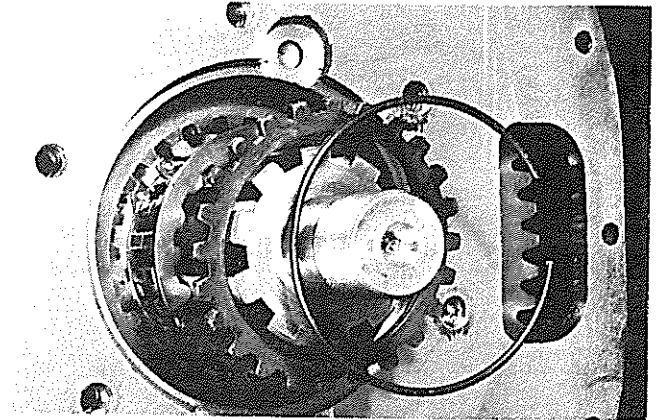


6. Shift the collar inside the reverse gear (back). This will prevent the gear from hanging when removing the rear bearing.

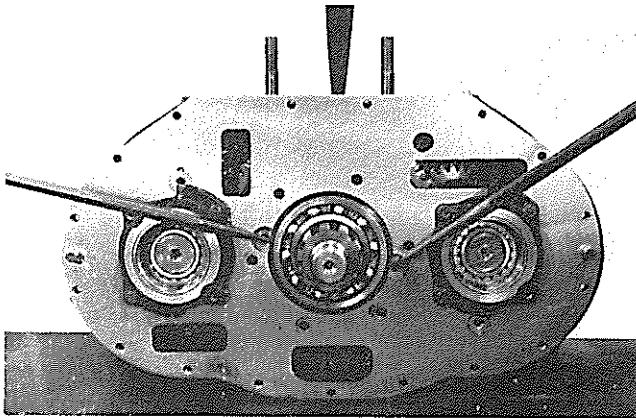
MAIN CASE DISASSEMBLY



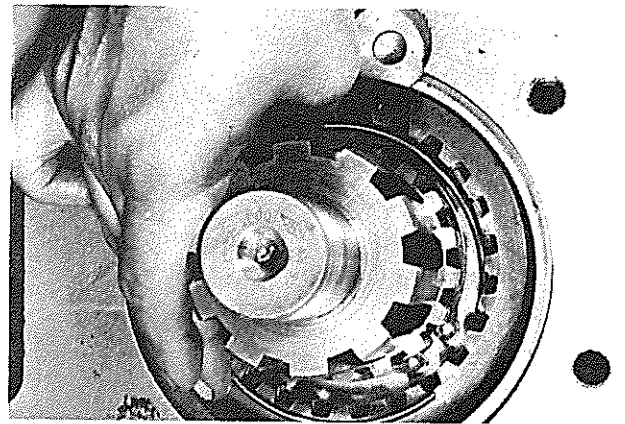
7. Remove the retaining plate of the rear bearing.



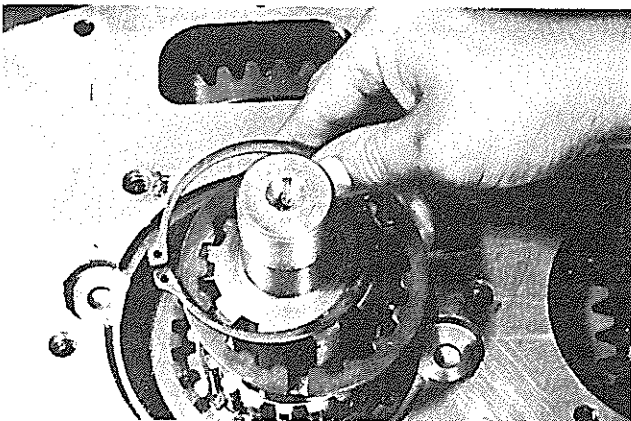
10. Using a thin screwdriver, remove the snap ring from the first groove inside the gear, the exterior splined washer and the second interior splined washer.



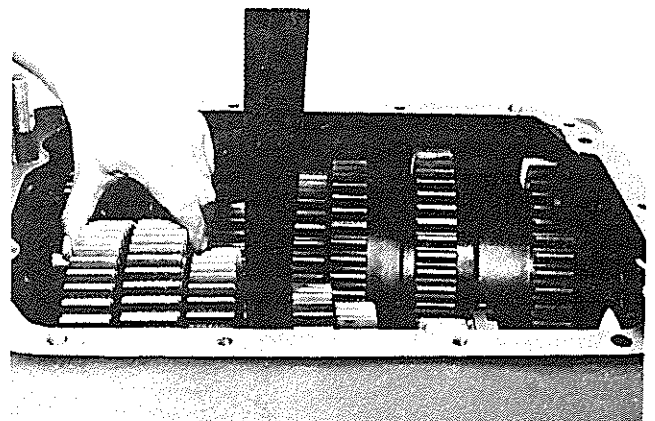
8. Extract the rear bearing. Use bars or a bearing puller with machined grooves for this purpose.



11. Remove the remaining snap ring from the second groove inside the gear.

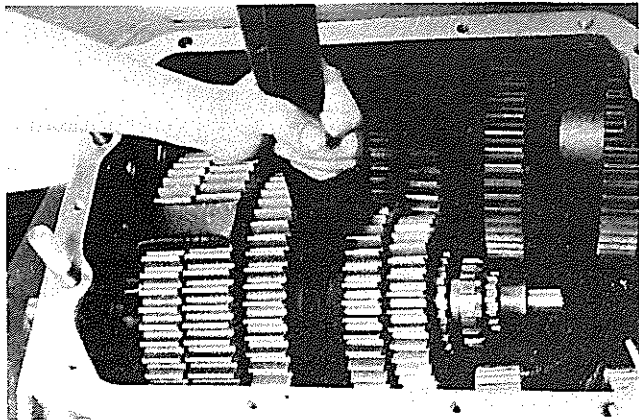


9. Using pliers for external eyelets, remove the snap ring and internal splined washer.
▲ Wear safety glasses for eye protection.

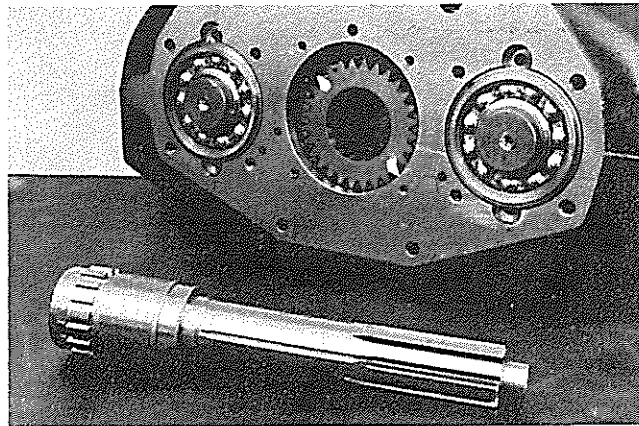


12. Slide the reverse gear and place it against the 1st gear.

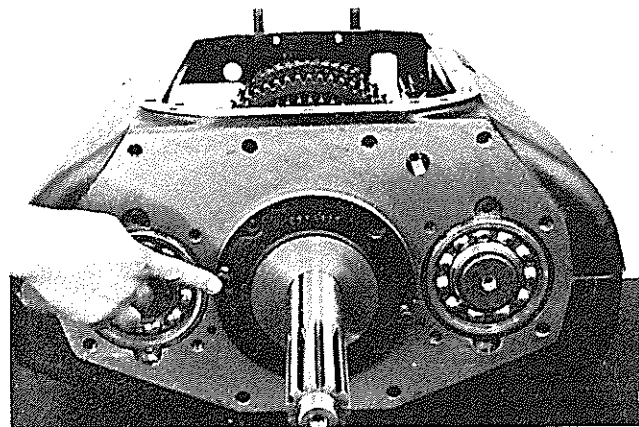
MAIN CASE DISASSEMBLY



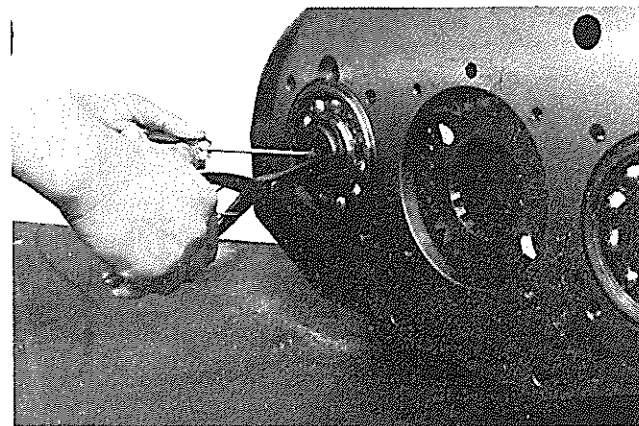
13. Once the two gears are together, fasten them with wire or a device similar to the one shown.



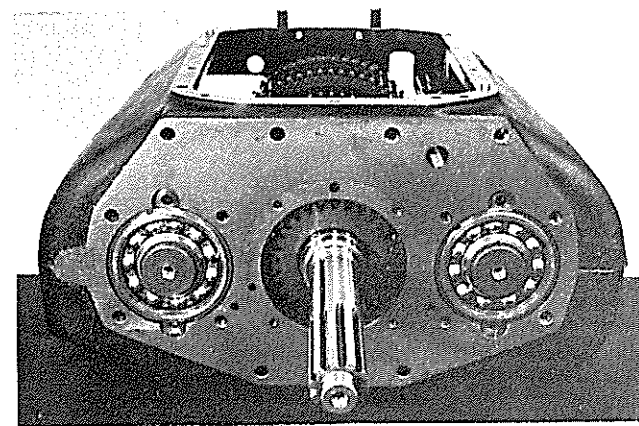
16. Turn and pull the input shaft slightly to remove it.



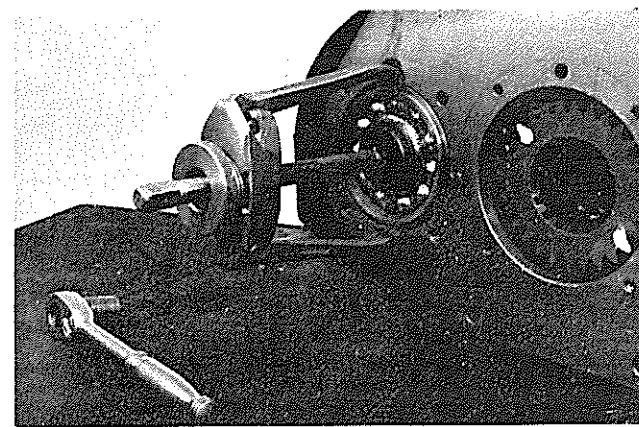
14. To remove the input shaft bearing cap, remove the four bolts. Place two of the bolts in the threaded holes and alternately tighten them.



17. Remove the snap ring from the countershaft with expansion pliers. Be sure to wear safety glasses.
▲Wear safety glasses for eye protection.

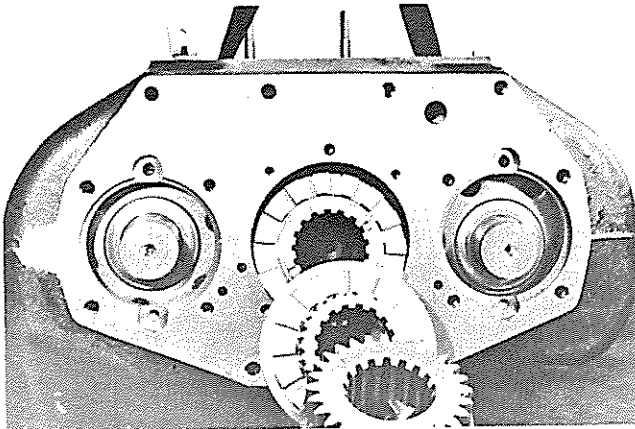


15. Remove the input shaft bearing cap, which contains the bearing.

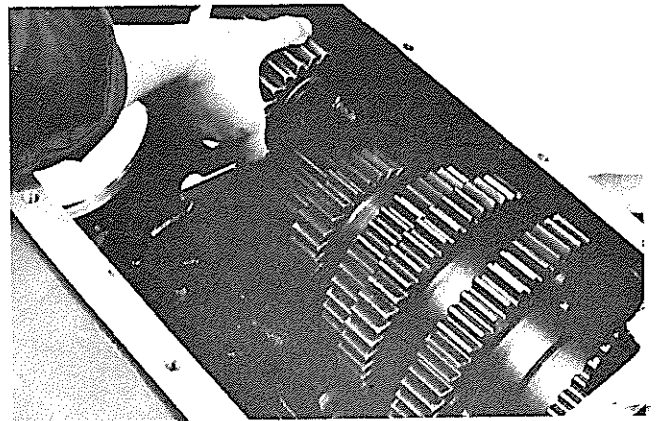


18. To remove the bearing from the countershafts, install the bearing puller behind the snap ring of the bearing. Tap the shaft from behind so that the bearing puller supports the bearing ring completely.

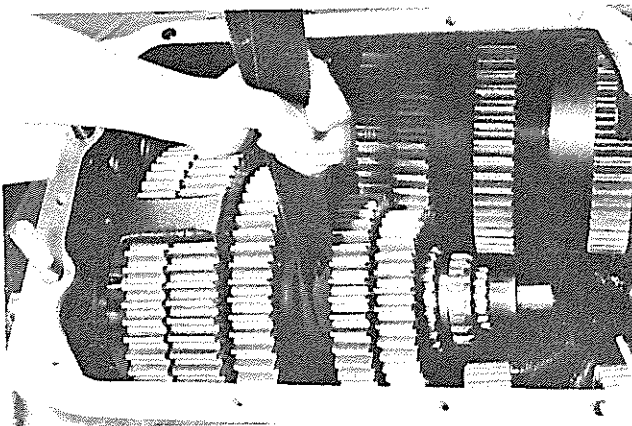
MAIN CASE DISASSEMBLY



19. Remove the gears, curvic clutch collar and splitter clutch gear.

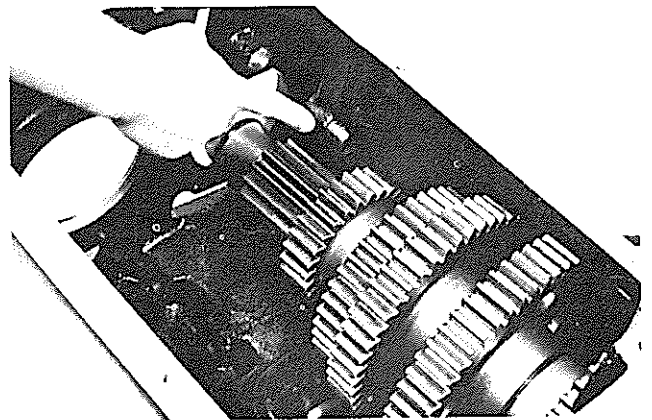


22. Remove the upper reverse idler gear.

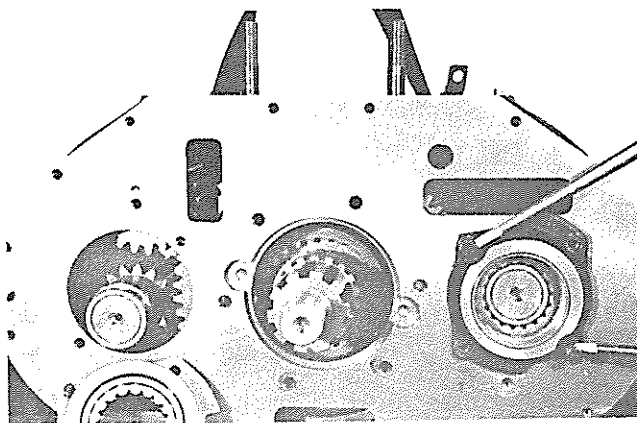


20. Move the shafts forward and remove the main shaft from the case.

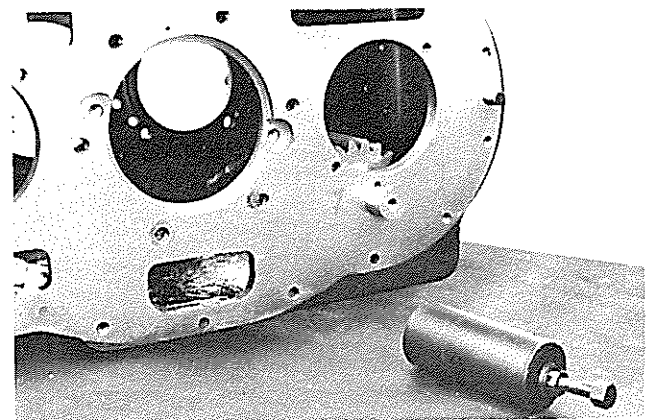
▲ Use a chain hoist to lift the mainshaft assembly.



23. The housing prevents the left countershaft from being removed first. Therefore, it is necessary to remove the right one first, and then the left.

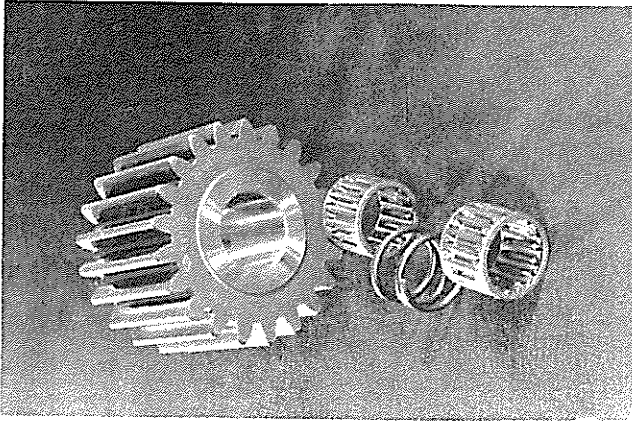


21. Remove the rear bearing retainers. The threaded holes can be used to remove them. Use the bearing puller to remove the countershaft rear bearings and inner rack.



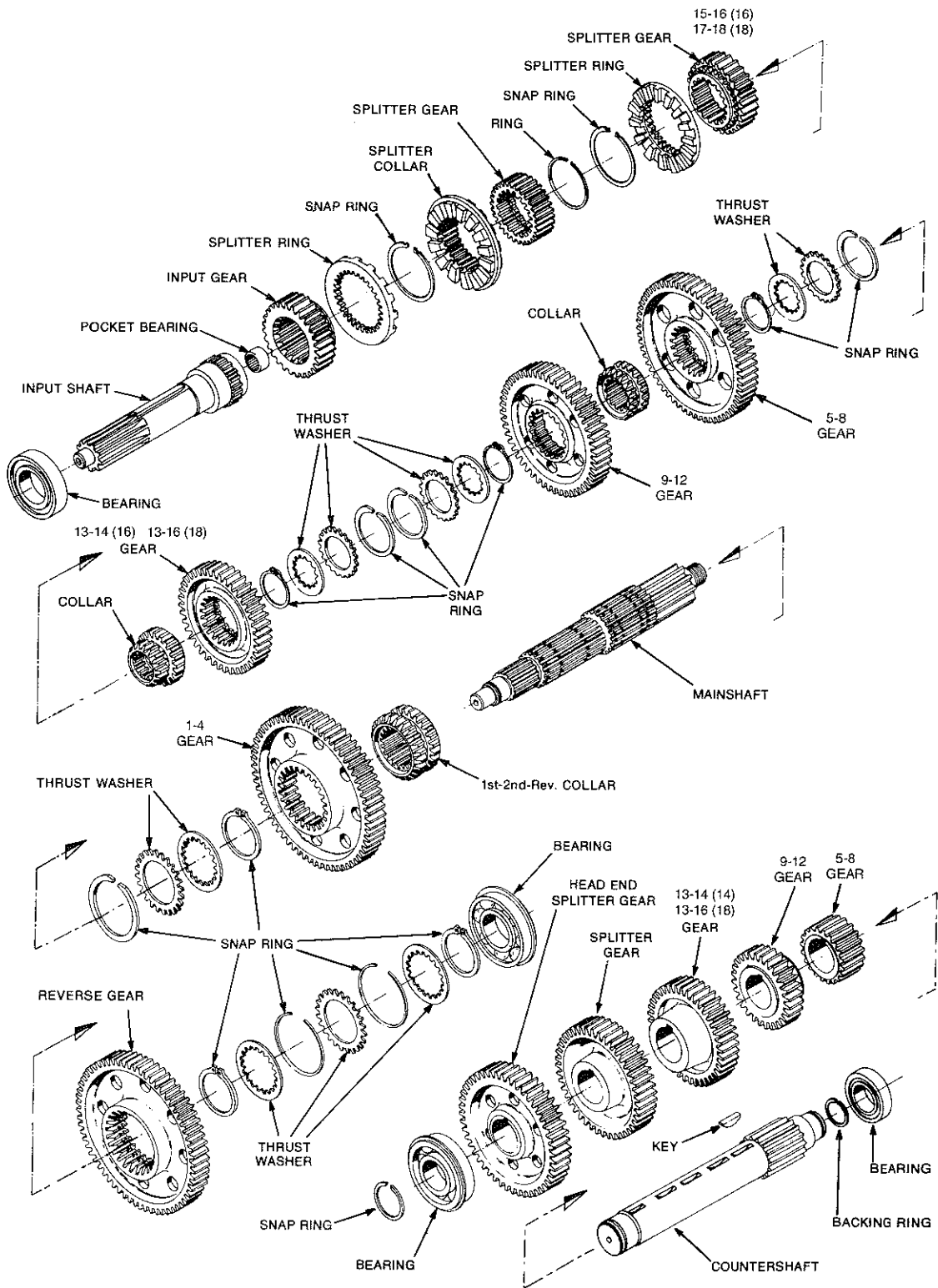
24. Remove the shaft of the lower reverse idler gear as well as its lock ball. Use a tool like the one shown.

MAIN CASE DISASSEMBLY

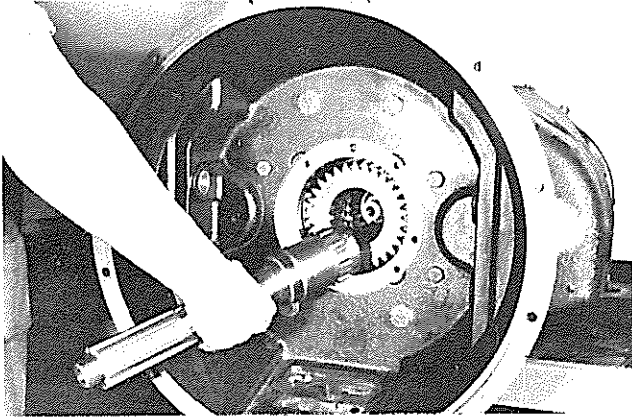


25. Remove the lower reverse idler gear. Inspect the interior diameter, needle bearings for wear.

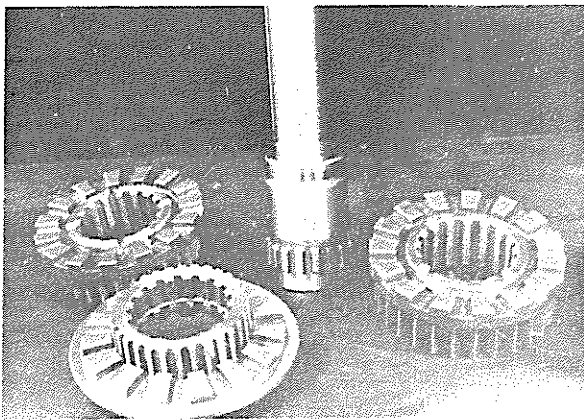
MAIN CASE GEARS AND RELATED PARTS



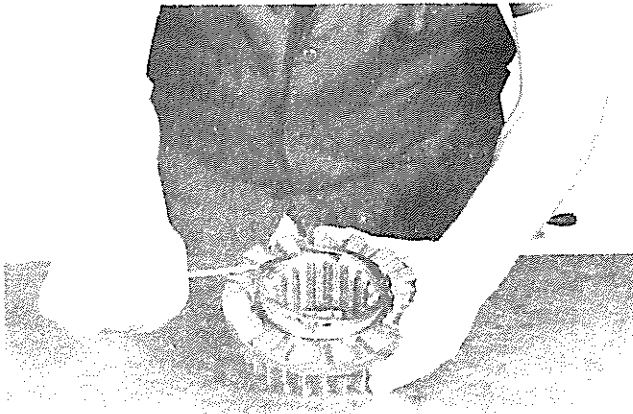
INPUT SHAFT AND SPLITTER GEARS



1. Remove the input shaft through the front by removing the bearing cover. The input shaft and the drive gear are two separate pieces.

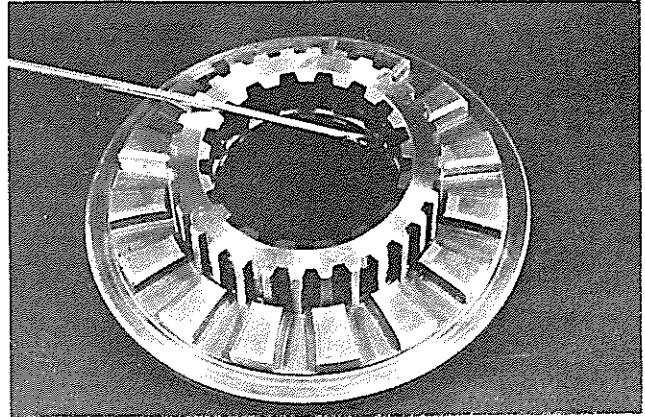


2. The splitter section is composed of the high splitter gear, low splitter gear, input shaft and curvic collar with clutch gear.

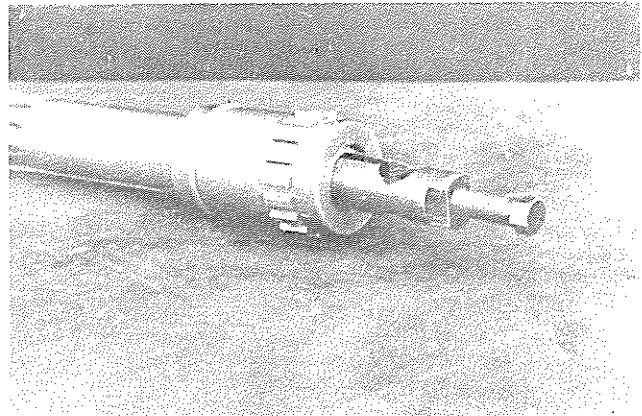


3. The curvic clutch rings of the splitter gears can be replaced by removing the snap rings that attach them to the gears.

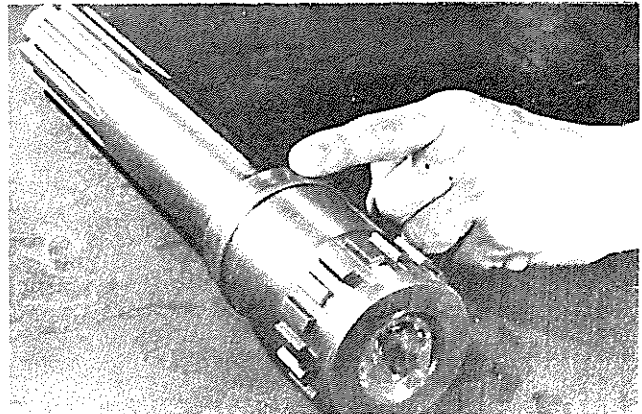
▲Wear safety glasses for eye protection.



4. The clutch gear of the splitter has a recessed groove inside where the snap ring is assembled. This ring is the stop for the input shaft, which is why it should always be assembled toward the rear of the transmission.

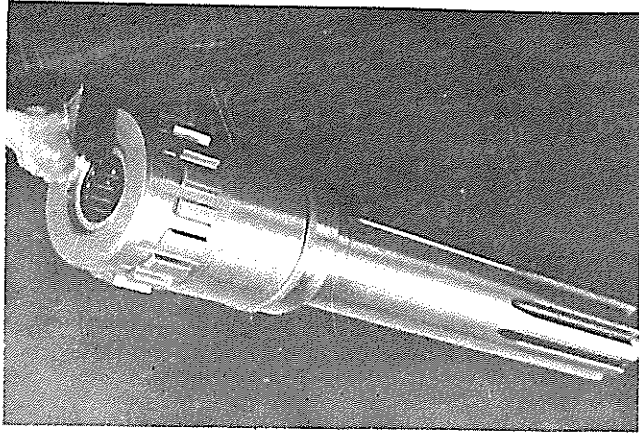


5. Remove the pilot bearing from the input shaft using a small puller like the one shown.

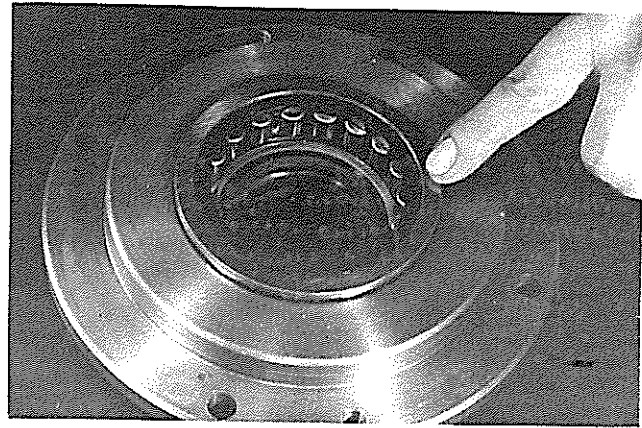


6. The inner rack of the input shaft bearing is pressed on this shaft. If there is excessive wear, remove and replace it.

INPUT SHAFT AND SPLITTER GEARS

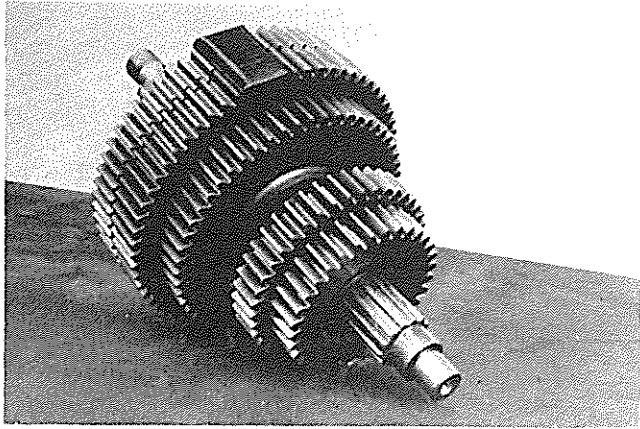


7. When installing the pocket bearing, the part number side of this bearing must face outward. Pre-lubricate this bearing with Moly #2.

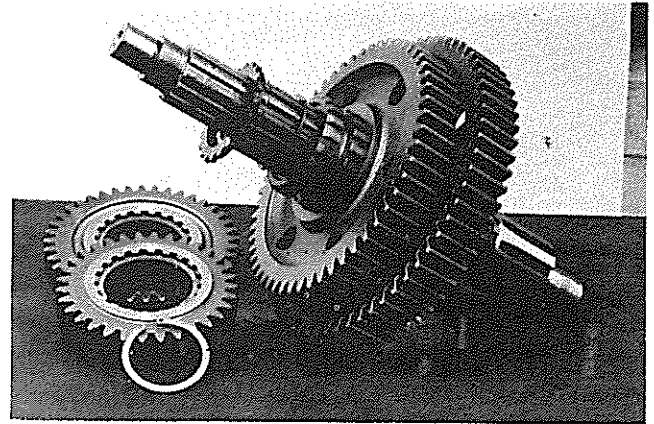


8. The input bearing is located in the bearing cap.

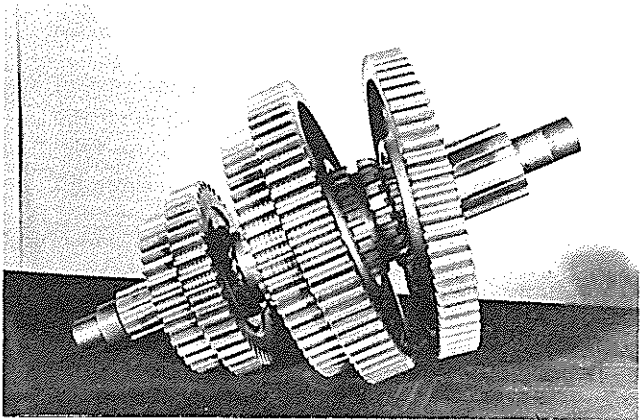
MAIN SHAFT DISASSEMBLY AND INSPECTION



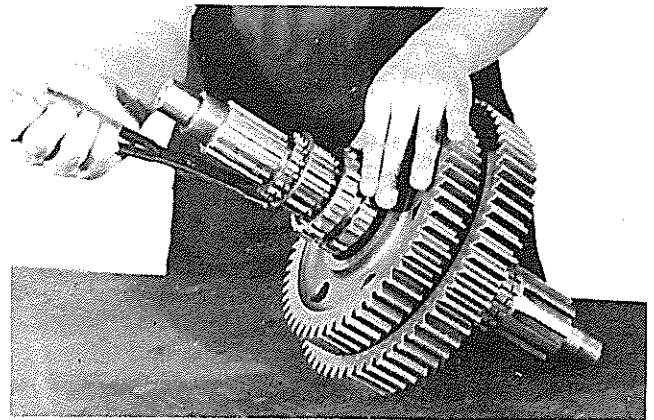
1. Place the main shaft on an appropriate work bench.



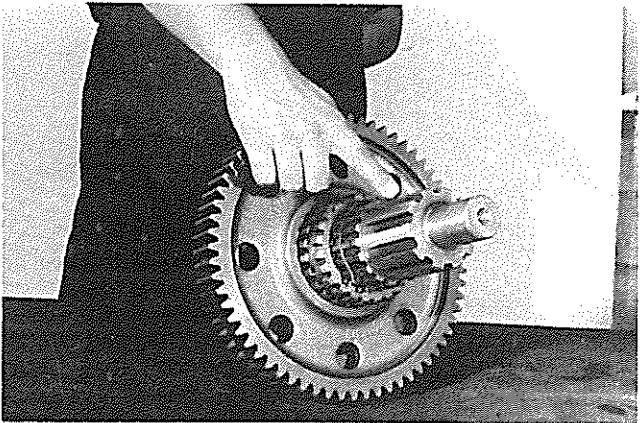
4. Carefully remove the shaft and dismantle the gears and thrust washers.



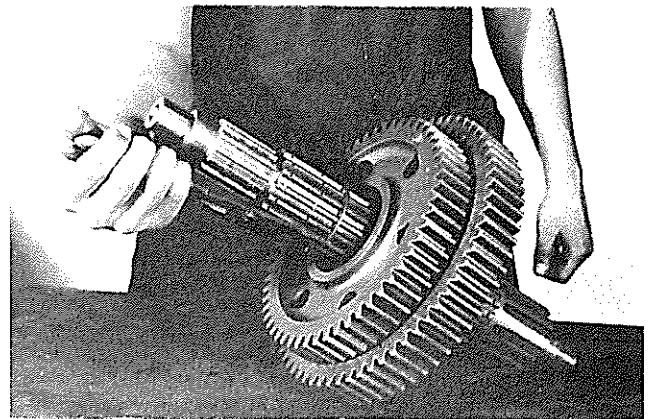
2. Separate and remove the reverse gear from the main shaft.



5. After taking off the snap ring, remove the clutch collar. **▲** Wear safety glasses for eye protection.

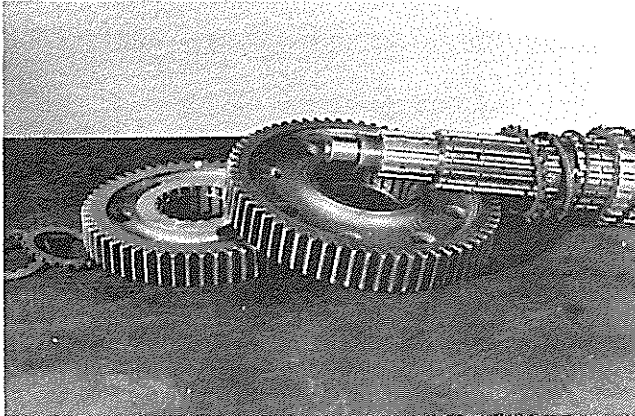


3. Notice that this part is larger and supports greater torque than older transmissions.

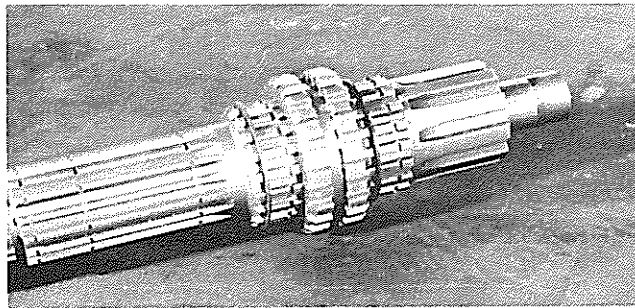


6. Remove the snap ring with pliers.

MAIN SHAFT DISASSEMBLY AND INSPECTION



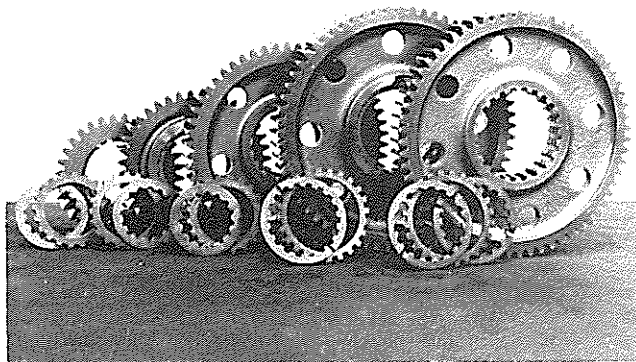
7. Remove the two remaining gears and accompanying thrust washers.



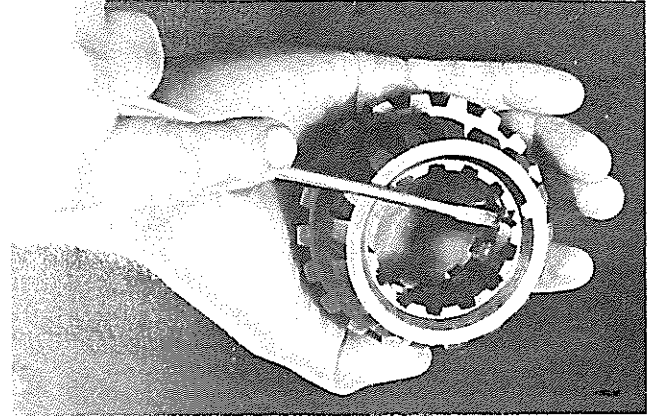
8. The clutch collar for 1st gear and reverse gear remains between two snap rings.

◆ Inspection

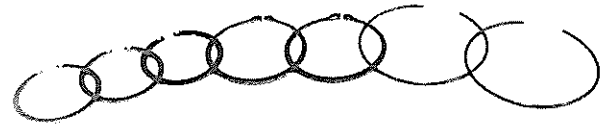
Check the gears (below) for wear or damage. Examine teeth for cracks, breaks or abnormal wear. The internal clutch teeth should not show excessive wear. Discard parts that are very worn or damaged.



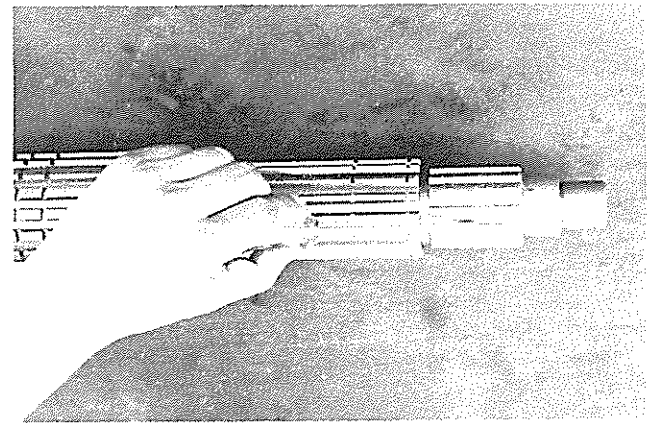
9. Verify that the thrust washers do not have cracks, lines or excessive wear. Before installing, lubricate all the washers with SAE 30 oil or the equivalent.



10. Inspect the collars. Internal and external teeth should have active, sharp edges. Round edges will cause gear shifts to lock. Verify that the groove for the shift forks is not worn. Discard parts that are very worn or damaged.

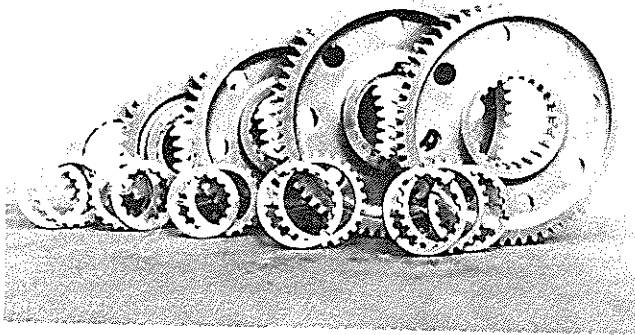


11. Inspect snap rings. Check for deformity or loss of tension. It is recommended that snap rings be replaced each time the transmission is repaired.



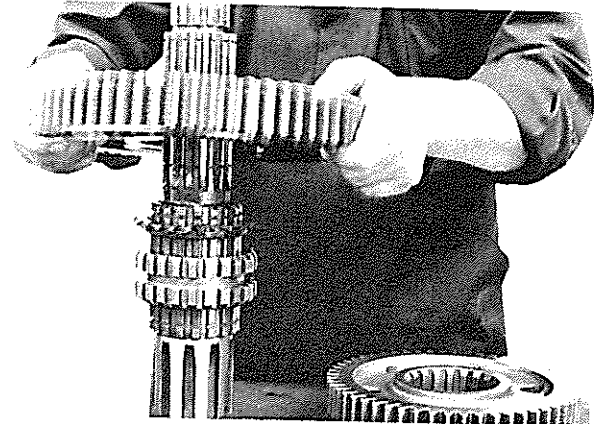
12. Inspect the main shaft. Verify that snap rings or gear locks on the main shaft have sharp edges. Excessive wear or deformity of the relief will cause gear jumping. Verify that the grooves for the snap rings are not worn.

MAIN SHAFT REASSEMBLY

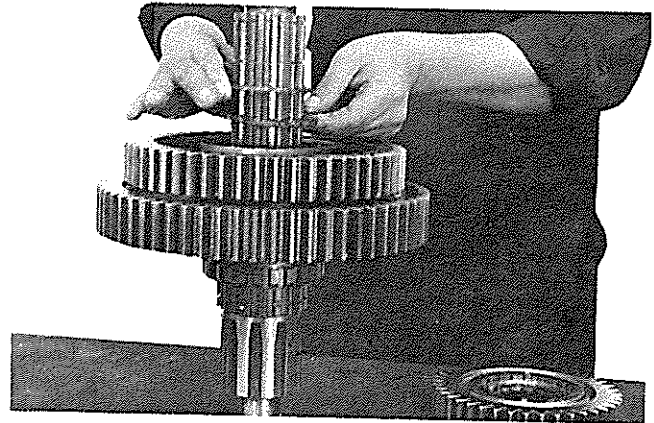


1. Begin reassembly of the main shaft by applying a coat of SAE 30 oil or equivalent grease on all thrust washers and support faces of the gears.

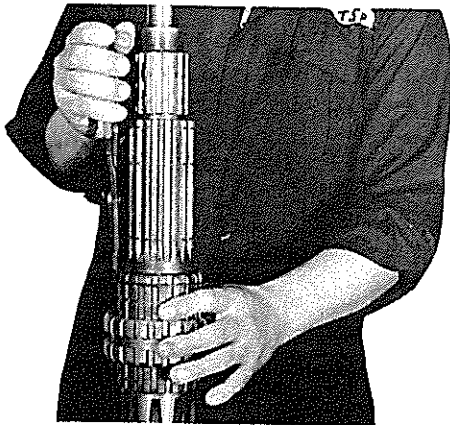
- ◆ All gears on the main shaft contain a set of thrust washers.
- ◆ External splines rest against snap rings housed in the interior of the gears. Internal splines, which are not as thick as external ones, rest against the snap rings of the main shaft.
- ◆ Washer sets are the same thickness but different diameters. Install washers with concern for the diameter.



3. Place the 1st gear and reverse gear on the shaft with its two thrust washers.



4. Install the 5th-8th gear over the previous one with the machined side face down. Also install its thrust washers and snap ring.
▲ Wear safety glasses for eye protection.

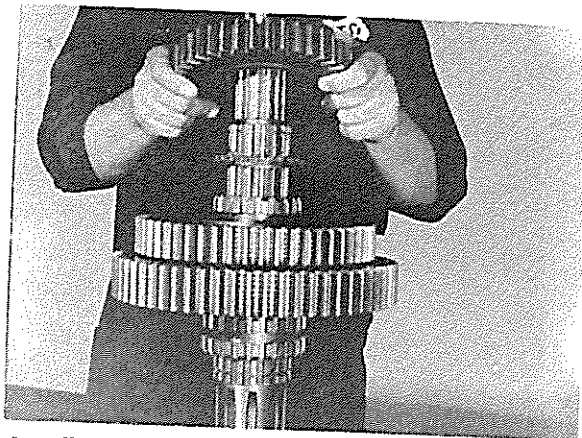


2. Place the clutch collar for 1st gear and reverse gear between the two snap rings.

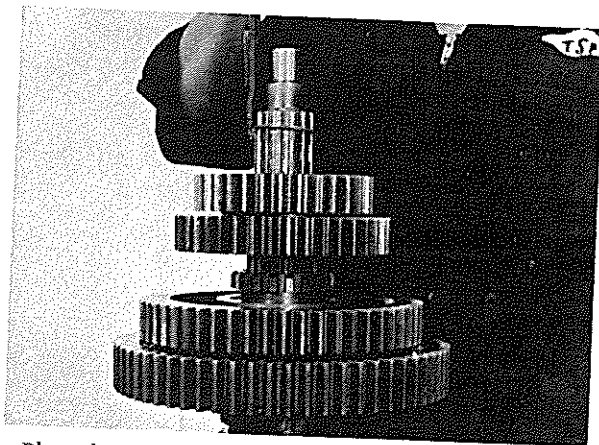


5. Install the clutch collar and place the next snap ring on the shaft.

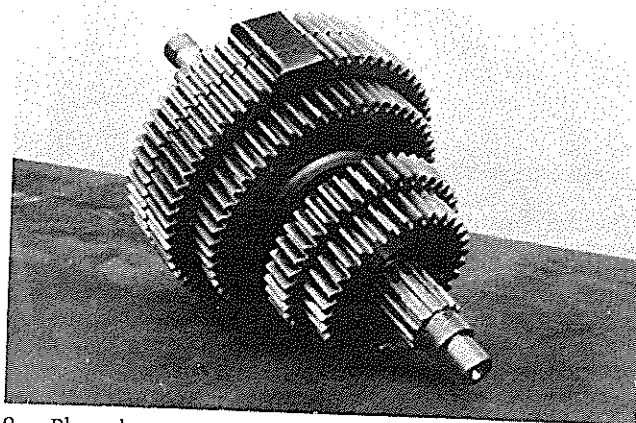
MAIN SHAFT REASSEMBLY



6. Install the 9th-12th gear with the machined side face up. Also install its thrust washers.

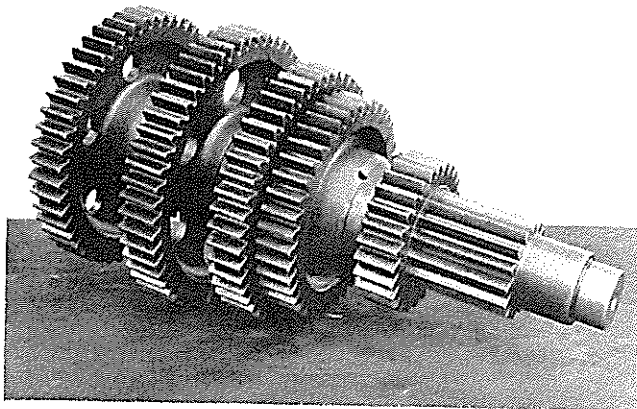


7. Place the next gear machined side face down. Install its set of thrust washers. Place the last snap ring on the shaft.
▲ Wear safety glasses for eye protection.

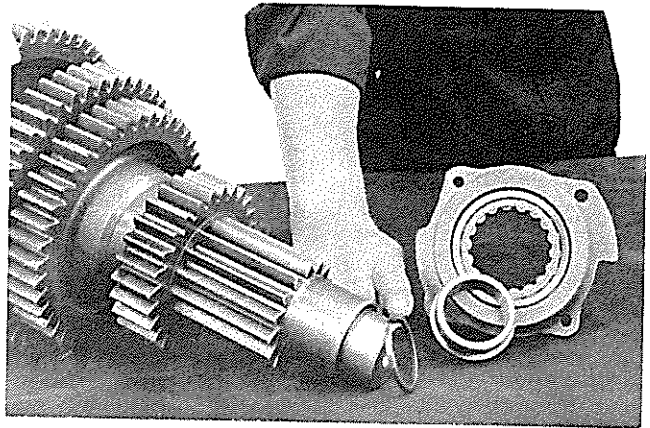


8. Place the reverse gear and couple it with the 1st-4th gear and refasten them.

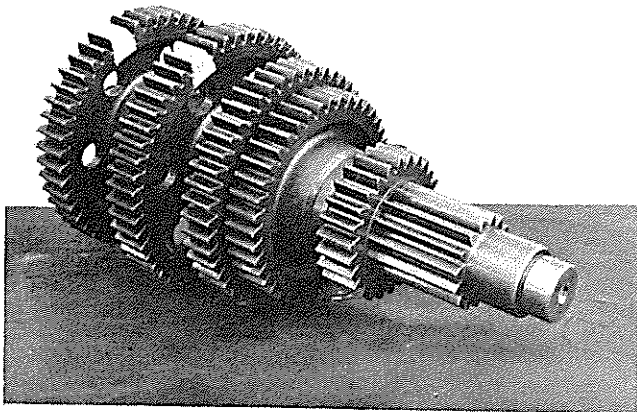
COUNTERSHAFT REASSEMBLY



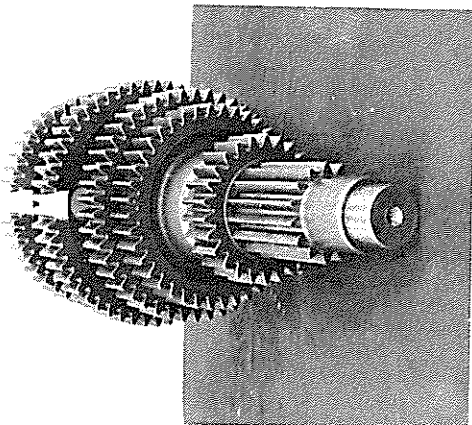
1. The 1st-4th gear and reverse gear are an integral part of the countershaft. The rest are pressed on to maintain alignment by means of individual keys.



4. The countershaft rear bearing requires a spacer for reassembly.

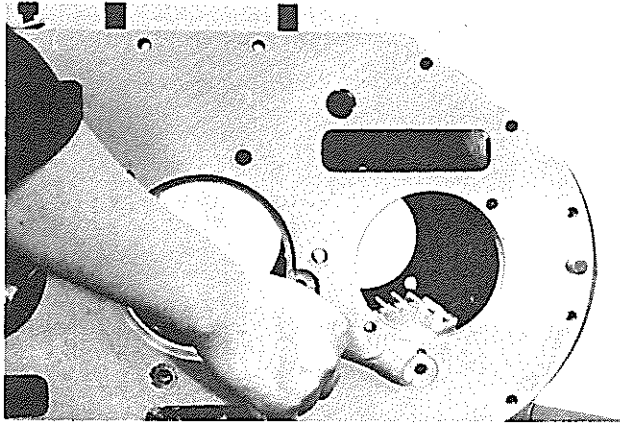


2. It is advisable to paint the teeth on each gear as it aligns with the timing mark on the head end gear. This procedure will facilitate reassembly.

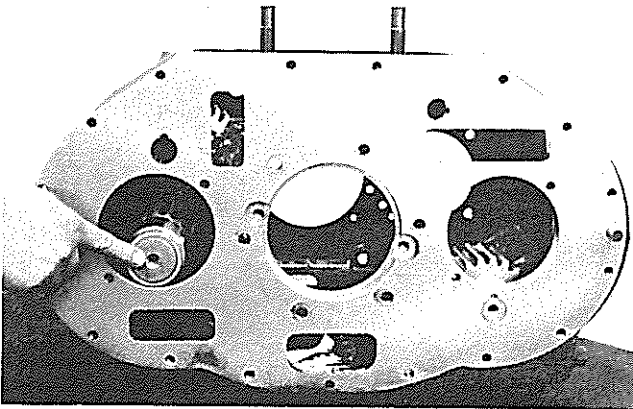


3. Position a straight edge between the painted gear teeth. Every gear on the countershaft will be in line. When you set the countershafts in time, these marks will be directly across from each other.

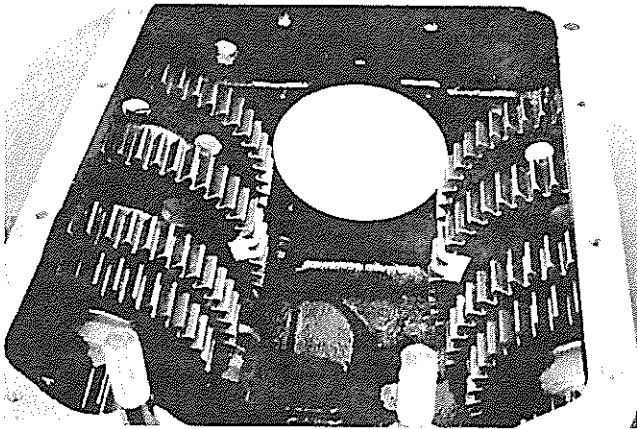
MAIN CASE REASSEMBLY



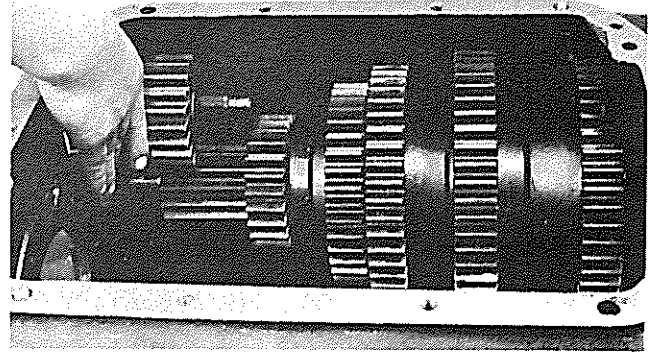
1. Position the main case on a workbench and begin reassembly by installing the lower idler gear, with its needle bearings and spacer. Use SAE 30 oil or an equivalent grease on the bearings. Install the shaft with its lock ball.



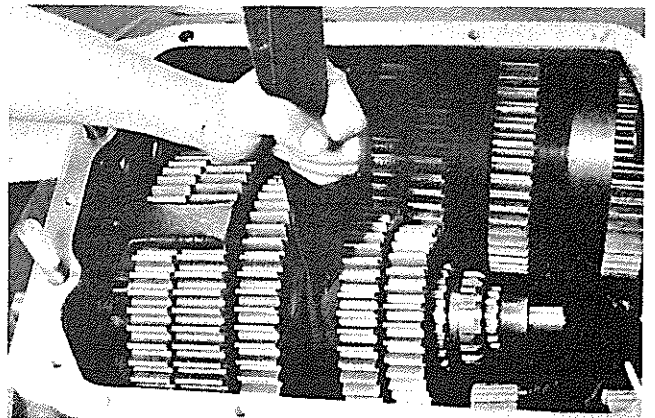
2. Insert the left countershaft first, since the base of the upper idler gear interferes. Next, install the right countershaft.



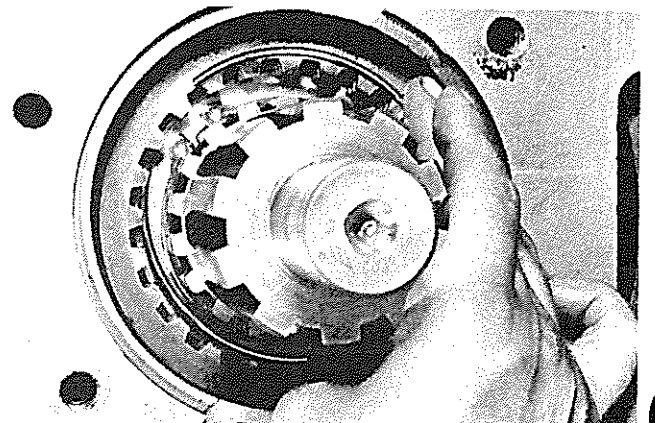
3. Move the countershafts forward and position the timing marks toward the center.



4. Install the upper reverse idler gear with its bearings and spacer. Be sure to first lubricate the bearings. Turn the gear toward the wall of the case. Do not install the shaft for this gear at this time.

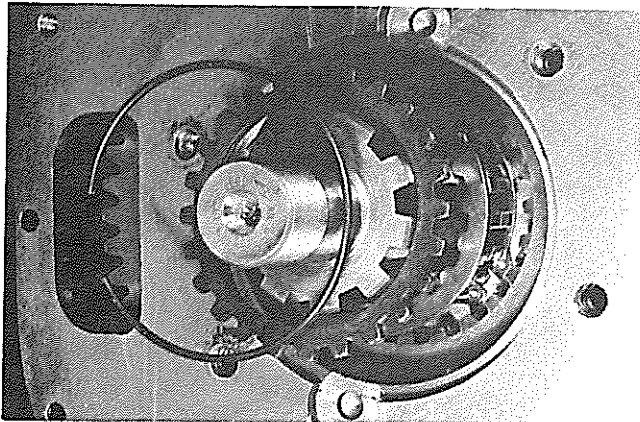


5. Insert the main shaft into the case and move it to the back by aligning the gears.
▲ Use a chain hoist to lift the mainshaft into the case.

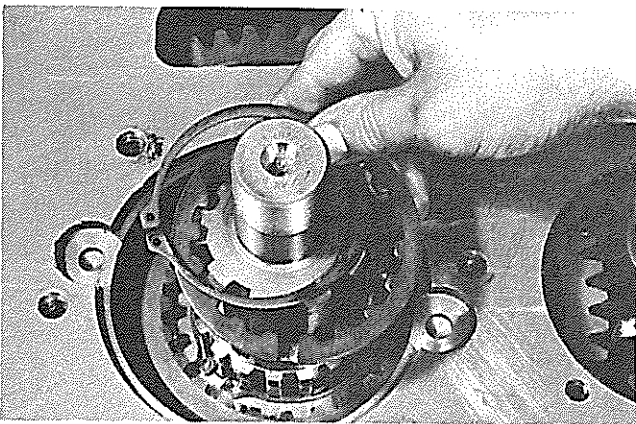


6. Remove the device that fastened the 1st and reverse gear and slide it back over the clutch collar. Install the first snap ring on the second groove inside of the gear.
▲ Wear safety glasses for eye protection.

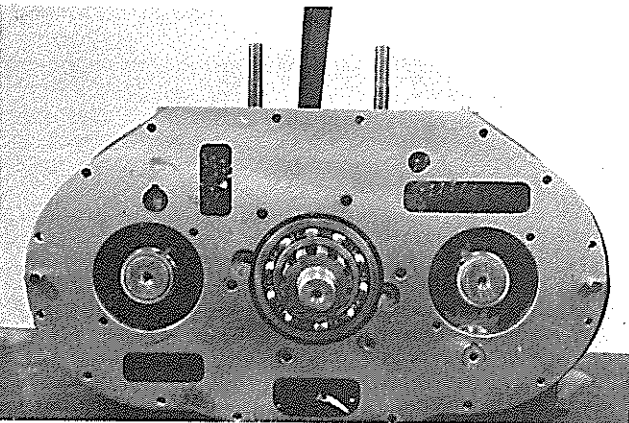
MAIN CASE REASSEMBLY



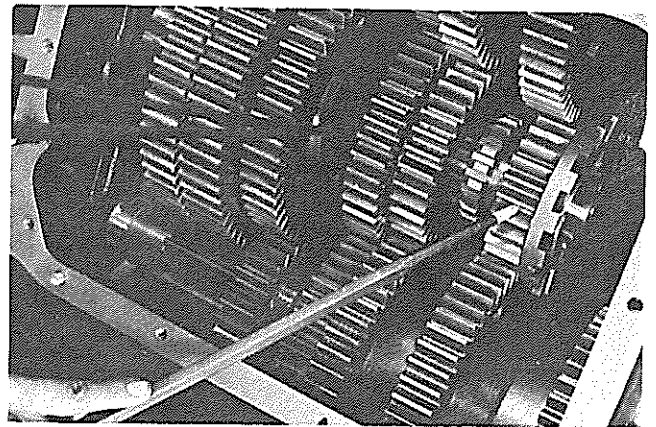
7. Install the washer with interior splines and the washer with outside splines. Place the other snap ring in the first groove inside the gear.



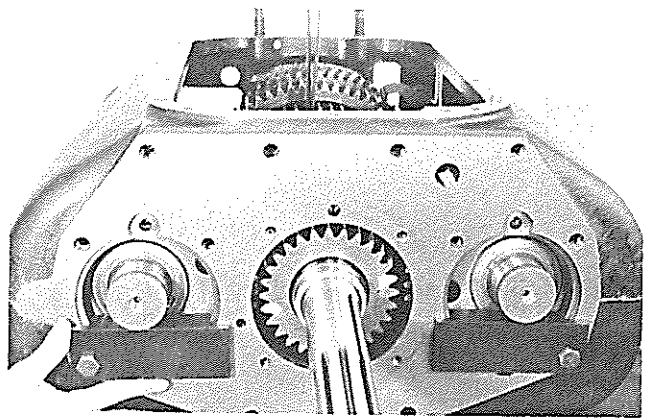
8. Install the last washer with internal splines and secure it with the shaft snap ring.



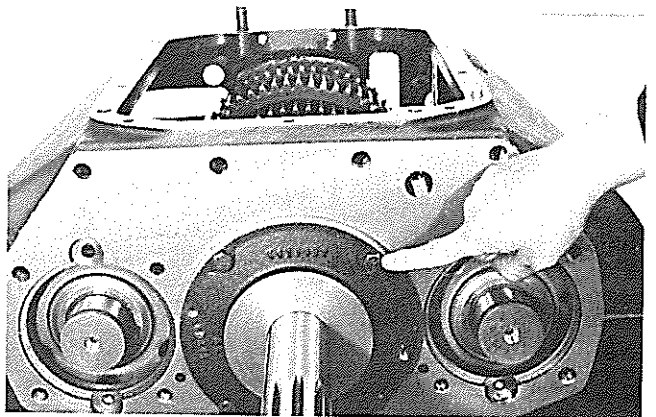
9. Install the rear bearing by inserting it until the bearing ring seats in the case.



10. Mount the splitter gear over the clutch collar and align it with the secondary gears. Paint the marks with a light color to facilitate timing.

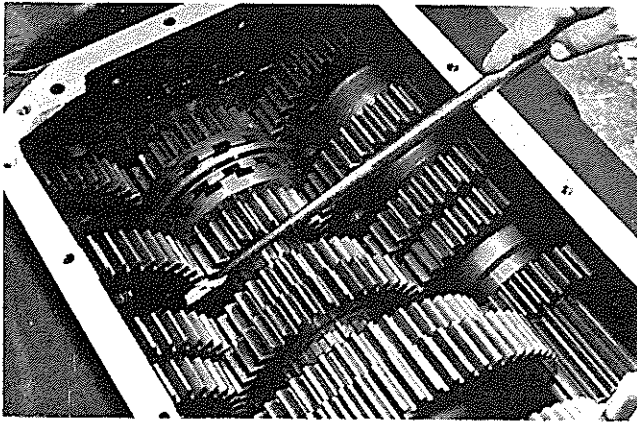


11. Position the curvic collar with the clutch gear pointing toward the back. Install the remaining splitter gear and insert the input shaft. Use the aligning tools on the countershafts before assembling the input shaft cover.

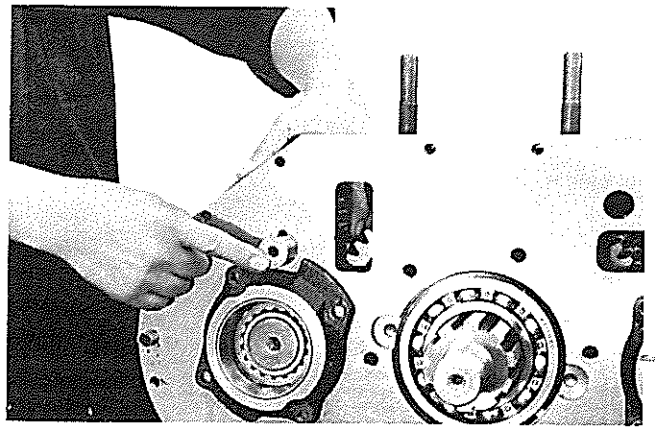


12. With the alignment devices installed, align the input shaft bearing cover. Align the lubrication holes and tighten the screw to 34 - 41 ft. lbs. Cover the shaft with masking tape to avoid damaging the oil seal when sliding the cover over it.

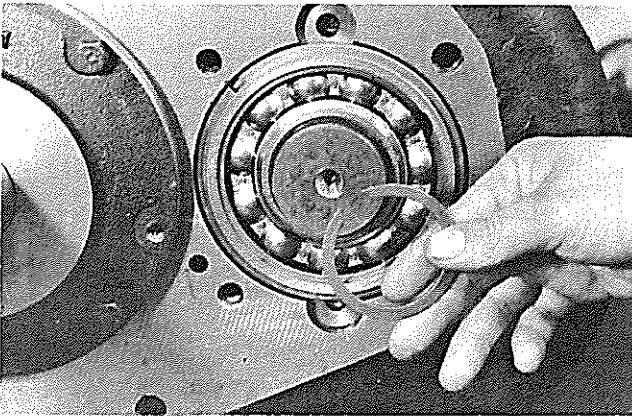
MAIN CASE REASSEMBLY



13. To time the countershafts, align countershaft synchronization marks with marks on the main shaft. Use a hook to lift the countershaft.

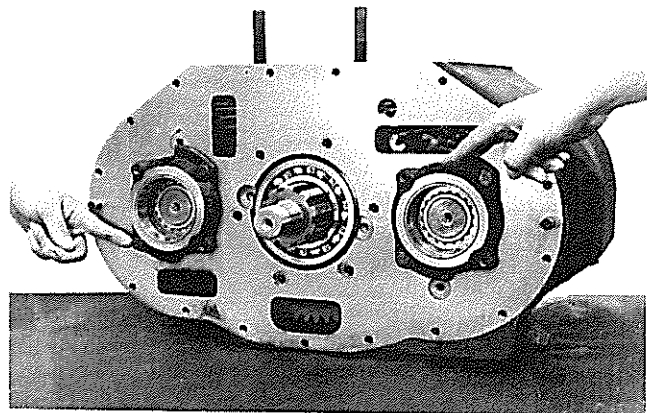


16. Insert the upper idler gear shaft into its housing. Raise the main reverse gear a little to attain proper alignment.

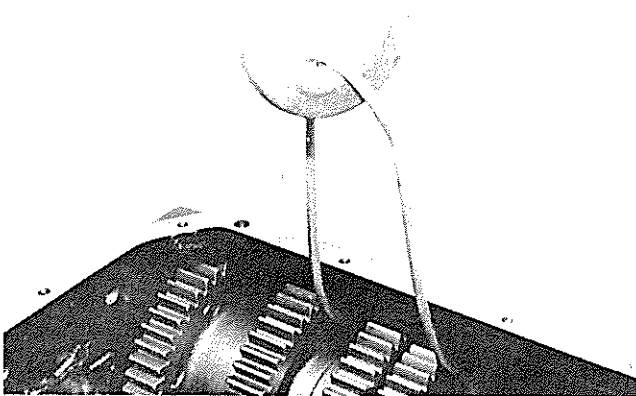


14. Assemble the front bearing with the tool. Install the rear bearing with its retainer and place the snap ring on the front bearing.

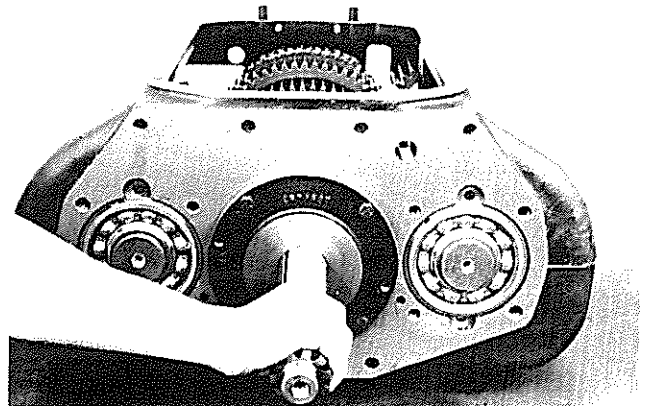
▲ Wear safety glasses for eye protection.



17. Secure the bearing retainers with the screws and torque to 34 - 41 ft. lbs. The lubrication opening should be placed face up.

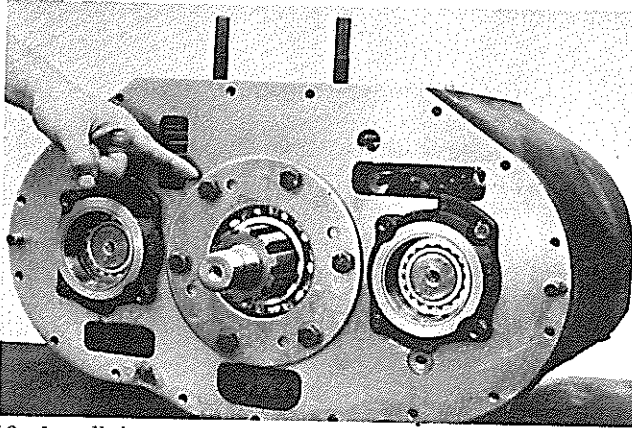


15. Time the other countershaft and repeat the above procedure.

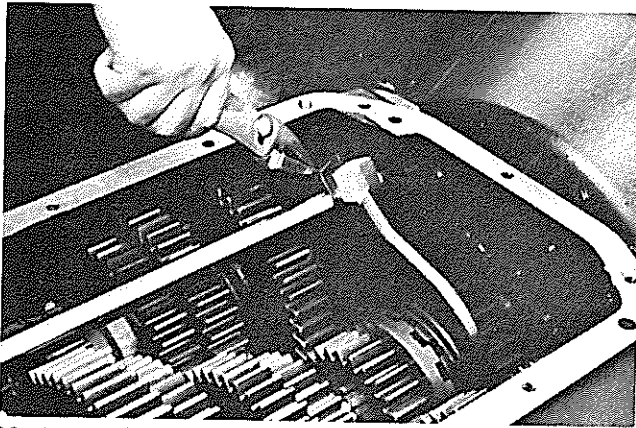


18. After all gears are aligned, turn the input shaft to verify timing. If the gear train turns freely, it is well timed. If it does not, inspect gear alignment.

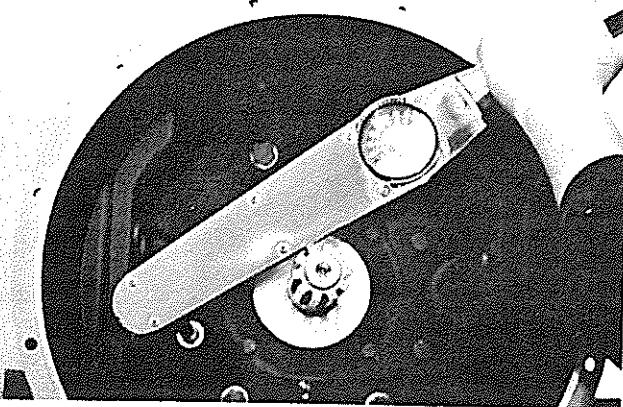
MAIN CASE REASSEMBLY



19. Install the rear bearing plate and tighten the screws to 80 ft. lbs.

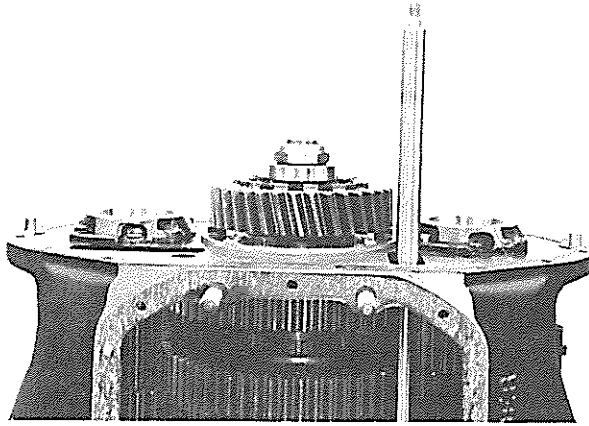


20. To install the splitter shift fork, insert the rod through the case and the hole in the shift fork. Tighten the screw to 52 ft. lbs. and secure it with wire.

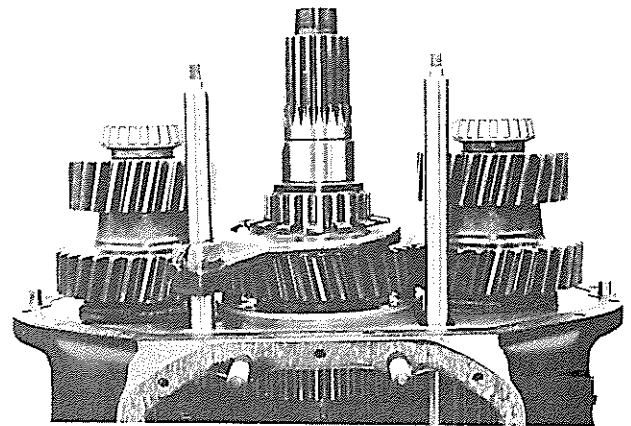


21. Position the clutch housing and gasket. Tighten the $\frac{1}{2}$ " screws to 78 - 98 ft. lbs. Tighten the $\frac{5}{8}$ " screws to 150 - 180 ft. lbs.

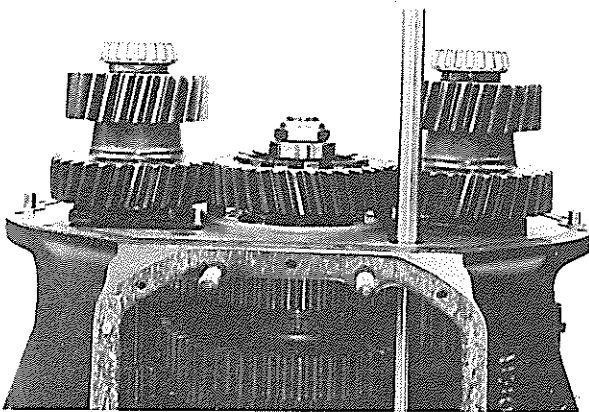
AUXILIARY SECTION REASSEMBLY



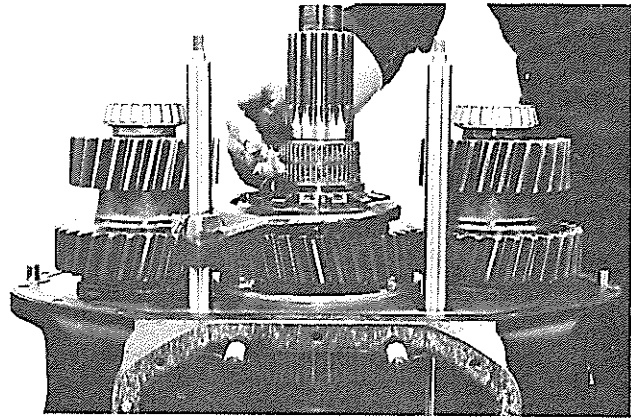
1. Stand the transmission upright. Install the drive gear. Position the timing marks toward the countershaft bearings. Place the roller with the greater diameter face down and install the bearing. Tighten the nut to 500 - 550 ft. lbs.



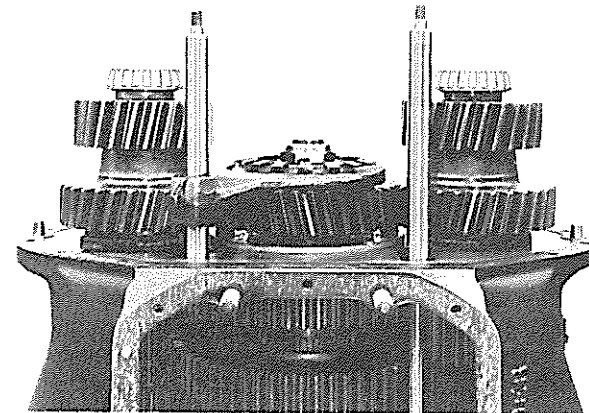
4. Insert the output shaft over the pilot bearing and through the splines of the curvic collar.



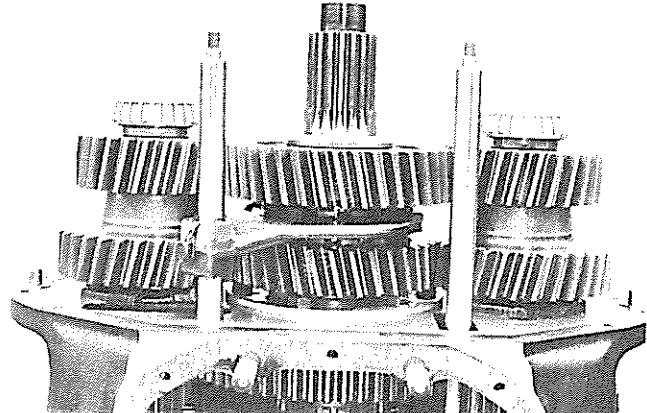
2. Install the countershafts by making sure the timing marks are aligned. From the left side of the transmission, install the shaft that is grooved on the right.



5. Install the low gear needle bearing and lubricate it with a good quality grease.

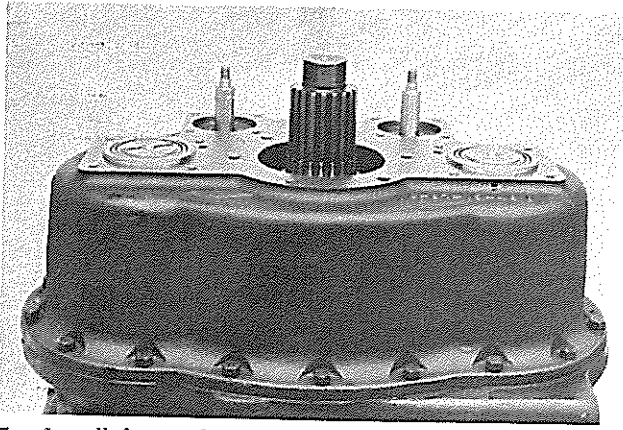


3. Place the rod and shift fork with the curvic clutch collar.

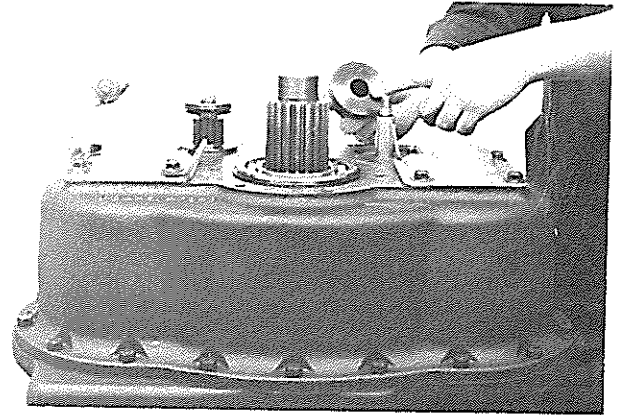


6. Install the low range gear, being sure the larger diameter of the thrust washer is facing toward the gear.

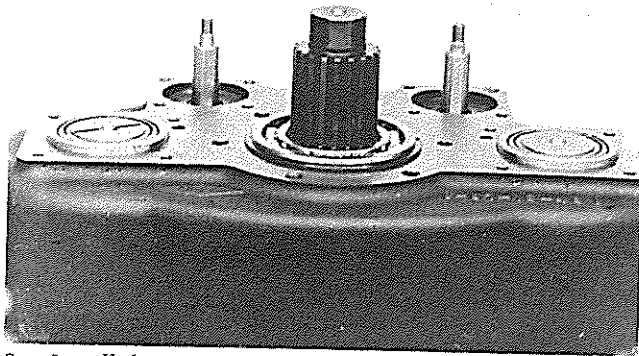
AUXILIARY SECTION REASSEMBLY



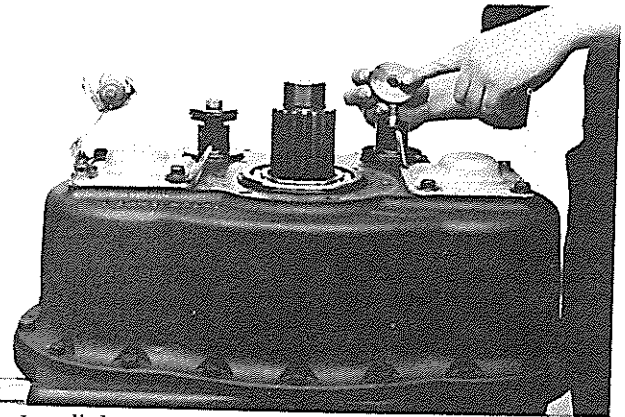
7. Install the auxiliary case by aligning it with the dowel pins and tightening it 34 - 41 ft. lbs.



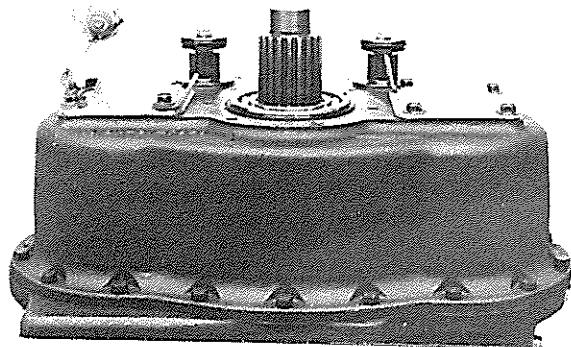
10. Place the piston stops and respective o-ring seals in the case housing and lubricate with an o-ring lubricant.



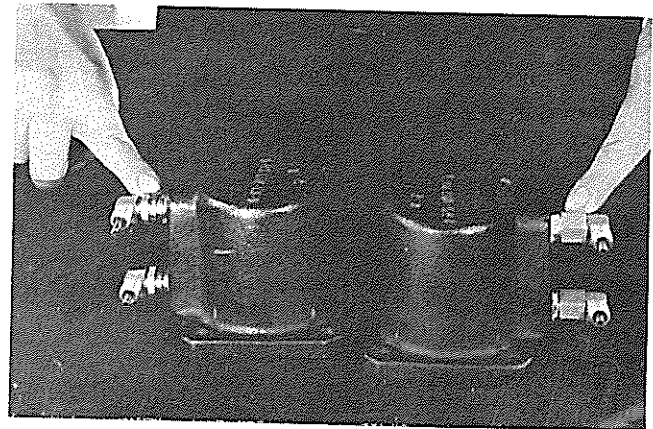
8. Install the output shaft bearing.



11. Install the pistons with o-ring seals, being sure to lubricate with an o-ring lubricant. Tighten the nuts on the bars to 40 - 50 ft. lbs.

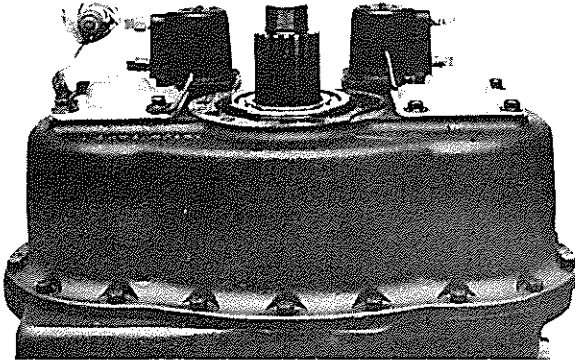


9. Place the countershaft bearing covers to coincide with the lubrication ports and their gaskets. Install the regulator filter and tighten the screw to 34 - 41 ft. lbs. The filter pressure is 50 - 55 lbs./sq. in.

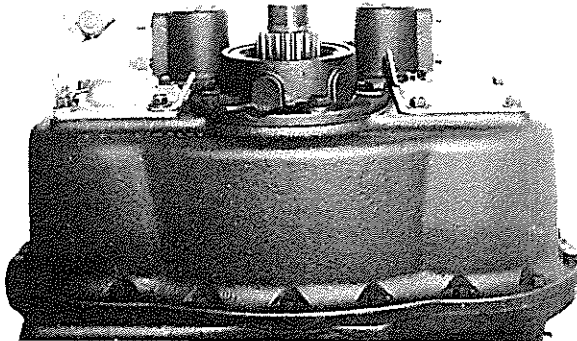


12. The piston housing has orifices to regulate air flow.

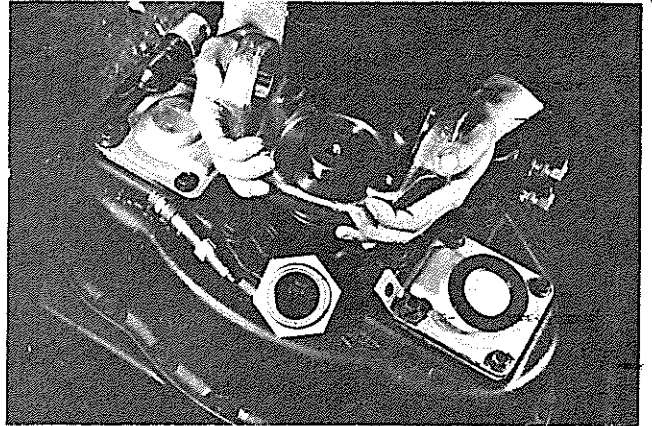
AUXILIARY SECTION REASSEMBLY



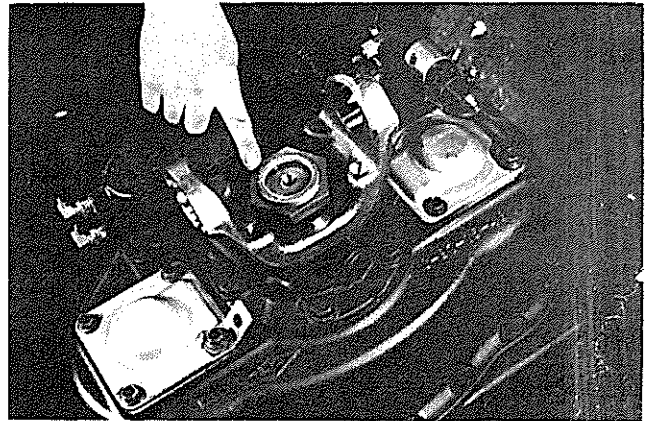
13. Before assembling the piston housing, cover the interior with a light coat of o-ring lubricant. Install the housing by tightening the screws to 34 - 41 ft. lbs. To avoid fractures, tighten the screws until the housings are completely seated.



14. Mount the output bearing cover with its gasket and tighten the screw to 78 - 90 ft. lbs.

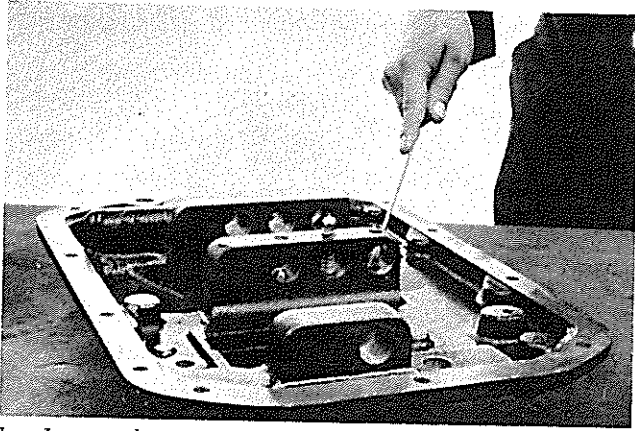


15. Install the output yoke with its speedometer gear and spacer. Install the speedometer pinion with its sleeve. Verify that when the yoke turns, there are no problems.

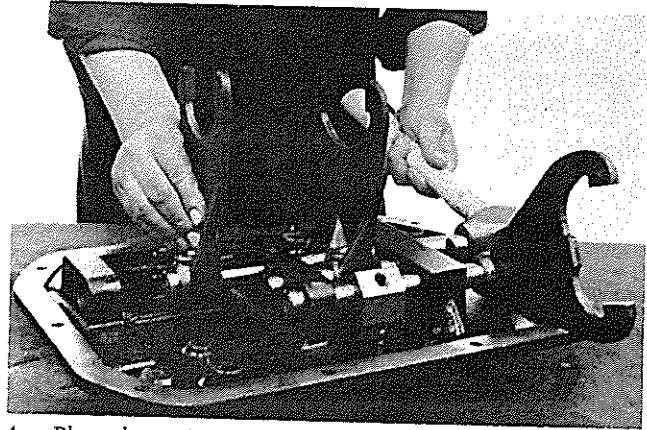


16. Install the yoke washer and nut. Tighten to 550 - 600 ft. lbs.

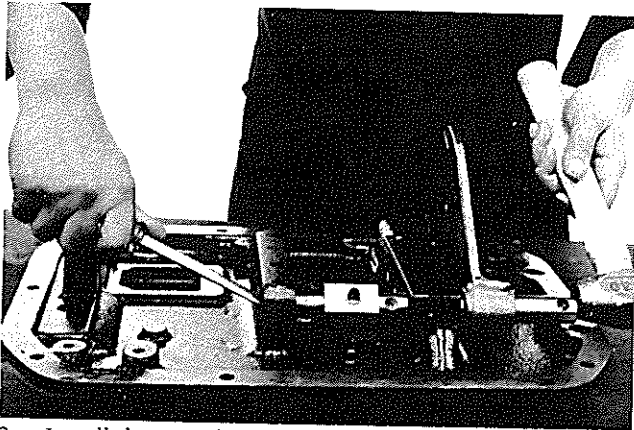
SHIFT HOUSING REASSEMBLY



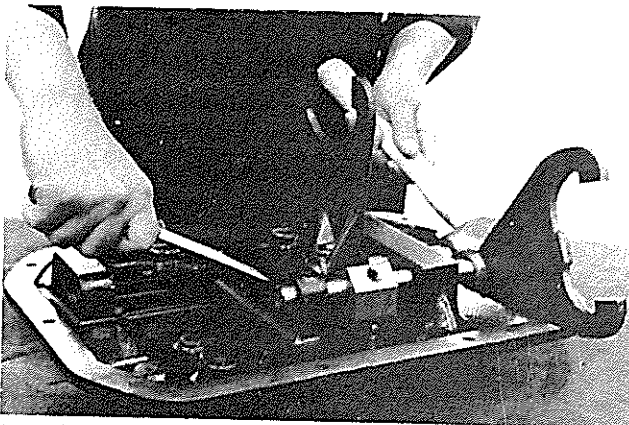
1. Inspect the poppet holes. They should have sharp edges. Rounded or chipped edges cause the transmission to lock in one gear, which prevents shifting.



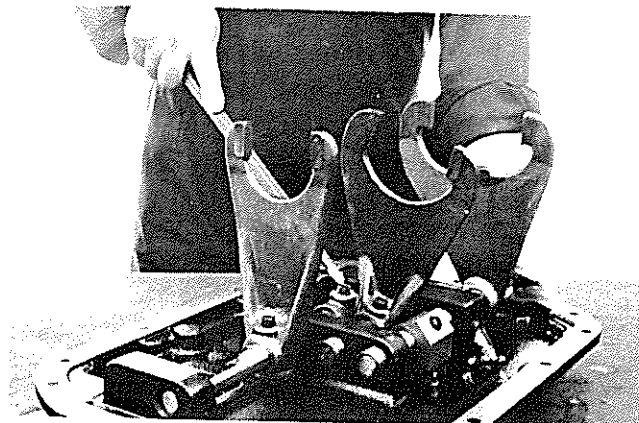
4. Place the spring, poppet and interlock in their correct positions. Install the last shift fork. Be sure to install the interlocks correctly so that two gears cannot be engaged during shifting. The interlocks are housed in the cross holes of the cover, between the three drilled holes on the rods.



2. Install the 1st-4th shift fork and reverse shift fork and its bracket. Place the spring and poppet. To install the rod, compress the poppet and spring with a screwdriver and simultaneously tap the rod.

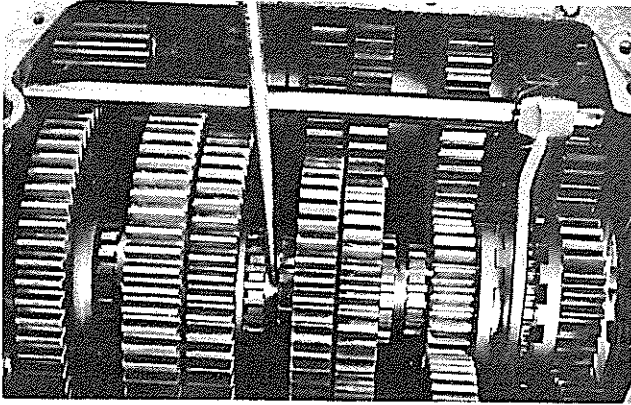


3. Place the interlock, spring and poppet in position and install the 5th-12th shift fork. Install the setscrew in the hole of the bar.

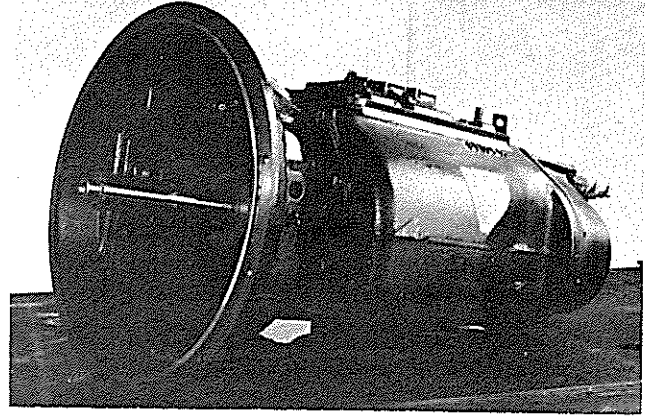


5. Be sure that the setscrews are torqued to 34 - 41 ft. lbs. Check for proper functioning by moving a shift fork and verifying that another one cannot be shifted at the same time.

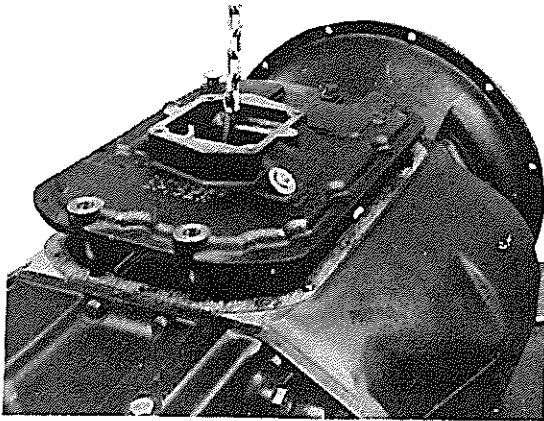
SHIFT HOUSING REASSEMBLY



6. Move the transmission and place it in a horizontal position, move the three clutch collars to the neutral position.



8. After the transmission is completely assembled, it is recommended that the lever hole be covered. This prevents contamination of the interior.



7. Install the shift cover, being careful that the shift forks enter the clutch collar grooves. Secure with shift cover screws and torque to 34 - 41 ft. lbs.

TROUBLESHOOTING

FATIGUE

All bearings are subject to fatigue and, ultimately, must be replaced. Individual operation experience determines the mileage at which bearings should be replaced.

CORROSION

Water and acidic or corrosive material formed by lubricant deterioration produces a reddish-brown film and small pitting on exposed surfaces of the cups. Corrosive oxides also act as abrasive agents. Marks are produced suddenly by incorrect assembly or disassembly, usually caused by hammering off center. It is recommended that extractors be used with a shaft.

ADJUSTMENT OF SHAFTS

Excessive play under load can produce leaking or sliding of the interior ring on the revolving shaft, which causes the surface metal of the shafts to cut or wear. Generally, a tight adjustment of the bearings on revolving shafts is specified. Even with .001" of play, a very powerful force tends to turn the interior ring on the shaft. This force causes the clearance or play among the parts and disappears when it does not exist.

DISMANTLING BEARINGS

It is more difficult to dismantle bearings from the shaft than to mount them. In most cases, it is necessary to remove the bearing throwing out the exterior, which can damage balls and cups. Damage is almost never visible and often does not show up until after complete reassembly. With good preventive maintenance, most of the ball bearings should be changed during a major repair. Replacing a bearing prevents the need to prematurely dismantle it for repair.

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:

- ◆ Fan out of balance or blades bent
- ◆ Defective vibration dampers
- ◆ Crankshaft out of balance
- ◆ Flywheel out of balance
- ◆ Loose flywheel mounting bolts
- ◆ Rough engine idle producing rattle in gear train
- ◆ Clutch assembly out of balance
- ◆ Loose or broken engine mounts
- ◆ Power take-off engaged
- ◆ Worn universal joints
- ◆ Driveshaft out of balance
- ◆ Universal joint angles out of phase or at excessive angles
- ◆ Center bearings in driveline dry, not mounted properly
- ◆ Wheels out of balance
- ◆ Tire treads humming or vibrating at certain speeds
- ◆ 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

TROUBLESHOOTING

gears. Next, try to categorize the noise into the following classifications:

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.

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.

Gear whine. This is usually caused by lack of backlash between mating gears. Improper PTO shimming is the big offender here.

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.

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:

- ✦ Misalignment of transmission
- ✦ Worn flywheel pilot bearing
- ✦ Worn or scored countershaft bearings
- ✦ Sprung or worn countershaft
- ✦ Excessive backlash in gears
- ✦ Scuffed gear tooth contact surface
- ✦ Insufficient lubrication
- ✦ Use of incorrect grade of lubricant

NOISE IN GEAR

Possible Causes:

- ✦ Rough, chipped, or tapered sliding gear teeth
- ✦ Noisy speedometer gears
- ✦ Excessive end play of countershaft gears
- ✦ Refer to conditions listed under “Noise in Neutral”



TROUBLESHOOTING

OIL LEAKS

Possible Causes:

- ✦ Oil level too high
- ✦ Wrong lubricant in unit
- ✦ Seals defective, wrong type or omitted from bearing cap
- ✦ Transmission breather omitted or plugged internally
- ✦ Bolts loose, omitted or missing from remote control, shift tower, bearing caps, PTO or covers
- ✦ Oil drain-back openings in bearing caps or case plugged with varnish or dirt
- ✦ Gaskets shifted or squeezed out of position, broken gaskets with pieces still under the shift tower
- ✦ Cracks or holes in castings
- ✦ Loose drain plug
- ✦ Oil leakage from engine
- ✦ Loose speedometer adaptor or connections

WALKING OR JUMPING OUT OF GEAR

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

- ✦ External interference, such as the floorboard opening, preventing full engagement,
or
- ✦ 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:

- ✦ Improperly positioned forward remote control, which limits full travel forward and backward from the remote neutral position
- ✦ Improper length shift rails or linkage that limits travel of forward remote from neutral position
- ✦ Loose bell cranks, sloppy ball and socket joints
- ✦ Shift rails, cables, etc., too spongy or flexible, or not secured properly at both ends
- ✦ Worn or loose engine mounts if forward unit is mounted to frame
- ✦ Forward remote mount too flimsy, or loose on the frame
- ✦ Setscrews loose at remote control joints, on shift forks inside remote
- ✦ Shift fork pads or groove sliding gear or collar worn excessively
- ✦ 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:

- ✦ Use of heavy shift lever extensions
- ✦ Broken shift rail poppet springs
- ✦ Worn shift rail poppet notches
- ✦ Bent or sprung shift rails
- ✦ Excessive end play in drive gear or countershaft, caused by worn bearings or retainers
- ✦ Worn or missing thrust rings

TROUBLESHOOTING

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:

- ❖ 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.)
- ❖ No lubrication in, or grease fittings on, u-joints or swivels of remote controls
- ❖ Lack of lubricant or wrong lubricant used, causing buildup of sticky varnish and sludge deposits on splines of shaft and gears
- ❖ Badly worn or bent shift forks
- ❖ Improper adjustment on shifter linkage
- ❖ Sliding clutch gears tight on splines of shaft
- ❖ Clutch teeth burred over, chipped or badly mutilated because of improper shifting
- ❖ Binding or interference of shift lever with other objects or rods inside the cab or near the remote control island
- ❖ Clutch dragging
- ❖ Free running gears seized or galled on either the thrust face or diameters

STICKING IN GEAR

Possible Causes:

- ❖ 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. If the vehicle is started in gear, the truck may lurch forward and injure passersby.
- ❖ Sliding clutch gears tight on splines
- ❖ Chips wedged between or under splines of shaft and gear
- ❖ Improper adjustment, excessive wear or lost motion in shift 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:

- ❖ Fatigue of raceways or balls
- ❖ Wrong type or grade of lubricant
- ❖ Lack of lubricant
- ❖ Broken retainers, brinelled races and fretting caused by vibration
- ❖ Bearings set up too tight or too loose
- ❖ Improper installation resulting in brinelled bearings
- ❖ Improper fit of shafts or bore

TROUBLESHOOTING

- ◆ Acid etching due to water in lube
- ◆ 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 adding or changing 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. As a result, 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.

TROUBLESHOOTING

INTERCHANGEABILITY OF BEARINGS

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 transmission. Here are the most common problems encountered with clutches.

- ◆ 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.
- ◆ 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:

- ◆ Continuity of the switch with the ball fully depressed
- ◆ Electrical plug connection
- ◆ Wiring



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