

SPICER[®]

1241

**4-SPEED AUXILIARY
TRANSMISSION**

SERVICE MANUAL



**DANA CORPORATION
SPICER TRANSMISSION
DIVISION**

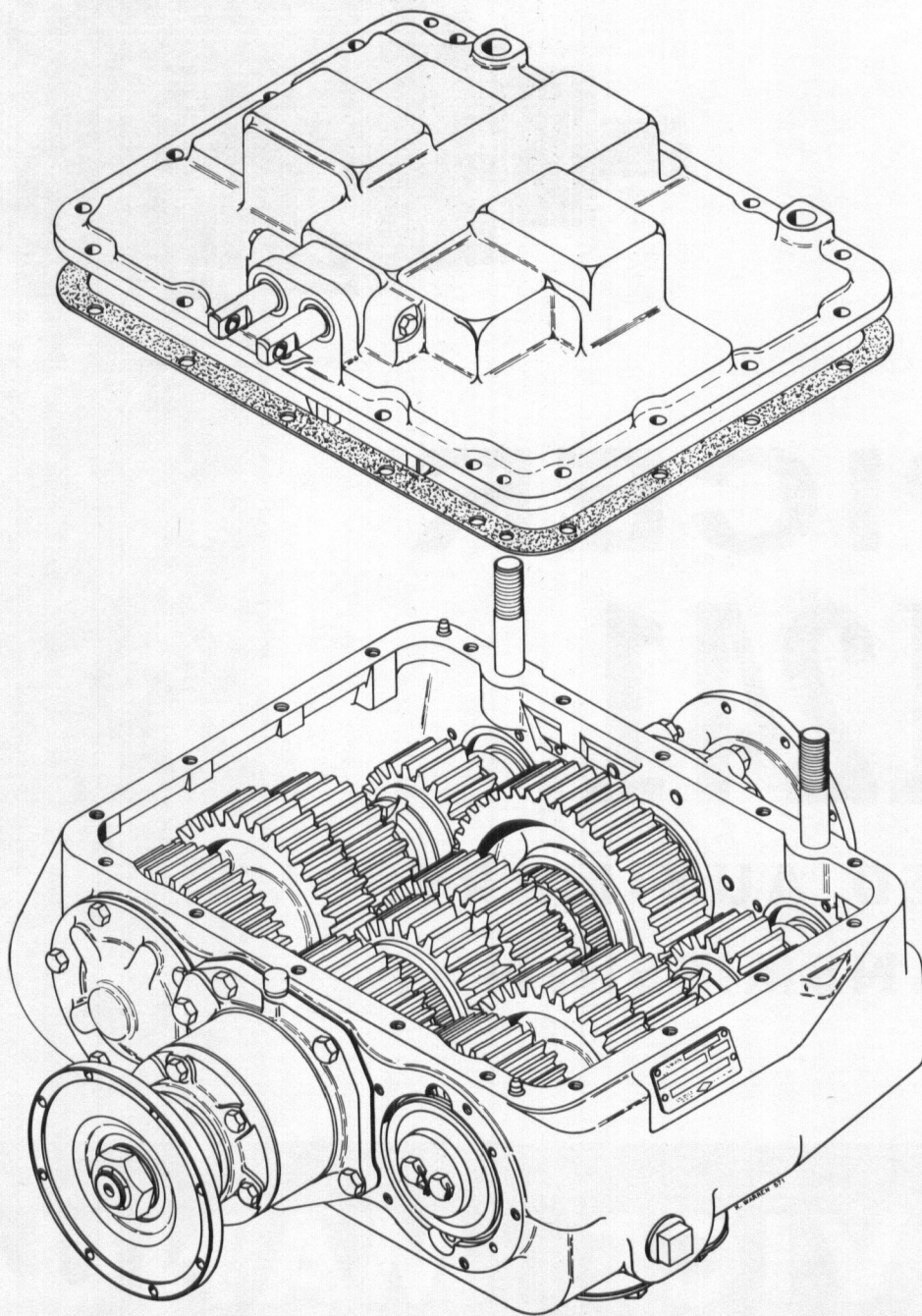


Figure 1

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SPECIFICATIONS

TORQUE WRENCH GUIDE FOR 1241 TRANSMISSIONS.

PART NAME	LBS. FT. TORQUE
Drive Gear Shaft & Mainshaft flange/yoke locknut	550-600
Left countershaft — front bearing retainer screws	60-80
Right countershaft — front bearing retainer screws	60-80
Mainshaft front bearing retainer capscrews	60-80 & 40-50
Mainshaft rear bearing capscrews	60-80
Countershafts front & rear bearing capscrews	25-32
Shifter housing capscrews	25-32
All set screws (shift forks, brackets and fingers)	40-50

GENERAL INFORMATION

MAINTENANCE INFORMATION:

We recommend that the procedures as outlined in the manual be followed when performing maintenance work on all transmissions.

REBUILD FACILITIES:

A suitable holding fixture or overhaul stand is desirable but not necessary to rebuild this unit. The flat bottom of the transmission case provides a suitable working platform when the unit is placed on a sturdy shop table.

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

CLEANLINESS:

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

Dirt is abrasive and will cause premature wear of bearings and other parts. We suggest that mechanics have a small wash tank 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.

END YOKES & FLANGES:

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

Serious damage can be done internally to bearings, thrust faces and washers, pilot bearings, etc., by hammering on external parts.

In most designs when the yoke/flange locknuts are tightened and secure, the internal bearings and gears are in proper location. When the yoke/flange is driven on the shaft, two conditions can exist.

- A. If the bearing fit is *tight* on the shaft, then usually the bearings will brinell as they must absorb the pounding forces.
- B. If the bearing is *loose*, the shaft will keep moving inward until it is stopped by the internal parts such as pilot bearing thrust washers, etc.

GENERAL INFORMATION

REPLACEMENT PARTS:

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

POWER FLOW:

This Spicer auxiliary transmission is designed for heavy duty on and off-highway applications.

The two countershaft design allows the engine torque to be equally divided between the two countershafts. This provides a high ratio of torque capacity to transmission weight. This also allows a reduction in the face width of each gear involved in the transmission. All the gears are in constant mesh through spur teeth.

The 1241 transmission has four forward speeds. All gear selections are made with a mechanical shift lever only.

SPEEDOMETER DRIVE:

The rear mainshaft bearing cap has provision for installation of speedometer driven gear and the attachment cable. Mainshaft bearing cap can be rotated 180° for opposite speedometer installation.

MAGNETIC OIL CLEANER:

The rear drain plug has a magnetic stem attached to the plug to catch and hold metallic particles deposited in the oil.

P.T.O. SPECIFICATIONS:

Power Take-Off

Left Bottom: S.A.E. Standard Heavy Duty 8-Bolt

Right Bottom: S.A.E. Standard Regular Duty 6-Bolt

CAUTION

Do not tow vehicles equipped with Spicer transmissions at high speeds or for long distances without first pulling the axles or disconnecting the drive shaft. Lubrication of the internal gear train is inadequate when the vehicle is towed.

LUBRICATION

GENERAL INFORMATION

The 4-speed auxiliary, constant mesh transmission is designed to utilize splash lubrication for all bearings, shafts and gears. To insure proper lubrication and operating temperatures in these units, it is most important that the proper lubricants be used and that correct oil levels be maintained.

RECOMMENDED LUBRICANTS:

TEMPERATURE	GRADE	TYPE
ABOVE 0°F BELOW 0°F	SAE 30, 40, or 50 SAE 30	HEAVY DUTY ENGINE OIL MEETING SPEC MIL-L-2104B OR MIL-L-45199 SERIES 3
ABOVE 0°F BELOW 0°F	SAE 90 SAE 80	STRAIGHT MINERAL GEAR OIL

The lubricant should not contain vegetable or animal oils, resin, soaps, graphite, fillers or foreign materials of any kind. **The use of extreme pressure additives, such as found in multi-purpose or rear axle type lubricants, is not recommended in a Spicer transmission.**

Capacity: Fill until oil runs out of fill hole on the transmission. 14 pints in level position. Higher when unit is installed on an angle.

NOTE: Regardless of the angle of installation, field experience indicates that this much oil is necessary for proper lubrication.

OIL CHANGES:

We recommend an initial oil change and flush at the first practical opportunity after the transmission is placed in service. This could take place after a drive-away delivery, only 100 miles or 24 hours of off-highway service, but not more than 2,000 miles of over-the-highway.

There are many factors that influence the oil change period and we have not specified a definite mileage interval. In general, it is suggested that a drain and flush period be scheduled every 20,000 miles for normal over-the-highway operations. Off-the-highway usually requires oil change every 30 days. The oil level in the transmission should be checked every 2,000 miles on-highway, or every 24 hours in off-highway operation.

OVERFILLING:

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

SHIFTER HOUSING—FRONT CONTROL

DISASSEMBLY:

1. Shift auxiliary into neutral. Remove retaining capscrews (K-2), lockwashers (K-3), stud nut (K-5) and washer (K-4). Separate cover (R-2) from case (G-1) and gasket (K-1) and lift straight up.

2. Remove plugs (R-7) from poppet ball holes and tip housing to remove poppet springs (R-6) and poppet balls (R-4) from housing.

3. Place shifter housing in a vise so that shift forks are facing out and the end of shift rods (R-8) are pointing to the right.

4. Cut and remove lockwire from setscrews (R-14) in shift forks (R-9). Remove setscrew (R-14) from shift fork (R-9) and use a brass drift to tap shift rod forward and free of Lo-Lo and underdrive shift fork (R-9). Pull shift rod free of seal (R-3) and out of housing.

5. Remove setscrew (R-14) from direct and overdrive shift fork (R-9). Use a brass drift to tap shift rod forward and free from fork. Use caution, as shift rod is pulled free of front boss, to prevent loss of interlock (R-10). Pull shift rod free of seal (R-3) and out of housing.

6. If shift rod seals (R-3) are to be replaced, then remove seals from housing bores at this time. Remove old gasket (K-1) from sealing surface and clean housing for inspection prior to reassembly.

7. Clean and inspect all shifter housing parts for wear or damage before reassembly.

ASSEMBLY:

1. To reassemble shifter housing, it may be placed on edge in a vise with the inside of housing facing out and shift rod seal bores to the right. Or, if desired, housing may be placed upside down on a bench.

2. Check fit of shift rods (R-8) in shift forks (R-9), as well as in their proper position in the housing bosses to make sure the parts assemble properly and slide freely. Remove shift rods and apply a light coat of grease to all bores in housing and to the rods as they are assembled in the housing.

3. If shift rod oil seals (R-3) were removed, use a light coat of cement on O.D. of seals and use $1\frac{1}{2}$ " O.D. tubing or proper tools to press seals into bores of housing.

4. Select either shift rod and enter it through the direct and overdrive speed lower seal (R-3) and into bore of housing. Position shift rod so that three poppet notches are down and will align with poppet ball access hole.

5. Slide shift rod through bore, with long hub of shift fork to the left (or toward the rear of housing), assemble direct and overdrive shift fork (R-9) onto rod.

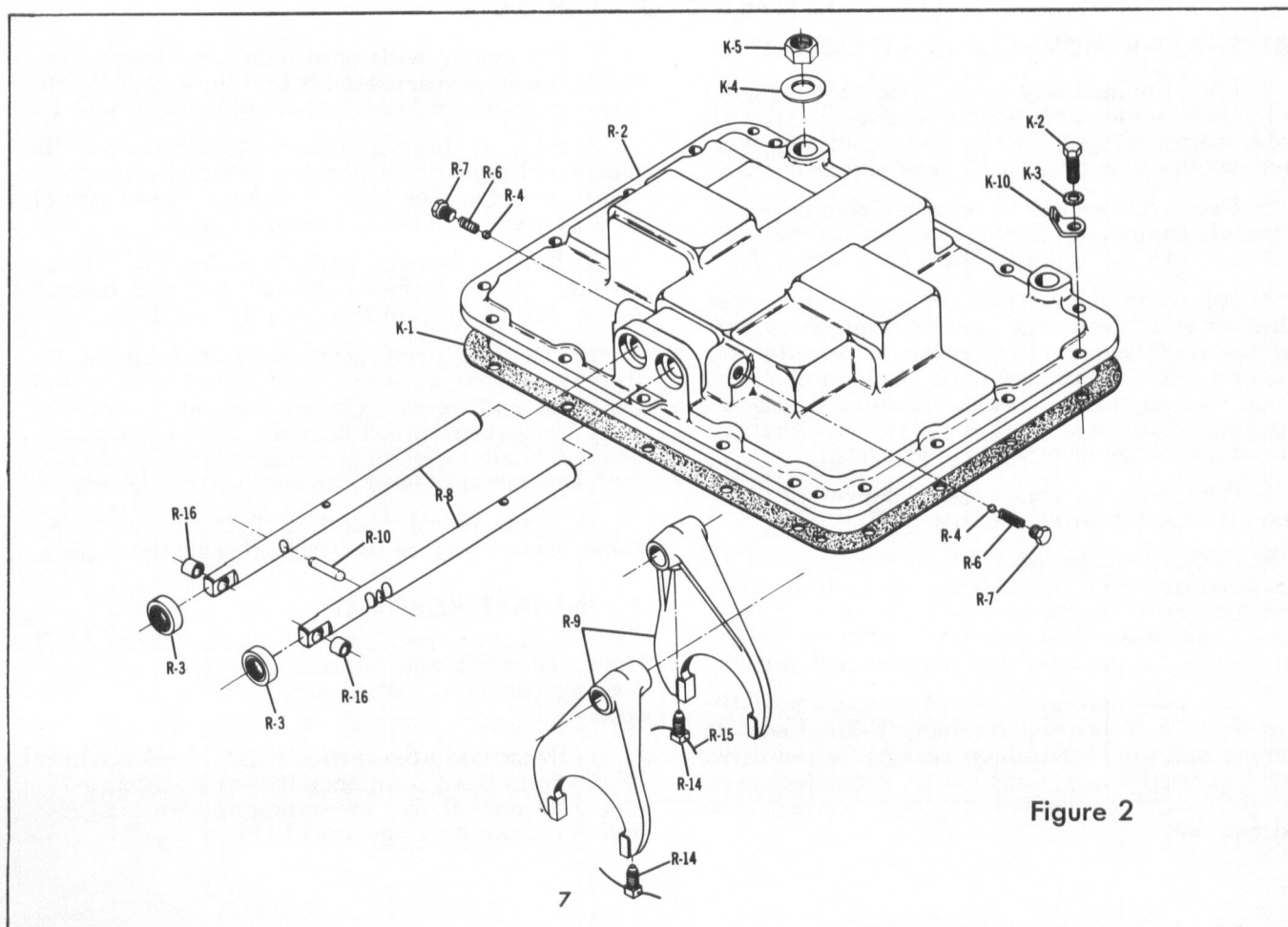


Figure 2

Shifter Housing — Front Control continued

6. Locate shift fork (R-9) in its proper position and secure to shift rod with setscrew (R-14). Torque screw to 40 - 50 lbs. ft. Then secure with lockwire.

7. Locate direct and overdrive shift rod in its neutral position and insert poppet ball and poppet spring (R-4, R-6) into housing access hole. Secure parts with poppet hole plug (R-7). Drop interlock (R-10) into interlock and poppet cross hole of front boss. Make sure interlock seats in neutral notch of shift rod (R-8).

8. Select the remaining shift rod, Lo-Lo and underdrive rod, (R-8) and enter it through upper seal (R-3) and through front boss of shifter housing. Position shift rod so that three poppet notches are up.

9. Slide shift rod through bore. With long hub of shift fork to the right (front), assemble Lo-Lo and underdrive shift fork (R-9) on rod.

10. Pass shift rod through rear boss and locate shift fork in its proper position and secure to shift rod with setscrew (R-14). Torque screw to 40 - 50 lbs. ft. Then secure with lockwire.

11. Assemble poppet ball (R-4) and poppet spring (R-6) into access hole of housing. Secure with poppet hole plug (R-7).

12. Use a large screwdriver and move Lo-Lo and underdrive shift fork out of its neutral posi-

tion. If interlocks are in place and operating, then direct and overdrive shift fork (R-9) will be locked in the neutral position.

13. Return Lo-Lo and underdrive rod to its neutral position. Check shifting of both rods in and out of their neutral positions to make sure they travel freely and completely into all shift positions. Shift the rods back into their neutral positions.

INSTALLATION OF SHIFTER HOUSING ON CASE:

1. Use light coat of cement and assemble shift cover gasket (K-1) to auxiliary case.

2. Place both clutch gear collars (B-2) in their neutral positions on the mainshaft.

3. Check to determine that shifter housing forks are in neutral and set shift housing assembly down into position on case. Make sure both shift forks are in their proper place on corresponding shift collars.

4. Secure shifter housing to main case with capscrews (K-2), lockwashers (K-3), also stud nut (K-5) and washer (K-4).

5. Use large screwdriver or small pry bar and check movement of each shift rod to make sure auxiliary will shift readily and completely into each gear position.

GEARS & CASE

MAINSHAFT REMOVAL AND DISASSEMBLY:

1. Lock the auxiliary in two gears by engaging Lo-Lo and underdrive clutch collar (B-2) with Lo-Lo mainshaft gear (B-13), and direct and overdrive clutch collar (B-2) with head end gear (A-1).

2. Use 2 $\frac{9}{16}$ " socket to remove drive gear and mainshaft companion flange or end yoke locknuts (A-5 and B-28), also flat washers (A-4 and B-27).

3. It is recommended that repairmen use proper puller, or equivalent, and remove main drive gear and mainshaft rear companion flanges, or end yokes (A-2 and B-26). Hammering on these components is not recommended, because it could cause dimensional distortion of these parts and perhaps later cause failure of other related parts.

4. Remove front transmission hanger (if used) from drive gear bearing retainer (F-7).

5. Remove capscrews (F-4), lockwashers (F-6) and separate front bearing cap (F-1) from main drive gear bearing retainer (F-7). Remove bearing cap gasket (F-3). Remove front bearing cap oil seal (F-2) if it is damaged and requires replacement.

6. Remove capscrews (F-9), lockwashers (F-10) from drive gear bearing retainer (F-7). Use soft hammer and tap on trunnion bearing face of drive gear bearing retainer, until it is separated from case far enough to use two pry bars between case and retainer.

7. Pry evenly with both bars until bearing retainer and drive gear assembly (A-1 through A-10) can be removed intact from the bore of main case (G-1).

8. Support bearing retainer assembly on its flange and press drive gear free of bearing retainer, bearings and spacer (A-7, A-8, A-9). Inner race of bearing (A-9) will remain on drive gear.

9. Remove bearing (A-7) from front of bearing retainer (F-7). Remove spacer (A-8) and bearing outer race (A-9) from bearing retainer (F-7).

10. Remove drive gear pocket bearing (A-10) from drive gear by prying out with a large screwdriver or equivalent. Use caution not to mar, or gouge pocket machined diameter with screwdriver, or other similar tool during removal of pocket bearing. Press inner race of bearing (A-9) off drive gear.

11. Remove old gasket (F-8) from bearing retainer sealing surface and wash all parts thoroughly.

MAINSHAFT REMOVAL:

1. Remove capscrews (H-5), lockwashers (H-7) from mainshaft rear bearing cap (H-1). Remove bearing cap (H-1) with gasket (H-4) from main case.

2. Remove capscrews (F-22), lockwashers (F-23) from front countershaft bearing caps (F-20) and countershaft rear capscrews and washers (J-3 and J-4) from bearing caps (J-1).

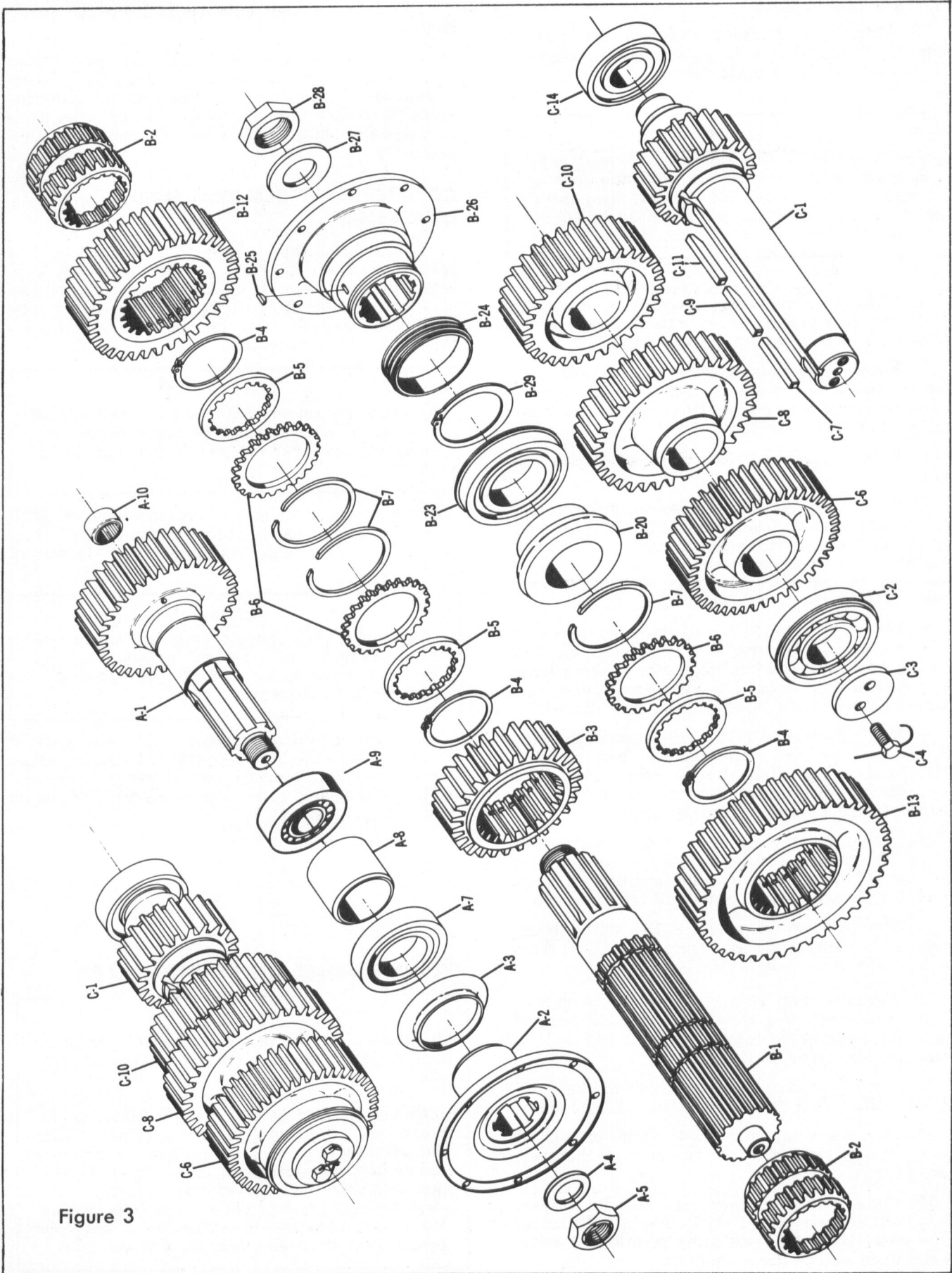


Figure 3

Gears and Case continued

3. Remove both front and rear countershaft caps (F-20 and J-1) with their respective gaskets (F-21 and J-2) from main case faces.

NOTE

If only the mainshaft sub-assembly is in need of repair and rebuild, the left hand side (looking from the rear of case) countershaft components and bearing caps (front and rear) can be left intact in the case.

4. Cut and remove lockwire from capscrews (C-4) on countershaft (C-1). Remove capscrews (C-4) with bearing retaining plate (C-3).

5. Force mainshaft rearward to expose snap ring on mainshaft bearing (B-23), install bearing puller tool on bearing snap ring and remove bearing from rear of mainshaft.

6. Remove mainshaft spacer (B-20) from mainshaft.

7. Force countershaft sub-assembly forward to expose snap ring on front bearing (C-2). Use bearing puller tool on bearing snap ring and remove bearing (C-2) from countershaft. It now may be necessary to use a lift strap on the countershaft assembly to permit easy performance of Step 8.

8. Locate countershaft sub-assembly rearward with bearing (C-14) out of rear case bore. Remove bearing outer race and roller assembly from inner bearing race and shaft. Do not remove inner race from shaft unless the bearing must be replaced.

9. With bearings removed from right side countershaft, or both countershafts, force countershaft to the side of the transmission case. This condition allows for easy clearance removal of the mainshaft sub-assembly from the case.

10. Using a lift strap or rope on clutch collar (B-2), lift mainshaft sub-assembly up and out of the case. Lay mainshaft sub-assembly on work bench for disassembly of gears and related parts.

11. Remove Lo-Lo gear (B-13) with thrust washers (B-5 and B-6) and snap ring (B-7) from the rear of the mainshaft (B-1).

12. Remove snap ring (B-4) from the groove of the mainshaft and slide snap ring off rear of shaft. At the same time, remove clutch collar (B-2) from the rear of the shaft.

13. Remove clutch collar (B-2) from the front side of mainshaft if it was not taken off previously.

14. Remove snap ring (B-4) from mainshaft groove that is located under the bore of the overdrive gear (B-3).

15. Slide overdrive gear, its thrust washers (B-5, B-6) and snap ring (B-7), along with under drive gear (B-12) and its same component parts off the front end of the mainshaft.

16. Remove snap ring (B-4) from the mainshaft groove.

17. It is recommended that all gear thrust washers (B-5 and B-6) and snap rings (B-7) be removed from gear bores for cleaning and close inspection to determine if replacement of these parts is necessary before rebuilding the mainshaft sub-assembly.

COUNTERSHAFT REMOVAL AND DISASSEMBLY:

1. Use lift strap or rope in back of head end gear (C-6) and lift right side countershaft sub-assembly from case. If left side countershaft must also be removed from the case, remove left side shaft sub-assembly in a like manner as done on the right side countershaft.

NOTE

If gears on countershafts require replacement because of tooth damage, or ratio change, etc., press all gears but integral Lo-Lo gear off the shaft.

2. Support head end (direct drive, C-6) with parallel bars as close to the hub as possible. Using an Arbor Press, press countershaft (C-1) out of gear (C-6).

NOTE

Countershaft (C-1) has a long continuous keyway. As each gear is pressed from the shaft, the key may come away with the gear instead of staying in the keyway.

3. Support underdrive gear (C-10) with parallel bars as close to the hub as possible. Using an Arbor Press, press countershaft out of gears (C-8) and (C-10) at the same time. Remove gear (C-8) as its bore clears the shaft.

PRESSING GEARS ON COUNTERSHAFT:

NOTE

It is advisable to coat the bores of all the gears with oil when pressing the gear on the countershaft.

We recommend that the keys for each gear be installed in shaft keyway one at a time as the countershaft is pressed into the gear bore. Note that all three keys are the same size, so that they can be used interchangeably in any gear. If keys become mutilated or burred after assembly to the shaft keyway, use mill file to align sides, remove burrs, etc. This prevents chips and slivers from peeling off and lodging between gear hub faces.

1. Press key (C-11) into keyway of countershaft (C-1). Support underdrive gear (C-10) with long hub up. Set countershaft and key into position under arbor. Align key with gear keyway and press shaft and key into gear. Seat gear face of shaft firmly against face of underdrive gear. Key must be flush to gear face or slightly under gear face.

2. Press key (C-9) into countershaft keyway. Support overdrive speed gear (C-8) with long hub down. Set shaft into gear under Arbor Press. Align key with gear keyway. Press shaft and key into gear. Seat gear face firmly against face of underdrive speed gear (C-10). Key must be under the face of gear (C-8).

3. Press third key (C-7) in keyway of countershaft. Support direct drive speed gear (C-6) with long hub up. As in above steps, press shaft into gear, seating gear face firmly against face of overdrive gear (C-8). Key must be under face of gear (C-6).

Notice tooth timing mark "V" on tooth web of gear. Be sure that it aligns itself to the center of gear keyway.

IMPORTANT

Key (C-7) face must be slightly under face of gear (C-6) because countershaft front bearing (C-2) inner race face rests against face of gear hub.

ASSEMBLY OF MAINSHAFT:

NOTE

Before assembly of all gears on the mainshaft, inspect all thrust washers (B-5, B-6) left in gear bores at the time of disassembly. If washers show heavy face galling or tooth wear indentations, the washers should be replaced.

1. Lubricate old or new thrust washers with S.A.E. #30 engine oil on the thrust faces as they are assembled.

NOTE

Both clutch collars (B-2) are identical. Either end of collar can be installed on the shaft at time of assembly.

2. Re-position mainshaft (B-1) on work bench and install clutch collar (B-2) over rear end of shaft, locating it ahead of first snap ring groove at rear of shaft. Install snap ring (B-4) into rearmost groove on shaft.

NOTE

Use caution when assembling snap rings on shaft to prevent extending or distorting snap rings.

3. Install Lo-Lo gear (B-13) with snap ring and thrust washers (B-5, B-6, B-7) on rear side of shaft. Locate internal aplied thrust washer (B-5) against shaft snap ring (B-4).

4. Install spacer (B-20) with the flanged portion toward face of Lo-Lo speed gear (B-13) and shoulder of mainshaft.

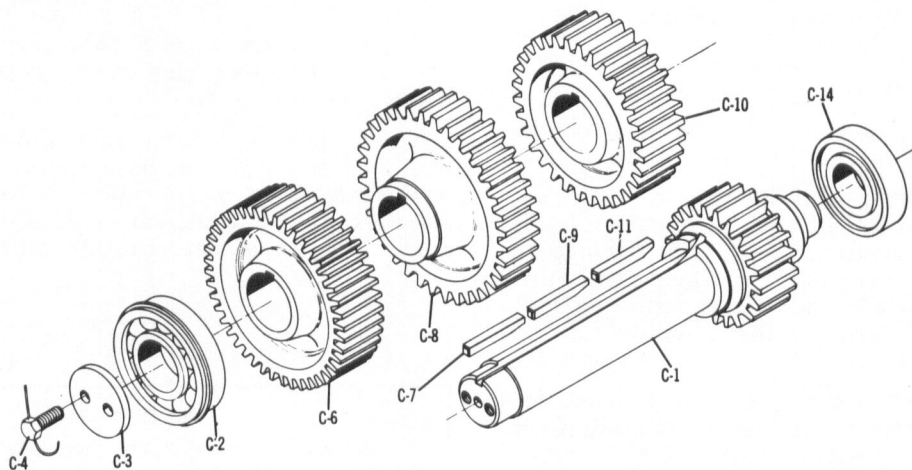


Figure 4

5. Position mainshaft (B-1) on work bench. From the front side of the mainshaft, install second snap ring (B-4) in shaft groove. Seat snap ring in groove of shaft securely.

6. From the front side of shaft, install underdrive gear sub-assembly (B-12) with snap ring and thrust washers (B-5, B-6, B-7). Internal splined teeth of thrust washer (B-5) should rest against shaft snap ring (B-4).

7. Install overdrive gear sub-assembly (B-3) with snap ring and thrust washers (B-5, B-6, B-7), with gear internal snap ring facing toward underdrive gear (B-12). Rest face of gear (B-3) against face of gear (B-12).

8. Install a second snap ring (B-4) on front end of shaft and locate it in last groove on mainshaft. Be sure snap ring is securely in place in groove of shaft.

9. Install second clutch collar (B-2) on front side of mainshaft. Place in the bore and in mesh with overdrive gear (B-3).

10. Place mainshaft sub-assembly on work bench for later installation into case.

ASSEMBLY OF DRIVE GEAR COMPONENT PARTS:

1. Position bearing (A-9) under Arbor Press, with inner race flange of bearing up on the press bed. Set drive gear (A-1) in place and press into position. Be sure inner race flange bottoms against front face of drive gear.

2. Install drive gear pocket bearing (A-10) into drive gear pocket: the bearing part number *JH1812* must be visible when pressed in bore. Seat pocket bearing firmly against pocket shoulder. Rim face of bearing will be tangent to gear counterbore face when it is seated against inside shoulder.

3. Install spacer (A-8) on stem of drive gear and rest it against bearing (A-9).

4. Install bearing retainer (F-7) onto drive gear and bearing (A-9).

5. Place drive gear and bearing retainer assembly on Arbor Press bed with gear clutch teeth facing bed. Install bearing (A-7) onto drive gear stem and press bearing on drive gear and into bearing retainer. Seat bearing (A-7) firmly against face of spacer (A-8) and against shoulder of the bore in the bearing retainer.

6. Assemble front bearing cap (F-1) with its gasket (F-3) on bearing retainer (F-7), align oil drain holes. Secure bearing cap cover to drive gear cap with capscrews (F-4) and lockwashers (F-6). Torque capscrews to 40 - 50 lbs. ft.

7. Lay drive gear bearing retainer sub-assembly aside for later installation after mainshaft sub-assembly has been installed into the case.

INSTALLATION OF COUNTERSHAFTS:

1. Take either of the countershaft sub-assemblies (C-1 through C-14). Place it inside the case on the left side (looking from the rear of case), with timing mark " \wedge " of head end gear toward the center of case. This timing mark must be mated to the drive gear timing mark " \wedge " later in assembly.

2. Install the remaining countershaft sub-assembly, placing it inside the main case on the right side. Turn the head end gear (C-6) around until the timing mark " \wedge " is toward center of case.

3. Do not install front, or rear countershaft bearing (C-3 or C-14) at this time. Allow countershafts to remain in bottom of case until the mainshaft sub-assembly is placed into the case.

INSTALLATION OF MAINSHAFT SUB-ASSEMBLY INTO CASE:

1. With a sling rope or wire around Lo-Lo, underdrive shift collar (B-2) to support the mainshaft assembly, use a chain hoist and hook on sling. Lower mainshaft assembly into position in the approximate center of case rear bore. Block mainshaft front stem with a piece of wood or brass plate.

2. Start mainshaft rear bearing (B-23) on rear of shaft, use drive tubing against inner race of bearing to drive bearing onto shaft and into bore of case. Seat bearing snap ring against main case counterbore.

3. Leave hoist and sling in place for support on mainshaft in its position until drive gear assembly has been assembled into case.

4. Assemble speedometer driven gear into mainshaft rear bearing cap (H-1) if it was removed. Install rear bearing cap with gasket (H-4) on mainshaft rear bearing and case face. Align oil port holes to return holes on bearing cap.

5. Dip capscrew (H-5) in sealer and use washers (H-7) to attach bearing cap to case. Torque capscrews 60 - 80 lbs. ft.

6. Install front drive gear and bearing cap assembly into front case bore and onto pilot stem of mainshaft. Dip capscrews (F-9) in sealer and use washers (F-10) to attach bearing cap assembly to case. Torque capscrews to 60 - 80 lbs. ft.

IMPORTANT

7. With all timing gears painted, bring timing teeth of countershaft head end gears parallel to bottom of case, or pointing to the center of the case. Position drive gear timing teeth (two) where they will match and mate to the timing teeth of the countershaft gears.

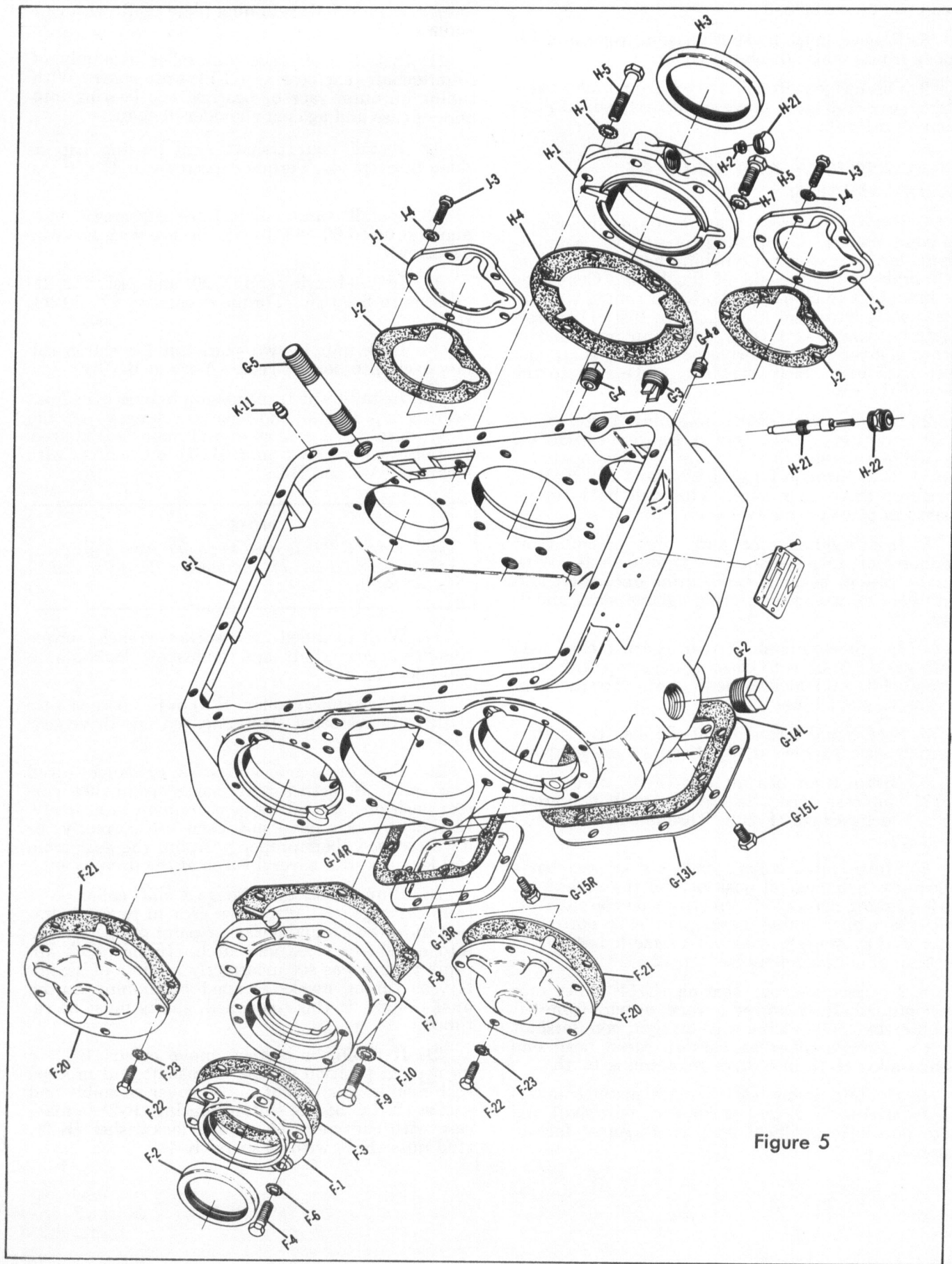


Figure 5

Gears and Case continued

8. Relieve hoist tension on sling rope and remove from mainshaft clutch collar.

9. Disengage shift collar (B-2) from under overdrive gear (B-3) and move it into its neutral position on mainshaft.

FINAL ASSEMBLY AND TIE-UP OF COUNTERSHAFTS:

1. Preassemble rear bearing (C-14) inner race to countershaft. Using sling rope on left countershaft, locate rope or wire behind head end gear on gear hubs, with the aid of the hoist. Centralize countershaft to case front bore and timing teeth in mesh with drive gear timing tooth. Install countershaft bearing (C-2), using tubing on front end of bearing inner race, to drive bearing on shaft and into case bore. Seat snap ring of bearing to the face of the case.

2. Install countershaft retaining plate (C-3) with capscrews (C-4). Hand tighten capscrews. Lock transmission in two gears by placing clutch collar (B-2) into Lo-Lo gear bore and collar (B-2) in direct drive gear bore. This will hold timing marks in place on the two gears.

3. Install outer race and roller assembly of countershaft rear bearing (C-14) onto shaft. With tubing race of bearing, tap bearing onto shaft and into bore of case, seat bearing against shaft shoulder.

4. Install countershaft rear bearing cap (J-1) with gasket (J-2) onto case. Secure cap with capscrew (J-3) and lockwashers (J-4). Torque capscrews to 40 - 50 lbs. ft.

5. Secure and torque to 60 - 80 lbs. ft. countershaft front capscrews (C-3). Secure with lockwire.

6. Install front bearing cap (F-20) and gasket (F-21) on case face. Secure cap with capscrews (F-22) lockwashers (F-23). Torque capscrews 40 - 50 lbs. ft.

7. Move clutch collars (B-2) out of gear bores and into their neutral positions on the mainshaft. Bring timing marks "∧" on right side countershaft with drive gear timing marks parallel to bottom of case if they were moved out of mesh because of lock up of clutch collars in Step #2.

8. Preassemble rear bearing (C-14) inner race to countershaft. Using sling rope, or wire from left countershaft, place sling rope on right countershaft in the same manner as before. Mesh head end gear timing teeth into drive gear timing tooth.

9. Holding timing teeth in place, install countershaft bearing (C-2) on the front of right shaft and into bore of case. Seat snap ring against face of case.

10. Install shaft retaining plate (C-3) with capscrews (C-4).

11. Install outer race and roller assembly of countershaft rear bearing (C-14) onto shaft. With tubing on outer race of bearing, tap bearing into bore of case and against shoulder of shaft.

12. Install countershaft rear bearing cap as done in Step #4. Torque capscrews to 40 - 50 lbs. ft.

13. Install countershaft front capscrews (C-4) and torque to 60 - 80 lbs. ft. Secure with lockwire capscrews.

14. Install bearing cap (F-20) and gasket (F-21) as done in Step #6. Torque capscrews 40 - 50 lbs. ft.

15. Lock unit in two gears moving clutch collars back into bore of gears (A-1 and B-13).

16. Install front transmission hanger over front bearing cap. Install end yokes, or flanges (A-2 and B-26) onto drive gear stem and mainshaft splines. Install washers (A-4 and B-27) on shafts, with locknuts (A-5 and B-28).

NOTE

Snap ring (B-29) is used to double secure speedometer gear (B-24) on companion flange or end yoke (B-26).

17. With modified $2\frac{9}{16}$ " socket wrench, torque the drive gear shaft and mainshaft locknuts to 550 - 600 lbs. ft.

18. Move clutch collar (B-2) out of bore of gear (B-13). Leave collar (B-2) engaged into drive gear (A-1).

19. Turn drive gear end yoke, or flange to roll gear train. If teeth timing marks are in their correct positions, the entire gear train will roll freely. If timing teeth have not been set correctly, or have escaped their proper position, the gear train will lock up after several turns of the drive gear.

20. If unit locks up, disengage shift collar (B-2) from drive gear. Turn drive gear in reverse rotation until the timing marks, or paint on teeth come into match, or close mismatch. If mismatch appears timing was set incorrectly at time of assembly, or timing marks escaped positioning during final tie-up. If this happened, shafts must be retimed.

21. If timing is correct, move collar (B-2) in its neutral position on the mainshaft and proceed with final installation of shifter cover assembly and gasket (K-1). Secure shifter housing (R-2) to main case with capscrews (K-2) and lockwasher (K-3), stud nuts (K-5) with washers (K-4).

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IMPORTANT PROCEDURE

When locating and correcting 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 and these reports do not always accurately describe the actual conditions. Sometimes symptoms seem to indicate trouble in the auxiliary; while, actually the trouble may be caused by the axle, propeller shaft, universal joints, engine or clutch. This is especially true of complaints on noise. Therefore, before removing transmission or related components to locate trouble, always road test to check possibility that trouble may exist in other closely associated units. If the mechanic can drive, road testing will be more effective; however, just riding with the driver can be very informative.

Check Functioning Prior to Disassembly:

If remote controls are used, a careful check of the remote and connecting linkage to auxiliary must be made. The remote units and linkage must be in good working order if the auxiliary is expected to shift satisfactorily.

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

Inspect Thoroughly During Disassembly:

It is poor practice to disassemble a unit as quickly as possible without bothering to examine the parts as they come down. It happens many times that a mechanic has completely disassembled a unit and failed to find the cause of the trouble because he did not bother to examine the parts as they came apart. After the auxiliary is disassembled, check the lubricant for breakdown and foreign particles which often reveal sources of trouble that are overlooked during the disassembly.

Repair or Replace Defective Parts:

Many times the parts or critical adjustments that have caused the trouble are not replaced or corrected because the mechanic will only inspect and replace parts that have failed completely. All pieces should be accurately examined because the broken parts are often just the result and not the cause of the trouble. All parts that are broken or worn and no longer meet specifications should be replaced. On large units, like an auxiliary, it is suggested that a mechanic replace parts that are worn to the extent that they do not have a long service life remaining. This avoids another teardown on the unit in the near future. It is also good practice to make the changes or modifications recommended to bring the auxiliary up to date and increase the service life of the unit.

Driver Training:

One of the major causes of bearing and gear failures in the auxiliary unit is poor driving habits. Driver should be taught to always use the lo speed or reductions available in the auxiliary unit and keep the front box in the higher ratios not vice versa.

Worn and pitted gears, as well as worn and pitted bearings are usually caused by excessive use of the auxiliary overdrive gears with the mainbox in lower gear ratios.

Broken teeth in the auxiliary unit are usually caused by drivers trying to start their vehicles with the auxiliary unit in the high ratio while the big reduction is made in the front box. Frogging or quick release of clutch gives a jump start also noted for breaking teeth.

Noisy Operation:

Noise is usually very elusive and generally not the fault of the auxiliary; therefore, mechanics should road test to determine if the driver's complaint of noise is actually in the auxiliary. Remember that auxiliary units act as sounding boxes and in numerous instances, drivers have insisted that the noise was in the auxiliary; however, investigations revealed the noise to be caused by one of the following conditions:

- (a) Fan out of balance or blades were bent.
- (b) Defective vibration dampers.
- (c) Crankshafts out of balance.
- (d) Flywheels out of balance.
- (e) Flywheels mounting bolts loose.
- (f) Engine rough at idle producing rattle in gear train.
- (g) Clutch assembly out of balance.
- (h) Engine mounts loose or broken.
- (i) P.T.O. gear not fully engaged or housing not properly shimmed.
- (j) Universal joints worn out.
- (k) Propeller shafts out of balance.
- (l) Universal joint angles out of plane or at excessive angle.
- (m) Center bearing in drive line dry, not mounted properly, etc.
- (n) Wheels out of balance.
- (o) Tire treads humming or vibrating at certain speeds.
- (p) Air leaks on suction side of induction system—especially with turbo-chargers.

Mechanics should try to locate and eliminate noise by means other than auxiliary removal, or overhaul. However, if the noise appears to be in the auxiliary try to break it down into the following classifications. If possible, determine what position the gear shift lever is in when the noise occurs. If the noise is evident in only one gear position, the cause of the noise is generally traceable to the gears in operation.

(a) Growl and humming or, more serious, a grinding noise. 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.

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

(c) Metallic rattles within the auxiliary usually result from a variety of conditions. Engine torsional vibrations are transmitted to the transmission through the clutch, which may be amplified and transmitted to the auxiliary through the connecting propeller shaft. 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. *Always leave the main box in neutral and the auxiliary unit in gear when idling.* A defective or faulty injector would cause a rough or lower idle speed and a rattle in the auxiliary. Rattle could also be caused by excessive backlash in P.T.O. unit mounting.

(d) Improper lubricants or lack of lubricant can produce noises. Auxiliaries with low oil levels sometimes run hotter than normal, as there is insufficient lubricant to cool and cover the gears.

(e) Squealing, particularly when the auxiliary is operating at higher speeds, could be caused by one of the free running gears seizing on the thrust face temporarily and then letting go. In general, a mild seizure will clear itself up and the auxiliary will continue to operate very satisfactorily without this defect being known. See (g) below:

(f) Gear seizure at high speed, usually accompanied with loud squealing noise. This type of seizure is readily apparent to the driver, since the truck will suddenly slow down as if the brakes were being applied. If the truck continues to move ahead, even though the gear shift lever is placed in neutral, it would indicate the floating gear on the mainshaft had seized. Depressing the clutch should interrupt the driving torque. The seized gear could be checked quite readily by depressing the clutch and checking the action with the gear shift lever progressively in all shift positions. If releasing the clutch tends to kill the engine, then this gear position has not seized. In other words, the auxiliary would be in two gears at the same time. By a process of elimination, the gear at fault can be readily identified. See (g) below:

(g) Vibration: Gear seizures on thrust faces are usually caused by vibrations in the power train—this could be engine, propeller shafts, joint angles rear axle, differentials, etc.

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Improved highways permit sustained high speeds. The fact that engines and entire power trains can now cruise at higher R.P.M. can introduce vibration frequencies, that were not critical in the past. At slower speeds these items would get by or only pass through critical periods while accelerating or decelerating through the gears.

In the past, drive line vibrations such as bent tubes, joints out of phase or alignment, bad angles due to short couples, clutches out of balance, gears and shafts in auxiliaries out of balance, were fairly obvious. These items will become more critical in vehicles running at sustained high speeds.

Critical vibrations associated with higher speeds are not the old thumping or bumping type, but are high frequency vibrations which sting or tingle the soles of your feet, tickle the end of your fingers, etc. This type of vibration will cause gear seizures, bearing failure due to retainer rivet failures, promote brinelling, fretting, corrosion, etc.

(h) Gear whine is usually caused by lack of backlash between mating gears—improper shimming of P.T.O. units is the big offender here.

Noise in Neutral

Possible Causes:

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

Noise in Gear

Possible Causes:

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

Oil Leaks

Possible Causes:

- (a) Oil level too high.
- (b) Wrong lubricant in unit.
- (c) Non-shielded bearing used at front or rear bearing cap. (Where applicable.)
- (d) Seals defective or omitted from bearing cap, wrong type seal used, etc.
- (e) Transmission breather omitted, plugged internally, etc.

- (f) Capscrews loose, omitted or missing from remote control, shifter housing, bearing caps, P.T.O. or covers, etc.
- (g) Oil drain-back openings in bearing caps or case plugged with varnish, dirt, covered with gasket materials, etc.
- (h) Broken gaskets, gaskets shifted or squeezed out of position, pieces still under bearing caps, clutch housing, P.T.O. and covers, etc.
- (j) Cracks or holes in castings.
- (k) Drain plug loose.
- (l) Also possibility that oil leakage could be from engine.

Walking or Jumping Out of Gear:

For clarification we would like to separate walking out of gear and jumping out of gear into two distinct groups.

Walking out of gear is usually associated with power applications or coasting on long smooth grades, i.e., when power is applied the shift lever moves into the neutral position. Occasionally it may be impossible to hold the shift lever in gear by hand.

Sometimes this condition may also be noted when coasting down a long relatively smooth grade or power is being applied on the coast side of the gear.

Dana/Spicer transmissions and auxiliaries are provided with "hopping guards" for most gear positions. Therefore, if the units are walking out of gear it could be caused by:

- (a) Interference or resistance in the shift mechanism preventing full engagement of the sliding clutch gear or —
- (b) If the gear has been shifted completely into position some other malfunction which could move the gear or the shaft itself out of its proper location.
- (c) On new or rebuilt units the wrong parts or old defective parts may have been used; thereby rendering the hopping-guard feature useless. High mileage units may start walking out of gear due to the general deterioration or rounding of clutch teeth due to numerous slip-outs or partial engagements due to conditions listed below.
- (d) Walkout on coast side could be caused by lack of hopping guard feature for this particular gear position.

If remote controls are used, the mechanic must satisfy himself that the remote units are satisfactory and that auxiliary is actually at fault. A number of items that would prevent full engagement of gears are:

- (a) Improperly positioned forward remote control which limits full travel forward and backward from the remote neutral position.
- (b) Improper length shift rods or linkage that limits travel of forward remote from neutral position.

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- (c) Loose ball cranks, sloppy ball and socket joints.
- (d) Shift rods, cables, etc., too spongy, flexible, or not secured properly at both ends.
- (e) Worn or loose auxiliary mounts if remote units is mounted to frame.
- (f) Forward remote mount too flimsy, loose on frame, etc.
- (g) Set screws loose at remote control joints or on shift forks inside remote or even inside auxiliary unit.
- (h) Shift fork pads or groove in sliding gear or collar worn excessively.
- (i) Worn taper on gear clutch teeth.
- (j) Auxiliary out of alignment either vertically or horizontally.

Jumping Out of Gear:

Jumping out of gear is usually associated with slip-out reports experienced when crossing railroad tracks — traveling rough roads, etc.

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

- (a) Use of long and heavy shift lever extensions.
- (b) Shift rod poppet springs broken.
- (c) Shift rod poppet notches worn.
- (d) Shift rod bent or sprung out of line.
- (e) Shift fork pads not square with shift rod bore.
- (f) Excessive end-play in drive gear, mainshaft or countershaft caused by worn bearings, retainers, etc.
- (g) Thrust washers or faces worn excessively, missing, etc.

Hard shifting:

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

- (a) No lubricant in remote control units. Forward remote is isolated and is often overlooked. However, many remote controls used on transmissions and auxiliaries require separate lubrication.
- (b) No lubricant in (or grease fittings on) U-joints or swivels of remote controls.
- (c) Lack of lubricant or wrong lubricant used, causing buildup of sticky varnish and sludge deposits on splines of shaft and gears.
- (d) Badly worn or bent shift rods.
- (e) Improper adjustment of shifter linkage.
- (f) Sliding clutch gears tight on splines of shaft.

- (g) Clutch teeth burred over, chipped or badly mutilated due to improper shifting.
- (h) Binding or interference of shift lever with other objects or rods inside the cab or near the remote control island.
- (i) Driver not familiar with proper shifting procedure for this transmission. Also includes proper shifting as used with 2-speed axle, auxiliary, etc.
- (j) Drive gear pocket bearing seized, rough, or dragging.
- (k) Gear seizure on thrust face.
- (l) Thrust washer failure.

Sticking in Gear:

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

Bearing Failures:

The service life of most transmissions either main or auxiliaries is governed by the life of the bearings. Majority of bearing failures can be attributed to vibration and dirt. Some of the more prominent reasons for unit removal with bearing failures are:

- (a) Worn out due to dirt.
- (b) Fatigue of raceways or balls.
- (c) Wrong type or grade of lubricant.
- (d) Lack of lubricant.
- (e) Vibrations—breakup of retainer and brinnelling of races—fretting corrosion.
- (f) Bearings tied-up due to chips in bearings.
- (g) Bearings set-up too tight or too loose.
- (h) Improper assembly—brinnelling bearing.
- (j) Improper fit of shafts or bore.
- (k) Acid etch of bearing due to water in lube.
- (l) Overloading of vehicle. Overload from engine or engine too large for transmissions used.

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

Softer material such as dirt, dust, etc., usually forms abrasive paste or lapping compounds within

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the bearings themselves since the unit 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 chips, etc., may enter the bearings during assembly from hammers, drifts, power chisels, etc., or be manufactured within the unit during service from raking teeth, etc. These chips produce small indentation in balls and races. Jamming of these hard particles between balls and races may cause the inner race to turn on 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 reddish-brown coating and small etched holes over outer and exposed surfaces of race. Corrosive oxides also act as lapping agent.

Brinelling caused by improper assembly or removal — usually hammering with off-center blows. Use drivers, preferably under an arbor, or pullers.

Shaft Fits:

Excessive looseness under load is very objection-

able because it produces a creeping or slipping of the inner ring on the rotating shaft. This causes the surface metal of shafts to scrub or wear off.

Bearing fits on rotating shafts are usually specified as tight. When play or looseness, even .001", exists between the bearing and shaft, there is a very powerful force tending to rotate the inner race on the shaft; this force is caused by the looseness or lost motion between the parts and disappears when no looseness exists.

Removal of Bearings:

It is far more difficult to remove bearings from a shaft than to put them on. In most cases it is necessary to remove the bearing by pulling on the outer-race which can damage the balls or races. Since such damage is seldom visible, it does not become known until after complete reassembly. It is good P.M. to replace most ball bearings during the overhaul period. If a bearing is not going to be replaced, avoid removal during low mileage rebuild.

Interchangeability:

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

Numbers and symbols stamped on inner and outer races of bearings designate size and type.

Numbering systems of different bearing manufacturers, however, have not been standardized. Consult interchangeable tables and use proper bearings for replacement parts.

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For further information write to:

Spicer Transmission Division
Dana Corporation
P.O. Box 986
Toledo, Ohio 43696