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Manual: _______________________________ Publication Number: ______
Vehicle Model: _________________________ Model Year: ______________

Do you find procedures properly organized and easy to follow?  □ Yes  □ No
If not, please explain: ______________________________________________
_______________________________________________________________
_______________________________________________________________

Manual page numbers: _____________________________________________

Are there any important procedures or other information presently not in this manual that you would like to see included?  □ Yes  □ No
If yes, please describe: _____________________________________________
_______________________________________________________________
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Did you find any errors in the procedures or illustrations?  □ Yes  □ No
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Thank You For Your Assistance
Mack Trucks, Inc.

(ATTENTION: RTS STAFF, 6S3)

DO NOT STAPLE — USE TRANSPARENT TAPE
ATTENTION

The information in this manual is not all inclusive and cannot take into account all unique situations. Note that some illustrations are typical and may not reflect the exact arrangement of every component installed on a specific chassis.

The information, specifications, and illustrations in this publication are based on information that was current at the time of publication.

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INTRODUCTION
SAFETY INFORMATION

Advisory Labels

Cautionary signal words (Danger-Warning-Caution) may appear in various locations throughout this manual. Information accented by one of these signal words must be observed to minimize the risk of personal injury to service personnel, or the possibility of improper service methods which may damage the vehicle or cause it to be unsafe. Additional Notes and Service Hints are used to emphasize areas of procedural importance and provide suggestions for ease of repair. The following definitions indicate the use of these advisory labels as they appear throughout the manual:

**DANGER**

Activities associated with Danger indicate that death or serious personal injury may result from failing to heed the advisory. Serious personal injury may be equated to career-ending injury.

**WARNING**

Activities associated with Warning indicate that personal injury may result from failing to heed the advisory. In this case, personal injury is not equated to career-ending injury, but results in possible change in quality of life.

**CAUTION**

Activities associated with Caution indicate that product damage may result from failing to heed the advisory. Caution is not used for personal injury.

**NOTE**

A procedure, practice, or condition that is essential to emphasize.

**SERVICE HINT**

A helpful suggestion that will make it quicker and/or easier to perform a procedure, while possibly reducing service cost.
INTRODUCTION

Service Procedures and Tool Usage

Anyone using a service procedure or tool not recommended in this manual must first satisfy himself thoroughly that neither his safety nor vehicle safety will be jeopardized by the service method he selects. Individuals deviating in any manner from the instructions provided assume all risks of consequential personal injury or damage to equipment involved.

Also note that particular service procedures may require the use of a special tool(s) designed for a specific purpose. These special tools must be used in the manner described, whenever specified in the instructions.

**WARNING**

1. Before starting a vehicle, always be seated in the driver’s seat, place the transmission in neutral, be sure that parking brakes are set, and disengage the clutch.
2. Before working on a vehicle, place the transmission in neutral, set the parking brakes, and block the wheels.
3. Before towing the vehicle, place the transmission in neutral and lift the rear wheels off the ground, or disconnect the driveline to avoid damage to the transmission during towing.

**DANGER**

Engine-driven components such as Power Take-Off (PTO) units, fans and fan belts, driveshafts and other related rotating assemblies, can be very dangerous. Do not work on or service engine-driven components unless the engine is shut down. Always keep body parts and loose clothing out of range of these powerful components to prevent serious personal injury. Be aware of PTO engagement or nonengagement status. Always disengage the PTO when not in use.

REMEMBER, SAFETY . . . IS NO ACCIDENT!
Mack Trucks, Inc. cannot anticipate every possible occurrence that may involve a potential hazard. Accidents can be avoided by recognizing potentially hazardous situations and taking necessary precautions. Performing service procedures correctly is critical to technician safety and safe, reliable vehicle operation.

The following list of general shop safety practices can help technicians avoid potentially hazardous situations and reduce the risk of personal injury. DO NOT perform any services, maintenance procedures or lubrications until this manual has been read and understood.

- Perform all service work on a flat, level surface. Block wheels to prevent vehicle from rolling.
- DO NOT wear loose-fitting or torn clothing. Remove any jewelry before servicing vehicle.
- ALWAYS wear safety glasses and protective shoes. Avoid injury by being aware of sharp corners and jagged edges.
- Use hoists or jacks to lift or move heavy objects.
- NEVER run engine indoors unless exhaust fumes are adequately vented to the outside.
- Be aware of hot surfaces. Allow engine to cool sufficiently before performing any service or tests in the vicinity of the engine.
- Keep work area clean and orderly. Clean up any spilled oil, grease, fuel, hydraulic fluid, etc.
- Only use tools that are in good condition, and always use accurately calibrated torque wrenches to tighten all fasteners to specified torques. In instances where procedures require the use of special tools which are designed for a specific purpose, use only in the manner described in the instructions.
- Do not store natural gas powered vehicles indoors for an extended period of time (overnight) without first removing the fuel.
- Never smoke around a natural gas powered vehicle.
EXPLANATION OF NUMERICAL CODE

The organization of MACK service manuals has been upgraded to standardize manual content according to a reference system based on component identification. The reference system helps link the information contained in this publication with related information included in other MACK service-warranty publications, such as associated service bulletins, warranty manuals, and MACK Service Labor Time Standards.

The system is based on a numerical code, the first digit of which identifies the general component grouping as listed here:

GROUP 000 — GENERAL DATA
GROUP 100 — CHASSIS
GROUP 200 — ENGINE
GROUP 300 — CLUTCH, TRANSMISSION, TRANSFER CASE AND PTO
GROUP 400 — STEERING, AXLES, WHEELS AND TIRES, DRIVELINE
GROUP 500 — BRAKES, AUXILIARY SYSTEMS
GROUP 600 — CAB, TRUCK BODY
GROUP 700 — ELECTRICAL

The second two digits of the 3-digit code are used to identify the system, assembly or subassembly, as appropriate, within each of the groupings. The codes applicable to this publication are shown at the beginning of each procedure, as necessary, to guide you to specific component information.

Additionally, a two-character alpha code (i.e., [GA] CASE, MAIN) may be shown with each operation. This alpha code, in combination with the three-digit Group number, identifies the specific assembly, subassembly or part, and directly relates to the first five positions of the operation code listed in the MACK Service Labor Time Standards.

Example of Numerical Code
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</tr>
<tr>
<td>Kilograms Force per Meter (kgf/m) to Pound Feet (lb-ft)</td>
<td>7.233</td>
</tr>
<tr>
<td>Kilograms Force per Meter (kgf/m) to Newton Meters (N·m)</td>
<td>9.807</td>
</tr>
</tbody>
</table>

## Radiator Specific Heat Dissipation Calculations

<table>
<thead>
<tr>
<th>Conversion Units</th>
<th>Multiply By:</th>
</tr>
</thead>
<tbody>
<tr>
<td>British Thermal Unit per Hour (Btu/hr) to Kilowatt per Degree Celsius (kW/(°C))</td>
<td>0.000293</td>
</tr>
<tr>
<td>Kilowatt per Degree Celsius (kW/(°C)) to British Thermal Unit per Hour (Btu/hr)</td>
<td>3414.43</td>
</tr>
</tbody>
</table>

## Temperature Calculations

<table>
<thead>
<tr>
<th>Conversion Units</th>
<th>Multiply By:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Degrees Fahrenheit (°F) to Degrees Celsius (°C)</td>
<td>(°F - 32) / 1.8</td>
</tr>
<tr>
<td>Degrees Celsius (°C) to Degrees Fahrenheit (°F)</td>
<td>(°C) * 1.8 + 32</td>
</tr>
</tbody>
</table>
## INTRODUCTION

### Pressure Calculations

<table>
<thead>
<tr>
<th>Conversion Units</th>
<th>Multiply By:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atmospheres (atm) to Bars (bar)</td>
<td>1.01325</td>
</tr>
<tr>
<td>Atmospheres (atm) to Kilopascals (kPa)</td>
<td>101.325</td>
</tr>
<tr>
<td>Bars (bar) to Atmospheres (atm)</td>
<td>0.98692</td>
</tr>
<tr>
<td>Bars (bar) to Kilopascals (kPa)</td>
<td>100</td>
</tr>
<tr>
<td>Bar (bar) to Pounds per Square Inch (psi)</td>
<td>14.5037</td>
</tr>
<tr>
<td>Inches of Mercury (in Hg) to Kilopascals (kPa)</td>
<td>3.377</td>
</tr>
<tr>
<td>Inches of Water (in H2O) to Kilopascals (kPa)</td>
<td>0.2491</td>
</tr>
<tr>
<td>Pounds per Square Inch (psi) to Kilopascals (kPa)</td>
<td>6.895</td>
</tr>
<tr>
<td>Kilopascals (kPa) to Atmospheres (atm)</td>
<td>0.00987</td>
</tr>
<tr>
<td>Kilopascals (kPa) to Inches of Mercury (in Hg)</td>
<td>0.2992</td>
</tr>
<tr>
<td>Kilopascals (kPa) to Inches of Water (in H2O)</td>
<td>4.0145</td>
</tr>
<tr>
<td>Kilopascals (kPa) to Pounds per Square Inch (psi)</td>
<td>0.145</td>
</tr>
</tbody>
</table>

### Power Calculations

<table>
<thead>
<tr>
<th>Conversion Units</th>
<th>Multiply By:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Horsepower (hp) to Kilowatts (kW)</td>
<td>0.74627</td>
</tr>
<tr>
<td>Kilowatts (kW) to Horsepower (hp)</td>
<td>1.34</td>
</tr>
</tbody>
</table>

### Fuel Performance Calculations

<table>
<thead>
<tr>
<th>Conversion Units</th>
<th>Multiply By:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Miles per Gallon (mile/gal) to Kilometers per Liter (km/L)</td>
<td>0.4251</td>
</tr>
<tr>
<td>Kilometers per Liter (km/L) to Miles per Gallon (mile/gal)</td>
<td>2.352</td>
</tr>
</tbody>
</table>

### Velocity Calculations

<table>
<thead>
<tr>
<th>Conversion Units</th>
<th>Multiply By:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Miles per Hour (mile/hr) to Kilometers per Hour (km/hr)</td>
<td>1.609</td>
</tr>
<tr>
<td>Kilometers per Hour (km/hr) to Miles per Hour (mile/hr)</td>
<td>0.6214</td>
</tr>
</tbody>
</table>

### Volume Flow Calculations

<table>
<thead>
<tr>
<th>Conversion Units</th>
<th>Multiply By:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cubic Feet per Minute (cu-ft/min) to Liters per Minute (L/min)</td>
<td>28.32</td>
</tr>
<tr>
<td>Liters per Minute (L/min) to Cubic Feet per Minute (cu-ft/min)</td>
<td>0.03531</td>
</tr>
</tbody>
</table>
Unit Identification Stamping Location

The following model code information is stamped on the left side of the transmission, toward the rear of the main case. Refer to Figure 1.

1. Unit Symbol Identification
   - T = transmission
   - 3 = 300 series
   - 10 = useable forward speeds

2. Transmission Serial No.

3. Transmission Assembly (Part) No.

4. Specific variant of the base assembly number (variant to item No. 3)
VISUAL IDENTIFICATION

Figure 2 — Cutaway View of T310 Transmission
DESCRIPTION AND OPERATION

T310 Transmissions

DESCRIPTION

The T310 transmission is a member of a new family of MACK transmissions designated as MAXITORQUE® ES (T300) Series transmissions. These transmissions are the next evolution of the durable triple-countershaft transmission. New features and product enhancements have been engineered into these transmissions to provide a wide range of advantages which include the following:

- New and revised gear ratios for greater overall range and versatility
- Lower “LOs” in forward and reverse for superior site maneuvering
- Improved shift quality through the use of a new sliding clutch with a fine-pitch tooth design versus the coarse-pitch tooth design of previous transmissions
- Enhanced durability
- Weight reduction versus the previous series transmissions

The T310 transmissions are triple-countershaft units. They consist of a compact main box which houses five non-synchronized forward-speed gear sets plus a reverse gear set. The rear case of the T310 transmission is also a triple-countershaft unit. The rear case consists of Lo-range and Hi-range gear sets which are air controlled by an air shift selector located on the main shift lever.

The main case and the bell housing are a one-piece casting, made from aluminum and heat-treated for strength.

The main case also has 6- and 8-bolt openings that allow for the addition of Power Take-Off (PTO) units. PTO operation is off the (53 tooth) countershaft fifth (10th) speed gear.

The bearings are housed in cast-iron bearing retainers (covers). Tapered roller bearings are used at each end of all transmission countershafts.

All gears are of the spur-type design and are in constant mesh with mating gears. All shifting is done by forks and sliding clutches. The shift rails and forks are integral with the shift cover for the main case.

A single gear shift lever is used to shift through a standard “H” pattern. An air shift range selector, mounted on the gear shift lever, is also used for shifting the T310. The range selector directs air pressure to the compound air shift cylinder. Operating the selector causes a shift between Hi range or Lo range in the compound.

The T310 has 10 forward speeds and two reverse speeds. Each of the five forward speeds in the main case is used once with the compound in Lo range (first, second, third, fourth and fifth), and once more with the compound in Hi range (sixth, seventh, eighth, ninth and tenth). Reverse may be used in either Lo range or Hi range. See Figure 7.

The compound range shift is accomplished using a plate-type synchronizer, shifted by a range shift cylinder and a shift fork.

The six countershafts, three in the main case and three in the rear case, are equally spaced around the mainshafts. This design distributes the load equally among the countershafts, thus keeping normal deflection and gear tooth loading to a minimum.

Figure 3 — Equal Torque Distribution
DESCRIPTION AND OPERATION

Lubrication

SPASH LUBRICATION

All parts inside the transmission are lubricated by a splash-and-gravity system. To minimize churning, only the lower countershaft dips into the lubrication oil. As the gears on that countershaft spin, a constant spray of oil is directed to all internal parts of the transmission. The oil cools as it circulates over the aluminum case. Troughs and passages, cast into the inside of the case, capture and direct oil to the bearings.

Figure 4 — Splash Lubrication

TRANSMISSION CASE OIL COOLER LINE PLUGS

An integral oil cooler pump system has been developed for MACK T300 series transmissions. The oil cooler is optional for engine ratings under 400 hp and chassis ratings under 80,000 GVW. The oil cooler system is required when the engine rating is equal to or exceeds 400 hp, or the chassis rating is greater than 80,000 GVW.

On T310 transmissions that are not built with oil cooler pump systems, the tube line openings are plugged or capped. The main suction tube area contains a metal plug and the outlet fitting area receives a plastic cap.

Figure 5 — Transmission Case Oil Cooler Line Plugs

MAGNETIC OIL FILTER

A magnetic oil filter assembly is built into the right side of the main case. It consists of a magnetic plug which removes ferrous metallic particles from the passing oil. After passing the magnetic plug, the oil is channelled upward to an outlet, where it returns (by gravity) down into the transmission case sump. The magnetic plug is removable from the outside of the transmission, without the necessity of draining the oil since this plug is above the oil level. The drain plug at the bottom of the case is also magnetic.

Figure 6 — Plug Locations

1. Magnetic Filter Plug
2. Oil Temperature Sensor
3. Oil Drain Plug
4. Oil Fill and Level Plug
DESCRIPTION AND OPERATION

Gear Ratios and Shift Pattern

<table>
<thead>
<tr>
<th>Gear Position (Main Box)</th>
<th>Lo-Range Ratios</th>
<th>Hi-Range Ratios</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/6</td>
<td>13.81</td>
<td>2.67</td>
</tr>
<tr>
<td>2/7</td>
<td>10.05</td>
<td>1.94</td>
</tr>
<tr>
<td>3/8</td>
<td>7.18</td>
<td>1.39</td>
</tr>
<tr>
<td>4/9</td>
<td>5.17</td>
<td>1.00</td>
</tr>
<tr>
<td>5/10</td>
<td>3.75</td>
<td>0.73</td>
</tr>
<tr>
<td>R/R</td>
<td>14.73</td>
<td>2.75</td>
</tr>
</tbody>
</table>

Figure 7 — T310 Gear Ratios and Shift Pattern

MAIN BOX

REAR COMPOUND

AIR SHIFT RANGE SELECTOR (ON SHIFT LEVER)
DESCRIPTION AND OPERATION

T310 Shifting Instructions

CAUTION

Make sure air pressure is at least 100 psi and unit is warmed before making range shifts. Always start in Lo range. This also applies to dynamometer testing. When the truck is stationary, do NOT shift into Hi range and then start moving the truck. Otherwise, damage to the synchronizer may result. To avoid transmission damage, do not change range while in reverse.

The T310 unit is a range-shifted transmission which has 10 forward “highway” speeds. This transmission features a Lo and Hi auxiliary compound section controlled by an air shift range selector located on the shift lever. The compound section is equipped with a synchronizer to facilitate Lo-/Hi-range shifting.

The Lo range provides five low ratios. Never attempt to move the vehicle from a stopped position in any gear higher than fifth speed gear. Depending on load, grade, or road conditions, it may be necessary to start in first, second, third or fourth speed gears. In Hi range there are five forward gears that can be shifted in the standard manner. Always remember, however, to double clutch whether moving up or down through these gears. Reverse gear can be used in Lo range or Hi range.

UPSHIFTING (NORMAL HIGHWAY)

With the shift lever in neutral, flip the air shift range selector down to Lo range. Then shift the transmission into first gear. Shift up to second, third, fourth and fifth speed gears, double clutching between the gears. When maximum engine RPM has been reached in fifth gear, flip the air shift range selector up to Hi range (preselect). Then move the shift lever through neutral to sixth gear. As the shift lever passes through neutral, the transmission is placed into Hi range. Continue following the normal sequence (7-8-9-10), being sure to double clutch from one gear to the next.

DOWNSHIFTING (NORMAL HIGHWAY)

Shift from 10th speed gear down through the Hi range (9-8-7-6), double clutching through each gear. While still in sixth speed gear, flip the air shift range selector down to Lo range (preselect). Then move the shift lever through neutral to fifth speed gear. As the shift lever passes through neutral, the transmission is placed into Lo range. Then, shift down to fourth, third, second and first speed gears, double clutching between all gears.

CAUTION

- Always start in Lo range according to shift marker plate instructions. Never start in a gear higher than fifth speed gear, even when dynamometer testing.
- When the truck is stationary, do not shift into Hi range and then start moving the truck. Damage to the synchronizer can result.
- Be careful not to overspeed the engine during downshifting. Damage to powertrain components may result.
- To avoid transmission damage, do not change range while moving in reverse gear.

Power Flow Diagrams

The following illustrations show power flow through the T310 transmission in each gear range.

Figure 8 — First Speed
DESCRIPTION AND OPERATION

Figure 9 — Second Speed
Figure 10 — Third Speed
Figure 11 — Fourth Speed
Figure 12 — Fifth Speed
Figure 13 — Sixth Speed
Figure 14 — Seventh Speed
DESCRIPTION AND OPERATION

Figure 15 — Eighth Speed
Figure 16 — Ninth Speed
Figure 17 — Tenth Speed
Figure 18 — Reverse Speed (Lo)
Figure 19 — Reverse Speed (Hi)
Figure 20 — Major Component Locations for T310 Transmission

1. Main Drive Pinion Assembly
2. Main Case Shift Cover Assembly
3. Range Shift Valve Assembly
4. Compound Main Drive Gear
5. Rear Mainshaft and Synchronizer Assembly
6. Range Shift Cylinder
7. Rear Mainshaft Bearing Cover
8. Synchronizer Assembly
9. Rear Countershaft Bearing Cover
10. Rear Countershaft Assembly
11. Front Countershaft Rear Bearing Cover
12. Reverse Idler Gear
13. Front Countershaft Assembly
14. Front Mainshaft Assembly
15. Front Countershaft Front Bearing Cover
# TROUBLESHOOTING

## TROUBLESHOOTING CHARTS

### NOISY TRANSMISSION

<table>
<thead>
<tr>
<th>Probable Cause</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Low oil level</td>
<td>a. Fill to correct level.</td>
</tr>
<tr>
<td>b. Wrong oil used</td>
<td>b. Drain and refill with correct oil.</td>
</tr>
<tr>
<td>c. Side-mounted PTO installed too tight or too loose</td>
<td>c. Reinstall PTO correctly.</td>
</tr>
<tr>
<td>d. Loose bell housing-to-flywheel housing capscrews</td>
<td>d. Install new capscrews, using Loctite®.</td>
</tr>
<tr>
<td>e. Incorrect clutch-driven discs used</td>
<td>e. Install correct clutch-driven discs.</td>
</tr>
<tr>
<td>f. Gears worn, chipped, rough, cracked</td>
<td>f. Replace gears.</td>
</tr>
<tr>
<td>g. Bearings worn, cracked, corroded, galled, etc.</td>
<td>g. Replace bearings.</td>
</tr>
<tr>
<td>h. Mismatched carrier ratios</td>
<td>h. Install correct matched gearing.</td>
</tr>
<tr>
<td>i. Resonating (ringing) driveshaft</td>
<td>i. Install suitable dampening material, then high-speed balance driveshaft.</td>
</tr>
<tr>
<td>j. Driveline angles (air bags deflated)</td>
<td>j. Correct driveline angles (allow air bags to fill).</td>
</tr>
</tbody>
</table>

### HARD SHIFTING

<table>
<thead>
<tr>
<th>Probable Cause</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Incorrect driving practices</td>
<td>a. Train driver in correct driving practices.</td>
</tr>
<tr>
<td>b. Low oil level</td>
<td>b. Fill to correct level.</td>
</tr>
<tr>
<td>c. Improperly adjusted clutch, clutch linkage, clutch brake or shift linkage</td>
<td>c. Adjust properly.</td>
</tr>
<tr>
<td>d. Wrong oil used</td>
<td>d. Drain and refill with correct oil.</td>
</tr>
<tr>
<td>e. Remote shift linkage not lubricated</td>
<td>e. Clean and lubricate.</td>
</tr>
<tr>
<td>f. Shift lever binding or has interference</td>
<td>f. Relieve binding or interference.</td>
</tr>
<tr>
<td>g. Popplet balls binding in their holes</td>
<td>g. Clean holes and balls.</td>
</tr>
<tr>
<td>h. Loose setscrews in shifters or shift forks</td>
<td>h. Tighten to correct torque.</td>
</tr>
<tr>
<td>i. Worn spigot bearing</td>
<td>i. Replace bearing.</td>
</tr>
<tr>
<td>j. Clutch brake ears broken</td>
<td>j. Replace clutch brake.</td>
</tr>
<tr>
<td>k. Clutch discs worn into main drive pinion</td>
<td>k. Replace clutch discs and main drive pinion.</td>
</tr>
<tr>
<td>l. Mainshaft snap ring or thrust washer failure</td>
<td>l. Replace snap rings or thrust washers.</td>
</tr>
<tr>
<td>m. Improperly adjusted fourth/fifth eccentric pin</td>
<td>m. Adjust properly.</td>
</tr>
<tr>
<td>n. PTO engaged</td>
<td>n. Disengage PTO.</td>
</tr>
</tbody>
</table>
GEAR DISENGAGEMENT (JUMPING OUT OF GEAR)

<table>
<thead>
<tr>
<th>Probable Cause</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Excessive length and/or weight of gear shift</td>
<td>a. Replace with standard lever and/or knob.</td>
</tr>
<tr>
<td>lever and/or knob</td>
<td>b. Remove interference.</td>
</tr>
<tr>
<td>b. Shift lever interference</td>
<td>c. Adjust properly.</td>
</tr>
<tr>
<td>c. Improperly adjusted remote control linkage</td>
<td>d. Replace insulators.</td>
</tr>
<tr>
<td>d. Wear or loose mounting insulators</td>
<td>e. Replace capscrews, check threads in case.</td>
</tr>
<tr>
<td>e. Loose, broken or missing capscrews between clutch</td>
<td>f. Replace springs.</td>
</tr>
<tr>
<td>housing and flywheel housing</td>
<td>g. Replace forks.</td>
</tr>
<tr>
<td>f. Weak or broken shift rail poppet springs</td>
<td>h. Replace snap rings.</td>
</tr>
<tr>
<td>g. Bent or worn shift forks</td>
<td>i. Replace shift rail.</td>
</tr>
<tr>
<td>h. Broken snap rings</td>
<td>j. Replace sliding clutch and mating gear if clutch teeth are damaged.</td>
</tr>
<tr>
<td>i. Shift rail bent or poppet notches worn</td>
<td>k. Replace bearing.</td>
</tr>
<tr>
<td>j. Worn taper or chipped teeth on sliding clutch</td>
<td>l. Replace bearing.</td>
</tr>
<tr>
<td>teeth</td>
<td></td>
</tr>
<tr>
<td>k. Worn or damaged spigot bearing</td>
<td>m. Correct resonance.</td>
</tr>
<tr>
<td>l. Engine flywheel housing misalignment</td>
<td></td>
</tr>
<tr>
<td>m. Chassis resonant ride</td>
<td></td>
</tr>
</tbody>
</table>

OIL LEAKS

<table>
<thead>
<tr>
<th>Probable Cause</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Oil level too high</td>
<td>a. Drain to correct level.</td>
</tr>
<tr>
<td>b. Fill plug loose or O-ring defective or missing</td>
<td>b. Tighten plug or correct O-ring condition.</td>
</tr>
<tr>
<td>c. Drain plug or magnetic plug loose</td>
<td>c. Tighten plug.</td>
</tr>
<tr>
<td>d. Loose or missing capscrews</td>
<td>d. Tighten or replace.</td>
</tr>
<tr>
<td>e. Improper lubricant used</td>
<td>e. Drain and refill with correct oil.</td>
</tr>
<tr>
<td>f. Clogged breather</td>
<td>f. Clean or replace.</td>
</tr>
<tr>
<td>g. Gaskets or O-rings broken, shifted or squeezed</td>
<td>g. Replace gaskets or O-rings.</td>
</tr>
<tr>
<td>out of position</td>
<td>h. Replace seals.</td>
</tr>
<tr>
<td>i. O-rings or seals in air shift cylinder leaking</td>
<td>i. Replace O-rings or seals.</td>
</tr>
<tr>
<td>air pressure into transmission</td>
<td></td>
</tr>
</tbody>
</table>

BEARING FAILURE

<table>
<thead>
<tr>
<th>Probable Cause</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Dirt in system</td>
<td>a. Clean system, replace bearings as needed, flush and refill with clean oil.</td>
</tr>
<tr>
<td>b. Wrong grade of oil or contaminated oil</td>
<td>b. Clean system, replace bearings as needed, flush and refill with clean oil.</td>
</tr>
<tr>
<td>c. Excessive vibrations</td>
<td>c. Eliminate vibrations, replace bearings.</td>
</tr>
<tr>
<td>d. Binding or seized propeller shaft slip yoke</td>
<td>d. Clean and replace as needed.</td>
</tr>
<tr>
<td>e. Improper bearing clamping</td>
<td>e. Replace bearings and reclamp using correct procedures.</td>
</tr>
<tr>
<td>f. Improper bearing installation (preloads, etc.)</td>
<td>f. Replace using correct procedures.</td>
</tr>
</tbody>
</table>
### TROUBLESHOOTING

#### AIR SHIFT MALFUNCTIONS

<table>
<thead>
<tr>
<th>Probable Cause</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Low system air pressure</td>
<td>a. Wait for pressure to build back up to normal.</td>
</tr>
<tr>
<td>b. Restricted or clogged air filter in range shift valve</td>
<td>b. Replace air filter.</td>
</tr>
<tr>
<td>c. Restricted air line (bent, squeezed, twisted, etc.)</td>
<td>c. Re-route and/or replace air lines</td>
</tr>
<tr>
<td>d. Air lines too small</td>
<td>d. Replace with correct size air lines.</td>
</tr>
<tr>
<td>e. Defective O-rings in air shift cylinder</td>
<td>e. Replace O-rings.</td>
</tr>
<tr>
<td>f. Scored air shift cylinder or piston</td>
<td>f. Repair or replace cylinder or piston.</td>
</tr>
<tr>
<td>g. Defective range shift valve and/or air shift selector valve (on shift lever)</td>
<td>g. Repair or replace cylinder or piston.</td>
</tr>
<tr>
<td>h. Defective synchronizer</td>
<td>h. Repair or replace as needed.</td>
</tr>
<tr>
<td>i. Incorrect driving practices (not preselecting)</td>
<td>i. Train driver in correct driving practices.</td>
</tr>
<tr>
<td>j. Range synchronizer friction discs worn or burned</td>
<td>j. Replace synchronizer discs as needed.</td>
</tr>
<tr>
<td>k. Intermixed synchronizer parts</td>
<td>k. Install matched parts.</td>
</tr>
</tbody>
</table>
TRANSMISSION MAINTENANCE

Checking Oil Level

**NOTE**
Perform oil level check when the oil is at operating temperature. The vehicle must be in a level position, both front-to-rear and side-to-side.

- Check the transmission oil level at the intervals specified in the Maintenance and Lubrication Manual (TS494).
- To check the oil level in the transmission, first remove the filler plug (2) from the right side of the main case.

![Figure 21 — Oil Filler and Check Plug](image)

- The oil must be level with the bottom of the filler plug hole as determined by feel or by visual inspection.

**WARNING**
Be careful not to burn your finger in hot gear oil when checking the oil level in the transmission.

- Add specified make-up oil, if needed, until the oil is level with the bottom of the filler plug hole. Do NOT overfill. Use oil of the proper specification. MACK-approved gear oils can be found on the internet at www.macktrucks.com.
- Reinstall and tighten the oil filler plug (Figure 21) as follows:
  1. Check that the O-ring on the plug is not cut or damaged. Replace as necessary.
  2. Install the plug and tighten to 35–50 lb-ft (47–68 N·m) torque.

![Figure 22 — Correct Oil Level](image)

- If oil can only be felt by reaching the finger down into the unit, the oil level is too low.

![Figure 23 — Incorrect Oil Level](image)
MAINTENANCE

Changing Oil

Preserve the environment! Drained gear oil is classified as a hazardous toxic material which must be recovered, handled, stored and disposed of according to applicable State or Federal guidelines.

Change Interval

- Change the oil at intervals specified in the Maintenance and Lubrication Manual (TS494).

Draining Oil

- Before draining oil from the transmission, the oil should be at normal operating temperature.
- Remove the magnetic drain plug from the bottom of the transmission main case and drain the hot oil into an industry-approved recovery container.
- Clean and replace the magnetic drain plug, then torque the plug to 25–30 lb-ft (34–41 N·m).

Figure 24 — Plug Locations

1. Magnetic Filter Plug
2. Oil Temperature Sensor
3. Oil Drain Plug
4. Oil Fill and Level Plug

Oil Fill

- Remove the oil filler plug (2) (Figure 25), then fill the transmission using specified oil until the oil is level with the bottom of the filler plug hole (also see Figure 22). Do NOT overfill.

NOTE

MACK-approved lubricants can be found on the internet at www.macktrucks.com, then click on the Parts and Service category.

- Reinstall and tighten the oil filler plug as follows:
  1. Check that the O-ring on the plug is not cut or damaged. Replace as necessary.
  2. Install the plug and tighten to 35–50 lb-ft (47–68 N·m) torque.

Figure 25 — Oil Filler and Check Plug

1. Magnetic Filter Plug (Not for Level Check)
2. Oil Filler and Level Plug

CAUTION

Be sure to add oil to the transmission through the filler hole, NOT the magnetic filter plug hole. Damage to the transmission and seals can occur due to overfilling. The magnetic oil filter hole is higher on the transmission case than the filler hole.
MAINTENANCE

Magnetic Oil Filter Plug
Remove the magnetic oil filter plug and clean the magnet in the plug every time the oil is changed. Reinstall the magnetic plug. Tighten the plug to 20–23 lb-ft (27–31 N·m) torque.

Air Breather
The T310 has one air breather located on the main case shift cover. The air breather should be removed and cleaned with a suitable solvent every time the oil is changed. Also check to be sure that airflow through the breather is unobstructed. Reinstall breather into the main case shift cover and tighten until snug.
REPAIR INSTRUCTIONS

TRANSMISSION DISASSEMBLY PROCEDURES [320]

NOTE
Unless a complete overhaul is necessary, remove only those parts required to gain access to faulty parts. Do not disturb parts with a heavy press fit (interference fit) unless replacement is necessary. When replacement is necessary, use proper press setups and pullers to protect usable parts from damage.

NOTE
External inspection of the unit before cleaning and disassembly often reveals information about existing operating conditions. This may help when diagnosing problems.

SERVICE HINT
During disassembly, remember the sequence in which components and individual parts are removed from the transmission. It is good practice to keep related parts together in groups when removed. Small parts such as shims and spacers can be wired to the larger pieces with which they belong. Groups of parts can be kept together in boxes.

SERVICE HINT
Keep parts such as shim packs, bearing cones, bearing retainers (covers), bearing cups and gears with the original countershaft from which they are removed. Mark each countershaft and bearing cover before removal. Mark the upper left front and rear countershafts and bearing covers (viewed from rear) as number 1. Mark the upper right front and rear countershafts and bearing covers (viewed from rear) as number 2. Mark the lower front and rear countershafts and bearing covers as number 3.

1. Clean the transmission externally and mount it in an overhaul stand. Drain the lubricant and plug any air line openings to prevent dirt from entering.

NOTE
Lift and move the transmission with a hoist, using the two lifting brackets provided.

2. Disconnect the air lines attached to the range shift valve and the range shift cylinder. Air lines are installed using a push/pull type fitting and are best removed using tool kit 9032-1800trk which can be obtained through the MACK parts system. Disconnect the air lines using the following procedure:
   a. Select the appropriate size release tool from kit 9032-1800trk.

Figure 26 — Air Line Release Tools
b. Insert the tool over the air line and release the lines from the fittings by pushing in toward the fitting and at the same time, pulling on the hose.

5. Remove the range shift valve, interlock sleeve, spring, pin and O-ring from the main case shift cover.

3. Label all disconnected air lines for proper reassembly.

4. Using the appropriate tools, remove the range shift valve 5/32 Allen-head screws (outer) and capscrews (inner).
6. Remove the clutch release bearing assembly, shafts, yoke and clutch brake (if equipped).

7. With transmission in neutral, remove the main case shift cover capscrews.

8. Remove the main case shift cover assembly and cover gasket.

9. Remove the rear case top cover capscrews.

10. Remove the rear case top cover. Carefully scrape RTV sealant from around top cover opening.
To remove the drive yoke bolt, place at least two gears in both the main case and the rear case into engagement. This will lock the transmission gearing and prevent it from rotating while removing the yoke bolt.

11. Reach through the rear case top opening and verify that the synchronizer assembly sliding clutch is engaged.

12. Reach into the main case top opening and move at least two sliding clutches into engagement. This locks two different gears to the main shaft and prevents the gears and shaft of the transmission from rotating.

13. Remove the drive yoke or drive flange by separating the capscrew and clamp plate.

14. Remove the drive yoke, using a suitable puller such as J 07804-A or equivalent.

15. Shift the transmission gears into neutral. Verify that the transmission is in neutral.

16. If not already done, disconnect the air lines from the range shift cylinder. Label air lines for correct installation during assembly.
REPAIR INSTRUCTIONS

17. Remove the shift fork locking bolt.

18. Remove the four bolts that secure the shift cylinder to the rear case.

19. Remove the shift cylinder cover and O-ring.

20. While holding the shift fork, slide the shift cylinder from the rear of the transmission. Remove the shift cylinder-to-rear case gasket.

NOTE
To help remove the shift cylinder, use a plastic mallet to lightly tap on the piston to loosen the shift rail from the fork.
21. Remove the range shift cylinder gasket and discard.

22. Number the front countershaft front bearing covers and the rear countershaft rear bearing covers, using a grease pencil. Write number 1 on the upper right front cover (viewed from front), number 2 on the upper left front cover (viewed from front) and number 3 on the lower front cover. Write number 1 on the upper left rear cover (viewed from rear), number 2 on the upper right rear cover (viewed from rear) and number 3 on the lower rear cover.

23. Remove all of the rear countershaft bearing cover capscrews.
24. Remove the jackscrew plugs from the covers.

25. Remove the rear countershaft bearing covers, shims and O-rings. Jackscrew holes are provided to assist removal.

26. Mark the rear countershafts as shown in Figure 46 so they can be installed in the same position during reassembly. Refer to Figure 42 for number locations.

27. Remove the rear mainshaft bearing cover capscrews. Remove the jackscrew plugs from the cover.

**NOTE**
Pry the plugs loose using a thin knife-edge or similar tool. Do not cut through plugs during removal. Save for reuse, or replace if necessary.
28. Remove the rear mainshaft bearing cover. Jackscrew holes are provided to assist in removal.

29. With the transmission in a vertical position (rear case upward), remove the two capscrews located inside the rear case.

30. Remove the remaining capscrews and dowel bolts holding the rear case to the main case.

**NOTE**

Tap dowel bolts out of the rear case using a brass hammer or a combination of a brass hammer and a steel hammer, as long as contact is made with the brass hammer only.

---

**WARNING**

When separating the rear case from the front case, make sure the transmission is in the vertical position. The rear countershafts are not supported when the case is removed. They can fall out and cause damage or personal injury.
REPAIR INSTRUCTIONS

Figure 52 — Removing Inner Rear Case-to-Main Case Capscrews

31. Lift the rear case from the front case. Lift only the case, not the compound gear set or output shaft. Tap on the output shaft to loosen it if necessary.

Figure 53 — Removing Rear Case

Figure 54 — Rear Countershaft Bearing Overhang

NOTE

Due to the relatively small size of the rear countershaft Lo gear, it is necessary to first remove each rear countershaft rear bearing cone to allow removal of the rear mainshaft. The rear countershaft bearings overhang the rear mainshaft Lo gear as shown in Figure 54. This bearing overhang prevents mainshaft removal if the bearings are not removed first.

WARNING

Be sure unit is vertical, so that the countershafts will not fall out when the case is removed.
32. Using a suitable puller arrangement, such as two jaw puller J 21834-4A and bearing separator J 8176 or equivalent, remove all three rear countershaft rear bearing cones.

33. Remove the synchronizer and rear mainshaft assembly from the main drive gear. Allow the Hi-range (forward) synchronizer plates and backing plate to remain on the main drive gear.

**Figure 55 — Removing Rear Countershaft Rear Bearing Cone**

**Figure 56 — Removing Synchronizer and Output Shaft**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Main Drive Gear Backing Plate</td>
</tr>
<tr>
<td>2</td>
<td>Hi-Range Synchronizer Plates</td>
</tr>
</tbody>
</table>
34. Remove the Hi-range synchronizer plates, and the main drive gear backing plate.

35. Mark the rear countershafts (if not already done) so that they can be installed in the same location during installation.

**NOTE**

Notice the gear timing marks. If no timing marks are present, use white paint to mark the gears in three equally spaced marks on the mainshaft. The countershaft mating gear teeth must be marked in alignment with the shaft keyway. Mark the mainshaft main drive gear-to-countershaft gears.

**Figure 57 — Removing Hi-Range Synchronizer Plates**

**Figure 58 — Removing Main Drive Gear Backing Plate**

**Figure 59 — Main Drive Gear-to-Countershaft Timing**

1. Lower Countershaft (No. 3)
2. Upper Left Countershaft (No. 1)
3. Upper Right Countershaft (No. 2)
4. Main Drive Gear-to-Countershaft Timing Marks
36. Remove the three rear countershafts from the rear of the transmission.

37. Remove the snap ring from inside the compound main drive gear.

To help in removing the compound main drive gear snap ring, use a pry bar to slightly lift the front mainshaft during removal. This allows more clearance and frees the snap ring from the snap ring groove.

38. Remove the compound main drive gear retaining plate capscrews.

39. Remove the compound main drive gear retaining plate.
40. Remove the compound main drive gear (with ball bearing) and the spacer from the front mainshaft.

41. Using suitable snap ring pliers, remove the mainshaft snap ring directly behind the previously removed spacer.

42. Mark the front countershaft rear bearing covers and front countershafts for correct placement during reassembly.

**NOTE**

If not already done, use a grease pencil to number the front countershaft rear bearing covers. Write number 1 on the upper left rear cover (viewed from rear), number 2 on the upper right rear cover (viewed from rear), and number 3 on the lower rear cover. Also, mark the front countershafts (use the same numbers and locations indicated above) so that they can be installed in the same position during reassembly.
43. Position the transmission case horizontally. Remove the main drive pinion bearing cover capscrews.

44. Remove the main drive pinion bearing assembly. Jackscrew holes are provided to assist in removal.

45. Remove main drive pinion bearing assembly from the case.

46. Remove the exposed sliding clutch.
47. Remove the No. 2 (upper left) front countershaft front bearing cover cap screws.

48. Using jackscrews, remove the No. 2 (upper left) front countershaft front bearing cover.

49. Remove the No. 2 (upper right) front countershaft rear bearing cover cap screws.
50. Remove the No. 2 (upper right) front countershaft rear bearing cover, using jackscrews. Remove shim with cover.

51. Using a pry bar, move the mainshaft rearward in the case to relieve pressure on the snap rings and free mainshaft gears from countershaft gears.

52. Remove the No. 2 countershaft (upper right, as viewed from rear) from the case.

53. Using tool J 34630 or a slide hammer, remove the upper right reverse idler shaft (next to No. 2 countershaft location). To prevent damage to the reverse idler gear, catch the gear as it separates from the shaft.

**SERVICE HINT**

Removal is easier if the transmission is in the vertical position.
54. Remove the No. 1 (upper left) front countershaft rear bearing cover capscrews.

55. Using jackscrews, remove the No. 1 (upper left) front countershaft rear bearing cover. Remove shims with cover.

56. Using tool J34630 or a slide hammer, remove the upper left reverse idler shaft (next to No. 1 countershaft). To prevent damage to the reverse idler gear, catch the gear as it separates from the shaft.

57. Remove the snap ring from inside the reverse speed gear.

58. Remove the external-toothed and internal-toothed thrust washers from inside the reverse speed gear.
59. Remove the reverse gear mainshaft snap ring.

60. From top of case, slide the reverse gear and reverse/first sliding clutch forward.

61. Using a pry bar, move the rear end of the No. 1 (upper left) countershaft away from the mainshaft as far as possible without damaging the bearing. Block the countershaft in this position, using wadding made from rags.

62. Tip the front end of the mainshaft outward and remove it from the case.

**NOTE**

The reverse gear is free on the mainshaft and can fall off when handling the mainshaft assembly.
63. Remove the No. 3 (lower) front countershaft rear bearing cover capscrews.

64. Using jackscrews, remove the No. 3 (lower) front countershaft rear bearing cover. Remove shims with cover.

65. Using tool J 34630 or a slide hammer, remove the lower reverse idler shaft (next to No. 3 countershaft). To prevent damage to the reverse idler gear, catch the gear as it separates from the shaft.

66. Remove the No. 1 (upper left) front countershaft by pulling and tilting the front end of the shaft upward.

67. Remove the No. 3 (lower) countershaft by pulling and tilting the front end of the shaft upward.

68. Remove the remaining No. 1 (upper right, viewed from front) and No. 3 (lower) front countershaft front bearing cover capscrews and bearing covers. Use jackscrews to remove the covers.
TRANSMISSION COMPONENT DISASSEMBLY [320]

NOTE

Unless a complete overhaul is necessary, remove only the parts that are required to repair the assembly. Do not disturb parts that have a heavy press fit (interference fit) unless replacement of the part is necessary. When replacement is necessary, use proper pullers and press setups to prevent damage to usable parts.

Main Case Shift Cover Disassembly [323]

Figure 92 — Main Case Shift Cover Component Locator

Figure 93 — Shift Cover Assembly
Figure 94 — Exploded View of Main Case Shift Cover

1. 4th/5th Shift Fork
2. 2nd/3rd Shift Fork
3. 1st/Reverse Shifter
4. Shifter Body Spring (Interlock)
5. Shifter Body Plunger (Interlock)
6. 1st/Reverse Shift Fork
7. 4th/5th Shifter
8. 4th/5th Rocker Pin
9. Washer
10. 4th/5th Rocker Arm
11. Bushing
12. Washer
13. Interlock Pin
14. Poppet Ball
15. Poppet Ball Spring
16. Interlock Rocker Hardware
17. Interlock Sleeve and O-Ring
18. Interlock Spring
19. 4th/5th Rocker Pin Hardware
20. Interlock Rocker
21. Interlock Rocker Bolt
22. Pipe Plug
23. Breather
24. Interlock Pin
25. Interlock Ball
26. 1st/Reverse Shift Rail
27. 2nd/3rd Shift Rail
28. Interlock Ball
29. Interlock Pin
30. Interlock Ball
31. 4th/5th Shift Rail
32. 1st/Reverse Shifter Ball
33. 1st/Reverse Shifter Spring
1. Remove the nut and washers from the interlock rocker bolt.

2. Remove the interlock rocker and bolt from the cover.

3. Remove the interlock ball from the cover.

4. Remove the setscrew from the first/reverse shift fork.
REPAIR INSTRUCTIONS

5. Remove the setscrew from the first/reverse shifter.

6. Slide the first/reverse shift rail to the left and remove the interlock pin.

Figure 99 — Removing Setscrew from First/Reverse Shifter

Figure 100 — Sliding First/Reverse Shift Rail
REPAIR INSTRUCTIONS

7. Remove the first/reverse shift fork from the cover.

8. Push the first/reverse shift rail forward, using a metal bar or large screwdriver. Hold a shop towel over the top opening. The shop towel prevents the spring and ball under the rail from popping out and becoming lost.

**WARNING**

Poppet balls are spring loaded and may cause injury when released.
9. Remove the poppet ball and spring from the first/reverse shift rail vertical pocket in line with the rail.

**SERVICE HINT**
A magnet is helpful in removing the poppet ball and spring.

10. Remove the interlock ball from the horizontal pocket between the first/reverse shift rail and the second/third shift rail.

![Figure 103 — Removing Poppet Ball and Spring](image1)

![Figure 104 — Removing Interlock Ball](image2)
11. Continue sliding the first/reverse shift rail forward to remove the first/reverse shifter.

12. Slide the first/reverse shift rail from the shift cover and at the same time, remove the fourth/fifth shift fork.
13. Remove the setscrew from the second/third shift fork.

14. Push the second/third shift rail forward, using a metal bar or large screwdriver. Hold a shop towel over the top opening. The shop towel prevents the spring and ball under the rail from popping out and becoming lost.

**WARNING**

Poppet balls are spring loaded and can cause injury when they are released.
15. Remove the poppet ball and spring from the second/third shift rail vertical pocket in line with the rail.

**SERVICE HINT**

A magnet is helpful in removing the poppet ball and spring.

16. Remove the interlock ball from the horizontal pocket between the second/third shift rail and the fourth/fifth shift rail.

![Figure 109 — Removing Poppet Ball and Spring](image1.png)

![Figure 110 — Removing Interlock Ball](image2.png)
17. Remove the interlock pin from the second/third shift rail.

18. Slide the second/third shift rail further forward and remove the second/third shift fork.

19. Continue sliding the second/third shift rail until it clears the cover.
20. Remove the setscrew from the fourth/fifth shifter.

21. Push the fourth/fifth shift rail forward using a metal bar or large screwdriver. Hold a shop towel over the top opening. The shop towel prevents the spring and ball under the rail from popping out and becoming lost.

**WARNING**

Poppet balls are spring loaded and can cause injury when they are released.

22. Continue sliding the fourth/fifth shift rail forward out of the shift cover. At the same time, remove the fourth/fifth shifter.
23. Remove the poppet ball and spring from under the fourth/fifth shift rail.

**SERVICE HINT**

A magnet is helpful in removing the poppet ball and spring.

24. Remove the poppet ball and spring and interlock plunger and spring from the first/reverse shifter.

25. Remove the reverse light switch from the shift cover.
26. Remove the reverse light switch rod.

27. Remove the nut and washers from the fourth/fifth rocker pin.

Figure 120 — Removing Reverse Light Switch Rod

Figure 121 — Loosening Fourth/Fifth Rocker Pin Nut
28. Remove the fourth/fifth rocker pin and rocker arm.

29. Remove the shift cover breather vent.
Two-Position Range Shift Cylinder
Disassembly [324]

1. With the range shift cylinder in hand, tap the end of the piston shift rail on a firm surface to begin removal of the piston/shift rail assembly.

2. Continue moving the piston/shift rail out of the cylinder housing to completely separate the piston/shift rail from the housing. Using a small screwdriver, remove the Teflon® seal and O-ring from the shift rail bore inside the cylinder housing.
3. Remove the wiper ring from the piston groove.

4. Using a small screwdriver, remove the Teflon® seal and O-ring expander from the second piston groove.

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**Range Shift Valve [323]**

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**Figure 129 — Removing Wiper Ring from Piston Groove**

**Figure 130 — Removing Teflon® Seal and O-Ring from Piston Grooves**

**Figure 131 — Range Shift Valve Component Locator**

**Figure 132 — Exploded View of Range Shift Valve Assembly**

1. 4 mm Screw
2. Top Cover Seal
3. Top Cover
4. Sintered Bronze Filter
5. Silicone Rubber O-Ring
REPAIR INSTRUCTIONS

1. Remove the four (4 mm) interlock valve top cover screws.

2. Separate cover from valve housing and remove sintered bronze filter and silicone rubber O-ring.

   **NOTE**
   The sintered bronze filter is the only part that is serviceable on the range shift valve. Replace the range shift valve as an assembly if any internal component has failed or if the valve has become contaminated.

3. Inspect top cover gasket and replace as necessary.
REPAIR INSTRUCTIONS

Main Drive Pinion Disassembly

1. Remove the gasket from the main drive pinion bearing cover.

2. Remove the spiral snap ring from the end of the main drive pinion shaft, inside the main drive pinion gear. Roll the snap ring out of the groove and over the shoulder of the main drive pinion, using a flat-blade screwdriver.

NOTE

The action of removing the snap ring may destroy the snap ring. Make sure a replacement snap ring is available.
3. Remove the main drive pinion gear by lifting it straight up.

4. Remove the spigot bearing snap ring from the main drive pinion, using suitable snap ring pliers.

5. Remove the spigot bearing from inside the end of the main drive pinion shaft.

6. Remove the main drive pinion cover bearing snap ring, using suitable snap ring pliers.

**WARNING**

The large snap ring is very difficult to compress and remove, and may fly off the snap ring pliers, causing injury.
REPAIR INSTRUCTIONS

7. Separate the main drive pinion shaft and bearing assembly from the main drive pinion bearing cover.

8. Remove the spiral snap ring securing the bearing to the main drive pinion shaft. Using a small flat-blade screwdriver, roll the spiral snap ring out of the groove until released.

9. Place the main drive pinion shaft and bearing into a suitable press and remove the bearing.

NOTE

The action of removing the spiral snap ring may destroy the snap ring. Make sure a replacement snap ring is available.

Figure 143 — Removing Main Drive Pinion Shaft and Bearing from Cover

Figure 144 — Removing Spiral Snap Ring from Main Drive Pinion

Figure 145 — Pressing Bearing off Main Drive Pinion Shaft
10. Thoroughly clean the bearing and inspect for damage.

11. Remove the oil seal from the main drive pinion bearing cover, using a hammer and a blunt punch.

**NOTE**

Removing the oil seal destroys the seal. Make sure a replacement oil seal is available.

The splines on the mainshaft are usually not aligned for the whole length of the shaft. The recommended procedure is to remove the second, third and fifth speed gears, gear thrust washers and snap rings, and second/third sliding clutch from the front of the shaft (parts shown to the left of the arrows). Remove the remaining reverse and first speed gears and components from the rear of the shaft (parts shown to the right of the arrows).
REPAIR INSTRUCTIONS

Figure 149 — Exploded View of Front Mainshaft

1. Mainshaft Snap Ring
2. Internal-Toothed Thrust Washer
3. Fifth (10th) Speed Gear
4. External-Toothed Thrust Washer
5. Gear Snap Ring
6. Spigot-Bearing Inner Race Snap Ring
7. Spigot-Bearing Inner Race
8. Front Mainshaft
9. Spigot Bearing
10. Spigot Bearing Snap Ring
11. Third (8th) Speed Gear
12. Gear Snap Ring
13. External-Toothed Thrust Washer
14. Internal-Toothed Thrust Washer
15. Mainshaft Snap Ring
16. Sliding Clutch
17. Mainshaft Snap Ring
18. Internal-Toothed Thrust Washer
19. Second (7th) Speed Gear
20. External-Toothed Thrust Washer
21. Gear Snap Ring
22. Gear Snap Ring
23. External-Toothed Thrust Washer
24. First (6th) Speed Gear
25. Internal-Toothed Thrust Washer
26. Mainshaft Snap Ring
27. Sliding Clutch
28. Mainshaft Snap Ring
29. Internal-Toothed Thrust Washer
30. Reverse Speed Gear
31. External-Toothed Thrust Washer
32. Gear Snap Ring
33. Mainshaft Snap Ring
34. Spacer
REPAIR INSTRUCTIONS

1. If not already done, remove the reverse speed gear mainshaft snap ring, using suitable snap ring pliers (fifth snap ring groove from the front of the mainshaft).

2. Slide the reverse gear off the mainshaft.

3. Remove the first/reverse sliding clutch from the mainshaft.

4. Using suitable snap ring pliers, remove the snap ring retaining the first (6th) speed gear to the mainshaft (fourth groove from the front of the mainshaft).
5. Remove the internal- and external-toothed thrust washers from inside the first (6th) speed gear.

6. Slide first (6th) speed gear from mainshaft.

7. Using suitable snap ring pliers, remove the snap ring from the outside groove, inside the first (6th) speed gear.

8. Working at the opposite end of the mainshaft and using suitable snap ring pliers, remove the snap ring that retains the fifth (10th) speed gear to the mainshaft (first groove from the front of the mainshaft).

9. Remove the internal- and external-toothed thrust washers and fifth (10th) speed gear from the mainshaft.
REPAIR INSTRUCTIONS

10. Remove the snap ring from inside the fifth (10th) speed gear.

![Figure 158 — Removing Snap Ring Inside Fifth Speed Gear](image1)

11. Slide the third (8th) speed gear from the mainshaft and remove the snap ring from inside the gear, using suitable snap ring pliers.

![Figure 159 — Removing Third Speed Gear](image2)

12. Remove the third (8th) speed gear external- and internal-toothed thrust washers.

![Figure 160 — Removing Third Speed Gear External- and Internal-Toothed Thrust Washers](image3)

13. Using suitable snap ring pliers, remove the third (8th) speed gear mainshaft snap ring (second groove from the front of the mainshaft).

![Figure 161 — Removing Third Speed Gear Mainshaft Snap Ring](image4)
14. Remove the second/third sliding clutch from the mainshaft. Slide straight off splines.

15. Using suitable snap ring pliers, remove the second (7th) speed gear mainshaft snap ring (third groove from the front of the mainshaft).

16. Remove the second (7th) speed gear internal- and external-toothed thrust washers.

17. Remove the second (7th) speed gear from the mainshaft. Slide straight off the shaft.
18. Remove the second (7th) speed gear snap ring, using suitable snap ring pliers.

19. Remove the snap ring that retains the spigot bearing inner race to the mainshaft, using suitable snap ring pliers.

20. Remove the spigot bearing inner race, using a suitable puller.

21. If inspection reveals the need to remove and replace the spigot bearing (rear end of shaft), first remove the snap ring and then the bearing.
REPAIR INSTRUCTIONS

Rear Mainshaft and Synchronizer Disassembly [322]

1. Remove the synchronizer assembly from the rear mainshaft.

2. Remove the reaction discs and the friction discs from inside the Lo-range gear.

1. Synchronizer Assembly
2. Reaction Discs
3. Friction Discs
4. Snap Ring
5. Lo-Range Gear
6. Snap Ring
7. Internal-Toothed Thrust Washer
8. Lo-Range Gear Hub
9. Snap Ring
10. Spigot Bearing Inner Race
11. Rear Mainshaft
3. Remove the spiral snap ring securing the Lo-range gear to the Lo-range gear hub and then remove the Lo-range gear.

4. Remove the snap ring from inside the Lo-range gear hub.

5. Remove the gear hub thrust washer from the rear mainshaft.
REPAIR INSTRUCTIONS

6. Remove the Lo-range gear hub from the rear mainshaft.

8. Press the spigot bearing inner race off the front end of the rear mainshaft using bearing separator J 22912-01 or equivalent.

7. Remove the spigot bearing inner race snap ring from the front of the rear mainshaft.

Figure 178 — Removing Lo-Range Gear Hub

Figure 179 — Removing Snap Ring

Figure 180 — Removing Snap Ring
REPAIR INSTRUCTIONS

Synchronizer Disassembly [322]

1. Remove the 12-point screws and threaded and nonthreaded inserts from the synchronizer assembly.

2. Remove the clutch housing from the assembly.

3. Remove the three support tubes and preload springs from the synchronizer assembly.

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1. 12-Point Screw
2. Nonthreaded Insert
3. Clutch Housing
4. Synchronizer Pin
5. Sliding Clutch
6. Synchronizer Pin
7. Clutch Housing
8. Threaded Insert
9. Support Tube
10. Preload Spring
REPAIR INSTRUCTIONS

4. Remove the sliding clutch from the remaining clutch housing.

**NOTE**

As you remove the synchronizer sliding clutch and pins, notice that the pins and the sliding clutch are marked with the letter "R", which stands for "Rear." All the R marks on either end of the pins are placed on the same side of the sliding clutch marked with the letter R. During reassembly, make sure to coordinate all R marks on both the pins and sliding clutch of the synchronizer assembly. All R marks must face the rear of the transmission when installed.

5. Remove the synchronizer pins from the remaining clutch housing.

**Figure 185 — Letter "R" on Sliding Clutch and Synchronizer Pins**

1. "R" on Sliding Clutch, Faces Rearward
2. "R" on Synchronizer Pins, Faces Rearward

6. Thoroughly clean the synchronizer assembly and inspect for damage.
**REPAIR INSTRUCTIONS**

**Rear Mainshaft Bearing Cover**

**Disassembly [321]**

1. Remove the gasket from the bearing cover.
2. Remove the snap ring securing the bearing in the rear mainshaft bearing cover, using suitable snap ring pliers.

![Figure 187 — Rear Mainshaft Bearing Component Locator](image1)

![Figure 189 — Removing Snap Ring from Rear Mainshaft Bearing Cover](image2)

3. Remove the bearing from the rear mainshaft bearing cover, using a suitable puller.

![Figure 188 — Exploded View of Rear Mainshaft Bearing Cover](image3)

![Figure 190 — Removing Bearing from Bearing Cover](image4)
4. Remove the oil seal from the rear mainshaft bearing cover, using a hammer and blunt punch. Drive the seal out from the opposite side. Discard the cover gasket.

![Using Hammer and Blunt Punch to Remove Oil Seal](image1)

**Figure 191 — Using Hammer and Blunt Punch to Remove Oil Seal**

**NOTE**

This action destroys the oil seal. Make sure a replacement oil seal is readily available.

5. Thoroughly clean the rear mainshaft bearing and bearing cover, and inspect for damage.

**Compound Main Drive Gear Disassembly [322]**

![Compound Main Drive Gear Component Locator](image2)

**Figure 192 — Compound Main Drive Gear Component Locator**

2. Thoroughly clean the main drive gear and bearing and inspect for damage.

![Exploded View of Compound Main Drive Gear](image3)

**Figure 193 — Exploded View of Compound Main Drive Gear**

1. Press the bearing off the main drive gear, using a suitable press tool.

![Pressing off Bearing](image4)

**Figure 194 — Pressing off Bearing**
REPAIR INSTRUCTIONS

Front Countershaft Front Bearing Cover Disassembly [321]

The following disassembly procedure applies to all front countershaft front bearing covers.

1. Remove the O-ring from the shoulder of the front countershaft front bearing cover.

2. Remove the bearing cone from the front countershaft front bearing cover, using a suitable puller.

3. Thoroughly clean the bearing cover and inspect for damage.
Front Countershaft Disassembly

The following disassembly procedure applies to all three front countershafts.

**DANGER**

The reverse, first and second speed gears on the countershaft must be pressed off the rear end of the shaft. The forward end of the shaft is slightly larger in diameter than the rear. If you try to press any of these gears on or off the forward end of the shaft, the gears can crack, and may fragment explosively, spraying metal pieces outward. This can cause severe injury or death.

1. Press the front countershaft main drive gear off the front of the countershaft.

---

**Figure 199 — Front Countershaft Component Locator**

**Figure 200 — Exploded View of Front Countershaft**

**Figure 201 — Pressing Main Drive Gear off Shaft**

<table>
<thead>
<tr>
<th>1. Bearing Cup</th>
<th>8. Bearing Cone</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Main Drive Gear</td>
<td>9. Reverse Speed Gear</td>
</tr>
<tr>
<td>3. Fifth (10th) Speed Gear</td>
<td>10. Spacer — Rear</td>
</tr>
<tr>
<td>4. Third (8th) Speed Gear</td>
<td>11. First (6th) Speed Gear</td>
</tr>
<tr>
<td>5. Spacer — Front</td>
<td>12. Second (7th) Speed Gear</td>
</tr>
<tr>
<td>6. Front Countershaft</td>
<td>7. Key</td>
</tr>
</tbody>
</table>
2. Press the fifth (10th) speed gear off the front of the countershaft.

3. Press the front countershaft third (8th) speed gear off the front of the countershaft.

Figure 202 — Pressing Fifth Speed Gear off Shaft

Figure 203 — Pressing Third Speed Gear off Shaft
4. Remove the front spacer located between the third and second speed gears from the shaft.

5. Press the reverse gear and rear bearing cone off the rear end of the countershaft.

6. In a similar manner, press off the first (6th) and second (7th) speed gears from the rear of the countershaft. The previous warning also applies when pressing these gears off the countershaft.

7. Remove the key from the keyway of the front countershaft.

**DANGER**

The reverse, first and second speed gears on the countershaft must be pressed off the rear end of the shaft. The forward end of the shaft is slightly larger in diameter than the rear. If you try to press any of these gears on or off the forward end of the shaft, the gears can crack, and may fragment explosively, spraying metal pieces outward. This can cause severe injury or death.

Figure 204 — Removing Spacer

Figure 205 — Pressing off Reverse Gear and Rear Bearing Cone

Figure 206 — Removing Key
8. Remove the bearing cup from the front countershaft main drive gear, using a suitable puller.

Front Countershaft Rear Bearing Cover Disassembly [321]

Figure 207 — Removing Bearing Cup from Main Drive Gear

Figure 208 — Front Countershaft Rear Bearing Cover Component Locator

Figure 209 — Exploded View of Front Countershaft Rear Bearing Cover

| 1. Front Bearing Cup | 2. Bearing Cover | 3. Rear Bearing Cup |
REPAIR INSTRUCTIONS

1. Remove the front and rear bearing cups from the front countershaft rear bearing cover.

**Figure 210** — Removing Front Bearing Cup

2. Thoroughly clean the bearing cover and inspect for damage.

**Figure 211** — Removing Rear Bearing Cup

**Figure 212** — Rear Countershaft Component Locator

**Figure 213** — Exploded View of Rear Countershaft

- 1. Front Bearing Cone
- 2. Main Drive Gear
- 3. Key
- 4. Rear Bearing Cone
- 5. Rear Countershaft (Lo-Range Gear Integral with Shaft)

**DANGER**

*Do not attempt to press-remove the Lo-range gears off these rear countershafts. This gear is integral with the shaft and could fragment explosively when pressing action is attempted.*
1. If not previously done at disassembly, press the rear bearing cone off the rear countershaft.

2. Press the rear countershaft main drive gear and the front bearing cone off the countershaft.

3. Remove the key from the keyway of the rear countershaft.

---

Figure 214 — Pressing off Rear Bearing Cone

Figure 215 — Pressing off Gear and Bearing

Figure 216 — Removing Key
REPAIR INSTRUCTIONS

Rear Countershaft Bearing Cover
Disassembly [321]

The following disassembly procedure applies to all three rear countershaft bearing covers.

1. Remove the shim(s) and O-ring from the shoulder of the countershaft rear bearing cover. Tag the shim(s) and record the markings for use during assembly.

2. Remove the bearing cup from the bearing cover, using a suitable puller.

3. Thoroughly clean the bearing cover and inspect for damage.
Reverse Idler Gear Disassembly

[322]

Reverse idler gear disassembly applies to all reverse idler gears.

1. Press the bearing out of the reverse idler gear, using a suitable driver.

2. Thoroughly clean the reverse idler gear and inspect for damage.
REPAIR INSTRUCTIONS

INSPECTION OF PARTS

Inspection and Cleaning

Thoroughly clean the cases, covers and all other parts of the transmission. Remove all grease, oil and foreign matter, using a suitable safety solvent. Dry the parts with moisture-free compressed air.

Bearing [322]

Soak bearings in fresh clean solvent to loosen all hardened grease and foreign matter, until the bearings are clean. Blow them dry with filtered, moisture-free compressed air.

CAUTION

Do not spin the bearings with compressed air. Doing so can damage the bearings.

Inspect each bearing for flaking, cracks, fractures, cavities, indentations, measurable wear, brinelling, fretting, corrosion, nicking, cage wear or deformation and other damage. If any of these conditions are present, the bearing should be replaced.

Apply a light coat of fresh, clean, specified gear oil to the bearings. (Refer to Recommended SAE Grade Gear Oil in “Transmission Specifications and Capacities” on page 176.) Turn the races and bearings slowly by hand to be sure they move freely and are smooth. If there is resistance to movement, or if the bearing cones or cups feel rough, replace the bearings.

CAUTION

If a bearing cone or cup needs replacement, a complete new assembly, including cup and mating cone, is required.

Do not remove a new bearing from its packing before time of installation. Never clean protective grease from new bearings.

Do not handle bearings with dirty hands. Rags must be clean and lint free.

Clean the bearings that are satisfactory for installation. Wrap the bearings in clean, lint-free cloth and store for assembly.

Gears [322]

Replace all gears having teeth that show signs of abrasive wear, scratching (except normal manufacturing tool marks), ridging, scoring, surface fatigue, pitting, spalling, corrosive wear, digging in or cracking. Gears should always be inspected using magnaflux (or similar method) for cracks that would not otherwise be detected.

Shifter Forks, Sliding Clutches and Shift Rails [323]

Replace forks and/or sliding clutches when the side clearance (A) between the fork (2) and sliding clutch (1) groove exceeds the specified limit (refer to “Fits and Limits” on page 174).
REPAIR INSTRUCTIONS

Replace shift rails if they are cracked in either the poppet or setscrew holes. If the clearance between the shift rail and housing (cover) bore exceeds 0.010 inch (0.254 mm) maximum, determine which part is worn before replacing. Shaft wear can be checked by measuring the shaft at an unworn location. Then measure the shaft at the worn area and compare measurements. When measuring a shift rail, the reading should be an average of diameter measurements taken at four locations. Compare one side of the shaft to the other, AB–CD as shown in Figure 225.

Be careful when installing a shaft through a new seal (or seal over shaft). Lubricate the shaft before inserting it through the seal. Splines, keyways and holes in a shaft can damage seals unless care is taken. Lubricate the seal to prevent damage during the initial start-up period, before normal lubrication begins. Keep anti-seize and sealing compounds away from oil seals.

If an oil seal does not have a preapplied sealant on its outer diameter, apply an appropriate sealer around the outside diameter to prevent leaks.

Lip-type oil seals are precision elements that require close attention and care during installation.

NOTE

The quality of the installation method and tools used has a direct influence on the life of the seal. Do not use a block of wood or discarded bearing as a substitute for the proper seal driver. However, with some seal applications, a seal driver may not be available. In these situations, light tapping in a circular motion using a light, broad-faced hammer is acceptable.

For the seal to function properly, install it squarely with respect to the shaft center line. The seal should be kept square within 0.010 inch (0.254 mm) Total Indicated Runout (TIR). Squareness of the seal to the shaft is controlled by using the proper seal installation tools, as shown in Figure 226 and Figure 227.

Press seals into housings using smooth, even pressure to prevent cocking the seal.

Oil Seals [321]

When an overhaul is required, replace all oil seals. Be careful to ensure that the sealing surface of any seal is not damaged, turned back or cut. A nick on a shaft sealing surface can cut the seal. Remove sharp edges that can damage the seal (chamfer edges if possible). Press seals into housings, using smooth, even pressure to prevent cocking the seal.

CAUTION

Be careful when using any abrasive polishing methods, such as emery or crocus cloth, on a sealing surface. It is possible to leave microgrooves on the sealing surface. This can cause oil to leak past the sealing lip(s) of the oil seal. With this condition, a new seal will not stop the oil leak.

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General Inspection

Any cracked transmission case should be replaced. Check all components for wear or damage. Replace all parts as required. Replace all gaskets, O-rings, and any part that shows mutilation or damage. Repair all stripped threads, using a thread repair insert that is compatible with patch-lock type capscrews.

General Reassembly Instructions

Refer to "Fits and Limits" on page 174 for fits and limits and "Torque Specifications" on page 170 for torque specifications.

All working metal parts, especially the bearings, should be coated with fresh, clean, specified gear oil while the transmission is being reassembled. This ensures immediate lubrication and helps prevent parts seizure during start-up. (Refer to Recommended SAE Grade Gear Oil in "Transmission Specifications and Capacities" on page 176.)

When installing bearings, use proper bearing drivers. When pressing a bearing onto a shaft, apply force to the inner race of the bearing. When pressing a bearing into a housing (bearing cover), apply force only to the outer race. Do not apply force that is transmitted through the bearing rollers, balls or cage. Damage and premature bearing failure can result. Always apply even pressure to the bearing to prevent it from cocking or distorting during installation.

As moving parts are installed, check the parts frequently to see that they are moving freely.
1. Install a new caged needle bearing into the reverse idler gear. Press the bearing until flush with gear surface. The bearing must not protrude on either side of the gear surface.

**NOTE**

Drawn cup needle bearings (reverse idler gear bearings) have a specific direction that they must be installed. The radius end of the bearing is to be installed first. The flat end (the end with identification markings) faces against the angled shoulder of the pressing tool.
The following reassembly procedure applies to all three rear countershaft bearing covers.

1. Press the bearing cup into the cover, using a suitable driver.

**Rear Countershaft Bearing Cover Reassembly [321]**
2. Keep the original shims and a new O-ring with each cover for reassembly. Bearing preload adjustments must be made before installing shim pack and O-ring.

Rear Countershaft Reassembly

1. Install the key into the keyway of the rear countershaft, using a soft-faced mallet.

DANGER

Do not attempt to press-remove the Lo-range gear off these rear countershafts. The gear is integral with the shaft and could fragment explosively when pressing action is attempted.
3. Press the front bearing cone onto the rear countershaft, using a suitable driver. Apply force to the inner race only.

Do not install the countershaft rear bearing cone until transmission reassembly. Bearing installation is delayed as this bearing overhangs the mainshaft Lo-gear and blocks mainshaft installation. Countershaft rear bearing will be installed after mainshaft installation and gear timing check.
1. Press the front and rear bearing cups into the front countershaft rear bearing cover, using a suitable driver.

2. Set the front countershaft rear bearing cover aside for later installation.
The following reassembly procedure applies to all three front countershafts.

1. Press the bearing cup into the front countershaft main drive gear, using a suitable driver.

2. Install the key into the keyway of the front countershaft, using a soft-faced mallet.

**NOTE**

Remember to apply the recommended oil to all shaft and gear surfaces before pressing parts together.

**DANGER**

Do not attempt to press the reverse, first or second speed gears onto the front end of the countershaft. The front end of the shaft is slightly larger in diameter than the rear of the shaft. Attempting to press any of these three gears onto the front end of the shaft can cause the gears to crack and fragment explosively, and cause personal injury or death.
3. Press the third (8th) speed gear onto the shaft approximately 2–3 inches from the front end of the shaft to start. Do not exceed three inches at this time. The next two gears will press this gear to the proper location.

4. Press the fifth (10th) speed gear onto the shaft approximately 2-1/4 inches from the front end of the shaft to start.

5. Press the main drive gear onto the front of the countershaft with the protruding hub of the gear facing rearward. Using a suitable pressing tool for support, press until the end of the shaft is exactly flush with the gear hub front surface.

**NOTE**

For the remaining pressing operations on this countershaft assembly, use a driver or other pressing tool that covers the end of the shaft and part of the main drive gear hub front surface. See Figure 251 for tool dimensions.

---

**Figure 249** — Pressing Third Speed Gear onto Shaft

**Figure 250** — Pressing Fifth Speed Gear onto Shaft

**Figure 251** — Pressing Tool Dimensions

**Figure 252** — Main Drive Gear Pressed Flush onto Shaft
(Driver or Press Tool Keeps Shaft and Gear Even)
6. Position the front end of the shaft on the driver (press tool), to maintain evenness of the shaft, during steps 7 through 11.

7. Install the longer (front) spacer onto the shaft next to the third (8th) speed gear and then press the second (7th) speed gear onto the shaft from the rear. Press until gear seats and compresses spacer against the third (8th) speed gear.

**DANGER**

Do not attempt to press the reverse, first or second speed gears onto the front end of the countershaft. The front end of the shaft is slightly larger in diameter than the rear of the shaft. Attempting to press any of these three gears onto the front end of the shaft can cause the gears to crack and fragment explosively, and cause personal injury or death.
9. Install the shorter (rear) spacer onto the shaft next to the first speed gear.

10. Press the reverse speed gear onto the shaft until the spacer is compressed against the first speed gear. Install the gear with the recess facing the rear end of the shaft. The recess allows full installation of the rear bearing cone.

11. Press the bearing cone onto the rear end of the shaft, using a suitable driver. Apply force only to the inner race of the bearing cone. Press the bearing until seated against the surface of the reverse speed gear.
The following reassembly procedure applies to all three front countershaft front bearing covers.

1. Press the bearing cone onto the front countershaft front bearing cover, using a suitable driver. Apply force to the inner race of the bearing only.

2. Install a new O-ring onto the shoulder of the front bearing cover.

3. Compound Main Drive Gear Reassembly [322]
REPAIR INSTRUCTIONS

Rear Mainshaft Bearing Cover Reassembly [321]

Figure 264 — Exploded View of Compound Main Drive Gear

1. Press the bearing onto the compound main drive gear, using a suitable driver. Apply force to the inner race of the bearing only.

Figure 265 — Pressing Bearing onto Main Drive Gear

2. Set the compound main drive gear and bearing assembly aside for later installation.

Figure 266 — Rear Mainshaft Bearing Cover Component Locator

Figure 267 — Exploded View of Rear Mainshaft Bearing Cover
REPAIR INSTRUCTIONS

1. Press a **new** oil seal into the rear mainshaft bearing cover. Refer to Oil Seals in "INSPECTION OF PARTS" on page 95 for installation instructions.

2. Press the bearing into the cover, using a suitable driver. Apply force to the outer race only.

3. Install the snap ring securing the bearing in the rear mainshaft bearing cover, using suitable snap ring pliers.
4. Install a new rear mainshaft bearing cover gasket. Make sure the oil passageways in the gasket line up with the oil passageways in the cover.

**Synchronizer Reassembly [322]**

1. 12-Point Screw
2. Nonthreaded Insert
3. Clutch Housing
4. Synchronizer Pin
5. Sliding Clutch
6. Synchronizer Pin
7. Clutch Housing
8. Threaded Insert
9. Support Tube
10. Preload Spring

**Figure 271 — Installing Gasket onto Cover**

**Figure 272 — Synchronizer Component Locator**

**Figure 273 — Exploded View of Synchronizer**
1. Install the synchronizer pins into one of the two identical synchronizer clutch housings. Install the pins with the marked letter "R" facing up. Alternate pin heads as shown.

**NOTE**
As you install the pins, notice that the pins and the sliding clutch are marked with the letter "R", which stands for "Rear." All the R marks on either end of the pins are placed on the same side of the sliding clutch marked with the letter R. During reassembly, make sure to coordinate all R marks on both the pins and sliding clutch of the synchronizer assembly. All R marks must face the rear of the transmission when installed.

2. The three synchronizer preload springs are made up of two pieces. Make sure that the preload springs are assembled with the smooth-sided inner portion of the spring inside the notched (detent) outer portion of the spring.
3. Position the synchronizer sliding clutch on the bench with the marked letter R facing up. Install the three preload springs into the sliding clutch holes provided. The smaller holes are ramped and found halfway between the three largest holes.

![Figure 277 — Installing Preload Springs into Sliding Clutch](image1)

4. Install the sliding clutch (with preload springs) over the synchronizer clutch housing and pins. Make sure the marked letter R on the clutch is facing in the same direction as the R marked on the pins.

![Figure 278 — Synchronizer Pins and Sliding Clutch Showing “R” Marks (Preload Springs Removed for Clarity)](image2)

5. Install the three support tubes into the synchronizer assembly.

![Figure 279 — Install Support Tubes into Assembly](image3)

6. Install the remaining synchronizer housing over the pins, tubes and springs. Align the housing with the pin heads.

7. Install the three 12-point screws, plus threaded and nonthreaded inserts into the largest holes of the synchronizer assembly.

![Figure 280 — Installing 12-Point Screws and Inserts](image4)

With this sliding clutch design, it is very important to make sure that the clutch is facing in the correct direction when installed. This is due to the differing number of clutch teeth on the Lo-range and Hi-range sides of the range clutch. The Lo-range side contains 21 clutching teeth and the Hi-range side contains 22 clutching teeth. Incorrectly installing the sliding clutch prevents proper shifting.
8. Tighten the three 12-point screws to specification, using a suitable hex wrench to hold the threaded inserts.

Figure 281 — Tightening 12-Point Screws

Rear Mainshaft Reassembly [322]

Figure 282 — Rear Mainshaft Component Locator

Figure 283 — Exploded View of Rear Mainshaft and Synchronizer Assembly

1. Synchronizer Assembly
2. Reaction Discs
3. Friction Discs
4. Snap Ring
5. Lo-Range Gear
6. Snap Ring
7. Internal-Toothed Thrust Washer
8. Lo-Range Gear Hub
9. Snap Ring
10. Spigot Bearing Inner Race
11. Rear Mainshaft
1. Press a new spigot bearing inner race onto the front end of the rear mainshaft and secure it with the retaining snap ring.

2. Install the Lo-range gear hub onto the rear mainshaft.

3. Install the gear hub thrust washer over the rear mainshaft, against the hub.

4. Install the Lo-range gear hub snap ring, using suitable snap ring pliers.
5. Install the Lo-range gear over the gear hub with friction disc surface of gear facing up.

6. Install the spiral snap ring to secure the Lo-range gear to the gear hub.

7. Lubricate all synchronizer friction and reaction discs, using the recommended lubricant.

**NOTE**

Before and during installation, make sure to lubricate all synchronizer friction and reaction discs and associated parts (gear and gear hub), using the recommended lubricant. This prevents premature wear to the individual parts of the synchronizer assembly during initial transmission start-up.

8. Install the first friction disc into the Lo-range gear.
9. Install the first reaction disc onto the friction disc just installed.

10. Continue adding alternating friction and reaction discs into the Lo-range gear until four of each have been installed.

11. Align the tangs of the reaction discs and then install the synchronizer assembly over the rear mainshaft. Engage the slots of the synchronizer clutch housing with the tangs of all four reaction discs.

   **NOTE**

   Make sure that the synchronizer assembly is installed with the R markings on the clutch and pins, facing the rear of the mainshaft, against the discs just installed.
The splines on the mainshaft are usually not aligned for the whole length of the shaft. The recommended procedure is to install the second, third and fifth speed gears, gear thrust washers and snap rings, and second/third sliding clutch onto the front of the shaft. Install the remaining reverse and first speed gears and components onto the rear of the shaft.
REPAIR INSTRUCTIONS

Figure 295 — Exploded View of Front Mainshaft

1. Mainshaft Snap Ring
2. Internal-Toothed Thrust Washer
3. Fifth (10th) Speed Gear
4. External-Toothed Thrust Washer
5. Gear Snap Ring
6. Spigot-Bearing Inner Race Snap Ring
7. Spigot-Bearing Inner Race
8. Front Mainshaft
9. Spigot Bearing
10. Spigot Bearing Snap Ring
11. Third (8th) Speed Gear
12. Gear Snap Ring
13. External-Toothed Thrust Washer
14. Internal-Toothed Thrust Washer
15. Mainshaft Snap Ring
16. Sliding Clutch
17. Mainshaft Snap Ring
18. Internal-Toothed Thrust Washer
19. Second (7th) Speed Gear
20. External-Toothed Thrust Washer
21. Gear Snap Ring
22. Gear Snap Ring
23. External-Toothed Thrust Washer
24. First (6th) Speed Gear
25. Internal-Toothed Thrust Washer
26. Mainshaft Snap Ring
27. Sliding Clutch
28. Mainshaft Snap Ring
29. Internal-Toothed Thrust Washer
30. Reverse Speed Gear
31. External-Toothed Thrust Washer
32. Gear Snap Ring
33. Mainshaft Snap Ring
34. Spacer
**REPAIR INSTRUCTIONS**

1. Install a **new** spigot bearing inner race onto the front of the mainshaft, using a suitable driver and hammer.

2. Install the inner race snap ring, using suitable snap ring pliers.

3. Install a **new** spigot bearing into the rear of the front mainshaft. Use a suitable driver and press that is coaxial with the shaft bore.

**NOTE**

Drawn cup needle bearings (spigot bearings) have a specific direction that they must be installed. The radius end of the bearing is to be installed first. The flat end (the end with identification markings) faces against the angled shoulder of the pressing tool.
REPAIR INSTRUCTIONS

1. Stamped End of Bearing
2. Press Tool Leader or Pilot
3. Front Mainshaft

4. Install the front mainshaft spigot bearing retaining snap ring.

5. Install the snap ring into the outer groove of the second (7th) speed gear, using suitable snap ring pliers.

6. Working at the front of the mainshaft, install the second (7th) speed gear onto the shaft (clutch teeth face forward).
7. Install the second (7th) speed gear external- and internal-toothed thrust washers over the mainshaft.

8. Install the second (7th) speed gear snap ring into the third groove from the front of the shaft, using suitable snap ring pliers.

9. Install the second/third sliding clutch onto the mainshaft.

10. Install the third (8th) speed gear mainshaft snap ring into the second groove of the shaft, using suitable snap ring pliers.
11. Install the snap ring into the outer snap ring groove of the third (8th) speed gear, using suitable snap ring pliers.

12. Install the internal-toothed and external-toothed thrust washers, for the third (8th) speed gear, onto the mainshaft. The oil groove side of the external-toothed thrust washer faces rearward.

13. Install the third (8th) speed gear onto the mainshaft. The clutch teeth on the gear face rearward.

14. Install the snap ring into the snap ring groove of the fifth (10th) speed gear, using suitable snap ring pliers.

15. Install the fifth (10th) speed gear and the external-toothed and internal-toothed thrust washers onto the mainshaft with the clutch teeth of the gear facing forward.
16. Install the snap ring on the mainshaft for the fifth (10th) speed gear. Install into first groove from the front.

![Figure 311 — Installing Fifth Speed Gear Mainshaft Snap Ring](image)

17. Working at the rear of the mainshaft, install the snap ring into the snap ring groove of the first (6th) speed gear and then, install the gear onto the shaft with clutch teeth facing rearward.

![Figure 312 — Installing First Speed Gear](image)

18. Install the external-toothed and internal-toothed thrust washers for the first (6th) speed gear onto the mainshaft.

![Figure 313 — Installing External- and Internal-Toothed Thrust Washers](image)
19. Install the mainshaft snap ring for the first (6th) speed gear onto the shaft. Install into fourth groove from the front of the shaft.

20. Install the first/reverse sliding clutch onto the mainshaft.

21. Temporarily install the reverse speed gear onto the mainshaft over the first/reverse sliding clutch (clutch teeth face forward).

22. Install the reverse speed gear mainshaft snap ring, using suitable snap ring pliers. Install into the fifth snap ring groove from the front (third from rear).
REPAIR INSTRUCTIONS

NOTE
The reverse speed gear thrust washers and remaining snap ring will be installed after the mainshaft has been installed into the case during transmission reassembly.

Main Drive Pinion Reassembly [322]

Figure 318 — Main Drive Pinion Component Locator

Figure 319 — Exploded View of Main Drive Pinion

<table>
<thead>
<tr>
<th>1. Main Drive Pinion Shaft</th>
<th>7. Bearing</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Spigot Bearing</td>
<td>8. Spiral Snap Ring</td>
</tr>
<tr>
<td>3. Snap Ring</td>
<td>9. Gasket</td>
</tr>
<tr>
<td>4. Main Drive Pinion Gear</td>
<td>10. Pinion Bearing Cover</td>
</tr>
<tr>
<td>5. Spiral Snap Ring</td>
<td>11. Oil Seal</td>
</tr>
</tbody>
</table>
REPAIR INSTRUCTIONS

1. Press the ball bearing onto the main drive pinion shaft. Support the inner race of the bearing while pressing.

Figure 320 — Installing Main Drive Pinion Bearing

2. To retain the ball bearing, install the spiral snap ring using a circular motion and, at the same time, pressing the snap ring tightly into the groove on the shaft.

Figure 321 — Installing Spiral Snap Ring

3. Position a new oil seal in the main drive pinion bearing cover.

Figure 322 — Positioning Bearing Cover Oil Seal

4. Install the oil seal into the front of the main drive pinion bearing cover. Refer to "INSPECTION OF PARTS" on page 94 for tool use and installation instructions.

Figure 323 — Installing Bearing Cover Oil Seal
5. Press the main drive pinion shaft and bearing assembly into the main drive pinion bearing cover.

6. Install the main drive pinion bearing snap ring, using suitable snap ring pliers.

**WARNING**

The large snap ring is very difficult to compress and may fly off the snap ring pliers, causing injury.

**NOTE**

One side of the large snap ring is bevelled and faces outward. The flat side of the snap ring is positioned against the bearing.

7. Install a new spigot bearing into the end of the main drive pinion shaft by hand, and then install the retaining snap ring.

**NOTE**

Drawn cup needle bearings (spigot bearings) have a specific direction that they must be installed. The radius end of the bearing is to be installed first. The flat end of the bearing faces out.
8. Install the main drive pinion gear onto the pinion shaft. Install the spiral snap ring using a circular motion and, at the same time, pressing the snap ring tightly into the groove on the shaft.

9. Install a new bearing cover gasket, using sealant between the gasket and cover. Make sure the oil passage hole and cap screw holes in the gasket align with the cover holes.
REPAIR INSTRUCTIONS

1. Install the filter O-ring and bronze filter into the filter bore of the housing. Set the filter on top of the O-ring.

NOTE
Lightly lubricate the O-ring before installation. Over lubricating the O-ring may restrict the filter. Make sure to properly seat the O-ring.

2. Position a new top cover seal (if required) into the groove of the top cover. Lightly lubricate the seal before installation, and make sure all portions of the seal are properly located.

3. Install the top cover over the range shift valve body. Install the cover screws and tighten the screws to the specified torque.

4. Set the assembly aside for later installation onto the main case shift cover.
Installing the Teflon® seal into the shift rail bores requires a special insertion tool to expand the seal into the groove. This tool must be locally fabricated from a length of nylon or plastic stock, 7-5/8 inches (19.4 mm) long and 1-1/8 inches (2.9 mm) in diameter. Refer to Figure 336 for a machining illustration and dimensions.

1. Shift Rail Seal
2. Piston Seal
3. Shift Cylinder Wiper Ring
4. Shift Cylinder Housing
5. Housing-to-Cover O-Ring
6. Cylinder Housing Cover
7. Bolt
8. Piston/Shift Rail Assembly
9. Gasket
Figure 336 — Shift Rail Teflon® Seal Insertion Tool
1. Install a new O-ring into the groove in the shift rail bore.
2. Form the Teflon® seal into a kidney shape as shown in Figure 337.

3. Insert the Teflon® seal into the cylinder bore and gently work the seal inside the bore and around the O-ring so that the seal lips seat over each side of the O-ring.

4. Align the relief of the insertion tool with the “V” fold of the seal. Gently insert the tool into the bore and push the tool all the way into the bore until the relief at the end of the tool is fully visible as shown in Figure 339 and Figure 340.

**NOTE**

Use care to avoid damaging the seal. For best results, gently twist the tool while it is being inserted. This aids in reforming the “V” fold of the Teflon® seal to the circumference of the shift rail bore.

**NOTE**

Note that the back side of the Teflon® seal is contoured to the shape of the O-ring. It is important that the contour of the seal fits the O-ring and that the seal lips are not bent over. Failure to properly fit the seal around the O-ring results in damage to the seal during the next step of the installation process.
REPAIR INSTRUCTIONS

SERVICE HINT

After the tool has been fully inserted, leave the tool in place while the remaining cylinder rebuild procedures are performed. This allows the Teflon® seal to form to the circumference of the shift rail bore.

5. On the shift piston, install a new O-ring into the second groove of the piston.

6. Carefully install the Teflon® seal over the O-ring in the second groove of the piston.

7. Using a small engine ring compressor or other suitable type of ring compressor, compress the Teflon® seal to facilitate installation into the cylinder housing.

NOTE

If a small engine ring compressor or other suitable type of ring compressor is not available, a shielded hose clamp may be used. Use of any hose clamp other than a shielded hose clamp results in damage to the Teflon® seal.

CAUTION

Do not over-stretch the Teflon® seal. Be sure that the seal lips seat over each side of the O-ring.

8. After installing the ring compressor, tighten sufficiently so that the piston can be installed into the assembly.

Figure 341 — Installing O-Ring into Second Groove of Piston

Figure 342 — Installing Teflon® Seal

Figure 343 — Installing a Shielded Hose Clamp to Compress the Teflon® Seal

Figure 344 — Tighten Ring Compressor (Shielded Hose Clamp Shown)
It is recommended that the piston assembly be allowed to sit for 15 minutes with the ring compressor (or shielded hose clamp) installed before proceeding with the next step. This will size the seal to the piston.

9. With the cylinder housing properly secured in a vise, install the piston assembly. Be sure to install the piston with the shift fork locking bolt hole in the rail facing the air line port in the cylinder housing as shown in Figure 345.

10. As the piston/shift rail is installed, the installation tool is pushed from the cylinder bore. Do not remove the installation tool prior to installing the piston/shift rail assembly.

11. Install the piston until the ring compressor rests on the edge of the cylinder housing and then, push the piston into the cylinder far enough so that the Teflon® seal just enters the bore. The first ring groove on the piston must remain above the cylinder housing so that the wiper ring can be installed.

12. Remove the ring compressor or shielded clamp from the second ring area.

13. Install the wiper ring in the first piston ring groove.

14. After installing the wiper ring, compress the wiper with fingers and gently tap the piston into the cylinder housing until the piston is fully inside the housing bore.
Main Case Shift Cover Reassembly [323]

1. Install the shift cover breather vent into the cover.

Figure 348 — Main Case Shift Cover Component Locator

Figure 349 — Installing Breather Vent
Figure 350 — Exploded View of Main Case Shift Cover

1. 4th/5th Shift Fork
2. 2nd/3rd Shift Fork
3. 1st/Reverse Shifter
4. Shifter Body Spring (Interlock)
5. Shifter Body Plunger (Interlock)
6. 1st/Reverse Shift Fork
7. 4th/5th Shifter
8. 4th/5th Rocker Pin
9. Washer
10. 4th/5th Rocker Arm
11. Bushing
12. Washer
13. Interlock Pin
14. Poppet Ball
15. Poppet Ball Spring
16. Interlock Rocker Hardware
17. Interlock Sleeve and O-Ring
18. Interlock Spring
19. 4th/5th Rocker Pin Hardware
20. Interlock Rocker
21. Interlock Rocker Bolt
22. Pipe Plug
23. Breather
24. Interlock Pin
25. Interlock Ball
26. 1st/Reverse Shift Rail
27. 2nd/3rd Shift Rail
28. Interlock Ball
29. Interlock Pin
30. Interlock Rocker
31. 4th/5th Shift Rail
32. 1st/Reverse Shifter Ball
33. 1st/Reverse Shifter Spring
REPAIR INSTRUCTIONS

2. Install the fourth/fifth rocker pin and rocker arm. Be sure to position the washer, bushing and washer on the rocker pin as illustrated. The bottom washer is positioned between the rocker arm and main case shift cover.

3. Install the fourth/fifth pin lock washer, flat washer and nut. Tighten nut to the specified torque.

Figure 351 — Installing Fourth/Fifth Rocker Pin and Rocker Arm

Figure 352 — Installing Washers and Nut

Figure 353 — Tightening Nut
4. Install the reverse light switch rod into the shift cover.

5. Install the reverse light switch into the shift cover.

6. Install the poppet ball and spring for the fourth/fifth shift rail.

7. Slide the fourth/fifth shift rail into the cover. At the same time, install the fourth/fifth shifter onto the shift rail.
REPAIR INSTRUCTIONS

8. Press the poppet ball down while sliding the fourth/fifth shift rail over the ball. A hollow tube works well to press down the ball.

9. Align the setscrew in the fourth/fifth shifter with the notch in the shift rail. Tighten the setscrew to the specified torque.

10. Slide the second/third shift rail into the shift cover. At the same time, install the second/third shift fork onto the shift rail.
11. Install the interlock pin into the second/third shift rail.
12. Install the interlock ball between the second/third shift rail and the fourth/fifth shift rail.

Figure 363 — Installing Interlock Ball Between Rails

13. Install the poppet ball and spring for the second/third shift rail.

Figure 364 — Installing Poppet Ball and Spring

14. Press the poppet ball down while sliding the second/third shift rail over the ball. A hollow tube works well to press down the ball.

Figure 365 — Pressing Poppet Ball Down
15. Align the setscrew in the second/third shift fork with the notch in the shift rail. Tighten the setscrew to the specified torque.

16. Slide the first/reverse shift rail into the shift cover. At the same time, install the fourth/fifth shift fork onto the shift rail.

17. Install the poppet ball and spring into the first/reverse shifter, followed by the spring and plunger. Depress the poppet ball and spring into the shifter to allow the spring and plunger to pass. The poppet ball rests in the radius of the plunger.
REPAIR INSTRUCTIONS

18. Install the first/reverse shifter onto the shift rail, behind the fourth/fifth shift fork.

19. Install the interlock ball between the first/reverse shift rail and the second/third shift rail.

Figure 369 — Installing First/Reverse Shifter

Figure 370 — Installing Interlock Ball
20. Install the poppet ball and spring for the first/reverse shift rail.

21. Press the poppet ball down while sliding the first/reverse shift rail over the ball. A hollow tube works well to press down the ball.

Figure 371 — Installing Poppet Ball and Spring

Figure 372 — Pushing Poppet Ball Down
22. Install the first/reverse shift fork onto the first/reverse shift rail.

23. Continue sliding the first/reverse shift rail as shown and then, install the interlock pin into the rail.

24. Finish sliding the shift rail through the fork and into position.
25. Align the setscrew in the first/reverse shifter with the notch in the shift rail. Tighten the setscrew to specified torque.

26. Align the setscrew in the first/reverse shift fork with the notch in the shift rail. Tighten the setscrew to the specified torque.

27. Install the interlock ball into the opening next to the interlock rocker location of the cover.
28. Install the interlock rocker and bolt into the cover.

29. Install the nut and washers onto the interlock rocker bolt. Tighten to the specified torque.

Figure 379 — Installing Interlock Rocker and Bolt

Figure 380 — Installing Nut and Washers
REPAIR INSTRUCTIONS

TRANSMISSION REASSEMBLY PROCEDURES [320]

SERVICE HINT

Locate the stamped letter “O” on the front of each front countershaft fifth (10th) speed gear that aligns with the keyway. Paint the front of the corresponding gear tooth with white paint for greater visibility when timing the countershafts later. Do this for each of the three front countershafts.

Locate the three gear tooth spaces on the mainshaft fifth (10th) speed gear, stamped with the letter “O”. Paint the front of each tooth space with white paint for greater visibility when timing the countershafts later. If there are no stamped letters, count the number of gear teeth (result should be divisible by three). Place a white paint mark on any tooth space. Then, count around one-third of the total spaces and place the second white mark. Finally, count around one-third of the total spaces again and place the third white mark. The three marks should now be evenly spaced around the gear.

Figure 381 — Gear Tooth Marked for Timing

Figure 382 — Gear Tooth Spaces Marked for Timing
REPAIR INSTRUCTIONS

1. Install the No. 1 (upper right, when viewed from front) and No. 3 (lower) front countershaft front bearing covers and capscrews. Make sure new O-rings are in place. Tighten the capscrews to the specified torque.

2. With the main case in a vertical position, front end down, install the No. 3 (lower) front countershaft into the main transmission case.

3. Center the countershaft over the front bearing.

4. Temporarily position a shim pack over one of the front countershaft rear bearing cover openings. Mark the overhang of the shim pack at the reverse idler shaft opening of the case. This helps position the reverse idler shaft and prevents bearing cover interference with the shaft. Mark all idler shaft openings.

NOTE

The bearing cover fits into the flat on the idler shaft to retain the shaft and prevent it from rotating.
5. Install the No. 3 (lower) reverse idler shaft into the opening provided next to the installed countershaft. As the reverse idler shaft is inserted into the case, install the reverse idler gear and thrust washer onto the shaft. The thrust washer fits on the small end of the shaft with the oil grooves of the thrust washer facing the idler gear when installed.

![Figure 386 — Order of Reverse Idler Components](image)

6. Align the flat on the end of the reverse idler shaft (next to No. 3 countershaft) with the mark made along the edge of the shim pack.

![Figure 387 — Aligning Reverse Idler Shaft with Marks](image)

7. Using a brass hammer, tap the reverse idler shaft (next to No. 3 countershaft) into the case until it bottoms (flat on idler shaft flush with case). Be sure to maintain mark alignment.

**CAUTION**

Make sure that the thrust washer is aligned correctly with the idler shaft while tapping the idler shaft into place. If not aligned, damage to the thrust washer may result.

![Figure 388 — Tapping Reverse Idler Shaft into Place](image)

8. Place the transmission in the vertical position (rear end up).

Install enough shims under the No. 3 (lower) front countershaft rear bearing cover to produce measurable countershaft end play. Then install the cover and tighten the capscrews to 36–54 lb-ft (49–73 N·m) torque. Measure end play of the countershaft, using a dial indicator.

**NOTE**

Use a pry bar to move the countershaft up and down while measuring end play on the dial indicator.

![Figure 389 — Setting Front Countershaft Bearing Preload](image)
9. For the No. 3 (lower) countershaft, measured end play determines the thickness of shims that must be removed from the shim pack to get zero end play. Then, remove additional shim thickness to get the required 0.003 to 0.007 inch preload.

**Example:**

a. Begin the procedure using enough shims under the cover to produce measurable end play.

b. Measure countershaft end play. (For this example, end play is 0.100 inch.)

c. Remove 0.100-inch shims from the shim pack to get zero end play.

d. Remove (subtract) additional 0.003 to 0.007 inch shims from the pack to get the specified preload.

e. Total shim thickness removed from the shim pack, to get 0.003 to 0.007 inch preload, must be 0.103 to 0.107 inch.

10. After determining the correct shim thickness, install the shim pack onto the front countershaft rear cover.

**NOTE**

Preload is negative end play or “crush.” It cannot be measured directly. Shim thickness must be carefully determined, as described, to obtain the correct preload on the bearings.

11. Install the No. 3 (lower) front countershaft rear bearing cover by aligning and lightly tapping the cover in place. Install the capscrews and tighten to 36–54 lb-ft (49–73 N·m) torque.
REPAIR INSTRUCTIONS

12. Tip the No. 1 (upper left, when viewed from the rear) front countershaft into position as described earlier for the No. 3 (lower) countershaft.

13. Install the reverse idler shaft, gear and thrust washer (next to No. 1 countershaft) as described in the steps for the lower reverse idler shaft and gear installation.

14. Pry the No. 1 (upper left) countershaft to the outside, using a suitable pry bar. Block the rear end of the countershaft off center, using a folded rag.

15. Install the mainshaft into the case.

NOTE

Before the mainshaft is installed, slide the first/reverse sliding clutch forward until it fully engages the first speed gear. Slide the reverse speed gear forward until it fully engages the sliding clutch.

WARNING

The reverse gear is not secured to the shaft and can fall off if not careful.

16. Place the transmission in a horizontal position.

17. Move the reverse gear and first/reverse sliding clutch to normal positions.

18. Position the mainshaft, No. 3 (lower) countershaft and No. 1 (upper right, when viewed from the front) countershaft so that the timing marks on the gears are aligned. Roll the shafts into place and make sure gear timing is correct.

SERVICE HINT

Timing the shafts is easier if the transmission is in a horizontal position, rotated 15 degrees clockwise, as viewed from the front of the transmission case.
19. Install the remaining reverse idler shaft, gear and thrust washer (next to No. 2 countershaft) as described in the steps for the lower (No. 3) reverse idler shaft and gear. Move the reverse speed gear on the mainshaft as far forward as possible. When installing the reverse idler shaft and gear, make sure that the thrust washer is held in place.

20. Shift the first/reverse sliding clutch and reverse gear rearward, to allow the gear teeth on the reverse speed gear to engage all three reverse idler gears. Temporarily install a folded rag between the first and reverse speed gears to hold them in place.

21. Install the No. 1 (upper left) countershaft rear bearing cover. Determine shim pack thickness for proper bearing preload adjustment, as described earlier for the No. 3 lower countershaft. Tighten the rear cover capscrews to the specified torque.

22. Working through the opening at the rear of the case, install the reverse speed gear mainshaft snap ring onto the shaft, if not already done. Install into third groove from rear of shaft.

23. Install the internal-toothed and external-toothed thrust washers onto the mainshaft. The grooves on the external thrust washer face forward.
24. Install the snap ring on the inside of the reverse gear, using suitable snap ring pliers.

25. Install the remaining No. 2 (upper right) countershaft. Align the timing marks on the countershaft with the mainshaft. All three countershafts and mainshaft timing marks should be aligned at this point.

26. Install the No. 2 (upper left, when viewed from front) countershaft front bearing cover. Pull up on the countershaft with one hand and wiggle or tap the cover into place. Tighten the cover capscrews to the specified torque.

**NOTE**

Do not attempt to pull any bearing cover in place, using the bearing cover capscrews. Damage to the bearings or bearing cover may result. Make sure all components are properly in place before tightening the capscrews.

27. Install the No. 2 (upper right) countershaft rear bearing cover. Determine shim pack thickness for proper bearing preload adjustment, as described earlier for the No. 3 lower countershaft. Tighten the rear cover capscrews to the specified torque.

28. Place the transmission in a vertical position, rear end up.

29. Install the mainshaft snap ring (located just behind the reverse speed gear and before the spacer) onto the mainshaft, using suitable snap ring pliers. Install into second groove from rear of shaft.
30. Install the front mainshaft rear bearing thrust spacer onto the mainshaft, over the last snap ring. Ensure that the oil grooves face forward.

31. Install the compound main drive gear and bearing assembly onto the front mainshaft.

32. Install the snap ring securing the compound main drive gear to the front mainshaft.

**SERVICE HINT**
Using a pry bar, move the mainshaft rearward while holding the main drive gear. This allows extra room for the snap ring to seat in the mainshaft groove.
34. Install the compound main drive gear bearing cover (retaining plate) capscrews and tighten to the specified torque.

35. Return the transmission to a horizontal position.

36. Working at the front of the mainshaft, install the remaining sliding clutch.

37. Install the main drive pinion bearing cover gasket. Make sure the rubber sealing material on the gasket is facing the bearing cover.

38. Align the main drive pinion bearing cover gasket. Make sure the hole in the cover gasket aligns with the oil passageway in the bearing cover.
REPAIR INSTRUCTIONS

39. Before installing the main drive pinion assembly, make sure to align the oil passage hole in the cover with the oil passage hole in the case.

40. Install the main drive pinion assembly onto the front of the case.

41. Install the main drive pinion bearing cover capscrews and tighten to the specified torque.

**NOTE**

Main drive pinions for these transmissions are designed with the equivalent of three degrees (0.069–0.071 inch or 1.753–1.803 mm) of backlash between the shaft splines and the mating splines of the main drive pinion gear. This amount of backlash was designed to eliminate a rattling noise that can occur when the engine is idling with the clutch engaged.

**CAUTION**

Make sure the oil passages in the gasket, cover and case are aligned.

41. Install the main drive pinion bearing cover capscrews and tighten to the specified torque.

**NOTE**

Main drive pinions for these transmissions are designed with the equivalent of three degrees (0.069–0.071 inch or 1.753–1.803 mm) of backlash between the shaft splines and the mating splines of the main drive pinion gear. This amount of backlash was designed to eliminate a rattling noise that can occur when the engine is idling with the clutch engaged.

**CAUTION**

Make sure the oil passages in the gasket, cover and case are aligned.

40. Install the main drive pinion assembly onto the front of the case.
42. Place the transmission in a vertical position, rear end up. Locate the stamped letter O on the rear face of the compound main drive gear at three tooth spaces 120 degrees apart. If there are no stamped letters, count the number of teeth (result should be divisible by three). Paint three white marks, each 120 degrees apart, on the rear face of the gear, on the tooth spaces.

43. Rotate transmission mainshaft to align the three timing marks on the compound main drive gear with the approximate center lines of the three front countershafts.

44. Locate the stamped letter O on the rear face of each rear countershaft main drive gear. If there is no stamped letter, mark the gear tooth on each countershaft that is directly in line with the keyway between the gear and the countershaft. Also locate the stamped letter, or mark the teeth on the countershaft Lo-range gear and the Lo-range gear of the rear mainshaft assembly.

45. Position each of the three rear countershafts on the cup of its mating front countershaft rear bearing cover.

Figure 414 — Marking Compound Main Drive Gear

Figure 415 — Installing Rear Countershafts
Due to the relatively small size of the rear countershaft Lo gear, it is necessary that each rear countershaft rear bearing not be installed until after mainshaft installation. If installed, the rear countershaft bearings overhang the rear mainshaft Lo gear as shown in Figure 416. Ensure that the rear countershaft rear bearings are not installed at this time.

46. Align the countershaft timing marks with the timing marks on the compound main drive gear.
47. Install the main drive gear backing plate onto the main drive gear.

**NOTE**

If backing plate has “R” or “Rear” stamped on one face, install that face toward the rear of the transmission. If there are no markings, install the face with sharp corner edges toward the front of the transmission.

48. Install the first synchronizer friction disc, followed by the first reaction disc. Be sure to oil both sides of each disc, using a liberal amount of gear oil.

![Figure 418 — Installing Main Drive Gear Backing Plate](image1)

![Figure 419 — Installing Synchronizer Friction Disc](image2)

![Figure 420 — Installing Synchronizer Reaction Disc](image3)
49. Continue installing the synchronizer discs, alternating types, until four of each have been installed. Apply gear oil to all friction discs during installation.

50. Align the tangs of the reaction discs with each other so that the synchronizer clutch housing slots can slide over these tangs.

51. Install the rear mainshaft and synchronizer assembly onto the main drive gear with disc pack. Ensure synchronizer clutch housing aligns with all four reaction discs.

52. Check that the timing mark on each countershaft Lo-range gear aligns with the timing marks on the Lo-range gear of the rear mainshaft.

53. Install the rear bearing cones on all three rear countershafts using a suitable driver and hammer. Apply only enough force to drive the rear bearing cone on, over-driving the cone may cause damage to the forward bearing.

Figure 421 — Reaction Discs Aligned

Figure 422 — Installing Rear Mainshaft and Synchronizer

Figure 423 — Installing Countershaft Rear Bearing Cone
54. Install a **new** gasket on the gasket surface of the main case.

55. Install the rear case on the main case.

56. Install the rear case dowel bolts and nuts and tighten them to the specified torque.

57. Install the inner and outer (case-to-case) capscrews to secure the rear case to the main case. There are two inner capscrews located just inside the rear compound cover. Tighten the inner and outer case-to-case capscrews to the specified torque.
REPAIR INSTRUCTIONS

58. Install a new gasket onto the rear mainshaft bearing cover, if not already done. Note the location of the lubrication hole.

59. Install the rear mainshaft bearing cover assembly to the rear case and secure with capscrews. Tighten the capscrews to the specified torque.

60. Install the rear countershaft bearing covers.

61. Determine the shim pack thickness for each rear countershaft bearing preload adjustment, using the procedure described in the example that follows.

62. Working at the rear of the rear countershafts, temporarily install the rear countershaft bearing covers, leaving the capscrews loose. Do not install shim packs or O-rings at this time. Measure the space between the bearing cover and transmission case using two feeler gauge sets. Take at least two more measurements to average the results.

A more accurate measurement can be obtained if the transmission is in a vertical position and each bearing cover is handheld firmly against the countershaft rear bearings.

63. For each countershaft, remove the bearing cover and add enough shims to bring the space under the bearing cover to zero. Then remove enough shim thickness to get the required 0.002 to 0.006 inch preload.

Example:
   a. Begin the procedure using no shims or O-rings under the cover.
   b. Measure the space under the cover. For this example, the space is 0.100 inch.
   c. A 0.100-inch shim pack is needed to fill the measured space.
   d. Remove (subtract) 0.002 to 0.006 inch shims from the pack to get the specified preload.
   e. To obtain the required 0.002 to 0.006 inch preload, final shim pack thickness must be 0.094 to 0.098 inch, for this example.

Preload is negative end play or “crush.” It cannot be measured directly. Shim thickness must be determined carefully, as described, to obtain the correct preload on the bearings.
64. When all shim packs have been determined, install the rear countershaft bearing covers, shim packs, O-rings and cover capscrews. Tighten the capscrews to the specified torque. Use new O-rings when installing the covers.

65. Return the transmission to a horizontal position.

66. Install the drive yoke, clamp plate and retaining capscrew onto the rear mainshaft.

**SERVICE HINT**

To install the drive yoke clamp plate and capscrew, place at least two gears in both the main case and the rear case into engagement. This is done to lock the gearing and prevent it from rotating while tightening the yoke capscrew.

67. Reach into the rear case top opening and verify that the synchronizer assembly sliding clutch is engaged.

68. Reach into the main case top opening and move at least two sliding clutches into engagement. This locks up the gearing to prevent it from turning while tightening the drive yoke capscrew.

69. Tighten the drive yoke capscrew to the specified torque. When finished, make sure all gear sliding clutches and the compound sliding clutch are returned to the normal neutral position.

70. Position the range shift fork in the rear case with the tips of the fork inserted into the groove of the sliding clutch. The shift fork is marked with an "R." Install the fork with the "R" facing the rear of the transmission. When properly installed, the wider portion at the top of the fork is facing the rear of the transmission.
71. Install a new gasket for the range shift cylinder housing onto the cylinder housing assembly. The red silicone bead on the gasket must face the transmission case.

72. Install the shift cylinder onto the rear case with the shift rail entering the shift fork bore. Make sure that the shift fork locking bolt hole in the rail is facing up.

73. After the cylinder has seated against the rear case, use a light plastic mallet to tap the piston further into the cylinder until the locking bolt hole in the shift rail aligns with the hole in the shift fork.

74. Once the locking bolt holes are in alignment, install the bolt and tighten to specifications.
75. Apply a small amount of MACK O-ring lubricant (part No. 243SX41) to the circumference of the shift cylinder housing.

![Figure 437 — Applying O-Ring Lubricant to Shift Cylinder](image)

76. Install a new O-ring for the shift cylinder end cover.

![Figure 438 — Installing Cylinder End Cover O-Ring](image)

77. Install the cylinder housing end cover and the four bolts that secure the housing assembly to the transmission rear case. Tighten the bolts to specifications.

![Figure 439 — Installing End Cover and Tightening Bolts](image)

78. Clean the gasket or sealant surface of the rear case top cover and cover opening on the transmission.

79. Apply a 1/8- to 3/16-inch (0.125 to 0.1875 mm) continuous bead of Dow-Corning Silastic® 732 RTV sealant (part No. 342SX32), or equivalent, to the edges of the transmission rear cover opening. Encircle all capscrew holes as shown.

![Figure 440 — Applying RTV Sealant](image)

**NOTE**

Do not overtighten the four long capscrews that hold the range shift cylinder cover to the rear case. Overtightening can cause the rear cover to bend.
80. Position the rear case top cover over the previously installed RTV and align cover with rear case opening.

82. Install the lift bracket and the longest cover capscrews at the right rear corner of the top cover, then install the remainder of the cover screws. Tighten the capscrews to the specified torque.

**NOTE**
The lift bracket capscrews are slightly longer than the remainder of the top cover capscrews. Make sure the longer capscrews are used to secure the lift bracket. The lift bracket is placed at the right rear corner of the shift cover.

81. Install the single short capscrew over the range shift cylinder at the center of the rear cover. If an incorrect capscrew is installed in this location, the capscrew will bottom prematurely and allow a transmission fluid leak.

83. Clean the gasket or sealant surface of the main case shift cover.

84. Install a new main case shift cover gasket. Use a small amount of adhesive or grease to hold it in place.

85. Make sure the shifters on the shift cover and the sliding clutches on the mainshaft are in the neutral position for shift fork alignment.

86. Align the shift forks with the sliding clutches and install the main case shift cover.
87. Install the main case shift cover and lift bracket capscrews and tighten to the specified torque. Install the lifting bracket and longer capscrews at the left front corner of the main case shift cover as shown.

The lift bracket capscrews are slightly longer than the remainder of the shift cover capscrews. Make sure the longer capscrews are used to secure the lift bracket.

88. Install the interlock O-ring, pin, spring and sleeve into the main case shift cover.

89. Position the range shift valve over the tip of the lock pin. Install the two (outer) Allen-head 5/32-inch screws and torque to specification.
90. Install the two (inner) hex-head screws and torque to specification.

91. Reconnect the air lines attached to the range shift cylinder and the range shift valve. Refer to "Schematic Diagrams" on page 178.

92. Install the transmission drain plug and magnetic filter plug and torque to specifications.

93. Install the clutch release bearing assembly, shafts, yoke and clutch brake (if equipped).

94. Reinstall the transmission into the chassis of the vehicle.

95. Fill the transmission to the proper fill level, using the recommended lubricant. Refer to "Transmission Specifications and Capacities" on page 176.

96. Install and tighten the filler plug to specification.

**RANGE SHIFT VALVE CHECK**

97. Reconnect all remaining air lines and gear shift linkage/gear shift lever.

98. Check range shift valve operation to make sure that the compound range shift can occur only when in neutral.
SPECIFICATIONS

Torque Specifications

Figure 445 — Torque Specifications
**SPECIFICATIONS**

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<th>Item and Location</th>
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<td>36–54 (49–73)</td>
</tr>
<tr>
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</tr>
<tr>
<td>9. Rear Mainshaft Bearing Cover Capscrews*</td>
<td>40–50 (54–68)</td>
</tr>
<tr>
<td>10. Drive Flange (or Yoke) Clamp Plate Capscrews</td>
<td>494–600 (670–814)</td>
</tr>
<tr>
<td>11. Synchronizer Special 12-Point Screws (Quantity 3)</td>
<td>24–28 (33–38)</td>
</tr>
<tr>
<td>12. Rear Countershaft Bearing Cover Capscrews*</td>
<td>40–50 (54–68)</td>
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<tr>
<td>13. Front Countershaft Rear Bearing Cover Capscrews</td>
<td>36–54 (49–73)</td>
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<tr>
<td>15. Front Countershaft Front Bearing Cover Capscrews*</td>
<td>36–54 (49–73)</td>
</tr>
<tr>
<td>— Oil Filler Plug</td>
<td>35–50 (47–68)</td>
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<tr>
<td>— Magnetic Filter Plug</td>
<td>20–23 (27–31)</td>
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<tr>
<td>— Transmission Case Eight-Hole PTO Cover Capscrews*</td>
<td>36–54 (49–73)</td>
</tr>
<tr>
<td>— Transmission Case Six-Hole PTO Cover Capscrews*</td>
<td>24–36 (33–49)</td>
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<tr>
<td>— Range Shift Interlock Rocker</td>
<td>20–25 (27–34)</td>
</tr>
<tr>
<td>— Range Shift Valve Mounting Screws (Two Hex, Two Allen)*</td>
<td>84–96 lb-in (9–11)</td>
</tr>
<tr>
<td>— Range Shift Valve Top Cover and End Cover Screws</td>
<td>30–40 lb-in (3.4–4.5)</td>
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</table>

* Indicates that fastener has epoxy-coated threads. Fastener can be reused a maximum of five times.
SPECIFICATIONS

Gear Identification

Figure 446 — T310 Gear Identification
### SPECIFICATIONS

<table>
<thead>
<tr>
<th>Mainshaft Gear (Main Box)</th>
<th>Number of Teeth</th>
<th>Outside Diameter</th>
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</thead>
<tbody>
<tr>
<td>1. Main Drive Pinion (4th/9th)</td>
<td>33</td>
<td>5.635</td>
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<tr>
<td>2. 5th/10th Speed</td>
<td>27</td>
<td>4.694</td>
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<tr>
<td>3. 3rd/8th Speed</td>
<td>39</td>
<td>6.605</td>
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<tr>
<td>4. 2nd/7th Speed</td>
<td>45</td>
<td>7.541</td>
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<tr>
<td>5. 1st/6th Speed</td>
<td>45</td>
<td>8.500</td>
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<tr>
<td>6. Reverse</td>
<td>42</td>
<td>8.129</td>
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<table>
<thead>
<tr>
<th>Mainshaft Gear (Compound)</th>
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<tbody>
<tr>
<td>7. Main Drive Gear (Hi-Range)</td>
<td>30</td>
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<td>8. Lo-Range Gear</td>
<td>57</td>
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<th>Countershaft Gear (Main Box)</th>
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<tr>
<td>9. Main Drive Gear</td>
<td>47</td>
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<tr>
<td>10. 5th/10th Speed (PTO) Gear</td>
<td>53</td>
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<tr>
<td>11. 3rd/8th Speed</td>
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<td>14. Reverse</td>
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<td>15. Reverse Idler</td>
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<td>16. Main Drive Gear</td>
<td>49</td>
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<td>17. Lo-Range Gear (Part of Shaft)</td>
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FITS AND LIMITS

ALL FORKS AND SLIDING CLUTCHES

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<th>Minimum New</th>
<th>Maximum New</th>
<th>Maximum Wear</th>
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<tbody>
<tr>
<td>0.005 inch</td>
<td>0.020 inch</td>
<td>0.050&quot; inch</td>
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<tr>
<td>0.073 inch</td>
<td>0.087 inch</td>
<td>0.135 inch</td>
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*If unit has experienced disengagement, clearance must not exceed 0.030-inch maximum.

**Figure 447 — Sliding Clutch Clearances**

**SHIFTER AND POPPET BALL SPRING SPECIFICATIONS**

<table>
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<tr>
<th>Springs</th>
<th>Free Length</th>
<th>Load</th>
<th>Length Under Load</th>
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</thead>
<tbody>
<tr>
<td>First (Lo)/Reverse Shifter Ball Spring</td>
<td>3.562 inches</td>
<td>41.8 ± 5 lbs.</td>
<td>0.875 inch</td>
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<tr>
<td>First (Lo)/Reverse Shifter Plunger Spring</td>
<td>1.500 inches</td>
<td>22.0 ± 2 lbs.</td>
<td>0.625 inch</td>
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<tr>
<td>Shift Rail Poppet Ball Springs (3)</td>
<td>2.250 inches</td>
<td>25 ± 2.5 lbs.</td>
<td>1.539 inches</td>
</tr>
<tr>
<td>Range Shift Interlock Pin Spring</td>
<td>1.310 inches</td>
<td>18.7 lbs.</td>
<td>1.120 inches</td>
</tr>
</tbody>
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### General Tolerances

#### Figure 448 — Gear End Play and Bearing Preload

<table>
<thead>
<tr>
<th>Component</th>
<th>Specification</th>
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</thead>
<tbody>
<tr>
<td>1. Mainshaft 3rd/8th to 5th/10th Speed Gear (Floating Gear) End Play</td>
<td>0.024 – 0.081 inch</td>
</tr>
<tr>
<td>2. Mainshaft 1st/6th to 2nd/7th Speed Gear (Floating Gear) End Play</td>
<td>0.020 – 0.080 inch</td>
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<tr>
<td>3. Compound Main Drive Gear End Play</td>
<td>0.006 – 0.045 inch</td>
</tr>
<tr>
<td>4. Rear Mainshaft Lo-Range Gear End Play</td>
<td>0.002 – 0.026 inch</td>
</tr>
<tr>
<td>5. Rear Countershaft Bearing Preload</td>
<td>0.002 – 0.006 inch</td>
</tr>
<tr>
<td>6. Reverse Idler Gear End Play</td>
<td>0.010 – 0.090 inch (shaft flush with case wall)</td>
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<tr>
<td>7. Reverse Gear to Spacer</td>
<td>0.003 – 0.050 inch (shaft seated)</td>
</tr>
<tr>
<td>8. Front Countershaft Bearing Preload</td>
<td>0.003 – 0.007 inch</td>
</tr>
<tr>
<td>Shift Rails-to-Mating Bore Clearance</td>
<td>0.010-inch maximum</td>
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Transmission Specifications and Capacities

Make: Mack Trucks, Inc.
Type: Overdrive, Triple Countershaft
Controls: Selective, One Lever Manual with Air-Shifted Rear Compound
Speeds: Ten Forward, Two Reverse
Bell Housing: SAE No. 1, Integral with Main Case
Cases: Cast Aluminum, Heat Treated
Gears: Spur Type
Shaft Splines: Fine Pitch, Rolled Involute
Lubrication: Splash Lubrication
Oil Filter: Integral, Magnetic
Drain Plug: Magnetic
PTO Openings:
  - Left Side: Std. SAE 8-Hole (Main Case)
  - Right Side: Std. SAE 6-Hole (Main Case)
Oil Capacity: Approx. 24 pints (depends on angle of installation in chassis)

Recommended SAE Grade Gear Oil for all temperature operations, MACK GO-J and GO-J Plus* or TO-A* Specification:
- SAE 90, 140, 80W-90, 80W-140, 85W-140 for Mineral Base
- SAE 50, 75W-90, 75W-140, 80W-140 for Synthetic Base

*GO-J Plus or TO-A Plus is required for MACK-geared component extended service drain intervals.

Visit Mack Trucks, Inc. internet web site at www.macktrucks.com for MACK-approved oil suppliers.
SCHEMATIC & ROUTING DIAGRAMS

SCHEMATIC DIAGRAMS
[543]

Air Piping Diagram

---

Figure 449 — Air Piping Diagram
Air Control Schematic

Figure 450 — Air Control Schematic
## SPECIAL TOOLS & EQUIPMENT

### SPECIAL TOOLS AND EQUIPMENT

#### Special Tools

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<tr>
<th>TOOL CODE</th>
<th>DESCRIPTION</th>
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</thead>
<tbody>
<tr>
<td>J 21834-4A</td>
<td>Two Jaw Adjustable Puller</td>
</tr>
<tr>
<td>J 22912-01</td>
<td>Bearing Separator</td>
</tr>
<tr>
<td>J 23775-01</td>
<td>100-600 lb-ft Torque Wrench</td>
</tr>
<tr>
<td>J 24407</td>
<td>30-250 lb-ft Torque Wrench</td>
</tr>
<tr>
<td>J 02619-A</td>
<td>Slide Hammer</td>
</tr>
<tr>
<td>J 29048</td>
<td>Tapered Feeler Gauge</td>
</tr>
<tr>
<td>J 29369-1</td>
<td>Bearing Puller</td>
</tr>
<tr>
<td>J 29369-2</td>
<td>Bearing Puller</td>
</tr>
<tr>
<td>J 34629</td>
<td>Snap Ring Pliers Set</td>
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<tr>
<td>J 34630</td>
<td>Reverse Idler Shaft Removal Tool</td>
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<tr>
<td>J 36052</td>
<td>Positioning Tool</td>
</tr>
<tr>
<td>J 36053</td>
<td>Seal Driver</td>
</tr>
<tr>
<td>J 39854</td>
<td>Seal Driver</td>
</tr>
<tr>
<td>J 39477</td>
<td>Bar Type Puller</td>
</tr>
<tr>
<td>J 05959-A</td>
<td>Dial Indicator Set</td>
</tr>
<tr>
<td>8092</td>
<td>Driver Handle</td>
</tr>
<tr>
<td>J 8175</td>
<td>Bearing Separator</td>
</tr>
<tr>
<td>OEM-4052</td>
<td>Internal Puller</td>
</tr>
<tr>
<td>J 07804-A</td>
<td>Yoke and Flange Remover</td>
</tr>
<tr>
<td>9032-1800trk</td>
<td>Air Line Quick Disconnect Fitting Tool Kit</td>
</tr>
</tbody>
</table>

Available through MACK Parts System

Above tools are available from Kent-Moore (except as noted):

#### KENT-MOORE

**O.E. TOOL AND EQUIPMENT GROUP**

**SPX CORPORATION**

28635 MOUND ROAD

WARREN, MICHIGAN 48092-3499

TEL: 1-800-328-6657

FAX: 1-800-578-7375
DISASSEMBLED VIEWS

1. 4th/5th Shift Fork
2. 2nd/3rd Shift Fork
3. 1st/Reverse Shifter
4. Shifter Body Spring (Interlock)
5. Shifter Body Plunger (Interlock)
6. 1st/Reverse Shift Fork
7. 4th/5th Shifter
8. 4th/5th Rocker Pin
9. Washer
10. 4th/5th Rocker Arm
11. Bushing
12. Washer
13. Interlock Pin
14. Poppet Ball
15. Poppet Ball Spring
16. Interlock Rocker Hardware
17. Interlock Sleeve and O-Ring
18. Interlock Spring
19. 4th/5th Rocker Pin Hardware
20. Interlock Rocker
21. Interlock Rocker Bolt
22. Pipe Plug
23. Breather
24. Interlock Pin
25. Interlock Ball
26. 1st/Reverse Shift Rail
27. 2nd/3rd Shift Rail
28. Interlock Ball
29. Interlock Pin
30. Interlock Ball
31. 4th/5th Shift Rail
32. 1st/Reverse Shifter Ball
33. 1st/Reverse Shifter Spring
### DISASSEMBLED VIEWS

**Figure 452 — Exploded View of Front Mainshaft**

1. Mainshaft Snap Ring
2. Internal-Toothed Thrust Washer
3. Fifth (10th) Speed Gear
4. External-Toothed Thrust Washer
5. Gear Snap Ring
6. Spigot-Bearing Inner Race Snap Ring
7. Spigot-Bearing Inner Race
8. Front Mainshaft
9. Spigot Bearing
10. Spigot Bearing Snap Ring
11. Third (8th) Speed Gear
12. Gear Snap Ring
13. External-Toothed Thrust Washer
14. Internal-Toothed Thrust Washer
15. Mainshaft Snap Ring
16. Sliding Clutch
17. Mainshaft Snap Ring
18. Internal-Toothed Thrust Washer
19. Second (7th) Speed Gear
20. External-Toothed Thrust Washer
21. Gear Snap Ring
22. Gear Snap Ring
23. External-Toothed Thrust Washer
24. First (6th) Speed Gear
25. Internal-Toothed Thrust Washer
26. Mainshaft Snap Ring
27. Sliding Clutch
28. Mainshaft Snap Ring
29. Internal-Toothed Thrust Washer
30. Reverse Speed Gear
31. External-Toothed Thrust Washer
32. Gear Snap Ring
33. Mainshaft Snap Ring
34. Spacer
Figure 453 — Cutaway View of Range Shift Cylinder

1. Shift Rail Seal  
2. Piston Seal  
3. Shift Cylinder Wiper Ring  
4. Shift Cylinder Housing  
5. Housing-to-Cover O-Ring  
6. Cylinder Housing Cover  
7. Cover Capscrew  
8. Piston/Shift Rail Assembly  
9. Gasket

Figure 454 — Cutaway View of Range Shift Interlock Valve Assembly

1. 4 mm Screw  
2. Top Cover Seal  
3. Top Cover  
4. Sintered Bronze Filter  
5. Silicon Rubber O-Ring

Figure 455 — Exploded View of Main Drive Pinion

1. Main Drive Pinion Shaft  
2. Spigot Bearing  
3. Snap Ring  
4. Main Drive Pinion Gear  
5. Spiral Snap Ring  
6. Snap Ring  
7. Bearing  
8. Spiral Snap Ring  
9. Gasket  
10. Pinion Bearing Cover  
11. Oil Seal
**DISASSEMBLED VIEWS**

**Figure 456 — Exploded View of Rear Mainshaft and Synchronizer Assembly**

1. Synchronizer Assembly
2. Reaction Discs
3. Friction Discs
4. Snap Ring
5. Lo-Range Gear
6. Snap Ring
7. Internal-Toothed Thrust Washer
8. Lo-Range Gear Hub
9. Snap Ring
10. Spigot Bearing Inner Race
11. Rear Mainshaft

**Figure 457 — Exploded View of Synchronizer**

1. 12-Point Screw
2. Nonthreaded Insert
3. Clutch Housing
4. Synchronizer Pin
5. Sliding Clutch
6. Synchronizer Pin
7. Clutch Housing
8. Threaded Insert
9. Support Tube
10. Preload Spring

**Figure 458 — Exploded View of Rear Mainshaft Bearing Cover**

1. Bearing Cover
2. Oil Seal
3. Gasket
4. Bearing
5. Snap Ring
**Figure 459 — Exploded View of Rear Compound Main Drive Gear**

1. Bearing and Snap Ring  
2. Main Drive Gear

**Figure 460 — Exploded View of Front Countershaft Front Bearing Cover**

1. O-Ring  
2. Bearing Cone  
3. Front Bearing Cover

**Figure 461 — Exploded View of Front Countershaft**

1. Bearing Cup  
2. Main Drive Gear  
3. Fifth (10th) Speed Gear  
4. Third (8th) Speed Gear  
5. Spacer — Front  
6. Front Countershaft  
7. Key  
8. Bearing Cone  
9. Reverse Speed Gear  
10. Spacer — Rear  
11. First (6th) Speed Gear  
12. Second (7th) Speed Gear

**Figure 462 — Exploded View of Front Countershaft Rear Bearing Cover**

1. Front Bearing Cup  
2. Bearing Cover  
3. Rear Bearing Cup
Figure 463 — Exploded View of Rear Countershaft

1. Front Bearing Cone
2. Main Drive Gear
3. Key
4. Rear Bearing Cone
5. Rear Countershaft

Figure 464 — Exploded View of Rear Countershaft Bearing Cover

1. Bearing Cup
2. O-Ring
3. Shim(s)
4. Bearing Cover

Figure 465 — Exploded View of Reverse Idler Gear Assembly

1. Thrust Washer
2. Reverse Idler Gear
3. Bearing
4. Reverse Idler Shaft
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