



Bulletin No. SPTS001-0306

AMO1750-4
March 2006

AMO1750-4 Series Auxiliary Transmission



MODELS:
APO1750-4
APO1000-4

Service Manual

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CAUTION

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

GENERAL INFORMATION

MAINTENANCE INFORMATION:

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

REBUILD FACILITIES:

A suitable holding fixture or overhaul stand is desirable but not necessary to rebuild this unit. The flat bottom of the transmission case provides a suitable working platform when the unit is placed on a sturdy shop table. For easier working conditions, table height should be 28 - 30 inches. A light chain hoist should be used to handle the mainshaft and countershafts during removal and reassembly procedures.

CLEANLINESS:

Transmissions should be steam cleaned prior to disassembly. Seal all openings before steam cleaning to prevent entry of dirt and water which can damage serviceable parts. Dirt is abrasive and will cause premature wear of bearings and other parts. We suggest that mechanics have a small wash tank to clean parts just prior to reassembly.

BEARINGS:

When a transmission is removed at relatively low mileage, bearings should be removed with pullers designed for this purpose. Wrap the bearings to keep out dirt. Clean, inspect and lubricate all bearings just prior to reassembly. If accumulated mileage is over 150,000 miles, we suggest that all bearings be replaced.

END YOKES & FLANGES:

Hammering on end yokes and flanges, to remove or install them is not only destructive to the yoke or flange itself, but can also cause serious internal damage. Hammering destroys or mutilates the pilot diameters and warps or bends the flange. Hammering on end yokes will close- in the bearing bores or misalign yoke lugs and result in early failures of journal needle bearings, etc. Serious damage can be done internally to bearings, thrust faces and washers, pilot bearings, etc., by hammering on external parts. In most designs when the yoke/flange locknuts are tightened and secure, the internal bearings and gears are in proper location. When the yoke/flange is driven on the shaft, two conditions can exist.

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

REPLACEMENT PARTS:

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

POWER FLOW:

This Spicer auxiliary transmission is designed for heavy duty on and off-highway applications. The two countershaft design allows the engine torque to be equally divided between the two countershafts. This provides a high ratio of torque capacity to transmission weight. This also allows a reduction in the face width of each gear involved in the transmission. All the gears are in constant mesh through spur teeth.

The AM01000-4 and 1241 transmissions have four forward speeds. All gear selections on the AM01000-4 and 1241 are made with a mechanical shift lever only. All gear selections of the AP01000-4 and P1241 are made with an air control valve mounted on the shift lever.

SPEEDOMETER DRIVE:

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

MAGNETIC OIL CLEANER:

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

P.T.O. SPECIFICATIONS:

Power Take-Off

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

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

LUBRICATION

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

RECOMMENDED LUBRICANTS:

TEMPERATURE	GRADE	TYPE
ABOVE 0°F	SAE30.40.or50	HEAVY DUTY ENGINE OIL MEETING SPEC MIL-L-2104B OR MILL-45199 SERIES 3
BELOW 0°F	SAE 30	
ABOVE 0°F	SAE 90	STRAIGHT MINERAL GEAR OIL
BELOW 0°F	SAE 80	

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

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

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

OIL CHANGES:

We recommend an initial oil change and flush at the first practical opportunity after the transmission is placed in service. This could take place after a drive-away delivery, only 100 miles or 24 hours of off-highway service, but not more than 2,000 miles of over-the-highway. There are many factors that influence the oil change period and we have not specified a definite mileage interval. In general, it is suggested that a drain and flush period be scheduled every 20,000 miles for normal over-the-highway operations. Off-the-highway usually requires oil change every 30 days. The oil level in the transmission should be checked every 2,000 miles on-highway, or every 24 hours in off-highway operation.

OVERFILLING:

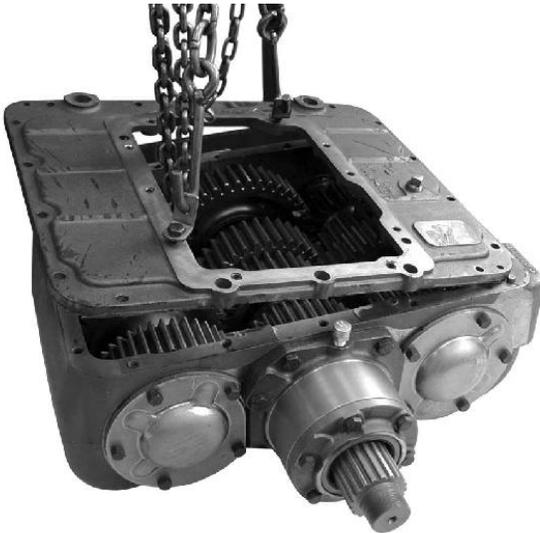
Do not overfill this transmission with lubricating oil. Overfilling usually results in oil breakdown due to excessive heat and aeration from the churning action of the gears. Early break-down of the oil will result in heavy varnish and sludge deposits that plug up oil ports and build up on splines and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



1. Shift the auxiliary into neutral. Remove the retaining capscrews holding the shifter housing to the auxiliary case. Separate the shifter housing and gasket from the case and lift straight up.



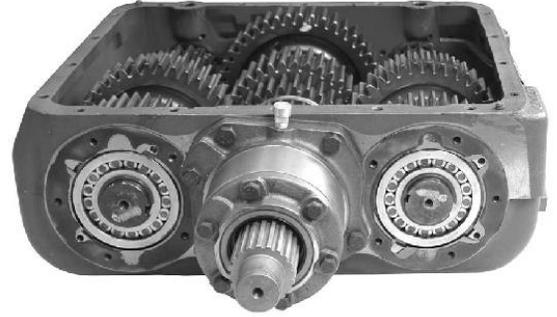
2. Remove two nuts and washers from the two rear anchor studs. Remove all retaining cap screw from adapter plate.



3. Remove the three Allen Head cap screws that are countersunk. Separate adapter plate from case and lift straight up.



1. Lock the auxiliary in two gears by moving the two shift collars on the mainshaft forward into 2nd and 3rd gear. Use two 9/16" sockets to remove the drive gear and mainshaft end yoke locknuts and washers. Remove the drive gear and mainshaft rear end yokes. Use a puller if the end yokes will not come off readily.



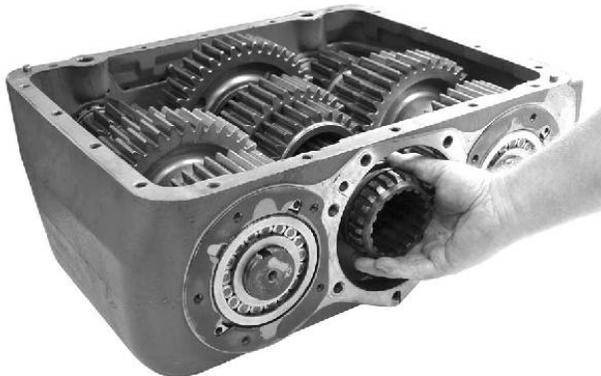
2. Remove the capscrews from the drive gear bearing retainer. Use soft hammer and tap on the retainer until it is separated from the case.



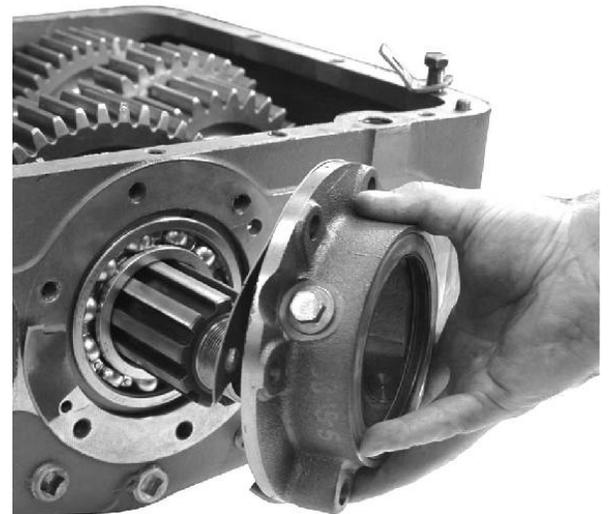
3. Remove the capscrews from the front counter shaft bearing caps. Remove the front bearing caps and gaskets. Then use a pair of pry bars, between the case and the retainer, and pry evenly until the bearing retainer and drive gear assembly is removed from the case bore.



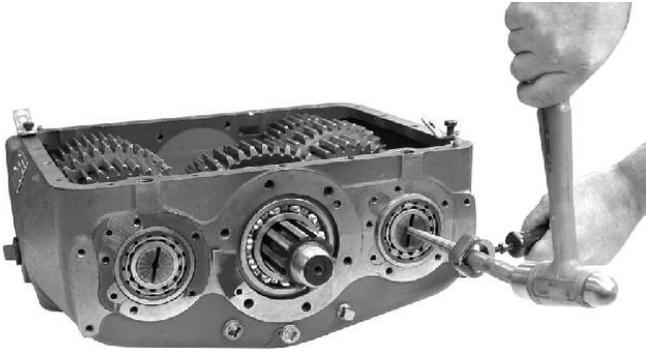
4. Drive gear bearing retainer and drive gear assembly removed.



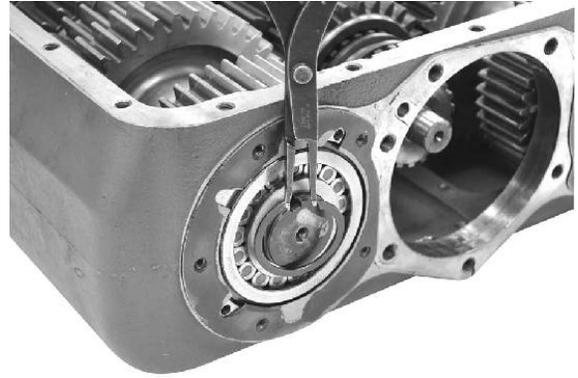
5. The 3rd-4th speed shift collar can be pulled from the mainshaft through the front of the case.



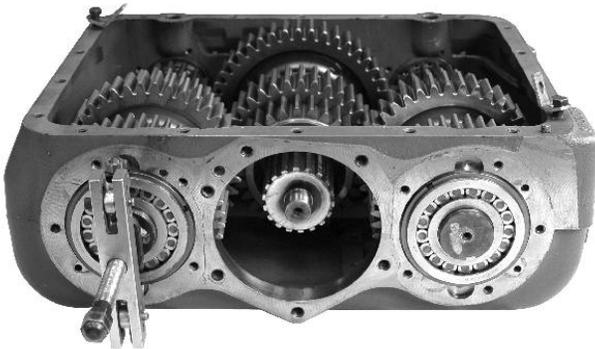
6. Remove the capscrews from the countershaft rear bearing caps and the mainshaft rear bearing cap. The mainshaft and countershaft rear bearing caps and gaskets can now be removed from the face of the case.



7. Remove bearing retaining snap rings from the front countershaft.



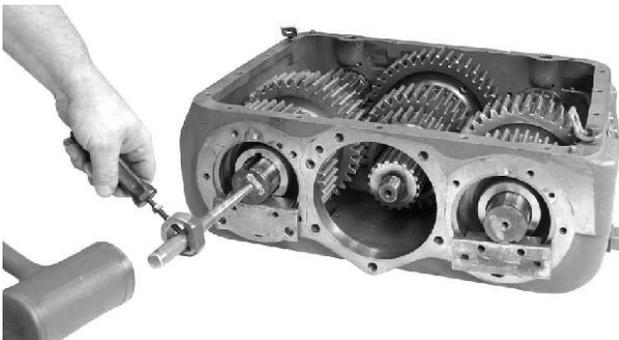
8. Use brass punch to tap on the rear of each countershaft. Tap on the countershafts until the front bearings have moved forward about 1/4 inch, enough to get the puller on the outside snap rings of the front bearings.



9. The front countershaft bearing bores have been machined out to allow enough clearance for the jaws of a bearing puller. Place the puller on the snap ring of the bearing and pull the bearing off the shaft and out of the case bore.



10. Here the countershaft front bearings on the right and left side have been removed. With the aid of a light chain hoist and a hook to relieve some of the weight of the mainshaft, use a soft mallet to drive the mainshaft assembly to the rear of the case.



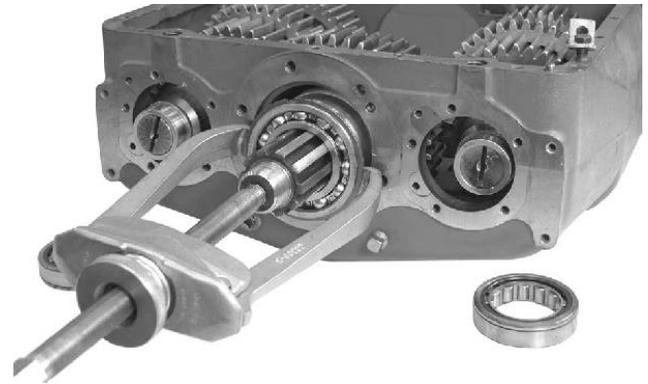
11. Install two countershaft supporting blocks - one on each side.



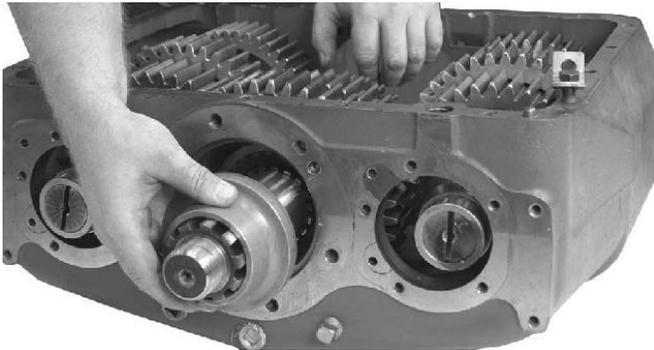
12. Drive on countershafts to move the mainshaft far enough to the rear to expose the rear bearings from the bores of the case.



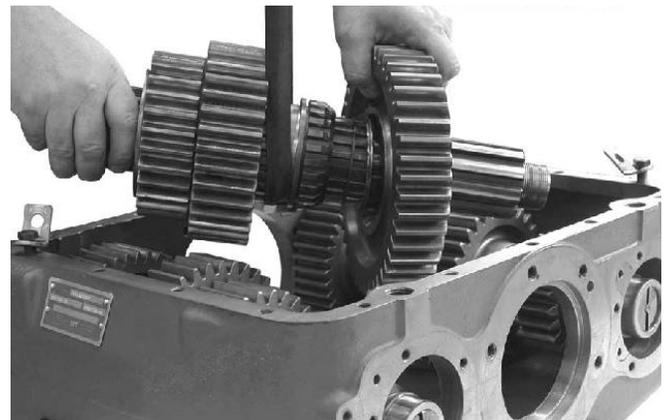
13. The rear countershaft bearings are two-piece bearings. The outer race and roller assembly can be removed from the inner race. Do not remove the inner race from the shaft unless the bearing is going to be replaced.



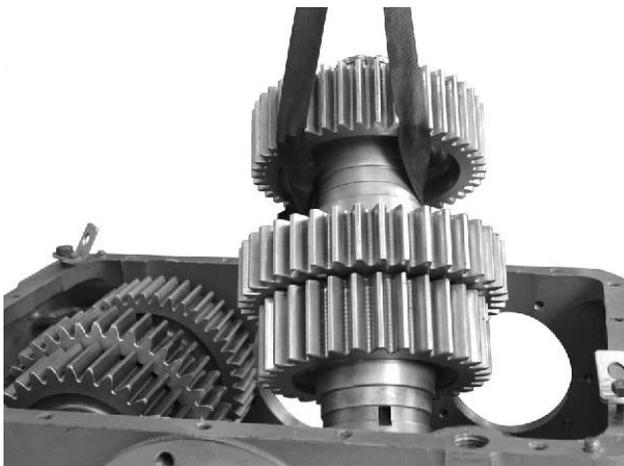
14. A puller can now be used to remove the mainshaft rear bearing from the mainshaft.



15. Remove the mainshaft spacer from the mainshaft.



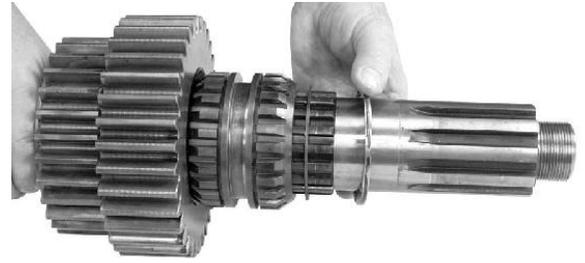
16. Use a lift strap around the 1st-2nd shift collar and lift the mainshaft sub-assembly up and out of the case. Lay the mainshaft sub-assembly on a work bench for disassembly of gears and related parts.



17. Use a lift strap around the countershaft behind the head end gear and lift the countershaft assembly up and out of the case. Do the same for the other countershaft.



1. Remove 1st speed gear with snap ring and external spline thrust washer from the rear of the mainshaft.



2. Remove 1st speed gear internal spline thrust washer from the rear of the mainshaft.



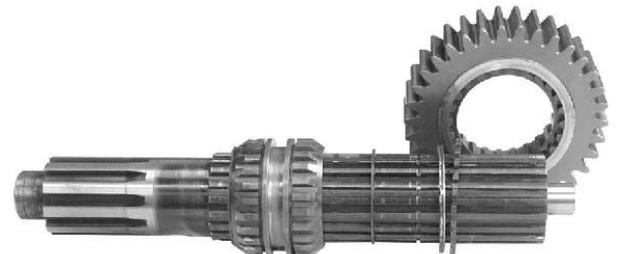
3. Remove snap ring and clutch collar from rear of the mainshaft.



4. At the front of the mainshaft, remove the snap ring from the mainshaft groove located under the bore of the overdrive gear.



5. Remove the internal and external spline thrust washers of the overdrive gear. Remove the overdrive gear with the snap ring from the mainshaft.



6. Remove 2nd speed gear with snap ring. The external and internal spline thrust washers of the 2nd speed gear can be removed from the shaft.



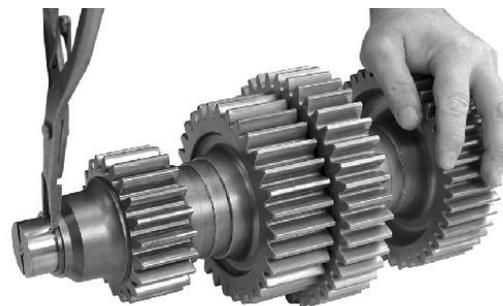
7. The 2nd speed gear snap ring to the shaft is removed. The 1st-2nd speed gear shift collar and 1st speed gear snap ring to the shaft can be taken off the mainshaft.



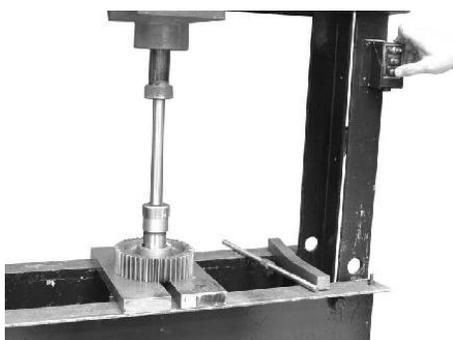
1. If the countershaft rear bearings are to be replaced, use a puller to remove the inner race off the countershaft.

Note:

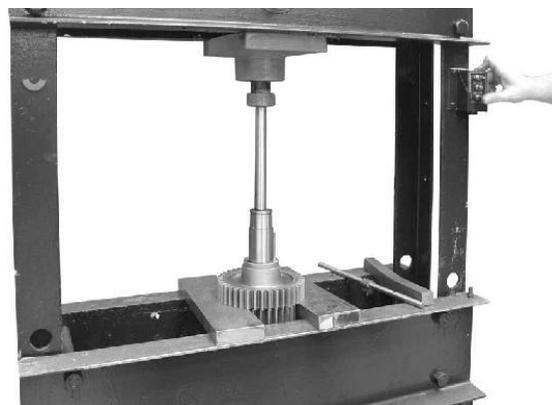
If gears on countershafts require replacement because of tooth damage, or ratio change, etc., press all gears but integral Lo-Lo gear off the shaft.



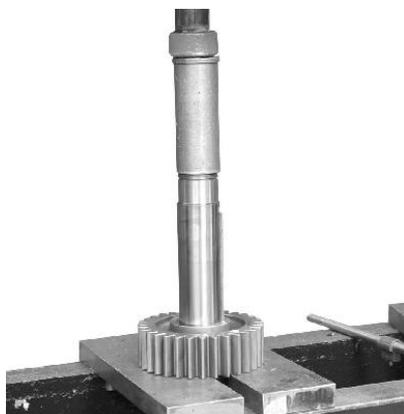
2. Remove spacer snap ring from rear of countershaft.



3. Support head end (direct drive) gear with parallel bars as close to the hub as possible. Using an arbor press, press countershaft out of head end gear.



4. Support 4th speed gear with parallel bars as close to the hub as possible. Using an arbor press, press countershaft out of 4th speed gear.



5. Using an Arbor Press, press the 2nd speed gear off the countershaft



6. The Lo-Lo gear (1st speed gear) is an integral part of the countershaft and does not press off. Keys are still intact in the keyway of the counter-shaft and can be removed, if necessary.

Note:

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

Note:

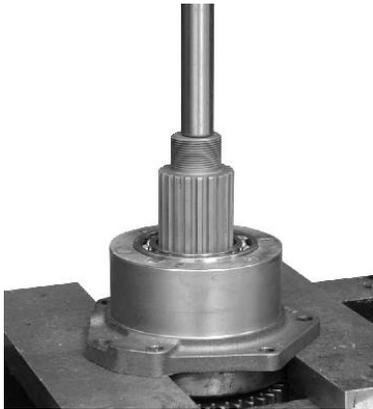
The later model countershafts no longer use three separate keys. One long key is now assembled to the countershaft keyway.



1. The drive gear front bearing cap and drive gear assembly as it was removed from the front of the case.



2. The capscrews holding the front bearing cap and gasket to the drive gear bearing retainer have been removed. The bearing cap has been removed from the retainer. Remove front bearing cap oil seal if it is damaged and requires replacement.



3. Support bearing retainer assembly on its flange and press drive gear free of bearing retainer, bearings and spacer.



4. Use snap ring pliers to remove drive gear retaining snap ring.



5. Remove the drive gear pocket bearing by prying out with a large screwdriver or equivalent. Use caution not to mar, or gouge pocket machined diameter with screwdriver or similar tool.



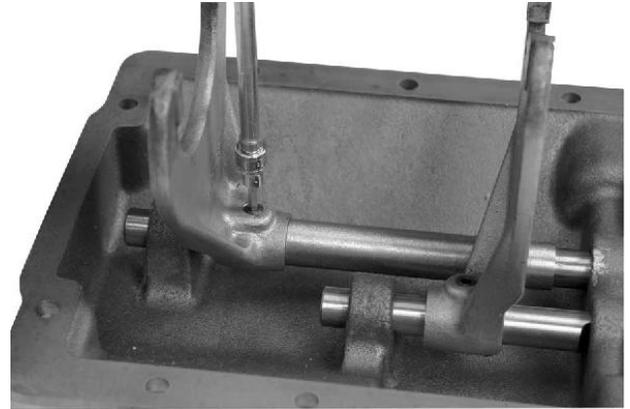
6. Use a brass drift to remove bearing from the front of the drive gear bearing retainer. The drive gear spacer can be removed from inside the retainer, at this time.

7. Use a brass drift to remove the outer bearing assembly of the drive gear rear bearing from the retainer.

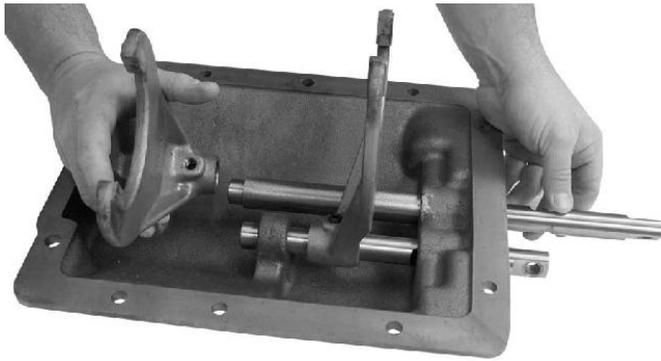




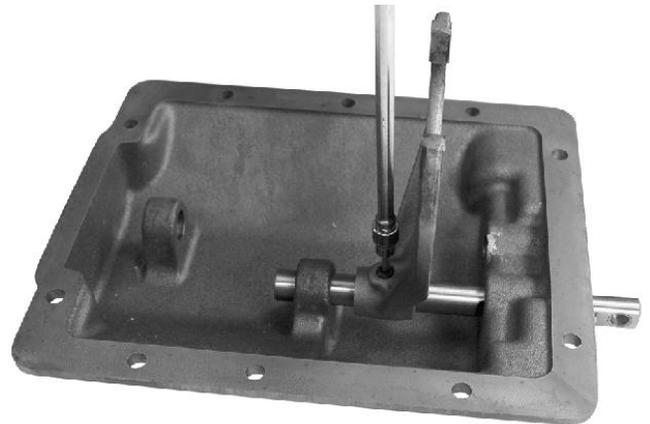
1. Remove the retainer plugs, poppet springs and poppets at the front of the shifter housing located on either side of the shift rails.



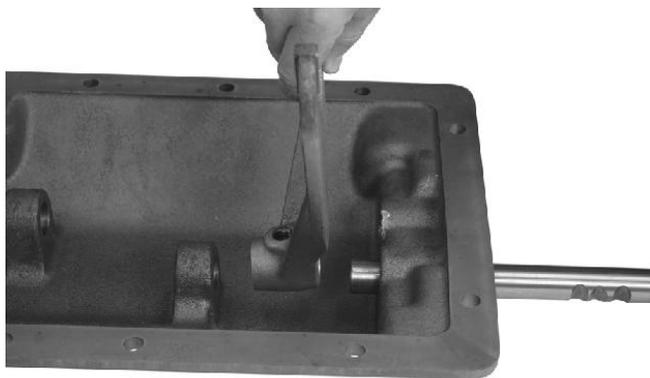
2. With the cover lying on its top on a work bench remove the set screw holding the 1st-2nd shift fork to the shift rail.



3. Slide the 1st-2nd shift rail out through the front of the cover. The two stop sleeves and shift fork can then be lifted out of the cover.



4. Remove the set screw holding the 3rd-4th shift fork to the shift rail.



5. Pull the shift rail out through the front of the cover, removing the long stop sleeve as the shift rail is pulled from the cover. Remove the 3rd-4th shift fork and short stop sleeve.



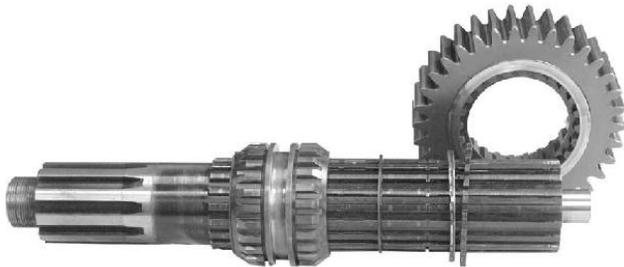
6. Remove the interlock from the interlock hole between the two shift rails. If the shift rod seals at the front of the cover are to be replaced, then remove the seals from the housing bores at this time.

Note:

When assembling the mainshaft, the internal and external spline thrust washers are all of the same thickness and size and are interchangeable from one gear to another. Before assembly of all gears on the mainshaft, inspect all thrust washers and snap rings. If washers show face galling or tooth wear indentations, the washers should be replaced. If the snap rings have been extended or distorted, they should be replaced. Lubricate old or new thrust washers with S.A.E. #50 engine oil on the thrust faces as they are assembled. Both shift collars are identical. Either end of collars can be installed on the shaft at time of assembly.



2. Install the 1st & 2nd speed clutch collar & retaining snap rings in the grooves on the mainshaft on either side of the 1st-2nd speed gear shift collar.

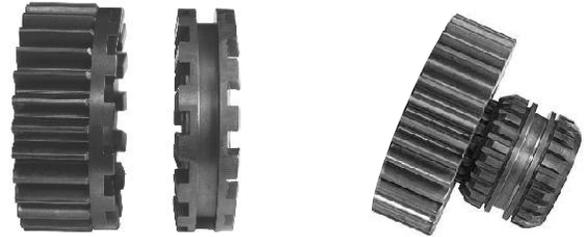


4. With the 2nd speed gear snap ring in the gear, place the 2nd speed gear on the mainshaft. The long spline in the gear bore toward the shift collar.



6. Place an internal spline thrust washer on the shaft and into the bore of the gear. Install the snap ring in the last groove on the mainshaft in the bore of the overdrive gear. Make certain all snap rings are seated firmly in place.

Note: To check for proper assembly of the mainshaft gears onto the mainshaft, the mating shift collar must make full entry into each gear bore.



1. **Air Shift**

Manual Shift



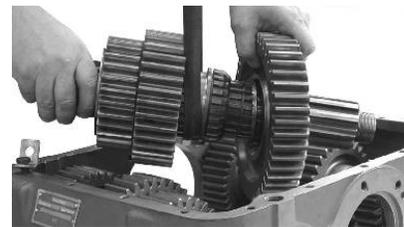
3. Place an internal spline thrust washer on the mainshaft. Place an external spline thrust washer next to the internal spline washer.



5. Place the 4th speed gear (overdrive) on the mainshaft. The snap ring is in the bore of the gear and the long spline of the gear bore faces the front of the shaft. Place an external spline thrust washer on the shaft and into the bore of the gear.



7. On the rear of the mainshaft place an internal spline and external spline thrust washer up against the 1st gear mainshaft snap ring.



8. The 1st speed gear with the snap ring in the gear bore is placed on the shaft. The long spline in the gear bore going toward the 1st-2nd speed shift collar. Lay the mainshaft on the bench for later installation into the case.

Note:

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

Note:

As the countershaft is pressed into each gear, make certain any metal chips or slivers are removed from the gear hub faces



1. Secure the key into keyway of countershaft by driving on the key with a hammer. Support 2nd speed gear (underdrive) with long hub up. Align key with gear keyway and press shaft and key into gear. Seat the gear face of shaft firmly against the face of 2nd speed gear (underdrive). Key must be under the face of gear.



2. Secure the key for the 4th speed gear (over-drive) into the countershaft keyway. Support the overdrive gear with the long hub down. Press the shaft and key into the gear. Seat the gear face firmly against the face of the underdrive speed gear. The key must be under the face of the gear.



3. Secure the third key in the keyway of the countershaft. Support the 3rd speed gear (direct drive) with the long hub up. Press the shaft into the gear, seating the gear face firmly against the face of the 4th speed gear (overdrive). The key must be under the face of the gear.

IMPORTANT

The key face must not protrude beyond the face of the 3rd speed gear (direct drive) because the countershaft front bearing inner race face rests against the face of the gear hub.

Notice there is a tooth timing mark "V" on the tooth web of the 3rd speed gear (direct drive). Be sure that it aligns itself to the center of the gear keyway. Use white paint on the timing marks "V" for easy identification on later assembly.

Note:

The later model countershafts no longer use three separate keys. One long key is now assembled to the countershaft keyway.



1. Install pocket bearing.



2. Install 3rd speed gear into the drive gear and install retaining snap ring.



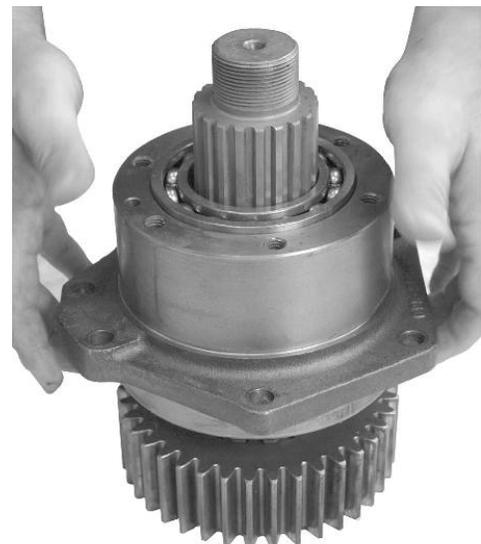
3. Install bearings and spacers into drive gear bearing retainer.



4. Place the spacer on the drive gear stem. It will rest against the drive gear rear bearing.



5. Bearings and spacers installed.



6. Install bearing retainer onto drive gear assembly.



7. Install bearing retainer front cap and seal assembly. Make sure to align oil hole on cap and retainer.



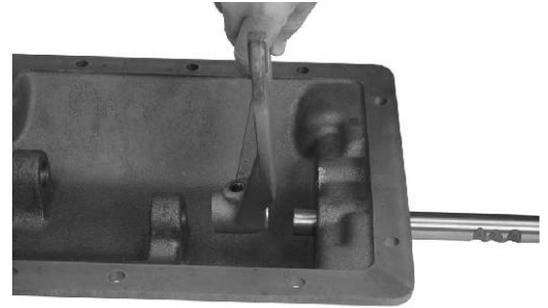
8. Install six (6) bearing cap retaining screws.



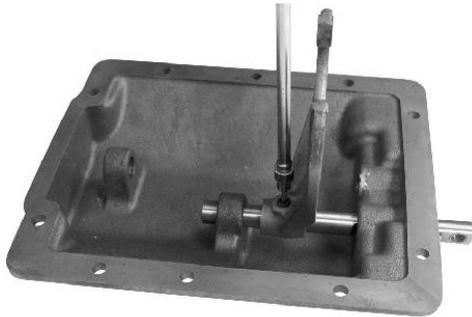
9. If previously removed, install breather into drive gear assembly.



1. Install poppet spring and poppet. Assemble 3rd-4th speed shift rail is assembled to the shifter housing through the front seal and bore. The small stop sleeve and 3rd-4th speed shift forks are placed on the rail. The long hub of the fork going to the rear.



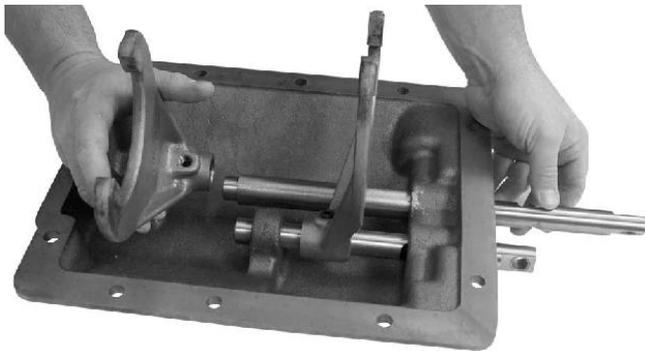
2. Slide the long stop sleeve on the shift rail behind the fork.



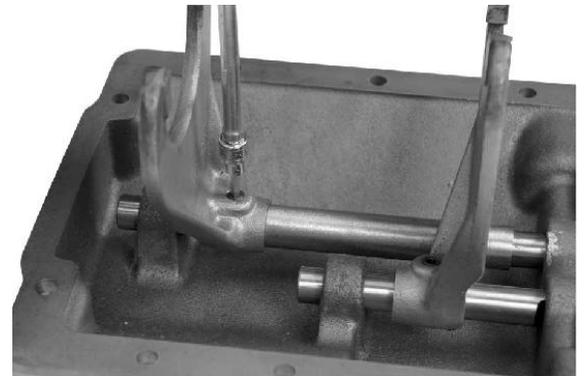
3. Align the set screw hole of the shift rail with the set screw hole of the fork. Secure the fork to the rail with the set screw. Torque the set screw to 40-50 lb. ft.



4. Drop the interlock into the interlock and poppet cross hole of the front boss. Make sure interlock seats in neutral notch of the shift rail. Secure with the poppet hole plug.



5. Assemble the 1st-2nd speed shift rail and fork to the housing. The long hub of the fork goes to the front. The long stop sleeve to the front and the short stop sleeve to the rear of the fork.



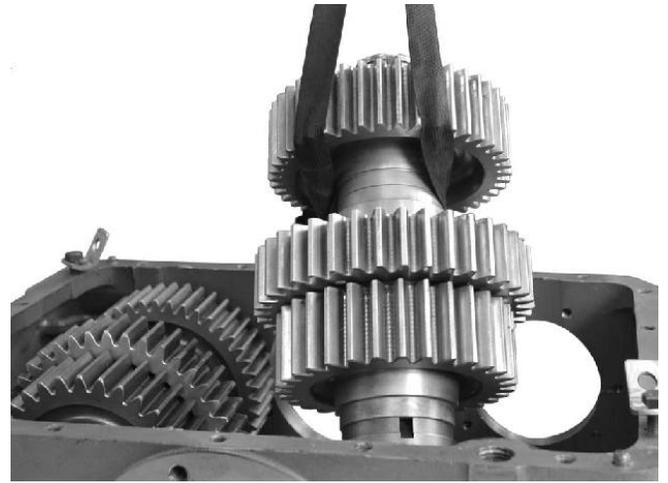
6. Align the set screw hole of the rail with the set screw hole of the fork. Secure the fork to the shift rail with the set screw. Torque the set screw to 40-50 IDS. Ft.

7. Assemble the poppet ball and poppet spring into the access hole of the housing. Secure with the poppet hole plug. Check the shifting of both rails in and out of their neutral position to make sure they travel freely and completely into all shift positions.

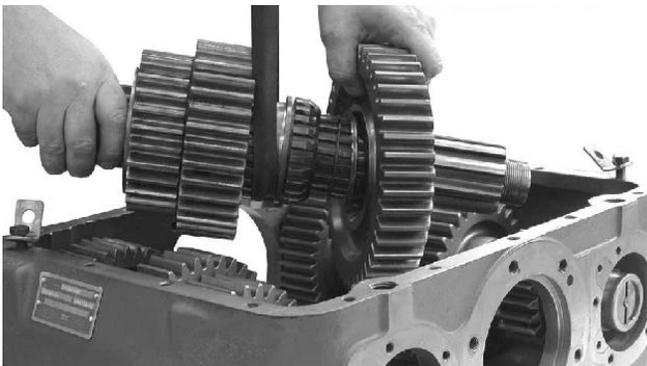




1. Use notch as reference point for timing marks on head end gear.



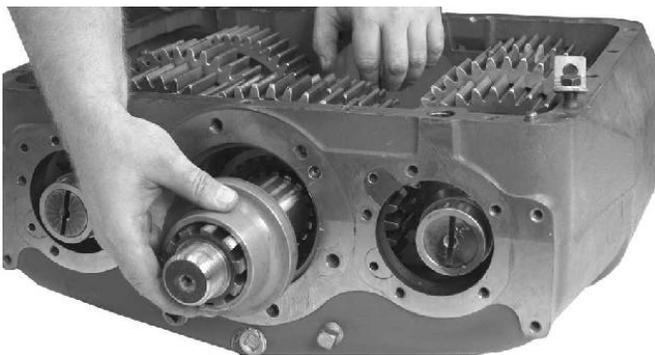
2. Install countershaft subassemblies. Try to keep the timing marks (notch) toward the center of the case. This timing mark must be mated to the drive gear timing mark later in assembly. Do not install countershaft front or rear bearings at this time.



3. With a sling placed around the 1st-2nd speed shift collar and the use of a light chain hoist, lower the mainshaft assembly into position in approximate center of the case rear bore.



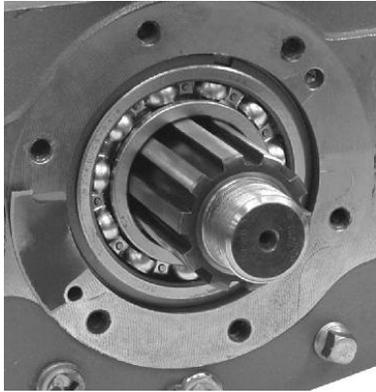
4. Leave the hoist and sling in place for support on the mainshaft in its position until the drive gear assembly and mainshaft rear bearing have been assembled into the case. Place the 3rd-4th speed shift collar on the mainshaft.



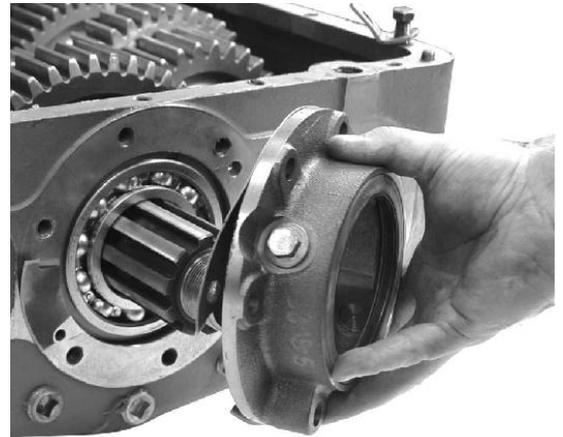
5. Place the mainshaft gear spacer on the shaft with the large flat side going against the hub of the 1st-2nd speed gear.



6. Install the front drive gear and bearing cap assembly with gasket into the front case bore and onto the pilot stem of the mainshaft. Torque the capscrews to 60-80 lbs. Ft.



7. Use a piece of tubing or suitable driver to drive on the inner race of the mainshaft rear bearing. Seat the outer snap ring on the bearing against the main case counterbore.



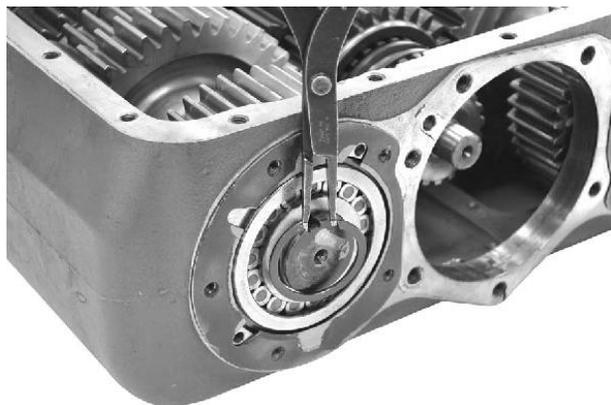
8. If the speedometer driven gear was removed from the bearing cap, assemble it at this time. Inspect and replace the mainshaft rear bearing cap oil seal if necessary. Align the oil port holes to the return holes on the bearing cap. Install the rear bearing cap with gasket on the mainshaft rear bearing and case face. Torque the capscrews to 60-80 lbs. ft.



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



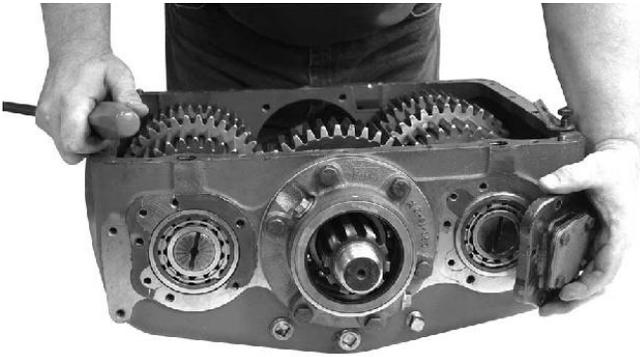
10. Install the countershaft front bearing onto the countershaft. Install the other front counter-shaft bearing in the same manner. Make certain timing marks of countershaft head end gear and drive are still in mesh.



11. Install the countershaft front bearing retaining snap rings.



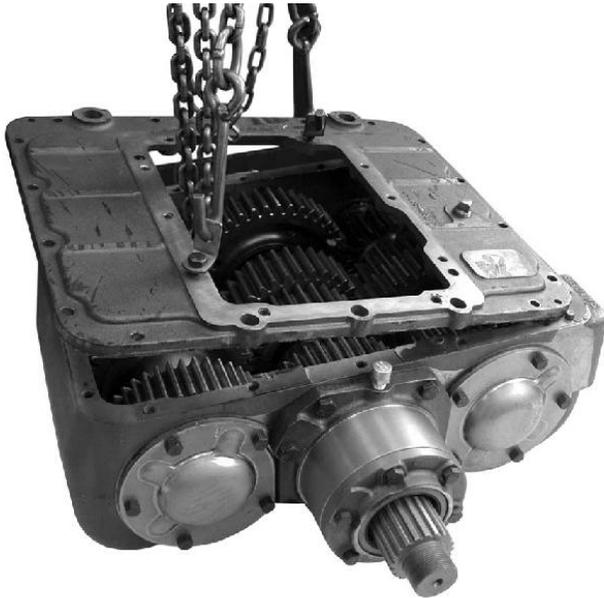
12. Install the countershaft front bearing caps with gaskets to the case face. Secure the caps with the capscrews and torque to 25-32 lbs. Ft.



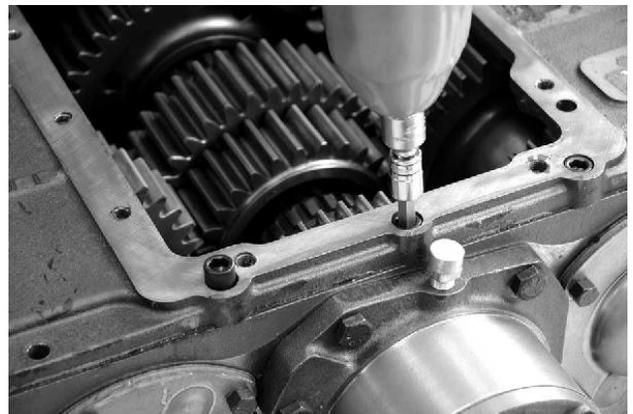
13. Install outer race and roller assembly of the countershaft rear bearing onto each shaft. Tap the bearing outer race with roller assembly onto the inner race and into the case bore of each countershaft. Install the countershaft rear bearing caps and gaskets onto the case. Secure with capscrews and torque to 25-32 lbs. ft.



14. Shift the 1st-2nd and 3rd-4th speed shift collars into gear, locking it into two gears. Install the end yokes onto the drive gear stem and mainshaft splines. Install the washers on the shafts with the locknuts. Use a 2 9/16" socket wrench to torque the drive gear shaft and mainshaft locknuts to 550-600 lbs. ft. Move the 1st-2nd shift collar to the neutral position. Turn the drive gear end yoke to roll the gear train. If the teeth timing marks are in their correct position the entire gear train will roll freely. If the timing teeth have not been set correctly, or have escaped from their proper position, the gear train will lock-up after several turns of the drive gear. If this happened, the shafts must be retimed. If the timing is correct, move the 3rd-4th shift collar to the neutral position and proceed with the final installation of the shifter housing.



15. Install adapter plate and gasket.



16. Install the three Allen head cap screws.



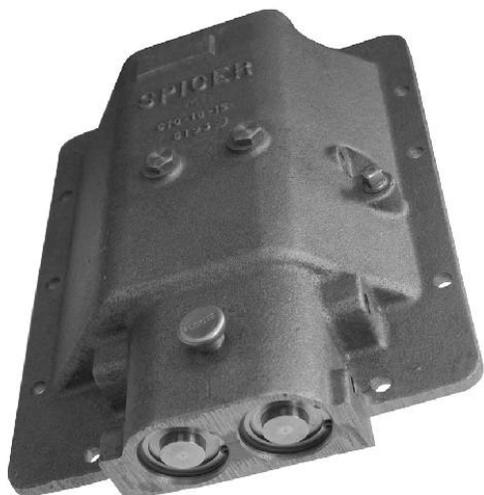
17. Install cap screw. Torque cap screws to 25-32 lb. ft.

IMPORTANT

We recommend using a torque wrench for verification of the specified 550-600 lbs. ft. torque on the input and output shaft lock-nuts.

Air Shifted

APO1000-4 & 1750-4



1. Remove the two air connectors and two elbows at the front of the shifter housing.



2. Remove the two retaining plugs and stop pins from the top of the shifter housing.



3. Remove the snap ring from in front of the piston cylinder cap.



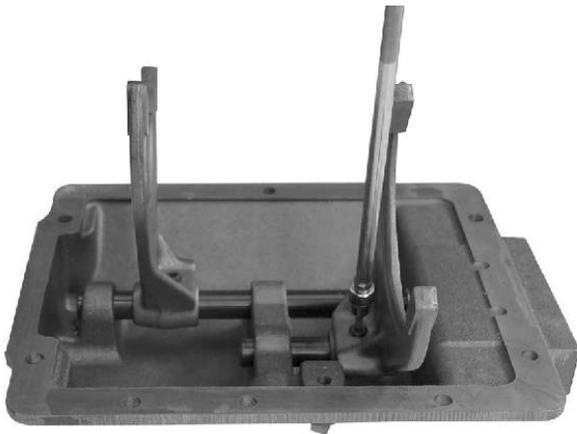
4. Remove the piston cylinder cap with "0" ring and washer. Follow the same procedure for the adjacent shift rail.



5. Remove the snap ring from inside each of the piston housing bores.



6. Also remove the locknut from the 3rd-4th piston rod.



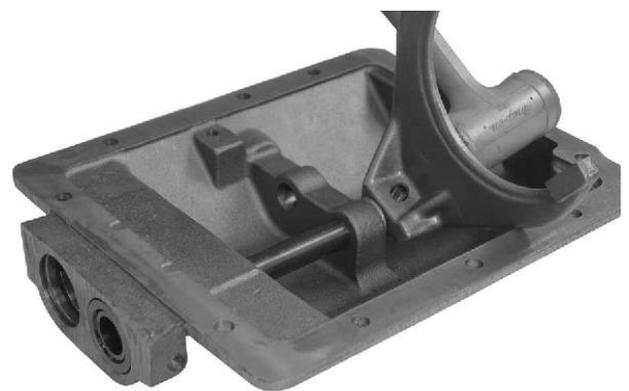
7. Now remove the set screw holding the 3rd-4th speed shift fork to the piston rod.



8. Use a brass drift to drive the 3rd-4th speed piston rod forward. As the rod comes forward, the internal piston can be removed from the front of the housing. The piston rod with the brass piston rod bushing can also be pulled from the front of the housing.



9. Remove the locknut from the 1st-2nd speed piston rod



10. Use a soft mallet to drive the 1st-2nd speed piston rod forward.



11. Remove the set screw holding the shift fork to the piston rod. Take the shift fork from the piston rod. The internal piston with the front external piston can be removed from the end of the rod. Remove the 1st-2nd speed piston rod with the piston rod brass bushing from the housing.



12. The piston rod with brass piston rod bushing and the internal piston.



13. Remove the cylinder snap ring from the bore of the piston housing.



14. Remove the rear external piston from the piston housing bore. Repeat the same procedures at the adjacent piston side.



15. Remove the two external piston "O" rings in each of the piston housing bores.



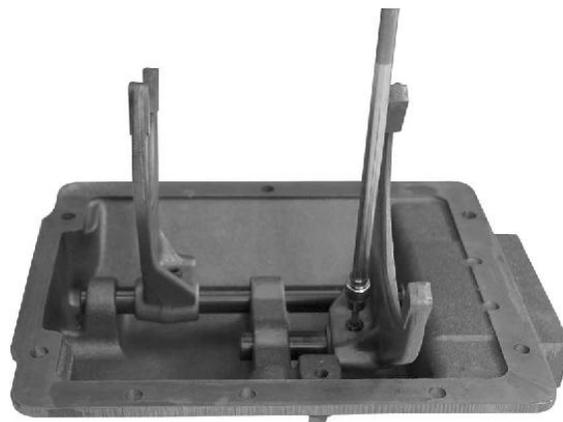
1. Inspect and replace all damaged or worn "O" rings before reassembly of the cover



2. Place the 1st-2nd speed piston rod into the shifter housing. Place the 1st-2nd speed shift fork on the piston rod with the long hub toward the front. Place the brass internal piston rod bushing on the end of the rod. Check and make sure the interlock is still in the cross hole between the rods.



3. Secure the shift fork to the piston rod with the set screw. Torque the set screw to 40-50 lbs.ft. Use a suitable driver to drive the piston rod bushing into the piston housing bore. Flange on bushing will seat against the face inside the piston housing bore.



4. Repeat the same procedures for the adjacent piston rod fork. Place the rear outer piston "O" ring into each piston housing bore.



5. Place the rear outer piston into each piston housing bore.



6. Assemble a snap ring into each piston housing bore.



7. Assemble the front outer piston "O" ring into each piston housing bore.



8. Place the internal piston with the front outer piston assembled to it, into the bore and onto the piston rod. Repeat the same procedure for the adjacent piston rod. Secure the internal pistons on the piston rods with the locknuts.



9. Assemble the snap ring to each piston housing bore.



10. Assemble the cylinder caps with "O" ring and washer in each piston housing bore.



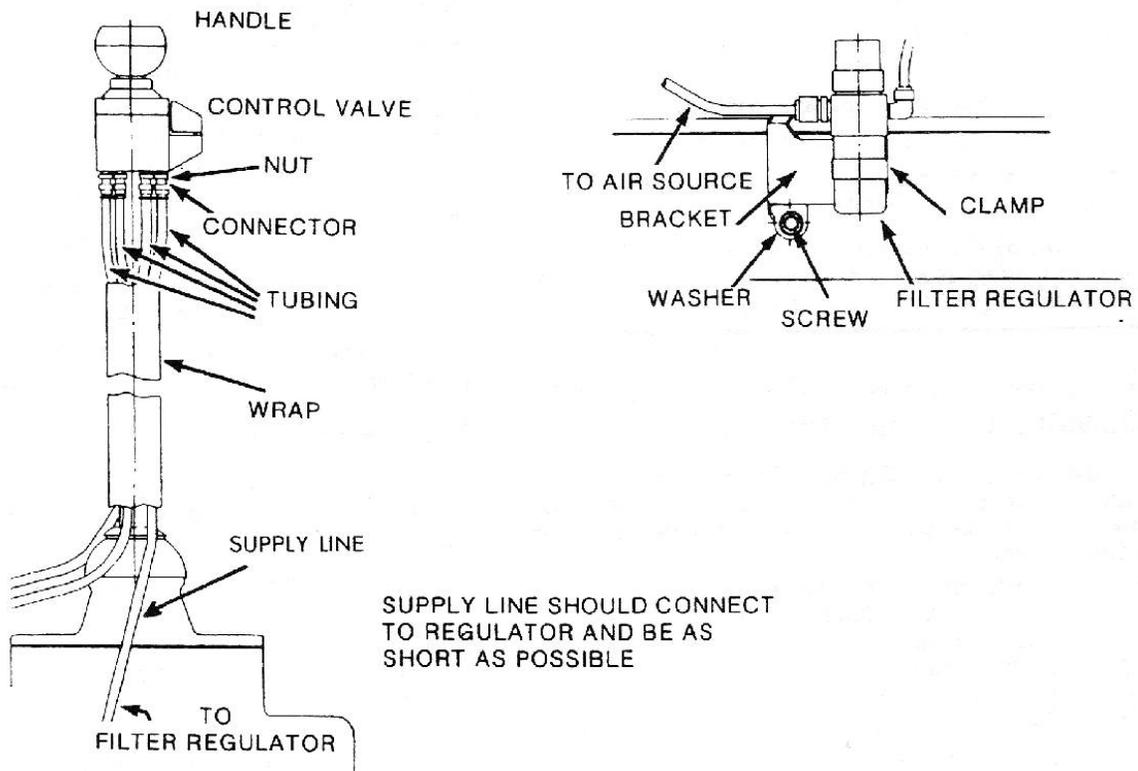
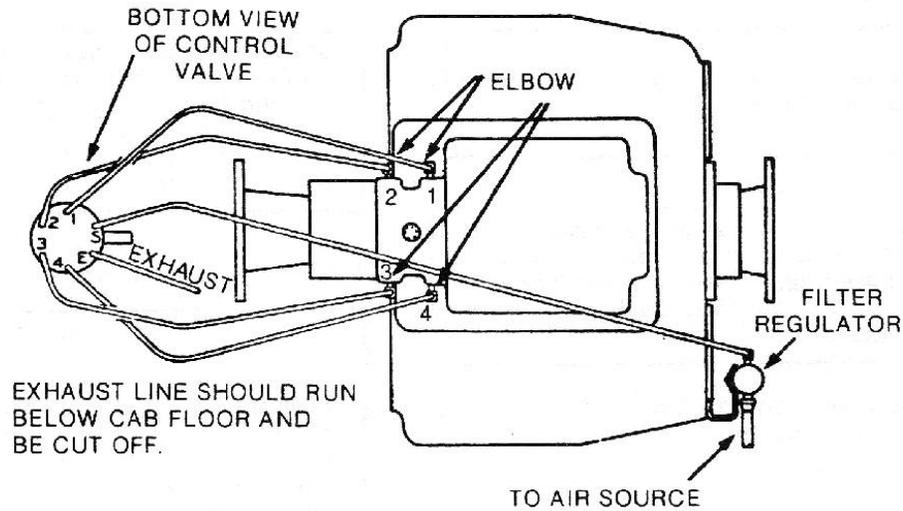
11. Place the snap ring at the front of each cylinder cap.



12. Place the stop pins and plugs in the top of the shifter housing. If remove reinstall air fitting to the front of the shifter.

Tubing Diagram

NOTE: ROUTE TUBING AWAY FROM HEAT. AVOID SHARP BENDS TO PREVENT KINKING. SECURE TUBING TO SHIFT LEVER.



Air Shifted

Removal of Air Control Lines:

1. Disconnect air line fitting from two air cylinders input ports.

Note:

Identify air lines as removed with tag or tape for convenience at time of reconnecting lines to cylinders.

- 1 == Lo-Gear \ On right side of case from
- 2 = Underdrive J driver's seat.
- 3 = Direct \ On left side from driver's
- 4 = Overdrive \ seat.

2. Tie air lines, two each, to the right and left side of the chassis frame.

Note:

This will eliminate damage to the plastic outer and most important, inner air lines from pinching or sharp bending. This will restrict or stop air passing through the lines when reconnected to the air cylinders.

3. Disconnect dry tank air line from the transmission air filter regulator.

REMOVAL OF AIR LINES:

Note:

If repair and replacement of "O" Rings in shift cylinders is required refer to Spicer parts list catalog for "O" ring kit required.

Disassembly Of Air Control Valve Assembly On Shift Lever:

1. Disconnect all fittings from beneath the control valve. Using tape that can be written on, identify each line with the air port involved, per the following:

(E) . . . Air Dump, or discharge line

- 1) . . . Lo Gear Air Charge Line
- 2) . . . Underdrive line
- 3) . . . Direct line
- 4) . . . Overdrive line
- 5) . . . Neutral Charge line

2. Remove shift knob from top of control valve. Remove control valve from shift lever.

Disassembly and Reassembly of Shift Selector Control Valve:

1. Remove three cap screws and lockwashers and remove valve top.

Note:

Top of valve is preloaded by a rotor pressure spring.

2. Displace pressure spring.

Note:

Mark with red pencil, or ink the tab location of the top rotor cam with relation to the main valve body. Note that these rotor tabs are held in solid location to slots in the valve top. Tab location to main valve body is important when reassembling the whole valve unit and its correct function.

3. Remove top rotor and plastic rotor in valve body by pulling upward on selector finger.

Note:

As rotor moves out of valve body, a small plunger will pop out from side of the rotor. Remove plunger and preload spring from rotor body. Remove the rotor completely from the valve body.

4. Inspect all "O" rings on rotor body and small plunger for wear, cuts, etc.

Note:

If "O" ring repair and replacement is required refer to Spicer parts list catalog for "O" ring kit required for selected control valve.

Reassembly of Control Valve:

Note:

It is recommended that "O" ring lubrication be used on "O" rings before reassembly of rotor into the valve body.

1. After replacing all "O" rings on rotor and side plunger, assemble side plunger spring and plunger into the rotor.

2. Insert rotor into valve body diameter. Preload side plunger in correct location to body diameter.

Use CAUTION: DO NOT PINCH "O" RINGS.

3. With rotor fully installed in valve, place selector finger of rotor in "E" position at bottom of valve.

Air Shifted

4. Place top rotor in correct position. Locate tabs in line with red ink or pencil marks put on valve at disassembly.
5. Place pressure spring on top of rotor. Place valve top on pressure spring with "N" or Neutral located in alignment with selector finger.
6. Preload top of valve. Reassemble lock-washer and capscrews to top. Tighten capscrews firmly.
7. Check valve operation by placing selector in each position on valve top from neutral through number 4 position and back to neutral (N). Make sure that finger locks into each position noted.

Note:

If selector finger moves into any position with very little force, it indicates top plastic rotor is not locating correctly, because it has excessive wear on the cam teeth of the top rotor to the main rotating rotor or the pressure spring is weak or broken.

Assembly of Shift Lever Control Valve:

1. Assemble jam nut to shift lever. (Turn down to last thread.) Assemble control valve shift lever threads and lock in position with jam nut. Assemble shift lever knob to top of control valve.
 2. With air lines identified with tape at disassembly, connect proper air line identified to proper valve port E, 1, 2, 3, 4, S.
- CAUTION: Do not over tighten fitting as it could collapse the plastic inner air line and pinch off air supply.*
3. Place control valve selector finger in neutral (N) position.
 4. Assemble pressure regulator to bracket with clamp.
 5. Locate regulator on right or left side of main transmission shift cover. Secure bracket to shifter cover with lockwashers and capscrews. This may vary depending on the O.E.M. vehicle installation.
 6. Connect DRY TANK air supply line to filter regulator port.

7. Connect plastic line Number 5 from cab valve control to air regulator unit "OUT" port.

All air lines have now been properly hooked up throughout air controls of units.

Check Air Operation of Rear Unit After Complete Reassembly of Air Controls into unit and Cab:

Main unit shift lever and the auxiliary unit air control valve are now in neutral position (N). Start engine and build up cab pressure of 100-120 P.S.I.

Note:

If air pressure gauge was installed at air regulator, check regulated air pressure coming through rear unit control system. Air pressure for control of rear unit shifting must be 50-55 P.S.I.

1. With proper air pressure build up for shifting auxiliary, shut off the engine. Check for any possible air leaks in the cab control valve, also filter regulator, at shift cylinders air line fittings.
2. If no air leaks are found in the air system, select position 1 (Lo) on cab shift lever control.

Note:

Check shifting before connecting the auxiliary to axle driveline. Thereby, transmission end yoke can be turned by hand to allow engagement of transmission shift collar teeth to mating gear teeth for gear position desired to check out air shift system.

3. Select position number 2 on shift lever control. Check air cylinder shift finger to be sure it has made a full engagement in the transmission or that no hang up has occurred.
4. In turn, select positions number 3 and number 4.
5. Reverse position selection from number 4 to neutral (N). Check selection of gears again by this reverse movement of control valve selector finger to each position.
6. As each gear selection is made on the shift lever valve, (E) empty line will exhaust air from that particular line. This is done to dump the air from one side of the air cylinder while the other side of the cylinder is being charged with air for gear position required.
7. After the garage test is proven satisfactory for all shifts, the tractor should be road tested several miles to be sure that all shifts are operating correctly.

Note:

The APO1000-4& 1750-4 models use filter-regulator pre-set at 50-55 P.S.I. Use only petroleum base solvent to clean parts. Blow air through filter (inside to outside) to dislodge surface contaminants. Do not disassemble regulator section (9), as it is not field repairable.

MAINTENANCE:

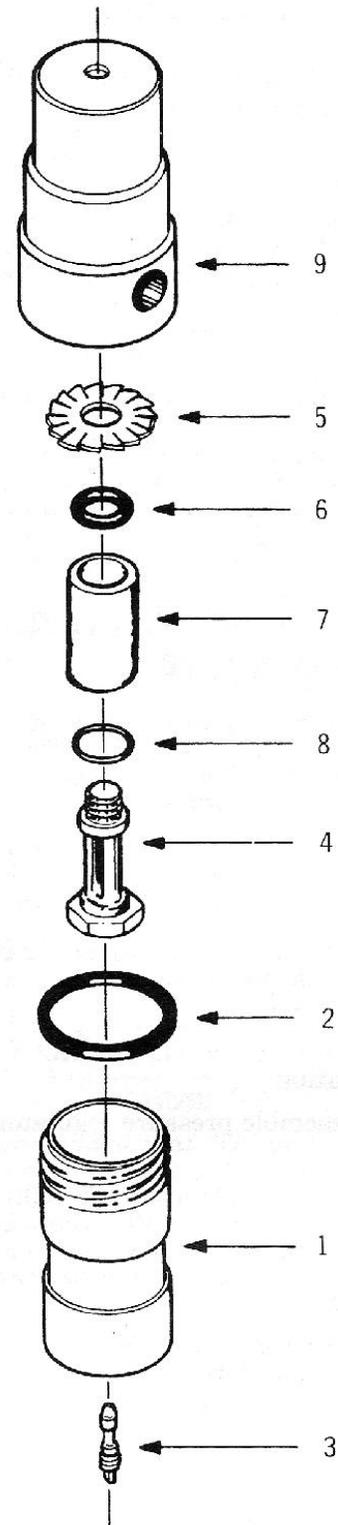
1. Clean or replace filter element (7) every six months to one year or whenever slow shifting is encountered. Element should be replaced after three cleanings. If regulator malfunction is indicated, replace entire unit.

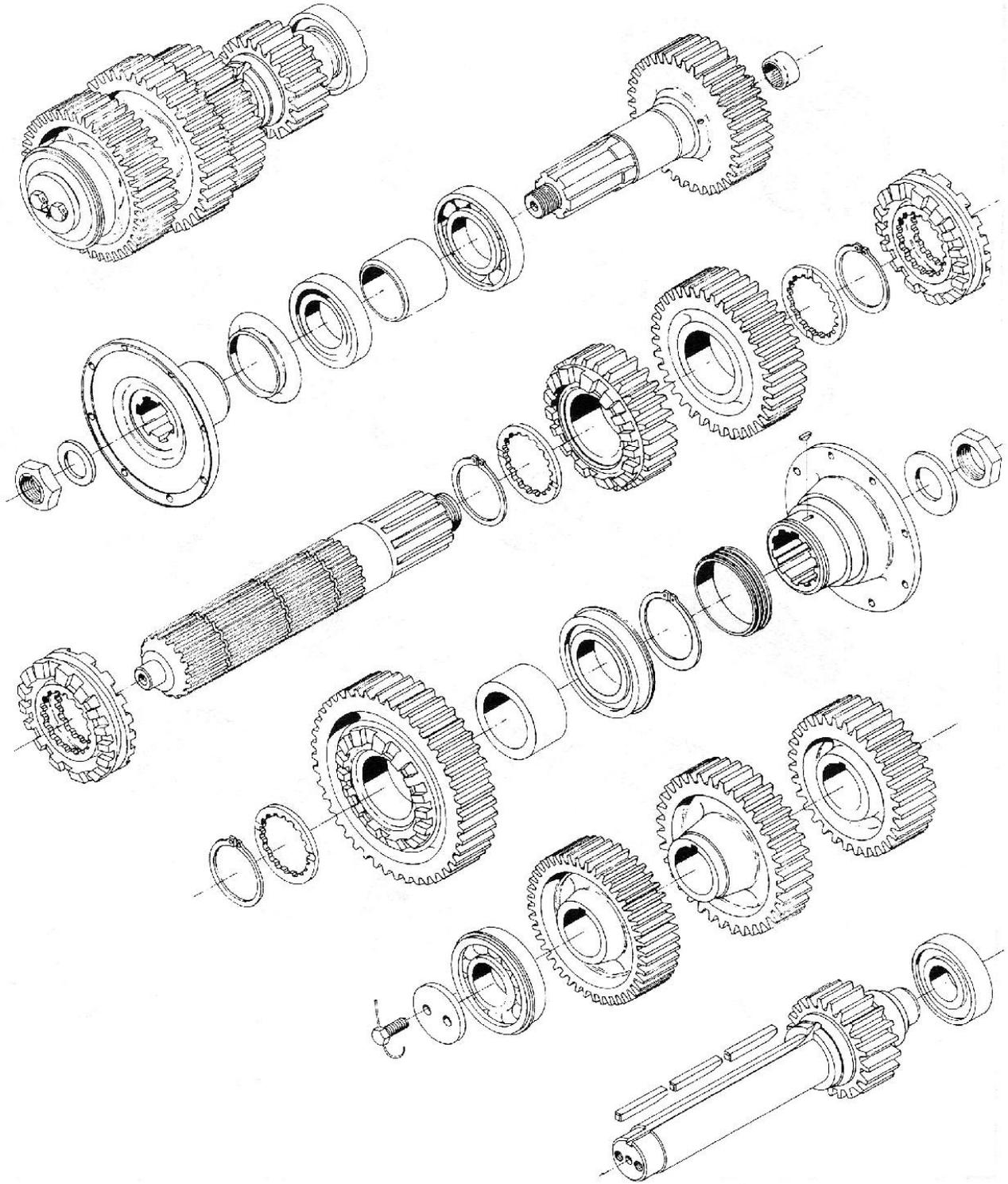
2. To service filter section, shut off air pressure. Unscrew bowl (1) and remove O-Ring (2). Unscrew stud (4). Remove louver (5), upper gasket (6), element (7), and lower gasket (8) from stud. Do not disassemble regulator section (9).

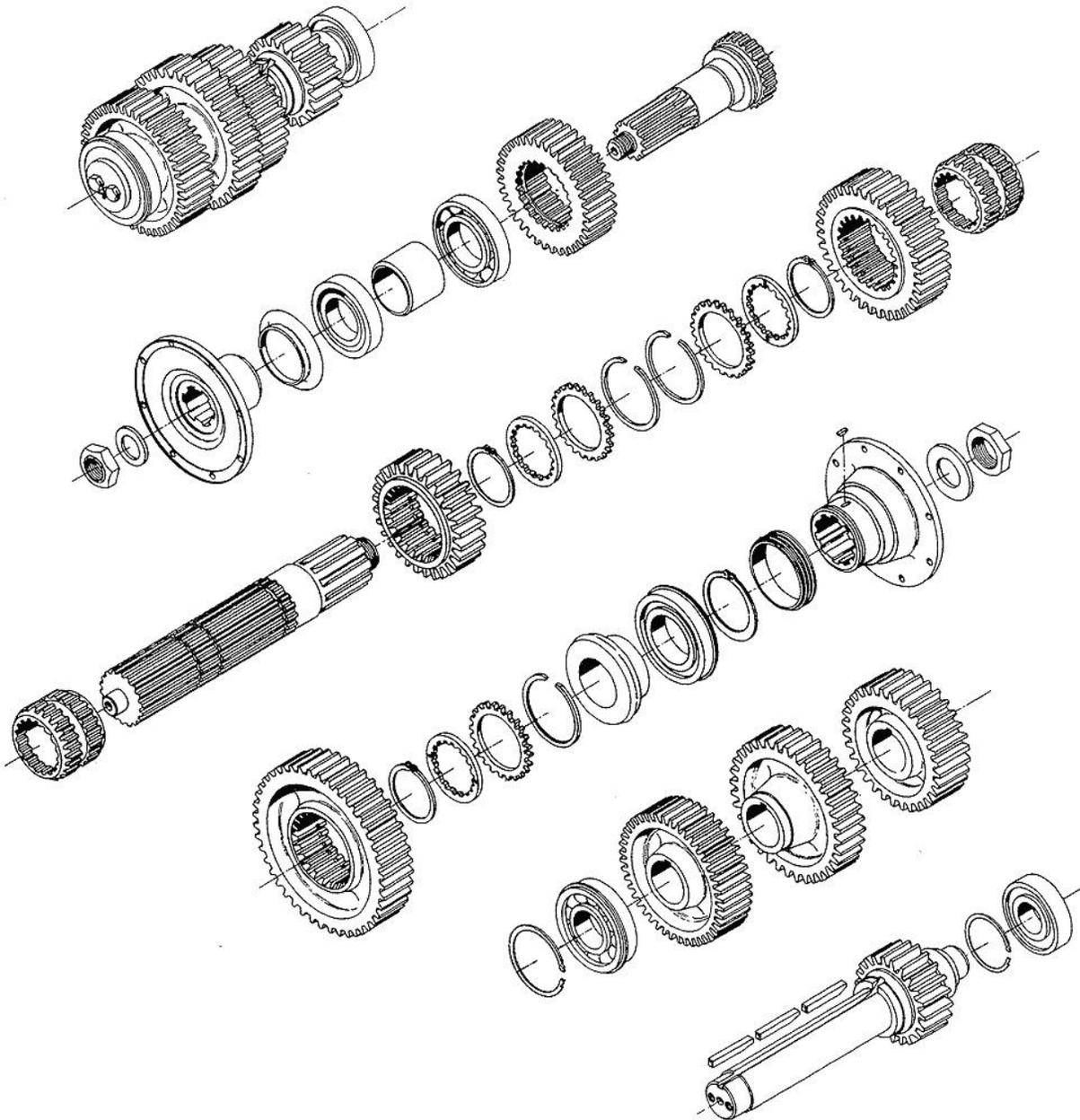
3. After cleaning, inspect parts carefully; replace any damaged parts.

4. Reassemble by installing element (7) on stud (4) so that large end of internal taper (thinnest wall section) is toward hex on stud. Torque stud to 5-10 inch pounds.

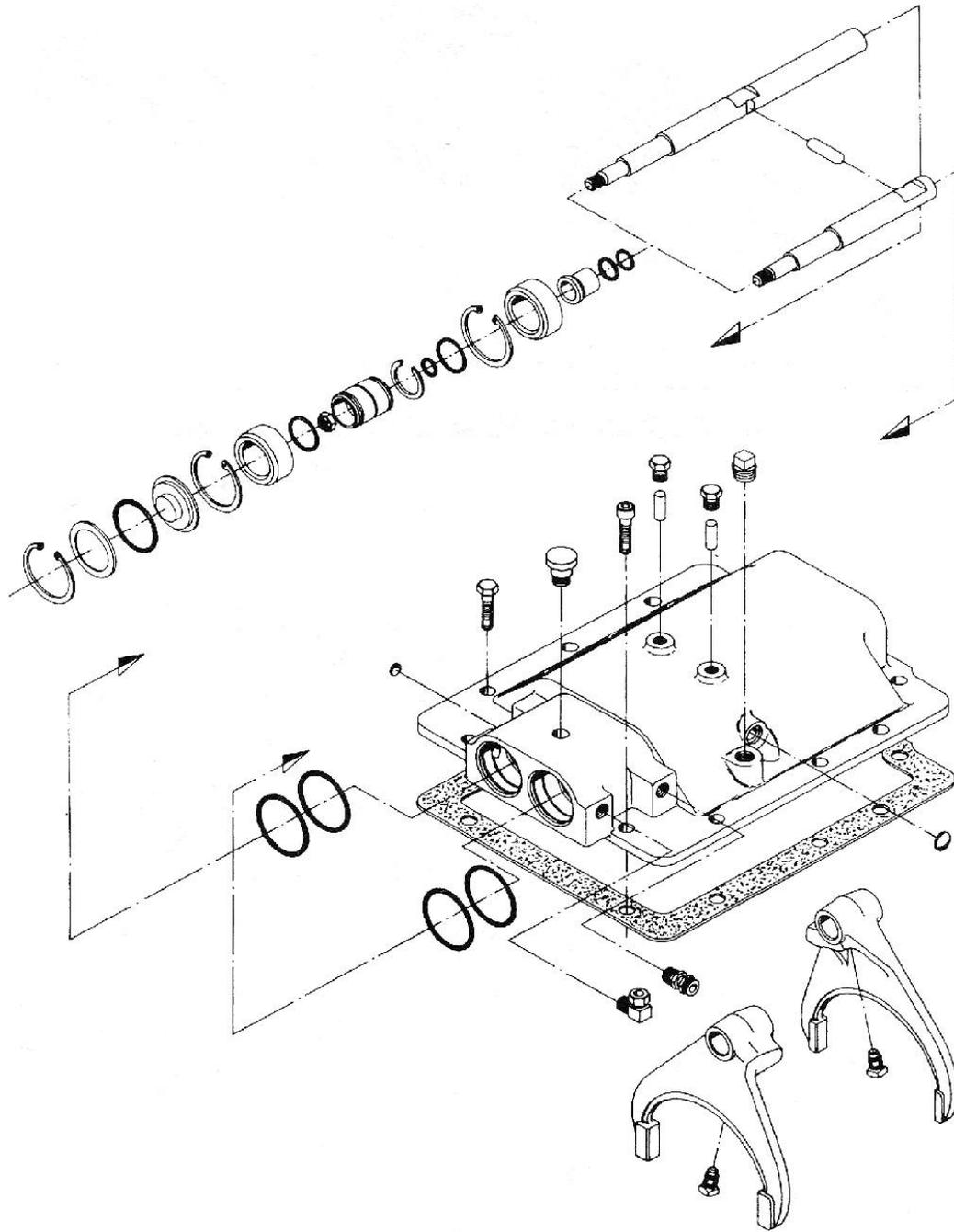
5. Apply a wipe coat of Dow Corning DC7 Silicone Grease (or equivalent) to O-Ring (2) seating surfaces on regulator (9) and bowl (1). Apply a light, even coat of Molykote "G" (or equivalent) to bowl threads. Torque bowl to 5-10 inch pounds. If drain valve (3) was removed, reinstall and torque to 10-15 inch pounds.

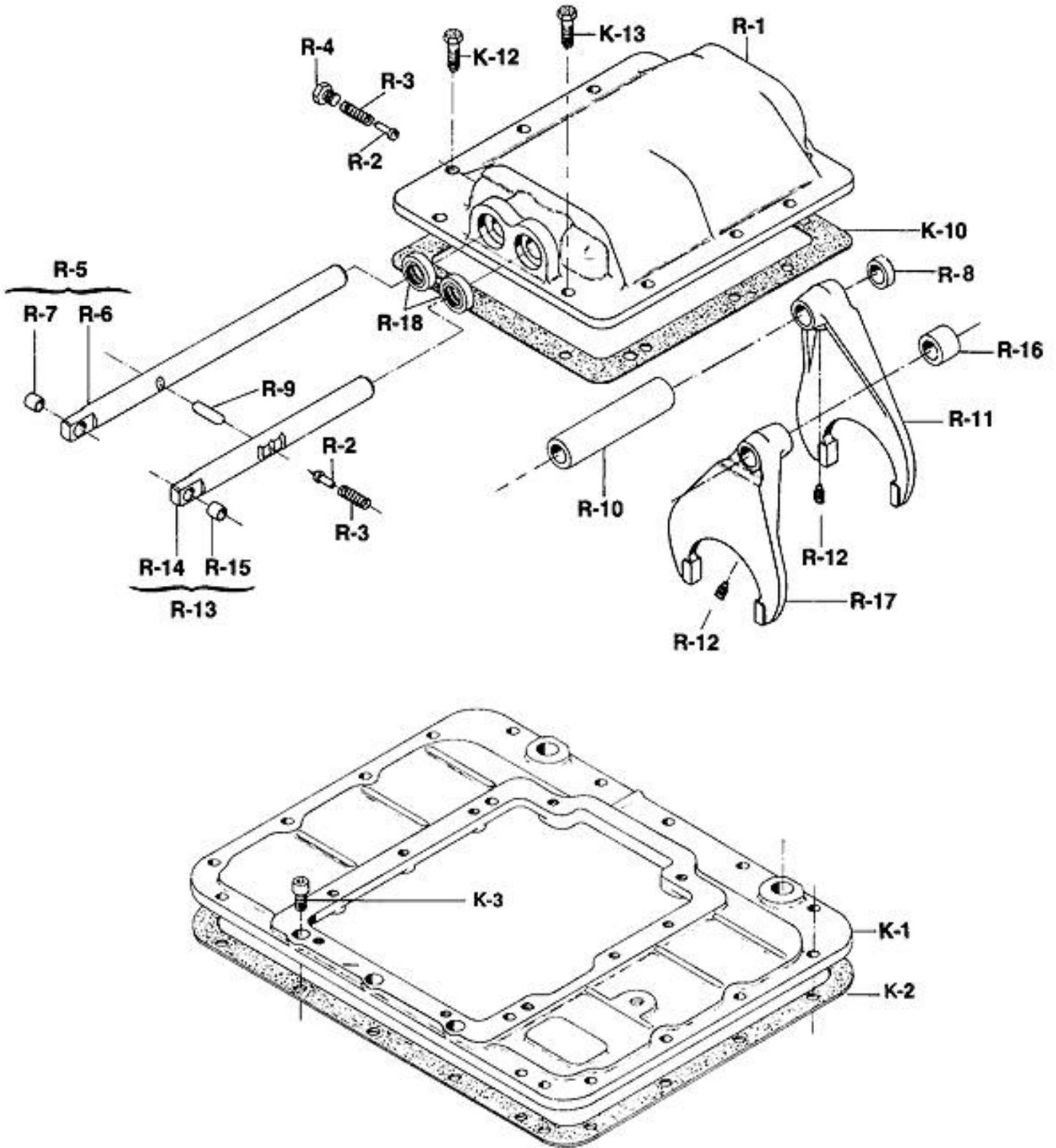




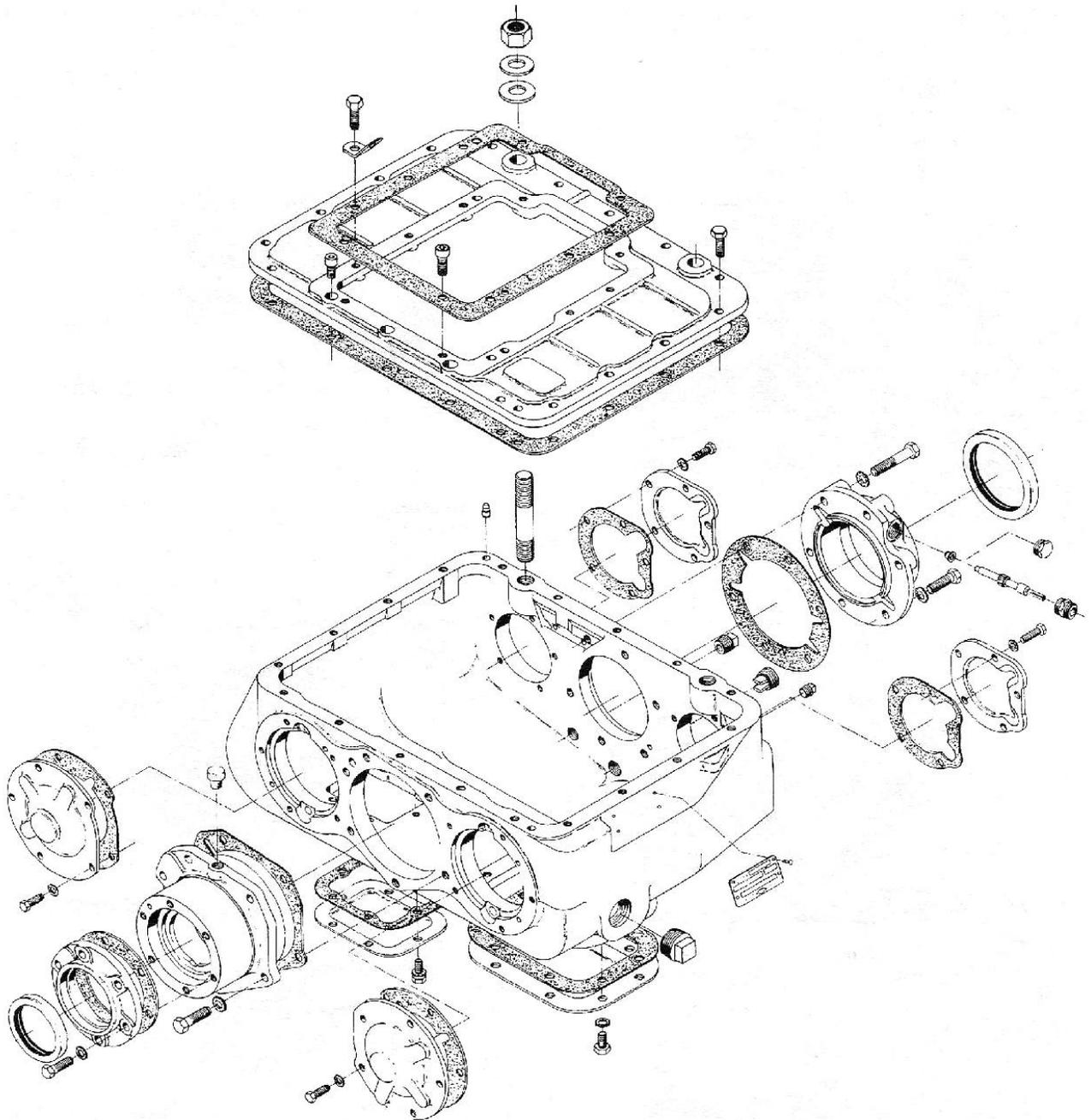


Shifter Housing Parts



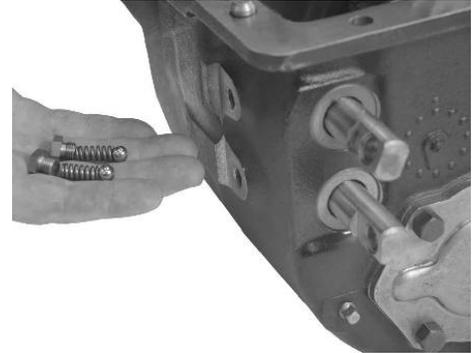
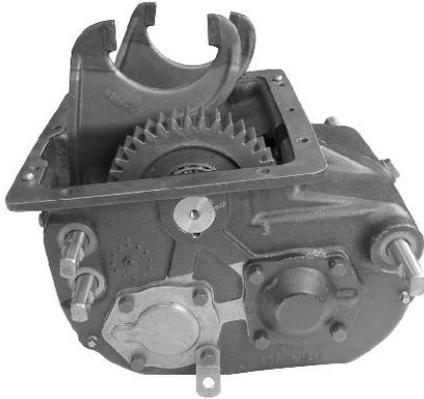


with Related Parts



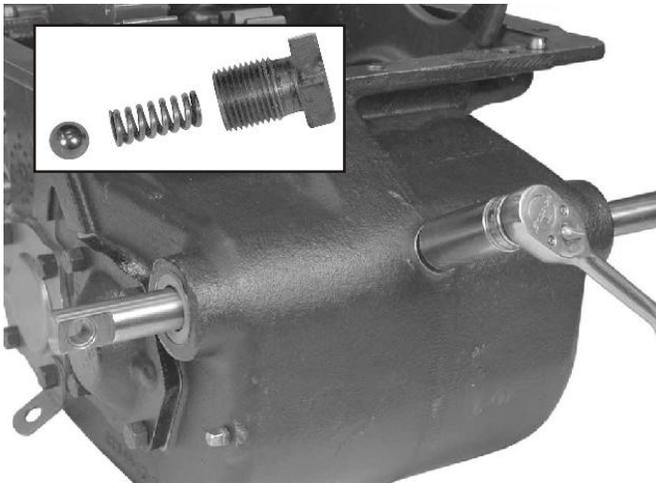
REMOVAL of TRANSMISSION SHIFT FORKS & INTERMEDIATE GEAR RELATED PARTS

The Top Mounted PTO comes with the output shaft facing to the front or to the rear. When reassembling the Top Mounting PTO, the desired direction of the output shaft can be attained by simply having the threaded end of the output shaft and the output shaft bearing cap (open end) assembled to the front or to the rear of the PTO.



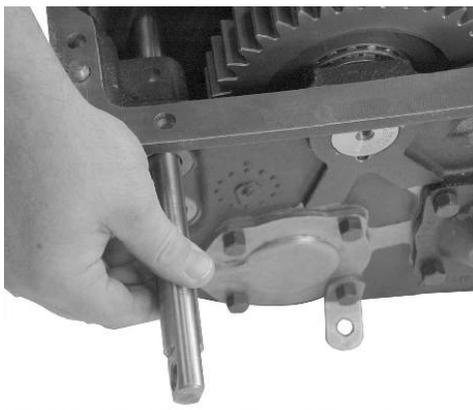
1. For disassembly, place the PTO on the bench with the forks upright. If the output yoke or flange has not been removed from the output shaft do so now.

2. Remove the poppet plugs, springs and balls from the transmission shift rod poppet holes.



3. The retainer, poppet spring and ball is removed from the output shift rod poppet hole.

4. Remove the set screw holding the shift fork to the shift rod. Pull the shift rod from the fork and out through the front of the case.



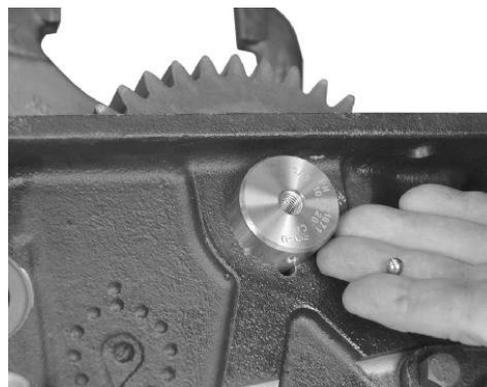
5. Pull shift rod from fork and through the front of the case.

6. Remove the nut and washer from the rear of the intermediate shaft.

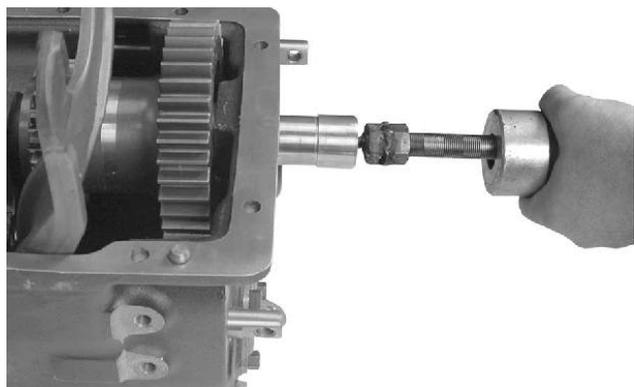
REMOVAL of TRANSMISSION SHIFT FORKS & INTERMEDIATE GEAR RELATED PARTS



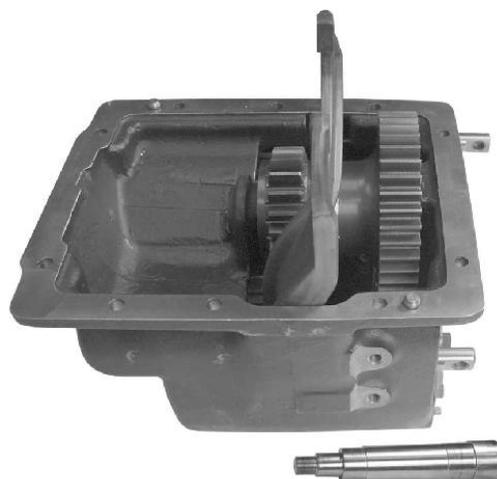
7. Use a brass punch to drive the intermediate shaft forward. Be careful no to damage the threads on the end of the shaft.



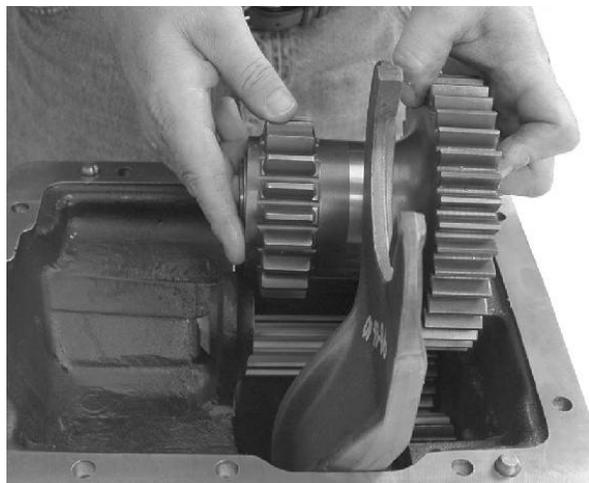
8. While driving shaft out - catch ball coming out of the front of shaft - also catch the shaft.



9. If the intermediate shaft does not readily move free of the case bore, a ram type puller can be used to pull the shoulder of the shaft from the bore of the case.



10. The shaft is removed from the intermediate gear and case.

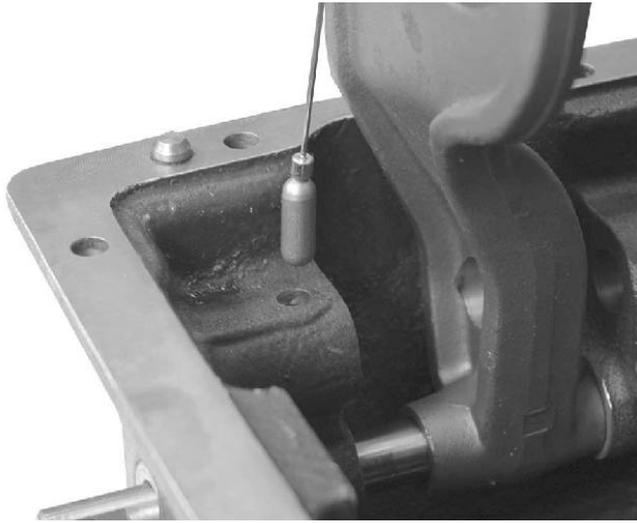


11. Lift the intermediate gear and front washer out of the case.

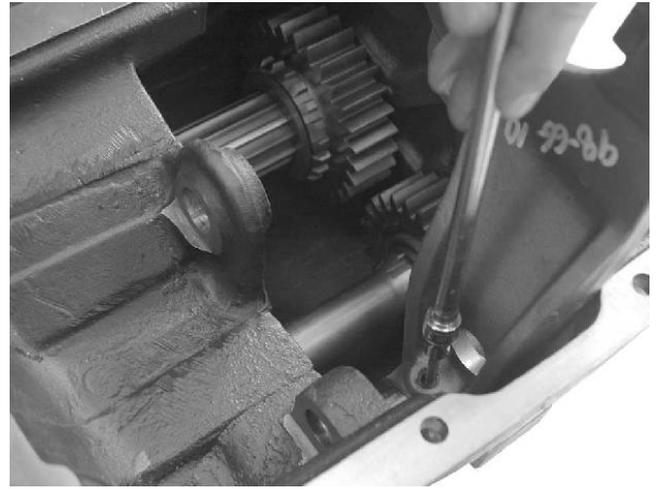


12. If the bearing cones or bearing cups are damaged and need to be replaced, use a brass drift to drive the bearing cups from the inside out of the gear bore.

REMOVAL of TRANSMISSION SHIFT FORKS & INTERMEDIATE GEAR RELATED PARTS



13. Use a magnet or turn the case on its side to remove the interlock pin from the interlock hole.



14. After removing the set screw from the transmission shift fork, slide the shift rod from the fork and out through the front of the case.



1. The four cap screws holding the reverse shaft, rear bearing cap can be removed.



2. The reverse shaft rear bearing cap and gasket is now off the case. The four cap screws holding the reverse shaft front bearing cap can be removed.



3. Remove the reverse drive gear snap ring from the snapping groove to the center of the shaft.



4. Move the reverse shaft forward until the outer race with cylindrical roller bearings comes out of the case bore.



5. Lift the reverse shaft assembly up and out of the case.

Note:

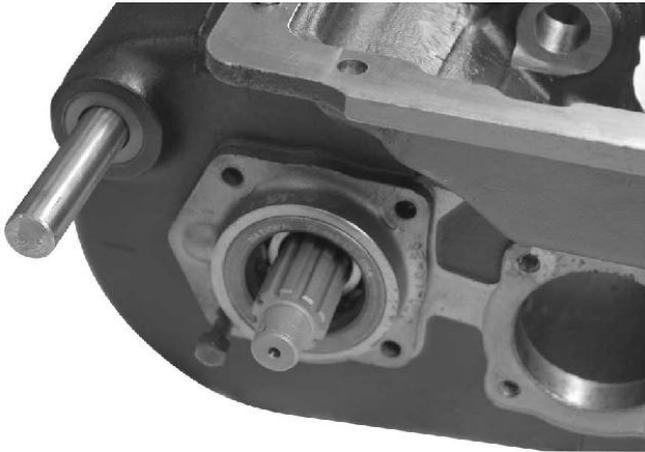
The reverse gear and reverse drive gear hub faces seat against the snap rings held in place by the bearing inner races. For easier removal of the snap rings, tap each gear to the outside until the snap ring turns freely in the groove.



6. With the aid of a small arbor press and by supporting the gear with parallel bars, the bearing inner race can be removed from each end of the shaft. If the snap rings have been distorted, remove them from the shaft and replace with new snap rings.



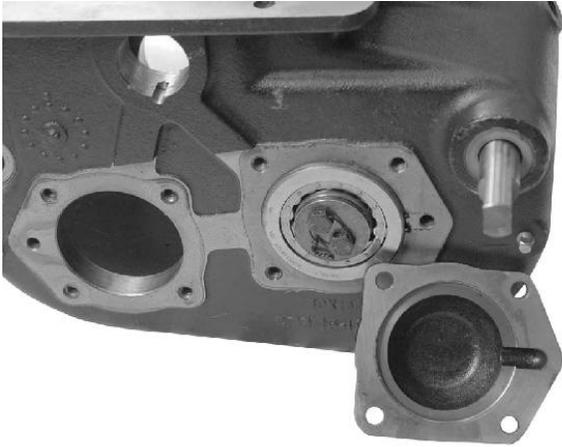
7. Use a soft hammer to tap the reverse shaft rear bearing outer race and rollers from the case bore.



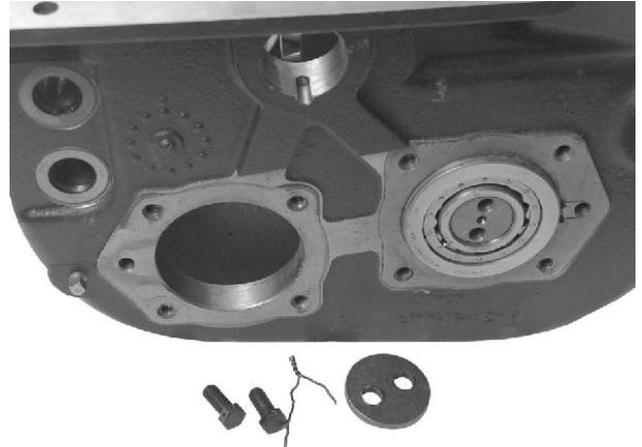
8. Remove the four capscrews from output shaft bearing cap.



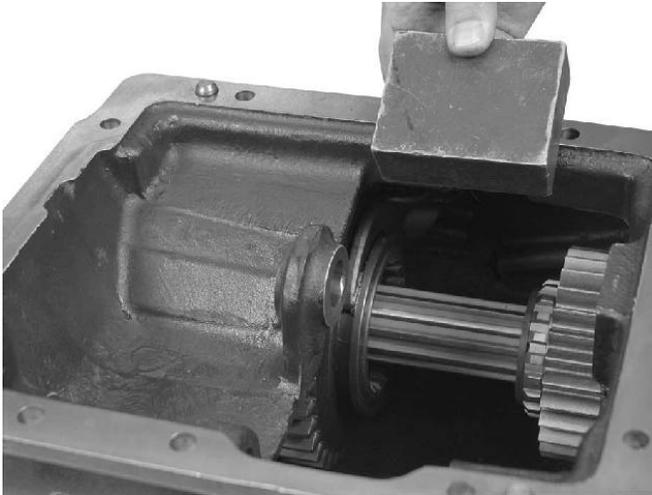
9. The output bearing cap and gasket is then removed from the case. Inspect and replace the output bearing cap oil seal if worn or damaged.



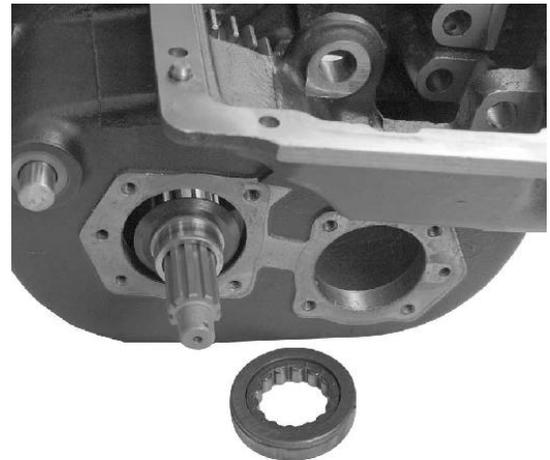
1. Remove the four capscrews from the output shaft rear bearing cap.



2. The bearing cap and gasket is removed from the case. Remove the lockwire and two capscrews holding the rear bearing retaining washer to the shaft.



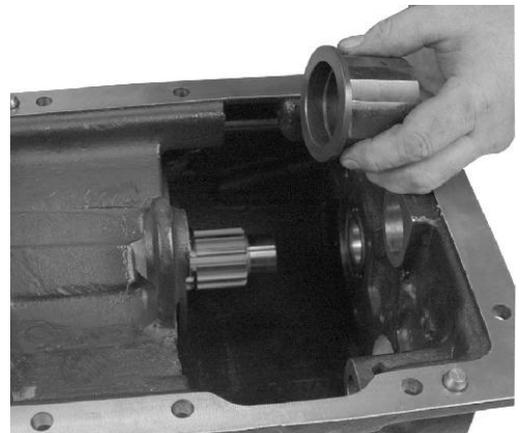
3. Here a piece of flat stock 3" x 6" and 1/2" wide is placed between the hub of the output sliding gears and the shoulder of the output drive gear sleeve. As the output shaft is moved to the rear, the bearing outer race with rollers will come out of the rear case bore.



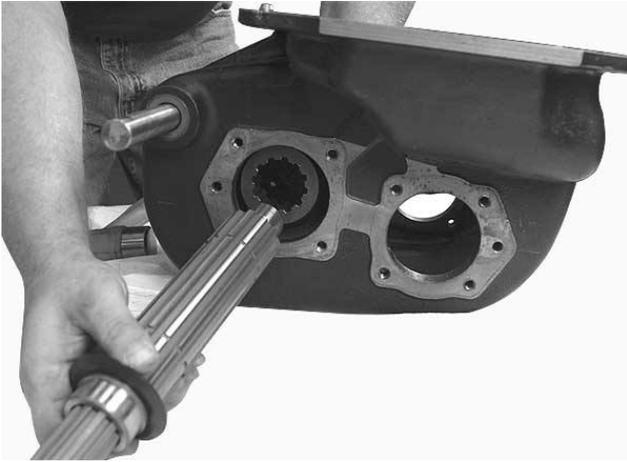
4. Use a soft mallet to drive the output shaft rearward and through the output gear sleeve. When the shaft is moved far enough to the rear so as to expose the lock ring, which is in the groove of the shaft and seats against the inside shoulder of the sleeve, remove the lock ring from the groove toward the front of the shaft.



5. The two-piece bearing and bearing washer on the front of the output shaft are removed as the shaft is driven rearward.



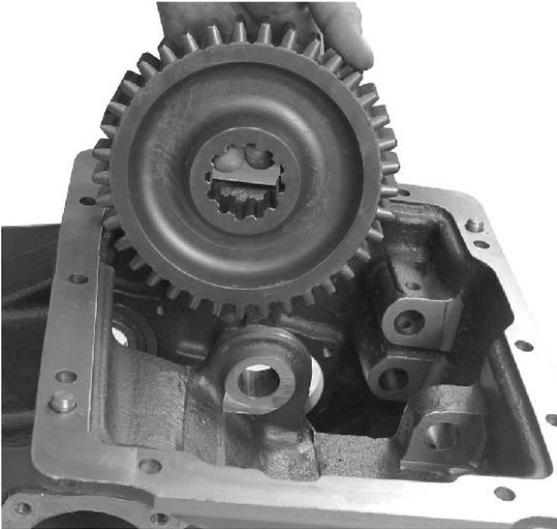
6. Once the output shaft has been driven free of the output gear sleeve, the output gear, lock ring and sleeve can be lifted out of the case. The output shaft can be slid out through the rear of the case.



7. The output shaft rear bearing inner race can be removed from the shaft with the aid of a small hand press.



8. Remove bearing inner race and bearing washer from the shaft.

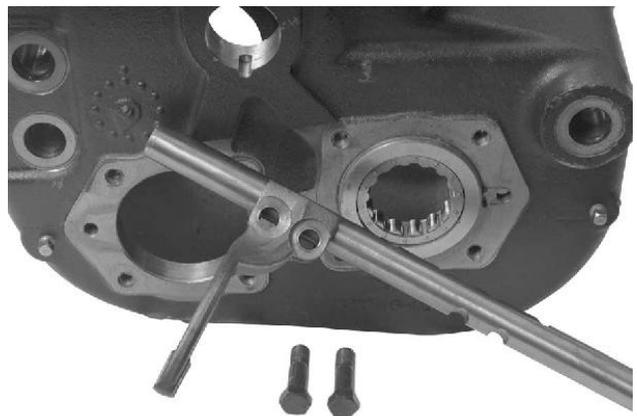


9. The output sliding gear can be lifted from the bottom of the case.



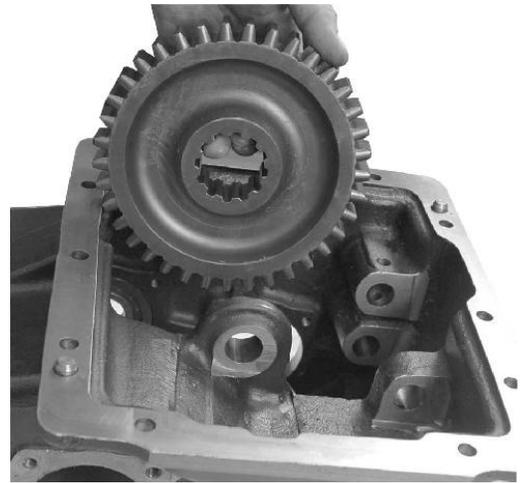
10. Remove the two cap screws holding the output sliding gear shift fork to the shift rod.

11. Slide the rod out through the case front and remove the shift fork from the case as the rod passes out of the fork. Inspect the four shift rod oil seals and if they are damaged or worn, remove them from the case and replace them with new seals.

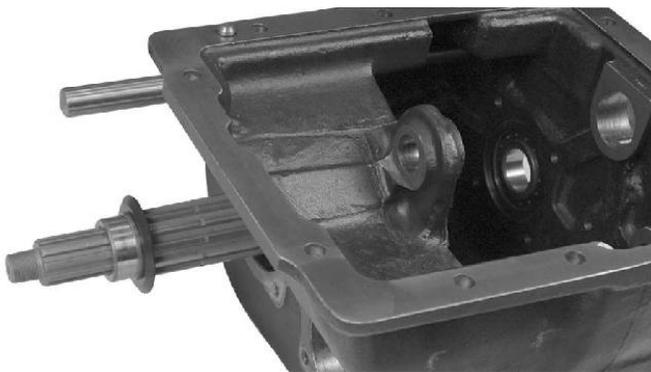




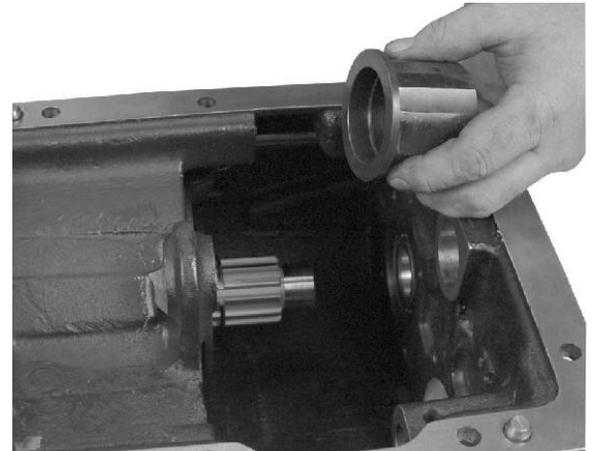
1. Assemble the output slide gear shift fork to the shift rod with the two cap screws. The spot face on the shift fork facing out. Torque the two cap screws to 40-50 lbs. ft.



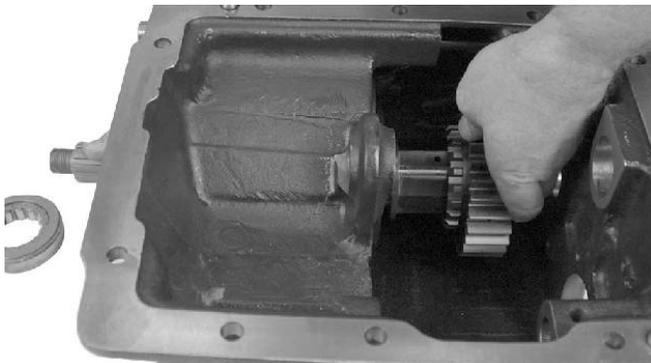
2 Place the output slide gear in the case with the fork slot toward the front.



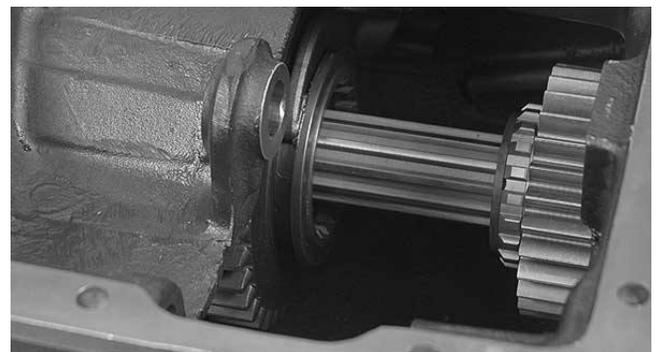
3. Slide the output shaft through the rear case bore. Align the spline of the output shaft with the splined bore of the slide gear and move the shaft on through the gear until the snap ring rests against the hub of the output slide gear. Check to make sure the sleeve pin is aligned to one of the grooves in the output shaft spline.



4. The output gear snap ring and the output gear sleeve are to be started on the threaded end of the output shaft. Do not secure them all the way on the shaft at this time.



5. Place the output drive gear over the output sleeve on the shaft. The clutch teeth on the gear hub face toward the output slide gear.



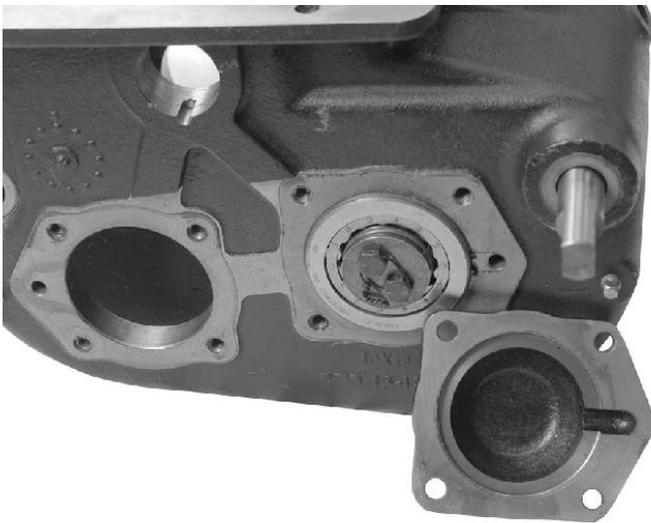
6. Move the output shaft and gear assembly to the front of the case. Use a soft mallet to drive on the rear of the output shaft. Drive the shaft forward until the snap ring is seated in the snapping groove of the shaft and against the shoulder in the bore of the output gear sleeve.



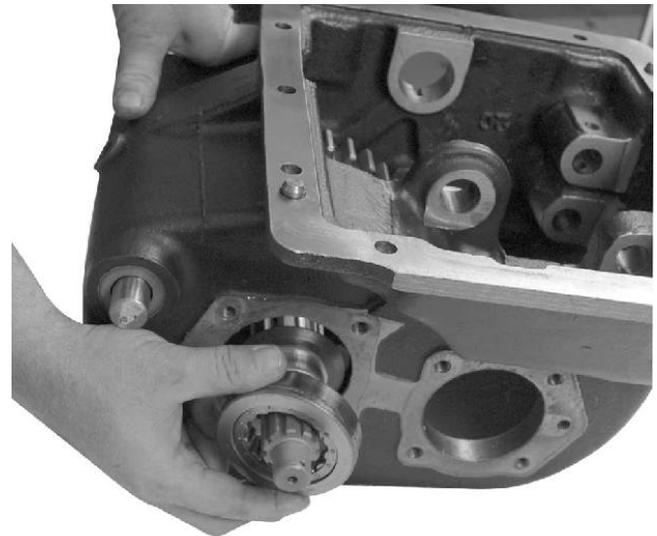
7. Place the output shaft bearing washer, with the flat side to the gear, on the rear of the output shaft. The bearing inner race goes on the shaft with the flanged end to the inside. Use a suitable driver to secure the bearing inner race to the shaft. The bearing washer will seat firmly against the shoulder of the shaft once the bearing inner race has been driven into position.



8. Secure the bearing to the shaft with the bearing retaining washer and two cap screws. Torque the cap screws to 25-32 lbs. Ft. Lockwire the two cap screws.



9. Align the oil return hole of the bearing cap and gasket to the oil port hole in the case. Secure the output shaft rear bearing cap and gasket to the case with the cap screws. Torque the cap screws to 25-32 lbs. ft.



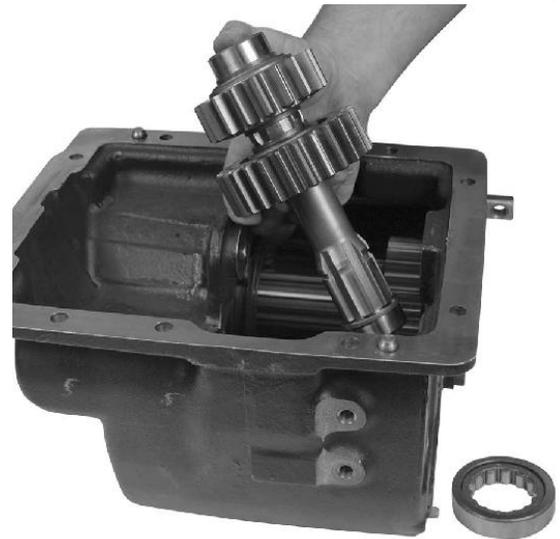
10. The bearing inner race goes on the shaft with the flanged end to the inside.

11. Inspect and replace, if necessary, the output shaft bearing cap oil seal. Align the oil return holes of the bearing cap and gasket to the oil port in the case. Secure the output shaft bearing cap and gasket to the case with the cap screws. Torque the cap screws to 25-32 lbs ft.

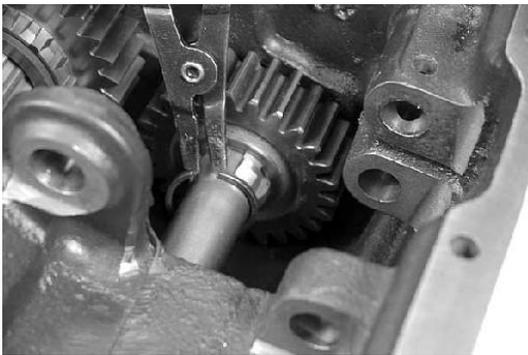




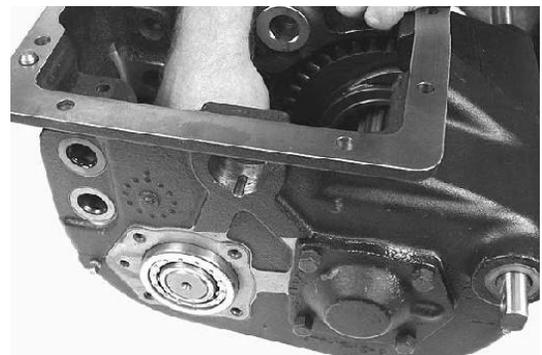
1. Assemble the reverse gear to the reverse shaft with the ground face of the gear hub facing out. Place the snap ring into position in the snap ring groove behind the reverse gear. Drive the inner race on the on the reverse shaft with the flanged end seating firmly against the reverse gear hub. Do not secure the reverse drive gear and snap ring into position on the shaft, at this time.



2. Lower the reverse shaft assembly into the case. The reverse gear goes to the rear of the case.



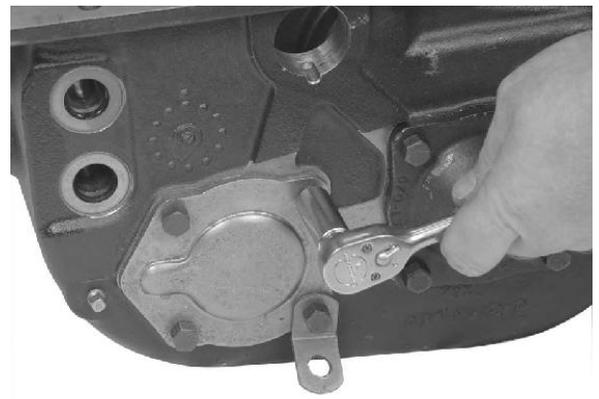
3. Place the reverse drive gear snap ring into the snap ring groove in the shaft.



4. Use a suitable driver to secure the bearing inner race on the shaft. The flanged end seats firmly against the hub of the reverse drive gear. Align the shaft in the center of the case bore and place the outer race with cylindrical rollers on the inner race. Tap evenly on the outer bearing in the case bore. Repeat procedure for the inner race and outer cylindrical rollers at the rear of the reverse shaft.

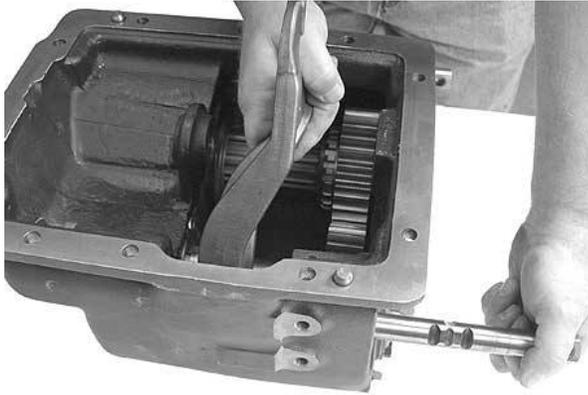


5. Align the oil return holes of the bearing cap and gasket to the oil port hole in the case.

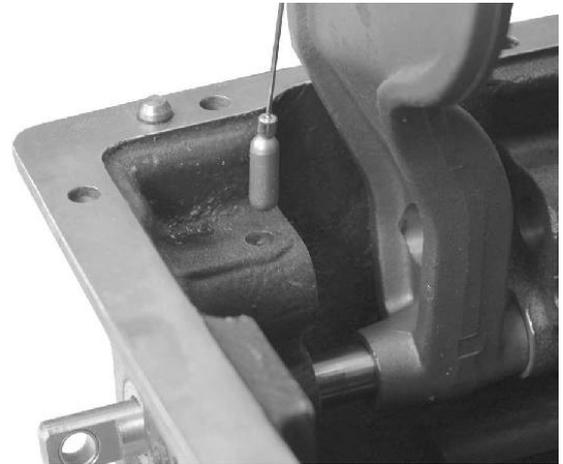


6. Secure the front bearing cap and gasket to the case with the capscrews. Torque the capscrews to 25-32 lbs. Ft. Repeat procedure for the rear bearing cap and gasket.

AND INTERMEDIATE GEAR & RELATED PARTS



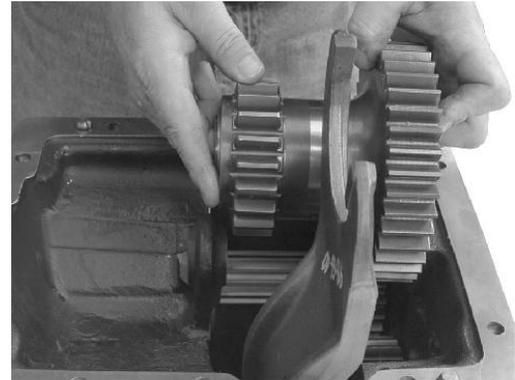
1. Place the 3rd-4th shift rod through the case front into the 3rd-4th shift fork. Align the set screw hole of the fork to the shift rod and secure the fork to the rod with the set screw. Torque the set screw to 40-50 lbs. ft.



2. Place the interlock pin in the interlock cross hole between the shift rod bores.



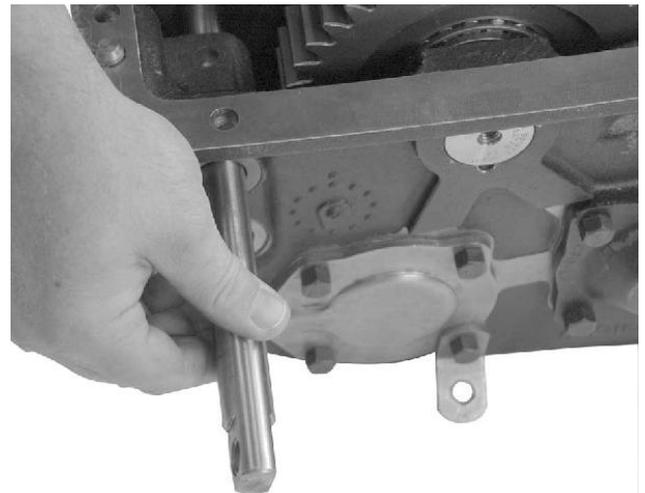
3. The intermediate gear, with the front and rear bearing cups seated in the gear bore, and the bearing cones are ready to be assembled in the case.



4. Lower the intermediate gear and bearings with the front bearing washer into the case.

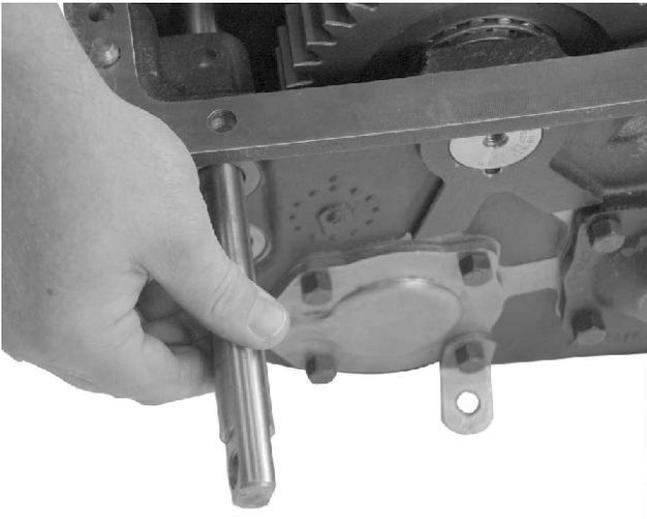


5. Slide the intermediate shaft through the front of the case and into the intermediate gear. Make sure the front bearing washer slides onto the shaft and does not drop to the bottom of the case. Drive the intermediate shaft into its final position.



6. Secure the intermediate shaft with the washer and nut.

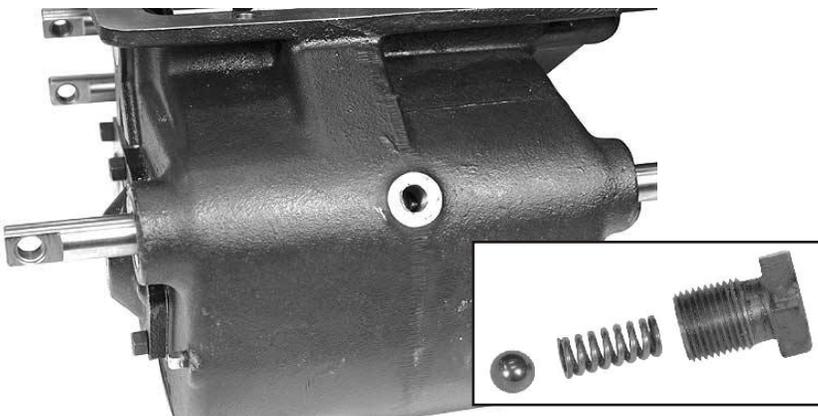
AND INTERMEDIATE GEAR & RELATED PARTS



7. Position the interlock pin in the neutral notch of the 3rd-4th shift rod before sliding the 1st-2nd shift rod into the case. Pass the rod through the opening in the rib of the 3rd-4th shift fork and on through the rear boss of the case.



8. Align the set screw hole of the 1st-2nd shift fork to the shift rod. Secure the shift fork to the rod with the set screw. Torque the set screw to 40-50 lbs. ft.



9. Assemble the poppet ball, spring and retainer to the output shift rod poppet hole.

IMPORTANT PROCEDURE

When locating and correcting unit power or auxiliary transmission troubles, a systematic procedure should be followed.

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

Check Functioning Prior to Disassembly:

If remote controls are used, a careful check of the remote and connecting linkage to auxiliary must be made. The remote units and linkage must be in good working order if the auxiliary is expected to shift satisfactorily. Many times the answer to the trouble is apparent when the unit is inspected prior to disassembly, but this evidence is often lost when the parts are separated. If possible, check the unit prior to disassembly. Bear in mind that a careful inspection of the unit should be made as each disassembly step is performed.

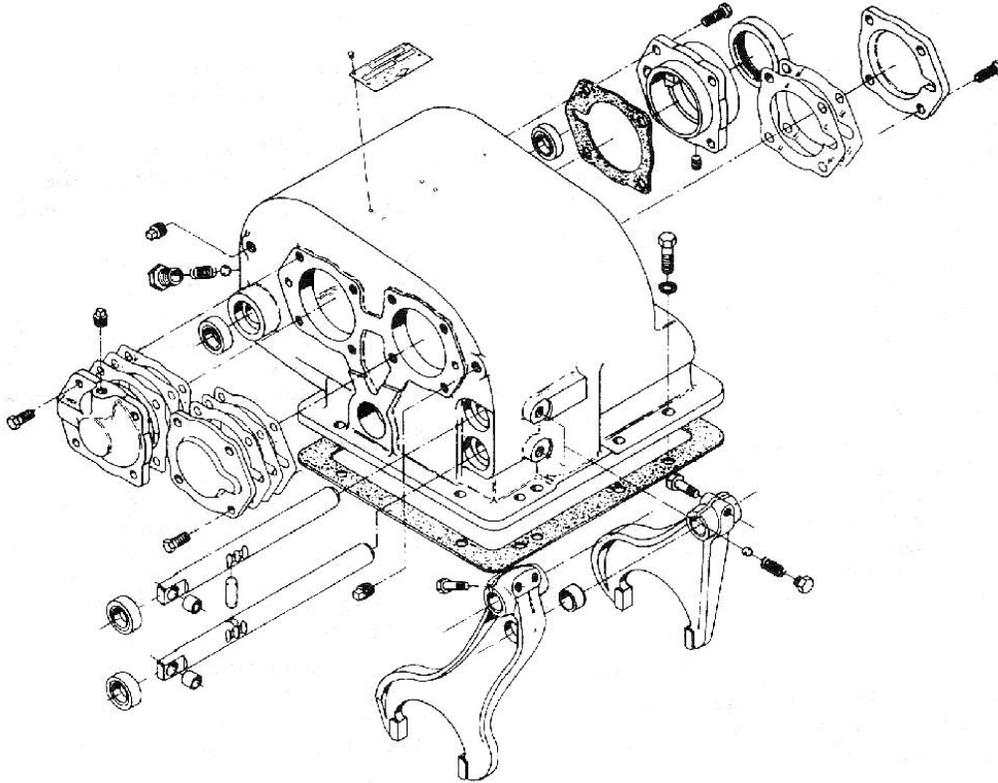
Inspect Thoroughly During Disassembly:

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

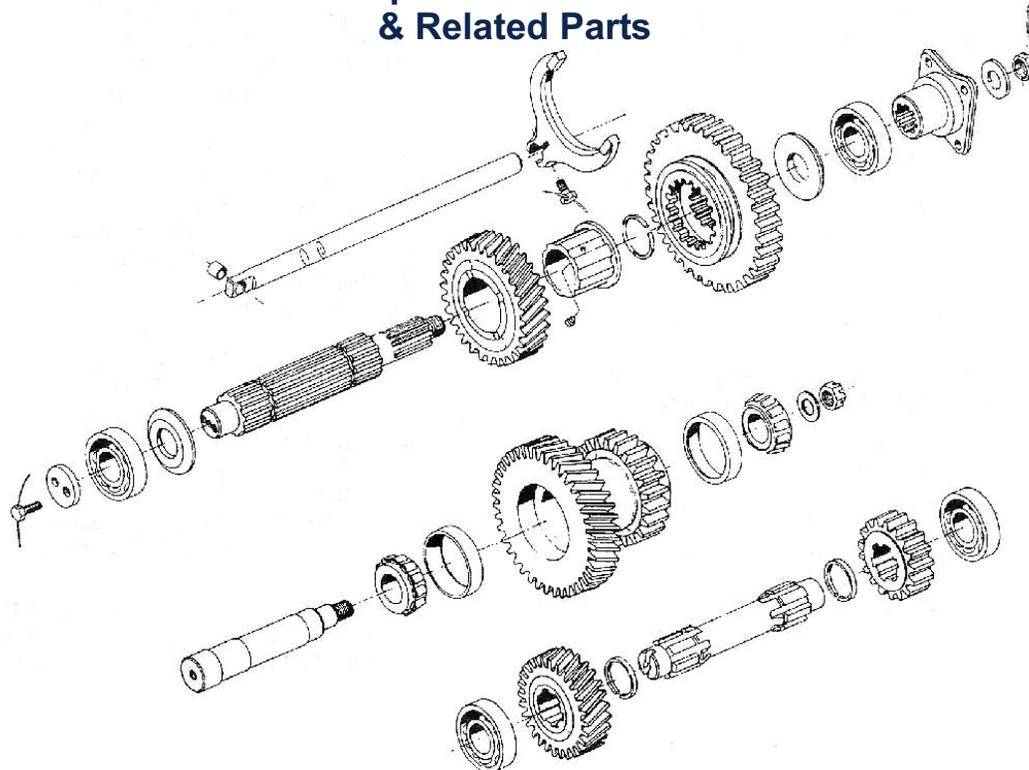
Repair or Replace Defective Parts:

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

Top Mounted PTO Assemblies



Top Mounted Gears & Related Parts



Driver Training:

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

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

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

Noisy Operation:

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

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

- (a) Growl and humming or, more serious, a grinding noise. These noises are caused by worn, chipped, rough or cracked gears. As gears continue to wear, the grinding noise will be noticeable, particularly in the gear position that throws the greatest load on the worn gear.
- (b) Hissing or, more serious, a thumping or bumping-type noise. Hissing noises caused by bad bearing. As bearings wear and retainers start to break up, etc., The noise could change to a thumping or bumping.
- (c) Metallic rattles within the auxiliary usually result from a variety of conditions. Engine torsional vibrations are transmitted to the transmission through the clutch, which may be amplified and transmitted to the auxiliary through the connecting propeller shaft. In heavy duty equipment, clutch discs with vibration dampers are not used, so a rattle,

particularly in neutral, is common with diesel equipment. In general, engine speeds should be 600 .

RPM or above to eliminate objectionable rattles and vibration during the idle. *Always leave the main box in neutral and the auxiliary unit in gear when idling.* A defective or faulty injector would cause a rough or lower idle speed and a rattle in the auxiliary. Rattle could also be

caused by excessive backlash in P T O unit mounting.

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

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

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

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

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

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

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

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

Noise in Neutral

Possible Causes:

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

Noise in Gear

Possible Causes:

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

Oil Leaks

Possible Causes:

- (a) Oil level too high.
- (b) Wrong lubricant in unit.
- (c) Non-shielded bearing used at front or rear bearing cap. (Where applicable.)
- (d) Seals defective or omitted from bearing cap, wrong type seal used, etc.
- (e) Transmission breather omitted, plugged internally, etc.
- (f) Capscrews loose, omitted or missing from remote control, shifter housing, bearing caps, P.T.O. or covers, etc.
- (g) Oil drain-back openings in bearing caps or case plugged with varnish, dirt, covered with gasket materials, etc.
- (h) Broken gaskets, gaskets shifted or squeezed out of position, pieces still under bearing caps, clutch housing, P.T.O. and covers, etc.
- (j) Cracks or holes in castings.
- (k) Drain plug loose.
- (1) Also possibility that oil leakage could be from engine.

Walking or Jumping Out of Gear:

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

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

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

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

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

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

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

Jumping Out of Gear:

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

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

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

Hard shifting:

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

- (a) No lubricant in remote control units. Forward remote is isolated and is often overlooked. However, many remote controls used on transmissions and auxiliaries require separate lubrication.
- (b) No lubricant in (or grease fittings on) U-joints or swivels of remote controls.
- (c) Lack of lubricant or wrong lubricant used, causing buildup of sticky varnish and sludge deposits on splines of shaft and gears.
- (d) Badly worn or bent shift rods.
- (e) Improper adjustment of shifter linkage.
- (f) Sliding clutch gears tight on splines of shaft.
- (g) Clutch teeth burred over, chipped or badly mutilated due to improper shifting.
- (h) Binding or interference of shift lever with other objects or rods inside the cab or near the remote control island.
- (i) Driver not familiar with proper shifting procedure for this transmission. Also includes proper shifting as used with 2-speed axle, auxiliary, etc.
- (j) Drive gear pocket bearing seized, rough or dragging.
- (k) Gear seizure on thrust face.
- (l) Thrust washer failure.

Sticking in Gear:

- (a) Clutch not releasing - also check remote units such as hydraulic or air assist, etc.

Note: On some units employing a full air control for clutch release, air pressure of approximately 60 lbs. or more must be secured before clutch can be released. *Do not leave these vehicles parked in gear.*

- (b) Sliding clutch gears tight on splines.
- (c) Chips wedged between or under splines of shaft and gear.
- (d) Improper adjustment, excessive wear or lost motion in shifter linkage.

Bearing Failures:

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

- (a) Worn out due to dirt.
- (b) Fatigue of raceways or balls.
- (c) Wrong type or grade of lubricant.
- (d) Lack of lubricant.

- (e) Vibrations - breakup of retainer and brinnelling of races - fretting corrosion.
- (f) Bearings tied-up due to chips in bearings.
- (g) Bearings set-up too tight or too loose.
- (h) Improper assembly - brinnelling bearing.
- (j) Improper fit of shafts or bore.
- (k) Acid etch of bearing due to water in lube.
- (l) Overloading of vehicle. Overload from engine or engine too large for transmissions used.

Dirt:

More than 90 of all ball bearing failures are caused by dirt which is always abrasive. Dirt may enter the bearings during assembly of the units or be carried into the bearing by the lubricant while in service. Dirt may enter through seals, breather or even dirty containers used for addition or change of lubricant. Softer material such as dirt, dust, etc., usually forms abrasive paste or lapping compounds within