

## SECTION X — TRANSMISSION, BEVEL GEAR, AND DRIVE SHAFT UNIVERSAL JOINT

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### 1. GENERAL DESCRIPTION

Power from the engine on HD 16 tractors without a torque converter, is transmitted through the engine clutch and the drive shaft universal joint assembly to the transmission. Power from the engine on HD 16 tractors with a torque converter, is transmitted through the engine clutch, torque converter, and the drive shaft universal joint assembly to the transmission.

The transmission case is attached to the front of the steering clutch and final drive housing with capscrews. The transmission case is piloted to the final drive housing by a boss, located on the rear of the transmission case. This boss also serves as a bearing retainer for the bevel pinion shaft rear roller bearing. From the transmission, power is transmitted to the bevel gear, and from the bevel gear through the steering clutches, to the final drives and track sprockets.

### 2. TRANSMISSION

#### A. Description of Transmission

The transmission on HD 16 tractors without a torque converter, is a constant mesh, helical gear, speed reduction unit designed to provide the proper ratio for the required speed or power for operation of the tractor. The various speed changes (6 forward and 3 reverse) are obtained by the use of shifting collars, located on gear hubs, assembled on the intermediate shaft and the bevel pinion shaft.

The transmission on HD 16 tractors with a torque converter, is a constant mesh, helical gear, speed reduction unit combined with the use of the torque converter to provide the proper ratio for the required speed or power for operation of the tractor.

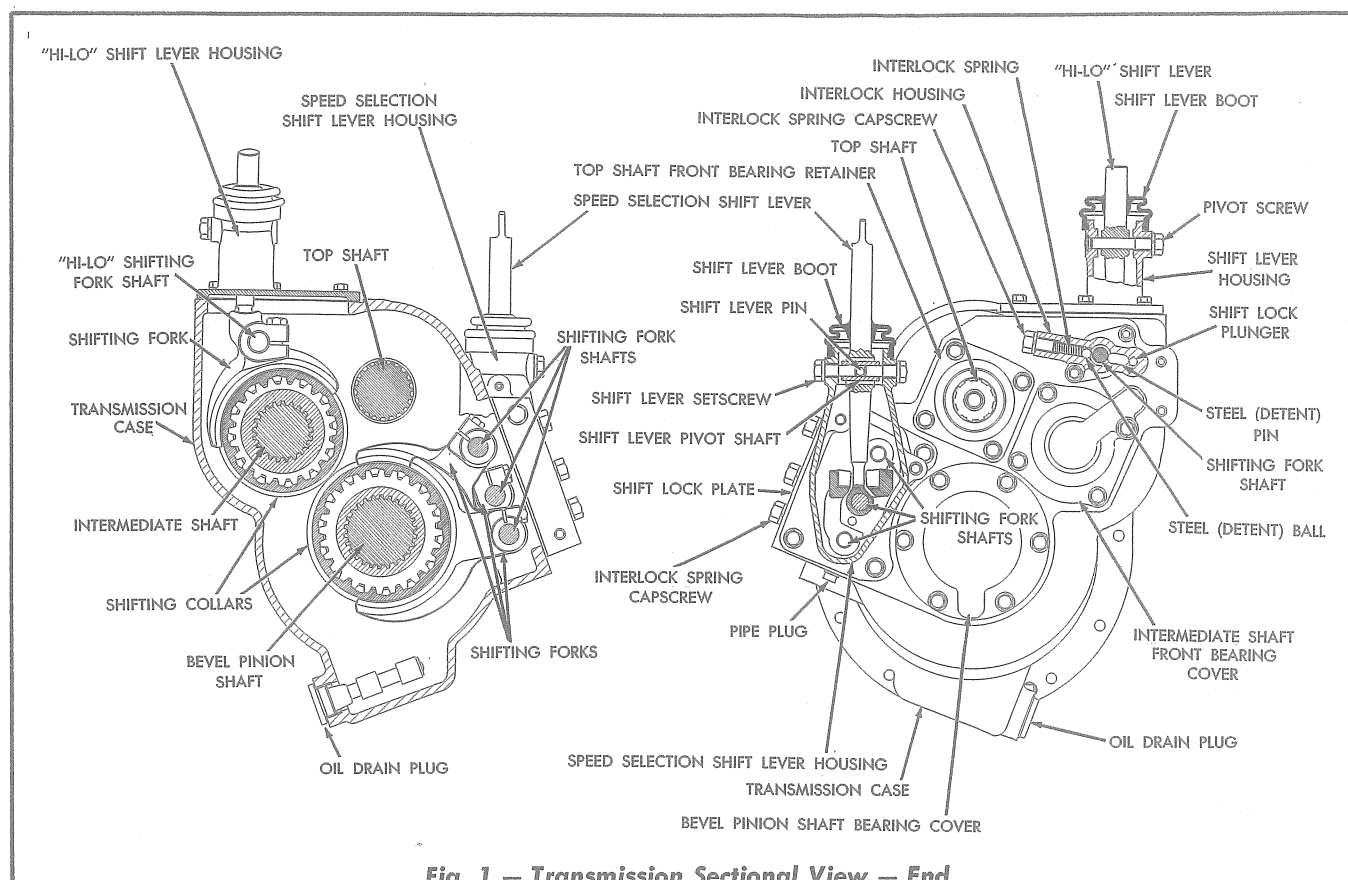
The various speed changes (3 forward and 2 reverse) are obtained by the use of shifting collars, located on gear hubs, assembled on the bevel pinion shaft.

The shifting collars are shifted into mesh with their corresponding gears by the use of shifting forks. The shifting forks are actuated by shifting fork shafts engaged with the transmission shift levers.

The shifting movement of each shifting fork shaft is controlled by detent notches in the shifting shafts and steel ball or steel pins (detent balls or pins) located in the transmission case and shift lock plate. Each shifting fork is so positioned and clamped to its shifting shaft so that when each shifting shaft is shifted to the desired speed range, the detent balls or pins enter the detent notches in the shifting shafts and properly locate the shifting collar with its corresponding gear.

**NOTE:** On tractors serial No. 2996 and above, the steel balls (detent balls), except those located between the center and lower shifting fork shafts in the shift lock plate, are replaced by steel pins (detent pins). Refer to Figs. 1 and 23.

On tractors without a torque converter, the shifting collars on both the bevel pinion and the intermediate shafts are locked in mesh with their corresponding gears by locking mechanisms. On tractors with a torque converter, there is no shifting collar on the intermediate shaft and only one locking mechanism is used on the shifting collars on the bevel pinion shaft. The locking mechanism consists of a shifting lock plunger attached to, and actuated by a shifting lock plunger rod. The front



**Fig. 1 — Transmission Sectional View — End View (Tractors Without Torque Converter)**

end of the shifting lock plunger rod is connected to the engine clutch shifting yoke shaft by linkage. When the engine clutch operating lever is pulled back to engage the clutch, the shifting lock plunger rod moves the shifting lock plunger to a position between the detent balls and locks the shifting shafts in the position to which they have been shifted. The shifting shaft locking mechanisms are so designed that the transmission shifting shafts can be shifted only when the engine clutch operating lever is in the disengaged position.

The transmission shafts are supported on one end by ball bearings and on the other end by roller bearings. The power input to the transmission is applied to the transmission top shaft.

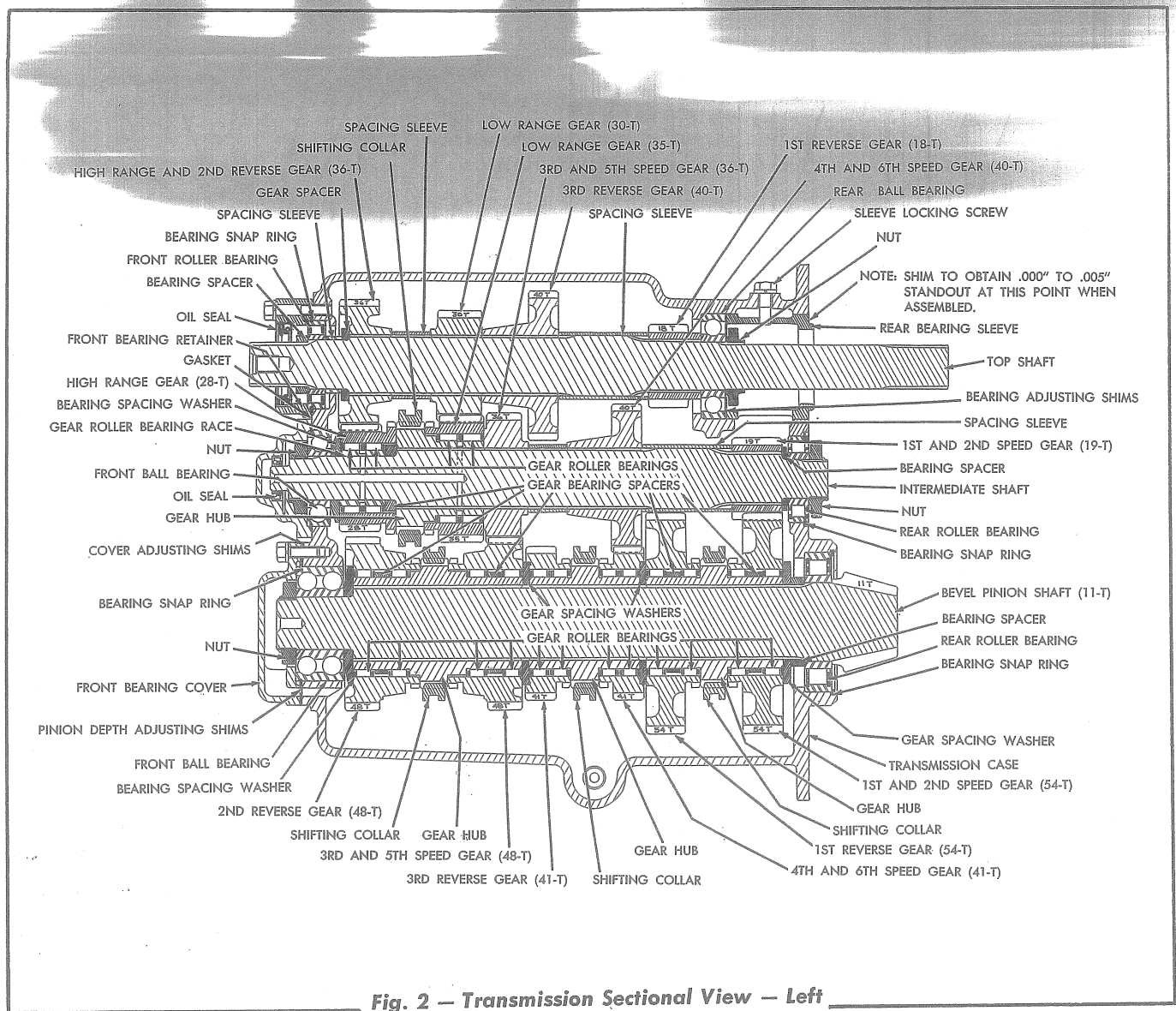
## B. Removal of Transmission

1. Remove the oil drain plugs from the transmission case and from the bottom of the bevel gear compartment of the steering clutch and final drive housing and allow the oil to drain.
2. Remove the seat cushions. Remove the two

steering clutch throwout bearing lubricating pipes, located at the right side of the tool box. Remove the jam nuts and lockwashers securing the upper end of the steering clutch lubricating hoses to the tool box supporting bracket. Remove the seat frame and tool box. Remove the floor plates and the floor plate supporting channels. Remove the extension(s) from the shift lever(s).

3. Disconnect and remove the steering clutch lower rear control rods and the lower front control rods from the cross shaft bracket and remove the cross shaft bracket.
4. Remove the yoke pin attaching the right front brake rod to the right pedal shaft outer lever. Remove the capscrews attaching the right brake pedal shaft bracket to the main frame and remove the bracket, right brake pedal shaft, and right brake pedal as an assembly. Tie the brake pedal shaft bracket shims to the bracket to prevent loss.





**Fig. 2 — Transmission Sectional View — Left Side (Tractors Without Torque Converter)**

5. Remove the capscrews and capscrew locks attaching the universal joint spider assemblies to the front and rear yokes. Place a pry bar between the spider assembly and the front yoke, then pry the front yoke forward to clear the spider assembly. Remove the universal joint assembly, then remove the front yoke.
6. Disconnect the shifting lock plunger rod(s) at the transmission end and allow the rod(s) to drop down to provide clearance for removal of the transmission.
7. Thoroughly clean the top of the transmission case and the surrounding area.
8. Attach a lifting sling to the transmission

case as shown in Figs. 5 and 6.

9. Using a suitable hoist, support the transmission and remove the capscrews attaching the transmission case to the steering clutch and final drive housing. Move the transmission straight forward until the boss on the rear of the transmission case is free of its bore in the steering clutch and final drive housing, then turn the transmission as

shown in Fig. 5 or 6 to gain additional clearance and remove the transmission from the tractor.

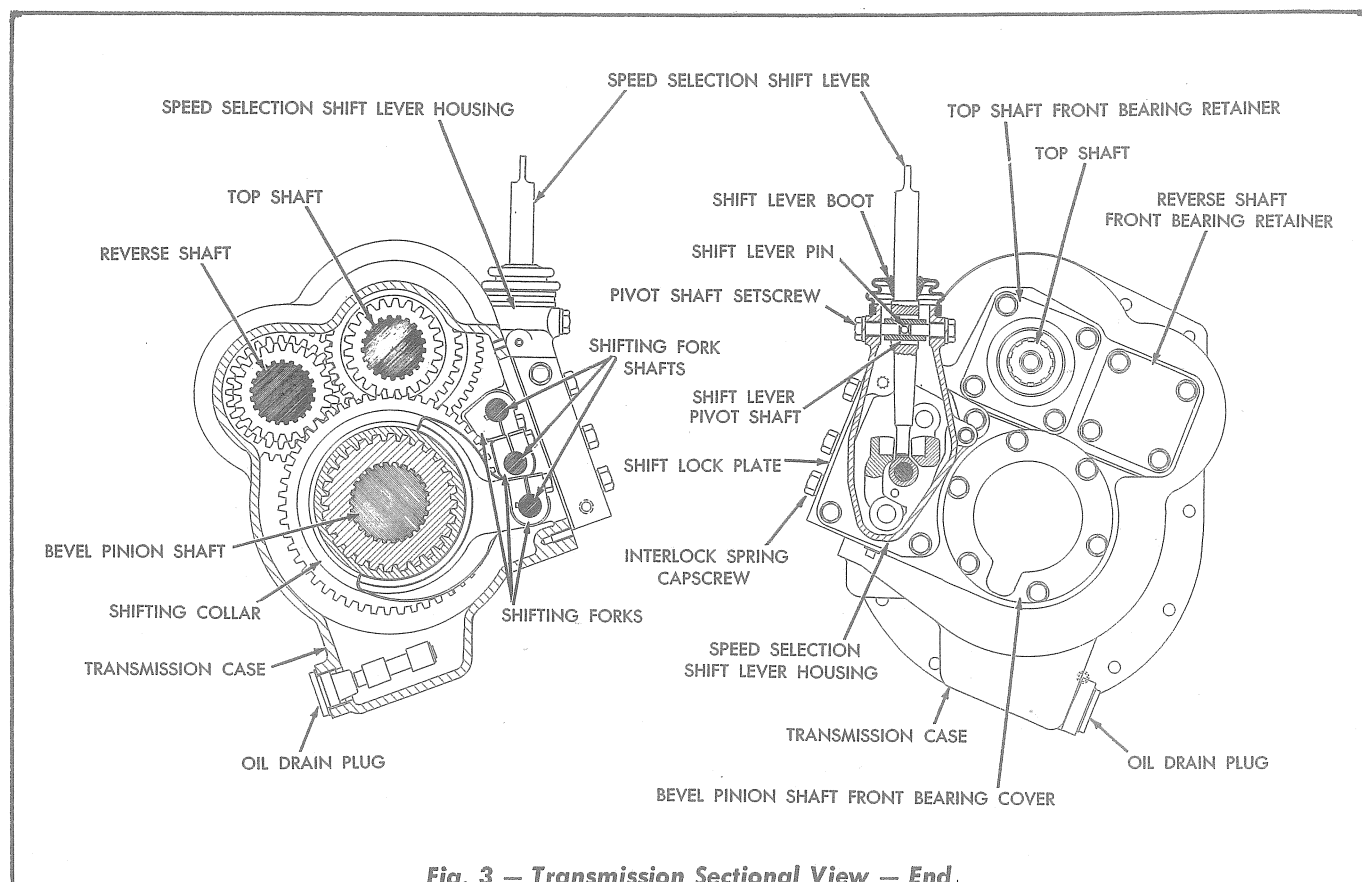


Fig. 3 — Transmission Sectional View — End View (Tractors with Torque Converter)

### C. Disassembly of Transmission (Tractors Without Torque Converter)

1. Thoroughly clean the transmission case before disassembly.
2. Place the transmission assembly on a clean work bench and remove the side cover.

Remove the capscrews attaching the speed selection shift lever housing and the "HI-LO" shift lever housing to the transmission case and remove the housings. Place one capscrew in the shift lock plate to hold it in position until the shifting fork shafts have been removed.

3. Loosen all shifting fork capscrews. Remove the three interlock spring capscrews from the shift lock plate. Remove the interlock spring and steel ball (detent ball) from each opening. Remove the two ( $\frac{3}{8}$ " NPT) pipe plugs from the bottom of the shift lock plate and the transmission case.

4. Move the rear fork on the lower shifting fork shaft until the fork is off the "Woodruff" key, then remove the key from the shaft. Pull the lower shifting fork shaft from the transmission case and remove the steel balls (detent balls) or steel pins (detent pins) which will fall from position at this time. Remove the rear fork from the shifting collar.
5. Pull the center shifting fork shaft from the front fork and out of the transmission case. Catch the steel balls (detent balls) or steel pins (detent pins) and the two shifting shaft interlock pins which will fall from position as the shaft is withdrawn.
6. Move the center fork on the upper shifting fork shaft until the fork is off the "Woodruff" key, then remove the key from the shaft. Pull the upper shifting fork shaft from the center fork and the transmission case. Remove the front and center forks from the shifting collars. NOTE: The upper shifting fork shaft has two keyways ma-

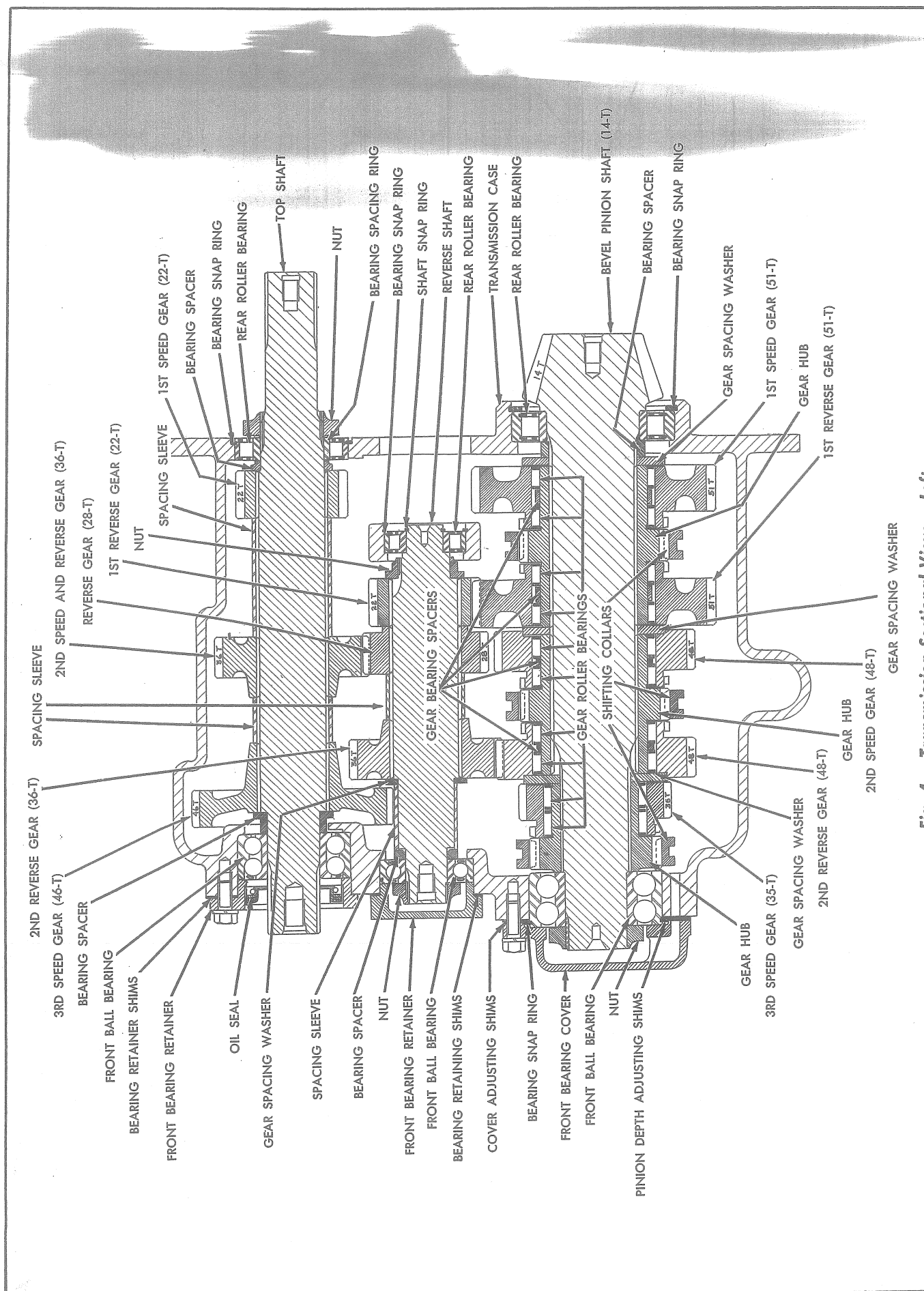
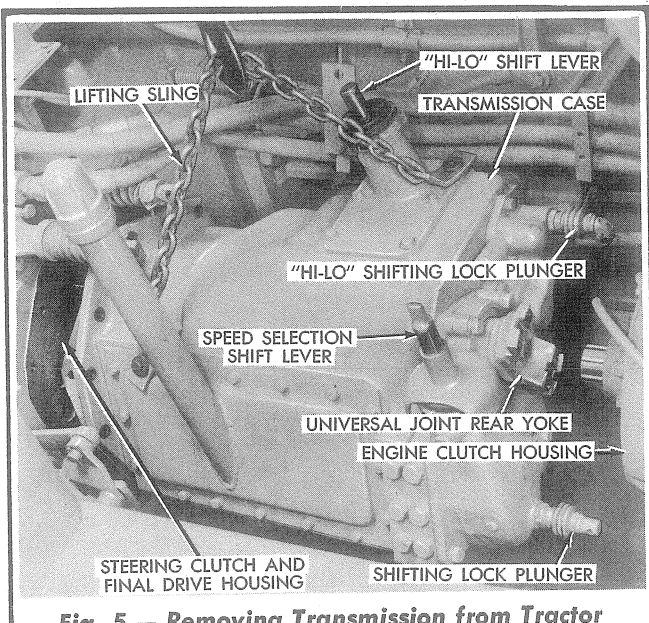
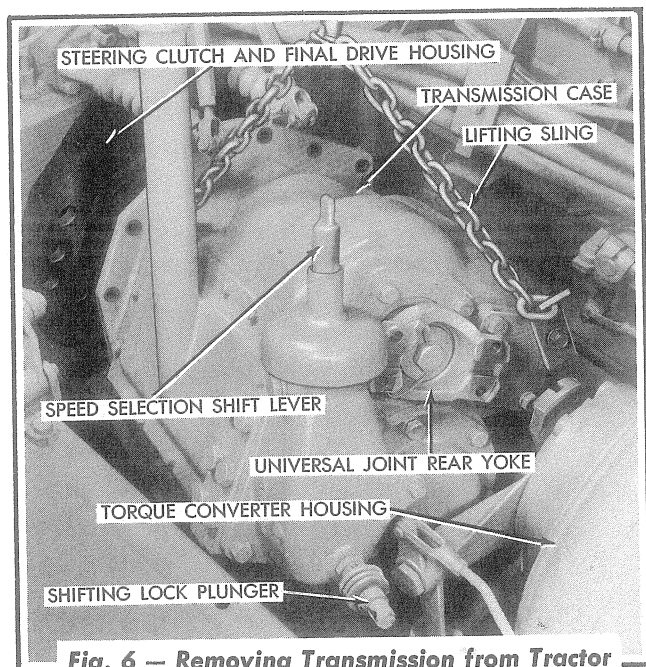


Fig. 4 — Transmission Sectional View — Left Side (Tractors with Torque Converter)



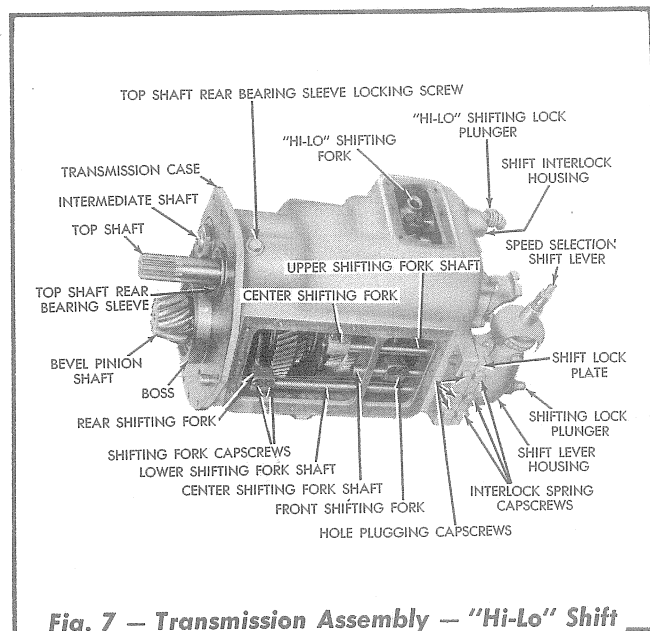
**Fig. 5 — Removing Transmission from Tractor (Tractors Without Torque Converter)**



**Fig. 6 — Removing Transmission from Tractor (Tractors with Torque Converter)**

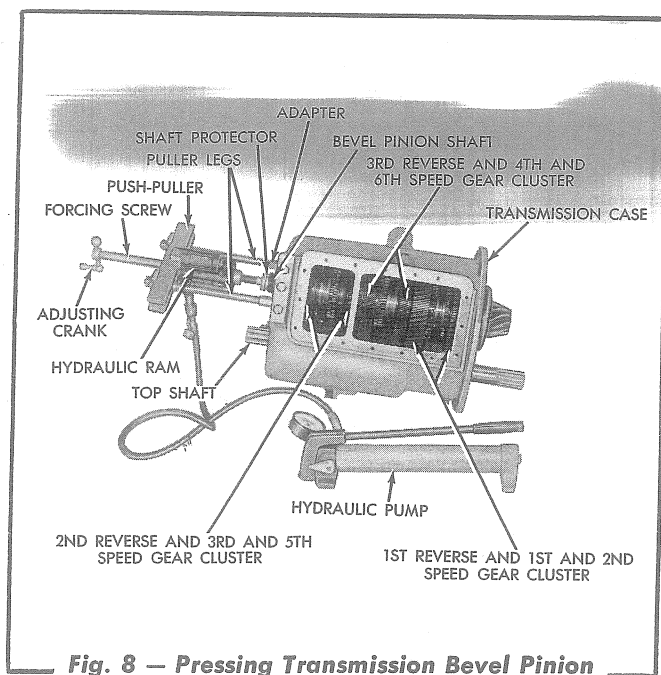
chined in it. Make certain that the "Woodruff" key is installed in the keyway at the rear of the shaft when the shaft is reinstalled.

7. Remove the capscrew attaching the shift lock plate to the transmission case and remove the lock plate.
8. Remove the bevel pinion shaft front bearing cover and shims, and the intermediate shaft front bearing cover and gasket.



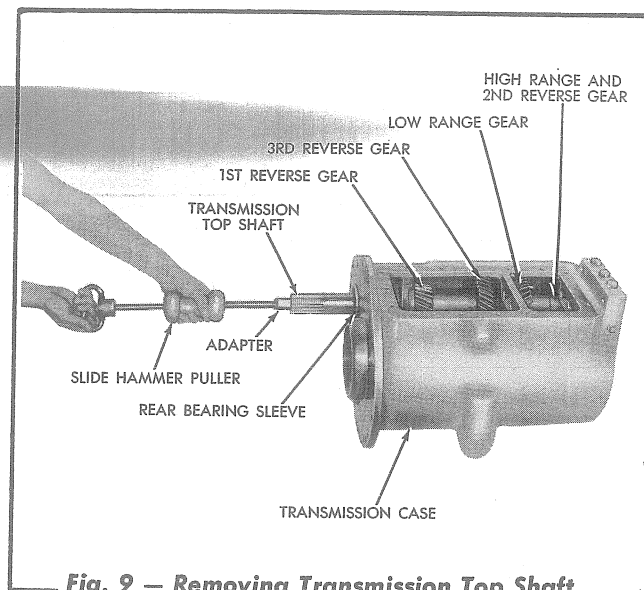
**Fig. 7 — Transmission Assembly — "Hi-Lo" Shift Lever Housing and Side Cover Removed (Tractors Without Torque Converter)**

9. Unlock and remove the bevel pinion nut from the bevel pinion shaft; do not remove the snap ring from the bevel pinion front ball bearing at this time. Unlock and remove the front nut and the rear nut from the intermediate shaft. Remove the locking wire and capscrew securing the universal joint rear yoke to the top shaft and remove the yoke. *NOTE: The bevel pinion shaft, intermediate shaft, and top shaft may be locked for the removal of the bevel pinion shaft nut, front and rear intermediate shaft nuts, and the universal joint rear yoke capscrew by moving the shifting collars and locking the gears.*
10. Turn the transmission case on the work bench so that the top of the case is down and block the case in this position. Using tools similar to the ones shown in Fig. 8, push the bevel pinion shaft from the bevel pinion front ball bearing, then withdraw the bevel pinion shaft from the gears and the transmission case. Remove the center cluster of gears (3rd reverse and 4th and 6th speed gears) and the gear spacing washers on each side of the cluster from the transmission case as an assembly.



**Fig. 8 — Pressing Transmission Bevel Pinion Shaft from Front Ball Bearing (Tractors Without Torque Converter)**

11. The front gear cluster (2nd reverse and 3rd and 5th speed gears) must be disassembled inside the transmission case as there is not sufficient space to permit their removal as a cluster. To disassemble this gear cluster, slide the rear gear (3rd and 5th) from the hub and remove the gear from the case. Slide the shifting collar from the hub and the hub from the front gear (2nd reverse) and remove these components and the 2nd reverse gear from the case.
12. The rear gear cluster (1st reverse and 1st and 2nd speed gears) may now be removed if desired by following the disassembly procedure as outlined in Step 11 above. However, it is suggested that the rear gear cluster be left in the transmission case until the top and intermediate shafts have been removed; the cluster can then be removed as an assembly.
13. Turn the transmission case on the bench so that the cover side of the transmission case is up. Remove the capscrews attaching the top shaft front bearing retainer to the transmission case and remove the retainer and gasket. Withdraw the front bearing spacer from the front end of the top shaft.



**Fig. 9 — Removing Transmission Top Shaft (Tractors Without Torque Converter)**

14. Remove the top shaft rear bearing sleeve locking screw (Fig. 7). Using a slide hammer puller, or similar tool, installed in the rear of the transmission top shaft, as shown in Fig. 9, pull the shaft out through the rear of the transmission case. The bearing sleeve, shims, top shaft nut, rear ball bearing, 1st reverse gear, and the gear spacing sleeve will be removed with the shaft. Remove the three gears, gear spacer, and the front bearing spacing sleeve from the transmission case.
15. Unlock and remove the nut from the top shaft and using a suitable press, remove the rear ball bearing and the 1st reverse gear from the shaft.
16. Loosen the capscrews in the "HI-LO" shifting fork and remove the capscrews securing the "HI-LO" shift interlock housing (Fig. 1) to the transmission case. Remove the interlock housing assembly and shifting fork shaft from the transmission case as a unit. Remove the "HI-LO" shifting fork from the shifting collar.
17. Using a slide hammer puller similar to the one shown in Fig. 10, installed in the rear of the shaft, pull the intermediate shaft toward the rear of the case to free it from the front ball bearing and from the high

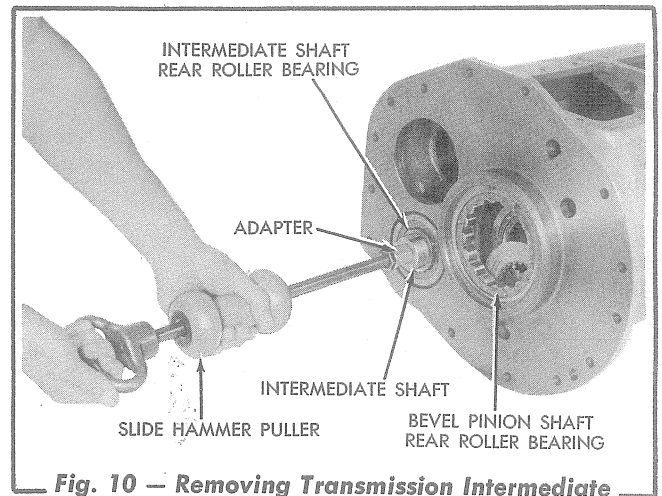


range gear roller bearing race. Withdraw the shaft from the transmission case, removing the components as they are freed from the shaft. The rear roller bearing, 1st and 2nd speed gear, and the gear spacing sleeve will be removed with the shaft.

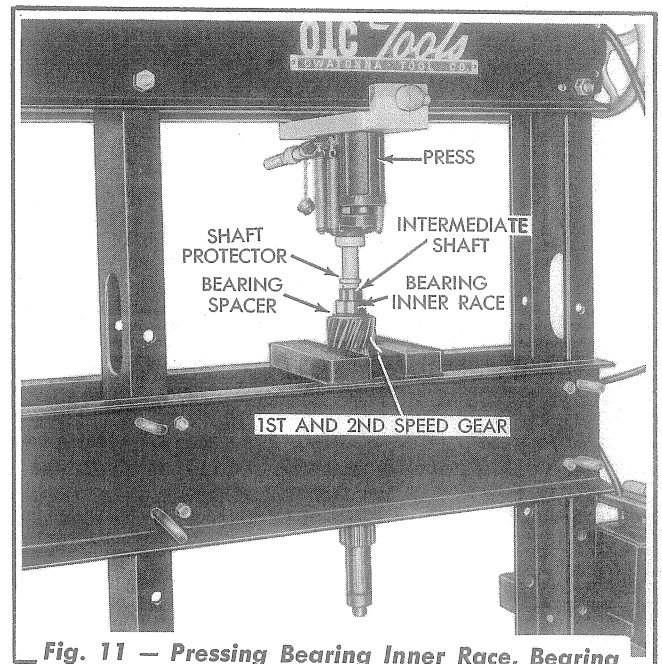
18. If the bevel pinion shaft rear gear cluster has not been removed, the cluster may now be removed from the transmission case as an assembly. Separate the cluster for inspection.
19. Remove the gear spacing sleeve and the rear roller bearing from the intermediate shaft. Using a suitable press remove the roller bearing inner race, gear spacing sleeve, and the 1st and 2nd speed gear from the shaft, refer to Fig. 11.
20. Remove the snap rings from the bores in the transmission case, then using special tools similar to the ones shown in Fig. 16, remove the ball bearings and roller bearings from the bores in the transmission case for cleaning and inspection.

#### D. Disassembly of Transmission (Tractors with Torque Converter)

1. Thoroughly clean the transmission case before disassembly.
2. Place the transmission assembly on a clean work bench and remove the side cover.
3. Remove the capscrews attaching the shift lever housing to the transmission case and remove the housing. Place one capscrew in the shift lock plate to hold it in position until the shifting fork shafts have been removed.
4. Loosen all shifting fork capscrews. Remove the three interlock spring capscrews from the shift lock plate, refer to Fig. 12. Remove the interlock spring and steel ball (detent ball) from each opening. Remove the two ( $\frac{3}{8}$ " NPT) pipe plugs from the bottom of the shift lock plate and the transmission case.



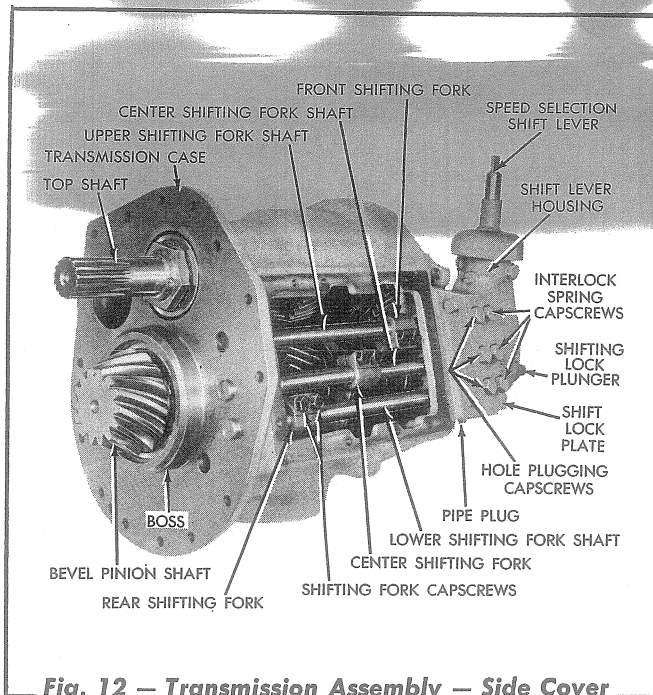
**Fig. 10 — Removing Transmission Intermediate Shaft (Tractors Without Torque Converter)**



**Fig. 11 — Pressing Bearing Inner Race, Bearing Spacer and 1st and 2nd Speed Gear from Transmission Intermediate Shaft (Tractors Without Torque Converter)**

5. Move the rear fork on the lower shifting fork shaft until the fork is off the "Woodruff" key, then remove the key from the shaft. Pull the lower shifting fork shaft from the transmission case and remove the steel balls (detent balls) or steel pins (detent pins) which will fall from position at this time.
6. Pull the center shifting fork shaft from the center shifting fork and out of the transmission case. Catch the steel balls (detent balls) or steel pins (detent pins) and the two shifting shaft interlock pins which will fall from position as the shaft is withdrawn.



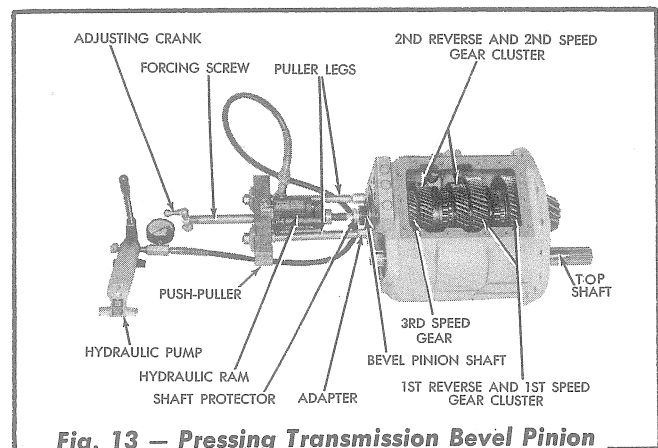


**Fig. 12 — Transmission Assembly — Side Cover Removed (Tractors with Torque Converter)**

7. Move the front fork on the upper shifting fork shaft until the fork is off the "Woodruff" key, then remove the key from the shaft. Pull the upper shifting fork shaft from the front fork and the transmission case. Remove the front, center and rear shifting forks from the shifting collars.
8. Remove the capscrew attaching the shift lock plate to the transmission case and remove the lock plate.
9. Remove the bevel pinion shaft front bearing cover and shims and the reverse shaft front bearing retainer and shims.
10. Unlock and remove the bevel pinion shaft nut from the bevel pinion shaft; do not remove the snap ring from the bevel pinion front ball bearing at this time. Unlock and remove the reverse shaft front nut, and the top shaft rear nut.
11. Remove the locking wire and capscrew securing the universal joint rear yoke to the top shaft and remove the yoke. **NOTE:** The bevel pinion shaft, top shaft, and reverse shaft may be locked for the removal of the bevel pinion shaft nut, reverse shaft nut, top shaft nut, and the capscrew attaching the universal joint rear yoke to the

front end of the top shaft by moving the shifting collars and locking the gears.

12. Remove the capscrews attaching the top shaft front bearing retainer to the transmission case and remove the retainer and shims.
13. Turn the transmission case on the work bench so that the top of the case is down and block the case in this position. Using tools similar to the ones shown in Fig. 13 push the bevel pinion shaft from the bevel pinion front ball bearing, then withdraw the bevel pinion shaft from the gears and the transmission case. Remove the center cluster of gears, (2nd reverse and 2nd speed gear) and the gear spacing washers from the transmission case as an assembly. Disassemble and remove the front gear cluster (3rd speed gear and 3rd speed gear hub) from the transmission case.

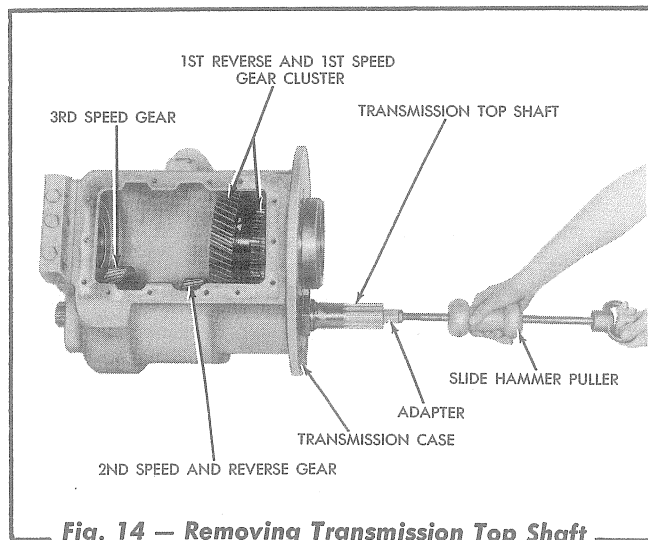


**Fig. 13 — Pressing Transmission Bevel Pinion Shaft from Front Ball Bearing (Tractors with Torque Converter)**

14. The rear gear cluster (1st reverse and 1st speed gear) must be disassembled inside the transmission case as there is not sufficient space to permit their removal as a cluster. To disassemble this gear cluster, slide the front gear (1st reverse gear) from the gear hub and remove the gear from the case. Slide the shifting collar from the hub and the hub from the rear gear (1st speed gear) and remove these components and the 1st speed gear from the case. However, it is suggested that the rear gear cluster be left in the transmission case until the top and reverse shafts have been removed; the

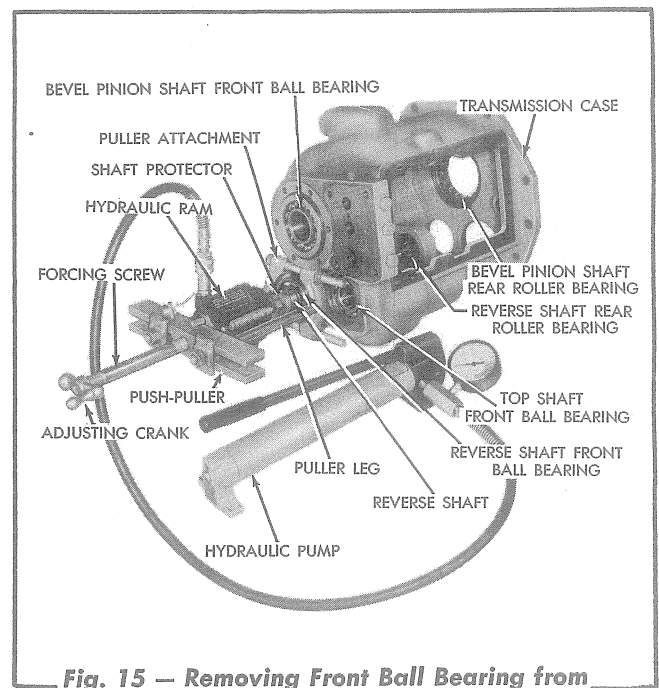
cluster can then be removed as an assembly.

15. Using a slide hammer puller, or similar tool, installed in the rear of the transmission top shaft, as shown in Fig. 14, pull the shaft out through the rear of the transmission case. The rear bearing spacer, rear roller bearing, bearing snap ring and rear bearing spacing ring will be removed with the shaft. Remove the three gears, spacing sleeves and front bearing spacer from the transmission case.
16. Remove the rear roller bearing from the top shaft and using a suitable press, remove the bearing spacer and rear roller bearing inner race from the shaft.

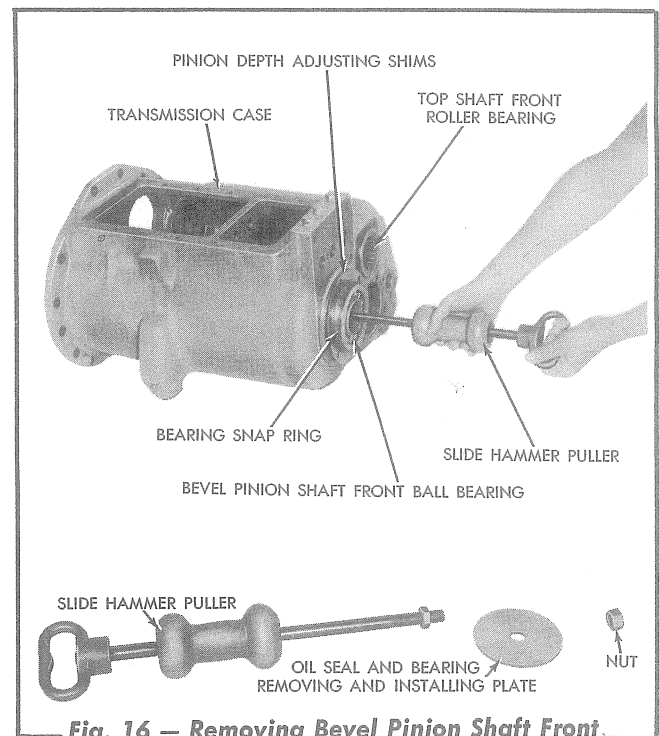


**Fig. 14 — Removing Transmission Top Shaft (Tractors with Torque Converter)**

17. Using a suitable brass bar, inserted through the rear of the transmission case, drive the reverse shaft forward until the reverse shaft front bearing is free from the transmission case. Using special tools similar to the ones shown in Fig. 15, remove the front ball bearing from the reverse shaft. Remove the front bearing spacer and the gear spacing sleeve and washer.
18. Remove the reverse shaft, 2nd reverse gear, gear spacing sleeve, reverse gear, 1st reverse gear, rear nut, rear roller bearing inner race, and the shaft snap ring as an assembly from the transmission case.
19. Remove the gears and the gear spacing



**Fig. 15 — Removing Front Ball Bearing from Transmission Reverse Shaft (Tractors with Torque Converter)**



**Fig. 16 — Removing Bevel Pinion Shaft Front Ball Bearing from Transmission Case (Tractors Without Torque Converter)**

- sleeve from the reverse shaft. Remove the shaft snap ring and the rear roller bearing inner race. Unlock and remove the rear nut from the reverse shaft.
20. If the bevel pinion shaft rear gear cluster has not been removed, the cluster may now

be removed from the transmission case as an assembly. Separate the cluster for inspection.

21. Remove the snap rings from the bores in the transmission case, then using special tools similar to the ones shown in Fig. 16, remove the ball bearings and roller bearings from the bores in the transmission case for cleaning and inspection.

## E. Cleaning and Inspection of Parts

Clean and inspect all the transmission parts thoroughly as described in pertinent parts of Section XX. Replace or recondition the worn or damaged parts.

## F. Assembly of Transmission (Tractors Without Torque Converter)

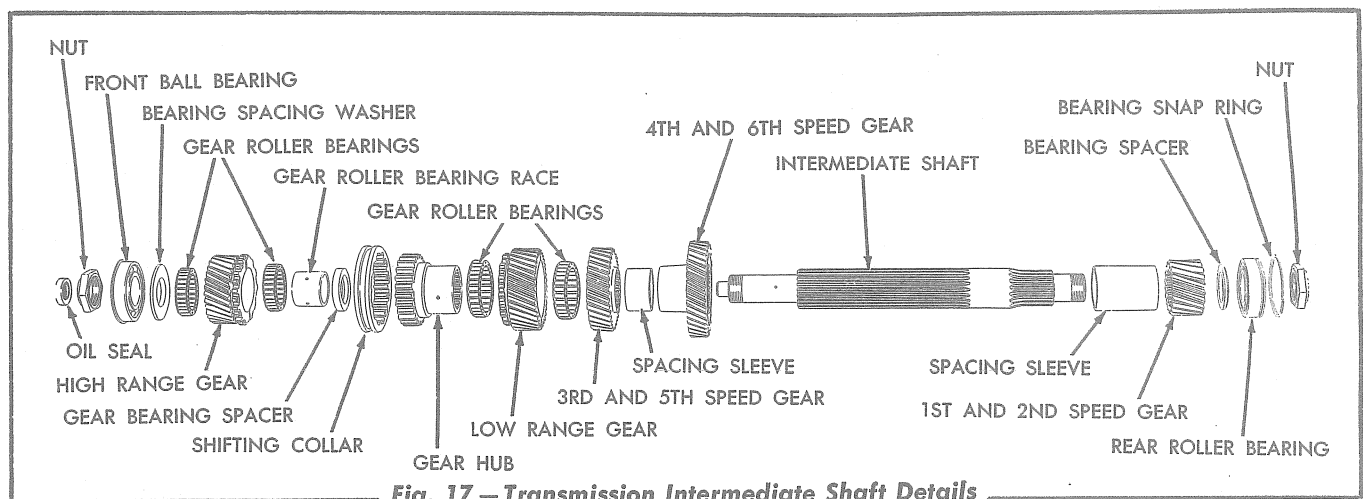
### 1. Installation of Intermediate Shaft

**NOTE:** Before installing the components of the intermediate shaft in the transmission case the bevel pinion shaft rear gear cluster should be assembled and placed in position inside the transmission case. Refer to Fig. 19, and assemble the bevel pinion shaft rear gear cluster (1st reverse gear and 1st and 2nd speed gear each having 54 teeth) on a work bench, then install the cluster into position in the transmission case. This will make the installation of the bevel pinion shaft components easier.

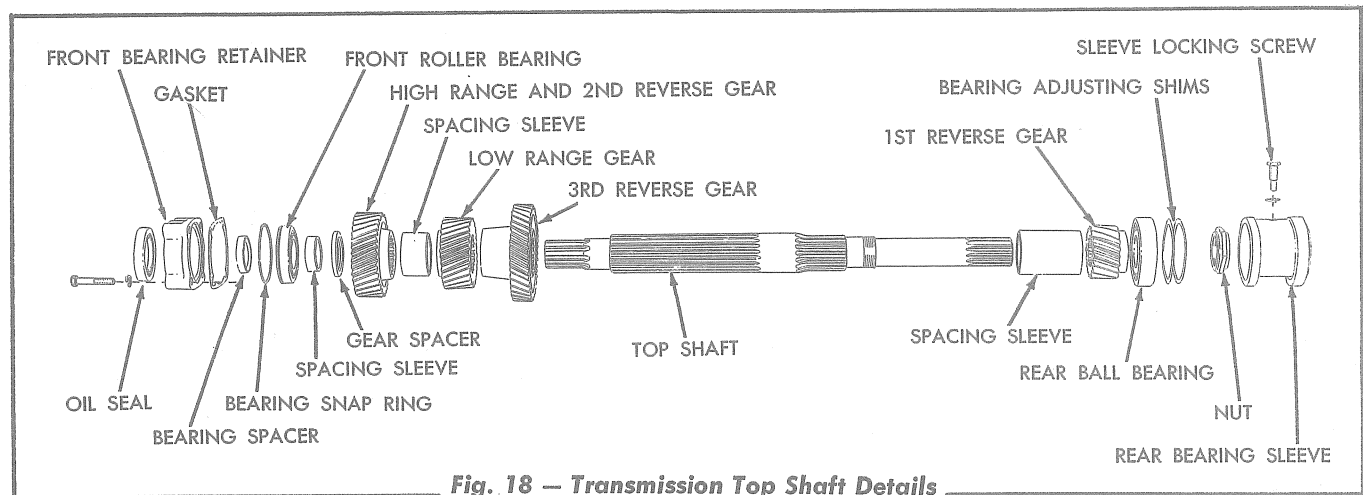
- a. Place the transmission case on a bench with the side cover opening in the case up.
- b. Install the 1st and 2nd speed gear (19 teeth) on the rear of the intermediate shaft, and position the rear bearing spacer against the rear face of the gear. Press the inner race of the rear roller bearing onto the shaft until it is tight against the bearing spacer.
- c. Place the gear spacing sleeve ( $4\frac{1}{8}$ " long) on the shaft and against the front face of the gear and insert the front end of the shaft into the transmission case from the rear, just far enough to start the remaining components onto the shaft.
- d. Start the 4th and 6th speed gear (40 teeth)

on the splines of the shaft, with the hub end of the gear toward the front of the transmission case. Install the gear spacing sleeve ( $1\frac{3}{4}$ " long) on the shaft and against the hub of the gear. Install the 3rd and 5th speed gear (36 teeth) on the shaft, with the hub end of the gear against the spacing sleeve.

- e. The low range gear is supported on the low range gear hub by two roller bearings. Install the two low range gear roller bearings in position on the low range gear hub and lubricate the bearings. Install the low range gear (35 teeth) in position on the roller bearings, with the clutch tooth side of the gear toward the front. Install this assembly in position on the shaft with the low range gear located next to the 3rd and 5th speed gear. Install the shifting collar in position on the low range gear hub.
- f. The high range gear is supported by two roller bearings. Install two high range gear roller bearings in position in the high range gear (28 teeth) and lubricate the bearings. Place the gear bearing spacer in the bore of the gear, with the chamfer on the I.D. of the spacer away from the bearings. Install this assembly on the intermediate shaft, with the clutch tooth side of the gear located next to the low range gear hub, and push the shaft forward into position. Start the gear roller bearing race for the high range gear bearings onto the front end of the shaft and drive it into position on the shaft against the gear bearing spacer.
- g. Install the front bearing spacing washer on the shaft, with the flat face of the washer located next to the high range gear. With the snap ring installed in the rear roller bearing, install the rear roller bearing into position in the rear bore of the transmission case and onto the inner race of the bearing, installed on the shaft.
- h. Install the front ball bearing into position in the bore of the transmission case and onto the shaft. Install the front and the rear



**Fig. 17 — Transmission Intermediate Shaft Details**  
(Tractors Without Torque Converter)



**Fig. 18 — Transmission Top Shaft Details**  
(Tractors Without Torque Converter)

nuts on the shaft. Do not tighten the nuts at this time as they will be tightened when assembly of the transmission is completed.

- i. Install a new oil seal in position in the intermediate shaft front bearing cover, with the sealing lip of the seal directed toward the front when the cover is installed. Install the bearing cover and its attaching gasket in position on the case, but do not tighten the attaching capscrews at this time.

## 2. Installation of Top Shaft

- a. Place the top shaft in a vise, with the rear end of the shaft up; protect the splines of the shaft by use of copper jaws on the vise. Install the 1st reverse gear (18 teeth) on the shaft, with the hub end of the gear towards the rear of the shaft. Install the rear ball bearing in position on the shaft.

Install the nut on the shaft. Tighten to a torque of 200 (+ 0 or - 25) lbs. ft., and lock the nut in position by staking.

- b. Start the front end of the shaft into the top shaft rear bore of the transmission case. Install a gear spacing sleeve ( $4\frac{1}{8}$ " long) on the shaft followed by the 3rd reverse gear (40 teeth), with the hub end of the gear facing the front of the transmission case.
- c. Install the low range gear (30 teeth) on the shaft and next to the 3rd reverse gear, with the hub end of the gear facing the front of the transmission case.
- d. Install the spacing sleeve ( $1\frac{3}{4}$ " long) next to the low range gear. Install the high range and 2nd reverse gear (36 teeth) on the shaft, with the hub end of the gear

facing the rear of the transmission case and against the spacing sleeve.

- e. Install the  $\frac{5}{16}$ " thick gear spacer (with chamfer toward the gear), front bearing spacing sleeve, and the inner race of the front roller bearing on the shaft in the order named. Install the roller bearing (with its snap ring) into position in the front bore of the transmission case and on the shaft. Install the front bearing spacer ( $\frac{1}{2}$ " thick) on the shaft and against the inner race of the front roller bearing (chamfer side toward inner race of bearing).
- f. Install the oil seal in the front bearing retainer, with the sealing lip of the seal directed toward the bearing when installed.
- g. Using gasket cement, cement a front bearing retainer gasket to the transmission case and attach the front bearing retainer to the case with four  $\frac{1}{2}$ " NC x  $2\frac{1}{2}$ " capscrews and lockwashers.
- h. Insert the rear bearing sleeve into the transmission top shaft rear bore, aligning the hole for the sleeve locking screw. Use sufficient bearing adjusting shims between the rear of the ball bearing and the front of the sleeve so that the outer diameter of the sleeve has .000" to .005" standoff from the rear face of the case (refer to Fig. 2).
- i. After the retaining sleeve has been properly positioned as outlined above, secure it in position with the sleeve locking screw and lockwasher.

### 3. Installation of Bevel Pinion Shaft

- a. With the bevel pinion shaft rear gear cluster in position in the transmission case as outlined in Paragraph F., Step 1 above, refer to Fig. 19 and assemble the front gear cluster (2nd reverse gear and 3rd and 5th speed gear, each having 48 teeth) inside the transmission case. Coat the rear face of the front bearing spacing washer with grease to hold it in position against the 2nd reverse gear. NOTE: The gear hub for the 2nd reverse and 3rd and 5th speed

gears of the front gear cluster, has two different width shoulders next to the bearing journals; this gear hub must be installed with the longer shoulder toward the rear of the transmission case.

- b. After the bevel pinion shaft front gear cluster has been assembled push it as far forward as possible in the case and into mesh with the mating gears on the top and intermediate shafts.
- c. Assemble the transmission bevel pinion shaft center gear cluster (3rd reverse gear and 4th and 6th speed gear each having 41 teeth) on a work bench. When assembling, coat the two gear spacing washers with grease to hold them in position against their corresponding gears. Install the assembled cluster in position in the transmission case, between the front and rear clusters. Make certain the gear spacing washers are in their proper positions and that the gears of the center gear cluster mesh properly with the mating gears on the top and intermediate shafts.
- d. With the three gear clusters in position in the transmission case, check to be sure that all gears are on the proper ends of their respective gear hubs, so that the helixes of the gear teeth will mesh with their mating gears.
- e. Press the inner race of the rear roller bearing into position on the bevel pinion shaft and install the rear roller bearing in position on the inner race. Install the rear bearing spacer (.643" to .646" long) on the bevel pinion shaft, with the chamfered end of the spacer toward the bearing. Place a gear spacing washer in position on the bevel pinion and against the rear bearing spacer.
- f. Turn the transmission case so that the top of the case rests on the work bench as shown in Fig. 20. Make certain that the three shifting collars are in their neutral position. Start the bevel pinion shaft into the case from the rear. While pushing on the pinion, turn the bevel pinion shaft as

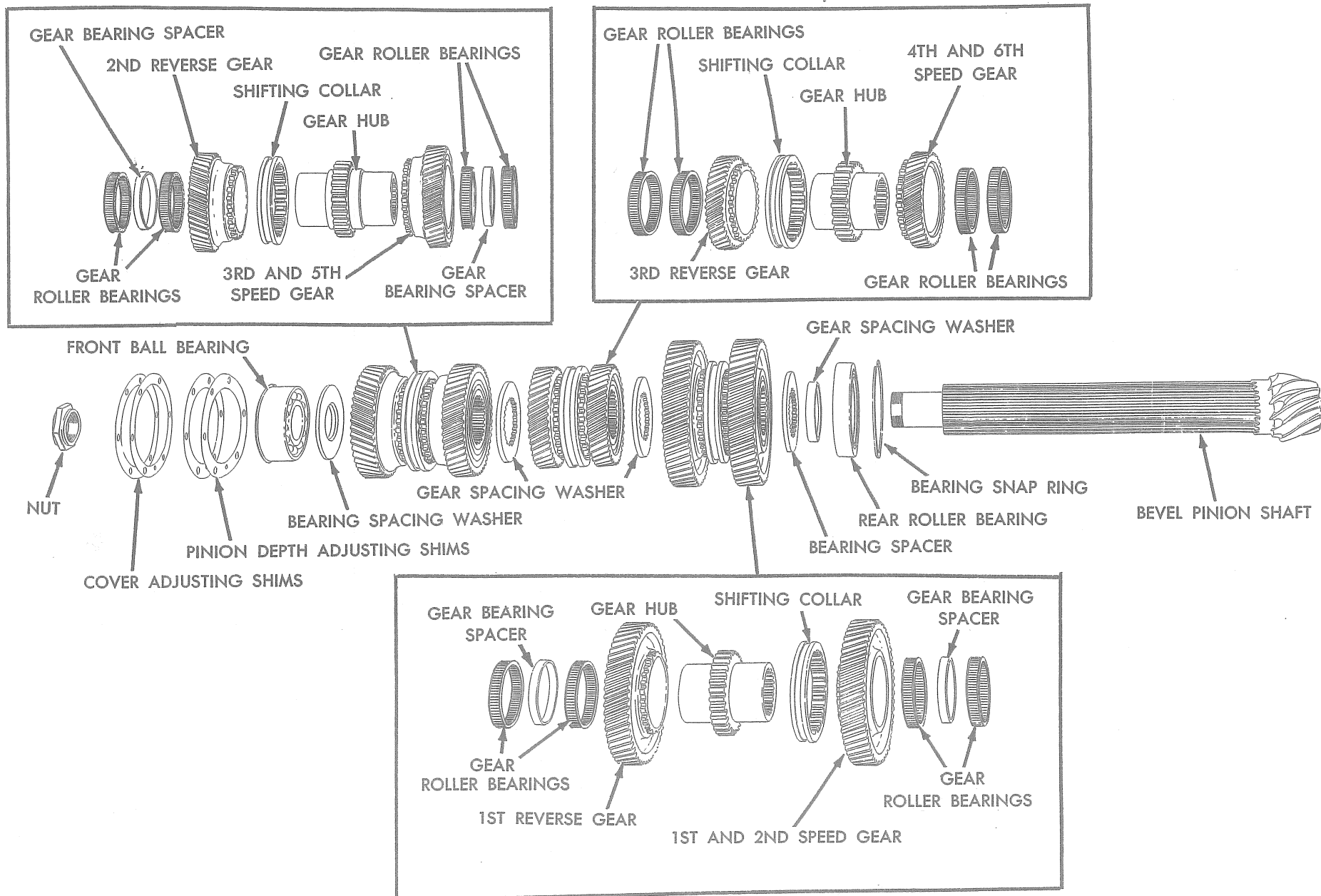
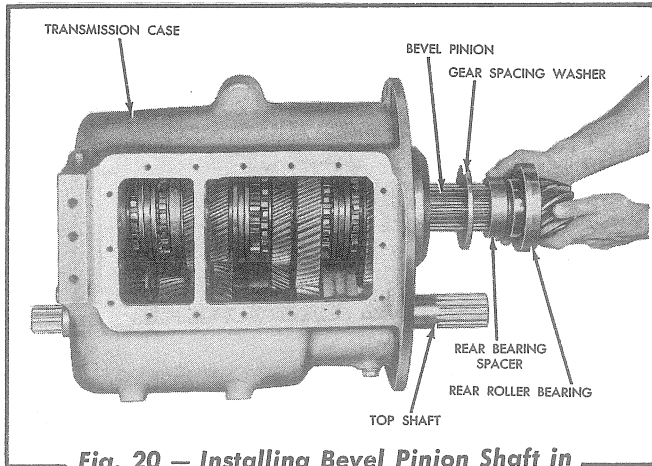


Fig. 19 — Transmission Bevel Pinion Shaft Details  
(Tractors Without Torque Converter)



necessary to align the splines of the shaft with the corresponding splines in the gear spacing washers and the gear hubs, and push the pinion shaft into the gear hubs until the rear bearing is started into the bore of the case. Drive the rear bearing into the bore of the case and install the rear bearing snap ring in position in the case.



**Fig. 20 — Installing Bevel Pinion Shaft in Transmission (Tractors Without Torque Converter)**

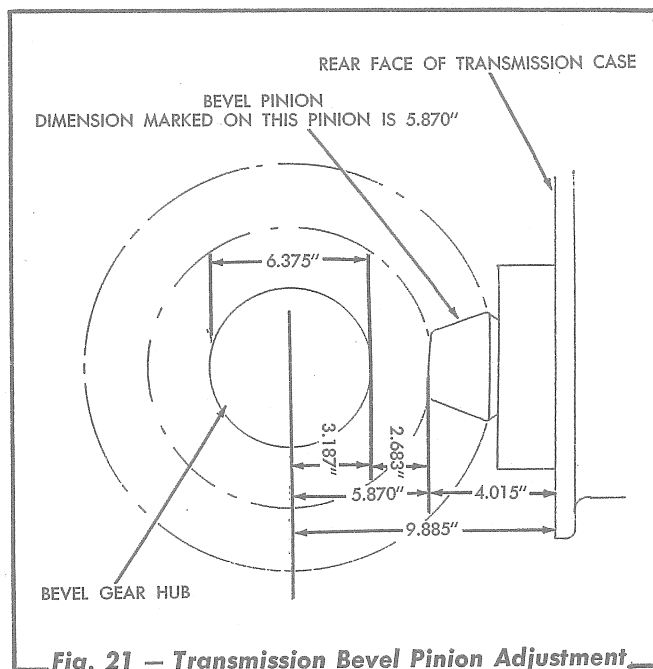
- g. Remove the snap ring from the bevel pinion shaft front ball bearing and start the bearing into position on the bevel pinion shaft. Start the nut on the bevel pinion shaft and tighten the nut to pull the ball bearing into position on the bevel pinion shaft and into the bore of the transmission case.
- h. Remove the front bearing cover from the intermediate shaft and tighten the intermediate shaft front nut to a torque of 500 (+ or -20) lbs. ft.; tighten the intermediate shaft rear nut to a torque of 200 (+ or -20) lbs. ft., and lock the nuts in position by staking. Tighten the bevel pinion shaft nut to a torque of 500 (+ or -20) lbs. ft. and lock the nut in position by staking. Install the intermediate shaft front bearing cover and gasket and secure the cover to the transmission case with the attaching capscrews.

Install the universal joint rear yoke in position on the front of the transmission top shaft, using a new yoke seal between the top shaft and the yoke retaining washer.

Install the yoke retaining washer and capscrew and tighten to a torque of 250 to 300 lbs. ft. Lock the capscrew with locking wire.

**NOTE:** The bevel pinion shaft, intermediate shaft, and top shaft may be locked for the installation of the bevel pinion shaft nut, front and rear intermediate shaft nuts, and the universal joint rear yoke capscrew by moving the shifting collars and locking the gears.

- i. Place the snap ring in its groove in the bevel pinion shaft front bearing and tap the bevel pinion shaft toward the rear of the transmission case until the snap ring is against the front face of the transmission case. Hold the front bearing cover firmly against the front bearing, and using a feeler gage, measure the gap between the bearing cover and the front face of the transmission case. Make up a shim pack of cover adjusting shims approximately .001" thicker than the feeler gage measurement; this will provide .000" to .002" bearing end play in the bearing cover when the bearing cover is attached to the case. Keep the shim pack with the bearing cover.
- j. Drive the transmission bevel pinion shaft forward approximately  $\frac{1}{16}$ " and remove the snap ring from the front ball bearing. Install the pinion depth adjusting shim pack (approximately .065" thickness), which was removed at disassembly, in place on the front ball bearing. Install the snap ring and drive the bevel pinion shaft toward the rear until the snap ring is tight against the depth adjusting shims.
- k. Install the bevel pinion shaft front bearing cover with the correct amount of cover adjusting shims, as determined in Step i above, and secure with the attaching capscrews.
- l. The initial transmission bevel pinion depth (controlled by depth adjusting shims located between the transmission bevel pinion shaft front ball bearing snap ring and the transmission case) should be set so that the rear face of the bevel pinion extends 4.015"



from the rear face of the transmission case as shown in Fig. 21.

- m. If the bevel pinion has a mounting distance dimension marked on the rear face of the pinion, subtract this dimension from 9.885", which is the specified dimension from the rear mounting face of the transmission case to the center of the bevel gear hub. The difference between these two dimensions is the distance the toe end of the pinion should extend from the rear mounting face of the transmission case, without the case mounting gasket in place (refer to Fig. 21).
- n. If the replacement bevel pinion does not have a mounting distance dimension marked on the rear face, the pinion should be adjusted so that the rear face (toe end) of the bevel pinion stands out approximately 4.015" from the rear face of the transmission case before the transmission is installed (refer to Fig. 21).

#### 4. Installation of Transmission Speed Selection Mechanism

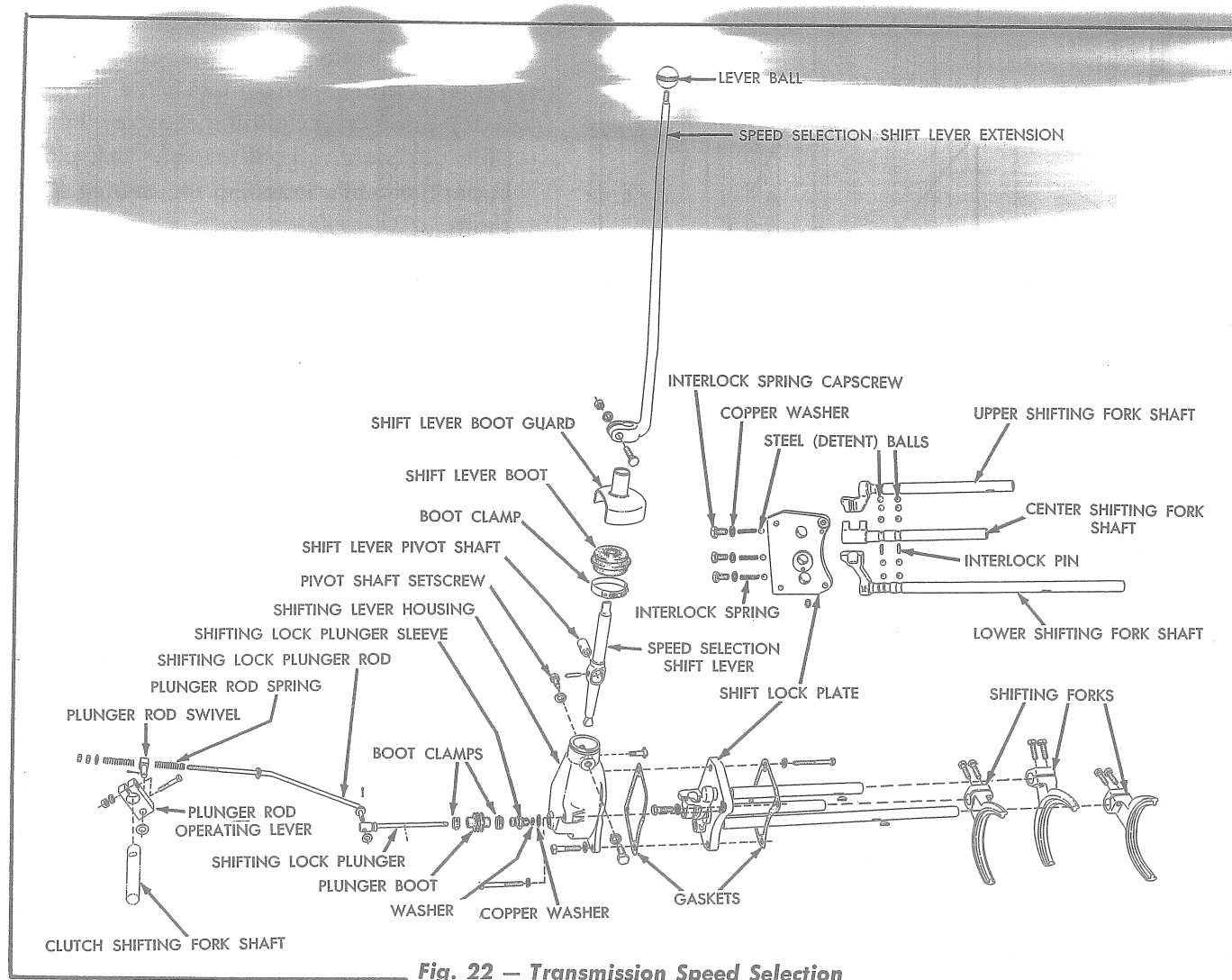
Turn the transmission case on the work bench so that the case rests on its top side. Refer to Figs. 1, 22, and 23 and install the shifting fork shafts and their components as follows:

- a. Place the shift lock plate in position on the front of the transmission case, using a new gasket between the shift lock plate and the transmission case. Install a capscrew in the shift lock plate to hold the shift lock plate in position while installing the shifting fork shafts.
- b. Install the three shifting forks in position in the slots of their corresponding shifting collars. *NOTE: The front shifting fork has no keyway. The forks must be installed with the bosses for the fork attaching capscrews positioned as shown in Fig. 7.*
- c. The three shifting fork shafts are of different lengths; the lower shaft being the longest, the upper shaft being next in length, and the center shaft being the shortest.

Insert the upper shifting fork shaft through the upper shifting shaft bore in the shift lock plate and into the transmission case. Insert the shifting fork shaft into the case far enough to permit installation of the "Woodruff" key in the keyway nearest the rear end of the shaft.

Install the "Woodruff" key in the keyway nearest the rear end of the shaft and insert the shaft into the center fork, located on the center cluster of gears. Refer to Figs. 22 and 23 and install the steel balls (detent balls) or steel pins (detent pins) in position as follows:

- (1) From the front of the shift lock plate, insert three steel balls into the bore for the center shifting fork shaft and roll them into place in the drilled hole provided in the lock plate between the upper shifting fork shaft and the center shifting fork shaft opening. If the transmission is equipped with steel pins (detent pins) instead of steel balls, insert a steel pin  $1\frac{1}{2}$ " long into position through the  $\frac{3}{8}$ " pipe plug hole.
- (2) Using the same procedure as above, insert three steel balls into the bore for



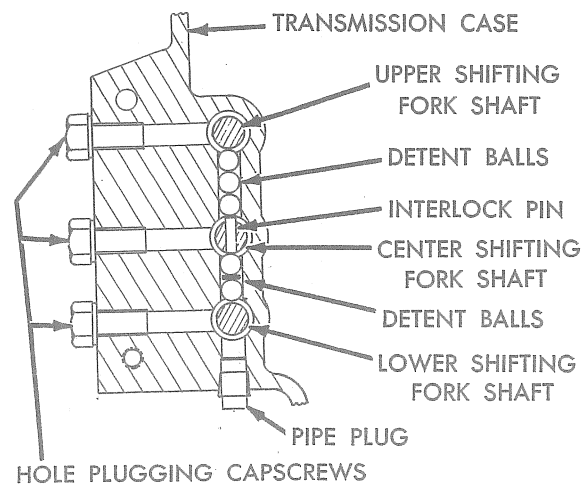
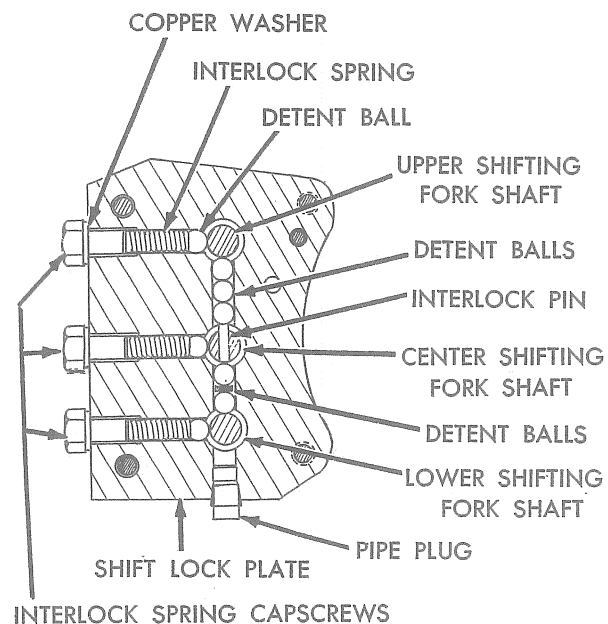
**Fig. 22 — Transmission Speed Selection Mechanism Details (Tractors Without Torque Converter)**

the center shifting fork shaft and roll them into place in the drilled hole provided in the transmission case between the upper shifting fork shaft and the center shifting fork shaft opening. If the transmission is equipped with steel pins (detent pins) instead of steel balls, insert a steel pin  $1\frac{1}{2}$ " long into position through the  $\frac{3}{8}$ " pipe plug hole. **CAUTION:** Use care when inserting the steel balls to avoid dropping them into the gear compartment. Make certain that the shifting fork shaft detent notches are properly positioned with the steel balls or steel pins.

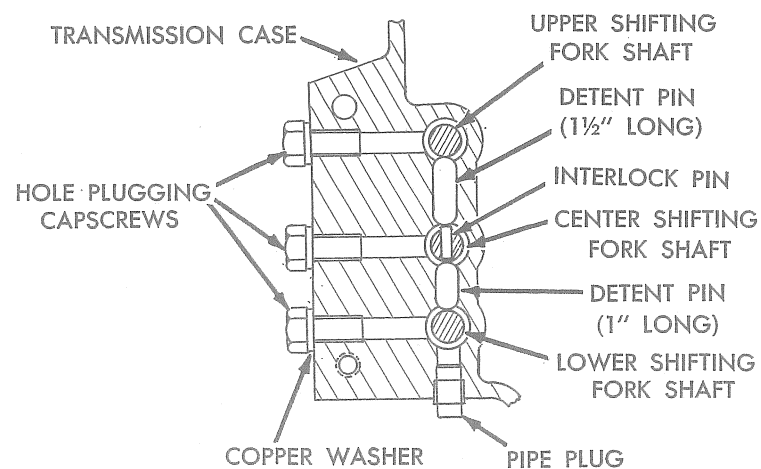
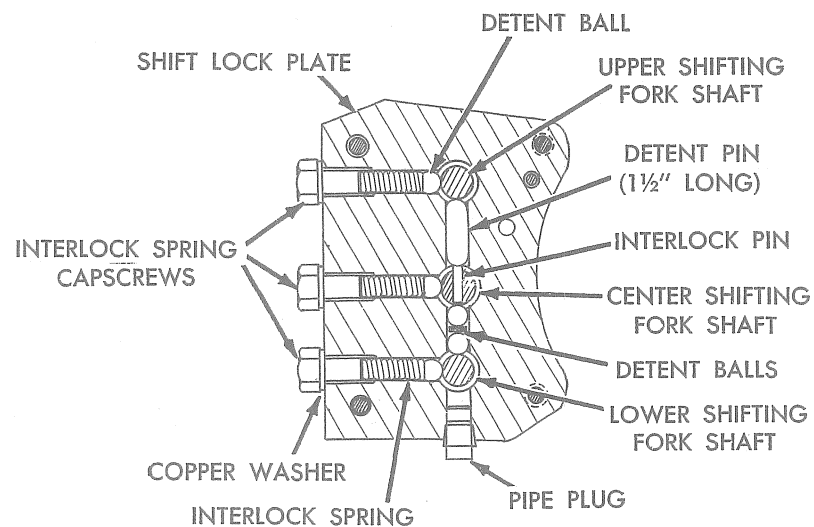
- d. Install the interlock pins in position in the center shifting fork shaft and insert the shaft through the center shifting shaft bore

in the shift lock plate and into the front fork, located on the front cluster of gears. Refer to Fig. 23 and install two steel balls (detent balls) in the drilled hole provided in the shift lock plate between the center shifting fork shaft and the lower shifting fork shaft; then install two steel balls in the drilled hole provided in the transmission case. If the transmission is equipped with steel pins (detent pins) instead of steel balls, insert a steel pin 1" long into position in the transmission case through the  $\frac{3}{8}$ " pipe plug hole (Fig. 23).

Make certain that the center shifting fork shaft detent notches are properly positioned with the steel balls or steel pins.



Tractors Prior to Serial No. 2996



Tractors Serial No. 2996 and Above

Fig. 23 — Shifting Fork Shaft Detent Balls and/or Pins Details — Sectional View

e. Insert the lower shifting fork shaft through the lower shifting shaft bore in the shift lock plate, and into the transmission case. Insert the shaft into the case far enough to permit installation of the "Woodruff" key in the keyway of the shaft. Install the "Woodruff" key in the keyway of the shaft and insert the shaft into the rear fork located on the rear cluster of gears.

f. Make certain the shift lever notches in the front ends of the shifting fork shafts are properly aligned. Install a steel ball (detent ball) and an interlock spring into each hole (over each shifting fork shaft) of the shift lock plate, then install three washers (copper) and three interlock spring capscrews. Tighten the capscrews securely. *NOTE: Detent balls and interlock springs are not used under the three hole plugging capscrews in the transmission case. Install*

the three hole plugging capscrews with copper washers if the capscrews were removed.

g. With the shift lever notches in the front end of each shifting fork shaft properly aligned, center the three shifting collars on the gear hubs and center the shifting forks in the grooves of the shifting collars. Tighten the shifting fork capscrews to a torque of 83 to 93 lbs. ft.

h. Remove the capscrew which was installed to hold the shift lock plate in position while installing the shifting fork shafts. Install the speed selection shift lever housing and gasket in position on the shift lock plate, inserting the lower end of the shift lever into position in the notched ends of the shifting fork shafts. Install the capscrews to secure the shift lever housing and the shift lock plate to the transmission case.

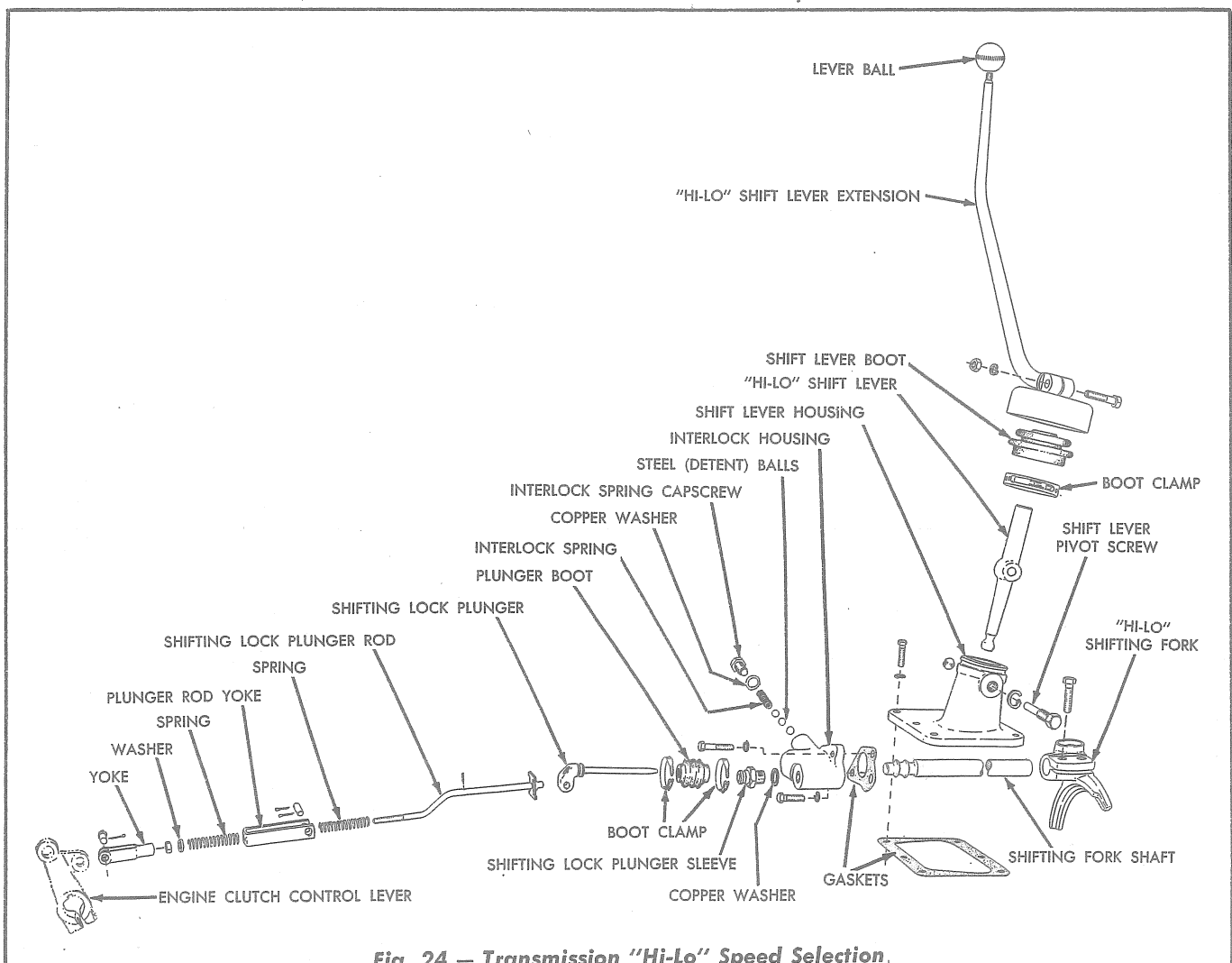


Fig. 24 — Transmission "Hi-Lo" Speed Selection Mechanism Details (Tractors Without Torque Converter)

- i. Install the "HI-LO" shifting fork in position on the shifting collar of the intermediate shaft, with the clamping slot of the fork facing toward the center of the transmission (refer to Fig. 7). Insert the "HI-LO" shifting fork shaft, assembled in the interlock housing, into the bore of the transmission case and into the shifting fork. Secure the interlock housing to the transmission case with capscrews and lockwashers.
- j. Center the shifting collar on the gear hub and center the shifting fork in the groove of the shifting collar. Tighten the shifting fork capscrews to a torque of 83 to 93 lbs. ft. Install the "HI-LO" shift lever housing assembly, with new housing-to-case gasket, in position on the transmission case, inserting the lower end of the shift lever into position in the shifting fork. Install and tighten the housing attaching capscrews.
- k. Install the oil drain plug in the transmission case. Thoroughly inspect the inside of the transmission for foreign objects. Check all capscrews inside the transmission and make certain they have been tightened securely. Using a small pry bar, or similar tool, move each shifting fork shaft into its various "detent" positions and check to see if the shifting forks are properly located on the shafts so that the shifting collars are properly engaged with their corresponding gears. Install the transmission side cover and gasket.

## **G. Assembly of Transmission (Tractors with Torque Converter)**

### **1. Installation of Reverse Shaft**

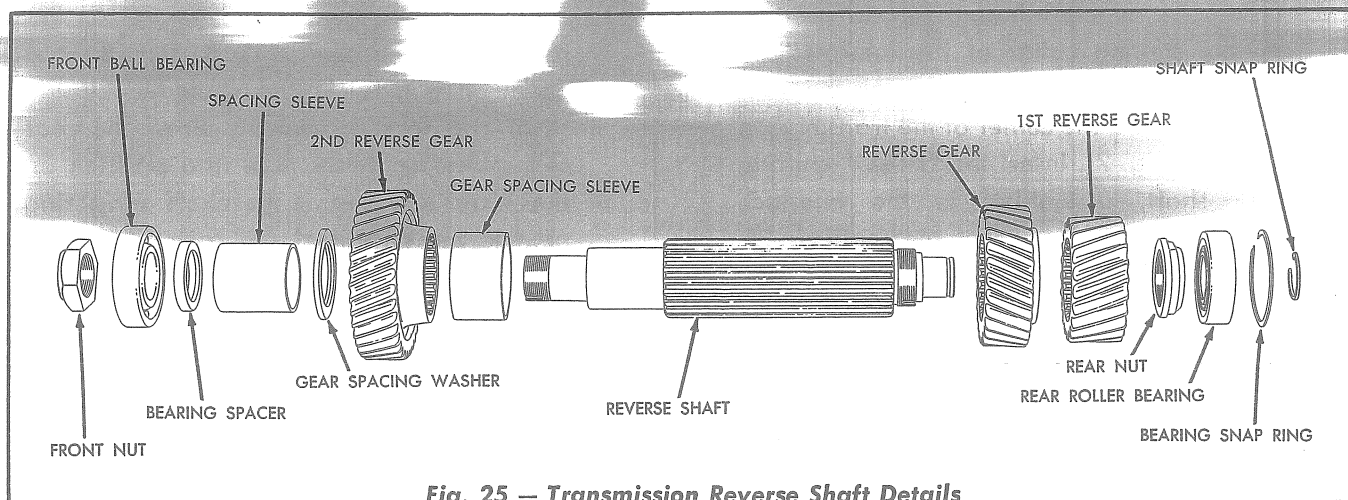
**NOTE:** Before installing the components of the reverse shaft in the transmission case the bevel pinion shaft rear gear cluster should be assembled and placed in position inside the transmission case. Refer to Fig. 27, and assemble the bevel pinion shaft rear gear cluster (1st reverse gear and 1st speed gear, each having 51 teeth) on a work bench, then install the cluster into position in the transmission case. This will make the installation of the bevel pinion shaft components easier.

- a. Refer to Fig. 25 and install the nut on the rear end of the reverse shaft. Turn the nut down snug against the shoulder on the shaft and lock by staking. Press the rear roller bearing inner race into position on the shaft and install the shaft snap ring next to the bearing inner race. Install the 1st reverse gear (22 teeth) on the shaft and next to the rear nut. Install the reverse gear (28 teeth) on the shaft, with the hub end of the gear toward the 1st reverse gear. Position the gear spacing sleeve ( $1\frac{3}{4}$ " long) next to the front face of the reverse gear. Install the 2nd reverse gear (36 teeth) on the shaft with the hub end of the gear toward the rear of the transmission case. Install the gear spacing washer on the shaft next to the 2nd reverse gear. Position the spacing sleeve ( $2\frac{1}{2}$ " long) on the shaft next to the gear spacing washer. Install the front bearing spacer with the chamfered side of the spacer next to the spacing sleeve. Install the front nut on the shaft, but do not tighten the nut at this time.
- b. Lubricate and install the reverse shaft rear roller bearing into position in the transmission case and install the bearing snap ring.
- c. Lower the reverse shaft and gear assembly into the transmission case, then move the reverse shaft back into position in the rear bearing. Lubricate the reverse shaft front ball bearing and install the snap ring in the groove in the outer circumference of the bearing if it has been removed. Remove the front nut from the reverse shaft. Start the bearing on the front of the shaft, then drive the bearing into position on the shaft and into the bearing bore in the front of the transmission case. Install the front nut on the reverse shaft but do not tighten the nut at this time.

### **2. Installation of Top Shaft**

- a. Refer to Fig. 26, and install the bearing spacer on the rear end of the top shaft with the smaller diameter of the spacer toward the rear of the shaft. Drive the rear





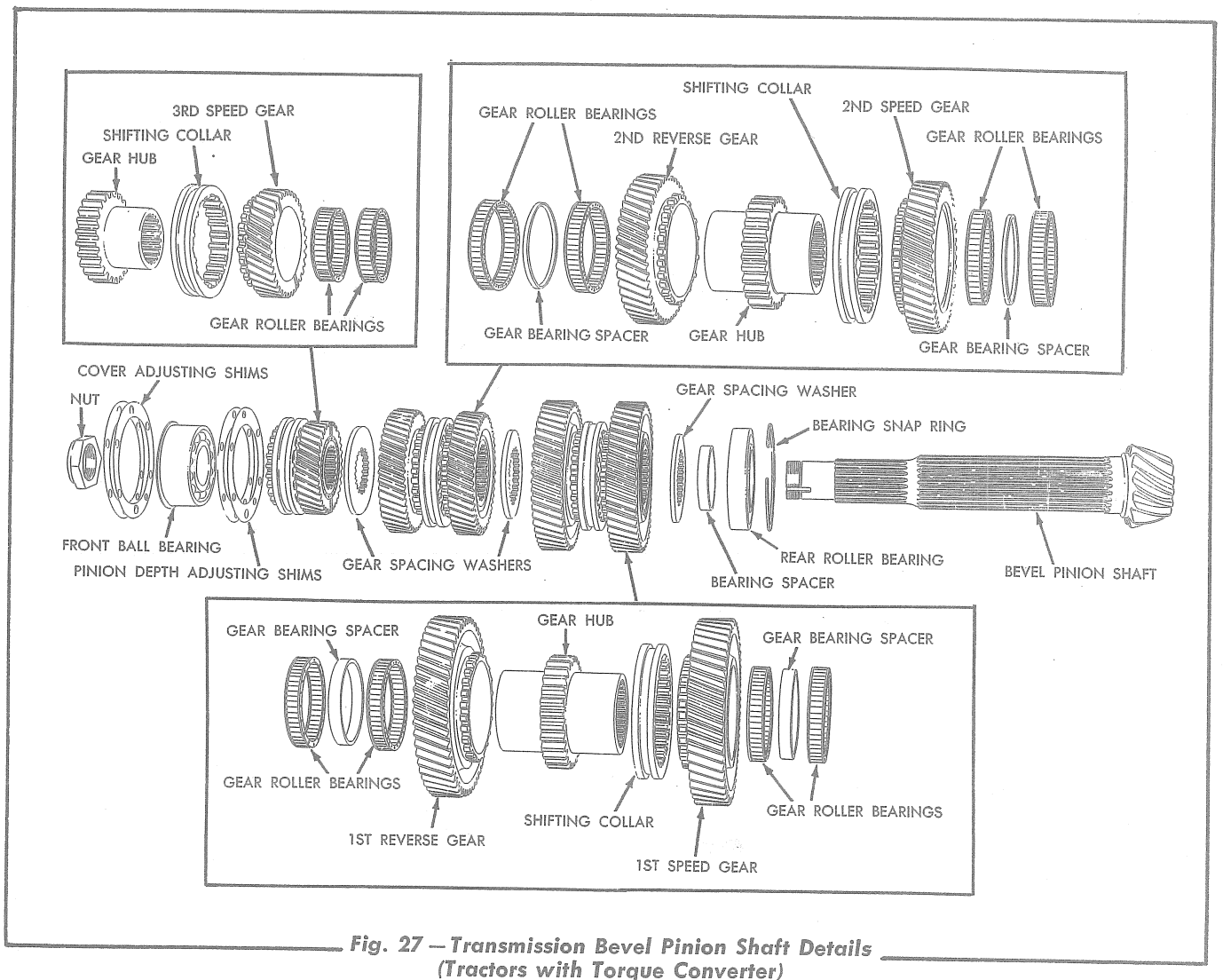
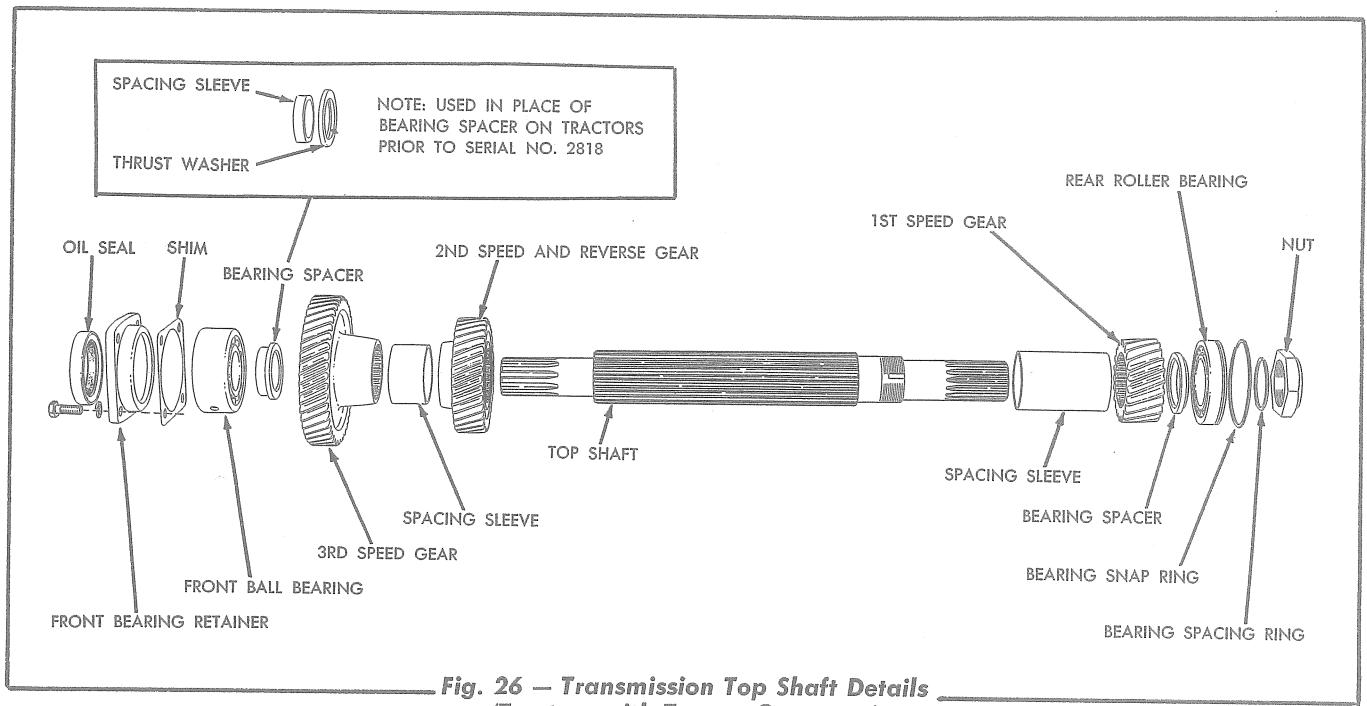
**Fig. 25 — Transmission Reverse Shaft Details**  
(Tractors with Torque Converter)

- b. Start the shaft into the transmission case, from the rear, just far enough so that the remaining components may be installed on the shaft.
- c. Install the 1st speed gear (22 teeth) and the spacing sleeve ( $4\frac{9}{16}$ " long) on the shaft. Install the 2nd speed and reverse gear (36 teeth) on the shaft, with the hub end of the gear facing the front end of the transmission case.
- d. Position the spacing sleeve ( $1\frac{3}{4}$ " long) on the shaft next to the 2nd speed and reverse gear. Install the 3rd speed gear (46 teeth) on the shaft with the hub end of the gear facing the rear of the transmission case. Position the bearing spacer on the shaft next to the 3rd speed gear.
- e. Start the front ball bearing in position on the shaft and in the bore in the front of the transmission case, and using a suitable "bucking" tool against the rear of the shaft, drive the bearing into position until the bearing bottoms in the bore of the transmission case.
- f. Install the oil seal in the front bearing retainer, with the sealing lip of the seal directed toward the bearing. Install the bearing retainer and the original amount of shims.

- g. Install the bearing snap ring on the rear roller bearing. Start the bearing in position on the bearing inner race and in the bore in the rear of the transmission case, and using a suitable sleeve, drive the bearing into position until the snap ring bottoms against the counterbore in the transmission case.
- h. Install the bearing spacing ring next to the rear roller bearing and install the nut on the shaft but do not tighten the nut at this time.

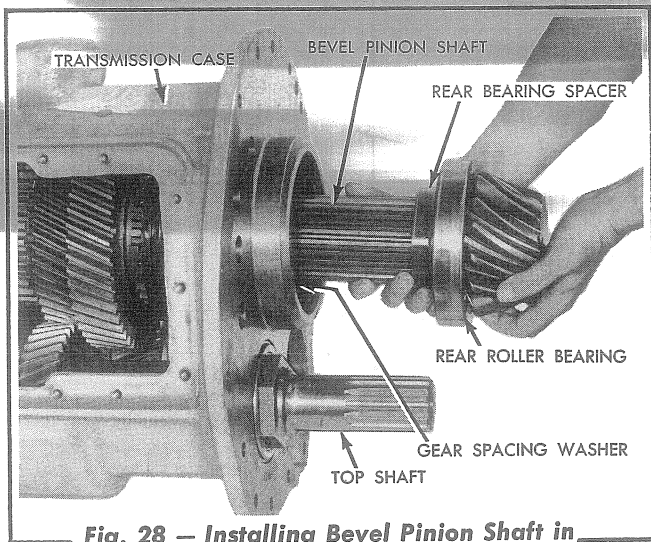
### 3. Installation of Bevel Pinion Shaft

- a. With the bevel pinion shaft rear gear cluster in position in the transmission case as outlined in Paragraph G, Step 1 above, refer to Fig. 27 and assemble the front gear cluster (3rd speed gear and 3rd speed gear hub) inside the transmission case. After the bevel pinion shaft front gear cluster has been assembled, push it as far forward as possible in the case and into mesh with the mating gears on the top and reverse shafts.
- b. Assemble the transmission bevel pinion shaft center gear cluster (2nd reverse gear and 2nd speed gear each having 48 teeth) on a work bench. When assembling, coat the two gear spacing washers with grease to hold them in position against their corresponding gears. Install the assembled cluster in position in the transmission case,



between the front and rear clusters. Make certain the gear spacing washers are in their proper positions and that the gears of the center gear cluster mesh properly with the mating gears on the top and reverse shafts.

- c. Press the inner race of the rear roller bearing into position on the bevel pinion shaft and install the rear roller bearing in position on the inner race. Install the rear bearing spacer (.643" to .646" long) on the bevel pinion shaft, with the chamfered end of the spacer toward the bearing. Place a gear spacing washer in position on the bevel pinion shaft and against the rear bearing spacer.
- d. Turn the transmission case so that the top of the case rests on the work bench as shown in Fig. 28. Make certain that the three shifting collars are in their neutral position. Start the bevel pinion shaft into the case from the rear. While pushing on the pinion, turn the bevel pinion shaft as necessary to align the splines of the shaft with the corresponding splines in the gear spacing washers and the gear hubs, and push the pinion shaft into the gear hubs until the rear bearing is started into the bore of the case. Drive the rear bearing into the bore of the case and install the rear bearing snap ring in position in the case.
- e. Remove the snap ring from the bevel pinion shaft front ball bearing and start the bearing into position on the bevel pinion shaft. Start the bevel pinion nut on the bevel pinion shaft and tighten the nut to pull the ball bearing into position on the bevel pinion shaft and into the bore of the transmission case.
- f. Tighten the top shaft rear nut to a torque of 200 (+ or - 20) lbs. ft., and lock the nut in position by staking. Tighten the reverse shaft front nut to a torque of 200 (+ or - 20) lbs. ft., and lock the nut in position by staking. Tighten the bevel pinion shaft nut to a torque of 500 (+ or

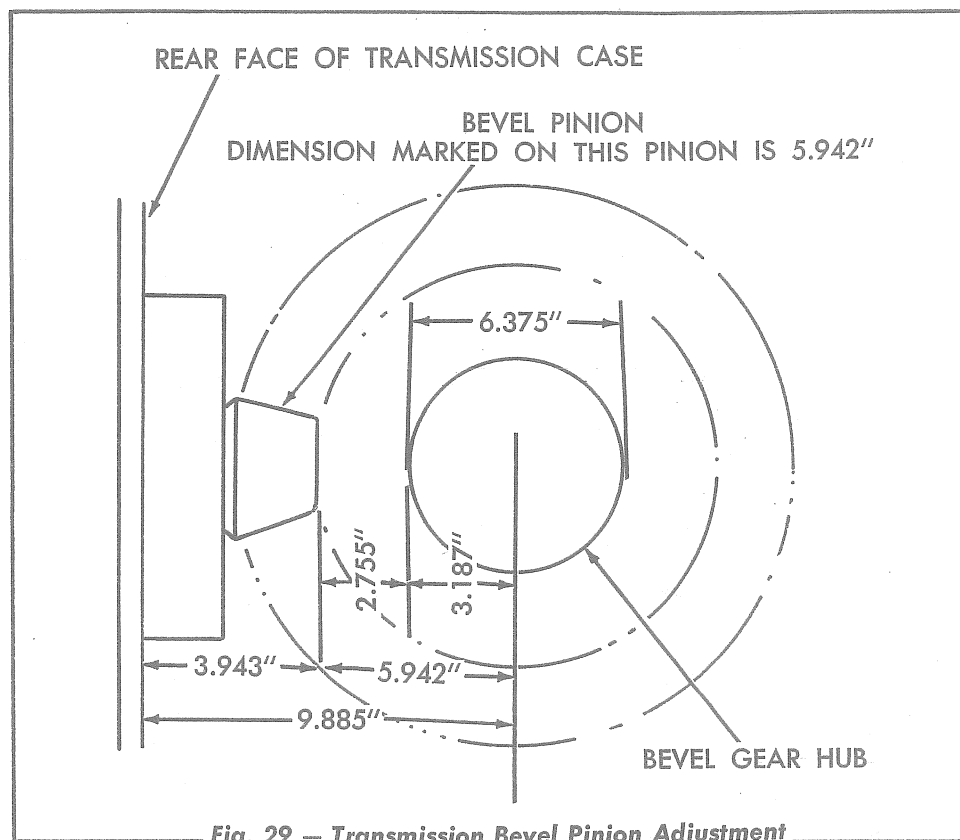


**Fig. 28 — Installing Bevel Pinion Shaft in Transmission (Tractors with Torque Converter)**

— 20) lbs. ft., and lock the nut in position by staking. Install the rear yoke (universal joint) in position on the front of the transmission top shaft, using a new yoke seal between the top shaft and the yoke retaining washer. Install the yoke retaining washer and capscrew and tighten to a torque of 250 to 300 lbs. ft.; lock the capscrew with locking wire. Install the reverse

shaft front bearing retainer, with the original amount of shims, and secure to the transmission case with capscrews and lockwashers. **NOTE:** The bevel pinion shaft, top shaft and reverse shaft may be locked for the installation of the bevel pinion shaft nut, reverse shaft nut, top shaft nut, and the capscrew attaching the universal joint rear yoke to the front end of the top shaft by moving the shifting collars and locking the gears.

- g. Place the snap ring in its groove in the bevel pinion shaft front bearing and tap the bevel pinion toward the rear of the transmission case until the snap ring is against the front face of the transmission case. Hold the front bearing cover firmly against the front bearing, and using a feeler gage, measure the gap between the bearing cover and the front face of the transmission case. Make up a shim pack of cover adjusting shims approximately .001"

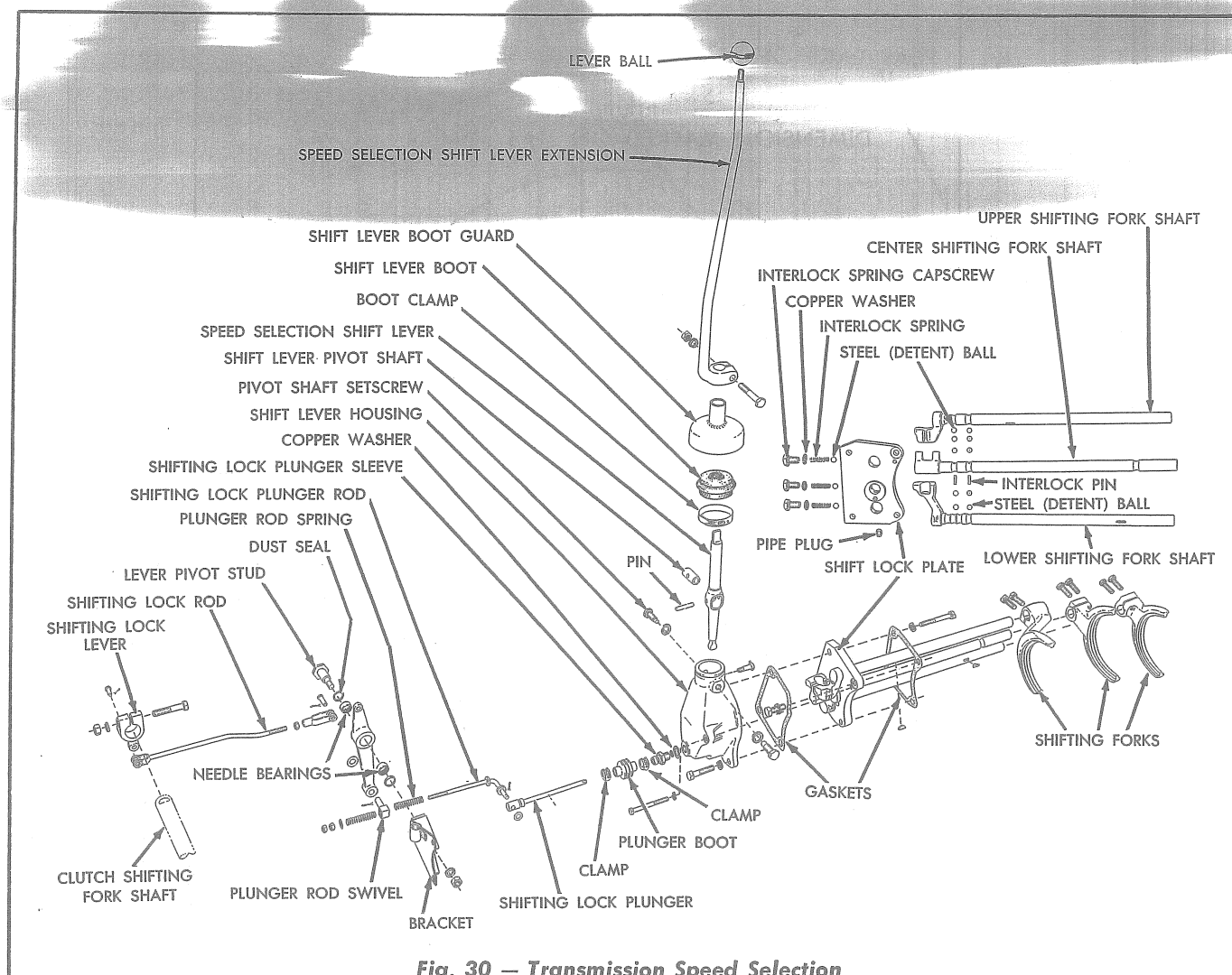


**Fig. 29 — Transmission Bevel Pinion Adjustment  
(Tractors with Torque Converter)**

thicker than the feeler gage measurement; this will provide .000" to .002" bearing end play in the bearing cover when the bearing cover is attached to the case. Keep the shim pack with bearing cover.

shaft front ball bearing snap ring and the transmission case) should be set so that the rear face of the bevel pinion extends 3.943" from the rear face of the transmission case as shown in Fig. 29.

- h. Drive the transmission bevel pinion shaft forward approximately  $\frac{1}{16}$ " and remove the snap ring from the front ball bearing. Install the pinion depth adjusting shim pack (approximately .065" thickness), which was removed at disassembly, in place on the front ball bearing. Install the snap ring and drive the bevel pinion shaft toward the rear until the snap ring is tight against the depth adjusting shims.
- i. Install the bevel pinion shaft front bearing cover with the correct amount of cover adjusting shims, as determined in Step g. above, and secure with the attaching cap-screws.
- j. The initial transmission bevel pinion depth (controlled by depth adjusting shims located between the transmission bevel pinion shaft front ball bearing snap ring and the transmission case) should be set so that the rear face of the bevel pinion extends 3.943" from the rear face of the transmission case as shown in Fig. 29.
- k. If the bevel pinion has a mounting distance dimension marked on the rear face of the pinion, subtract this dimension from 9.885", which is the specified dimension from the rear mounting face of the transmission case to the center of the bevel gear hub. The difference between these two dimensions is the distance the toe end of the pinion should extend from the rear mounting face of the transmission case, without the case mounting gasket in place (refer to Fig. 29).
- l. If the replacement bevel pinion does not have a mounting distance dimension marked on the rear face, the pinion should be adjusted so that the rear face (toe end) of the bevel pinion stands out approximately 3.943" from the rear face of the transmission case before the transmission is installed (refer to Fig. 29).



**Fig. 30 — Transmission Speed Selection Mechanism Details (Tractors with Torque Converter)**

#### 4. Installation of Transmission Speed Selection Mechanism

Turn the transmission case on the work bench so that the case rests on its top side. Refer to Figs. 12, 23, and 30 and install the shifting fork shafts and their components as follows:

- a. Place the shift lock plate in position on the front of the transmission case, using a new gasket between the shift lock plate and the transmission case. Install a capscrew in the shift lock plate to hold the shift lock plate in position while installing the shifting fork shafts.
- b. Install the three shifting forks in position in the slots of their corresponding shifting collars. The forks must be installed with the

bosses for the shifting fork capscrews positioned as shown in Fig. 12.

- c. Refer to Fig. 30 and insert the upper shifting fork shaft through the upper shifting shaft bore in the shift lock plate and into the transmission case. Insert the shifting fork shaft into the case far enough to permit installation of the "Woodruff" key. Install the "Woodruff" key in the shaft and insert the shaft into the front fork, located on the front cluster of gears. Refer to Fig. 23 and 30 and install the steel balls (detent balls) or steel pins (detent pins) in position as follows:

- (1) From the front of the shift lock plate, insert three steel balls into the bore for the center shifting fork shaft and roll

them into place in the drilled hole provided in the lock plate between the upper shifting fork shaft and the center shifting fork shaft opening. If the transmission is equipped with steel pins (detent pins) instead of steel balls, insert a steel pin  $1\frac{1}{2}$ " long into position through the  $\frac{3}{8}$ " pipe plug hole.

- (2) Using the same procedure as above, insert three steel balls into the bore for the center shifting fork shaft and roll them into place in the drilled hole provided in the transmission case between the upper shifting fork shaft and the center shifting fork shaft opening. If the transmission is equipped with steel pins (detent pins) instead of steel balls, insert a steel pin  $1\frac{1}{2}$ " long into position through the  $\frac{3}{8}$ " pipe plug hole. **CAUTION:** Use care when inserting the steel balls to avoid dropping them into the gear compartment. Make certain that the shifting fork shaft detent notches are properly positioned with the steel balls or steel pins.
- d. Install the interlock pins in position in the center shifting fork shaft and insert the shaft through the center shifting shaft bore in the shift lock plate and into the center fork, located on the center cluster of gears. Refer to Fig. 23 and install two steel balls (detent balls) in the drilled hole provided in the shift lock plate between the center shifting fork and the lower shifting fork shaft, then install two steel balls in the drilled hole provided in the transmission case. If the transmission is equipped with steel pins (detent pins) instead of steel balls, insert a steel pin 1" long into position in the transmission case through the  $\frac{3}{8}$ " pipe plug hole (Fig. 23). Make certain that the center shifting fork shaft detent notches are properly positioned with the steel balls or steel pins.
- e. Insert the lower shifting fork shaft through the lower shifting shaft bore in the shift lock plate, and into the transmission case. Insert the shaft into the case far enough to permit installation of the "Woodruff" key in the keyway of the shaft. Install the "Woodruff" key in the keyway of the shaft and insert the shaft into the rear fork located on the rear cluster of gears.
- f. Make certain the shift lever notches in the front ends of the shifting fork shafts are properly aligned. Install a steel ball (detent ball) and an interlock spring into each hole (over each shifting fork shaft) of the shift lock plate, then install three washers (copper) and three interlock spring capscrews. Tighten the capscrews securely. **NOTE:** Detent balls and interlock springs are not used under the three hole plugging capscrews in the transmission case. Install the three hole plugging capscrews with copper washers if the capscrews were removed.
- g. With the shift lever notches in the front end of each shifting fork shaft properly aligned, center the three shifting collars on the gear hubs and center the shifting forks in the grooves of the shifting collars. Tighten the shifting fork capscrews to a torque of 83 to 93 lbs. ft.
- h. Remove the capscrew which was installed to hold the shift lock plate in position while installing the shifting fork shafts. Install the speed selection shift lever housing and gasket in position on the shift lock plate, inserting the lower end of the shift lever into position in the notched ends of the shifting fork shafts. Install the capscrews to secure the shift lever housing and the shift lock plate to the transmission case.
- i. Install the oil drain plug in the transmission case. Thoroughly inspect the inside of the transmission for foreign objects. Check all capscrews inside the transmission and make certain they have been tightened securely. Using a pry bar, or similar tool, move each shifting fork shaft into its various "detent" positions and check to see if the shifting forks are properly located on the shafts so that the shifting collars are properly engaged with their corresponding gears. Install the transmission side cover and gasket.



## H. Installation of Transmission

1. Use a new mounting gasket between the transmission case and the steering clutch and final drive housing and install the transmission assembly by a direct reversal of the removal procedure (refer to Fig. 5 or 6). After the transmission has been secured in position, the backlash between the bevel gear and bevel pinion teeth, and the tooth contact pattern **MUST** be checked (refer to "INSTALLATION OF BEVEL GEAR" in this Section).

2. Connect the shifting lock plunger rod to the shifting lock plunger and check the adjustment of the rod as follows:

To adjust the shifting lock plunger rod, pull the engine clutch operating lever to its "engaged" position. Measure the compressed length of the plunger rod rear spring and record this measurement. Push the engine clutch operating lever to its "disengaged" position, turn the nuts on the front end of the plunger rod front spring to obtain the same compressed length as recorded for the rear spring. When the correct adjustment is obtained, tighten the jam nut.

3. On tractors without a torque converter, install the yoke pin used to connect the "HI-LO" shifting lock plunger rod to the "HI-LO" shifting lock plunger and check the adjustment as follows:

The "HI-LO" shifting lock plunger rod is properly adjusted when there is  $\frac{1}{8}$ " clearance between the shoulder of the plunger and the shifting lock plunger

sleeve, with the engine clutch lever in the "disengaged" position. The correct adjustment can be made by turning the adjustable yoke at the front end of the shifting lock plunger rod as necessary.

4. Install the drive shaft universal joint (refer to Topic 4 in this Section).
5. Install the right brake pedal shaft with its components in position, using the original amount of brake pedal shaft bracket shims. Install the capscrews, nuts, and lockwashers securing the right brake pedal shaft bracket to the main frame. Connect the right front brake rod to the right pedal shaft outer lever.
6. Install the steering clutch lower cross shaft bracket (with levers) in position on the engine clutch or torque converter housing and secure with capscrews and lockwashers. Install and connect the steering clutch lower front and lower rear control rods. Adjust the steering clutch control linkage (refer to Section XI, Topic 2).
7. Install the floor plate supporting channels, floor plates, tool box and seat frame. Insert the upper end of the steering clutch lubricating hoses into the holes provided in the tool box supporting bracket and secure each hose with a lockwasher and a jam nut. Insert the steering clutch lubricating pipes into the upper end of the lubricating hoses and tighten. Install the seat cushions, install the extension(s) on the shift lever(s).
8. Install the drain plug in the bevel gear compartment and fill the transmission and bevel gear compartment to the proper level with the specified lubricant.

### 3. BEVEL GEAR

#### A. Description

The bevel gear, located in the center compartment of the steering clutch and final drive housing, is bolted to the flange of the bevel gear shaft. The bevel gear shaft is supported at each end by tapered roller bearings contained in removable bearing cages. Bearing adjustment shims are provided between the bearing cages and the walls of the housing for bearing adjustment and bevel gear adjustment. The bevel gear is driven by the transmission bevel pinion and power from the bevel gear is delivered through the steering clutches to the final drives.

On tractors without a torque converter the bevel gear is located on the left side of the bevel pinion. On tractors with a torque converter the bevel gear is located on the right side of the bevel pinion.

#### B. Removal of Bevel Gear

With the transmission removed from the steering clutch and final drive housing, the bevel gear may be removed as follows: This removal procedure applies to tractors with or without a torque converter.

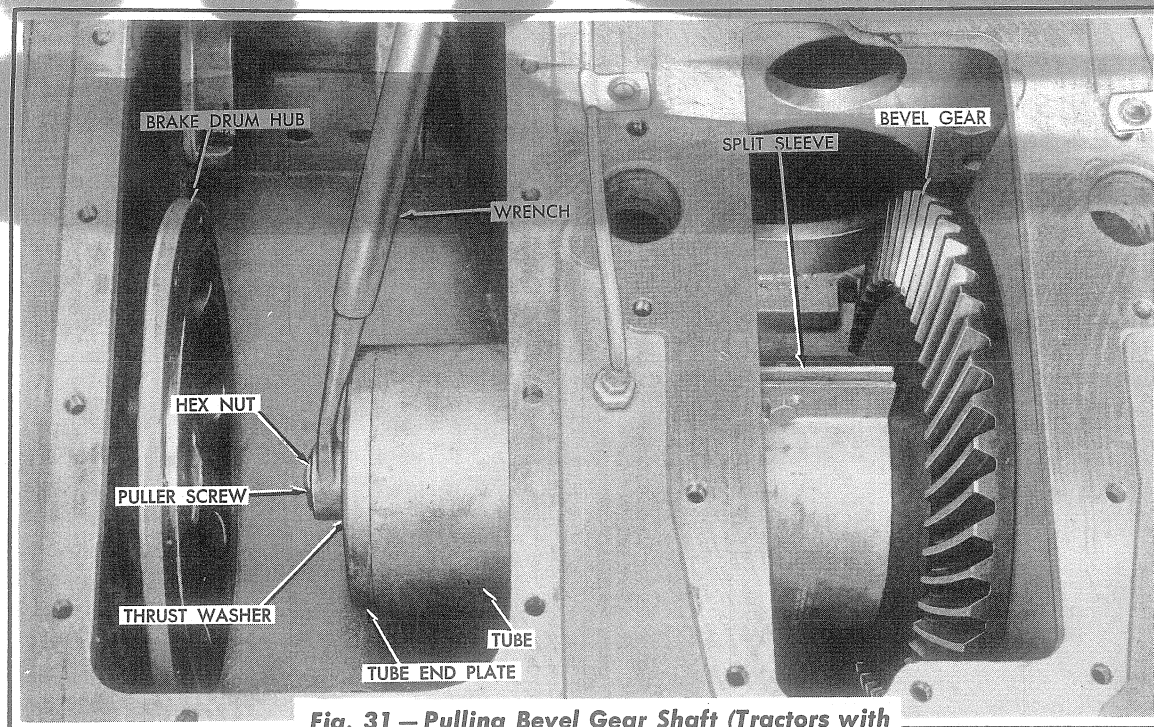
1. Remove both steering clutches (refer to Section XI, Topic 2, Paragraph E).
2. Remove the hydraulic control valve (refer to Section XI, Topic 4, Paragraph D).
3. Remove the steering clutch throwout yoke and bearing assemblies (refer to Section XI, Topic 3, Paragraph B).
4. Remove the high nuts and the nut locking plates securing the bevel gear to the bolting flange of the bevel gear shaft.
5. Remove the capscrews attaching the bevel gear shaft bearing cage assemblies to the inner walls of the steering clutch compartments. Using two  $\frac{1}{2}$ " NC pusher screws in the tapped holes in each bearing cage, turn the pusher screws in evenly and remove the bearing cages. Tie the bearing adjustment shims to their respective bearing cage to prevent loss.

6. Using tools similar to the ones shown in Figs. 31 and 32, pull the bevel gear shaft as follows:

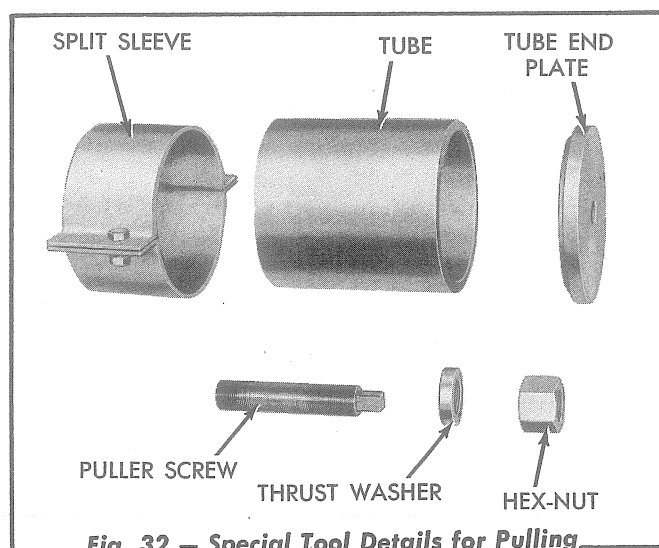
- a. Place a one inch wooden block under the bevel gear to center the bevel gear shaft in the bores from which the bearing cages were removed.
  - b. Install the split sleeve over the bevel gear shaft as shown in Fig. 31, with one end against the bevel gear and the other end against the wall of the bevel gear compartment.
  - c. On tractors without a torque converter turn the puller screw into the tapped hole in the right end of the bevel gear shaft. On tractors with a torque converter turn the puller screw into the tapped hole in the left end of the bevel gear shaft until it bottoms in the tapped hole. Install the puller tube, tube end plate, thrust washer, and hex-nut over the puller screw and shaft as shown in Fig. 31. Tighten the hex-nut and pull the bevel gear shaft from the bevel gear. The bearing cone to the rear of the bevel gear will be pressed from the bevel gear shaft as the shaft is pulled from the bevel gear.
  - d. Remove the puller tools and remove the bevel gear shaft and bearing cone through the steering clutch compartment. Remove the bevel gear, wooden block, and bearing cone from the bevel gear compartment.
7. Remove the bearing cone from the bevel gear shaft and the bearing cups from the bearing cage assemblies.

#### C. Cleaning and Inspection of Bevel Gear Shaft Components

Clean and inspect all the parts as described in pertinent pages in Section XX. Replace or recondition any damaged parts. Install new oil seals when assembling.



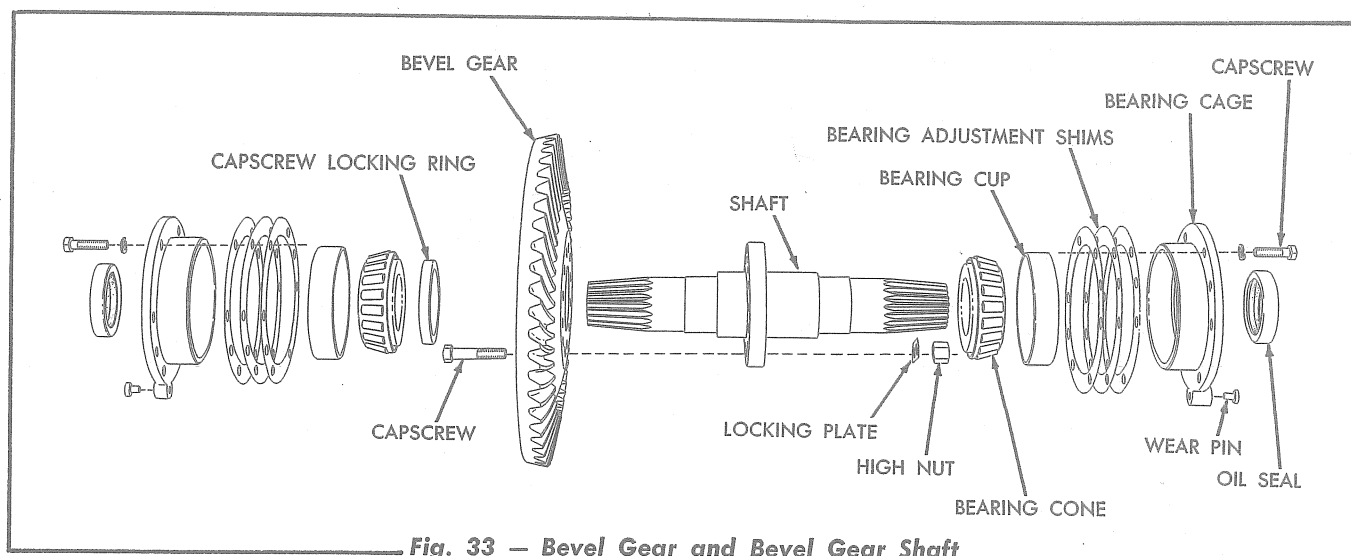
**Fig. 31 — Pulling Bevel Gear Shaft (Tractors with Torque Converter Shown — Tractors Without Torque Converter, Bevel Gear on Opposite Side of Compartment)**



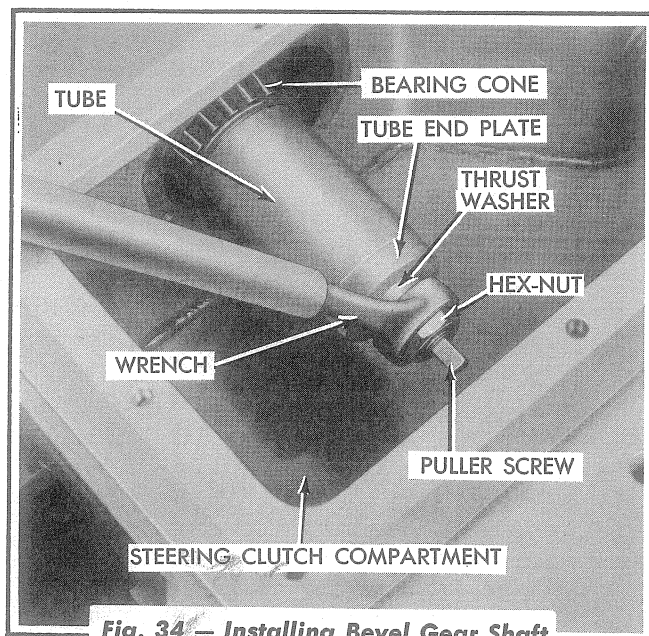
**Fig. 32 — Special Tool Details for Pulling Bevel Gear Shaft**

#### **D. Installation of Bevel Gear**

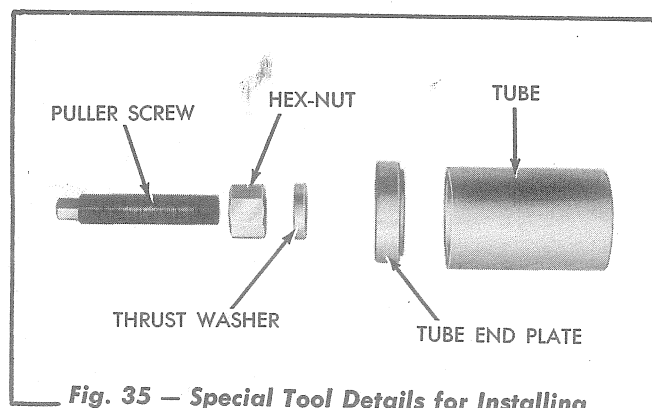
1. Press the bearing cone into position on the long end of the bevel gear shaft, with the large diameter of the bearing against the shoulder of the shaft. Install the bevel gear attaching capscrews in position in the gear. *NOTE: When installing the capscrews, position the capscrew heads so that the capscrew locking ring may be installed.*
2. Place the bevel gear in position in the housing, with the teeth of the gear toward the left side on tractors with a torque converter and to the right side on tractors without a torque converter, when viewed from the rear. Start the bevel gear shaft into the bevel gear and start the flange of the shaft onto the attaching capscrews. Bump or drive the bevel gear shaft into the bevel gear until the nut locking plates and the high nuts may be started on the attaching capscrews. Place the nut locking plates in position on the attaching capscrews and start the high nuts. Tighten several of the high nuts evenly until the gear is properly located on the shaft. Install the capscrew locking ring in position, making certain that the heads of the capscrews are positioned so that the locking ring will contact the bevel gear when installed.
3. Lubricate the other bearing cone and start it on the short end of the bevel gear shaft, with the large diameter of the bearing toward the bevel gear. Using tools similar to the ones shown in Fig. 34 and 35, install the puller screw (used in removal) in the tapped hole in the end of the bevel gear



**Fig. 33 — Bevel Gear and Bevel Gear Shaft Details (Tractors Without Torque Converter Shown — Tractors with Torque Converter Similar)**



**Fig. 34 — Installing Bevel Gear Shaft Bearing Cone**



**Fig. 35 — Special Tool Details for Installing Bevel Gear Shaft Bearing Cone**

shaft. Place a tube (having an O.D. the size of the inner race of the bearing cone) over the puller screw and against the inner race of the bearing cone. Install a tube end plate, thrust washer, and hex-nut on the puller screw as shown in Fig. 35. Tighten the hex-nut to press the bearing cone tight against its shoulder on the shaft, then remove the installing tools.

4. Press the bearing cups into position in the bearing cage assemblies. Lubricate the bearing cones with clean engine oil and insert one cage and cup assembly into each bore of the housing using the original amount of bearing adjustment shims, removed at disassembly, between each cage and the wall of the housing. **CAUTION: Make certain each bearing cage is installed in the bore from which it was removed.**
5. Make certain the wear pin in each bearing cage is toward the bottom when installed, then start the attaching capscrews but do not tighten at this time.
6. Tighten all of the high nuts of the bevel gear attaching capscrews to a torque of 165 to 175 lbs. ft. and lock the high nuts in position with the nut locking plates.



7. Tighten the bearing cage attaching cap-screws and bump the bearing cages to make certain the bearing cones are properly seated, then check the bearing pre-load. **NOTE: THE BEARING PRE-LOAD MUST BE CHECKED WITHOUT THE OIL SEALS IN POSITION IN THE BEARING CAGES AND WITH THE TRANSMISSION REMOVED, IN ORDER TO DETERMINE THE PROPER PRE-LOAD OF THE BEVEL GEAR SHAFT BEARINGS.**

8. A spring scale may be used to weigh the bearing pre-load as shown in Fig. 36. Proceed as follows:

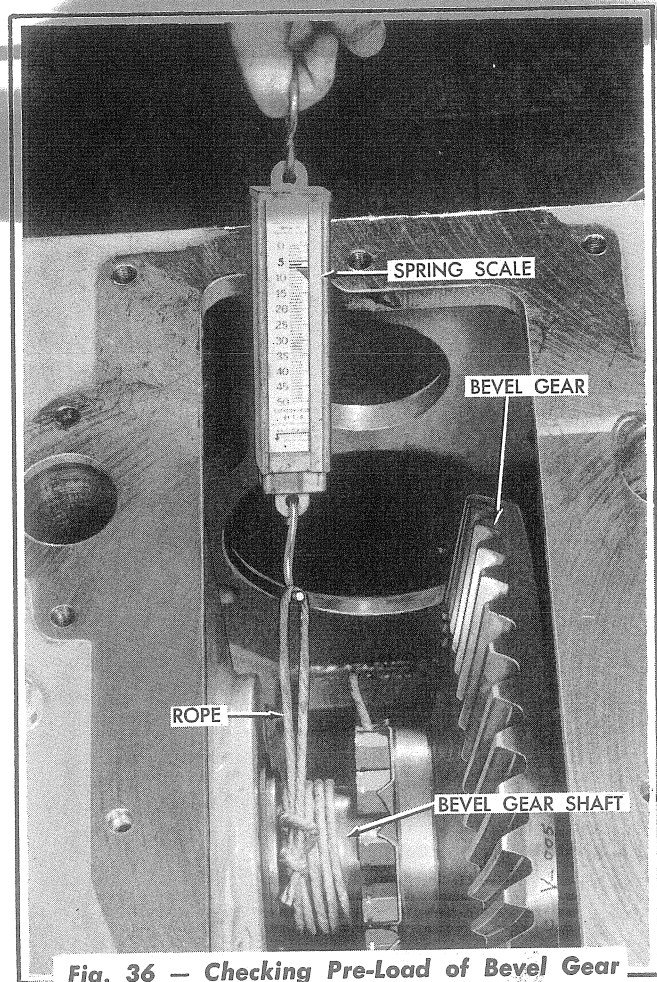
a. Use a length of heavy cord or light rope and wind the rope around the bevel gear shaft several times as shown in Fig. 36. Tie a loop in the free end of the rope and hook the spring scale in the loop. Pull on the spring scale and note the pounds pull required to revolve the bevel gear shaft. A pull of approximately 6 to 14 pounds shown on the spring scale is required to indicate that the bearings are adjusted to the specified 10 to 25 lbs. in. pre-load.

b. Add or remove bearing adjustment shims as necessary to obtain the specified pre-load. When adjusting, bump the bearing cages to make certain the bearings are properly seated.

9. Install the transmission assembly in position on the steering clutch and final drive housing and tighten the attaching capscrews securely.

10. To adjust the bevel pinion depth (or mounting distance) with the transmission installed in the tractor, refer to Fig. 37 and proceed as follows:

a. Using a telescoping gage, or an inside caliper, measure the distance from the flat surface on the toe end of the bevel pinion to the machined surface of the bevel gear shaft bolting flange. Lock the telescoping gage in position; use



**Fig. 36 — Checking Pre-Load of Bevel Gear Shaft Bearings (Tractors with Torque Converter Shown — Tractors Without Torque Converter Similar)**

an outside micrometer to measure the telescoping gage, and record this measurement.

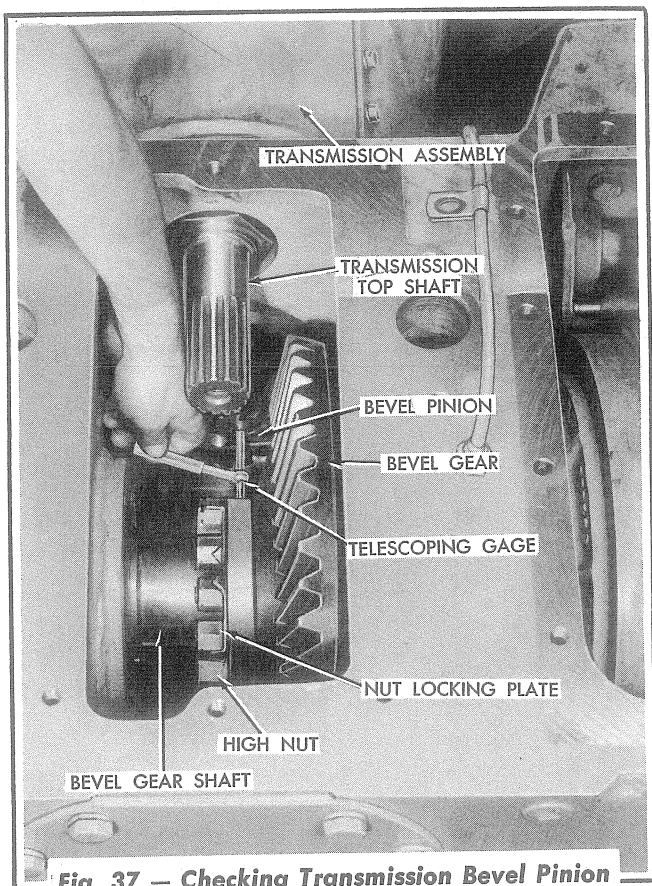
b. Measure the diameter of the bevel gear shaft bolting flange.

c. To calculate the mounting distance (refer to Fig. 21 or 29), divide the diameter of the bevel gear shaft bolting flange by two and subtract this from the mounting distance marked on the toe end of the bevel pinion.

**EXAMPLE:** The diameter of the bevel gear shaft bolting flange is 6.375" and the mounting distance marked on the toe end of the bevel pinion is 5.942".

$$6.375" \div 2 = 3.187"$$

$$5.942" - 3.187" = 2.755"$$



**Fig. 37 — Checking Transmission Bevel Pinion Adjustment (Tractors with Torque Converter Shown — Tractors Without Torque Converter Similar)**

Therefore, 2.755" is the proper mounting distance from the toe end of the bevel pinion to the machined surface of the bolting flange of the bevel gear shaft. Add or remove bevel pinion depth adjusting shims to obtain this measurement.

**NOTE:** If the bevel pinion has no mounting distance marked on the toe end, the pinion should be adjusted so that the rear face (toe end) of the bevel pinion is located the following distance from the bolting flange of the bevel gear shaft:

- (1) 4.015" (approx.) on tractors without a torque converter.
- (2) 3.943" (approx.) on tractors with a torque converter.

Add or remove bevel pinion depth adjusting shims to obtain the specified dimension.

- d. Check the backlash between the bevel gear and the bevel pinion teeth at several points around the gear; the specified backlash is .008" to .014".

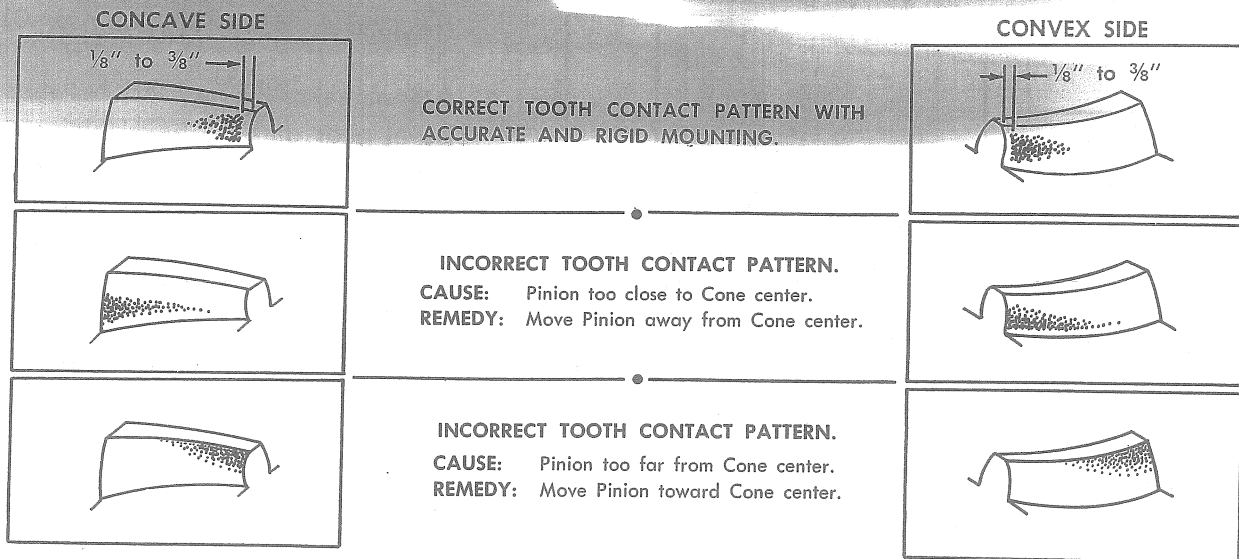
Adjustment of the backlash between the bevel gear and the bevel pinion teeth is accomplished by changing bevel gear shaft bearing adjustment shims (as necessary) from one bearing cage to the other. If the backlash is excessive, remove adjustment shims, from under the bearing cage on the same side as the bevel gear and add to the bearing cage on the opposite side. If the backlash is insufficient, remove adjustment shims from under the bearing cage on the opposite side of the bevel gear and add them to the bearing cage on the same side as the bevel gear. In this manner, the bevel gear is moved without disturbing the preload adjustment of the bevel gear shaft bearings. **NOTE:** Transferring a .005" adjustment shim will change the backlash approximately .003".

After the backlash has been set, the tooth contact pattern **MUST** be checked. The tooth contact pattern can be determined by painting the pinion teeth with marking compound or bluing, then rotating the gear and the tooth contact pattern will show plainly (refer to Figs. 38 and 39). The tooth contact pattern should start  $\frac{1}{8}$ " to  $\frac{3}{8}$ " from the toe end of the tooth. The contact pattern should "feather out" as it progresses toward the center of the tooth. **NOTE:** The tooth contact pattern without load should not extend the full length of the teeth; when the gears are placed under load, the tooth contact will lengthen toward the heel end and will cover a larger area.

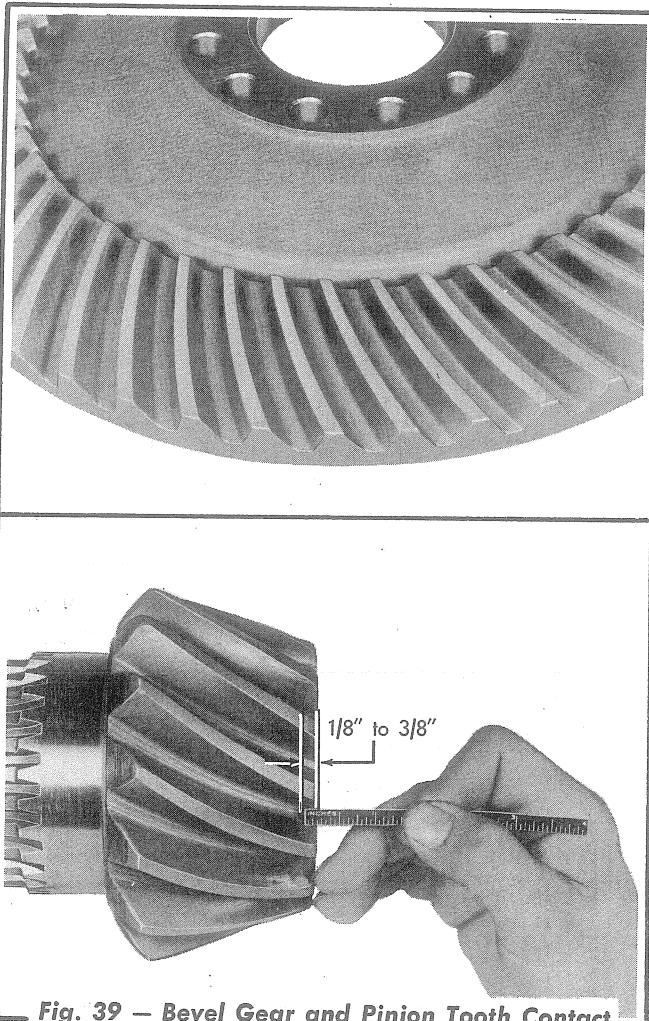
The bevel pinion adjustment dimensions in the above examples are given as an aid for locating the bevel pinion in respect to the bevel gear, and the dimensions may vary from tractor to



### Tooth Contact Patterns (Without Load)



**Fig. 38 — Tooth Contact Pattern Diagram**



**Fig. 39 — Bevel Gear and Pinion Tooth Contact Pattern — Without Load (Tractors with Torque Converter Shown — Tractors Without Torque Converter Similar)**

tractor, therefore, THESE DIMENSIONS ARE NOT TO BE USED FOR FINAL ADJUSTMENT PURPOSES. It is very important that the tooth contact pattern be checked after the transmission bevel pinion and the bevel gear have been adjusted in the above manner and to change the location of the bevel pinion by adding or removing bevel pinion depth adjusting shims as necessary to obtain the desired tooth contact pattern. If it was necessary to change the location of the bevel pinion, be sure to readjust the bevel gear to obtain the specified .008" to .014" backlash.

- After the backlash of the bevel gear and pinion has been properly adjusted, remove the bevel gear shaft bearing cages (keep the adjustment shims with their respective cages) then lubricate and install the oil seals in position in the bearing cages; install the oil seals in the bearing cages so that the sealing lips of the seals are directed toward the bevel gear when installed. Lubricate the bevel gear shaft and reinstall the bearing cages (with shims), using care so that the lips of the seals are not crimped or damaged. **IMPORTANT:** When installing

*the bearing cages, make certain they are positioned so that the wear pin for each clutch throwout yoke is located at the bottom when installed.*

12. Install each steering clutch throwout bearing, throwout yoke, and steering clutch driving hub in position on the bevel gear shaft as an assembly. Install the steering clutch driving hub retaining washers, locks, and retaining capscrews and tighten the retaining capscrews to a torque of 300 lbs. ft. Lock the capscrews in position with the capscrew locks. Connect the upper ends of

the lubricating tubes (right and left) for the steering clutch throwout bearings.

13. Install both steering clutches and brake assemblies (refer to Section XI, Topic 2).
14. Install the oil drain plug in the transmission and in the bevel gear compartment, then fill the transmission and the bevel gear compartment to the proper level using the specified lubricant.
15. Install the steering clutch hydraulic control valve (refer to Section XI, Topic 4).

## 4. DRIVE SHAFT UNIVERSAL JOINT

### A. Description

Power is transmitted from the engine through the engine clutch and/or the engine clutch and torque converter to the transmission by the drive shaft universal joint assembly. The main parts of the universal joint assembly are: Front and rear yokes, center coupling and the front and rear spider assemblies. The universal joint may be removed by disconnecting the front and rear yokes; then sliding the front yoke forward on the splines. The transmission, engine clutch, and torque converter can now be removed without disturbing the bevel gear and steering clutch assembly or the engine.

### B. Service of Drive Shaft Universal Joint

The universal joint assembly is provided with two lubricating fittings, one in each spider assembly. To reach these fittings, remove the center floor plate. After the universal joints have been lubricated, reinstall the floor plate.

The universal joint assemblies should be lubricated after each 400 hours of operation under severe operating conditions or after every 1000 hours under normal operating conditions. Whenever the transmission, torque converter, or engine clutch are removed, the universal joint assembly should be inspected.

### C. Removal, Disassembly, and Inspection of Drive Shaft Universal Joint

1. Remove the center floor plate.
2. Remove the capscrews and capscrew locks attaching the universal joint spider assemblies to the front and rear yokes. Place a pry bar between the spider assembly and the front yoke, then pry the front yoke forward to clear the spider assembly. Tape or tie the bearing assemblies to the spiders to prevent loss or damage. Remove the universal joint assembly, then remove the front yoke.
3. Remove the bearing assemblies from the spiders and remove the spider bearing sealing washers.
4. Wash the parts thoroughly in clean solvent and inspect the components for damage or wear; replace any worn or damaged parts.

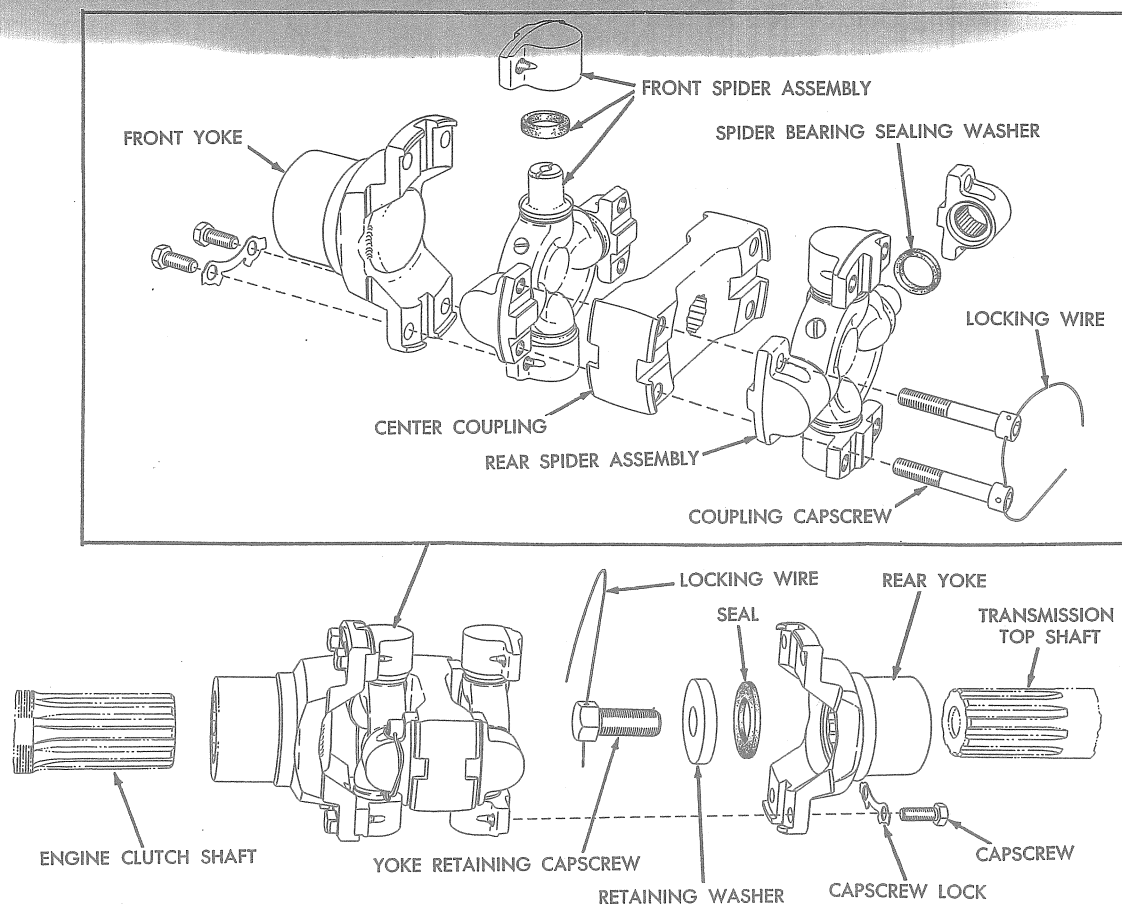
### D. Assembly and Installation of Drive Shaft Universal Joint

1. The universal joint assembly may be re-assembled and installed by a direct reversal of the removal and disassembly procedure.

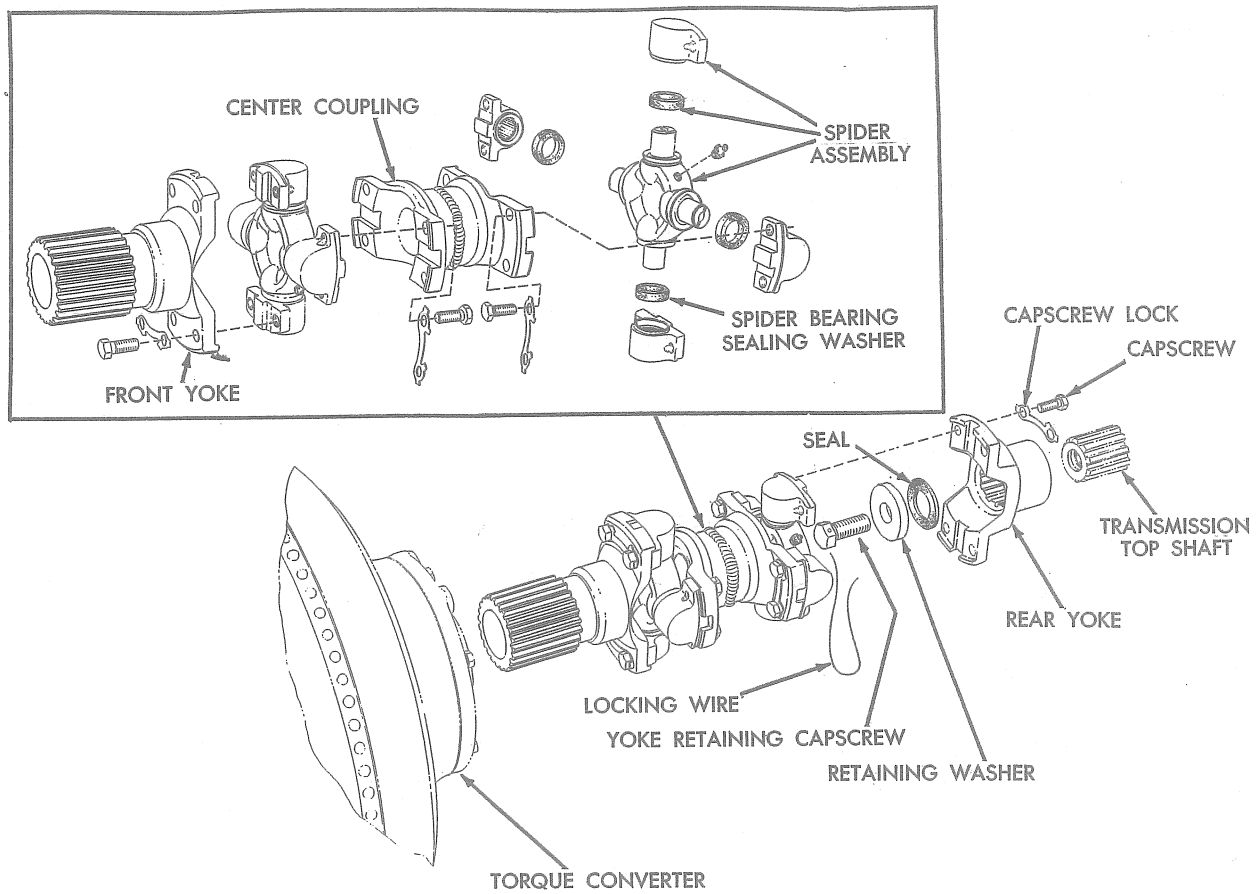
When installing the spider assemblies install them so that both lubricating fittings are in line. Install the bearing assemblies with new

sealing washers in position on the spiders.

2. Install the center floor plate.



**Fig. 40 — Drive Shaft Universal Joint Assembly  
Details (Tractors Without Torque Converter)**



**Fig. 41 — Drive Shaft Universal Joint Assembly  
Details (Tractors with Torque Converter)**