

1972



**40-60 SERIES TRUCK  
SUPPLEMENT**

# **OVERHAUL MANUAL**



ST 334-72



# 1972 CHASSIS OVERHAUL MANUAL

## SUPPLEMENT

covering

## SERIES 40-60 CHEVROLET TRUCKS

### FOREWORD

This manual includes procedures involved in disassembly and assembly of major components peculiar to Series 40-60 Trucks, and is a supplement to the 1972 Passenger Car and Series 10-30 Truck Chassis Overhaul Manual. Information on maintenance and adjustments, minor service operations, and removal and installation of components is contained in the 1972 Series 40-60 Truck Chassis Service Manual.

The Section Index on this page enables the user to quickly locate any desired section. At the beginning of each section containing more than one major subject is a Table of Contents, which gives the page number on which each major subject begins. An index is placed at the beginning of each major subject within the section.

This manual should be kept in a handy place for ready reference. If properly used, it will enable the technician to better service the owners of Chevrolet built vehicles.

All information, illustrations and specifications contained in this literature are based on the latest product information available at the time of publication approval. The right is reserved to make changes at any time without notice.

### CHEVROLET MOTOR DIVISION

General Motors Corporation  
DETROIT, MICHIGAN

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## SECTION 4

# REAR AXLE DIFFERENTIAL CARRIER

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## 11,000 THROUGH 17,000 LB. CAPACITY SINGLE-SPEED

(See Figures 1G, and 2G)

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### Case and Drive Pinion

#### Removal

1. Drain lubricant from differential, remove axle shaft as outlined in Truck Service Manual. See "Axle Shaft Removal".
2. Remove two trunnion bearing "U" bolts from the rear yoke and split the rear universal joint.

**NOTE:** The bearings can be left on the trunnion and held in place with tape.

3. Swing propeller shaft to one side and tie to the frame side rail.
4. Remove bolts and lock washers which retain the carrier assembly to the axle housing. Support the differential housing with a floor jack and roll it from under truck.

#### Disassembly

1. Mount carrier assembly in a bench vise or holding fixture.
2. On all axles except 13,500 lb., loosen ring gear thrust pad locknut and remove thrust pad.

3. Remove differential adjusting nut locks and bearing cap bolts and lock washers.
4. Mark bearing caps and carrier for reassembly in same position. Remove bearing caps and adjusting nuts by tapping on bosses of caps with a soft faced hammer until caps are free from dowels.

**CAUTION:** Do not attempt to pry cap off as this may damage machined face of cap.

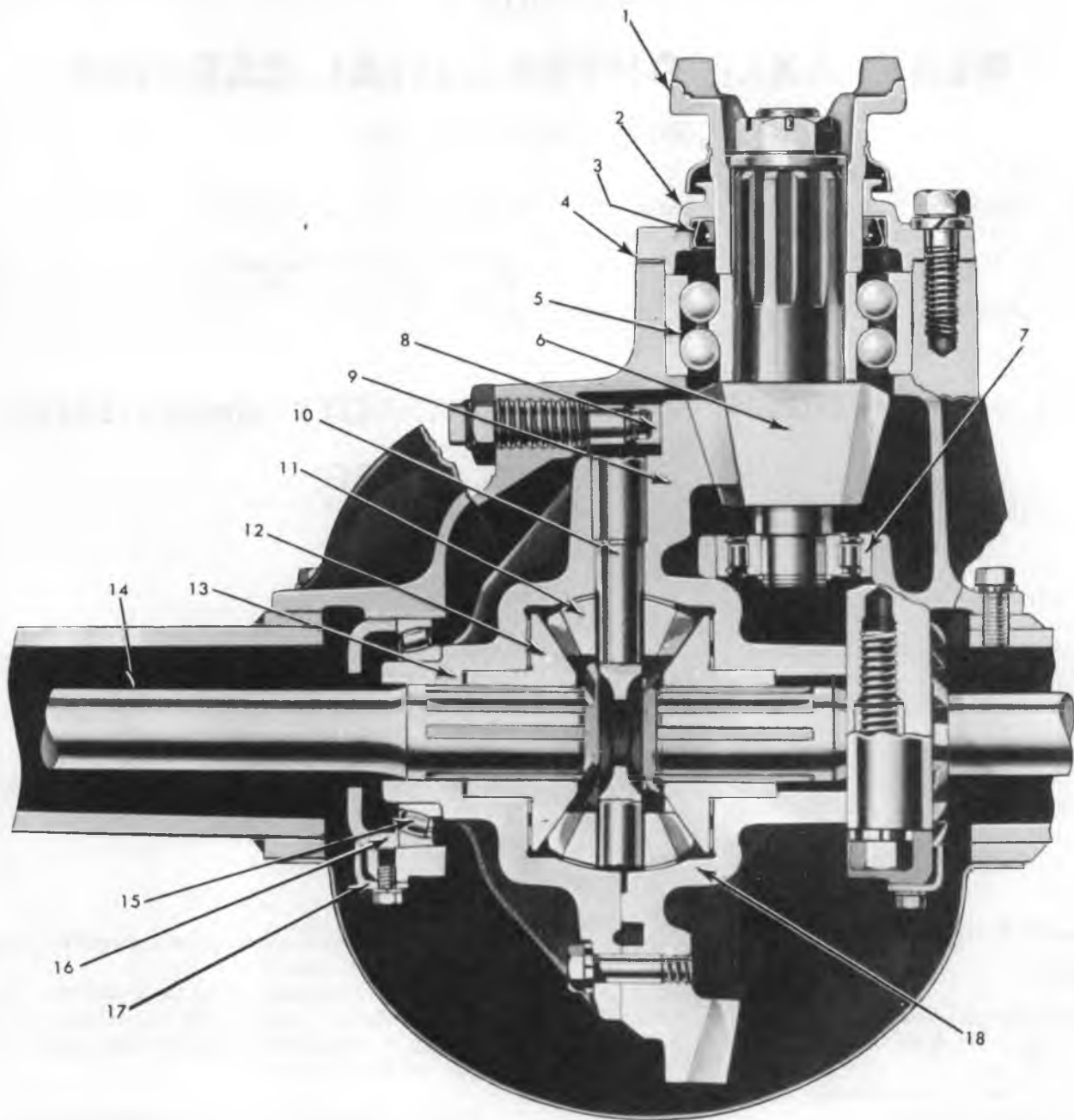
5. Remove differential and ring gear assembly from the carrier.

**CAUTION:** Exercise care that differential bearing outer races are not dropped in removing assembly from carrier.

6. Remove the bolts which attach the pinion bearing retainer to the carrier.
7. Remove the pinion and bearing assembly from the carrier.

**NOTE:** It may be necessary to drive this unit from carrier. Use brass drift against pilot end of pinion.

4-2 REAR AXLE DIFFERENTIAL CARRIER



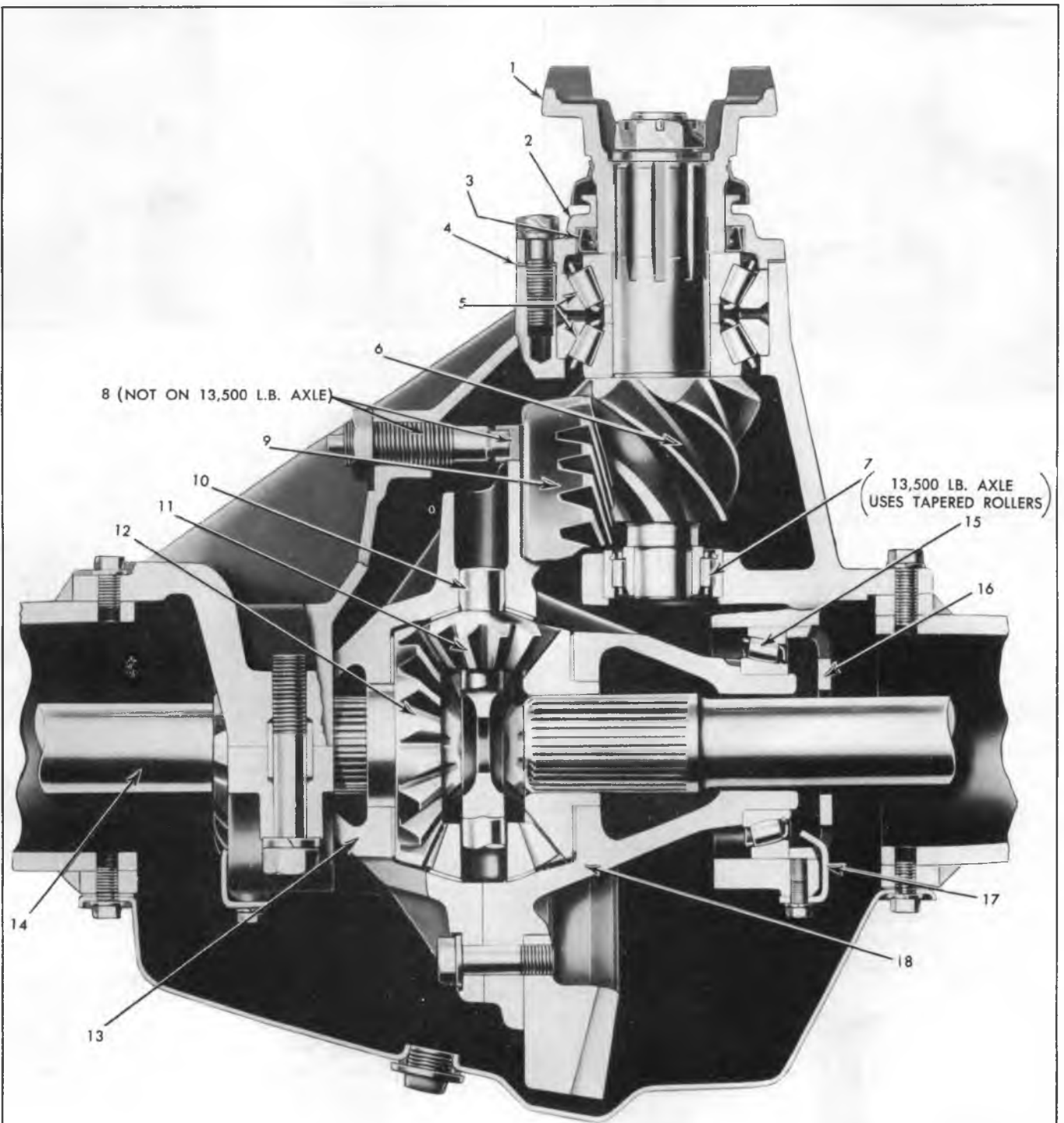
- 1. Universal Joint Yoke
- 2. Pinion Bearing Oil Seal and Retainer
- 3. Oil Seal
- 4. Oil Seal Gasket
- 5. Front Pinion Bearing
- 6. Drive Pinion
- 7. Rear Pinion Bearing

- 8. Ring Gear Thrust Pad
- 9. Ring Gear
- 10. Differential Spider
- 11. Differential Pinion (Spider) Gear
- 12. Differential Side Gear
- 13. Differential Case--Left Half

- 14. Axle Shaft
- 15. Differential Bearing
- 16. Differential Bearing Adjusting Nut
- 17. Adjusting Nut Lock
- 18. Differential Case--Right Half

Fig. 1G--11,000 lb. Capacity Axle--Cross Section





- |                            |                                   |                                       |  |
|----------------------------|-----------------------------------|---------------------------------------|--|
| 1. Universal Joint Yoke    | 6. Drive Pinion                   | 11. Differential Pinion (Spider) Gear | 15. Differential Bearing               |
| 2. Pinion Bearing Retainer | 7. Rear Pinion Bearing            | 12. Differential Side Gear            | 16. Differential Bearing Adjusting Nut |
| 3. Oil Seal                | 8. Ring Gear Thrust Pad and Screw | 13. Differential Case (Left Half)     | 17. Adjusting Nut Lock                 |
| 4. Shims                   | 9. Ring Gear                      | 14. Axle Shaft                        | 18. Differential Case (Right Half)     |
| 5. Pinion Bearing Assembly | 10. Differential Spider           |                                       |  |

Fig. 2G--13,500, 15,000 and 17,000 lb. Capacity Axle--Cross Section

## 4-4 REAR AXLE DIFFERENTIAL CARRIER

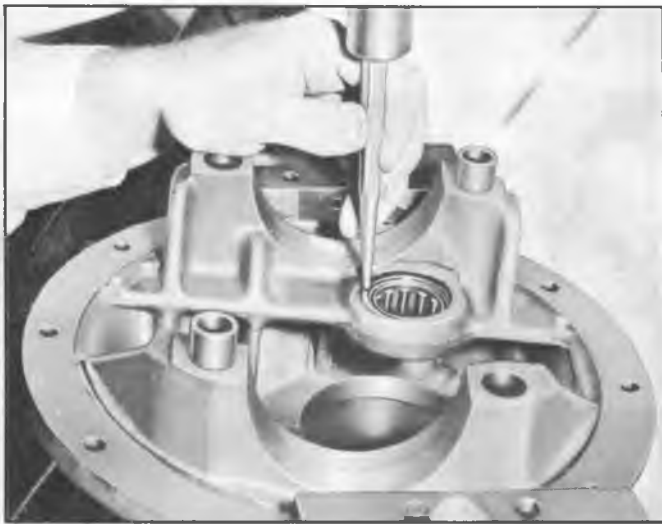


Fig. 3G—Pinion Rear Bearing Removal  
(All Axles Except 11,000 Lb.)

8. On all axles except the 11,000 lb., remove shims from carrier making note of number and total thickness of shims removed.
9. On all axles except the 11,000 lb., the pinion rear bearing outer race and roller assembly is pressed into the carrier. Remove assembly by driving it from its seat using a soft drift or punch (fig. 3G).

### Repairs

#### Pinion Disassembly

1. Clamp pinion drive flange in bench vise.
2. Remove cotter pin, nut and washer from end of pinion.
3. Remove drive flange and bearing retainer assembly from pinion.
4. Drive oil seal from retainer. Discard seal as new parts should be used at assembly.
5. On the 11,000 lb. axle, remove pinion rear bearing snap ring and press bearing from pinion, using Tool J-1453 (fig. 4G).

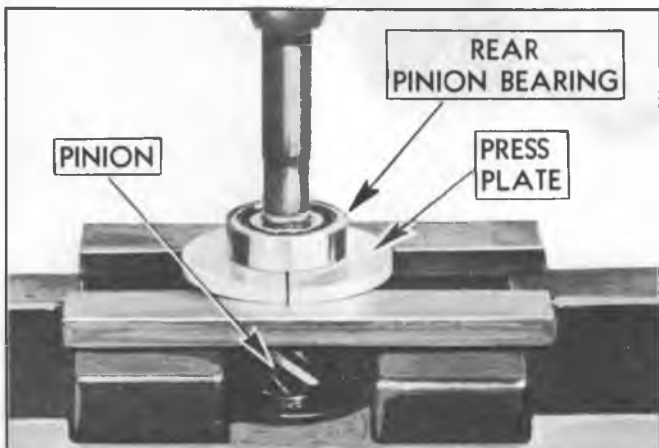


Fig. 4G—Pinion Rear Bearing Removal (11,000 Lb. Axle)

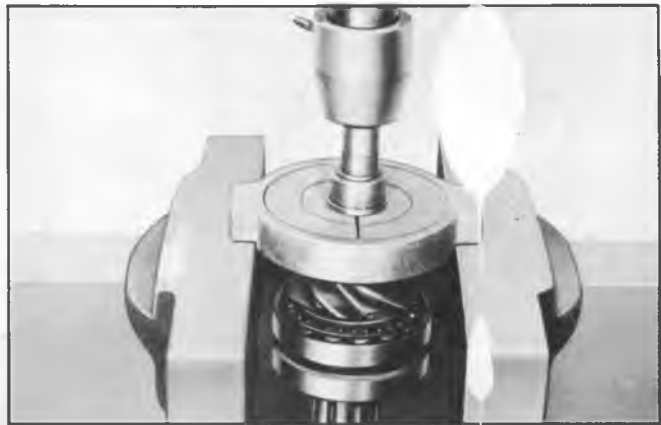


Fig. 5G—Pinion Rear Bearing Inner Race Removal (13,500, 15,000 and 17,000 Lb. Axles)

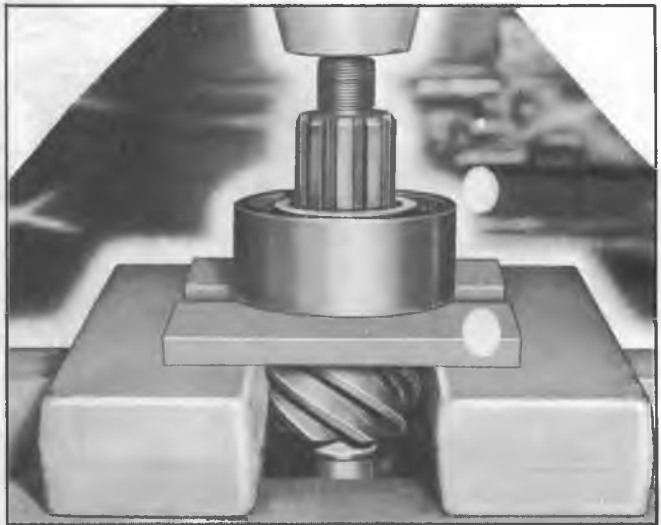


Fig. 6G—Drive Pinion Front Bearing Removal (11,000 Lb. Axle)

6. On the 13,500, 15,000, and 17,000 lb. axles press inner race of rear bearing from pinion, using Tools J-0358 and J-1453 (fig. 5G).
7. On the 11,000 lb. axles, position drive pinion in an arbor press so that the bearing is supported by two pieces of flat steel stock as shown in Figure 6G. Place flat stock parallel to each other and against pinion so as to pick up a large area of bearing outer race. Press pinion from bearing making sure pinion is supported to prevent damage when removed from bearing
8. On the 13,500, 15,000 and 17,000 axles, press the pinion front bearing assembly from the pinion as shown in Figure 7G using appropriate tool as follows:
  - a. J-6171--five tooth pinion.
  - b. J-6203--six tooth pinion.
  - c. J-2225--seven tooth pinion.

#### Pinion Inspection

1. Wash all parts in cleaning solvent.
2. Inspect pinion for scored, cracked, chipped or worn teeth.

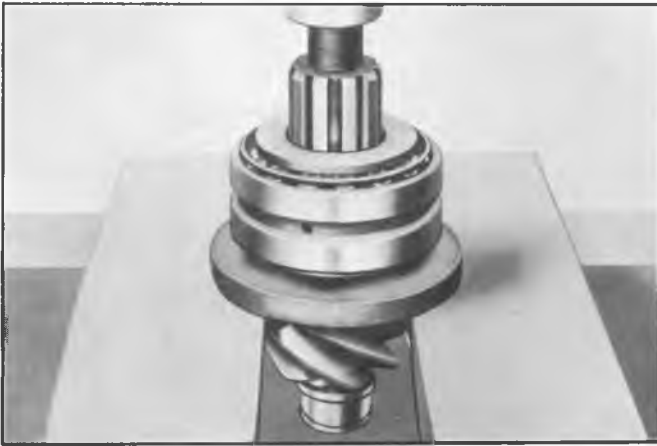


Fig. 7G--Removal Drive Pinion Front Bearing (Typical) (13,500, 15,000 and 17,000)

3. Inspect splines on pinion shaft for excessive wear.
4. Inspect pinion bearing assemblies for roughness, defects or excessive wear.

**Pinion Reassembly**

1. Pack the cavity between the pinion oil seal lips with a lithium-base EP lubricant to provide initial lubrication and to aid in inserting pinion flange.
2. Press the oil seal into the retainer-position seal lips toward the pinion bearing--using Tool J-22281 as shown in Figure 8G.
3. On 13,500, 15,000 and 17,000 lb. axles, lubricate the pinion rear bearing and carefully press it into carrier. Then install the inner race on the 13,500, 15,000 and 17,000 lb. axle pinion shaft as shown in Figure 9G.
4. Install the 11,000 lb. axle pinion rear bearing assembly on pinion shaft making sure that chamfered side of inner race seats against shoulder on pinion shaft. Then install pinion bearing lock ring using Tool J-1364 as shown in Figure 10G.
5. Install pinion front bearing as follows:
  - a. 11,000 lb. axles--Position the one-piece double row



Fig. 8G--Pinion Oil Seal Installation (Typical)

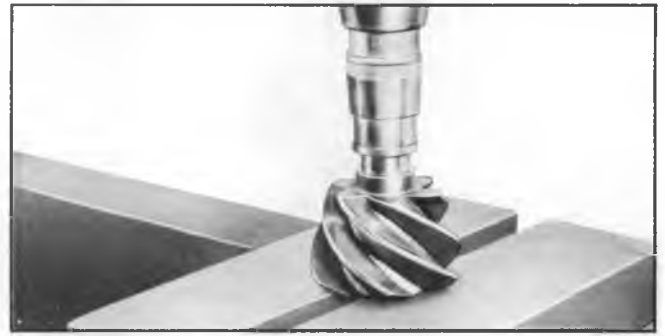


Fig. 9G--Pinion Rear Bearing Inner Race Installation (13,500, 15,000 and 17,000 Lb. Axles)

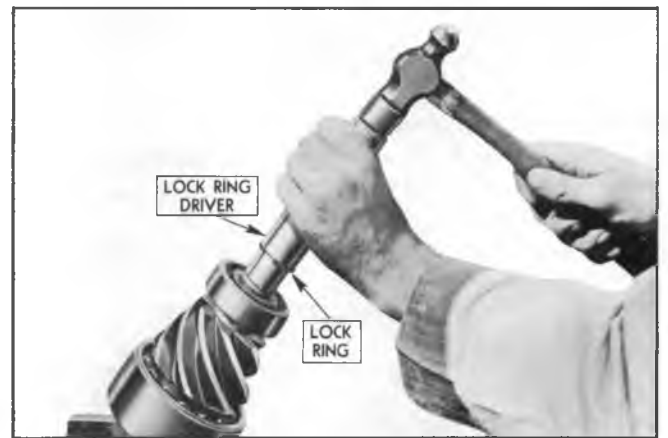


Fig. 10G--Pinion Rear Bearing Lock Ring Installation (11,000 Lb. Axle)

ball bearing on pinion shaft, so that extended portion of inner race is toward pinion head. Then, using a suitable length of 2 inch pipe, press bearing onto shaft until it seats against the pinion head.

**CAUTION:** When pressing bearing on pinion, exercise care to prevent damage to ground surface of pilot.

- b. 13,500, 15,000 and 17,000 lb. axles--Place one cone and roller assembly on pinion shaft so that large end of bearing is toward pinion then position outer race, spacer and cone and roller assembly on pinion shaft. Position pinion and bearing assembly in press as shown in Figure 11G and seat bearing against pinion head.

**NOTE:** The opposed tapered bearing assembly is serviced as a unit and consists of one double outer race, two inner race and roller assemblies and one spacer. These parts should always be installed as a group as the spacer is preselected to give proper pinion bearing adjustment.

6. Slide oil seal retainer on pinion shaft, then tap drive flange onto pinion splines.
7. Clamp drive flange in a bench vise and install flange



## 4-6 REAR AXLE DIFFERENTIAL CARRIER



Fig. 11G--Pinion Front Bearing Installation (13,500, 15,000 and 17,000 Lb. Axles)

washer and nut. Torque nut to specifications and install cotter pin without backing off on nut.

### Differential Disassembly

1. Check differential case to make sure that the two halves are marked so they may be reassembled in same relation (fig. 12G).
2. Remove bolts holding case and cover together.

**NOTE:** Ring gear is mounted on the case.

3. Separate cover from case and remove differential side gears and thrust washers, pinion gears with thrust washers and differential spider.

### Differential Inspection

1. Wash all parts thoroughly in cleaning solvent.
2. Inspect ring gear for chipped, scored or worn teeth.
3. Check radial clearance between differential side gears and differential case, also fit of differential pinions on spider.
4. Inspect spider arms for wear and distortion.
5. Inspect splines and teeth of differential side gears and pinions for chipping or excessive wear.

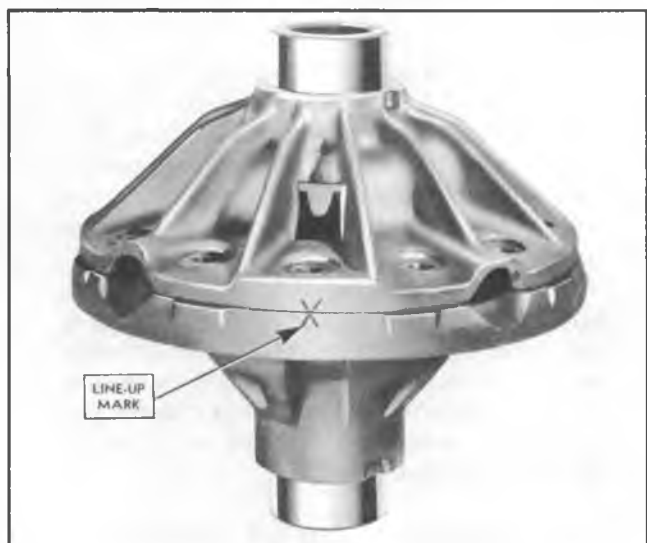


Fig. 12G--Differential Case Line-Up Marks



Fig. 13G--Differential Bearing Removal

6. Check thrust washers for wear and replace if even slight wear is indicated.
7. Check differential side bearings and cups for broken races, discoloration or roughness.
8. Inspect differential case for cracks or distortion.

### Ring Gear Replacement

1. Remove ring gear from case by tapping the back of the gear with a soft faced hammer.
2. Inspect ring gear pilot case flange and back of ring gear for dirt or burrs.
3. Install two guide pins (made from cap screws with heads cut off and ends slotted) to new gear diametrically opposite each other.
4. Start guide pins through case flange and tap ring gear on case.

### Differential Bearing Replacement

1. Install Tool J-8107 making sure puller legs are fitted securely in notches in case and tighten retaining yoke (fig. 13G).
2. Tighten puller screw to remove bearing.
3. Place new bearing on hub with thick side of inner race toward case and install bearing using appropriate tool as shown in Figure 14G.
  - a. J-1488--11,000 lb. axle.
  - b. J-22300--13,000 lb. axle.
  - c. J-22301--15,000 and 17,000 lb. axles.

**NOTE:** The side bearing tool is counterbored and has pilot to assure proper installation and seating of bearing.

### Differential Reassembly

1. Lubricate differential side gears, pinions and thrust washers.
2. Place differential pinions and thrust washers on spider.
3. Assemble side gears and pinions and thrust washers to left half of differential case.



Fig. 14G--Differential Bearing Installation

4. Assemble right half of case to left half being sure to line up marks on the two halves.
5. Install differential-to-ring gear bolts and lock washers and tighten evenly until ring gear is flush with case flange.
6. Remove two guide pins and install remaining two bolts. Torque all bolts alternately and evenly to specifications.

**Reassembly**

To facilitate adjusting of pinion depth in the ring gear, there are five shims available for service use. They are .012", .015", .018", .021" and .024".

**NOTE:** Pinion depth adjustment shims are not required for the 11,000 lb. axle.

If the original ring gear and pinion are to be used it is advisable to replace the same thickness of shims in the carrier counter bore that were removed.

If a new ring gear and pinion are used, one .021" shim should be used as a standard starting set up.

1. Place shim in bore in carrier or between carrier and pinion oil seal retainer.
2. Place new pinion bearing retainer gasket on the retainer and install pinion assembly in carrier.

**NOTE:** The pinion assembly should be pressed into the carrier to prevent the possibility of damaging the shims.

3. Install pinion bearing retainer bolts and lock washers and torque bolts to specifications.
4. Lubricate differential bearing rollers with engine oil and place outer races over them.
5. Install differential assembly in carrier and install adjusting nuts.

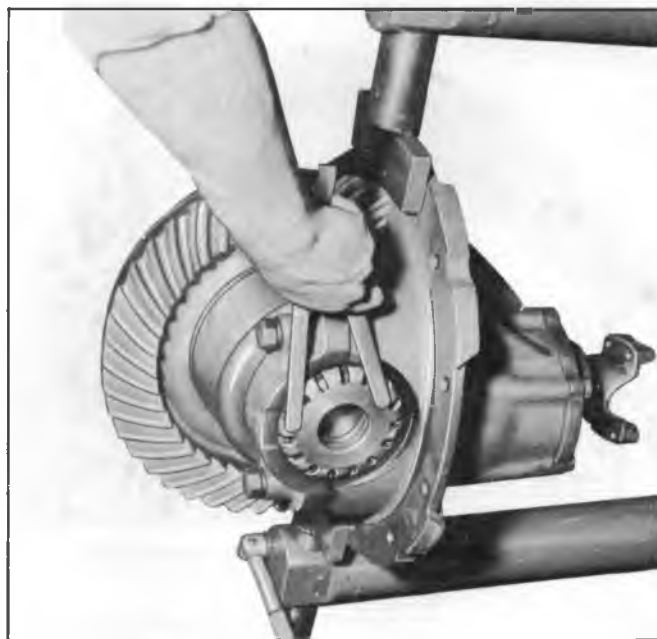


Fig. 15G--Ring Gear and Pinion Adjustment

**CAUTION:** Carefully slide adjusting nuts alongside the bearings so that threads on nuts fit into threads in carrier.

6. Install differential bearing caps making sure the marks on the caps line up with the marks on the carrier.
7. Install bearing cap bolts and lock washers and tighten until lock washers just flatten out.

**Ring Gear and Pinion Adjustment**

1. With differential bearing cap bolts loosened just enough to permit turning bearing adjusting nuts with Tool J-0972, remove all lash between ring gear and pinion (fig. 15G).
2. Back off left hand adjusting nut one to two notches to a locking position.
3. Tighten right hand adjusting nut firmly to force differential in solid contact with left hand adjusting nut.
4. Back off right hand adjusting nut until free of bearing; then retighten snugly against bearing.
5. Tighten right hand nut from one to two additional notches to a locking position.

**NOTE:** This method of adjustment provides for proper preload of bearings.

6. Mount a dial indicator on the carrier and check the backlash between ring gear and pinion (fig. 16G). Backlash should be from .003" to .012" (.005" to .008" preferred).

**NOTE:** If backlash is more than .012" loosen the right hand adjusting nut one notch and tighten left hand adjusting nut one notch. If backlash is less than .003" loosen the left hand adjusting nut one notch and tighten right hand nut one notch.

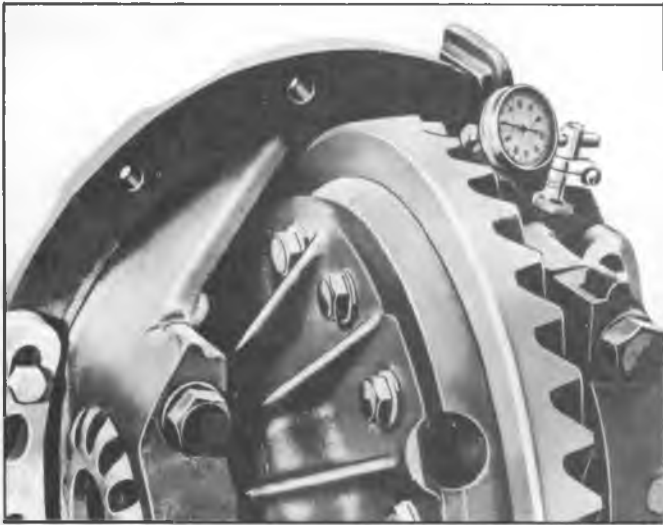


Fig. 16G--Checking Ring Gear and Pinion Backlash

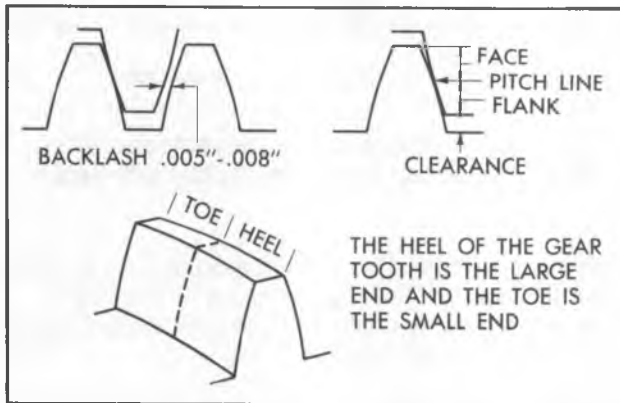


Fig. 17G--Gear Tooth Nomenclature

7. Tighten bearing cap bolts to specifications.
8. Install side bearing adjusting nut locks and torque to specifications.

**Checking Pinion Depth**

1. Coat the ring gear teeth lightly and evenly with a mixture of powdered red lead and oil of a suitable consistency to produce a contact pattern. Then turn the pinion shaft several revolutions in both directions.
2. Examine the pattern on the ring gear teeth. If the pinion depth is correct, the tooth pattern will be centered on the pitch line Fig. 17G and toward the toe of the ring gear (fig. 18G).
3. If the pattern is below the pitch line on the ring gear teeth, the pinion is too deep and it will be necessary to remove the pinion assembly and increase the shim thickness between the pinion bearing and the carrier.
4. If the pattern is above the pitch line on the ring gear teeth, the pinion is too shallow and it will be necessary to remove the pinion assembly and decrease the shim thickness between the pinion bearing and the carrier.
5. Changing the pinion depth will make some change in the backlash; therefore, it will be necessary to readjust the backlash.

**Ring Gear Thrust Pad Adjustment**

( 11,000, 15,000 and 17,000 Lb. Axles)

1. Inspect bronze tip of thrust pad and if worn install a new one.
2. Install thrust pad and tighten screw until bronze tip engages back face of ring gear while rotating gear.
3. Back off screw one-twelfth (1/12) turn and tighten locknut to specifications (fig. 19G).

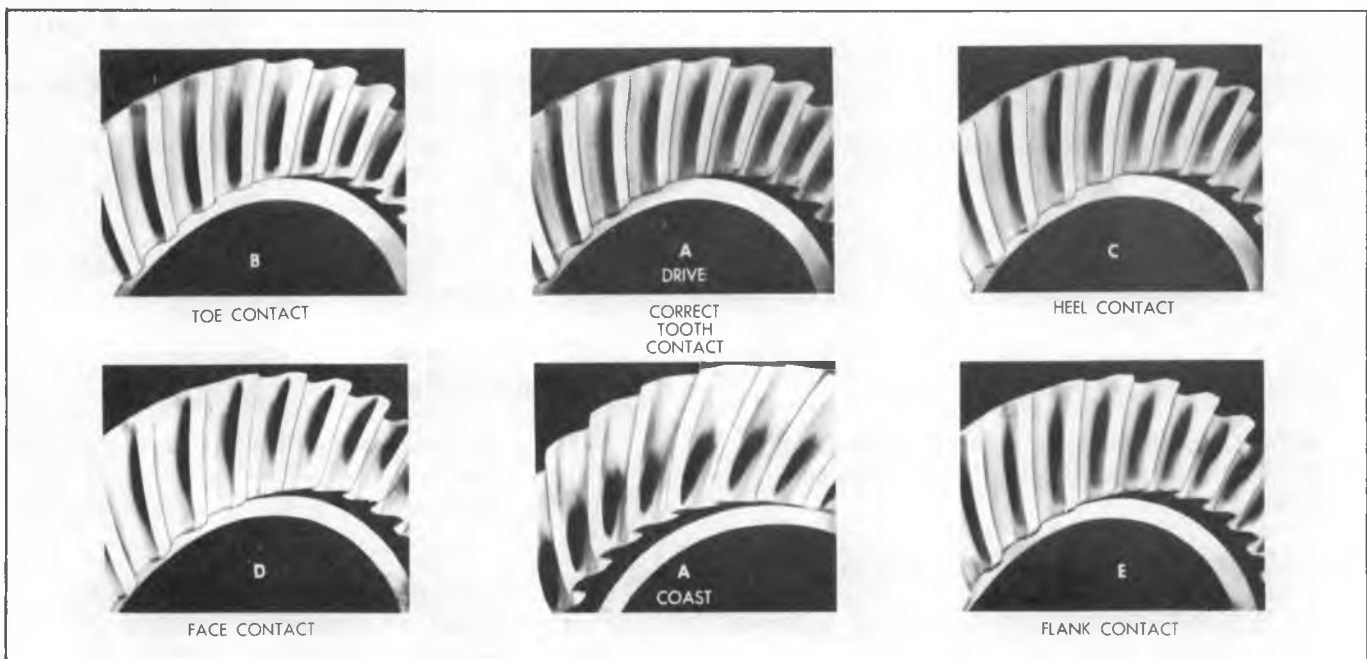


Fig. 18G--Gear Tooth Contact Patterns





Fig. 19G--Ring Gear Thrust Pad Adjustment

**NOTE:** Make sure screw does not turn during locking process. This adjustment provides .005" to .007" clearance between thrust pad and ring gear face.

**Installation**

1. Clean out axle housing and cover and place new gasket over axle housing.

2. Assemble differential carrier to axle housing, install lockwashers and bolts and tighten securely.
3. Replace axle housing inspection cover, if removed, using new gasket.

**NOTE:** This propeller shaft to pinion flange fastener is an important attaching part in that it could affect the performance of vital components and systems, and/or could result in major repair expense. It must be replaced with one of the same part number or with an equivalent part if replacement becomes necessary. Do not use a replacement part of lesser quality or substitute design. Torque values must be used as specified during reassembly to assure proper retention of this part.

4. Assemble rear universal joint.
5. Install axle shafts as outlined in applicable axle installation procedure in Service Manual.
6. Fill axle with lubricant to a level even with bottom of filler hole. See Section 0 Service Manual for proper lubricant.

## 15,000 AND 17,000 LB. CAPACITY TWO-SPEED

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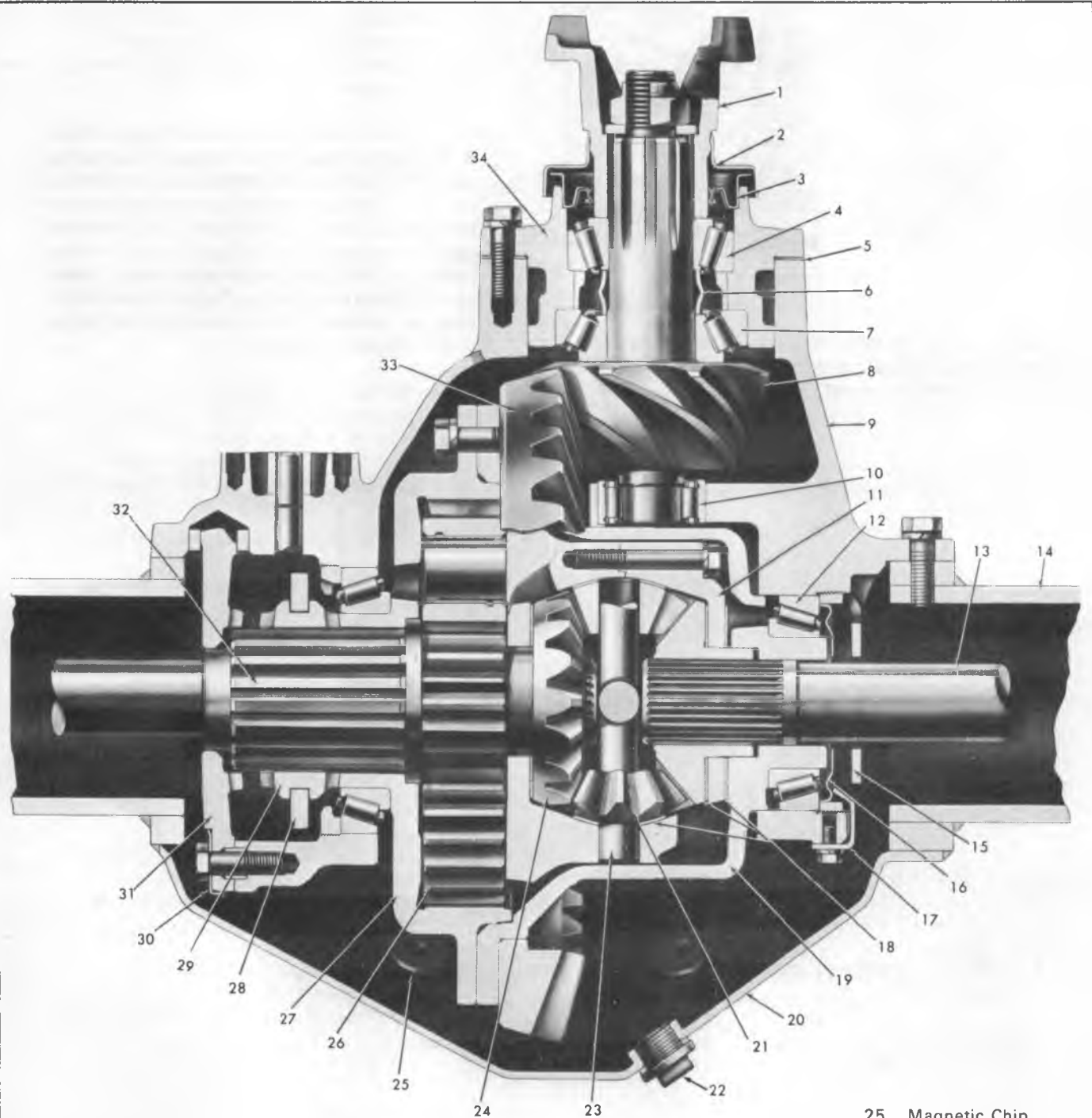
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### DIFFERENTIAL CARRIER ASSEMBLY

**Removal**

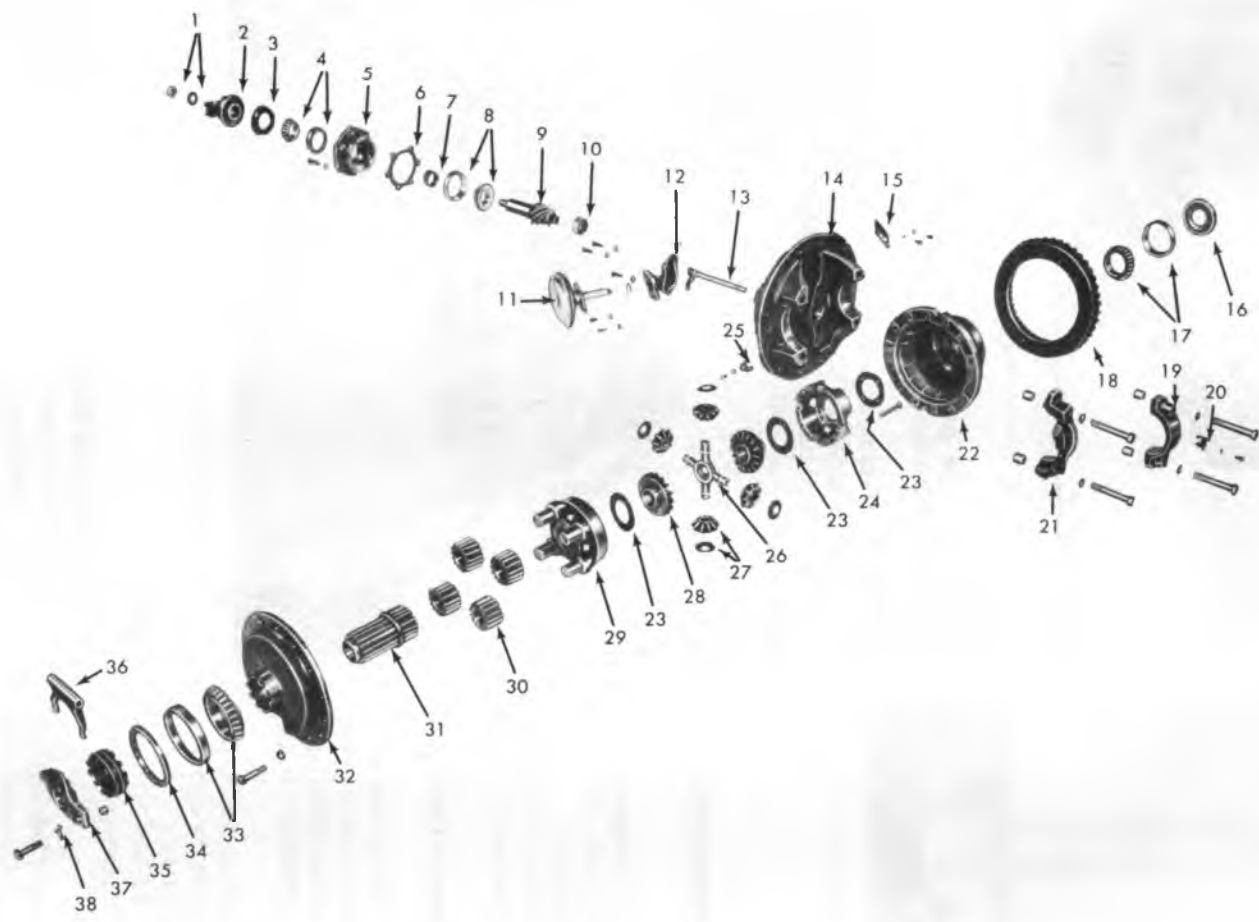
1. Loosen the lower carrier-to housing attaching cap screws and drain lubricant from housing.
2. Remove axle shafts and electric or vacuum lines as outlined in Truck Service Manual.
3. Remove propeller shaft from pinion flange. Tape bearing caps to keep them in place. Swing the propeller shaft to one side and tie it to the frame side rail.
4. Remove all differential carrier-to-axle housing cap screws and lock washers except two near top of carrier. Loosen the two cap screws at the top, but leave installed to prevent carrier from falling.
5. Tap along the outer perimeter of the carrier with a soft-faced hammer to break bond between carrier and housing.
6. Support carrier with a roller jack, then remove the remaining cap screws and lock washers. Work the assembly forward until it clears the housing. A small, round pry bar or a long drift may be inserted in one of the upper holes to keep carrier aligned with housing.

## 4-10 REAR AXLE DIFFERENTIAL CARRIER



- |                                  |  |  |  |
|----------------------------------|--|--|--|
| 1. Pinion Flange                 | 10. Pinion Rear Bearing                        | 18. Thrust Washers                             | 25. Magnetic Chip Collector              |
| 2. Dust Deflector                | 11. Differential and Planet Support            | 19. Differential and Planet Support Case Cover | 26. Planet Gears (4)                     |
| 3. Pinion Oil Seal               | 12. Differential Bearing (Right)               | 20. Axle Housing Cover (Welded)                | 27. Differential and Planet Support Case |
| 4. Pinion Front Bearing          | 13. Axle Shaft                                 | 21. Differential Pinion                        | 28. Shift Yoke                           |
| 5. Pinion Adjusting Shim         | 14. Axle Housing                               | 22. Filler Plug                                | 29. Shift Sleeve                         |
| 6. Pinion Bearing Preload Spacer | 15. Differential Bearing Adjusting Nut (Right) | 23. Differential Pinion Shaft                  | 30. Anchor Bolt Lock                     |
| 7. Pinion Intermediate Bearing   | 16. Oil Baffle                                 | 24. Differential Side Gear (Left)              | 31. Anchor                               |
| 8. Pinion                        | 17. Adjusting Nut Lock (Right)                 |  | 32. Sun Gear                             |
| 9. Differential Carrier          |  |  | 33. Ring Gear                            |
|                                  |  |  | 34. Pinion and Bearing Retainer          |

Fig. 1J—Two-Speed Axle Cross Section



- |                                     |                                 |   |  |   |   |
|-------------------------------------|---------------------------------|---|--|---|---|
| 1. Pinion Retaining Nut and Washer  | 8. Pinion Intermediate Bearing  | 16. Differential Bearing Adjusting Nut and Oil Baffle | 21. Differential Baring Cap (Left)             | 26. Differential Pinion Shaft                 | 31. Sun Gear                                  |
| 2. Pinion Flange and Dust Deflector | 9. Pinion                       | 17. Differential Bearing (Right)                      | 22. Differential and Planet Support Case Cover | 27. Differential Pinion and Thrust Washer (4) | 32. Differential and Plane Support Case       |
| 3. Pinion Oil Seal                  | 10. Pinion Rear Bearing         | 18. Ring Gear   | 23. Thrust Washer                              | 28. Differential Side Gear                    | 33. Differential Bearing (Left)               |
| 4. Pinion Front Bearing Retainer    | 11. Shift Unit (Vacuum)         | 19. Differential Bearing Cap (Right)                  | 24. Differential and Planet Support Cover      | 29. Differential and Planet Support           | 34. Differential Bearing Adjusting Nut (Left) |
| 5. Pinion and Bearing               | 12. Shift Unit Mounting Bracket | 20. Adjusting Nut Lock (Right)                        | 25. Adjusting Nut Lock (Left)                  | 30. Planet Gears (4)                          | 35. Shift Sleeve                              |
| 6. Pinion Adjusting Shim            | 13. Shifter Yoke Lever          |   |  |   | 36. Shift Yoke                                |
| 7. Pinion Bearing Preload Spacer    | 14. Differential Carrier        |   |  |   | 37. Shift Anchor                              |
|                                     | 15. Oil Trough                  |   |  |   | 38. Anchor Bolt Lock                          |

Fig. 2J--Exploded View of Carrier



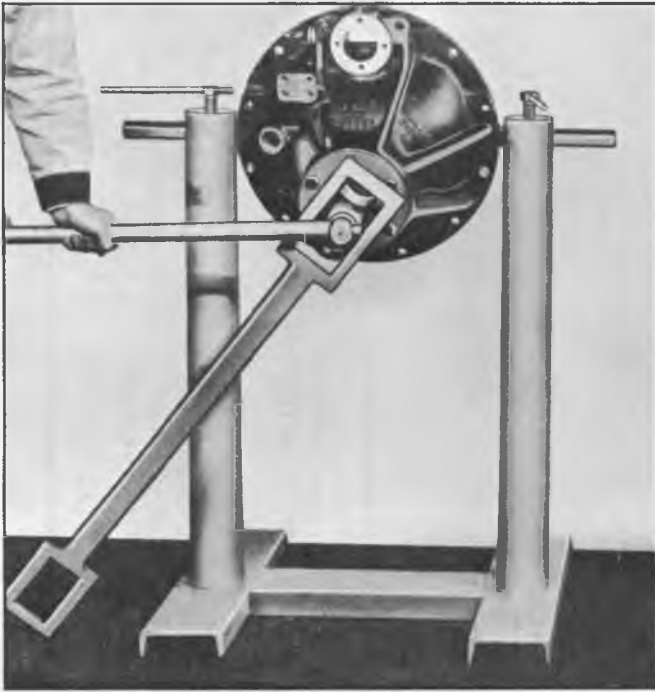


Fig. 3J--Removing Drive Pinion Nut (Typical)



Fig. 4J--Removing Shifter Yoke Shaft

### Disassembly

(Refer to Figure 2J for Carrier Components)

1. Place differential carrier assembly in a suitable repair stand or in a large vise with padded jaws and clamp securely to prevent assembly from falling.
2. Using Tool J-3453 to hold flange, remove drive pinion nut and washer (fig. 3J). Discard nut and use a new nut for reassembly.
3. Remove flange from pinion by tapping on flange with a brass drift and hammer.
4. Remove cap screws securing pinion bearing retainer to carrier. Rap retainer sharply with a soft-faced hammer to loosen retainer from carrier. If required a blunt chisel may be used between the carrier and retainer to separate them.
5. Withdraw retainer and pinion from carrier and remove shim(s) from between carrier and retainer. Save shim(s) to facilitate adjustment during reassembly.
6. Remove the three bolts and lock washers retaining shifter assembly to the carrier and remove the shifter assembly.
7. Bend tang on bolt lock down and remove bolt and bolt lock from shift yoke anchor, then remove anchor from carrier.
8. Drive out shifter yoke shaft, using drift and hammer as shown in Figure 4J.
9. Slide the shifter yoke and sleeve to the left, removing the sleeve and shifter yoke from the end of the sun gear (fig. 5J).
10. Remove differential bearing adjusting nut lock from each nut and remove locks from both sides.

11. Remove the two retaining bolts and withdraw oil trough from the carrier (fig. 6J).
12. Remove bearing caps and adjusting nuts by tapping on bosses of caps until free from dowels (fig. 7J). Remove the differential and planet assembly from the housing.



Fig. 5J--Removing Shifter Yoke and Sleeve

### Repairs

#### Drive Pinion and Bearing Retainer Disassembly

1. Pry pinion oil seal from the retainer using care not to damage machined surfaces.
2. Position retainer and pinion assembly in an arbor press with retainer resting on bed of arbor. Press pinion downward and out of retainer (fig. 8J). Remove pinion front bearing inner race from the retainer and remove bearing spacer from pinion-discard spacer.
3. Using 1/2 inch bar stock, cut to a suitable length and positioned in the provided notches, press pinion front and intermediate bearing cups from the retainer (fig. 9J).

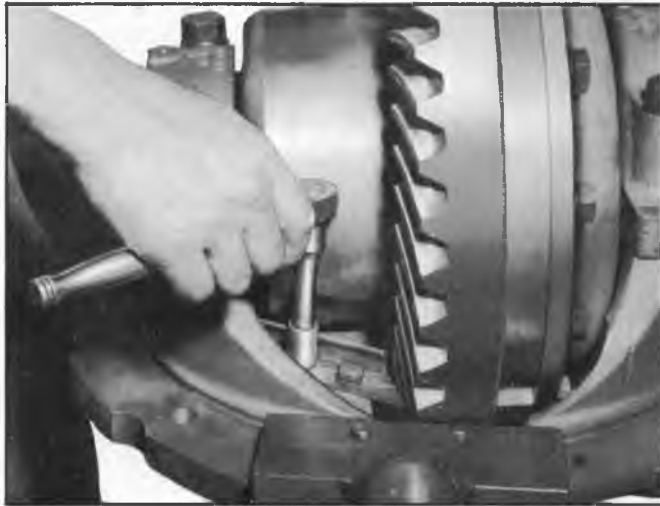


Fig. 6J--Removing Oil Trough

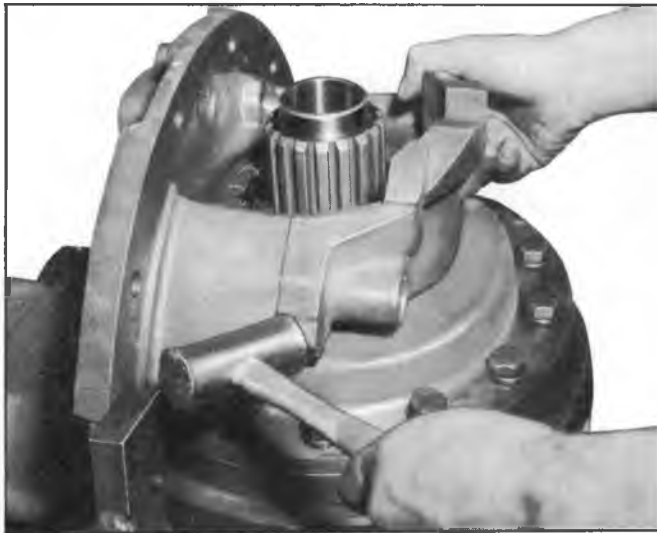


Fig. 7J--Removing Bearing Caps

4. Select appropriate tool as required and remove pinion intermediate inner bearing from the drive pinion as follows.
  - a. 6-tooth pinion--position Tool J-6203 over head of pinion so that it contacts inner race of bearing, and press pinion from bearing (fig. 10J).
  - b. 7-tooth pinion--position the two halves of J-22307 over the pinion bearing so that the lip of tool picks up the bearing rollers (fig. 11J). Tighten the two halves with provided bolts until bearing is fully seated in tool. Press pinion from bearing (fig. 12J).
5. Remove the pinion rear bearing from the carrier by tapping on the outer race with a brass drift to unseat the bearing (fig. 13J).

### Inspection

1. Wash all metal parts thoroughly in cleaning solvent and dry with air.

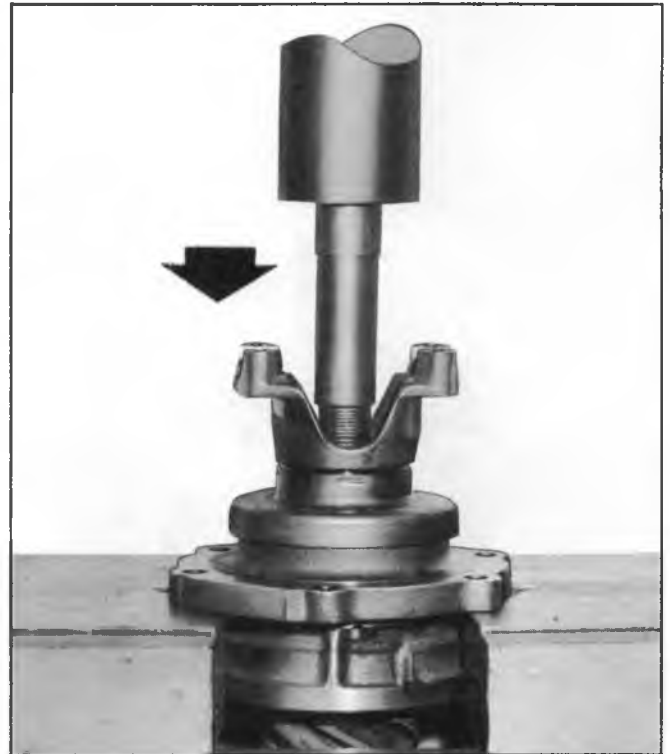


Fig. 8J--Removing Pinion from Retainer

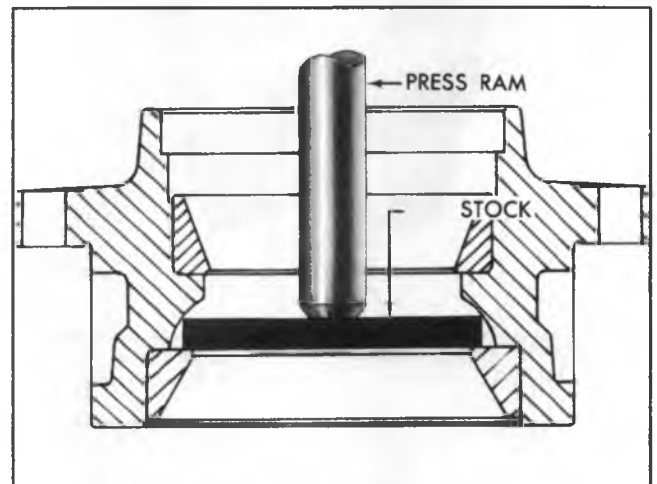


Fig. 9J--Removing Pinion Bearing Cup Retainer

**CAUTION:** Do not spin bearings while drying with air hose.

2. Inspect the drive pinion for chipped, cracked or excessively worn teeth and inspect the splines for wear. Inspect the bearings for worn or pitted rollers or inner races. Inspect the pinion flange for worn splines.
3. Inspect bearing retainer for cracks, and any imperfections such as corrosion, pits and grooves in the oil seal area.
4. Replace defective parts as required.



Fig. 10J--Removing Pinion Intermediate Bearing Using J-6203

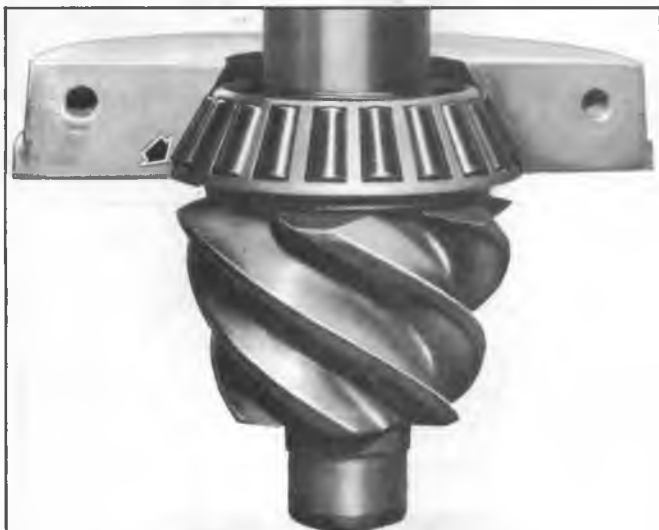


Fig. 11J--Installing J-22307 to Pinion Bearing

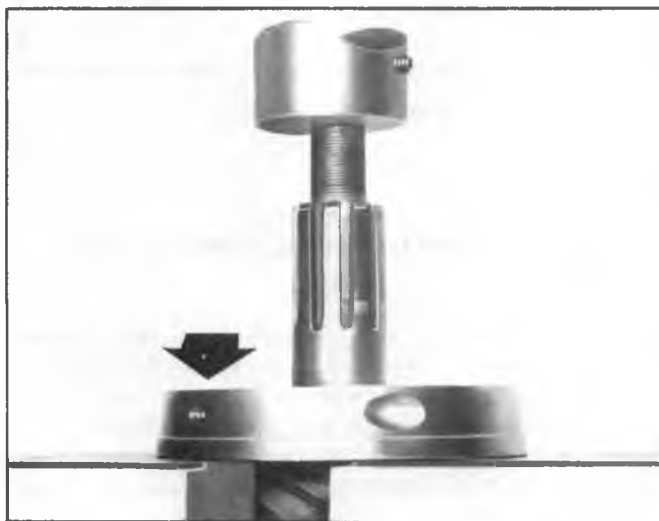


Fig. 12J--Removing Pinion Intermediate Bearing Using J-22307



Fig. 13J--Removing Pinion Rear Bearing from Carrier

**NOTE:** The pinion and ring gear are serviced in matched sets only. Therefore, if replacement is required both new components must be installed.

### Reassembly

1. Position pinion front bearing outer race in the bearing retainer with the thick edge of race toward internal shoulder in retainer. Using Tool J-22306 and Driver Handle J-8092 press race into retainer until it is firmly seated against shoulder.
2. Position pinion intermediate bearing outer race in retainer as described in Step 1; then, using Tool J-22377 and Driver Handle J-8092, install race as above until it seats firmly against shoulder (fig. 14J).
3. Install pinion intermediate bearing inner race on pinion with thick end of race toward pinion head, using a suitable length of 2 inch I.D. pipe to press against inner race (fig. 15J).
4. Place pinion bearing spacer over pinion and against bearing, then position pinion in retainer and install front bearing inner race over pinion-thin edge of inner race toward bearing spacer.
5. Press front bearing on pinion so that inner race contacts bearing spacer. A suitable length of 2 inch I.D. pipe may be used to install the bearing (fig. 16J).

**CAUTION:** The pilot end of the pinion serves as an inner race for the pinion rear bearing, exercise care so as not to damage this machined surface.

6. Pack the cavity between the seal lips with a lithium-base extreme pressure lubricant and install the pinion oil seal in the retainer bore, using Tool J-22283 (fig. 17J). Press the seal into the bore until it bottoms against internal shoulder.





Fig. 14J--Installing Pinion Intermediate Bearing Outer Race

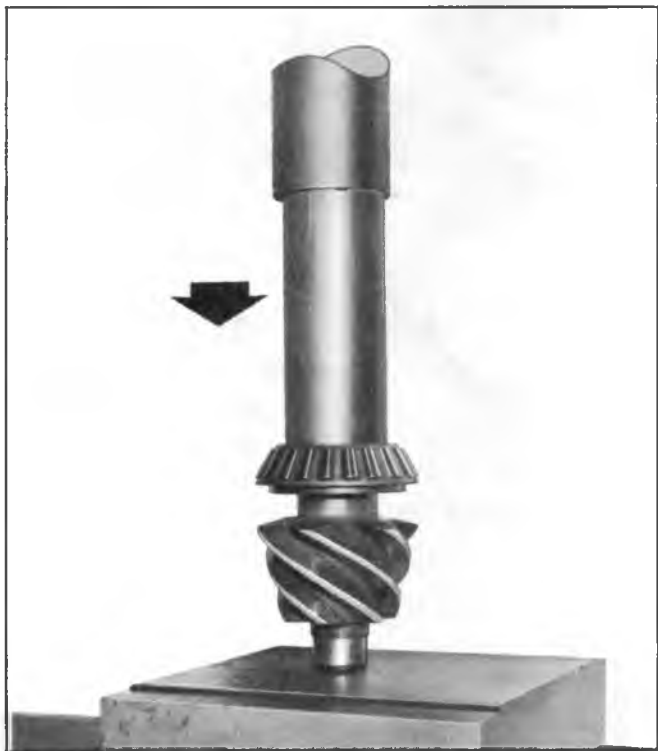


Fig. 15J--Installing Pinion Intermediate Bearing Inner Race

7. Position pinion rear bearing into carrier bore and install bearing so that it seats against stop, using Tool J-22303 and Driver Handle J-8092 (fig. 18J).

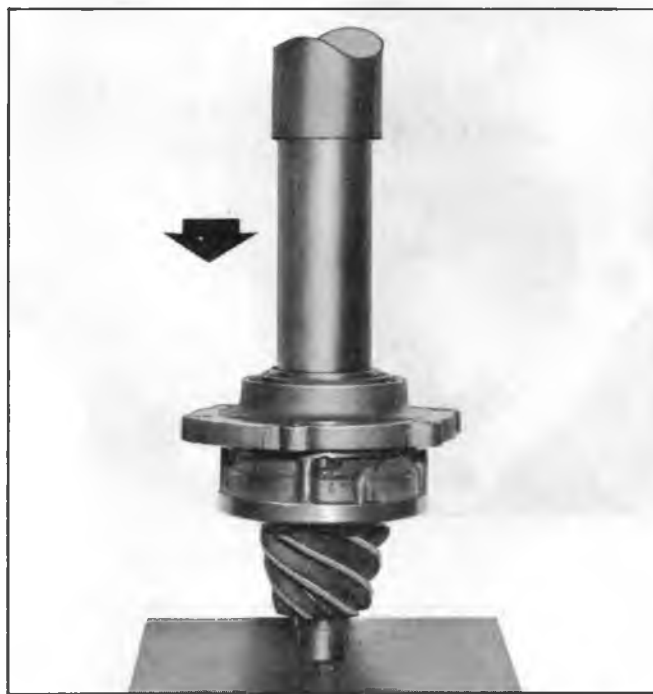


Fig. 16J--Installing Pinion and Front Bearing to Retainer

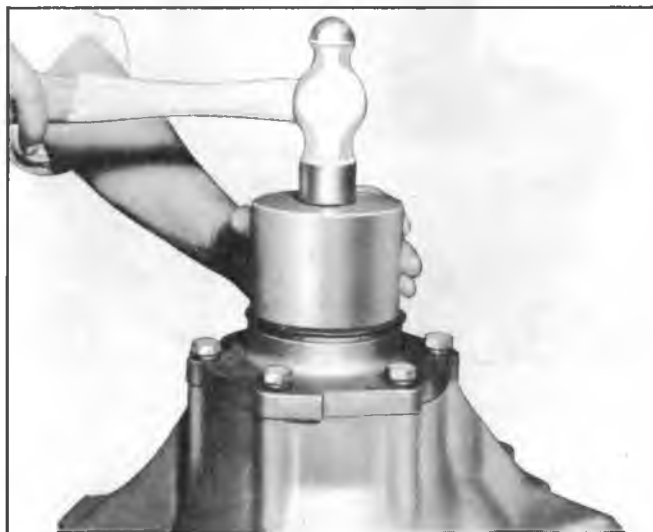


Fig. 17J--Installing Pinion Oil Seal

### Differential and Planet

#### Disassembly

1. Mark the ring gear and differential and planet support case and case cover for alignment by scribing or making lines on case, cover and gear (fig. 19J).
2. Remove the retaining bolts and lock washers retaining ring gear to planet support case and cover assembly and remove cover.
3. Mark or tag all gears so that they may be reassembled in the same relative position; then remove the sun gear and planet gears.



Fig. 18J--Installing Pinion Rear Bearing

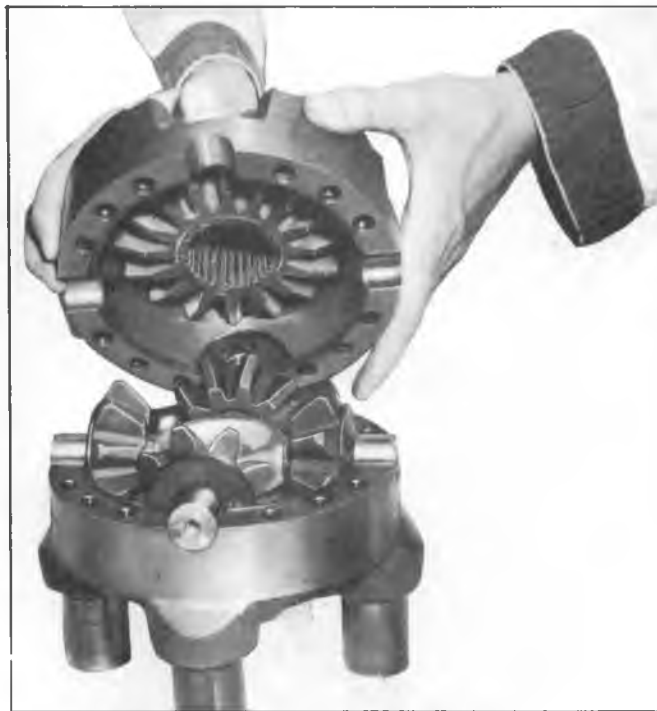


Fig. 20J--Separating Support Case and Cover

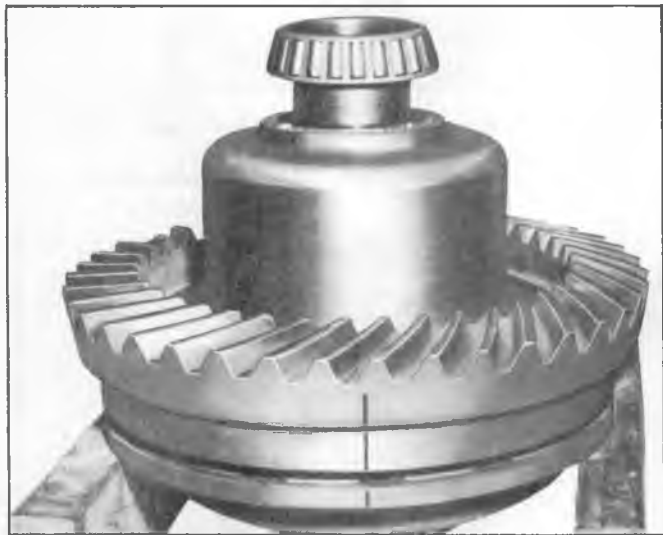


Fig. 19J--Alignment Marks on Ring Gear, Case and Cover



Fig. 21J--Removing Differential Bearings Using Brass Drift

4. Lift the differential and planet support assembly from the support case.
5. Remove the retaining bolts and lock washers from the planet support and cover, then separate the two parts (fig. 20).
6. Mark or tag all parts for reassembly in same relative position, then remove the spider, pinion gears and thrust washers.
7. Remove the right and left side gears and thrust washers from each side of the housing.
8. Remove the differential bearings from the differential planet support case and case cover by inserting a suitable size drift through the cast holes in the case and cover. Tap alternately through the holes from side to side of bearing to prevent race from binding on hub (Fig. 21J).

**Inspection**

1. Clean all parts thoroughly in cleaning solvent.
2. Inspect the ring gear, planet gears, differential pinion gears, and sun gear for damaged teeth or excessive wear. Inspect the thrust washers for excessive wear. Inspect the spider for wear or scored pinion bearing area. Inspect the differential side gears and thrust washers for damaged teeth or excessive wear.
3. Replace all damaged or excessively worn parts including mating parts where necessary.



Fig. 22J--Installing Differential Bearings

**Reassembly**

1. Replace differential bearings using Tool J-22294 for the left bearing and Tool J-22295 for the right bearing (fig. 22J). Both tools have a pilot to permit proper alignment of the bearing with the hub. Install both bearings until they are firmly seated on the case or cover as applicable.
2. Lubricate the thrust washers, side gear, spider and differential pinion gears. Assemble the parts in the differential and planet support, using reference marks made at disassembly to properly align parts.

**NOTE:** The side gear with the longest hub should be positioned in the support cover. Make sure side gear thrust washers are in place before installation.

3. Align and install cover--torque retaining bolts to specifications.
4. Install the planet gears on the support journals, then position the sun gear in the planet gears.
5. Install ring gear to support cover, using alignment marks previously scribed. Improved guide pins made from ring gear retaining bolts with heads cut off and slotted may be used to guide cover onto ring gear (fig. 23J).
6. Support the differential and planet support cover and ring gear with ring gear teeth on two blocks of wood; then the assembled planet and differential assembly into cover. Make sure thrust washer is in position at bottom of case.
7. Align and install the differential and planet support case, using the alignment marks previously scribed in disassembly procedures.



Fig. 23J--Installing Ring Gear Using Improved Guide Pins

8. Install case-to-ring gear bolts and lock washers in holes that do not have guide pins installed, then remove guide pins and install remaining bolts. Tighten bolts in a cross-wise pattern to draw case, cover and ring gear evenly together. Torque all bolts to specifications

**Installation**

1. Position the differential bearing outer races on the bearing, then using a suitable lift, position the differential into the carrier.
2. Install the differential adjusting nuts in each side of the carrier.
3. Position the differential bearing caps in the carrier making sure that the adjusting nuts properly engage the threads in the caps (fig. 24J). Bearing caps will seat flush with carrier and adjusting nuts will turn freely if caps are properly installed. Tap caps lightly with a soft-faced hammer to seat, but do not attempt to force caps on nuts.
4. Tighten cap bolts evenly until the adjusting nuts turn freely in the threads.



Fig. 24J--Installing Differential Bearing Caps

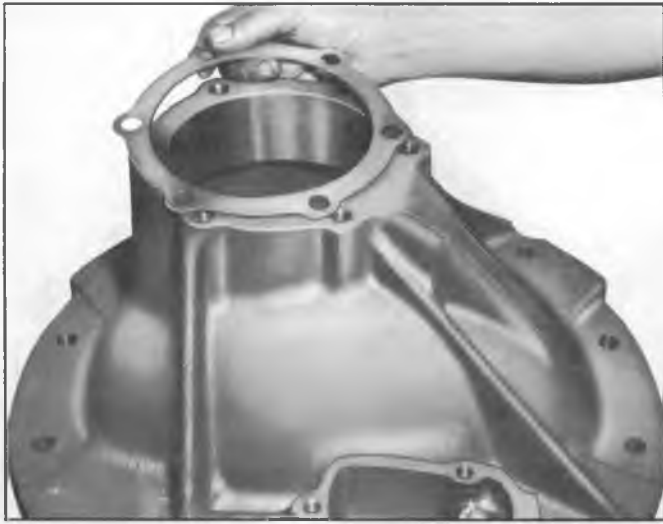


Fig. 25J--Installing Pinion Bearing Shim

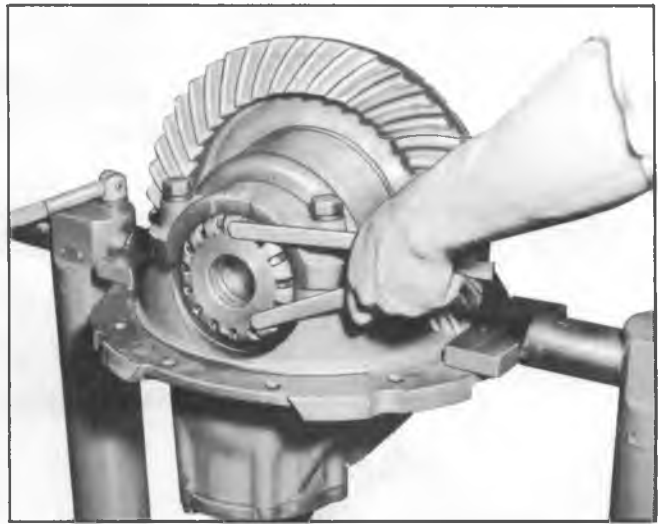


Fig. 27J--Tightening Differential Right Adjusting Nut Using J-0972

5. Using the original shim pack removed in disassembly procedures, install shim pack on the carrier, aligning holes in shim(s) with holes in carrier (fig. 25J).
6. Carefully guide the pinion and bearing retainer assembly into the carrier bore. Making sure rear of pinion is properly seated in pinion rear bearing.
7. Install bearing retainer-to-carrier bolts and lock washers and torque bolts to specifications.
8. Install pinion flange to pinion, making sure splines are properly engaged, then tap gently on flange with soft-faced hammer until sufficient clearance for washer and nut installation is obtained.
9. Install washer and self-locking nut to pinion, and using holding Tool J-3453 to hold flange, tighten pinion nut to seat flange and to preload pinion bearings.

**NOTE:** To properly preload the pinion bearings it may be necessary to apply torque up to 500 ft. lbs. at the pinion nut.

10. Tighten nut until flange, bearings and spacer are all

firmly seated then measure torque required to rotate pinion.

11. Continue tightening in small increments and measure until the torque required to rotate pinion is 25-35 in. lbs. for new pinion bearings or 5-15 in. lbs. when used bearings are reinstalled (fig. 26J).

#### **Ring Gear and Pinion Adjustment**

1. Loosen right differential adjusting nut and tighten left adjusting nut. Use Tool J-0972 on the right side (fig. 27J) and a drift and hammer on the left side (fig. 28J).
2. Tighten left adjusting nut until the ring gear contacts pinion and zero lash is obtained; however, do not force gears into contact so as to bind them.
3. Back off left adjusting nut approximately two notches to a point where nut lock and nut are aligned. Install nut lock and torque to specifications.
4. Tighten right adjusting nut firmly to force the differential and planet assembly into solid contact with left adjusting nut. Loosen right adjusting nut until it is free

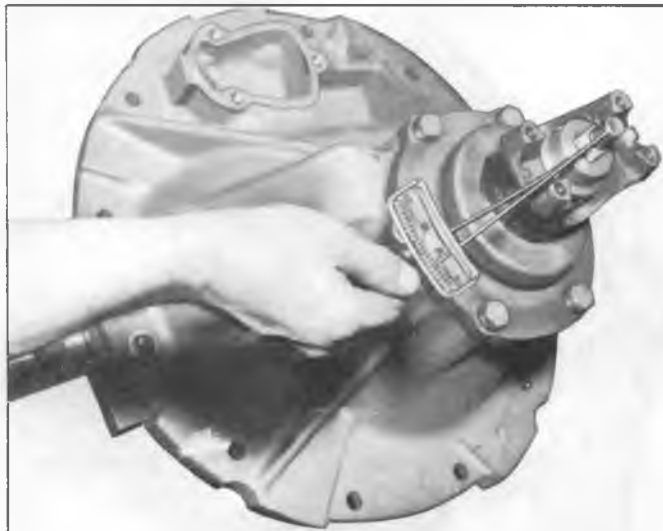


Fig. 26J--Measuring Pinion Rotating Torque

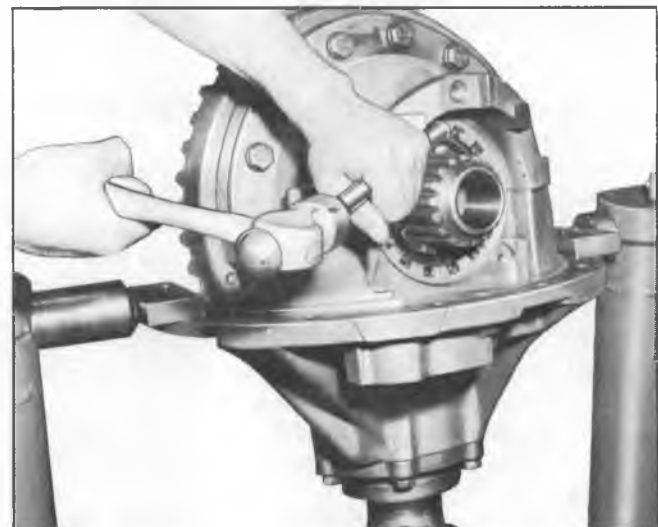


Fig. 28J--Tightening Differential Left Adjusting Nut Using Drift



from contact with its bearing, then retighten until nut contacts bearing. Tighten right adjusting nut from one to two notches additionally if old bearings are used, and two to three notches if new bearings are used, to a position where nut and nut lock are aligned. Install nut lock and torque to specifications.

**NOTE:** At this point the differential bearings are properly preloaded. If any additional adjustments are required in the following procedures make sure that the preload remains as established. If one adjusting nut is loosened the other nut must be tightened an equal amount to maintain this preload.

5. Mount a dial indicator on the housing and measure the backlash between the ring gear and pinion. Backlash should be from .003" to .012" with .005" to .008" preferred.

**NOTE:** If backlash is more than .012" loosen the right adjusting nut one notch and tighten left adjusting nut one notch. If backlash is less than .003" loosen the left adjusting nut one notch and tighten the right adjusting nut one notch.

#### Checking Pinion Depth

1. Thoroughly clean the ring and pinion gear teeth.
2. Paint ring gear teeth lightly and evenly with a mixture of powdered red lead and oil of a suitable consistency to produce a contact pattern.
3. Rotate pinion through several revolutions in the forward and reverse direction until a definite contact pattern is developed on the ring gear. Apply pressure to the ring gear while turning the pinion-this is to create a load on gears to produce a simulated driving pattern.
4. Examine the pattern on the ring gear teeth, if the pinion depth is correct the tooth pattern will be centered on the pitch line and toward the toe of the ring gear (fig. 18G).
5. If the pattern is below the pitch line on the ring gear teeth, the pinion is too deep and it will be necessary to remove the pinion assembly and increase the shim thickness between the pinion bearing retainer and the carrier.
6. If the pattern is above the pitch line on the ring gear teeth, the pinion is too shallow and it will be necessary to remove the pinion assembly and decrease the shim thickness between the pinion bearing retainer and the carrier.
7. Changing the pinion depth will cause some change in the backlash. Therefore adjust backlash, to maintain specified limits, if required.
8. Torque bearing cap bolts to specifications and recheck ring gear to pinion backlash. Install adjusting nut locks and torque to specifications.
9. Install oil trough to differential carrier-adjust trough-to-ring gear so that clearance is .03" to .09"-torque retaining bolts to specifications.

#### Shifter Yoke, Sleeve and Shaft Installation

1. Position the shifter yoke in radial groove of shifter sleeve.
2. Slide shifter sleeve over sun gear so that internal splines of sleeve align with splines on sun gear.

**NOTE:** Splined end of shifter yoke must be positioned toward rear of differential.

3. Install the shifter yoke lever through the housing into the shifter yoke mating splines. Tap end of lever lightly to fully seat it in the shifter yoke.
4. Using a new gasket, position the shifter unit over mounting pad, aligning lever in carrier with shift rod in shift unit.

**NOTE:** On axles equipped with electrical shift units, shift electrical leads must be connected to shift unit before installing shift unit to carrier.

5. Install shifter-to-carrier retaining bolts and torque bolts to specifications.

#### Differential Installation

1. Place a new gasket on carrier and place assembly on a roller jack. Make sure assembly is adequately supported on jack to prevent unit from falling and to allow installation in housing.
2. Use a long round-ended pry bar or drift to align carrier assembly with housing, then install carrier and secure with retaining cap screws.
3. Tighten cap screws in a cross-wise pattern until they are all pulled down snugly; then torque to specifications.
4. Swing the propeller shaft into place, remove the tape from the universal joint trunnion bearings and seat them in the universal joint yoke on the pinion flange.

**NOTE:** This propeller shaft to pinion flange fastener is an important attaching part in that it could affect the performance of vital components and systems, and/or could result in major repair expense. It must be replaced with one of the same part number or with an equivalent part if replacement becomes necessary. Do not use a replacement part of lesser quality or substitute design. Torque values must be used as specified during reassembly to assure proper retention of this part.

6. Connect vacuum lines to shift unit, making sure lines are not transposed.
7. Install axle shafts as outlined under the procedures given in the Truck Service Manual.
8. Fill axle with lubricant to a level even with bottom of filler hole, using lubricant meeting the requirements specified in Section 0 Truck Service Manual.

# DIFFERENTIAL CASE AND DRIVE PINION (EATON) 18,500 AND 23,000 LB. CAPACITY SINGLE-SPEED

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## DIFFERENTIAL CARRIER ASSEMBLY

(Refer to Figure 1K)

### Removal

1. Drain lubricant from differential, and remove axle shafts. See Truck Service Manual, "Axle Shaft Removal and Installation, Eaton Single Speed."
2. Remove two trunnion bearing "U" bolts from the pinion flange and split the rear universal joint.

**NOTE:** The bearings can be left on the trunnion and held in place with tape.

3. Swing propeller shaft to one side and tie it to the frame side rail.
4. Remove all differential carrier to axle housing bolts and lock washers, except the two near top. Loosen two at top and leave installed to prevent carrier from falling.
5. Break carrier loose from axle housing by tapping carrier with rawhide mallet.
6. Support carrier on roller jack; then remove the two top bolts and lock washers. A small pinch bar may be used to keep carrier straight in housing bore while carrier is withdrawn, provided end of bar is rounded to prevent damage to carrier flange.

### Disassembly

1. Mount differential carrier in Holding Fixture J-3409 or in a vise equipped with padded jaws. Key numbers in text refer to Figure 1K unless otherwise noted.
2. Center punch side of differential carrier leg and bearing cap, for identification when reassembling.
3. Remove bearing cap attaching bolts, bearing caps (5), and adjusters (6) and (26).
4. Lift differential and gear assembly from carrier.

**CAUTION:** Exercise care that differential side bearing cups (7) are not dropped in removing assembly from housing.

5. Remove bolts and lock washers which attach pinion cage (34) to carrier. Invert carrier and tap inner end of drive pinion until pinion and cage assembly drops free of carrier.
6. Remove adjusting shims (33) from between carrier and cage. Wire shim pack together to maintain bolt hole alignment at reassembly.

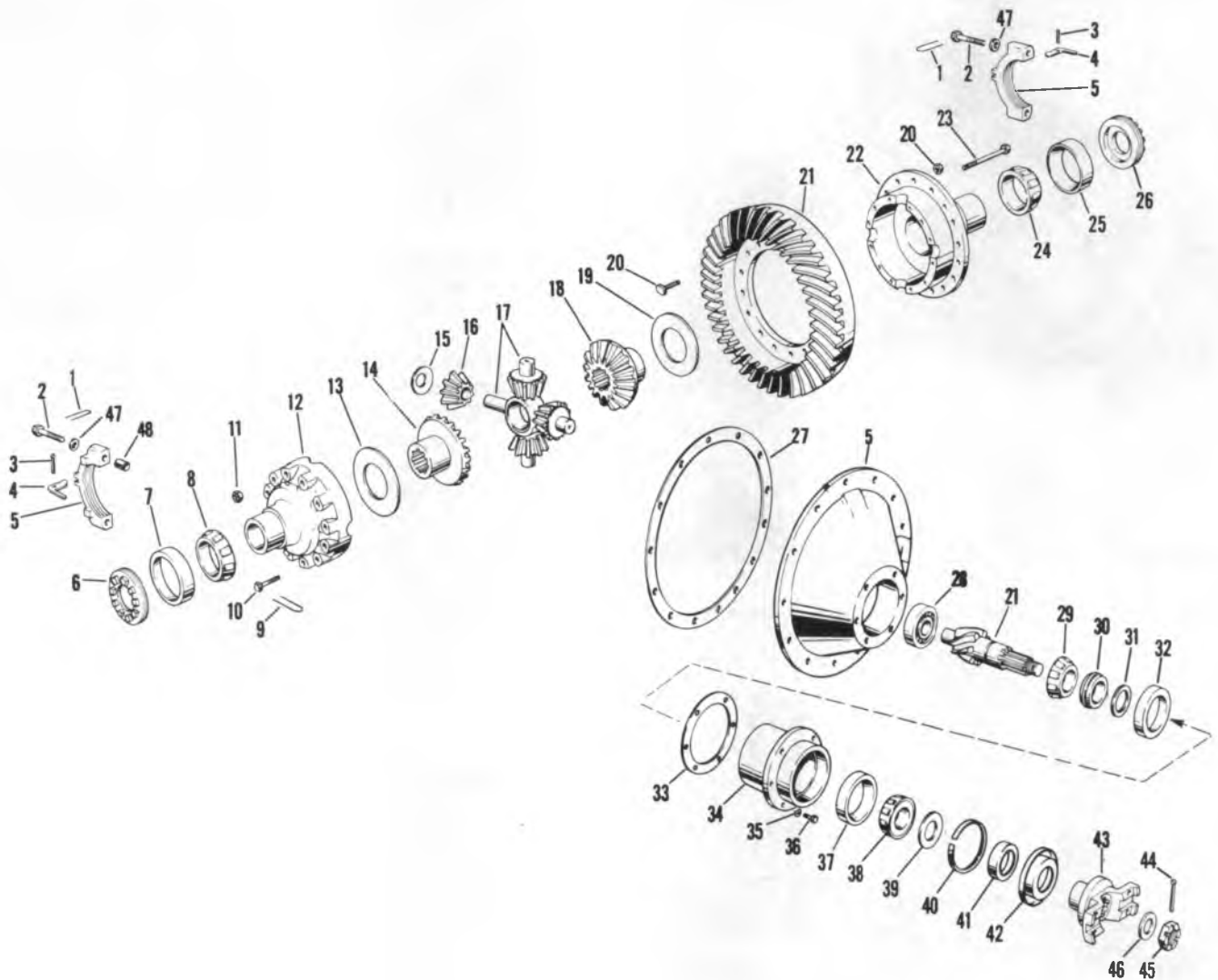
### Repairs

#### *Pinion Disassembly*

1. Place companion flange in vise, remove cotter pin, nut and flange washer (fig. 6L).
2. Place assembly in arbor press with cage on bed of arbor. Press drive pinion (21) downward and out of cage.
3. Remove pinion flange, and retainer and oil seal assembly (42). Remove pinion bearing spacer (30), from pinion.
4. Lift outer bearing cone and roller assembly (38) from cage.
5. When inspection indicates necessity, cups (32 and 37) can be removed from cage with Tool J-3940 as shown in Figure 2K.
6. Remove stake points holding straight roller bearing (28) to pinion, then press pinion from bearing with bearing supported by Tool J-3493 as shown in Figure 3K.
7. Remove inner pinion cone (29). Position Tool J-3493 over head of pinion so that it contacts inner race and press pinion from bearing (fig. 3K).

#### *Pinion Inspection*

1. Wash all parts thoroughly in cleaning solvent.
2. Inspect splines of pinion shaft for excessive wear.
3. Inspect pinion for scored, cracked, chipped or worn teeth.



- |   |  |  |   |
|---|--|--|---|
| 1. Lockwire   | 13. Side Gear Thrust Washer (RH)             | 25. Differential Bearing Cup (LH)      | 36. Cap Screw                           |
| 2. Cap Screw  | 14. Side Gear (RH)                           | 26. Differential Bearing Adjuster (LH) | 37. Pinion Bearing Cup (Outer)          |
| 3. Cotter Pin   | 15. Side Pinion Thrust Washer                | 27. Carrier Gasket                     | 38. Pinion-Bearing Cone (Outer)         |
| 4. Adjuster Lock  | 16. Side Pinion                              | 28. Pinion Pilot Bearing               | 39. Companion Flange Flat Washer        |
| 5. Differential Carrier and Bearing Caps (Matched Parts) (Conical Type) | 17. Spider                                   | 29. Pinion Bearing Cone (Inner)        | 40. Strip Sealer (Seal Retainer)        |
| 6. Differential Bearing Adjuster (RH)                                   | 18. Side Gear (LH)                           | 30. Pinion Bearing Spacer              | 41. Oil Seal                            |
| 7. Differential Bearing Cup (RH)  | 19. Side Gear Thrust Washer (LH)             | 31. Pinion Bearing Spacer Washer       | 42. Oil Seal Retainer (Pressed-in-Type) |
| 8. Differential Bearing Cone (RH)                                       | 20. Bolt and Nut                             | 32. Pinion Bearing Cup (Inner)         | 43. Companion Flange                    |
| 9. Lockwire   | 21. Ring Gear and Drive Pinion (Matched Set) | 33. Pinion Bearing Cage Shims          | 44. Cotter Pin                          |
| 10. Cap Screw   | 22. Differential Case (Flanged Half)         | 34. Pinion Bearing Cage                | 45. Pinion Nut                          |
| 11. Nut   | 23. Bolt                                     | 35. Lock Washer                        | 46. Flat Washer                         |
| 12. Differential Case (Plain Half)                                      | 24. Differential Bearing Cone (LH)           |  |   |

Fig. 1K—Exploded View of Eaton Single-Speed

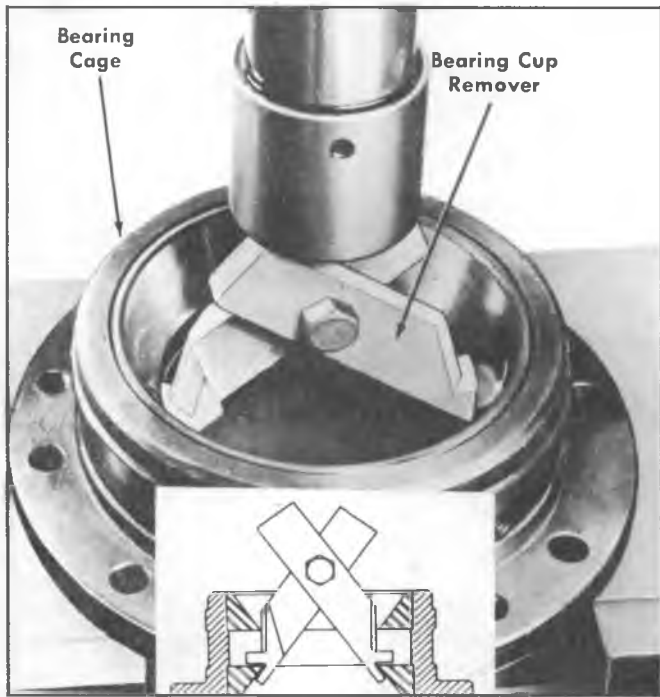


Fig. 2K--Removing Pinion Cage Bearing Cup, Using Tool J-3940

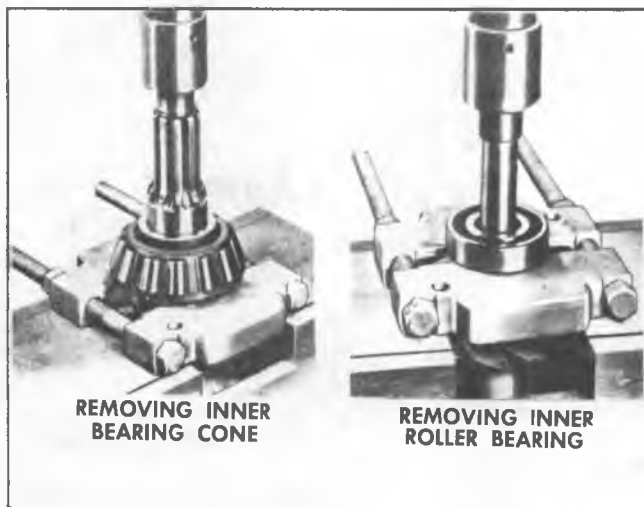


Fig. 3K--Pinion Bearing Removal

4. Examine pinion bearings and cups for roughness, defects or excessive wear.
5. Check condition of oil seal and oil seal contacting surface on pinion flange.

**NOTE:** If a pinion and ring gear set requires replacement and wear pattern on the gears was normal for length of service, record the shim pack thickness used with the pinion being removed, as well as the "individual variation distance" (etched on shaft spline) of that pinion. This information will be used in determining the approximate thickness of shim pack to be used with the new pinion.

### Pinion Assembly

If inspection indicates that drive pinion should be replaced, replacement of ring gear is also necessary as these parts are serviced as matched sets.

1. Press inner pinion bearing onto pinion shaft until wide side of bearing cone seats against pinion shoulder. Use J-3493 and space bearing from split ring with a discarded pinion bearing spacer.
2. Press the straight roller pilot bearing onto the shaft and stake end of shaft at six points using a round nose punch.
3. If new bearing cups are to be installed press cups firmly against shoulder of pinion cage using Tool J-22377 for the 18,500 lb. axle and J-21106 for the 23,000 lb. axle.
4. Lubricate pinion bearings with recommended axle lubricant, then insert pinion and bearing assembly into cage. Place original bearing spacer over pinion shaft.
5. Press outer pinion bearing onto pinion.
6. Adjust pinion bearing pre-load as instructed under "Rear Axle Adjustments, Eaton Axles."
7. Install oil seal assembly (41) into retainer (42).
8. Install strip sealer (40) into seal retainer.
9. Press seal retainer into pinion bearing cage (34).
10. Install pinion flange on pinion shaft. Install washer and pinion flange nut (45), then tighten to torque recommended in "Rear Axle Specifications." Insert cotter pin. Do not back off pinion flange nut to align cotter pin hole.

### Pinion Installation

1. Install original shim pack on carrier unless a new pinion is being installed. If a new pinion is being installed, an estimate of the shim pack thickness required can be obtained by increasing or decreasing thickness of shim pack removed by the amount that the old and new pinions differ in "Individual Variation Distance" (etched on pinion splines).
2. Position pinion and cage assembly on carrier over housing bolt holes. Align oil passages in shims, cage and carrier.
3. Install bolts and lock washers. Tighten bolts to torque shown in "Rear Axle Specifications."

### Differential Disassembly

1. Place differential assembly on bench. If original identification marks on case halves are not clear, punch mark both halves to assist in properly matching at reassembly.
2. Cut lock wires, then remove cap screws holding together the two-piece case, and separate case (fig. 4K).
3. Remove four pinions (16) and thrust washers (15) from spider (17). Remove differential side gears (14 and 18) and thrust washers (13 and 19) from case.
4. If differential bearings require replacement, use Tool J-3493 in manner shown in Figure 5K to remove bearings.

### Differential Inspection

1. Wash all parts thoroughly in cleaning solvent.



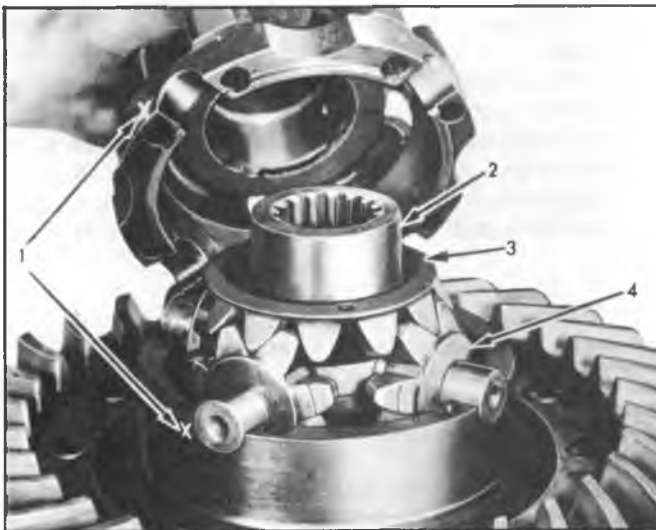


Fig. 4K--Removing Differential Case

- |                    |                  |
|--------------------|------------------|
| 1. Alignment Marks | 3. Thrust Washer |
| 2. Side Gear       | 4. Thrust Washer |

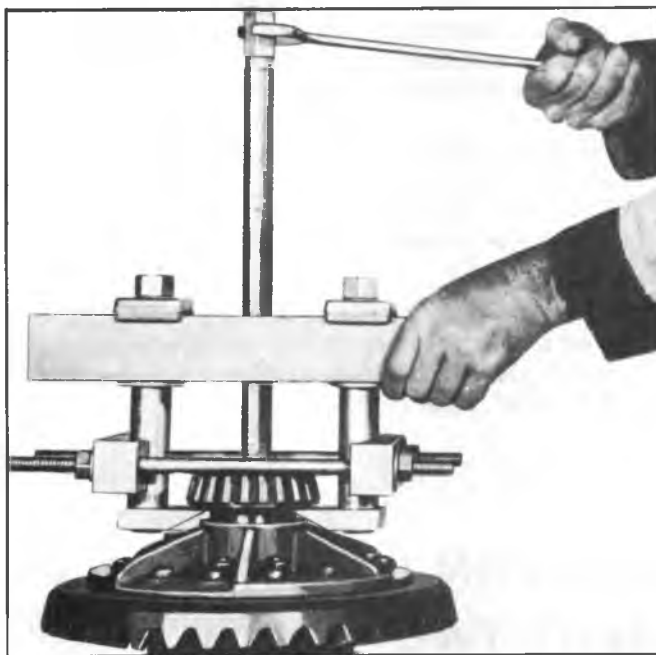


Fig. 5K--Removing Differential Bearing, Using Tool J-3493

2. Inspect ring gear for chipped or worn teeth and loosened bolts.
3. Check radial clearance between differential side gears and differential case, also fit of differential pinions on spider.
4. Inspect spider arms for wear and distortion.
5. Inspect splines and teeth of differential side gears and pinions for chipping or excessive wear.
6. Check thrust washers for wear and replace if even slight wear is indicated.
7. Check differential bearings and cups for broken races, discoloration or roughness.
8. Inspect differential case for cracks or distortion.

### Ring Gear Replacement

whenever inspection reveals that the ring gear must be replaced, it is also necessary to install a new pinion as these parts are serviced in matched sets.

1. Remove locknuts and bolts, ring gear and differential case.
2. After cleaning differential case thoroughly, position ring gear on case and install bolts and locknuts. Tighten bolt nuts to specifications.

### Differential Reassembly

1. Lubricate differential case inner walls and all the component parts with recommended axle lubricant.
2. Press differential side bearings (8 and 24) onto differential case.
3. Position new thrust washer (13 and 19) and side gear (14 and 18) in ring gear half on case. Install spider (17) with pinions (16) in position, using all new thrust washers (15). Install remaining side gear and new thrust washer.
4. Install other half of case over assembly. Align mating marks on differential case halves (fig. 4K). Install four bolts holding two halves of case together. Draw the two halves together firmly. Check assembly for free rotation of gears; then install remaining bolts. Tighten bolts to correct torque; then install lock wire.

### Differential to Carrier Reassembly

1. Lubricate side bearings and cups with axle lubricant. Place cups over bearings and position differential assembly in carrier housing.
2. Install differential bearing adjusters (6 and 26) into place on carrier. Thread adjusters hand-tight against bearing cups. Install bearing caps in original positions according to marks made at disassembly.

**CAUTION:** If bearing caps do not seat properly, adjusters may be cross-threaded. Remove caps and reposition adjusting nuts. Do not force into position or threads will be damaged.

3. Install bearing cap bolts. Tighten snugly; then back off only enough to permit turning adjusting nuts.

### Ring Gear and Pinion Adjustment

1. Tighten adjusting nuts alternately until all end play has been eliminated. Revolve assembly after each tightening step to prevent bearing from becoming cocked.
2. Pre-load differential bearings as follows:
  - a. With dial indicator against back face of ring gear, loosen one of the differential bearing adjusting nuts until end play can be noticed on indicator.
  - b. Tighten the same adjusting nut until 0.000" end play is obtained.
  - c. Check ring gear run-out as shown in Figure 6K. If run-out exceeds limits listed in "Specifications" remove differential assembly and check for cause.



Fig. 6K--Checking Ring Gear Run Out

- d. Tighten each bearing adjusting nut one notch beyond 0.000" end play position, to place correct pre-load on differential bearings.
- 3. Perform "Backlash Adjustment" shown under "Rear Axle Adjustments." in the Tandem Rear Axles and Power Divider Section.

**Checking Pinion Depth**

- 1. Attain correct gear tooth contact pattern as described in Tandem Rear Axles and Power Divider Section under "Rear Axle Adjustments."
- 2. Tighten bearing cap bolts to the correct torque, then install lock wires. Install adjusting nut locks.

**Differential Carrier Installation**

- 1. Clean out axle housing and cover.
- 2. Install four temporary studs, four or five inches long, in the holes on the carrier face of the axle housing.

- 3. Install new differential carrier gasket over temporary studs.
- 4. Move carrier into position on roller jack. Start carrier over temporary studs and into housing, using flat washers under stud nut or bolts at four points. Tighten alternately and evenly until carrier is in position. Replace temporary studs and flat washers. Install lock washers and bolts at all locations and tighten to specified torque.

**NOTE:** Driving carrier into housing with a hammer may distort the carrier flange and result in oil leaks.

- 5. Assemble rear universal joint.

**NOTE:** This propeller shaft to pinion flange fastener is an important attaching part in that it could affect the performance of vital components and systems, and/or could result in major repair expense. It must be replaced with one of the same part number or with an equivalent part if replacement becomes necessary. Do not use a replacement part of lesser quality or substitute design. Torque values must be used as specified during reassembly to assure proper retention of this part.

- 6. Install axle shaft as covered under "Axle Shaft Removal and Installation, Eaton Single Speed" in the Truck Service Manual.
- 7. Fill axle with lubricant and install filler plug.

**NOTE:** On forward tandem axle add 2 pints (1-3/4 pints Imperial Measure) through the forward filler hole located slightly offset to right in top portion of differential carrier.

- 8. Check axle operation.

**DIFFERENTIAL CASE AND DRIVE PINION (EATON) 18,500 AND 23,000 LB. CAPACITY TWO-SPEED**

**INDEX**

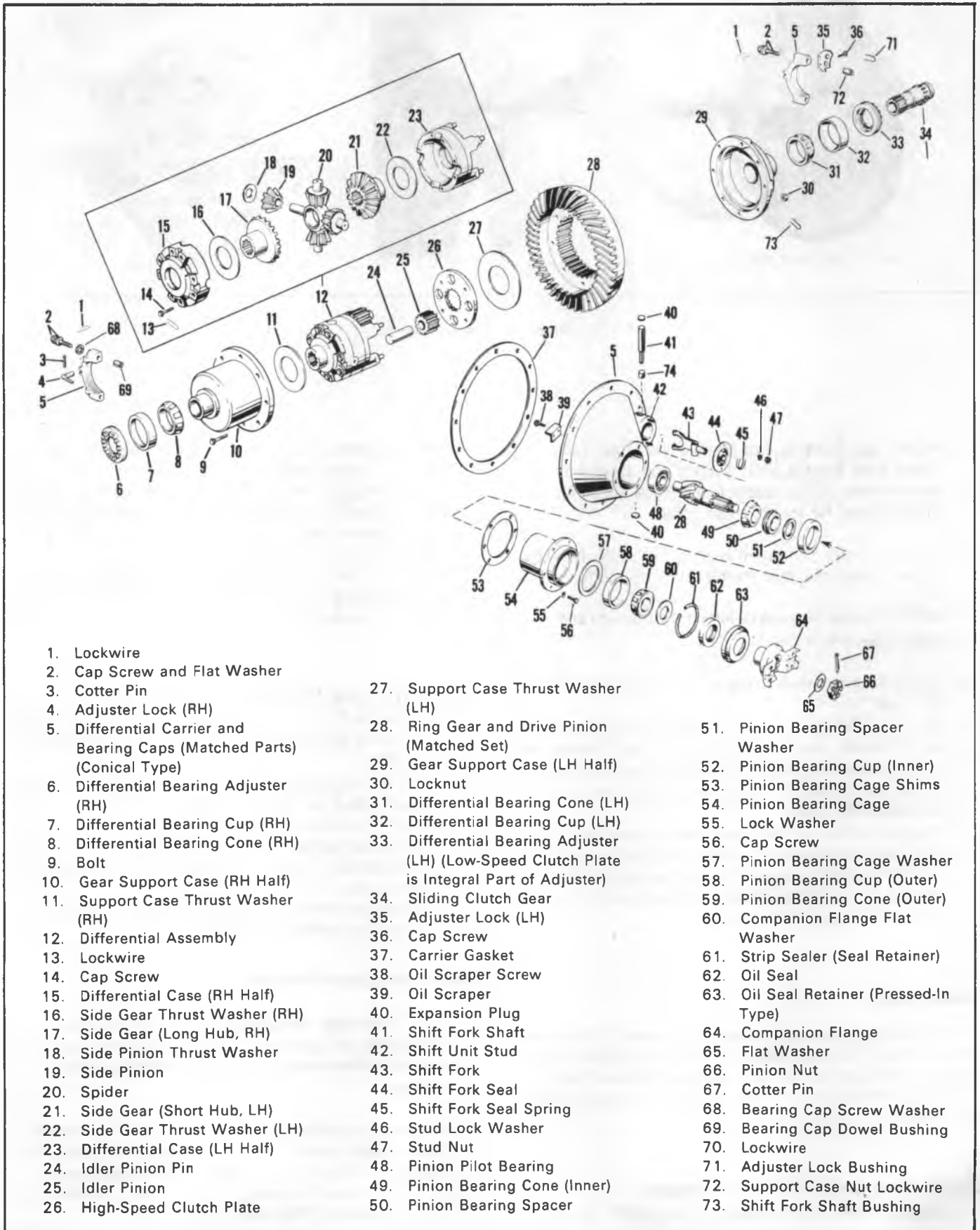
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**Differential Carrier**

**Removal**

- 1. Drain lubricant and remove axle shafts. See Truck Service Manual "Axle Shaft Removal and Installation, Eaton Single Speed".

- 2. Remove shift unit connections. Electric shift; remove electrical lead wires at harness plug. Piston air shift; bleed system and disconnect air line at piston housing cover.
- 3. Remove two stud nuts retaining shift unit to carrier and pull unit from carrier.



- |   |  |   |
|---|--|---|
| 1. Lockwire   | 27. Support Case Thrust Washer (LH)  | 51. Pinion Bearing Spacer Washer        |
| 2. Cap Screw and Flat Washer  | 28. Ring Gear and Drive Pinion (Matched Set)   | 52. Pinion Bearing Cup (Inner)          |
| 3. Cotter Pin   | 29. Gear Support Case (LH Half)  | 53. Pinion Bearing Cage Shims           |
| 4. Adjuster Lock (RH)   | 30. Locknut  | 54. Pinion Bearing Cage                 |
| 5. Differential Carrier and Bearing Caps (Matched Parts) (Conical Type) | 31. Differential Bearing Cone (LH)   | 55. Lock Washer                         |
| 6. Differential Bearing Adjuster (RH)                                   | 32. Differential Bearing Cup (LH)  | 56. Cap Screw                           |
| 7. Differential Bearing Cup (RH)  | 33. Differential Bearing Adjuster (LH) (Low-Speed Clutch Plate is Integral Part of Adjuster) | 57. Pinion Bearing Cage Washer          |
| 8. Differential Bearing Cone (RH)                                       | 34. Sliding Clutch Gear  | 58. Pinion Bearing Cup (Outer)          |
| 9. Bolt   | 35. Adjuster Lock (LH)   | 59. Pinion Bearing Cone (Outer)         |
| 10. Gear Support Case (RH Half)   | 36. Cap Screw  | 60. Companion Flange Flat Washer        |
| 11. Support Case Thrust Washer (RH)                                     | 37. Carrier Gasket   | 61. Strip Sealer (Seal Retainer)        |
| 12. Differential Assembly   | 38. Oil Scraper Screw  | 62. Oil Seal                            |
| 13. Lockwire  | 39. Oil Scraper  | 63. Oil Seal Retainer (Pressed-In Type) |
| 14. Cap Screw   | 40. Expansion Plug   | 64. Companion Flange                    |
| 15. Differential Case (RH Half)   | 41. Shift Fork Shaft   | 65. Flat Washer                         |
| 16. Side Gear Thrust Washer (RH)  | 42. Shift Unit Stud  | 66. Pinion Nut                          |
| 17. Side Gear (Long Hub, RH)  | 43. Shift Fork   | 67. Cotter Pin                          |
| 18. Side Pinion Thrust Washer   | 44. Shift Fork Seal  | 68. Bearing Cap Screw Washer            |
| 19. Side Pinion   | 45. Shift Fork Seal Spring   | 69. Bearing Cap Dowel Bushing           |
| 20. Spider  | 46. Stud Lock Washer   | 70. Lockwire                            |
| 21. Side Gear (Short Hub, LH)   | 47. Stud Nut   | 71. Adjuster Lock Bushing               |
| 22. Side Gear Thrust Washer (LH)  | 48. Pinion Pilot Bearing   | 72. Support Case Nut Lockwire           |
| 23. Differential Case (LH Half)   | 49. Pinion Bearing Cone (Inner)  | 73. Shift Fork Shaft Bushing            |
| 24. Idler Pinion Pin  | 50. Pinion Bearing Spacer  |   |

Fig. 1L—Eaton Two-Speed Axle

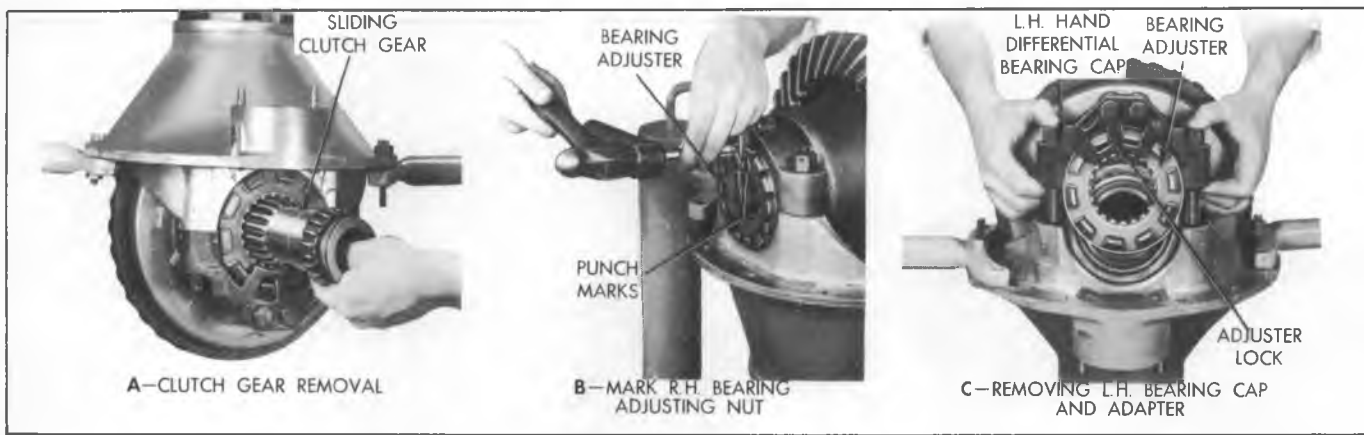


Fig. 2L—Differential Carrier Assembly

**NOTE:** See Truck Service Manual "Chevrolet Two-Speed Axle, Electric Shift System" for service on electric units or "Two-Speed Eaton Axles Piston-Air Shift System" for service on air units.

4. Remove the two trunnion bearing "U" bolts from the pinion flange and split the rear universal joint.

**NOTE:** The bearings can be left on the trunnion and held in place with tape.

5. Swing propeller shaft to one side and tie it to the frame side rail.
6. Remove all differential carrier to axle housing bolts and lock washers, except the two near the top. Loosen two at top and leave installed to prevent carrier from falling.
7. Break carrier loose from axle housing by tapping carrier with rawhide mallet.
8. Support carrier on roller jack; then remove the two top bolts and lock washers. A small pinch bar may be used to keep carrier straight in housing bore while carrier is withdrawn, provided end of bar is rounded to prevent damage to carrier flange.

### Disassembly

The following paragraphs cover the removal of the subassemblies and component parts from the differential carrier assembly, with the carrier mounted in Holding Fixture J-3409. Key numbers in text refer to Figure 1L unless otherwise noted.

### Clutch Gear and Shift Fork-Removal

1. Remove shift fork seal (44) and spring (45). Note that

seal has words "BOTTOM HOLE;" also 1/8" hole to indicate correct positioning at reassembly.

2. At underside of carrier, remove expansion plug covering shift fork shaft. Use brass drift and hammer to drive shaft upward which will also remove expansion plug from top side of carrier.
3. Slide shift fork up and free from clutch gear. Pull sliding clutch gear out of planetary unit (View A, fig. 2L), and remove shift fork.

### Differential and Planetary Unit-Removal

1. Mark right differential bearing adjuster (6) and cap (5) with punch (View B, fig. 2L) for locating purposes at assembly.
2. Remove bearing cap bolt lock wires, loosen bolts, then remove cotter pin and adjuster lock (4) from right adjuster (6) and remove.
3. Remove left adjuster (33) bearing cap (5) and lock (35) as an assembly to insure correct location at assembly (View C, fig. 2L).
4. Lift support case and ring gear, differential and planetary unit assembly out of carrier.

### Pinion and Cage-Removal

**NOTE:** On axles with straddle mounted pinion the differential and planetary unit assembly must be removed before pinion and cage assembly can be removed.

1. Remove pinion bearing cage bolts, and lock washers.
2. Invert carrier and tap inner end of drive pinion (28) until pinion and cage assembly is free from carrier.
3. Remove shims (53) noting quantity and thickness for use at assembly. Wire shim pack together.



**Repairs**

**Pinion Disassembly**

Check pinion end play and bearing adjustment before disassembling; then proceed as follows:

1. Place companion flange in vise, remove cotter pin, nut and washer (66 and 65) from pinion (fig. 6L).
2. Place assembly in arbor press with cage on bed of arbor. Press pinion (28) downward and out of cage. Remove companion flange (64).
3. Remove bearing adjusting spacer (50) from pinion and tag for reassembling reference.
4. Press oil seal and retainer assembly (63) from pinion cage (54).
5. Remove pinion outer bearing cone (59) from cage assembly.
6. If necessary, pinion bearing cone (49) can be pressed off using Puller J-3493 (fig. 3K).
7. Remove stake points holding straight roller pilot bearing (48), then press pinion from bearing with bearing supported in J-3493 (fig. 3K).
8. When inspection indicates necessity, cups (52 and 58) can be removed from cage with Tool J-3940 as shown in Figure 2K.

**Planetary Unit-Disassembly**

1. Remove nuts from ring gear bolts (9); then remove bolts.
2. Tap ring gear (28) with rawhide mallet until free of support case flange.
3. Lift left-hand support case (29), thrust washer (27) and ring gear (28) off right-hand support case.
4. Pry high speed clutch plate (26) off idler pinion and clutch plate pins (25 and 24) as shown in Figure 3L then remove pinions and pins.
5. Remove differential assembly from right-hand support case (10). Remove support case thrust washer (11, View A, fig. 4L).

**Differential Disassembly**

1. Mark both halves of differential case distinctly to assure correct positioning at assembly.
2. Cut cap screw lock wire, then remove differential cap screws (14).

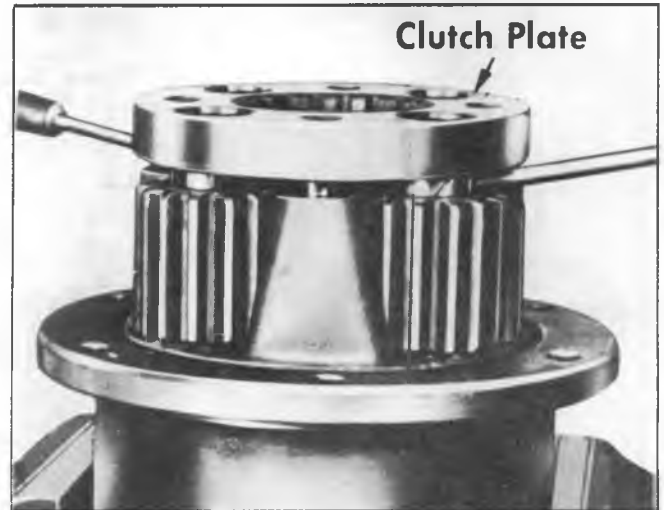


Fig. 3L--High-Speed Clutch Plate Removal

3. Lift off right-hand half of case; then remove side gear (17) and thrust washer (View B, fig. 4L).
4. Remove spider (20) and pinion gears (19) from case; then remove thrust washers (18) and pinion gears (19) from spider(20).
5. Remove left-hand side gear and thrust washer (21) from left case (22).
6. Remove differential bearing cones (8 and 31) from support case by striking inner races on alternate sides with a pin punch through holes in case (View C, fig. 4L).

**Inspection**

**NOTE:** Discard old gaskets and oil seals as they are usually no longer serviceable and replacement is recommended.

1. Wash all parts in cleaning solvent.
2. Rotate each bearing slowly and at the same time examine bearing for roughness, defects or wear. Inspect bearing cups and cage bores for pitting and discoloration.
3. Examine all gears, pinions and splines for surface hardening, distortion, worn spots or other defects.
4. Check the support case for run-out. If run-out exceeds



Fig. 4L--Differential Disassembly

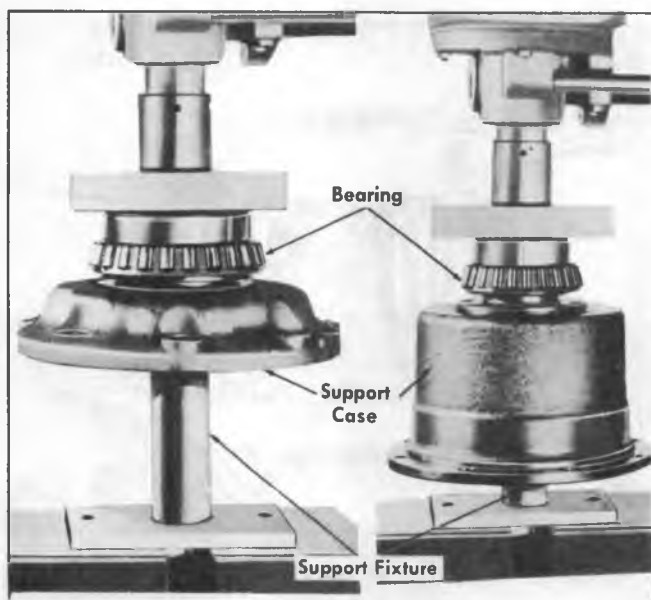


Fig. 5L—Installing Differential Bearings

limits shown in "Specifications" the case must be replaced.

5. Carefully inspect shims for uniform thickness and replace any split shims in the pack. Where various thickness of shims are used in a pack, the thickest shim should be used between the thin shims.
6. If even the slightest wear is indicated on thrust washers they should be replaced.
7. Inspect spider arms for wear and distortion.
8. Check radial clearance between differential side gears and differential case, also fit of differential pinions on spider.

#### Differential-Assembly

1. Press differential bearing cones (8 and 31) onto support case hubs using support fixture J-3941 as shown in Figure 5L.
2. Install thrust washer (22) on hub of left side gear, with chamfered edge of washer next to gear, then place side gear in left-hand differential case (23).
3. Place pinions (19) and pinion thrust washers (18) on spider (20); then lay assembly on side gear with gear teeth in mesh.
4. Position right-hand side gear (17) on pinion gears; then place side gear thrust washer (16) on gear hub with chamfered edge of washer next to gear.
5. Install right-hand differential case (15) on left-hand case with punch marks on case halves aligned (fig. 4K).
6. Install and tighten differential case bolts (14). Check assembly for free rotation of gears. Thread lock wire through bolt heads in such a manner that wire will be drawn tighter if bolts should loosen.

#### Planetary Unit-Assembly

1. Place support case thrust washer (11) in right-hand support case; then position differential assembly in case.

2. Install idler pinion pins (24) in left-hand differential case (23); then install idler pinions (25) on pins (24).
3. Install high speed clutch plate (26) on support case with bevel edge of clutch teeth toward the idler pinions, then tap gear lightly until seated.
4. Position left-hand support case (29) on ring gear; then install ring gear bolts (9) and nuts. Tighten nuts alternately and evenly.

#### Pinion and Cage-Assembly

1. Press straight roller (48) onto pinion (28), then stake end of pinion using a round nosed punch.
2. Press pinion inner tapered bearing cone (49) onto pinion (28) with wide portion of cone toward pinion teeth, until seated against shoulder. Use Tool J-3493 and space bearing from tool with a discarded pinion bearing spacer.
3. Press tapered roller bearing cups (52) and (58) into cage until seated tightly against shoulders in case. Installer Tool J-22377 (18,500 lb. axle) or J-21106 (23,000 lb. axle) may be used for this purpose.
4. Install pinion and bearing assembly in pinion cage. Install same bearing adjusting spacer (50) and spacer washer if required (51) as removed at disassembly. Press outer bearing cone (59) on pinion.
5. Place companion flange washer (60) on bearing cone (59).
6. Install oil seal assembly (62) into retainer (63) and apply strip sealer onto seal retainer.
7. Press seal retainer into pinion bearing cage (54).
8. Press pinion flange (64) on pinion. Install washer (65) and nut (66). Tighten nut (fig. 6L) to torque listed in "Specifications."
9. Check and adjust pinion bearing pre-load as instructed in "Rear Axle Adjustments (Eaton Axles)."

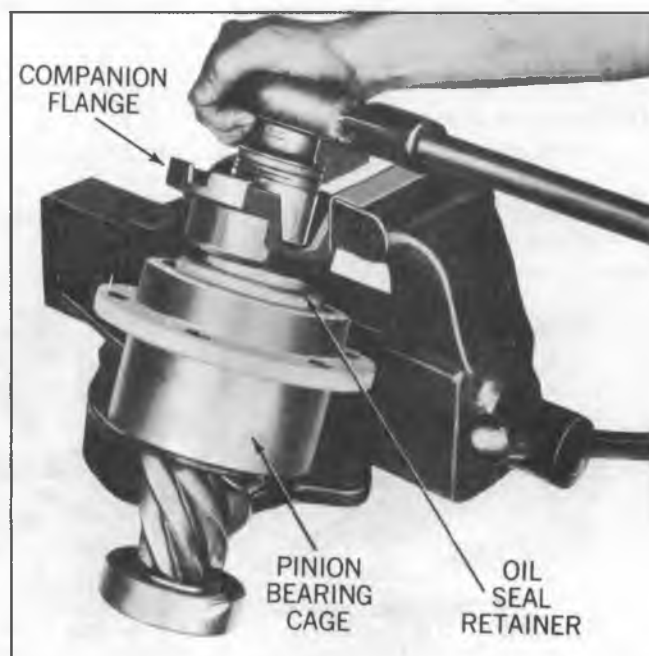


Fig. 6L—Removal and Installation of Companion Flange

**Assembly**

The following paragraphs cover the installation of sub-assemblies and component parts in the differential carrier.

All gears, thrust washers and contact surfaces should be coated with differential lubricant before parts are installed to prevent scoring during initial operation.

**Pinion and Cage-Installation**

1. Place same shims (53), that were removed at disassembly, on differential carrier.
2. Press pinion and cage assembly into place in carrier.
3. Install pinion bearing cage attaching bolts and lock washers. Tighten to torque listed in "Specifications."

**Differential and Planetary Unit-Installation**

1. Position bearing cups (7 and 32) on support bearing (8 and 31), then position differential and planetary unit in carrier.
2. Install bearing adjusters (6) and (33), caps (5), and cap bolts.

**CAUTION:** If caps do not position properly, nuts may be cross-threaded. Lift caps and reposition nuts. Forcing caps into position in the event nuts are cross-threaded will result in damage to carrier and bearing caps. Tighten cap bolts snugly, then back off only sufficiently to turn adjusting nuts.

3. Turn in right-hand adjuster until punch mark is in original position (View B, fig. 2L). Turn in left-hand adjuster until no end play exists between differential and carrier. Check for end-play using dial indicator as shown in Figure 7L. Then revolve ring gear and check for run-out.
4. Perform "Backlash Adjustment" shown under "Rear Axle Adjustments." in the Tandem Rear Axle and Power Divider Section

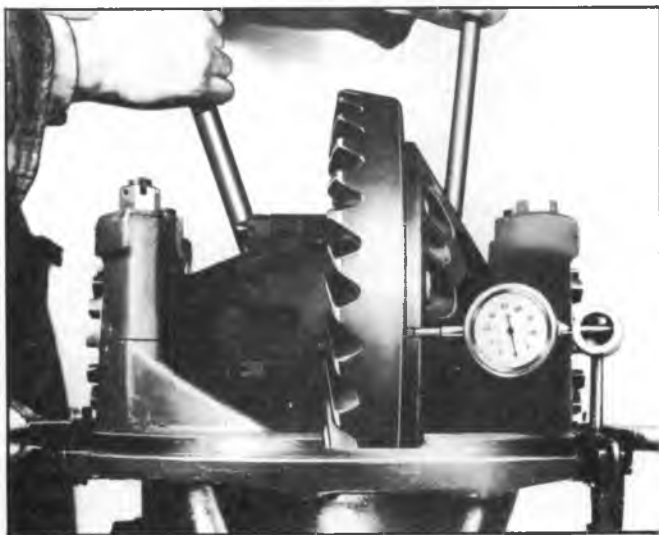


Fig. 7L--Checking End Play, Using Dial Indicator

**NOTE:** Position after final adjustment of left-hand bearing adjusting nut must be such that lock can be properly installed over notches of nut.

5. After gear lash and tooth contact adjustments have been made, and with .000" end play existing between differential and carrier; add light pre-load to differential bearings by turning in right-hand adjuster 1-1/2 to 2 notches.
6. Install right-hand bearing adjuster lock (4) and secure with cotter pin.

**NOTE:** Check fit of left-hand lock (35) in bearing cap (5). Lock should be an interference fit in the bearing cap. If lock is loose replace with a service lock which is 1/8" wider than the production lock Figure 8L. To fit the new lock to the bearing cap, grind both ends of the lock until an interference fit of .008" to .012" exists between the cap and lock. Care should be taken to keep lock surfaces parallel with the mating surfaces of the bearing cap.

7. Install left-hand lock (35) and attach with two bolts (36). Secure bolt with lock wire.
8. Tighten bearing cap bolts to torque given in "Specifications." Wire bolts securely.

**Clutch Gear and Shift Fork-Installation**

1. Install sliding clutch gear (34) into left side of differential planetary unit and mesh teeth with idler pinions.
2. Position shift fork (43) in carrier with off-set at lower end of fork toward outside, with lugs inserted in clutch gear grooves.
3. Insert serrated end of shift fork shaft (41) into hole on top of carrier and through hole in shift fork (43). Use brass rod and hammer to drive shaft down until seated. Serrations on shaft will prevent movement of shaft in carrier. At underside of carrier, install expansion plug and at top side of carrier install an expansion plug covering shift fork shaft.

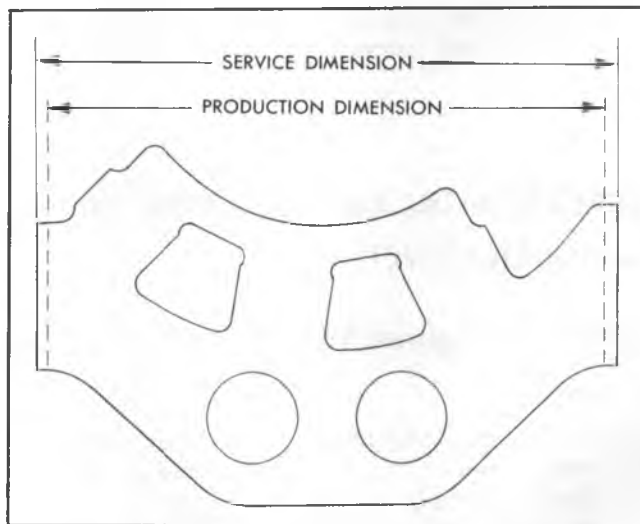


Fig. 8L--Bearing Adjusting Lock Service Replacement

## 4-30 REAR AXLE DIFFERENTIAL CARRIER

4. Install shift fork seal (44) and spring (45) over shift fork. Be sure that hole in seal marked "BOTTOM HOLE" is at bottom.

### Installation

1. Clean out axle housing and cover.
2. Install four temporary studs, four or five inches long in the holes on the carrier face of the axle housing.
3. Install new differential carrier gasket over temporary studs.
4. Move carrier into position on roller jack. Start carrier over temporary studs and into housing, using flat washers under stud nut or bolts at four points. Tighten alternately and evenly until carrier is in position. Replace temporary studs and flat washers. Install lock washers and bolts at all locations and tighten to specified torque.

**NOTE:** Driving carrier into housing with a hammer may distort the carrier flange and result in oil leaks.

5. Install shaft unit and connect lead wires to harness plug or air line to piston housing cover on Piston-Air units.
6. Assemble rear universal joint.

**NOTE:** This propeller shaft to pinion flange fastener is an important attaching part in that it could affect the performance of vital components and systems, and/or could result in major repair expense. It must be replaced with one of the same part number or with an equivalent part if replacement becomes necessary. Do not use a replacement part of lesser quality or substitute design. Torque values must be used as specified during reassembly to assure proper retention of this part.

7. Install axle shafts as covered under "Axle Shaft Removal and Installation" in the Truck Service Manual, Eaton Single Speed.
8. Fill axle with recommended gear lubricant, and install filler plug.
9. Check axle operation.

## TANDEM REAR AXLES AND POWER DIVIDER

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## DIFFERENTIAL CARRIER AND/OR CARRIER COVER

(Refer to Figures 1M and 2M)

### Removal

1. Remove drain plug from axle housing and from differential carrier cover and allow lubricant to drain.
2. Remove valve from shift lever bracket.
3. Remove Propeller shaft at input and output shafts.
4. Hold flanges with holding Tool J-3453 or J-8478, then

remove cotter pins from input and output flange nuts and remove nuts and washers (fig. 3M).

5. Pull flanges from shafts and remove bearing retaining washer and spacer from axle housing cover.
6. Remove axle housing cover nuts and lock washers and remove cover, oil seal and bearing outer race and roller assembly from output shaft and housing.
7. The differential carrier cover assembly (includes input shaft, input shaft bearing, bearing retainer, helical and differential side gear and inter-axle lock-out shift components) may now be removed from the differential carrier, or the cover assembly and differential carrier assembly may be removed as a unit:



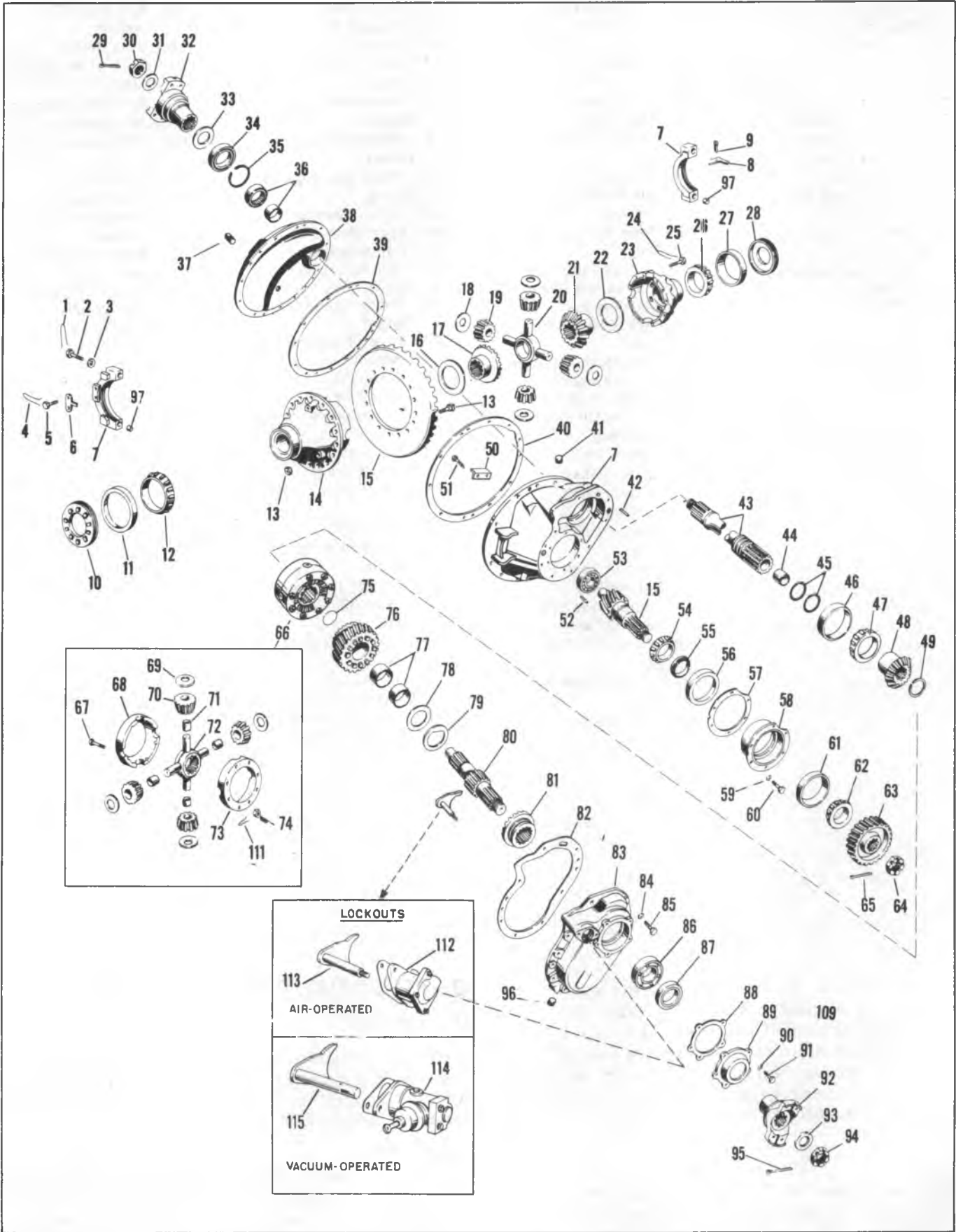


Fig. 1M--Forward Rear Axle Assembly--Exploded View (See legend on next page)

## 4-32 REAR AXLE DIFFERENTIAL CARRIER

- |   |  |   |   |
|---|--|---|---|
| 1. Lockwire   | 27. Differential Bearing Cup (LH)                      | 51. Cap Screw                               | 79. Side Gear "D" Washer                                |
| 2. Cap Screw  | 28. Differential Bearing Adjuster (LH)                 | 52. Dowel Pin                               | 80. Input Shaft   |
| 3. Flat Washer  | 29. Cotter Pin   | 53. Pinion Pilot Bearing                    | 81. Input Shaft Sliding Clutch                          |
| 4. Lockwire   | 30. Output Shaft Nut                                   | 54. Pinion Bearing Cone (Inner)             | 82. Differential Carrier Cover Gasket                   |
| 5. Cap Screw  | 31. Flat Washer  | 55. Pinion Bearing Spacer                   | 83. Differential Carrier Cover                          |
| 6. Adjuster Lock (RH)   | 32. Output Companion Flange                            | 56. Pinion Bearing Cup (Inner)              | 84. Lock Washer   |
| 7. Differential Carrier and Bearing Caps (Matched Parts) (Conical Type) | 33. Rear Bearing Retainer Washer                       | 57. Pinion Bearing Cage Shims               | 85. Cap Screw   |
| 8. Adjuster Lock (LH)   | 34. Oil Seal   | 58. Pinion Bearing Cage                     | 86. Input Shaft Bearing                                 |
| 9. Cotter Pin   | 35. Rear Bearing Snap Ring                             | 59. Lock Washer                             | 87. Oil Seal  |
| 10. Differential Bearing Adjuster (RH)                                  | 36. Output Shaft Rear Bearing and Sleeve (Matched Set) | 60. Cap Screw                               | 88. Bearing Cover Shims                                 |
| 11. Differential Bearing Cup (RH)                                       | 37. Axle Cover Filler Plug                             | 61. Pinion Bearing Cup (Outer)              | 89. Bearing Cover                                       |
| 12. Differential Bearing Cone (RH)                                      | 38. Axle Housing Cover                                 | 62. Pinion Bearing Cone (Outer)             | 90. Lock Washer   |
| 13. Bolt and Locknut  | 39. Cover Gasket                                       | 63. Pinion Helical Gear                     | 91. Cap Screw   |
| 14. Differential Case (RH Half)   | 40. Carrier Gasket                                     | 64. Pinion Nut                              | 92. Input Companion Flange                              |
| 15. Ring Gear and Drive Pinion (Matched Set)                            | 41. Carrier Oil Passage Hole Plug                      | 65. Cotter Pin                              | 93. Flat Washer   |
| 16. Side Gear Thrust Washer (RH)  | 42. Dowel Pin  | 66. Inter-Axle Differential Assembly Bolt   | 94. Input Shaft Nut                                     |
| 17. Side Gear (RH)  | 43. Output Shaft                                       | 67. Bolt                                    | 95. Cotter Pin  |
| 18. Side Pinion Thrust Washer   | 44. Output Shaft Bushing                               | 68. Differential Case (Female Half)         | 96. Drain Hole Pipe Plug                                |
| 19. Side Pinion   | 45. Output Shaft "O" Rings                             | 69. Side Pinion Thrust Washer               | 97. Bearing Cap Dowel Bushing                           |
| 20. Spider  | 46. Output Shaft Front Bearing Cup                     | 70. Side Pinion                             | 111. Lockwire Lockouts                                  |
| 21. Side Gear (LH)  | 47. Output Shaft Front Bearing Cone                    | 71. Side Pinion Bushing                     | 112. Air-Operated Lockout Assembly                      |
| 22. Side Gear Thrust Washer (LH)  | 48. Output Shaft Side Gear                             | 72. Spider                                  | 113. Shift Fork and Push Rod Assembly (Air Operated)    |
| 23. Differential Case (LH Half)   | 49. Output Shaft Snap Ring                             | 73. Differential Case (Male Half)           | 114. Vacuum-Operated Lockout Assembly                   |
| 24. Lockwire  | 50. Oil Scraper  | 74. Locknut                                 | 115. Shift Fork and Push Rod Assembly (Vacuum-Operated) |
| 25. Cap Screw   |  | 75. Input Shaft Snap Ring                   |   |
| 26. Differential Bearing Cone (LH)                                      |  | 76. Helical and Differential Side Gear Ring |   |
|   |  | 77. Side Gear Bushings                      |   |
|   |  | 78. Side Gear Thrust Washer                 |   |

- a. To remove the Differential Carrier and Carrier Cover Assemblies: Remove axle shafts. (See "Axle Shaft-Removal, Truck Service Manual"). Remove differential carrier to axle housing nuts and lock washers and, with cover assembly and differential carrier assembly supported in suitable cradle, pull the assembly forward out of housing.
- b. To remove the Differential Carrier Cover Assembly: Remove differential carrier cover bolts and lock washers (fig. 4M). Tap cover to loosen and pull cover assembly from dowels on differential carrier.

## DIFFERENTIAL CARRIER COVER

### Disassembly

If cover assembly and carrier assembly were removed from vehicle as a unit, remove cover-to-carrier bolts and lock washers. Tap cover to loosen and pull cover assembly from dowels on carrier. (Refer to Figure 1M.)

### Input Shaft

1. Remove helical and differential side gear snap ring and lift gear, bronze washer and "D" washer from shaft (fig. 5M). If the lockout shift components have been removed, lift the sliding clutch and the fork and push rod assembly out of cover.

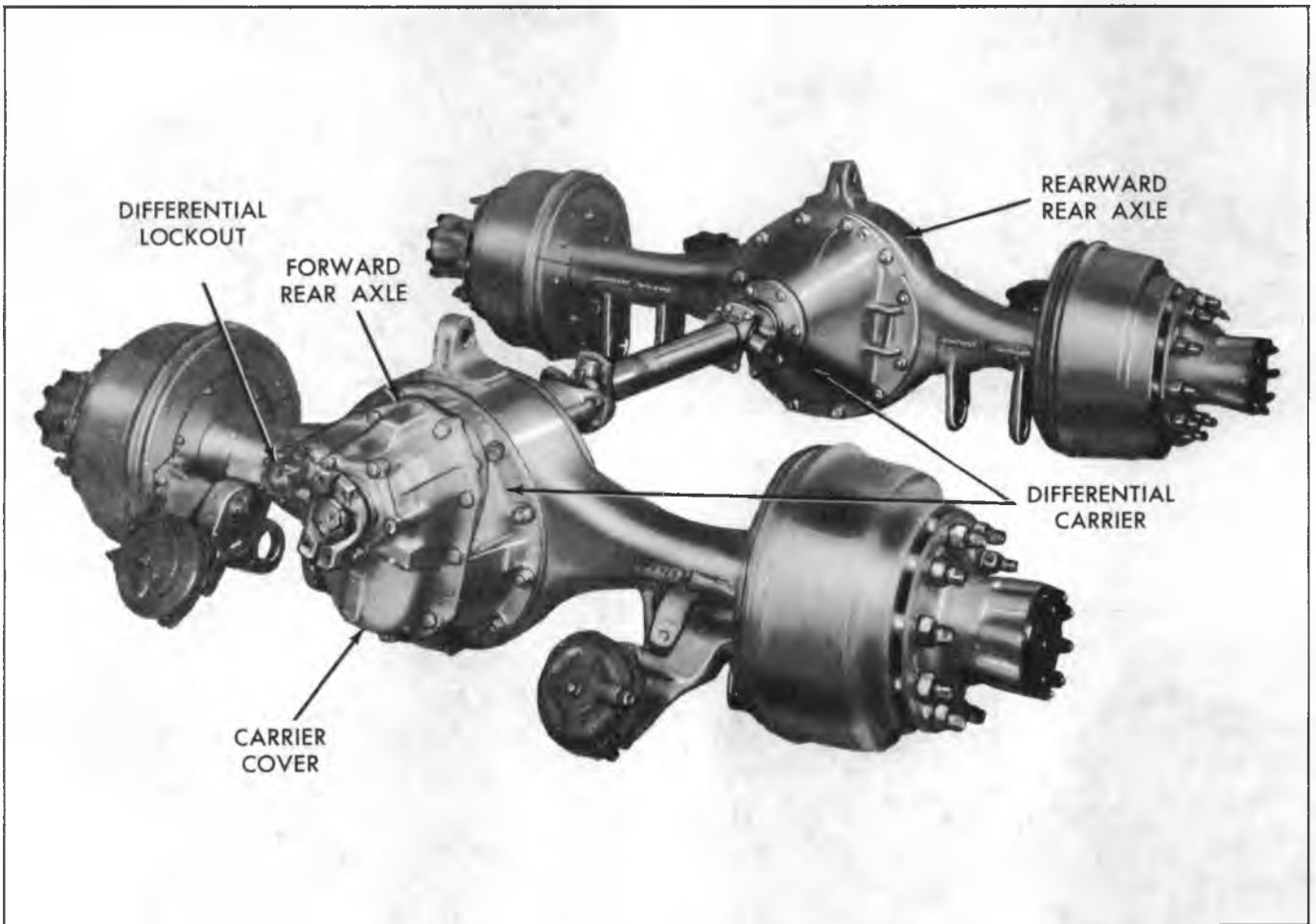


Fig. 2M—Tandem Rear Axles and Power Divider

2. Remove input shaft bearing retainer bolts and lock washers (fig. 6M).
3. Tap end of input shaft to drive bearing out front of differential cover and lift out the input shaft assembly and shims (fig. 6M).
4. If lockout shift components have not been removed, slip the sliding clutch out of shift fork and remove clutch from cover.

**Vacuum Operated Differential Lockout**

1. Remove shift lever boot from shift lever (fig. 7M).
2. Remove lever pivot pin cotter pin and pull pivot pin and lever out of bracket.



Fig. 3M—Removing Input Shaft Flange Nut

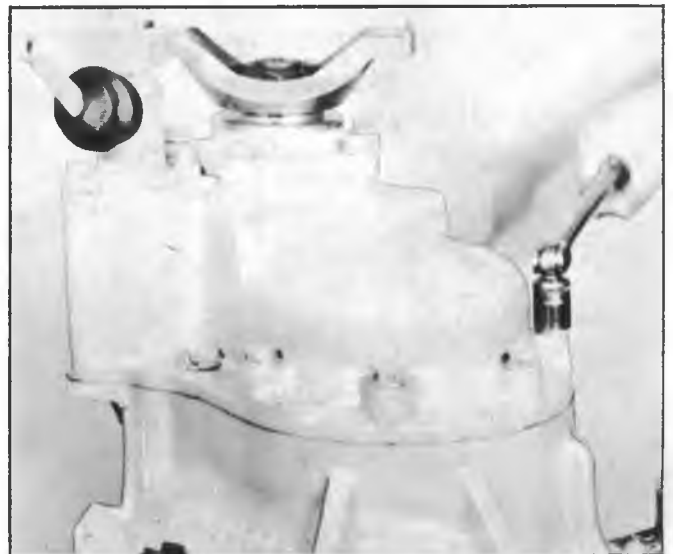


Fig. 4M—Removing Differential Carrier Cover Bolts

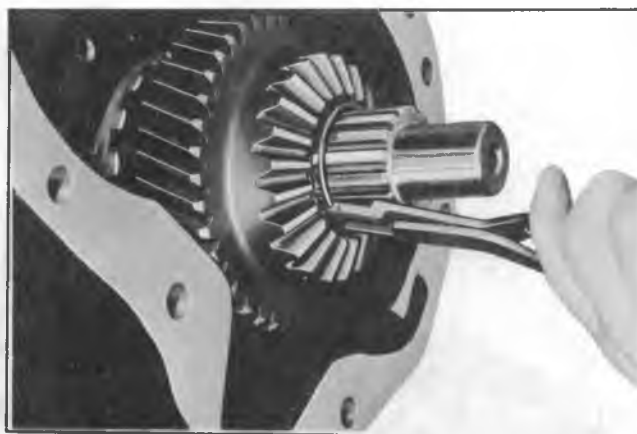
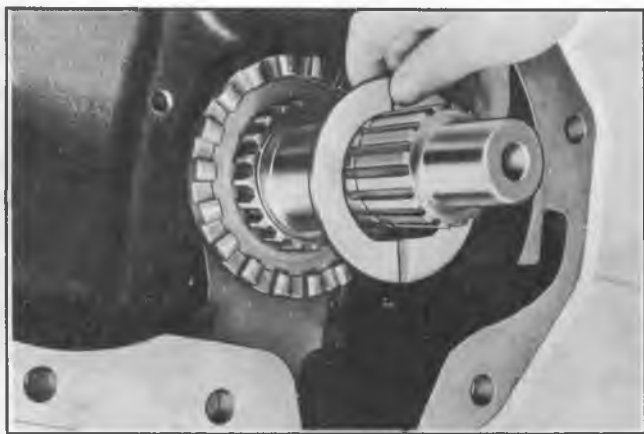


Fig. 5M--Removing Helical and Differential Side Gear and "

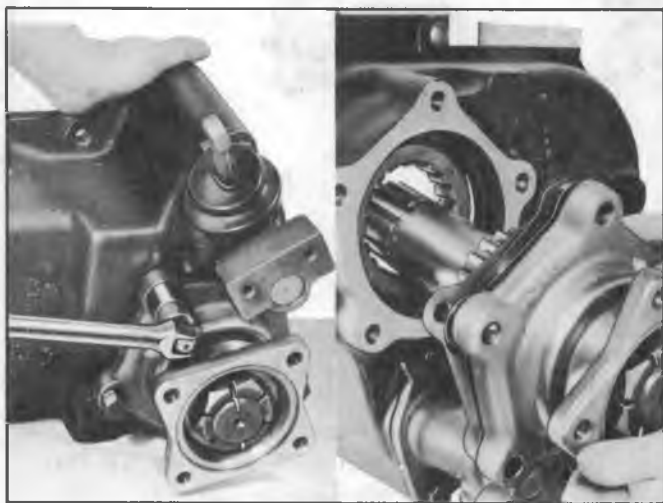


Fig. 6M--Removing Input Shaft Assembly



Fig. 7M--Removing Inter-Axle Lock Out Shift Lever

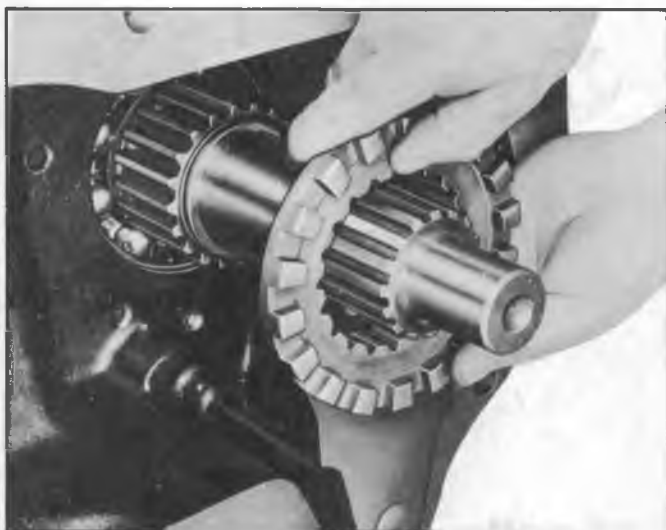


Fig. 8M--Removing Shift Spring, Fork and Clutch



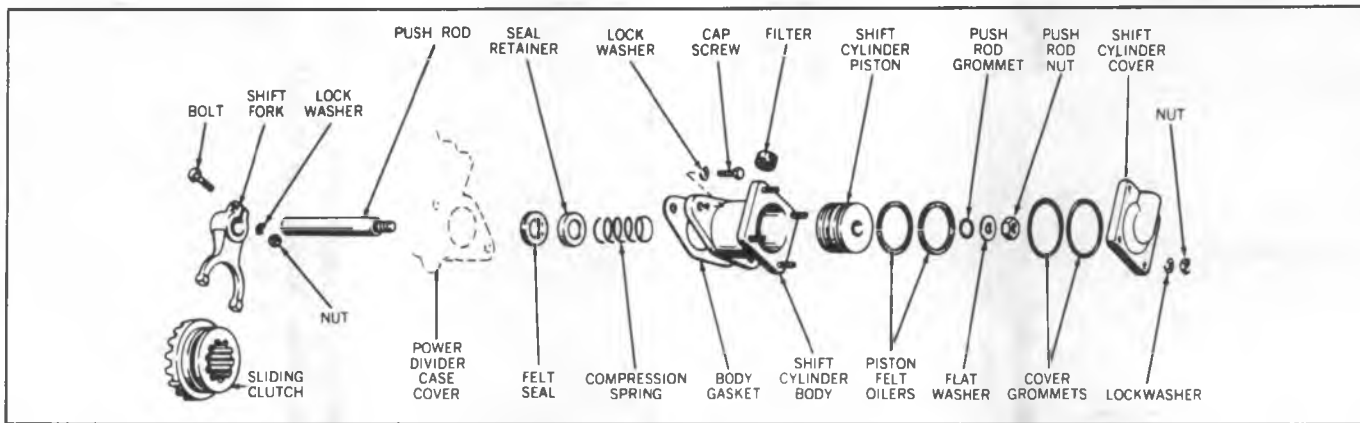


Fig. 9M—Exploded View of Air Operated Differential Lockout

3. Remove two bracket-to-carrier cover bolts and lock washer and remove bracket from carrier cover.
4. Remove retaining pin and washer from push rod and remove spring (fig. 8M).
5. If not previously removed; remove helical and differential side gear snap ring and pull gear, bronze washer and "D" washer from input shaft.
6. Slide shift fork and push rod assembly and sliding clutch out rear of cover (fig. 9M).

**Air Operated Differential Lockout**

*(Refer to Figure 10M)*

1. Remove nuts, lock washers and cover from shift cylinder body. Discard cover grommets. Remove nut, flat washer and grommet from push rod (fig. 11M).
2. Remove cap screws, lock washers, shift cylinder body assembly and gasket from case cover (fig. 12M). Shift cylinder body assembly includes a piston, two felt oilers and a filter.
3. Remove compression spring from push rod (fig. 13M). The push rod is secured to shift fork assembly by a bolt and nut.
4. If not previously removed, remove helical and differential side gear snap ring and gear, bronze washer and "D" washer from input shaft.
5. Slide shaft fork and push rod assembly and sliding clutch out rear of cover (fig. 9M).

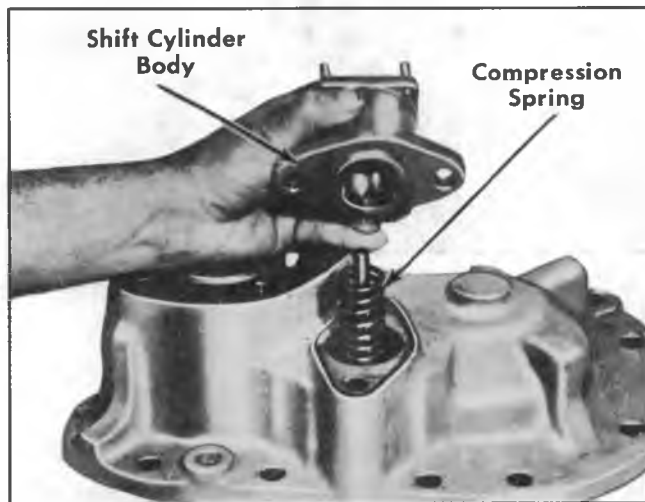


Fig. 11M—Removal or Installation of Air Operated Lockout

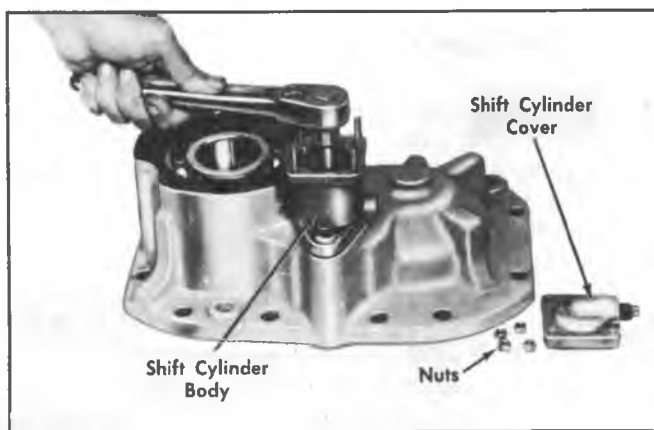


Fig. 10M—Removal or Installation of Air Operated Lockout Piston

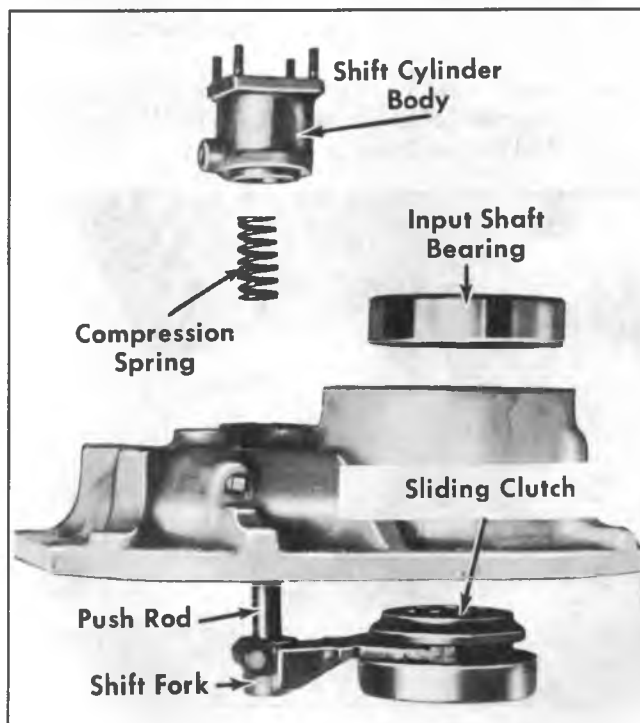


Fig. 12M—Air Operated Lockout Shift Components



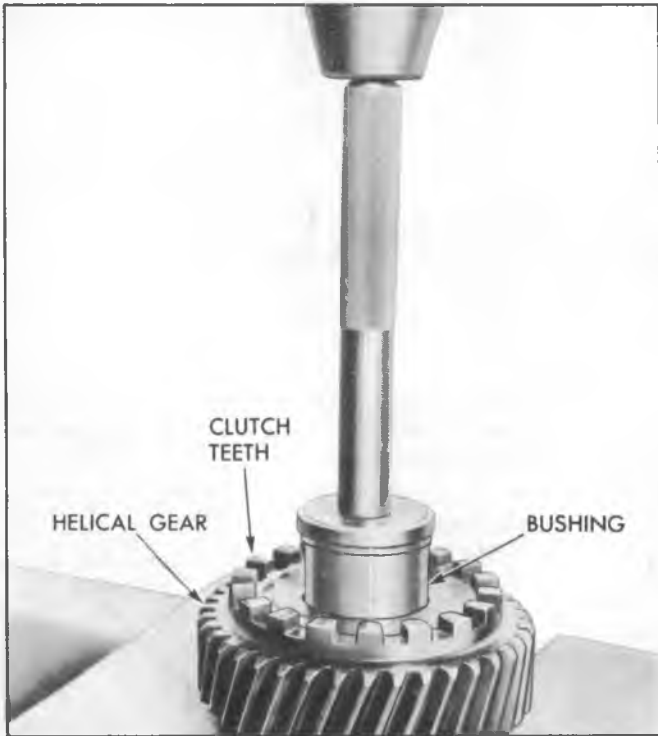


Fig. 13M--Installing Helical and Differential Side Gear Bushing With Tool J-8474

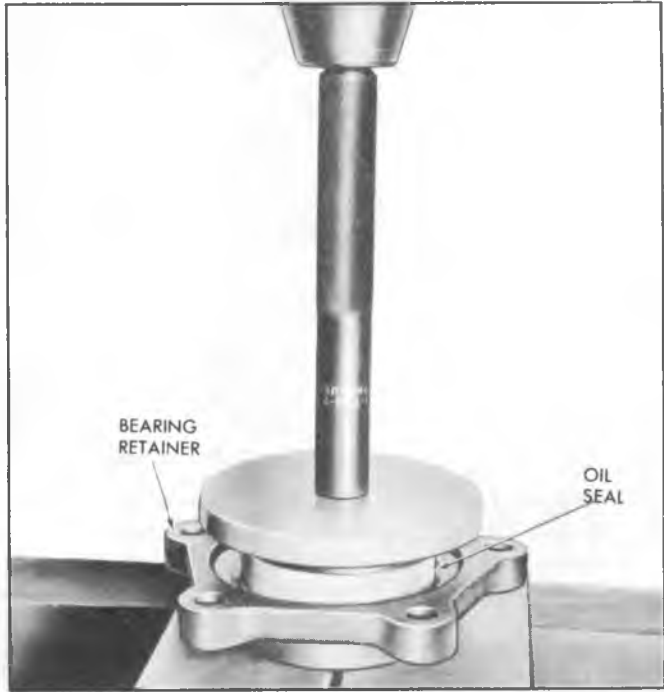


Fig. 15M--Installing Oil Seal in Input Shaft Bearing Retainer With Tool J-8477

**Repairs**

**Helical and Differential Side Gear Bushing**

1. Support face of gear on bed of arbor press, and, using Tool J-8474-2 with driver J-7079-2, press bushings out of gear.
2. Install new bushing on Tool J-8474-2 and start bushing straight in bore, then position Tool J-8474-1 on top of J-8474-2 as follows:
  - a. When installing bushing at clutch teeth end of gear, place side of tool marked "CLUTCH" against Tool J-8474-2 as shown in Figure 14M.

- b. When installing bushing at side gear end of gear, place side of tool marked "SIDE GEAR" against Tool J-8474-2.
3. Insert Driver J-7079-2 through installer tools and, with opposite side of helical gear supported, press bushing into gear until Tool J-8474-1 contacts gear.
4. Remove tool and repeat Steps 2 and 3 for second bushing.

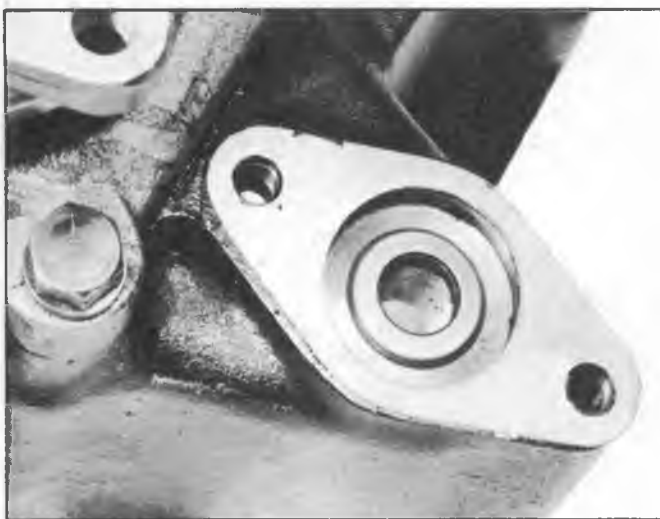


Fig. 14M--Push Rod Oil Seal Installed

**Inter-Axle Shift Fork Push Rod Oil Seal**

1. Pry oil seal out of carrier cover.
2. Start new seal straight in bore in cover and, using 1-1/2" rod, tap seal flush in counterbore in cover (fig. 15M).

**Input Shaft, Bearing, Oil Seal and Bearing Retainer**

1. Remove end nut cotter pin and, with flange held in large vise or suitable tool, remove end nut and pull flange and bearing retainer from shaft, then slide bearing retainer from flange.
2. To replace oil seal in bearing retainer:
  - a. Pry out oil seal.
  - b. Start new oil seal straight in counterbore with lips of seal facing up and, using Tool J-8477 as shown in Figure 16M, press seal into position.
3. To replace bearing or shaft:
  - a. Support bearing on split plates and, using brass rod between threaded end of shaft and ram of press as shown in Figure 17M, press shaft out of bearing.

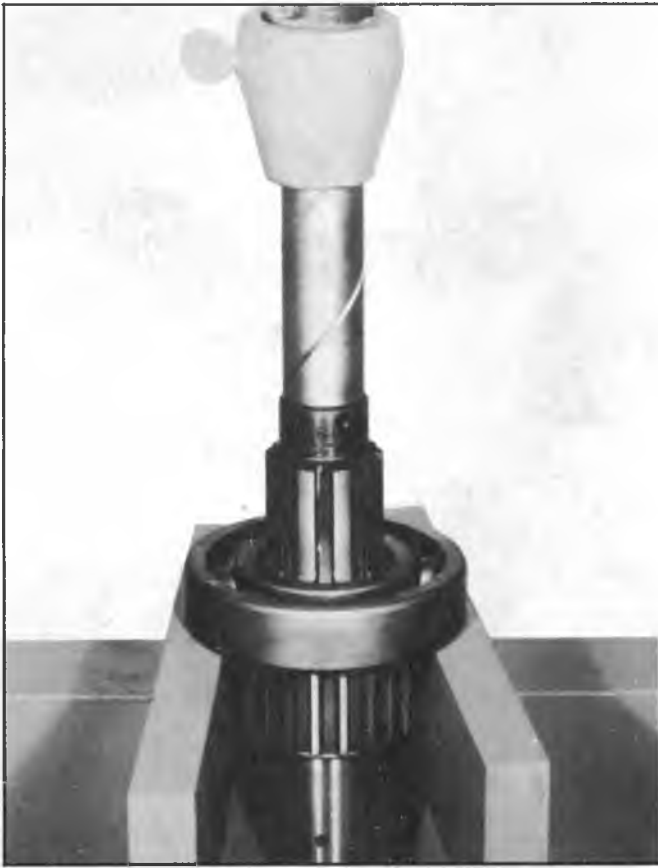


Fig. 16M--Removing Input Shaft Bearing

- b. Start new bearing straight on shaft, support ground end of shaft in press and, using a 2-1/4" I.D. pipe against inner race of bearing, press bearing tight against shoulder on shaft.

**Assembly**

**Vacuum Operated Differential Lockout**

1. If input shaft is not in place, insert push rod through cover and oil seal from rear of cover, being careful to avoid damage to the oil seal.
2. If input shaft is in place, mate shift fork in groove of sliding clutch, start clutch on input shaft and insert



Fig. 17M--Removing Inter-Axle Differential from Carrier

push rod through opening in cover as shown in Figure 8M. Align clutch splines with input shaft splines and slide the clutch and push rod forward into cover.

3. Place spring over end of push rod and install washer against spring, compress spring and install retaining pin through push rod (fig. 8M).
4. Install lever bracket gasket on cover. Position bracket over push rod so opening for lever faces away from center of cover, then rotate bracket slightly so flats on push rod fit into bracket. Align mounting bolt holes and install bolts and lock washer.
5. Insert lever in bracket and into push rod slot so free end of lever points forward. Install pivot pin and cotter pin.
6. Install shift lever boot.

**Air Operated Differential Lockout**

1. If input shaft is not in place, insert push rod through cover and oil seal from rear of cover, being careful to avoid damage to the oil seal.
2. If input shaft is in place, mate shaft fork in groove of sliding clutch, start clutch on input shaft and insert push rod through opening in cover as shown in figure 106. Align clutch splines with input shaft splines and slide the clutch and push rod forward into cover.
3. Place compression spring, gasket and shift cylinder body over push rod and on case cover. Secure body with screws and lock washers.
4. Piston felt oilers should be soaked in SAE-30 oil prior to assembly
5. Install felt oilers and grommet on piston and insert piston assembly in body and on push rod. Place grommet on push rod, then install flat washer and nut.
6. Install cover grommet on cylinder cover, then install cover and secure to cylinder body with nuts and lock washers.

**Input Shaft Assembly**

1. If lockout shift components are installed, mate sliding clutch with shift fork and position clutch (clutch teeth to rear) in line with opening for input shaft.
2. Insert input shaft in cover, locate clutch on splines and start bearing into bore in cover.
3. Position bearing retainer, without shims, over shaft and against cover. Install bolts and tighten bolts just enough to seat bearing in cover.
4. Using feeler gauge, check gap between cover and retainer to determine shim thickness required to seal cover to retainer so bearing will have .001 end-play.
5. Remove retainer, install shims and re-install retainer. Tighten bolts to 80-100 ft. lbs. torque.
6. Start companion flange and slinger on output shaft splines, hold flange from turning and install nut. Tighten nut to 500-700 ft. lbs. torque and install cotter pin.
7. Install "D" washer on rear of input shaft so flat in I.D. of washer rests on flat of shaft (fig. 5M).
8. Install bronze washer in clutch end of helical and differential side gear, install gear on rear of shaft making sure "D" washer remains in position, and install wire snap ring (fig. 5M).

## DIFFERENTIAL CARRIER

### Disassembly

1. Remove unit from vehicle and remove differential carrier cover assembly as outlined previously.
2. Lift inter-axle differential assembly from carrier as shown in Figure 17M.
3. Output shaft, side gear and bearing assembly may be removed as an assembly by tapping end of shaft to bring bearing forward out of carrier (fig. 18M), or output shaft may be removed separately from the side gear and bearing as follows:
  - a. Support output shaft to avoid dropping, remove side gear snap ring from shaft and slide shaft out rear of carrier.
  - b. Install Tool J-8119 inside side gear and, using slide hammer, pull bearing and side gear from carrier.
4. Remove pinion shaft helical gear as follows:
  - a. Remove cotter pin from pinion shaft end nut.
  - b. Block ring gear from turning and remove end nut.
  - c. Using puller J-3493; pull gear from pinion shaft (fig. 19M).
5. Remove Ring Gear and Differential Assembly, and Pinion Assembly in the same manner as outlined under "Single Speed Eaton Rear Axles".



Fig. 18M—Removing Output Shaft Assembly from Carrier

### Repairs

#### Output Shaft, Bushing, Side Gear and Bearing

1. To replace side gear or bearing:
  - a. Remove snap ring retaining side gear to output shaft and lift gear and bearing from shaft.
  - b. Support bearing on split plates and using 2 1/2" O.D. bar against hub of gear, press gear out of bearing as shown in Figure 20M.
  - c. Start new bearing straight on hub of side gear and, with Tool J-6419-6 centered on inner race of bearing, press bearing tight against back of gear.
  - d. Install gear on shaft and install snap ring.
  - e. Tap bearing cup from its seat in differential carrier. Then install new cup making sure it seats firmly and is not cocked in carrier.
2. If rear bearing is to be replaced remove inner race from shaft. Start new bearing inner race straight on shaft and,

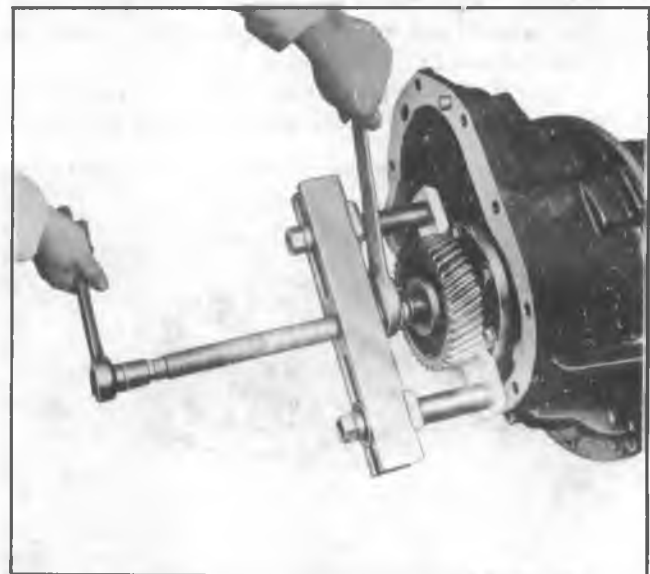


Fig. 19M—Removing Pinion Shaft Helical Gear

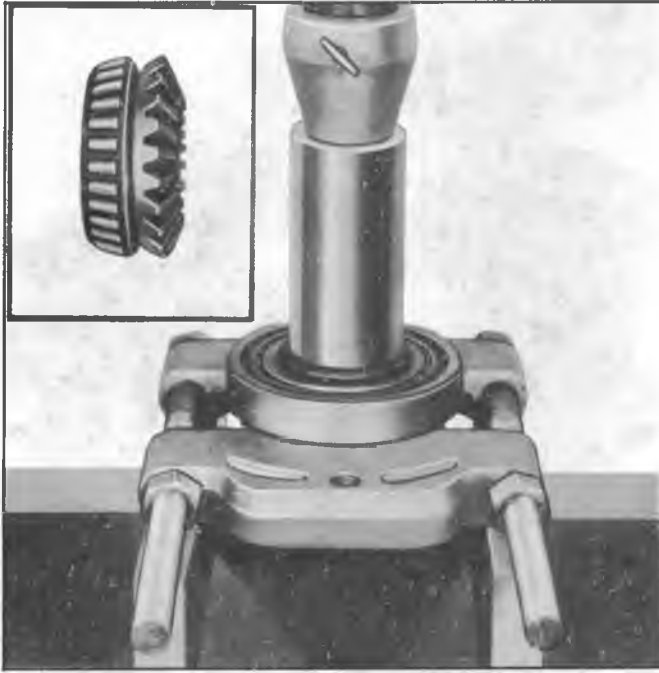


Fig. 20M--Removing Output Shaft Side Gear and Bearing

using Tool J-6419-1 and 2, press race tight against shoulder on shaft (see fig. 29M).

3. To replace bushing, cut old bushing from shaft and using Tool J- 8476 as shown in Figure 21M, press new bushing into shaft until tool bottoms on shaft.
4. Remove output shaft "O" rings and install two new rings.



Fig. 21M--Installing Output Shaft Bushing Using Tool J-8476

## Inter-Axle Differential

(Refer to Figure 1M)

### Disassembly

1. Mark case halves so they can be reassembled in same relative position. Also mark the half against which nuts are installed for easy identification.
2. Cut and remove lockwire from differential case bolt nuts and remove nuts and bolts.
3. Lift one half of case from assembly and separate thrust washers, side pinions, bushings and spider from other half of case.

### Assembly

1. Install bushings on spider journals and install pinions on bushings.
2. Set spider and pinion assembly in one half of case and place other half of case over the assembly so marks made at disassembly are aligned.
3. Install bolts through case halves so nuts will go against case half identified at disassembly. This half has the step, at the mating surface which fits inside the counter-bore of the other half.
4. Install nuts, torque to 50-70 ft. lbs. and install lockwire.

### Pinion Assembly

Repair operations and adjustment procedures for the pinion assembly are the same as outlined under "Single Speed Eaton Rear Axles"--with the following exceptions:

1. Use Tool J-8479 to install bearing cups in cage as shown in Figure 22M.

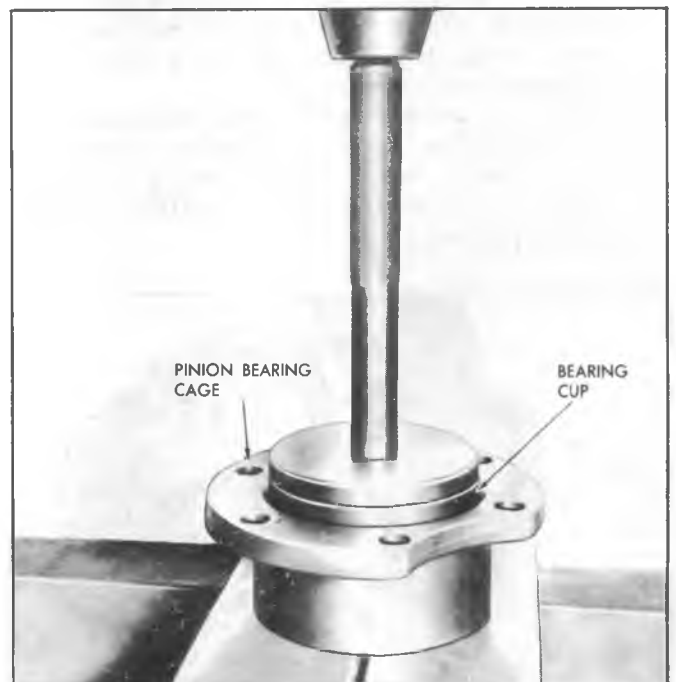


Fig. 22M--Installing Pinion Gage Bearing Cup with Tool J-8479

## 4-40 REAR AXLE DIFFERENTIAL CARRIER



Fig. 23M—Installing Pinion Shaft Helical Gear

2. No felt, oil seal, cork seal or seal retainer is used and a helical gear is used in place of the flange. The helical gear and the end nut are installed after the bearing cage is bolted to the carrier. To install the helical gear:
  - a. Start gear straight on pinion shaft and tap onto splines as shown in Figure 23M, just far enough so end nut can pick up threads.
  - b. Install end nut and tighten to draw helical gear against bearing (fig. 24M). Tighten end nut to 500-700 ft. lbs. torque.

### Ring Gear and Differential Assembly

Repair operations and service procedures for the ring gear and differential assembly are the same as outlined under "Single Speed Eaton Rear Axles" and "Rear Axle Adjustments (Eaton Axles)".

### Assembly

1. Install pinion assembly and ring gear and differential assembly as outlined under "Single Speed Eaton Rear Axles" using helical gear instead of flange (see "Repairs--Pinion Assembly").
2. If side gear and bearing were removed, assemble to output shaft as outlined under "Repairs". Insert end of output shaft in carrier and start bearing straight in counterbore (fig. 25M). Using Tool J-0358 press bearing into position.

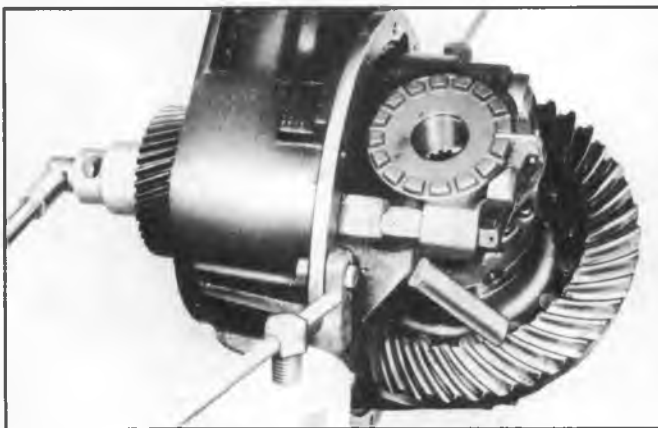


Fig. 24M—Installing Pinion Shaft End Nut



Fig. 25M—Installing Output Shaft Assembly

3. If side gear and bearing were not removed from carrier, insert output shaft through side gear from rear of carrier and install side gear snap ring in shaft. Install inter-axle differential assembly on side gear so case nuts face toward front (fig. 17M).

## FORWARD AXLE HOUSING COVER

### Output Shaft Bearing and/or Oil Seal

#### Replacement

Refer to Figure 30M.

1. Disconnect propeller shaft from output flange.
2. Remove flange nut cotter pin, hold flange from turning and remove nut and washer.
3. Pull flange from shaft and remove bearing retainer washer.
4. If oil seal only is to be replaced, remove oil seal, clean the counterbore and start new seal, then, using Tool J-6419-1 as shown in Figure 26M drive seal into bottom of counterbore.
5. If bearing is to be replaced, remove cover from housing, remove oil seal and replace bearing as follows:
  - a. Remove snap ring retaining bearing in cover as shown in Figure 27M, and tap bearing out rear of cover.





Fig. 26M--Installing Output Shaft Oil Seal Using Tool J-6419-1

- b. Start new bearing straight in counterbore in cover and using Tool J-6419-4, tap bearing into bottom counterbore as shown in Figure 28M. Install snap ring in cover.
  - c. Remove bearing inner race from output shaft using suitable tool. Start new bearing inner race straight on shaft and, using Tool J-6419-1 and -2 as shown in Figure 29M, install race tight against shoulder on shaft.
  - d. Install new oil seal (Step 4), and install cover.
6. Slide bearing spacer on output shaft, start flange on shaft and install washer and nut. Tighten nut to 225-240 ft. lbs. and install cotter pin.

**NOTE:** This propeller shaft to pinion flange fastener is an important attaching part in that it could affect the performance of vital components and systems, and/or could result in major repair expense. It must be replaced with one of the same part number or with an equivalent part if replacement becomes



Fig. 27M--Removing Output Shaft Bearing Snap Ring



Fig. 28M--Installing Output Shaft Bearing in Cover Using Tool J-6419-1 and -4

necessary. Do not use a replacement part of lesser quality or substitute design. Torque values must be used as specified during reassembly to assure proper retention of this part.

7. Install propeller shaft.

## REAR AXLE ADJUSTMENTS (EATON AXLES)

### Pinion Bearing Pre-Load

Pinion bearings must be adjusted for pre-load before assembly is installed in carrier. Refer to respective axle "Specifications" for bearing preload.

Since installation of oil seal would produce false rotating torque the seal should not be installed until after adjustment is completed.



Fig. 29M--Installing Output Shaft Bearing Race With Tool J-6419-1 and -2

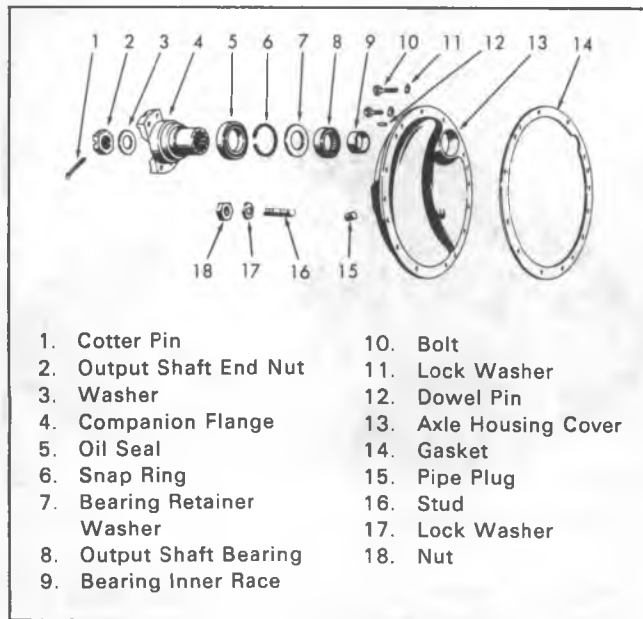


Fig. 30M—Axle Housing Cover Details

1. With pinion bearings, and adjusting spacers installed in cage, rotate the cage several revolutions to assure normal bearing contact.
2. Place assembly in arbor press and apply pressure to outer bearing.
  - a. 18,500 lb. axle 15,000 lbs.
  - b. 23,000 lb. axle 19,000 lbs.
3. Wrap soft wire around cage and pull on horizontal line with a spring scale (fig. 31M). Rotating (not starting) torque should be within limits given in "Rear Axle Specifications". If not within limits, replace the spacer with one of a different thickness.
4. If press is not available, pre-load torque can also be checked by installing pinion drive flange, washer, and nut. Tighten nut to recommended torque (see "Rear Axle Specifications"); then check as previously explained. Remove drive flange after correct adjustment is obtained.

**NOTE:** On tandem Forward Axle the helical gear takes the place of the drive flange.

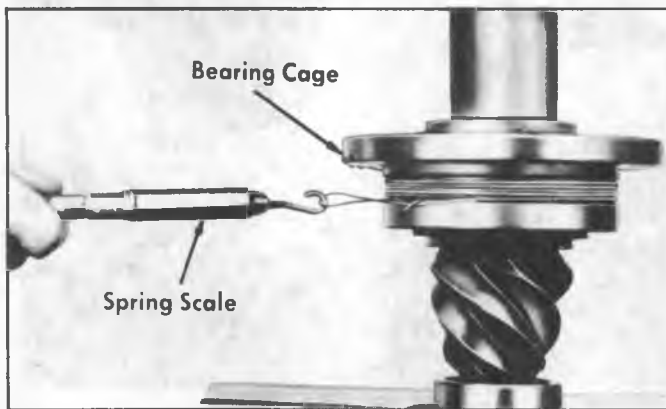


Fig. 31M—Checking Pinion Bearing Pre-Load

**NOTE:** Method of determining inch lbs. torque with scale is to divide diameter of cage by 2 in order to determine radius. Multiply radius in inches by lbs. pull required to rotate cage to determine inch lbs. torque. Example: An 8-inch diameter divided by 2 equals 4-inch radius, multiply 4-inch (radius) by 5 lbs. (pull) equals 20-inch lbs. torque.

### Gear Backlash

Pinion and ring gears that have been in service for extensive periods form running contacts due to wear of teeth; therefore the original shim pack (between pinion cage and carrier) should be maintained when checking backlash. In the event backlash exceeds maximum tolerance shown in "Axle Specifications." Reduce backlash only in the amount that will avoid overlap of worn tooth section. Smoothness and roughness can be noted by rotating ring gear.

If a slight overlap takes place at worn tooth section, rotation will be rough.

If new gears are installed, check backlash with dial indicator. Figure 32M, illustrates typical method of checking backlash.

Backlash is increased by moving ring gear away from pinion, and is decreased by moving ring gear towards pinion.

Backlash is accomplished at differential bearing adjusting nuts. Keep in mind that when one nut is tightened the opposite nut must be loosened an equal amount to maintain previously established bearing adjustment.

### Gear Tooth Contact (Red Lead Method)

Gear tooth contact cannot be successfully accomplished until pinion and ring gear bearings are in proper adjustment and gear backlash is within limits given in "Specifications" section for respective axle.

Check for proper tooth contact by painting a few teeth of ring gear with oiled red lead. Turn pinion in direction of normal rotation, then note tooth impression on ring gear.



Fig. 32M—Checking Backlash

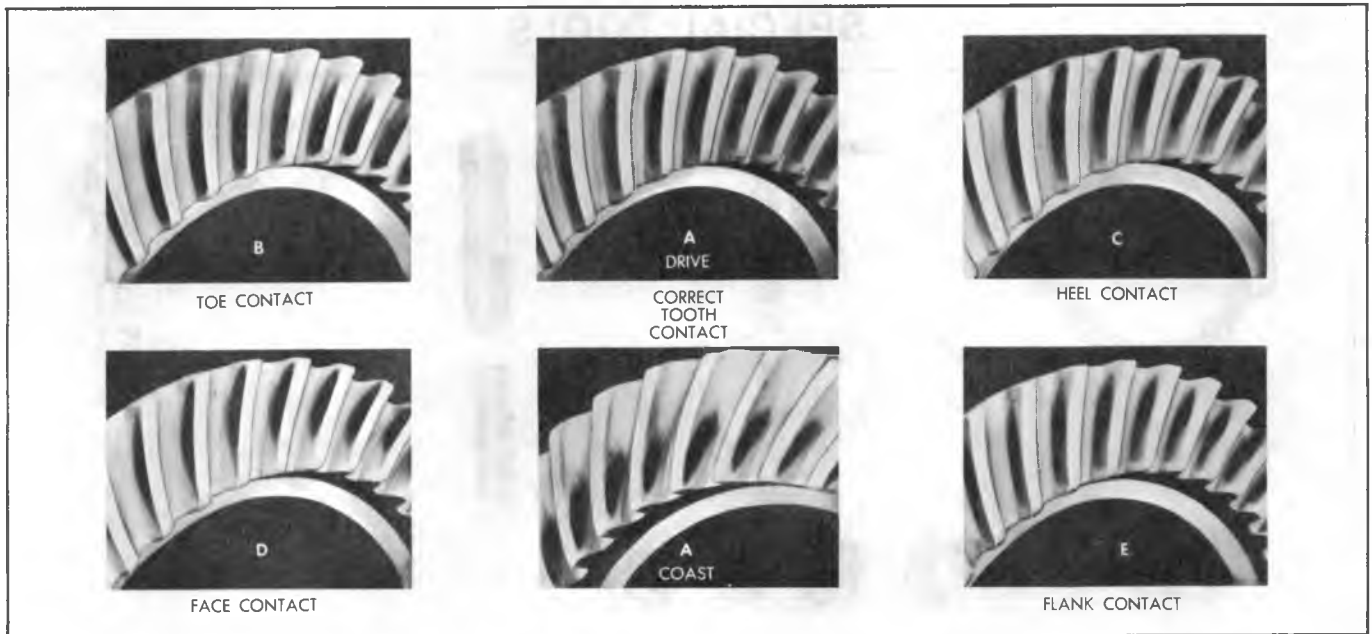


Fig. 33M—Gear Tooth Contact Patterns

Inspect the contact pattern produced by the following procedure. Figure 33M shows correct and incorrect contact patterns.

Figure 34M shows the terminology used in analyzing contact patterns. The large end of the tooth is called the "heel" and the small end the "toe". Also, the top of the tooth, which is the part above the pitch line, is called the "face", while the part below the pitch line is called the "flank". The space between the meshed teeth is referred to as "backlash".

Tooth pattern "A" (fig. 33M) provides the ideal pattern for quietness and long life. If the pattern shows a toe contact "B", it indicates not enough backlash. To correct, move the ring gear away from the pinion by loosening left-hand differential bearing adjusting nut and tightening right-hand adjusting nut.

**NOTE: Make adjustment one notch at a time, repeat check with red lead and continue adjustment until tooth contact appears in "A". Backlash must remain within limits.**

If the pattern shows a heel contact "C", it indicates too much backlash. Make correction as for "B", however, loosen right hand differential adjusting nut and tighten left hand adjusting nut to move ring gear toward pinion. Backlash must remain within limits.

If the pattern shows a high face contact "D", it indicates that the pinion is not set deep enough into the carrier.

To correct a pattern such as in "D", it will be necessary to reduce the thickness of the pinion shim pack. Removal of the thinnest shim in the pack is recommended as a starting point. Further shim changes may be necessary to obtain the correct setting.

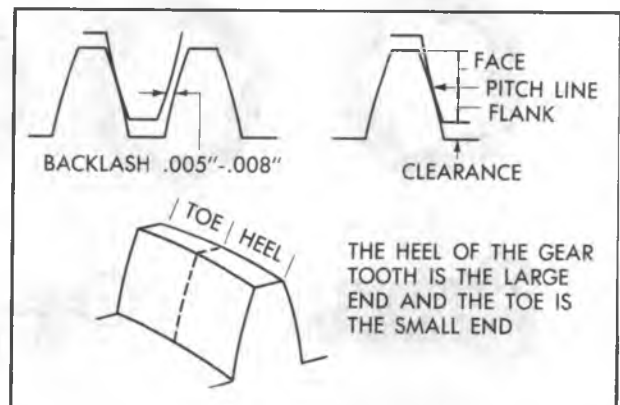


Fig. 34M—Gear Tooth Nomenclature

If the pattern shows a flank contact "E", it indicates that the pinion is set too deep into the carrier. To correct, add a .003" shim to the pinion shim pack and a recheck contact pattern. Additional shim changes may be necessary to obtain the correct pattern.

In making pinion adjustments, be sure backlash is correct before retesting with red lead for tooth pattern. Moving the pinion in reduces backlash and moving it out increases it.

**NOTE: When proper tooth contact is obtained, wipe red lead from gears and carrier with cloth moistened in cleaning solvent.**

Pour a liberal quantity of rear axle lubricant on gears and bearings and revolve gears to distribute lubricant to all surfaces.

## SPECIAL TOOLS

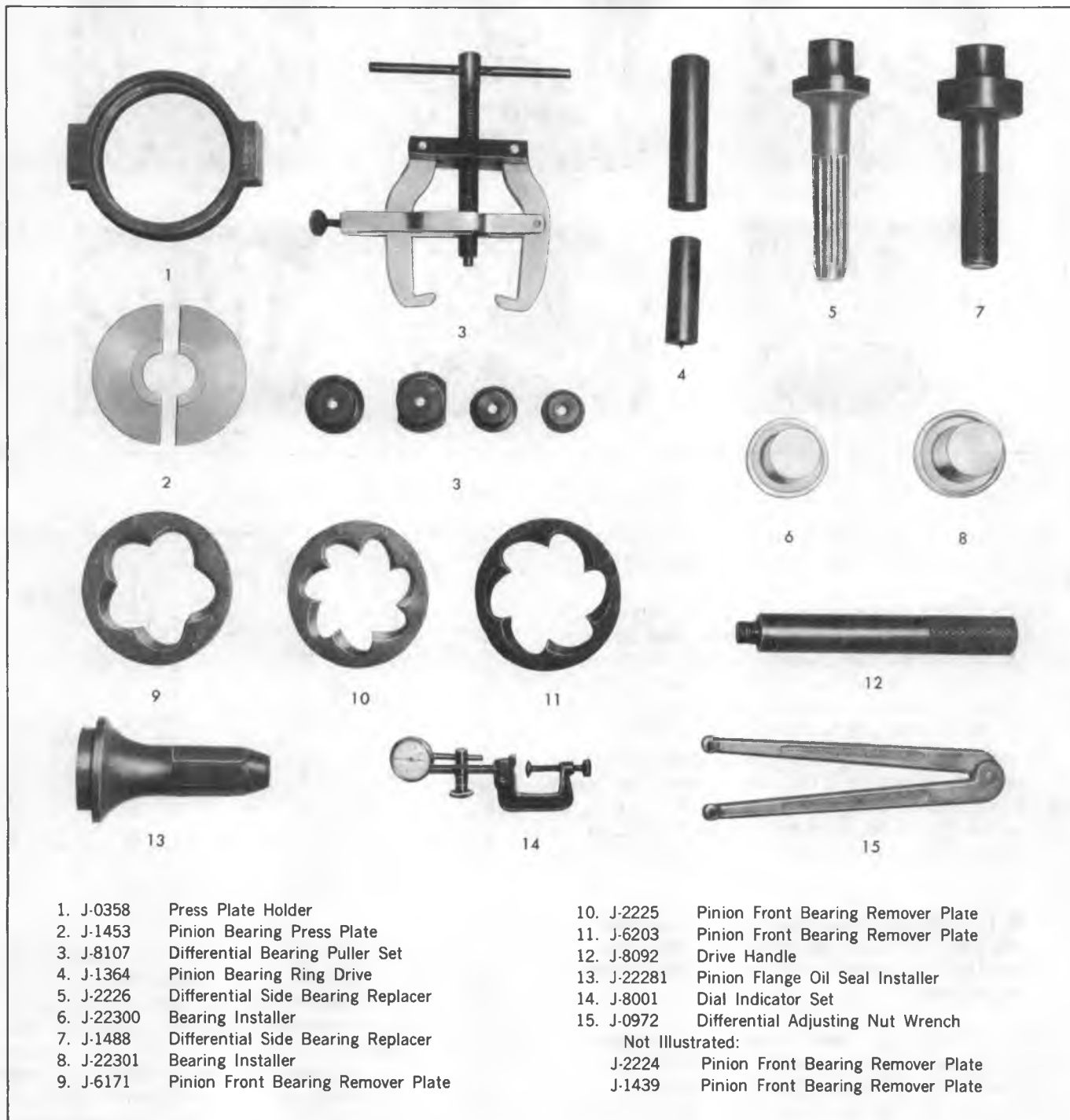


Fig. 1T—Special Tools, 11,000 Through 17000 Lb. Capacity Single Speed

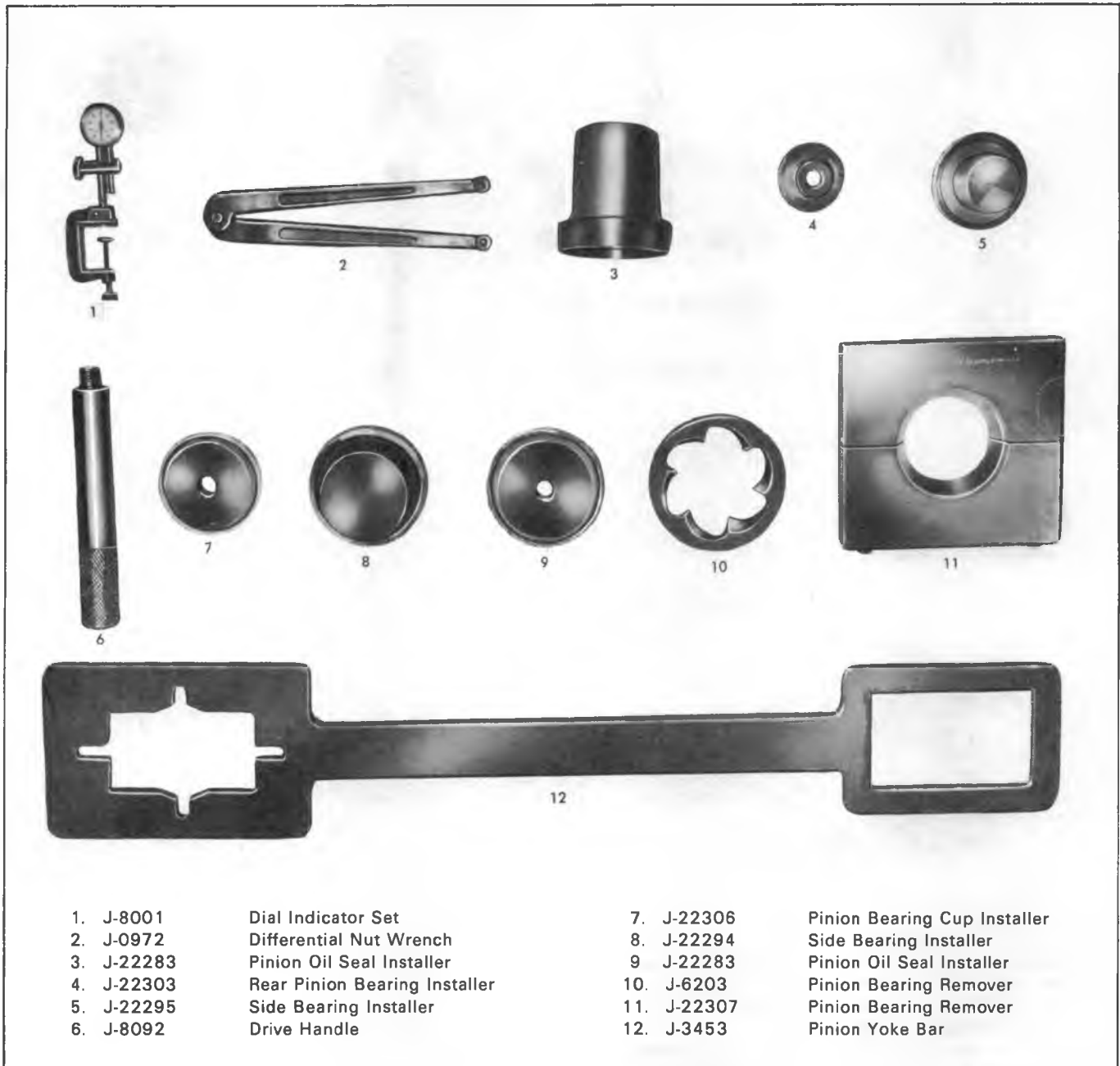
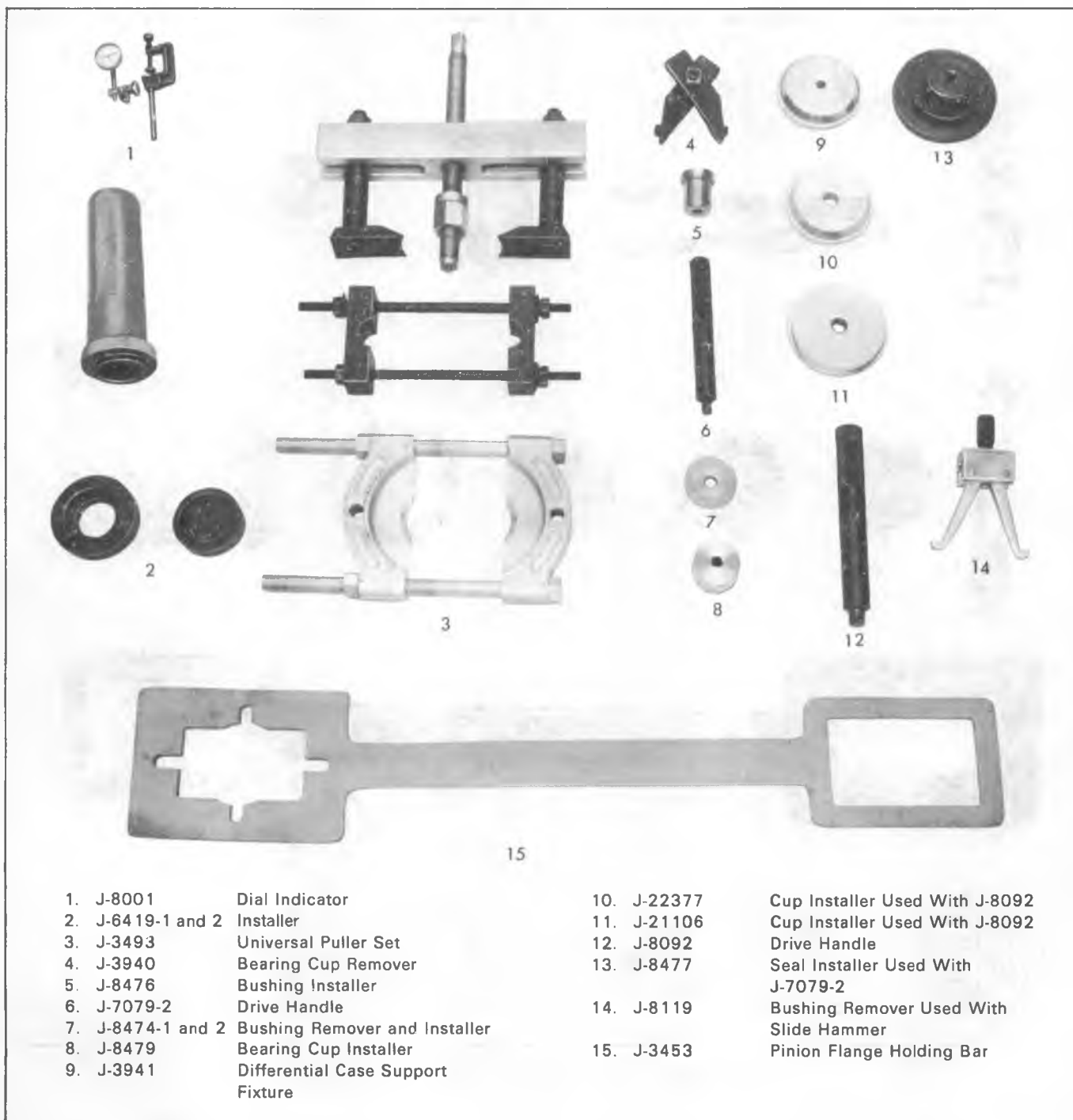


Fig. 2T-Special Tools-15000 and 17000 Lb. Two-Speed





- |                   |                                   |             |  |
|-------------------|-----------------------------------|-------------|--|
| 1. J-8001         | Dial Indicator                    | 10. J-22377 | Cup Installer Used With J-8092         |
| 2. J-6419-1 and 2 | Installer                         | 11. J-21106 | Cup Installer Used With J-8092         |
| 3. J-3493         | Universal Puller Set              | 12. J-8092  | Drive Handle                           |
| 4. J-3940         | Bearing Cup Remover               | 13. J-8477  | Seal Installer Used With J-7079-2      |
| 5. J-8476         | Bushing Installer                 | 14. J-8119  | Bushing Remover Used With Slide Hammer |
| 6. J-7079-2       | Drive Handle                      | 15. J-3453  | Pinion Flange Holding Bar              |
| 7. J-8474-1 and 2 | Bushing Remover and Installer     |             |  |
| 8. J-8479         | Bearing Cup Installer             |             |  |
| 9. J-3941         | Differential Case Support Fixture |             |  |

Fig. 3T-Eaton Special Tools

## SECTION 5

# BRAKE COMPONENTS

### CONTENTS OF THIS SECTION

Bendix Single Diaphragm Type Hydrovac .....	5-1
Bendix Tandem Diaphragm Type Hydrovac .....	5-4
Air Compressor and Governor .....	5-7

## BENDIX

# SINGLE DIAPHRAGM TYPE HYDROVAC

### INDEX

Disassembly .....	5-2
Cleaning and Inspection .....	5-3
Assembly .....	5-3

## DESCRIPTION AND OPERATION

The Single Diaphragm Hydrovac is a self contained vacuum hydraulic power brake unit for use on a vehicle with a vacuum source such as the intake manifold of the conventional four-cycle gasoline engine (fig. 1D). The Hydrovac consists of three basic elements:

1. A **vacuum power chamber** which consists of a power diaphragm and a push rod that connects the power diaphragm to the hydraulic piston.
2. A **hydraulic (slave) cylinder** which contains a hydraulic piston with a drilled passage to permit the filling of the hydraulic cylinder and return of the fluid to the master cylinder upon release of the brakes.

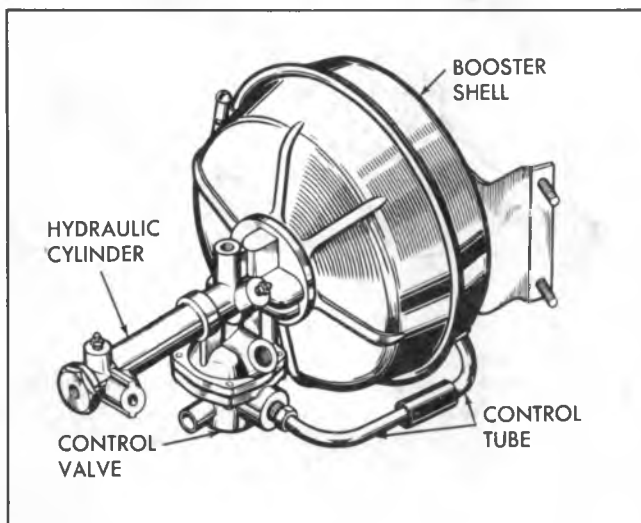


Fig. 1D-Bendix Single Diaphragm Hydrovac

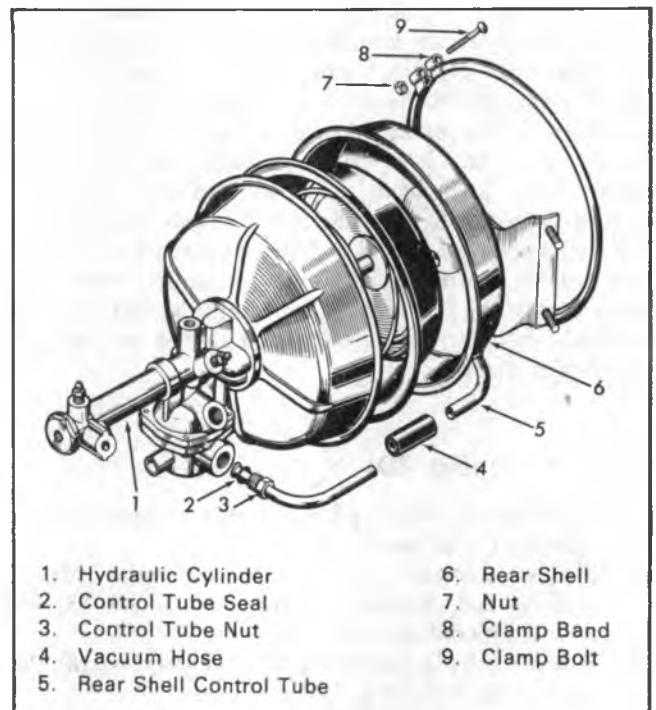


Fig. 2D-Removal of Control Tube, Clamp Band, Rear Shell and Diaphragm

3. A **vacuum control valve** built integral with the hydraulic cylinder which controls the power output of the vacuum power chamber in accordance with the hydraulic pressure developed within the vehicle master cylinder.

## 5-2 POWER BRAKE CYLINDER

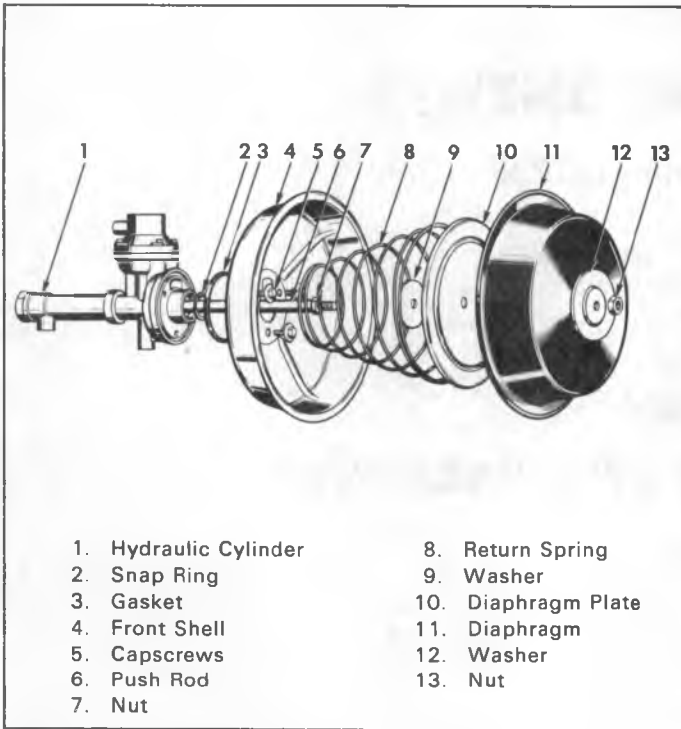


Fig. 3D--Removal of Diaphragm, Spring, Front Shell and Gasket

The Hydrovac is attached to the vehicle frame by means of a mounting bracket attached to the power chamber shell and a mounting pad boss on the side of the hydraulic cylinder. The vacuum inlet port of the vacuum control valve is connected to the intake manifold or other vacuum source through a vacuum check valve. The atmospheric port in the control valve is connected to an air cleaner installed in a location protected from road dirt and splash. The hydraulic line from the brake master cylinder is attached to the fluid inlet port on top of the Hydrovac hydraulic cylinder. The outlet port of the Hydrovac is located in the end cap of the hydraulic cylinder and is connected to the vehicle brake wheel cylinders.

### Disassembly (Fig. 2D)

1. Scribe across front and rear shells. Clamp hydraulic cylinder (1) in bench vise.
2. Slide vacuum hose (4) on control tube toward hydraulic cylinder end. Remove control tube and nut (3) with hose from control valve body.
3. Remove nut (7), clamp bolt (9) and clamp ring (8), then remove rear shell (6).

### Diaphragm, Spring and Front Shell (Fig. 3D)

1. With hydraulic cylinder held securely in vise in a horizontal position, press in on diaphragm (11) and plate (10) to compress diaphragm return spring.
2. Turn rim of diaphragm back and, still maintaining pressure with your stomach, use both hands and snap ring

pliers to remove snap ring (2) from groove inside bore of cylinder (1).

**CAUTION:** After snap ring is free lay pliers aside and use both hands to pull complete assembly of diaphragm, spring, push rod and piston parts straight out of cylinder. If necessary to replace diaphragm or other parts (6 through 13), use open end wrench on nut (7) and remove nut (13), washer (12), diaphragm (11), plate (10), washer (9), return spring (8), nut (7). Remove three capscrews (5) and lift front shell (4) off flange of cylinder. Remove rubber gasket (3) from groove in flange of hydraulic cylinder.

### Push Rod and Piston (Fig. 4D)

1. Working on clean bench, remove piston parts (2 through 12) from push rod (8) off piston end of push rod.
2. Slide retainer ring (12) out of groove in piston (10) and separate piston from push rod (8) by removing retainer pin (11).
3. With ice pick or thin-bladed screwdriver, remove cup (9) from piston. Slide seal retainer (2), push rod seal cup (3), push rod bearing (4), stop washer (6) and snap ring (7) off piston end of push rod.
4. Remove "O" ring seal (5) from bearing groove.
5. If necessary to replace push rod seal (13) located in end of push rod, grip seal with pliers and pull it from end of push rod. Discard seal.

### Control Valve (Fig. 5D)

1. Scribe across flanges of control valve body (12) and hydraulic cylinder housing (3).

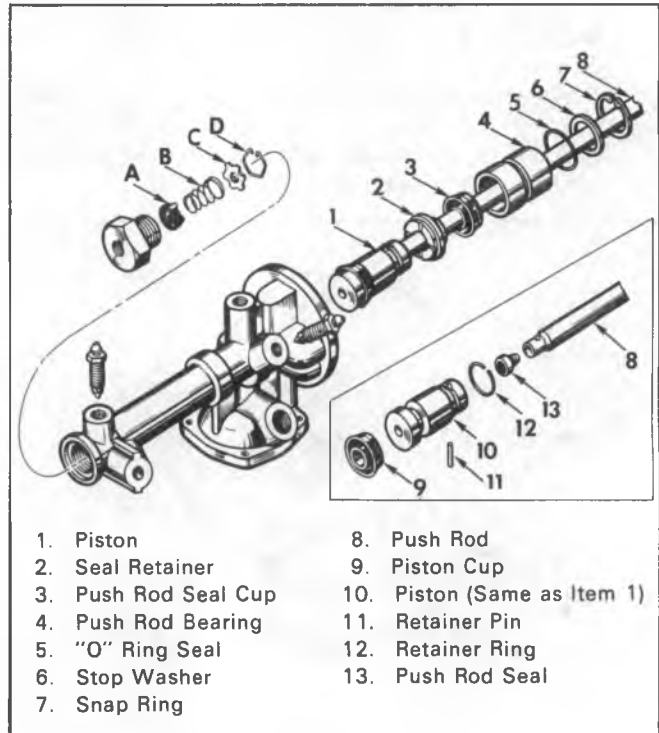


Fig. 4D-- Disassembly of Push Rod and Piston

- Remove four capscrews (13) and lift off valve body and spring (9).
- Remove washer (8), diaphragm (7), washer (6), and cup (4) from valve piston (5).
- Using screwdriver, carefully pry off plastic valve body cover (16).
- Pry off plastic retainer (1st stage poppet) (15), lift off atmospheric (2nd stage) poppet (14) and then remove vacuum poppet and stem (10) and poppet spring (11) from valve body (12).
- Using 1-3/8" wrench, remove end cap (1) and gasket (2).
- To disassemble residual pressure check valve (if used) contained in end cap, use pliers or screwdriver to lift snap ring (D) from groove inside end cap. Remove spring retainer (C) spring (B) and residual pressure check valve (A).

### Cleaning and Inspection

Thoroughly clean all metal parts in Bendix Metalclene or equivalent. After cleaning, rewash all hydraulic system parts in clean isopropyl alcohol or equivalent before reassembly. Inspect all parts for excessive wear or damage. Replace worn or damaged parts. Inspect control valve body atmospheric valve seat. If damaged, replace housing. Always use the correct repair kit when overhauling unit.

### Assembly (Fig. 4D)

#### Piston and Push Rod

- To install a new push rod seal (13) in push rod (8), place new seal (Rubber side down) on a clean block of wood.
- Hold push rod vertically (threaded end up) with drilled end of rod resting on shaft end of seal and then strike threaded end of push rod with soft hammer to seat seal with its shoulder firmly against end of push rod.
- Dip cup (9) in brake fluid and assemble cup on piston (10) with lip of cup as shown.
- Install piston parts (2 through 12) on push rod from seal end of push rod in order shown.
- Slide snap ring (7), stop washer (6), bearing (4) with "O" ring (5) installed in bearing groove, push rod seal cup (3), seal retainer (2), retainer ring (12) and piston assembly (1) on push rod.
- Assemble retainer pin (11) through holes in piston and rod. Secure pin in place with retainer ring (12), making certain ring is seated in groove on piston.

#### Front Shell Assembly to Piston (Fig. 3-D)

- Place new gasket (3) in groove on flange of hydraulic cylinder (1).
- Assemble front shell (4) to cylinder, aligning cut-out in shell with porting in cylinder flange.
- Assemble capscrew and tighten to 130-230 in. lbs.
- If diaphragm, plate and return spring were disassembled, install nut (7) (if nut is undercut, install undercut side first) and tighten to 160-200 in. lbs.,

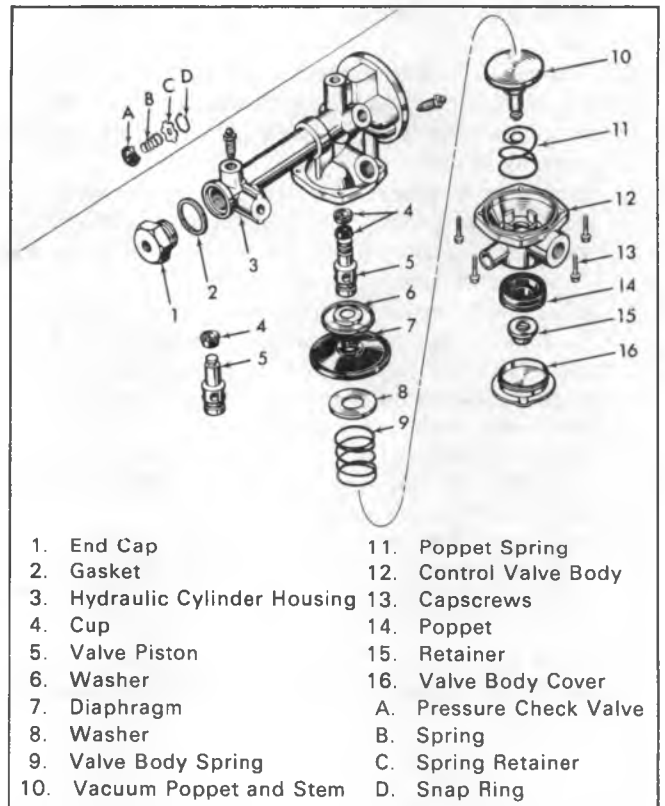


Fig. 5D--Removal and Disassembly of Control Valve

then washer (9), diaphragm plate (10), concave side first, on threaded end of push rod.

- Install diaphragm (11), washer (12) and nut (13) on push rod, as shown, and securely tighten nuts (7 and 13) to 160-200 in. lbs.
- Coat hydraulic cylinder bore with clean brake fluid. Dip hydraulic piston and bearing parts in clean brake fluid. Slide diaphragm return spring (8) onto push rod large diameter of spring first, over hydraulic piston end.
- Seat spring against concave surface of diaphragm plate (10) and align entire assembly with hydraulic cylinder bore.
- Carefully insert hydraulic piston assembly, retainer, seal and bearing in cylinder bore. Press against diaphragm and plate to compress return spring and seat stop washer against bearing inside bore and then, using snap ring pliers, install snap ring (2) securely in groove in cylinder bore.

**WARNING:** Make sure snap ring is seated all the way around its groove before releasing pressure against return spring.

#### Control Valve (Fig. 5D)

- Assemble cup (4) facing up on control valve piston (5), as shown. If two cups are used, install them on piston back to back. Then assemble piston, washer (6) and

## 5-4 POWER BRAKE CYLINDER

- diaphragm (7) and seat inner bead of diaphragm in piston groove.
2. Lay piston and diaphragm assembly aside. Assemble poppet return spring (11), vacuum poppet (10) and atmospheric poppet (14) in valve body (12) from opposite sides, as shown.
  3. Snap poppet retainer (15) over end of vacuum poppet stem. (Set valve body with vacuum poppet down on 1" wooden cube and tap retainer with soft hammer until it snaps onto stem of vacuum poppet).
  4. Assemble cover (16) securely in groove of valve body. Assemble spring retainer washer (8) and spring (9) on end of control valve piston, from end shown. Insert control valve piston, diaphragm and spring assembly in valve body with spring around bosses.
  5. Press outer bead of diaphragm into valve body groove and, while holding spring compressed, dip piston and cup(s) in clean brake fluid.
  6. Align valve body to scribe marks and assemble control valve piston carefully in its bore below hydraulic cylinder bore. Secure valve body with four capscrews (13).
  7. Tighten screws to 40-60 in. lbs. Install check valve (A), spring (B), retainer (C) and snap ring (D) in end fitting

(1). Install fitting and gasket (2) on end of hydraulic cylinder and tighten fitting to 50-85 ft. lbs. If removed, install bleed screw(s), tighten to 10-15 ft. lbs.

### *Rear Shell, Control Tube, Hose (Fig. 2D)*

1. Coat bead of diaphragm or flanges of front and rear shells with talcum powder or equivalent and place rear shell (6) on diaphragm.
2. Align scribe marks on both shells. Make certain bead of diaphragm is seated in outer flanges of both shells and hold rear shell in position while assembling clamp band (8) over flanges of shells and bead of diaphragm. Position opening in band 45 degrees off vertical center line of Hydrovac on side away from mounting bracket.
3. Squeeze ends of band together and assemble bolt (9) and nut (7). Tap band lightly with soft hammer while tightening bolt to seat band securely on shells. After tapping, re-tighten to 40-60 in. lbs.
4. Place new seal (2) on control tube (3), as shown, and assemble hose (4) to tube (5) of rear shell and to control tube. Attach tube and nut (3) to control valve body port. Securely tighten to 7-10 ft. lbs.

## BENDIX

### TANDEM DIAPHRAGM TYPE HYDROVAC

#### INDEX

Disassembly .....	5-4
Cleaning and Inspection .....	5-6
Assembly .....	5-6

#### Disassembly

##### *Control Tube, Rear Shell, Center Shell (Fig. 6-D)*

1. Scribe across shells and clamp bands. Clamp hydraulic cylinder (1) in bench vise in horizontal position. Remove hose clamps (13, 14 and 15) with hose tee (16).
2. Disconnect control tube (12) from control valve housing. Remove rear clamp band nut (10), bolt (11), clamp band (9) and then remove rear shell (17). Remove front clamp band nut (3), bolt (4), clamp band (2) and then remove center shell and diaphragm assembly (6 and 7).

##### *Diaphragm Return Spring, Hydraulic Parts (Fig. 7D)*

1. To remove return spring use 3-way metal hose tee (3/4" diameter) or length of wood drilled in its center to fit over end of push rod. Slide tee or wood on end of push rod and press against it to compress return spring. Using Snap Ring Pliers, remove snap ring (2) from groove inside bore of end plate.

**WARNING:** Maintain pressure on return spring while snap ring is being removed.

2. After snap ring is free, lay pliers aside and use both hands to guide complete assembly (return spring, push rod, and hydraulic piston parts) straight out of cylinder. If necessary to replace damaged parts (push rod, spring retainer, retaining ring or spring), remove retaining ring (9) and spring retainer (8) from push rod. Lay complete assembly on clean work bench. To remove front shell and gasket, remove three capscrews (6) and lift front shell (4) and support plate (5) off flange of cylinder (1). Remove rubber gasket (3) from groove in flange of cylinder.

##### *Push Rod and Piston (Fig. 4D)*

1. Working on clean bench, remove piston parts (2 through 12) from push rod (8) off piston end of push rod.
2. Slide retainer ring (12) out of groove in piston (10) and



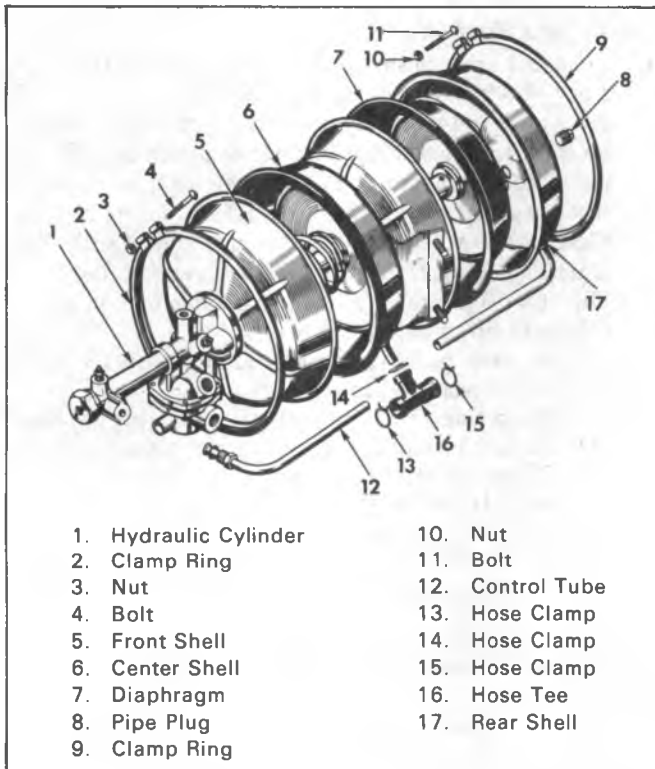


Fig. 6D--Removal of Control Tube, Clamp Band, Rear Shell, Center Shell and Diaphragm

separate piston push rod (8) by removing retainer pin (11).

3. With ice pick or thin-bladed screwdriver, remove cup (9) from piston. Slide seal retainer (2), push rod seal cup (3), push rod bearing (4), stop washer (6) and snap ring (7) off piston end of push rod.
4. Remove "O" ring seal (5) from bearing groove. If necessary to replace push rod seal (13) located in end of push rod, grip seal with pliers and pull it from end of push rod. Discard seal.

**Control Valve and Check Valve (Fig. 5D)**

1. Scribe across flanges of control valve body (12) and hydraulic cylinder housing (3). Remove four capscrews (13) and lift off valve body and spring (9). Remove washer (8), diaphragm (7), washer (6) and cups (4) from valve piston (5).
2. Using screwdriver, carefully pry off plastic valve body cover (16). Pry off plastic retainer (1st stage poppet) (15), lift off atmospheric (2nd stage) poppet (14) and then remove vacuum poppet and stem (10) and poppet spring (11) from valve body (12).
3. Using 1-3/8" wrench, remove end cap (1) and gasket (2). To disassemble residual pressure check valve contained in end cap, use pliers or screwdriver to lift snap ring (D) from groove inside end cap. Remove spring retainer (C), spring (B) and residual pressure check valve (A).

**Diaphragm and Center Shell (Fig. 8D)**

1. Clamp nut (12) on end of shaft in vise and remove nut

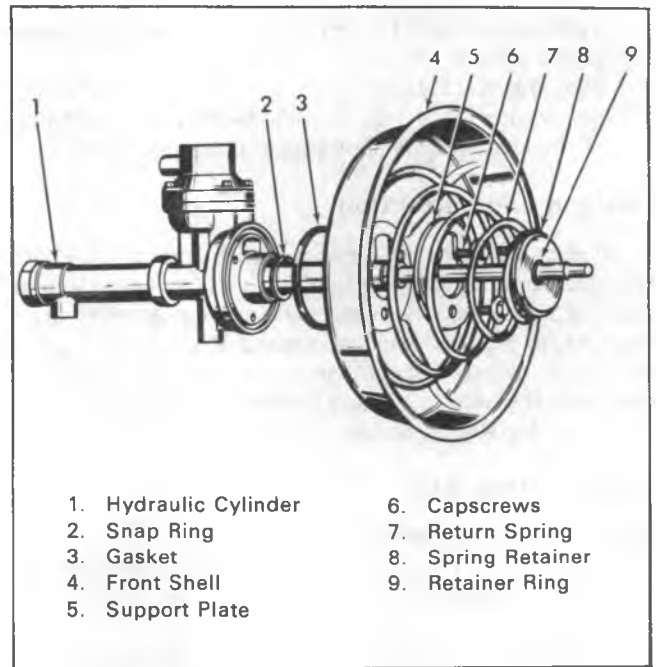


Fig. 7D--Removal of Diaphragm Return Spring, and Front Shell

(1), diaphragm plate (2), diaphragm (3) and washer (4) from shaft (7). Carefully slide center shell assembly (6) off shaft and, using an ice pick, remove seal (5) from groove inside brass bearing hub of center shell. No further disassembly of the center shell assembly is possible without damage to parts.

2. Remove shaft and diaphragm assembly from vise and insert drift punch through holes in shaft next to diaphragm (10) and, using 1-3/4" wrench, remove nut (12)

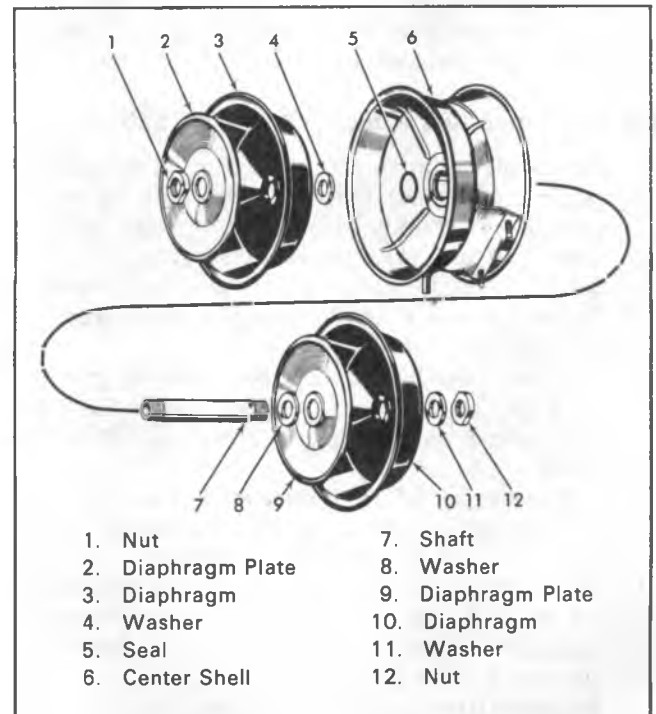


Fig. 8D--Disassembly of Diaphragm and Center Shell Assembly

## 5-6 POWER BRAKE CYLINDER

from end of shaft. Use care to avoid damaging chrome plated surface of shaft.

- Slide washer (11), diaphragm (10), diaphragm plate (9), and washer (8) off end of shaft. No further disassembly of the shaft is possible without damage to parts.

### Cleaning and Inspection

Thoroughly clean all metal parts in denatured alcohol. After cleaning, wash all hydraulic system parts in clean alcohol before reassembly. Inspect all parts not included in the repair kit for excessive wear or damage. Replace any that are worn or damaged. Inspect control valve body atmospheric valve seat. If damaged, replace housing. Always use the correct repair kit when overhauling unit.

### Assembly (Fig. 8D)

#### Diaphragm and Center Shell

- Slide washer (8), diaphragm plate (9), diaphragm (10), washer (11) on shaft (7) and thread nut (12) on until tight.
- Insert drift punch through holes in shaft next to diaphragm and use 1-3/4" wrench to tighten nut (12) securely. Stake nut to washer (11) in two places. Press new "O" ring seal (5) into groove inside brass bearing hub of center shells (6). Clamp nut (12) on end of shaft in vise and lightly lubricate the full length of the chrome-plated bearing area of the shaft with lubriplate or equivalent.
- Moderately lubricate the entire inside surface of the brass bearing hub and seal in the center shell assembly and slide center shell carefully onto shaft, seal side of hub last.
- Install washer (4) on push rod end of shaft, followed by diaphragm (3), diaphragm plate (2), and nut (1). With nut (12) securely held by vise, tighten nut (1) to 160-200 in.lbs. and then stake nut in place.

#### Control Valve and Check Valve (Fig. 5D)

- Assemble poppet return spring (11), vacuum poppet and stem (10) and atmospheric poppet (14) in valve body (12) from opposite sides, as shown. Snap poppet retainer (15) over end of vacuum poppet stem. (Set valve body with vacuum poppet down over 1" wooden cube and tap retainer with soft hammer.)
- Assemble valve body cover (16) securely in groove of body. Dip cups (4) in clean brake fluid and assemble back-to-back on valve piston (5) with lips of cups as shown.
- Align valve body (12) to scribe marks, seat outer edge of diaphragm in groove in valve body and assemble four capscrews (13). Securely tighten screws.
- To assemble residual pressure check valve, install check valve (A) in end cap, curved side first, followed by spring (B) and spring retainer (C), concave center diameter centered on spring. Compress spring and install snap ring (D) in groove inside end cap. Place new gasket (2) on end cap (1) and install end cap, securely tightened, in cylinder.

#### Piston and Push Rod (Fig. 4D)

- To install a new push rod seal (13) in push rod (8), place a new seal (rubber side down) on a clean block of wood. Hold push rod vertically with drilled end of rod resting on shaft end of seal and then strike upper end of push rod with soft hammer to seat seal with its shoulder firmly against end of push rod. (If the spring retainer plate was removed from shaft to install new seal, slide plate onto shaft from seal end, concave side last.)
- Dip cup (9) in brake fluid and assemble cup on piston (10) with lip of cup as shown.
- Install piston parts (2 through 12) on push rod from seal end of push rod in order shown.
- Slide snap ring (7), stop washer (6), bearing (4) with "O" ring (5) installed in bearing groove, push rod seal cup (3), seal retainer (2), retainer ring (12), and piston assembly (1) on push rod.
- Assemble retainer pin (11) through holes in piston and rod. Secure pin in place with retainer ring (12), making certain ring is seated in groove of piston.

#### Front Shell, Return Spring and Hydraulic Parts (Fig. 7D)

- Place new gasket (3) in groove on flange of hydraulic cylinder (1).
  - Assemble front shell (4) and support plate (5) to cylinder, aligning cut-outs in shell and plate with porting in cylinder flange, and assemble capscrews (6) securely.
  - Coat hydraulic cylinder bore with clean brake fluid. If removed, install spring retainer (8) and snap ring (9) on end of push rod.
  - Dip hydraulic piston and bearing parts in clean brake fluid. Slide diaphragm return spring (7) onto push rod, small diameter end of spring first, over hydraulic piston end. Seat spring against concave surface of spring retainer (8) and then align entire assembly of push rod, spring hydraulic piston and bearing parts with hydraulic cylinder bore, as shown.
  - Carefully insert piston, bearing and seals in bore.
  - Slide metal hose tee tool (or block of wood drilled with 3/4" diameter hole) on end of push rod and press against it to compress return spring. Using both hands while maintaining pressure against spring with your stomach, seat stop washer against bearing inside bore and then, using Snap Ring Pliers, install snap ring (2) securely in groove in cylinder bore.
- WARNING:** Make sure snap ring is seated all the way around its groove before releasing pressure against return spring.
- Remove hose tee or wooden block from end of push rod.

#### Shells, Diaphragms, Clamp Bands (Fig. 6D)

- With hydraulic cylinder (1) held in vise with bleed screws up, guide center shells and diaphragm assembly (6) onto end of push rod, seating push rod in seat in end

- of rear shaft. Do Not lubricate shaft with any lubricant besides alcohol or brake fluid.
2. Align scribe marks on center shell and front shell and press shells together to seat bead of front diaphragm in flanges of shells. Diaphragm and flanges should be dusted with talcum powder to simplify future disassembly.
  3. Assemble clamp band (2) over shell flanges while holding center shell and diaphragm assembly in position. Position opening in band 45 degrees from vertical center line of Hydrovac on side away from mounting bracket.
  4. Squeeze ends of band together and assemble bolt (4) and nut (3). Tap band lightly with soft hammer while tightening bolt to 30-40 in. lbs. to seat band securely on shells.
  5. Assemble rear shell (17) to scribe marks and seat bead of rear diaphragm in shell flanges.
  6. Assemble clamp band (9) over shell flanges while holding rear shell in position. Position opening in band directly in line with front clamp band opening and squeeze ends of band together and assemble bolt (11) and nut (10). Tap band lightly as above and tighten to 30-40 in. lbs.
  7. Place new seal on control tube (12), as shown, and assemble hose tee (16) with hose clamps (13, 14 and 15) to tube on rear shell (17), tube on center shells (6) and to control tube (12).
  8. Attach control tube and nut to control valve body port. Securely tighten tube nut. Secure hose tee to tubes with clamps. If removed, install pipe plug (8) in port in rear shell. Tighten securely.

## AIR COMPRESSOR AND GOVERNOR (BENDIX—WESTINGHOUSE)

### INDEX

Description and Operation of compressor.....	5-7	Assembly of Compressor .....	5-15
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Cleaning, Inspection, and Repair.....	5-12	Compressor Tests After Overhaul .....	5-22

## DESCRIPTION AND OPERATION OF COMPRESSOR

The compressors covered in this manual are single-acting, two cylinder reciprocating type (fig. 1G). The rated capacity of compressor is its piston displacement in cubic feet per minute when operating at 1250 rpm. Compressors can be readily identified by referring to name plate attached to cylinder block. Plate will indicate either type 400 or 500. Capacity of TU-FLO 400 is 7-1/4 cubic-feet per minute. Capacity of TU-FLO 500 is 12 cubic-feet per minute. Compressors are lubricated by the engine lubrication system.

Governor, acting in conjunction with the air compressor unloading mechanism, controls compression of air as explained later under "Air Compressor Governor." Connecting rod bearings are replaceable insert type. Upper ends of connecting rods are equipped with replaceable bushings. Piston pins are retained in pistons by wire-type locks.

On belt driven air compressors, the crankshaft is mounted in crankcase on a ball bearing in front and an insert-type bearing in rear. On gear-driven air compressors, crankshaft is mounted on insert-type bearings (bushings) both front and rear.

Figure 1G is typical of all compressors covered herein and all the procedures are applicable to all models. The difference in material composition between models has no effect on the methods of service or repair.

The air compressor crankshaft turns continuously while the engine is running. Actual compression of air, however, is

controlled by the governor. Acting with the compressor unloader mechanism, the governor loads or unloads the compressor when pressure in air system reaches a preset maximum or minimum.

### Operation With Unloader Valve Closed (Compressing) (Figs. 2G and 3G)

During the downstroke, a partial vacuum is created above each piston. Intake air forces open the inlet valve and air fills the cylinder.

As the piston starts its upstroke, the air pressure on top of the inlet valve, plus inlet valve return spring force, closes the inlet valve. As air above the piston is further compressed, pressure lifts the discharge valve and compressed air is forced through discharge line into reservoirs. At start of downstroke, discharge valve returns to seat, blocking return flow of compressed air to cylinder as cycle is repeated.

### Operation With Unloader Valves Open (Not Compressing) (Fig. 4G)

When air in system reaches maximum pressure for which governor is set, air passes through governor into unloader

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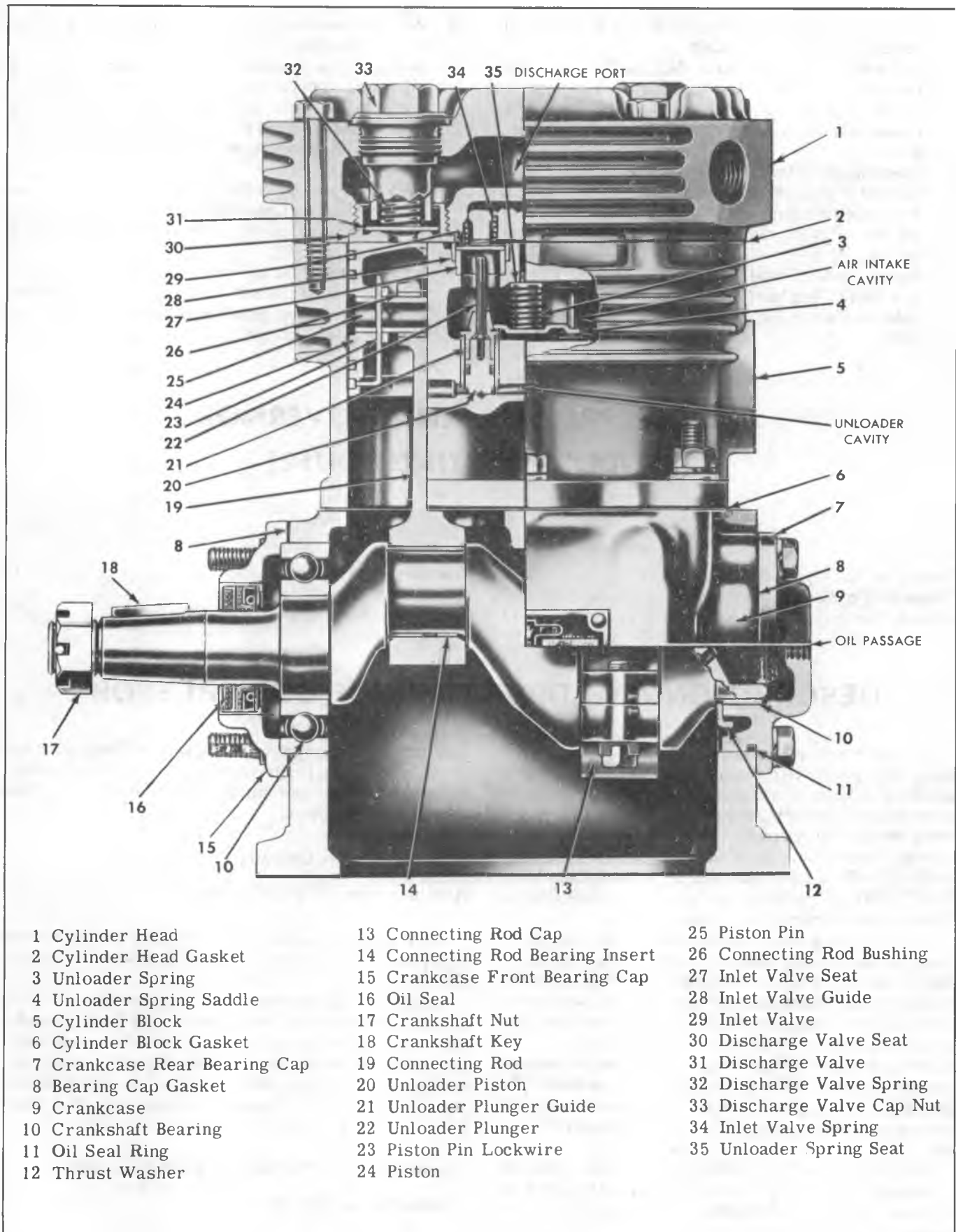


Fig. 1G—Air Compressor (Typical)

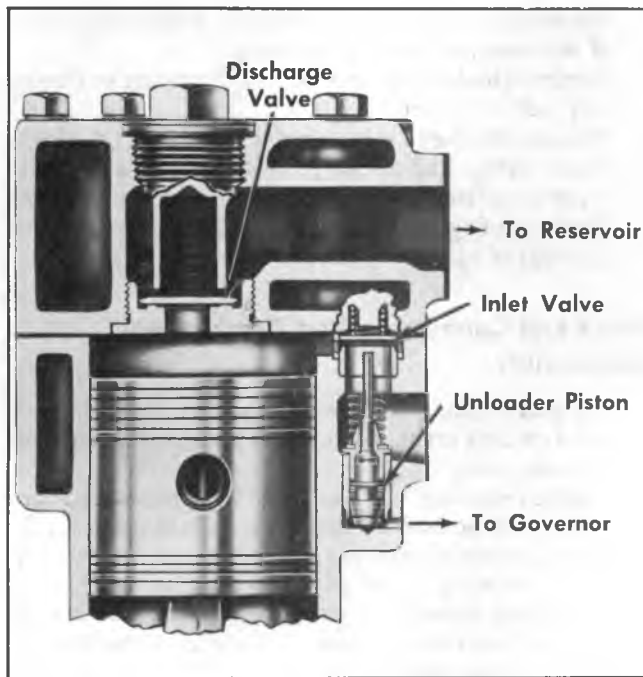


Fig. 2G—Intake of Air

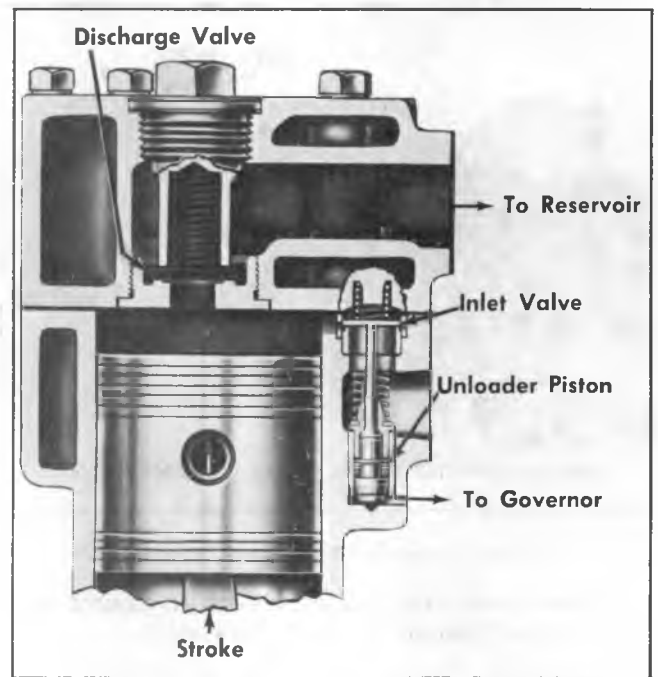


Fig. 3G—Compression of Air

cavity below unloader pistons in compressor cylinder block. Upward movement of unloader pistons caused by air pressure lifts both air inlet valves off inlet valve seats. With both inlet valves unseated, the air intake cavity in the cylinder block forms a passage between the cylinders above the pistons. Upstroke of one piston exhausts air into cylinder of other piston on downstroke, without compression.

When pressure in air system is reduced to governor cut-in setting, the governor releases pressure from beneath unloader pistons. Pressure of unloader spring on unloader spring saddle, acting against reduced governor pressure, forces pistons away from inlet valves. As inlet valve springs, in turn, overcome reduced plunger pressure, the inlet valves reseat and compression is resumed.

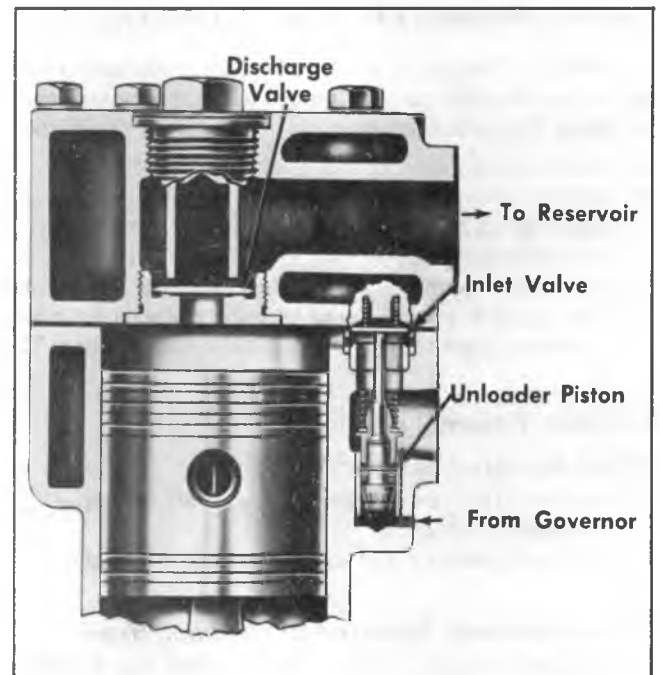


Fig. 4G—Unloading Compressor

## DISASSEMBLY OF COMPRESSOR

The crankcase, crankcase bottom cover, cylinder block, and cylinder head are so designed, that the method of assembly may be varied to meet different installation requirements. All of these parts should be marked before disassembling, to assure proper positioning at assembly. Refer to figure 1G for cross-section of complete compressor assembly.

### Air Strainer Removal and Disassembly

#### *Polyurethane Foam Filter (Fig. 5G)*

1. Remove two cap screws securing the air strainer to compressor.
2. Remove air strainer assembly.



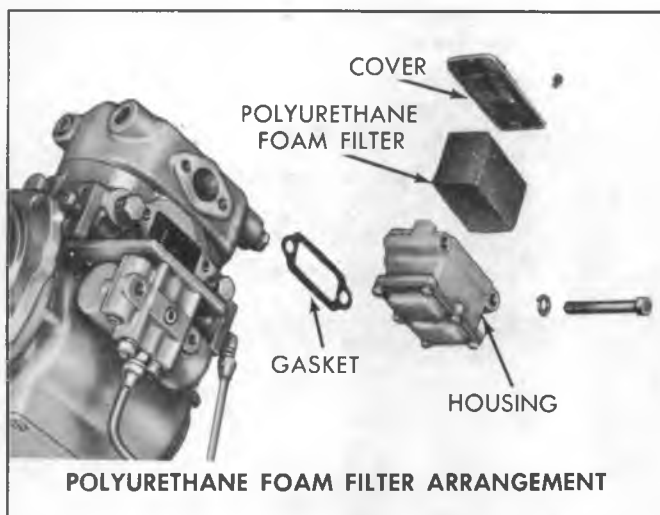


Fig. 5G—Compressor Air Strainer Components

3. Remove two cross recess screws on air strainer cover.
4. Remove foam filter element and discard.

**NOTE:** Refer to "Cleaning, Inspection, and Repair" in this manual for servicing of air strainer components.

### Unloader Assembly Removal (Fig. 6G and 7G)

Parts are available in a kit for replacing unloader assembly. Unloader parts may be changed without removing cylinder head. The unloader assembly is located in the block.

1. Remove air inlet elbow and discard gasket.
2. Insert screwdriver blade under unloader spring and raise spring off unloader spring saddle. Remove spring and spring saddle.
3. Lift each plunger guide, then remove guide and plunger. Lift pistons out of bores. If piston is not easily removed, use shop air pressure as shown in figure 7G.

### Governor Assembly Removal

#### *When Mounted to Cylinder Block*

1. Remove both cap screws and washers which attach governor to block.
2. Remove governor and discard governor gasket.

#### *When Remotely Mounted to Cylinder Head*

1. Loosen two cap screws which attach the governor bracket to air compressor head.
2. Remove the governor tube assembly.
3. Remove two cap screws which attach the bracket to cylinder head.
4. Remove governor and bracket as a unit.

**NOTE:** Governor overhaul information is explained later in this manual.

### Cylinder Head Removal and Disassembly

1. Remove all cylinder head cap screws, then lift off cylin-

der head assembly. Tap head lightly with soft hammer, if necessary, to break gasket joint.

2. Scrape cylinder head and block, if necessary to remove any part of gasket.
3. Remove discharge valve cap nuts and lift out discharge valve springs and discharge valves. Remove discharge valve seats. Remove inlet valve springs and inlet valves from top of cylinder block. Figure 23G illustrates components of cylinder head.

### Piston and Connecting Rod Removal and Disassembly

1. On gear driven models, remove screws and lock washers attaching crankcase bottom cover to crankcase and remove cover.
2. Before removing, mark each piston in relation to bore. Marks will be used to reassemble parts in original position. Connecting rods and caps have matching ribs (fig. 20G), showing proper position of cap on rod.
3. Straighten prongs of connecting rod bolt washers and remove bolts and washers. Remove connecting rod bearing caps and bearing inserts. Push pistons with connecting rods attached out top of cylinder block. Replace caps on rods with inserts in place to prevent damage to bearing inserts.
4. Remove piston rings from pistons. If connecting rods are to be removed from pistons, remove piston pin lock wires, then press piston pins out of pistons and connecting rods.

### Crankshaft Removal

#### *Belt-Driven Type*

1. Remove cap screws and lock washers attaching front

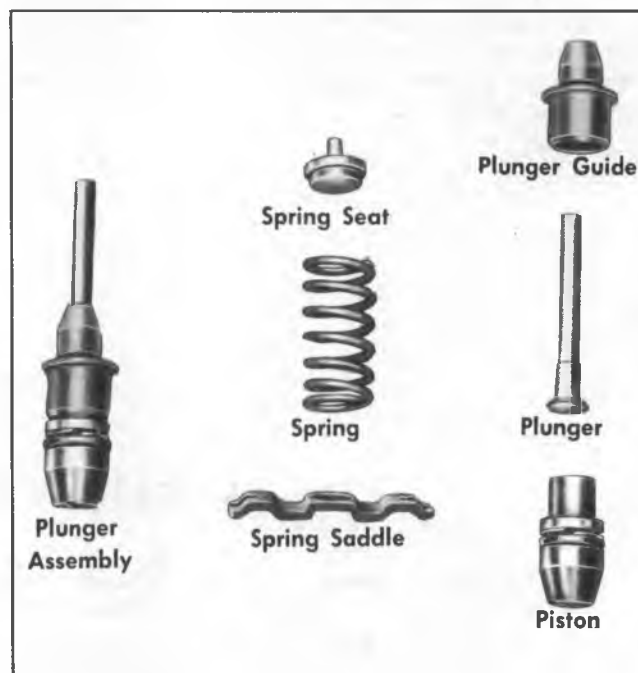


Fig. 6G—Unloader Assembly Components

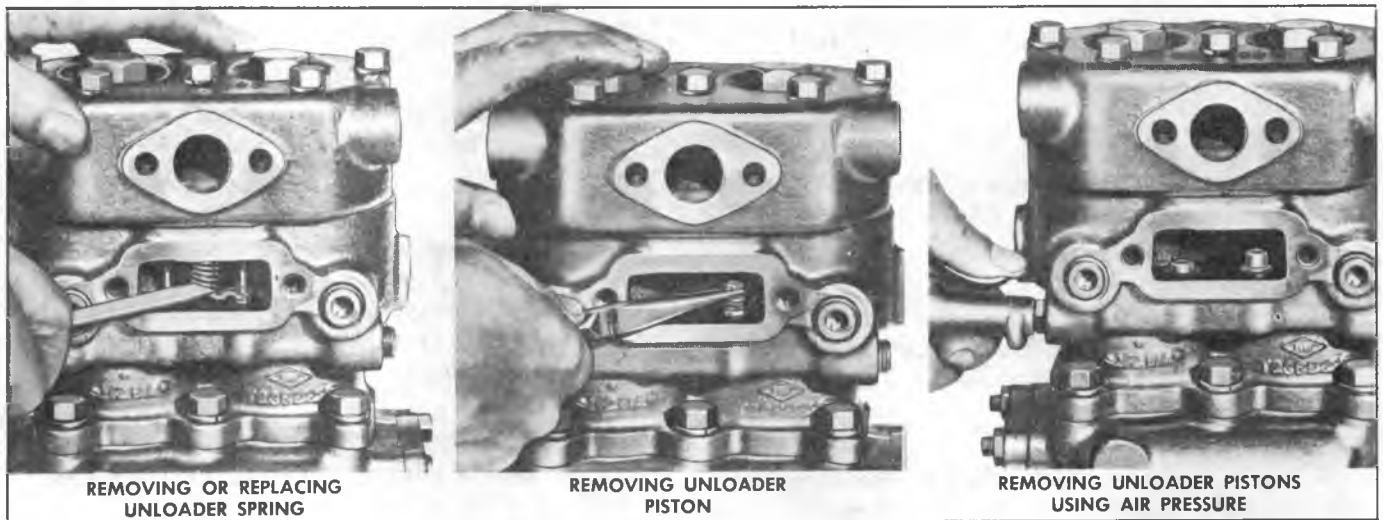


Fig. 7G--Removing Unloader Components

end cover to crankcase, then remove front end cover and end cover gasket. Remove and discard cover oil seal.

2. Remove cap screws and lock washers attaching crankcase rear end cover to crankcase. Remove rear end cover and gasket.
3. Press crankshaft and front bearing out of crankcase.

**NOTE:** It may not be necessary to remove crankshaft bearing if inspection indicates bearing to be in good condition. Check condition of bearing on crankshaft as directed later under (Cleaning, Inspection, and Repair.)

4. If bearing is found defective, press front bearing off crankshaft using arbor press.

#### **Gear-Driven Type (Fig. 8G)**

1. Remove cotter pin and nut from front end of crankshaft and pull drive hub off shaft. Remove drive hub key from keyway in shaft.
2. Remove cap screws attaching rear end cover to crankcase and remove cover and oil seal. Remove oil seal from boss on cover.

**NOTE:** Crankshaft rear bearing will come off with end cover.

3. Remove crankshaft through rear end cover opening.
4. Remove crankcase front and rear thrust washers. Do not remove crankshaft bearings from crankcase and end cover unless inspection shows necessity for removal.

#### **Cylinder Block Removal and Disassembly**

Remove cap screws securing cylinder block to crankcase, then remove cylinder block and cylinder block gasket. Discard gasket.

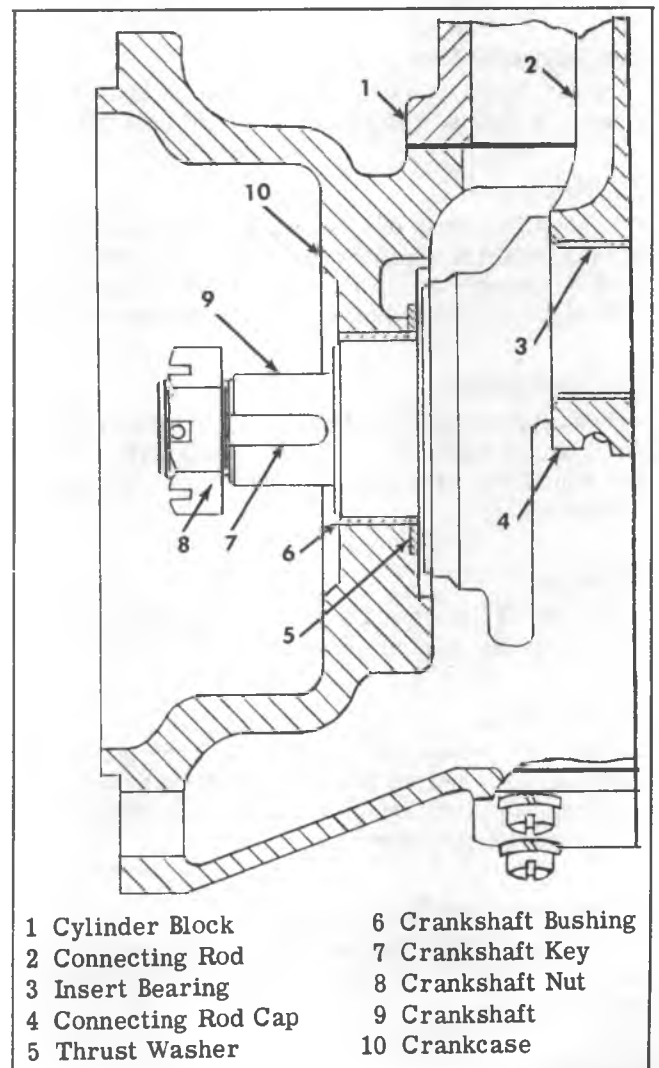


Fig. 8G--Crankshaft Bushing Installed (Gear Drive)

## Cleaning, Inspection and Repair

### Cleaning

#### General

Thoroughly wash all parts in a suitable cleaning fluid to remove all traces of dirt, oil, or grease.

#### Air Strainer

Thoroughly clean all air passages with a suitable cleaning fluid to remove all traces of dirt, oil, or grease. Install new polyurethane foam filter element into air strainers.

#### Cylinder Head

Soak cylinder head in cleaning fluid to loosen carbon from discharge valve cavities and unloading cavity, and to loosen rust and scale. Blow dirt out of all cavities with compressed air. Scrape carbon and dirt from all surfaces. Scrape gasket particles from gasket surfaces.

#### Discharge Valves

Clean discharge valves, if not worn excessively or damaged, by lapping with crocus cloth held on a flat surface.

#### Oil Passages

Thoroughly clean oil passages through crankshaft, connecting rods, and crankcase rear end cover. If necessary, prod oil passages with a piece of wire, then flush passages with cleaning fluid and blow out with compressed air.

#### Cylinder Block

Soak cylinder block in cleaning fluid to loosen carbon and dirt from air intake cavity. If water-cooled type, clean rust and scale from water passages. Blow out all passages with compressed air.

#### Pistons

Scrape All Carbon and dirt out of ring grooves in pistons. Clean drain holes in oil ring grooves.

#### Ball Bearing

Immerse bearing in cleaning fluid, then brush off old lubricant. Blow bearing dry with compressed air, and wrap in clean cloth. Avoid spinning bearing with air blast, as spinning might damage bearing.

#### Crankcase and Bottom Cover

On gear driven compressors, wash crankcase and bottom cover in cleaning fluid. Remove all sediment from sump in bottom of cover.

### Inspection

#### Cylinder Head

Inspect cylinder head for cracks or breaks. Replace with new head if cracked or damaged.

#### Inlet and Discharge Valve Springs

Discard used inlet and discharge valve springs and replace with new springs.

#### Inlet and Discharge Valves and Seats

Inspect inlet and discharge valves and seats for signs of excessive wear. Replace valves if grooved deeper than 0.003" at point of seat contact. Replace valve seats if condition is such that seats can no longer be refaced.

#### Unloading Pistons and Plungers

Inspect pistons, plungers, and plunger guides for signs of damage or excessive wear. New unloading pistons should slide easily in bores. Replace "O" rings in unloader piston.

#### Crankcase and End Covers

Check crankcase and end covers for cracks or other damage. Replace with new parts if damaged.

#### Crankcase Bearing Bore

Check the fit of ball bearing in the compressor crankcase bearing bore. The bearing should require a finger press fit. It is recommended to replace compressor crankcase if bore is worn or damaged.

#### Cylinder Block (Fig. 9G)

Use telescoping gauge to check cylinder bores for out-of-round and taper. Bores which are scored or out-of-round more than 0.002", or tapered more than 0.003" must be



Fig. 9G—Measuring Cylinder Bore Diameter



Fig. 10G—Measuring Piston Diameter

rebored, honed or ground oversize. Pistons and rings 0.010", 0.020", and 0.030" oversize are available. Cylinder bores must be smooth, straight, and round and must be finished with a 500 (or finer) grit hone. The clearance between piston and cylinder wall on models using cast iron pistons must not be less than 0.002" or more than 0.004".

Cylinders must be cleaned thoroughly after honing or boring operation. Even slight traces of abrasive material left on the cylinder walls may cause rapid ring and wall wear and early compressor failure. Wipe down the cylinder walls with very fine crocus cloth. This loosens embedded abrasive material and also knocks off foreign material left by the honing stones; then use a stiff brush and hot, soapy water to wash down the walls. After cleaning the cylinder walls, wash the walls with a cloth and light engine oil, wiping the oil off with a clean, dry cloth. Repeat this until the clean, dry cloth is free of all visible dirt.

### Pistons (Fig. 10G)

Examine pistons for scoring, cracks, or damage of any kind. Measure outside diameter of piston with a micrometer and compare this measurement with the inside diameter of cylinder bore. Clearance should not be less than 0.002" or more than 0.004". Piston over 0.004" smaller than cylinder bore must be replaced with an oversize piston.

**NOTE:** When measuring the outside diameter of the piston, make sure that the micrometer is at 90 degree angle to the piston pin bore. This will enable correct measurement.

### Piston Pins and Bushings

Check fit of piston pins in pistons and connecting rods. Pins must be light press fit in pistons. If piston pin is loose in piston, the pin, piston, or both must be replaced. Check fit of piston pins in connecting rod bushings by rocking pins in bushings. If looseness is evident, replace connecting rod bushings as directed under "Compressor Repair." Discard all piston pin lock wires.

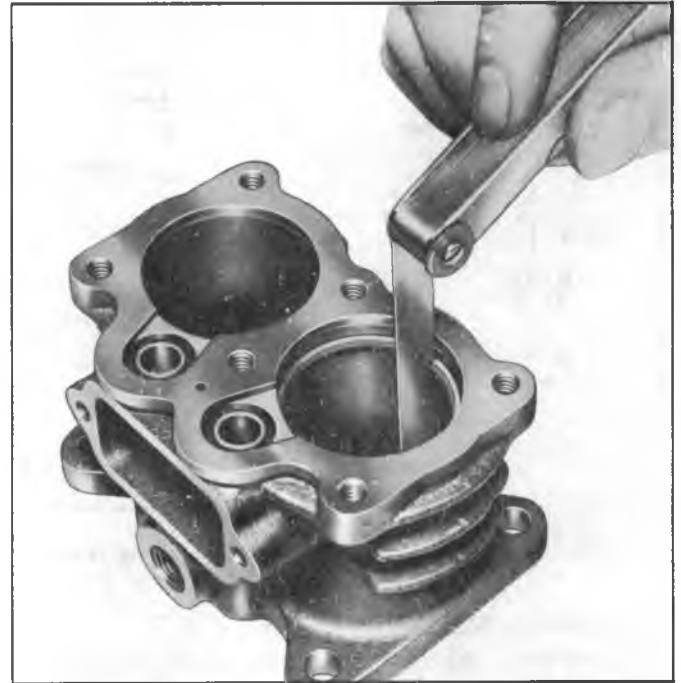


Fig. 11G—Measuring Piston Ring Gap

### Piston Rings (Figs. 11G, 12G, and 13G)

Check fit of piston rings in ring grooves, and check ring gap with ring in cylinder bore. Rings are of cast-iron material.

1. Clearance between rings and sides of ring grooves in 7-1/4 cubic-foot compressor should be from 0.0015" to 0.0030" as shown in figure 12G. Ring gap should be from 0.002" to 0.010".
2. Clearance between rings and sides of ring grooves in 12 cubic foot compressor should be from 0.0035" to 0.0055" for wide rings and from 0.002" to 0.004" for narrow rings as shown in figure 13G. Ring gap should be from 0.002" to 0.010".

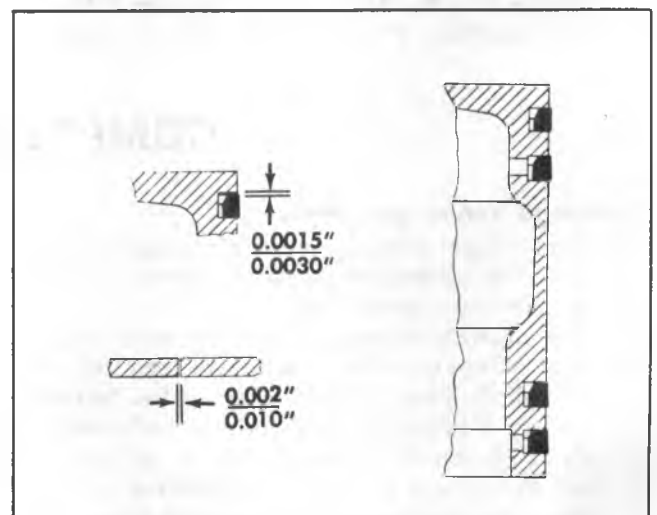


Fig. 12G—Piston Ring Arrangement and clearances 7 1/4 cu. ft. Compressor

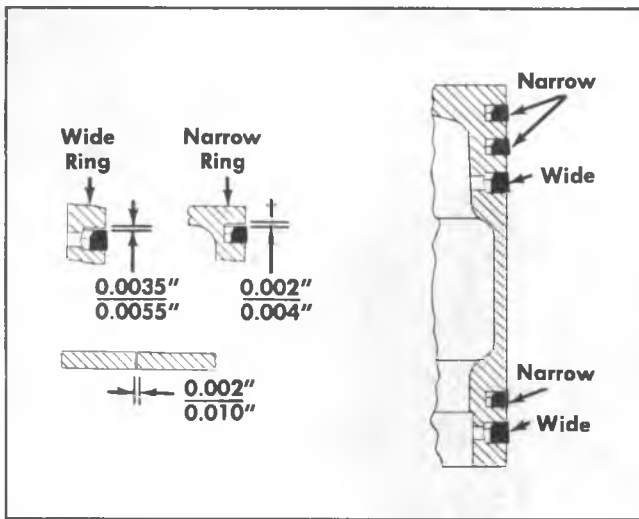


Fig. 13G—Piston Ring Arrangement and Clearances 12 cu. ft. Compressor

### Connecting Rods and Bearings

Check fit of connecting rod bearing inserts on crankshaft journals. Clearance between bearings and crankshaft journals should not exceed 0.0021".

### Checking Clearance by Plastigage Method (Refer to Figure 14G)

To check fit of bearings on crankshaft, install bearing inserts into connecting rod. Clean the crankshaft journals and the inserts so that all oil is removed. Plastigage is soluble in oil, therefore oil will affect the accuracy of the reading. Plastigage is placed on the lower half of the bearings (fig. 14G).

**IMPORTANT:** To check clearance properly, using Plastigage, it is essential to not move the connecting rod or crankshaft. Install connecting rod caps and tighten connecting bolt nuts to torque. This should flatten Plastigage to not less than 0.0003" or not more than 0.0021". Check measurement on Plastigage scale (fig. 14G). Replace bearing inserts if clearance is excessive, or if bearings are cracked or flaked.

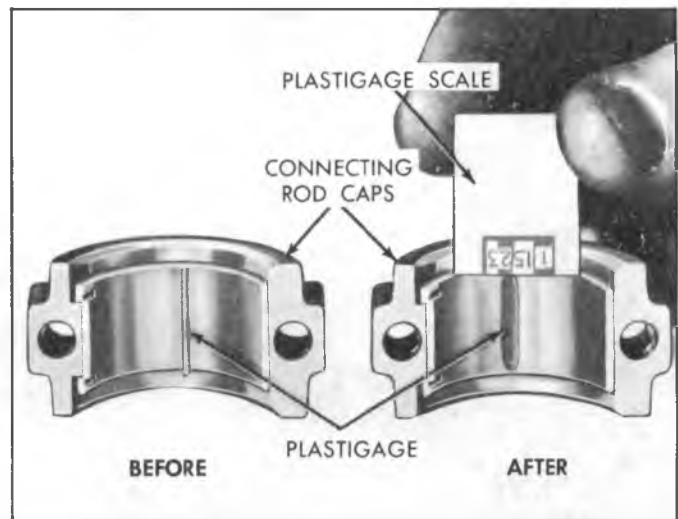


Fig. 14G—Checking Clearance Using Plastigage

Connecting rod caps are not interchangeable. Position caps so that locking slots are both located adjacent to same cap screw.

**CAUTION:** DO NOT file or lap bearing caps or rods to take up clearance; always use new bearing inserts if clearances are excessive.

### Crankshaft

Crankshaft journals should not be out-of-round more than 0.001", ridged or scored. If grinding is necessary, do not grind fillets at ends of journals. Connecting rod bearing inserts are available in 0.010", 0.020", 0.030" undersize for reground crankshafts. Check main bearing journals for excessive wear. Dimensions should be such that ball bearing is a press fit on journal.

### Crankshaft Bearing

Examine bearing for wear or flat spots by rotating races. If any roughness is detected bearing should be replaced with new bearing.

## COMPRESSOR REPAIR

### Discharge Valves and Seats

1. Remove slight scratches and pits from discharge valve seats. Use lapping stone, grinding compound, lapping disc, and valve grinding tool.
2. Place discharge valves on valve seats, install discharge valve springs in cap nuts, and thread cap nuts firmly into cylinder head. To test discharge valves for leakage, connect air line to discharge port in cylinder head. Apply 100 pounds air pressure to valves and apply soap suds to discharge valve openings in bottom of cylinder head. Leakage in excess of a one-inch bubble in one second is not permissible. If leakage is excessive, leave air pressure applied. Using a fiber or a hardwood dowel

and a light hammer, tap valves off seats several times. This should improve fit of valve on seat. Check leakage around top of area. No leakage is permissible. Shut off air pressure and disconnect line from cylinder head.

### Inlet Valves and Seats

1. Remove slight scratches or pits from inlet valve seats. Use lapping stone, grinding compound, lapping disc, and valve grinding tool. Replace seats that cannot be repaired. Dimension from the top of the cylinder block to the inlet valve seat should not exceed 0.145", nor be less than 0.101".



2. Inlet valves not badly worn or damaged can be repaired by lapping valves on a piece of crocus cloth held on a flat surface.

### **Connecting Rod Bushings**

If piston pin bushings in connecting rods require replacement, press old bushings out of connecting rods. Press new bushings in, making sure the oil holes in the bushings line up

with the oil passages in the connecting rods. Bushings must then be reamed, honed, or bored to provide 0.0001" to 0.0006" clearance on piston pin. Wipe the bushing, which has been honed, with a clean cloth to remove all abrasive material.

**IMPORTANT: Make sure not to overlook any of the above (Cleaning, Inspection, and Repair) items before assembling the air compressor.**

## **ASSEMBLY OF COMPRESSOR**

**NOTE: Refer to figure 15G while assembling air compressor.**

### **Crankshaft Installation**

#### **Belt-Driven Type**

1. Install ball bearing on front of crankshaft. Press bearing on crankshaft until inner race is seated firmly against shoulder on crankshaft.
2. Position thrust washer on the rear end of crankshaft with oil grooves toward shoulder on shaft.
3. Install rear end cover oil seal in groove of end cover.
4. Install rear end cover and bearing assembly against the crankcase.
5. Install cap screws and washers attaching end cover to crankcase. Tighten cap screws firmly.
6. Insert crankshaft and front ball bearing, as an assembly, through crankcase bearing bore and press front ball bearing into crankcase front bore by using an arbor press. Make sure that a suitable tool is used to press bearing and crankshaft assembly into crankcase. The tool, which can be improvised locally (using a section of tubing), must press on the outer race of bearing to insure no shifting of ball bearings or damage to the bearing assembly. Refer to figure 16G for tool dimensions.

**CAUTION: Before pressing the bearing and crankshaft assembly into crankcase, make sure that the crankcase is properly supported. This will prevent damage to rear cover pipe plugs or cap screws.**

7. Install new oil seal in front bearing cap. Place a new gasket on bearing cap and slide bearing cap on crankshaft.
8. Install cap screws and lock washers attaching end cover to crankcase. Tighten cap screws firmly.

#### **Gear-Driven Type**

1. Place front thrust washer on crankshaft with oil grooves toward shoulder on shaft.
2. Insert crankshaft through end cover opening in crankcase.
3. Position rear thrust washer on crankshaft with oil grooves toward shoulder on shaft.

4. Install rear end cover oil seal in groove of rear end cover.
5. Position rear end cover and bearing assembly on crankshaft until end cover is against the crankcase.
6. Install cap screws and washers attaching rear end cover to crankcase. Tighten cap screws.
7. Install key in keyway in front end of crankshaft, install drive hub on shaft, and secure with nut and cotter pin.

**NOTE: Crankshaft should rotate freely.**

### **Cylinder Block Installation**

Place new cylinder block gasket on crankcase. Position cylinder block on crankcase, aligning marks made before disassembly. Install cap screws and washers. Tighten firmly.

### **Piston and Connecting Rod Assembly and Installation**

1. Position connecting rod in piston and press piston pin into piston with lock wire holes in pin aligned with lock wire holes in piston (refer to fig. 17G). The piston pin can be rotated by inserting a screwdriver into the piston pin slot (fig. 18G) to align piston pin lock wire hole with the lock wire hole in the piston boss.
2. Install new piston pin lock wires in piston pin so that long end extends through piston and pin. Snap short end into lock wire hole at bottom of piston skirt.
3. Install piston rings in grooves of pistons. Rings must be installed in proper location and with pip marks (may be numbered 1 to 5) upward. Refer to figures 12G and 13G for proper clearance dimensions and location of rings on pistons.
4. Press bearing inserts into rod and cap by hand, with locating lips in proper alignment.

**NOTE: All locating lips are on the same side as cap bolt (fig. 19G).**

5. Lubricate pistons, rings, piston pin bushings, and bearing inserts with clean engine oil.
6. Turn crankshaft to position bearing journal nearest drive end of crankshaft (No. 1) downward. Remove bearing cap from No.1 connecting rod.

**NOTE: Stagger ring gaps 120 degrees from each other**

- 1 Cap Screw
- 2 Washer
- 3 Bracket
- 4 Governor
- 5 Washer
- 6 Cap Screw
- 7 Compression Rings
- 8 Piston
- 9 Oil Control Rings
- 10 Inlet Valve Spring
- 11 Inlet Valve
- 12 Inlet Valve Guide
- 13 Inlet Valve Seat
- 14 Unloader Spring Seat
- 15 Unloader Spring
- 16 Unloader Plunger Guide
- 17 Unloader Spring Saddle
- 18 Unloader Plunger
- 19 Washer
- 20 Grommet
- 21 Unloader Piston
- 22 Bushing
- 23 Cylinder Block
- 24 Gasket
- 25 Gasket
- 26 Key
- 27 Main Ball Bearing Assy.
- 28 Gasket
- 29 Front End Cover
- 30 Stud
- 31 Oil Seal
- 32 Crankshaft Nut
- 33 Screw
- 34 Cover
- 35 Filter
- 36 Housing
- 37 Bolt
- 38 Washer
- 39 Screw
- 40 Crankshaft
- 41 Cap Screw
- 42 Washer
- 43 Crankcase
- 44 Gasket
- 45 Insert Bearing
- 46 Connecting Rod Cap
- 47 Lock Washer
- 48 Bolt
- 49 Cap Screw
- 50 Washer
- 51 Rear End Cover
- 52 Main Insert Bearing
- 53 Thrust Washer
- 54 End Cover Oil Seal
- 55 Washer
- 56 Nut
- 57 Insert Bearing
- 58 Connecting Rod
- 59 Connecting Rod Bushing
- 60 Lock Wire
- 61 Piston Pin
- 62 Cap Screw
- 63 Discharge Valve Seat
- 64 Gasket
- 65 Cylinder Head
- 66 Discharge Valve
- 67 Discharge Valve Spring
- 68 Discharge Valve Cap Nut
- 69 Tube Assembly

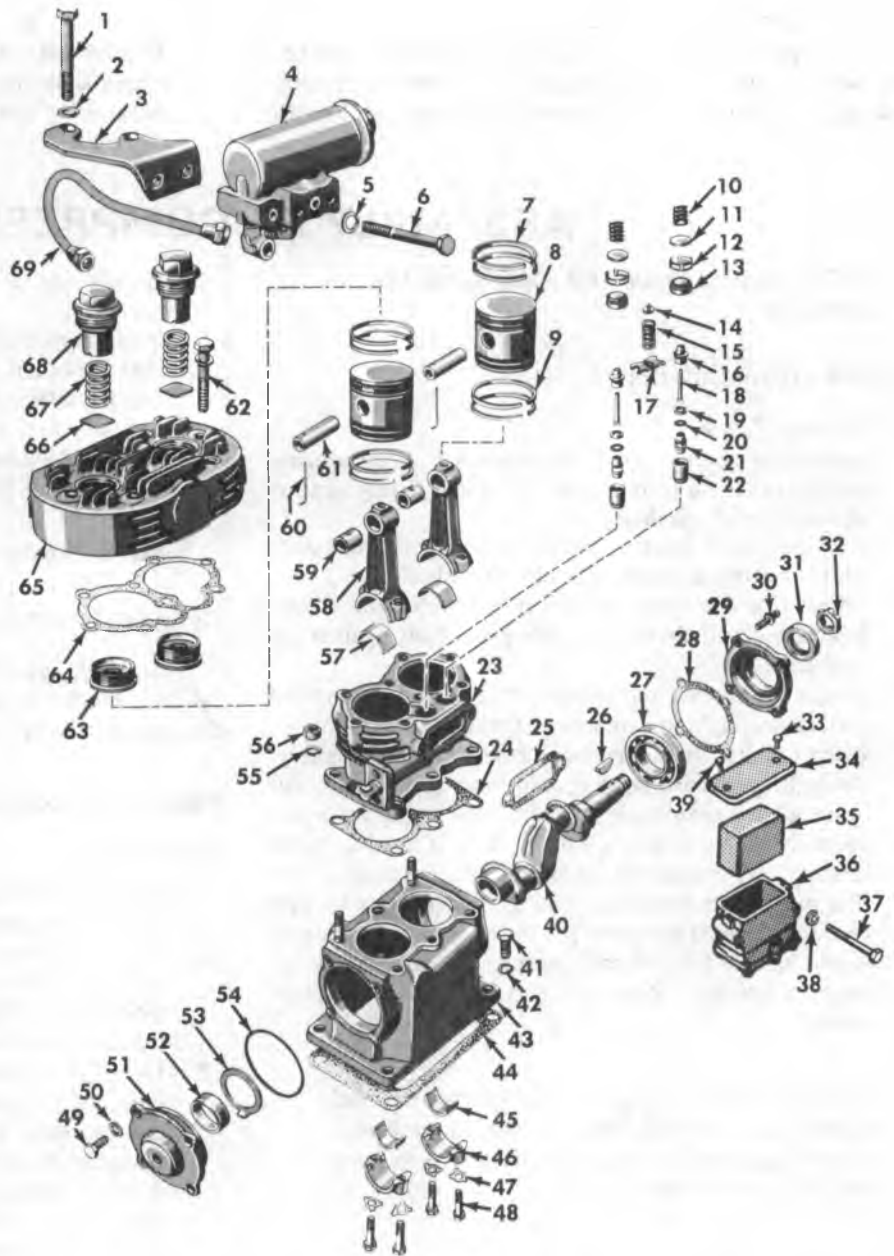


Fig. 15G--Air Compressor Components

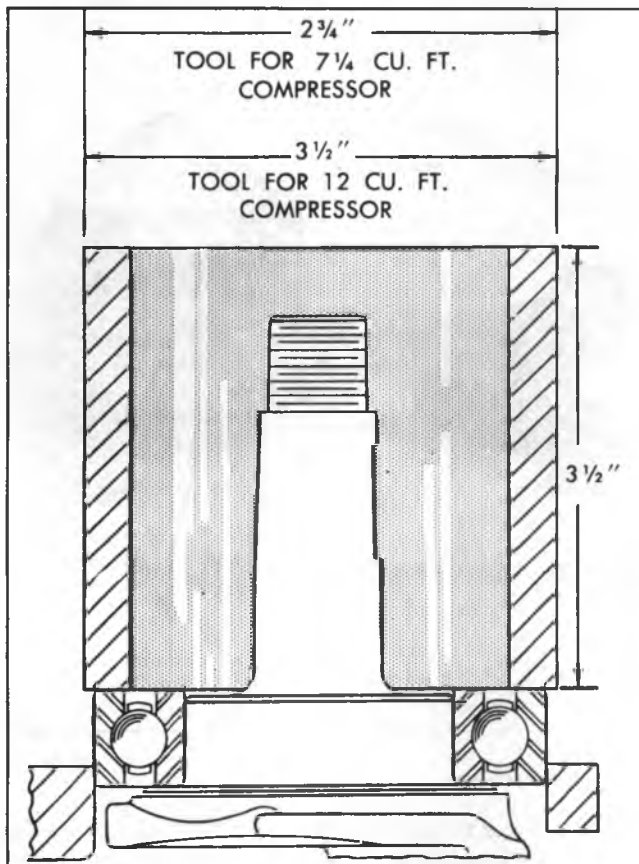


Fig. 16G--Pressing Main Bearing Using Arbor Press Tool

before inserting pistons into cylinder block. Refer to figure 19G for an example of staggered ring gaps.

**CAUTION:** All crankshaft journals should be wiped of all abrasive material by using crocus cloth, then a clean ordinary cloth.

7. Insert No. 1 connecting rod and piston through top of

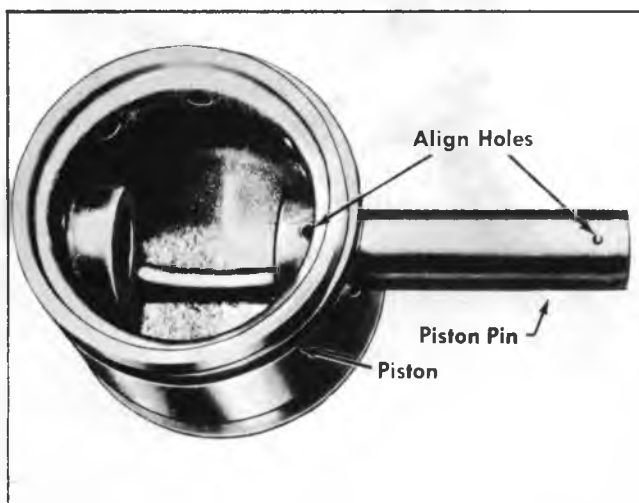


Fig. 17G--Alignment of Piston Pin and Piston Lockwire Holes

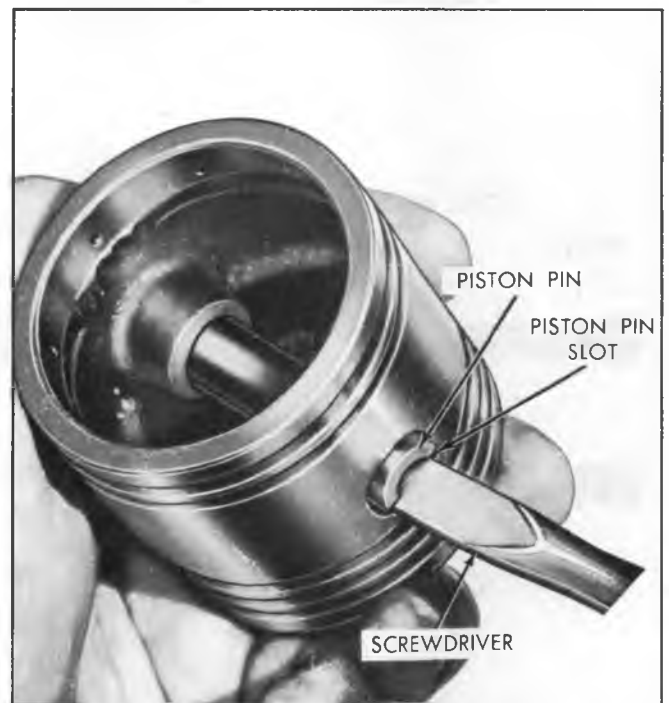


Fig. 18G--Rotation of Piston Pin

No. 1 cylinder, as previously marked, and seat squarely on connecting rod bearing journal. Install bearing cap. Make sure that the matching ribs are in alignment to each other on the connecting rod assembly (fig. 20G). This will enable correct assembly. For proper assembly, two slots in bearing inserts and in rod and cap should be on side of same cap bolt. Install lock washers. The isolated prong must be inserted into the connecting rod cap prong insert (fig. 21G). Install the special hardened bolt and tighten to 100 to 115 inch pounds of torque. Bend prongs of lock washers over heads of bolts. Refer to figure 21G.

8. Install No. 2 piston and connecting rod in same manner as described in Step 7.
9. Install crankcase bottom cover (on gear driven models), using a new gasket, with marks made prior to disassembly aligned. Attach cover to crankcase with screws and lock washers.

### Unloader Piston and Plunger Assembly and Installation

(Refer to Figures 6G and 22G)

1. Coat each unloader piston, "O" ring, and piston bore with a silicone type lubricant. Insert piston in bore.
2. Insert plunger in plunger guide. Hold guide and plunger with long-nose pliers and install over unloader piston.
3. Install unloader spring saddle and unloader spring. Make certain that saddle rests squarely on top of plunger guides, and make sure top of spring engages spring seat pressed into cylinder block.

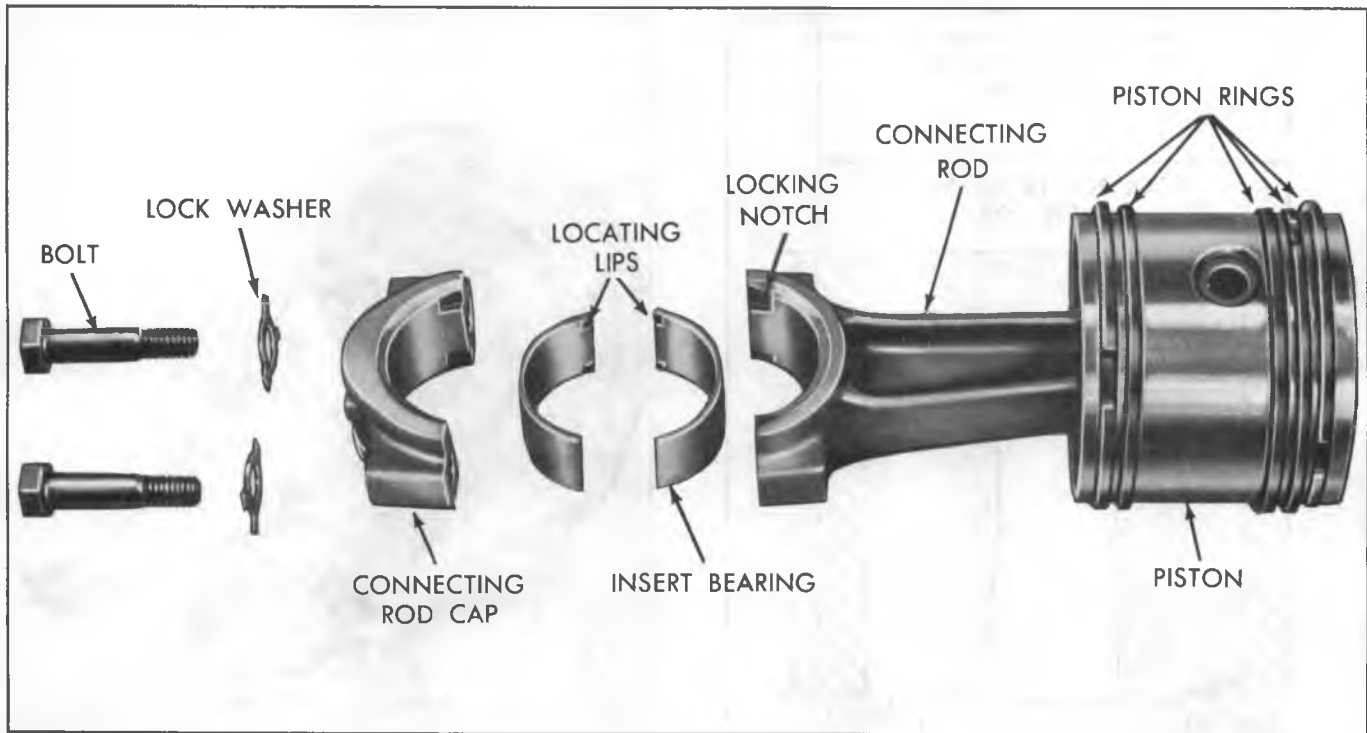


Fig. 19G—Piston and Connecting Rod Assembly

### Cylinder Head Assembly and Installation

(Refer to Figure 23G)

1. Install the discharge valve seats. Place discharge valve on seat through opening in top of cylinder head. Place discharge valve spring in discharge valve cap nut. Thread cap nut into cylinder head. Tighten nuts firmly.
2. Place inlet valves, inlet valve guides, and inlet valve springs in top of cylinder block.
3. Install new cylinder head gasket on cylinder block. Carefully align inlet valve springs with inlet valve guides in cylinder head. Align marks made before dis-

- assembly and install cylinder head on cylinder block. Install cylinder head cap screws and tighten firmly. Replace all pipe plugs.
4. Install new gasket and replace air inlet elbow.

**NOTE:** If, by chance, the pulley has to be changed during overhaul, it is required that it be replaced by

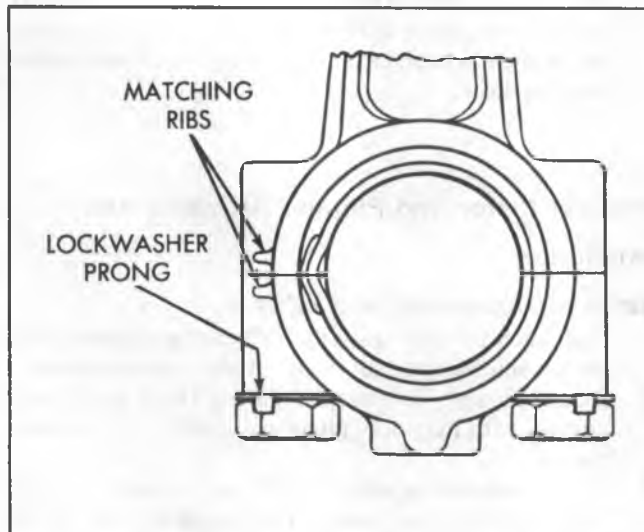


Fig. 20G—Matching Ribs on Connecting Rods and Caps

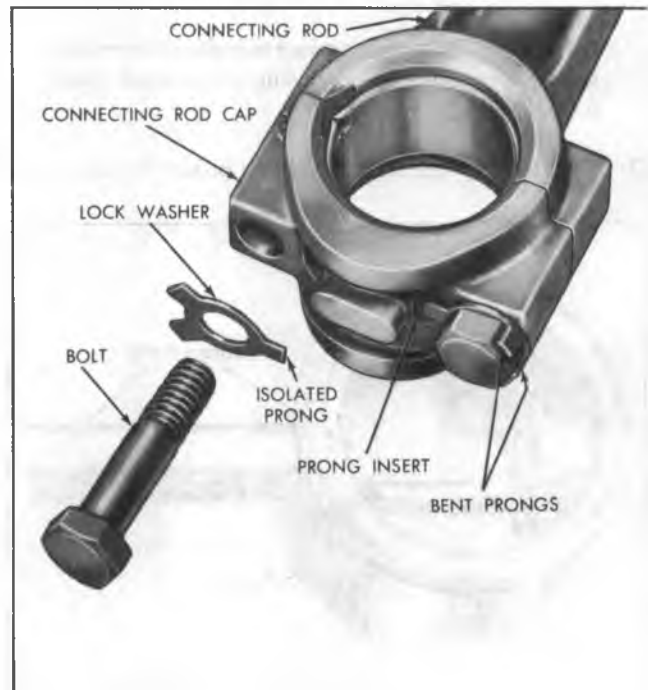


Fig. 21G—Installation of Lockwasher and Bolt on Connecting Rod and Cap

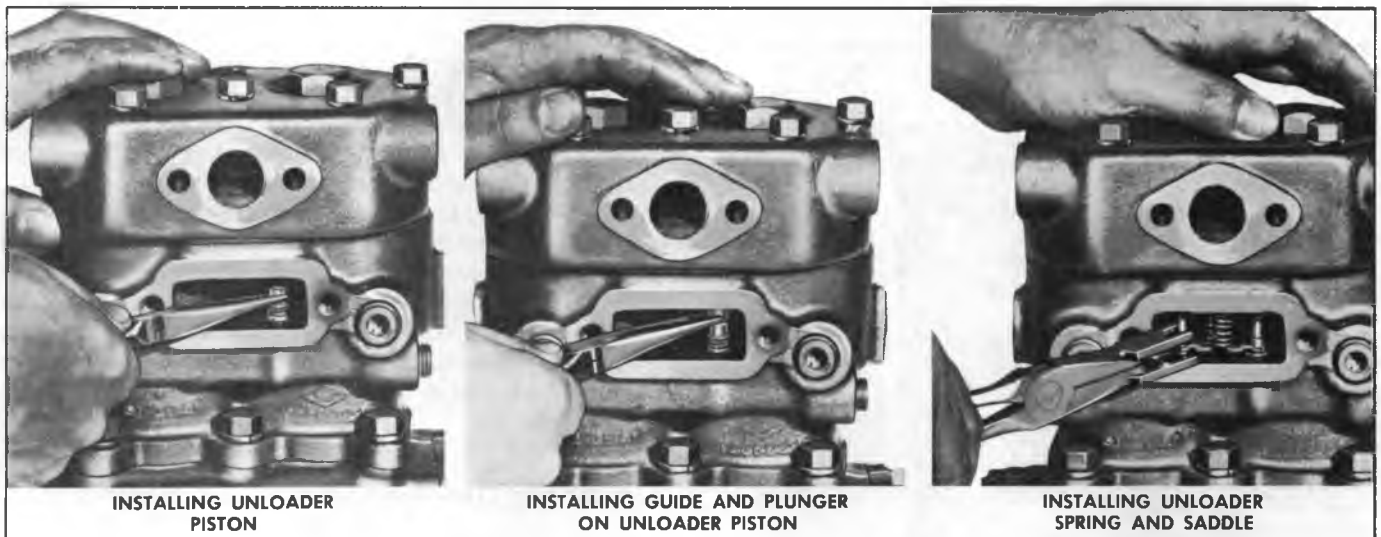


Fig. 22G—Installing Unloader Components

the same size pulley. A difference between the sizes of pulley will result in a difference of output in relation to engine speed.

### Governor Installation

1. One type of governor is directly attached to air compressor cylinder block by two cap screws. Use new gasket.
2. The other type governor is mounted on the compressor head by a bracket and two cap screws. Leave the two cap screws loose until the air tube assembly is tightened, then tighten the cap screws.

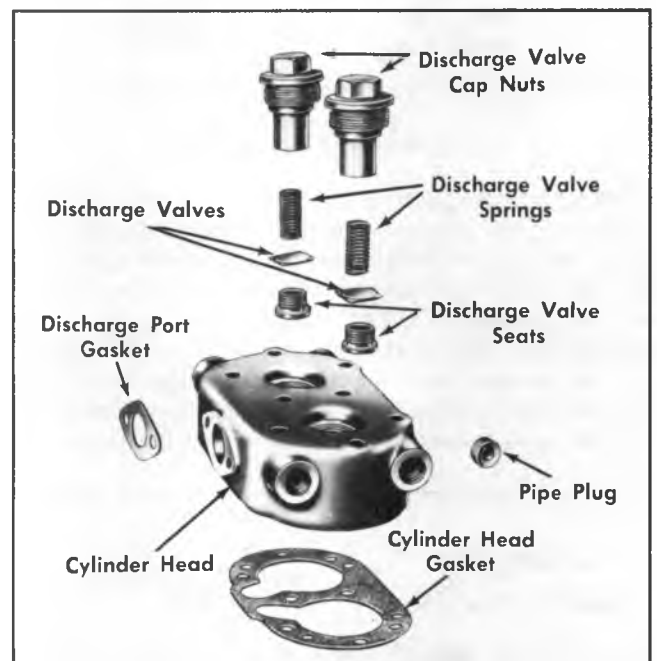


Fig. 23G—Cylinder Head Components

## Air Compressor Governor Description and Operation

### Description

The governor, operating in conjunction with air compressor unloading mechanism, automatically controls air pressure in the air brake or air supply system between the desired, predetermined maximum, and minimum pressures. The air compressor runs continually while the engine runs, but actual compression of air is controlled by the governor which stops or starts compression when the maximum or minimum reservoir pressures are reached. The "D-2" governor as used with these compressors, has a piston upon which air pressure acts to overcome the pressure setting spring and control the

inlet and exhaust valve to either admit or exhaust air to or from air compressor unloading mechanism.

The governor can be attached to the air compressor or mounted remotely. They are adaptable to either mounting. Connections in this system are to the reservoir and compressor unloading ports. They also have an exhaust port (fig. 24G).

### Operation

#### *Refer to Fig. 25G*

Reservoir air pressure enters the governor at one of its



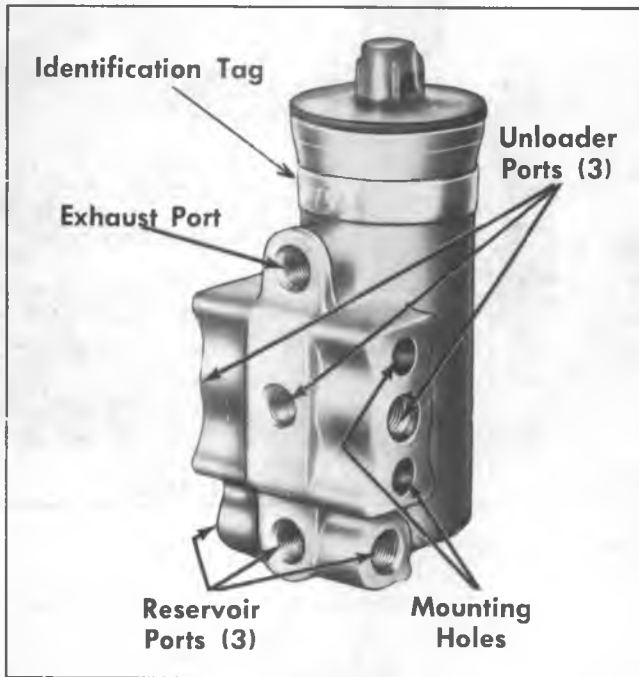


Fig. 24G--Type D-2 Governor

reservoir ports and acts on the area of the piston and on top of the inlet and exhaust valve. As air pressure builds up, the piston moves against resistance of the pressure setting spring. The piston and inlet exhaust valve move up when reservoir air pressure reaches cut-out setting of the governor. The exhaust stem seats on the inlet and exhaust valve and then the inlet passage opens. Reservoir air pressure then flows by the open inlet valve, through the passage to piston and out unloader port to the compressor unloading mechanism. The

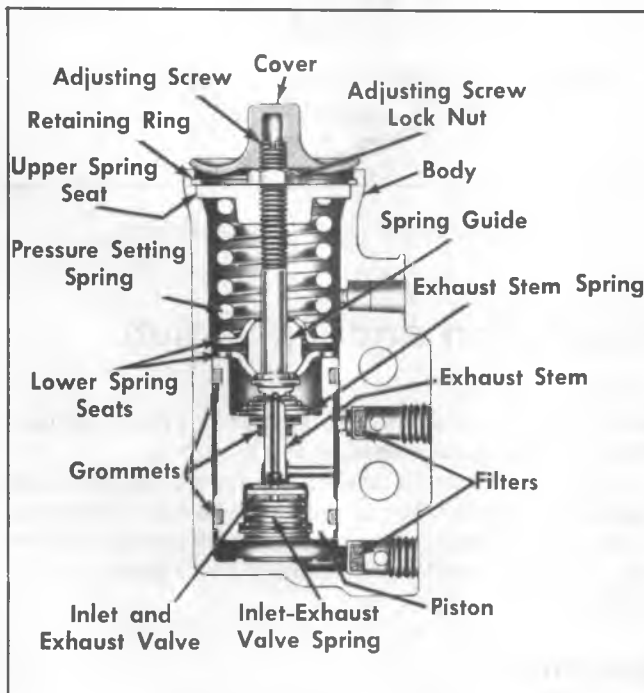


Fig. 25G--Type D-2 Governor Cutaway

air, besides flowing to compressor unloading mechanism, also flows around the piston and acts on additional area of the piston. This additive force which results from a larger area on the piston assures a positive action and fully opens the inlet valve.

As the system reservoir air pressure drops to the cut-in setting of the governor, force exerted by the air pressure on the piston will be reduced so that the pressure setting spring will move the piston down. The inlet valve will close and exhaust will open. With exhaust open, air in the unloader line will escape back through the piston, through the exhaust stem and out the exhaust port.

## Governor Overhaul

### Disassembly (Refer to Fig 26G)

1. Using cleaning solvent and a brush, clean dirt and grease from exterior of governor.
2. Using fingers, remove rubber cover from governor assembly. Remove two pipe plugs from governor body.
3. Using Snap Ring Pliers, remove cover retaining ring from groove in governor body.
4. Remove adjusting screw and spring assembly from governor body.
5. Remove the piston assembly from governor body. It may be necessary to tap governor body flat against work bench to dislodge piston.
6. Remove two piston grommets from grooves in piston. Discard grommets.
7. Remove valve spring, valve, exhaust stem, and exhaust stem spring from piston.
8. Remove exhaust stem grommet and washer from bore. Discard grommet.
9. Mount adjusting screw and spring assembly in a vise with soft jaws.
10. Remove lock nut from adjuster screw; then thread adjuster screw out of upper spring seat.
11. Remove spring, lower spring seat, spring guide, and second lower spring seat from adjuster screw.

### Cleaning and Inspection

1. Wash all metal parts in cleaning solvent. Blow parts dry. Wipe rubber parts dry.
2. Check valve spring, exhaust stem spring, and adjuster screw spring for free length, active coils, or collapsed coils.
3. Inspect governor body for cracks, nicks, burrs, or other damage. Check for crossed or stripped threads.
4. Inspect adjuster screw for crossed or stripped threads and distortion.
5. Examine the piston for nicks, burrs, or other damage.
6. Check governor valve for deterioration or other damage.
7. Examine the two filters in governor body. If damaged, use a sharp hooked tool and remove them. Use a suitable sleeve; press new filters in governor body ports.
8. Inspect all air passages in ports for obstructions

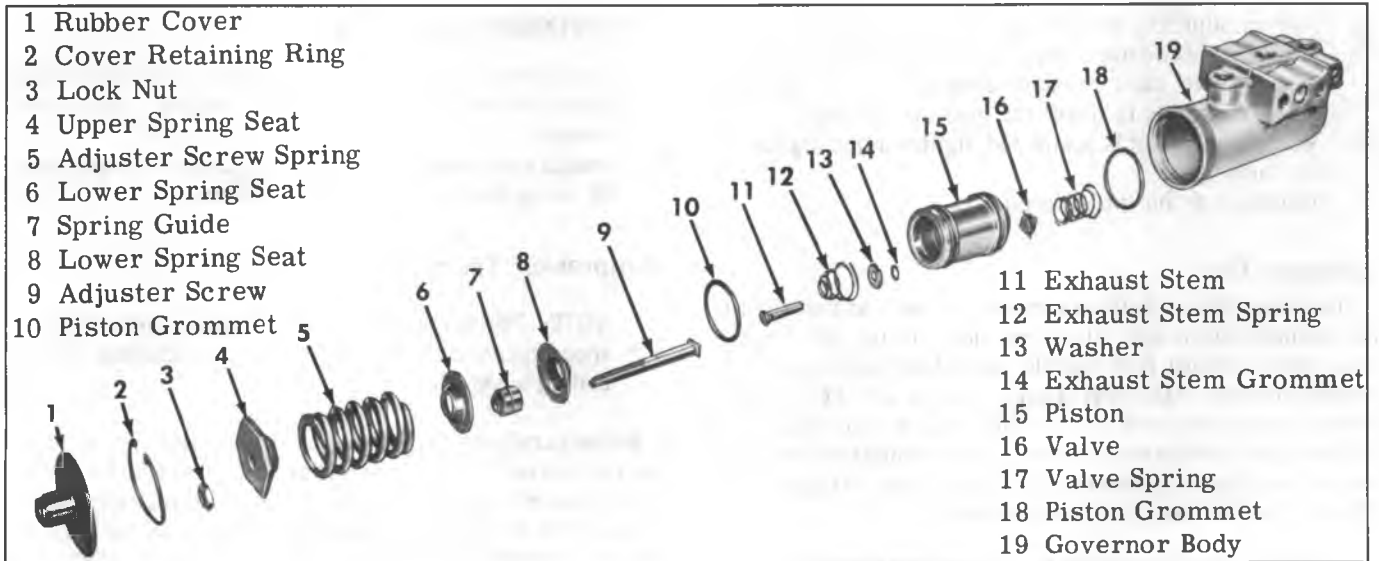


Fig. 26G--Type D-2 Governor Components

**Assembly (Refer to Fig. 26G)**

Prior to assembly of governor, lubricate governor body bore, top of piston, piston grooves, piston grommets, spring guide, and adjusting screw with a barium-base grease.

1. Position first lower spring seat, spring guide, second lower spring seat, and spring on adjuster screw.
2. Thread adjuster screw into upper spring seat until the dimension from the top of the seat to the bottom of the stem head is 1-7/8" as shown in figure 27G; then mount adjuster screw and spring assembly in a vise having soft jaws.
3. Install lock nut on adjuster screw.
4. Position new exhaust stem grommet in groove inside piston. Install new washer in piston. Prick punch washer in four places.
5. Install two new grommets in grooves on out side of piston.
6. Position exhaust stem spring, exhaust stem, valve, and valve spring in piston. Narrow end of inlet valve spring is against the valve.
7. Insert piston assembly in bore of governor body.
8. Position adjusting screw and spring assembly in governor body; then using Snap Ring Pliers, install the retaining ring.
9. Install rubber cover on governor body over adjusting screw.
10. If previously removed, install two pipe plugs in governor body.
11. After the governor is installed in shop testing equipment or in the vehicle, make "Governor Tests."

**Governor Tests After Overhaul**

**NOTE:** This test can be made, using shop testing equipment, or with unit installed in vehicle as explained following:

**Operating Test**

Start the engine and build up air pressure in system.

Observe reading on air pressure gauge in gauge panel when governor cuts-out, stopping compression of air by the compressor. Refer to "Specifications" for proper cut-out pressure and check with reading on the air pressure gauge, which is located in the cab of the truck.

With the engine still running, slowly reduce air pressure in the system by applying and releasing brakes. Observe pressure registered by gauge when governor cuts-in and compression is resumed. Refer to "Specifications" at rear of this manual, for proper cut-in pressure and check with reading on the air pressure gauge, which is located in cab of truck.

Before condemning or adjusting the governor, be sure the dash air gauge is registering accurately. Use an accurate test gauge to check pressure registered by the dash gauge. If the pressure settings of the governor are inaccurate, or it is necessary that they be changed, adjust governor as described in the following paragraphs:

**Adjustment**

1. Unscrew cover at top of the governor.

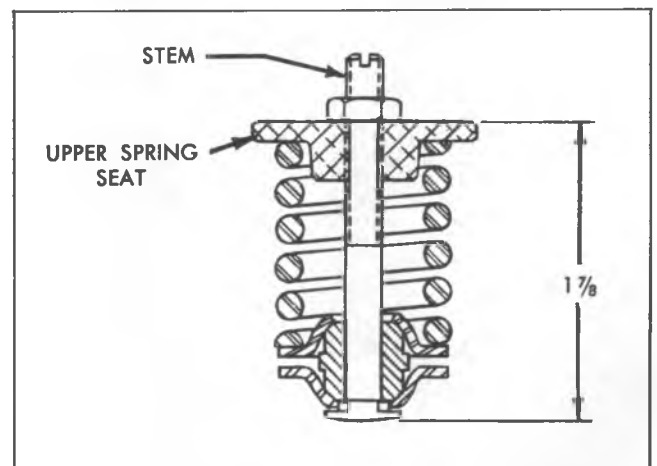


Fig. 27G--Adjusting Screw Measurement

## 5-22 POWER BRAKE CYLINDER

2. Loosen adjusting screw lock nut.
3. Using a screwdriver, turn adjusting screw counterclockwise to raise pressure settings. Turn adjusting screw clockwise to lower the pressure settings.
4. When adjustment is completed, tighten adjusting screw lock nut.
5. Install cover on the governor.

### Leakage Test

Leakage checks on the governor are made at its exhaust port in both cut-in and cut-out positions. In the cut-in position, check exhaust port for inlet valve leakage by applying a soap solution at the port. Leakage could also be past the bottom piston grommet. In the cut-out position, check the exhaust port to determine if leakage is present at the exhaust valve seat or stem grommet. In this position leakage could also be past the upper piston grommet.

**NOTE:** After the leakage test, thoroughly clean governor of soap.

### Air Strainer Assembly and Installation

#### *(Refer to Figure 5G)*

If compressor is to be tested after overhaul, then **DO NOT** install air strainer until after compressor test.

### Polyurethane Foam Filter

1. Install new foam filter element into air strainer body.
2. Install air strainer cover to body, using two cross-recess screws.
3. Install air strainer unit with a new gasket to compressor by using two cap screws and washers.

### Compressor Tests After Overhaul

**NOTE:** The following applies to making test with shop equipment, but it can be readily adapted to testing in vehicle:

A comparatively simple compressor efficiency or build-up test can be run. The compressor must be connected to an oil supply line of at least 15 pounds pressure during the test and an oil return line must be installed to keep crankcase drained. The compressor (when tested) should be tested without a strainer.

To the discharge port of the compressor connect a reservoir whose volume, plus the volume of the connecting line, equals 1300 cubic inches. Run the compressor between 1700 and 1750 rpm. Elapsed time that the compressor takes to build up from 0 to 100 psi depends on the type compressor as follows: The Tu-Flo 400 (7-1/4 cu. ft.) type compressor should build up in 47 seconds. The Tu-Flo 500 (12 cu. ft.) type compressor should build up in 30 seconds.

During the above test the compressor should be checked for oil leakage and noisy operation.

## Section 6M

**CARBURETOR****HOLLEY 4150G**

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**GENERAL DESCRIPTION**

The Holley four-barrel carburetor model 4150G, (fig. H1) is used with either the 366 or 427 cu. in. truck engine.

This is a four-barrel two-stage carburetor consisting of eight sub-assemblies. The sub-assemblies are: the throttle body, the main body, primary and secondary fuel bowls, primary and secondary metering bodies, secondary throttle operating assembly, and the governor assembly. The secondary throttle operating assembly controls the second stage throttle plates (Fig. H2). A vacuum signal to the spring loaded vacuum diaphragm assembly determines the position of the throttle plates.

The governor incorporated on this carburetor (fig. H3) provides a positive means of controlling engine speed. The throttle lever controls the engine until the governing speed is reached, at this time the governor assembly adjusts the throttle plates to maintain this speed under the various loadings. A clutch arrangement on the throttle body allows the manual control below governing speeds.

**On the Vehicle Governor and Secondary Diaphragm Control Valve Checks**

- a. To test governor setting on the service floor, run the engine up to governor specifications. Adjust governor as necessary.

- b. If there is no governor control, start with step number 1.
- c. If the engine governs at light load and doesn't govern at wide open throttle, the problem is probably in the dump valve. Go to step number 3.

**Step Number 1**

Disconnect vacuum line at slave unit. Leave dump valve line attached; speed the engine up to 2200-2400 rpm, wet your finger and place over the vacuum passage to the distributor. If the engine speed is reduced to near idle, the problem is in the control (spinner) valve or the line or fittings to the control valve.

**Step Number 2**

If the job does not return to idle; disconnect the line to the dump valve and remove the vacuum fitting from the slave unit. Again speed the engine up to 2200-2400 rpm and place a wet finger over the vacuum passage. If the job now returns to near idle, the problem is in the dump valve line. If it does not return to idle, the problem is in the slave unit or vacuum connections or passages behind the slave unit.

**Step Number 3**

Disconnect the secondary link and move it to one side. Run the free engine up against the governor to determine the amount of over-run that might be expected from the calibration.

**Step Number 4**

When the problem is suspected to be in the dump valve, take the vehicle (bob-tailed or empty) out on the

highway and run it up to governed speed and see if it governs. 150-250 rpm initial over-run is permissible. If it doesn't govern, disconnect the secondary diaphragm link and move it to one side; operate the vehicle again as a two-barrel carburetor. If it governs now, the problem is the dump valve.

**NOTE:** The secondary control valve is serviced as a complete assembly. Only part designated with part numbers are available for service. The secondary control valve cannot be adjusted in the field and must not be disassembled.

## REPAIR PROCEDURES

**Disassembly (Refer to Exploded View Fig. H11)**

**NOTE:** Do not disassemble carburetor until above quick checks (Governor Testing) have been completed on the vehicle.

**Disassemble Into Subassemblies**

**NOTE:** Before disassembly, loosen the fuel inlet fitting, fuel bowl sight plugs and needle and seat assembly lock screws.

1. Remove primary fuel bowl screws (4) and remove fuel bowl, metering body, splash shield and gaskets then remove fuel tube and discard tube seals (fig. H4).
2. Remove secondary fuel bowl screws (4) then remove fuel bowl, secondary metering body and remove metering body and gaskets.
3. Remove governor control vacuum line.
4. Remove fitting on governor assembly.
5. Remove choke lever and governor cover.
6. Remove governor spring, governor lever nut and lock washer, governor assembly to main body screws.
7. Slide governor assembly off throttle shaft. Remove throttle shaft seal.
8. Remove secondary throttle operating rod "E" ring clip and remove assembly.
9. Remove throttle body to main body screw and remove main body and gasket.

**Disassemble Fuel Bowls (Fig. H5)**

1. Remove float hinge pin retainer and slide float from bowl then, if necessary, remove spring from float assembly.
2. Remove inlet baffle from bowl.
3. Remove fuel level sight plugs and gasket.
4. Remove inlet fitting fuel filter, spring and gaskets.
5. PRIMARY BOWL ONLY--
  - Remove air vent valve assembly.
  - Remove pump diaphragm screws and lift pump housing, diaphragm and spring from fuel bowl.

● Check pump inlet ball for free movement and damage. Damage to ball, passage or retainer requires new bowl assembly.

**Disassemble Metering Bodies**

1. Remove main metering jets with a jet wrench or wide blade screw driver (fig. H6).

**NOTE:** A small screw driver will distort jet and change carburetor calibration.

2. Remove power valves with a 1" 12-point socket (fig. H7).
3. Remove idle mixture screws and seals from secondary bowl.

**Disassemble Secondary Throttle Operating Assembly (Fig. H8, H8a and H9)**

1. Remove secondary throttle operating cover screws. Remove cover, spring, diaphragm and check ball.
2. Remove secondary control valve cover, screws, cover, spring and diaphragm.

**NOTE:** Do not disassemble control valve for any reason

3. Remove clean air filter.

**Disassemble Main Body**

1. Remove choke lever retaining clip and choke rod clip then remove choke lever spring.
2. Remove pump discharge nozzle screw, nozzle and gasket, then up-end the body assembly to remove pump discharge check valve (fig. H10).

**NOTE:** The choke rod seal will withstand normal cleaning in carburetor cleaner, therefore, further disassembly of the main body is not required for cleaning purposes. If part replacement is required, proceed as follows:



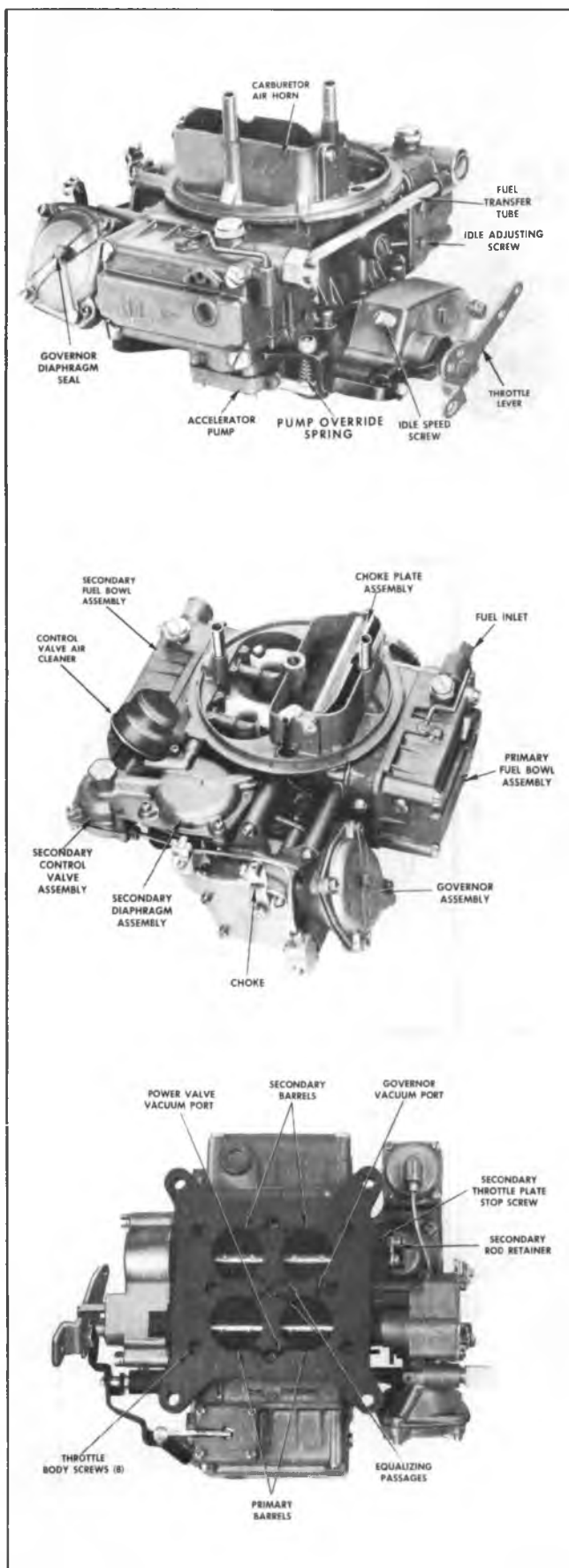


Fig. H1-Holley 4150G Carburetor

- File off the staked ends of shaft screws then remove screws.

- Remove valve from shaft slot and slide shaft from main body.

- Remove choke rod (upward through seal) and remove seal from main body.

**Disassemble Throttle Body (Fig. H11)**

1. Remove throttle operating housing cover screws and cover.

**NOTE:** Ordinarily the throttle body need not be disassembled for cleaning and inspection purposes. If necessary, disassemble for part replacement as outlined below.

2. Remove pump operating lever assembly. Disassemble spring, bolt and nut, if needed.
3. Remove idle speed screw from housing.
4. Remove screw retaining throttle operating lever to shaft. Remove lever from shaft and withdraw shaft from housing.
5. Remove accelerator pump operating cam screw and remove cam.
6. Remove cotter keys from throttle connecting rod and remove rod.
7. Remove secondary throttle shaft lever screw and remove lever.
8. File off staked ends of the throttle valve screws. Drive out primary throttle valve screws pin.
9. Scribe primary and secondary throttle plates along shafts and number plates for assembly purposes (fig. H12). Plates must be installed in same bores they were removed from.
10. Remove plate screws and slide shafts and bushings out of throttle body.

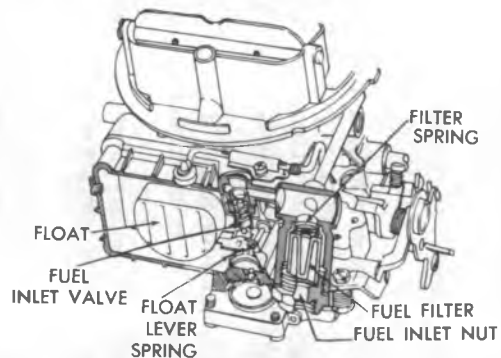
**Cleaning and Inspection**

**NOTE:** The most frequent causes of carburetor malfunction are gum, carbon, and water. Carefully clean and inspect all parts and castings as the carburetor is being serviced as follows:

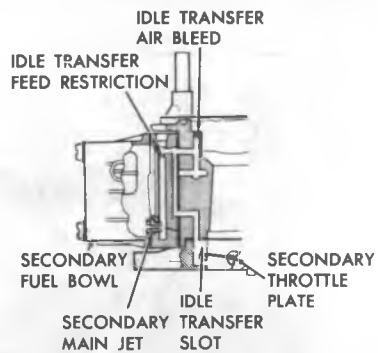
1. Clean throttle flange (if not disassembled), and all non metallic parts, in alcohol or gasoline.

**NOTE:** Secondary throttle shaft bushings and accelerator pump cam are plastic.

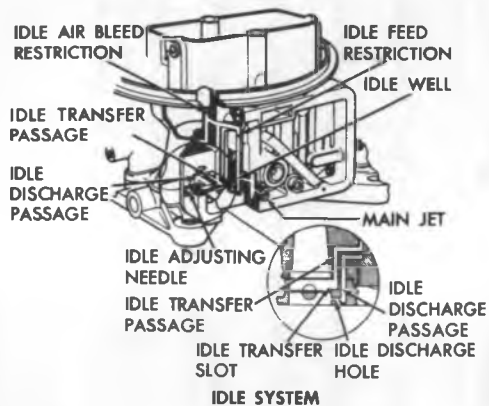
2. Wash all other parts in cleaning solvent.
3. Inspect holes in all operating levers and castings for excessive wear.
4. Inspect bearing surfaces of all shafts for excessive clearance. It is not necessary to remove shafts and plate to inspect.



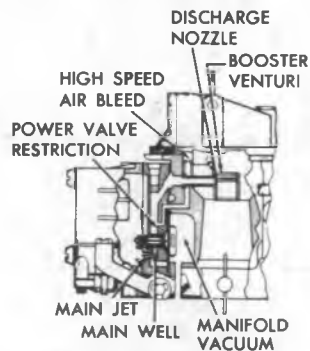
FUEL INLET SYSTEM



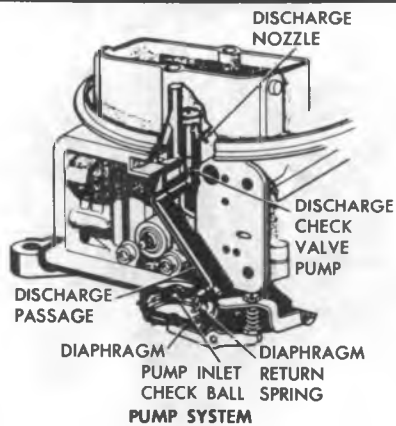
4150 SECONDARY SYSTEM (IDLE & LOW SPEED)



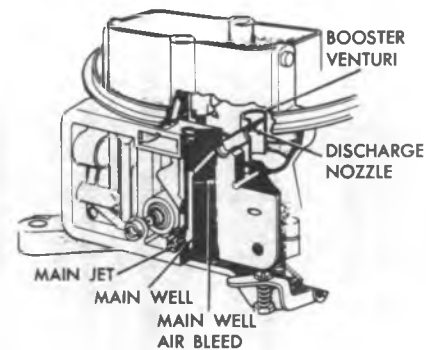
IDLE SYSTEM



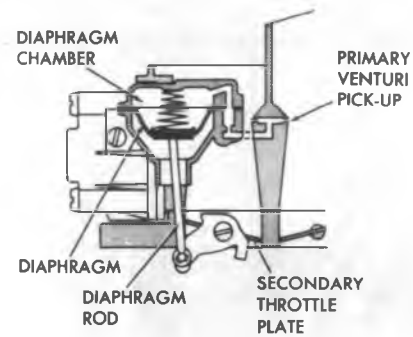
POWER SYSTEM



PUMP SYSTEM



MAIN METERING SYSTEM



SECONDARY THROTTLE OPERATING SYSTEM

Fig. H2-Fuel Systems

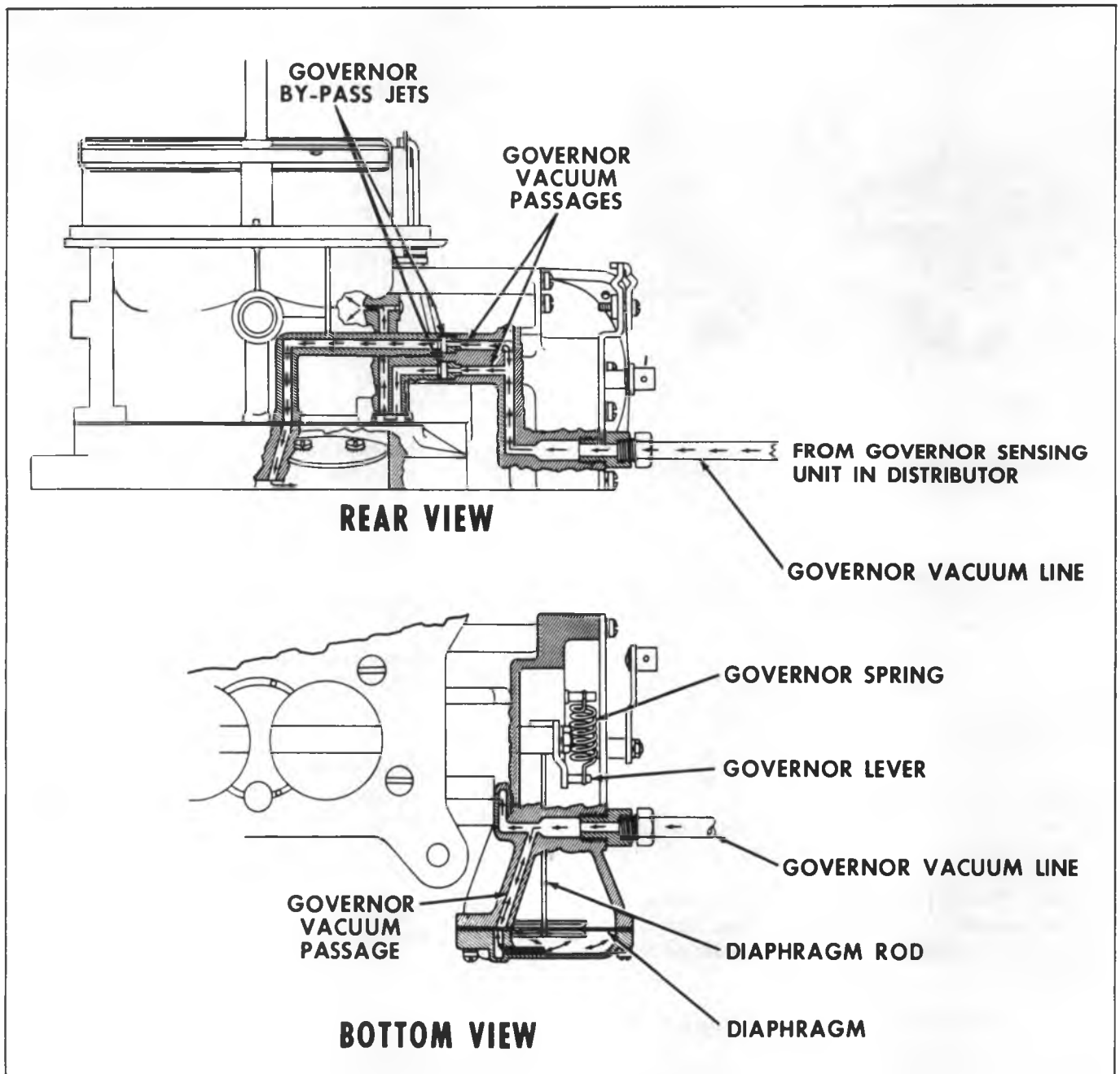


Fig. H3--Governor System

**NOTE:** If wear is excessive to the extent of improper operation of the carburetor, the worn parts should be replaced.

5. Inspect floats for bad dents and/or possible leaks.
6. Inspect pump diaphragm for damage.
7. Inspect float needles and seats for burrs and ridges; if present, replace both the needle and seat. Never replace either alone as these are an assembly.
8. Inspect edges of primary and secondary throttle valves for gouges and other deformations. If these or any other conditions exist which would prevent full seating, replace the faulty valve.
9. Inspect all mating surfaces of fuel bowl, carburetor body, and throttle flange for burrs, gouges, or other surface irregularities. All surfaces must be smooth and square to prevent leaks.
10. Check secondary throttle operating diaphragm for free operation and leakage by moving diaphragm rod to the up position then covering vacuum passage opening in housing with thumb. The diaphragm should hold upward. Remove thumb from vacuum passage and diaphragm rod should move down readily.
11. After washing solvent, clear all passages in the metering body and main body with compressed air. If passages or welsh plugs in either body are damaged, the body must be replaced.
12. Check filter element for restriction by blowing on cone

## 6M-6 CARBURETORS

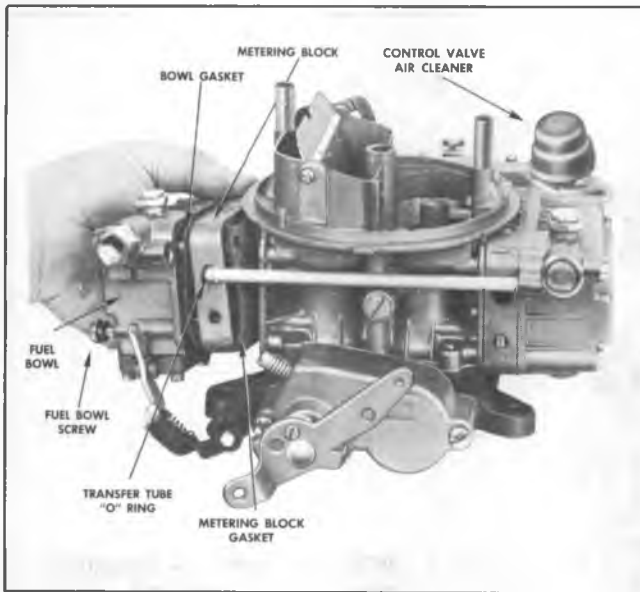


Fig. H4—Fuel Bowl Removal

end, element should allow air to pass freely.

13. Clean element by washing in solvent and blowing out. Blow in opposite direction of fuel flow.

### Assembly and Adjustments (Fig. H11)

#### Assemble Throttle Body

1. Install secondary throttle stop screw (if removed).
2. Install throttle shafts in throttle body.

**NOTE:** The throttle shafts have plastic bushings. Roll new bushing between thumb and first finger to help shape the bushing on the shaft for easier installation.

3. Install the throttle valves on the shaft (do not tighten retaining screws).
4. Center the throttle valves on the shafts by holding the valves closed and aligning scribe marks while tightening the screws.

**NOTE:** The throttle valves are installed with stamped identification numbers up.

5. Support the throttle shafts and stake the throttle valve screws.
6. Install the throttle connecting rod to the throttle shaft levers (Fig. M13 and M14).
7. Install fast idle cam lever on primary throttle shaft lever and diaphragm lever on secondary throttle shaft.
8. Install idle speed screw and spring.
9. Install accelerator pump cam on throttle lever.
10. Assemble and install pump operating lever assembly.

11. Install throttle shaft in housing. Install inner lever on shaft, tighten retaining screw.
12. Install throttle operating housing on throttle body, install and tighten screws.

#### Assemble Main Body

1. Install pump discharge valve.
2. Install pump discharge nozzle. Use new gaskets.
3. Install choke rod seal and choke rod in main body.
4. Install choke shaft in main body and connect upper end of choke rod.
5. Install choke valve on choke shaft (do not tighten retaining screws).
6. Center choke valve on shaft by holding valve closed while tightening screws.
7. Stake screw ends with pliers.

**NOTE:** The choke valve is offset and should fall freely to wide open position from its own weight.

8. Install choke lever and spring then retainer.

#### Assemble Secondary Diaphragm Housing Assembly

1. Install throttle operating diaphragm and spring.
2. Install air cleaner and tighten all screws securely.

#### Assemble Metering Bodies

1. With a new gasket, install power valve and tighten securely (use a 1" 12-point socket).
2. Install main jets with a jet wrench or wide blade screw driver.

**NOTE:** A small screw driver will distort jet and change carburetor calibration.

3. Install idle mixture screws with new seals.

#### Assemble Fuel Bowls

1. Install sight plugs with new gaskets.
2. Install inlet needle and seats leaving locknuts loose. Use new gaskets.
3. Install inlet fitting, fuel filter, spring and new gaskets.
4. Assemble spring to float, slide float into bowl and install float hinge pin retainer.
5. Install inlet baffle in bowl.
6. Install pump spring and diaphragm in primary fuel bowl.
7. Install air vent valve assembly in primary fuel bowl.

#### Adjust Float (Fig. H15)

1. Invert fuel bowl allowing float to drop to the fully closed position.

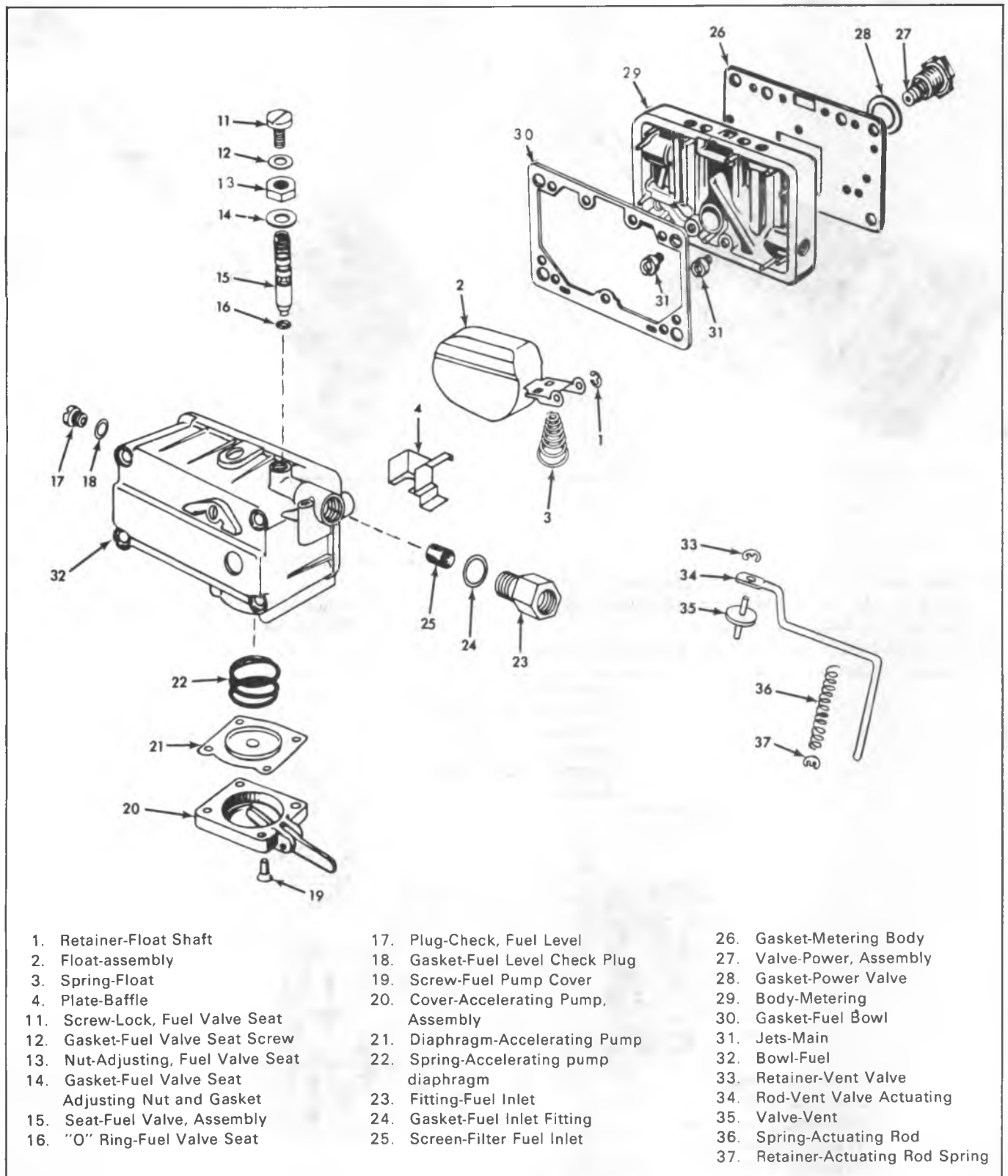


Fig. H5--Fuel Bowl and Metering Block--Exploded View





Fig. H6--Main Jet Removal



Fig. H7--Power Valve Removal

2. Using specified pin gauge from universal carburetor gauge set, check float level setting from lower edge of float bowl to lower edge of float.
3. To adjust float level, turn adjustable needle seat nut.

Lock down adjustment with screw.

**NOTE:** Final adjustment of float should be made on the vehicle. Refer to Section 6M of the Chassis Service Manual.

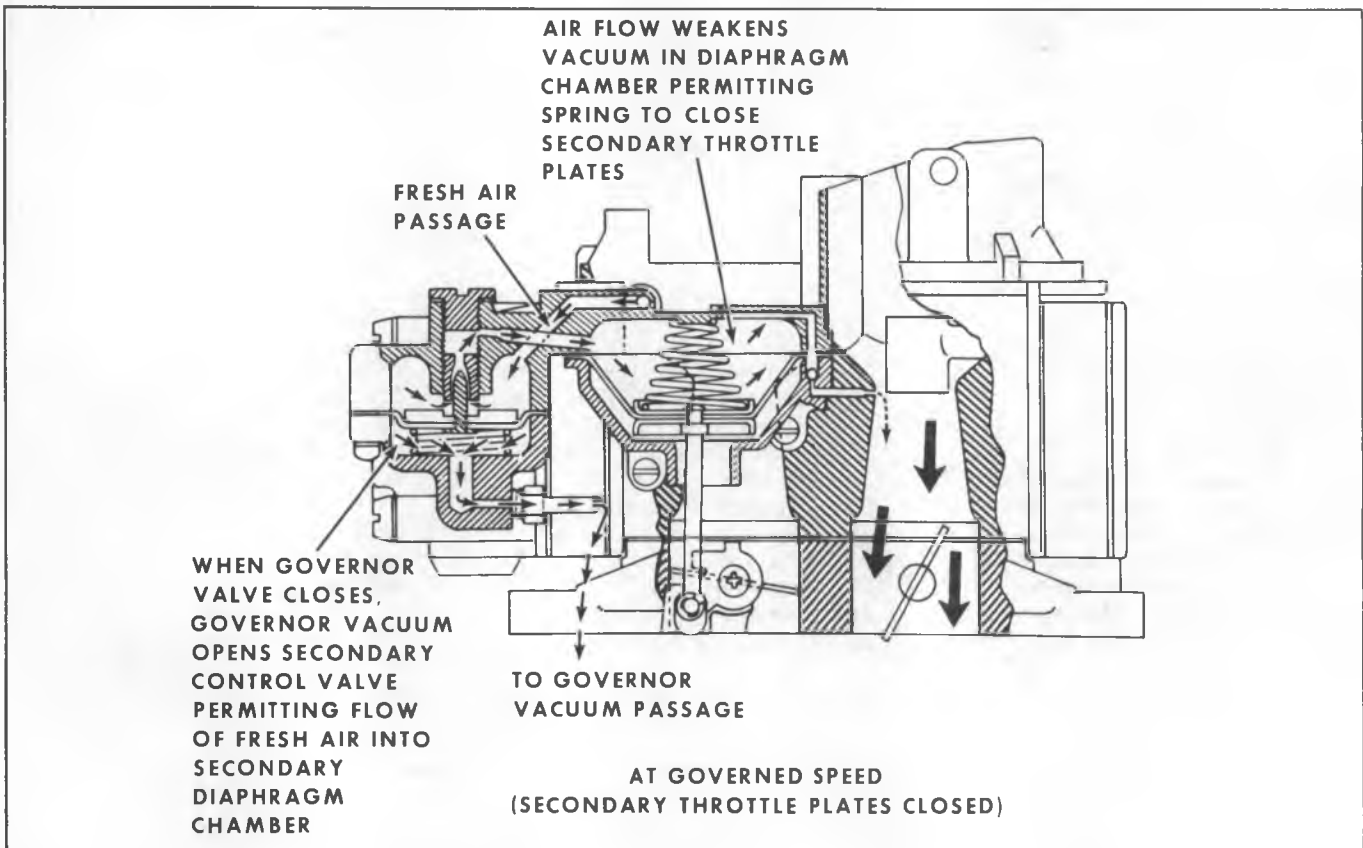


Fig. H8--Secondary Control Valve Operation (at Governed Speed)

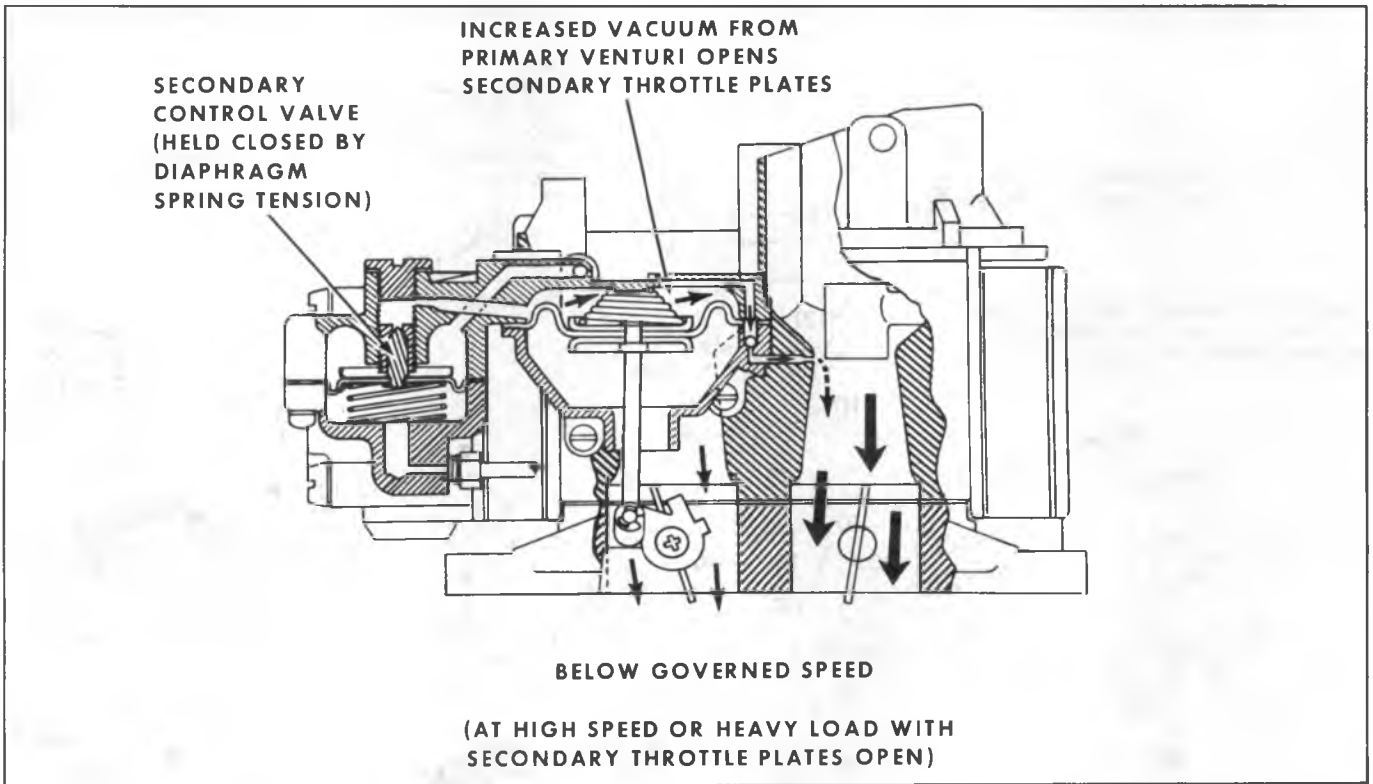


Fig. H8A--Secondary Control Valve Operation (below Governed Speed)

**Assemble Subassemblies**

1. Invert the main body, align new throttle body to main body gasket, then position throttle body assembly and install the screws and tighten securely.

2. Using a new gasket, install secondary throttle operating assembly on main body and tighten securely. Install operating rod and clip on secondary throttle lever.
3. Install new governor body gaskets in main body.
4. Install throttle shaft seal. Slide governor assembly onto throttle shaft. Install and tighten governor body screws.

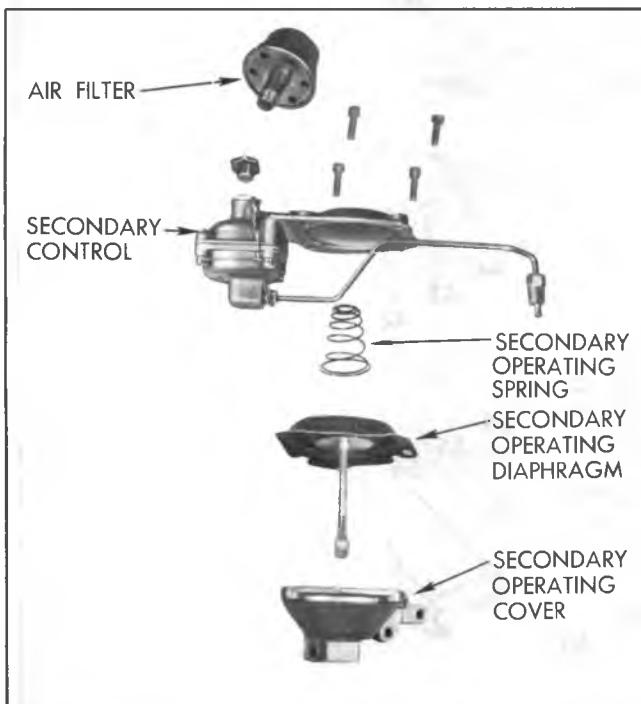


Fig. H9--Secondary Throttle Operating and Control Assembly

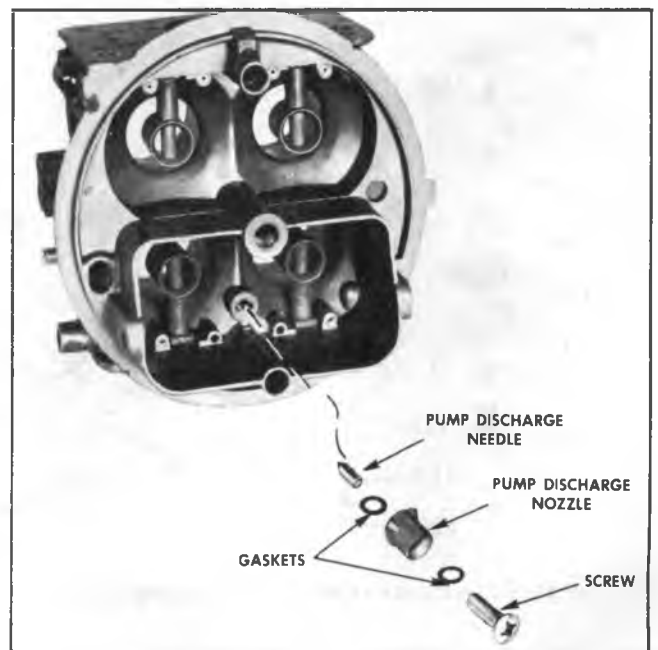


Fig. H10--Pump Discharge Needle Assembly

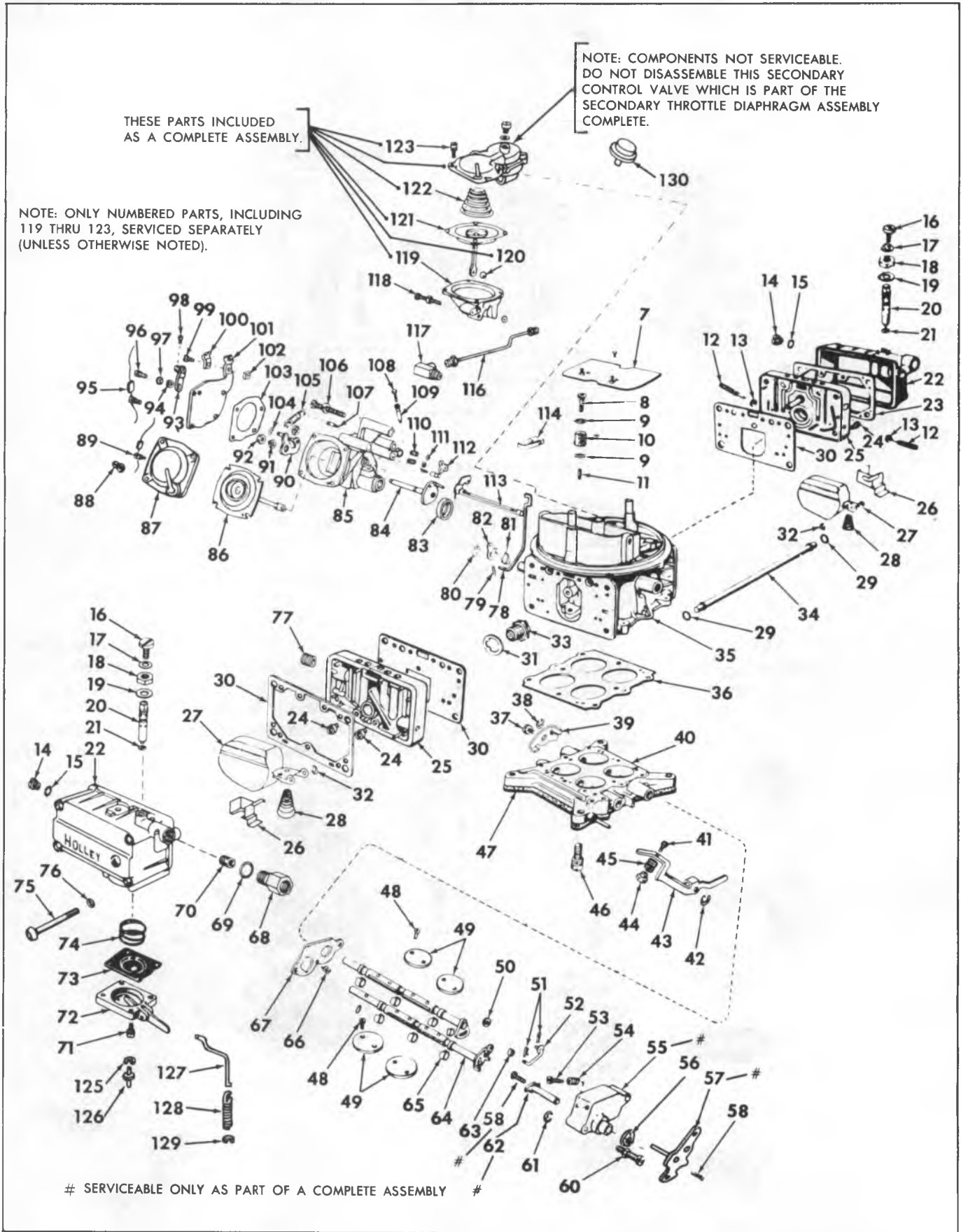


Fig. H11--Holley Model 4150G--Exploded View

1. Plug-Secondary Control Valve (a)
2. Cover-Secondary Control Valve (a)
3. Gasket (a)
4. Diaphragm-Secondary Control Valve (a)
5. Spring-Secondary Control Valve (a)
6. Housing-Secondary Control Valve (a)
7. Plate-Choke
8. Screw-Nozzle
9. Gasket-Nozzle
10. Nozzle-Pump Discharge
11. Valve-Pump Nozzle
12. Needle-Idle Adjusting
13. Seal-Idle Needle
14. Plug-Sight
15. Gasket-Sight Plug
16. Screw-Valve Seat
17. Gasket-Valve Seat Screw
18. Nut-Valve Seat Adjusting
19. Gasket-Valve Seat
20. Valve-Fuel Inlet
21. Seal-Fuel Inlet Valve
22. Bowl-Fuel
23. Gasket-Fuel Bowl
24. Jet-Main
25. Body-Metering
26. Plate-Baffle
27. Float-Assembly
28. Spring-Float
29. "O" Ring-Fuel Tube
30. Gasket-Metering Body
31. Gasket-Power Valve
32. Retainer-Float Shaft
33. Valve-Power
34. Tube-Fuel
35. Body-Main
36. Gasket-Main Body
37. Screw
38. Retainer
39. Lever
40. Body-Throttle
41. Screw-Pump Lever Adjusting
42. Retainer
43. Lever-Pump Operating
44. Nut-Pump Lever Adjusting Screw
45. Spring-Pump Lever Screw
46. Screw-Throttle Body to Main Body
47. Gasket-Mounting Carburetor
48. Screw-Throttle Plate
49. Plate-Throttle
50. Washer-Throttle Rod
51. Retainer-Throttle Rod
52. Rod-Throttle Connect
53. Screw-Throttle Stop
54. Spring-Throttle Stop Screw
55. Housing-Throttle Operating (b)
56. Cam-Accelerator Pump Operating
57. Lever-Throttle Shaft (b)
58. Screw-Throttle Shaft Lever (b)
59. Screw-Throttle Operating Lever
60. Screw-Throttle Operating Housing
61. Retainer
62. Lever-Throttle Operating (b)
63. Spacer-Throttle Rod
64. Shaft-Throttle
65. Bushing-Throttle Shaft
66. Screw-Throttle Shaft Housing Plate
67. Plate-Throttle Shaft Housing
68. Fitting-Fuel Inlet
69. Gasket-Fuel Inlet Fitting
70. Screen-Filter
71. Screw-Accelerator Pump Cover
72. Cover w/Lever-Accelerator Pump
73. Diaphragm-Accelerator Pump
74. Spring-Accelerator Pump Diaphragm
75. Screw-Float Bowl
76. Gasket-Float Bowl Screw
77. Plug
78. Rod-Choke
79. Retainer-Choke Rod
80. Retainer-Choke Lever
81. Spring-Choke Rod
82. Lever-Choke Rod
83. Seal-Throttle Shaft
84. Shaft-Fast Idle Cam
85. Housing w/Plug-Governor
86. Diaphragm-Governor, Assembly
87. Cover-Governor Diaphragm
88. Screw-Governor Cover
89. Wire-Seal Governor Cover Screw
90. Lever-Governor, Assembly
91. Washer-Governor Lever Nut
92. Nut-Governor Lever
93. Lever-Choke
94. Washer-Choke Lever
95. Wire-Seal
96. Screw-Governor Housing Cover
97. Nut-Choke Lever
98. Screw-Choke Lever Swivel
99. Screw-Choke Cable Clamp
100. Clamp-Choke Cable
101. Cover-Governor Housing
102. Nut-Choke Cable Clamp Screw
103. Gasket-Governor Housing Cover
104. Retainer
105. Spring-Governor
106. Screw-Governor Housing
107. Post-Governor Spring
108. Screw-Fast Idle
109. Pin-Fast Idle
110. Jet-By-Pass-Governor
111. Seal-Governor Passage
112. Gasket-Governor Housing
113. Shaft w/Lever-Choke
114. Seal-Choke Rod
115. Screw-Secondary Control Valve Housing
116. Pipe-Fuel Control Valve
117. Tee
118. Screw-Control Valve Housing
119. Housing-Control Valve
120. Ball-Check
121. Diaphragm-Control Valve
122. Spring-Control Valve Diaphragm
123. Screw-Control Valve Cover
124. Gasket-Secondary Control Valve Plug
125. Retainer-Vent Valve
126. Valve-Vent
127. Rod-Vent Valve Actuating
128. Spring-Vent Valve Rod
129. Retainer-Vent Valve Rod Spring
130. Air Cleaner-Control Valve

(a) Serviceable Only as Part of a Complete Assembly - Not Shown.

(b) Serviceable Only as Part of a Complete Assembly.

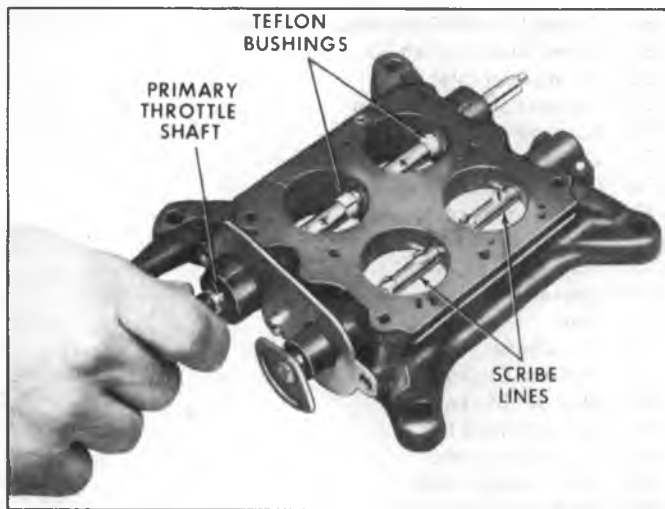


Fig. H12—Throttle Body Assembly

5. Install governor lever, lock washer and nut. Tighten securely. Install governor spring.
6. Install governor cover and lever. Tighten nut and screws securely.
7. Install vacuum fitting and governor control tube assembly. Tighten securely.
8. Lay throttle body and main body on primary side then install new fuel bowl gasket and secondary metering body assembly onto main body aligning dowel pins and holes.
9. Lubricate "O" ring seals and install on fuel tube at very end. (They will roll into position during installation.) Then install fuel tube into secondary bowl inlet.
10. Install splash shield, new gasket and primary fuel bowl. Align fuel tube into inlet.
11. Align pump lever under operating lever duration spring, then install fuel bowl retaining screws with new gaskets under heads and tighten securely.

#### **Adjust Secondary Throttle Valve Stop Screw (Fig. H16)**

1. Back off on adjustment screw until throttle plates are fully closed.
2. Turn adjustment screw until it just touches the throttle lever and turn one-half turn more to position the valves.

#### **Adjust Air Vent Valve (Fig. H17)**

1. Back off idle speed screw until throttle valves are fully closed. (Choke valve open and throttle arm off idle screw).
2. Check clearance between air vent valve and seat.
3. Bend air vent valve rod to adjust.
4. Turn idle screw in until contact is made with throttle lever, then turn screw in 1-1/2 additional turns for preliminary idle speed adjustment.

#### **Adjust Fast Idle Cam (Fig. H18)**

1. Adjust fast idle screw to provide specified clearance between screw head and fast idle cam.

#### **Adjust Accelerator Pump (Fig. H19)**

1. Hold throttle lever in wide open position with a rubber band and hold pump lever fully compressed (down), then measure the clearance between spring adjusting nut and arm of the pump lever.
2. Clearance should be .015"; adjust by turning nut or screw as required while holding opposite end. (The pump operating lever is not threaded).
3. After adjustment is made, rotate the throttle lever to fully closed and partly open again. Any movement of the throttle lever should be noticed at operating lever spring end, indicating correct pump tip-in.



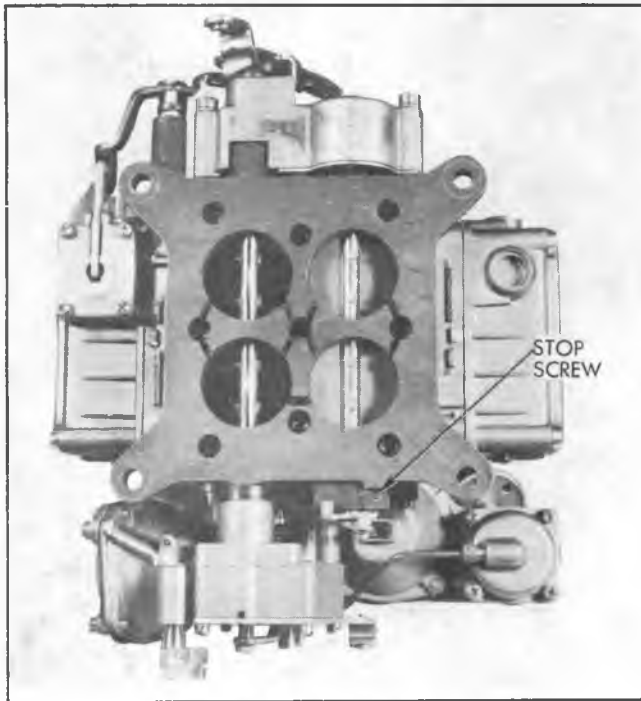


Fig. H13--Throttle Body Linkage

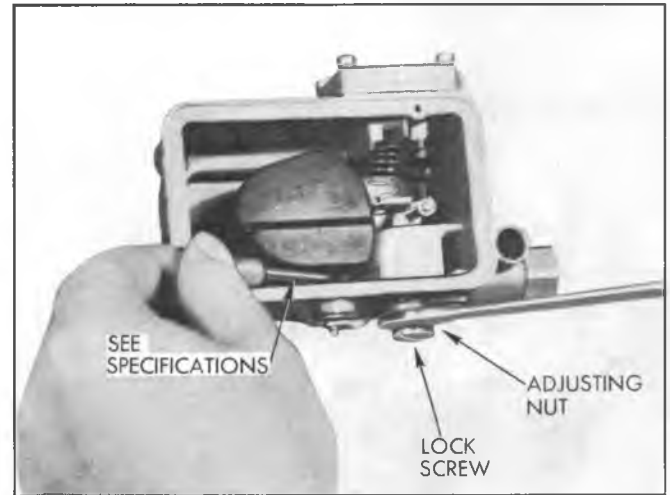


Fig. H15--Preliminary Float Adjustment

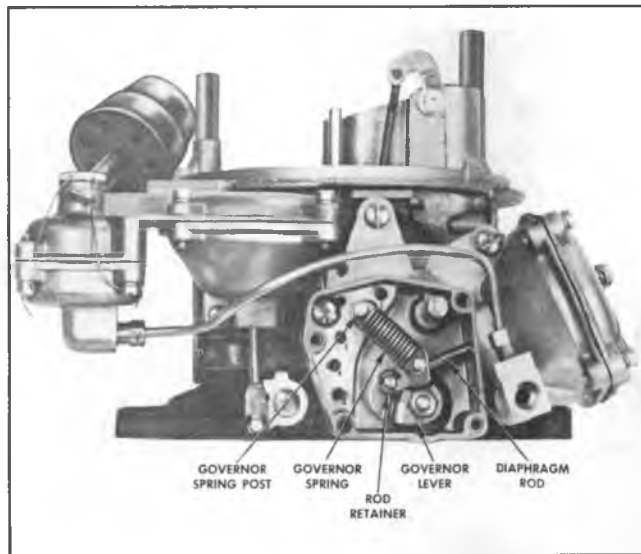


Fig. H14--Governor Control Linkage

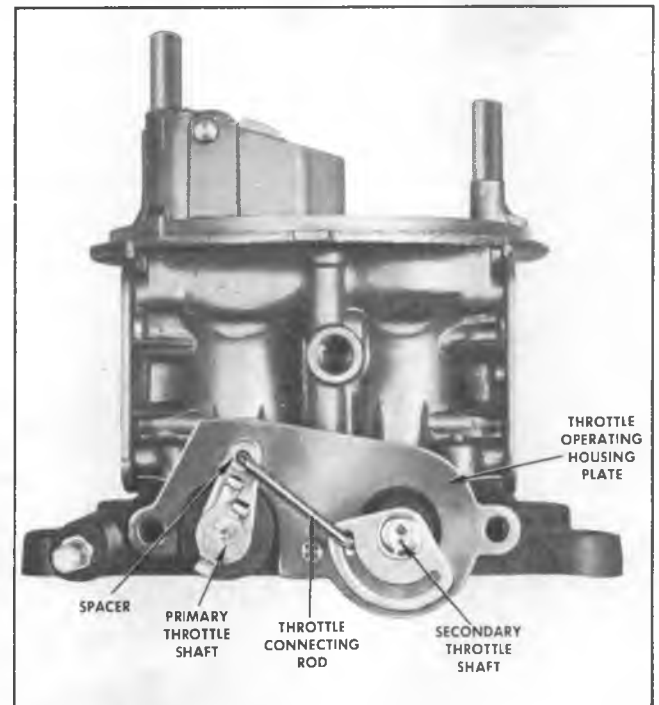


Fig. H16--Secondary Throttle Stop Screw



Fig. H17--Air Vent Valve Adjustment



Fig. H18--Fast Idle Adjustment



Fig. H19--Accelerator Pump Adjustment

# SPECIAL TOOLS



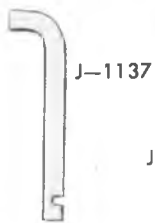
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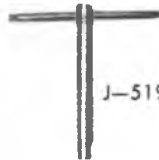
J - 10176



J-1137



J-4552



J-5197

**BENDING TOOLS**

- J-1137 Choke Rod Bending
- J-4552 Choke Rod Bending (1 and 2 bbl.)
- J-5197 Unloader Bending



J-8328

- J-8328 Carburetor Holding Tool
- J-9789 Universal Carburetor Kit
- J-10176 Fast Idle Wrench
- J-22973 Ther-Mac Thermometer

Fig. H20--Engine Fuel Special Tools



## SECTION 6Y

# DELCOTRON

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## 6.2" SERIES 2D TYPE 150 DELCOTRON

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### DISASSEMBLY (Figs. 1C and 2C)

1. Hold generator in a vise, clamping the drive end mounting flange lengthwise.
2. Remove two screws securing the cover to the brush holder and remove cover (fig. 3C).
3. Remove the nut retaining indicator light wire to the blade connector post and disconnect wire lead from post.
4. Remove two screws retaining the capacitor and brush holder to rear end frame. Remove brush holder.

**NOTE:** Capacitor lead is connected inside the generator. Allow capacitor to remain with the generator to avoid undue strain on the lead wire.

5. Remove three slip ring end frame attaching bolts and tab nuts.
6. Carefully pry the end frame and case apart (using a screw driver) slowly all the way around the circumference to remove the end frame.
7. Remove the three drive end frame attaching bolts and tab nuts and remove the end frame, rotor and pulley as an assembly.

8. Remove shaft nut, washer, pulley and woodruff key from rotor shaft, then slide rotor from end frame.
9. Remove drive end frame bearing retainer plate and bearing from end frame.
10. To remove slip ring end frame bearing from rotor shaft, use Tool J-6627 as shown in Figure 8C.
11. Disconnect the three stator leads by cutting the leads between coil and diodes (fig. 6C). An alternate method is to scrape epoxy coating from lead connections and unsolder stator leads, using a minimum amount of heat to avoid damage to diodes.

**NOTE:** Separating these three leads will allow diode and stator tests outlined in this section.

12. Remove heat sink-to-case retaining screws and remove heat sinks. Insulated heat sink (with batt. terminal) holds positive diodes.

### CLEANING AND INSPECTION

With generator completely disassembled, except for removal of diodes, the components should be cleaned and inspected. Be sure testing equipment is in good working order



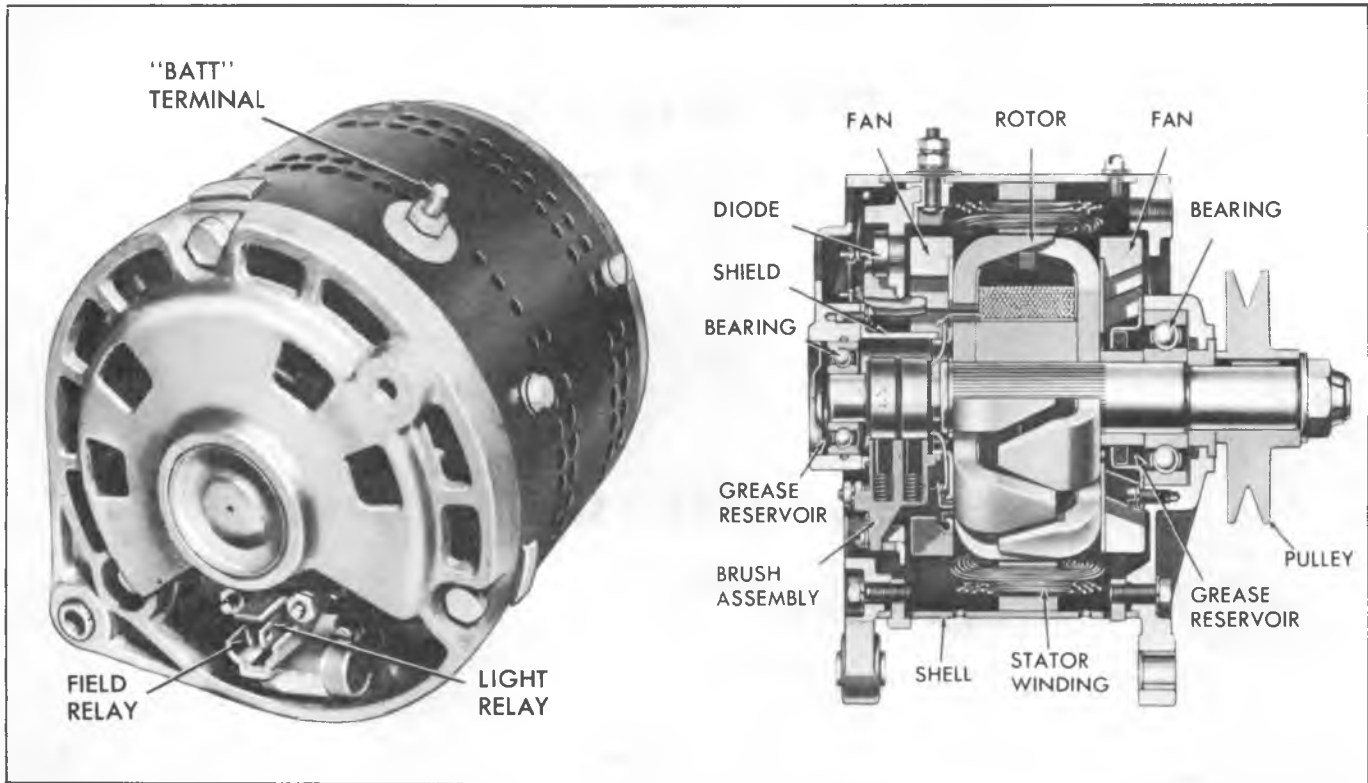


Fig. 1C--6.2" Series 2D Type 150 Delcotron

before attempting to check the generator.

1. Wash all metal parts except stator and rotor assemblies.
2. Clean bearings and inspect for sealing, pitting or roughness.
3. Inspect rotor slip rings, they may be cleaned with 400 grain polishing cloth. Rotate rotor for this operation to prevent creating flat spots on slip rings.
4. Slip rings which are out of round may be tured in a lathe to .001" maximum indicator reading. Remove only enough material to make the rings smooth and concentric. Finish with 400 grain polishing cloth and blow dry.
5. Slip rings are not replaceable--excessive damage will require rotor assembly replacement.
6. Inspect brushes for wear. If they are worn halfway, replace. Inspect brush springs for distortion or weakening. If brushes appear satisfactory and move freely in brush holder, springs may be reused.

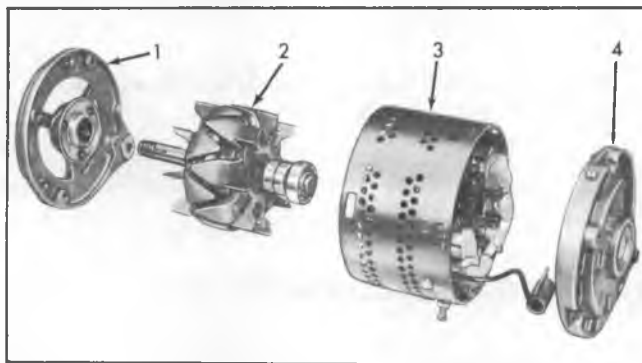


Fig. 2C--6.2" Series 2D Delcotron Assembly

### Testing Rotor (Fig. 4C)

The rotor may be checked electrically with a 110-volt test lamp or an ohmmeter.

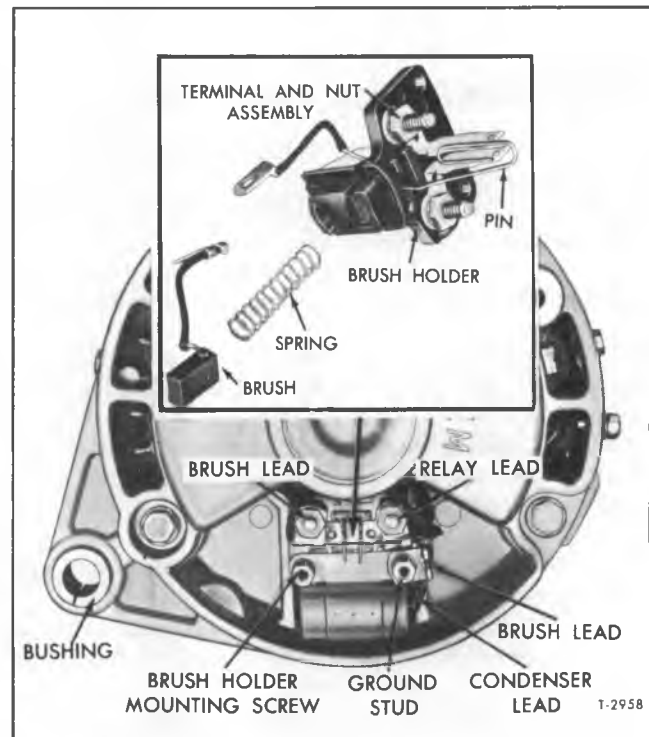


Fig. 3C--6.2" Series 2D Delcotron Brush Holder Assembly

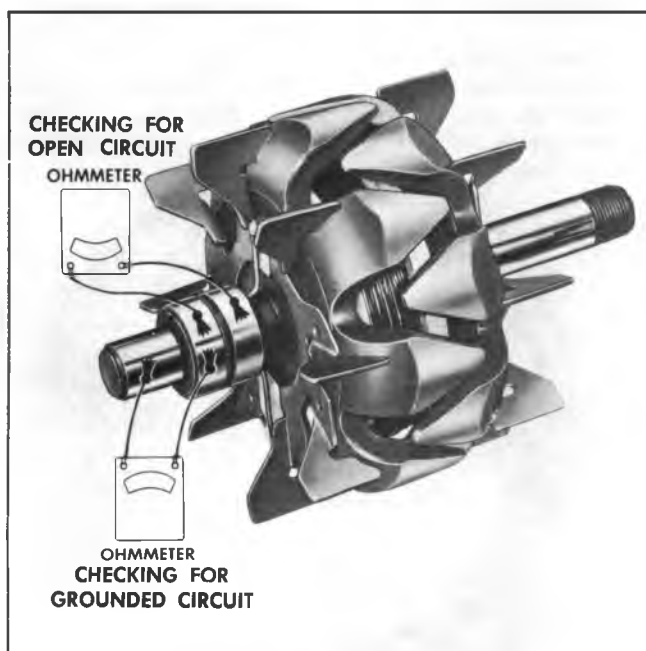


Fig. 4C--Checking Rotor

### Grounds

Connect test lamp or ohmmeter from either slip ring to the rotor shaft or to the rotor poles. If the lamp lights or if the ohmmeter reading is low, the field windings are grounded.

### Opens

Connect one test lamp or ohmmeter lead to each slip ring. If the lamp fails to light or if the ohmmeter reading is high, the windings are open.

### Short Circuit

The windings are checked for shorts by connecting a 12 volt battery and an ammeter in series with the two slip rings.

Note the ammeter reading. An ammeter reading above the specified field amperage draw indicates shorted windings. Refer to Specifications at the end of this manual.

## TESTING STATOR (Fig. 5C)

### Grounds

Connect a 110-volt test lamp or an ohmmeter from any stator lead to the stator frame. If test lamp lights or if ohmmeter reads low, the windings are grounded.

### Open Circuit

If lamp fails to light or if ohmmeter reads high when successively connected between each pair of stator leads, the windings are open.

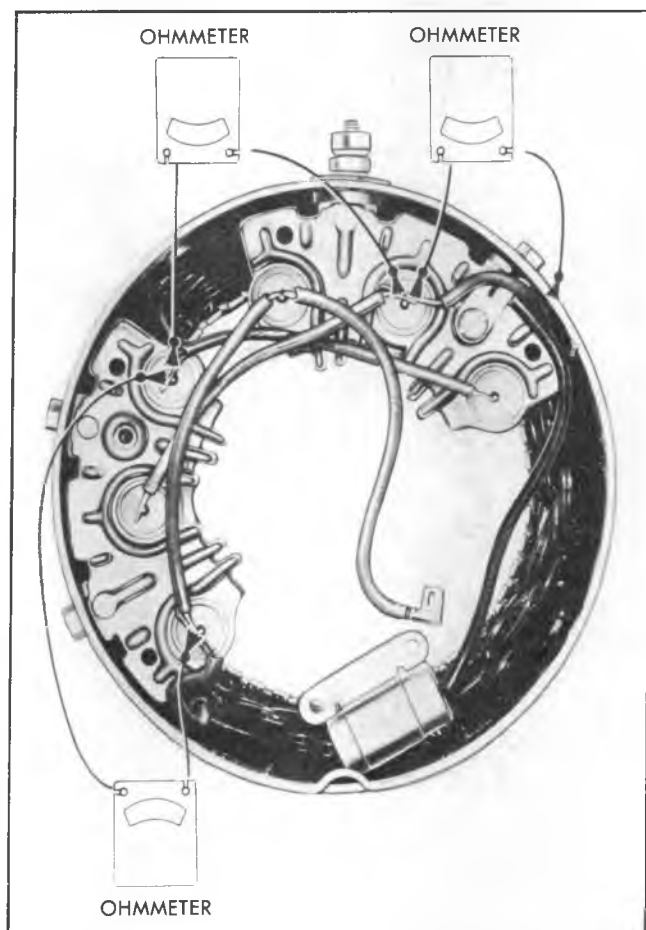


Fig. 5C--Checking Stator for Grounds or Opens

### Short Circuit

A short in the stator windings is difficult to locate without special test equipment due to the low resistance of the windings. However, if all other electrical checks are normal and the generator fails to supply rated output, shorted stator windings are indicated. Also, look for heat discoloration on the windings.

## TESTING DIODES (Fig. 6C)

Two methods may be used to check diodes for shorts or opens, a test lamp of not more than 12 volts or an ohmmeter.

**CAUTION:** Do not use a 110-volt test lamp to test diodes.

### Test Lamp Method

#### Diode in Heat Sink

With the stator previously disconnected connect one of the lamp leads to the heat sink and other lead to the diode lead. Observe condition of lamp. Reverse the lamp leads and observe condition of lamp. A good diode will allow the lamp to light in only one of the test directions. If lamp lights in both directions or fails to light at all, the diode is defective.

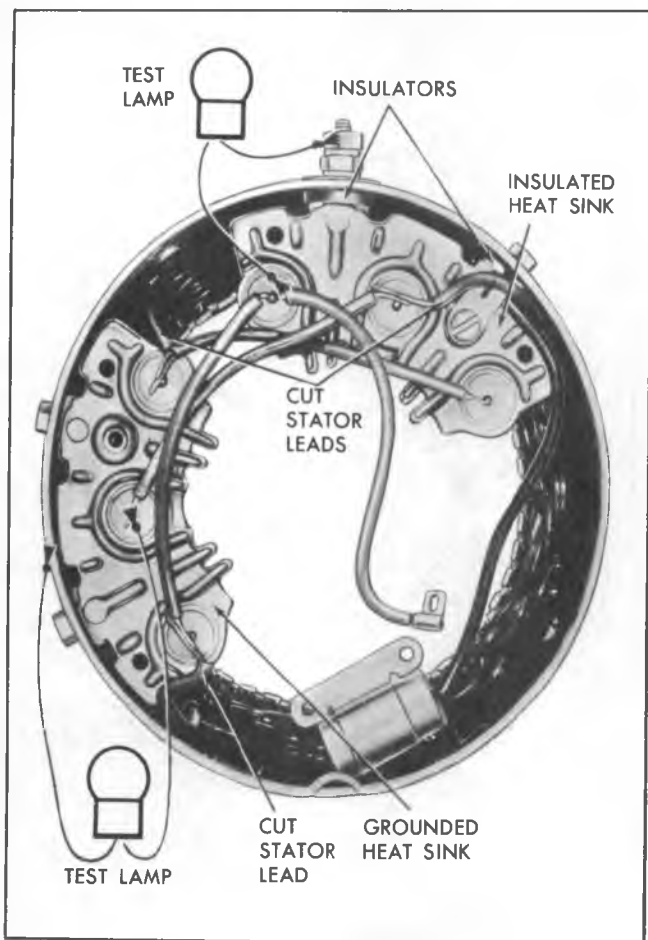


Fig. 6C—Checking Diodes

### Diode in the End Frame

Connect one lamp lead to the end frame and the other lamp lead to the diode lead, and observe lamp condition. Reverse the lamp lead connections and observe the lamp condition. A good diode will allow lamp to light in only one direction. If lamp lights in both directions or fails to light at all, the diode is defective.

## OHMMETER METHOD

Use an ohmmeter with a 1-1/2 volt cell and use the lowest range scale.

Connect the ohmmeter leads at each diode as previously described using a test lamp first in one direction and then the other. Note the readings. If both readings are identical (very high or very low), the diode is defective. A good diode will give one high and one low reading.

## REPAIRS

### Diode Replacement (Fig. 7C)

1. Chip away all epoxy from around diode stem, then cut leads connected to diode stem as close to stem as possible, if not previously done during disassembly.

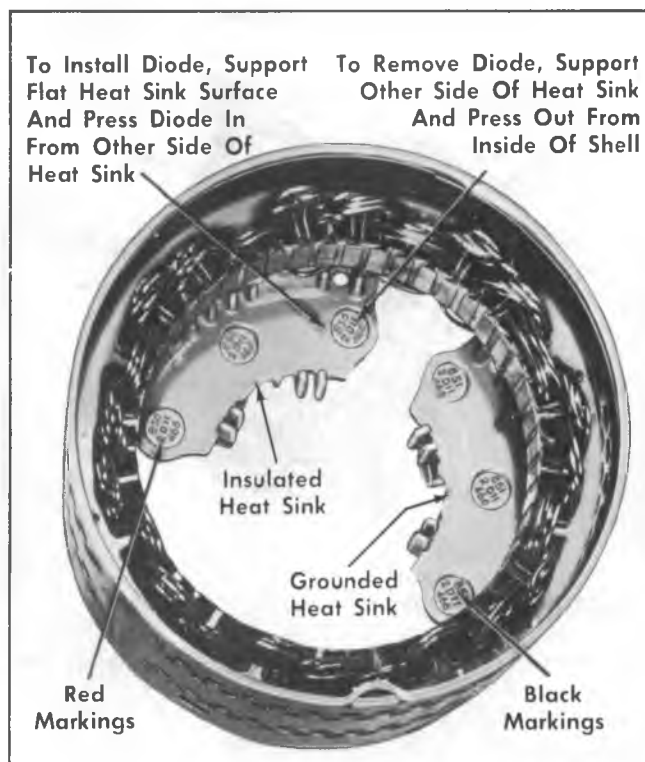


Fig. 7C—Diode Replacement

2. Support end frame with support Tool J-9712-2 and press out diode with diode removal Tool J-9717-1 and an arbor press or vise.

**CAUTION:** Do not strike diode as shock may damage other diodes.

3. Select diode with proper color marking.

**NOTE:** Diodes in the heat sink (with batt terminal) are positive (red markings) and those in the heat sink grounded to the case are negative (black markings).

4. Support outside end of frame around diode hole on a flat, smooth surface and press diode into position with J-9600-2 and an arbor press or vise. Make sure diode is square with end frame and started straight (fig. 5C).

**CAUTION:** Avoid bending or moving diode stem as excessive movement can cause internal damage and result in diode failure.

5. Scrape enough insulation from diode stem and lead to insure good contact. Locate a sleeve over the diode and place the "T" clip from the diode package over the diode stem.
6. Place the flexible lead and, if applicable, the stator lead into the "T" connector. Crimp and solder securely using 60% tin, 40% lead rosin core solder.

**CAUTION:** Do not heat excessively, and avoid bending or moving diode stem as excessive heat and



Fig. 8C--Removing Bearing

movement can cause internal damage and result in diode failure.

7. Fill the area around the diode stem and "T" clip with epoxy so as to completely cover the stem and "T" clip.
8. Tie or tape the leads together to resist vibration.

### Heat Sink Replacement

1. Detach heat sink from case by removing the attaching bolts. Note carefully the proper stack up of parts so the "BAT" and "GRD" terminal bolts can be reassembled in the same manner. Chip away all epoxy, then cut all leads on each side of the three diode stems as close to the stems as possible.
2. Replace diodes, if necessary, as outlined in Diode Replacement.
3. Assemble heat sink to the case, following carefully the proper stack up of parts as noted in Step 1. Reconnect leads as described under diode replacement.

### Bearing Replacement-Drive End Frame

1. The drive end frame bearing can be removed by detaching the retainer plate bolts and separating retainer plate and seal assembly from end frame, and then pressing bearing out using suitable tube or pipe on outer race.
2. Refill bearing one-quarter full with Delco-Remy No. 1948791 grease or equivalent. Do not overfill.
3. Press bearing into end frame using tube or pipe as in Step 1.
4. Install retainer plate. Use new retainer plate if felt seal is hardened or excessively worn.

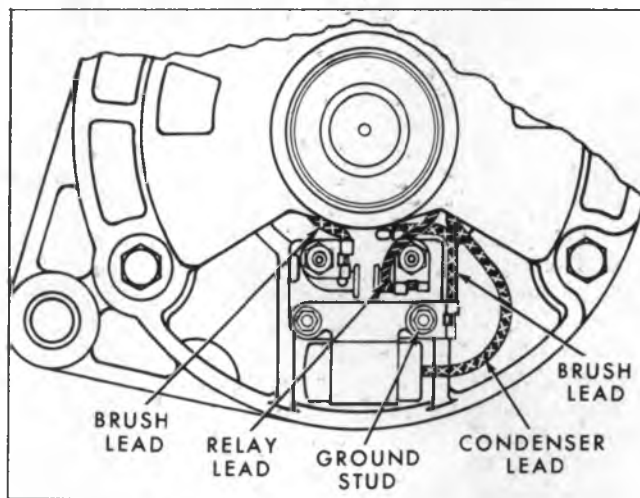


Fig. 9C--Lead Arrangement After Assembly

### Bearing Replacement-Slip Ring End Frame

1. Remove bearing from rotor shaft using Tool J-6627 or other suitable puller as shown in Figure 8C.
2. Install bearing over shaft using Tool J-9610 or tube or pipe of suitable diameter over inner race and press to locate bearing even with end of shaft.

### ASSEMBLY

1. Install stator assembly in slip ring end frame and locate diode connectors over the relay, diode and stator leads, and tighten terminal nuts.
2. Install the front frame over rotor.
3. Install fan, spacer, woodruff key, pulley, washer and nut.
4. Clamp pulley in soft jaw vise and tighten shaft nut to 50-60 ft. lbs.

**NOTE:** Do not clamp rotor since this may cause rotor segment deformation.

5. Position rotor and drive end frame assembly into slip ring end frame and stator. Install and tighten through bolts.
6. To install brushes, push brushes into holder and install pin to keep the brushes in holder.
7. Attach brush assembly and condenser to the end frame with hex head stud on the left side only.
8. Rearrange leads as shown in Figure 9C with right-hand brush lead connected under the right hand hex-head stud.
9. Remove pin and attach terminal cover with two screws, making sure leads are not caught underneath the cover.

# 6.6" SERIES 4D TYPE 150 DELCOTRON

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### DISASSEMBLY (Fig. 10C)

1. Remove 4 thru bolts (exposed at the slip ring end frame).
2. Extract rotor unit and drive end frame assemblies from the stator and slip ring end frame.

**CAUTION:** To prevent damage to the brush units

insert one of the thru bolts into the end frame opening and physically lift brushes against spring pressure.

3. Place a piece of tape over the slip ring end frame bearing to prevent entry of dirt or other foreign material.
4. Remove shaft nut, pulley, fan and woodruff key from shaft.
5. Slip drive end frame from rotor shaft and disassemble bearing retainer and grease reservoir.

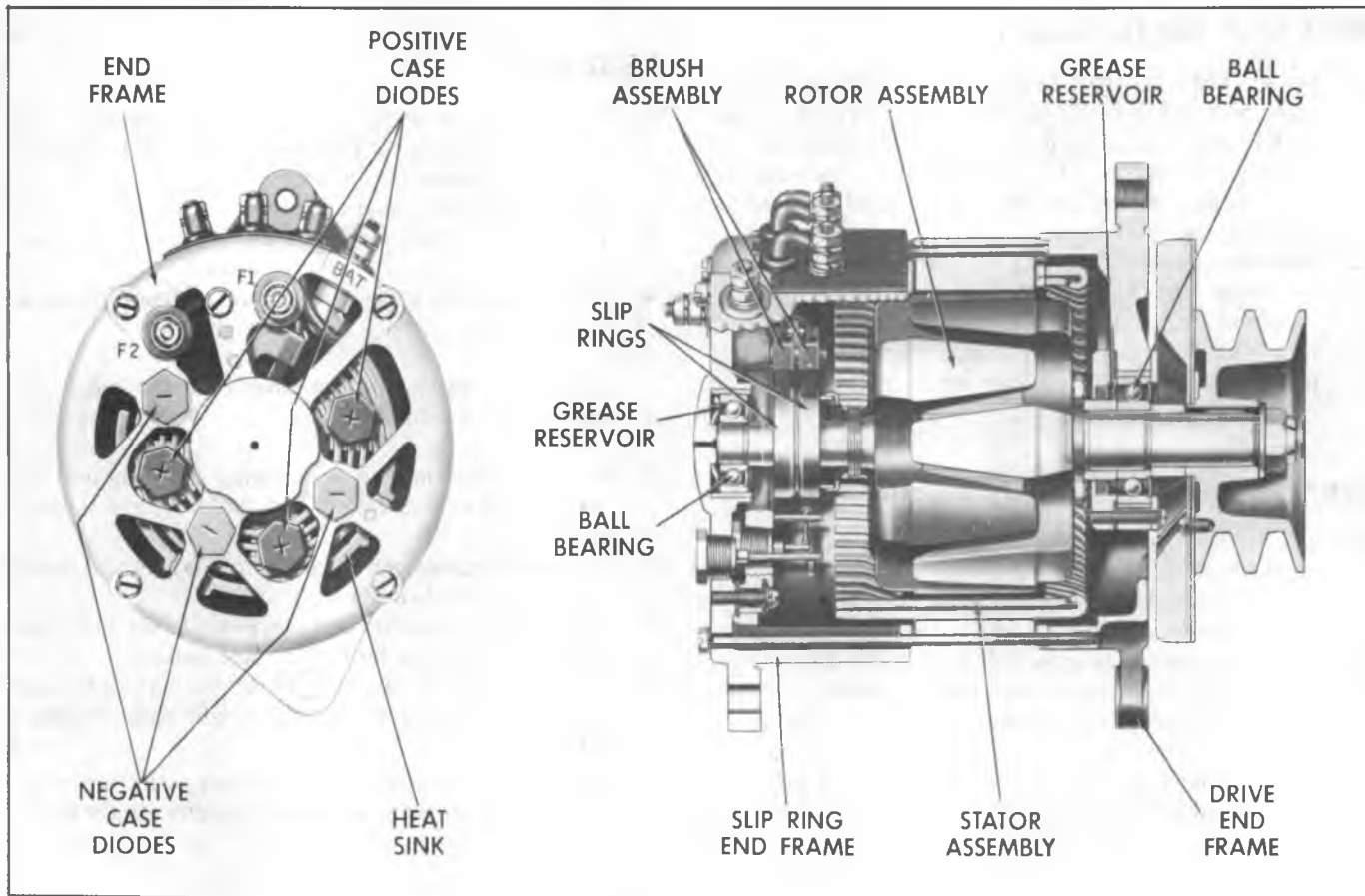


Fig. 10C-130 Amp Series 4D, Type 150 Delcotron



6. Disconnect the slip ring end frame from the 3 external terminals and separate the end frame from the rear of the stator shell.

**NOTE:** At this point, the generator is disassembled sufficiently to allow the subsequent cleaning, inspection, testing and replacement operations outlined in this section.

## CLEANING AND INSPECTION

With generator completely disassembled, except for removal of diodes, the components should be cleaned and inspected. Be sure testing equipment is in good working order before attempting to check the generator.

1. Wash all metal parts except stator and rotor assemblies.
2. Clean bearings and inspect for sealing, pitting or roughness.
3. Inspect rotor slip rings, they may be cleaned with 400 grain polishing cloth. Rotate rotor for this operation to prevent creating flat spots on slip rings.
4. Slip rings which are out of round may be trued in a lathe to .001" rings smooth and concentric. Finish with 400 grain polishing cloth and blow dry.
5. Slip rings are not replaceable--excessive damage will require rotor assembly replacement.
6. Inspect brushes for wear. If they are worn halfway, replace. Inspect brush springs for distortion or weakening. If brushes appear satisfactory and move freely in brush holder, springs may be reused.

## TESTING ROTOR

The rotor may be checked electrically with a 110-volt test lamp or an ohmmeter.

### Grounds

Connect test lamp or ohmmeter from either slip ring to the rotor shaft or to the rotor poles. If the lamp lights or if the ohmmeter reading is low, the field windings are grounded.

### Open Circuit

Connect one test lamp or ohmmeter lead to each slip ring. If the lamp fails to light or if the ohmmeter reading is high, the windings are open.

### Short Circuit

The windings are checked for shorts by connecting a 12 volt battery and an ammeter in series with the two slip rings. Note the ammeter reading. An ammeter reading above the specified field amperage draw indicates shorted windings. Refer to Specifications or appropriate service bulletin.



**OHMMETER PRODS  
(TOUCH TO DIODE CASE  
AND DIODE LEAD)**

Fig. 11C--Checking diodes

## TESTING DIODES

Two methods may be used to check diodes for shorts or opens, a test lamp of not more than 12 volts or an ohmmeter.

**CAUTION:** Do not use a 110-volt test lamp to test diodes.

### Test Lamp Method

#### Diode in Heat Sink

Touch test lamp lead to diode case and diode lead on generator (fig. 11C). Observe condition of lamp. Reverse the lamp leads and observe condition of lamp. A good diode will allow the lamp to light in only one of the test directions. If lamp lights in both directions or fails to light at all, the diode is defective.

#### Diode in the End Frame

Touch test lamp lead to diode case and diode lead on generator (fig. 11C) and observe lamp condition. Reverse the lamp lead connections and observe the lamp condition. A good diode will allow lamp to light in only one direction. If lamp lights in both directions or fails to light at all, the diode is defective.

### Ohmmeter Method

Use an ohmmeter with a 1-1/2 volt cell and use the lowest range scale.

Connect the ohmmeter leads at each diode as previously described using a test lamp first in one direction and then the

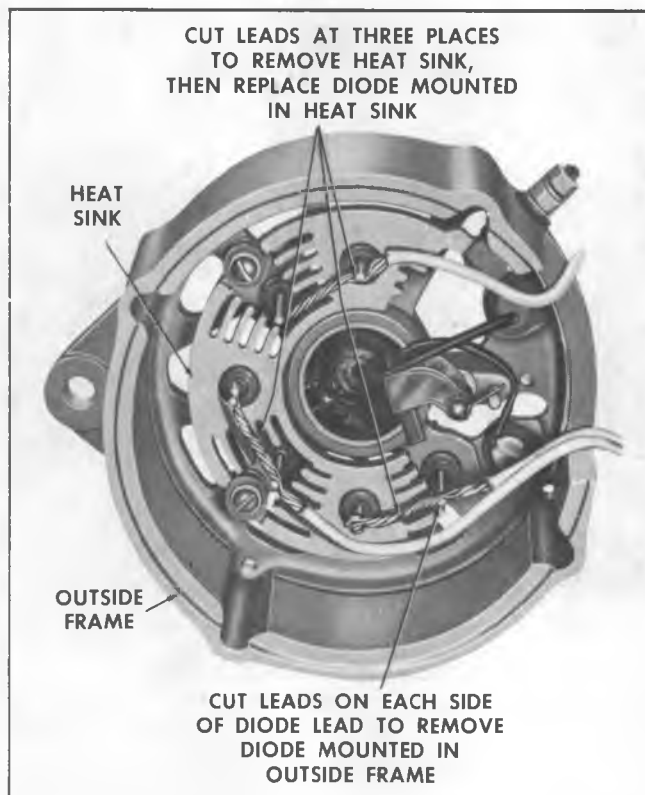


Fig. 12C--Replacing Defective Diodes

other (fig. 11C). Note the readings. If both readings are identical (very high or very low), the diode is defective. A good diode will give one high and one low reading.

## REPAIRS

### Diode Replacement

1. Cut the flexible lead(s) as close as possible to the defective diode lead (fig. 12C).
2. Remove the diode from the end frame or heat sink as required.
3. Select diode with proper polarity marking (Fig. 13C).

**NOTE:** If diode is to be assembled into the heat sink to an overall length of 1-3/8" (fig. 14C), do not grip the diode case when cutting the lead as this will damage the diode internally.

4. Lightly coat threads of new diode with silicone grease or light engine oil and install diode into sink or frame. Torque diode to 160-190 in. lbs.
5. Connect flexible lead(s) to diode as follows:
  - a. Place the clip over the diode lead and tightly crimp the flexible leads into the clip.
  - b. Solder the leads to the clip and the clip to the diode lead.

**CAUTION:** Use only 60% tin, 40% lead rosin core solder or equivalent with 360 degrees F. melting point. Do not hold soldering iron on diode lead

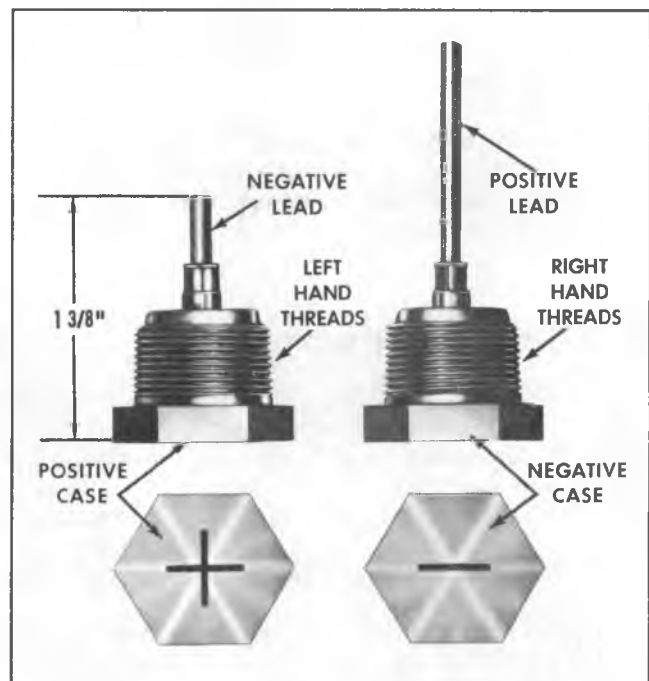


Fig. 13C--Diodes Showing Polarity Marking On Case

any longer than necessary, as excessive heat may damage the diode.

### Heat Sink Replacement

1. Detach heat sink from end frame by removing the attaching screws. Note carefully the proper stack up of parts so the "BAT" and "GRD" terminal bolts can be reassembled in the same manner. Cut all leads on each side of the three diode stems as close to the stem as possible.
2. Replace diodes, if necessary, as outlined in Diode Replacement.
3. Assemble heat sink to the end frame, following carefully the proper stack up of parts as noted in Step 1. Reconnect leads as described under Diode Replacement.

### Brush Replacement

1. Remove retaining clip and slide brush holder assembly from the pivot pin.

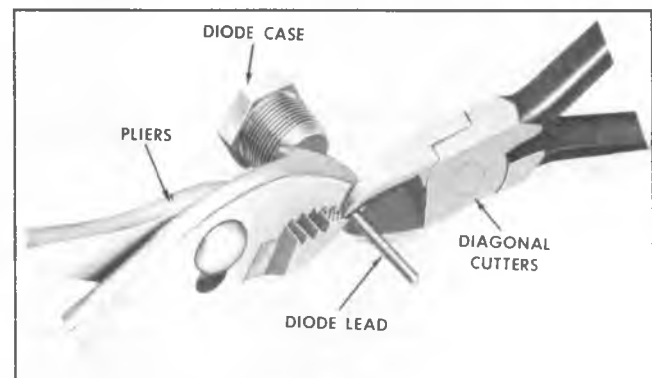


Fig. 14C--Cutting Diode Lead

2. Remove terminal nuts and stud assembly from end frame.
3. Install new holder, brush and lead assembly onto pivot pin (fig. 12C). Attach retaining clip to pivot pin.
4. Install terminal assembly to end frame.

**NOTE:** Brush spring tension should be checked as shown in Figure 15C. Excessive tension will cause rapid wear, whereas low tension results in erratic generator output and burning of slip rings. Defective springs must be replaced.

### End Frame Replacement

1. Remove heat sink as outlined in Heat Sink Replacement.
2. Attach brush holder assembly to the new end frame.
3. Replace heat sinks to end frame as outlined in Heat Sink Replacement.

### Bearing Replacement--Drive End Frame

1. The drive end frame bearing can be removed by detaching the retainer plate bolts and separating retainer plate and seal assembly from end frame, and then pressing bearing out using suitable tube or pipe on outer race.
2. Refill bearing one-quarter full with Delco-Remy No. 1948791 grease or equivalent. Do not overfill.
3. Press bearing into end frame using tube or pipe as in Step 1.
4. Install retainer plate. Use new retainer plate if felt seal is hardened or excessively worn.

### ASSEMBLY

1. Reassemble bearing retainer and grease reservoir assembly to drive end frame.
2. Assemble rotor unit to drive end frame and install spacer, fan, woodruff key, pulley, washer and shaft nut.

**NOTE:** Torque shaft nut to 60 lb. ft.

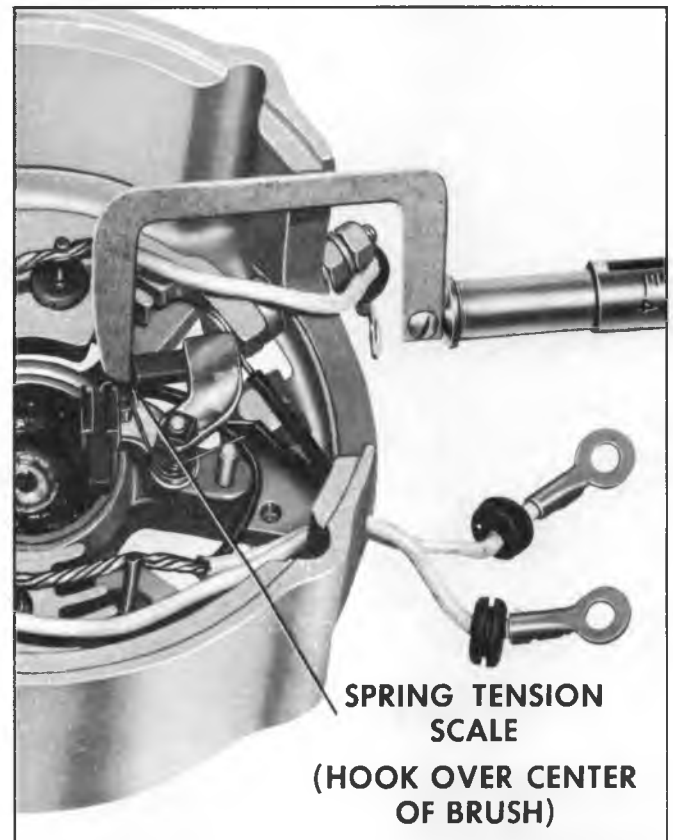


Fig. 15C--Checking Brush Spring Tension

3. Assemble stator unit to slip ring end frame, connect lead wires to the three external terminals, and install terminal nuts.
4. Assemble rotor and drive end frame assembly to stator and slip ring end frame assembly.

**CAUTION:** To prevent damage to brush units, physically lift brushes away from the slip rings.

5. Install the four frame through bolts.

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# SECTION 7

## CLUTCHES AND TRANSMISSIONS

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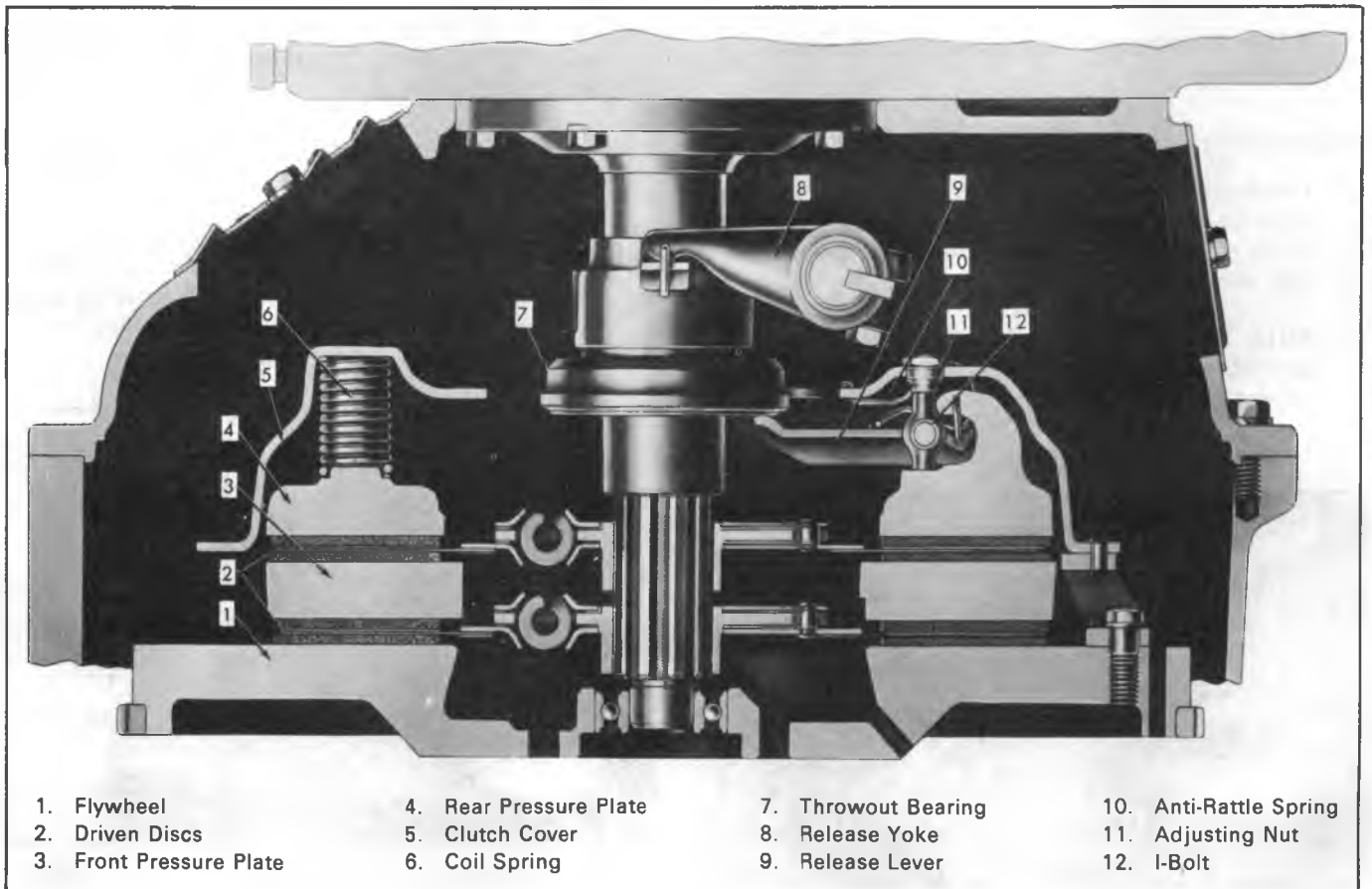
## TWO PLATE COIL SPRING CLUTCH

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### Disassembly

1. With assembly (on floor or bench) resting on front pressure plate side, remove 4 drive strap-to-front pressure plate bolts and the washers.
2. Lift the cover and rear pressure plate off front pressure plate and rear driven disc, turn it over and remove drive strap bolt and strap from rear pressure plate.
3. Place the cover assembly on the bed of an arbor or drill press with a block under the pressure plate so arranged that the cover is left free to move down.
4. Place a block or bar across the top of the cover with the



- |                         |                        |                     |                        |
|-------------------------|------------------------|---------------------|------------------------|
| 1. Flywheel             | 4. Rear Pressure Plate | 7. Throwout Bearing | 10. Anti-Rattle Spring |
| 2. Driven Discs         | 5. Clutch Cover        | 8. Release Yoke     | 11. Adjusting Nut      |
| 3. Front Pressure Plate | 6. Coil Spring         | 9. Release Lever    | 12. I-Bolt             |

Fig. 1E-2-Plate Clutch Cross-Section

## 7-2 TRANSMISSION AND CLUTCH



Fig. 2E--Compressing Clutch

spindle. Hold compressed while the adjusting nuts are removed as shown in Figure 2E, then slowly release pressure to prevent springs flying out.

5. Lift off cover and all parts will be available for inspection. Note carefully the location of all parts including arrangement of springs, see (fig. 3E).
6. To remove levers grasp lever and eyebolt between thumb and fingers as shown in Figure 4E, so that inner end of lever and upper end of eyebolt are close together, keeping eyebolt pin seated in its socket in lever.
7. Lift strut over ridge on end of lever, (fig. 5E).
8. Lift lever and eyebolt off pressure plate.

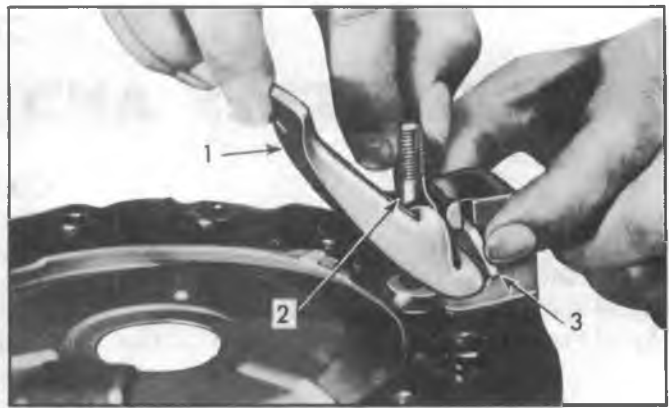
**NOTE:** It is important to replace all parts which show wear.

### Inspection

1. Check drive straps for looseness at the clutch cover and evidence of looseness at pressure plate bolt holes.
  2. Wash all parts, except driven disk and throwout bearing, in cleaning solvent.
- NOTE:** The throwout bearing is permanently packed with lubricant and should not be soaked in cleaning solvent as this will dissolve the lubricant.
3. Inspect pressure plate and flywheel for scores on the



Fig. 3E--Disassembly of Clutch



1. Release Lever      2. Eyebolt      3. Strut

Fig. 4E--Removing Levers (Step 1)

contact surfaces. Use a straight-edge and check for flatness of contact surfaces.

4. Check throwout bearing for roughness and free fit on the sleeve of the transmission clutch gear bearing retainer. Replace retainer if rough.
5. Inspect clutch disc for worn, loose or oil soaked facings, broken springs, loose rivets, etc. Replace if necessary.
6. Examine splines in hub and make sure they slide freely on splines of transmission clutch shaft. If splines are worn, the clutch disc or clutch gear should be replaced as necessary.
7. Inspect clutch fork ball socket and fingers for wear and ball retaining spring for damage. Spring should hold fork tightly to ball stud.

**NOTE:** Ball spring on fork may be bent in toward fork if necessary.

8. Inspect ball stud for wear. Replace if scored.
9. Check run out of transmission pilot hole in clutch housing by removing a flywheel bolt and installing a dial indicator. The run out should be within .000-.015".
10. Lubricate ball stud before reassembly.



1. Release Lever      2. Eyebolt      3. Strut

Fig. 5E--Removing Levers (Step 2)





Fig. 6E--Greasing Lug

## Assembly

1. Lay the pressure plate on the block in the press and coat the lugs with a thin film of approved lubricant such as lubriplate as shown in Figure 6E.
2. Assemble lever, eyebolt and pin, holding eyebolt and lever as close together as possible and with the other hand grasp strut as shown in figure 7E.
3. Insert Strut in the slots in the pressure plate lug, drop slightly and tilt the lower edge until it touches vertical milled surface of lug.
4. Insert lower end of eyebolt in hole in pressure plate. The short end of the lever will then be under the hook of the pressure plate and near the strut, (fig. 5E).
5. Slide the strut upward in the slots of the lug, lifting it over the ridge on the short end of the lever and drop it into the groove in the lever, (fig. 4E).
6. Assemble the pressure springs, on the small bosses of the pressure plate in accordance with Figure 8E in order to retain original balance.

**NOTE:** If there are spaces for more springs than specified for the particular assembly, or if two different colors of springs are used, Figure 8E shows the proper sequence. It is very important that each group be arranged in like sequence.

7. Assemble anti-rattle springs in cover as shown in Figure 9E. The spring to the left is in operating position.
8. Lower the cover on top of the assembled parts, (fig. 10E) being sure that the anti-rattle springs are in correct position and also that the punch marks made before

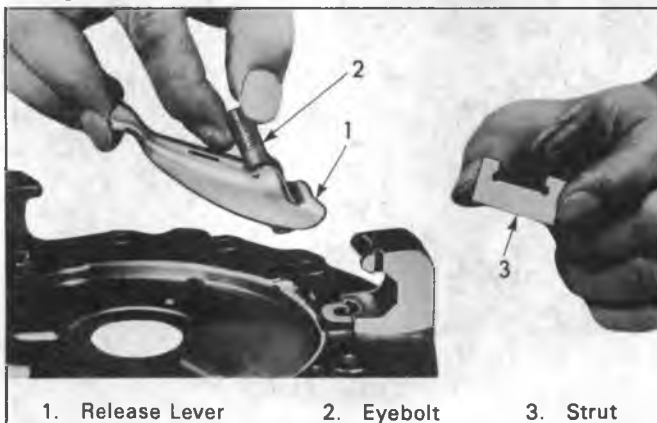


Fig. 7E--Installing Lever

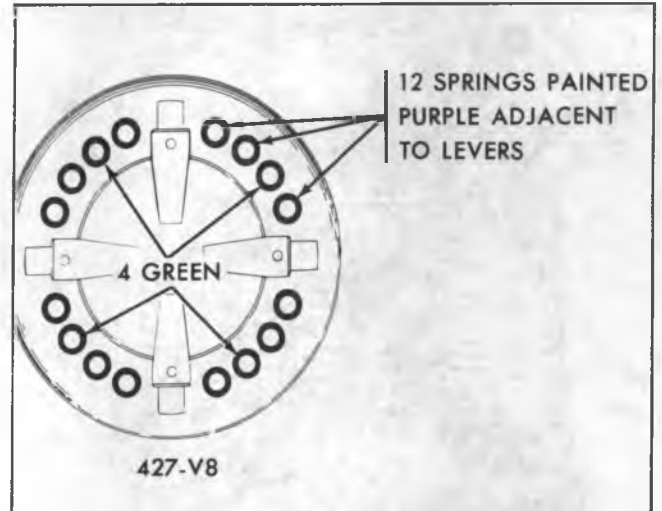


Fig. 8E--Spring Arrangement Diagram

dismantling are matched to insure retaining the original balance.

9. Place a bar across the cover and slowly compress, guiding the holes in the cover over the pressure plate lugs and all springs into their spring seats in the cover.
10. Assemble adjusting nuts on the eyebolts and screw them down until their tops are flush with the tops of the eyebolts. Slowly release pressure of spindle and remove cover assembly from press.
11. Place cover assembly on bench with pressure plate side up and install drive straps, bolts and washers (special and lock) as shown in Figure 11E.
12. Place one driven plate on rear pressure plate with hub up, then set front pressure plate on driven plate (with drive boss flush side toward rear driven plate).
13. Install drive strap to front pressure plate bolts as shown in Figure 11E.
14. Adjustment of the fingers is done during installation to

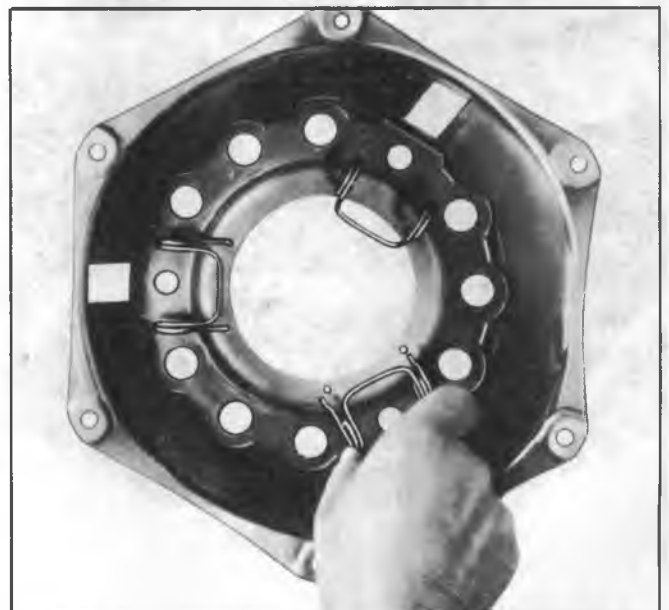


Fig. 9E--Installing Anti-Rattle Spring



Fig. 10E--Assembling Cover and Pressure Plate

vehicle procedure using alignment arbor as a gauge plate.

**NOTE:** Do not place bending load on front pressure plate drive straps.

### Adjusting Levers

While no wear adjustment is needed because of the coil spring design, it is imperative that the clutch release levers are each set to exactly the same height at the time of manufacture or rebuild to insure uniform clutch application. To obtain exactly the same adjustment at each release lever, use gauge plate J-1048 and release lever height gauge J-6456 as follows:



Fig. 11E--Drive Strap Assembly



Fig. 12E--Gauge Plate Position (Typical)

1. Place gauge plate J-1048 (fig. 12E) on the flywheel in position normally occupied by driven plate.

**NOTE:** It is recommended that a spare flywheel be obtained so that this operation may be performed at the bench.

2. Bolt cover on flywheel with gauge plate center.

**NOTE:** On assemblies with three levers, the three flat machined lands of the gauge plate must be located directly under the levers. On the larger 13" clutch with four levers, any position is satisfactory.

3. Depress each lever several times with a hammer handle to settle all parts into working position.
4. Position height gauge J-6456 on the hub of the gauge plate and the bearing surface of one lever (fig. 13E). Turn adjusting nut until lever is flush with proper step of height gauge. Adjust remaining levers in same manner. The height gauge (insert) has three steps for use



Fig. 13E--Depressing Lever

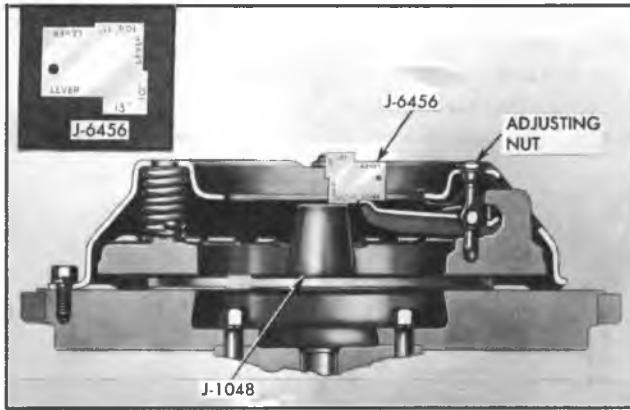


Fig. 14E--Coil Spring Clutch Adjustment

with the five basic coil spring clutches currently available. One step is used for the 10" clutch, one step for the 13" clutch, while the third step is used for 10-1/2", 11", and 12" clutches. Each side is identified accordingly, with the step of the gauge contacting the bearing surface of the lever identified by "Lever". Use the 10-1/2, 11 step for 12" clutches.

5. Stake adjusting nut (fig. 15E) to eyebolt with a dull punch to lock adjustment.
6. Loosen the cover to flywheel bolts a turn or two at a time and in rotation until spring pressure is relieved to allow clutch and gauge plate to be removed.

**PILOT BEARING (Ball Type)**

The single row radial ball bearing with sealed in lubricant should be inspected each time the clutch assembly is removed. Check for free rotation of inner race, noisy or sticking that indicates worn or chipped bearings or races. If it is necessary to replace the bearing, proceed as follows:

1. Assemble Tool J-5822 on slide hammer J-2619 and



Fig. 15E--Staking Nut



Fig. 16E--Pilot Bearing Replacement

install in bearing as shown in Figure 16E, and remove the bearing.

2. Install new bearing using Tool J-9225.

**NOTE:** The bearing bottoms against the crankshaft and should be installed only when flywheel is on the crankshaft.

**NEW PROCESS 5-SPEED TRANSMISSION  
(MODELS 540 AND 542)**

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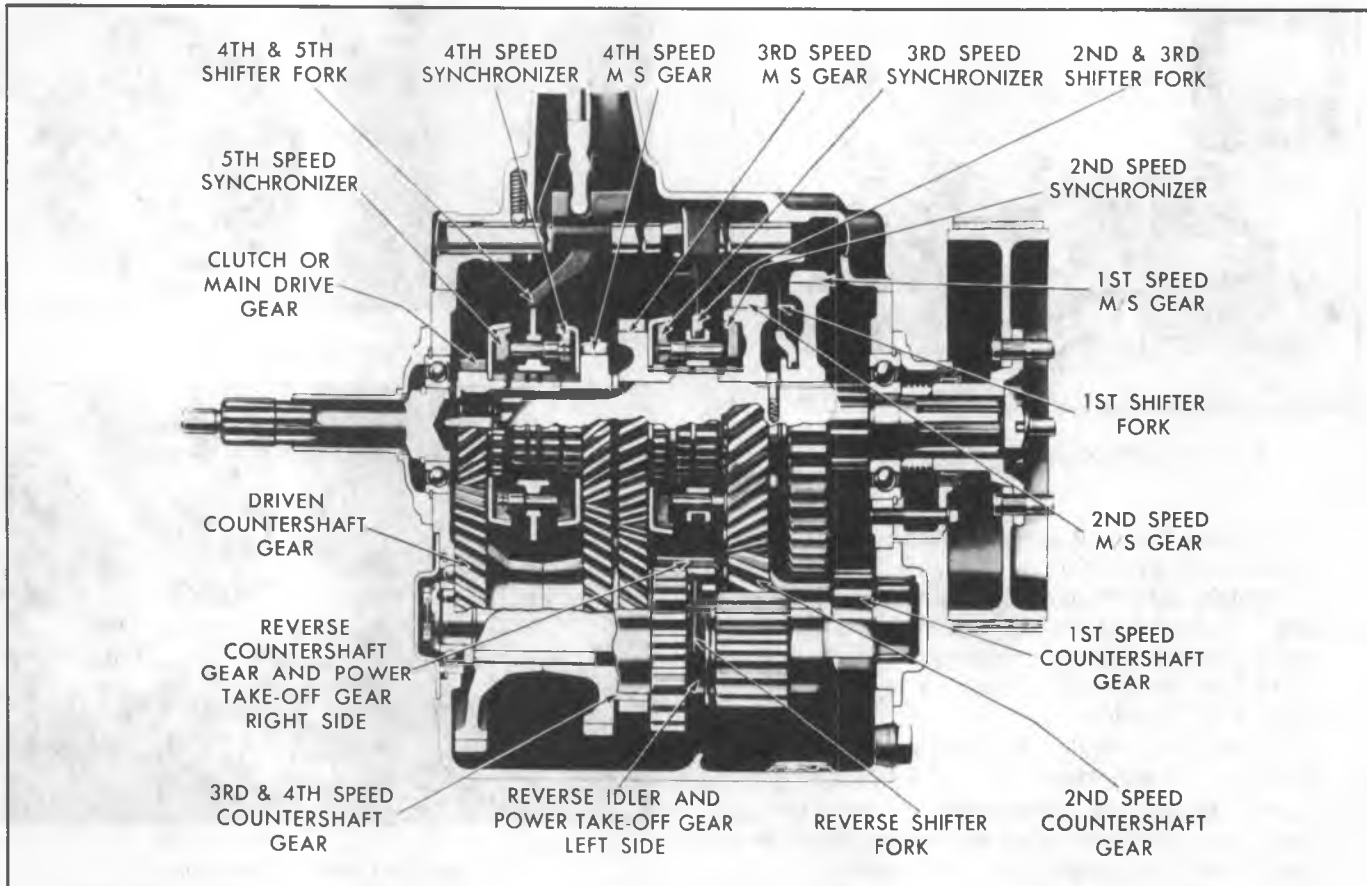


Fig. 1NP-Transmission Cross Section (Model 540)

## DISASSEMBLY OF TRANSMISSION

### (Figs. 1NP and 2NP)

**NOTE:** The following procedures apply to both the Model 540 and 542 transmissions except where noted as applying to a particular model. The 542 units replace the 541 models offering greater durability because of a stronger case with heavier rear deck, heavier synchronizer cones, larger synchronizer clutches, a steel-backed bushing under the second gear, and involute splines for the drive yoke. In addition the 542 model uses a single piece snap ring in front of the 3rd speed gear instead of a two piece ring, a snap ring behind the 2nd speed gear in lieu of a spring and lock pin, and energizer spring on the 2nd speed synchronizer and on the countershaft, a single inner bearing retainer bolt instead of two bolts and lock wire.

1. Mount transmission in holding fixture Tool-5750 and remove propeller shaft band and linkage assembly from back of transmission.
2. Shift transmission into 3rd gear, then remove gearshift lever from transmission cover, using Tool J-8109.
3. Remove cap screws attaching transmission cover to transmission case and remove cover.
4. Place transmission in two gears at once to lock main-

shaft and remove universal joint flange retaining cotter pin and nut, then pull universal joint flange and brake drum from mainshaft.

5. Remove speedometer driven gear from rear bearing retainer, remove rear bearing retainer and speedometer drive gear.
6. Remove clutch gear bearing retainer and gasket and remove clutch gear and bearing assembly from case.
7. Slide mainshaft assembly to the rear of case until mainshaft rear bearing is free of bore in case. Then use puller Tool J-1619 to remove bearing from mainshaft.

**NOTE:** Make sure 1st gear and the 2nd and 3rd synchronizer assembly does not bind as mainshaft is moved to the rear.

8. Hold first and reverse gear and 4th and 5th speed synchronizer to keep them from sliding off the mainshaft while lifting assembly out top of case.
9. Remove reverse idler gear shaft retainer and install reverse idler shaft removal Tool J-6382. Attach slide hammer to Tool J-6382 and pull reverse idler shaft (fig. 3NP).
10. Lift reverse idler gear from case.
11. Remove countershaft rear bearing retainer and bearing and gasket.
12. Remove countershaft front bearing outer retainer and gasket, cut inner bearing retainer bolt lock wire and

- remove inner retainer bolts and retainer. On 542 models, remove inner retainer bolt and retainer.
- Use brass drift to drive countershaft to rear of case and out of front bearing. Raise front end of countershaft and lift out of case.
  - Remove countershaft front bearing from bore in case by tapping outer bearing race from inside case.

## CLEANING AND INSPECTION

### Bearings

- Wash the bearings thoroughly in a cleaning solvent.
- Blow out the bearings with compressed air.

**CAUTION:** Do not allow the bearings to spin but turn them slowly by hand. Spinning bearings will damage the race and balls.

### Transmission Case

- Wash the transmission case inside and outside with a cleaning solvent and inspect for cracks.
- Check the front and rear faces for burrs and if present, dress them off with a fine mill file.
- Check bearing and shaft bores in case and if damaged, replace case.

### Gears

- Inspect all gears for excessive wear, chips or cracks, and replace any that are worn or damaged.
- Check first and reverse gear, 2nd and 3rd clutch ring, and 4th and 5th clutch ring for freedom of movement when shifting.

## SUBASSEMBLY OPERATIONS

### Transmission Cover

#### Disassembly

- Using a square edged "easy-out," remove the pin retaining the 1st shifter fork and shifter head to shifter shaft (fig. 4NP).
- Turn shifter shaft one-half turn to push lock ball out of the notch in the shifter shaft and, with other shifter shafts in neutral position, drive 1st shifter shaft out of cover. Shifter shaft will push out expansion plug.

**NOTE:** The shifter shafts are in neutral position when the ends of all four shafts are in approximate alignment toward the rear end of the transmission cover.

- Using an easy out, remove the pins retaining the other forks and heads to their shaft and remove the shafts, one at a time as in Step 2.

**CAUTION:** Care should be taken so that the shifter lock balls and springs and the interlock balls and pins are not lost as the shifter shafts are removed.

#### Assembly

- In reassembling the transmission cover, care should be used in reinstalling the shifter shafts. They should be installed in order; reverse, 4th and 5th, 2nd and 3rd, and 1st speed.
- Start shifter shafts into cover. Hold shifter forks and heads in position and push shafts through forks and heads.
- Install shifter shaft detent springs and balls and interlock ball and pins (fig. 5NP). Depress detent balls with small punch and press shafts over balls. Turn shafts, if necessary, to position balls in grooves in shifter shafts.
- Install shifter fork and shifter head retaining pins.
- Install shifter shaft hole expansion plugs and stake them in place. Use a small amount of Permatex or equivalent around expansion plugs to seal.

### Clutch Gear and Bearing

#### Disassembly

- Remove clutch gear bearing retaining snap ring.
- To remove bearing, place clutch gear and bearing assembly in an arbor press. Using Tools J-2228 and J-1358, press gear and shaft out of bearing (fig. 6NP).
- To remove transmission mainshaft pilot bearing rollers, remove retainer snap ring and washer and remove rollers from recess in clutch gear shaft.

#### Inspection

- Wash all parts in a cleaning solvent.
- Inspect roller bearings for pits or galling.
- Inspect bearing diameter in shaft recess for galling.
- Inspect gear teeth for excessive wear.
- Inspect clutch shaft pilot for excessive wear.
- Rotate clutch gear bearing slowly by hand and check for roughness.
- Inspect seal in retainer for damage of any sort.

#### Assembly

- Apply a small amount of grease to bearing surface in clutch gear shaft recess and install transmission mainshaft pilot roller bearings, washer, and snap ring in recess (fig. 7NP).
- Install bearing on shaft with bearing outer retainer ring toward pilot end (front) of shaft. Use Tools J-8108 and J-0358 to press bearing into position on shaft (fig. 8NP).
- Install clutch gear bearing retaining snap ring on shaft.

**CAUTION:** The bearing must turn as freely after it is installed on the shaft, as it turned before being pressed into position.



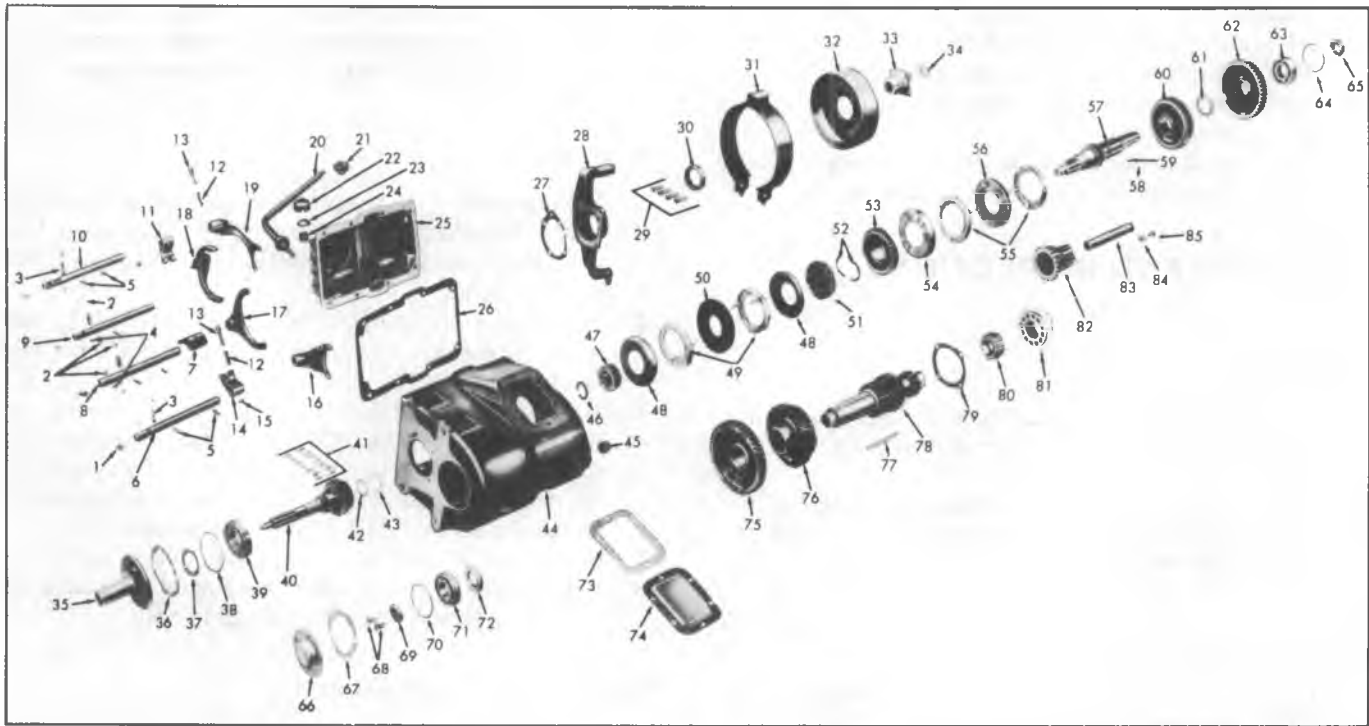


Fig. 2NP-Transmission Exploded View (Model 540)

## Mainshaft Assembly

### Disassembly

1. Remove 1st and reverse gear from mainshaft.
2. Remove 4th and 5th synchronizer ring and clutch assembly (5 pieces) from mainshaft.
3. Remove shim from 4th speed gear. Remove snap ring from front end of mainshaft, and remove synchronizer hub and 4th gear.
4. Remove 2-piece snap ring, and remove 3rd speed gear. On 542 models, remove snap ring, spacer and gear.
5. Remove 2nd and 3rd synchronizer ring and clutch assembly (4 pieces).
6. Depress lock pin into recess in mainshaft, turn thrust washer to clear splines on washer on mainshaft (fig.



Fig. 3NP-Removing Reverse Idler Shaft

9NP), and remove thrust washer and 2nd speed gear from mainshaft. On 542 models, remove snap ring and thrust washer. No lock pin and spring is used.

**CAUTION:** Be careful not to lose lock pin and spring when removing washer as pin and spring are under tension with washer in place.

7. Inspect all parts and replace any that are damaged or worn excessively.

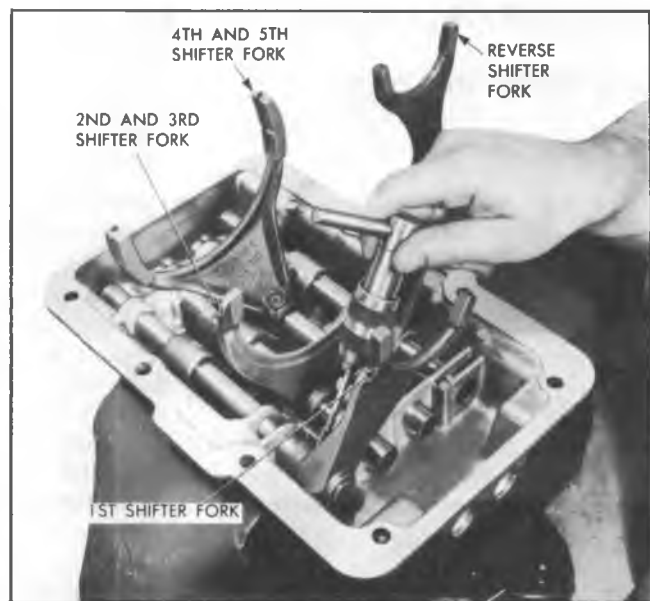


Fig. 4NP-Removing Retaining Pin



- |   |  |  |  |
|---|--|--|--|
| 1. Expansion Plug                                     | 25. Transmission Cover                             | 49. Four and Fifth Speed Inner Synchronizer Ring       | 68. Countershaft Front Bearing Inner Retainer Screws |
| 2. Shift Detent Ball                                  | 26. Transmission Cover Gasket                      | 50. Fourth and Fifth Speed Synchronizer Sliding Clutch | 69. Countershaft Front Bearing Inner Retainer        |
| 3. Shift Detent Ball Spring                           | 27. Transmission Rear Bearing Retainer Gasket      | 51. Fourth Speed Gear                                  | 70. Countershaft Front Bearing Snap Ring             |
| 4. Shift Lock Pin                                     | 28. Transmission Rear Bearing Retainer             | 52. Third Speed Gear Retainer Ring                     | 71. Countershaft Front Bearing                       |
| 5. Fork and Head Retaining Pin                        | 29. Brake Drum To Flange Bolts                     | 53. Third Speed Gear                                   | 72. Countershaft Spacer Washer                       |
| 6. First Speed Shifter Shaft                          | 30. Oil Seal                                       | 54. Second and Third Speed Outer Synchronizer Ring     | 73. Transmission Power Take-Off Cover Gasket         |
| 7. Second and Third Speed Shifter Head                | 31. Brake Band                                     | 55. Second and Third Speed Inner Synchronizer Ring     | 74. Transmission Power Take-Off Cover                |
| 8. Second and Third Speed Shifter Shaft               | 32. Brake Drum                                     | 56. Second and Third Speed Synchronizer Sliding Clutch | 75. Countershaft Driven Gear                         |
| 9. Fourth and Fifth Speed Shifter Shaft               | 33. Universal Joint Flange                         | 57. Transmission Mainshaft                             | 76. Countershaft Third and Fourth Gear Cluster       |
| 10. Reverse Shifter Shaft                             | 34. Flange Nut and Washer                          | 58. Lock Pin   | 77. Countershaft Gear Key                            |
| 11. Reverse Shifter Head                              | 35. Clutch Gear Bearing Retainer and Seal          | 59. Lock Pin Spring                                    | 78. Countershaft                                     |
| 12. Shifter Head Plunger Spring                       | 36. Clutch Gear Bearing Retainer Gasket            | 60. Second Speed Gear                                  | 79. Countershaft Rear Bearing Retainer Gasket        |
| 13. Shifter Head Plunger                              | 37. Clutch Gear Bearing Retainer Snap Ring         | 61. Second Speed Gear Thrust Washer                    | 80. Countershaft Rear Bearing                        |
| 14. First Speed Shifter Head                          | 38. Clutch Gear Bearing Snap Ring                  | 62. First and Reverse Gear                             | 81. Countershaft Rear Bearing Retainer               |
| 15. Shifter Head Plunger Retainer                     | 39. Clutch Gear Bearing                            | 63. Transmission Mainshaft Bearing                     | 82. Reverse Idler Gear                               |
| 16. First Speed Shifter Fork                          | 40. Clutch Gear                                    | 64. Transmission Mainshaft Bearing Snap Ring           | 83. Reverse Idler Gear Shaft                         |
| 17. Second and Third Speed Shifter Fork               | 41. Transmission Mainshaft Pilot Roller Bearings   | 65. Speedometer Drive Gear                             | 84. Reverse Idler Gear Shaft Retainer                |
| 18. Fourth and Fifth Speed Shifter Fork               | 42. Roller Bearing Washer                          | 66. Countershaft Front Bearing Outer Retainer          | 85. Reverse Idler Gear Shaft Retainer Bolt           |
| 19. Reverse Shifter Fork                              | 43. Roller Bearing Washer Retainer Ring            | 67. Countershaft Front Bearing Outer Retainer Gasket   |  |
| 20. Transmission Control Lever                        | 44. Transmission Case                              |  |  |
| 21. Transmission Control Lever Knob                   | 45. Drain Plug                                     |  |  |
| 22. Transmission Lever Cap 23. Transmission Lever Cup | 46. Clutch Hub Gear Retainer Ring                  |  |  |
| 24. Transmission Lever Spring                         | 47. Clutch Hub Gear                                |  |  |
|   | 48. Fourth and Fifth Speed Outer Synchronizer Ring |  |  |

### Assembly

- Lubricate mainshaft and install second speed gear on mainshaft.
- Install spring and lock pin in recess of mainshaft and depress pin with a small punch. Install splined thrust washer on mainshaft and turn washer so the splines of the washer bear against the splines of the mainshaft and so that the lock pin locks the washer in place. On 542 models, a snap ring is used in place of the lock pin and spring.
- Install 2nd and 3rd synchronizer ring and clutch assembly (4 pieces) on mainshaft.

**NOTE:** 2nd and 3rd sliding clutch must be positioned on mainshaft with the longer hub of the clutch rings internal gear toward the front end of the mainshaft.

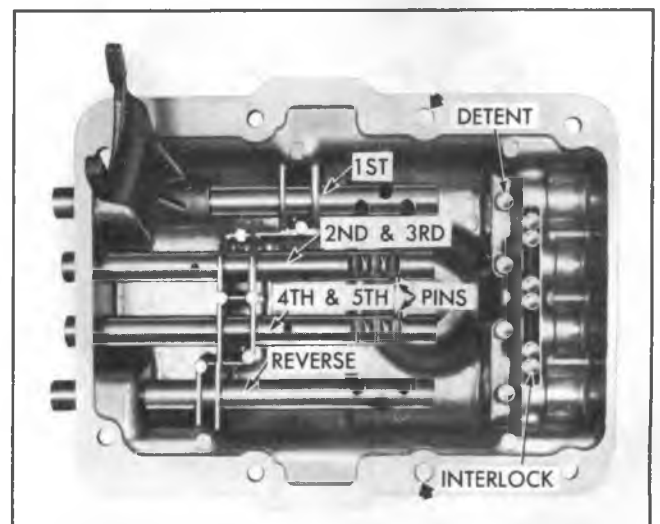


Fig. 5NP-Shifter Shaft Installation

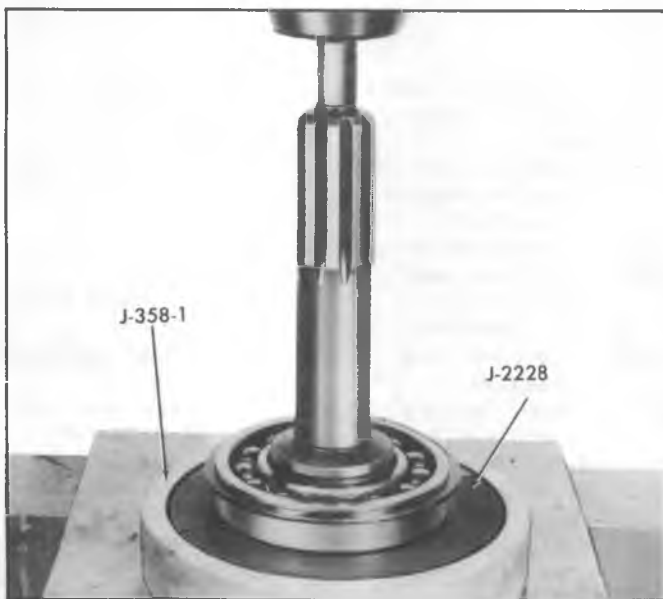


Fig. 6NP--Removing Clutch Gear Bearing

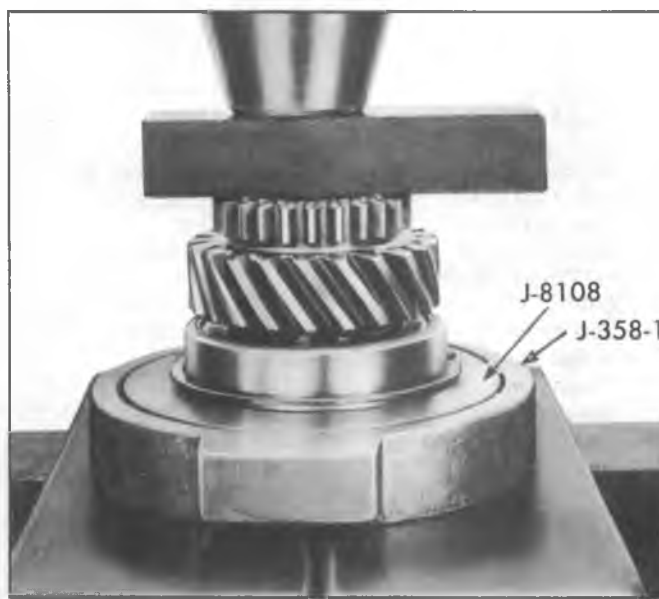


Fig. 8NP--Installing Clutch Gear Bearing

4. Install 3rd speed gear and 2-piece snap ring on mainshaft. On 542 models install spacer and snap ring. Check the clearance (axial float) between the 3rd speed gear and the synchronizer outer ring (plate) as follows:
  - a. Place two feeler gauges diametrically opposite each other between 3rd synchronizer outer ring and 3rd gear. Make sure synchronizer parts are "square" and the gauges are close enough to center of shaft to be up on small shoulder of 3rd gear. Clearance should be .070"-.090".
  - b. If float is more than .090", select different outer ring to decrease the float.
  - c. If float is less than .070", remove synchronizer assembly and, using a belt sander, remove the required amount from the small ends of the

5. Install 4th speed gear and synchronizer hub on the mainshaft.

**NOTE:** Synchronizer hub must be positioned so that oil slots on the back face of the gear are toward the rear of the mainshaft.

6. Select and install the proper snap ring for the mainshaft (fig. 10NP) to obtain end clearance of .004" to .011".

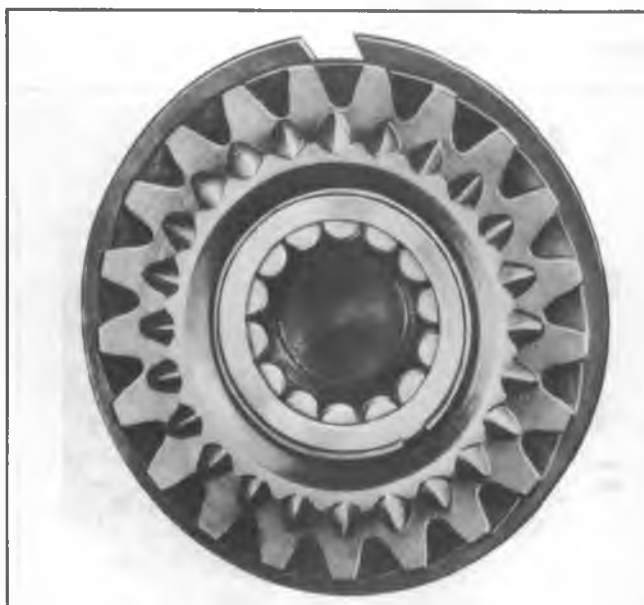


Fig. 7NP--Mainshaft Pilot Bearing



Fig. 9NP--Removing Thrust Washer and 2nd Gear

**NOTE:** The snap ring is available in the following sizes: .087", .090", .093" and .096".

7. Install 1st and reverse gear on mainshaft.

**NOTE:** 1st and reverse gear must be positioned so that the projection in center of gear which accommodates shifter fork is toward front of mainshaft.

8. Install shims on 4th speed gear, using same shims removed or an equal amount.
9. Install 4th and 5th synchronizer ring and clutch assembly (5 pieces).

## Countershaft

### Disassembly

1. Remove spacer washer from front end of countershaft.
2. Press counter driven gear from countershaft with an arbor press.
3. Press 3rd and 4th countergear cluster from countershaft with an arbor press.
4. Remove key from shaft assembly.
5. Inspect all parts and replace any that are damaged or worn excessively.

### Assembly

1. Replace key in countershaft.
2. Press 3rd and 4th countergear cluster on countershaft with an arbor press.



Fig. 10NP--Selecting Proper Retainer Ring

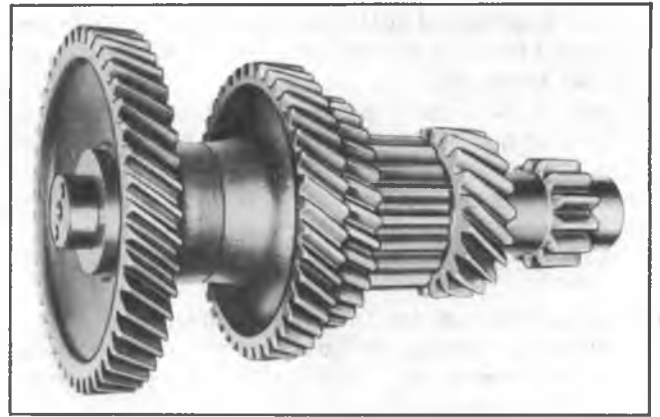


Fig. 11NP--Correct Countershaft Gear Position

3. Press counter driven gear on countershaft with an arbor press.
4. Replace spacer washer on front end of countershaft. Figure 11NP shows correct relation of gears and washer when installed on countershaft.

## Reverse Idler Gear Bushings

If the reverse idler gear bushings shown signs of wear, the gear and bushing assembly should be replaced.

## Assembly of Transmission

(Refer to Figure 2NP for relative location of all parts.)

1. Lower countershaft assembly into case with rear of shaft through rear bearing hole.
2. Install countershaft front bearing outer retainer snap ring on countershaft front bearing and install bearing in bore in case and onto front end of countershaft.
3. Install countershaft rear bearing retainer and bearing and gasket on countershaft and secure to case with four bolts.
4. Install countershaft front bearing inner retainer and install two retainer bolts finger tight. On 542 models, install front bearing inner retainer and large single retaining bolts.
5. Place reverse idler gear in transmission case and after applying sealing compound to rear end of reverse idler gear shaft, drive shaft through holes in case and through idler gear until the inner edge of locking slot in shaft is level with outside of case.

**NOTE:** Be sure slot in end of shaft is positioned horizontally and downward so that the idler shaft retainer can be installed.

6. Install reverse idler shaft retainer, washer and bolt.
7. Install mainshaft assembly into case with rear of shaft protruding out of case through mainshaft rear bearing hole.
8. Install mainshaft rear bearing outer retainer snap ring on bearing and install bearing on mainshaft and in bore in case.
9. Install clutch bearing outer retainer snap ring on clutch

## 7-12 TRANSMISSION AND CLUTCH

gear bearing, and install clutch gear assembly into case so that front end of mainshaft enters pilot hole in clutch gear assembly.

10. Install clutch gear bearing retainer and gasket and secure to case with four bolts.

**NOTE:** Be sure retainer and gasket are correctly positioned in line with oil hole toward bottom of case.

11. Install speedometer drive gear on mainshaft.
12. Install rear mainshaft bearing retainer and two gaskets (to give bearing fit of .006 tight to .003 loose) on mainshaft and secure to case with five bolts.
13. Install universal joint flange and brake drum assembly to mainshaft, and place transmission in two gears at once to lock transmission. Install universal joint flange retainer washer and nut, tighten to 125 ft. lbs. and install cotter pin.
14. Tighten countershaft front bearing inner retainer bolts securely and lock with lock wire through both bolt heads 540 models only. Install front bearing outer retainer with two new gaskets (to give fit of .006 tight to .003 loose).

**NOTE:** Be sure lock wire on bolts is along side of bolt heads. If wire is on top of heads, bearing retainer will be damaged.

15. Check the float of the 4th speed synchronizer by placing two feeler gauges diametrically opposite each other between the synchronizer outer plate and the shim on the 4th speed gear. If necessary, disassemble and add or remove shims to obtain .050" to .070" float.

16. Install speedometer driven gear in rear bearing retainer.
17. Install cover assembly.

## Transmission Cover

### Installation

1. Put reverse idler gear in neutral (move forward). Put 2nd- 3rd sliding clutch into 3rd gear position (move forward and put 4th- 5th sliding clutch slightly ahead of neutral.
2. Rotate mainshaft by turning clutch gear until the teeth on the 1st speed sliding gear will butt against the low speed teeth on the countershaft, as the sliding gear is pushed rearward. (This will prevent the sliding gear from moving too far rearward.)
3. Put shift forks in cover into 3rd gear position. Place new gasket on case and install cover as follows:
  - a. Engage reverse shifter fork on reverse idler gear.
  - b. While keeping left side of cover up, align 4th-5th shifter fork on 4th-5th synchronizer clutch.
  - c. Engage 2nd-3rd shifter fork in 2nd-3rd synchronizer clutch.
  - d. Make sure that 1st speed shifter fork is engaged in 1st speed sliding gear and drop cover in place.
4. Align holes in cover with holes in case and install a shouldered dowel screw, with lock washer, in the second hole from front in each side of cover (arrows, fig. 5NP).
5. Install all other screws and lock washers in cover and torque to 20-25 ft. lbs.
6. Using Tool J-8109, replace gearshift lever and check operation by shifting into all gears.

## 5-SPEED SPICER TRANSMISSION (MODELS 5652, 5756)

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## DISASSEMBLY OF TRANSMISSION

(Fig. 1R)

1. Mount transmission in holding fixture Tool J-5750 as shown in Figure 2R and remove parking brake band and linkage. Remove cotter pin and nut from rear of mainshaft and pull brake drum and flange from shaft.

2. Remove transmission cover and gasket.
3. Remove speedometer driven gear from rear bearing retainer and remove retainer.
4. Remove speedometer drive gear and thrust washer from rear of mainshaft.
5. Slide mainshaft assembly to rear to bring rear bearing out of case. Remove snap ring, and using Tool J-1619, pull bearing from shaft as shown in Figure 3R.

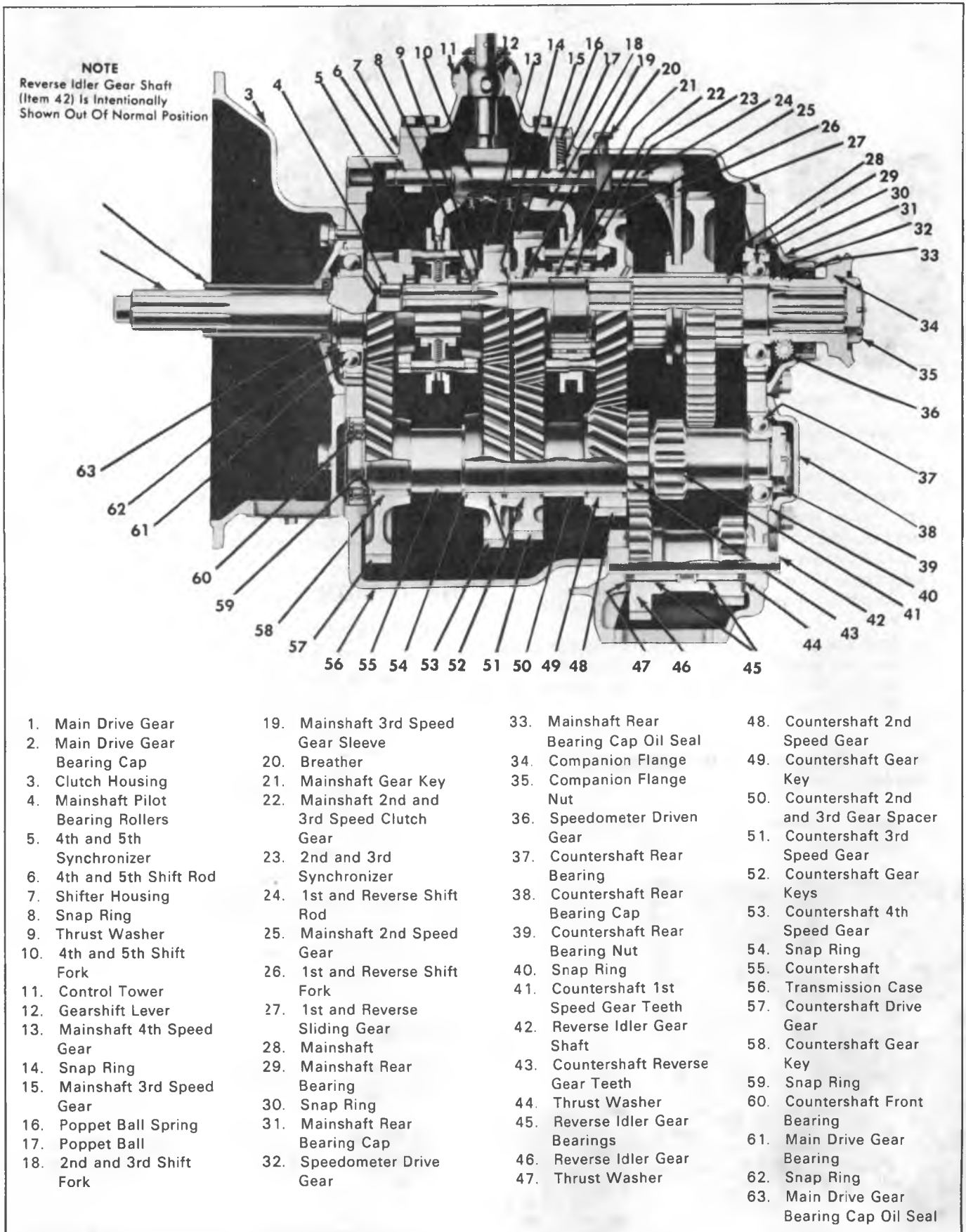


Fig. 1R-Spicer 5-Speed Transmission



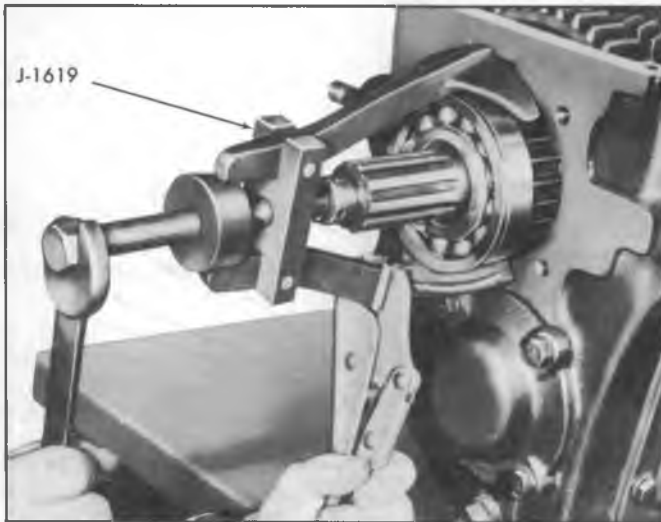


Fig. 2R--Removing Mainshaft Rear Bearing

6. Holding first-and-reverse gear and fourth-and-fifth speed synchronizer to keep them from sliding off shaft, lift assembly out top of case.
7. Pick bearing rollers out of clutch gear, remove clutch gear bearing retainer from front of case and tap gear and bearing from case.
8. Remove countershaft assembly and reverse idler gear assembly as follows:
  - a. Remove countershaft rear bearing retainer and gasket.
  - b. Install adapter Tool J-4761 in end of idler gear shaft and using slide hammer as shown in Figure 4R, pull idler gear shaft. Lift idler gear from case and remove thrust washers.

**NOTE:** Hold gear horizontal to avoid dropping bearings from either end.

- c. Block countershaft from turning and remove countershaft cotter pin, nut and washer.

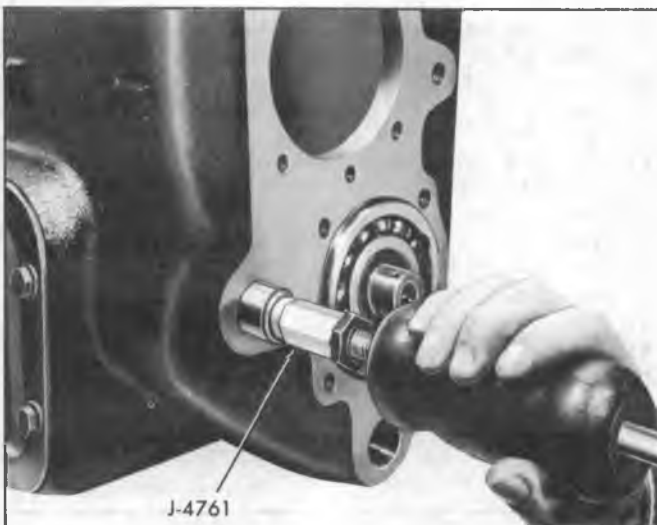


Fig. 3R--Remove Idler Gear Shaft

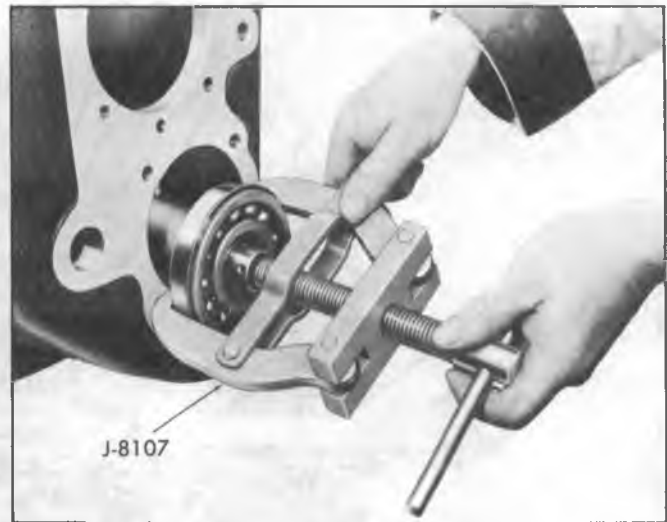


Fig. 4R--Removing Countershaft Rear Bearing

- d. Slide countershaft assembly to rear to move rear bearing out of case. Then using Tool J-8107, pull bearing from shaft (fig. 4R). Lift countershaft assembly out top of case.

If countershaft front bearing is to be removed from case, tap out bearing and spacer (plug) from inside case.

## INSPECTION

Prior to assembly of the transmission, the individual parts should be carefully checked to eliminate those damaged from previous service. Broken parts are often the result and not the cause of the trouble. This inspection procedure should be carefully followed to ensure the maximum of wear life from the rebuilt unit.

All components of the transmission (except bearing assemblies) should be thoroughly cleaned with cleaning solvent and dried with air pressure.

Whenever available, the Magna-Flux method should be used on all parts, except ball and roller bearings. This method is especially suited for detecting minute cracks and wear on highly finished or ground surfaces, which otherwise would not be visible to the naked eye. Check all components for discoloration or warpage due to heat or binding.

## Bearings

Bearings should always be cleaned separately from other transmission components in CLEAN cleaning solvent.

**NOTE:** Steam or water is not recommended for cleaning bearings as they usually rust in a very short time.

1. Slush bearings in solvent until all old lubricant is loosened. Hold bearing races so bearings will not rotate; then brush bearing with a soft bristled brush until all



- foreign material has been removed.
- Rinse bearings in clean solvent; then blow bearings dry with air pressure. **DO NOT SPIN BEARINGS WHILE DRYING.**
  - Rotate bearing slowly while examining balls or rollers for roughness, damage, or excessive wear. Replace all bearings which are in questionable condition.
  - Pack all bearings with bearing lubricant (such as NLGI No. 0 Light Weight Ball and Roller Bearing Grease or equivalent).
  - Wrap each bearing in clean lint-free paper until ready to install in transmission.

## Gears and Shafts

- Check operating gear teeth for pitting on tooth faces. Gears with pitted teeth should be replaced.
- Check all engaging gear teeth. Gears with teeth worn, tapered or reduced in length from clashing in shifting should be replaced.

**NOTE:** Small nicks or burrs may be removed with a fine abrasive stone.

**IMPORTANT:** The splines on many clutching gears, mainshaft, etc., are equipped with a machined relief called a hopping guard as shown in Figure 5R. With the clutch gear in the engaged position, the mating gear is free to slip into this notch, preventing the two gears from separating or walking out of gear under various load conditions. This is not a worn or chipped gear. **DO NOT GRIND IT DOWN OR DISCARD THE GEAR FOR THIS REASON.**

- Check the splines on all shafts for wear. If the mainshaft 1st and reverse sliding gear or clutch hub have worn into the sides of the splines, the shaft in this condition should be replaced.

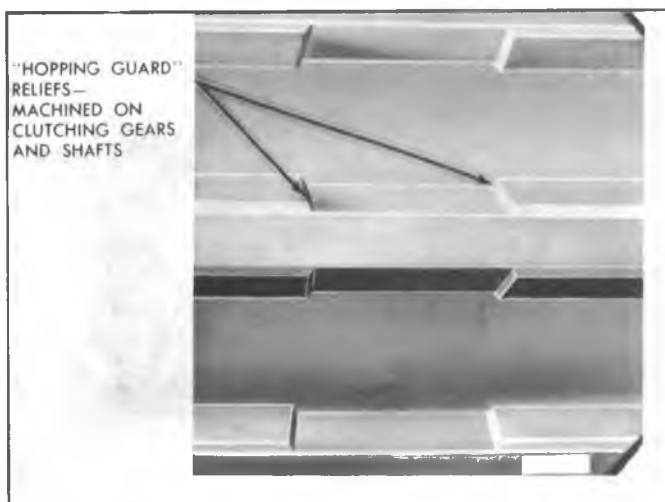


Fig. 5R—Spicer Hopping Guard

## Housings and Bearing Caps

- Check each housing or bearing cap for cracks, or breaks or other damage. Since repairs by welding, brazing, etc., are not recommended, replace all damaged parts.
- Check bores for wear. Replace components worn over-size.
- Check bearing caps for end thrust from bearings. Replace if worn or grooved.

## Synchronizers and Shifter Housing

### Components

Check bronze synchronizer cone for wear or possibly steel chips embedded in cone.

- Inspect blocker pin detents of synchronizer for wear or other damage.

**NOTE:** If any portion of a synchronizer is damaged, replace entire synchronizer assembly.

- Inspect each of the three shift forks for wear, distortion, or other damage.
- Check each shift rod, interlock ball, and the interlock pin for scoring, distortion or other damage. Replace all damaged components.

## Gaskets, Thrust Washers, Etc.

- Replace all gaskets, oil seals, lock wire, cotter pins and snap rings.

**NOTE:** If snap rings are not damaged or distorted and are not used for sealing as well as retaining, they may be reused.

- Check all threaded fasteners and mating parts for damaged, stripped, or crossed threads. Correct as necessary.
- Check keys and keyways for condition and fit.
- Check surfaces of all thrust washers. Washers scored or reduced in thickness should be replaced.
- Inspect the breather assembly to see that it is open and not damaged.

## SUBASSEMBLY OPERATIONS

### Transmission Cover

#### Disassembly

- Remove plunger retainer (fig. 6R) and spring from transmission cover, then tilt cover so outer plunger pin will come out of cover.
- Remove control lever housing-to-cover bolts, lift housing from cover and remove gasket.
- Remove inner plunger pin from first-and-reverse shifter lever (fig. 7R) and, if control lever housing of first-and-reverse shifter lever is to be replaced, remove nut and

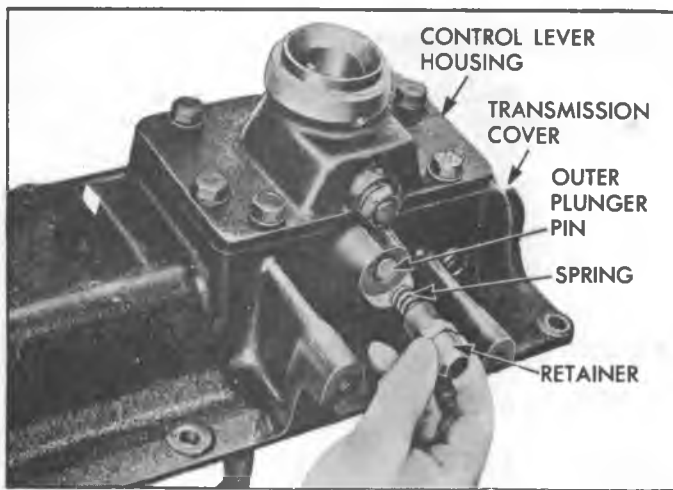


Fig. 6R--Removing Plunger Retainer

- lock washer from shifter lever stud. Tap stud into housing to remove lever.
4. Lift poppet springs from holes in cover (fig. 8R). Turn cover upside down over a clean container so poppet balls will drop out of holes in container.
  5. Place cover upside down, remove plugs from front of cover and remove lock wire from set screws in shifter forks (fig. 9R).
  6. Remove set screws from fourth-and-fifth speed shifter fork and tap shaft out through hole in front cover. Remove fork. Remove interlock poppet through opening for shaft (fig. 10R).
  7. Remove set screw from second-and-third shifter shaft and tap shaft out through hole in front of cover. Remove fork. Slip interlock pin from shaft (fig. 11R). Remove interlock poppet through hole for shaft (fig. 10R).
  8. Remove set screw from first-and-reverse shifter fork and from shifter head. Tap shaft out through hole in front of cover, removing fork and head from shaft.

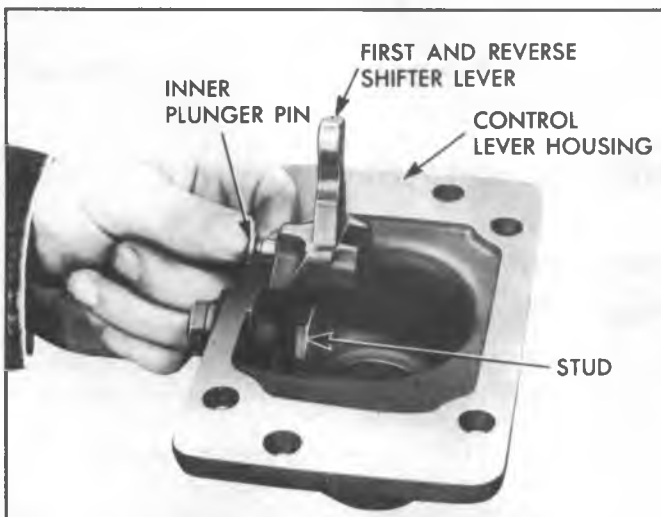


Fig. 7R--Removing Inner Plunger Pin

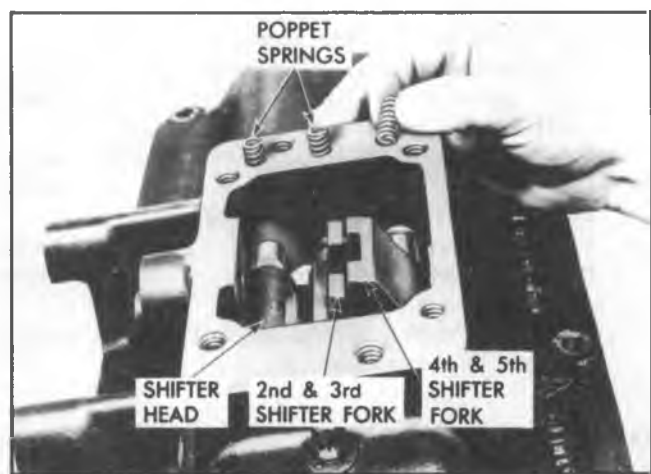


Fig. 8R--Removing Poppet Spring

### Assembly

1. With cover upside down on bench, insert first-and-reverse (longest) shifter shaft through hole in front of cover through forward boss. Then slide shifter head on shaft with slot in head toward center of cover (fig. 12R). Push shaft through rear boss and install set screw through head into shaft and install lockwire.
2. Install first-and-reverse (smallest) shifter fork on end of shaft, install set screw and lock with wire
3. Tilt cover and install interlock poppet into position against first-and-reverse shaft (fig. 10R).
4. Insert second-and-third shifter shaft (shaft with hole for interlock pin) through hole in front of cover and through forward boss. Slide fork having largest web onto end of shaft, with fork to rear and install interlock pin in shaft (fig. 11R).
5. Slide shaft the rest of the way in, holding shaft level so pin will stay in shaft. Install set screw in shaft and lock with wire.
6. Tilt cover and install interlock poppet into position against second-and-third shifter shaft (fig. 10R).
7. Insert fourth-and-fifth shifter shaft through hole in front of cover (fig. 9R). Position previously installed

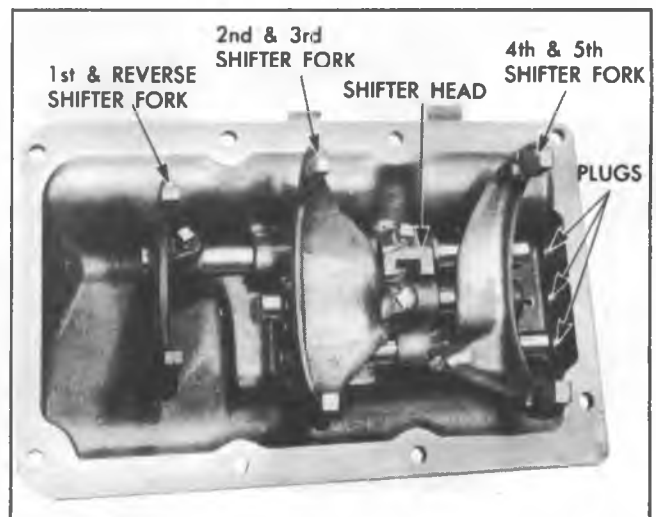


Fig. 9R--Shifter Shaft and Fork Installation



Fig. 10R--Location of Interlock Poppets

shifter shafts so interlock poppet will permit passage of this shaft and slide shaft through forward boss.

8. Install shifter fork on shaft with fork to front (fig. 13R). Install set screw and lock with wire.
9. Install plugs in front of cover (fig. 9R), using a small amount of Permatex or equivalent around plugs to seal.
10. Place cover right side up on bench and install poppet balls and springs in holes in cover (Fig. 14R).
11. Position first-and-reverse shifter lever in control lever housing with boss next to housing and install stud from inside housing. Secure stud with nut and lock washer, then insert plunger pin in first-and-reverse shift lever (fig. 7R). Assemble new gasket on cover and install

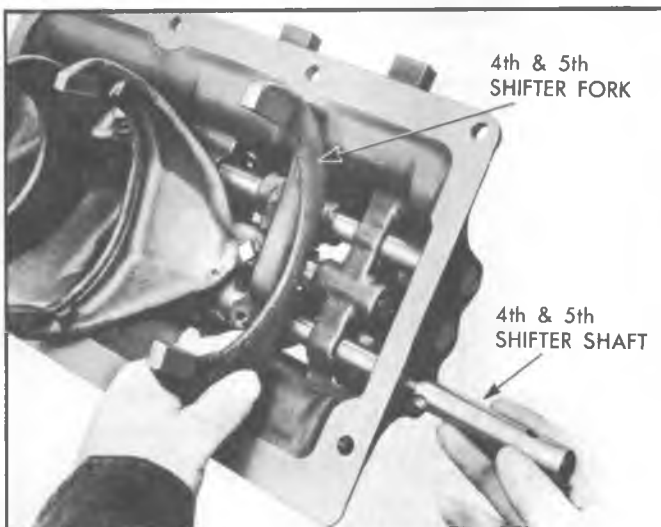


Fig. 11R--Removing Interlock Pin

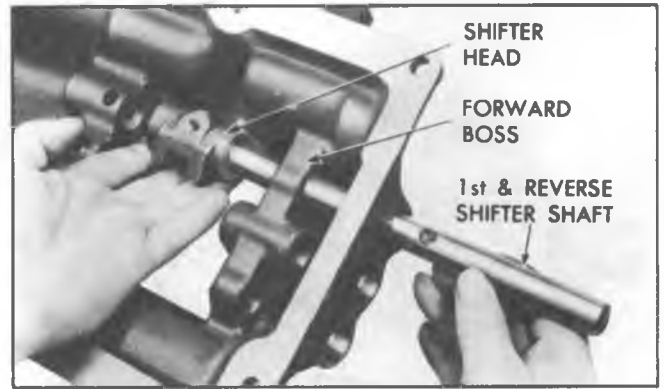


Fig. 12R--Installing Shifter Head

housing so lever fits in slot in shifter head.

12. Insert outer plunger pin in cover and install spring and retainer as shown in Figure 6R.

## Mainshaft

### Disassembly (See Fig. 15R)

1. Slide fourth-and-fifth speed synchronizer assembly off forward end of shaft and slide first-and-reverse gear off rear end of shaft.
2. Remove snap ring from mainshaft and slide thrust washer and fourth speed gear off gear sleeve.
3. Support rear face of third speed gear on suitable press plates and press shaft from gear. Fourth speed gear sleeve will be pushed off ahead of gear (fig. 16R).

**NOTE: Second-and-third speed synchronizer may be shifted to engage second speed gear to obtain maximum space for placement of press plates (fig. 15R).**

4. Slide second-and-third speed synchronizer off shaft.
5. If inspection shows the need for replacement of second speed gear, second-and-third synchronizer hub, or mainshaft, proceed as follows:
  - a. Remove synchronizer hub snap ring from shaft.

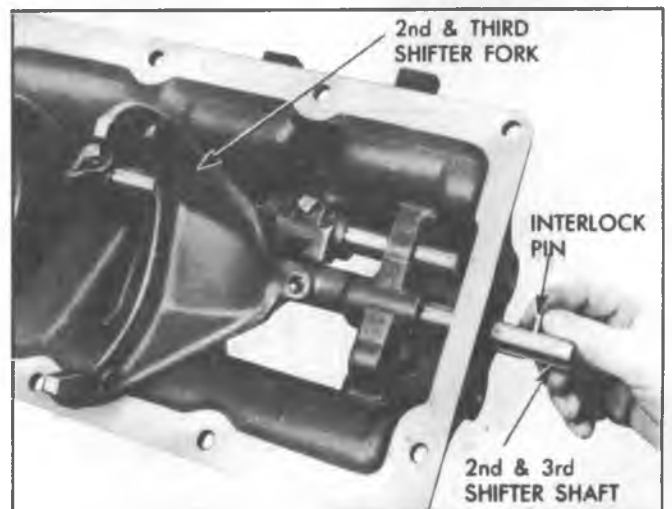


Fig. 13R--Installing 4th and 5th Shifter Fork

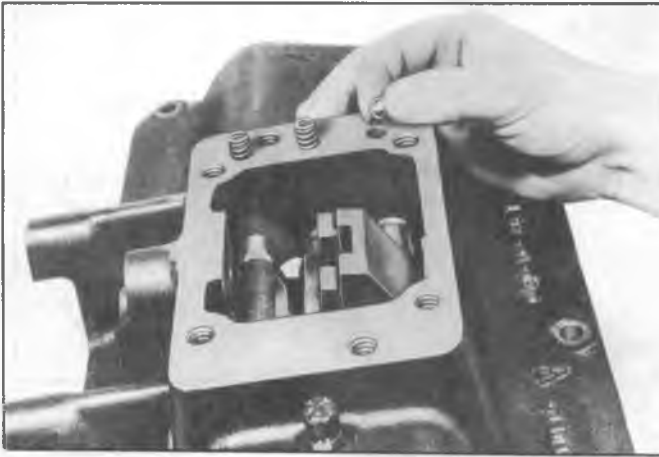


Fig. 14R--Installing Poppet Balls and Springs

- b. Support rear face of second speed gear on suitable press plates and press shaft to obtain 5/16 clearance between rear hub of second speed gear and forward end of splines on mainshaft (fig. 17R).

**CAUTION:** If shaft is pressed further than shown, forward hub of gear will wedge on Woodruff keys of synchronizer hub.

- c. Remove press plates from under second speed gear and install Tool J-6418, between gear and synchronizer hub. Locate shaft so keys in shaft are in line with space between plates, and press shaft out of hub as shown in Figure 18R.

**NOTE:** If tool will not fit between gear and hub, insert washers between gear and hub and repeat operation described in Step b.

**Assembly**

1. Slide second-speed gear on mainshaft with synchronizer cone toward front end of shaft.
2. Install Woodruff Keys opposite each other in shaft. Start synchronizer hub on shaft and align keyways in hub with keys in shaft. Support shaft on Tool J-6418 and, using Tool J-6419-1, as shown in Figure 19R, press hub onto shaft tight against shoulder on shaft. Install snap ring.

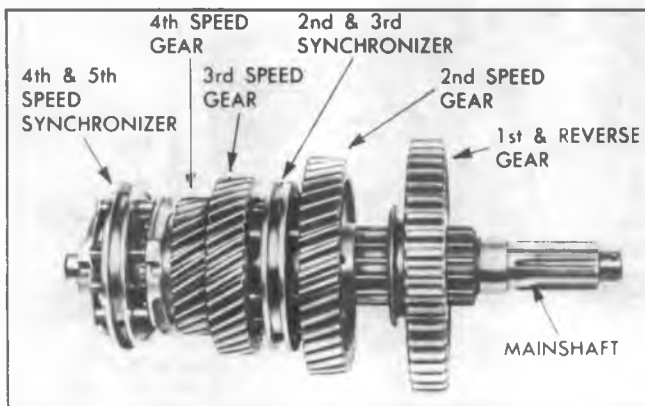


Fig. 15R--Mainshaft Assembly



Fig. 16R--Removing Mainshaft from 3rd Gear

3. Slide second-and-third speed synchronizer on hub, with longer hub of synchronizer toward second-speed gear (fig. 20R).
4. Slide third speed gear on shaft with synchronizer cone toward rear of shaft.
5. Start fourth-speed gear sleeve on shaft with flanged end of sleeve facing third speed gear and pin in sleeve between splines of shaft. Support shaft in press plates Tool J-0996 and, using Tool J-6419-1 and -2 as shown in Figure 20R, press sleeve onto shaft until flange is tight against shoulder on shaft.
6. Slide fourth-speed gear onto sleeve with synchronizer cone toward forward end of shaft.
7. Slide fourth-and-fifth speed synchronizer assembly on forward end of shaft so bronze ring slides onto tapered hub of fourth speed gear.
8. Place first-and-reverse gear on splines at rear end of shaft, with shift fork collar toward forward end of shaft.

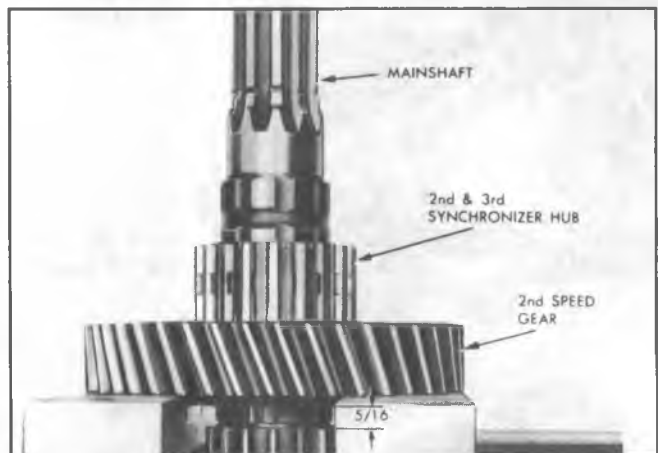


Fig. 17R--Removing Synchronizer Hub (Step 1)

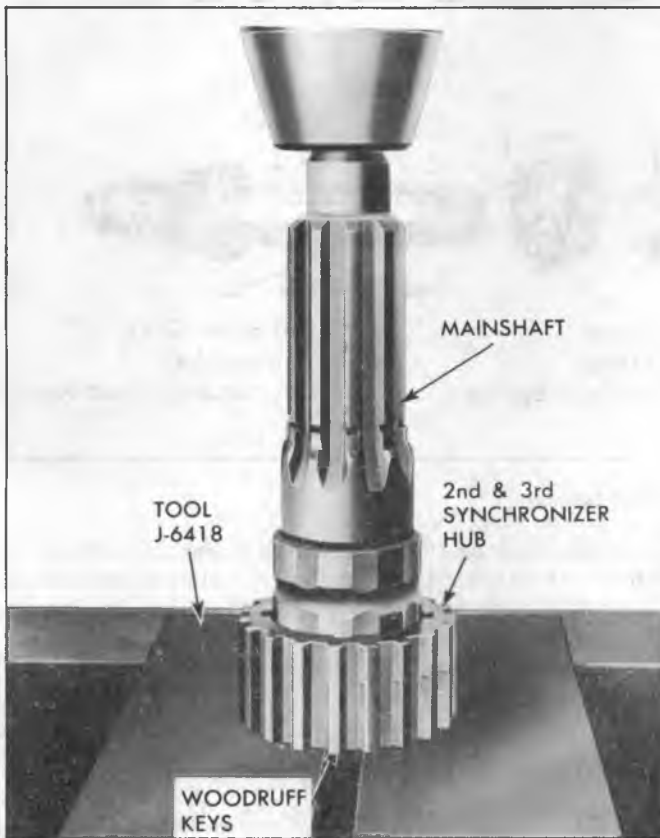
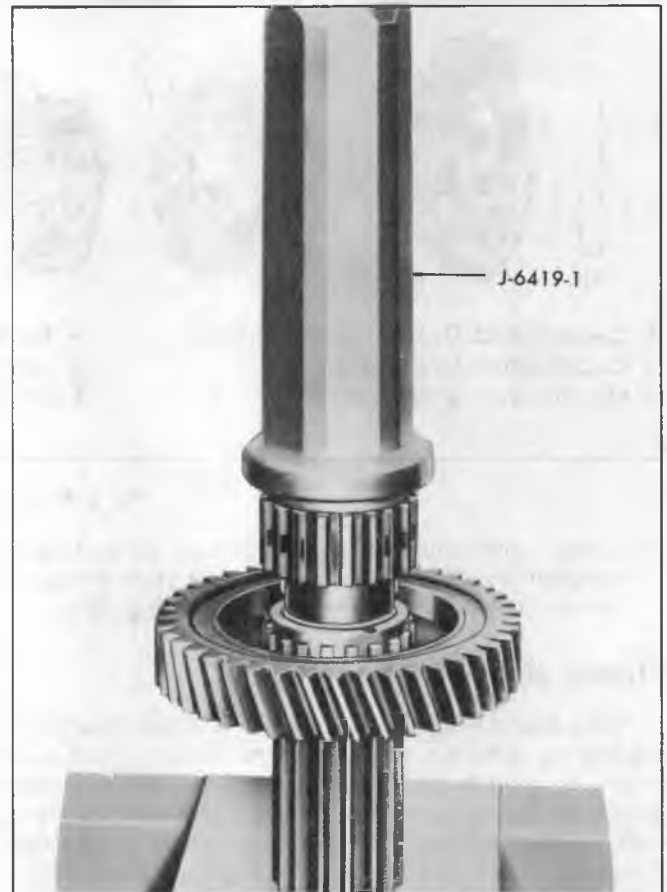


Fig. 18R--Remove Synchronizer Hub (Step 2)



19R--Installing 2nd and 3rd-Speed Synchronizer Hub

## Countershaft

### Disassembly

Key Numbers Refer to Figure 21R.

1. Remove countershaft drive gear snap ring (1). Support drive gear (2) with parallel bars under as close to hub as possible and press countershaft (8) free of gear.
2. Remove exposed countershaft gear key (9) and snap ring (3). Support 4th speed gear (4) and press countershaft free of gear.
3. Remove exposed countershaft gear key (9). Support 3rd speed gear (5) and press countershaft free of gear.
4. Remove exposed countershaft gear key (9).

### Assembly

Key Numbers Refer to Figure 21R.

1. Position first countershaft gear key (9) in slot of countershaft (8). Using a suitable sleeve, press 2nd speed gear (7) on countershaft.
2. Place 2nd and 3rd gear spacer (6) on countershaft against 2nd speed gear.
3. Install the remaining countershaft gear keys (9) on countershaft. Dress keys with a file, if necessary.
4. Align keyway of 3rd speed gear (5) with key and press gear on the countershaft. Seat 3rd speed gear firmly against 2nd and 3rd gear spacer.
5. Align 4th speed gear (4) with key and press gear on the countershaft. Install 4th gear snap ring (3) in groove of countershaft.

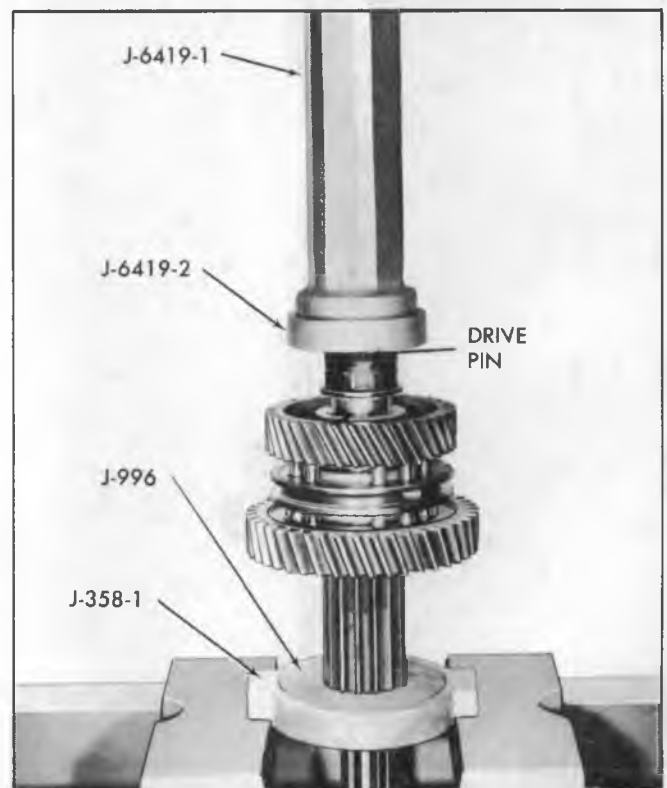


Fig. 20R--Installing 4th Speed Gear Sleeve



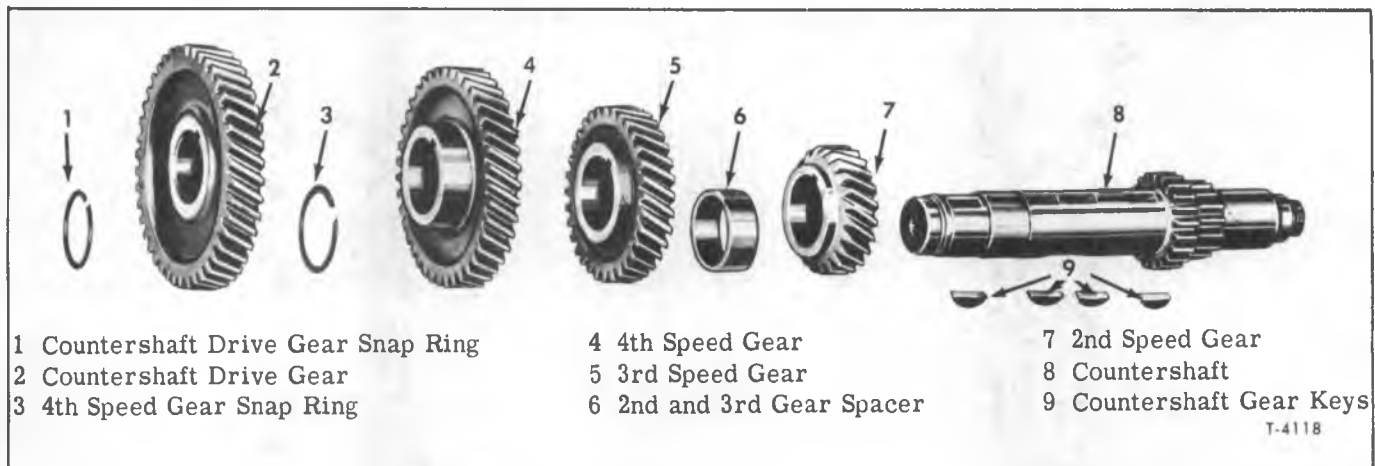


Fig. 21R--Countershaft Assembly

- Align countershaft drive gear (2) with key and press gear on the countershaft. Install countershaft drive gear snap ring (1) in groove of countershaft (fig. 22R).

### Clutch Gear and Bearing

Wash assembly in cleaning solvent and inspect gear teeth and bearing surfaces for excessive wear. Rotate clutch gear bearing by hand to check for roughness. If inspection indicates need for replacement of bearing or clutch gear and shaft, remove snap ring from shaft, support bearing snap ring on suitable press plates to start bearing far enough to get clearance to position Tool J-5740 under bearings as shown in Figure 23R, and press gear and shaft out of bearing.



Fig. 22R--Installing Countershaft Drive Gear

To install new bearing start bearing straight on end of gear with snap ring toward shaft end of gear. Support bearing on Tool J-5740 as shown in Figure 24R and, using a hard wood block against rear face of gear, press bearing tight against thrust surface of gear. Install large snap ring in bearing and small snap ring in shaft.

### Assembly of Transmission

(Refer to Figure 25R for relative location of parts.)

- If countershaft front bearing was removed from case, start bearing into place, then position spacer (plug) against bearing and tap into case as shown in Figure 26R until edge of spacer is flush with case. Use Permatex or equivalent to seal plug.
- Place thrust washer on forward end of countershaft assembly and lower assembly into case, with rear of shaft through rear bore in case.

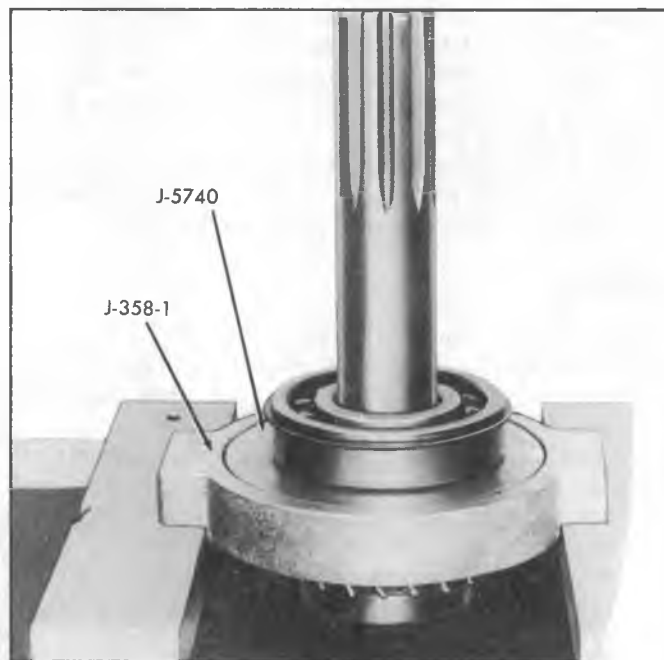


Fig. 23R--Removing Clutch Gear Bearing



3. Start rear bearing on countershaft with snap ring toward rear, slide countershaft forward into front bearing and start rear bearing into bore in case. Using Tool J-6419-1 and -2, tap bearing on shaft and into case as shown in Figure 27R.
4. Install flat washer and castellated nut on countershaft. Tighten nut to 150 ft. lbs. torque and install cotter pin.
5. Install reverse idler gear as follows:
  - a. Coat thrust washers with heavy grease and place in position in case, with lugs on washers in slots at each boss (grooves in washers facing each other).
  - b. Install roller bearing assemblies in each end of idler gear and insert gear in position (large gear toward front of case).
  - c. Insert idler gear shaft in rear of case and turn shaft so flat on shaft is vertical and faces countershaft (fig. 28R). Push shaft through rear thrust washer, bearings, front thrust washer and into front bore. Tap shaft into case until flat on shaft is flush with rear of case.
6. Install countershaft rear bearing retainer with new gasket. Locate retainer so extended boss on retainer fits in flat on reverse idler shaft.
7. Lower the mainshaft assembly into case with threaded end of shaft extending out rear bore in case. (See NOTE under Step 10).
8. If not previously installed, slide fourth-and-fifth speed synchronizer assembly on front of mainshaft.
9. Start rear bearing straight on mainshaft with snap ring toward rear. Move shaft and gear forward to start bearing straight into case and, using Tool J-6419-1 and -2, tap bearing onto shaft and into case as shown in Figure 29R.
10. Coat pilot bearing rollers with heavy grease and install in clutch gear. Start bearing into case with rollers over mainshaft. Using Tool J-6419-1 and -2, tap bearing to bring snap ring tight against case.

**NOTE:** When assembling a close ratio model, the clutch gear can not be installed from the front of the

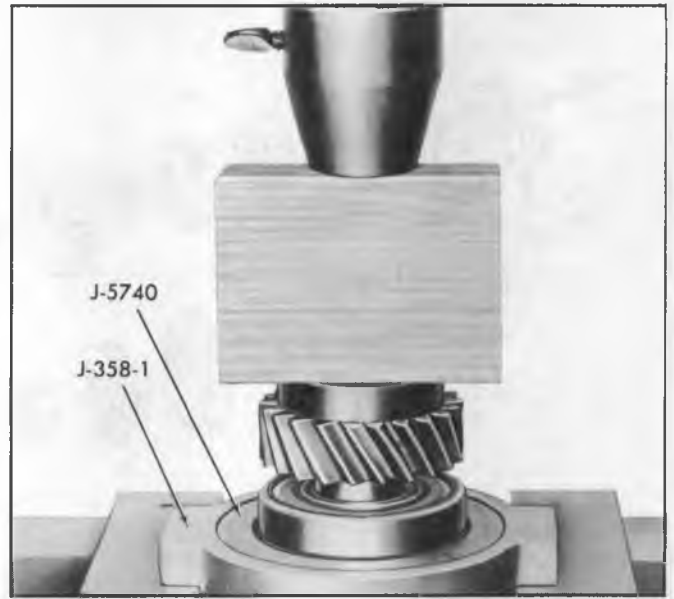


Fig. 24R--Installing Bearing On Clutch Gear

**case. In these models the clutch gear will have to be installed from inside the case, before Step 7 above is performed.**

11. Install new gasket and install bearing retainer, making sure the oil slot in gasket and retainer line up with oil hole in front of transmission case.
12. Install speedometer drive gear thrust washer on mainshaft and then install drive gear tight against washer.
13. Install mainshaft rear bearing retainer with new gasket making sure the oil slots in gasket and retainer line up with hole in transmission case.
14. Install propeller shaft flange and brake drum on output shaft and install nut. Torque nut to 280 ft. lbs. and install cotter pin.
15. Install transmission cover gasket and cover assembly.
16. Install propeller shaft brake band and levers.

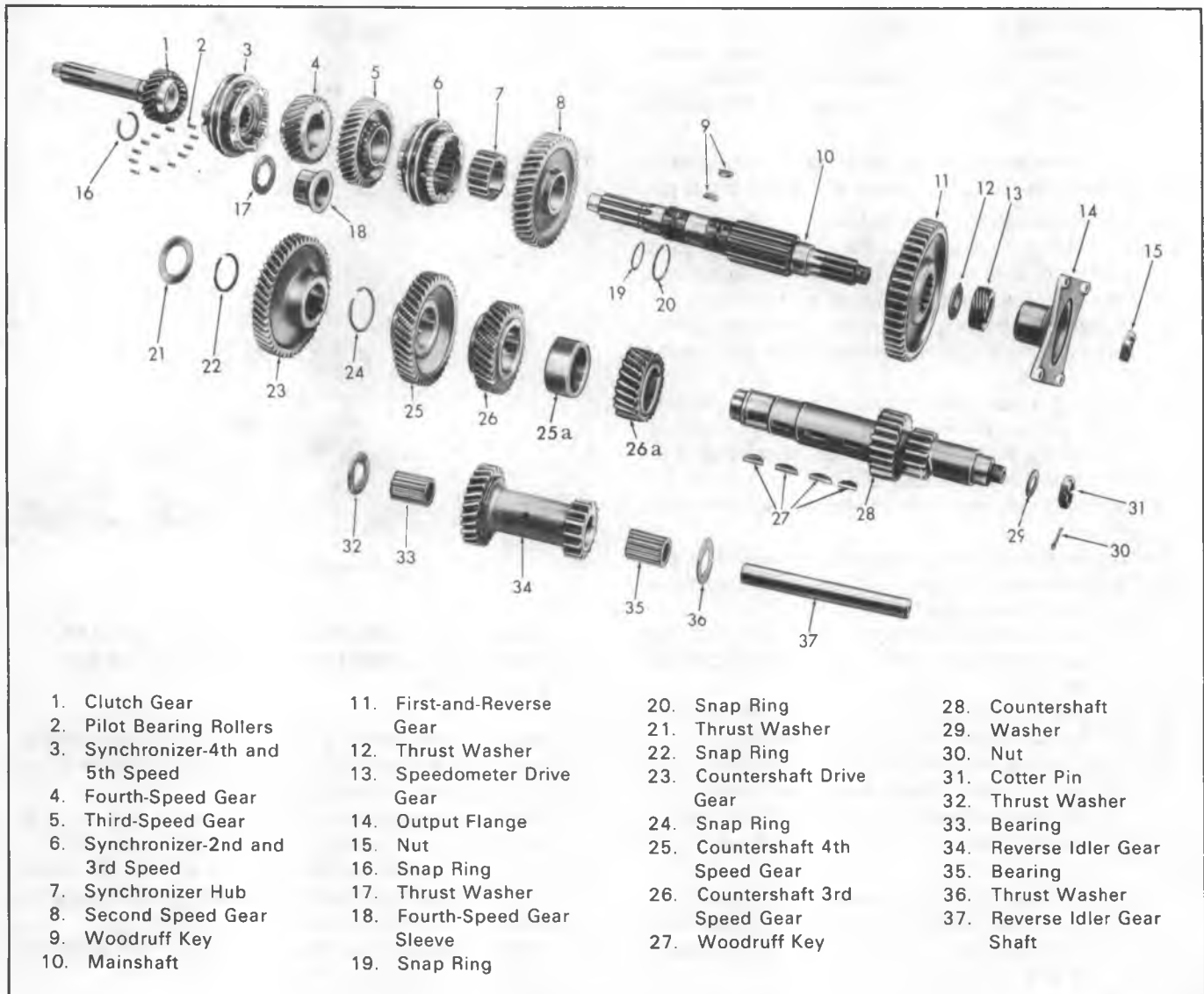


Fig. 25R-5-Speed Transmission Gear Details and Relative Parts



Fig. 26R-Installing Countershaft Front Bearing Spacer

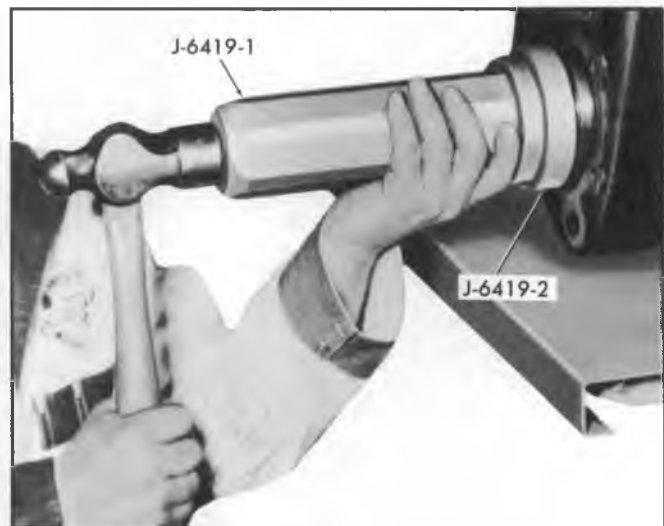


Fig. 27R-Installing Countershaft Rear Bearing

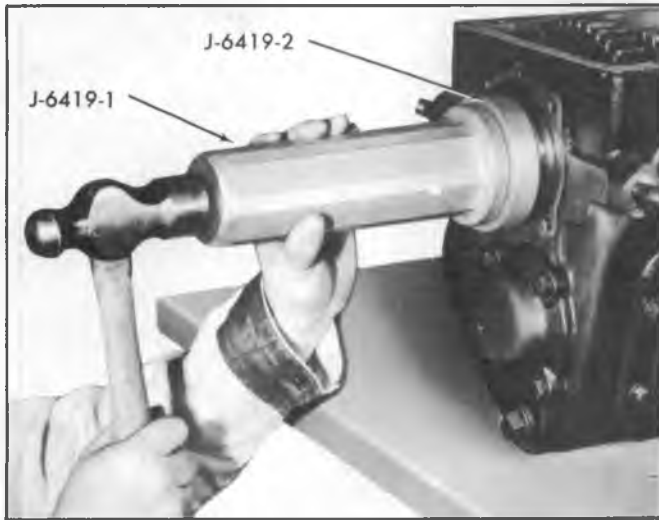


Fig. 28R--Reverse Idler Shaft Installation

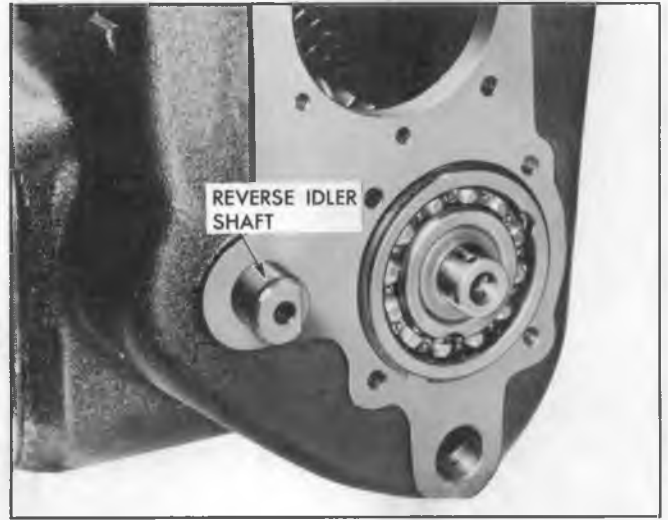


Fig. 29R--Installing Mainshaft Rear Bearing

## CLARK 5-SPEED TRANSMISSION (MODELS 282 AND 285)

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### DISASSEMBLY OF TRANSMISSION (Figs. 1N and 3N)

**IMPORTANT:** Cleanliness is extremely important and an absolute must when repairing or overhauling the transmission. Before attempting overhaul procedures, thoroughly clean exterior of the transmission with cleaning solvent to prevent dirt from getting into the gear mechanism.

**NOTE:** Clutch housing should not be removed from transmission case unless housing or case require replacement, or unless the countershaft front bearing requires replacement.

#### Shift Rod Support Assembly

##### Removal (Fig. 2N)

1. Remove control top or remote control assembly.

2. Remove shift rod cover capscrews and cover.
3. Remove shift rod support assembly retaining bolts and assembly from case (fig. 2N).

**CAUTION:** Be careful not to lose lock springs and balls from support.

#### Mainshaft Removal

1. Remove parking brake and drum assembly. Refer to Brakes, Section 5, Truck Service Manual.

**NOTE:** Lock transmission in two gears before removing brake drum retaining nut (fig. 4N).

2. Remove bolt and lock washer assemblies; then remove rear bearing cap and speedometer drive gear. Discard gaskets (fig. 5N).
3. Remove bolt and lock washer assemblies; then remove countershaft rear bearing cap and gasket. Discard gasket.

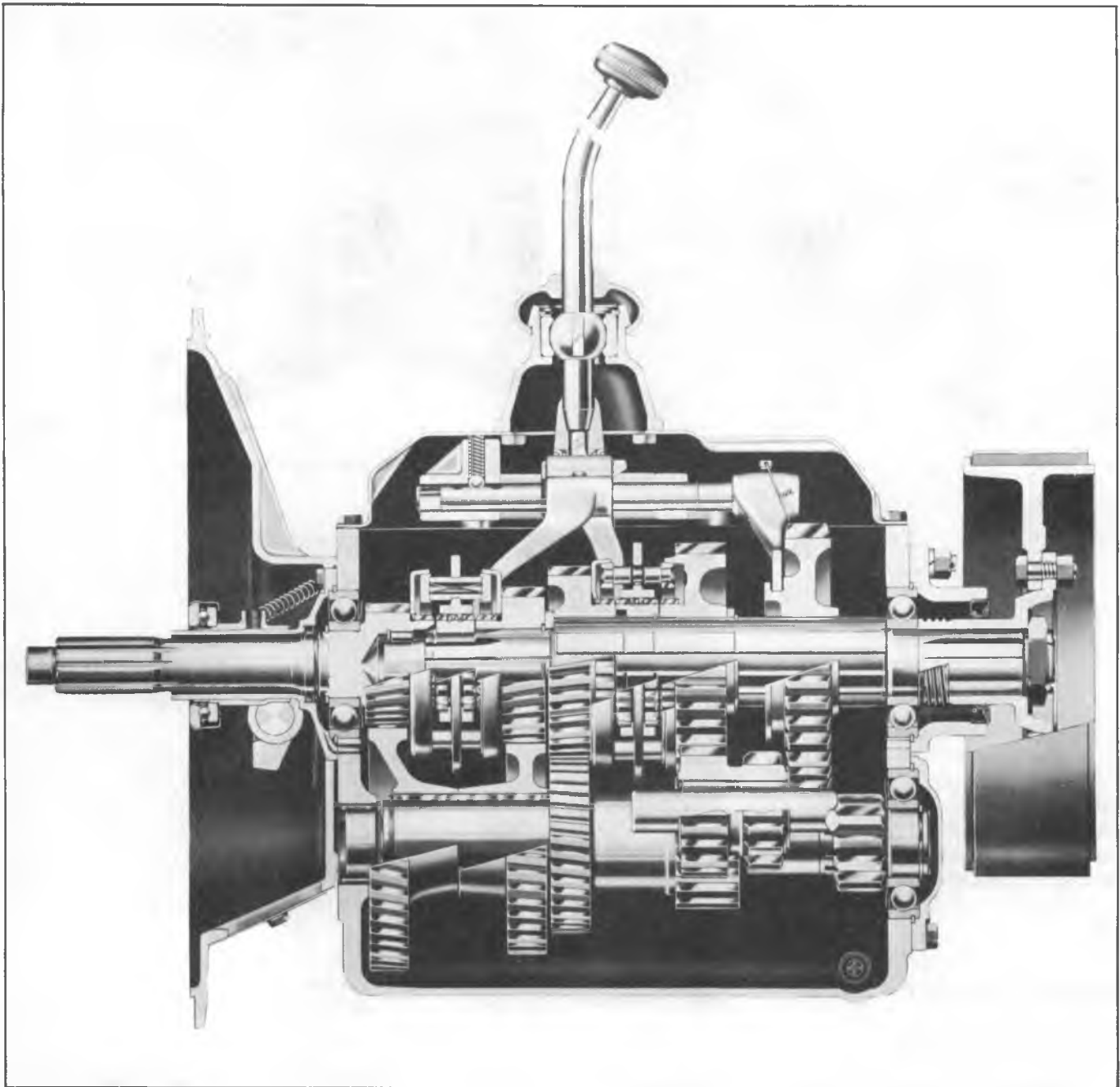


Fig. 1N--Transmission Cross-Section

4. Using snap ring pliers, remove countershaft rear bearing retaining snap ring (fig. 6N).
5. Remove main drive gear bearing cap and main drive gear (fig. 7N).

**NOTE:** Use caution so as not to drop mainshaft spigot bearing rollers in transmission case.

6. Pry mainshaft assembly to rear of transmission case to expose rear bearing. Remove snap ring from bearing, using a suitable puller, remove rear bearing (fig. 8N).
7. Raise front end of mainshaft to clear case, then remove the mainshaft assembly.

### Reverse Idler Gear Removal

1. Remove reverse idler lockscrew and lock.
2. Using a suitable puller remove reverse idler shaft (fig. 9N).
3. Remove reverse idler gear, bearings, and two thrust washers from case (fig. 10N).

### Countershaft Removal

1. Pry countershaft to the rear to expose rear bearing and remove snap ring from bearing.

- |  |   |
|--|---|
| 1. Gear Shift Lever Dust Cover                           | 22. 2nd Speed Overshift Spacer            |
| 2. Gear Shift Lever Pivot Pin                            | 23. Reverse Shift Lug Lock Screw          |
| 3. Control Top   | 24. Reverse Shift Lug                     |
| 4. Gear Shift Lever                                      | 25. 4th and 5th Shift Rod                 |
| 5. Gear Shift Lever Support Washer                       | 26. Mesh Lock Ball                        |
| 6. Support Spring  | 27. Interlock Cross Pin                   |
| 7. Control Top Gasket                                    | 28. 2nd and 3rd Shift Rod                 |
| 8. Shift Rod Cover                                       | 29. 1st and Reverse Shift Rod             |
| 9. Shift Rod Cover Gasket                                | 30. Mesh Lock Ball                        |
| 10. Shift Rod Support Screw and Lock Washer              | 31. Mesh Lock Spring                      |
| 11. Shift Rod Support                                    | 32. Reverse Hatch Plunger                 |
| 12. 1st and Reverse Shift Fork Lockscrew                 | 33. Reverse Hatch Plunger Retainer Washer |
| 13. 1st and Reverse Shift Fork                           | 34. Reverse Hatch Plunger Spring          |
| 14. Shift Fork Lock Pin                                  | 35. 1st and Reverse Rocker                |
| 15. 4th and 5th Shift Fork Assembly-Inc. Items 16 and 17 | 36. Reverse Latch Plunger Nut             |
| 16. Shift Fork Bushing                                   | 37. Reverse Latch Plunger Nut Cotter      |
| 17. Shift Fork Bushing                                   | 38. Backup Switch Hole Plug               |
| 18. Shift Fork Bushing                                   | 39. Backup Switch Hole Plug Gasket        |
| 19. Shift Fork Bushing                                   | 40. Welch Plug                            |
| 20. Shift Fork Lock Pin                                  | 41. Control Top Screw and Lock Washer     |
| 21. 2nd and 3rd Fork Assembly-Inc. Items 18 and 19       |   |

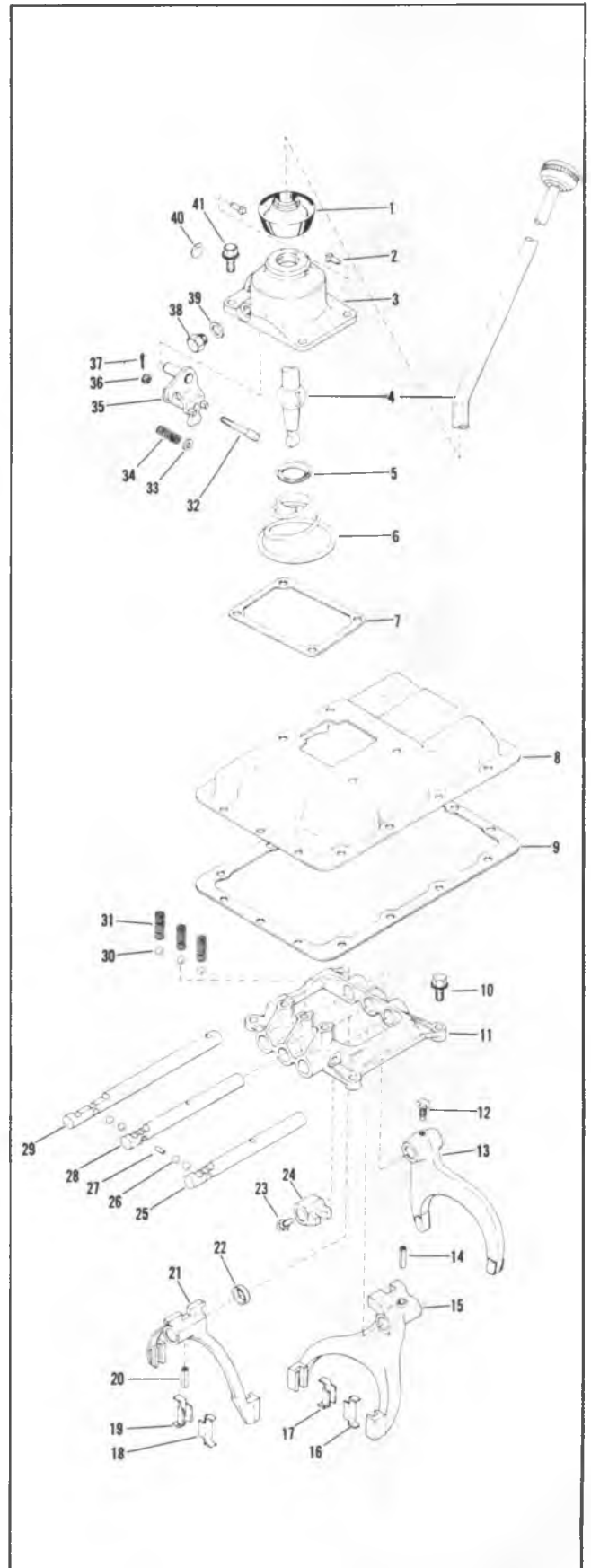


Fig. 2N--Cover Explode

- Using a suitable puller, remove countershaft rear bearing and oil slinger (fig. 11N).
- Raise forward end of countershaft and lift assembly from case.

## OVERHAUL OF SUBASSEMBLIES

### Mainshaft Disassembly

- Remove mainshaft 1st and reverse sliding gear. Set mainshaft in a vise with copper or brass jaws so splines will not be damaged.
- Remove 4th and 5th synchronizer assembly (fig. 12N).

**NOTE:** Bottom synchronizer cup may stay on mainshaft.

- Remove 4th and 5th shift hub sleeve retainer ring hub sleeve and 4th speed gear (fig. 13N).
- Remove 3rd speed gear retainer ring, 3rd speed gear and locating washer.
- Remove 2nd and 3rd synchronizer assembly, 2nd and 3rd shift hub sleeve retainer ring and hub sleeve (fig. 14N).

# 7-26 TRANSMISSION AND CLUTCH

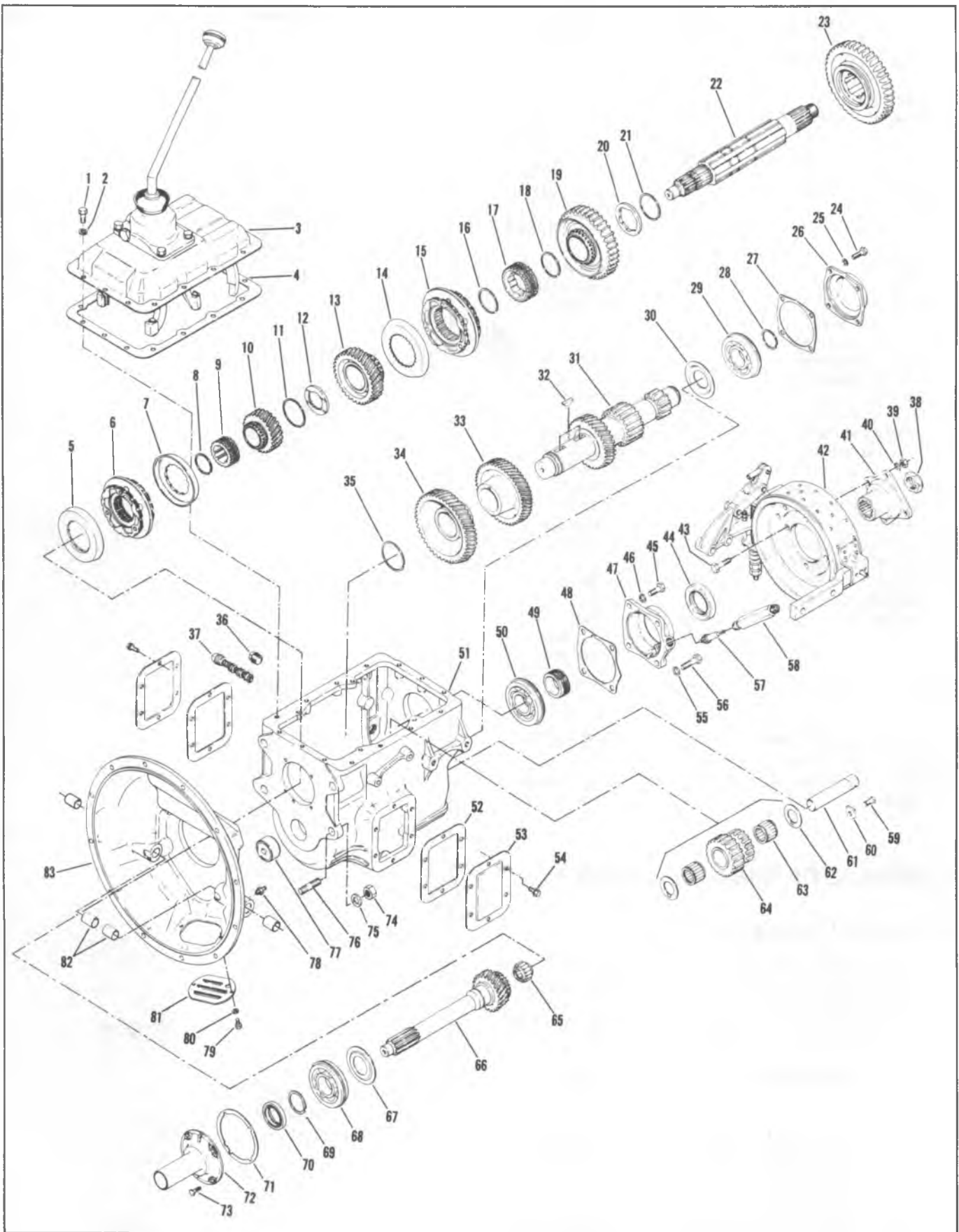


Fig. 3N-Transmission Assembly-Exploded View



- |  |   |   |   |
|--|---|---|---|
| 1. Shift Rod Cover Screw                             | 20. Mainshaft 2nd Speed Gear Locating Washer  | 44. Mainshaft Rear Oil Seal   | 63. Reverse Idler Bearing                       |
| 2. Shift Rod Cover Screw Lock Washer                 | 21. Mainshaft 2nd Speed Gear Retainer Ring    | 45. Mainshaft Rear Bearing Cap Screw                                | 64. Reverse Idler Gear                          |
| 3. See Control Cover                                 | 22. Mainshaft                                 | 46. Mainshaft Rear Bearing Cap Screw Lock Washer                    | 65. Mainshaft Spigot Bearing                    |
| 4. Control Cover Gasket                              | 23. Mainshaft 1st Speed Gear                  | 47. Mainshaft Rear Bearing Cap-Inc. Speedometer Driven Gear Bushing | 66. Main Drive Gear                             |
| 5. Mainshaft 5th Speed Synchronizer Cup              | 24. Countershaft Rear Bearing Cap Screw       | 48. Mainshaft Rear Bearing Cap Gasket                               | 67. Main Drive Gear Bearing Oil Slinger         |
| 6. Mainshaft 4th and 5th Synchronizer Assembly       | 25. Countershaft Rear Bearing Cap Lock Washer | 49. Speedometer Drive Gear  | 68. Main Drive Gear Bearing                     |
| 7. Mainshaft 4th Speed Synchronizer Cup              | 26. Countershaft Rear Bearing Cap             | 50. Mainshaft Rear Bearing  | 69. Main Drive Gear Bearing Retainer Ring       |
| 8. Mainshaft 4th and 5th Shift Hub Sleeve Ret. Ring  | 27. Countershaft Rear Bearing Cap Gasket      | 51. Transmission Case   | 70. Main Drive Gear Bearing Cap Oil Seal        |
| 9. Mainshaft 4th and 5th Shift Hub Sleeve            | 28. Countershaft Rear Bearing Retainer Ring   | 52. P.T.O. Cover Plate Gasket                                       | 71. Main Drive Gear Bearing Cap Gasket          |
| 10. Mainshaft 4th Speed Gear                         | 29. Countershaft Rear Bearing                 | 53. P.T.O. Cover Plate  | 72. Main Drive Gear Bearing Cap                 |
| 11. Mainshaft 3rd Gear Retainer Ring                 | 30. Countershaft Rear Bearing Oil Slinger     | 54. P.T.O. Cover Plate Screw  | 73. Main Drive Gear Bearing Cap Screw           |
| 12. Mainshaft 3rd Gear Locating Washer               | 31. Countershaft                              | 55. Mainshaft Rear Bearing Cap Screw Lock Washer                    | 74. Clutch Housing Stud Nut                     |
| 13. Mainshaft 3rd Speed Gear                         | 32. Countershaft Gear Key                     | 56. Mainshaft Rear Bearing Cap Screw                                | 75. Clutch Housing Stud Nut Lock Washer         |
| 14. Mainshaft Gear Synchronizer Cup                  | 33. Countershaft 4th Speed Gear               | 57. Speedometer Driven Gear   | 76. Clutch Housing Stud Bearing                 |
| 15. Mainshaft 2nd and 3rd Synchronizer Assembly      | 34. Countershaft Drive Gear                   | 58. Speedometer Tube Nut  | 77. Countershaft Pilot Bearing                  |
| 16. Mainshaft 2nd and 3rd Shift Hub Sleeve Ret. Ring | 35. Countershaft Drive Gear Retainer Ring     | 59. Reverse Idler Shaft Lock Screw                                  | 78. Pedal Shaft Grease Fitting                  |
| 17. Mainshaft 2nd and 3rd Shift Hub Sleeve           | 36. Filler Plug                               | 60. Reverse Idler Shaft Lock  | 79. Clutch Housing Inspection Plate Bolt        |
| 18. Mainshaft 2nd and 3rd Shift Hub Sleeve Ret. Ring | 37. Magnetic Drain Plug                       | 61. Reverse Idler Shaft Washer                                      | 80. Clutch Housing Inspection Plate Lock Washer |
| 19. Mainshaft 2nd Speed Gear                         | 38. Flange Nut                                | 62. Reverse Idler Thrust Washer                                     | 81. Clutch Housing Inspection Plate             |
|  | 39. Retainer Nut                              |   | 82. Clutch Pedal Shaft Bushing                  |
|  | 40. Lock Washer                               |   | 83. Clutch Housing                              |
|  | 41. Flange                                    |   |   |
|  | 42. Parking Brake Assembly                    |   |   |
|  | 43. Bolt                                      |   |   |

- Remove 2nd gear retainer ring, 2nd gear and locating washer (fig. 15N).

### Shift Bar Housing Disassembly

- Remove 1st and reverse shift lug lockscrew, then remove 1st and reverse shift fork, rod and lug from shift rod support (fig. 16N).
- Using a small pin or drift, remove 2nd and 3rd shift fork roll pin (fig. 17N).
- Remove 2nd and 3rd shift rod.

**CAUTION:** Do not lose interlock cross pin or 2nd speed overshift spacer.

- Remove 4th and 5th shift fork roll pin, shaft rod and fork.

### CLEANING

Clean all parts thoroughly using solvent type cleaning fluid. It is recommended that parts be immersed in cleaning fluid and moved up and down slowly until all old lubricant and foreign material is dissolved and parts are thoroughly cleaned.

**CAUTION:** Care should be exercised to avoid skin rashes, fire hazards, and inhalation of vapors when using solvent type cleaners.

### Bearings

Remove bearings from cleaning fluid and strike against a block of wood to dislodge solidified particles of lubricant. Immerse again in cleaning fluid to flush out particles. Repeat above operation until bearings are thoroughly clean. Dry bearings using moisture-free compressed air. Be careful to

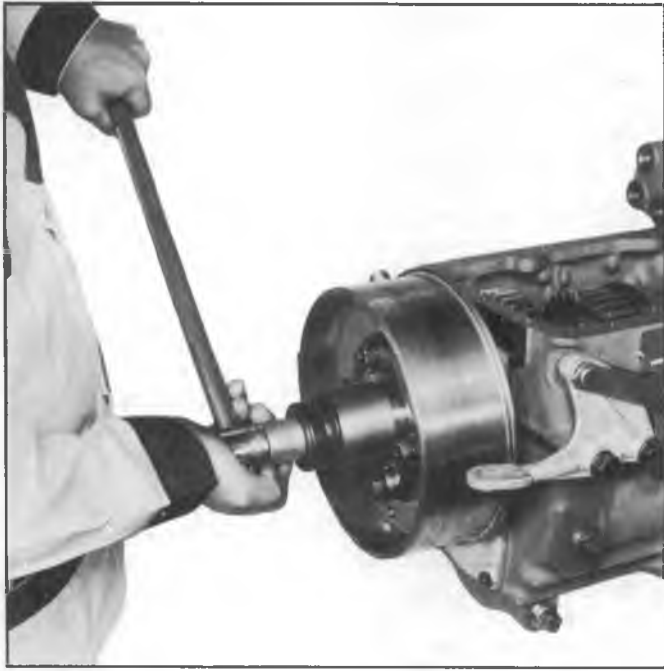


Fig. 4N--Removing Brake Drum Retaining Nut

direct air stream across bearing to avoid spinning. Do not spin bearings when drying. Bearings may be rotated slowly by hand to facilitate drying process.

### Housing

Clean interior and exterior of housings, bearing caps, etc., thoroughly. Cast parts may be cleaned in hot solution tanks with mild alkali solutions providing these parts do not have ground or polished surfaces. Parts should remain in solution

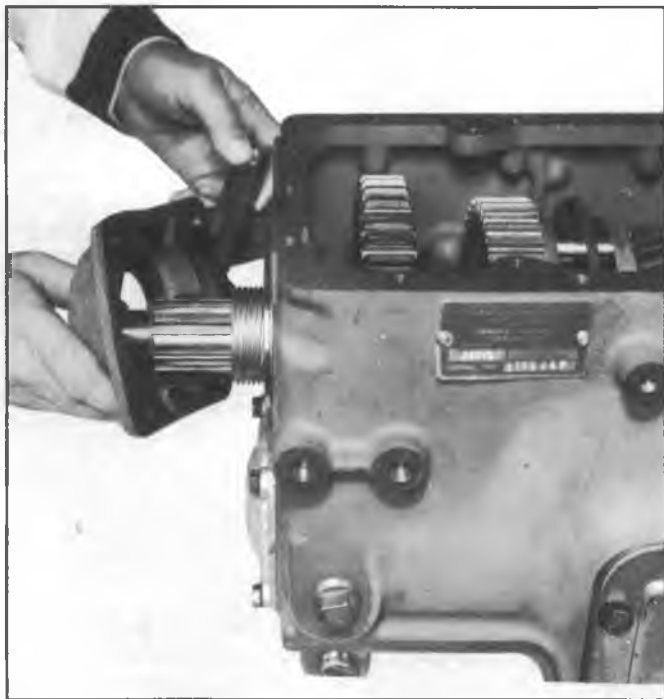


Fig. 5N--Removing Rear Bearing Cap



Fig. 6N--Removing Countershaft Rear Bearing Retainer Ring

long enough to be thoroughly cleaned and heated. This will aid the evaporation of the cleaning solution and rinse water. Parts cleaned in solution tanks must be thoroughly rinsed with clean water to remove all traces of alkali. Cast parts may also be cleaned with steam cleaner.

**CAUTION:** Care should be exercised to avoid inhalation of vapors and skin rashes when using alkali cleaners.



Fig. 7N--Removing Main Drive Gear



Fig. 8N--Removing Mainshaft Rear Bearing

All parts cleaned must be thoroughly dried immediately by using moisture-free compressed air or soft, lintless absorbent wiping rags free of abrasive materials such as metal filings, contaminated oil or lapping compound.

## INSPECTION

The importance of careful and thorough inspection of all parts cannot be overstressed. Replacement of all parts show-



Fig. 10N--Removing Idler Gear and Bearings

ing indication of wear or stress will eliminate costly and avoidable failures at a later date.

## Bearings

Carefully inspect all rollers and balls for wear, chipping or nicks to determine fitness of bearings for further use. After inspection, dip bearings in clean oil and wrap in clean lintless cloth or paper to protect them until installed.

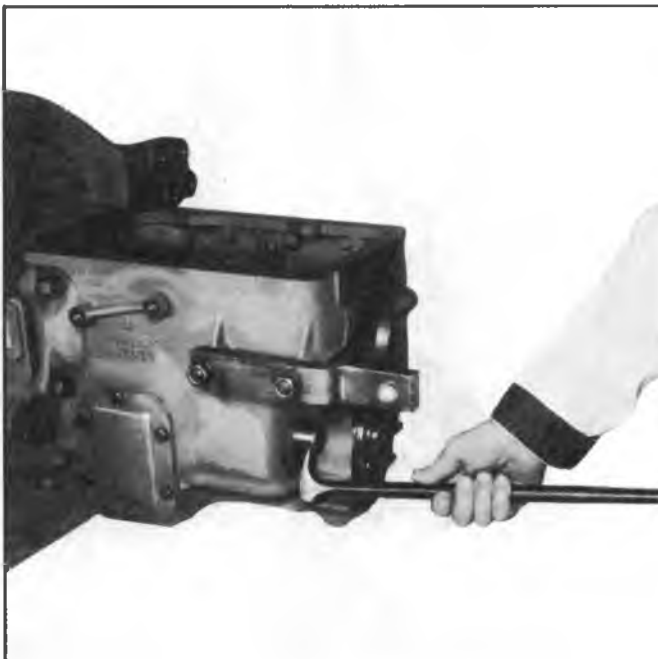


Fig. 9N--Removing Reverse Idler Shaft



Fig. 11N--Removing Countershaft Rear Bearing



Fig. 12N--Removing 4th and 5th Synchronizer Assembly

### Oil Seals, Gaskets, Etc.

Replacement of spring loaded oil seals, gaskets and snap rings is more economical when unit is disassembled than premature overhaul to replace these parts at a future time. Further loss of lubricant through a worn seal may result in failure of other more expensive parts of the assembly. Sealing members should be handled carefully, particularly when be-



Fig. 13N--Removing 4th and 5th Shift Hub Sleeve Retainer Ring



Fig. 14N--Removing 2nd and 3rd Shift Hub Sleeve Retainer Ring

ing installed. Cutting, scratching, or curling under of lip of seal seriously impairs its efficiency.

### Gears and Shafts

If Magna-Flux process is available, use process to check parts. Examine teeth on all gears carefully for wear, pitting, chipping, nicks, cracks, or scores. If gear teeth show spots



Fig. 15N--Removing 2nd Gear Retainer Ring



Fig. 16N--Removing 1st and Reverse Shift Lug Lockscrew

where case hardening is worn through or cracked, replace with new gear. Small nicks may be removed with suitable hone. Inspect shafts to make certain they are not sprung, bent or splines twisted, and that shafts are true.

### Housing, Cover, Etc.

Inspect housings, covers, and bearings caps to be certain they are thoroughly cleaned and that mating surfaces, bear-



Fig. 17N--Removing 2nd and 3rd Shift Fork Roll Pin

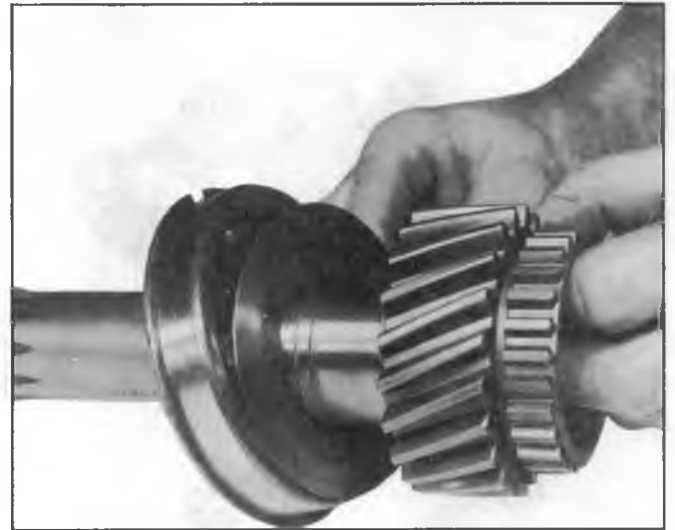


Fig. 18N--Main Drive Gear Assembly

ing bores, etc., are free from nicks or burrs. Check all parts carefully for evidence of cracks or condition which would cause subsequent oil leaks or failures.

## REASSEMBLY OF SUBASSEMBLIES

### Main Drive Gear Disassembly and Assembly

1. Remove main drive gear bearing retainer ring.
2. Press bearing and oil slinger from main drive gear.
3. Position bearing and slinger on gear (fig. 18N) and press bearing and slinger onto gear.



Fig. 19N--Installing 4th and 5th Shift Fork Rod Roll Pin



Fig. 20N--Installing Interlock Balls

4. Install retainer ring.

### Shift Bar Housing Assembly

1. Install 4th and 5th shift rod through support and into 4th and 5th shift fork.
2. Install 4th and 5th shift fork to shift rod roll pin, move rod to neutral (fig. 19N).
3. Install two interlock balls between 4th and 5th, and 2nd and 3rd shift rods (fig. 20N).



Fig. 21N--Installing Countershaft Front Bearing

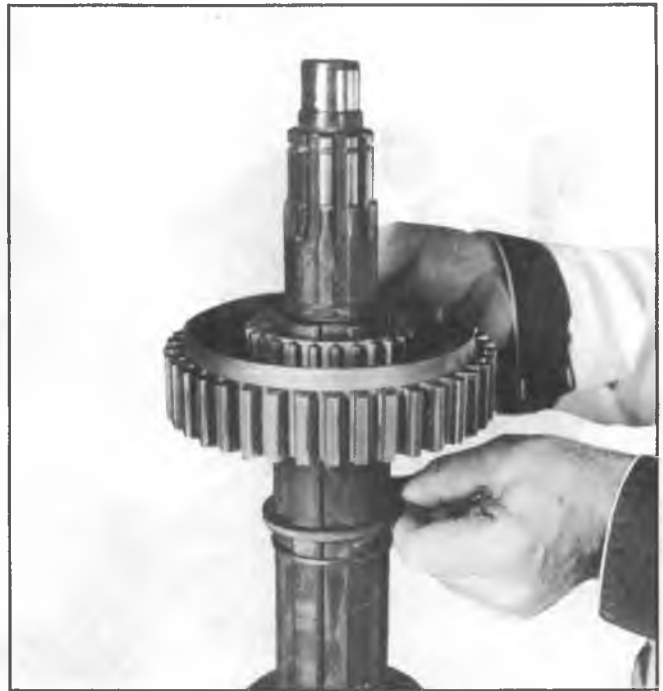


Fig. 22N--Installing 2nd Speed Gear

4. Install 2nd and 3rd shift rod through shift support. Install over shift spacer shift fork and interlock cross pin.
5. Install 2nd and 3rd shift fork to shift rod roll pin. Move rod to neutral.
6. Install two interlock balls between the 2nd and 3rd and 1st and reverse shift rods.
7. Install 1st and reverse rod through support and into lug. Install 1st and reverse lug lock screw and lock wire to prevent loosening (fig. 16N).



Fig. 23N--Installing 3rd Speed Gear and Washer



## Clutch Housing or Countershaft Front Bearing Replacement

1. Remove clutch housing and drive front bearing from transmission case.
2. Apply a light coat of permatex No. 2 on the outer diameter of the new bearing. Install in transmission case with end of bearing .001 to .007 below face of case (fig. 21N).
3. Install main drive gear and bearing assembly in transmission case.
4. Install main drive gear bearing cap on drive gear.
5. Install clutch housing and tighten stud nuts 60 to 80 ft. lbs. torque. Remove drive gear bearing cap and main drive gear.

## Mainshaft Assembly

1. Install 2nd speed gear retainer ring, locating washer, and 2nd speed gear on mainshaft (fig. 22N). (Note: Clutching teeth are up.)
2. Install 2nd gear retainer ring.
3. Install 2nd and 3rd shift hub sleeve and sleeve retainer ring.
4. Install 2nd and 3rd synchronizer assembly.
5. Install 3rd speed gear with clutching teeth down. Install 3rd gear locating washer (fig. 23N).
6. Install 3rd gear retainer ring.
7. Install 4th gear with clutching teeth up. Note chamfer on 4th and 5th shift hub sleeve (fig. 24N). Chamfer must go down. Install bottom cup of 4th and 5th synchronizer on 4th speed gear clutching teeth before installing 4th and 5th shift hub sleeve. Install sleeve retainer ring.



Fig. 24N--Installing 4th and 5th Shift Hub Sleeve

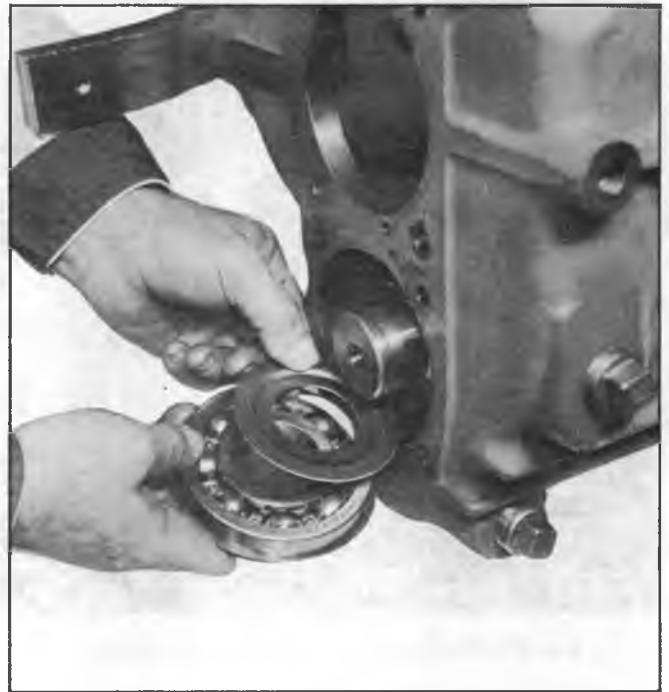


Fig. 25N--Positioning Rear Bearing and Oil Slinger

8. Install 4th and 5th synchronizer of shift hub sleeve.
9. Turn mainshaft assembly over and install 1st and reverse sliding gear with shift fork slot down.

## ASSEMBLY OF TRANSMISSION

1. Apply light coat of sealer to bearing O.D. and install countershaft front bearing in case with end of bearing .001 to .007 below face of case.
2. Tip rear of countershaft down and into transmission



Fig. 26N--Installing Countershaft Rear Bearing

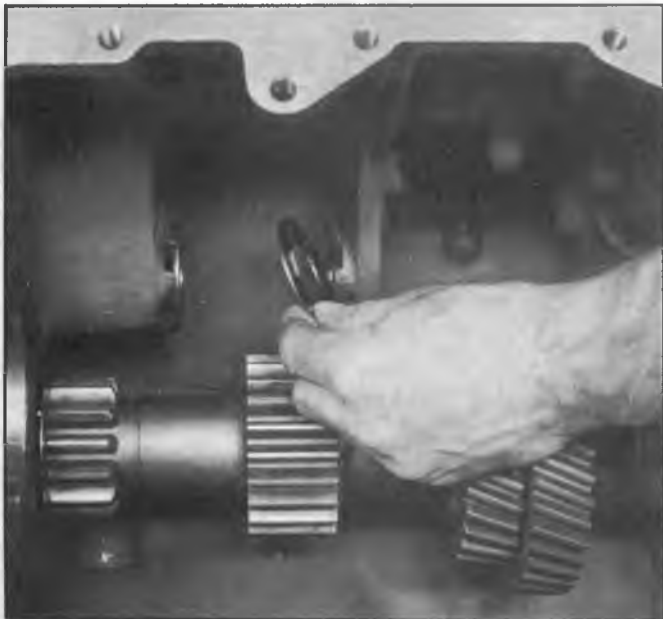


Fig. 27N--Position Reverse Idler Thrust Washers



Fig. 29N--Main Drive Gear Installed

case. Feed rear of countershaft through rear countershaft bearing bore. Move countershaft forward and into pilot bearing.

3. Position rear bearing oil slinger and start rear bearing (fig. 25N).
4. Drive rear bearing on countershaft and into rear bearing bore (fig. 26N).

**NOTE:** Countershaft drive gear must be supported

on each side with a 1/4" flat bar to prevent damage to countershaft pilot bearing. Install bearing retainer ring.

5. Use heavy grease on reverse idler thrust washers to hold in place (fig. 27N).
6. Insert two reverse idler gear bearings in idler gear.
7. Install reverse idler gear (fig. 9N). Insert idler shaft through case and idler gear.



Fig. 28N--Installing Pilot Bearing



Fig. 30N--Mainshaft Rear Bearing Installation

**NOTE:** Idler shaft lock groove must line up with lock bolt hole. Drive shaft into position. Install shaft lock and bolt. Tighten bolt to 20-25 ft. lbs. torque.

8. Install mainshaft assembly into transmission case.
9. Assemble the pilot bearing in the main drive gear as follows (fig. 28N):
  - a. If a new pilot bearing is used, it will come from the factory with a plastic sleeve. Stand drive gear on end. Set bearing and sleeve over bearing pocket in drive gear. Slide bearing rollers and cage from plastic sleeve into bearing pocket.
  - b. If old pilot bearing is used, set rollers in bearing cage and hold in place with a rubber band. Slide bearing rollers and cage from rubber band into bearing pocket.
10. Install main drive gear assembly in transmission case. Clutching teeth on main drive gear must enter 5th speed synchronizer cup without binding (fig. 29N).
11. Press oil seal into drive gear bearing cap with lip of seal up. Shellac a new gasket to bearing cap, use caution as not to cover oil return groove in bearing cap.
12. With bearing cap oil return groove lined up with oil hole in transmission case install bearing cap and bolts. Tighten bolts 20 to 25 ft. lbs. torque.
13. Install mainshaft rear bearing (fig. 30N).
14. Shellac a new gasket to countershaft bearing cap. Install bearing cap and bolts, tighten bolts 20 to 25 ft. lbs. torque.
15. Install speedometer drive gear.
16. Press a new oil seal in mainshaft rear bearing cap with lip of seal down. Shellac gasket to bearing cap, use caution as not to cover oil return grooves in bearing cap. Install bearing cap with oil grooves lined up with oil holes in case. Tighten bolts 20 to 25 ft. lbs. torque.
17. Install parking brake and drum assembly as described in Section 5, Truck Chassis Service Manual.

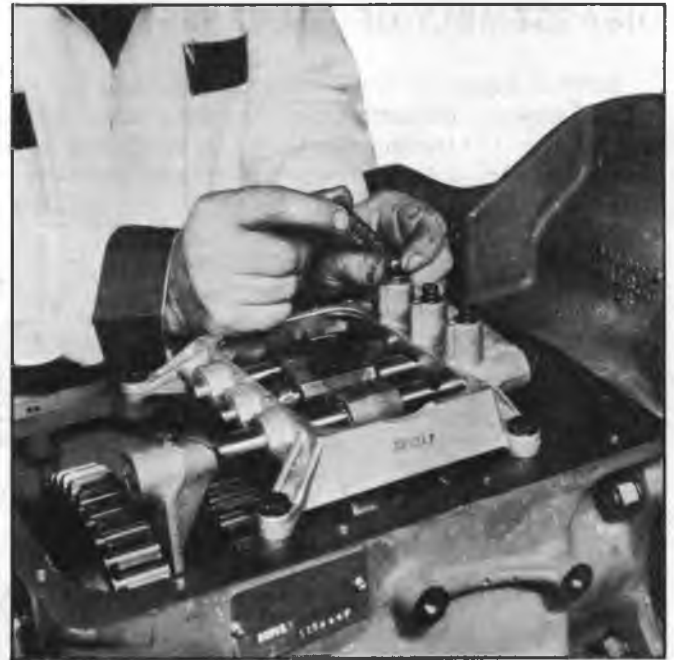


Fig. 31N--Positioning Lock Balls and Springs in Support Housing

18. With transmission shifted into neutral, install shift control assembly. 2nd and 3rd, 4th and 5th shift forks set over shift hubs, 1st and reverse fork enters slot on 1st and reverse gear. Tighten bolts 20 to 25 ft. lbs. torque. Position three mesh lock balls and springs in support housing (fig. 31N).
19. Install shift support cover. Tighten shift support cover bolts 20 to 25 ft. lbs. torque.
20. Install remote control or shift control top, tighten bolts 20 to 25 ft. lbs. torque.

## CLARK 5-SPEED TRANSMISSION (MODEL 325V, 327V)

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## DISASSEMBLY OF TRANSMISSION

Refer to Figure 1P unless otherwise specified.

The following procedures cover complete overhaul of the transmission. The transmission should be overhauled in sequence described unless only one unit is to be worked on.

**IMPORTANT:** Cleanliness is extremely important and an absolute must when repairing or overhauling the transmission. Before attempting overhaul procedures, thoroughly clean the exterior of the transmission with cleaning solvent to prevent dirt from getting into the gear mechanism.

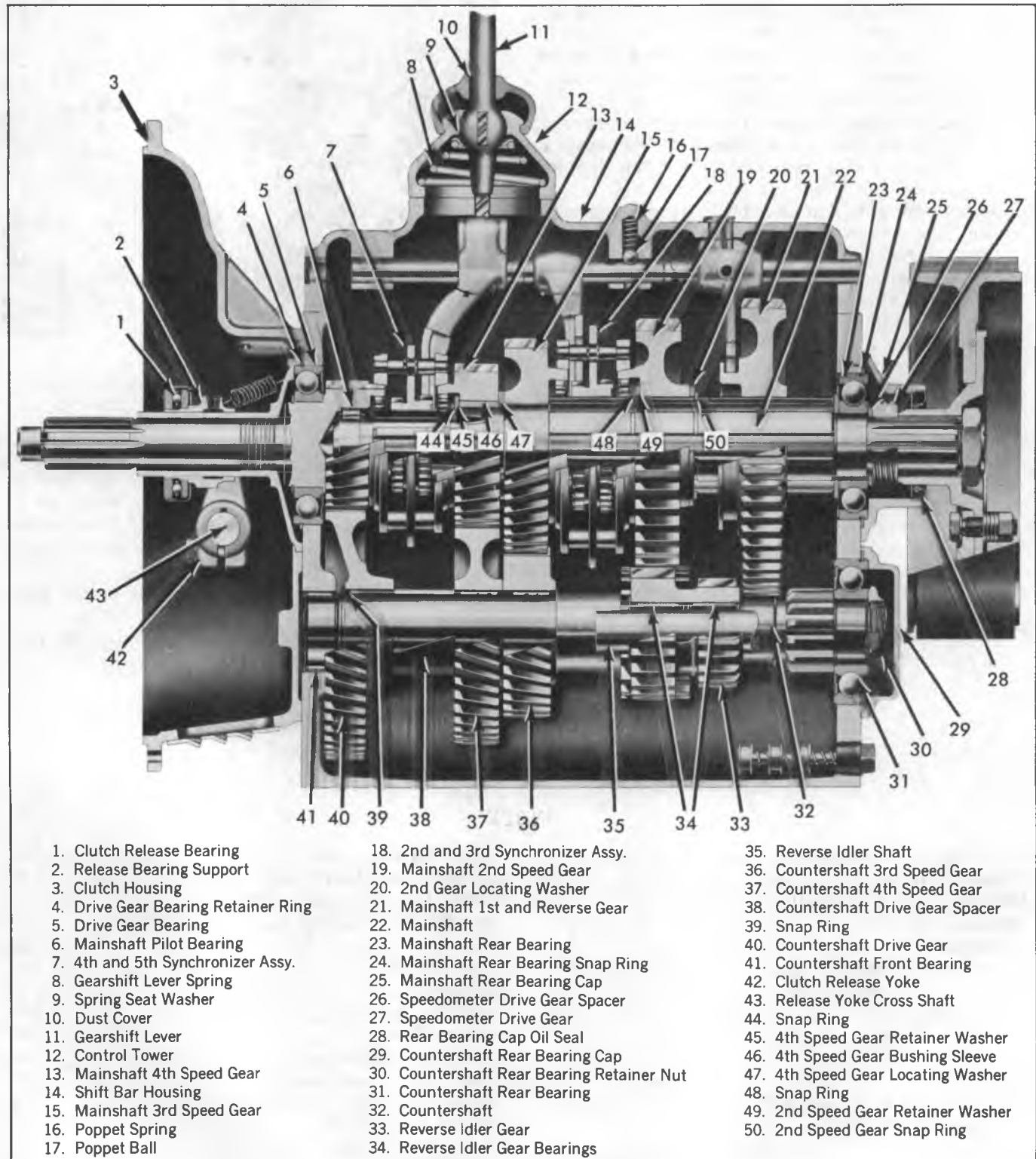


Fig. 1P—Transmission Cross-Section

**NOTE:** Clutch housing should not be removed from transmission case unless housing or case require replacement.

### Control Tower Removal

**NOTE:** On transmissions having a conventional gearshift lever, accomplish the following procedures:

1. Move gearshift lever to "Neutral" position.
2. Remove four bolts and lock washers attaching control tower to shift bar housing.
3. Lift shift control tower straight off shift bar housing. Remove and discard tower to housing gasket.

### Shift Bar Housing Removal

1. Mount transmission in holding fixture (J-5750); then remove drain and filler plugs and completely drain the transmission.

2. Remove power take-off covers and gaskets. Discard gaskets.
3. Remove bolt and lock washer assemblies, then remove the shift bar housing and gasket from transmission case (fig. 2P). Discard gasket.
4. Shifting by hand, engage transmission into two speeds at the same time to lock up the transmission.

### Mainshaft Removal

1. Remove parking brake parts (if used).
2. Remove nut and pull companion flange (and brake drum if used) from rear end of mainshaft.
3. Remove speedometer driven gear and adapter (if used) from the mainshaft rear bearing cap.
4. Remove bolt and lock washer assemblies, then remove mainshaft and countershaft, rear bearing caps and gaskets. Discard gaskets.
5. With transmission still locked in two speeds, remove countershaft rear bearing retaining nut.

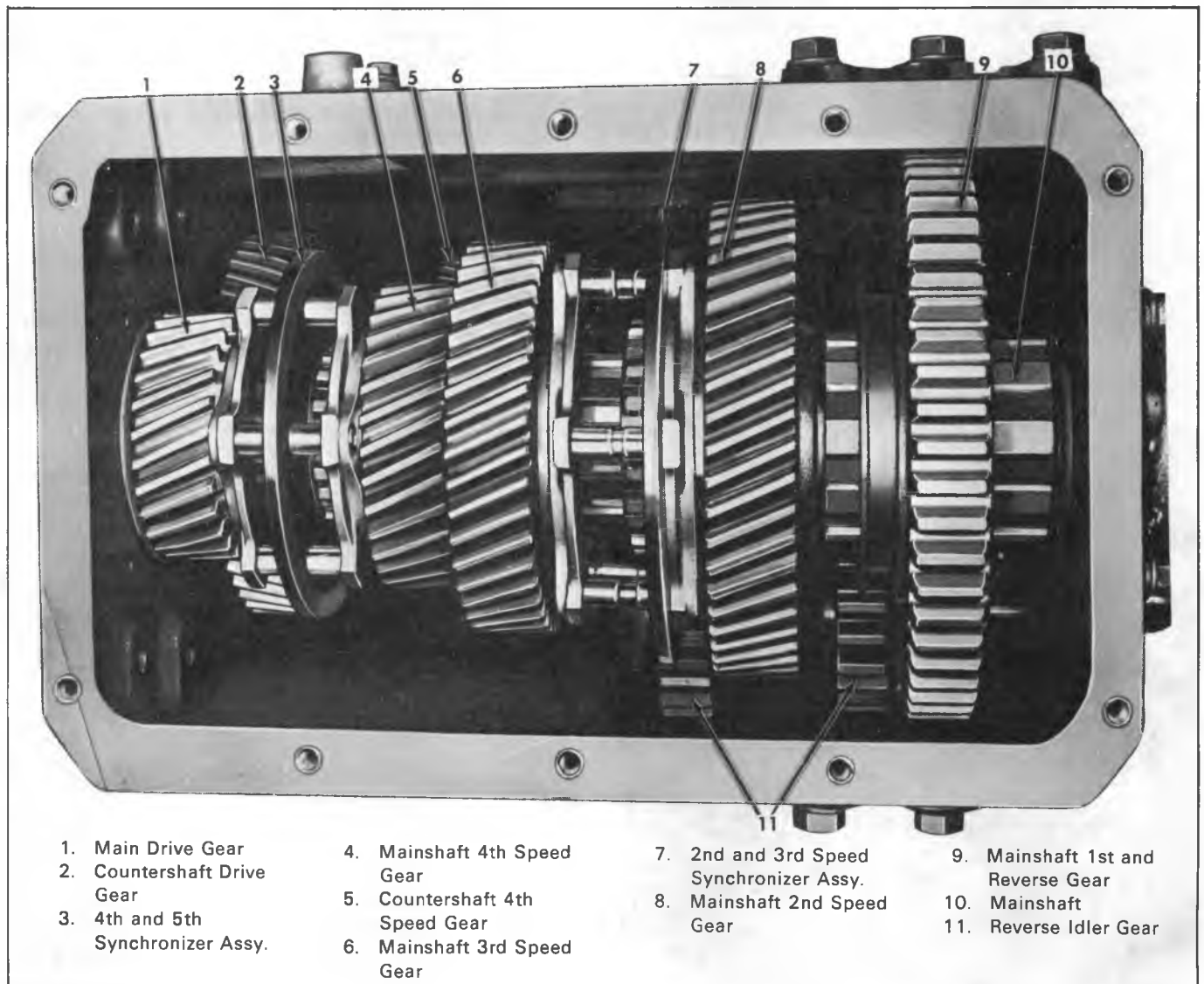


Fig. 2P--Transmission--Shift Bar Removed



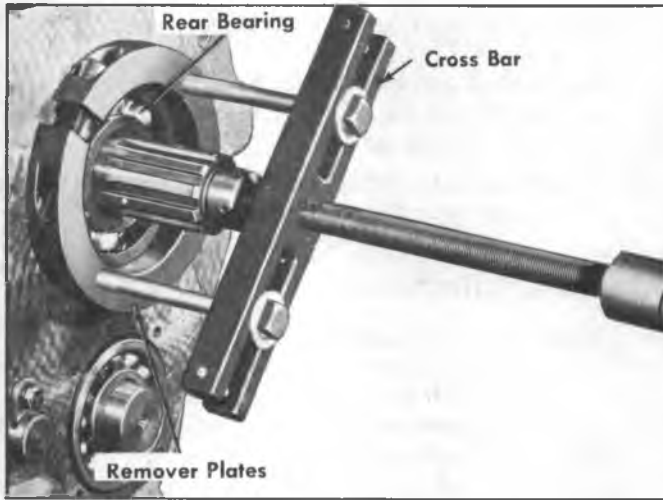


Fig. 3P-Removing Mainshaft Rear Bearing

6. Remove clutch release bearing and support assembly from main drive gear. Remove clutch release yoke.
7. Remove four bolt and lock washer assemblies; then remove main drive gear bearing cap and gasket. Discard gasket.
8. Remove main drive gear and bearing assembly from front of transmission case. Use care as mainshaft pilot bearing consisting of 12 rollers and a bearing may fall in the transmission case; avoid dropping and damaging the bearing. Remove pilot bearing from gear pocket or from pilot end of mainshaft.
9. Remove speedometer drive gear and spacer (if used).
10. Push mainshaft assembly toward rear of transmission case far enough so mainshaft rear bearing clears transmission case.
11. Using a suitable puller, remove mainshaft rear bearing from end of mainshaft (fig. 3P).
12. Tilt front end of mainshaft to clear front end of transmission case, then remove the mainshaft assembly.

### Reverse Idler Gear Removal

1. Remove reverse idler lock screw and lock washer, then

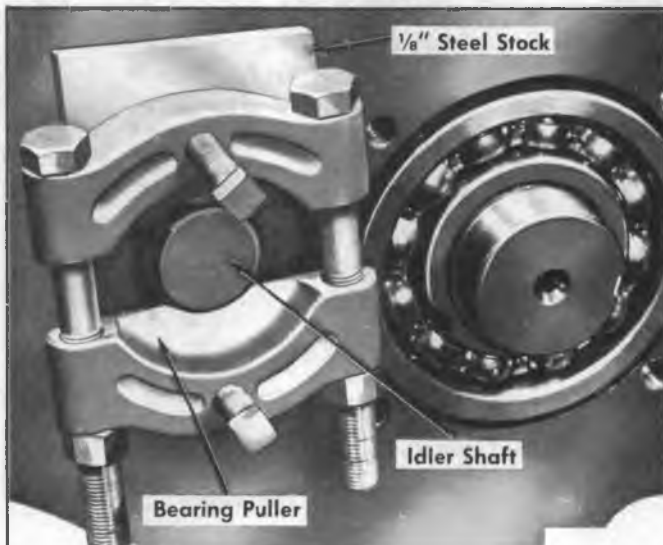


Fig. 4P-Removing Reverse Idler Shaft

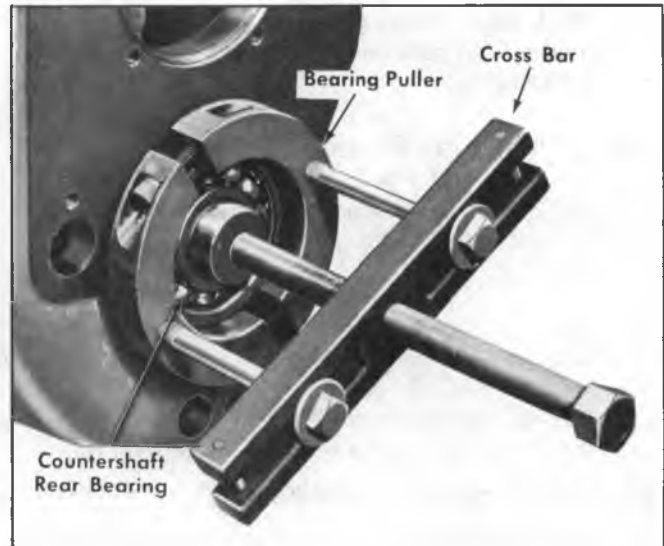


Fig. 5P-Removing Countershaft Rear Bearing

2. remove reverse idler shaft lock.
2. Using a suitable puller in slot in end of reverse idler shaft, pull shaft out of transmission case and reverse idler gear (fig. 4P).
3. Remove reverse idler gear, bearings, and thrust washer from transmission case.
4. Remove two reverse idler gear bearings and bearing spacer from hub of idler gear.

### Countershaft Removal

1. Push countershaft toward rear to move countershaft rear bearing out of transmission case far enough to remove snap ring from bearing.
2. Using a suitable puller, remove countershaft rear bearing (fig. 5P).

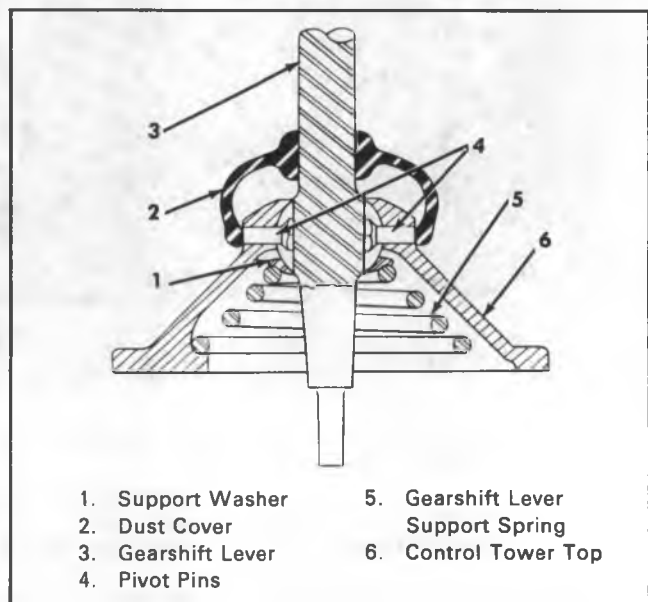
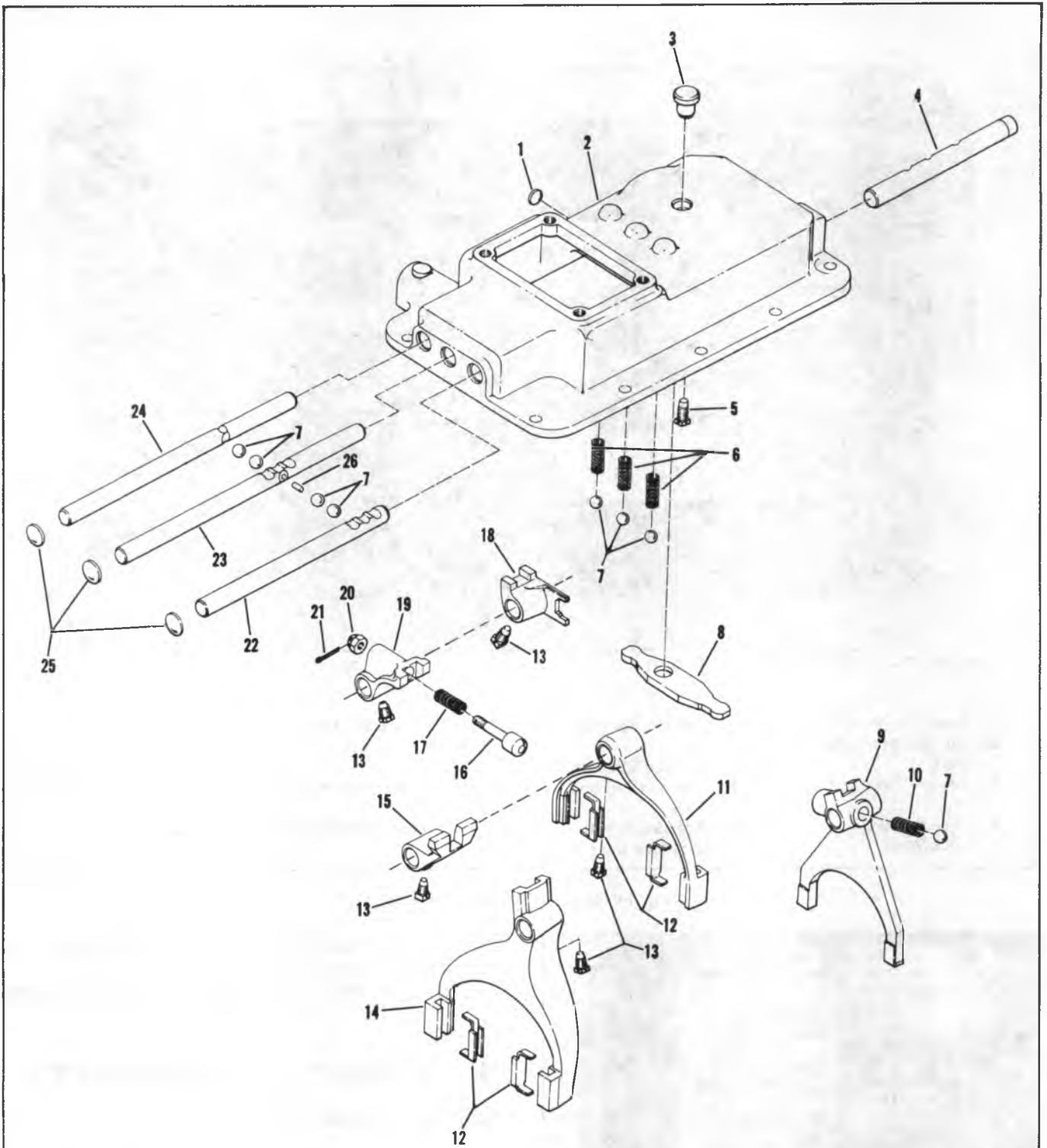


Fig. 6P-Control Tower and Gearshift Lever





- |                          |                           |                                      |                           |
|--------------------------|---------------------------|--------------------------------------|---------------------------|
| 1. Welch Plug            | 8. 1st-Reverse Rocker Arm | 14. 4th-5th Shift Fork               | 19. 1st-Reverse Shift Lug |
| 2. Shift Rod Cover       | 9. 1st-Reverse Shift Fork | 15. 2nd-3rd Shift Lug                | 20. Adjusting Nut         |
| 3. Pivot Pin             | 10. Poppet Spring         | 16. 1st-Reverse Latch Plunger        | 21. Lock Pin              |
| 4. 1st-Reverse Shift Bar | 11. 2nd-3rd Shift Fork    | 17. 1st-Reverse Latch Plunger Spring | 22. 1st-Reverse Shift Rod |
| 5. Lock Screw            | 12. Shift Fork Bushing    | 18. 1st-Reverse Rocker Lug           | 23. 4th-5th Shift Rod     |
| 6. Poppet Spring         | 13. Lock Screws           |                                      | 24. 1st-3rd Shift Rod     |
| 7. Interlock Balls       |                           |                                      | 25. Welch Plugs           |
|                          |                           |                                      | 26. Interlock Cross Pin   |

Fig. 7P-Shift Bar Housing-Exploded View

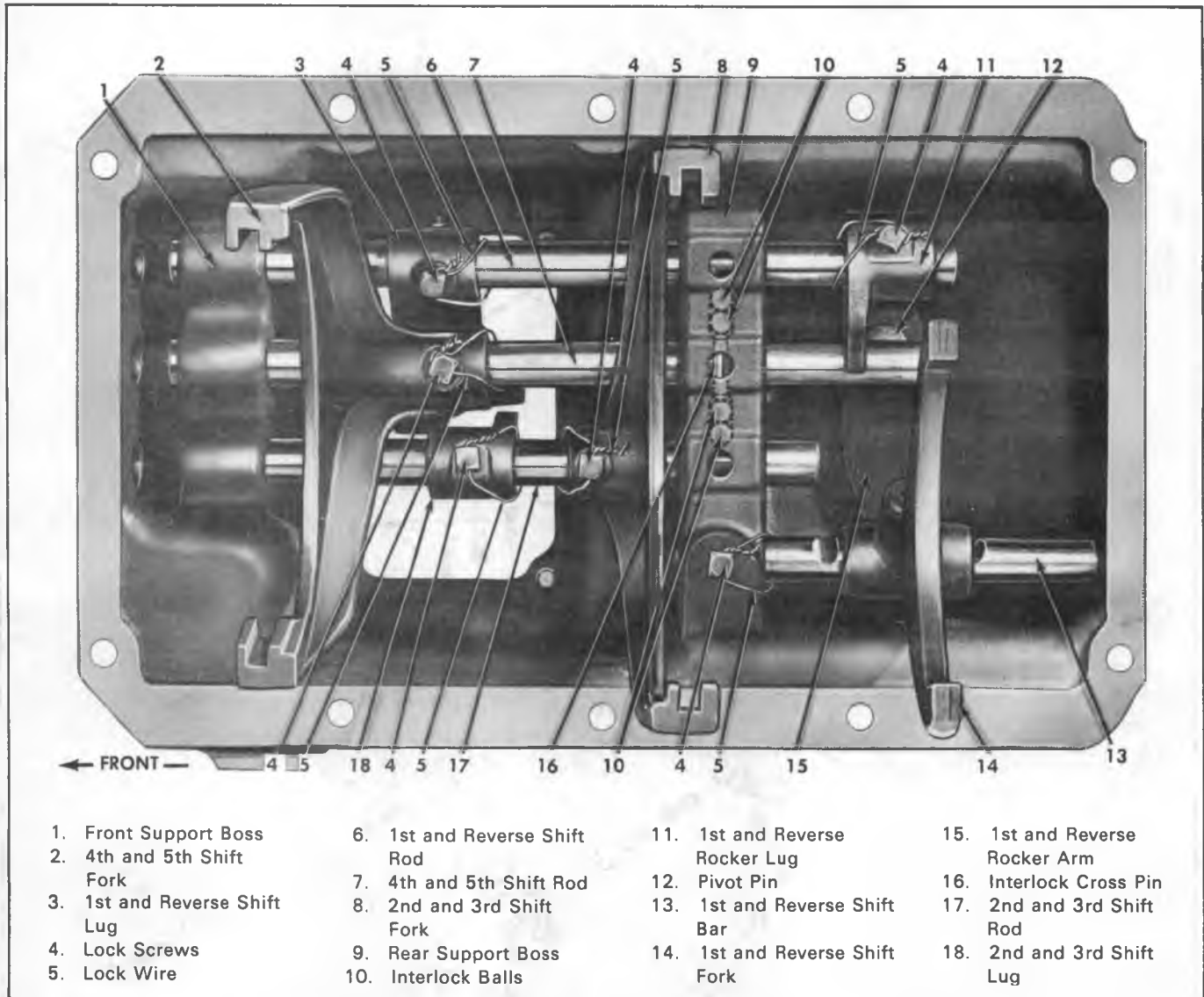


Fig. 8P-Shift Bar Housing Assembly

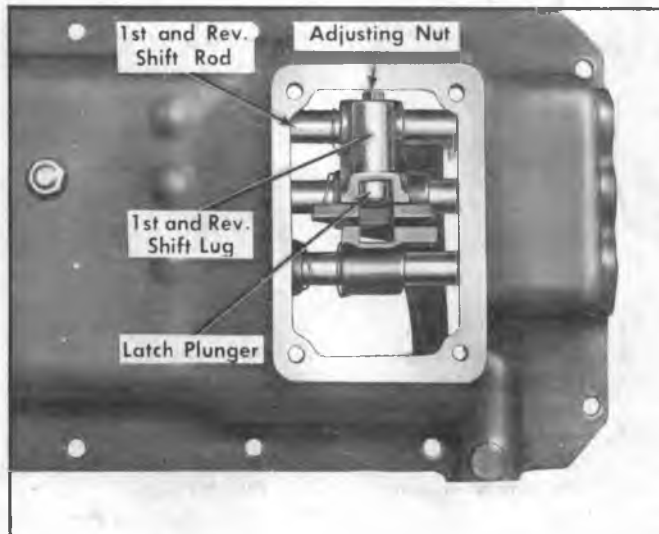


Fig. 9P-1st and Reverse Shift Lug and Latch Plunger

3. Raise front end of the countershaft and lift the assembly from transmission case.
4. Remove clutch housing and press front bearing from case.

## DISASSEMBLY OF SUBASSEMBLIES

### Control Tower (Fig. 6P)

**NOTE:** On transmissions having a conventional gearshift lever, accomplish the following procedures:

1. Remove shift lever knob and dust cover from shift lever.
2. Remove gearshift lever support spring and support spring washer.
3. Push gearshift lever out through bottom of control tower top. Remove Shift Lever pivot pins.

## Shifter Bar Housing (Figs. 7P and 8P)

1. It is suggested that each shift rod, shift fork, and shift lug be tagged so they can be properly positioned when the shift bar housing is reassembled.
2. Place shift bar housing on bench upside down with Welch plug openings toward repairman. Remove three shift rod hole Welch plugs.
3. Remove lock wire from shifter lugs and shift forks; then shift all rods into "Neutral" position.
4. Remove lock screw from 2nd and 3rd shift fork and from 2nd and 3rd shift lug.
5. While holding hand over poppet ball hole in housing rod support to prevent loss of poppet ball and spring, remove 2nd and 3rd shift rod, lug, and fork, from housing. Remove poppet ball and spring.
6. Remove lock screw from 4th and 5th shift fork.
7. While holding hand over poppet ball hole to prevent loss of poppet ball and springs, remove 4th and 5th shift rod, and fork from housing. Remove poppet ball, springs, and interlock cross pin.
8. Remove lock screw securing 1st and reverse shift bar in housing.
9. Holding hand over rear side of shift fork hub, remove 1st and reverse shift fork and shift fork bar from housing. Remove poppet ball and spring.
10. Remove four interlock balls from holes in rear rod support.
11. Remove lock screw from 1st and reverse rocker lug, and from 1st and reverse shift lug.
12. Remove 1st and reverse shift rod, rocker lug, and shift lug.
13. Remove cotter pin from the end of 1st and reverse latch plunger (fig. 9P).
14. Remove nut from end of latch plunger; then remove latch plunger and spring from well in 1st and reverse shift lug (fig. 9P). Rocker arm may now be lifted from pivot pin.

## Mainshaft (Fig. 10P)

1. Remove the 4th and 5th speed synchronizer assembly from the mainshaft.
2. Remove 1st and reverse sliding gear from mainshaft; then place balance of the assembly in a vise with copper or brass jaws so splines will not be damaged. The assembly should be positioned in vise with the front end up.
3. Using snap ring picks (J-8461-1), remove snap ring holding the 4th speed gear to mainshaft.
4. Turn 4th speed gear retaining washer to align internal splines of washer with splines of mainshaft and remove washer.
5. Remove the 4th speed gear from mainshaft.
6. Remove mainshaft assembly from vise and with the front end pointed down, lightly pound the assembly against a block of wood. This will cause weight of 3rd speed gear to force 4th speed gear bushing sleeve off mainshaft. After bushing sleeve has loosened, remove it with 4th speed gear locating washer from shaft. When bushing is removed the locating pin will come off shaft.

Care should be used not to lose pin.

7. Remove 3rd speed gear, thrust washer, and 2nd and 3rd synchronizer assembly.
8. Remove 2nd speed gear retaining ring, washer, and 2nd speed constant mesh gear from mainshaft.
9. Remove 2nd speed gear locating washer and snap ring from mainshaft.

## Countershaft (Fig. 10P)

1. Remove snap ring from end of the countershaft.
2. Position countershaft assembly in an arbor press and press countershaft drive gear from shaft. Remove Woodruff key from slot in countershaft.
3. Remove drive gear spacer. Remove 4th speed gear, and 3rd speed gear in same manner used to remove the drive gear.
4. Remove two remaining Woodruff keys from countershaft.

## Main Drive Gear and Bearing

1. Place drive gear assembly in a vise having copper or lead jaws so gear teeth will not be damaged.
2. Remove jam nuts or snap ring retaining bearing assembly on drive gear.
3. Using bearing remover plates (J-8176) and an arbor press, remove drive gear bearing from drive gear.

## CLEANING, INSPECTION AND REPAIR

### Cleaning

During overhaul procedures all components of the transmission (except bearing assemblies) should be thoroughly cleaned with cleaning solvent and dried with air pressure prior to inspection and reassembly of the transmission.

1. Clean the bearing assemblies as follows:
  - a. Careful and proper cleaning of bearings is of utmost importance. Bearings should always be cleaned separately from other parts.
  - b. Soak all bearing assemblies in CLEAN cleaning solvent. Gasoline is not recommended. Bearings should never be cleaned in a hot solution tank.
  - c. Slush bearings in solvent until all old lubricant is loosened. Hold bearing races so bearings will not rotate; then brush bearings with a soft bristled brush until ALL DIRT has been removed. Remove loose particles of dirt by striking bearing flat against a block of wood.
  - d. Rinse bearings in clean solvent; then blow bearings dry with air pressure. DO NOT SPIN BEARINGS WHILE DRYING.
  - e. Rotate each bearing slowly while examining balls or rollers for roughness, damage, or excessive wear. Replace all bearings that are not in first class condition.

**NOTE:** After cleaning and inspecting bearings as directed, lubricate bearings generously with lubricant recommended in LUBRICATION (SEC. 10) of this manual; then wrap each bearing in clean paper until ready to install in transmission.

# 7-42 TRANSMISSION AND CLUTCH

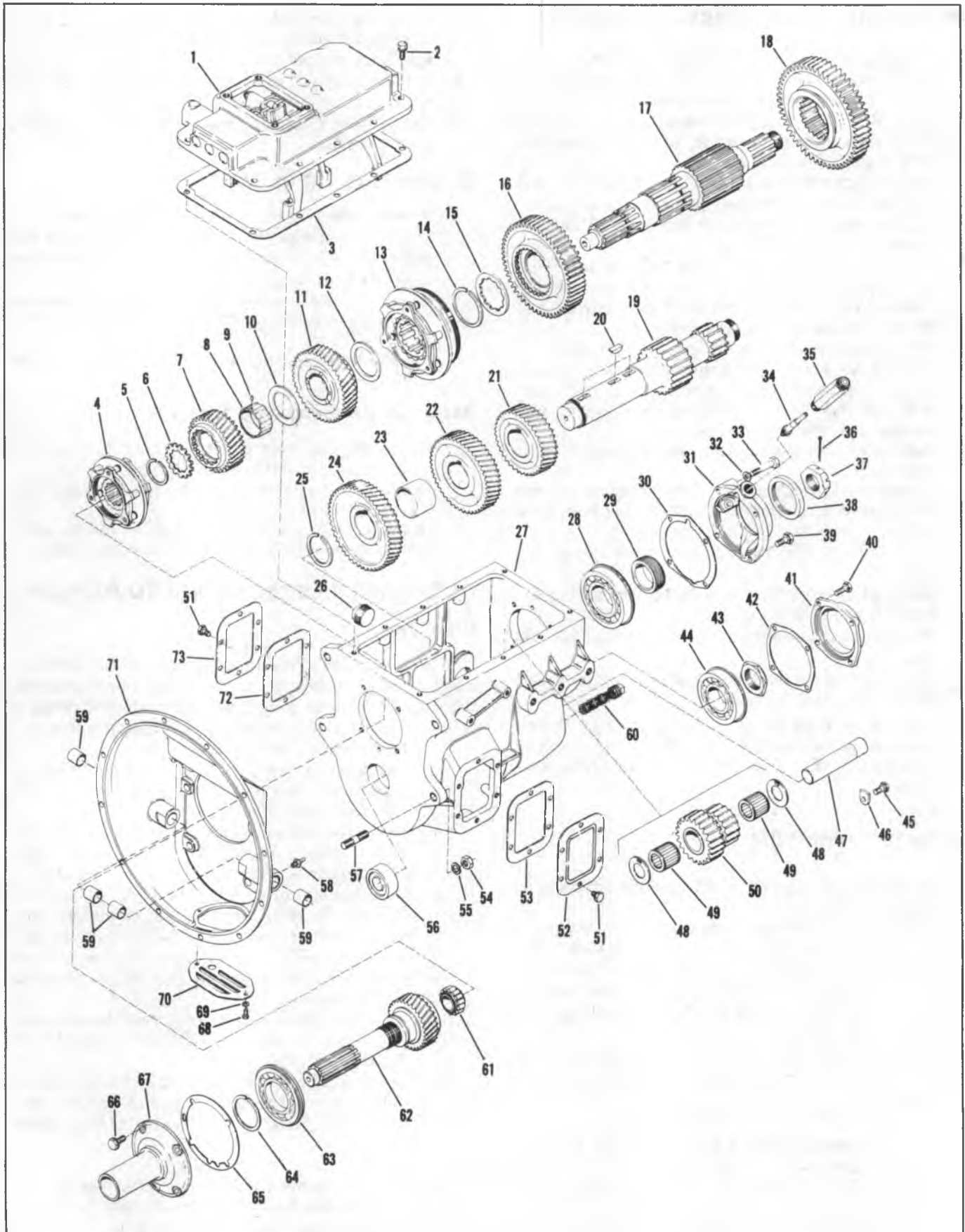


Fig. 10P--Transmission Exploded View

- |   |  |  |   |
|---|--|--|---|
| 1. Shift Rod Cover                          | 18. Mainshaft 1st and Reverse Gear               | 36. Lock Pin                               | 55. Lock Washer                                 |
| 2. Shift Rod Cover Screw                    | 19. Countershaft                                 | 37. Companion Flange Nut                   | 56. Countershaft Front Bearing                  |
| 3. Control Cover Gasket                     | 20. Woodruff Keys                                | 38. Rear Bearing Cap Oil Seal              | 57. Clutch Housing Stud                         |
| 4. 4th and 5th Speed Synchronizer Assembly  | 21. Countershaft 3rd Speed Gear                  | 39. Bolt and Lock Washer                   | 58. Pedal Shaft Grease Fitting                  |
| 5. Snap Ring                                | 22. Countershaft 4th Speed Gear                  | 40. Bolt and Lock Washer                   | 59. Clutch Pedal Shaft Bushing                  |
| 6. 4th Speed Gear Retainer Washer           | 23. Countershaft Drive Gear Spacer               | 41. Countershaft Rear Bearing Cap          | 60. Drain Plug                                  |
| 7. Mainshaft 4th Speed Gear                 | 24. Countershaft Drive Gear                      | 42. Gasket                                 | 61. Mainshaft Pilot Bearing                     |
| 8. 4th Speed Gear Bushing Sleeve            | 25. Snap Ring                                    | 43. Countershaft Rear Bearing Retainer Nut | 62. Main Drive Gear                             |
| 9. 4th Speed Gear Bushing Sleeve Pin        | 26. Filler Plug                                  | 44. Countershaft Rear Bearing              | 63. Main Drive Gear Bearing                     |
| 10. 4th Speed Gear Locating Washer          | 27. Transmission Case                            | 45. Shaft Lock                             | 64. Bearing Retainer Snap Ring                  |
| 11. Mainshaft 3rd Speed Gear                | 28. Mainshaft Rear Bearing                       | 46. Bolt and Lock Washer                   | 65. Gasket                                      |
| 12. 3rd Speed Gear Thrust Washer            | 29. Speedometer Drive Gear                       | 47. Reverse Idler Gear Shaft               | 66. Bolt  |
| 13. 2nd and 3rd Speed Synchronizer Assembly | 30. Gasket                                       | 48. Thrust Washers                         | 67. Drive Gear Bearing Cap                      |
| 14. Snap Ring                               | 31. Mainshaft Rear Bearing Cap                   | 49. Reverse Idler Gear Bearings            | 68. Clutch Housing Inspection Plate Bolt        |
| 15. 2nd Speed Gear Retainer Washer          | 32. Mainshaft Rear Bearing Cap Screw             | 50. Reverse Idler Gear                     | 69. Clutch Housing Inspection Plate Lock Washer |
| 16. Mainshaft 2nd Speed Gear                | 33. Mainshaft Rear Bearing Cap Screw Lock Washer | 51. Bolt and Lock Washer                   | 70. Clutch Housing Inspection Plate             |
| 17. Mainshaft                               | 34. Speedometer Driven Gear                      | 52. Power Take-Off Covers                  | 71. Clutch Housing Gaskets                      |
|   | 35. Speedometer Tube Nut                         | 53. Gaskets                                | 72. Gaskets                                     |
|   |  | 54. Nut                                    | 73. Power Take-Off Covers                       |

- Remove all portions of old gaskets from parts, using a stiff brush or scraper.

### Inspection

- Inspect rods and shafts for evidence of fatigue. Check bearing surfaces for scoring or wear.
- Inspect all parts for discoloration or warpage due to heat.
- Examine all gear teeth and splines for chipped, worn, broken, or nicked teeth or splines. Small nicks or burrs may be removed with a fine abrasive stone.
- Inspect the breather assembly to see that it is open and not damaged.
- Check all threaded parts for damaged, stripped, or crossed threads.
- Check all oil passages for obstructions, using brass rods and air pressure.
- Replace all gaskets, oil seals, lock wire, cotter pins, and snap rings. (If snap rings are not damaged or distorted and are not used for sealing as well as retaining, they may be reused.)
- Examine synchronizer assemblies for scoring, wear, or other damage. Replace synchronizers if not in first class condition.
- Inspect housing and covers for cracks, breaks, or other damage. Since repairs by welding, brazing, etc., are not recommended, replace all damaged parts.
- Inspect all bushings for wear or other damage.
- Check keys and keyways for condition.
- Inspect shift forks for wear, distortion, or other damage.

- Check springs for free length, compressed length, distortion, or collapsed coils.

### REPAIRS

#### Mainshaft Rear Bearing Cap

- If inspection shows necessity, press or drive rear bearing cap oil seal assembly out of rear bearing cap. Discard oil seal.
- Using a suitable sleeve and hammer or press, drive or press new oil seal in bore of bearing cap. Lip of oil seal goes in toward transmission case.

#### Clutch Release Bearing and Support

- If inspection shows clutch release bearing assembly or support are damaged, press bearing off support. Replace damaged parts.
- Using a press and suitable sleeve, press new bearing on support.

#### Clutch Housing Replacement

- Remove nuts and lock washers from clutch housing to transmission case studs, then remove clutch housing from transmission case.
- In order to obtain correct location of clutch housing on transmission case, the following procedure must be followed:
  - Install main drive gear and bearing assembly in transmission case.

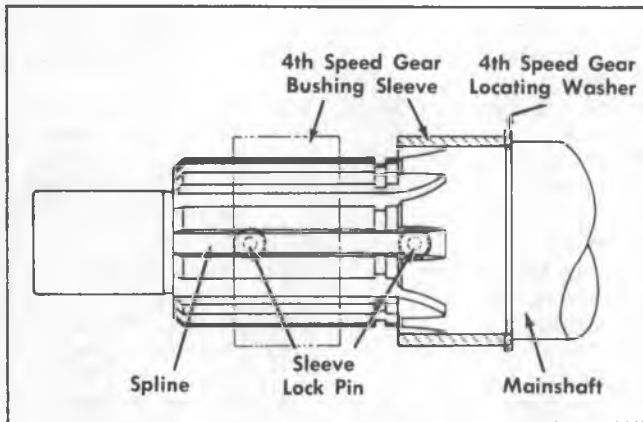


Fig. 11P--Sleeve Lock Properly Installed

- b. Install drive gear bearing cap over drive gear and bearing and secure in place with bolt and lock washer assemblies.
- c. Install clutch housing on transmission case, install lock washers and nuts on studs, and tighten firmly.
- d. Remove drive gear bearing cap, drive gear, and bearing assembly from transmission case.

## ASSEMBLY OF SUBASSEMBLIES

Refer to Figure 10P unless otherwise specified.

The importance of cleanliness cannot be over emphasized. Rebuild of the transmission should not be attempted in a dirty working area. All parts except those being actually worked on should be kept covered with clean paper. Avoid nicking, marring, or burring all surfaces. Whenever a common tool is specified, such as "soft" hammer or a vise with "soft-jaws," the tool should be used. Substitution of a hard hammer for example, may seriously damage the transmission. Special tools mentioned in text and shown in illustrations should be employed.

When assembling the transmission, use new lock wire, snap rings, cotter pins, gaskets, and oil seals. Lubricate each moving part with lubricant specified in LUBRICATION (SEC. 0) in the Truck Service Manual. Coat all bushings with a light coat of petrolatum before installation.

### Main Drive Gear

1. Lubricate main drive gear bearing and drive gear shaft with lubricant recommended in LUBRICATION (SEC. 0) in the Truck Service Manual.
2. Start bearing assembly straight on shaft of drive gear with bearing snap ring toward pilot end of gear. Support front inner race of bearing and press gear into bearing tight against front face of gear.
3. Install bearing retainer nut or snap ring.
4. Assemble the pilot bearing in the main drive gear as follows:
  - a. If a new pilot bearing is used it comes from the factory with a plastic sleeve. Stand drive gear on end. Set bearing and sleeve over bearing pocket in drive gear. Slide bearing rollers and cage from plastic sleeve into bearing pocket.

- b. If old pilot bearing is used, set rollers in bearing cage and hold in place with a rubber band. Slide bearing rollers and cage from rubber band into bearing pocket.

Use caution when installing drive gear and pilot bearing on pilot end of mainshaft, and into transmission clutch housing.

### Countershaft

1. Install Woodruff keys in 3rd and 4th gear slots in countershaft.
2. Lubricate the countershaft and bore of each gear before installing gears on countershaft.
3. Using an arbor press, start 3rd speed gear straight on countershaft with long hub of gear toward the rear. Align keyway in gear with key in countershaft and press gear tight against shoulder on shaft.
4. Press 4th speed gear on countershaft in same manner used to install the 3rd speed gear. Long hub of gear goes toward rear.
5. Install drive gear spacer and drive gear key.
6. Press countershaft drive gear (4) on countershaft with long hub toward rear. Install gear in same way used to install other gears.
7. Install snap ring in groove of countershaft. Be sure snap ring is well seated and locked in groove.

### Mainshaft

1. Clamp mainshaft in a vise with soft jaws with front end up.
2. Drop 2nd speed gear snap ring and locating washer into position over mainshaft.
3. Install 2nd speed gear retainer ring, locating washer and 2nd speed gear on mainshaft.
4. Select another 2nd speed gear locating washer that will assure a tight stack-up through the assembly. Place washer in position on shaft and install retaining ring.
5. Place 2nd and 3rd speed synchronizer assembly large end of hub toward rear, on splines of mainshaft and drop into position. Install 3rd speed gear locating thrust washer on mainshaft.
6. Position 3rd speed gear over mainshaft with toothed hub down and drop into place.
7. Position 4th speed gear locating washer on mainshaft.

**NOTE:** When assembling 4th speed gear bushing sleeve and lock pin assembly in Step 8 following, make certain sleeve lock pin is centered in a spline of mainshaft before pressing sleeve into place. Failure to do this may shear head of lock pin and cause bushing seizure (fig. 11P).

8. With lock pin in place in 4th speed gear bushing sleeve, install bushing sleeve on mainshaft with lock pin toward pilot or front end of mainshaft (43). It may be necessary to use a suitable sleeve and hammer to properly install sleeve.
9. To insure a proper tight stack-up between the 4th speed gear locating washer, 4th speed gear bushing sleeve, 4th



speed gear selective retainer washer, and snap ring, the following procedures must be accomplished:

- a. Before the 4th speed gear is installed on bushing sleeve, place retaining washer on mainshaft and hold down securely against bushing sleeve.
- b. While holding snap ring parallel to the retaining washer, slip snap ring into snap ring groove in mainshaft. Select variable thickness retaining washers, until a washer is selected that will assure a tight stack-up through the assembly (fig. 12P).
- c. Remove selected washer and install 4th speed gear and bushing assembly over bushing sleeve.
- d. Place selected washer in position; then install snap ring into groove of mainshaft.

**NOTE:** If end play on 4th speed gear is more than .006" a thicker washer must be used.

10. Remove assembly from vise and install 4th and 5th speed synchronizer assembly on mainshaft with large end of hub toward the rear.
11. Install 1st and reverse gear on mainshaft with fork slot toward front.

### Shift Bar Housing (Fig. 7P)

1. Position shift bar housing on bench upside-down with Welch plug openings toward repairman.
2. Install 1st and reverse rocker arm on pivot pin, then insert pin through housing from inside. Secure pin with washer and nut.
3. Assemble 1st and reverse shift rod, shift lug, and rocker lug in housing as follows:
  - a. Install plunger spring and plunger in 1st and reverse shift lug and secure with adjusting nut. Adjust plunger so rounded end is flush or slightly above flat ends of lug (1/32" max.). Secure adjustment with cotter pin (fig. 13P).

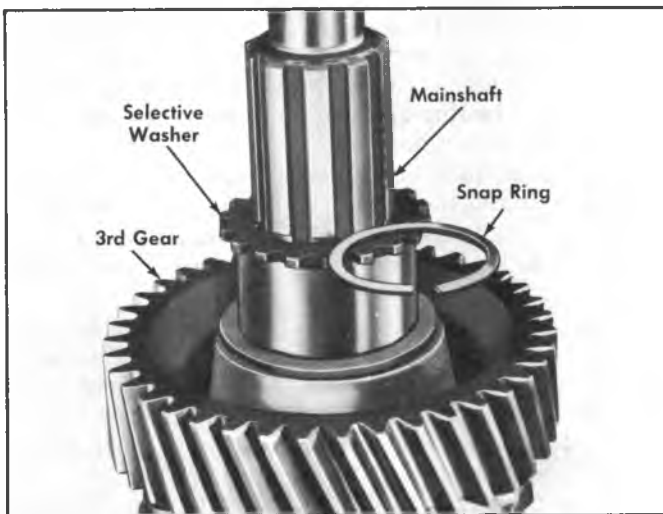


Fig. 12P—Selecting 4th Speed Gear Variable Thickness Retainer Washer

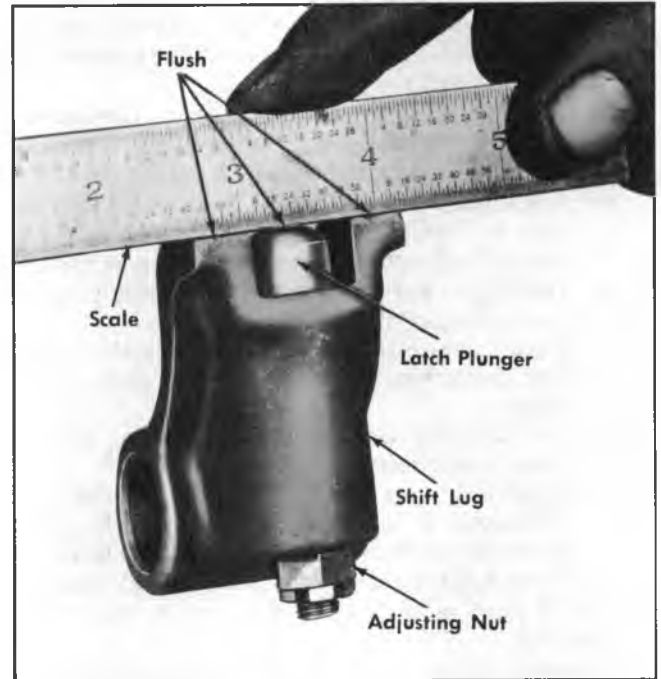


Fig. 13P—Adjusting Latch Plunger

- b. Starting at left side of shift bar housing, push 1st and reverse shift rod through opening in housing and through front support boss and while holding 1st and reverse rocker lug in position, continue pushing shift rod through rocker lug.
- c. Position lugs on rod so lock screw holes in lugs align with screw holes in rod, then install lock screws in lugs, tighten screws firmly, and secure with new lock wire.
- d. Move 1st and reverse shift rod into "Neutral" position.
4. Install 4th and 5th shift rod and 4th and 5th shift fork in housing as follows:
  - a. Install two interlock balls in crossbore in rear support boss between 1st and reverse and 4th and 5th shift rod holes.
  - b. Place poppet spring, inner poppet spring, and poppet ball in well in center opening in rear support boss.
  - c. Insert shift rod installer tool (J-8633) tapered end first through forward side of center opening in rear support boss. Push tool part way through support boss to compress poppet spring.
  - d. Start 4th and 5th shift rod in housing with interlock pin hole toward rear. Push rod through front support boss, place 4th and 5th shift fork on shift rod with hub toward rear, and install interlock cross pin in hole in shift rod.
  - e. Push 4th and 5th shift rod through rear support boss, driving installer tool out.
  - f. Align lock screw hole in shift fork with hole in shift rod, then install lock screw, tighten screw firmly, and secure with new lock wire.
  - g. Move shift rod into "Neutral" position.
5. Install 2nd and 3rd shift rod, shift fork, and shift lug in housing as follows:

- a. Install two interlock balls in cross bore in rear support boss between 4th and 5th shift rod hole and 2nd and 3rd shift rod hole.
  - b. Place poppet spring and ball in well in rear support boss at 2nd and 3rd shift rod opening.
  - c. Insert shift rod installer tool (J-8633) tapered end first through forward side of 2nd and 3rd shift rod hole in rear support boss. Push tool part way through support boss to compress poppet spring.
  - d. Install 2nd and 3rd shift rod in housing (33) and push through front support boss.
  - e. Place 2nd and 3rd shift lug and 2nd and 3rd shift fork on shift rod, with hub of both parts toward front.
  - f. Push 2nd and 3rd shift rod through rear support boss, driving installer tool out.
  - g. Align lock screw holes in shift lug and shift fork with holes in shift rod, then install lock screws, tighten screws firmly and secure with new lock wire.
  - h. Move 2nd and 3rd shift rod into "Neutral" position.
6. Install three welch plugs in openings in front end of housing.
  7. Assemble 1st and reverse shift fork bar and shift fork (38) as follows:
    - a. Install yellow poppet spring and ball in well in 1st and reverse shift fork.
    - b. Insert installer Tool (J-8633) tapered end first through shift fork from rear side to compress poppet spring.
    - c. Insert 1st and reverse shift bar through opening at rear of housing.
    - d. Position shift fork and installer tool in housing, then push shift bar through shift fork, driving out installer tool.
    - e. Make sure shift fork engages 1st and reverse rocker arm when poppet ball is engaging groove in shift bar, then push shift bar forward into rear support boss.
    - f. Align screw hole in bar with lock screw hole in support boss, then install lock screw, tighten screw firmly and secure with new lock wire.
  8. Check assembly of shift bar housing by shifting in and out of all speeds.
  9. Check action of interlock balls and pin by attempting to move two shift rods out of "Neutral" at the same time. Rods should not shift into more than one speed at a time.

## Control Tower

**NOTE:** On transmissions having conventional gearshift lever, accomplish the following procedures:

1. Install gearshift lever pivot pins in control tower; then insert gearshift lever through bottom of tower. Position shift lever so notch in ball portion engages pivot pin heads.
2. Install spring seat washer (concave side against ball portion of lever). Install gearshift lever support spring against spring seat washer and control tower.
3. Position dust cover on gearshift lever.
4. Install gearshift lever knob.

## ASSEMBLY OF TRANSMISSION

(Refer to Figure 1P)

### Countershaft Installation

1. Install countershaft front bearing in transmission case with end of bearing .001 to .007 below face of case.
2. Position countershaft front bearing spacer on forward end of countershaft.
3. Tip rear end of countershaft assembly down and lower into transmission case, running rear of countershaft through opening for countershaft rear bearing in rear of case far enough so front of countershaft can be lowered into position. Push countershaft forward into position in front bearing.
4. Using suitable installer tool, install countershaft rear bearing. Press bearing into place on countershaft with snap ring toward rear. Press bearing into transmission case until snap ring contacts the case.
5. Install countershaft rear bearing retainer nut loosely.

### Reverse Idler Gear Installation

1. Insert one reverse idler gear bearing in reverse idler gear; then install bearing spacer and the second bearing in bore of idler gear.
2. Install the reverse idler gear assembly in transmission case with chamfered teeth on gear toward rear of case.
3. Insert reverse idler shaft through opening in rear of transmission case, into reverse idler gear and into forward support boss. Make sure groove for the retainer lock in rear of idler shaft is at bottom of shaft. Drive shaft in until inner edge of groove is flush with transmission case. Install retainer lock with bolt and lock washer. Tighten bolt securely.

### Mainshaft Installation

1. Install mainshaft assembly in transmission case by tilting rear end of the assembly down and lowering into and through opening in rear of case, which is provided for the mainshaft rear bearing. Lower front end in line with pilot bearing opening. Move mainshaft assembly forward into position.
2. Position mainshaft rear bearing over end of mainshaft with snap ring in outer race of bearing facing the rear.
3. Using suitable installer tool and hammer drive mainshaft rear bearing on mainshaft into transmission case until snap ring on bearing contacts case.
4. Position main drive gear and bearing assembly into front of case so that drive gear engages and meshes with countershaft drive gear and snap ring on bearing contacts transmission case. It may be necessary to use a suitable sleeve and hammer to drive gear and bearing into place.
5. Install main drive gear bearing cap with new gasket on transmission case. Tighten bolts firmly.

**IMPORTANT:** Oil return hole in bearing cap must line up with oil hole in transmission case.

6. Install clutch throw-out bearing return spring clip under head of bolt when installing bearing cap.
7. Lock transmission gears into two speeds at the same time to lock up the transmission; then tighten countershaft rear bearing retaining nut. After nut is driven up tight, stake nut in position with punch and hammer.
8. Install countershaft rear bearing cap and new gasket. Tighten bolts firmly.
9. Install speedometer drive gear spacer and drive gear (if used) on mainshaft.
10. Install mainshaft rear bearing cap and new gasket. Tighten bolts firmly.
11. Install parking brake drum (if used) and companion flange on rear end of mainshaft.
12. With transmission still locked up in two speeds at the same time install companion flange nut. Tighten nut to 250 foot-pounds torque and install a new cotter pin.

### Shifter Bar Housing Installation

1. If previously removed, install P.T.O. covers and new gaskets. Tighten bolts firmly.

2. With transmission in "Neutral," position shift bar housing and new gasket on transmission case. Be sure shift forks engage gear slots.
3. Install shift bar housing to transmission case attaching bolts and lock washer.
4. Install parking brake parts (if used) as directed in BRAKES (Sec. 5) of this manual.

### Control Tower Installation

**NOTE:** On transmissions having a conventional gearshift lever, accomplish the following:

1. With transmission in "Neutral," position a new gasket on shift bar housing.
2. Place shift control lever in shifter shaft collar; then install shift lever pivot bolt, nut, and lock washer attaching control lever to anchor bracket. Tighten nut to 25-31 foot-pounds torque.

## AUXILIARY 4-SPEED TRANSMISSION SPICER MODEL 6041

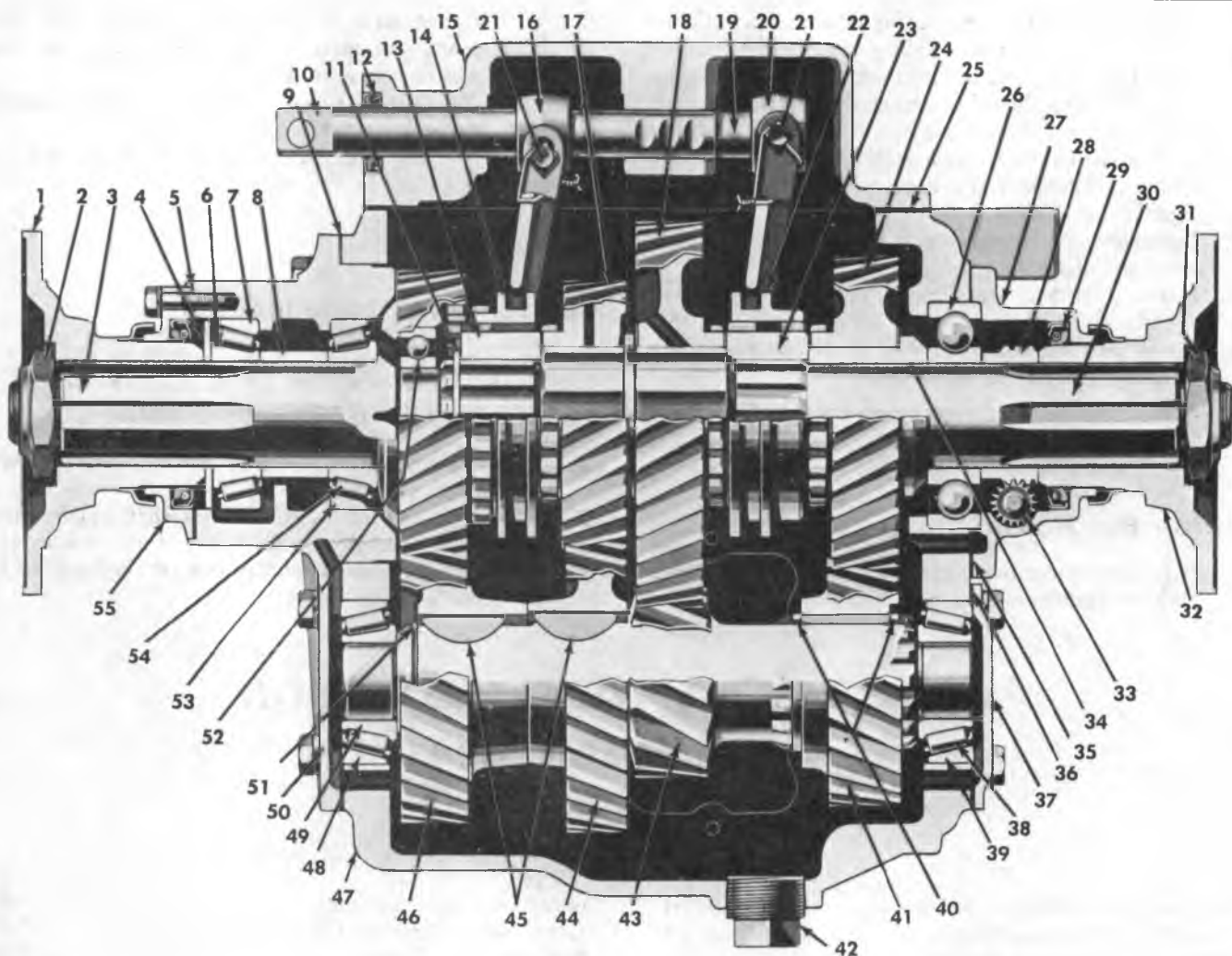
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### DISASSEMBLY OF TRANSMISSION

**NOTE:** Refer to Figure 1F.

1. Remove drain plug and drain fluid from transmission. Remove cover to case bolts and lift cover from transmission case.
2. Lock transmission by locking both shift collars into engagement with mating gears at same time. Remove mainshaft nut; then remove rear flange.
3. If front support has not been removed, then remove front support from main drive gear bearing cap.
4. Remove countershaft rear bearing cap, noting number of shims under cap.
5. Remove mainshaft rear bearing cap and gasket with oil seal and speedometer driven gear in cap, then remove oil seal and speedometer driven gear from cap and sleeve.
6. Remove main drive gear bearing cap with bearings, main drive gear, seal and seal cap.
7. Remove speedometer drive gear. Then using puller (J-4558) as shown in figure 2F, press mainshaft with front pilot bearing, mainshaft over drive gear snap ring, overdrive and direct clutch gear, collar, and overdrive gear out through front of case, leaving 1st speed gear, 1st and 2nd speed clutch gear and collar and mainshaft 2nd speed gear and sleeves in case. Remove these items from case after removing mainshaft.
8. Remove mainshaft rear bearing assembly from transmission case.
9. Drive countershaft toward rear far enough to force rear bearing cup out of case. Using snap ring pliers, remove countershaft 2nd speed gear front snap ring from groove, slide 2nd speed gear forward, then lift countershaft assembly out of case.
10. Remove countershaft front bearing cup from case.
11. Remove power take-off covers, and filler plug from case.



- |  |  |   |                                       |
|--|--|---|---------------------------------------|
| 1. Propeller Shaft Flange              | 16. Direct and Overdrive Shift Fork      | 28. Speedometer Drive Gear                                    | 41. Countershaft 2nd Speed Gear       |
| 2. Main Drive Gear Nut                 | 17. Mainshaft Overdrive Gear             | 29. Oil Seal  | 42. Drain Plug                        |
| 3. Main Drive Gear                     | 18. Mainshaft 1st Speed Gear             | 30. Mainshaft   | 43. Countershaft 1st Speed Gear       |
| 4. Companion Flange Washer             | 19. 1st and 2nd Shift Rod                | 31. Mainshaft Nut   | 44. Countershaft Overdrive Gear       |
| 5. Seal Gasket                         | 20. 1st and 2nd Shift Fork               | 32. Flange  | 45. Countershaft Keys                 |
| 6. Outer Bearing Cone                  | 21. Shift Fork Screw                     | 33. Speedometer Driven Gear                                   | 46. Countershaft Drive Gear           |
| 7. Outer Bearing Cup                   | 22. 1st and 2nd Speed Clutch Gear Collar | 34. Mainshaft 2nd Speed Gear Sleeve                           | 47. Transmission Case                 |
| 8. Drive Gear Bearing Spacer           | 23. 1st and 2nd Speed Clutch Gear        | 35. Retainer Cap Gasket                                       | 48. Countershaft Front Bearing Cup    |
| 9. Bearing Cap Gasket                  | 24. Mainshaft 2nd Speed Gear             | 36. Rear Bearing Cap Adjusting Shims (0.003, 0.010 and 0.030) | 49. Countershaft Front Bearing Cone   |
| 10. Direct and Overdrive Shift Rod     | 25. Shifter Housing Gasket               | 37. Countershaft Rear Bearing Cap                             | 50. Main Drive Gear Bearing Cup       |
| 11. Mainshaft Overdrive Gear Snap Ring | 26. Mainshaft Rear Bearing Assy.         | 38. Countershaft Rear Bearing Cone                            | 51. Countershaft Drive Gear Snap Ring |
| 12. Shift Rod Oil Seal                 | 27. Mainshaft Rear Retainer Cap Assy.    | 39. Countershaft Rear Bearing Cup                             | 52. Mainshaft Front Bearing           |
| 13. Overdrive and Direct Clutch Gear   |  | 40. Countershaft 2nd Speed Gear Snap Rings                    | 53. Bearing Cup                       |
| 14. Overdrive and Direct Clutch Collar |  |   | 54. Bearing Cone                      |
| 15. Shift Housing (Cover)              |  |   | 55. Seal Cap                          |

Fig. 1F-Auxiliary Transmission Cross-Section

## DISASSEMBLY OF SUBASSEMBLIES

### Main Drive Gear and Bearings

1. Remove oil seal and oil seal cap with gasket from main drive gear bearing cap. Seal can then be removed from cap.
2. Support cap at flange; then press main drive gear out of cap.
3. Remove spacer and bearing cone from main drive gear shaft. Washer and bearing cone may be lifted from bearing cap.
4. If inspection reveals damage or wear at bearing cups, they may be driven out of cap and replaced with new parts.
5. If bearing has remained in pocket of drive gear, remove with suitable puller.

### Mainshaft and Gears

1. Remove shift collar from clutch gear. If bearing has remained on mainshaft, it will first be necessary to remove this part.
2. Remove snap ring. Pull clutch gear off splines at front of mainshaft; then remove overdrive gear.

### Countershaft Gears and Bearings

Countershaft gears should be marked so that correct position will be known when installing.

1. Using suitable puller, remove bearing cones from countershaft.
2. Remove countershaft 2nd speed gear rear snap ring from end of countershaft, then remove 2nd speed gear from countershaft.
3. Remove countershaft drive gear snap ring from front of countershaft.
4. Using arbor press, press drive gear and countershaft overdrive gear from countershaft.

### Cover and Shifting Mechanism (fig. 3F)

1. Mount cover in vise and remove lock wires and shift fork clamp screws.
2. Remove poppet screw from each side of cover and jar springs, balls and retainer out through poppet screw holes.

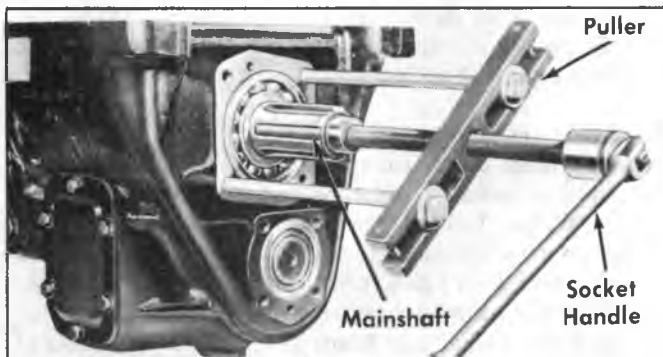


Fig. 2F--Pressing Mainshaft Out of Case

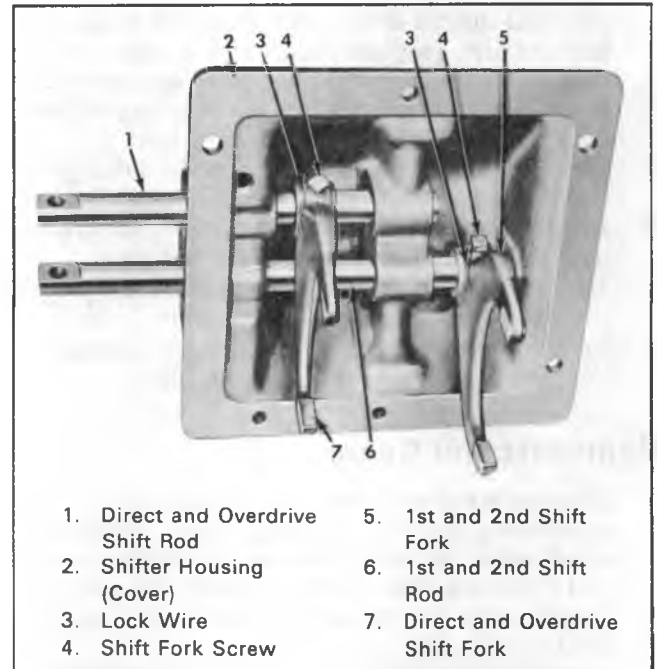


Fig. 3F--Cover and Shifting Mechanism

3. Remove shift rods from cover, stripping off forks as shift rods are removed. Tip cover on one side and jar interlock out of shift rod boss.
4. Remove shift rod oil seals, in the event new seals are required.
5. Remove transmission breather assembly from cover.

## CLEANING AND INSPECTION

1. When transmissions are overhauled, the component parts must be thoroughly cleaned and inspected. Parts should be thoroughly cleaned in suitable cleaning solvent, then inspected for wear and tolerances.
2. Remove all portions of old gaskets or sealing compound. Use a stiff brush on all parts.
3. Slush bearing assemblies in cleaning solvent. If solid particles remain in bearings, tap the assembly sharply on a block of wood to dislodge particles. When drying bearings with compressed air, do not spin bearings. Slowly turn bearings with hand while directing air pressure at right angle to the assembly. Lubricate clean bearings thoroughly; then cover with clean lint-free cloth until ready to assemble.
4. Gears having broken, chipped, cracked, or worn teeth must be replaced. Small nicks or burrs on gear teeth may be removed with a slip stone or hone. This method, however, is practical only on very small nicks.
5. Snap rings should be replaced with new parts when transmission is reassembled. New gaskets should be used.

## ASSEMBLY OF SUBASSEMBLIES

### Countershaft Gears and Bearings

1. Drive gear keys in countershaft slots, then using arbor



## 7-50 TRANSMISSION AND CLUTCH

- press and suitable driver, press countershaft overdrive gear and drive gear into place. Refer to marks made at disassembly for correct relative position of each gear.
2. Install new countershaft drive gear snap ring in groove at forward edge of countershaft drive gear.
3. Press cone on front end of countershaft, making sure that cone seats firmly against countershaft.
4. Install 2nd speed gear front snap ring over end of countershaft. Do not install in groove at this time.
5. Install 2nd speed gear on countershaft, then position rear snap ring in groove in countershaft.
6. Press cone on rear end of countershaft, making sure that cone seats firmly against countershaft.

### Mainshaft and Gears

1. Place mainshaft in soft jaws of vise, front end up, then apply heavy gear oil on bearing surfaces. Install overdrive gear on mainshaft, then install overdrive and direct clutch gear with shoulder toward overdrive gear.
2. Install mainshaft overdrive gear snap ring in groove at front of end of mainshaft.
3. Install mainshaft overdrive and direct clutch gear collar, with external teeth toward front end of mainshaft.
4. Install mainshaft pilot bearing on mainshaft, using suitable bearing replacer.

### Main Drive Gear, Bearings, and Bearing Cap

**IMPORTANT:** Apply transmission lubricant to drive gear bearings before installing.

1. Press main drive gear bearing cups into cap and install inner bearing on main drive gear, then install drive gear bearing spacer on main drive gear.
2. Place main drive gear and bearing cap in arbor press, with bearing spacer in place.
3. Apply pressure on front bearing inner race using a piece of 2" diameter tubing about 4" long over end of shaft. Bearing cap should turn readily, but not spin on shaft with pressure applied. If bearing adjustment is too loose or too tight, select correct spacer listed in "Specifications" at end of this group. After correct spacer has been installed, remove assembly from arbor press.
4. If seal has been removed from seal cap, press new seal in cap being careful not to damage seal.
5. Place washer in position against bearing cone; then install seal cap with new gasket. Install cap bolts and tighten firmly.

### Cover and Shifting Mechanism

1. Mount cover in vise. Coat oil seal recesses with sealing cement, and press new shift rod oil seals into recess.
2. Insert 1st and 2nd shift rod (longer of two rods) in bottom hole of cover, being careful not to damage oil seal.

3. Move shift rod through support and install 1st and 2nd shift fork on rod with offset toward front as rod is moved into position.
4. Install clamp screw, move rod to neutral position, and tighten clamp screw. Install lock wire retaining clamp screw.
5. Insert interlock in rod support boss; then insert direct and overdrive shift rod (shorter of two rods) in top of cover.
6. Install direct and overdrive shift fork on rod with offset toward front and move rod through rod support boss.
7. Install poppet balls, springs, retainer and poppet screws.
8. Move rod to neutral position, tighten fork clamp screw firmly and retain with lock wire.

### ASSEMBLY OF TRANSMISSION

With subassemblies assembled and prepared as directed previously in "Assembly of Subassemblies" in this section, proceed as follows to install the subassemblies into case.

1. Install countershaft front bearing cup in bore at front of transmission case.
2. Lower the countershaft and gear assembly into case with rear end of shaft out through rear bearing bore, then move countershaft assembly forward so that front bearing enters cup. Install drive gear bearing cap assembly temporarily with new gasket. Tighten cap screws evenly and firmly. Then slide countershaft 2nd speed gear into place on countershaft and install snap ring in groove ahead of 2nd speed gear.
3. Install rear bearing cup. Using same thickness of shims as was removed at disassembly, install rear bearing cap temporarily. Tighten bearing cap bolts, meanwhile turning countershaft by hand. If any binding of countershaft bearings is noted before cap bolts are fully tightened, remove cap and add shims. If cap bolts are tightened with a shim pack which is too thin, bearings will be damaged. Three sizes of shims (0.003", 0.010", and 0.030") are available for use in adjusting countershaft bearings. Bearing adjustment is correct when countershaft can be turned without evidence of binding and without perceptible end play.
4. Remove main drive gear bearing cap assembly that was temporarily installed in step 2.
5. Lower mainshaft 1st speed gear, mainshaft 1st and 2nd clutch gear and collar and 2nd speed gear into position in case. Then guide mainshaft assembly through front of case and through gears in case. Slide 2nd speed gear sleeve into hub of 2nd speed gear through rear of case.
6. Using new gasket, install main drive gear bearing cap with main drive gear and bearings on front of case, guiding mainshaft pilot bearing into pocket of main drive gear. Tighten cap to case bolts firmly.
7. Press mainshaft rear bearing onto rear of mainshaft and into case, then place speedometer drive gear on mainshaft, with shoulder toward front of transmission.
8. Install mainshaft rear bearing cap and gasket on rear of case with cap screws and washers. Tighten cap screws firmly.



**NOTE:** It is recommended that new mainshaft and main drive gear nuts be used when overhauling transmission.

9. Install propeller shaft flange on splines at rear of mainshaft and retain with nut, tightening nut to 400-450 foot-pounds torque to lock clutch gear, 2nd speed gear

sleeve, rear bearing, speedometer gear, and flange solidly together.

10. Place transmission front support bracket on trunnion at bearing cap, then install front flange and retain with nut. Tighten nut to 400-450 foot-pounds torque.
11. Using a new cover gasket, install cover on transmission case, being sure that shift forks enter grooves in shift collars. Install breather assembly in transmission cover.

## AUXILIARY TRANSMISSION 4-SPEED—MODEL 7041

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### SHIFT CONTROLS

#### Disassembly (Figure 4F)

1. Remove retaining capscrews, lock nuts and lock washers. Separate cover (1) from case and gasket.
2. Remove the two poppet retainers (2) from side of case and use small magnet to remove poppet balls (4) and poppet springs (2).
3. Cut lock wire and remove set screws (5) from 3rd-4th speed shift fork (6), and 1st-2nd speed shift fork (7).
4. Use soft rod to tap (upper) 3rd-4th shift rod (8) and (lower) 1st-2nd shift rod (9) free of shift forks and out of case.

**NOTE:** Use caution as shift rod (9) is removed from case to prevent loss of shift rod interlock (11).

5. If shift rod oil seals (10) are damaged, pry out with large screwdriver and discard.
6. Remove old gaskets or sealing materials from machined surfaces and clean case cover.
7. Wash all shift control parts and examine thoroughly before reassembly.

#### Assembly

1. If shift rod oil seals (10) were discarded, use 1-1/2" tubing and assemble new oil seals into bore of case.
2. Check both shift rods (8 9) in their proper position in case, to make sure they slide freely.
3. Remove shift rods and apply a light coat of grease to all case bores and rods as they are assembled.

4. Select the longer shift rod (1st-2nd shift rod 9) and enter into bottom shift rod opening.
5. With long hub toward the front, assemble 1st-2nd shift fork (7) to 1st-2nd speed clutch collar (7), Figure 4. Pass shift rod (9) through shift fork (7) and rear case boss.
6. Locate shift fork in its proper position and secure to shift rod with set screw (5). Tighten set screw securely in notch and torque to 50 lbs. ft. Secure with lock wire.
7. Locate 1st-2nd shift rod in neutral position and drop interlock pin (11) through hole provided in top right corner of case. Be sure interlock is seated in neutral notch of shift rod.
8. Enter 3rd-4th speed shift rod (8) in top shift rod opening.
9. With long hub toward the front, assemble 3rd-4th speed shift fork (6) in 3rd-4th speed clutch collar (19), Figure 10. Pass shift rod through shift fork and rear case boss.
10. Locate shift fork in its proper position and secure to rod with set screw (5). Tighten set screw securely in notch and torque to 50 lbs. ft. Secure with lock wire.
11. Assemble poppet ball (4), spring (3) and spring retainer (2) in lower hole on right side of transmission case.
12. In a similar manner, assemble poppet ball, spring and spring retainer in upper hole.
13. With 3rd-4th speed shift rod in 4th speed position, use large screwdriver and try to move 1st-2nd shift fork out of neutral position. If interlock is in place, 1st-2nd shift rod will be locked in neutral position.
14. Return 3rd-4th speed shift rod to neutral position. Rotate drive gear and check shifting of both rods to make

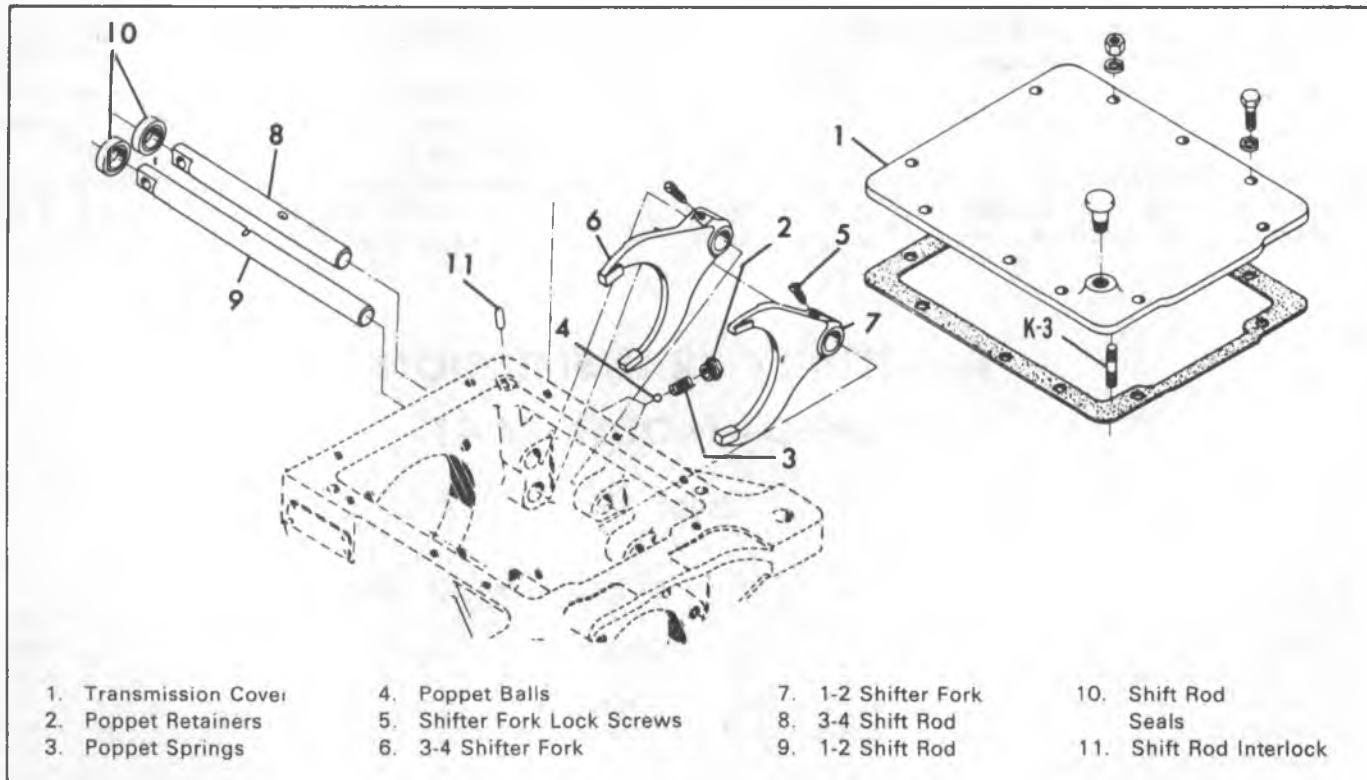


Figure 4F--Auxiliary Transmission Shift Controls and Cover

- sure the forks are free in clutch collars and move readily and completely into each gear position.
15. Use light coat of gasket cement and assemble cover to gasket to transmission case.
  16. Assemble transmission case cover (1) to case and secure with cap screws, lock washers and stud nuts.
  17. If breather was removed, use light coat of gasket cement on threads of breather and assemble to cover.

## GEARS AND CASE DISASSEMBLY (Fig. 5F)

### Drive Gear

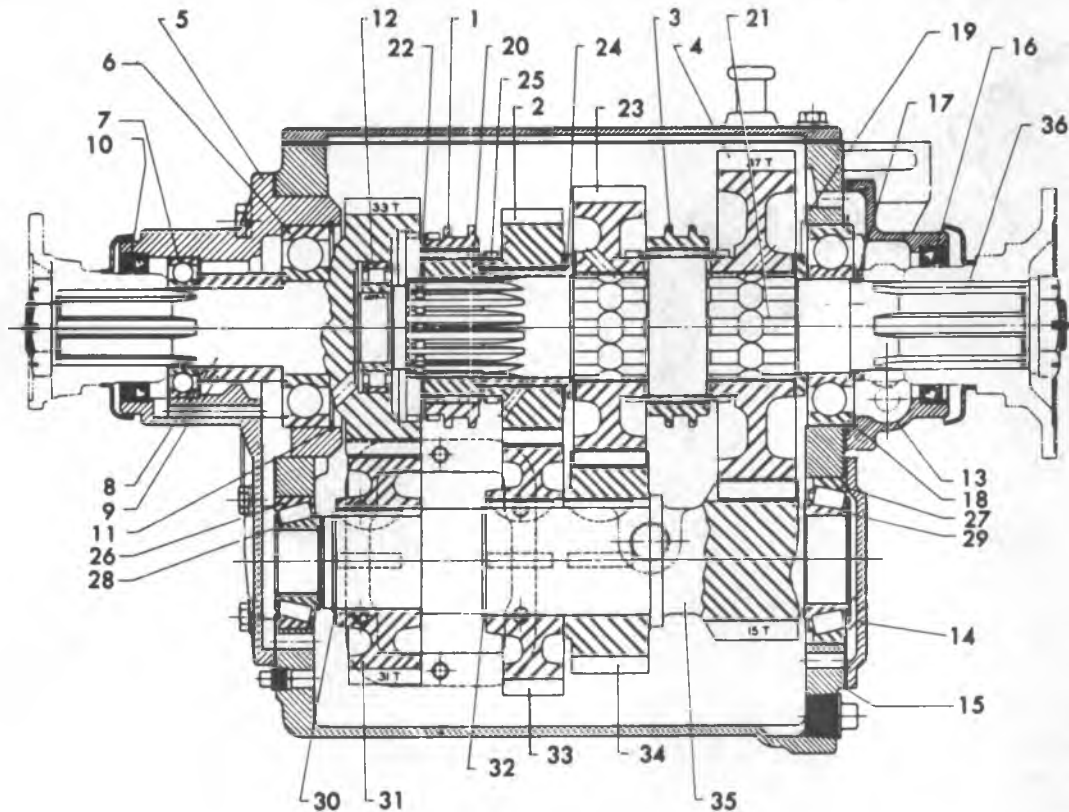
1. Remove transmission cover, shift forks and shift rods from transmission as outlined under shift controls disassembly.
2. Lock auxiliary transmission in two gears by engaging 3rd-4th speed shift collar (1) with 4th speed gear (2) and 1st-2nd speed shift collar (3) with 1st speed gear (4).
3. Pull cotter pins and use 2-1/8" socket to remove drive gear and mainshaft companion flange nuts.
4. Use puller J-7804 or equivalent and remove drive gear and mainshaft companion flanges.
5. Remove cap screws and lock washers from drive gear bearing cap (5). Use two puller screws 3/8-16 N.C. at least 2-1/2" long and remove drive gear bearing cap with bearings (6 and 7) and drive gear (8) intact.
6. Support bearing cap assembly on flange and press drive gear free of bearing cap, bearings and spacer.
7. Move drive gear bearing spacer (9) aside and use drift

to tap outer roller bearing and oil seal (10) out front of bearing cap. Remove bearing spacer.

8. Remove snap ring (11) and press drive gear rear bearing from bearing cap.
9. Remove old gasket and sealing compounds and wash all parts thoroughly.

### Mainshaft

1. Use a suitable puller and remove drive gear pocket bearing (12) from front of mainshaft.
2. Remove retaining cap screws with lock washers from mainshaft and countershaft rear bearing caps (13 and 14). Separate bearing caps from gaskets, shims and case. Tie countershaft shims (15) together for reassembly. Check and remove speedometer bushing if it is to be replaced. Remove bearing cap oil seal (16) if it is to be replaced.
3. Remove speedometer drive gear or spacer and rear bearing washer (17) from mainshaft.
4. Use a soft hammer and tap forward on rear of mainshaft to start rear bearing (18) off mainshaft.
5. Use two pry bars to slide mainshaft and gear assembly toward rear of case as far as possible. Remove mainshaft rear bearing (18) with puller that clamps on the snap ring of rear bearing.
6. Remove 1st speed gear thrust washer (19) from mainshaft. 7. Remove 3rd-4th speed clutch gear collar (1) from clutch gear (20).
8. Remove mainshaft and gear assembly by lifting front of shaft upward and out through top of case.



- |   |                                   |                                     |   |
|---|-----------------------------------|-------------------------------------|---|
| 1. 3-4 Shift Collar                       | 12. Drive Gear Pocket Bearing     | 20. 3-4 Speed Clutch Gear           | 29. Countershaft Rear Bearing               |
| 2. 4th Speed Gear                         | 13. Mainshaft Rear Bearing Cap    | 21. 1st Speed Sleeve                | 30. Countershaft Drive Gear Snap Ring       |
| 3. 1-2 Shift Collar                       | 14. Countershaft Rear Bearing Cap | 22. 3-4 Speed Clutch Gear Snap Ring | 31. Countershaft Drive Gear                 |
| 4. 1st Speed Gear                         | 15. Countershaft Shim Pack        | 23. 2nd Speed Gear                  | 32. Countershaft 4th Speed Gear Snap Ring   |
| 5. Drive Gear Bearing Cap                 | 16. Rear Oil Seal                 | 24. 4th Speed Gear Sleeve           | 33. Countershaft 4th Speed (overdrive) Gear |
| 6. Drive Gear Rear Bearing                | 17. Mainshaft Rear Bearing Washer | 25. 4th Speed Gear Sleeve Lock Pin  | 34. Countershaft 2nd Speed Gear             |
| 7. Drive Gear Front Bearing               | 18. Mainshaft Rear Bearing        | 26. Countershaft Front Bearing Cup  | 35. Countershaft                            |
| 8. Drive Gear                             | 19. 1st Speed Gear Thrust Washer  | 27. Countershaft Rear Bearing Cup   | 36. Mainshaft                               |
| 9. Drive Gear Bearing Spacer              |                                   | 28. Countershaft Front Bearing      |   |
| 10. Front Oil Seal                        |                                   |                                     |   |
| 11. Drive Gear Rear Bearing Retainer Ring |                                   |                                     |   |

Figure 5F--Transmission Assembly (Cross-Section)

9. Slide 1st speed gear (4) and 1st-2nd speed clutch collar (3) off rear of mainshaft.
10. Remove 1st speed gear sleeve (21) if sleeve did not come off with gear.
11. Remove 3rd-4th speed clutch gear snap ring (22).
12. Support under rear of 2nd speed gear (23) and press mainshaft free of 3rd-4th speed clutch gear (20), 4th speed gear (2) and sleeve (24).
13. Remove lock pin (25) from inside 4th speed gear sleeve.
14. Wash all parts dry and examine thoroughly before assembly.

## Countershaft

1. Use soft drift and hammer to tap countershaft forward; this will remove front bearing cup (26) from case.
2. Use soft drift and hammer to tap countershaft rearward to remove rear bearing cup (27) from case.
3. Remove countershaft and gear assembly by lifting countershaft up and out top of case.
4. Use a suitable puller and remove countershaft front (28) and rear (29) bearing cones.
5. Remove countershaft drive gear snap ring (30). Support countershaft drive gear (31) with parallel bars as close

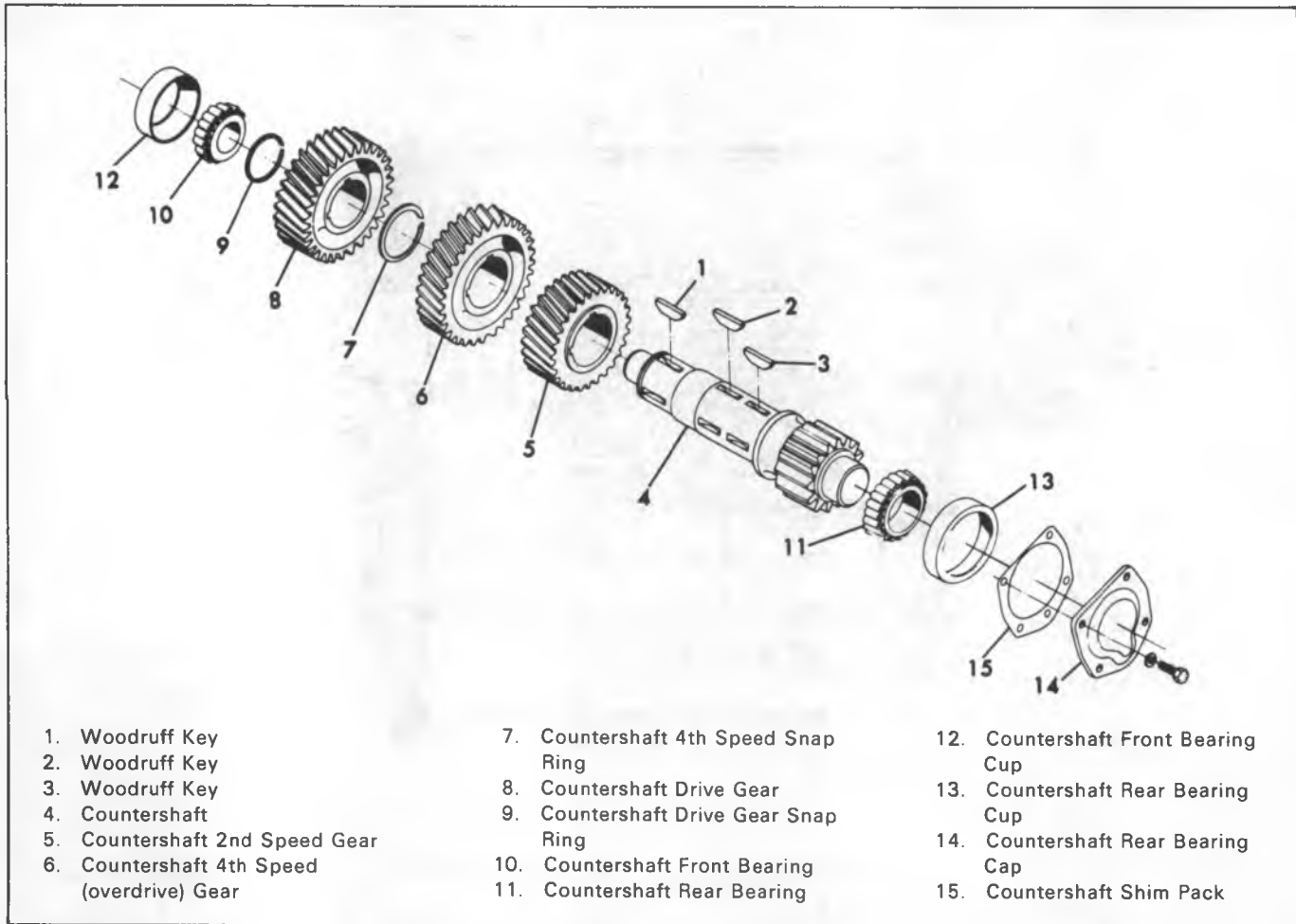


Figure 6F--Countershaft with Gears and Bearings

- to hub as possible. Press countershaft free of gear.
6. Remove 4th speed gear snap ring (32). Support 4th speed (overdrive) gear (33) and press countershaft free of gear.
7. Support 2nd speed gear (34) and press countershaft free of gear.

## GEARS AND CASE ASSEMBLY

### Countershaft (Figure 6F)

**NOTE:** All countershaft gears should fit tight on the countershaft. As a shrink (or interference) fit of .0015" to .003" is built into new parts, it presents a field assembly problem.

If heat is used to expand gear bores, boiling water, hot oil or steam are usually satisfactory. **DO NOT EXCEED** 250 degrees F. Do not use hot plates, acetylene torches or other methods that will turn the steel blue or straw color and damage the heat treated gears.

If heat is not used, it is advisable to coat the gear bores heavily with white lead to prevent galling or seizing of parts.

When in doubt about which end of the hub to assemble on

the shaft first, look for the chamfered end in the bore.

1. Assemble Woodruff Keys (1, 2, 3) to countershaft (4). Seat keys securely and dress up with file, if necessary.
2. Support 2nd speed gear (5) in arbor press, with long hub down and chamfer up. Set countershaft into position, align keys with keyway, and press shaft into gear. Seat shoulder firmly against gear.
3. Support hub of 4th speed (overdrive) gear (6), with long hub down and chamfer up. Set countershaft into position, align key with keyway and press shaft into gear. Seat gear firmly against shoulder of 2nd speed gear.
4. Assemble snap ring (7) to lock 2nd and 4th speed gears in place.

**NOTE:** Use caution when assembling snap ring to shaft to prevent overextending or distorting snap ring. All snap rings must seat firmly in grooves to give secure lock.

5. Support drive gear (8) with long hub down and chamfer up. Set countershaft into position, align key with keyway and press shaft into gear until seated firmly against shoulder.
6. Assemble snap ring (9) to lock drive gear in place. Observe note following Step 4.

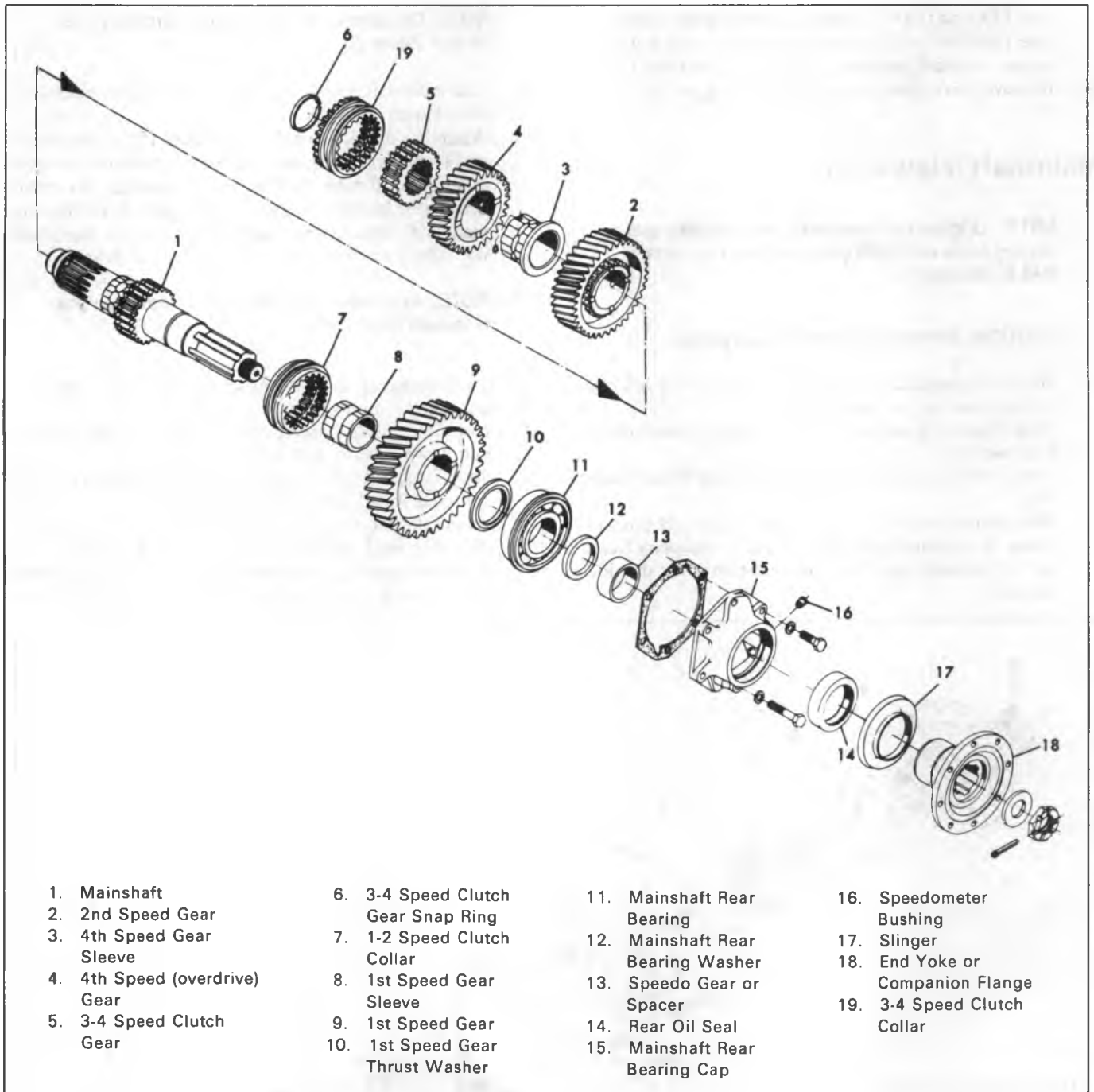


Figure 7F—Mainshaft and Rear Bearing Details

7. Support countershaft in arbor press. Use tubing to press and seal cones of front (10) and rear (11) tapered roller bearings against shoulders on countershaft.
8. Lower rear or small end of countershaft and gear assembly into case and slide end of shaft and 1st speed gear out through rear case bearing bore. Lower front of countershaft into its approximate position and maintain alignment with a cable support or by blocking up countershaft drive gear (8).
9. Use a soft hammer to tap front (12) and rear (13) roller bearing cups into bearing bores of case and over cones on countershaft.
10. Assemble drive gear bearing cap (5), Figure 8, and gasket to case with cap screws in the lower four holes. Torque to 40 lbs. ft.
11. Assemble countershaft rear bearing cap (14) and shim pack (15) to case with cap screws and lock washers. Torque to 40 lbs. ft.
12. Check bearing preload of countershaft roller bearings. Add or remove shims (15) behind rear bearing cap to secure zero end play without preload. Shaft should roll free to slight drag of 2-3 pounds pull with cord wrapped around 2nd and 4th speed gear.
13. After adjustment is made, remove rear bearing cap and

coat I.D. and O.D. of shim pack with gasket cement to give good oil seal. Secure rear bearing cap with cap screws and lock washers and torque to 40 lbs. ft.

14. Remove drive gear bearing cap (1), Figure 8F.

### Mainshaft (Figure 7F)

**NOTE:** Lubricate all mainshaft free running gear bearing bores with light grease as gears are assembled to mainshaft.

**CAUTION:** Do not plug oil holes with grease.

1. Position mainshaft (1) vertically in vise, using soft jaws to clamp on the output splines.
2. Assemble 2nd speed gear (2) to mainshaft, with clutch teeth down.
3. Insert new lock pin inside 4th speed gear fluted sleeve (3).
4. With flanged end of sleeve (3) down, align lock pin with spline of mainshaft and tap or press, if necessary fluted sleeve (3) onto mainshaft. Seat sleeve against shoulder on shaft.

**NOTE:** Do not press or drive against ground thrust face of sleeve (3).

5. Assemble 4th speed (overdrive) gear (4) to mainshaft with clutch teeth up.
6. Assemble 3rd-4th speed clutch gear (5) to mainshaft and secure with snap ring (6). Snap ring must be seated in groove of mainshaft and not distorted. Assemble drive gear pocket bearing (12), Figure 8 to front of mainshaft. Since pocket bearing fits right on mainshaft, use tubing to drive against inner race of bearing.

**NOTE:** Assemble pocket bearing, so that snap ring is toward mainshaft.

7. Turn mainshaft end for end in vise and clamp on 3rd-4th speed clutch gear (5).
8. Assemble 1st-2nd speed clutch collar (7) with longer hub down toward 2nd speed gear (2).
9. Slide 1st speed gear sleeve (8) in position on mainshaft and coat fluted area with light grease.
10. Assemble 1st speed gear (9) over gear sleeve with clutching teeth down toward front of mainshaft.
11. Remove mainshaft sub-assembly from vise and assemble to case by lowering rear of shaft into case and out

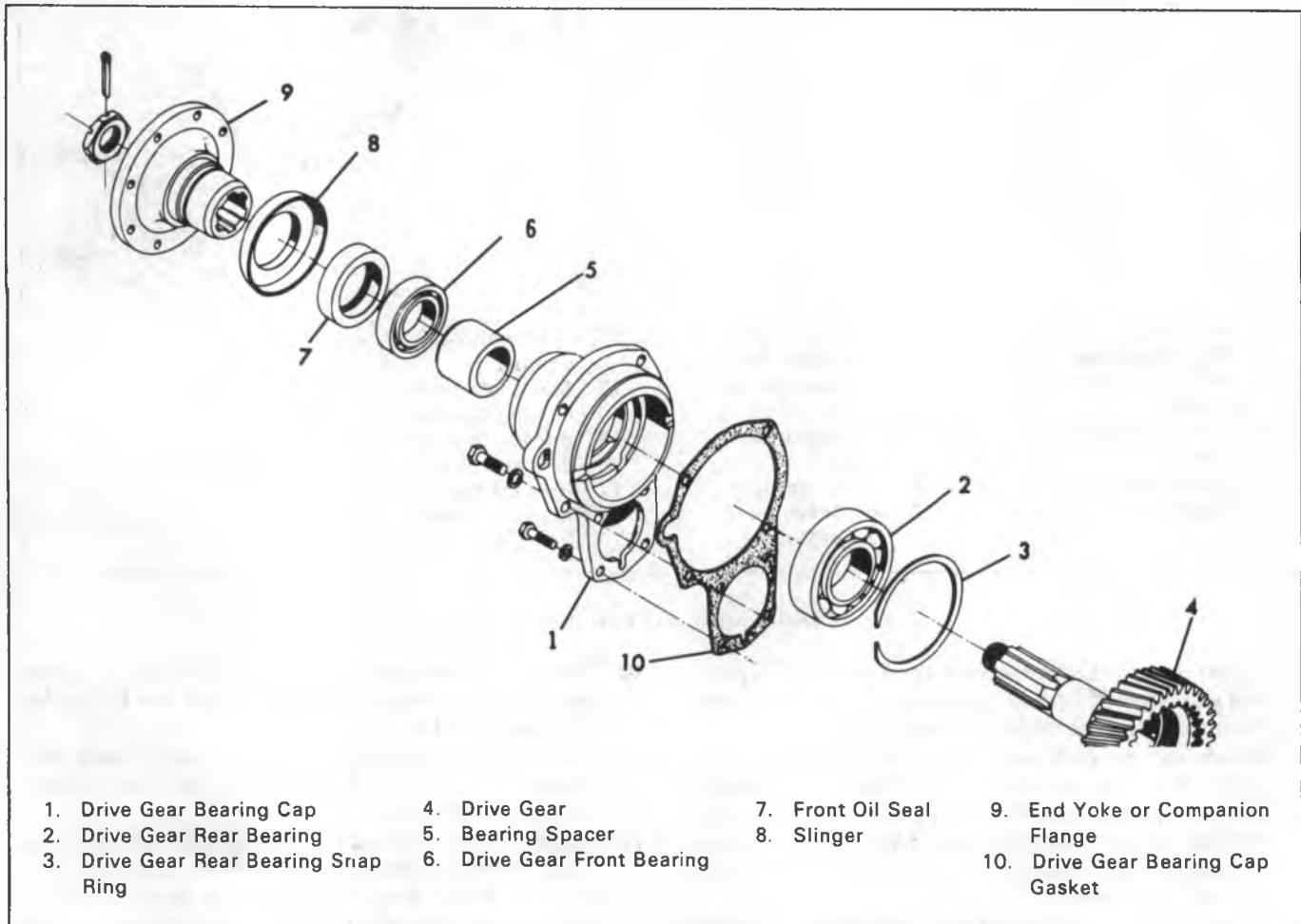


Figure 8F—Main Drive Gear and Bearing Details



through mainshaft rear bearing bore. Lower front of mainshaft into position and mesh all gears.

12. Coat thrust face of 1st speed gear thrust washer (10) with light grease and assemble on rear of mainshaft with flat face in toward 1st speed gear.
13. Use 3/4" stock to block mainshaft across drive gear bearing cap opening at front of case. Position mainshaft rear bearing (11) on shaft with snap ring to rear. Use caution to align outer race of bearing with case bore. Use tubing to drive on inner race of bearing until bearing is seated against thrust washer (10). Remove 3/4" stock and tap bearing into case until snap ring seats against case.
14. Coat rear bearing washer (12) with light grease and assemble next to rear bearing.
15. Assemble speedometer drive gear or spacer (13) on mainshaft.
16. If oil seal (14) was removed from rear bearing cap (15), use gasket cement on O.D. of seal and press into bearing cap.

**CAUTION: Use care to avoid distorting seal. Press in new speedometer bushing (16) if removed.**

17. Apply gasket cement to mainshaft rear bearing cap gasket and install on rear bearing cap. Align the oil passage ports.
18. Apply gasket cement to other side of gasket and assemble bearing cap and gasket to rear of case with cap screws and lock washers. Torque to 40 lbs. ft.
19. If slinger (17) has been removed from companion flange (18) replace at this time.
20. Assemble yoke or companion flange (18) to rear of mainshaft with tool similar to J-7801-1. If proper tools are not available always block front of mainshaft with 3/4" stock across drive gear bearing bore opening. Use tubing to assemble flange or yoke to mainshaft.
21. Assemble flat washer and lock nut to mainshaft. Hand-tighten nut only at this time.
22. Assemble 3rd-4th speed clutch collar (19) on front of mainshaft, with external clutch teeth toward front of case. Shift clutch collar into mesh with 4th speed gear (4).

### Drive Gear (Figure 8F)

1. Position drive gear bearing cap (1) in press, rear bearing

(2) in bearing cap. Secure with snap ring (3).

2. Position drive gear (4) on bed of press with spline or front end up. Position drive gear bearing cap sub-assembly down over splines of drive gear. Assemble bearing spacer (5) to front of drive gear. Use tubing and press against spacer until bearing is seated against gear.
3. Assemble smaller bearing (6) over front of drive gear. Use tubing and press on inner race of bearing until seated against spacer.
4. Coat O.D. of oil seal (7) with Permatex or equivalent and assemble to front of bearing cap.

**CAUTION: Use care to prevent distortion of seal.**

**NOTE: If slinger (8) has been removed from companion flange, replace at this time.**

5. Prelube lip of front seal and press end yoke or companion flange (9) on drive gear.
6. Rotate bearing cap assembly, under load of press, to see if all parts are seated properly. Bearing cap should rotate freely. Assemble front lock nut hand tight.
7. Apply gasket cement to drive gear bearing cap gasket (10) and install on bearing cap.
8. Apply gasket cement to other side of gasket and assemble drive gear and bearing cap to front of case. Use soft hammer and tap into position.
9. Secure front bearing cap assembly to case with cap screws and lock washers. Torque to 40 lbs. ft.
10. Refer to Figure 5F and engage 3rd-4th speed shift collar (1) with drive gear (8) and 1st-2nd speed clutch collar (3) with 1st speed gear (4) to lock transmission in two gears.
11. Use 2-1/8" socket and tighten drive gear and mainshaft flange nuts. Torque to 425 lbs. ft. and secure with cotter pin if castellated nuts are used.
12. Shift clutch collars back into neutral and make sure all shafts turn free.
13. Use pressure type oil can to force lubricant down the oil holes and end slots of all floating gears on mainshaft to flush out grease and insure initial lubrication of the over-running gear and bearings.
14. Install shift rods, shift forks and cover as outlined under shift controls assembly.

# AT-475 TRANSMISSION

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# TRANSMISSION OVERHAUL

## GENERAL

NOTE: Certain precautions must be observed when overhauling automatic transmissions. Unless proper care is exercised, considerable damage may be done to the various components of the transmission.

1. The importance of cleanliness cannot be over-emphasized. Overhaul should not be attempted where dirt or other foreign materials are present. Before attempting any disassembly operation, the exterior of the case should be thoroughly cleaned to prevent the possibility of dirt entering the transmission internal mechanism. During overhaul procedures, all parts should be thoroughly cleaned in cleaning solvent and then air dried. Do not use a solvent which could damage rubber seals or clutch plate facings. Wiping cloths or rags should not be used to dry parts as lint may be deposited on the

parts. All parts, except those being actually worked on, should be kept covered with clean paper.

2. Avoid nicking, marring, or burring all surfaces, particularly those precision-finished. At many points in the transmission, a metal-to-metal contact without gasket is depended upon to prevent leakage of oil at high pressure.

3. No materials, other than those listed should be used in overhauling the transmission. Do not, under any circumstances, use grease, shellac, or ordinary engine oil inside the transmission.

4. In assembling components, use new snap rings, cotter pins, gaskets, and oil seals.

5. When assembling the transmission or sub-assemblies during overhaul procedures, lubricate each moving part with clean transmission fluid before part is installed.

## DISASSEMBLY

1. With transmission in cradle on portable jack, remove converter assembly by pulling straight out.

NOTE: Converter contains a large amount of oil.

2. Install holding fixture (J-8763-01) on the

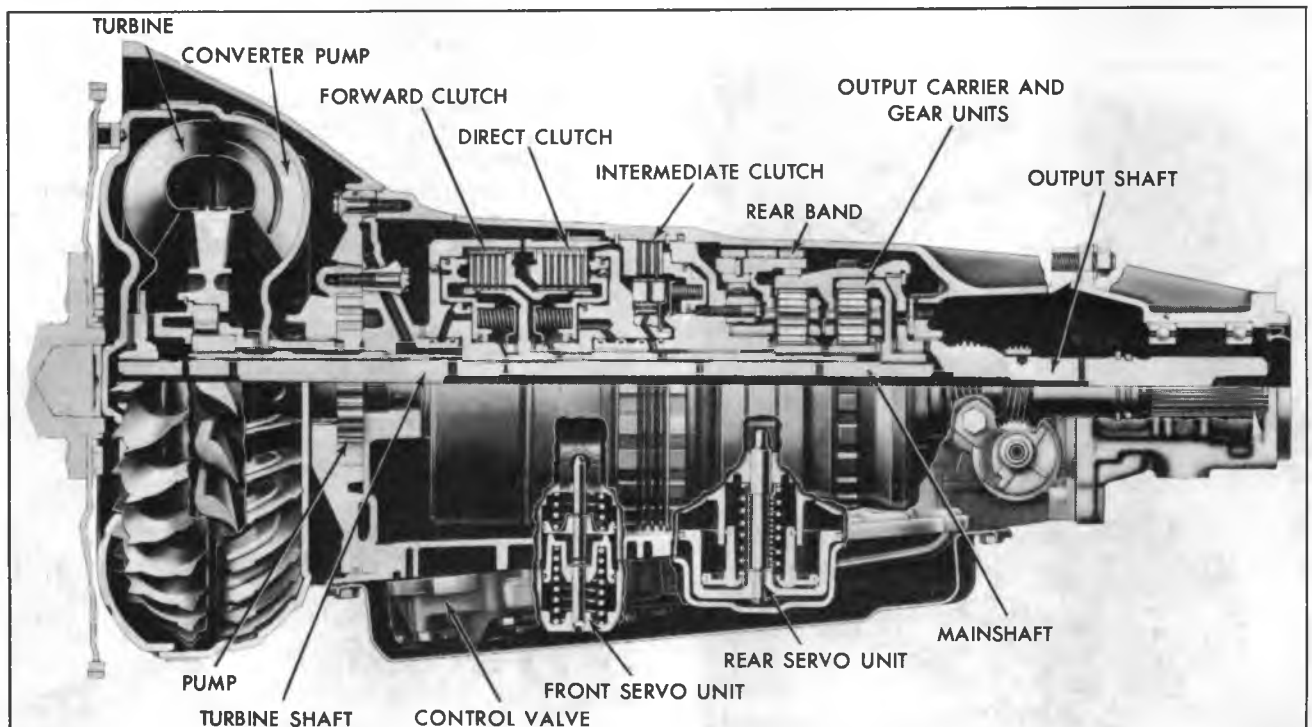


Figure 1—Transmission Cross Section



Figure 2—Transmission in Holding Fixture

transmission so that modulator will be located on side of holding fixture nearest bench (fig. 2).

NOTE: Do not over-torque holding screw. This will bind center support.

3. Install fixture and transmission into holding tool base (J-3289-20) with oil pan facing up.

4. Remove modulator attaching screw and retainer (fig. 3).

5. Remove modulator assembly and O-ring seal from case (fig. 4).

6. Remove modulator valve from transmission case.



Figure 3—Removing Modulator Retainer



Figure 4—Removing Vacuum Modulator and Valve

### REMOVAL OF GOVERNOR, SPEEDOMETER DRIVEN GEAR, PAN, FILTER AND INTAKE PIPE

1. Remove attaching screws, governor cover and gasket (fig. 5). Discard gasket.

2. Withdraw governor assembly from case.

3. Remove speedometer driven gear attaching screw and retainer (fig. 6).

4. Withdraw speedometer driven gear assembly from case.

5. Remove oil pan attaching screws, oil pan, and pan gasket (fig. 7). Discard gasket.

6. Remove the filter retainer bolt.

7. Remove filter and intake pipe assembly from case and discard filter (fig. 8).

8. Remove intake pipe to case O-ring seal from intake pipe assembly or case. Discard O-ring.



Figure 5—Removing Governor Cover



Figure 6—Removing Speedometer Driven Gear Retainer

**REMOVAL OF CONTROL VALVE ASSY., ELECTRICAL CONNECTOR, GOVERNOR PIPES, GOVERNOR SCREEN ASSY., AND DETENT SPRING ASSY.**

1. Remove control valve body attaching screws and detent roller spring assembly (fig. 9).

NOTE: Do not remove solenoid attaching screws.

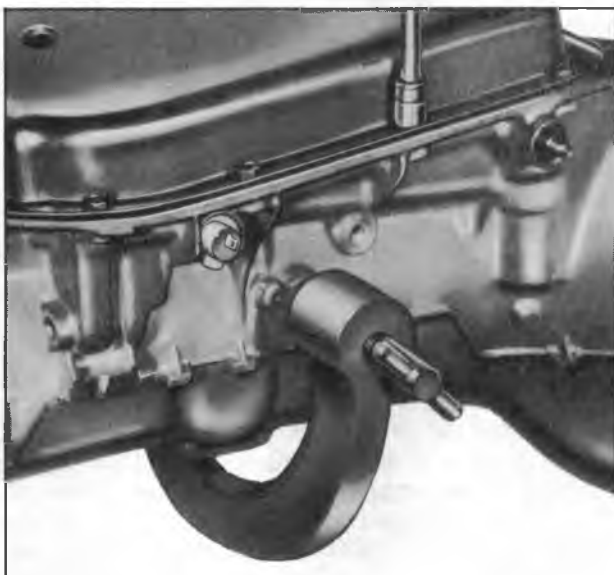


Figure 7—Removing Oil Pan Attaching Screws

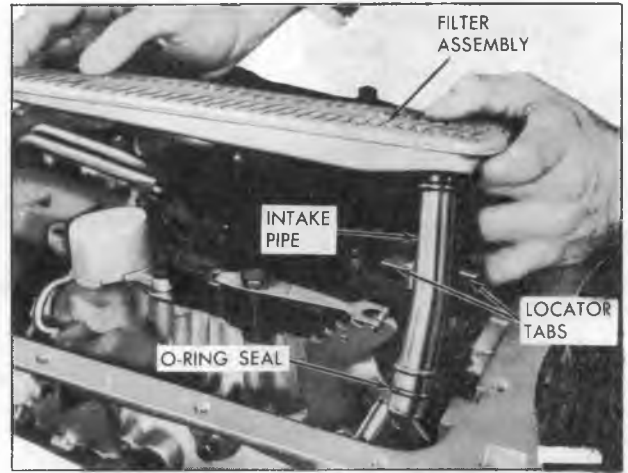


Figure 8—Removing Filter and O-Ring Assembly

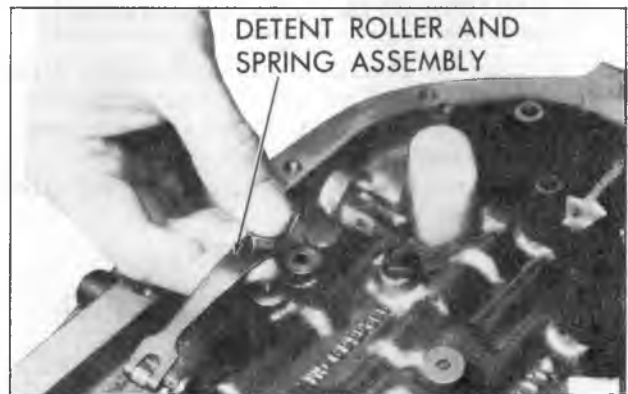


Figure 9—Removing Detent Roller and Spring Assembly

**CAUTION: IF TRANSMISSION IS IN VEHICLE, THE FRONT SERVO PARTS MAY DROP OUT AS THE CONTROL VALVE ASSEMBLY IS REMOVED.**

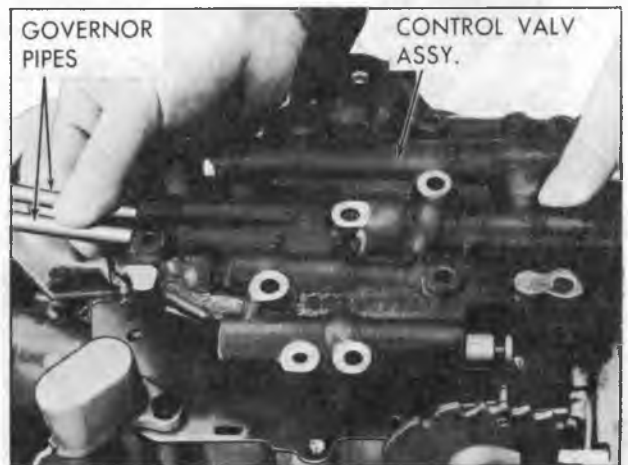


Figure 10—Removing Control Valve and Governor Pipes



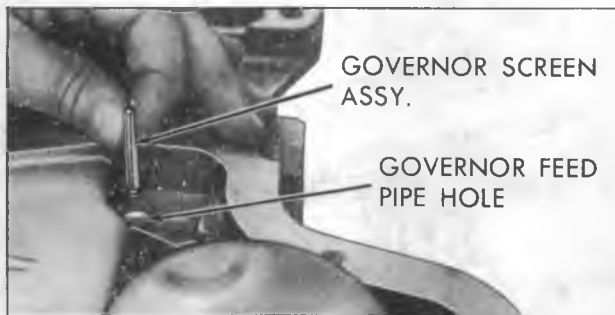


Figure 11—Removing Governor Screen

2. Disconnect solenoid lead from connector terminal.

3. Remove control valve body assembly and governor pipes (fig. 10).

**CAUTION: DO NOT drop manual valve.**

4. Remove governor screen assembly from governor feed pipe hole in case or from end of governor feed pipe (fig. 11). Clean screen in cleaning solvent and air dry.

5. Remove governor pipes from control valve assembly.

### REMOVAL OF REAR SERVO, VALVE BODY SPACER, GASKET, AND FRONT SERVO

1. Remove rear servo cover attaching screws, servo cover and gasket. Discard gasket (fig. 12).



Figure 12—Removing Rear Servo Cover



Figure 13—Removing Rear Servo Assembly

2. Remove rear servo assembly from case (fig. 13).

3. Remove rear servo accumulator spring.

4. Make band apply pin selection check to determine possible cause of malfunction (fig. 131).

**NOTE:** There are six selective pins identified as shown in figure 14. Selecting proper pin is equivalent to adjusting band.

a. Attach band apply pin selection gauge (J-21370-9 and J-21370-6), to transmission case (lever pivot pin to rear) with rear servo cover attaching screws.

b. Attach tool attaching screws finger tight and check freeness of selective pin. Torque attaching screws to 15 foot-pounds and recheck pin to make certain it does not bind.

c. Apply 25 foot-pounds torque to the lever on Tool (J-21370-6) (fig. 131). Selection of the proper rear band apply pin is determined by the relation of the flat on Tool (J-21370-9) to the flat machined area around the hole on Tool (J-21370-6).

d. Before removing gauging tool make note of the proper band apply pin to be used during assembly of the transmission as determined by the six selective pins identified as shown in figure 14.

**NOTE:** If the transmission is in the vehicle, be careful when the detent solenoid is removed as



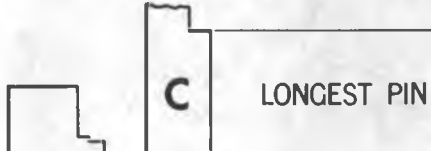
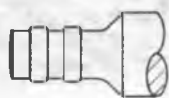
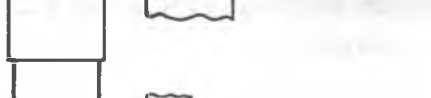
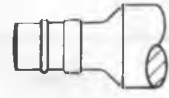

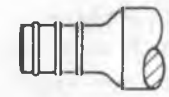
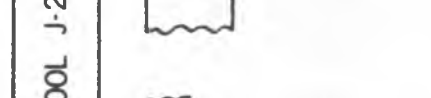
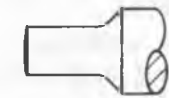
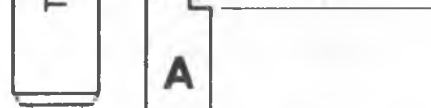
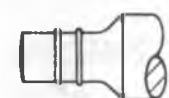


GAGING STEPS LOCATED ON ON THREE SIDES OF TOOL J-21370-9	PART NO.	PIN IDENTIFICATION
	THIS STEP: USE PIN NO. 8627195	
	THIS STEP: SIDES <b>B</b> TO <b>C</b> USE PIN NO. 8627194	
	THIS STEP: USE PIN NO. 8624141	
	THIS STEP: SIDES <b>A</b> TO <b>B</b> USE PIN NO. 8627193	
	THIS STEP: USE PIN NO. 8624140	
	LOWER STEP: USE PIN NO 8627192	
<p>Note: The Identification Rings are .030" and .100" wide.</p>		

Figure 14—Rear Band Apply Pin Identification

it prevents the spacer plate and gasket and check balls from dropping down.

5. Remove solenoid attaching screws, solenoid assembly and gasket (fig. 15).



Figure 15—Removing Detent Solenoid and Gasket

6. Withdraw electrical connector and O-ring seal (fig. 16).

7. Remove control valve assembly spacer plate and gasket.



Figure 16—Removing Electrical Connector and O-Ring

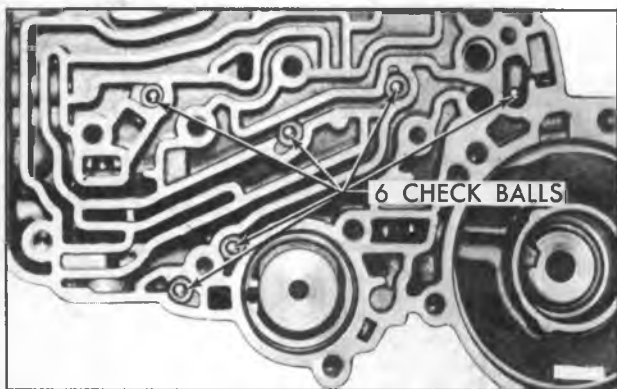


Figure 17—Location of Check Balls

8. Remove six (6) check balls from cored passages in transmission case (fig. 17).

NOTE: Mark location of balls for aid in re-assembly.

9. Remove front servo piston, retainer ring, pin, retainer and spring from transmission case (fig. 18).

### REMOVAL OF REAR OIL SEAL AND CASE EXTENSION

1. If necessary to replace, pry rear oil seal from case extension (fig. 19).

2. Remove case extension to case attaching nuts and washers.

3. Remove case extension housing and case extension to case seal (fig. 20).

4. If necessary, remove ball bearing assemblies from case extension as follows:

- a. Remove rear oil seal.
- b. Remove snap ring.



Figure 18—Removing Front Servo Piston Retainer Ring and Pin



Figure 19—Removing Rear Oil Seal

c. Remove ball bearings and bearing spacer, using a brass rod on the outside race of bearing. An arbor press can be used if tool to press bearings out is located on outer race of bearing.

**CAUTION: DO NOT** locate against inner race or balls.

### FRONT UNIT END PLAY CHECKING PROCEDURE

1. Remove one front pump attaching bolt, and bolt seal. (See figure 125 for location.)

2. Install a 3/8"-16 threaded slide hammer bolt or J-9539, into bolt hole.

3. Mount a dial indicator on rod and index indicator to register with end of turbine shaft.

4. Push on turbine shaft rearward.

5. Push output shaft forward.

6. Set dial indicator to Zero.

7. Pull turbine shaft forward.

Read resulting travel or end play. Should be 0.003"-0.024".

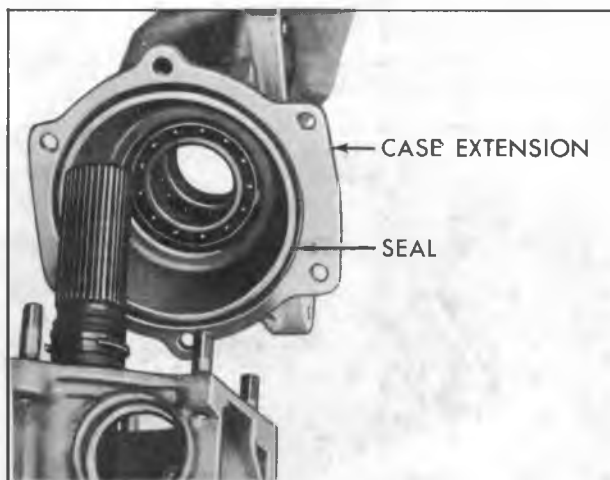


Figure 20—Case Extension and Seal



Figure 21—Removing Front Seal

Selective washer controlling this end play is the washer located between pump cover and forward clutch housing. If more or less washer thickness is required to bring end play within specifications, select proper washer from the following chart:

Thickness	Color
.060 - .064	Yellow
.071 - .075	Blue
.082 - .086	Red
.093 - .097	Brown
.104 - .108	Green
.115 - .119	Black
.126 - .130	Purple



Figure 22—Removing Pump Assembly

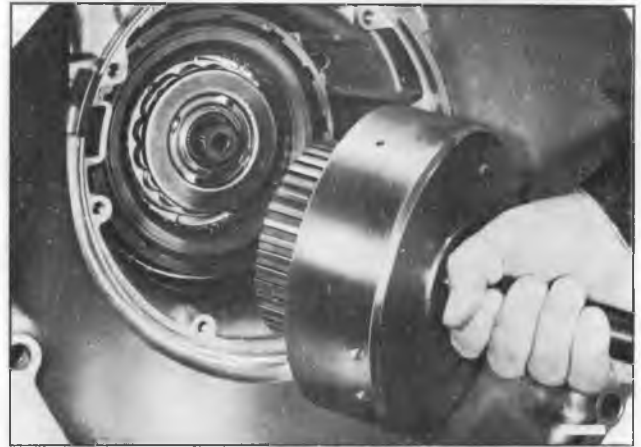


Figure 23—Removing Turbine Shaft and Forward Clutch

NOTE: An oil soaked washer may tend to discolor, so it will be necessary to measure washer for its actual thickness.

### REMOVAL OF OIL PUMP, FORWARD CLUTCH, DIRECT CLUTCH, MANUAL LINKAGE, AND GEAR UNIT

1. If necessary to replace, pry front seal from pump (fig. 21).
2. Remove pump attaching bolts.
3. Install 3/8"-16 threaded slide hammer adapters (J-9539) into bolt holes in pump body with slide hammers (J-6585-2), and remove pump assembly from case. (See figure 22 for location of threaded holes.)



Figure 24—Removing Direct Clutch Assembly



Figure 25—Removing Manual Shaft Retaining Pin

4. Remove and discard pump to case seal ring and gasket.
5. Remove forward clutch assembly and turbine shaft from transmission (fig. 23).
6. Remove forward clutch hub to direct clutch housing thrust washer if it did not come out with forward clutch housing.
7. Remove direct clutch assembly (fig. 24).

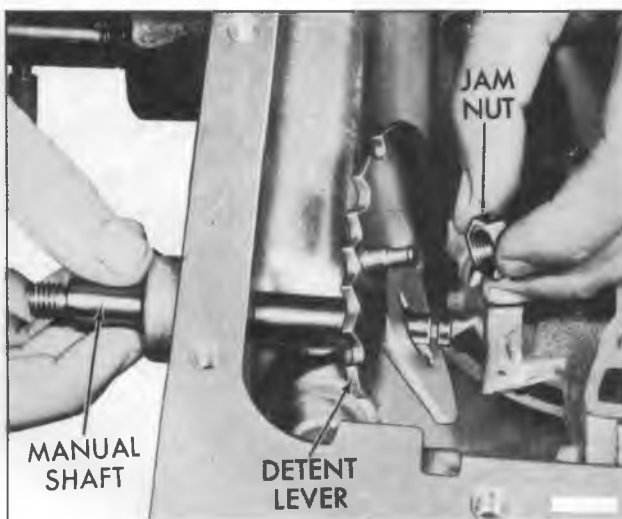


Figure 26—Removing Detent Lever and Jam Nut from Manual Shaft



Figure 27—Removing Front Band

NOTE: If necessary, remove manual linkage as follows:

- a. Unthread jam nut holding detent lever to manual shaft.
- b. Remove manual shaft retaining pin from case (fig. 25).

**CAUTION: DO NOT** lose jam nut as it becomes free from manual shaft.

- c. Remove manual shaft, jam nut, and detent lever from case (fig. 26).

**CAUTION: Be sure** manual shaft flats for detent lever are free of burrs before removing from case.

8. Remove front band (fig. 27).
9. Remove sun gear shaft (fig. 28).
10. Check rear unit end play as follows (fig. 123):
  - a. Install slide hammer adapters (J-9539) or a 3/8"-16 threaded bolt into an extension housing attaching bolt hole (fig. 123).
  - b. Mount a dial indicator on rod and index with end of output shaft.
  - c. Move output shaft in and out to read end play. End play should be from 0.007"-0.019". Selective washer controlling this end play is a steel washer having 3 lugs that is located between output shaft thrust washer and rear face of transmission case.

If a different washer thickness is required to bring end play within specification, it can be selected from the following chart:



Figure 28—Removing Sun Gear Shaft

<u>Thickness</u>	<u>Identification</u> <u>Notches and/or Numeral</u>
.074 - .078	None . . . . . 1
.082 - .086	1 Tab Side . . . . . 2
.090 - .094	2 Tab Side . . . . . 3
.098 - .102	1 Tab O.D. . . . . 4
.106 - .110	2 Tabs O.D. . . . . 5
.114 - .118	3 Tabs O.D. . . . . 6



Figure 29—Removing Center Support to Case Bolt

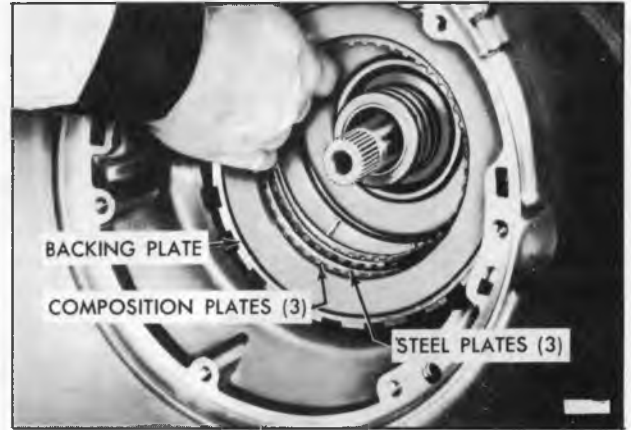


Figure 30—Removing Intermediate Backing Plate and Clutch Plates

11. Remove case center support to case bolt, using a 3/8" 12-point thin wall deep socket (fig. 29).
12. Remove intermediate clutch backing plate to case snap ring.
13. Remove intermediate clutch backing plate, three (3) composition, and three (3) steel clutch plates (fig. 30).
14. Remove center support to case retaining snap ring (fig. 31).
15. Remove entire gear unit assembly by lifting with gear assembly installing and removing tool (J-21795 with J-6585-2), slide hammer and bolt (J-9539) (fig. 32).
16. Remove output shaft to case thrust washer from rear of output shaft or inside case.
17. Place gear unit assembly, with output shaft facing down, in hole in work bench or holding fixtures (J-6116-01) with adapter (J-21364). Remove tool (J-21795).
18. Remove rear unit selective washer from transmission case (fig. 33).



Figure 31—Removing Center Support to Case Snap Ring



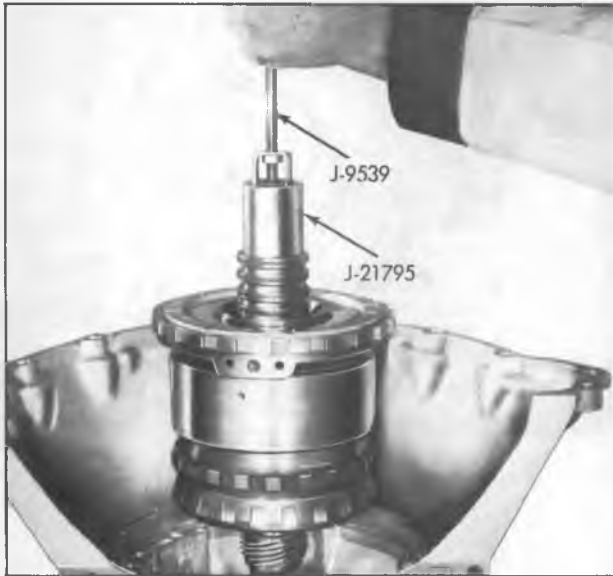


Figure 32—Removing Case Center Support and Gear Unit from Case

19. Remove center support-to-case spacer (fig. 119).

20. Remove rear band assembly. Refer to figure 120.

### DISASSEMBLY OF GEAR UNIT

1. Remove center support assembly (fig. 34).  
2. Remove center support to reaction carrier thrust washer (fig. 35).

3. Remove center support to sun gear races and thrust bearing.

NOTE: One race may have been removed with center support.



Figure 33—Removing Selective Washer



Figure 34—Removing Case Center Support Assembly

4. Remove reaction carrier and roller clutch assembly (fig. 36). Lift roller clutch assembly out of carrier.

5. Remove front internal gear ring from output carrier assembly.

6. Remove sun gear (fig. 37).

7. Remove reaction carrier to output carrier thrust washer.

8. Turn carrier assembly over.

9. Remove O-ring from output shaft.



Figure 35—Removing Center Support Thrust Washer



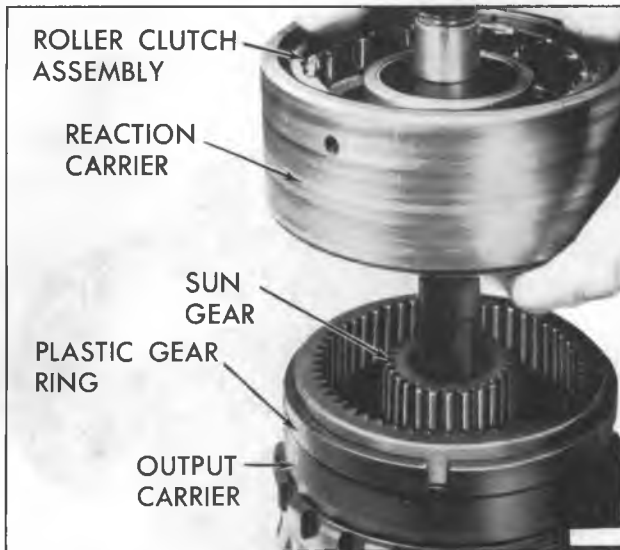


Figure 36—Removing Reaction Carrier and Roller Clutch from Output Carrier

10. Remove output shaft to output carrier snap ring (fig. 38).
11. Remove output shaft.

NOTE: If replacement of speedometer drive gear is necessary, remove in following manner:

- a. Remove snap ring from output shaft.
- b. Install speedometer gear removing tool



Figure 37—Removing Sun Gear



Figure 38—Removing Output Shaft to Carrier Snap Ring

(J-21427-01) and 3/8"-16 bolts with suitable puller (J-9539), on output shaft and remove speedometer drive gear (fig. 39).

c. Install new speedometer drive gear and drive to location (5-43/64" below end of output shaft) using J-5590 (fig. 40).

d. Install snap ring in groove nearest output shaft flange.

12. Remove output shaft to rear internal gear thrust bearing and two (2) races.



Figure 39—Removing Speedometer Drive Gear

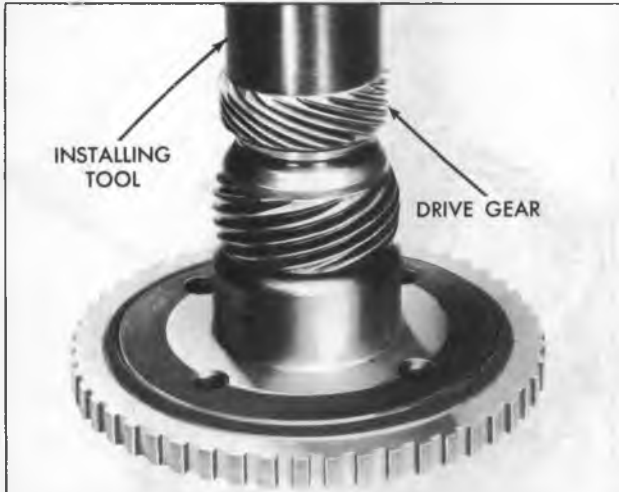


Figure 40—Installing Speedometer Drive Gear

13. Remove rear internal gear and mainshaft (fig. 41).

NOTE: DO NOT DROP BEARINGS.

14. Remove rear internal gear to sun gear thrust bearing and two (2) races.

15. If necessary, remove rear internal gear to mainshaft snap ring; to remove mainshaft, refer to figure 107.



Figure 41—Removing Rear Internal Gear and Mainshaft

## DISASSEMBLY AND ASSEMBLY OF UNITS

### GOVERNOR ASSEMBLY

All components of governor assembly, with exception of driven gear, are a select fit and each assembly is calibrated. The governor, including the driven gear, is serviced as a complete assembly. However, the driven gear can also be serviced separately.

It is necessary to disassemble governor as-

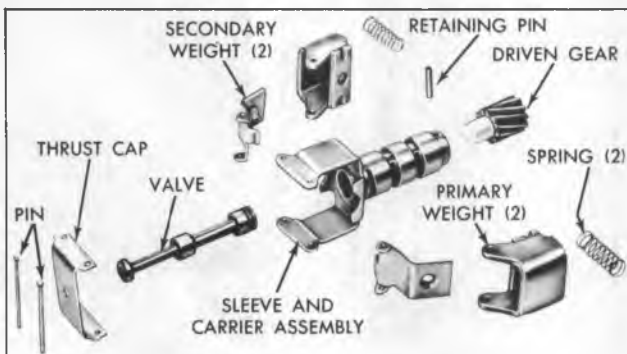


Figure 42—Governor Assembly Components

sembly in order to replace driven gear. Disassembly may also be necessary due to foreign material causing improper operation. In such cases, proceed as follows:

#### DISASSEMBLY OF GOVERNOR

1. Cut off one end of each governor weight pin and remove pins, governor thrust cap, governor weights, and springs. Governor weights are interchangeable from side to side and need not be identified (fig. 42).

2. Remove governor valve from governor sleeve. Be careful not to damage valve.

3. Perform following inspections and replace governor driven gear, if necessary.

#### INSPECTION OF GOVERNOR

1. Wash all parts in cleaning solvent, air dry and blow out all passages.

2. Inspect governor sleeve for nicks, burrs, scoring or galling.

3. Check governor sleeve for free operation in bore of transmission case.

4. Inspect governor valve for nicks, burrs,



Figure 43—Checking Governor Valve Opening at Entry

scoring or galling.

5. Check governor valve for free operation in bore of governor sleeve.

6. Inspect governor driven gear for nicks, burrs, or damage.

7. Check governor driven gear for looseness on governor sleeve.

8. Inspect governor weight springs for distortion or damage.

9. Check governor weights for free operation in their retainers.

10. Check valve opening at entry (0.020" minimum) with a feeler gauge, holding governor as shown with governor weights extended completely outward (fig. 43).

11. Check valve opening at exhaust (0.020" minimum) with a feeler gauge, holding governor as shown with governor weights completely inward (fig. 44).

#### GOVERNOR DRIVEN GEAR REPLACEMENT

To facilitate governor repair in the field, a governor driven gear and replacement pins are available for service use. The service package contains a nylon driven gear, two governor weight retaining pins and one governor gear retainer split pin. Replacement of gear must be performed with care in the following manner:

1. Drive out governor gear retaining split pin using small punch (fig. 45).

2. Support governor on 7/64" plates installed in exhaust slots of governor sleeve, place in arbor press, and with a long punch, press gear out of sleeve.

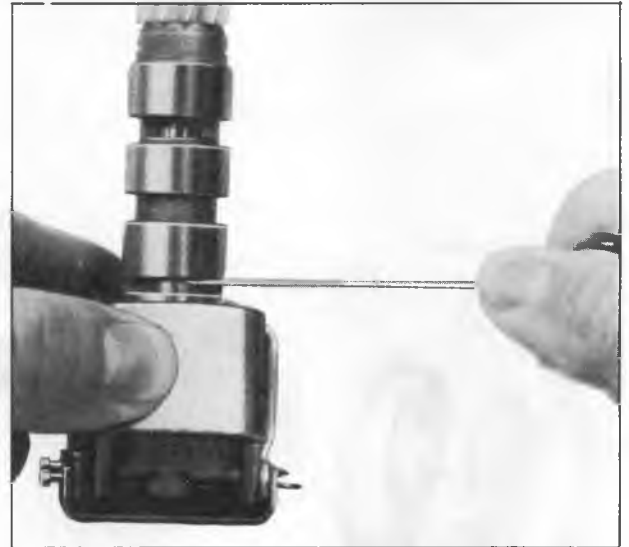


Figure 44—Checking Governor Valve Opening at Exhaust

3. Carefully clean governor sleeve of chips that remain from original gear installation.

4. Support governor on 7/64" plates installed in exhaust slots of sleeve, position new gear in sleeve and, with a suitable socket, press gear into sleeve until nearly seated. Carefully remove any chips that may have shaved off gear hub and press gear in until it bottoms on shoulder.

5. A new pin hole must be drilled through sleeve and gear. Locate hole position 90 degrees from existing hole, center punch and then while supporting governor in press, drill new hole through sleeve and gear using a standard 1/8" drill.

6. Install retaining pin.

7. Wash governor assembly thoroughly to remove any chips that may have collected.

#### ASSEMBLY OF GOVERNOR

1. Install governor valve in bore of sleeve.

2. Install governor weights and springs, and thrust cap on governor sleeve.

3. Align pin holes in thrust cap, governor

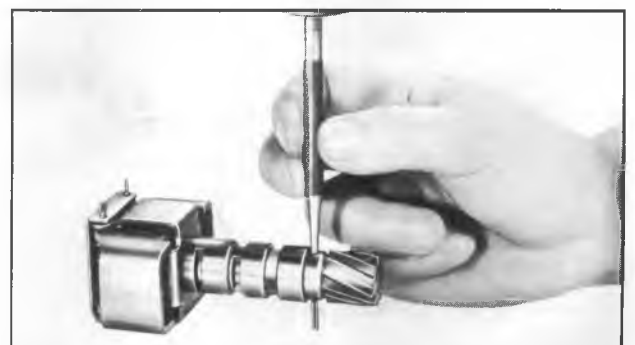


Figure 45—Removing Governor Gear Retaining Pin

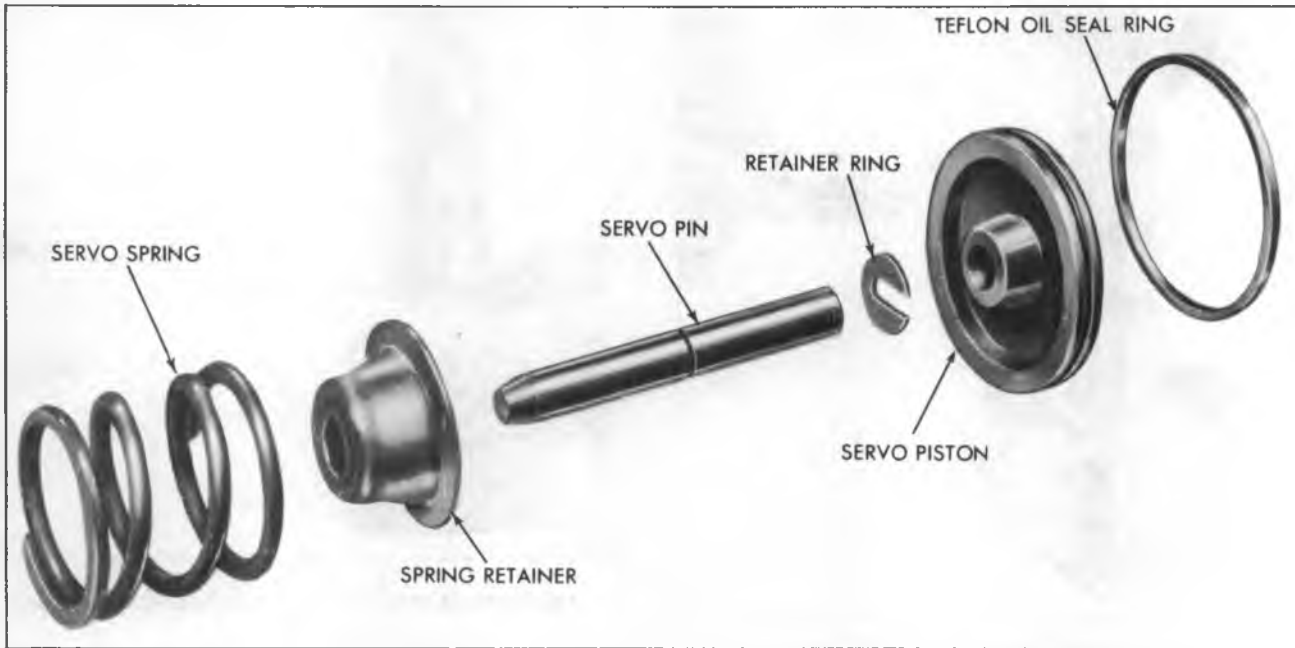


Figure 46—Front Servo Piston Assembly Components



Figure 47—Removing Piston from Rear Servo Assembly

weight assemblies and governor sleeve, and install new pins. Crimp both ends of pins to prevent them from falling out.

4. Check governor weight assemblies for free operation on pins.

5. Check governor valve for free movement in governor sleeve.

### INSPECT FRONT SERVO

NOTE: Refer to figure 46. Do not remove the teflon oil seal ring from the front servo piston unless the oil seal ring requires replacement. For service, the oil seal ring will be aluminum.

1. Inspect servo pin for damage.
2. Inspect piston and oil ring for damage. Check freedom of ring in groove.
3. Check fit of servo pin in piston.

### REAR SERVO

#### DISASSEMBLY

1. Remove rear accumulator piston from rear servo piston (fig. 47).

2. Remove E-ring retaining rear servo piston to band apply pin (fig. 48).

NOTE: Band apply pin is spring loaded.

3. Remove rear servo piston and seal from band apply pin (fig. 49).

4. Remove washer, spring and retainer.

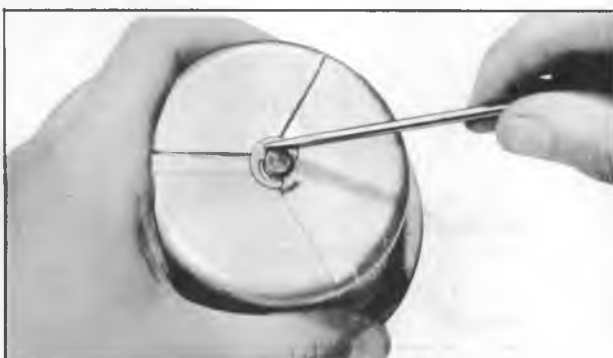


Figure 48—Removing Retainer from Rear Servo Pin

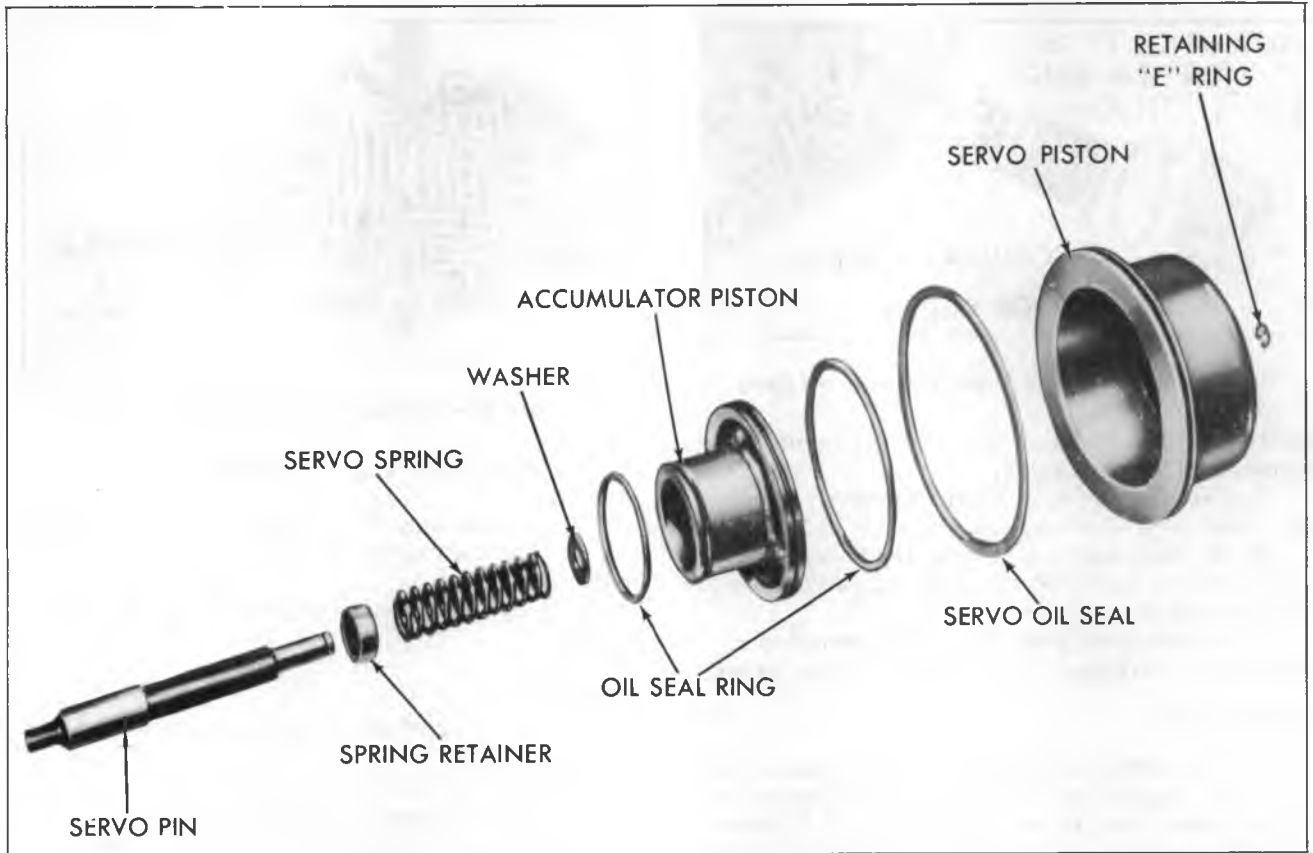


Figure 49—Rear Servo and Accumulator Components

**INSPECTION**

1. Inspect freedom of ring in piston.
2. Inspect fit of band apply pin in servo piston.
3. Inspect band apply pin for scores or cracks.
4. Inspect accumulator and servo pistons for scoring or cracks.

**ASSEMBLY**

1. Install spring retainer, spring and washer on band apply pin.
2. Install band apply pin, retainer, spring and washer into bore of servo piston and secure with E-ring.
3. Install oil seal ring on servo piston, if removed.
4. Install outer and inner oil rings on accumulator piston, if removed, and assemble into bore of servo piston.

**CONTROL VALVE**

**DISASSEMBLY**

1. Position control valve assembly with cored face up and accumulator pocket nearest operator.
2. Remove manual valve from upper bore.
3. Install special tool (J-21885), on accumulator piston valve and remove retaining ring (fig. 50).

4. Remove front accumulator piston and spring (fig. 51).

NOTE: Refer to figure 52.

5. On right side adjacent to manual valve, remove retaining pin, bushing, 1-2 regulator valve, spring, 1-2 detent valve and 1-2 shift valve.
6. From the next bore down, remove retaining pin, 2-3 shift valve spring, modulator valve

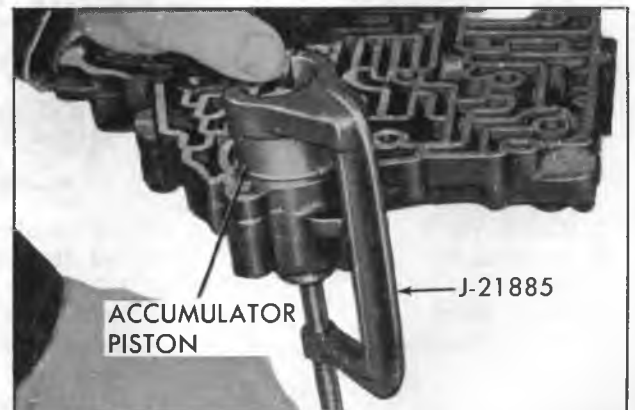


Figure 50—Installing Tool to Remove Front Accumulator Piston Retainer



Figure 51—Removing Front Accumulator Piston and Spring

bushing, 2-3 modulator valve, 3-2 intermediate spring, and 2-3 shift valve.

7. From next bore down, remove retaining pin, bore plug, spring, spacer, and 3-2 valve.

8. At other end of assembly, top bore, remove retaining pin, and bore plug, detent valve, detent regulator valve, spring and spacer.

9. In next bore down, remove the grooved retaining pin, bore plug, and 1-2 accumulator valve.

INSPECTION

NOTE: Refer to figure 51. Do not remove the teflon oil seal ring from the front accumulator piston unless the oil seal ring requires replacement. For service, the oil seal ring will be cast iron.

1. Inspect all valves for scoring, cracks, and free movement in their respective bore.

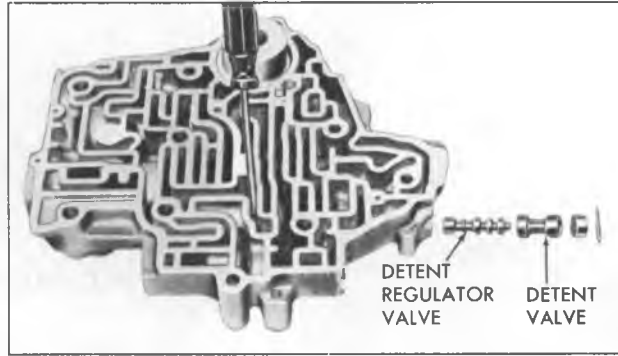


Figure 53—Installing Detent Regulator and Valve

2. Inspect bushing for cracks, scratches or distortion.

3. Inspect body for cracks, or scored bores.

4. Check all springs for distortion or collapsed coils.

5. Inspect accumulator piston and oil ring for damage.

ASSEMBLY

1. Install front accumulator spring and piston into valve body.

2. Install special tool (J-21885) and compress spring and piston and secure with retaining E-ring.

3. Install 1-2 accumulator valve, stem end out, into lower left-hand valve bore. Place the bore plug into valve bore and install grooved retaining pin from cast surface side of the valve body, with the grooves entering the pin hole last. Tappin with

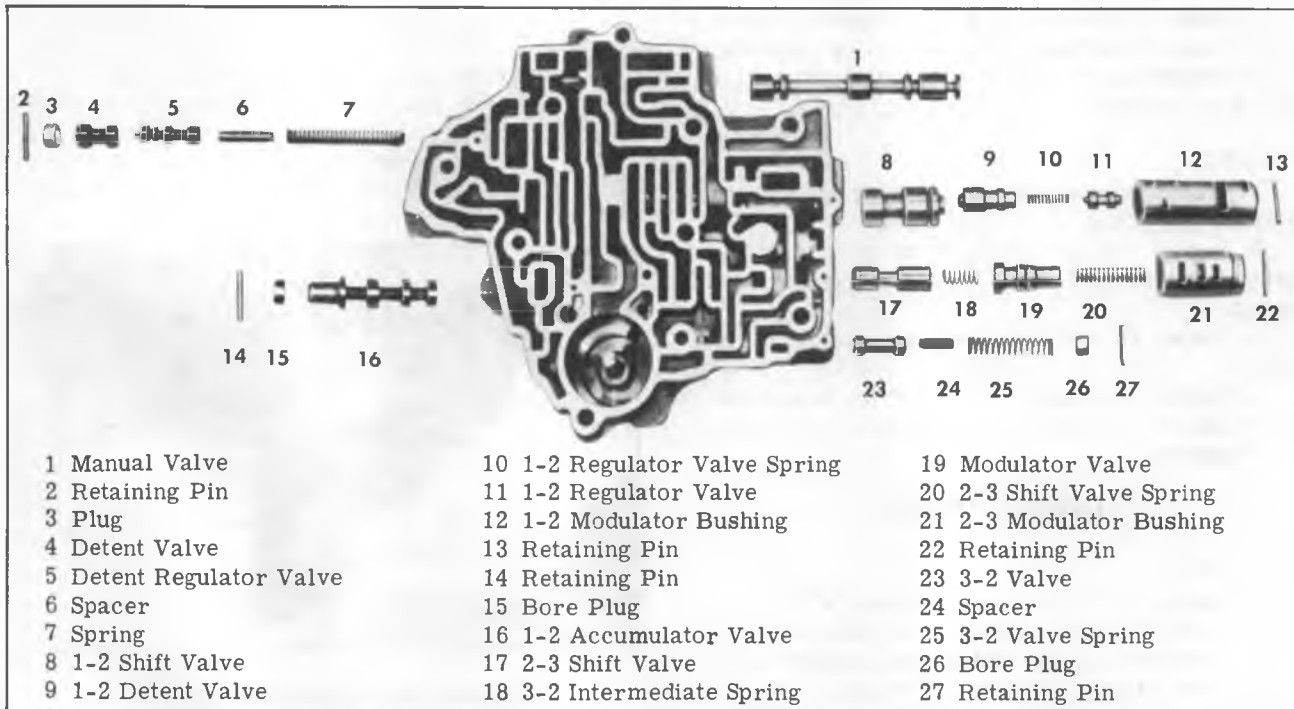


Figure 52—Control Valve Assembly Components



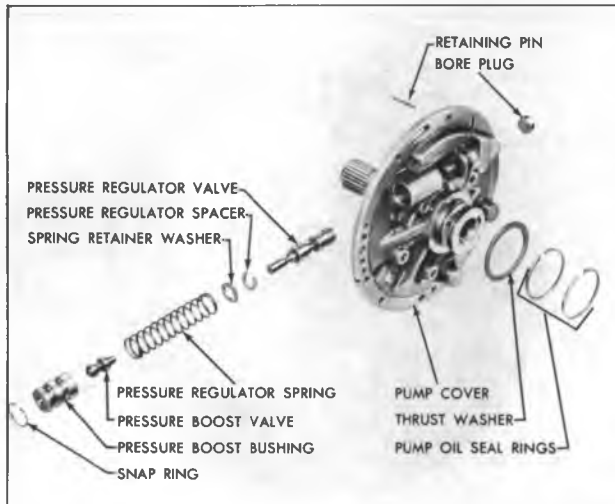


Figure 54—Oil Pump Components

a hammer until flush with cast surface.

4. In next bore up, install detent spring and spacer. Compress spring and secure with small screwdriver (fig. 53).

5. Install detent regulator valve, wide land first.

6. Install detent valve, narrow land first.

7. Install bore plug (hole out), depress spring by pressing in on plug, install retaining pin, and remove screwdriver.

8. In lower right-hand bore, install 3-2 valve.

9. Install 3-2 spring, spacer, bore plug (hole out) and retaining pin.

10. In next bore up, install 2-3 valve, open end out, and 3-2 intermediate spring.

11. Install 2-3 modulator valve into bushing and install both parts into valve body bore.

12. Install 2-3 valve spring and retaining pin.

13. In next bore up, install 1-2 valve, stem end out.

14. Install 1-2 regulator valve, spring, and detent valve into bushing, aligning spring in bore

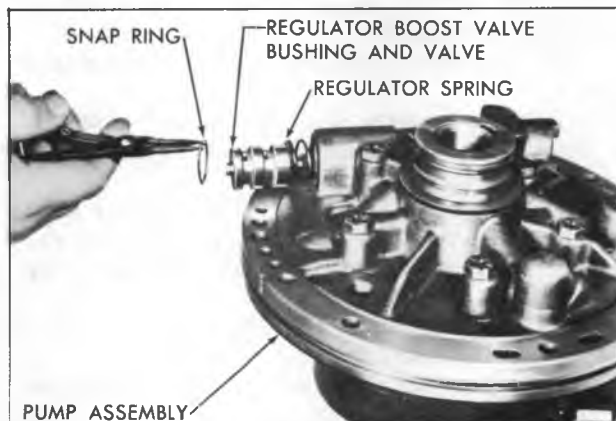


Figure 55—Removing Regulator Valve Snap Ring

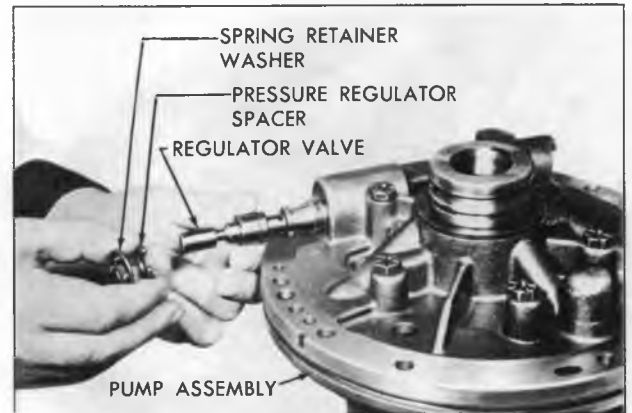


Figure 56—Removing Pressure Regulator Valve

of detent valve, and install parts into valve body bore.

15. Compress bushing against spring and install retaining pin.

16. Install manual valve with detent pin groove to the right.

## OIL PUMP

### DISASSEMBLY (Fig. 54)

1. Place oil pump assembly in holding fixture (J-6116-01) and adapter (J-21364).

2. Compress regulator boost valve bushing against pressure regulator spring and remove snap ring, using pliers (J-5403) (fig. 55).

3. Remove regulator boost valve bushing and valve.

4. Remove pressure regulator spring.

5. Remove regulator valve, spring retainer and spacer(s), if present (fig. 56).

6. Remove pump cover to body attaching bolts.

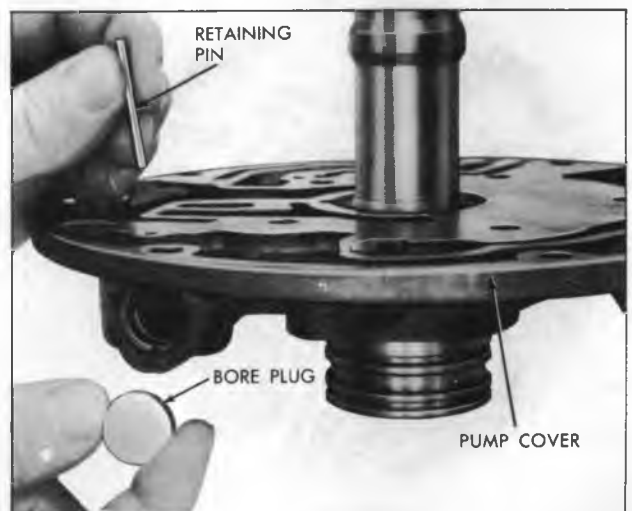


Figure 57—Installing Pressure Regulator Retaining Pin and Bore Plug



Figure 58—Checking Pump Body Face to Gear Face Clearance

7. Remove pump cover from body.
8. Remove retaining pin and bore plug from pressure regulator bore (fig. 57).
9. Remove hook type oil rings from pump cover.
10. Remove pump to forward clutch housing selective washer.
11. Mark top face of drive and driven gears for reassembly in same position and remove gears (fig. 61).

**INSPECTION**

1. Inspect drive gear, driven gear, gear pocket and crescent for scoring, galling or other damage.
2. Place pump gears in pump and check pump body face to gear face clearance, should be 0.0008" - 0.0035" (fig. 58).

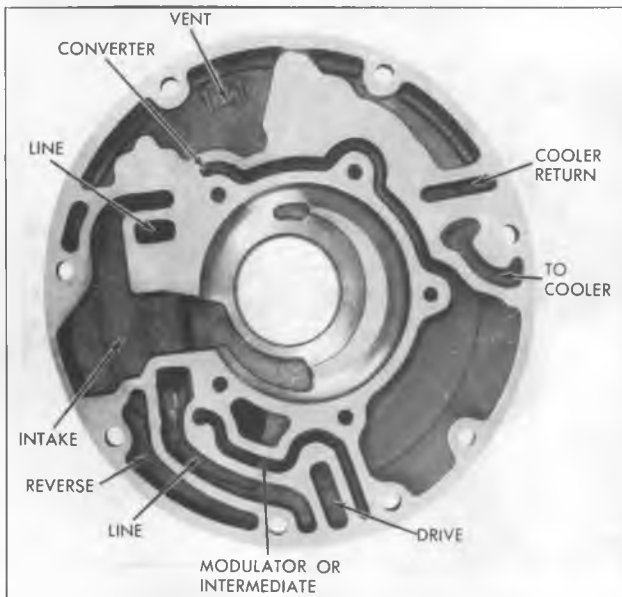


Figure 59—Identification of Oil Passages in Pump Body

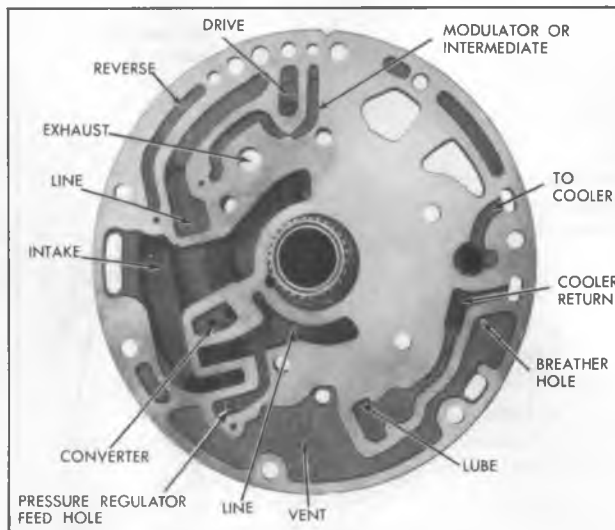


Figure 60—Identification of Oil Passages in Pump Cover

3. Check face of pump body for scores or nicks.
4. Check oil passages (fig. 59).
5. Check for damaged cover bolt attaching threads.
6. Check for overall flatness of pump body face.
7. Check bushing for scores or nicks. If replacement is necessary proceed as follows:
  - a. Using tool (J-21465-17) and driver handle (J-8092), remove bushing.
  - b. From front side of pump, using tool (J-21465-17) and driver handle (J-8092), install new bushing flush to 0.010" below machined surface for seal.
8. Inspect pump attaching bolt seals for damage, replace if necessary.
9. Inspect pump cover face for overall flatness.
10. Check for scores or chips in pressure regulator bore.
11. Check that all passages are open and not interconnected (fig. 60).
12. Check for scoring or damage at pump gear face.
13. Inspect stator shaft for damaged splines, or scored bushing. If replacement of bushings is necessary proceed as follows:
  - a. Thread tool (J-21465-15) into stator shaft bushing. Thread slide hammer (J-2619) into remover. Clamp slide hammer handle into vise. Grasp stator shaft and remove.
  - b. Using installer J-21465-3 (front) or J-21465-2 (rear) install bushing.
14. Inspect oil ring grooves for damage or wear.
15. Inspect selective washer thrust face for wear or damage.

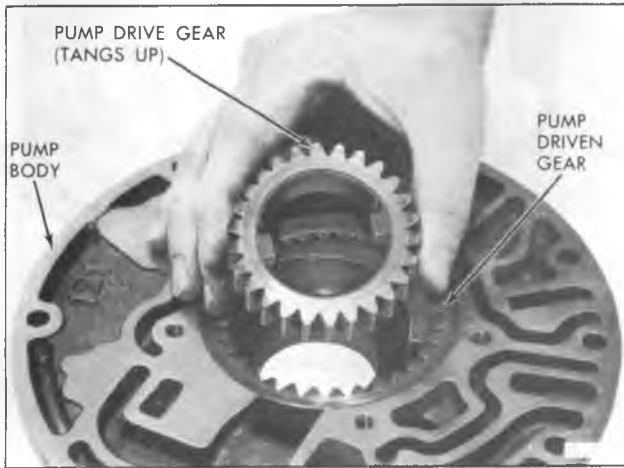


Figure 61—Installing Pump Drive Gear

16. Inspect pressure regulator and boost valve for free operation.

**ASSEMBLY**

1. Install drive and driven pump gears into pump body with alignment marks up (fig. 61).

NOTE: Install drive gear with drive tangs up.

2. Protect stator shaft and install pump in vise.

3. Install spacer(s) if used, retainer and spring, into pressure regulator bore (fig. 54).

4. Install pressure regulator valve from opposite end of bore, stem end first.

5. Install boost valve into bushing, stem end out, and install both parts into pump cover by compressing bushing against spring.

6. Install retaining snap ring.

7. Install pressure regulator valve bore plug and retaining pin into opposite end of bore.

8. Install previously selected front unit selective thrust washer over pump cover delivery sleeve.

9. Install two (2) hook type oil seal rings.

10. Assemble pump cover to pump body with attaching bolts.

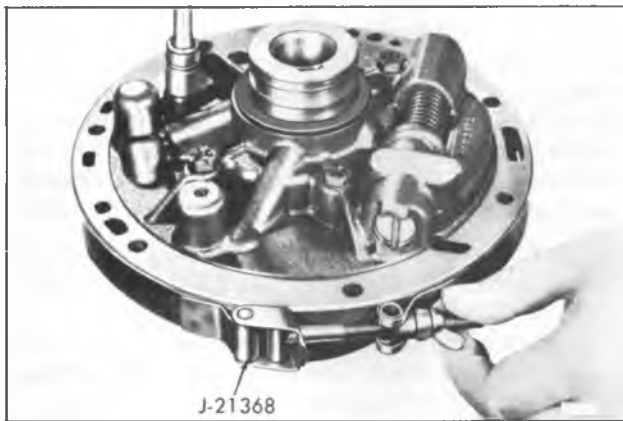


Figure 62—Installing Pump Cover to Pump Body

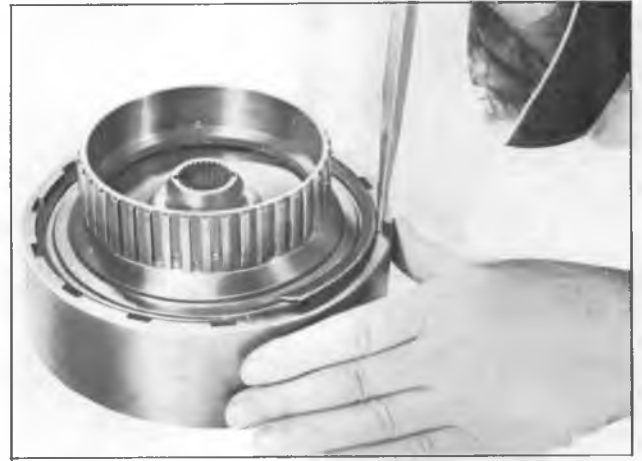


Figure 63—Removing Direct Clutch Hub Snap Ring

NOTE: Leave bolts one turn loose at this time.

11. Place pump aligning strap (J-21368), over pump body and cover, and tighten tool (fig. 62).

12. Tighten pump cover bolts (16-20 ft.-lbs. torque).

13. Install and align new pump-to-case gasket.

14. Install new pump-to-case O-ring seal.

**FORWARD CLUTCH**

**DISASSEMBLY**

1. Place forward clutch and turbine shaft in hole in bench or holding fixture (J-6116-01), and remove forward clutch housing to direct clutch hub snap ring (fig. 63).

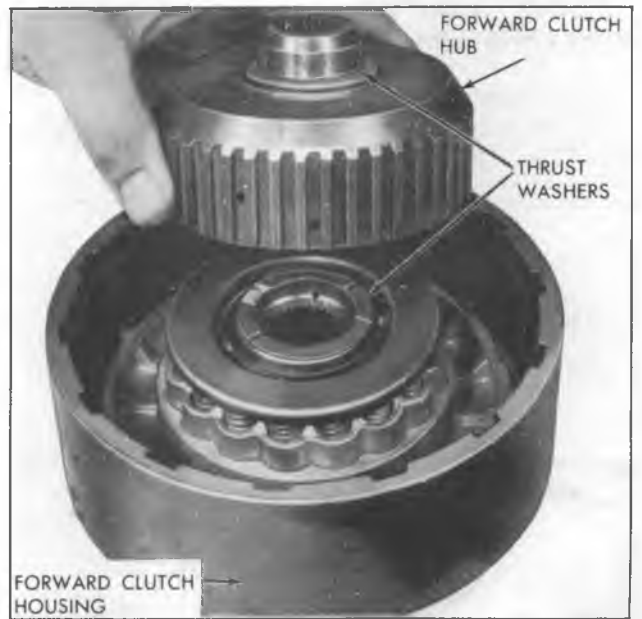


Figure 64—Removing Forward Clutch Hub and Thrust Washers

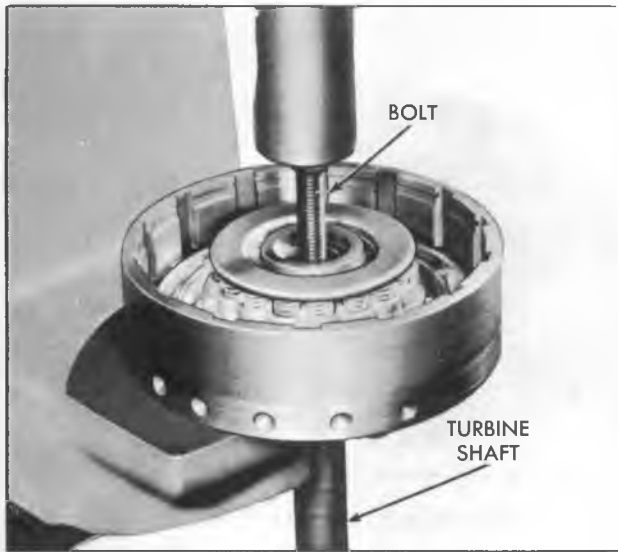


Figure 65—Removing Turbine Shaft

2. Remove direct clutch hub.
3. Remove forward clutch hub and thrust washers (fig. 64).
4. Remove five (5) radial grooved composition and five (5) steel clutch plates.
5. If necessary place forward clutch and turbine shaft in arbor press and remove turbine shaft (fig. 65).
6. Using clutch spring compressor (J-4670-01) with adapter (J-6129) and tool (J-21664) compress spring retainer and remove snap ring (fig. 66).
7. Remove snap ring, spring retainer and sixteen (16) clutch release springs.

NOTE: Keep these springs separate from direct clutch release springs.

8. Remove forward clutch piston.
9. Remove inner and outer clutch piston seals (fig. 67).

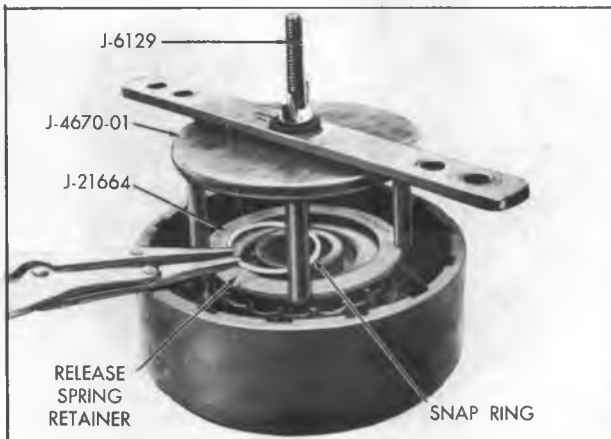


Figure 66—Removing Forward Clutch Spring Snap Ring



Figure 67—Removing Forward Clutch Piston Outer Seal

NOTE: The forward clutch housing does NOT use a clutch center seal.

INSPECTION

1. Inspect composition faced and steel clutch plates for signs of burning, scoring or wear.
2. Inspect sixteen (16) springs for collapsed coils or signs of distortion.
3. Inspect clutch hubs for worn splines, proper lubrication holes, thrust faces.
4. Inspect piston for cracks.
5. Inspect clutch housing for wear, scoring, open oil passages and free operation of ball check.
6. Inspect turbine shaft:
  - a. Inspect for open lubrication passages at each end.
  - b. Inspect splines for damage.
  - c. Inspect ground bushing journals for damage.
  - d. Inspect shaft for cracks or distortion.

NOTE: Turbine shaft and clutch housing are serviced separately. Shaft may be removed from housing by using a suitable size socket in an arbor press (fig. 65).

ASSEMBLY (Refer to Fig. 68)

1. Place new inner and outer oil seals on clutch piston, lips face away from spring pockets (fig. 67).

NOTE: The forward and direct clutch pistons have identical inside and outside diameters. It is possible to reverse the pistons during reassembly. Therefore, care should be exercised to make certain the proper piston be installed in the clutch assemblies. As shown in figure 81, the forward clutch piston can be identified by the blind hole.

2. Place seal protector tool (J-21362), over clutch hub and install outer clutch piston seal protector (J-21409), into clutch drum and install piston, rotating piston on drum until seated (fig. 69).
3. Install sixteen (16) clutch release springs (green) into pockets in piston.
4. Place spring retainer and snap ring on springs.

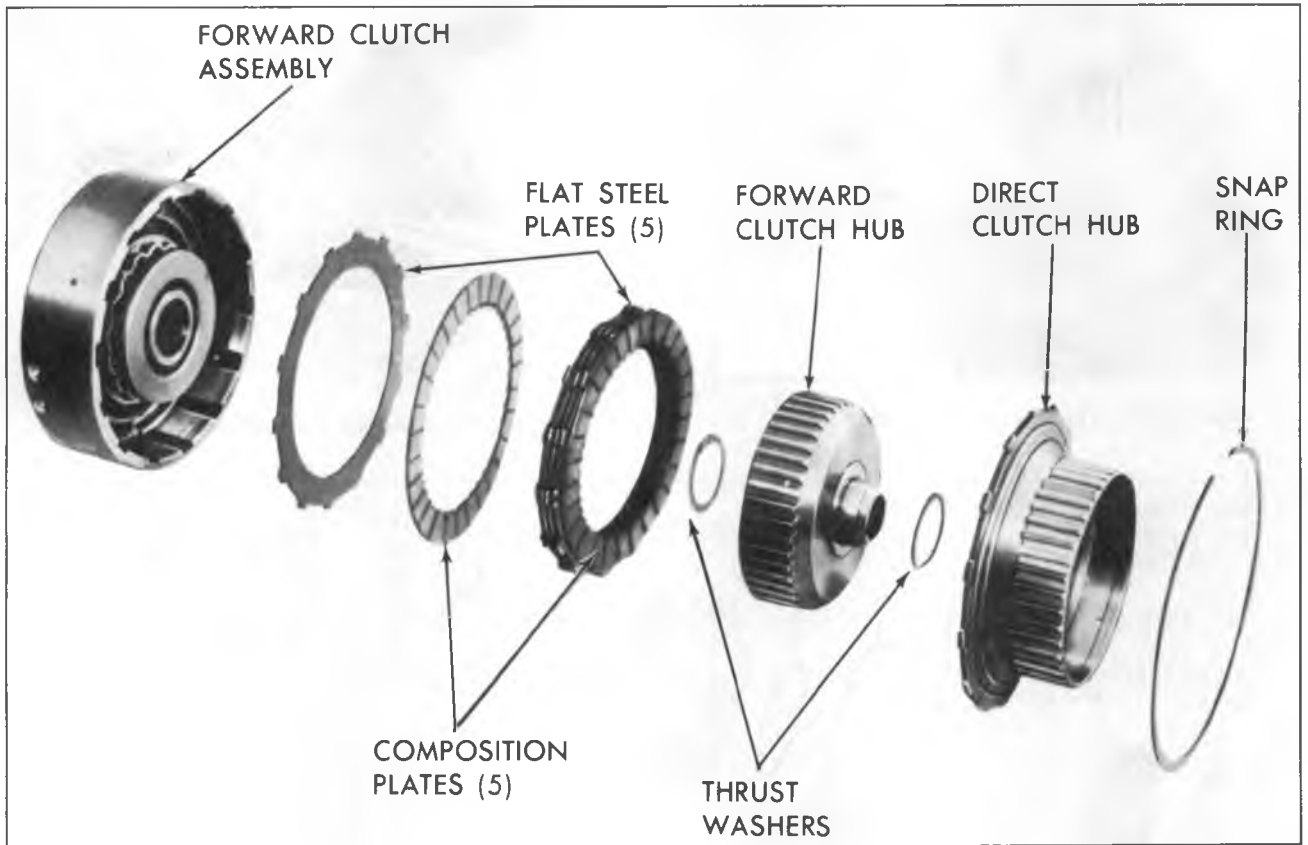


Figure 68—Forward Clutch Assembly Components

5. Compress springs using clutch compressor tools (J-4670-01, J-6129, and J-21664), and install snap ring.
6. If removed, install turbine shaft in forward clutch housing, using arbor press.
7. Install forward clutch hub washers on forward clutch hub. Retain with petrolatum.
8. Place forward clutch hub into forward clutch

housing.

9. Oil and install five (5) radial grooved composition and five (5) flat steel clutch plates starting with flat steel and alternating composition and steel clutch plates (fig. 70).

10. Install direct clutch hub and retaining snap ring (fig. 63).



Figure 69—Installing Forward Clutch Piston

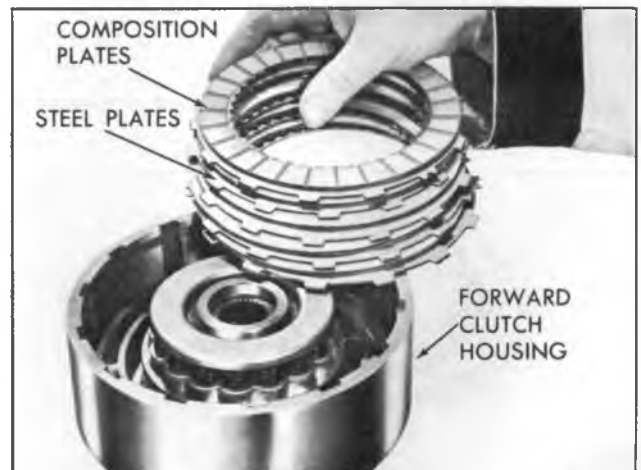


Figure 70—Installing Forward Clutch Composition and Steel Plates



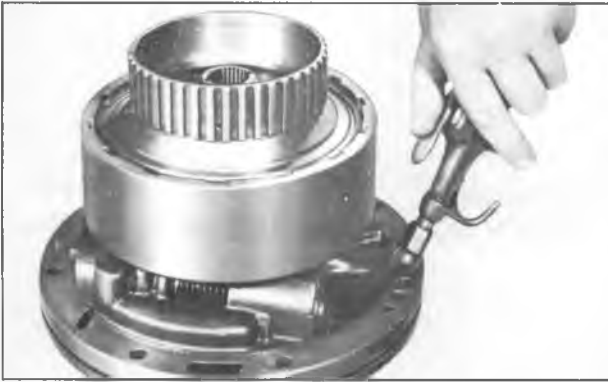


Figure 71—Air Checking Forward Clutch Assembly

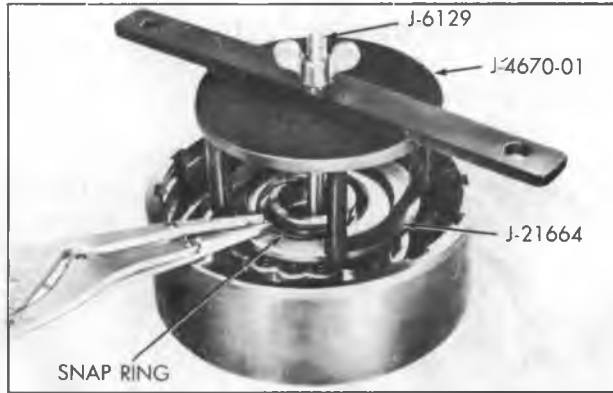


Figure 74—Removing Direct Clutch Snap Ring

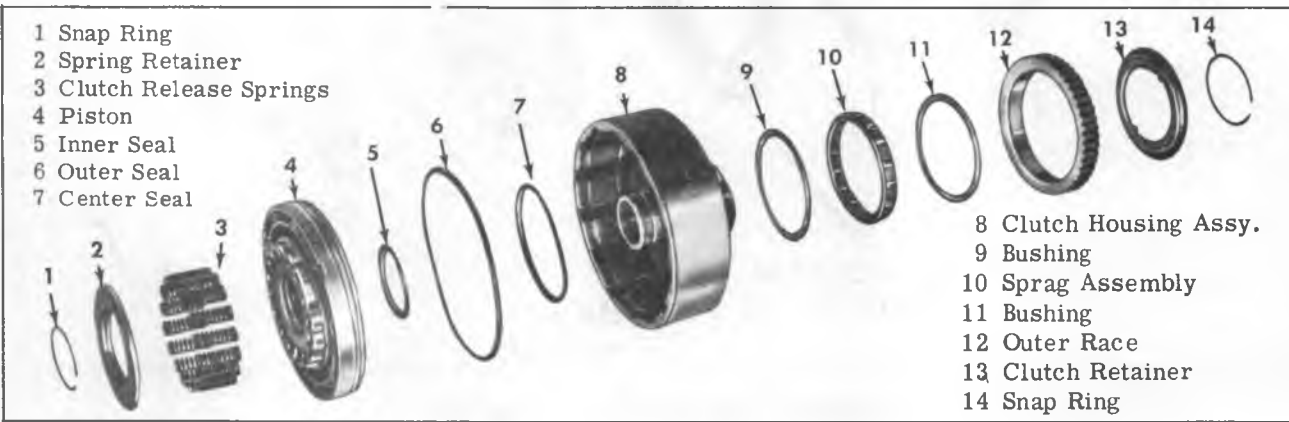


Figure 72—Direct Clutch and Intermediate Sprag Components

11. Place forward clutch housing on pump delivery sleeve and air check clutch operation (fig. 71).

## DIRECT CLUTCH AND INTERMEDIATE SPRAG

### DISASSEMBLY (Refer to Fig. 72)

1. Remove intermediate sprag retainer snap ring and retainer (fig. 86).



Figure 73—Removing Direct Clutch Backing Plate Snap Ring



Figure 75—Removing Direct Clutch Piston Assembly

2. Remove sprag outer race, bushings and sprag assembly.

3. Turn unit over and remove backing plate to direct clutch housing snap ring (fig. 73).

4. Remove direct clutch backing plate, six (6) composition, and six (6) steel clutchplates (fig. 76).



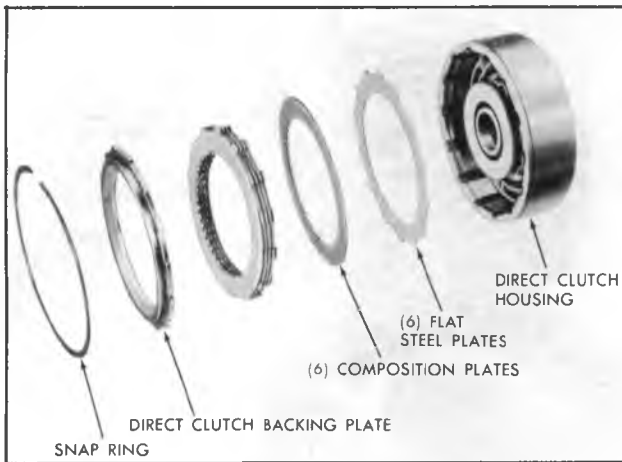


Figure 76—Direct Clutch Assembly Components

NOTE: Radial grooved composition plates are not used in this clutch pack.

5. Using clutch compressor tools (J-4670-01, J-6129 and J-21664), compress spring retainer and remove snap ring (fig. 74).

6. Remove retainer and fourteen (14) clutch release springs.

NOTE: Keep these springs separate from the forward clutch release springs.

7. Remove direct clutch piston (fig. 75).

8. Remove outer seal from piston.

9. Remove inner seal from piston.

10. Remove center piston seal from direct clutch housing.

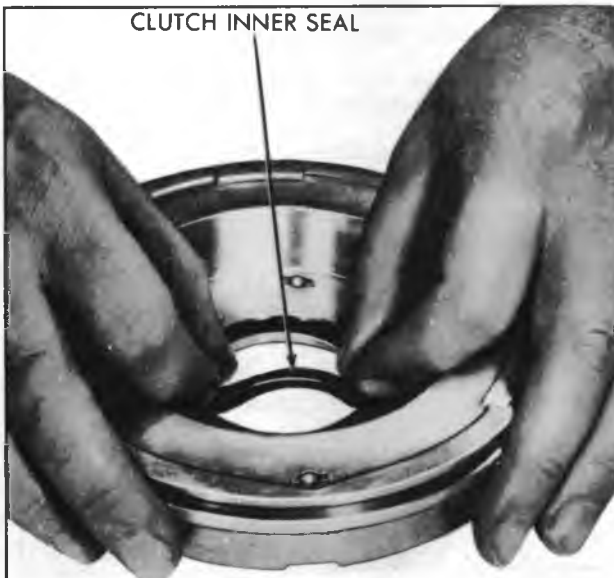


Figure 77—Installing Direct Clutch Inner Seal



Figure 78—Installing Direct Clutch Outer Seal

INSPECTION (Refer to Fig. 72)

1. Inspect sprag assembly for popped or loose sprags.
2. Inspect bushings for wear or distortion.
3. Inspect inner and outer races for scratches or wear.
4. Inspect clutch housing for cracks, wear, proper opening of oil passages or wear on clutch plate drive lugs.
5. Inspect composition faced and steel clutch plates for signs of wear or burning.
6. Inspect backing plate for scratches or other damage.
7. Inspect clutch piston for cracks and free operation of ball checks.
8. Inspect springs for collapsed coils or signs of distortion.

NOTE: The 14 direct clutch release springs are not serviced. If one or more of these springs require replacement, discard all of them and install the 16 service direct clutch release springs.

ASSEMBLY

1. Install a new inner clutch piston seal on piston with lip facing away from spring pockets (fig. 77).



Figure 79—Installing Direct Clutch Center Seal



Figure 80—Installing Direct Clutch Piston

2. Install a new outer clutch piston seal with lip away from spring pockets (fig. 78).

NOTE: The forward and direct clutch pistons have identical inside and outside diameters. It is possible to reverse the pistons during reassembly. Therefore, care should be exercised to make certain the proper piston be installed in the clutch assemblies. As shown in figure 81, the direct clutch piston can be identified by the two check balls.

3. Install a new center seal on clutch housing with lip of seal facing up (fig. 79).

NOTE: Apply Hydra-Matic oil to all seals.

4. Place seal protectors, tools (J-21362 - Inner and J-21409 - Outer), over hub and clutch housing and install clutch piston, with a rotating motion (fig. 80).

5. Install fourteen (14) springs into pockets in clutch piston, leaving 2 pockets diametrically opposite without springs.

6. Place spring retainer and snap ring on retainer.

7. Using clutch compressor tools (J-4670-01,

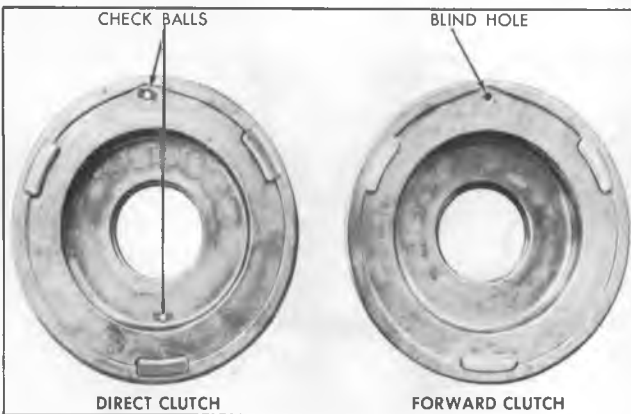


Figure 81—Forward and Direct Piston Identification

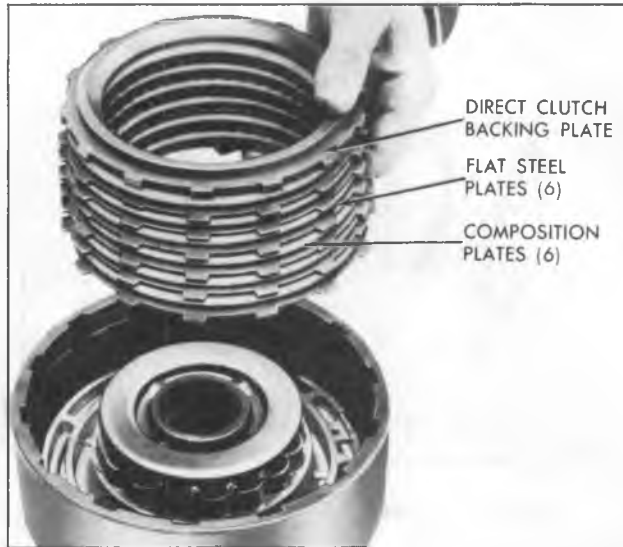


Figure 82—Installing Direct Clutch Backing Plate, Composition Plates, and Steel Plates

J-6129, and J-21664), install snap ring (fig. 66).

8. Install six (6) composition and six (6) steel clutch plates, starting with steel and alternating composition and steel (fig. 82).

NOTE: DO NOT use radial grooved plates here.

9. Install clutch backing plate.

10. Install backing plate retaining snap ring (fig. 73).

11. Turn unit over and install one sprag bushing, cup side up, over inner race.

12. Install sprag assembly into outer race.

13. With ridge or shoulder on inner cage down, start sprag and outer race over inner race with clockwise turning motion (fig. 83).

NOTE: Outer race should not turn counter-clockwise after installation (fig. 84).

14. Install sprag bushing over sprag, cup side down (fig. 85).



Figure 83—Installing Intermediate Sprag to Direct Clutch

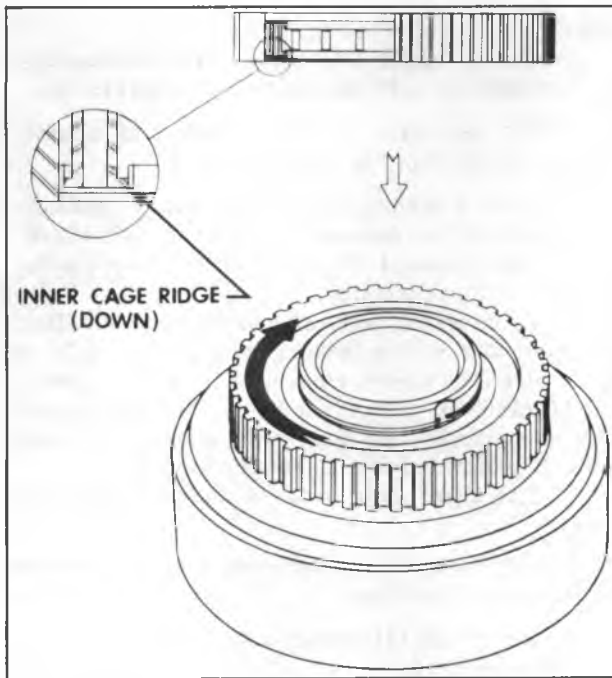


Figure 84—Intermediate Sprag to Direct Clutch Relationship



Figure 87—Air Checking Direct Clutch Assembly

15. Install sprag retainer and snap ring (fig. 86).

16. Place direct clutch assembly over center support and air check operation of direct clutch (fig. 87).

NOTE: If air is applied through reverse passage (right oil feed hole), it will escape from direct clutch passage (left oil feed hole). This is considered normal. Apply air through left oil feed hole to actuate piston and move direct clutch.

### CASE CENTER SUPPORT

#### DISASSEMBLY

1. Remove three (3) hook-type cast iron oil seal rings from the center support. Do not remove the teflon oil seal ring unless replacement is required. All service center support oil seal rings are hook-type cast iron (fig. 88).



Figure 85—Installing Intermediate Clutch Retainer



Figure 86—Installing Retainer Snap Ring

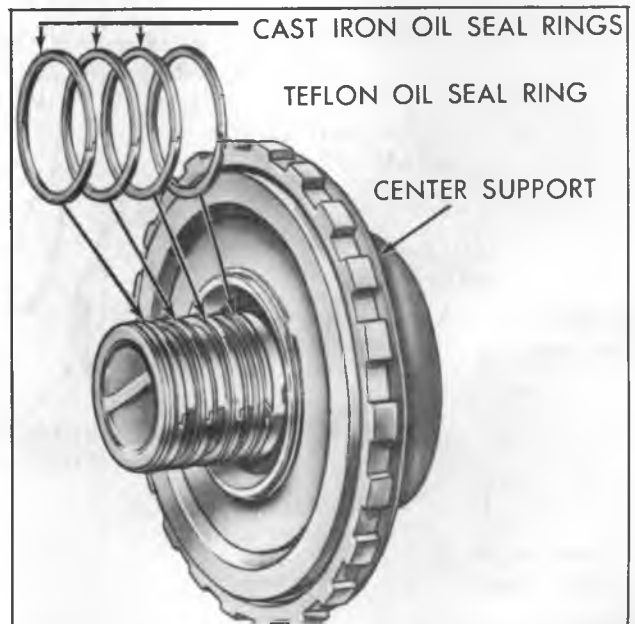


Figure 88—Center Support Oil Seal Rings

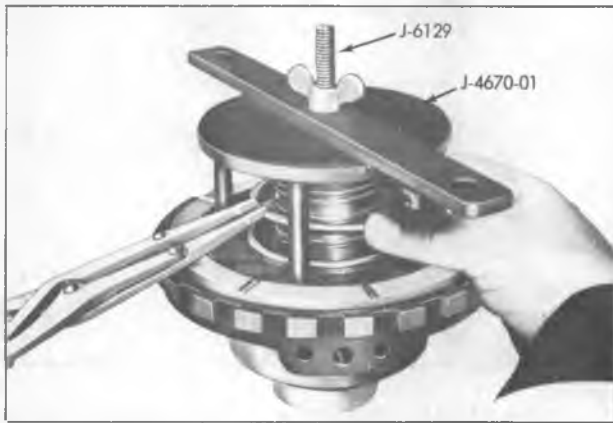


Figure 89—Removing Intermediate Clutch Piston Snap Ring

2. Using clutch compressor (J-4670-01) and adapter (J-6129), compress spring retainer and remove snap ring (fig. 89).

3. Remove spring retainer and three (3) clutch release springs.

4. Remove intermediate clutch piston.

5. Remove inner and outer piston seal.

NOTE: Do not remove three (3) screws retaining roller clutch inner race to center support.

INSPECTION (Refer to Fig. 90)

1. Inspect roller clutch inner race for scratches or indentations. Be sure lubrication hole is open.

NOTE: Be sure constant bleed plug orifice (approx. 0.020" Dia.) is open (fig. 35).

2. Inspect bushing for scoring, wear or galling. If replacement is necessary, proceed as follows:

a. Using tool (J-21465-6) with driver handle (J-8092), remove bushing.

b. From front side of center support, align elongated slot in the bushing with drilled hole in the oil delivery sleeve closest to the piston. Using tool (J-21465-6) and driver handle (J-8092), drive bushing squarely into bore until bushing is flush to 0.010" below top of oil delivery sleeve.

3. Check oil ring grooves and oil rings for damage.

NOTE: All service center support oil seal rings are hook-type cast iron.

4. Air check oil passages to be sure they are not interconnected.

5. Inspect the piston sealing surfaces for scratches.

6. Inspect piston seal grooves for nicks or other damage.

7. Inspect piston for cracks or porosity.

8. Inspect release springs for distortion.

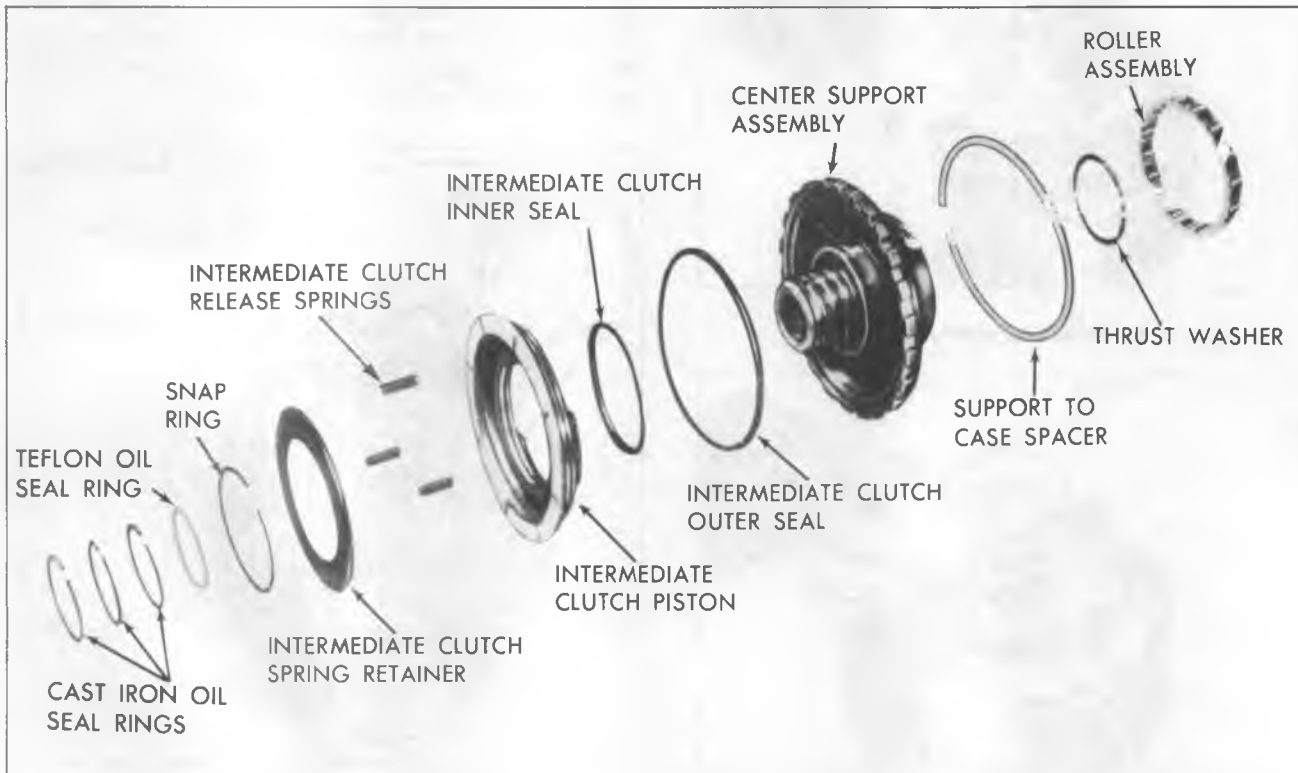


Figure 90—Center Support Assembly Components



Figure 91—Installing Intermediate Clutch Inner Seal



Figure 92—Installing Intermediate Clutch Outer Seal

9. Inspect center support-to-case spacer for burrs or raised edges. If present, remove with a fine stone or fine sandpaper.

**ASSEMBLY**

1. Install new inner and outer seals on piston with lip of seal facing away from spring pocket (figs. 91 and 92).

2. Install inner seal protector (J-21363) on center support hub, install piston, indexing spring pockets of piston into cored areas of center support (fig. 93).

3. Install three (3) release springs into counterbores of piston. Space equally during assembly.

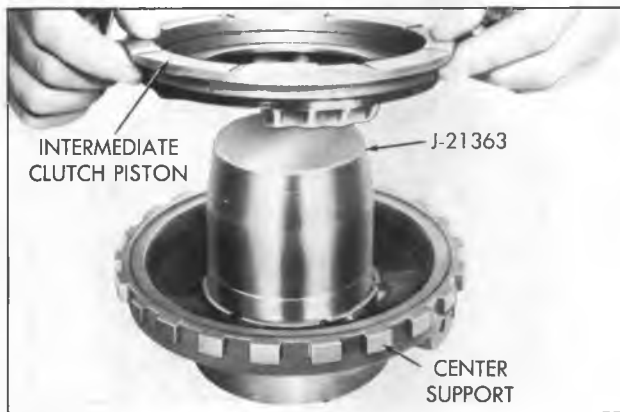


Figure 93—Installing Intermediate Clutch Piston

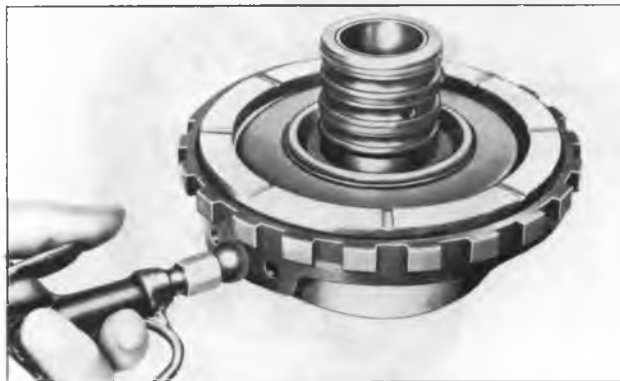


Figure 94—Air Checking Intermediate Clutch Piston

4. Place spring retainer and snap ring over springs.

5. Using clutch spring compressor (J-4670-01) and adapter (J-6129), compress springs and install snap ring (fig. 89).

6. Install three (3) hook-type cast iron oil seal rings on the center support if the teflon ring was not removed. If the teflon ring was removed, install four (4) hook-type cast iron oil seal rings.

7. Air check operation of intermediate clutch piston (fig. 94).

**INSPECTION OF REACTION CARRIER, ROLLER CLUTCH, AND OUTPUT CARRIER ASSEMBLY**

1. Inspect band surface on reaction carrier for signs of burning or scoring.

2. Inspect roller clutch outer race for scoring or wear.

3. Inspect thrust washer surfaces for signs of scoring or wear.

4. Inspect bushing for damage. If bushing is damaged, reaction carrier must be replaced.

5. Inspect reaction carrier pinions for damage, rough bearings, or excessive tilt.

6. Check pinion end play. Pinion end play should be 0.009"-0.024" (fig. 95).



Figure 95—Checking Pinion End Play





Figure 96—Checking Output Carrier Pinion End Play

7. Inspect roller clutch for damaged members.
8. Inspect roller clutch cage for damage.
9. Inspect front internal gear (output carrier) for damaged teeth.
10. Inspect output carrier pinions for damage, rough bearings or excessive tilt.
11. Check pinion end play. Pinion end play should be 0.009"-0.024" (fig. 96).
12. Inspect lugs for cracks or damage.
13. Inspect output locating splines for damage.
14. Inspect front internal gear ring for flaking. Refer to figure 36.

### PINION REPLACEMENT

1. Support carrier assembly on its front face.
2. Using a 1/2-inch diameter drill, remove stake marks from the end of the pinion pin, or pins, to be replaced. This will reduce the probability of cracking the carrier when pinion pins are pressed out.

**CAUTION: DO NOT allow drill to remove any stock from the carrier.**



Figure 97—Removing Planet Pinion Pin

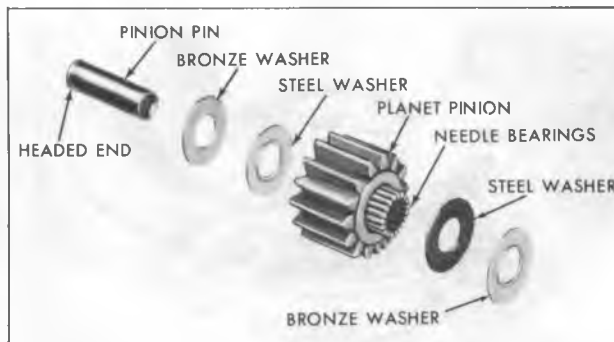


Figure 98—Planet Pinion Assembly Components

3. Using a tapered punch, drive or press pinion pins out of carrier (fig. 97).
4. Remove pinions, thrust washers and roller needle bearings.
5. Inspect pinion pocket thrust faces for burrs and remove if present.
6. Install eighteen (18) needle bearings into each pinion using petrolatum to hold bearings in place. Use pinion pin as guide (fig. 98).
7. Place a bronze and steel washer on each side of pinion so steel washer is against pinion, hold them in place with petrolatum.
8. Place pinion assembly in position in carrier and install a pilot shaft through rear face of assembly to hold parts in place.
9. Drive a new pinion pin into place while rotating pinion from front, being sure that headed end is flush or below face of carrier (fig. 99).
10. Place a large punch in a bench vise to be used as an anvil while staking opposite end of pinion pin in three places.

**NOTE:** Both ends of pinion pins must lie below face of carrier or interference may occur.



Figure 99—Installing Planet Pinion Pin



## INSPECTION AND REPAIR OF MAJOR UNITS

### Output Shaft

1. Inspect bushing for wear or galling. If replacement is necessary, proceed as follows:
  - a. Thread tool (J-21465-16) into bushing and using slide hammer (J-2619), remove bushing.
  - b. Using tool (J-21465-1), install bushing into place until tool bottoms.
2. Inspect bearing and thrust washer surfaces for damage.
3. Inspect governor drive gear for rough or damaged teeth.
4. Inspect splines for damage.
5. Inspect orificed cup plug in lubrication passage.
6. Inspect drive lugs for damage.

### Rear Internal Gear

1. Inspect gear teeth for damage or wear.
2. Inspect splines for damage.
3. Inspect gear for cracks.

### Sun Gear

1. Inspect gear teeth for damage or wear.
2. Inspect splines for damage.
3. Be sure oil lubrication hole is open.

### Sun Gear Shaft

1. Inspect shaft for cracks or splits.
2. Inspect splines for damage.
3. Inspect bushings for scoring or galling. If necessary to replace, proceed as follows:
  - a. Remove Front Bushing. With sun gear shaft properly supported, using remover tool (J-21465-15), with slide hammer and adapter (J-2619), remove bushing.
  - b. Install Front Bushing. Using installer tool (J-21465-5) with adapter (J-8092) press or drive replacement bushing into place until tool bottoms.
  - c. Remove Rear Bushing. With sun gear shaft properly supported, using remover tool (J-21465-15) with slide hammer and adapter (J-2619), remove bushing.
  - d. Install Rear Bushing. Using installer tool (J-21465-5), with adapter (J-8092), press or drive replacement bushing into place until tool bottoms.
4. Inspect ground bushing journals for damage.
5. Be sure oil lubrication hole is open.

### Main Shaft

1. Inspect shaft for cracks or distortion.
2. Inspect splines for damage.
3. Inspect ground bushing journals for damage.
4. Inspect snap ring groove for damage.
5. Be sure oil lubrication holes are open.

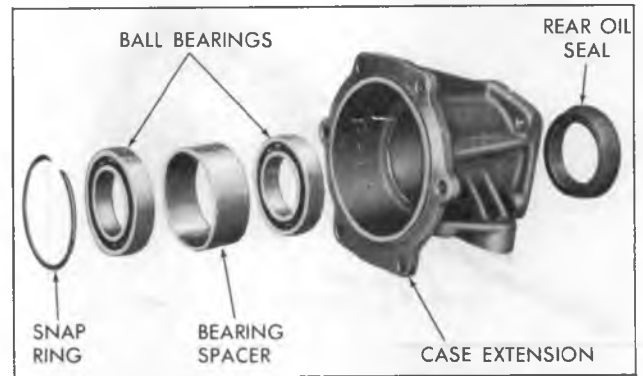


Figure 100—Case Extension Components

NOTE: If mainshaft is being replaced, and if the service mainshaft contains an orifice cup plug, remove the plug. This can be done using a  $\frac{1}{4}$ " diameter by 12" long rod.

### Front and Rear Bands

1. Inspect lining for cracks, flaking, burning, or looseness.
2. Inspect bands for cracks or distortion.
3. Inspect end for damage at anchor lugs or apply lugs.

### Case Extension (Refer to Fig. 100)

1. Inspect seal (case extension to case) groove for damage.
2. Inspect for cracks, or porosity.
3. Inspect dowel pin in rear face for damage.
4. Inspect oil seal for damage. If replacement is required, proceed as follows:
  - a. Pry oil seal from extension (fig. 19).
  - b. Apply non-hardening sealer to outside of new oil seal, and install oil seal into case extension using tool (J-24057) (see fig. 126).
5. Inspect ball bearing assemblies. If they are damaged, or if they require cleaning, proceed as follows:
  - a. Remove rear seal.
  - b. Remove snap ring.
  - c. Remove ball bearings and bearing spacer, using a brass rod on the outside race of bearing. An arbor press can be used if tool to press bearing out is located on outer race of bearing.

**CAUTION: DO NOT locate against inner race or balls.**

- d. Install ball bearing assembly and spacer, bearing first.
- e. Install ball bearing assembly and snap ring.
- f. Install new rear oil seal.

### Modulator and Valve

1. Inspect modulator assembly for any signs of bending or distortion (fig. 101).

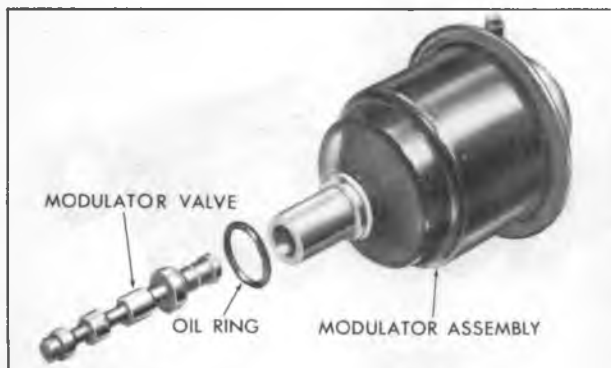


Figure 101—Modulator Assembly and Valve

2. Inspect O-ring seal seat for damage.
3. Apply suction to vacuum tube and check for diaphragm leaks.
4. Check modulator bellows (modulator plunger is under pressure - 16 lbs.). If bellows is damaged, plunger will have very little pressure.
5. Inspect modulator valve for nicks or damage.
6. Check freeness of valve operation in case bore.

Manual Shaft Components (Fig. 102)

1. Inspect manual shaft for damaged threads, rough oil seal surface or loose lever.
2. Inspect inside detent lever for cracks or a loose pin.
3. Inspect detent roller and spring assembly.

Case Assembly Inspection (Figs. 103 and 104)

**CAUTION:** If the case assembly requires replacement, make sure the center support-to-case spacer is removed from the old case and reinstalled in the new case.

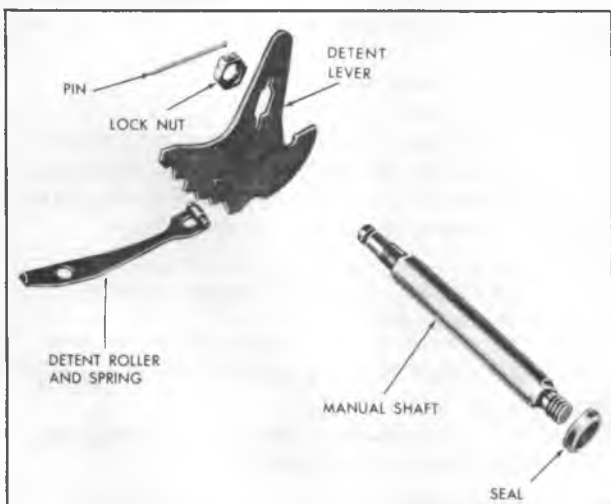


Figure 102—Manual Shaft Components

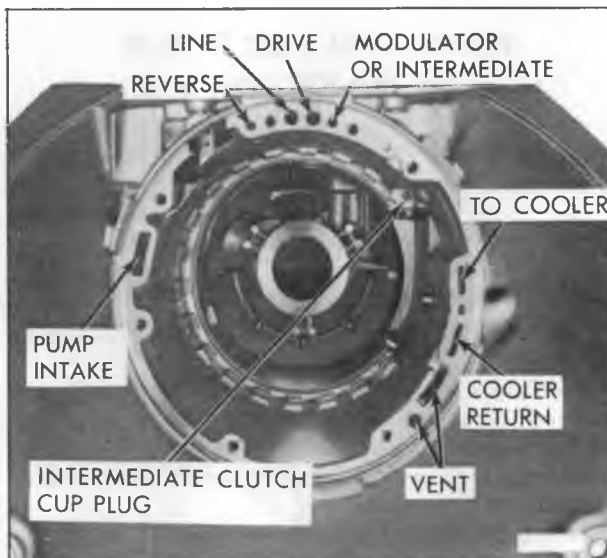


Figure 103—Case Passage Identification—Front View

1. Inspect case for cracks or broken lugs. Replace case if cracked or broken.
2. Inspect for internal porosity or cross channel leaks in valve body face passages. Inspect for porosity or defects in modulator valve bore, case intake bore, pump case face, etc. Replace case if internal porosity or damage is found.
3. Inspect for missing or loose intermediate clutch cup plug (fig. 103). If loose or missing, replace as directed later under "Case Assembly Repairs."
4. Inspect for damaged snap ring grooves; replace case if damaged.
5. Inspect case bushing for presence of oil lubrication grooves, severe scoring, or wear. If necessary, replace bushing as directed later under "Case Assembly Repairs."
6. Inspect all bolt holes for stripped threads. Damaged threads can be repaired, using Heli-coils, as directed later under "Case Assembly Repairs."
7. Inspect studs for thread damage, and make sure they are tight.

NOTE: The two (2) studs at 9 o'clock and 11 o'clock (when viewed from the rear of case and transmission in vehicle) are approximately 1/4" longer than the other four (4) studs. These two longer studs are required to accommodate the parking brake actuating cable bracket.

Case Assembly Repairs

Intermediate Clutch Cup Plug Installation

1. With transmission case in holding fixture, position with front end facing up.
2. Make sure intermediate clutch cup plug hole (fig. 103) is free of foreign material such as dirt, chips, etc.

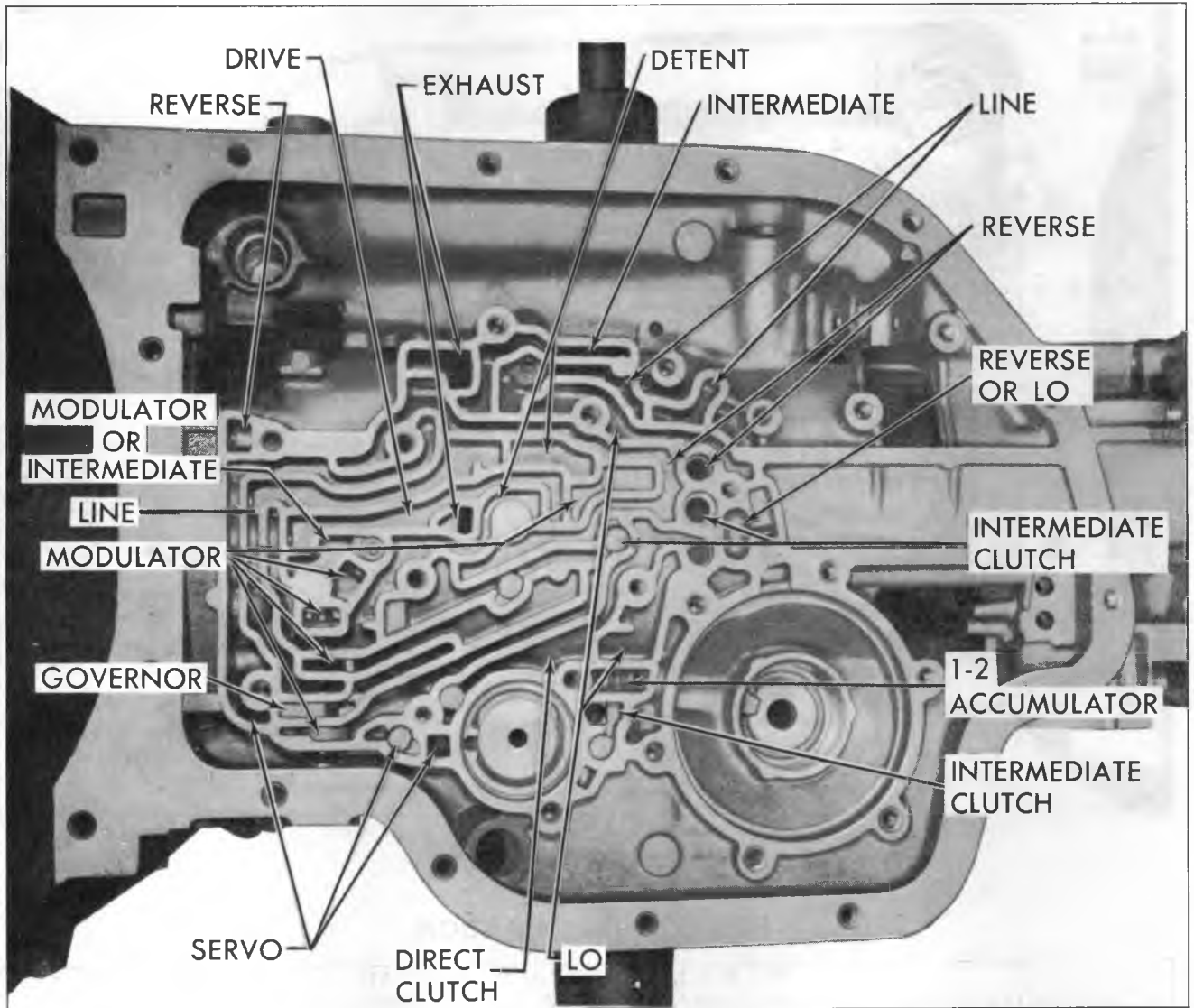


Figure 104—Inspect Transmission Case

3. Place intermediate clutch cup plug into hole, open end out.

4. Drive plug in until flush or slightly below top of hole, using a 3/8" diameter rod 10" long.

**CAUTION:** Make certain the rod used is large enough to locate on the lip edge of the plug (not in the bottom of the plug).

5. Stake plug securely in case.

Case Bushing Replacement

1. Remove. With case properly supported, remove bushing using tool (J-21465-8) with driver handle (J-8092).

2. Installation. Using installer tool (J-21465-8) adapter ring (J-21465-9), driver handle (J-8092),

and extension (J-21465-13), drive bushing into place, with lube passage facing front of case, until 0.040" to 0.050" above selective thrust washer face. Stake bushing in place with tool (J-21465-10). Stake marks must be in bushing lubrication grooves.

Bolt Hole Repairs (Heli-Coil)

1. Refer to figure 104A and tabulation which follows for bolt hole identification, drill size, tap size, and heli-coil size.

2. Shield the area around the hole to be heli-coiled to contain chips.

3. Drill old threads and debris from hole.

**CAUTION:** Drill only to the depth of the original hole.

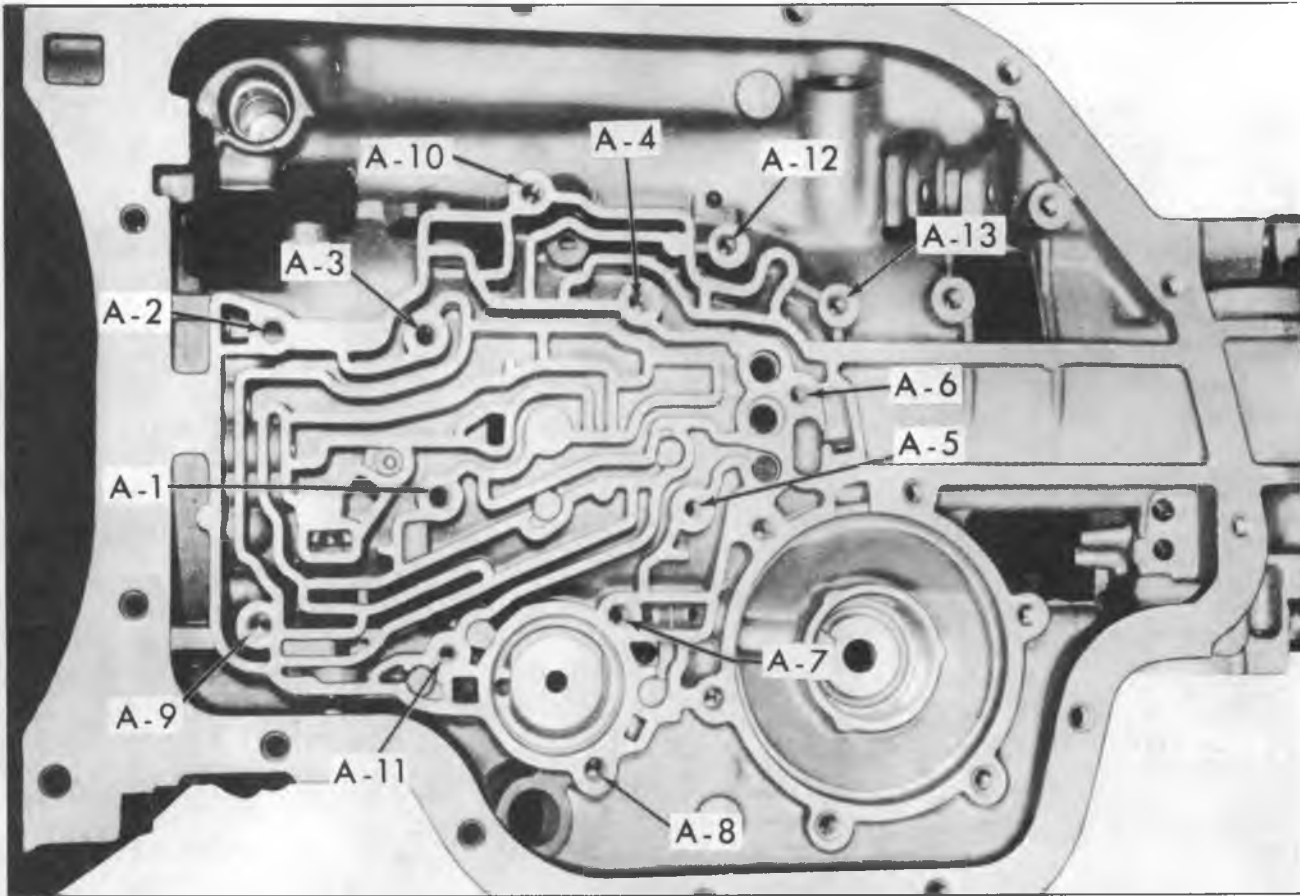


Figure 104A—Bolt Hole Identification

**HELI-COIL INFORMATION**

HOLE LOCATION	HOLE NO. (FIG. 104A)	DRILL SIZE	TAP SIZE	HELI-COIL SIZE
Pump to Case	All	21/64	5/16-18 UNC-2B	5/16-18 STI-NC
Valve Body to Case	A-1 thru A-4	21/64	5/16-18 UNC-2B	5/16-18 STI-NC
Valve Body to Case	A-5 and A-6	17/64	1/4-20 UNC-2B	1/4-20 STI-NC
Converter to Flex Plate	All	25/64	3/8-16 UNC-2B	3/8-16 STI-NC
Case Extension to Case	All	25/64	3/8-16 UNC-2B	3/8-16 STI-NC
Governor Cover to Case	All	21/64	5/16-18 UNC-2B	5/16-18 STI-NC
Modulator Retainer to Case	-	21/64	5/16-18 UNC-2B	5/16-18 STI-NC
Speedometer Driven Gear Assembly to Case	-	21/64	5/16-18 UNC-2B	5/16-18 STI-NC
Oil Pan to Case	All	21/64	5/16-18 UNC-2B	5/16-18 STI-NC
Rear Servo to Case	All	21/64	5/16-18 UNC-2B	5/16-18 STI-NC
Valve Body to Case	A-7 thru A-10	21/64	5/16-18 UNC-2B	5/16-18 STI-NC
Valve Body to Case	A-11	17/64	1/4-20 UNC-2B	1/4-20 STI-NC
Solenoid to Case	A-12 and A-13	17/64	1/4-20 UNC-2B	1/4-20 STI-NC

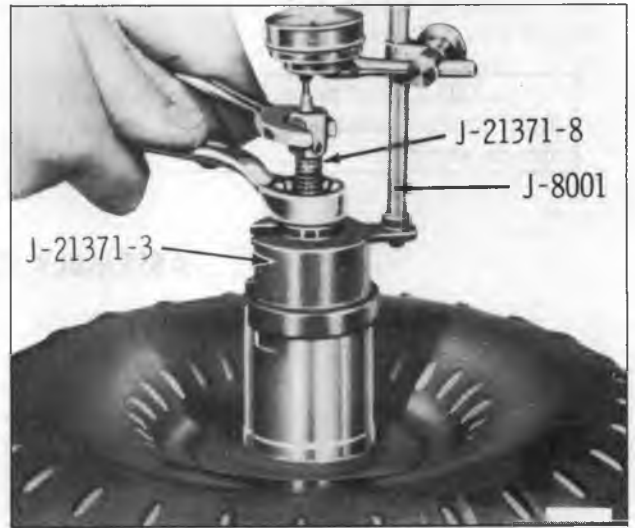
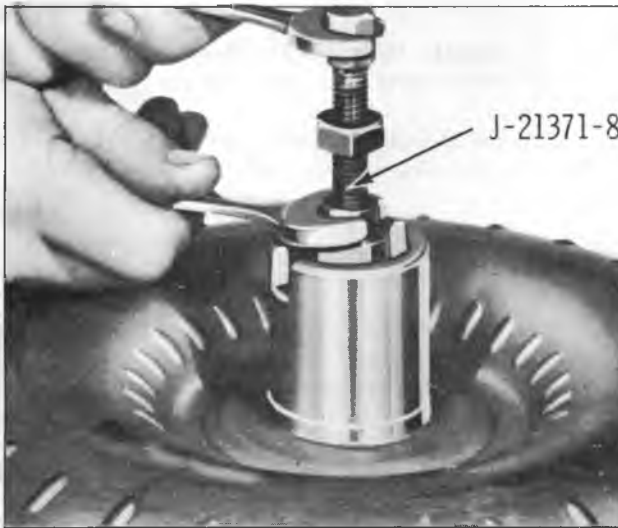


Figure 104B—Checking Converter End Play

4. Tap the hole with the heli-coil tap.
5. Install the standard insert (STI) heli-coil.
6. Remove the shields and make sure all chips are removed.

Converter Inspection

1. Inspect converter hub surfaces for signs of scoring or wear that can damage seal. Repair hub with crocus cloth, if practical, or replace.

2. Inspect converter for loss of balance weight or broken converter to crankshaft pilot. Replace converter if balance weight is off or if pilot is broken.

3. Inspect the converter internally for damage to the roller bearing, thrust races, and roller clutch.

a. The thrust roller bearing and thrust races can be checked by viewing them when looking into the opening to make sure they are not cracked, broken, or mispositioned.

b. The roller clutch function can be checked by placing a finger into the converter neck and, with side pressure against the spline, turning the stator race. The race should turn fairly free in a clockwise direction and should not turn in the counterclockwise direction.

4. Check converter for excessive end play as follows:

a. Fully release collet end of tool (J-21371-8).

b. Install collet end of tool (J-21371-8) into converter hub until it bottoms; then tighten its cap nut to 5 foot-pounds torque (fig. 104B)

c. Install tool (J-21371-3) and tighten hex nut to 3 foot-pounds torque (fig. 104B).

d. Install dial indicator (J-8001) and set it at zero, while its plunger rests on the cap nut of tool (J-21381-8) (fig. 104B).

e. Loosen hex nut while holding cap nut stationary. With the hex nut loosened and holding tool (J-21371-3) firmly against converter hub, the reading obtained on the dial indicator will be the converter end clearance. End clearance should be less than 0.050". If it is 0.050" or greater, the converter must be replaced.

5. If fluid in converter appears full of "aluminum paint," converter is damaged internally and must be replaced.

NOTE: Do not replace the converter if a failure in some other part of the transmission has resulted in the converter containing dark, discolored fluid. The full-flow filter is designed to remove all harmful residue from failures, other



Figure 105—Air Checking Converter



## 7-92 AUTOMATIC TRANSMISSION

than converter pump failures, before the oil is pumped into the converter.

**CAUTION:** If the cause of failure was fluid contaminated by anti-freeze, replace the converter.

6. Check the converter for leaks as follows:
  - a. Install tools (J-21369-2, -6) and tighten.
  - b. Fill converter with 80 psi air pressure (fig. 105).
  - c. Submerge in water and check for leaks. Replace if leakage is evident.

## ASSEMBLY OF TRANSMISSION

### REAR UNIT ASSEMBLY

(Refer to Figure 106)

1. Install rear internal gear on end of mainshaft.
2. Install internal gear retaining snap ring (fig. 107).
3. Install sun gear to internal gear thrust races and bearings against inner face of rear internal gear as follows, and retain with petrolatum:

- a. Place large race against internal gear with flange facing forward or up (fig. 108).
- b. Place thrust bearing against race.
- c. Place small race against bearing with inner flange facing into bearing or down.
4. Install output carrier over mainshaft so that pinions mesh with rear internal gear.
5. Place above portion of "build-up" through hole in bench so that mainshaft hangs downward.
6. Install rear internal gear to output shaft

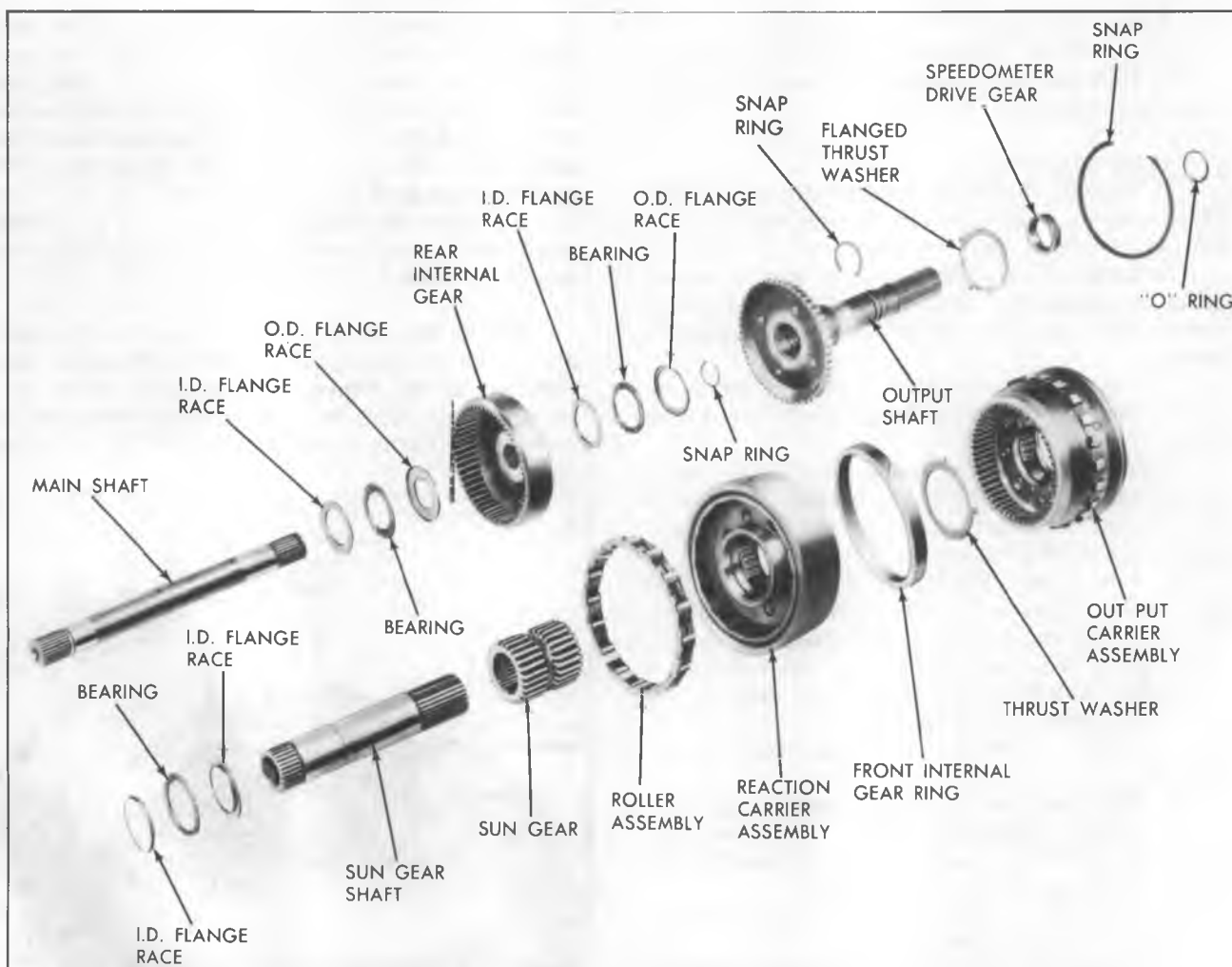


Figure 106—Rear Unit Assembly Components





Figure 107—Installing Rear Internal Gear Snap Ring

thrust races and bearings as follows and retain with petrolatum (fig. 109):

- a. Place small diameter race against internal gear with center flange facing up.
- b. Place bearing on race.
- c. Place second race on bearing with outer flange cupped over bearing.

7. Install output shaft into output carrier assembly (fig. 110).

8. Install output shaft to output carrier snap ring with beveled side facing up.

9. Install new O-ring in groove nearest propeller shaft end of output shaft.

10. Turn assembly over and support so that output shaft hangs downward.

11. Install reaction carrier to output carrier plastic thrust washer with tabs facing down in pockets.

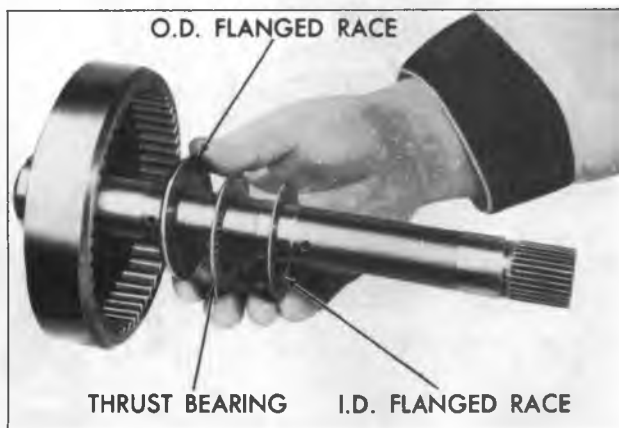


Figure 108—Installing Rear Internal Gears to Sun Gear Bearing and Races



Figure 109—Installing Rear Internal Gear to Output Shaft Bearing and Races

12. Install sun gear, splines with chamfer down
13. Install composition ring over output carrier (fig. 111).
14. Install sun gear shaft with long splined end down.
15. Install reaction carrier (fig. 112).

NOTE: When a new output carrier and/or reaction carrier is being installed and if the front internal gear ring prevents assembly of the carriers, replace the front internal gear ring with the service ring.



Figure 110—Installing Output Shaft

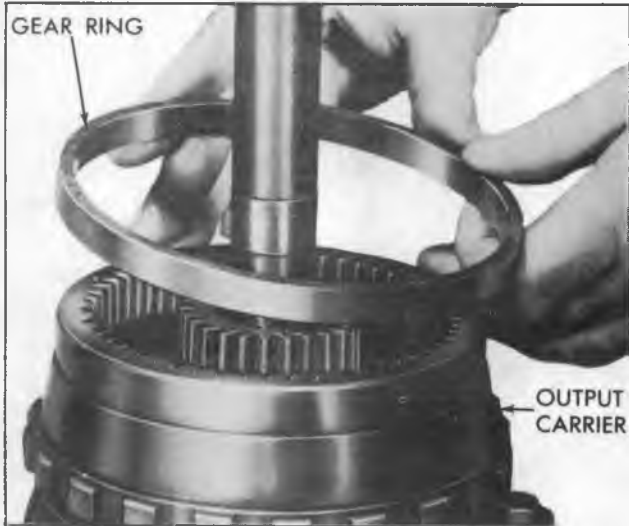


Figure 111—Installing Front Internal Gear Ring



Figure 114—Installing Rollers in Clutch Cage

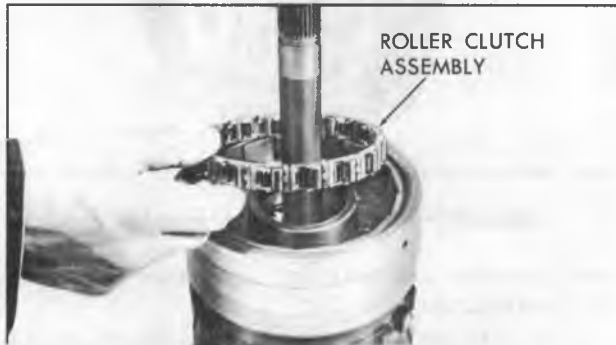


Figure 115—Installing Roller Clutch Assembly



Figure 112—Installing Reaction Carrier

16. Install center support to sun gear thrust races and bearings as follows:
  - a. Install large race, center flange up over sun gear shaft.
  - b. Install thrust bearing against race.
  - c. Install second race, center flange up (fig. 113).
17. Install rollers that may have come out of roller clutch cage, by compressing energizing spring with forefinger and inserting roller from

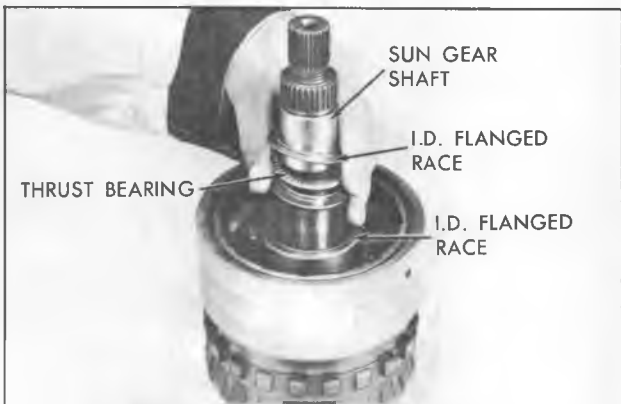


Figure 113—Installing Center Support to Sun Gear Thrust Bearing and Races



Figure 116—Installing Center Support to Reaction Carrier Thrust Washer



Figure 117—Installing Center Support into Reaction Carrier and Roller Clutch Assembly

outer side (fig. 114).

18. Install roller clutch assembly into reaction carrier outer race (fig. 115).

19. Install center support to reaction carrier thrust washer into recess in center support. Retain with petrolatum (fig. 116).

20. Install center support into reaction carrier and roller clutch assembly (fig. 117).

NOTE: With reaction carrier held, center support should only turn counterclockwise.

21. Install gear remover (J-21795) (fig. 32), on gear unit assembly to hold units in place.

22. Install output shaft to case thrust washer tabs in pockets (fig. 118).

### ASSEMBLY OF UNITS INTO TRANSMISSION CASE

1. Install rear band so that two lugs index with two anchor pins. Check to make sure band is seated on lugs (fig. 119).

2. Install the center support-to-case spacer against the shoulder at the bottom of case splines and with the gap located adjacent to the band anchor pin (fig. 120).



Figure 118—Installing Case to Output Shaft Thrust Washer



Figure 119—Installing Rear Band

CAUTION: DO NOT confuse this spacer (0.040" thick and both sides flat) with either the center support-to-case snap ring (one side is beveled) or the intermediate clutch backing plate-to-case snap ring (0.093" thick and both sides flat).

3. Install proper rear selective washer (proper washer determined by previous end play check) into slots provided inside rear of transmission case.

4. Install complete gear unit assembly into case, using tools J-21795, J-9539, and J-6585-2, making sure center support bolt hole is properly aligned with hole in case. Refer to figure 32.

5. Oil and install center support to case retaining snap ring with bevel side up (flat side against center support) and locating gap adjacent to band anchor pin. Make certain ring is properly seated in case (fig. 121).

6. Install case to center support bolt by placing the center support locating tool into the case direct clutch passage, with the handle of the tool



Figure 120—Positioning Center Support to Case Spacer



Figure 121—Installing Center Support to Case Snap Ring

pointing to the right as viewed from the front of the transmission and parallel to the bell housing mounting face. Apply pressure downward on the tool handle which will tend to rotate the center support counterclockwise as viewed from the front of the transmission. While holding the center support firmly counterclockwise against the case splines, torque the case to center support bolt to 20-25 foot-pounds using a 3/8" 12-point thin wall deep socket (fig. 122).

**CAUTION:** When using the locating tool, care should be taken not to raise burrs on the case valve body mounting face.

7. Install three (3) steel and three (3) composition intermediate clutch plates. Start with



Figure 122—Installing Case to Center Support Bolt



Figure 123—Checking Rear Unit End Play

waved steel, alternate plates. Refer to figure 30.  
8. Install intermediate clutch backing plate, ridge up.

9. Install backing plates to case snap ring, locating gap opposite band anchor pin.

NOTE: Both sides of this snap ring are flat, and it is 0.093" thick.

10. Check rear end play as follows:

a. Install a 3/8"-16 bolt (J-9539) into an extension housing attaching bolt hole (fig. 123).

b. Mount dial indicator (J-8001), on rod and index with end of output shaft.

c. Move output shaft in and out to read end play. End play should be from 0.007"-0.019". The selective washer controlling this end play is a steel washer having 3 lugs and is located between thrust washer and rear face of transmission case.

If a different washer thickness is required to bring end play within specifications, it can be selected from the following chart:

Thickness	IDENTIFICATION	
	Notches and/or Numeral	
.078-.082	None . . . . .	1
.086-.090	1 Tab Side . . . . .	2
.094-.098	2 Tabs Side . . . . .	3
.102-.106	1 Tab O.D. . . . .	4
.110-.114	2 Tabs O.D. . . . .	5
.118-.122	3 Tabs O.D. . . . .	6

11. Install front band with anchor hole placed over band anchor pin and apply lug facing servo hole. Refer to figure 27.

12. Install manual shaft components as follows:

a. If necessary, install a new manual shaft seal into transmission case using a 3/4" Dia. rod to seat seal.

b. Install manual shaft through case and detent lever.

**CAUTION:** Be sure manual shaft flats for detent lever are free of burrs before inserting through seal in case.

c. Install detent retaining hex lock nut on the manual shaft, and tighten to 15-18 foot-pounds torque. Refer to figure 26.

d. Install retaining pin indexing with groove in manual shaft. Rotate transmission to vertical position and remove gear remover (J-21795).

NOTE: If procedure is being performed with transmission in the vehicle, install bent pin, then straighten it.

13. Install direct clutch and intermediate sprag assembly. It will be necessary to twist housing to allow sprag outer race to index with composition-faced plates. Housing hub will bottom on sun gear shaft. Refer to figure 24.

NOTE: Removal of direct clutch steel and composition-faced plates may be helpful.

14. Install forward clutch hub to direct clutch housing thrust washer on forward clutch hub. Retain with petrolatum.

15. Install forward clutch assembly and turbine shaft, indexing direct clutch hub so end of mainshaft will bottom on end of forward clutch hub. When forward clutch is seated it will be approximately 1/4" from pump face in case. Refer to figure 23.

16. Install 2 guide pins into case for locating pump assembly.

17. Install front pump assembly.

18. Install all but one pump attaching bolt and seals. Torque to 16-20 foot-pounds.

NOTE: If turbine shaft cannot be rotated as pump is being pulled into place, forward or direct clutch housing has not been properly installed to index with all clutch plates. This condition must be corrected before pump is pulled fully into place.

19. If necessary, install a new front seal. Apply a non-hardening sealer on outside of seal body, then using tool (J-21359), drive seal in place (fig. 124).

20. Check front unit end play as follows (fig. 125).

- a. Install a 5/16"-18 threaded slide hammer or J-6585-2 and J-9539 into bolt hole in pump.
- b. Mount a dial indicator on rod and index indicator to register with end of turbine shaft.
- c. Push turbine shaft rearward.
- d. Push output shaft forward.
- e. Set dial indicator to zero.
- f. Pull turbine shaft forward.

Read resulting travel or end play which should be 0.003"-0.024". Selective washer controlling this

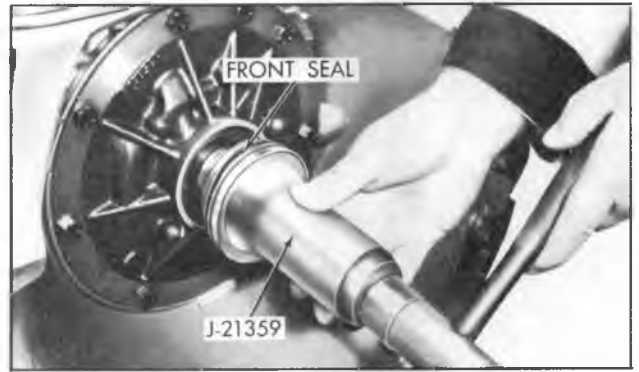


Figure 124—Installing Pump Seal

end play is located between pump cover and forward clutch housing. If more or less washer thickness is required to bring end play within specifications, select proper washer from the chart below:

Thickness (In Inches)	Color
.060 - .064	Yellow
.071 - .075	Blue
.082 - .086	Red
.093 - .097	Brown
.104 - .108	Green
.115 - .119	Black
.126 - .130	Purple

NOTE: An oil soaked washer may tend to discolor. It will be necessary to measure washer for its actual thickness.

21. Install remaining front pump attaching bolt and seal. Torque to 16-20 foot-pounds,

## REAR EXTENSION HOUSING INSTALLATION

1. Install extension housing to case seal on extension housing.

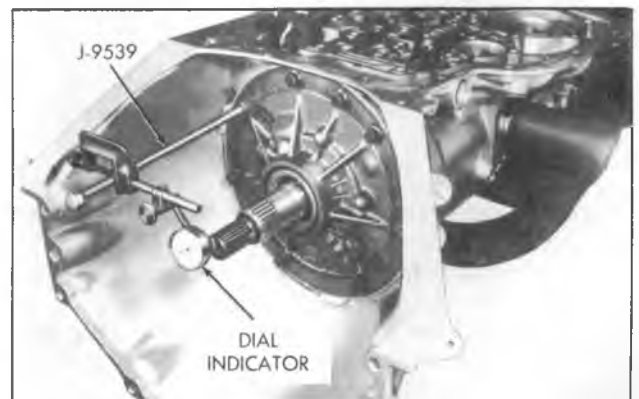


Figure 125—Checking Front Unit End Play





Figure 126—Installing Rear Extension Seal (Using Tool J24057)

2. Attach extension housing to case using attaching nuts and washers. Torque nuts to 12-16 foot-pounds.

3. If necessary, install new seal. Apply a non-hardening sealer to outside of seal body, then using tool (J-5154), drive seal into place (fig. 126).

### INSTALLATION OF CHECK BALLS, CONTROL VALVE SPACER PLATE AND GASKET, DETENT SOLENOID, FRONT SERVO ASSEMBLY, AND ELECTRICAL CONNECTOR

1. Install two control valve assembly attaching bolts with heads cut off as guide pins as shown in figure 136.

2. Install six check balls into ball seat pockets in transmission case (fig. 17).

NOTE: If transmission is in vehicle, install check balls into ball seat pockets on spacer plate (fig. 127).

3. Install control valve spacer plate-to-case gasket (gasket with extension for detent solenoid (fig. 128)).

4. Install control valve spacer plate.

5. Install detent solenoid gasket.

6. Install detent solenoid assembly with connector facing outer edge of case (fig. 15). Do not tighten bolts at this time.

7. Install front servo spring and spring retainer into transmission case.

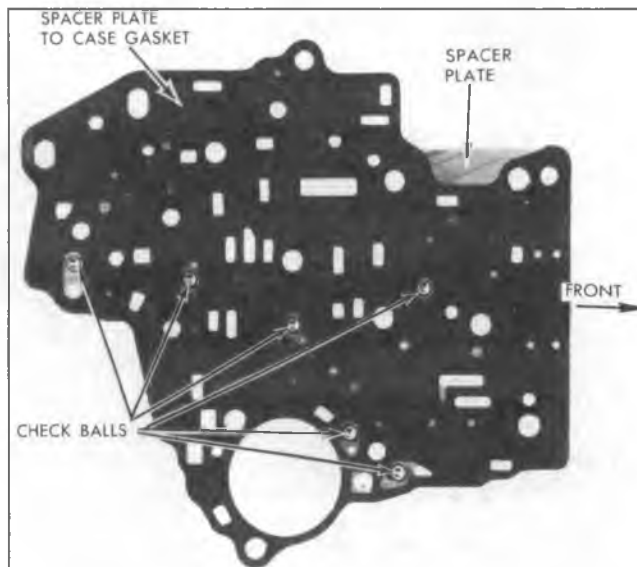


Figure 127—Location of Check Balls in Spacer Plate

8. Install retainer ring in front servo pin groove and install pin into case so that tapered end contacts band. Make certain retainer ring is installed in servo pin groove (fig. 18).

9. Install seal ring on servo piston, if removed, and install on servo pin with flat side of piston positioned toward bottom pan when installed.

NOTE: The teflon ring allows the front servo piston to slide very freely in the case. The free fit of the ring in the bore is a normal characteristic and does not indicate leakage during operation. The teflon ring should only be replaced if it shows damage or if evidence of leakage during operation exists.

NOTE: If transmission is in vehicle, assemble front servo group as shown in figure 129, and install this group of parts into front servo bore in

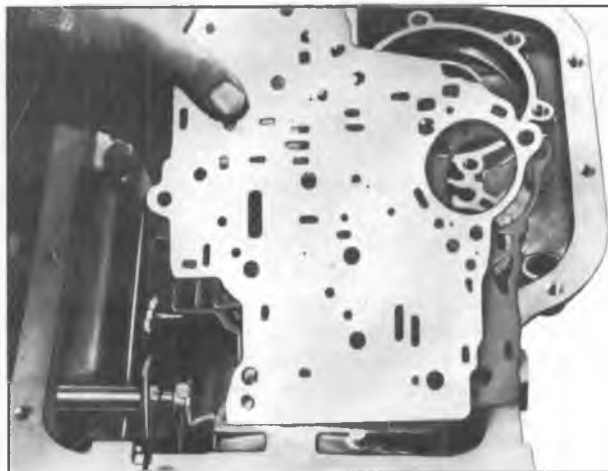


Figure 128—Installing Control Valve Spacer Plate and Gasket



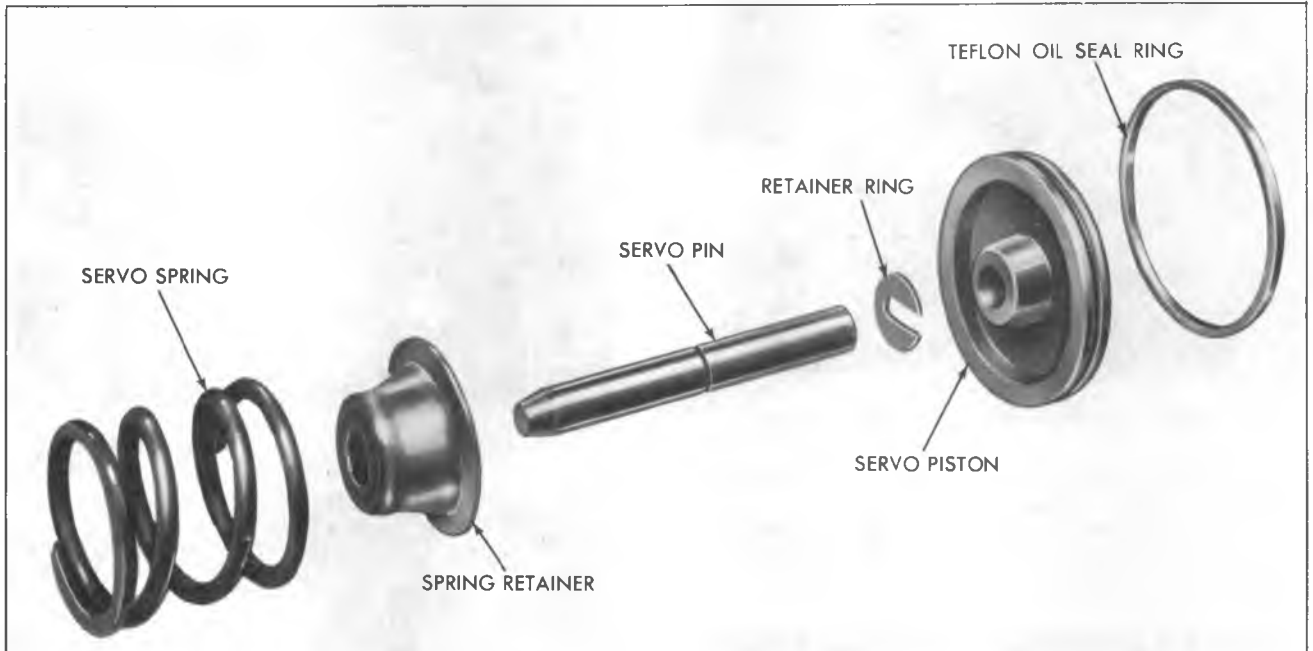


Figure 129—Front Servo Components

case and hold. Slip a length of straight, clean feeler gauge or shim stock (about 0.20") between spacer plate and front servo piston to temporarily retain front servo group (fig. 130).

10. Install O-ring seal on solenoid connector.

11. Lubricate and install case connector with lock tabs facing into case, positioning locator tabs in notch on side of case. Refer to figure 16.

12. Install detent solenoid connector into electrical connector.

### REAR SERVO INSTALLATION

NOTE: Before installing rear servo, check band apply pin using gauge tools (J-21370-6 and 9) as follows (fig. 131):

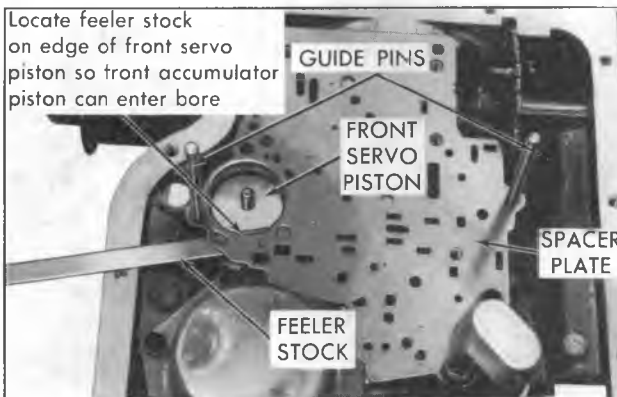


Figure 130—Use of Feeler Stock to Retain Front Servo Group

1. Attach band apply pin selection gauge (J-21370-6 and 9) to transmission case (lever pivot pin to rear) with rear servo cover attaching screws.

NOTE: Attach tool attaching screws finger tight and check freeness of selective pin. Torque attaching screws to 15 foot-pounds and recheck pin to make certain it does not bind.

2. Apply 25 foot-pounds torque to the lever on tool (J-21370-6) (fig. 131). Selection of the proper rear band apply pin is determined by the relation of the flat on tool (J-21370-9) to the flat machined area around the hole on tool (J-21370-6) as previously described under "Removal of Rear Servo, Valve Body Spacer, Gasket, and Front Servo." Selecting the proper pin is equivalent to adjusting band.

3. Install rear accumulator spring into case (fig. 132).

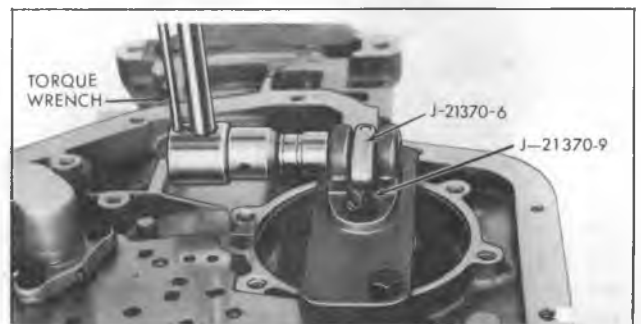


Figure 131—Checking Rear Band Pin



Figure 132—Installing Rear Accumulator Spring

4. Lubricate and install rear servo assembly into case. Refer to figure 13.
5. Install rear servo gasket and cover (fig. 133).
6. Install attaching screws. Torque bolts to 16-20 foot-pounds.

### INSTALLATION OF CONTROL VALVE, GOVERNOR PIPES, AND GOVERNOR SCREEN ASSEMBLY

1. Install control valve to spacer gasket (fig. 134).
2. Install governor pipes on control valve assembly. Governor pipes are interchangeable.
3. Install governor screen assembly, open end first, into governor feed pipe hole in case (hole nearest the center of transmission) (fig. 135).

**NOTE:** If transmission is in vehicle, before installing the control valve assembly and governor pipes as outlined in Step 4 below, insert governor screen, closed end first, into governor feed pipe. (This pipe locates in the governor feed pipe hole in case nearest the center of the transmission). Refer to figure 135.



Figure 133—Installing Rear Servo Cover and Gasket

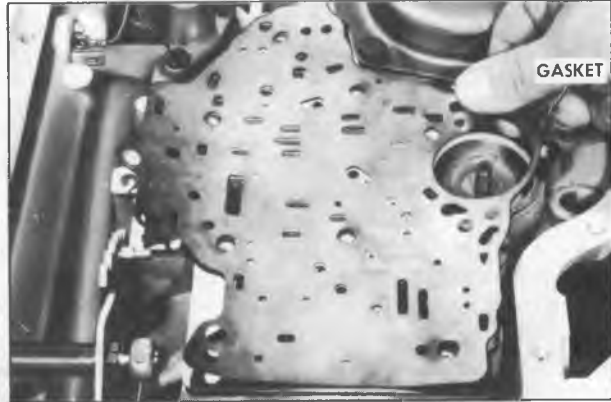


Figure 134—Installing Control Valve Gasket

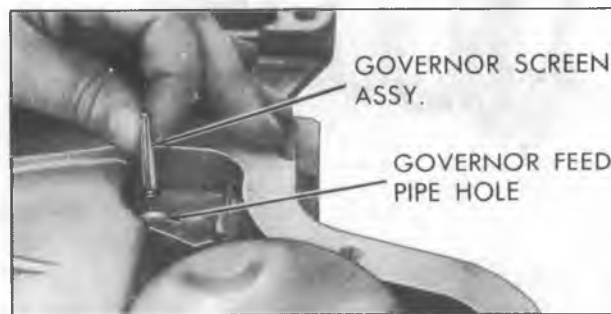


Figure 135—Installing Governor Screen Assembly

4. Install control valve assembly and governor pipes on transmission, while carefully aligning the governor feed pipe over the governor screen (fig. 136). Make certain gasket and spacer do not become mispositioned.

**NOTE:** Check the manual valve to make sure it is indexed properly with pin on detent lever and

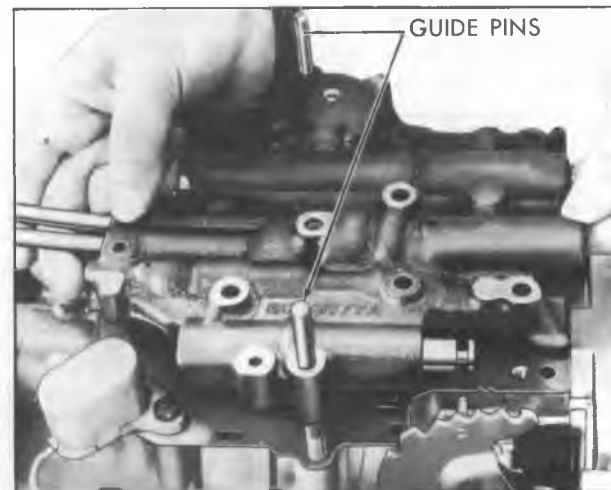


Figure 136—Installing Control Valve and Governor Pipes



Figure 137—Installing Governor Assembly

governor pipes to make certain they are properly seated in case holes.

5. Start control valve assembly attaching bolts.

NOTE: If transmission is in vehicle, remove feeler stock before tightening any control valve bolts

6. Remove guide pins and install detent roller and spring assembly and remaining bolts (fig. 9). Torque bolts to 8 foot-pounds.

### FILTER AND INTAKE PIPE

1. Install new case to intake pipe O-ring seal on intake pipe and assemble pipe into filter assembly.
2. Install filter and intake pipe into case.

NOTE: After any major repair, the filter must be replaced.

3. Install filter retainer bolt.
4. Install new oil pan gasket on oil pan and attach pan to case with attaching screws. Torque to 11-13 foot-pounds.



Figure 138—Installing Speedometer Driven Gear

### MODULATOR VALVE AND VACUUM MODULATOR

1. Install modulator valve into case, stem end out. Refer to figure 4.
2. Install new O-ring seal on vacuum modulator.
3. Install vacuum modulator into case.
4. Install modulator retainer and attaching bolt. Torque bolt to 16-20 foot-pounds.

### GOVERNOR

1. Install governor into case (fig. 137).
2. Attach governor cover and gasket with four (4) attaching bolts. Torque bolts to 16-20 foot-pounds.

### SPEEDOMETER DRIVEN GEAR ASSEMBLY

1. Install speedometer driven gear (fig. 138).
2. Install speedometer driven gear retainer and attaching bolt. Torque bolt to 6-8 foot-pounds.

## SPECIAL TOOLS

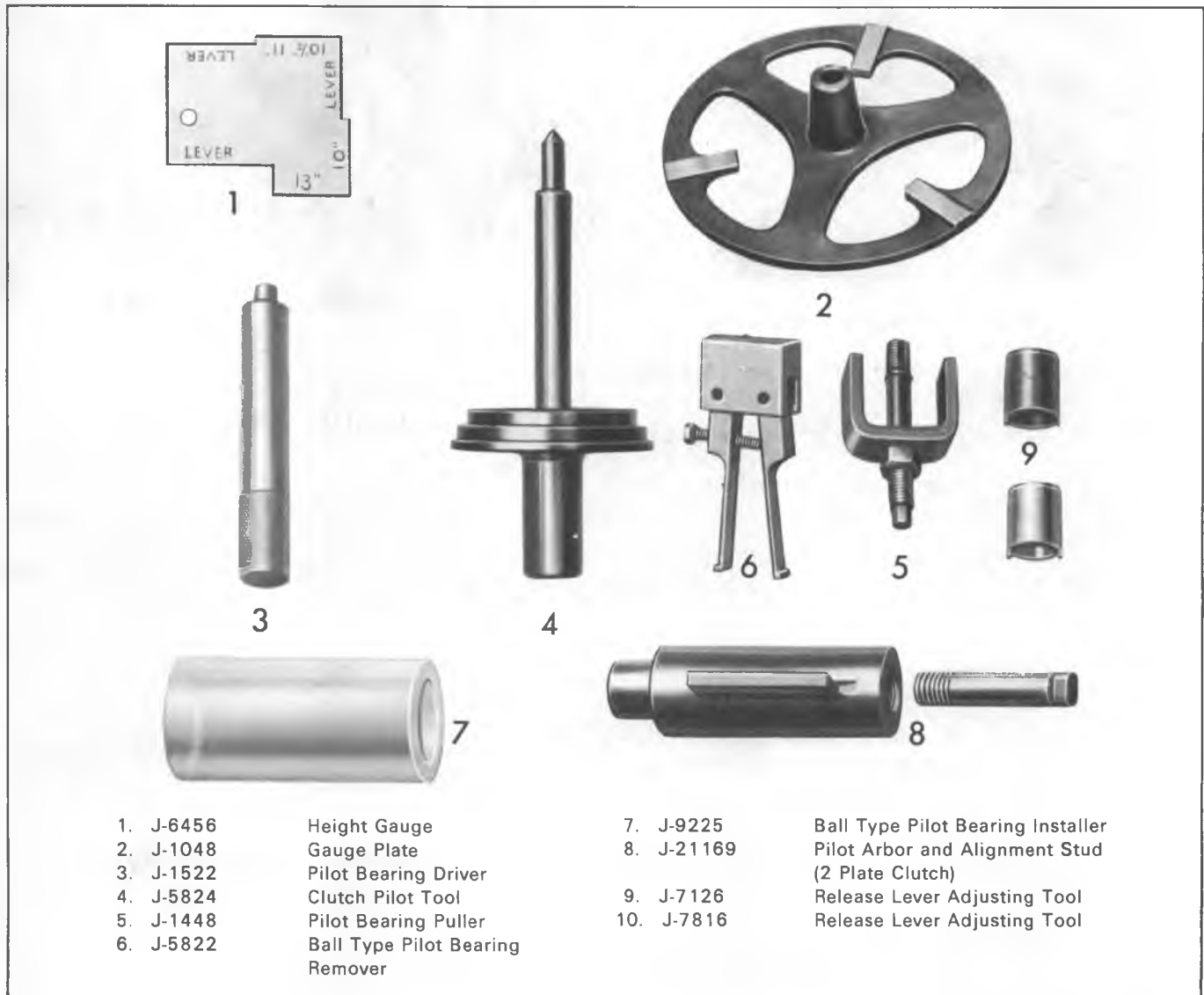
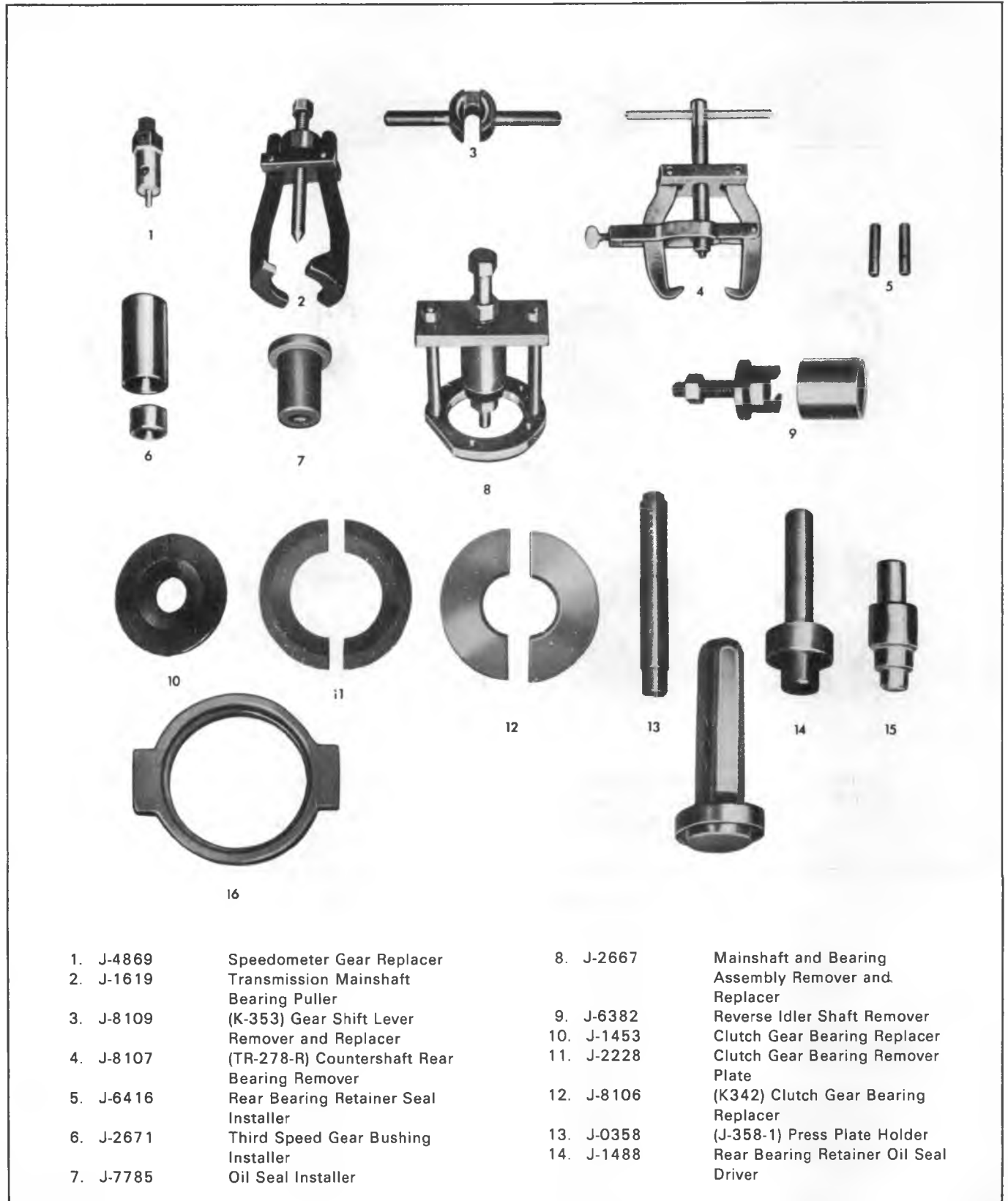


Fig. 1ST-Clutch Special Tools



- |           |   |            |   |
|-----------|---|------------|---|
| 1. J-4869 | Speedometer Gear Replacer                     | 8. J-2667  | Mainshaft and Bearing Assembly Remover and Replacer |
| 2. J-1619 | Transmission Mainshaft Bearing Puller         | 9. J-6382  | Reverse Idler Shaft Remover                         |
| 3. J-8109 | (K-353) Gear Shift Lever Remover and Replacer | 10. J-1453 | Clutch Gear Bearing Replacer                        |
| 4. J-8107 | (TR-278-R) Countershaft Rear Bearing Remover  | 11. J-2228 | Clutch Gear Bearing Remover Plate                   |
| 5. J-6416 | Rear Bearing Retainer Seal Installer          | 12. J-8106 | (K342) Clutch Gear Bearing Replacer                 |
| 6. J-2671 | Third Speed Gear Bushing Installer            | 13. J-0358 | (J-358-1) Press Plate Holder                        |
| 7. J-7785 | Oil Seal Installer                            | 14. J-1488 | Rear Bearing Retainer Oil Seal Driver               |

Fig. 2ST--New Process Transmission

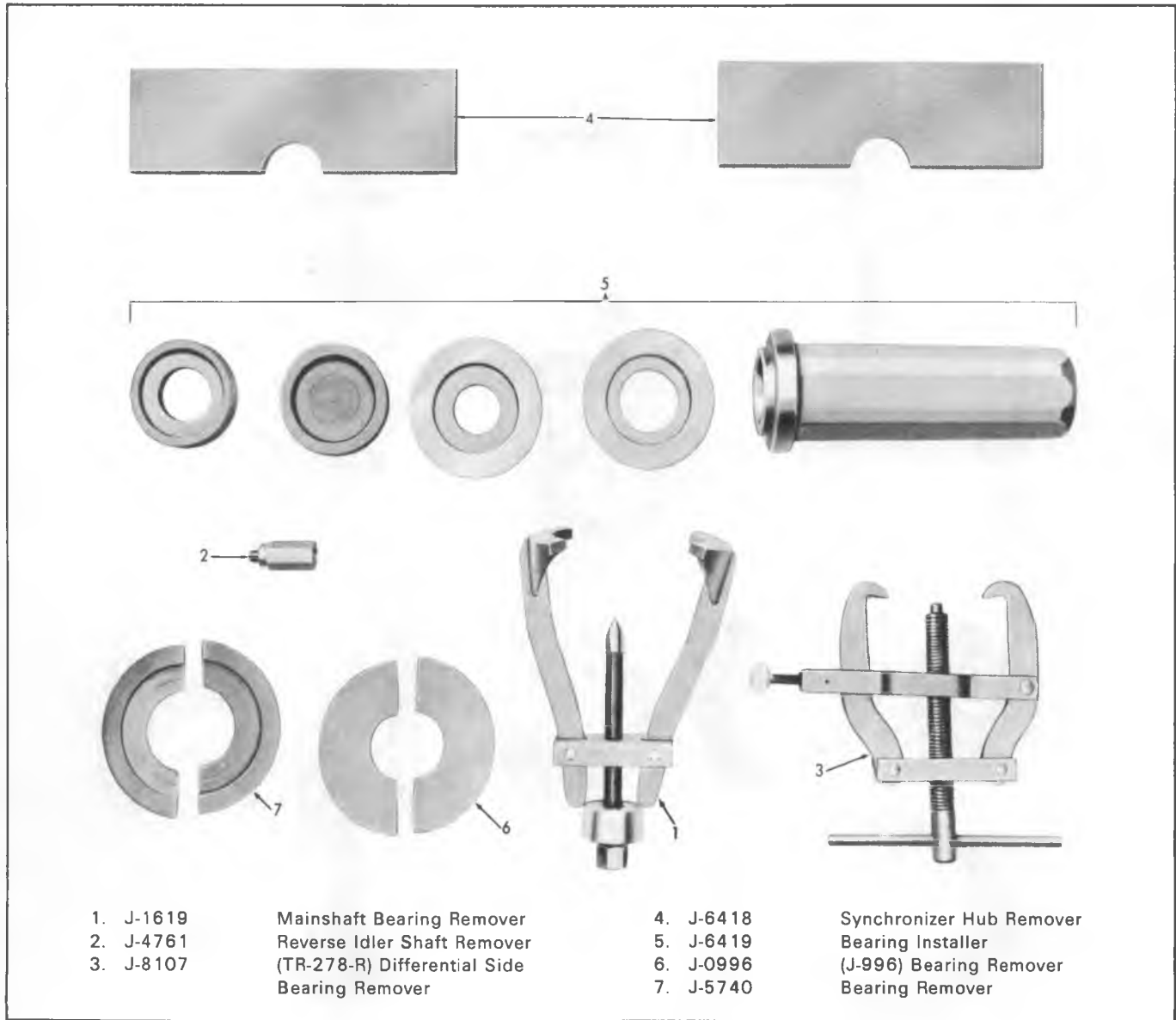


Fig. 3ST-Spicer Transmission Special Tools



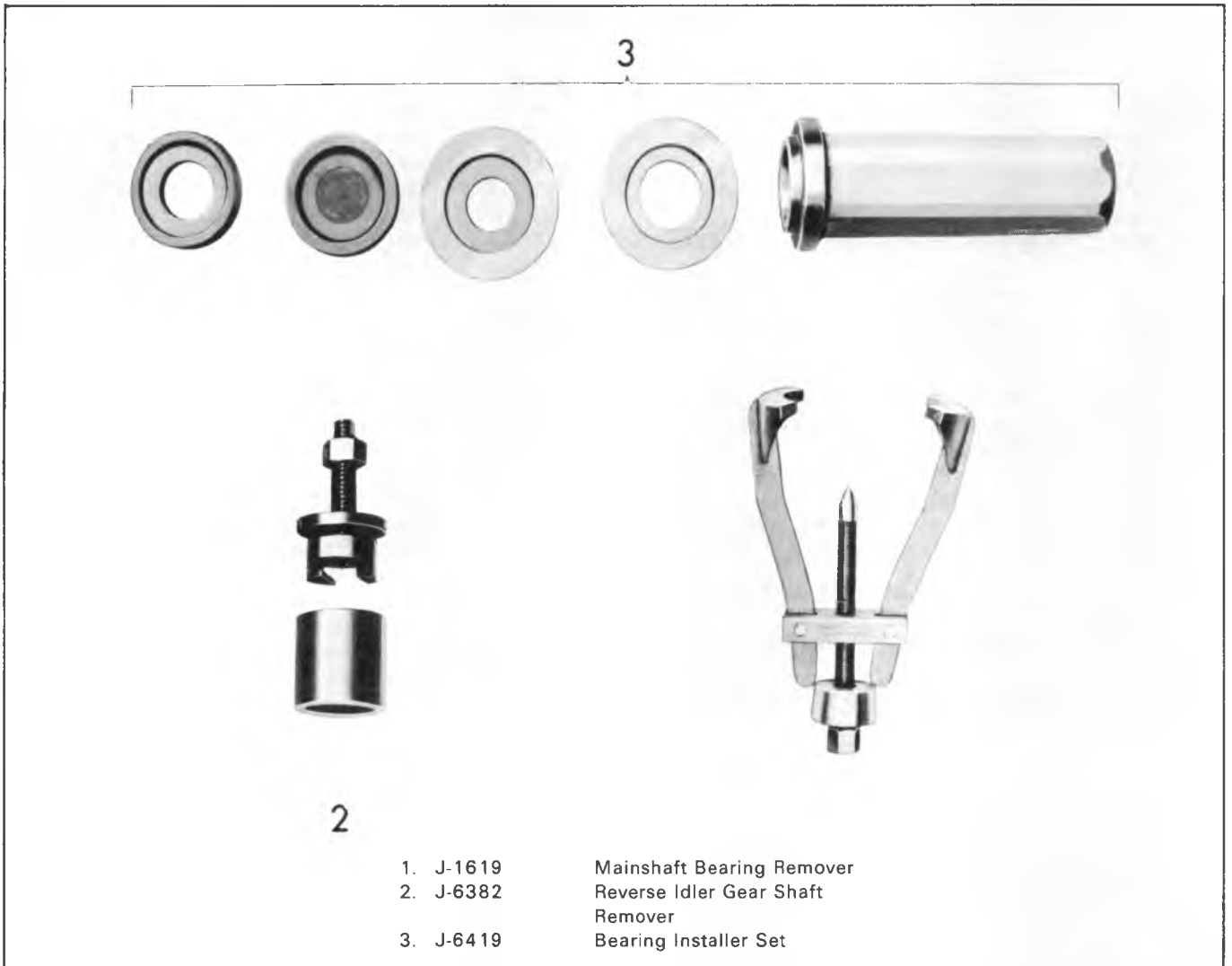


Fig. 4ST-Clark Transmission Special Tools

## SPECIAL TOOLS

<u>Tool No.</u>	<u>Tool Name</u>	<u>Tool No.</u>	<u>Tool Name</u>
J-2619	Slide Hammer	J-21409	Outer Seal Protector
J-3289-20	Holding Fixture Base	J-21427-01	Speedometer Gear Removing Tool
J-4670-01	Clutch Spring Compressor	J-21465-1	Output Shaft Bushing Installer
J-24057	Rear Extension Seal Installer	J-21465-2	Rear Bushing Installer (Stator Shaft)
J-5403	Snap Ring Pliers	J-21465-3	Front Bushing Installer (Stator Shaft)
J-5590	Speedometer Drive Gear Installer	J-21465-5	Sun Gear Shaft Bushings Installer
J-6116-01	Gear Unit Holding Fixture	J-21465-6	Center Case Bushing Remover and Installer
J-6129	Clutch Spring Compressor Adapter	J-21465-8	
J-6585-2	Slide Hammer	J-21465-9	Case Bushing Remover and Installer
J-8001	Dial Indicator	J-21465-13	
J-8092	Bushing Installer Handle	J-21465-10	Bushing Staking Tool
J-8763-01	Transmission Holding Fixture	J-21465-15	Stator Shaft and Sun Gear Shaft Bushings Remover
J-9539	Slide Hammer Adapter (Bolt)	J-21465-16	Output Shaft Bushing Remover
J-21359	Front Seal Installer	J-21465-17	Bushing Remover and Installer
J-21362	Center Seal Protector	J-21664	Clutch Spring Compressor Retainer
J-21363	Inner Seal Protector	J-21795	Gear Remover
J-21364	Gear Unit Holding Fixture Adapter	J-21885	Accumulator Piston Remover and Installer
J-21368	Oil Pump Aligning Strap	J-22182	Case Extension Bushing Remover and Installer
J-21369-2	Converter Air Checking Tool	J-22619	Speedometer Drive Gear Remover
J-21369-6			
J-21370-6	Band Apply Pin Selection Gauge		
J-21370-9			
J-21371-3	Converter End Play Checking Fixture		
J-21371-8			

# SECTION 9 STEERING

## CONTENTS OF THIS SECTION

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## STEERING GEAR

### INDEX

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Three general types of steering gears are used in the heavy duty (40-60 Series) trucks. These gears differ in that either one or two housing bushings or roller bearings are used to support the pitman shaft; however, the basic overhaul procedures remain the same.

### Disassembly (Figs. 1, 2, and 3)

As with any ball bearing unit the steering gear parts must be kept free of dirt. Clean paper or rags should be spread on the work bench before starting disassembly of the steering gear.

1. Place the steering gear in a vise, clamping onto one of the mounting tabs. The wormshaft should be in a horizontal position.
2. Loosen the locknut on the end of the pitman shaft and turn the lash adjuster a few turns counter-clockwise. This will remove the load from the worm bearings caused by the close meshing of the rack and sector teeth.
3. **Tilt Cab Models Only-** Loosen the back-up adjuster locknut and then remove the back-up adjuster and locknut.
4. **Except Tilt Cab Models with 9000 lb. Axle-** Loosen the locknut on the adjuster plug and turn the adjuster plug counter-clockwise a few turns.
5. Place a pan under the assembly to catch the lubricant

and remove the three bolts attaching the side cover to the housing.

6. Tap lightly on the end of the pitman shaft with a plastic hammer and lift the side cover and pitman shaft assembly from the gear housing (fig. 4).

**NOTE:** If the sector does not clear the opening in the housing easily, turn the wormshaft by hand until the sector will pass through the opening in the housing.

7. **Except Tilt Cab Models with 9000 lb. Axle-**
  - a. Remove the adjuster plug and locknut assembly. Then draw the wormshaft and ball nut assembly from the housing.

**CAUTION:** Use care that the ball nut does not run down to either end of the worm. Damage will be done to the ends of the ball guides if the nut is allowed to rotate until stopped at the end of the worm.

- b. Remove the upper bearing from the wormshaft and the lower bearing from the housing.
- c. Remove the locknut from the lash adjuster screw in the side cover. Remove the lash adjuster screw from the side cover by turning the screw clockwise. Slide the adjuster screw and shim out of the slot in the end of the pitman shaft.

9-2 STEERING GEAR AND POWER CYLINDER

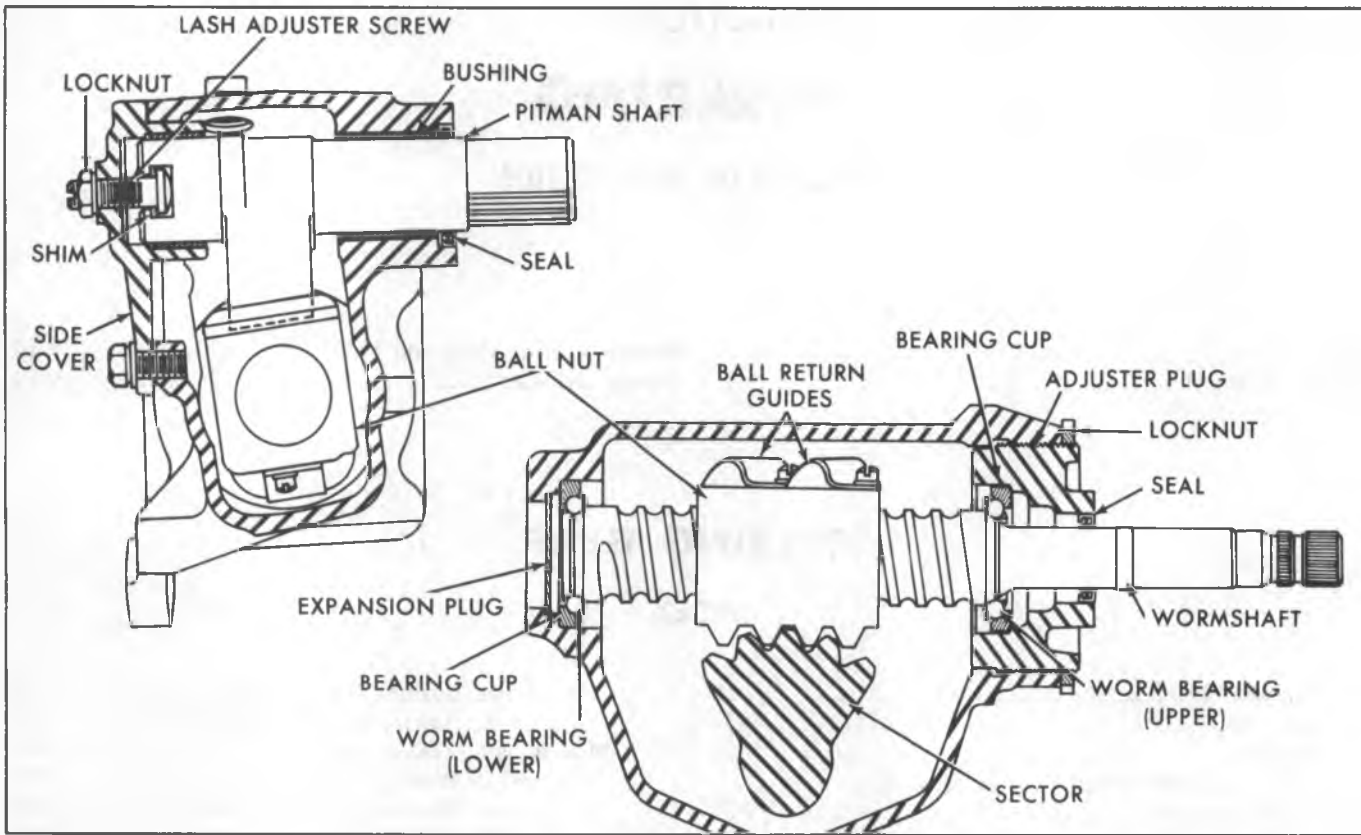


Fig. 1—Steering Gear—Typical of All Except Tilt Cab Models

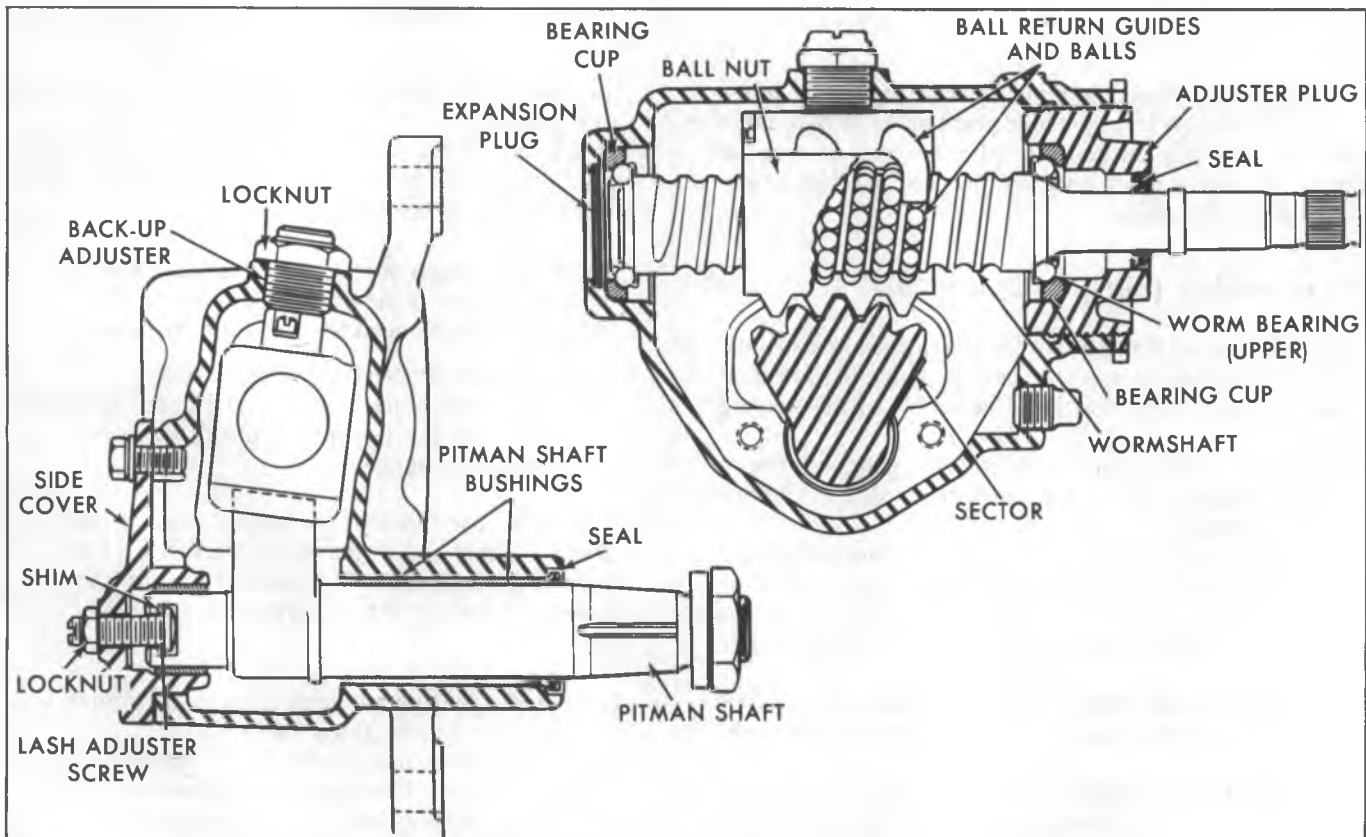


Fig. 2—Steering Gear—TA 50-60 Models with 7000 Lb. Axle

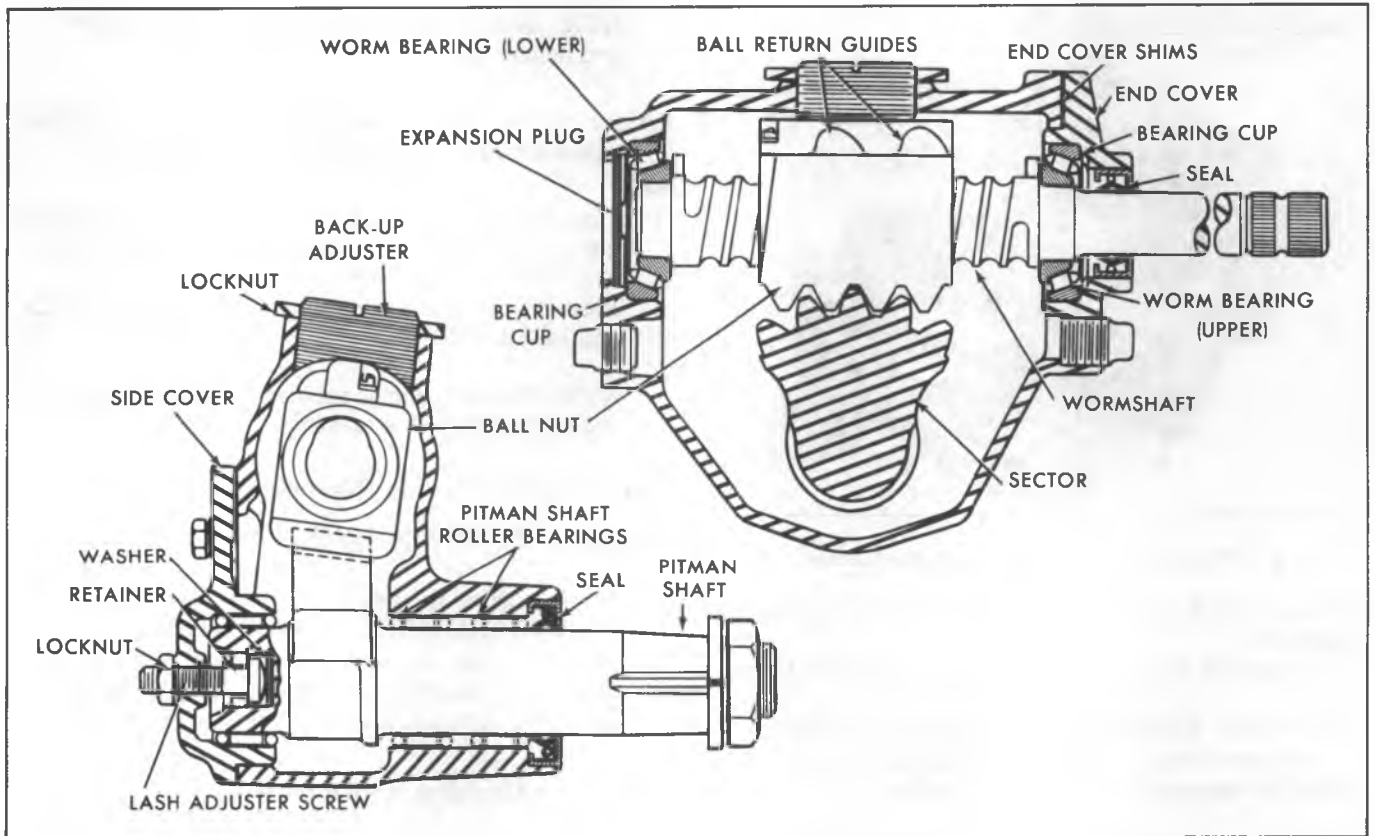


Fig. 3—Steering Gear—TE 60 Models with 9000 Lb. Axle

**8. Tilt Cab Models with 9000 lb. Axle-**

- a. Remove the end cover bolts and remove the end cover assembly. Then draw the wormshaft and ball nut from the housing.

**CAUTION:** Use care that the ball nut does not run down to either end of the worm. Damage will be done to the ends of the ball guides if the nut is allowed to rotate until stopped at the end of the worm.

- 9. Pry out and discard both the pitman shaft and wormshaft seals.

**Inspection**

With the steering gear completely disassembled, wash all parts in cleaning solvent. Dry them thoroughly with air. With a magnifying glass inspect the bearings and bearing cups for signs of indentation. Also check for any signs of chipping or breakdown of the surface. Any parts that show signs of damage should be replaced.

Inspect all seals. Any seal that is worn or has been removed should be replaced.

Inspect the pitman shaft for wear.

Check steering gear wormshaft assembly for being bent or damaged in any way. Never attempt to salvage steering parts by welding or straightening.

On all except Tilt models with 9000 lb. axle, check fit of the pitman shaft in the housing and side cover bushings. The housing bushings can be replaced; however, if the side cover

bushing indicates need for replacement, the entire side cover assembly must be installed new.

**Repairs**

**Pitman Shaft and/or Wormshaft Seal**

**Replacement**

The pitman shaft and wormshaft seals should be replaced

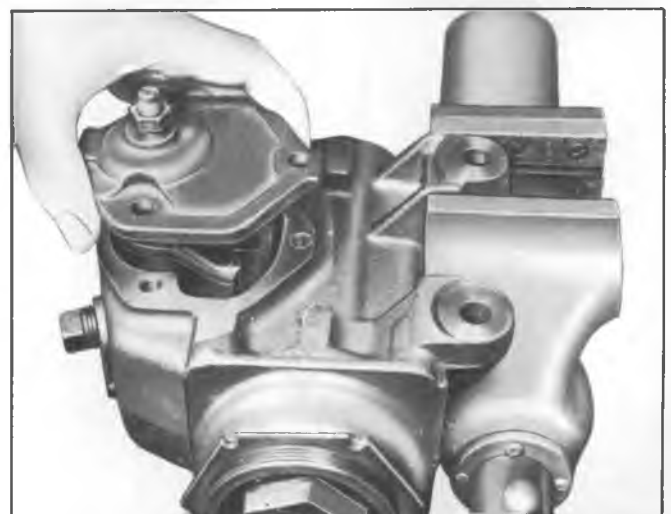


Fig. 4—Removing Pitman Shaft Assembly—Typical

## 9-4 STEERING GEAR AND POWER CYLINDER

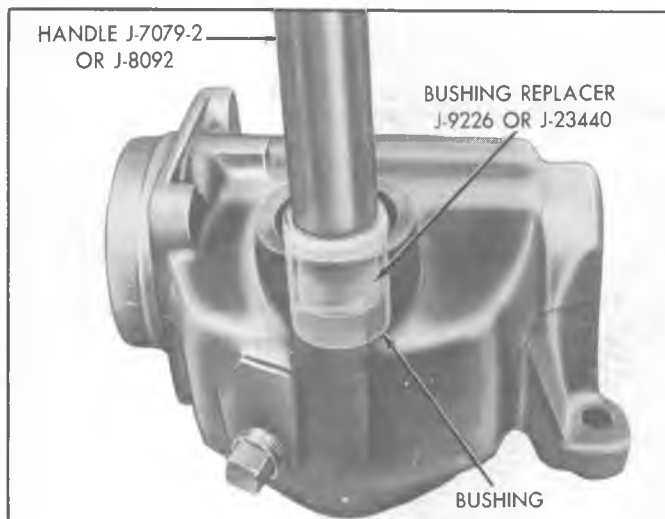


Fig. 5--Replacing Pitman Shaft Bushing--Typical

each time a defective seal is indicated or the steering gear is disassembled.

1. Pry out the old seal using a suitable size screw driver.

**CAUTION:** Before installing a new seal, check the condition of the pitman shaft bushing(s) or bearings and/or the upper wormshaft bearing cup.

2. A suitable size socket, pressing on the outer diameter of the seal, may be used to install a new seal.

### Pitman Shaft Bushing Replacement

*PA 40, CA 40-50 (Exc. 02) with 5000 lb. Axle and TA 50-60 Models with 7000 lb. Axle*

1. Support the steering gear in an arbor press and press the pitman shaft bushing(s) from the housing using Tool J-23440 with Handle J-8092 as shown in Figure 5.
2. Press the new bushings into the housing using Tool J-23440 and Handle J-8092. Note bushing location as shown in Figures 1 and 2.

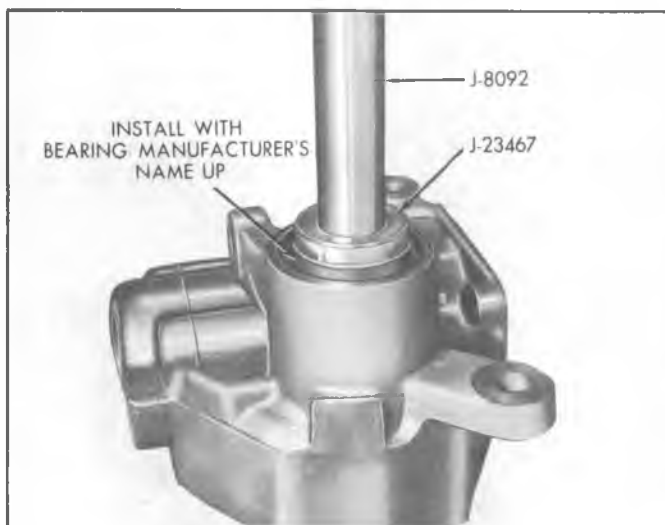


Fig. 6--Replacing Needle Bearing in Housing

**NOTE:** Service bushings are diamond bored to size and require no further reaming.

*All Except PA 40, CA 40-50 (Exc. 02) with 5000 lb. Axle and TA 50-60 Models with 7000 lb. Axle*

### Axle

1. Support the steering gear in an arbor press and press the pitman shaft bushing from the housing using Tool J-9226 and Handle J-7079-2 (fig. 5).
2. Press the new bushing into position using Tool J-9226 and Handle J-7079-2.

**NOTE:** Service bushings are diamond bored to size and require no further reaming.

### Pitman Shaft Bearing Replacement (TE 60

*Models with 9000 lb. Axle)*

1. Press or drive the needle bearings from the housing using Tool J-23467 and Handle J-8092 (fig. 6).
2. Install the new bearings into either end of the housing using Tool J-23467 and Handle J-8092. Press only against the stamped identification side of the bearing.

### Side Cover Bushing Replacement

The entire side cover assembly, including bushing, is serviced as a unit and should be replaced when it is desired to replace the bushing.

### Side Cover Bearing Replacement (TE 60 Models with 9000 lb. Axle)

1. Pull the needle bearing from the side cover using Puller Tool J-5829 and Slide Hammer J-2619 (fig. 7).
2. Press or drive the new needle bearing into the side cover using Tool J-23467 and Handle J-8092. Press only against the stamped identification side of the bearing.

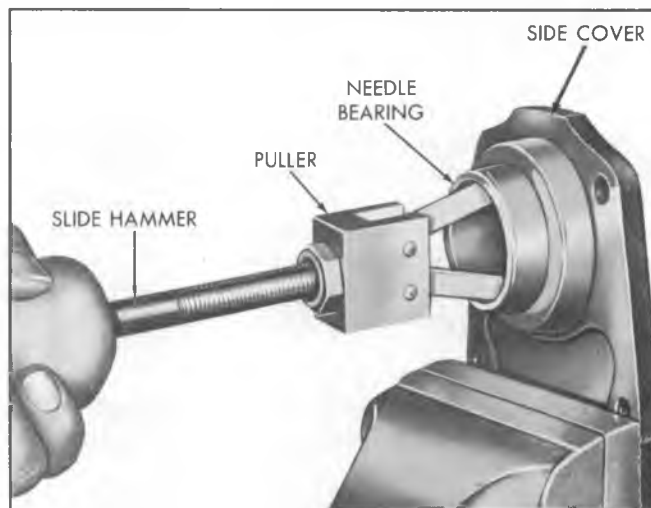


Fig. 7--Removing Side Cover Needle Bearing



**Wormshaft Bearing Replacement**

**All Except TE 60 Models with 9000 lb. Axle**

The wormshaft upper bearing is removed with the wormshaft and the lower bearing is loose in the housing. All that is required is to lift the bearing off the end of the wormshaft and retrieve the other bearing from inside the housing.

**TE 60 Models with 9000 lb. Axle**

1. Position the ball nut at the center of the worm and tape it in position.
2. Place the assembly in an arbor press and press the bearing cones from either end of the wormshaft.
3. If the ball nut pin stops are damaged, they should be replaced.
4. Press the new bearing cones onto the wormshaft.

**NOTE:** If the ball nut indicates need of replacement, it should be done while the bearings are removed from the wormshaft.

**Wormshaft Bearing Cup Replacement**

**Lower Bearing Cup**

1. Place steering gear housing in an arbor press and then using a suitable size socket, press the sheet metal expansion plug and bearing cup out of the housing (fig. 8).
2. Install a new expansion plug in the lower end of the housing. Press on center of plug to deform it outward and secure it in the housing. Make sure that the plug is tight in the housing or lubricant leakage could occur.
3. Position the new bearing cup squarely over the recess in the gear housing and press the cup in until it is firmly and evenly seated. Use an old cup to press the new cup into place.

**Upper Bearing Cup**

1. Except TE 60 Models with 9000 lb. axle-- using a suitable punch and hammer, drive the upper bearing cup from the adjuster plug.

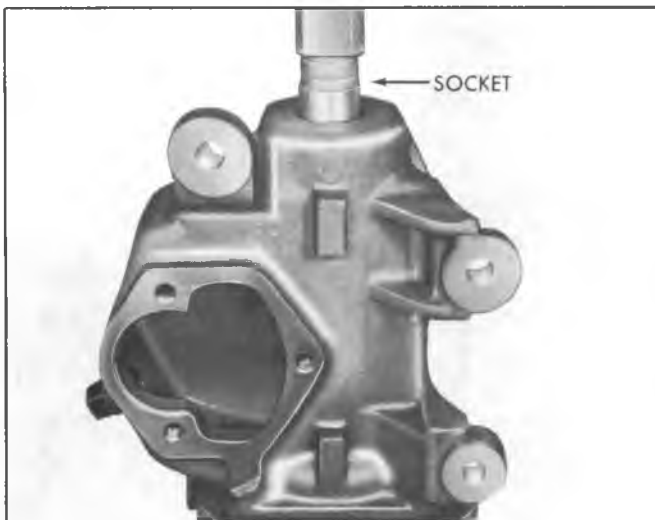


Fig. 8--Removing Expansion Plug and Lower Bearing Cup--Typical



Fig. 9--Checking Lash Adjuster End Clearance

2. **TE 60 Models with 9000 lb. Axle--** place the end cover in a vise and using Puller J-5822 and Slide Hammer J-2619, remove the bearing cup.
3. Position the new bearing cup squarely over the recess in the adjuster plug or end cover and press the cup in until it is firmly and evenly seated. Use an old cup to press the cup into position.

**Lash Adjuster Replacement**

**All Except TE 60 Models with 9000 lb. Axle**

Position the lash adjuster (with shim) in the slotted end of the pitman shaft. Check the end clearance--it should not be greater than .002" (fig. 9). If clearance is greater than .002", a steering gear lash adjuster shim unit is available. It contains four shims- .063", .065", .067" thick.

**TE 60 Models with 9000 lb. Axle**

1. The lash adjuster retainer is tack-welded in the end of

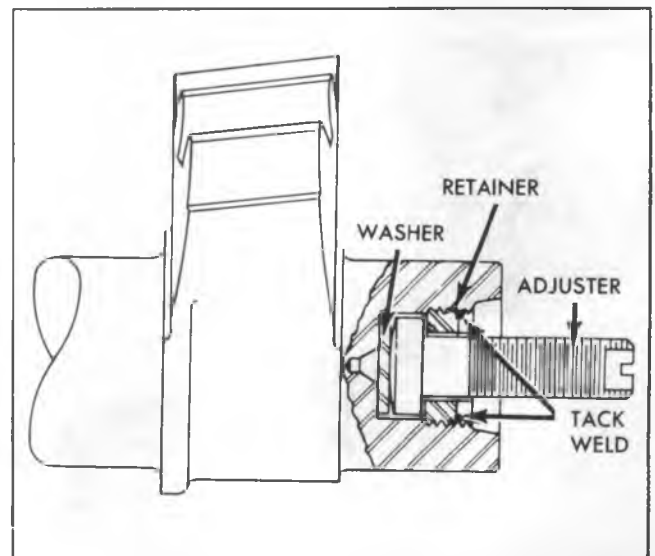


Fig. 10--Lash Adjuster Screw Installation

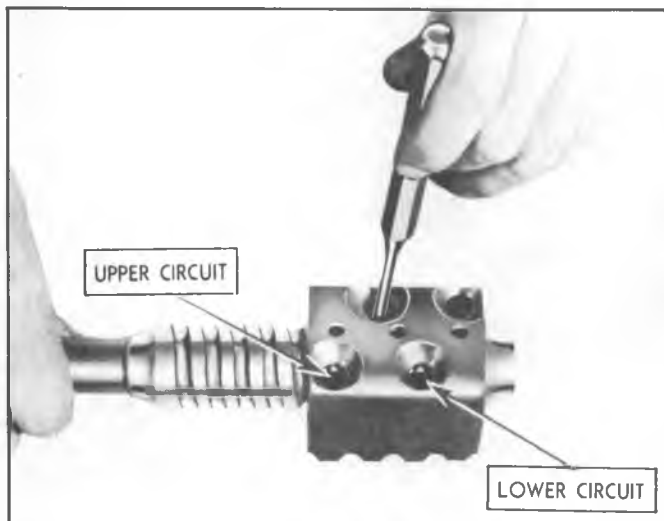


Fig. 11--Filling Ball Circuit in Nut

the pitman shaft (fig. 10). Break the tack-weld and withdraw the retainer from the shaft. Remove the adjuster screw and lockwasher.

2. Install a new thrust washer and screw, lubricating the end of the adjuster with regular steering gear lubricant.
3. Screw the retainer in tight and then back off 30 degrees to obtain the correct adjustment. Tack-weld the retainer at the points shown in Figure 10.

### Ball Nut Servicing

As a rule, disassembly of the ball bearing nut will not be necessary, if it is perfectly free with no indication of binding or tightness when rotated on the worm. However, if there is any indication of binding or tightness, the unit should be disassembled, cleaned and inspected.

1. Remove the screws and clamp retaining the ball guides in the nut. Draw the guides out of the nut.
2. Turn the nut upside down and rotate the wormshaft back and forth until all balls have dropped out of the nut into a clean pan. With the balls removed, the nut can be pulled endwise off the worm.



Fig. 12--Filling Ball Guides

**NOTE:** On TE 60 Models with 9000 lb. axle, the upper or lower bearing cone must be removed before the nut can be removed from the worm.

3. Place the wormshaft flat on the bench and slip the nut over the worm with the ball guide holes up and the shallow end of the rack teeth to the left from the steering wheel position. Align the grooves in the worm and nut by sighting through the ball guide holes.
4. Count 53 balls (all except TE 60 Models with 9000 lb. axle), 45 balls (TE 60 Models with 9000 lb. axle) into a suitable container. This is the proper number of balls for one circuit. Drop the counted balls from the container into one of the guide holes while turning the worm gradually away from that hole. Continue until that ball circuit is full from the bottom of one guide hole to the bottom of the other or until stopped by reaching the end of the worm.

**NOTE:** In cases where the balls are stopped by the end of the worm, hold down those balls already dropped into the nut with the blunt end of a clean rod or punch (fig. 11) and turn the worm in the reverse direction a few turns. The filling of the circuit can then be continued. It may be necessary to work the worm back and forth, holding the balls down first in one hole then the other, to close up the spaces between the balls and fill the circuit completely and solidly.

5. Lay one-half of the ball guide, groove up, on the bench and place the remaining balls from the count container in it (fig. 12). The number of the balls remaining should just fill the guide.
6. Close this half of guide with the other half. Hold the two halves together and plug each open end with heavy lubricant so the balls will not drop out while installing the guide.
7. Push the guide into the guide holes of the nut (fig. 13). This completes one circuit of balls. If the guide does not push all the way down easily, tap it lightly into place



Fig. 13--Removing and Replacing Ball Guide

with the wooden handle of a screw driver.

8. Fill the second ball circuit in the same manner as described for the first ball circuit.
9. Assemble the ball guide clamp to the nut, being sure to use lock washers under the clamp screws; then tighten the screws securely.

Check the assembly by rotating the nut on the worm to see that it moves freely. Do not rotate the nut to the end of the worm threads as this may damage the ball guides. If there is any "stickiness" in the motion of the nut, some slight damage to the ends of the ball guides may have been overlooked.

### Assembly (Fig. 14)

After a major service overhaul where all of the original factory installed lubricant has been washed out of the steering gear assembly; the threads of the adjuster, side cover bolts and lash adjuster should be coated with a suitable nondrying, oil-resistant sealing compound. This is to prevent leakage of gear lubricant from the steering gear assembly. The compound should not be applied to female threads and extreme care should be exercised in applying this compound to the

bearing adjuster, as the compound must be kept away from the bearing race. Also apply grease to the bearings, bushings and ball nut teeth.

1. Place the steering gear housing in a vise with the wormshaft horizontal and the side cover up.
2. Check that the pitman shaft and wormshaft seals, pitman shaft bushings or bearings and wormshaft bearing cups are installed. The ball nut should be installed on the wormshaft.
3. **All Except TE 60 Models with 9000 lb. Axle--**
  - a. Place a wormshaft bearing in the housing cup. Slide the other bearing and the adjuster plug assembly over the upper end of the wormshaft.
  - b. Insert the wormshaft, nut and adjuster assembly into the housing, indexing the lower end of the worm in the housing bearing.

**NOTE: Keep the ball nut away from the end of the worm threads. This may be accomplished by taping the nut in place.**

- c. Thread the adjuster plug into the housing until

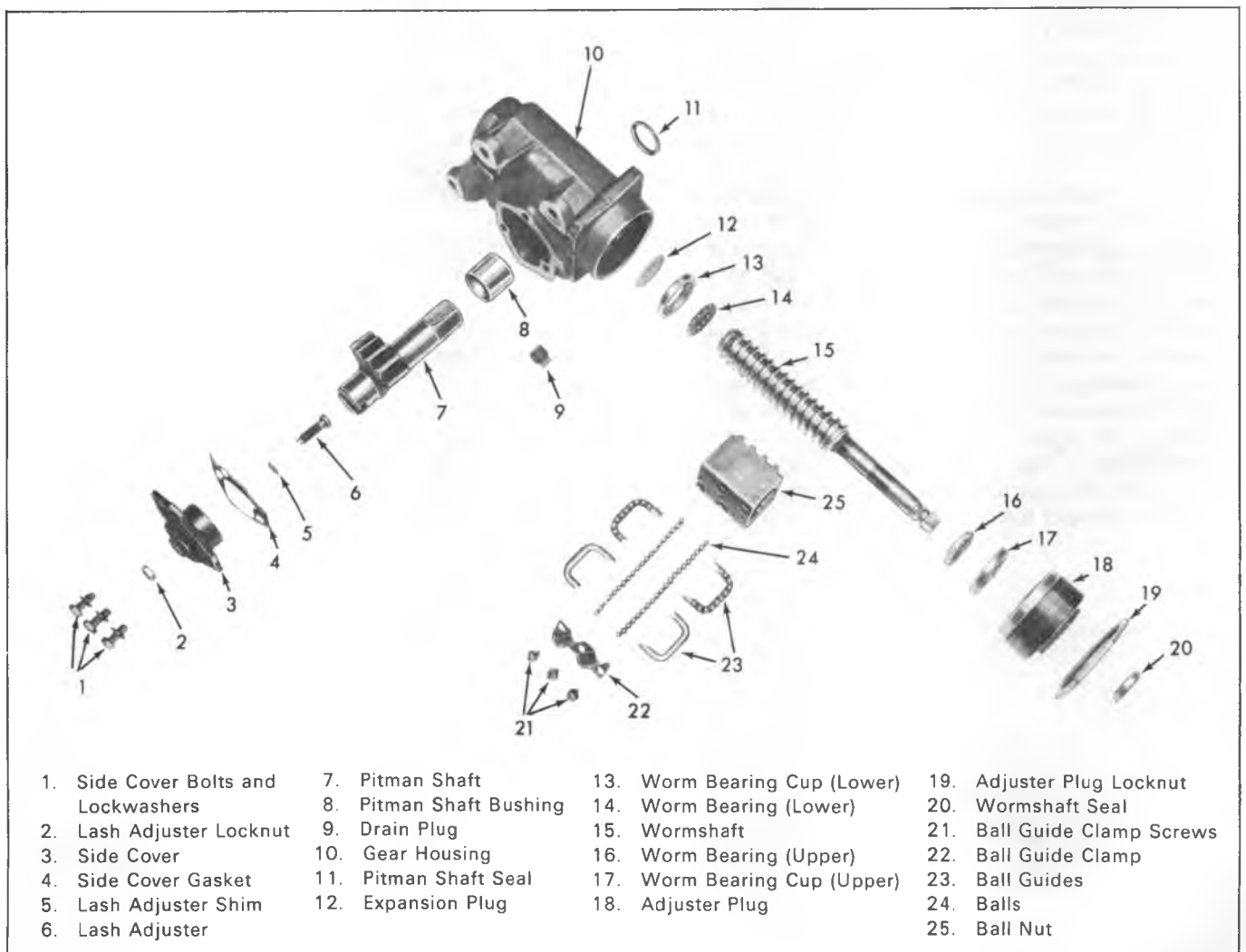


Fig. 14--Steering Gear--Typical of 40-60 Series (Except Tilt Models with 9000 lb. Axle)

nearly all end play is removed from the wormshaft.

4. **TE 60 Models with 9000 lb. axle-**
  - a. The bearing cones should be installed in their proper location on the wormshaft assembly.
  - b. With the ball nut taped in position, place the wormshaft assembly in the housing until the lower cone is indexed in the lower bearing cup.
  - c. Supporting the upper end of the wormshaft, install the end cover to the housing using the original pack of shims between the housing and end cover; tighten the end cover bolts. Shims are available in 0.002", 0.005" and 0.010" thickness. A minimum of three 0.002" and two 0.005" shims must be used for initial adjustment.
5. Start the pitman shaft into the side cover bushing. Then, using a screw driver, through the hole in the side cover, turn the lash adjuster counter-clockwise to pull the pitman shaft into the side cover bushing as far as it will go.
6. Rotate the wormshaft by hand until the ball nut is about in the center of travel. This is to make sure that the ball nut and sector will engage properly with the center tooth of the sector entering the center tooth space of the nut.
7. Lubricate the steering gear with 22 oz. of lubricant (Except for TE 60 Models with 9000 lb. axle) or 2-1/2 lbs. lubricant (TE 60 Models with 9000 lb. axle) meeting GM Standard GM 4673M. Pack as much new lubricant into the housing, at either end of the ball nut, as possible without loosing it out the pitman shaft opening.
8. Tape the serrations on the end of the pitman shaft (to prevent seal damage). Install a new gasket on the side cover and carefully lower the pitman shaft assembly part way into the housing. Install the remaining portion of gear lubricant and then lower the pitman shaft assembly the rest of the way into the housing.
9. After making sure that there is some lash between the ball nut and sector teeth, assemble and tighten the cover bolts to 30 ft. lbs.
10. On models so equipped, install the back-up adjuster. Screw the adjuster in until it bottoms, back it off 1/8 to 1/4 turn and tighten the locknut.

## Adjustment On Bench

1. **All Except TE 60 Models with 9000 lb. axle-**
  - a. With the lash adjuster backed off, tighten the adjuster plug until all end play has been removed; then tighten the locknut.
  - b. Using an 11/16" 12-point socket and an in. lb. torque wrench, carefully turn the wormshaft all the way to one stop and then turn back about one turn.
  - c. Measure the amount of torque required to keep the shaft in motion. If necessary, adjust the adjuster plug until the proper preload is obtained (see specifications Section at the rear of this manual). Tighten the locknut to 85 ft. lbs.
2. **TE 60 Models with 9000 lb. Axle-**
  - a. Using an 11/16" 12-point socket and an in. lb. torque wrench, carefully turn the wormshaft all the way to one stop and then turn back about one turn.
  - b. Measure the amount of torque required to keep the shaft in motion. If necessary, adjust the worm bearing preload by adding or subtracting end cover shims until the proper preload is obtained (see Specifications Section at the rear of this Manual). Tighten the end cover bolts to 40 ft. lbs.
3. Turn the wormshaft from one stop all the way to the other, counting the number of turns. Then turn the shaft back exactly half the number of turns to the center position.
4. Turn the lash adjuster screw clockwise to remove all lash between ball nut and sector teeth. Tighten the locknut.
5. Again using the 11/16" 12-point socket and an in. lb. torque wrench, observe the highest reading while the gear is turned through center position. See Specifications Section for proper sector lash adjustment.
6. If necessary, readjust lash adjuster screw to obtain proper torque. Tighten the locknut to 30 ft. lbs. torque and again check torque reading through center of travel.

# POWER STEERING PUMP

## GENERAL DESCRIPTION

A vane-type power steering pump is used on all cars and trucks. The Overhaul procedure is outlined in the 1971 Passenger Car and Series 10-30 Truck Chassis Overhaul Manual on Pages 9-8 thru 9-12. The difference between the pumps is in the amount of pressure delivered as shown in the specifications chart. This difference is accomplished by the use of different flow control valves.

When replacing this valve be sure the correct replacement is used.

**NOTE:** When assembling pressure plate and springs, install one spring over each dowel pin (see figure 16).



Fig. 16--Installing Pressure Plate Springs

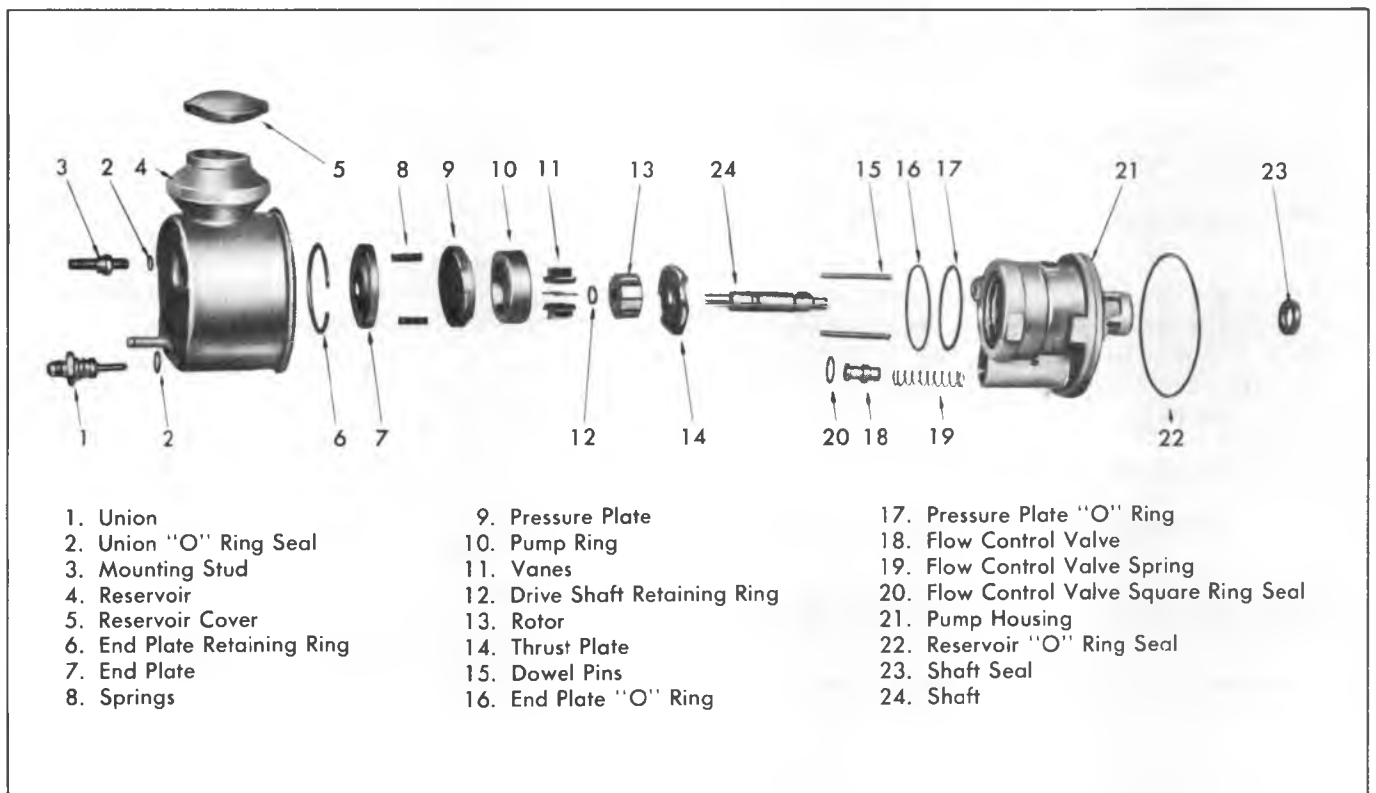


Fig. 15--Power Steering Pump Exploded View

# POWER STEERING GEAR AND VALVE

## INDEX

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## OVERHAUL OPERATIONS

### GEAR DISASSEMBLY (Fig. 17)

Steering gear parts must be kept free of dirt during disassembly and assembly operations. After draining the lubricant from the gear housing, mount the steering gear in a vise or holding fixture with the wormshaft horizontal. Do not grip the housing too tightly in the vise.

1. Loosen the lash adjuster locknut and then, using a screw driver, loosen the lash adjuster.
2. Remove the three side cover to housing bolts and washers.
3. Making sure the wormshaft is horizontal, rotate the wormshaft as necessary to position the pitman shaft so that it will pass through the opening in the housing. Withdraw the pitman shaft and side cover from the housing assembly.
4. Remove the adjuster plug locknut.
5. Remove the adjuster plug assembly using Tool J-7624 (fig. 18).
6. Remove the valve assembly by grasping the stub shaft and pulling it out of the top cover assembly (fig. 19).
7. Remove the top cover bolts and carefully withdraw the

top cover, wormshaft and ball nut assemblies as a unit (fig. 20). Remove and discard the top cover gasket.

**CAUTION:** Do not hold the wormshaft and ball nut assembly in a vertical position since the ball will travel, by its own weight, to the end of the shaft. If the ball nut strikes either end of the shaft worm sharply enough, damage may result to the ball guides.

8. Remove the wormshaft lower bearing retainer and bearing from the housing.
9. If the expansion plug in the lower end of the housing is loose or allowing lubricant leakage, remove the plug from the housing by pressing inward on the center of the plug. As the curvature of the plug is changed, it becomes loose and can be readily removed.
10. If the lower bearing cup is cracked, scored or worn, indicating need for replacement, assemble Slide Hammer J-2619 and Adapter J-2619-4 into Puller Tool J-5822. Insert the lugs of the puller tool through the bearing cup. Once the lugs are under the lower side of the bearing cup, the slide hammer can be operated to remove the cup from the housing.
11. Using Internal Pliers J-4245, remove the pitman shaft seal retaining snap ring. Using a suitable size screw driver, pry out the pitman shaft seal, being careful not to damage the housing bore.



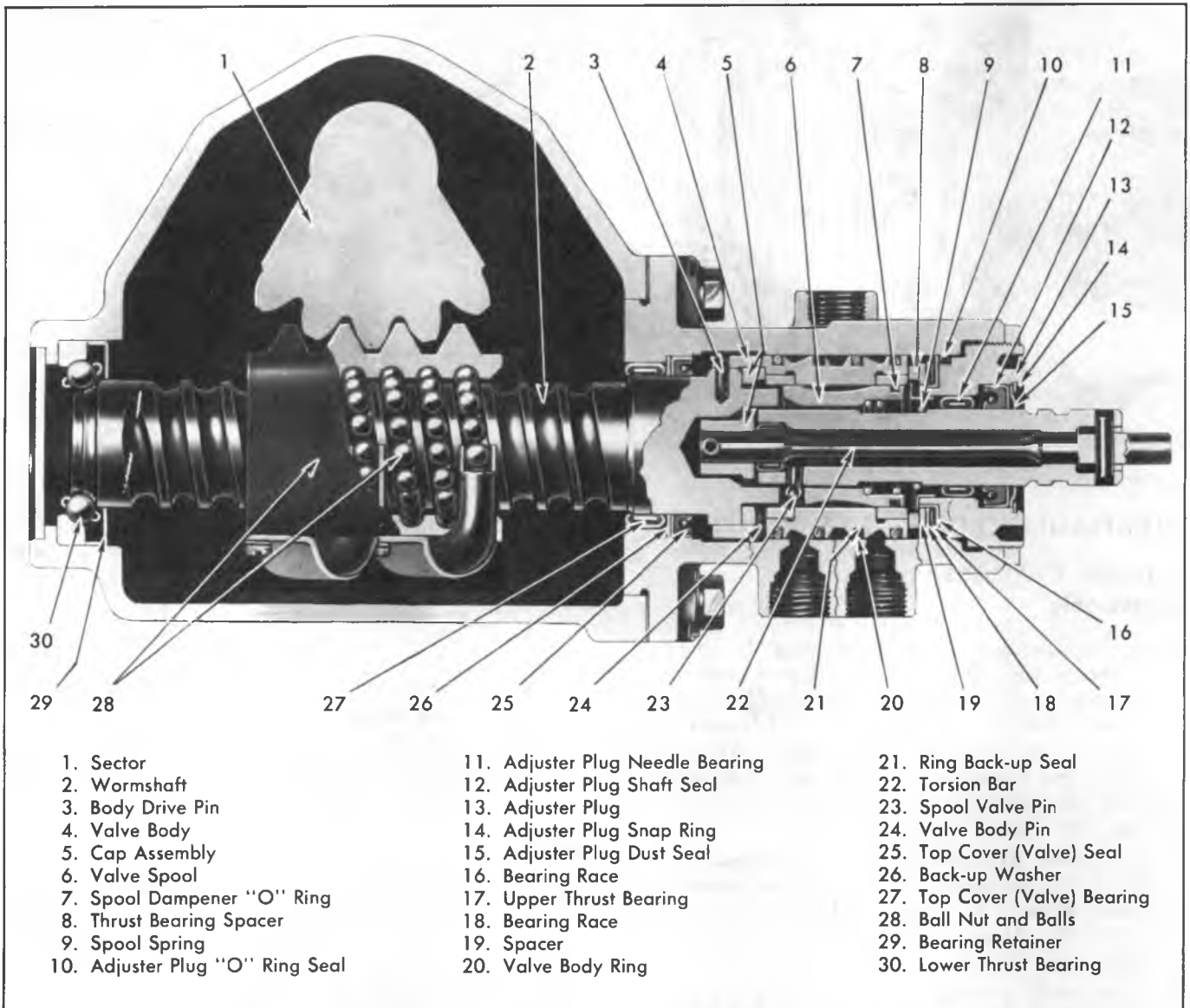


Fig. 17--Power Steering Gear and Valve (Typical)



Fig. 18--Removing Adjuster Plug Assembly Using Tool J-7624



Fig. 19--Removing Valve Assembly



Fig. 20--Removing Top Cover, Worm, and Ball Nut Assembly

## OVERHAULING INDIVIDUAL UNITS

### Adjuster Plug Assembly

#### Disassembly

1. Remove and discard the adjuster plug "O" ring seal.
2. If the oil seal ONLY is to be replaced, and not the bearing, install the adjuster plug loosely in the gear housing. Remove the retaining ring with Internal Pliers J-4245. Remove the seal back-up washer. With a screw driver, pry the oil seal from the bore of the adjuster plug, being careful not to score the needle bearing bore (fig. 21). Discard the oil seal.
3. If the thrust bearing ONLY is to be removed, pry the thrust bearing retainer at the two raised areas with a small screw driver (fig. 22). Remove the retainer, spacer, thrust bearing races and thrust bearing. Discard the bearing retainer.
4. If the needle bearing is to be replaced, remove the retaining ring using Internal Pliers J-4245. Remove the seal back-up washer. Remove the thrust bearing as out-

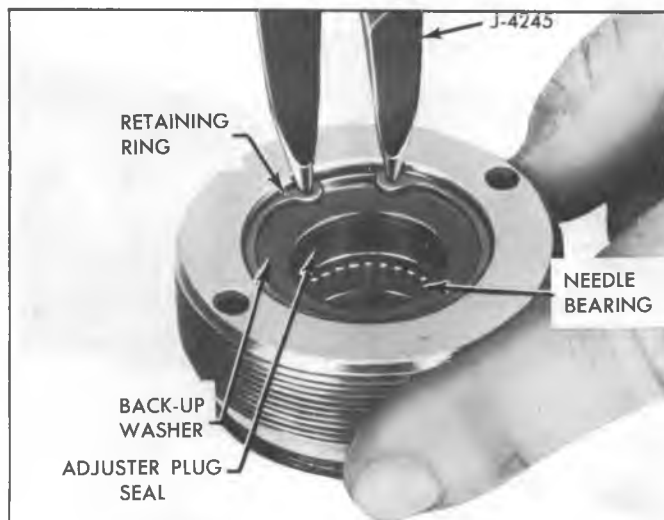


Fig. 21--Removing Adjuster Plug Seal Retaining Ring

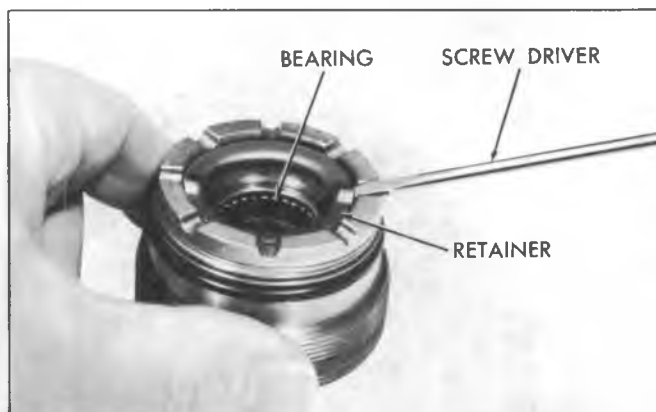


Fig. 22--Removing Thrust Bearing Retainer

lined in Step 3 above. Drive the needle bearing and oil seal from the adjuster plug using Bearing Remover J-8524-2 and Driver J-7079-2 (fig. 23). Discard the oil seal.

5. Wash all parts in clean solvent and dry with compressed air.
6. Inspect the thrust bearing spacer for wear or cracks and replace if damaged.
7. Inspect the thrust bearing and needle bearing rollers and races for wear, pitting or scoring. If any of those conditions exist, replace the bearings and races.

#### Assembly

1. If the needle bearing was removed, place the new needle

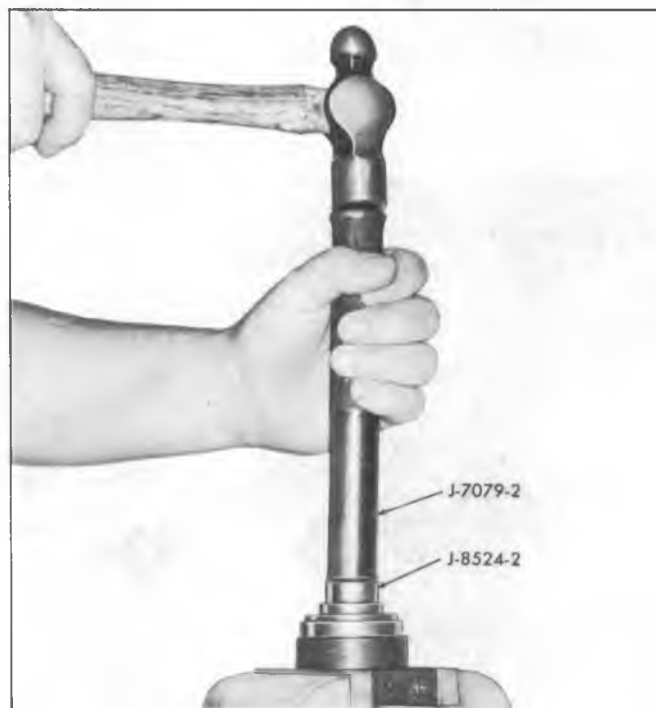


Fig. 23--Removing Needle Bearing and Seal

bearing over Tool J-8524-1 and J-7079-2, with the bearing manufacturer's identification away from the tool, and drive the bearing into the adjuster plug until the tool bottoms in the housing.

**CAUTION:** Place a block of wood under the adjuster plug to protect the thrust bearing surface.

2. Temporarily install the adjuster plug in the gear housing and place the seal back-up washer and a new oil seal on Tool J-8524-1 and J-7079-2 (lip of seal away from tool). Lubricate the seal with Transmission Fluid and drive or press the seal into the adjuster plug, just far enough to provide clearance for the retaining ring.
3. Install the retaining ring with Internal Pliers J-4245; then remove the adjuster plug from the housing.
4. Lubricate the thrust bearing assembly with Transmission Fluid. Place the large thrust bearing race on the adjuster plug hub; then install the upper thrust bearing, small bearing race and spacer (grooves of spacer away from the bearing race).
5. Install a new bearing retainer on the adjuster plug by carefully tapping on the flat surface of the retainer.

**NOTE:** The projections must not extend beyond the spacer when the retainer is seated. The spacer must be free to rotate.

6. Lubricate a new "O" ring seal with Transmission Fluid and install onto the adjuster plug assembly.

### Valve Assembly

The valve assembly is a precision unit with effectively fitted parts and is hydraulically balanced at the factory. If replacement of any valve part other than those called out in the following procedure, is necessary, the rotary valve assembly should be replaced complete. Cleanliness of the parts, tools, and work area is of the utmost importance during servicing of the valve assembly.

**NOTE:** It is very uncommon to have to make any service repairs to the valve assembly, with the possible exception of replacing the valve spool dampener "O" ring. **DO NOT** disassemble the valve unless absolutely necessary since this may result in a damaged assembly. If the valve spool dampener "O" ring requires replacement, remove the valve spool only. Replace the "O" ring and re-install the spool immediately. **DO NOT** disassemble further.

### Disassembly

1. Using a small screw driver, remove the spool spring by prying on the small coil. **DO NOT** pry against the valve body as this may result in a sticky valve. Work the spring onto the bearing diameter of the stub shaft. Slide the spring off the stub shaft.
2. Remove the valve spool with extreme care.

**CAUTION:** The diametral clearance between the

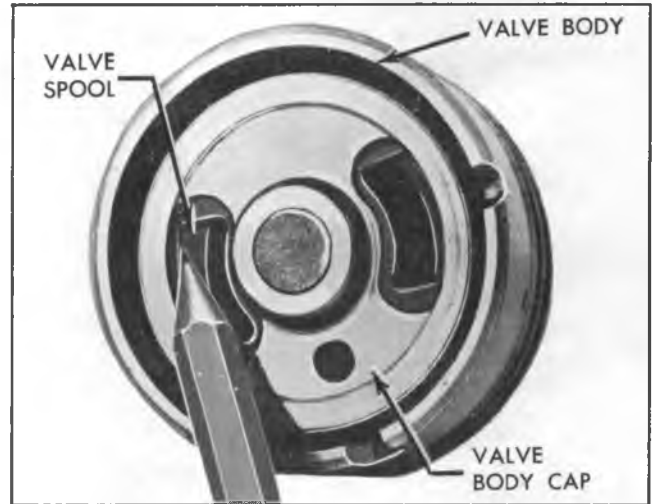


Fig. 24--Separating Valve Spool from Valve Body

valve body and the spool may be as low as .0004 inches. The slightest cocking of the spool may jam it in the valve body. To remove the valve spool, hold the valve assembly in both hands with the stub shaft pointing downward. Push lightly on the valve spool with a pencil (or small brass rod) by inserting the pencil through the openings in the valve cap until the spool is far enough out of the valve so that it may be grasped by the hand (fig. 24). **WITHDRAW THE SPOOL WITH A STEADY OSCILLATING PULL TO PREVENT JAMMING** (fig. 25). If slight sticking occurs, make a gentle attempt to reverse the withdrawal procedure. If this does not free the spool, it has become cocked in the valve body bore. Do not attempt to force the spool in or out if this occurs. In this case, continue to disassemble the valve assembly as follows and return to the spool as described later.

3. Remove the stub shaft, torsion bar, and valve cap assembly by holding the valve in both hands as before



Fig. 25--Removing Valve Spool

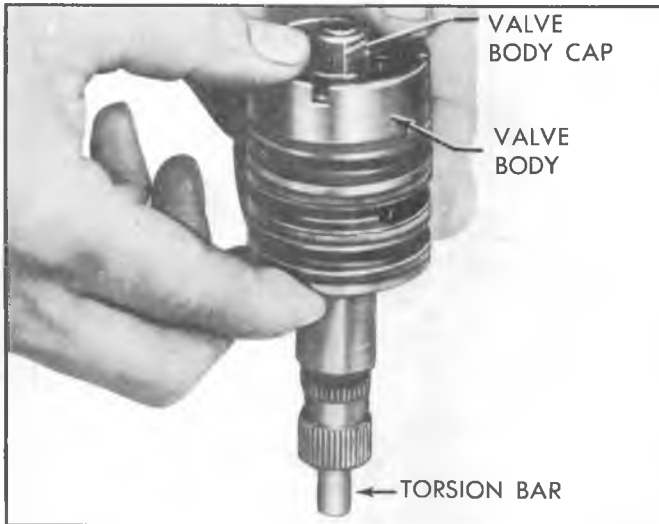


Fig. 26--Removing Stub Shaft and Cap Assembly from Valve Body

only with thumbs on the valve body. Tap torsion bar lightly against workbench (fig. 26). This will dislodge the cap from the valve body to cap pin. The stub shaft and valve cap assembly can now be removed from the valve body.

4. If the valve spool has become cocked as described in step 2 above, it can now be freed. By visual inspection on a flat surface, it can be determined in which direction the spool is cocked. A very few light taps with a light, soft plastic or rawhide mallet should align the spool in the bore and free it.

**CAUTION:** Do not tap the spool with anything metallic. If the spool can be rotated, it can be removed.

5. Remove the "O" ring dampener seal from the spool and discard.
6. The valve rings are made of filled teflon and rarely require replacement. However, if the rings show evidence of excessive wear, carefully cut the rings and back-up seals, remove and discard.

**Inspection**

1. If the valve assembly leaks externally around the torsion bar, the entire valve assembly should be replaced.
2. Check the pin in the valve body which engages the cap. If it is badly worn, cracked, or broken, the entire valve assembly should be replaced.
3. Check the worm pin groove in the valve body (the smaller of the two). If it is worn badly, the entire valve assembly should be replaced.
4. Check the spool drive pin in the stub shaft. If it is worn badly, the entire valve assembly should be replaced.
5. Examine the spool O.D. for nicks, burrs, or excessive wear areas. If any are found, the entire valve assembly should be replaced. A slight polish is normal on the valve surfaces.
6. Examine the valve body for nicks, burrs, or bad wear spots. If any are found, the entire valve assembly should

be replaced. As on the spool, a slight polishing is normal on the valving surfaces.

7. Check the fit of the spool in the valve body without the valve spool dampener "O" ring seal and lubricating Transmission Fluid. The spool should rotate smoothly without binding or catching. If either occurs, the entire valve assembly should be replaced. A small burr on the spool or in the valve body can usually be removed by use of a very fine hone.
8. Measure the length of the spool spring. The free length should be approximately .79 inches. If it measures .76 inches or less, the spring should be replaced as it has taken a permanent set.

**Assembly**

1. Lubricate four valve rings and four back-up "O" ring seals with Transmission fluid and assemble in the four ring grooves on the valve body. Do not allow the seals to become twisted. Assemble the valve rings in the ring grooves over the "O" ring seals by carefully slipping the rings over the valve body (fig. 27). The rings may appear loose or twisted in the grooves but the heat of the oil after assembly will cause them to straighten.
2. Install the new valve spool dampener "O" ring seal in the valve spool groove. Lubricate the seal in Transmission Fluid. Do not allow the seal to twist in the groove.
3. Assemble the stub shaft in the valve body by aligning the groove in the valve cap with the pin in the valve body. Tap lightly on the cap with a plastic or rawhide mallet until cap is against the shoulder in the valve body with the valve body pin in the cap groove.

**CAUTION:** Make sure the groove and pin are in line before tapping on the cap. Hold these parts together during the rest of the assembly.

4. Lubricate the valve spool with Transmission Fluid. Slide the spool over the stub shaft with notch toward the valve body. Align the notch with the spool drive pin



Fig. 27--Installing Valve Body Rings

in the stub shaft and carefully engage the spool in the valve body bore.

**CAUTION:** Because the clearance between the spool and the valve body is very small, extreme care must be taken when assembling these parts. Push the spool evenly and slowly with a slight oscillating motion until the spool reaches the drive pin. Rotate the spool slowly with pressure until the notch engages the pin. Before pushing the spool completely in, make sure the dampener "O" ring is evenly distributed in the spool groove. Slowly push spool completely in, with extreme care taken not to cut or pinch the "O" ring seal (fig. 28).

5. Slide the spool spring over Seal Protector J-6222 and work the spool spring down until it is seated in the undercut part of the stub shaft. Take care not to scratch or mar the sealing surfaces of the stub shaft.
6. If, during the assembly of the valve, the stub shaft and cap assembly is allowed to slip out of engagement with the valve body pin, the spool will be permitted to enter the valve body too far. The dampener "O" ring seal will expand into the valve body oil grooves preventing withdrawal of the spool. Attempt to withdraw the spool with a slight pull and much rotary motion. If this does not free the spool after several tries, make sure the spool is free to rotate; place the valve body on a flat surface (notched end up) and tap the spool with a wooden or plastic rod until the "O" ring seal is cut and the spool can be removed. Replace the dampener "O" ring seal and proceed with assembly as before.

## Top Cover, Wormshaft and Ball Nut Assembly

### Disassembly

1. Rotate the ball nut on the wormshaft; it must rotate

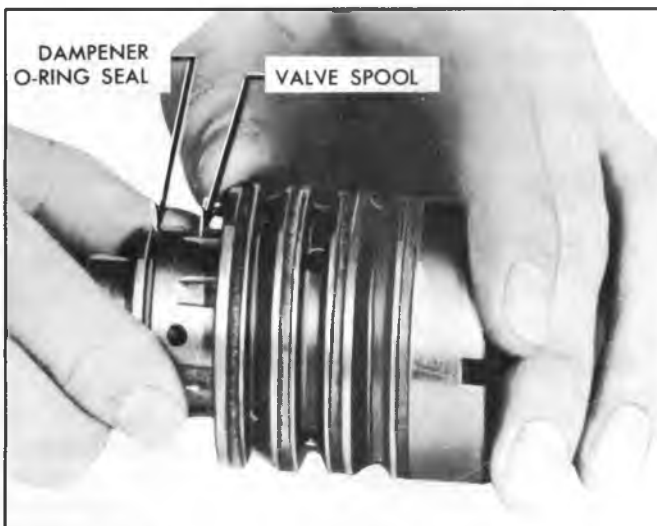


Fig. 28--Assembling Stub Shaft, Torsion Bar, and Cap Assembly in Valve Body



Fig. 29--Removing Top Cover Needle Bearing and Seal Using Tool J-8526-2

- smoothly with no evidence of binding or roughness.
2. Remove the screws attaching the ball guide clamp to the ball nut and remove the clamp. Pull the guides out of the ball nut, separate the guide halves and remove the balls.
3. Turn the ball nut upside down over a clean pan and rotate the wormshaft back and forth until all the balls have been removed.
4. Pull the ball nut endwise off the wormshaft.
5. Remove the wormshaft from the top cover assembly.
6. If the top cover needle bearing requires replacing, press the needle bearing, top cover seal and seal back-up washer from the cover using Tools J-8526-2 and J-7079-2 as shown in Figure 29. Discard the old seal.
7. If the brass inverted flare connectors need replacing, tap threads into the center hole of the connector with a 5/16-18 tap. Thread a bolt, with a nut and flat washer attached, into the tapped hole so that the washer rides against the face of the port boss and the nut rides



Fig. 30--Installing New Connector in Housing Using Tool J-6217



## 9-16 STEERING GEAR AND POWER CYLINDER

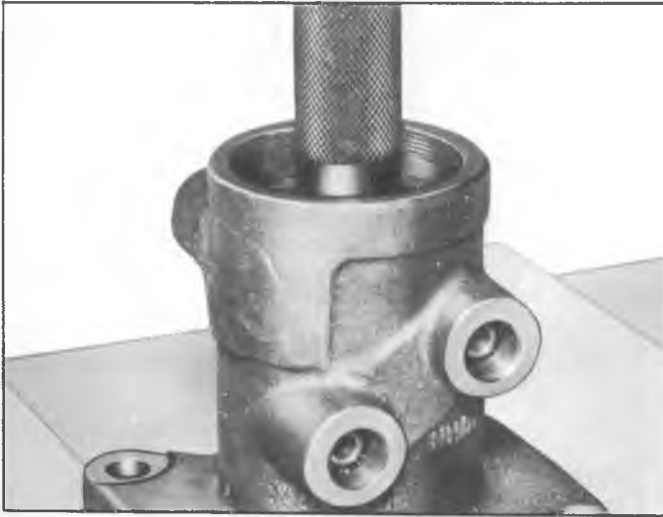


Fig. 31--Installing Top Cover Needle Bearing and Seal Using Tool J-8526-1

against the washer. Hold the bolt from rotating while turning the nut off the bolt. This will force the washer against the port boss and will back out the bolt, thus drawing the connector from the top cover housing. Discard the connector. Clean the housing thoroughly to remove any tapping chips.

### Inspection

1. Wash all parts in clean solvent and dry with compressed air.
2. Inspect the worm and ball nut grooves and all balls for scoring.
3. Inspect the ball return guide halves for distortion, especially at the guide ends.

### Assembly

1. Drive the new connectors against the housing seat using Tool J-6217, being careful not to damage either the connector or housing seat (fig. 30).
2. Install the new needle bearing, lubricated with Transmission Fluid, using Installer J-8526-1 and Handle J-7079-2 (fig. 31) Press against the stamped identification side of the bearing.
3. Install the seal back-up washer. Lubricate a new seal assembly with Transmission Fluid and press into the top cover housing (open end of seal towards the adjuster plug end of the housing).
4. Place the wormshaft in the top cover, being careful not to damage the seal assembly.
5. Lay the top cover and wormshaft flat on the bench and slip the ball nut over the worm with the ball guide holes up and the shallow end of the rack teeth to the left from the steering wheel position. Align the grooves in the worm and nut by sighting through the ball guide holes.
6. Count 53 balls into a suitable container. This is the proper number of balls for one circuit. Drop the counted balls from the container into one of the guide holes while turning the worm gradually away from the

bottom of one guide hole to the bottom of the other or until stopped by reaching the end of the worm.

**NOTE:** In cases where the balls are stopped by the end of the worm, hold those balls already dropped into the nut with the blunt end of a clean rod or punch and turn the worm in the reverse direction a few turns. The filling of the circuit can then be continued. It may be necessary to work the worm back and forth, holding the balls down first in one hole then the other, to close up the spaces between the balls and fill the circuit completely and solidly.

7. Lay one-half of the ball guide, groove up, on the bench and place the remaining balls from the count container in it. The number of the balls remaining should just fill the guide.
8. Close this half of the guide with the other half. Hold the two halves together and plug each open end with heavy lubricant so the balls will not drop out while installing the guide.
9. Push the guide into the guide holes of the nut. This completes one circuit of balls. If the guide does not push all the way down easily, tap it lightly into place with the wooden handle of a screw driver.
10. Fill the second ball circuit in the same manner as described for the first circuit.
11. Assemble the ball guide clamp to the nut, being sure to use lock washers under the clamp screws; then tighten the screws securely.

Check the assembly by rotating the nut on the worm to see that it moves freely. Do not rotate the nut to the end of the worm threads as this may damage the ball guides. If there is any "stickiness" in the motion of the nut, some slight damage to the ends of the ball guides may have been overlooked.

## Pitman Shaft and Side Cover Assembly

### Disassembly

1. Remove the lash adjuster locknut. Discard the locknut.
2. Rotate the side cover counter-clockwise on the lash adjuster and remove the side cover assembly.
3. Slide the lash adjuster and shim from the "T" slot in the end of the pitman shaft.
4. Check the side cover bushing for damage. If the bushing must be replaced, the side cover and bushing must be replaced as an assembly.
5. Check all other parts for signs of wear and replace if needed.

### Assembly

1. Assemble the lash adjuster, with shim, in the slot in the end of the pitman shaft. Check the end clearance, which should not be greater than .002". For the purpose of adjusting this end clearance, a steering gear lash adjuster shim unit is available. It contains four shims - .063", .065", .067" and .069" thick.
2. Start the adjuster into the side cover bushing, then with



a screw driver inserted through the hole in the cover, turn the lash adjuster in a counter-clockwise direction to pull the pitman shaft pilot into the cover bushing as far as it will go.

- Loosely install a new lash adjuster locknut on the adjuster.

## GEAR ASSEMBLY

- If the expansion plug was removed, place a new plug in the housing with the convex side facing inward in the housing. Press on the center of the plug to deform it, thus securing the plug in the housing.
- If the lower bearing cup was removed, position a new cup squarely over the recess in the gear housing and press the cup in until it is firmly and evenly seated. Use the old cup to press the new cup into place.
- Place the new pitman arm seal in the end of the housing just far enough to install the retaining snap ring. Install the snap ring using Internal Pliers J-4245.

**NOTE:** When installing the seal, be sure it is installed squarely in the housing bore.

- Lubricate the lower wormshaft bearing and install the bearing and retainer in the gear housing.
- Place a new top cover gasket on the housing. Lift the top cover, worm and ball nut assembly by grasping the top cover and worm. Carefully guide the assembly into the gear housing until the wormshaft contacts the worm thrust bearing (fig. 32). Rotate the worm so that the ball nut return guide clamp faces the back-up adjuster opening in the top of the housing. Bolt the top cover to the gear housing.



Fig. 32--Installing Top Cover, Worm and Ball Nut



Fig. 33--Inserting Valve into Housing

- Align the valve body drive pin on the worm with the narrow pin slot on the valve body. Insert the valve assembly into the top cover (fig. 33).

**CAUTION:** Do not push against the stub shaft as this may cause the stub shaft and cap to push out of the valve body, allowing the spool seal to slip in the valve body oil grooves. The valve assembly should be pushed in by pressing against the valve body with the finger tips. Be sure the valve is properly seated before adjusting the adjuster plug assembly. The return port in the valve housing should be fully visible at this time (fig. 34).

- Place Seal Protector J-6222 over the end of the stub shaft and install the adjuster plug assembly. Check the valve assembly drag as shown in Figure 35. Adjust the thrust bearing so that the preload is 1 to 3 in. lbs. in excess of valve assembly drag. Install the adjuster locknut and torque to 58 ft. lbs.

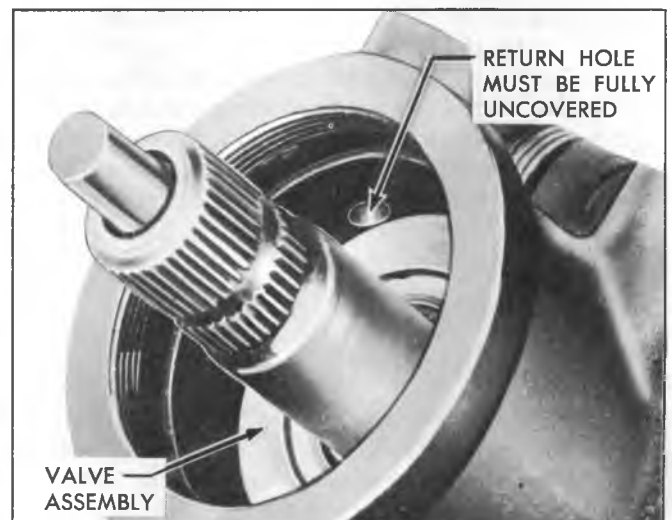


Fig. 34--Valve Assembly Properly Installed in Housing

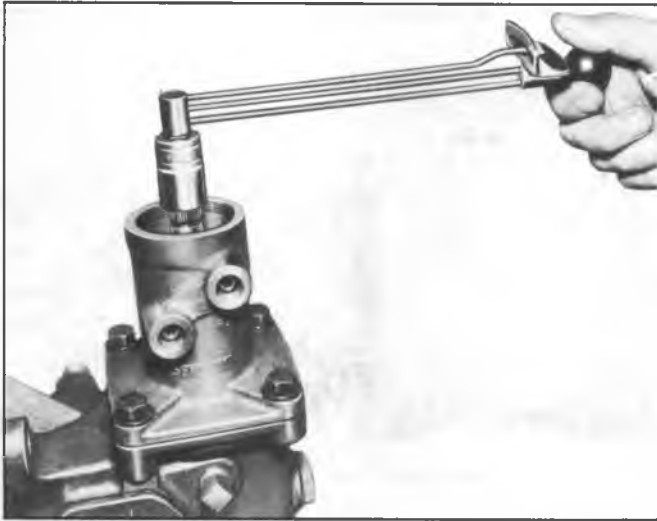


Fig. 35--Checking Valve Assembly Drag

8. While holding the worm nut, turn the wormshaft to move the nut to the center of the worm. This is necessary so that the worm nut and pitman shaft will mesh properly when the pitman shaft is installed.
9. Place tape over the serrated end of the pitman shaft to prevent damage to the housing seal. Install the pitman shaft and side cover assembly, being careful to align the center tooth of the pitman shaft with the center groove in the ball nut. Install and tighten the side cover bolts.
10. Adjust the pitman shaft lash adjuster screw so that the worm bearing preload is 4 to 8 in. lbs. in excess of the bearing preload and valve drag readings combined (Step 7 above). This pitman shaft preload reading should be taken with the gear on center and while rotating the steering shaft through an angle of not more than 20 degrees. Tighten the lash adjuster locknut. The final over center reading, which represents the total of the valve and seal drag, the worm bearing preload and the lash adjuster preload, should not exceed 16 in. lbs.

## POWER CYLINDER

### INDEX

General Description .....	9-18	Disassembly .....	9-18
Overhaul Operations.....	9-18	Cleaning and Inspection .....	9-18
		Assembly .....	9-19

## GENERAL DESCRIPTION

A power steering cylinder is used on 40-60 Series Trucks. The cylinder is either side mounted or axle mounted and acts as a power assist to the mechanical steering. The side mounted power cylinder is attached to the pitman arm at one end and is bracket mounted to the frame side rail at the other end. The axle mounted cylinder is bracketed to the front axle at one end and to the steering tie rod at the other end.

Metal tubes and flexible hoses connect the power cylinder to the power steering gear valve. When the steering wheel is turned, the control valve on the steering gear housing directs hydraulic fluid (under pressure from the hydraulic pump) to the left or right side of the power cylinder piston. This produces movement of the piston and the attached steering linkage.

### OVERHAUL OPERATIONS

#### Disassembly (Fig. 36)

1. If not previously removed, remove the cotter pin, adjuster screw and ball seats from one end of the power cylinder. Use a wide blade screw driver to turn the adjuster screw out. Repeat these procedures at the opposite end of the cylinder.
2. Loosen the clamp on the outside of the socket and then

while holding the piston rod from turning, unthread the socket assembly from the piston rod.

3. Force the piston rod in and out of the power cylinder to drain the remaining fluid.
4. Using Snap Ring Pliers J-4245, remove the scraper retaining snap ring from the groove in the piston rod guide assembly.
5. Apply air pressure to the retraction port in the guide assembly while holding a finger over the extension port. This will dislodge the scraper assembly, scraper assembly "O" ring and piston rod seal from the guide assembly.

**NOTE:** If air pressure is not sufficient to dislodge the parts, they can be pried out using a small screw driver. Be extremely careful not to damage the piston rod or housing bore.

#### Cleaning and Inspection

Clean and inspect the components using cleaning solvent and compressed air. Replace scraper assembly, "O" ring and seal with new parts.

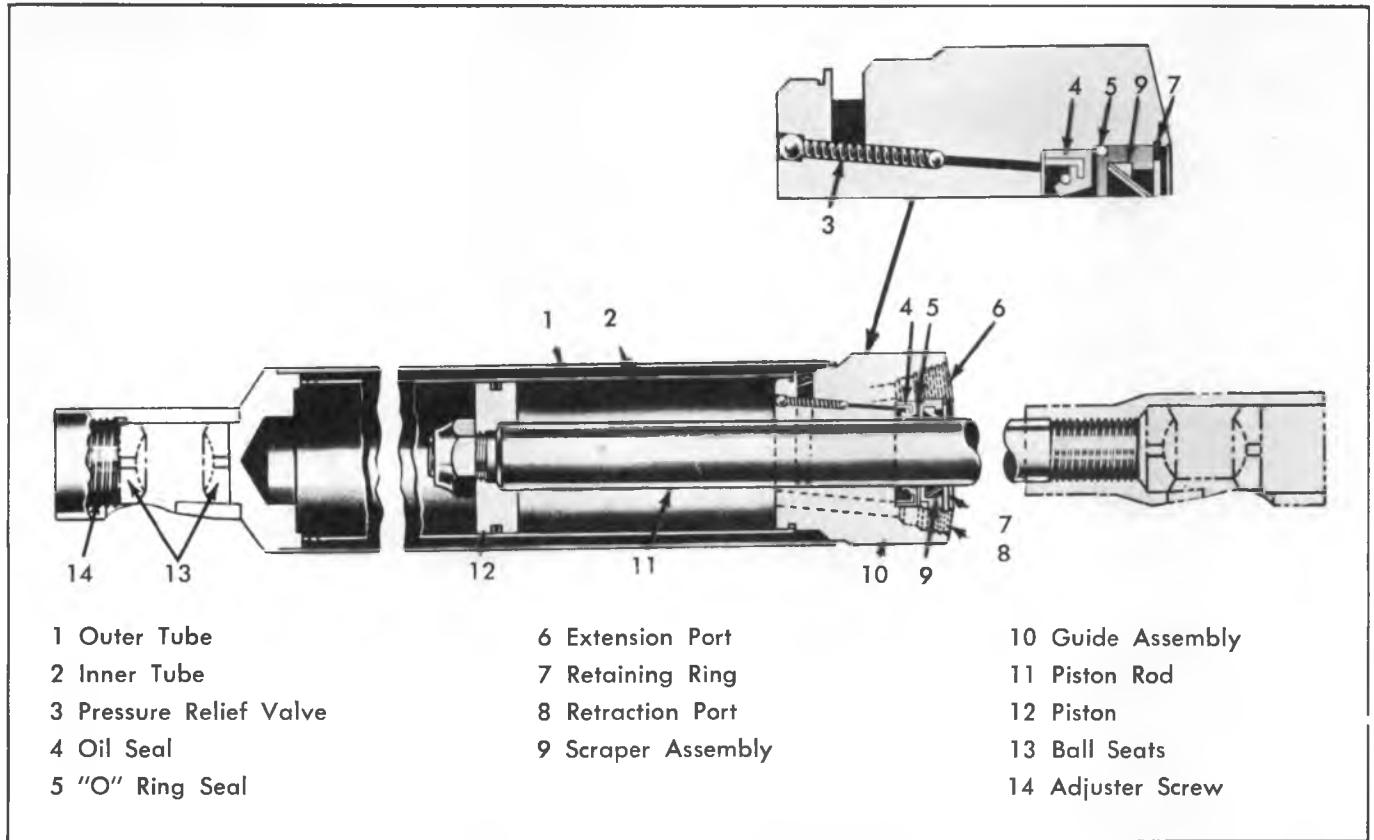


Fig. 36--Power Cylinder Assembly--40-60 Series Trucks

**Assembly**

1. Lubricate the tip of the new piston rod seal with transmission fluid and insert it into the guide assembly with the "U" of the cup toward the bottom of the opening in the guide.
2. Lubricate a new "O" ring with transmission fluid and install it onto a new scraper assembly.
3. Install the scraper and "O" ring assembly in the guide ("O" ring towards guide opening), being careful not to damage the "O" ring.
4. Using Snap Ring Pliers J-4245, install the retaining snap ring into the guide groove. Make sure the snap ring is well seated in the guide assembly.
5. Thread the socket end assembly onto the piston rod until it shoulders against the rod.
6. Tighten the socket clamp bolt securely.
7. Install the ball seats at both ends of the power cylinder and then thread the adjuster screws into the sockets.



# SPECIFICATIONS

	Page
Rear Axle . . . . .	1
Brakes . . . . .	4
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Engine Electrical . . . . .	7
Transmission . . . . .	13
Steering . . . . .	14

## REAR AXLE

### SECTION 4

#### REAR AXLE TORQUE SPECIFICATIONS

ITEM	TORQUE (FT. LB.)	ITEM	TORQUE (FT. LB.)
<b>DRIVE PINION YOKE NUT</b>		<b>OIL SEAL RETAINER &amp; PINION CAGE</b>	
Eaton		Eaton	
1 $\frac{1}{8}$ "-18 . . . . .	320-450	$\frac{9}{16}$ "-12 . . . . .	115-125
1 $\frac{1}{4}$ "-12 . . . . .	400-600	Rockwell	
1 $\frac{1}{2}$ "-18 . . . . .	500-700	7 $\frac{1}{16}$ "-14 . . . . .	60-70
Rockwell		$\frac{1}{2}$ "-13 . . . . .	80-105
1"-20 . . . . .	300-400	$\frac{9}{16}$ "-12 . . . . .	115-150
1 $\frac{1}{4}$ "-18 . . . . .	700-900	Corporation	
1 $\frac{1}{2}$ "-18 . . . . .	800-1100	$\frac{1}{2}$ "-13 (H135) . . . . .	160-170
Corporation		$\frac{1}{2}$ "-13 (H150) . . . . .	80-105
1 $\frac{1}{8}$ "-18 . . . . .	160-280	$\frac{1}{2}$ "-13 (T150) . . . . .	80-105
<b>DIFFERENTIAL CARRIER TO HOUSING</b>		$\frac{5}{8}$ "-11 (H110) . . . . .	160-170
Eaton		<b>SHIFT CHAMBER</b>	
$\frac{1}{2}$ "-13 Cap Screw . . . . .	75-85	Stud Nut— $\frac{3}{8}$ "-24 . . . . .	30-35
$\frac{5}{8}$ "-11 Cap Screw . . . . .	160-175	Bolt— $\frac{7}{16}$ "-14 . . . . .	40-50
$\frac{5}{8}$ "-18 Stud Nut . . . . .	220-240	<b>AXLE SHAFT FLANGE</b>	
Rockwell		Stud Nut— $\frac{1}{2}$ " . . . . .	50-60
$\frac{1}{2}$ "-20 Stud Nut . . . . .	92-118	Stud Nut— $\frac{3}{8}$ " . . . . .	90-110
$\frac{5}{8}$ "-18 Stud Nut . . . . .	185-235	Cap Screw— $\frac{5}{16}$ "-24 . . . . .	11-18
Corporation			
$\frac{7}{16}$ "-20 Cap Screw . . . . .	75-90		
$\frac{9}{16}$ "-18 . . . . .	130-170		

**SPECIFICATIONS 2**

**REAR SUSPENSION SPECIFICATIONS**

SPRING EYE BUSHING—(40) (Steel Backed Rubber Type)	(Width)	3.270"-3.300"
	(O.D.)	1.750"-1.755"
	(I.D.)	0.940"-0.950"
RADIUS LEAF BUSHING—(All 40) (Steel Backed Rubber Type)	( $\frac{5}{8}$ " x 18 Bolt Size) (Width)	2.725"-2.750"
	(O.D.)	1.375"-1.380"
	(I.D.)	0.627"-0.632"
	(1" x 14 Bolt Size) (Width)	3.215"-3.240"
	(O.D.)	1.815"-1.821"
	(I.D.)	1.002"-1.009"

**TORQUE SPECIFICATIONS**

PART	FT. LBS. TORQUE
Spring U-Bolt Nuts (All "C/S" Series)	250-350
(All "T" Series)	190-210
Shock Absorber Nuts (when used) Upper Nut	85-90
Lower Nut	25-30
Rear Spring Radius Leaf Bolt Nut Bolt Nut (All 40 Series)	175-225
(All T Series)	290-320
(All "C/S" Series with $\frac{5}{8}$ " x 18 Bolt)	60-80
(All "C/S" Series with 1" x 14 Bolt)	150-200
Rebound Pin Retainer Bolt (All Except "T" Series)	10-14
("T" Series)	
50	5-10
60	20-25
Rear Axle Bumper Bolt Nuts (All Except "T" Series)	6-8
("T" Series)	10-12

**HENDRICKSON TANDEM SUSPENSION SPECIFICATIONS**

Spring Eye Bushing		
I.D.	1.247" installed*	1.253"
O.D.	1.498"	1.501"
LGT		3.96"
Spring Eye Pin (O.D.)	1.247"	1.248"
LGT		7 $\frac{3}{16}$ "

\*Ream at assembly.

**HENDRICKSON (SERIES RT) TORQUE SPECIFICATIONS**

		Ft. Lbs.
Spring Center Bolt	Bolt $\frac{7}{16}$ "-20	50-60
	Bolt $\frac{1}{2}$ "-20	65-75
Spring Saddle Top Pad Bolt	Nut	275-300
Spring Saddle Cap Stud	—	55-65
	Nut	275-300
	Nut*	225-275
Spring Saddle Top Pad Set Screw	—	100-150
Rear Spring Rear Rebound Bolt	Nut	40-50
Rear Spring Front Pin Lock Bolt	Nut	30-40
Equalizing Beam End Adapter	Bolt	300-320
	Nut	190-210
Torque Rod to Axle Housing Stud	Nut	110-120
Torque Rod Bracket to Side Rail Lower Flange Bolt	Nut	40-50
Torque Rod Bracket to Crossmember	Bolt	100-120
	$\frac{5}{8}$ " x 11	90-110 Straddle Mount
	$\frac{1}{2}$ " x 13	50-60 Straddle Mount
Torque Rod Ball Stud	Nut	450-500

\*With Hardened Washers.

**REAR HUB AND BEARING**

**TORQUE SPECIFICATIONS**

ADJUSTING NUT	FT. LBS.
All Axles Except Corp. H-110	50
Corp. H-110	75-100
<b>LOCK NUT</b>	
W/Rockwell and Eaton	100-150
W/Corp. T, H-150	135
W/Corp. H-110	250



**UNIVERSAL JOINT APPLICATION**

The following tabulation lists universal joints used with standard equipment only. Refer to parts book for universal joints used with optional equipment.

TRUCK SERIES	UNIVERSAL JOINT
CE-40	1350
CE-50	1410
CS-50	1410
SE-50	1410
TE-50	1480
TS-50	1410
CE-60	1410
ME-60	1480-58 WB
TE-60	1480

**UNIVERSAL JOINT SPECIFICATIONS**

JOINT SERIES	JOURNAL DIAMETER	NO. OF NEEDLES PER BEARING	DIAMETER OF NEEDLES	LENGTH OF NEEDLES
1350	0.7730"-0.7735"	34	0.0783"-0.0785"	0.625"
1410	0.7730"-0.7735"	34	0.0783"-0.0785"	0.625"
1480	0.8942"-0.8947"	33	0.0936"-0.0938"	0.765"
58 WB	1.0621"-1.0625"	39	0.0928"-0.0930"	0.829"

**TORQUE SPECIFICATIONS**

<b>UNIVERSAL JOINT U-BOLT NUT</b>		
$\frac{3}{8}$ " x 24 Nut	1350-1410	20-24 ft. lbs.
$\frac{7}{16}$ "-20 Nut	1480	32-37 ft. lbs.
<b>PROPELLER SHAFT-TO-HANGER ATTACHING PARTS</b>		
$\frac{7}{16}$ " x 20 Nut		25-30 ft. lbs.
<b>PROPELLER SHAFT TO REAR AXLE</b>		
$\frac{3}{8}$ " x 24 Nut	1350-1410	20-24 ft. lbs.
$\frac{7}{16}$ " x 20 Nut	1480	32-37 ft. lbs.
	58 WB	40-50 ft. lbs.
<b>PROPELLER SHAFT TO TRANS.</b>		
$\frac{7}{16}$ " x 20 Nut	1350-1410	50-60 ft. lbs.
$\frac{1}{2}$ " x 20 Nut	1480	60-70 ft. lbs.
	58 WB	40-50 ft. lbs.
<b>PROPELLER SHAFT TO PROPELLER SHAFT</b>		
$\frac{3}{8}$ " x 24 Nut	1350-1410	20-24 ft. lbs.
$\frac{7}{16}$ " x 20 Nut	1480	32-37 ft. lbs.
	58 WB	40-50 ft. lbs.
<b>PROPELLER SHAFT HANGER-TO-CROSSMEMBER</b>		
$\frac{3}{8}$ " x 16 Nut		15-20 ft. lbs.
<b>TRANSMISSION COMPANION FLANGE (NUT) (Except ME-60)</b>		30-40 ft. lbs.
<b>TRANSMISSION COMPANION FLANGE (NUT) (ME-60)</b>		65-85 ft. lbs.
<b>PROPELLER SHAFT GUARD (NUT)</b>		50-60 ft. lbs.
<b>YOKE BOLT TO FRONT DIFFERENTIAL</b>		90-130 ft. lbs.
<b>YOKE U-BOLT TO FRONT AND REAR DIFFERENTIAL (NUT)</b>		40-55 ft. lbs.

# BRAKES

## SECTION 5

### FRONT BRAKES

TRUCK MODELS	CE, CS40 CE, CS50 SE, SS50	CE, CS50 <sup>(1)</sup> CE, ME60 <sup>(3)</sup> TE, TS50 <sup>(3)</sup> TE60 "F"	CE, CS50 <sup>(2)</sup> SE, SS50
Type	Duo-Servo	Manual	"FA"
Adjustment	Automatic	Manual	Automatic
Size	14 x 2½"	15 x 3	15 x 3
Lining Width	2½"	3"	3"
Lining Thickness	9/32"	5/16"	5/16"
Lining Area—Sq. In. per Axle	136.4	198.1	198.1

(1) Cab Models—Only.  
(2) Cowl Models—Only.  
(3) Available with 15 x 3.5 Shoes.

### REAR BRAKES

TRUCK MODELS	CE, CS40 <sup>(1)</sup> CE, CS50 SE, SS50 TE, TS50	CE, CS50 CE, ME60 <sup>(2)</sup> TE, TS50 TE60 <sup>(2)</sup>	SE, SS50
Type	Twin-Action	"FR-3"	"FR-3A"
Adjustment	Automatic	Manual	Automatic
Size	15 x 4	15 x 6	15 x 6
Lining Width	4"	6"	6"
Lining Thickness	17/32"	1/2"	1/2"
Lining Area—Sq. In. per Axle	249.4	377.3	377.3

(1) Available with 15 x 5 Shoes.  
(2) Available with 15 x 7 Shoes.

### POWER CYLINDERS

TRUCK MODELS	STANDARD OR OPTIONAL	*MFG.	MFG. MODEL NO.	OVERALL DIAMETER	CYLINDER BORE	POWER DIAPHRAGM STROKE	HYDRAULIC PISTON STROKE
CE, CS, PS40	Opt.	B-P	2508827	12.78"	—	5.44"	5.31"
CE50	Std.						
CE60	Std.						
CE60	Opt.						
ME60	Std.	B-P	2508643	12.78"	—	4.30"	4.19"
SE, SS50	Std.	B-P	2508829	12.78"	—	5.44"	5.31"
All Models with Split Brakes	Opt.						
TE, TS50	Std.	B-P	2503139	12.78"	—	4.70"	4.66"
TE60	Std.						

\*B-P—Bendix Products

### WHEEL CYLINDERS

BRAKE CONTROLS MASTER CYLINDER			WHEEL CYLINDERS		
TRUCK MODELS	MASTER CYLINDER*	MASTER CYLINDER BORE	TYPE BRAKE	AXLE MODEL	WHEEL CYLINDER BORE
CE, CS40	Std.	1¼"	Duo-Servo	F-050, F-055	7/8"
	Opt.	1½"	"F"	F-070, F-090	1⅜"
				F-110	1⅜"
CE50	Std.	1½"	"FA"	F-070	1⅜"
	Opt.	1¾"	Twin-Action	H-110, H-135	1½"
CE60	Std.	1½"	"FR-3"	H-150, T-150	1½"
	Opt.	1¾"		H-170, T-170	1⅝"
ME60	Std.	1¾"		30DSC	1⅝"
SE, SS50	Std.	1¾"	"FR-3A"	17121, 17221	1¾"
TE, TS50	Std.	1½"		H-170, T-170	1⅝"
TE60	Std.	1½"			
	Opt.	1¾"			

\*All Models with Optional Split Brake System have a 1¼" Master Cylinder Bore.

## AIR BRAKES

### FRONT BRAKES SPECIFICATIONS

Brake Size .....	15 x 3
Brake Shoe Lining	
Width .....	3"
Thickness .....	$\frac{7}{16}$ "
Area (sq. in. per axle) .....	199
Brake Chamber	
Type .....	12
Diameter .....	$5\frac{23}{32}$ "
Adjust Travel to .....	Short as possible w/o brakes dragging

### REAR BRAKES (EXCEPT STOPMASTER)

Brake Size .....	15 x 6
Brake Shoe Lining	
Width .....	6"
Thickness .....	$\frac{3}{4}$ "
Area (sq. in. per axle) .....	377
Brake Chamber	
Type .....	30
Diameter .....	$8\frac{1}{8}$ "
Adjust Travel to .....	Short as possible w/o brakes dragging

### STOPMASTER BRAKE SPECIFICATIONS

Brake Size .....	15 x 7
Brake Shoe Lining	
Width .....	7"
Thickness .....	$\frac{3}{4}$ " Crescent
Area (sq. in. per axle) .....	440
Brake Chamber	
Standard	
Diameter (at clamp band) .....	5.66"
"Fail-Safe"	
Diameter (at chamber body) .....	5.264"

## PARKING BRAKE

BRAKE TYPE	BAND	BAND	INTERNAL EXPANDING
Brake Size .....	$9\frac{1}{2} \times 2\frac{1}{2}$	$9\frac{1}{2} \times 3$	11 x 2
Brake Drum Diameter			
Outside .....	$9\frac{1}{2}$ "	$9\frac{1}{2}$ "	—
Inside .....	—	—	11"
Lining Length (approx.) .....	$27\frac{5}{8}$ "	$27\frac{5}{8}$ "	—
Internal .....	—	—	—
External .....	—	—	—
Lining Width .....	$2\frac{1}{2}$ "	3"	2"
Lining Thickness .....	$\frac{5}{16}$ "	$\frac{5}{16}$ "	$\frac{1}{4}$ "
Total Lining Area (Sq. In.) .....	67.5	85.0	41.75

# CARBURETOR

## SECTION 6M

### ROCHESTER CARBURETOR SPECIFICATIONS

CARBURETOR MODEL NUMBER	"M"		"2G"		
Carburetor Number	7042011	7042012	7042134	7042124	7030699
Engine Model	250	292	350	350	350
Float Level	1/4	1/4	23/32	23/32	23/32
Float Drop	—	—	1 9/32	1 9/32	1 9/32
Accelerator Pump	—	—	1 1/2	1 1/2	1 1/2
Metering Rod	0.070	0.070	—	—	—
Idle Vent	—	—	0.025	0.025	0.025
Fast Idle (Bench)	0.100	0.100	—	—	—
Fast Idle (Running)	2400 RPM		—	—	—
Governed Speed * (Full Load) Vacuum Spinner Type	—	—	4000 RPM (Except w/AT475 Transmission) 4100 RPM (w/AT475 Transmission)		3000 RPM

\* No Load Speed is Approximately 200-250 RPM Higher Than Full Load.

### HOLLEY CARBURETOR SPECIFICATIONS

CARBURETOR MODEL		4150G	
Engine Displacement		366	427
GM Part Number		685981	685982
Holley Part Number		R-6292A	R-6293A
Fuel Level		Bottom of Sight Plug	
Accelerator Pump		0.015 Min.	0.015 Min.
Air Vent		0.060	0.060
Fast Idle	Mechanical	0.035	0.035
	Running	1800-2400 RPM	1800-2400 RPM
Main Metering Jet	Primary	#56	#56
	Secondary	#71	#71
Throttle Bore	Primary	1 9/16	1 9/16
	Secondary	1 9/16	1 9/16
Governed Speed *		4000 RPM (Except w/AT475 Transmission)	
(Full Load)		4100 RPM (w/AT475 Transmission)	

\* No Load Speed is Approximately 200-250 RPM Higher Than Full Load.

### BENDIX - STROMBERG CARBURETOR SPECIFICATIONS

CARBURETOR SERIES	WW	
Engine Displacement	351C*	351C**
GM Part No.	685275	687113
Bendix No.	381304	381312
Code No.	23-244	23-248
Venturi Size	1 3/16	1 3/16
Main Discharge Jet No.	No. 28-36	No. 28-36
Main Metering Jet Size	0.058	0.057
High Speed Bleeder	No. 70	No. 70
Power By-Pass Jet	2 No. 60	2 No. 59
Accelerator Pump Discharge Jet	No. 70	No. 70
Float Level	0.190	0.190
Accelerator Pump Travel	0.420—0.450	0.420—0.450
* Excluding California Vehicles.		
** California Vehicles Only.		

# ENGINE ELECTRICAL

## SECTION 6Y

### BATTERY

The standard and optional type batteries used on vehicles covered by this manual are shown in the "Battery Model Application Chart" following:

#### BATTERY MODEL APPLICATION CHART

##### TRUCK SERIES

STANDARD	PART NO.	MODEL
Series TE/TM-50 (03); TE/TM-6500 (03-13) . . . . .	1980030	E-5000
Series CE/CS-40; CE/CM/CS-5500 . . . . .	1980145	E-5000
Series CE/CM/ME-60 . . . . .	1980145	E-5000
Series SE/SM/SS-50 . . . . .	1980149	E-5000
Series CG/SG/TG-50 . . . . .	1980758	20T-4A

##### TRUCK SERIES

OPTIONAL	PART NO.	MODEL
Series TE/TM-50; TE/TM-6500 . . . . .	1980038	E-3000
Series CG/SG/TG-50 . . . . .	1980046	8D-250
Series CE/CS-40; CE/CM/CS-50 . . . . .	1980149	E-5000
Series CE/CM/ME-60 . . . . .	1980149	E-5000

#### BATTERY SPECIFICATIONS

BATTERY MAKE	Delco-Remy	Delco-Remy	Delco-Remy	Delco-Remy	Delco-Remy
PART NO.	1980030	1980034	1980038	1980145	1980149
Model No.	E-5000	E-3000	E-3000	E-5000	E-5000
Catalog No.	R-58	Y-58	Y-70	R-88	R-88W
Volts	12	12	12	12	12
No. of Plates per Cell	11	9	11	11	15
Amp. Hr. Capacity at 20 Hr. Rate	61	53	70	61	80
Cranking Ability at 0°F and 300 Amps.	1.6 Min.	1.1 Min.	2.0 Min.	1.6 Min.	2.6 Min.
Load Test					
Amp. Load	180	160	210	180	240
Voltage and Temperature Chart*	No. 1	No. 1	No. 1	No. 1	No. 1

\*Voltage Must Not Drop Below Minimum Listed at Given Temperature When Battery is Subjected to Proper Load for 15 seconds and is 1.200 Specific Gravity at 80°F or more.

#### CHART NO. 1—VOLTAGE AND TEMPERATURE CHART

Electrolyte Temperature	80°F	70°F	60°F	50°F	40°F	30°F	20°F	10°F	0°F
Voltage (Minimum)	9.6	9.6	9.5	9.4	9.3	9.1	8.9	8.7	8.5

#### STARTING SYSTEM

The standard and optional type starting motors used on vehicles covered by this manual are shown in the "Model Application Chart" following:

#### STARTING SYSTEM MODEL APPLICATION CHART

TRUCK SERIES	STANDARD PART NO.
CE-40; CS/SS-50 . . . . .	1108360
CE/SE/TE-50 . . . . .	1108362
CS-40 (With Automatic Transmission) . . . . .	1108367
CS-40 (With Manual Transmission) . . . . .	1108368
CM/SM/TM-50; CM/TM-60 . . . . .	1108483
CE/ME/TE-60 . . . . .	1108487
CG/SG/TG-50 . . . . .	1113686
OPTIONAL PART NO.	
CE/CS-40; CE-50 (03-13); CS/SE/SS-50 . . . . .	1108486
CS-40; CE-50 (02); CS/SE/TE-50 . . . . .	1108485
SE-50 . . . . .	1108372
CE-50 (03-13); Except With AT-540 Automatic Trans. . . . .	1108485
CS-40 With L6-292 Engine and Manual Transmission . . . . .	1108360
CE/SE-50 With V8-366 Engine . . . . .	1108369
TE-50 With V8-366 Engine . . . . .	1108487
CE-60 (03-13); ME/TE-60 With V8-427 Engine . . . . .	1108484

**STARTING SYSTEM SPECIFICATIONS**

STARTER MODEL	1108360 (a)	1108367	1108368	1108369
	1108362 (b)			1108372
Make .....	Delco-Remy	Delco-Remy	Delco-Remy	Delco-Remy
Series .....	10MT	10MT	10MT	10MT
Type .....	125	125	125	125
Type of Drive .....	Overrunning Clutch	Overrunning Clutch	Overrunning Clutch	Overrunning Clutch
Rotation (Viewed at Drive End)	CW	CW	CW	CW
No Load Test				
Volts .....	9	9	9	9
Min. Amps. * .....	55	50	50	35
Max. Amps. * .....	80	80	80	75
Min. RPM .....	3500	5500	5500	6000
Max. RPM .....	6000	10,500	10,500	9000
Pinion Clearance .....	0.010"-0.140"	0.010"-0.140"	0.010"-0.140"	0.010"-0.140"

\* Includes Solenoid

STARTER SOLENOID MODEL	1114356 (a)	1114362	1114356	1114356
	1114344 (b)			1114356
Rated Voltage .....	12	12	12	12
Current Consumption				
Pull-In Winding				
Amps. ....	13-15.5	13-15.5	13-15.5	13-15.5
Volts .....	5	5	5	5
Hold-In Winding				
Amps. ....	14.5-16.5	14.5-16.5	14.5-16.5	14.5-16.5
Volts .....	10	10	10	10

STARTER MODEL	1108483	1108484	1108485	1113686
			1108486	1108487
Make .....	Delco-Remy	Delco-Remy	Delco-Remy	Delco-Remy
Series .....	10MT	10MT	10MT	35MT
Type .....	125	125	125	185
Type of Drive .....	Overrunning Clutch	Overrunning Clutch	Overrunning Clutch	Overrunning Clutch
Rotation (Viewed at Drive End)	CW	CW	CW	CW
No Load Test				
Volts .....	9	9	9	9
Min. Amps. * .....	55	35	35	130
Max. Amps. * .....	80	75	75	160
Min. RPM .....	3500	6000	6000	5000
Max. RPM .....	6000	9000	9000	7000
Pinion Clearance .....	0.010"-0.140"	0.010"-0.140"	0.010"-0.140"	0.010"-0.140"

\* Includes Solenoid

STARTER SOLENOID MODEL	1114356	1114359	1114356	1115518
Rated Voltage .....	12	12	12	12
Current Consumption				
Pull-In Winding				
Amps. ....	13-15.5	13-15.5	13-15.5	26-29
Volts .....	5	5	5	5
Hold-In Winding				
Amps. ....	14.5-16.5	14.5-16.5	14.5-16.5	18-20
Volts .....	10	10	10	10



## IGNITION SYSTEM SPECIFICATIONS

ENGINE DISTRIBUTOR	250	292	351-C	350	350	366 427
Make .....	Delco-Remy	Delco-Remy	Delco-Remy	Delco-Remy	Delco-Remy	Delco-Remy
Model No. ....	1110489	1110486	1110478	1111364	1112048	1111365
Rotation (Viewed at Rotor) .....	Clockwise	Clockwise	Clockwise	Clockwise	Clockwise	Clockwise
Point Opening (In.)						
New .....	0.019	0.019	0.019	—	—	—
Used .....	0.016	0.016	0.016	—	—	—
Cam Angle (Degrees) .....	31-34 (1)	31-34 (1)	31-34 (1)	28-32 (2)	28-32 (2)	28-32 (2)
Centrifugal Advance						
Start Degrees .....	0-2	0.5-2.5	0-2	0-2	0-2	0-2
RPM .....	650	600	510	550	600	625
Intermediate Degrees .....			4-6			
RPM .....			750			
Intermediate Degrees .....	6-8	7.5-9.5	6.5-8.5	4-6	4-6	7.5-9.5
RPM .....	1150	1050	1100	850	850	1200
Maximum Advance Degrees .....	11-13	13-15	10-12	9-11	9-11	12-14
Rpm .....	2050	2000	1750	1900	1900	2200
Firing Order .....	1-5-3-6-2-4	1-5-3-6-2-4	1-6-5-4-3-2	1-8-4-3-6-5-7-2	1-8-4-3-6-5-7-2	1-8-4-3-6-5-7-2
*(1) Set with vacuum in full retard.						
(2) Satisfactory Range When Adjusting Set to 30° Gives .016 Point Opening.						
Ignition Timing						
Idle Speed (RPM) .....	700	700	600	600	600	550
Distributor Setting (1) .....	4° BTDC	4° BTDC	7 1/2° BTDC	4° BTDC	4° BTDC	8° BTDC
(1) With Distributor Vacuum Ports on Carburetor Plugged.						
Distributor Vacuum Control						
Model No. ....	1973434	1973435	1973423	NONE	1973437	NONE
Inches of Mercury to Start Advance .....	7-9	8-10	3-5	—	7-9	—
Inches of Mercury for Maximum Advance ..	15.0-16.5	15.5-16.3	6.25-8.2	—	15-16	—
Maximum Advance (Distributor Degrees)* ..	11.5	9	7.5	—	8	—
** Plus or minus one degree.						
Ignition Coil						
Model No. ....	115208	1115208	1115205	1115293	1115429	1115293
Spark Plugs						
Make .....	AC	AC	AC	AC	AC	AC
Type .....	R-46-T	R-44-T	CR-43-N	R-44-T	R-44-T	R-43-T (1)
Size .....	14MM-5/8"	14MM-5/8"	14MM-13/16"	14MM-5/8"	14MM-5/8"	14MM-5/8"
Point Gap .....	0.035	0.035	0.035	0.035	0.035	0.030 (1)
Torque (Ft. Lbs.) .....	15	15	30-34	15	15	15
(1) Use R-42-T on V8-427 Engine and Set Point Gap to 0.035".						

## ALTERNATING CURRENT GENERATING SYSTEM (NON-INTEGRAL TYPE)

### MODEL APPLICATION CHART

AMPERAGE STANDARD	GENERATOR	USE WITH REGULATOR
37-AMP. - CE/CS-40 (02); CE/CS-50 (02) .....	1100838	1119515
42-AMP. - CE/CS-40 (03); CE-50 (03-13) .....	1100842	1119515
42-AMP. - CM/CS/TE/TM-50 (03); CM/TE/TM-60 .....	1100842	1119515
42-AMP. -TG-50 (03-13) .....	1100842	1119507
42-AMP. - CE/ME-60 .....	1100547	Integral
61-AMP. - CG/SE/SG/SM/SS-50 .....	1100849	1119515
<b>OPTIONAL</b>		
42-AMP. - CE/CS-40 (02); CE/CS-50 (02) .....	1100842	1119515
42-AMP. - CE-50 (02-03-13) .....	1100547	Integral
61-AMP. - CE/CS-40 (02-03); CE/CM/CS-50 .....	1100849	1119515
61-AMP. - TE-TM-50; CM/TE/TM-60 .....	1100849	1119515
61-AMP. - TG-50 .....	1100849	1119507
61-AMP. - CE-50; CE/ME-60 .....	1100548	Integral
62-AMP. - CE/CS-40; CE/CM/CS/SE/SG/SM/SS-50 .....	1117782	1116378
62-AMP. - TE/TM-50; TE/TM-60 .....	1117782	1116378
62-AMP. - TG-50 .....	1117782	1116374
100-AMP. - SE-SG/SM/SS-50 .....	1117141	Integral

### NON-INTEGRAL TYPE GENERATOR SPECIFICATIONS

GENERATOR MODEL	1100838	1100842	1100849	1117754 1117782	1117128
Make .....	Delco-Remy	Delco-Remy	Delco-Remy	Delco-Remy	Delco-Remy
Series .....	10DN	10DN	10DN	20DN	40DN
Type .....	100	100	100	150	125
Rotation (Viewing Drive End) .....	Clockwise	Clockwise	Clockwise	Clockwise	Clockwise
Brush Spring Tension (Oz.) .....	—	—	—	—	10
Field Current at 80° F.					
Amps .....	2.2-2.6	2.2-2.6	2.2-2.6	4.1-4.6	2.2-2.4
Volts .....	12	12	12	12	12
Cold Output					
Specified Volts .....	14.0	14.0	14.0	14.0	14.0
Amps .....	25	28	33	20 (b)	40 (b)
Generator RPM (Approx.) .....	2000	2000	2000	1100	1100
Amps .....	35	40	58	55 (b)	126 (b)
Generator RPM (Approx.) .....	5000	5000	5000	2500	2500
Rated Hot Output (Amps) (a) .....	37	42	61	62	130

(a) Rated Hot Output at Maximum Operating Speed.

(b) If Generator Output is checked without a Regulator, the Output should be 5-10% higher than the value given.

## TWO-UNIT TYPE REGULATOR (MODEL 1119515)

MAKE MODEL	DELCO-REMY 1119515
Field Relay	
Air Gap (In.) (a) .....	0.015
Point Opening (In.) .....	0.030
Closing Voltage Range .....	1.5-3.2
Voltage Regulator	
Air Gap (In.) (Approx.) (b) .....	0.067
Point Opening (In.) .....	0.014
Voltage Chart .....	No. 1

(a) Tolerance Plus or Minus 20%  
(b) Make Field Adjustment as Per Text.

### TEMPERATURE VOLTAGE CHART NO. 1

Degree F. ....	65	85	105	125	145	165	185
Voltage Setting .....	13.9-15.0	13.8-14.8	13.7-14.6	13.5-14.4	13.4-14.2	13.2-14.0	13.1-13.9

\*Operation on Lower Contacts Must be 0.1-0.4 Volt Lower Than on Upper Contacts.

## FULL TRANSISTOR TYPE REGULATOR (MODEL 1116378)

MAKE MODEL	DELCO-REMY 1116378
Field Relay	
Closing Voltage Range .....	2.0-3.0
Voltage Chart (a) .....	No. 2

(a) Allowable Range at "0" Position of Adjusting Screw.

### TEMPERATURE—VOLTAGE CHART NO. 2

Regulator Ambient Temp. (Deg. F.) .....	65	85	105	125	145	165	185
Voltage Setting Range .....	14.1-14.8	13.9-14.7	13.7-14.5	13.6-14.3	13.4-14.2	13.2-14.0	13.1-13.8

## FULL TRANSISTOR TYPE REGULATOR SPECIFICATIONS

Make .....	Delco-Remy
Model .....	9000590
Voltage Setting (a) .....	13.7-14.3
(a) Allowable Range at "0" Position of Adjusting Screw.	

## FIELD RELAY UNIT SPECIFICATIONS

Relay Model .....	1116972
Make .....	Delco-Remy
Air Gap at Core	
Points Closed (In.) .....	0.010 (Min.)
Point Opening (In.) .....	0.015-0.025
Closing Voltage Range .....	7-9
Sealing Voltage .....	11.0 Max.

## GENERATOR TORQUE SPECIFICATIONS

ITEM	TYPE OF PART	TORQUE (FT. LBS.)
Generator Pulley Nut.....	Nut	55-65
Generator Adjusting Arm Pivot Bolt		
With 37-, or 42-Amp. Generator.....	Bolt	15-20
With 61-Amp. Generator.....	Bolt	20-25
With 62-Amp. Generator.....	Bolt	25-30
With 130-Amp. Generator.....	Bolt	30-35
Generator to Mounting Bracket Pivot Bolt*		
With 37-, or 42-Amp. Generator*.....	Nut	15-20
	Bolt	25-30
With 61-Amp. Generator.....	Nut	15-20
	Bolt	30-35
With 62-Amp. Generator.....	Nut	35-45
	Bolt	40-50
With 130-Amp. Generator.....	Nut	25-30
Generator Support Bracket-To-Mounting Bracket.....	Bolt	40-50
Generator Mounting Bracket-To-Engine		
With 37-, or 42-Amp. Generator.....	Nut	25-30
	Bolt	45-55
With 61-Amp. Generator.....	Nut	25-35
	Bolt	45-55
With 62-Amp. Generator.....	Bolt	40-50
With 130-Amp. Generator.....	Bolt	40-50

\*Tighten Pivot Bolts prior to tightening other mounting bolts.

## ALTERNATING CURRENT GENERATING SYSTEM

### (INTEGRAL TYPE)

### MODEL APPLICATION CHART

<u>AMPERAGE</u>	<u>TRUCK SERIES</u>	<u>GENERATOR</u>
<u>STANDARD</u>		
42-Amp. -	CE/ME-60 .....	1100547
<u>OPTIONAL</u>		
42-Amp. -	CE-50(02-03) .....	1100547
61-Amp. -	CE-50; CE/ME-60 .....	1100548
100-Amp. -	SE/SS-50 .....	1117141

## INTEGRAL-TYPE ALTERNATING CURRENT GENERATING SYSTEM SPECIFICATIONS

GENERATOR MODEL	1100547	1100548	1117141
Make.....	Delco-Remy	Delco-Remy	Delco-Remy
Series.....	10SI	10SI	40SI
Type.....	100	100	150
Rotation (Viewing Drive End).....	Clockwise	Clockwise	Clockwise
Field Current at 80° F.			
Amps.....	4.0-4.5	4.0-4.5	4.0-4.5
Volts.....	12	12	12
Cold Output			
Specified Volts.....	(b)	(b)	(b)
Amps.....	—	—	—
Generator RPM (Approx.).....	—	—	—
Amps.....	37	55	110
Generator RPM (Approx.).....	5000	5000	5000
Rated Hot Output (Amps) (a).....	42	61	100

(a) Rated Hot Output at Maximum Operating Speed.

(b) Voltmeter not needed for Cold Output Check. Load Battery with a Carbon Pile to obtain Maximum Output.

# TRANSMISSION

## SECTION 7

### NEW PROCESS—MODEL 540 and 542

Countershaft Bearing Retainer Bolts	18 to 27 ft. lbs.
Drive Gear Bearing Cap Bolts	8 to 17 ft. lbs.
Propeller Shaft Flange Nut	125-150 ft. lbs.
Clutch Housing Cover Bolts	8-10 ft. lbs.
Brake Locating Bracket Bolt	65-75 ft. lbs.
Brake Anchor Bar Bolt	65-75 ft. lbs.

### FIVE SPEED SPICER—5000 SERIES

Shift Fork Set Screws	45 ft. lbs.
Main Drive Gear Bearing Cap Retaining Screws	28 ft. lbs.
Mainshaft Rear Bearing Cap Retaining Screws	70 ft. lbs.
Mainshaft Flange or Yoke Retaining Nut	475 ft. lbs.
Countershaft Rear Bearing Retaining Nut	475 ft. lbs.
Countershaft Rear Bearing Cap Retaining Screws	70 ft. lbs.
Clutch Housing Retaining Cap Screws	70 ft. lbs.

### FIVE SPEED CLARK—MODEL 282 and 285

Idler Shaft Lock Bolt	22 ft. lbs.
Clutch Gear Bearing Retainer Cap Retaining Bolts	22 ft. lbs.
Countershaft Front Bearing Cap Retaining Bolts	22 ft. lbs.
Mainshaft Rear Bearing Cap Retaining Bolts	22 ft. lbs.
Mainshaft Flange or Yoke Retaining Nut	425 ft. lbs.
Shift Control Assembly Bolts	22 ft. lbs.
Shift Support Cover Bolts	22 ft. lbs.
Shift Control Top Bolts	22 ft. lbs.

### FIVE SPEED CLARK—MODEL 325 and 327

Shift Lever Attaching Nut	28 ft. lbs.
Selector Finger to Shifter Shaft Screw	25 ft. lbs.
Companion Flange or Yoke Nut	425 ft. lbs.

### AUXILIARY 4-SPEED SPICER—6041 and 7041

Drive Gear Bearing Cap Retaining Screws	38 ft. lbs.
Rear Bearing Cap Retaining Screws	38 ft. lbs.
Countershaft Rear Bearing Cap Retaining Screws	38 ft. lbs.
Shift Fork Set Screws	48 ft. lbs.
Drive Gear Flange Nut (7041)	525 ft. lbs.
Mainshaft Rear Flange Nut (7041)	525 ft. lbs.
Drive Gear Flange Nut (6041)	425 ft. lbs.
Mainshaft Rear Flange Nut (6041)	425 ft. lbs.

### AT-475 AUTOMATIC

	Ft.-Lbs.		Ft.-Lbs.
Pump Body to Pump Cover Bolts	18 ± 2	Modulator Retainer Bolt	18 ± 2
Center Support Bolt	22 ± 2	Governor Cover Bolts	18 ± 2
Pump to Case Attaching Bolts	14 ± 2	Manual Lever to Manual Shaft Nut	25 ± 5
Case Extension to Case Attaching Nuts	12 ± 16	Manual Shaft to Inside Detent Lever Nut	16 ± 1
Rear Servo Cover Bolts	18 ± 2	Linkage Swivel Clamp Nut	10 ± 2
Line Pressure Plug	12 ± 2	Transmission to Engine Mounting Bolts	40 ± 5
Detent Solenoid Bolts	8 ± 2	Oil Cooler Line	25 ± 2
Control Valve Body Bolts	8 ± 2	Converter to Flexplate Bolt	27 ± 2
Speedometer Driven Gear Retainer to Case Bolt	7 ± 1		
Bottom Pan Attaching Screws	12 ± 1	Neutralizer Switch Screws	25 ± 10
Filter Retainer Bolt	8 ± 2	Converter Dust Shield Screws	34 ± 15

# STEERING

## SECTION 9

### MECHANICAL STEERING SPECIFICATIONS STEERING GEAR APPLICATION CHART

TRUCK MODELS	GEAR MODEL	GEAR RATIO
C40, 50	549-D-176	28.14 to 1
S50	553-D-78	28.14 to 1
C60	553-D-72	28.14 to 1
T50, 60	553-D-17	28.14 to 1

### STEERING GEAR ADJUSTMENTS

WORM BEARINGS Pull to keep wheel moving	1½ to 2 lbs.
SECTOR GEAR LASH: Pull over center	2¾ to 3¼ lbs.
Lash Adjuster Shim Thickness	0.063", 0.065", 0.067", 0.069"

### TORQUE SPECIFICATIONS

LOCATION	TYPE OF PART	TORQUE (1) FT. LBS.
STEERING GEAR		
Lash Adjuster Screw	Nut	25-35
Side Cover to Housing	Bolt	25-35
Worm Bearing Adjuster Screw	Nut	70-100
Back Up Adjuster Jam Nut (if used) (553-D-17 only)	Nut	30-50
STEERING WHEEL-TO-STEERING SHAFT		
Except "T" Models		35-45
"T" Models		45-50
STEERING COLUMN CLAMP BOLT		
All Models	Bolt	15-20
STEERING SHAFT "STOP" CLAMP BOLT		
All Models	Nut	8-12
STEERING SHAFT-TO-WORM SHAFT CLAMP BOLT		
"T" Models	Nut	40-50
"S" Models	Nut	30-40
"C" Models	Bolt	25-35
STEERING GEAR-TO-FRAME BOLT		
All Except "T" Models	Nut	90-130
"T" Models	Nut	90-110
PITMAN ARM TO PITMAN SHAFT		
"T" Models	Nut	220-250
All Others (Pitman Arm Clamp Bolt)	Nut	100-110
CONNECTING ROD STUD-TO-PITMAN ARM AND STEERING ARM		
Except "T" Models	Nut	40 (2)
"T" Models	Nut	125-150 (2)
STEERING ARM-TO-TIE ROD STUD		
F050, F055	Nut	150-160 (2)
F070	Nut	150-180 (2)
F090, F110, F120	Nut	125-150 (2)
STEERING TIE ROD CLAMP BOLT		
F050, F055	Nut	45-55
F070	Nut	80-100
F090, F110, F120	Nut	65-75
STEERING ARM-TO-STEERING KNUCKLE STUD		
F050, F055	Nut	115-165 (2)
F070	Nut	180-240 (2)
F090, F110, F120	Nut	400 (2)

- (1) NOTE: All tapered ball studs must be clean and dry.  
 (2) Tighten as indicated, then tighten to next notch to insert cotter pin.



**POWER STEERING GEAR APPLICATION CHART**

TRUCK SERIES	GEAR MODEL	RATIO
CE/CS40; CE/CG/CM/CS50; CE/CM/ME60 .....	553-DV 92 and 93 .....	28.14 to 1
SE/SG/SM/SS50 .....	553-DV 93 .....	28.14 to 1
TE/TG/TM50; TE/TM60 .....	553-DV 94 .....	28.14 to 1

**STEERING GEAR ADJUSTMENT**

Thrust Bearing Preload .....	1 to 3 Inch Pounds in Excess of Valve Assembly Drag
Thrust Bearing Adjustment Plus Seal Drag .....	8 to 10 Inch-Pounds Maximum
Pitman Shaft Preload * .....	4 to 8 Inch-Pounds in Excess of Total Preload and Drag
Final Over-Center Reading—(Total of Valve and Seal Drag, Worm Bearing Preload and Lash Adjuster Preload) .....	20 Inch Pounds Maximum

\*Readings are to be made through an Arc NOT Exceeding 20° with Gear on Center and Pitman Shaft Backed off.

**POWER STEERING HYDRAULIC PUMP  
MODEL APPLICATION CHART**

TRUCK SERIES	PUMP MODEL	TYPE
CS-40; CS/SS 50 .....	235-P-129	Vane
CE 40-50; SE-50; CE/ME-60 .....	235-P-118	Vane
CG-50 .....	235-P-107	Vane
TS-50 .....	235-P-19	Vane
TE 50-60 .....	235-P-20	Vane

**HYDRAULIC PUMP SPECIFICATIONS**

**VANE TYPE PUMP**

Make .....	Saginaw Steering Gear Division
Type .....	Vane
Models .....	235-P-19; 235-P-20; 235-P-36
Capacity Per Minute	
Maximum .....	3.5 G.P.M. of Power Steering Fluid (Specified in LUBRICATION-SEC. O) at 170°F. Temperature When Operating Pump at 1500 R.P.M. Against 50 P.S.I. Pressure.
Minimum .....	2.35 G.P.M. of Power Steering Fluid (Specified in LUBRICATION-SEC. O) at 170°F. Temperature When Operating Pump at Idle Speed Against 665, 735 P.S.I. Pressure.
Pressure Relief Valve	
Minimum P.S.I. ....	900
Maximum P.S.I. ....	1000

**VANE TYPE PUMP**

Make .....	Saginaw Steering Gear Division
Type .....	Vane
Models .....	235-P-107; 235-P-118; 235-P-129
Capacity Per Minute	
Maximum .....	4.25 G.P.M. of Power Steering Fluid (Specified in LUBRICATION-SEC. O) at 170°F. When Operating Pump at 1500 R.P.M. Against 50 P.S.I. Pressure.
Minimum .....	2.35 G.P.M. of Power Steering Fluid (Specified in LUBRICATION-Sec. O) at 170°F. When Operating Pump at Idle Speed Against 665, 735 P.S.I. Pressure.
Pressure Relief Valve	
Minimum P.S.I. ....	900
Maximum P.S.I. ....	1000

POWER STEERING POWER CYLINDER SPECIFICATIONS

Make ..... Saginaw Steering Gear Division  
 Type ..... Hydraulic  
 Model ..... See Chart Below

TRUCK SERIES	MODEL	RETRACTED LENGTH	EXTENDED LENGTH	STROKE
CE/CS-40(03)	5690726	15.735"	24.795"	9.06"
CE/CG/CS-50(03)	5690726	15.735"	24.795"	9.06"
CE/ME-60(03-13)	5690726	15.735"	24.795"	9.06"
CE/CS-40(02)	7802292	16.87"	27.07"	10.20"
CE/CS/SE/SS-50(02)	7802292	16.87"	27.07"	10.20"
CE-60(02)	7802292	16.87"	27.07"	10.20"
TE/TS-50; TE-60 (Except F-090; F-120 front axle)	5690726	15.735"	24.795"	9.06"
TE/TS-50; TE-60 (with F-090 or F-120 front axle)	5688931	18.915"	29.975"	11.06"

POWER STEERING TORQUE SPECIFICATIONS

LOCATION	TYPE OF PART	TORQUE (1) (FT. LBS.)
Steering Gear to Frame Bolt		
Conventional Cab and "S" Models	Nut	90-130
Tilt Cab Models	Nut	90-110
Pitman Arm to Pitman Shaft		
Conventional Cab and "S" Models (Pinch Bolt)	Nut	100-110
Steel Tilt Cab Models	Nut	220-250
Steering Gear Adjustments		
Lash Adjuster Screw	Nut	25-35
Side Cover to Housing	Bolt	25-35
Worm Bearing Adjuster Screw	Nut	50-110
Control Valve to Steering Gear	Bolt	35-45
Hose Fittings to Ports	—	20-30
Steering Column Clamp Bolt	Bolt	15-20
Steering Shaft "Stop" Clamp Bolt	Nut	8-12
Steering Shaft to Worm Shaft Clamp Bolt		
All Except "S" Models	Nut	40-50
"S" Models	Nut	30-40
Steering Connecting Rod Stud to Pitman Arm and Steering Arm		
Conventional Cab and "S" Models (2)	Nut	40 (2)
Tilt Cab Models (2)	Nut	125-150 (2)
Tie Rod to Steering Arm Stud		
F-050; F-055 Front Axle	Nut	150-160 (2)
F-070 Front Axle	Nut	150-180 (2)
F-090; F-110; F-120 Front Axle	Nut	125-150 (2)

## POWER STEERING TORQUE SPECIFICATIONS (CONT.)

LOCATION	TYPE OF PART	TORQUE (1) (FT. LBS.)
Steering Tie Rod End Clamp Bolt		
F-050, F-055 Front Axle	Nut	45-55
F-070 Front Axle	Nut	80-100
F-090, F-110 Front Axle	Nut	65-75
F-120 Front Axle	Nut	60-80
Power Steering Cylinder Anchor Bracket to Frame Bolt	Nut	80-120
Power Steering Cylinder Anchor Bracket to Axle Bolt	Nut	50-60
Power Steering Cylinder to Pitman Arm Stud	Nut	125-150 (2)
Power Steering Cylinder Anchor Bracket to Tie Rod U-Bolt		
Except Tilt Cab Models	Nut	30-40
Tilt Cab Models	Nut	35-45
Power Steering Cylinder Anchor Stud to Axle	Nut	125-150
Power Steering Cylinder Ball Stud Socket Clamp Bolt		
With Frame Mounted Cylinder	Nut	55-65
Except Tilt Cab Models	Bolt	55-65
Tilt Cab Models	Bolt	40-50
Power Steering Pump Pulley		
CE/CS-40; CE/CS/SE/SS-50	Nut	65-95
CG-50	Nut	25-30
TE-50; CE/ME/TE-60	Nut	40-55
TS50	Nut	55-65
Power Steering Pump Mounting Bracket to Engine	Bolt	25-30
Power Steering Pump Support Bracket to Mounting Bracket	Bolt	20-30
Power Steering Pump to Mounting Bracket	Bolt	25-30
Power Steering Pump to Support Bracket Bolt	Nut	20-30
Power Steering Pump Stud to Mounting Bracket	Nut	25-30
Reservoir Mounting Bracket to Support	Bolt	20-25
Reservoir to Mounting Bracket	Bolt	20-25
Oil Cooler to Support Bracket	Bolt	10-15
Vane Type Hydraulic Pump		
Mounting Bolt or Stud	—	25-40
Port Fitting	—	25-40
Slipper Type Hydraulic Pump		
Reservoir Cap Screw	—	15-20
Pressure Relief Valve	—	30
Front Insert Nut	Nut	95-105

(1) NOTE: All Tapered Ball Studs must be Clean and Dry.

(2) Tighten Nut to Specified Torque, then Advance to Next Aligning Slot and Install a New Cotter Pin.



