Service Manual

Fuller Heavy Duty Transmissions TRSM0501

October 2007

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SERVICE MANUAL
MODEL RT-610

TWIN COUNTERSHAFT ROADRANGER® TRANSMISSION

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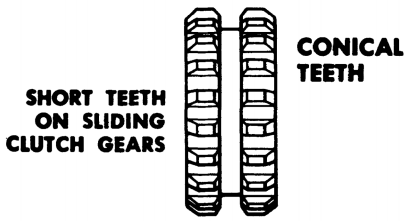
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DESCRIPTION

This model features the twin-countershaft design and ROADRANGER® principle of operation, and is designed for medium-duty vehicles with engines in the 600 lb.-ft. maximum torque range.

Engine torque is split between the two countershafts, thus reducing tooth pressures on mainshaft and countershaft gears. This enables a reduction in gear, shaft and bearing size while maintaining a high capacity level.



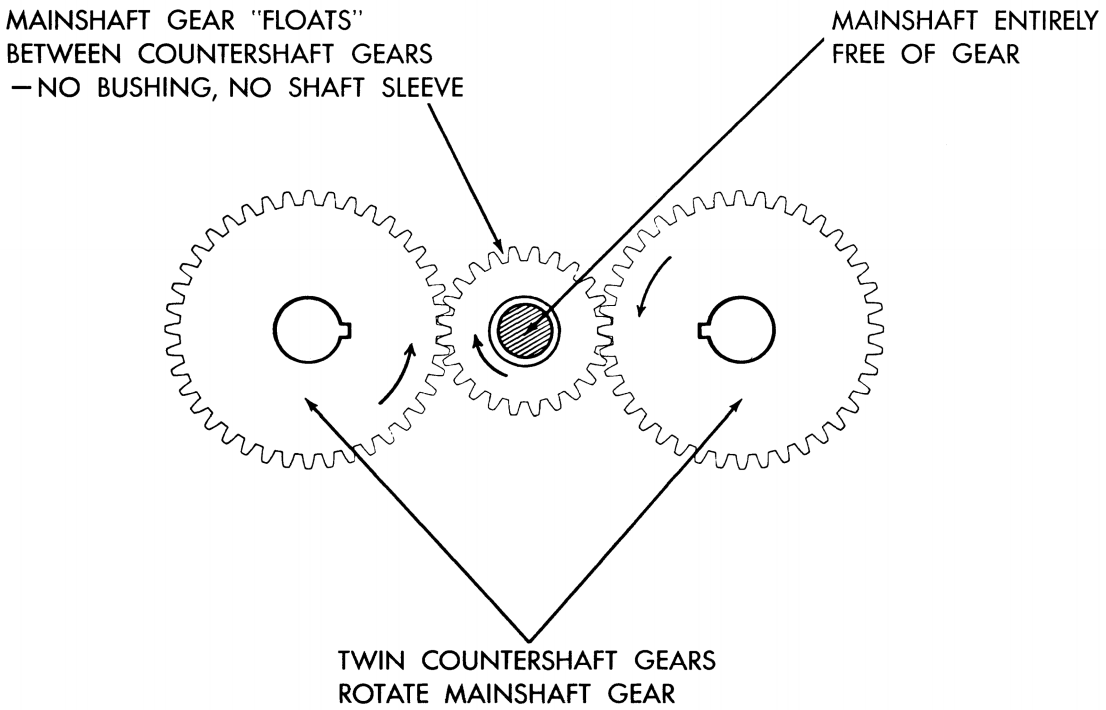
"Floating" mainshaft gears are held in radial position by rotation of countershaft gears. Axial position is maintained by washers. This provides equal tooth loading on mainshaft gears and eliminates the need for sleeves and bushings.

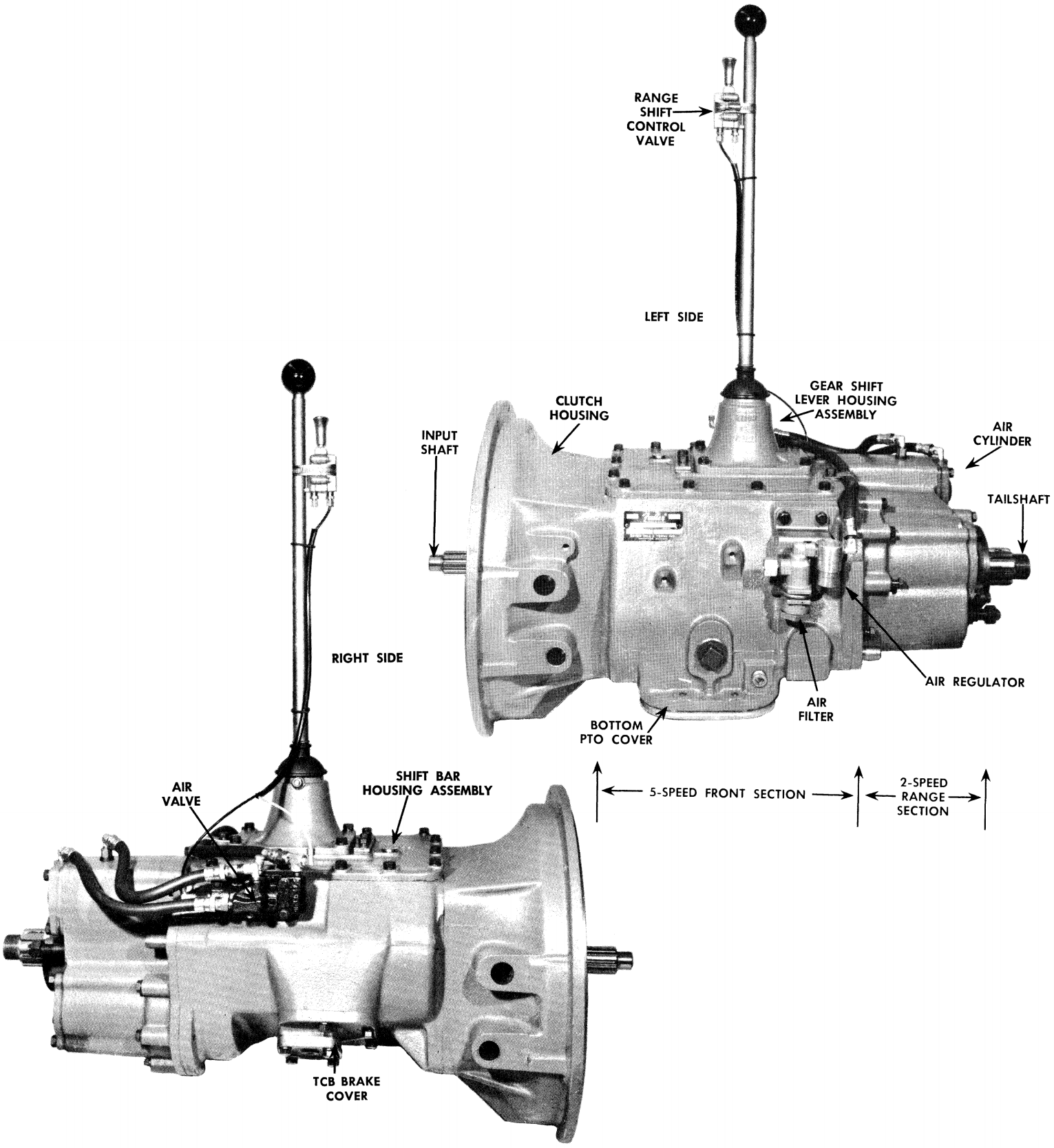
Gears are clutched to the mainshaft by short sliding clutch gears on the mainshaft which engage internal splines in gear hubs. Sliding clutch gears with conical clutching teeth, provide short and easy shifts.

Ten speeds are obtained by a five speed main section and a two speed range section. The five gear ratios in the main section are used once through reduction in low range and again in high (direct) range.

All ten speeds are controlled by one gear shift lever and a range control button. Range shifts are automatic after pre-selection.

FLOATING GEAR PRINCIPLE




RANGE SHIFT CONTROL VALVE
LEFT SIDE
GEAR SHIFT LEVER HOUSING ASSEMBLY
CLUTCH HOUSING
INPUT SHAFT
AIR CYLINDER
TAILSHAFT
AIR REGULATOR
AIR FILTER
BOTTOM PTO COVER
5-SPEED FRONT SECTION
2-SPEED RANGE SECTION
RIGHT SIDE
AIR VALVE
SHIFT BAR HOUSING ASSEMBLY
TCB BRAKE COVER

OPERATION

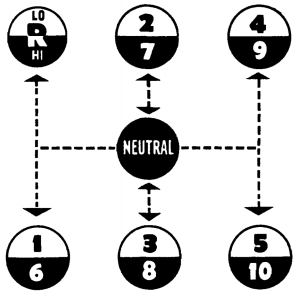
In the following instructions, it is assumed that the driver is familiar with motor trucks and tractors, and that he can coordinate the necessary movements of the shift lever and clutch pedal to make progressive and selective gear engagements in either direction, up or down.

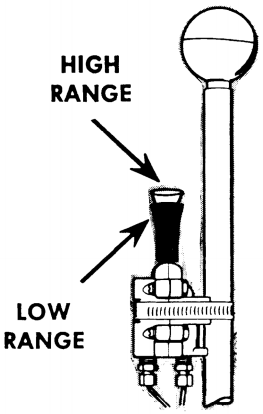
The RT-610 has ten selective ratios which are progressively spaced. Do not shift this transmission as you would a conventional model with an auxiliary or two-speed axle, because there is no split-shifting.

All shifts are made with one lever. The range control button is used one time only during an up shift sequence, and one time only during a down shift sequence.

Since the transmission consists of a five-speed front section and a two-speed range section, the ten forward speeds are obtained by using a five-speed shifting pattern twice — the first time with the transmission in low range, and the second time with the transmission in high range.

By using the same shifting pattern twice, the shift lever position for 6th speed is the same as 1st . . . 7th the same as 2nd, 8th the same as 3rd, 9th the same as 4th, and 10th the same as 5th.





Upshifting

A. Move the gear shift lever to the neutral position.

B. Start the engine.

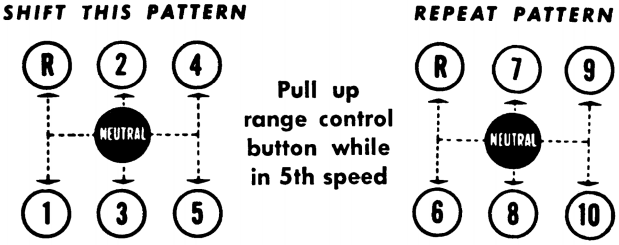
C. Wait for air system to reach normal line pressure.

D. Now look at the Range Control Button. If it is *up* push it to the down position. (With the downward movement of the button, the transmission will shift into low range.) If the button *was* down when the truck was last used, the transmission is already in low range.

E. Now start the vehicle and shift progressively through 1st, 2nd, 3rd and 4th to 5th.

F. When in 5th and *ready for the next upward shift,* PULL the Range Control Button UP and move the lever to 6th speed. As the lever *passes through the neutral position,* the transmission will automatically shift from low range to high range.

G. With the transmission in high range, you may now shift progressively through 7th, 8th and 9th to 10th.



Downshifting

A. When shifting down, move the lever from 10th through each successive lower speed to 6th.

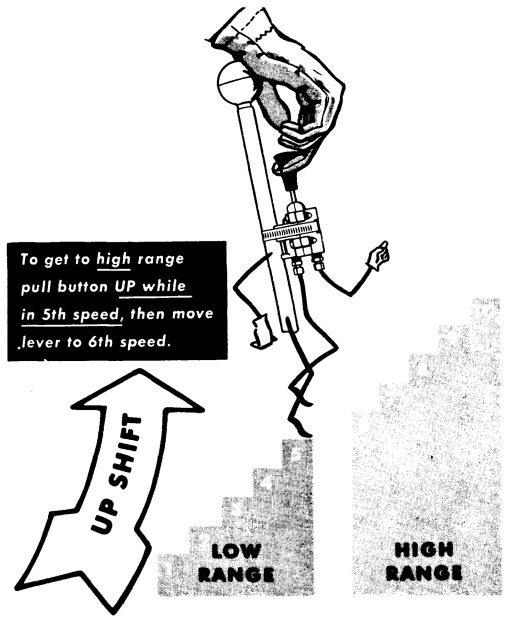
B. When in 6th, and *ready for the next downward shift,* PUSH the Range Control Button DOWN and move the lever to 5th speed. As the lever *passes through the neutral position,* the transmission will automatically shift from high range to low range.

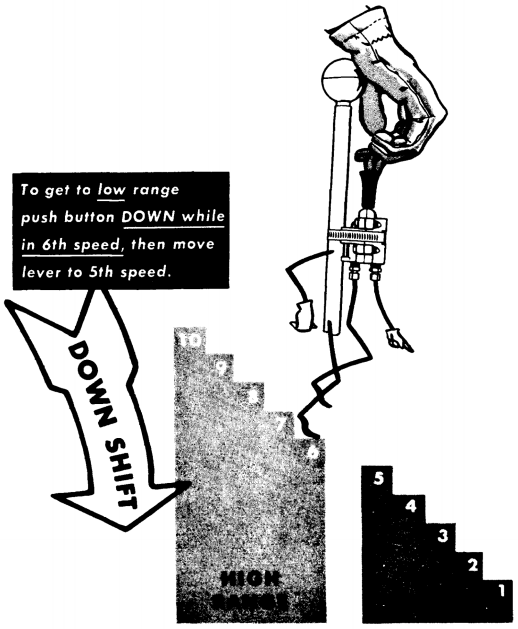
C. With the transmission in low range, shift downward through each of the four remaining steps.

Precautions

To protect the transmission from abuse, the following precautions should be observed when shifting the vehicle:

1. Do not attempt to shift from high range to low range at high vehicle speeds. This downward range shift should be made only at a road speed



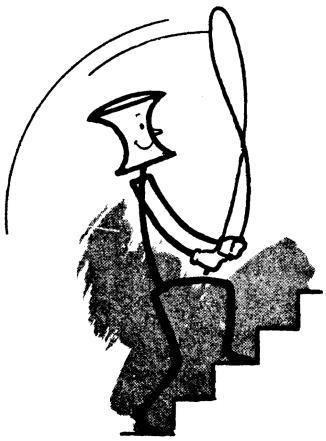


equal to that provided by fifth or a lower gear at governed engine speed.

2. Do not attempt to make any range shifts either up or down when the vehicle is moving in reverse. Stay in the range originally selected.

Skip Shifting

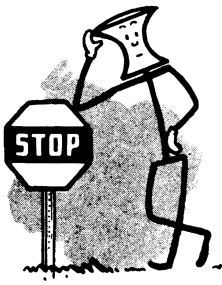
After becoming proficient in shifting this transmission, the operator may wish to skip some of the gear ratios to offset a particular operating condition. Skip shifting can be done when up shifting providing the range control button is pulled up to the high range position before making any shift which passes fifth speed.



Skip shifting is also possible during down shifting providing the range control button is pushed down to the low range position before making any shift which passes sixth speed.

General Instructions

The shift through neutral is important only on the first shift made after the control button is moved. Subsequent shifts through neutral will not activate the automatic range shift until the control button is moved once more.



When necessary to slow or stop the vehicle, shift down through the individual short steps, allowing the compression of the engine to slow the vehicle. The life of chassis and trailer brakes can thus be prolonged.

When slowing the vehicle, it is also permissible to coast in high range with the clutch disengaged. The shift to low range, however, should not be made until it is necessary to accelerate the vehicle once more.

A shift diagram should be on your dashboard. If your shift diagram has been misplaced, write to Service Department, Fuller Transmission Division, Eaton Yale & Towne Inc., Kalamazoo, Michigan, for replacement at cost.

LUBRICATION

Proper lubrication procedures are the key to a good all-round maintenance program. If the oil is not doing its job, or if the oil level is ignored, all the maintenance procedures in the world are not going to keep the transmission running or assure long transmission life.

Oil is important, because here are some of the things it must do:



- Provide a protective film — To protect surface of heavily loaded parts such as gear teeth and bearings, thus preventing metal to metal contact which causes scoring, scuffing and seizure.
- Act as a coolant — To dissipate heat.



- Have sufficient fluidity — To follow, coat and cushion all loaded surfaces.
- Be chemically stable — To withstand heat and agitation without separation, gumming-up, oxidizing or corroding.
- Be non-foaming — To prevent excessive foam and increased volume under severe conditions.
- Be free of sediment and water — To prevent sludge and rust.

Fuller Transmissions are designed so that the internal parts operate in a bath of oil circulated by the motion of gears and shafts. Grey iron parts have built-in channels where needed, to help lubricate bearings and shafts.

Thus, all parts will be amply lubricated if these procedures are closely followed:

1. **Maintain oil level. Inspect regularly.**
2. **Change oil regularly.**
3. **Use the correct grade and type of oil.**
4. **Buy from a reputable dealer.**

Lubrication Change and Inspection
HIGHWAY USE

First 3,000 to 5,000 miles (4827 to 8045 Km)	Change transmission oil on new units.
Every 5,000 miles (8045 Km)	Inspect Oil Level. Check for leaks.
Every 50,000 miles (80450 Km)	Change transmission oil.
OFF-HIGHWAY	
First 30 hours	Change transmission oil on new units.
Every 40 hours	Inspect oil level. Check for leaks.
Every 500 hours	Change transmission oil where severe dirt conditions exist.
Every1,000 hours	Change transmission oil (Normal off-highway use).
Change oil filter element, if so equipped, at each oil change.	

Recommended Lubricants
ON-HIGHWAY VEHICLES

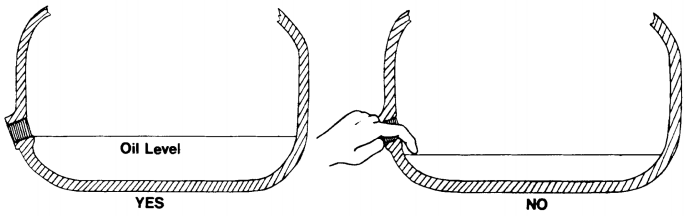
Type	Grade	Temperature
Heavy Duty Engine Oil MIL-L-2104C, or MIL-L-46152, or API-SE, or API-CC	SAE 50 or SAE 40 SAE 30	Above + 10°F. (—12.5°C.) Below + 10°F.
Mineral Gear Oil R and O Type	SAE 90 SAE 80W	Above + 10°F. Below + 10°F.
OFF-HIGHWAY		
Heavy Duty Engine Oil MIL-L-2104C, or MIL-L-46152, or API-SE, or API-CC	SAE 50 or SAE 40 SAE 30	Above + 10°F. Below + 10°F.
Special Recommendation — For extreme cold weather where temperature is consistently below 0° F.		
Heavy Duty Engine Oil MIL-L-2104C, or MIL-L-46152, or API-SE, or API-CC	SAE 20W	Below 0°F. (—18°C.)

Miscellaneous Lubricants

O-Rings and Surfaces — Dow Corning #200 Silicone, 30,000 Centistokes. Union Carbide L-45 Silicone, 30,000 Centistokes.

Proper Oil Level

Make sure oil is level with filler opening. Because you can reach oil with your finger does not mean oil is at proper level.



Draining Oil

Drain transmission while oil is warm. To drain oil remove the drain plug at bottom of case. Clean the drain plug before re-installing.

Refilling

Clean area around filler plug and remove plug from side of case. Fill transmission to the level of the filler opening. If transmission has two filler openings, fill to level of rear opening on single countershaft models; fill to level of both openings on twin countershaft models.

The exact amount of oil will depend on the transmission inclination and model. *In every instance, fill to the level of the filler opening.*

Do not over fill — this will cause oil to be forced out of the case through mainshaft openings.

Adding Oil

It is recommended that types and brands of oil not be intermixed because of possible incompatibility.

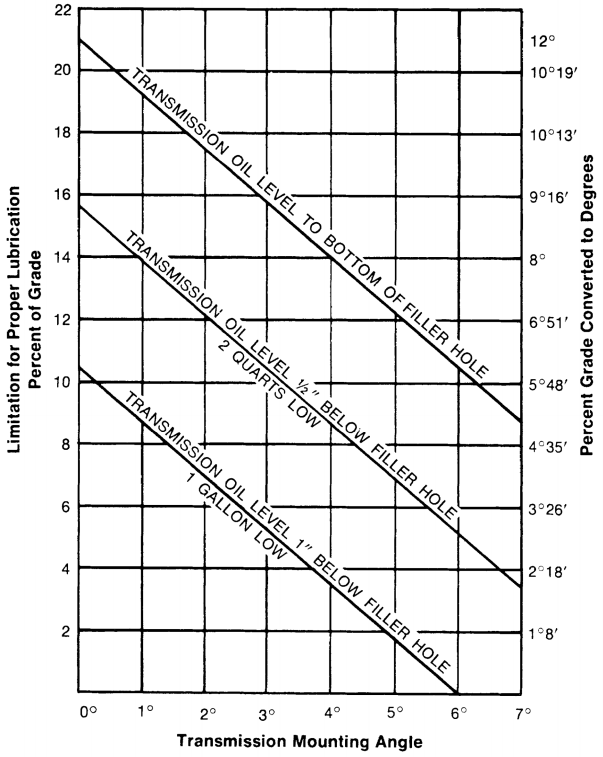
Operating Temperature

It is important that the transmission operating temperature does not exceed 250° F. (120° C.) for an extended period of time. Operating temperatures above 250° F. will cause breakdown of the oil and shorten transmission life.

The following conditions in any combination can cause operating temperatures of over 250° F: (1) operating consistently at roadspeeds under 20 MPH, (2) high engine RPM, (3) high ambient temperature, (4) restricted air flow around transmission, (5) exhaust system too close to transmission, (6) high horsepower, overdrive operation. High operating temperatures may require more frequent oil changes.

External cooler kits are available to keep the transmission operating temperature under 250° F. when the conditions described above are encountered.

Proper Lubrication



If the transmission operating angle is more than 12 degrees, improper lubrication can occur. The operating angle is the transmission mounting angle in the chassis plus the percent of upgrade (expressed in degrees).

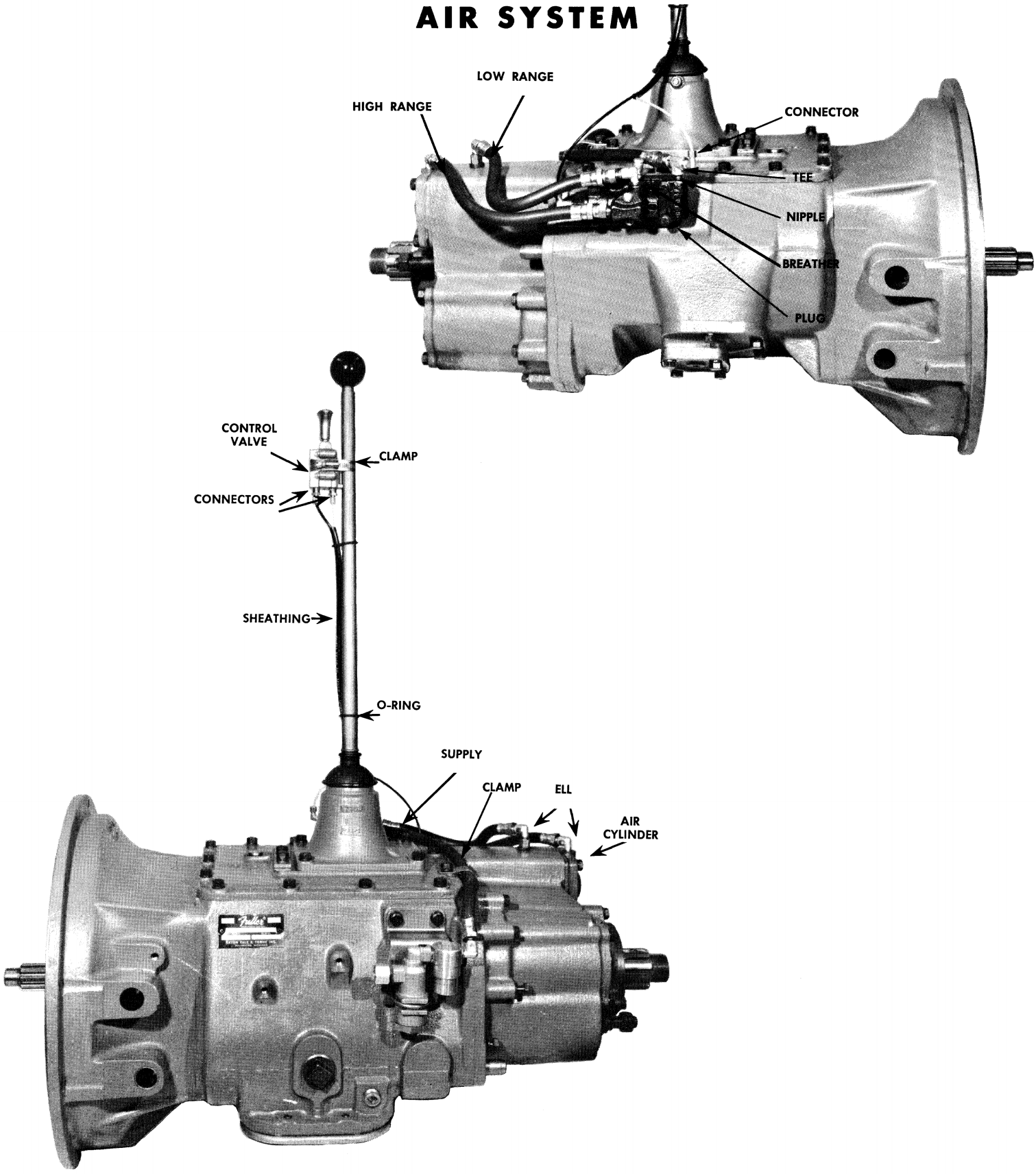
The above chart illustrates the safe percent of upgrade on which the transmission can be used with various chassis mounting angles. For example: If you have a 4 degree transmission mounting angle, then 8 degrees (or 14 percent of grade) is equal to the limit of 12 degrees. If you have a 0 degree mounting angle, the transmission can be operated on a 12 degree (21 percent) grade.

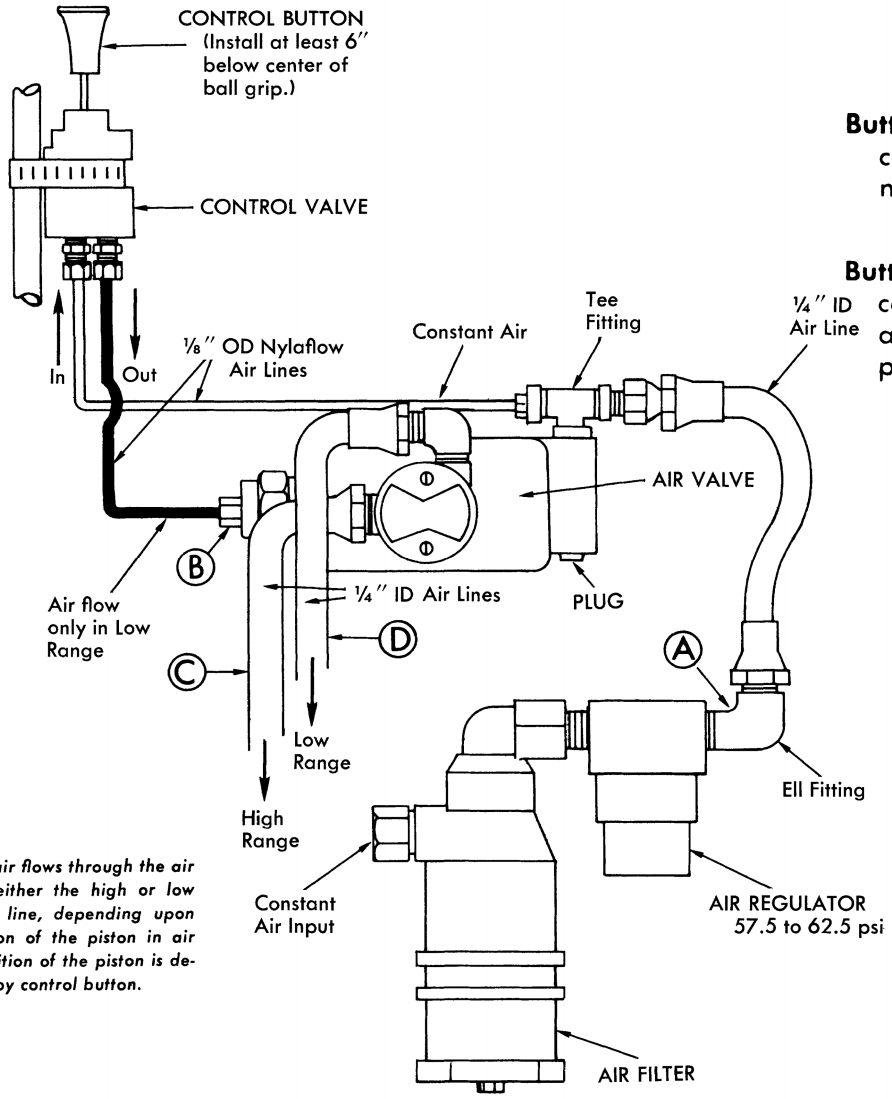
Anytime the transmission operating angle of 12 degrees is exceeded for an extended period of time the transmission should be equipped with an oil pump or cooler kit to insure proper lubrication.

Note on the chart the effect low oil levels can have on safe operating angles. Allowing the oil level to fall ½″ below the filler plug hole reduces the degree of grade by approximately 3 degrees (5.5 percent).

Proper Lubrication Levels are Important!

AIR SYSTEM


LOW RANGE
HIGH RANGE
CONNECTOR
TEE
NIPPLE
BREATHER
PLUG
CONTROL VALVE
CLAMP
CONNECTORS
SHEATHING
O-RING
SUPPLY
CLAMP
ELL
AIR CYLINDER



Button Up: High range, control valve is closed and no air passes through

Button Down: Low range, control valve is open and air passes through to end port of air valve

Constant air flows through the air valve to either the high or low range air line, depending upon the position of the piston in air valve. Position of the piston is determined by control button.

Basic Installation and Trouble Shooting Guide

Operation

The range shift air system consists of an air filter, regulator, air valve, control valve, an air cylinder which is built into the auxiliary housing, fittings, and connecting lines.

Range shifts can only be made when the gear shift lever is in, or passing through, neutral. Thus, the range desired can be pre-selected while the shift lever is in a gear position. As the lever is moved through neutral, an actuating plunger in the shift bar housing releases the air valve piston allowing it to move to the range position selected.

Constant regulated air is supplied to the tee in top port of air valve and to the "IN" port of control valve. With control button down, the control valve is open, and air passes through control valve and to the end port of air valve. This permits air from the constant supply to flow through the low range port in air valve to the air cylinder in auxiliary housing. Air at the cylinder moves the shift piston and shaft to the rear to engage the low range gear.

With the control button up, the control valve is closed, and air is removed from end port of air valve. This permits movement of the air valve piston; air from the constant supply now flows through the high range port of the air valve and to the high range port of air cylinder in auxiliary housing. The shift piston and shaft are moved forward to engage the high range or direct gear.

When the control button is moved from one position to another, air from the previously charged line exhausts through the breather in air valve.

Trouble Shooting Range Shift Air System

If transmission fails to make a range shift or shifts too slow, the fault may be in the air system or actuating parts in the shifting bar housing. To check the air system and pin-point the trouble area, the following procedures are recommended, using the check points indicated by letters in the diagram on page 9.

Checks are to be made with the vehicle engine off, but with normal vehicle air pressure.

1. Incorrect Hook-up

With normal vehicle air pressure and gear shift lever in the neutral position, move the control button up and down, from one range to another.

a. If lines are crossed between the control valve and the air valve on transmission, there will be a steady flow of air from the bottom exhaust in control valve with button in the up position.

b. If lines are crossed between the air valve on transmission and the air or shift cylinder, the transmission gearing will not correspond with the button position. Low range, down position of button, will result in high range gear engagement in the transmission and vice versa.

2. Air Leaks

With normal vehicle air pressure and gear shift lever in the neutral position, coat all air lines and fittings with soapy water and check for leaks, moving control button to both positions.

a. If there is a steady leak out exhaust of control valve, there are defective parts or O-rings in the control valve.

b. If there is a steady leak out breather on air valve: there is a defective O-ring in the air valve, or there is a leak past O-rings on the shift cylinder piston.

c. If transmission fails to shift into low range or is slow to make the shift and the transmission case is pressurized, see Check Point E.

d. Tighten all loose connections and replace defective parts or O-rings.

3. Check Point A, Air Regulator

With normal line pressure and gear shift lever in neutral, check exhaust port of air regulator. There should be no leak from this port.

Cut off the vehicle air pressure and install air gauge in line at output port of air regulator. Bring vehicle air pressure to normal. Regulated pressure should be 57.5 to 62.5.

Only as a last resort should an adjustment be made with the screw in bottom of regulator. This adjustment has been set for correct operating limits. Any deviation from these limits, especially on regulators which have been in operation for some time, will in most cases be caused by dirt or worn parts. Adjustment of screw will give only a temporary remedy.

(1) Turning screw in (clockwise) raises air pressure.

(2) Turning screw out lowers air pressure.

Air regulator is not serviceable and should be replaced if defective.

4. Check Point B

With normal vehicle air pressure and the gear shift lever in the neutral position, pull the control button up to high range and disconnect the 1/8" nylon air line from out port of control valve at the air valve.

a. When control button is pushed down a steady blast of air will flow from disconnected line. Air will shut off when button is pulled up. This indicates that control valve is operating correctly. Reconnect air line.

b. If control valve does not operate correctly, check for restrictions and leaks; leaks indicate bad O-rings.

5. Check Point C

With normal vehicle air pressure and gear shift lever in the neutral position, push the control button down to the low range position and disconnect the high range air line, either at fitting on shift cylinder or at side port of air valve.

a. Pull the control button up. There should be a steady flow of air from the high range port. Push button down to shut off air.

b. Make sure vehicle engine is off and move the gear shift lever to a gear position. Pull the button up; there should be no air at high range port. Move the gear shift lever to neutral; there should now be a steady flow of air from the high range port. Push button down to shut off air and reconnect the high range air line.

c. If air system operates incorrectly, this indicates that air valve is defective, or that actuating parts in shifting bar housing are jammed or defective.

6. Check Point D

With normal vehicle air pressure and gear shift lever in the neutral position, pull the control button up to high range and disconnect the low range air line, either at fitting on shift cylinder or at side port of air valve.

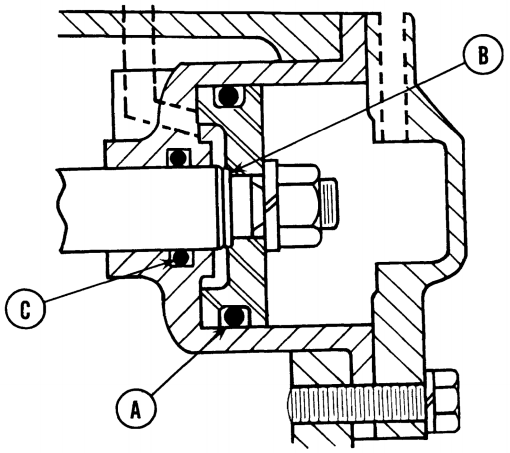
a. Repeat procedures under Check Point C, reversing the position of the control button in order to check the low range operation.

7. Check Point E

If any of the seals in the range shift cylinder are defective the range shift will be affected. The degree of lost air will govern the degree of failure, from slow shift to complete failure.

a. Leak at seal A or B as shown in diagram results in failure to shift into either low or high range; steady leak out air valve breather in both ranges.

b. Leak at seal C results in failure to shift into low range; pressurizing of transmission.



Check Point E—Cross section of range shift cylinder, showing location of seals.

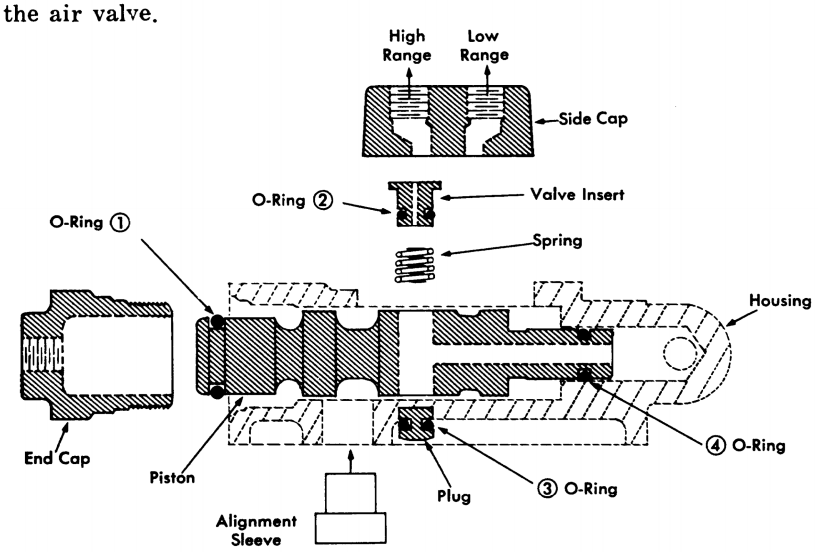
Air Valve Pre-Selection

An actuating pin protruding from the shifting bar housing prevents the actuating piston in the air valve from moving while the gear shift lever is in a gear position and releases the piston when the lever is moved to or through neutral. See detailed installation of air valve for installation precaution concerning the actuating pin.

Air Valve

With the range control button up the control valve shuts off the air supply to the end cap. Thus, the constant air entering at the constant supply port forces the piston to the rear. The constant air also flows through a channel in the center of the piston and to an external port which is aligned with the high range port of the air valve.

With the control button down the control valve opens and supplies air to the end cap. Since the piston area is larger on this end of the piston, it is forced in the opposite direction. The external air port in the piston is now aligned with the low range port of the air valve.



Exploded view of air valve. The alignment sleeve is not part of the assembly, but must be installed in housing for proper pre-select operation.

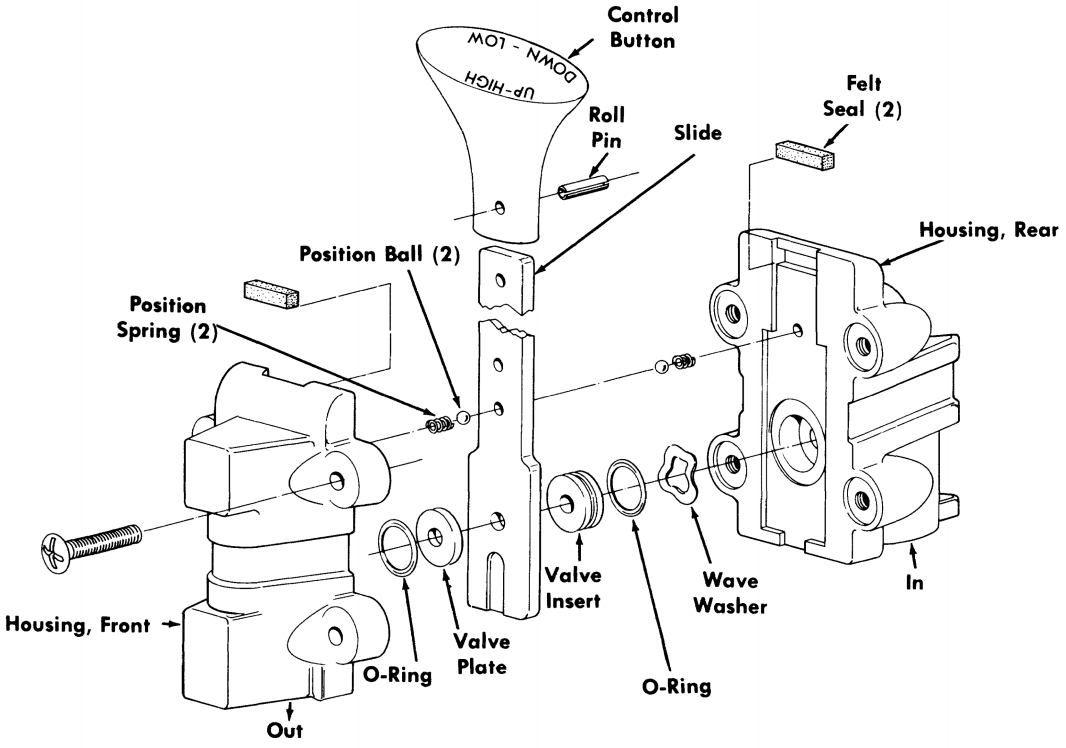
The four O-rings are indicated by circled numbers. If any of these are defective, there will be a constant air leak out of the exhaust on the air valve. In normal operation, exhaust will occur only for an instant as the range shift is made. The following chart is to be used as a guide to determine defective O-rings.

Defective O-Rings	RESULT
1	Constant leak through exhaust in low range only.
2 or 3	Constant leak through exhaust in both ranges.
4	Constant leak through exhaust in high range; steady but low volume leak through exhaust in low range.

To Disassemble Air Valve

1. Turn out the two capscrews and remove the side cap from valve body.
2. Remove the valve insert from piston and remove O-ring from the valve insert.
3. Remove the spring from piston.
4. Turn end cap from valve body and withdraw piston from bore.
5. Remove the two O-rings from piston.
6. Remove the nylon plug from piston and remove O-ring from plug.

Control Valve



Exploded View of Control Valve

The "IN" port is constant supply. The "OUTLET" port is connected by ⅛" OD air line to end cap of air valve.

If the O-rings or parts in the control valve are defective there will be a constant air leak out the exhaust located on bottom of control valve.

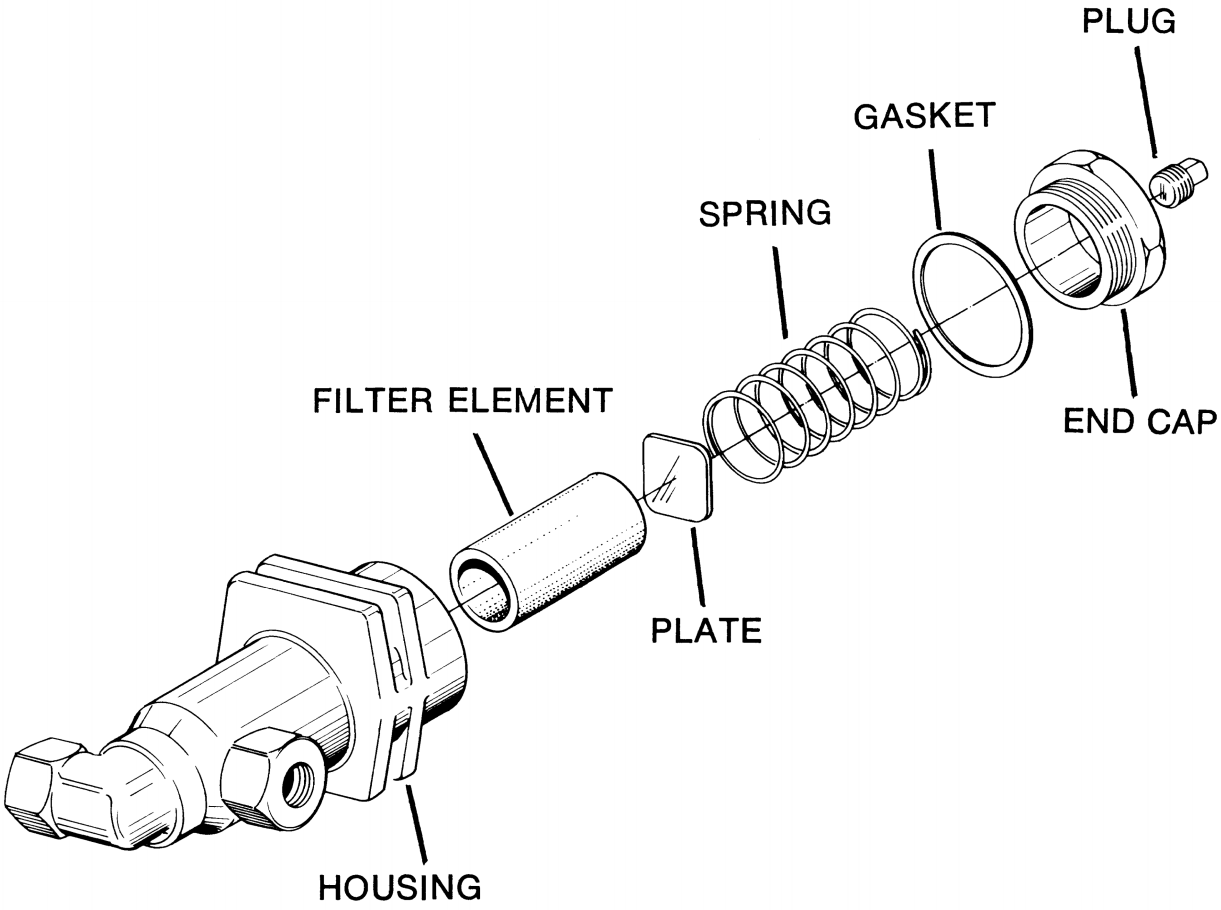
A defective insert valve O-ring will result in a constant leak through exhaust in both ranges and valve will not make range shifts.

A defective housing O-ring will result in a constant, low volume leak through exhaust in low range only.

If the slide is assembled backwards, there will be a constant leak through exhaust in high range. When installing slide in control valve make sure that slot in slide faces the outlet port.

1. Place control valve with rear housing (inlet side) on bench and remove the four screws to separate front and rear housings.
2. Remove the slide and the two position balls and springs.
3. Remove the flat metal seal from outlet side and remove the O-ring from body.
4. Remove the valve insert from front housing and remove the O-ring from valve insert.
5. Remove the wave washer installed under valve insert.
6. Remove the two felt wipers from valve housings.
7. Punch out roll pin and remove control button from slide.

Air Filter



AIR FILTER

The air filter contains a replaceable filter element which can be removed by turning out the end cap and removing the spring and tension plate. This element should be cleaned at each oil change, or more often under high humidity conditions.

SPECIFICATIONS

TORQUE CAPACITY — 600 lb.-ft. nominal rating.

SPEEDS — 10 forward, 2 reverse.

GEAR RATIOS —	**SPEED**	**RATIO**	**% STEP**
	10th	1.00	24%
	9th	1.24	29%
HIGH	8th	1.60	28%
RANGE	7th	2.05	28%
	6th	2.62	31%
	RANGE SHIFT		
	5th	3.43	24%
	4th	4.26	29%
LOW	3rd	5.48	28%
RANGE	2nd	7.02	28%
	1st	9.00	
HIGH RANGE REVERSE		2.77	
LOW RANGE REVERSE		9.50	

CLUTCH RELEASE MECHANISM —

Push Type Clutches — Single and 2-Plate — Clutch release bearing carrier, release bearing, extended front bearing cover, release yoke, pedal shafts and pedal adjusting arm furnished.

Pull Type 2-Plate Clutches — Deep clutch housing, long drive gear and flat bearing cover machined for clutch brake furnished. Secure release yoke, pedal shafts and pedal adjusting arm from clutch manufacturer.

RANGE SHIFT AIR SYSTEM — The air range shift system consists of a control valve mounted on the gear shift lever and a slave valve mounted on the side of the transmission case connected with nylon air hoses. The range shift cylinder is internally contained in the auxiliary case and operates automatically upon pre-selection.

AIR CLEANER — Heavy duty air cleaner furnished as standard equipment to protect range shift control system and air cylinder from water, dirt and sludge.

AIR REGULATOR — An air regulator is furnished in the range shift air system to provide regulated pressure.

POWER TAKE-OFF —

Openings —

Right Side — SAE standard 6-bolt regular duty type, short length.

Bottom — SAE standard 8-bolt heavy duty type.

PTO DRIVE GEAR SPEEDS —

Right Side — 33 tooth 6/8 pitch gear turning .723 engine speed.

Bottom — 33 tooth 6/8 pitch gear turning .723 engine speed.

SPEEDOMETER DRIVE — Provision is made in rear bearing cover for installation of speedometer gears and attachment of cable.

CLUTCH HOUSING SIZE —

Gray Iron — SAE No. 2 Deep only, 6⅝", for push or pull type clutches.

WEIGHT — With Standard Controls —

Gray Iron Case, SAE No. 2 deep clutch housing, less clutch release parts — 425 lbs.

OIL CAPACITY — Approximately 12 pints, depending upon inclination of engine and transmission. Fill to level of case filler opening.

GENERAL PRECAUTIONS FOR DISASSEMBLY

IMPORTANT: Read this section before starting the detailed disassembly procedures.

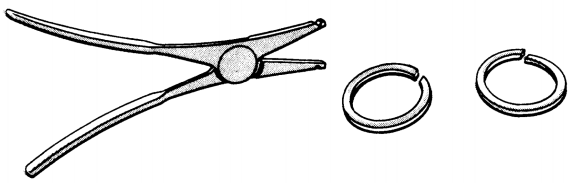
It is assumed in the detailed disassembly instructions that the transmission lubricant has been drained and the transmission has been removed from the chassis.

Removal of the gear shift lever housing assembly is included in the detailed instructions; however, this assembly must also be removed from transmission before removing unit from vehicle.

Follow each procedure closely in each section, making use of both the text and pictures.

1. **BEARINGS** — Carefully wash and relubricate all bearings as removed and protectively wrap until ready for use. Whenever possible, remove all bearings with pullers designed for this purpose.

2. **SNAP RINGS** — Remove snap rings with pliers designed for this purpose. Rings removed in this manner can be reused.



3. **INPUT SHAFT** — The clutch or input shaft can be removed without removing the countershafts, mainshaft or drive gear.

4. **CLEANLINESS** — Provide a clean place to work. It is important that no dirt or foreign material enters the unit during repairs. The outside of the unit should be carefully cleaned before starting the disassembly. Dirt is abrasive and can damage highly polished parts such as bearings and washers.

5. **WHEN DRIVING** — Apply force to shafts, housings, etc., with restraint. Movement of some parts is restricted. Do not apply force after the part being driven stops solidly. Use soft hammers and bars for all disassembly work.

DETAILED DISASSEMBLY INSTRUCTIONS

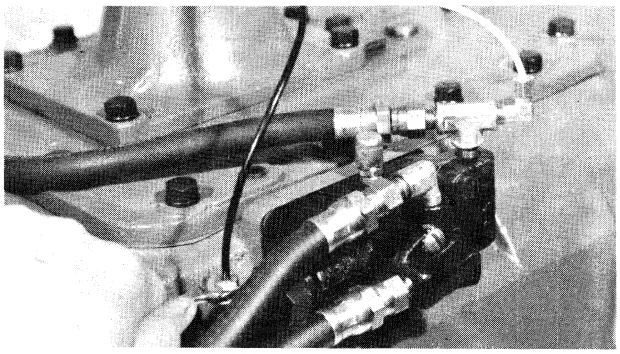
I. RANGE SHIFT AIR SYSTEM

A. To Remove the Range Shift Control Valve.

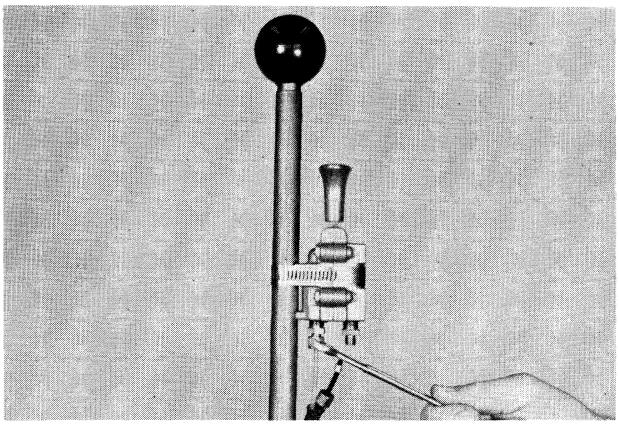
1. Disconnect the two nylon air lines at air valve on transmission. Illustration No. 1.

   NOTE: *If desired, the gear shift lever housing lever and control valve can now be removed from the transmission as a unit by turning out the four capscrews which attach the housing to the transmission.*

2. Disconnect the two nylon air lines at the control valve on gear shift lever. Illustration No. 2.
3. Remove the ball grip from gear shift lever.
4. Loosen the mounting clamp and remove the control valve and mounting clamp from lever.
5. Remove nylon air lines, sheathing and O-ring clamp from the gear shift lever.



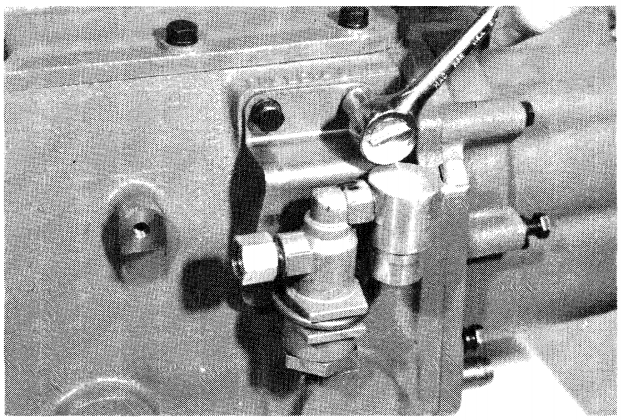
1. *Disconnecting the control valve air lines at air valve.*



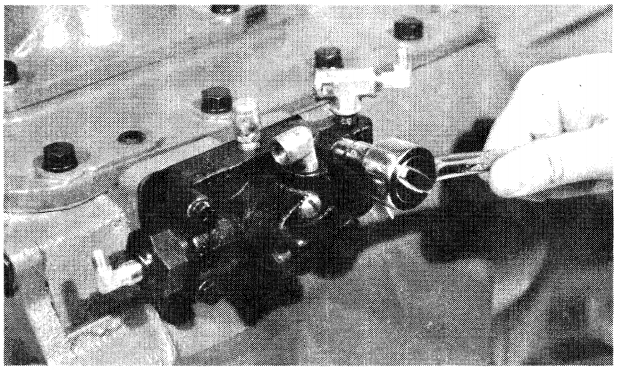
2. *Disconnecting air lines from range shift control valve.*

B. To Remove Air Regulator and Filter Assembly.

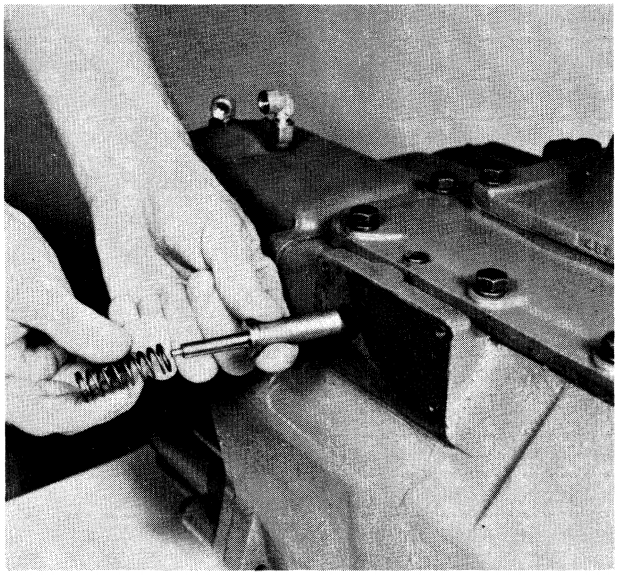
1. Disconnect and remove the air line, including clamp, between the air valve and air regulator.
2. Remove street ell and reducer from regulator if necessary.
3. Turn out capscrews and remove the air regulator and filter assembly from transmission. Illustration No. 3.
4. Turn the air regulator from nipple.
5. Turn out the two u-bolt nuts and remove bracket from filter.



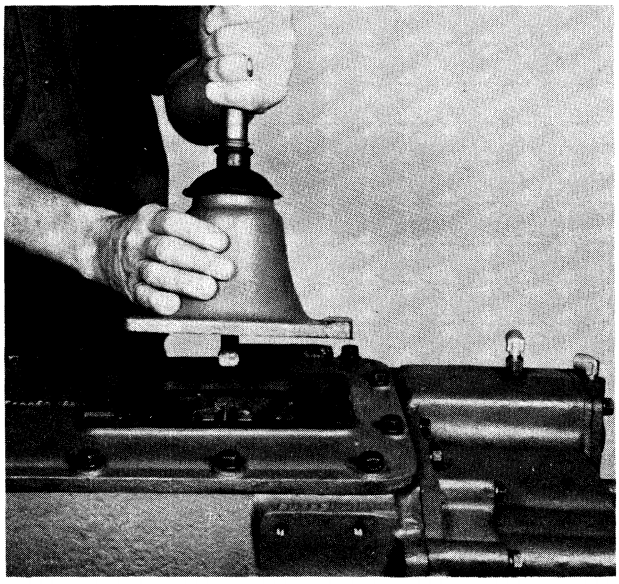
3. *Removing air regulator and filter assembly from transmission.*



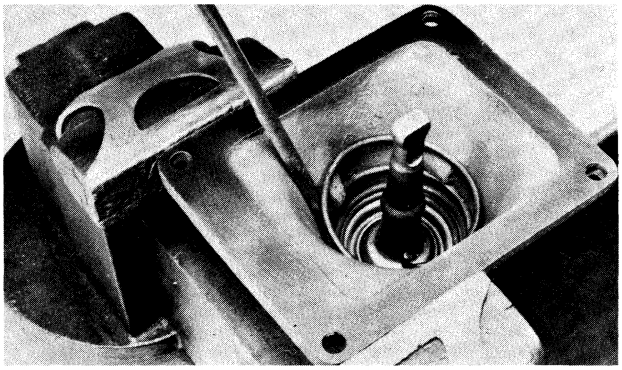
4. *Removing air valve from transmission.*



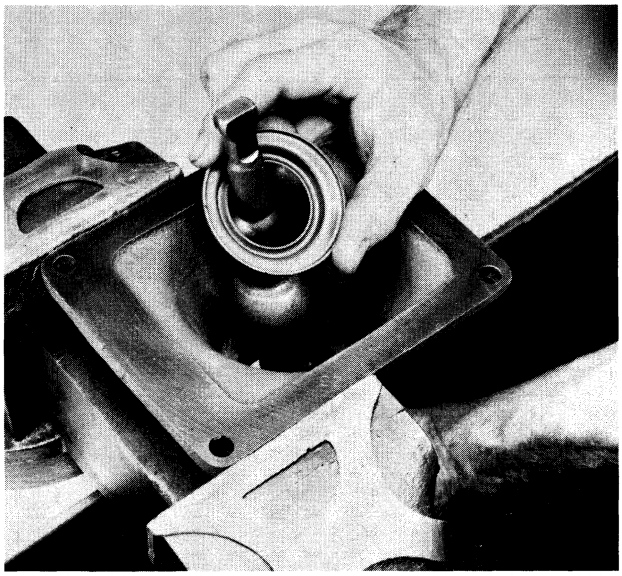
5. *Removing actuating spring and pin from case.*



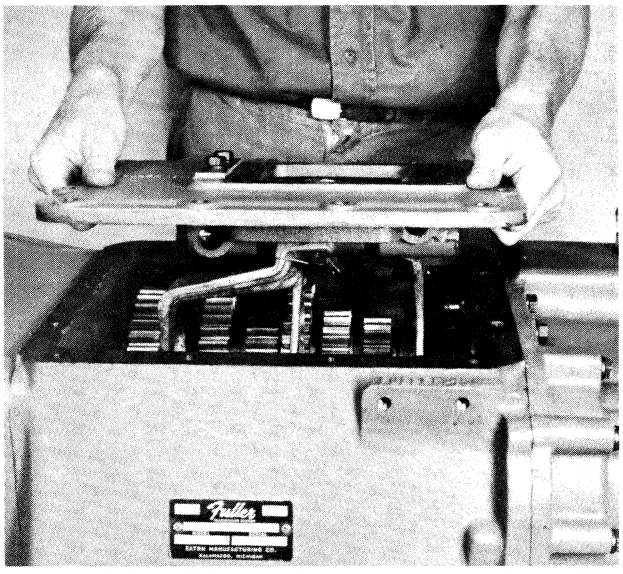
6. *Removing the gear shift lever housing.*



7. *Removing the gear shift lever tension spring.*



8. *Withdrawing the tension spring washer and gear shift lever from housing.*



9. *Lifting the shifting bar housing from transmission.*

C. To Remove the Air Valve.

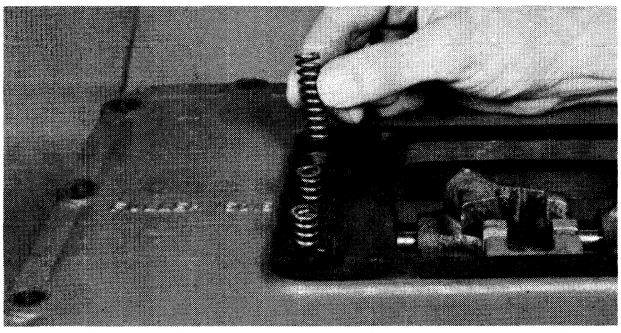
1. Remove the two air lines between the air valve and air cylinder in auxiliary.
2. Turn out the four capscrews and remove the air valve from transmission. Illustration No. 4.
3. If necessary, remove fittings from air valve.
4. Remove the actuating spring and pin from bore in transmission. Illustration No. 5.

NOTE: For disassembly of air system parts, see Air System section.

II. GEAR SHIFT LEVER

A. To Remove and Disassemble the Gear Shift Lever Housing Assembly.

1. Turn out the attaching capscrews and lift the gear shift lever housing or remote control housing from the shift bar housing. Illustration No. 6.
2. Remove the rubber dust protector from gear shift lever.
3. Mount the assembly in a vise with the large opening up.
4. Free the gear shift lever tension spring by twisting a heavy screwdriver between the spring and housing, forcing the spring from its seat under lugs cast in housing. Illustration No. 7.
5. Remove the tension spring from housing.
6. Withdraw the tension spring washer and gear shift lever out through bottom of housing. Illustration No. 8.
7. Remove the nut and lockwasher from the gear shift lever pivot pin.
8. Remove pivot pin by forcing it inward and through wall of housing.



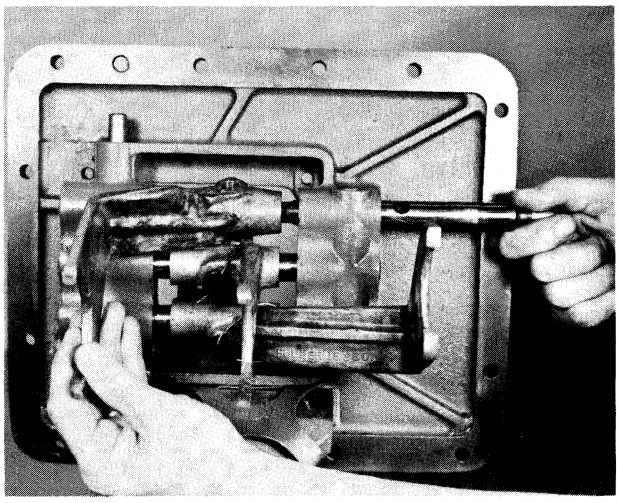
10. *Removing the tension springs.*

III. SHIFTING BAR HOUSING

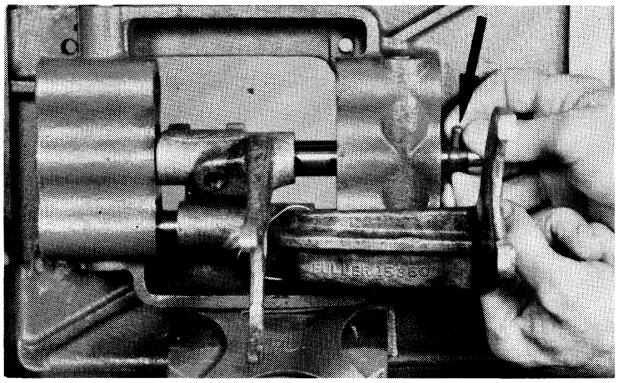
A. To Remove and Disassemble the Shifting Bar Housing.

1. Turn out the attaching capscrews, jar to break gasket seal, and lift the shifting bar housing from transmission. Illustration No. 9.
2. Turn out the two capscrews and remove the tension spring cover from top of housing.
3. Remove the three tension springs installed under cover. Illustration No. 10.
4. Tilt housing and remove the three tension balls installed under springs.
5. Place the housing in a vise with the plunger side up; front of housing will be to the right.

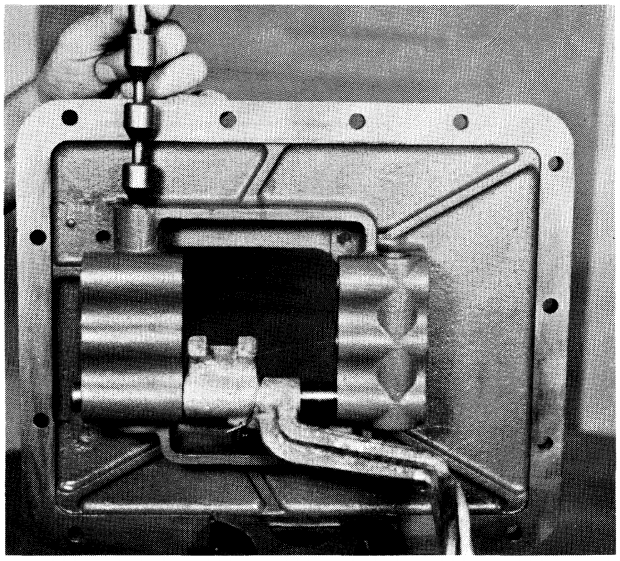
   NOTE: *During disassembly, lay all parts on a clean bench in the order of removal to facilitate reassembly. Bars not being removed must be kept in the neutral position or interlock parts will lock bars.*
6. Starting with the upper bar, move all bars to the right and out front of housing as detailed in the following instructions. Cut lockwire and remove lockscrews from each bar just prior to its removal.
7. Move top shifting bar to the right and out of housing, removing shifting yoke from bar. Illustration No. 11.



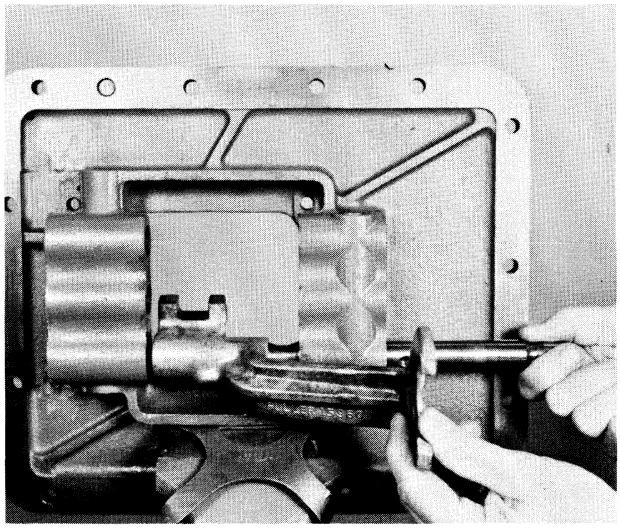
11. *Pulling the upper (1st-reverse speed) shifting bar from housing.*



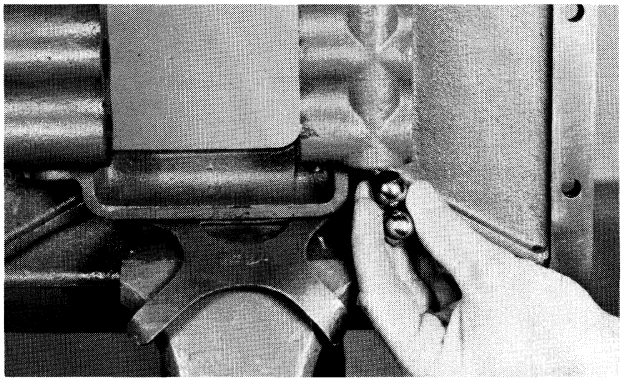
12. *Removing the interlock pin from neutral notch in center (2nd-3rd speed) shifting bar.*



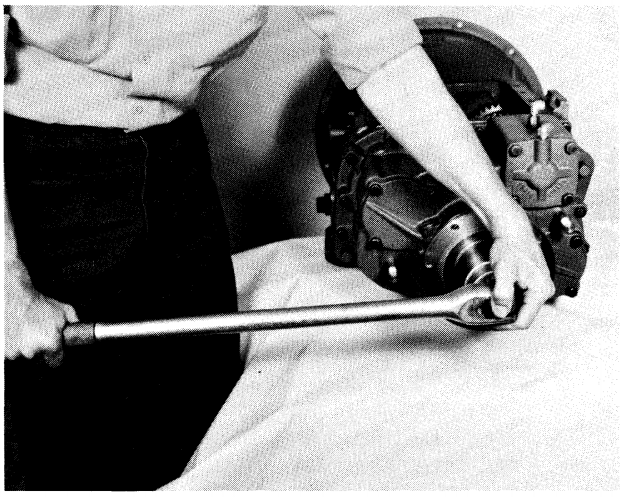
13. *Removing the actuating plunger from housing.*



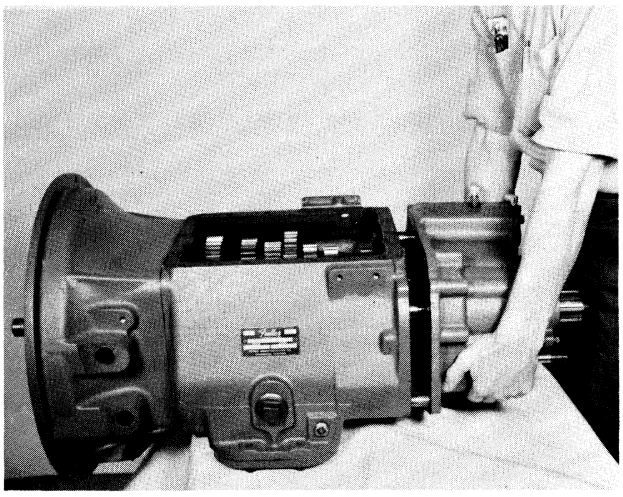
14. *Pulling the lower (4th-5th speed) shifting bar from housing.*



15. *Two interlock balls are located between bars in front web.*



16. *Turning nut from output shaft.*



17. *Pulling auxiliary section from transmission.*

8. Move center bar to the right and out of housing, removing shifting yoke from bar. As neutral notch in bar clears the front web, remove the interlock pin from bore in neutral notch. Illustration No. 12.
9. Remove the actuating plunger from rear web. Illustration No. 13.
10. Move the lower bar to the right and out of housing, removing shifting yoke from bar. Illustration No. 14.
11. Remove the two interlock balls from front web. Illustration No. 15.

IV. COMPANION FLANGE, AUXILIARY SECTION AND CLUTCH HOUSING REMOVAL

A. To Remove the Universal Joint Companion Flange or Yoke.

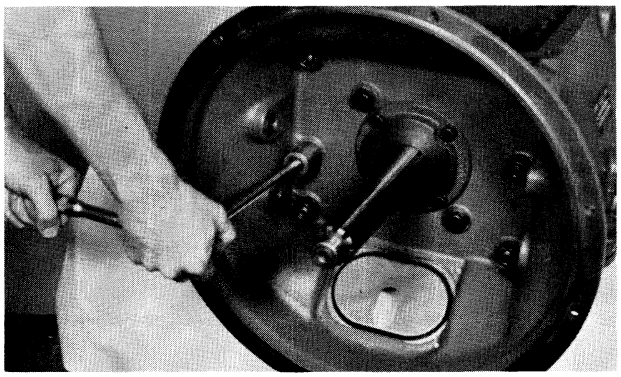
1. Lock the transmission by engaging two speeds with the mainshaft sliding clutch gears.
2. Turn the elastic stop nut from output shaft. Illustration No. 16.
3. Pull the flange or yoke straight to the rear and off shaft.

B. To Remove the Auxiliary Section from Transmission.

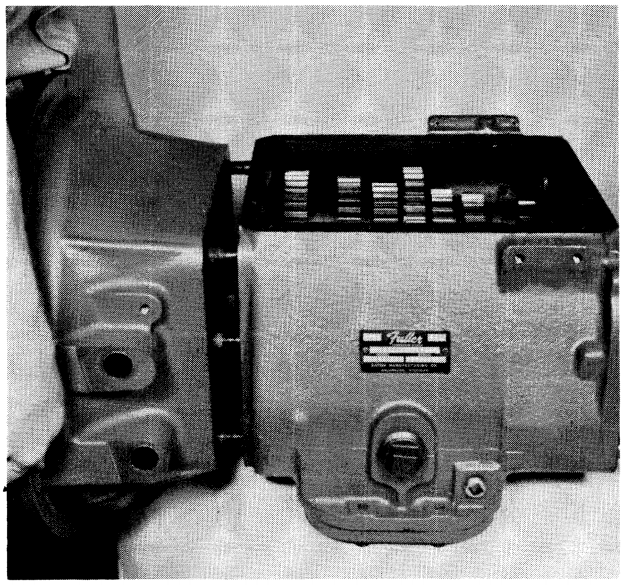
1. Turn out the capscrews that attach the two sections.
2. Insert puller screws in auxiliary housing flange.
3. Tighten puller screws evenly to move the auxiliary section straight to the rear and from front section. Illustration No. 17.

C. To Remove the Clutch Housing and Front Bearing Cover.

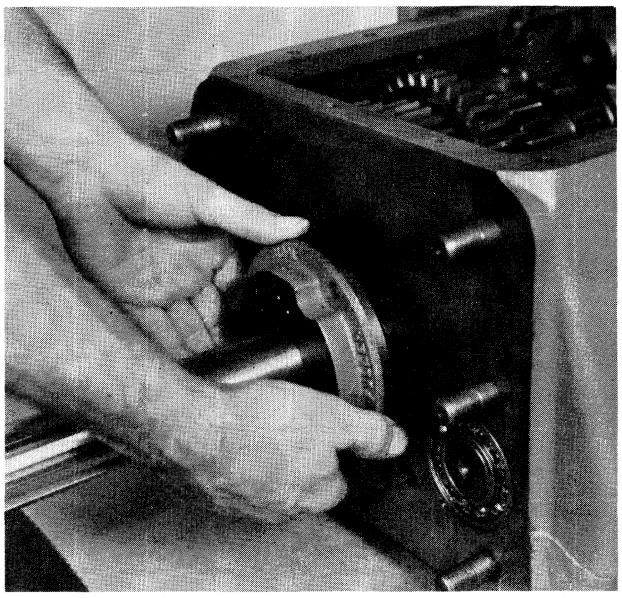
1. Remove the clutch release mechanism if so equipped.
2. Turn nuts from the six studs and turn out the two bolts which attach clutch housing to case. Illustration No. 18.
3. Break gasket seal and remove clutch housing from case. Illustration No. 19.
4. Turn out capscrews and remove the front gear cover. (Tap against drive gear from inside case to move cover forward to break gasket seal.) Illustration No. 20.



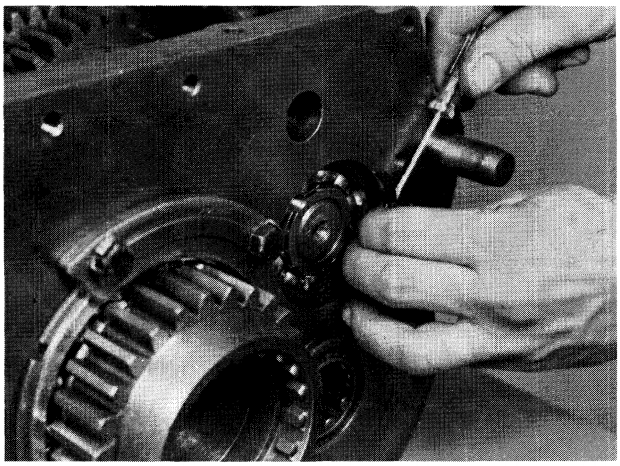
18. *Removing attaching nuts and bolts from clutch housing.*



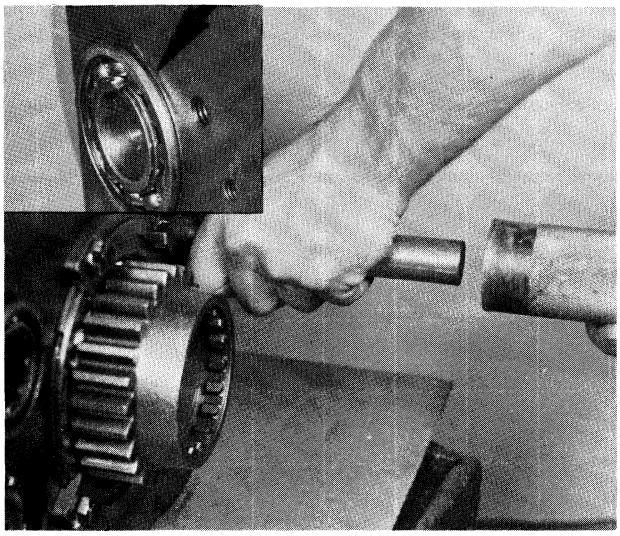
19. *Removing clutch housing from transmission.*



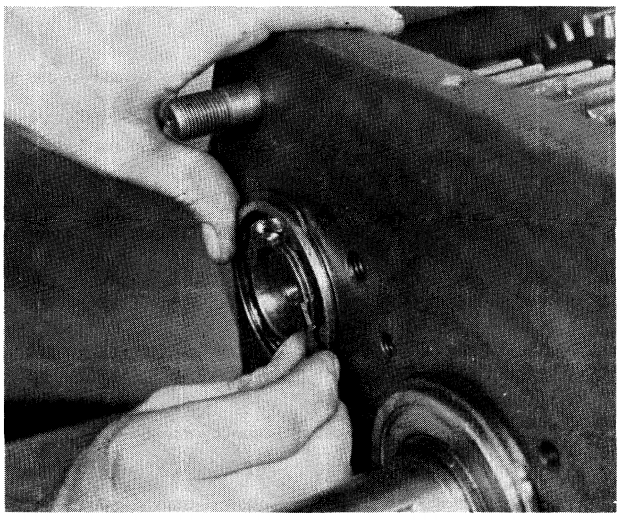
20. *Removing the drive gear bearing cover.*



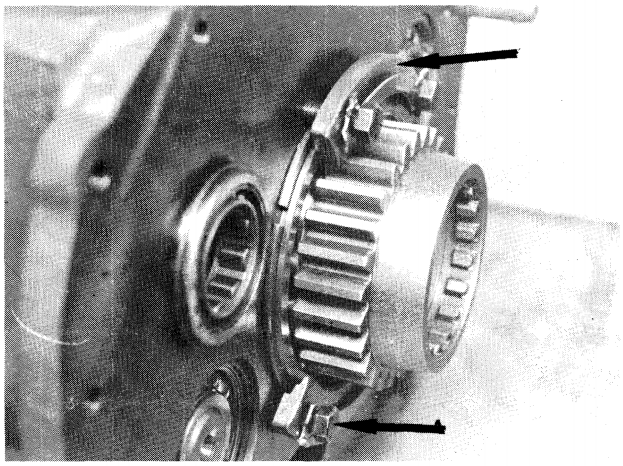
21. *Removing snap ring at rear of right countershaft.*



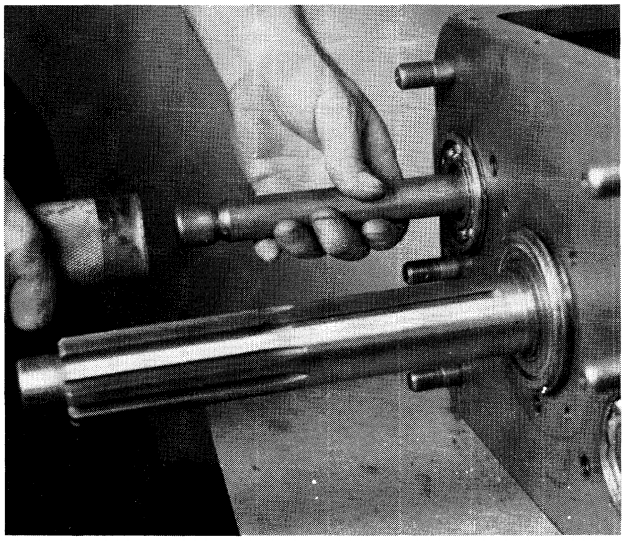
22. *Countershaft is moved forward until snap ring groove in front bearing is exposed.*



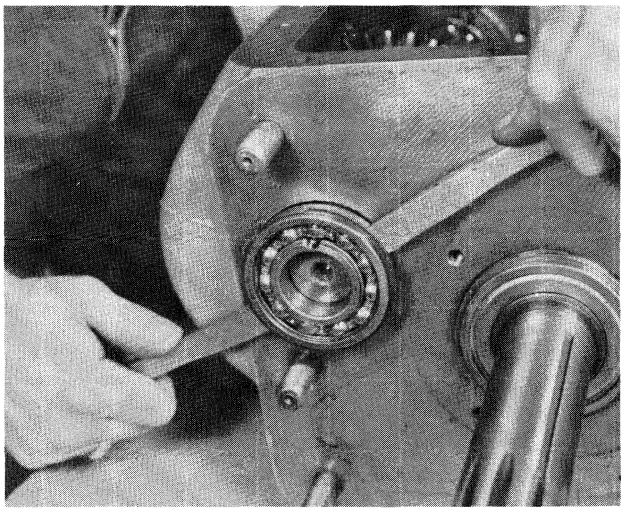
23. *Installing snap ring in groove in front bearing.*



24. *Loosen bearing retaining rings.*



25. *Moving countershaft to the rear as far as possible.*



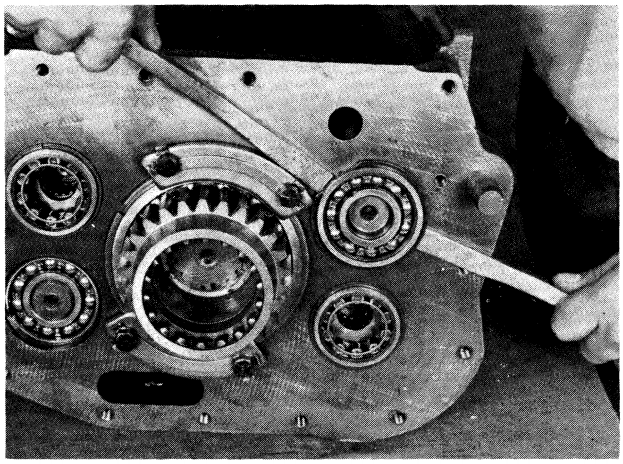
26. *Using pry bars to complete removal of countershaft front bearing.*

V. FRONT SECTION DISASSEMBLY

A. To Remove Bearings from Right Countershaft.

1. Remove snap ring in rear bearing bore of case. Illustration No. 21.
2. Using soft bar and maul against rear of countershaft, move the assembly forward as far as possible until snap ring groove in front bearing is exposed. Illustration No. 22.

   NOTE: If front bearing snap ring groove can not be exposed (due to variances in thickness of case), use punch between hub of countershaft drive gear and inner race of bearing to move the gear forward on shaft.
3. Install snap ring in the exposed bearing snap ring groove. (Use snap ring which was removed from rear bearing bore.) Illustration No. 23.
4. Loosen the capscrews at the bearing retaining rings on auxiliary drive gear. This will allow movement to the rear of the countershaft and mainshaft assemblies. Illustration No. 24.
5. Using soft bar and maul against front of countershaft, move the countershaft assembly to the rear as far as possible. This will move front bearing forward on shaft. Illustration No. 25.
6. Using soft bar and maul against rear of countershaft, again move the countershaft as far forward as possible to unseat front bearing from case bore.
7. Use puller or pry bars to remove front bearing. Illustration No. 26.

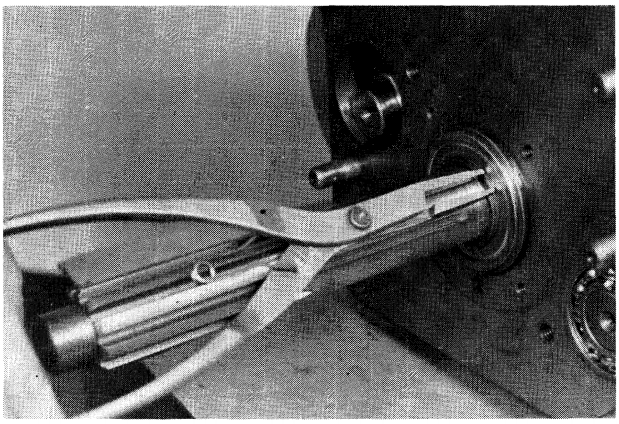


27. *Using pry bars to complete removal of countershaft rear bearing.*

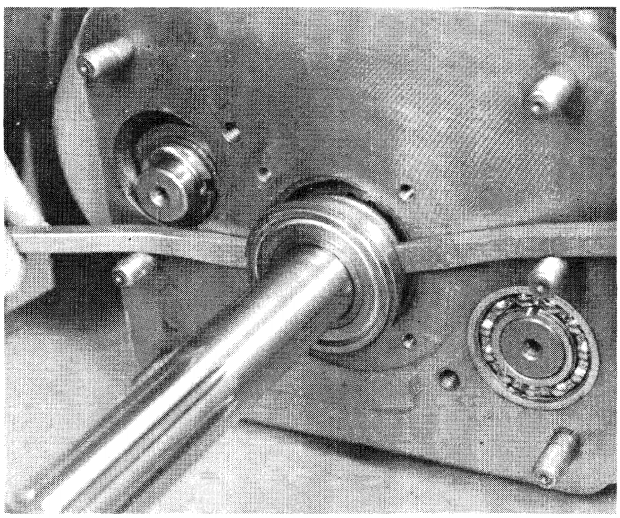
8. Used curved soft bar and maul from inside case to move the rear countershaft bearing to the rear far enough to expose snap ring groove in rear bearing.
9. Install snap ring in groove in rear bearing (same snap ring as used on front bearing), and use pullers or pry bars to remove countershaft rear bearing. Illustration No. 27.

B. To Remove the Clutch Shaft.

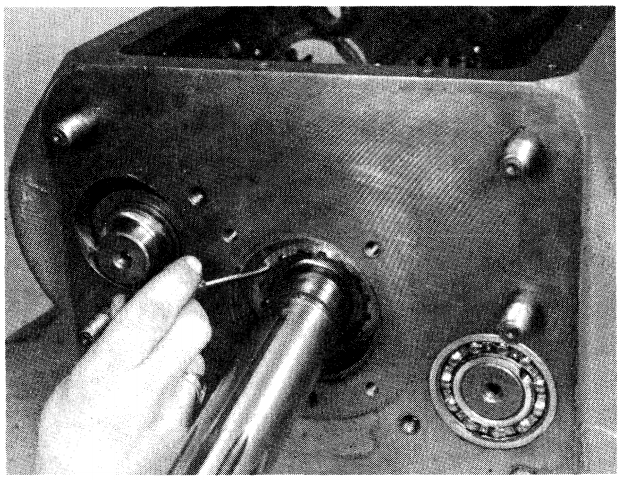
1. Move the drive gear and shaft forward as far as possible.
2. Remove the bearing retaining snap ring from groove in shaft. Illustration No. 28.
3. Hold shaft in position and tap the drive gear forward to unseat bearing from case.
4. Use pullers or pry bars to complete removal of bearing. Illustration No. 29.



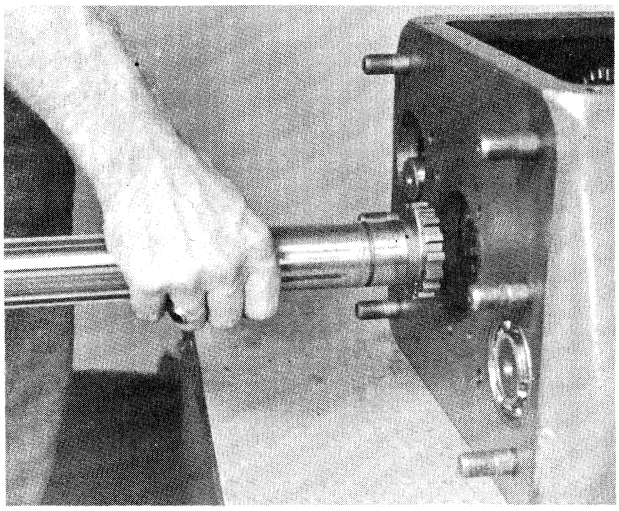
28. *Removing bearing retaining snap ring from groove in clutch shaft.*



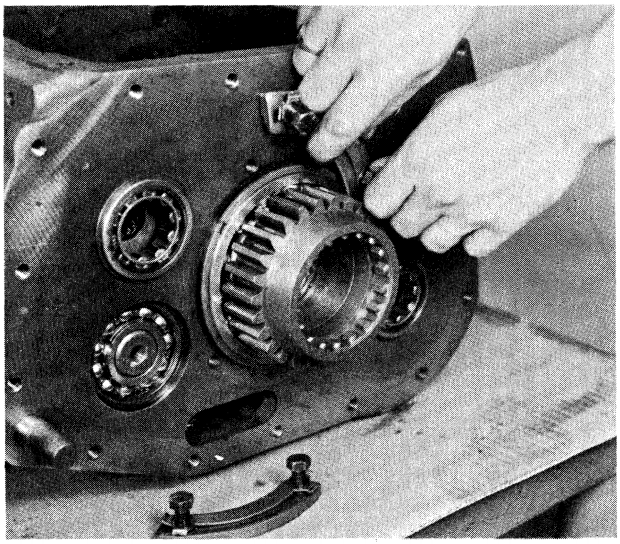
29. *Removing drive gear bearing.*



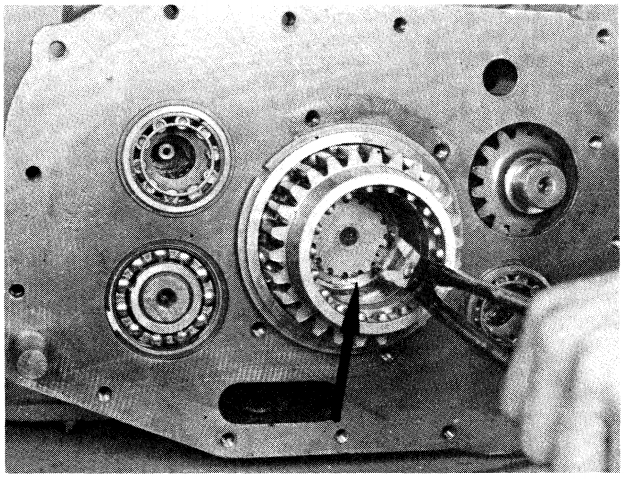
30. *Removing snap ring from groove in ID of drive gear.*



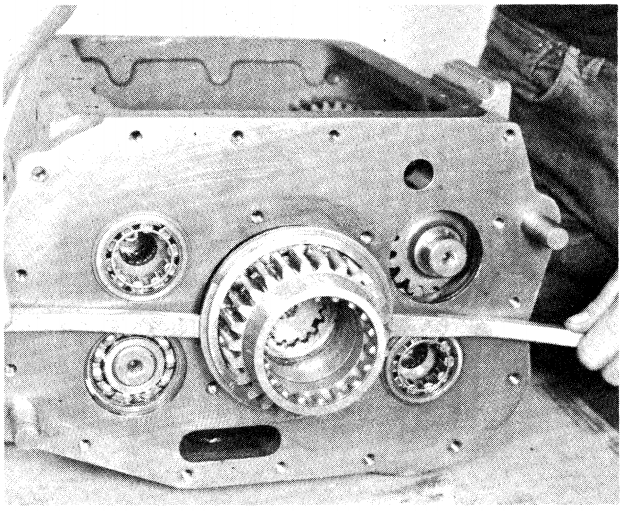
31. *Removing clutch shaft from splines of drive gear.*



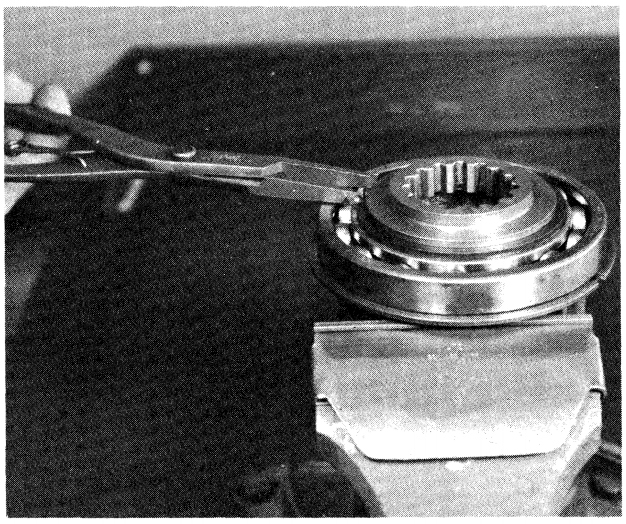
32. *Removing the bearing retaining rings.*



33. *Removing coupling snap ring from groove in mainshaft.*



34. *Removing auxiliary drive gear assembly from case bore and splines of mainshaft.*



35. *Removing snap ring from shoulder of auxiliary drive gear.*

5. Remove the drive gear washer.
6. Remove the snap ring from groove in ID of drive gear. Illustration No. 30.
7. Pull shaft forward and from splines of drive gear. Illustration No. 31.
8. If necessary, remove bushing from pocket in clutch shaft.
9. Move the drive gear to the rear and against the 4th speed gear, engaging teeth of sliding clutch gear.

C. To Remove and Disassemble the Auxiliary Drive Gear Assembly.

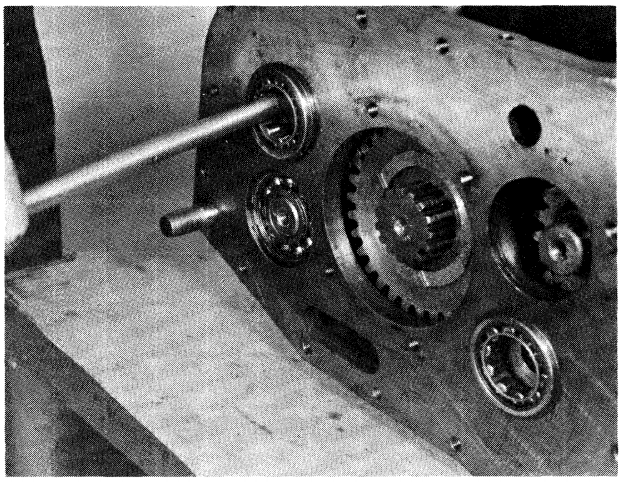
1. Turn out capscrews and remove the two bearing retainer rings from case. Illustration No. 32.
2. Remove the coupling snap ring from the groove in mainshaft (located in bore of auxiliary drive gear). Illustration No. 33.
3. Tap against front of mainshaft to move the auxiliary drive gear bearing to the rear, exposing the bearing snap ring.
4. Use pry bars to remove the auxiliary drive gear assembly from case bore and from splines of mainshaft. Illustration No. 34.
5. Remove snap ring from groove in auxiliary drive gear. Illustration No. 35.
6. Press or use driver to remove bearing from auxiliary drive gear. Illustration No. 36.

D. To Remove the Left Reverse Idler Gear.

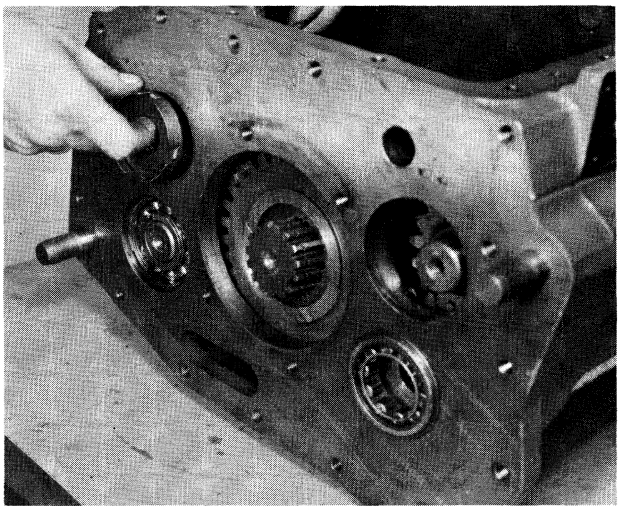
1. Use curved pry bar to walk bearing from idler bore in case. Illustration No. 37.
2. Remove the rear idler washer and holder from bore. (If necessary, bend holder lugs and remove washer from holder.) Illustration No. 38.
3. Remove reverse idler gear from case. Illustration No. 39.



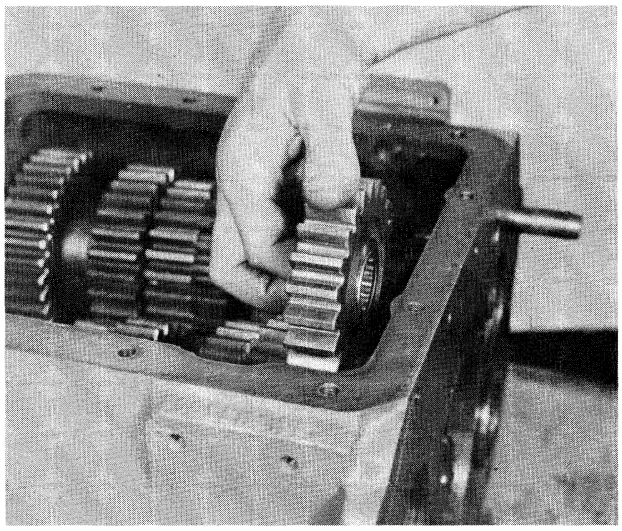
36. *Driving auxiliary drive gear from bearing.*



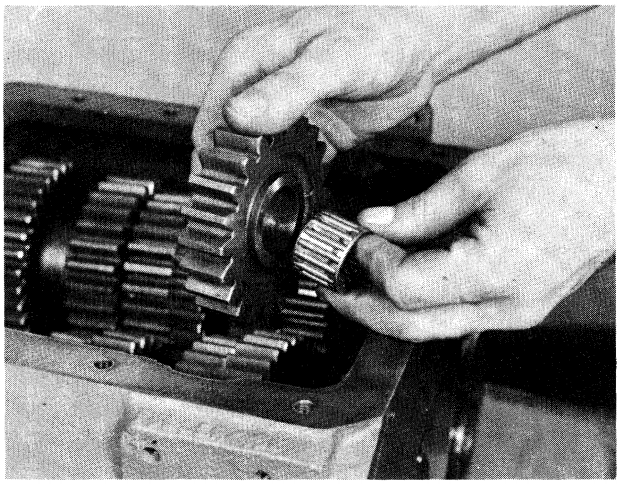
37. *Removing auxiliary countershaft front bearing from left reverse-idler bore.*



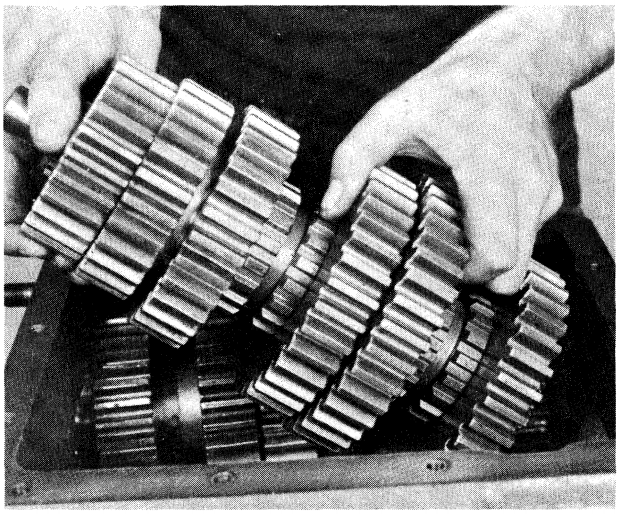
38. *Removing the reverse-idler washer and holder.*



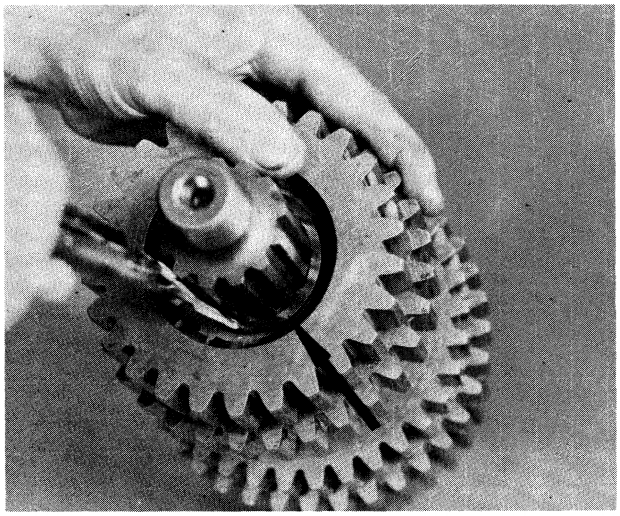
39. *Removing the reverse-idler gear from case.*



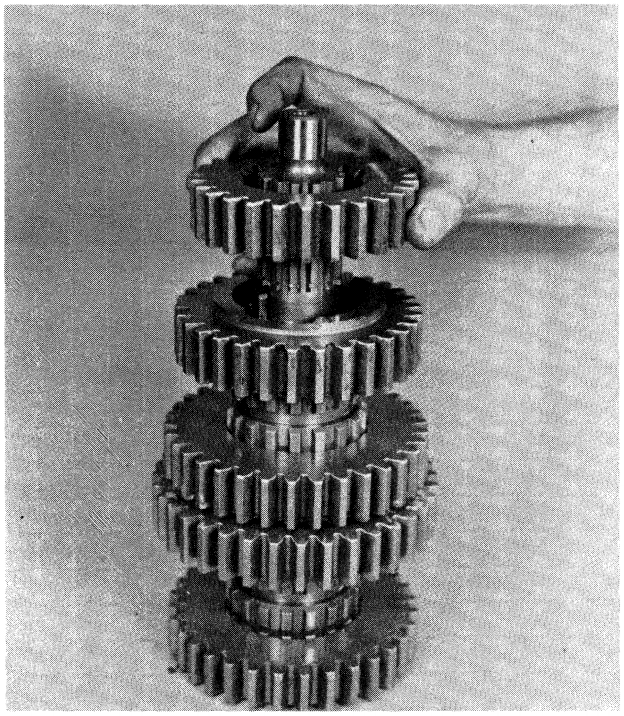
40. *Removing bearing from reverse-idler gear.*



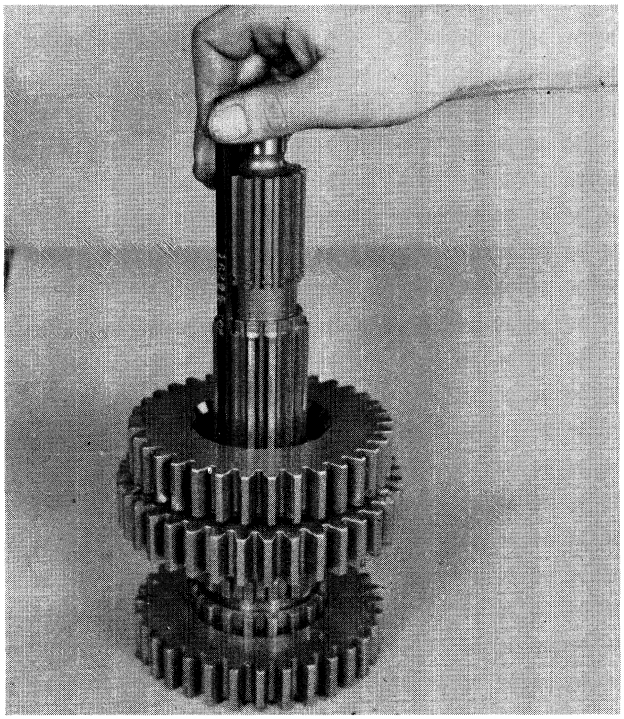
41. *Lifting the mainshaft assembly from case.*



42. *Removing gear retaining snap ring from groove in mainshaft.*



43. *Removing the 4th speed gear and washer.*

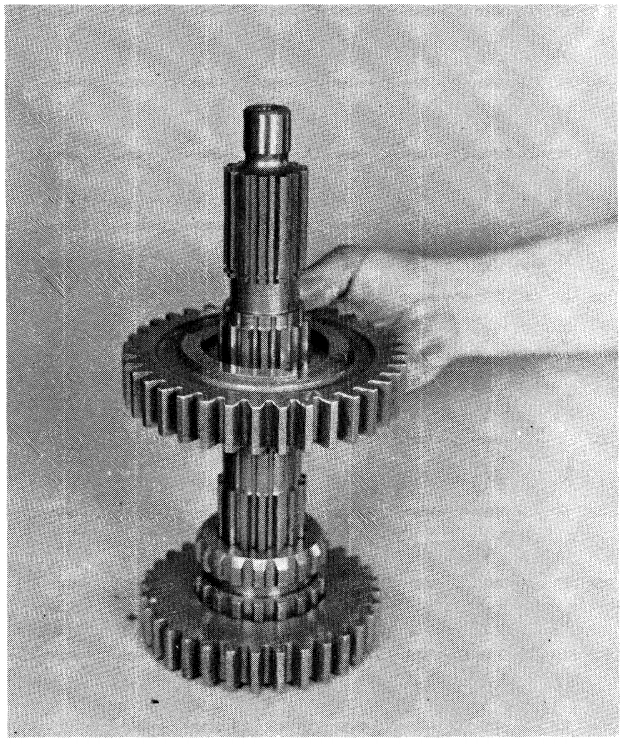


44. *Removing key from mainshaft.*

4. Remove the idler bearing from reverse idler gear. Illustration No. 40.
5. Remove the front idler washer from case.

E. To Remove and Disassemble the Mainshaft Assembly.

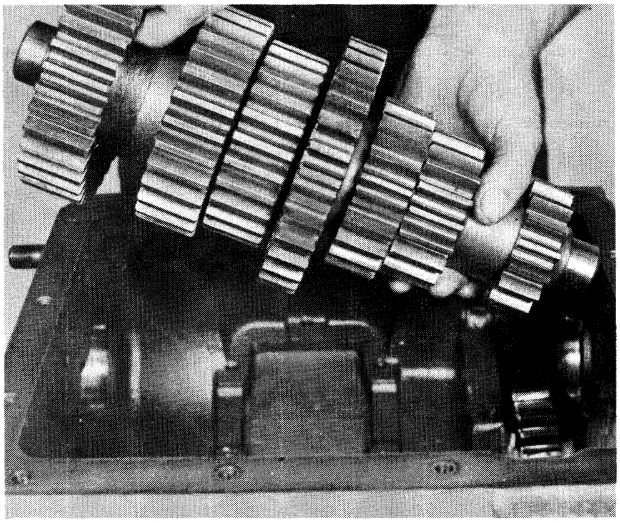
1. Block the right countershaft to the right as far as possible and lift the mainshaft assembly from case. Illustration No. 41.
2. Remove the drive gear and the 4th-5th sliding clutch from mainshaft.
3. Inside hub of the 4th speed gear, remove snap ring from groove in mainshaft. Illustration No. 42.
4. Remove the 4th speed gear and washer. Illustration No. 43.
5. Remove the 3rd speed gear and washer.
6. Remove the 2nd-3rd speed sliding clutch.
7. Remove the long key from slot in mainshaft. Illustration No. 44.
8. Remove the 2nd speed gear and washer.
9. Remove the 1st speed gear and washer. Illustration No. 45.
10. Remove the 1st-reverse sliding clutch.
11. Remove the reverse gear and washer.



45. *Removing the 1st speed gear and washer.*

F. To Remove the Countershaft Assemblies.

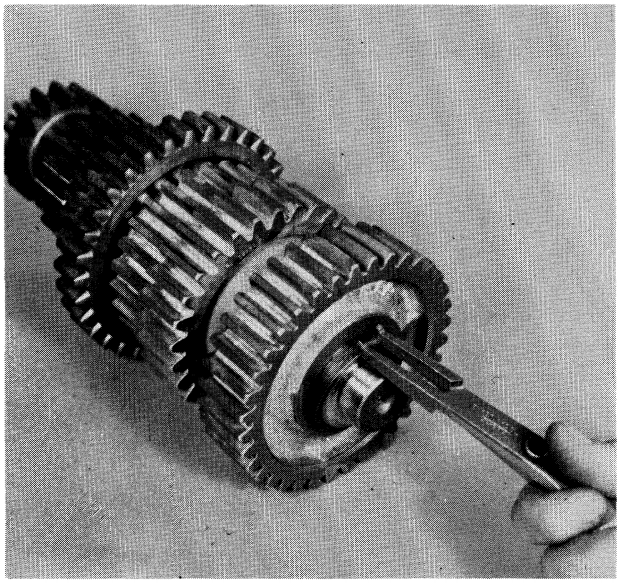
1. Lift the right countershaft from case. Illustration No. 46.
2. Remove bearings from the left countershaft in the same manner in which bearings were removed from right countershaft.
3. Lift the left countershaft from case. Illustration No. 47.



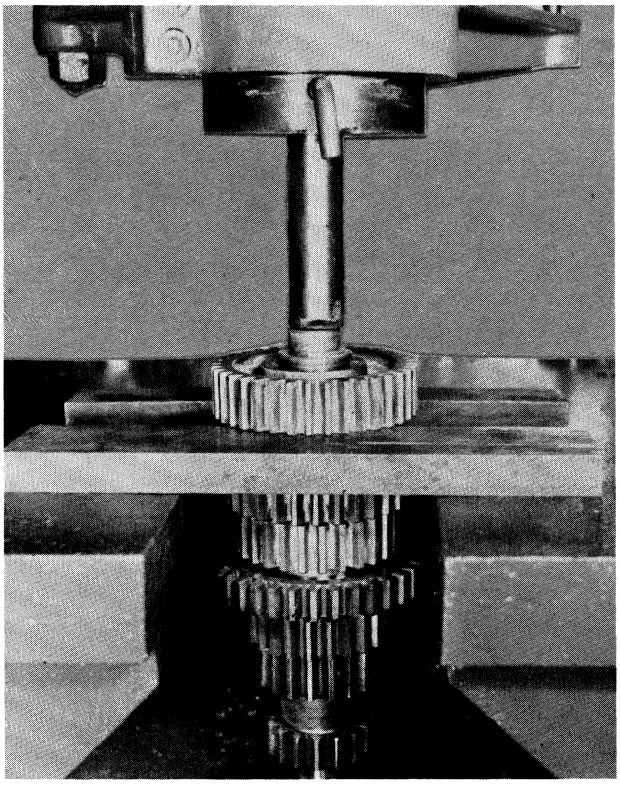
46. *Lifting the right countershaft from case.*



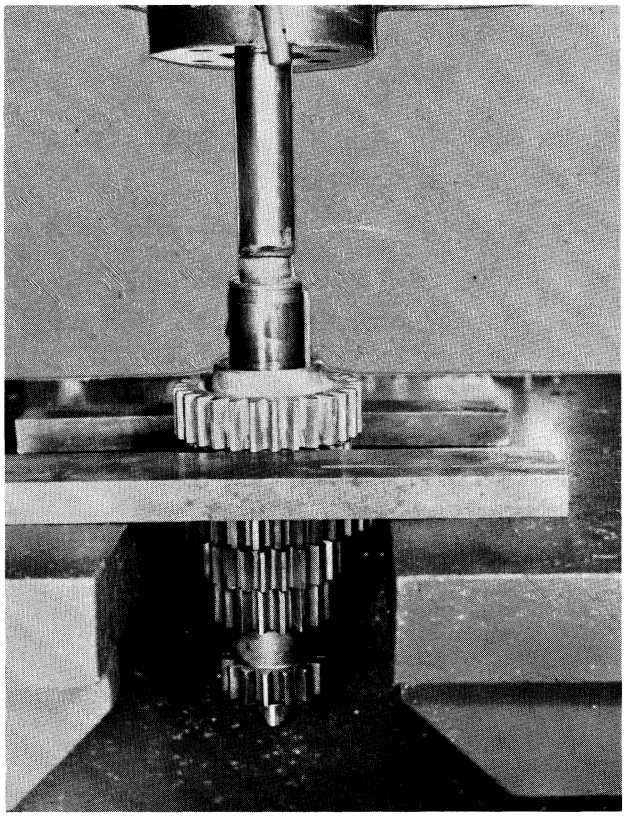
47. *Lifting the left countershaft from case*



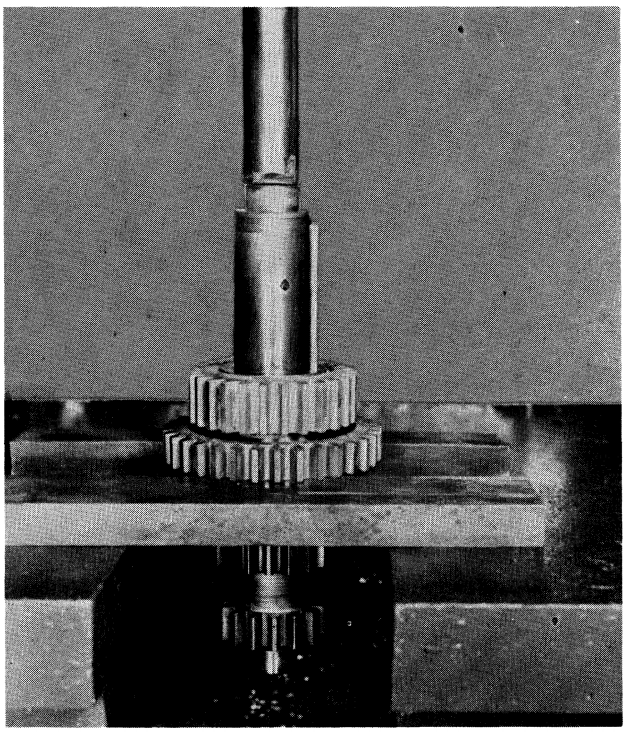
48. *Removing snap ring from front of countershaft.*



49. *Pressing drive gear from shaft.*



50. *Pressing the 4th speed gear from shaft.*

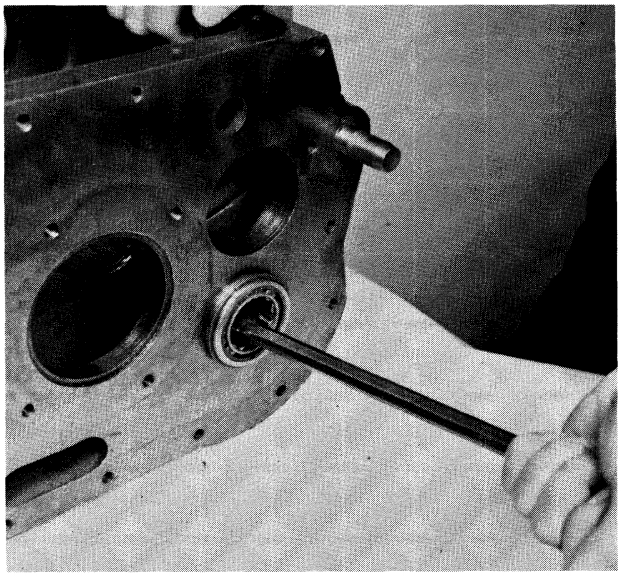


51. *Pressing the PTO gear cluster and 3rd speed gear from shaft.*

G. To Disassemble the Countershaft Assemblies.

NOTE: *Both countershafts are disassembled in the same manner as construction is identical.*

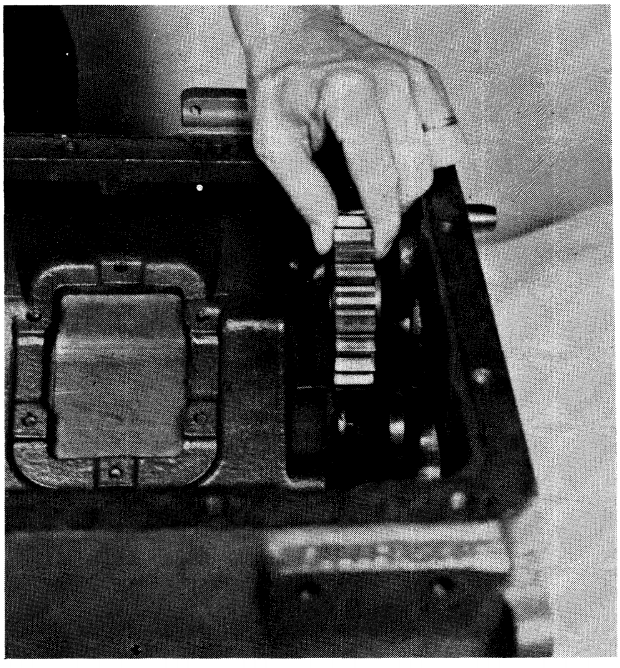
1. Remove snap ring from front of countershaft. Illustration No. 48.
2. Press the drive gear from shaft. Illustration No. 49.
3. Press the 4th speed gear from shaft. Illustration No. 50.
4. Using the rear face of the PTO gear as a base in press, press the 3rd speed gear, and the PTO-2nd speed gear cluster from shaft. Illustration No. 51.
5. If necessary, remove woodruff key, long key and roll pin from shaft.



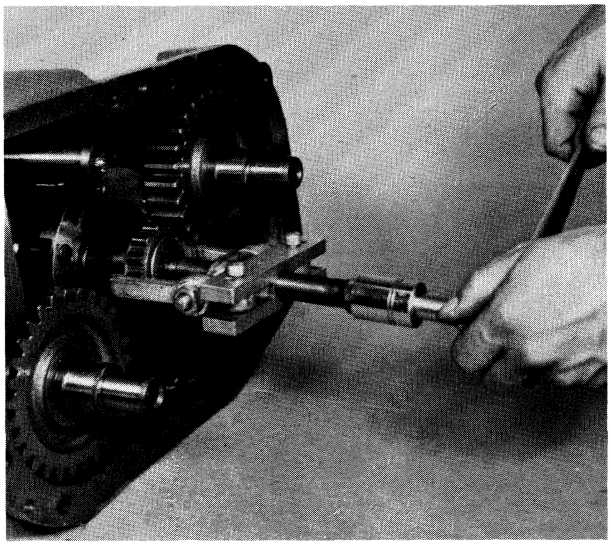
52. *Removing auxiliary countershaft front bearing from right reverse-idler gear bore.*

H. To Remove the Right Reverse Idler Gear.

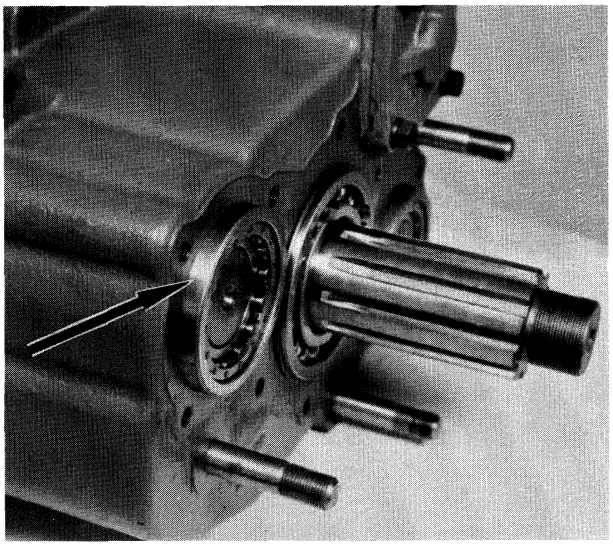
1. Use curved pry bar to walk bearing from idler bore in case. Illustration No. 52.
2. Remove the rear idler washer and holder from bore. If necessary, bend holder lugs and remove washer from holder.
3. Remove the reverse idler gear from case. Illustration No. 53.
4. Remove the idler bearing from reverse idler gear.
5. Remove the front idler washer from case.



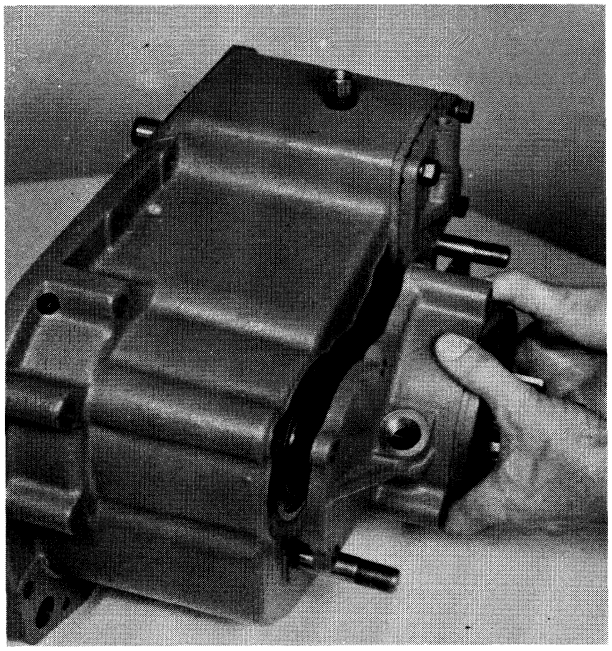
53. *Removing the right reverse-idler gear from case.*



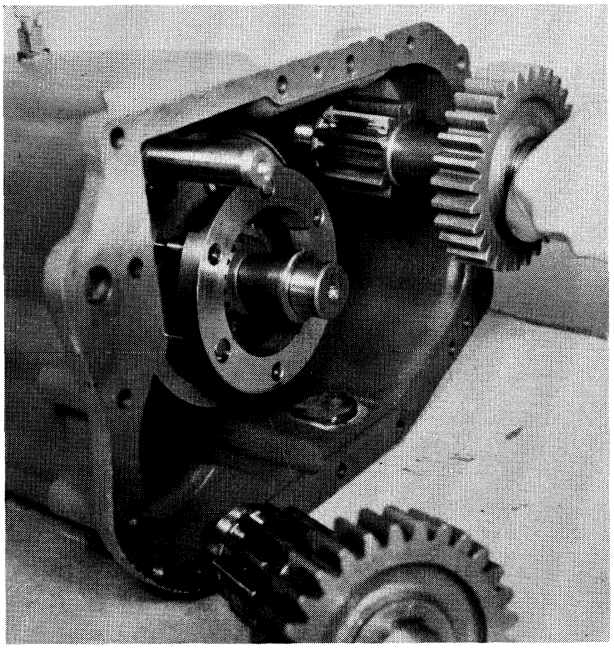
54. *Removing bearing from front of auxiliary tailshaft.*



56. *Move outer races of countershaft rear bearings to the rear so that they protrude from case approximately ½ inch.*



55. *Removing the rear bearing cover from auxiliary.*

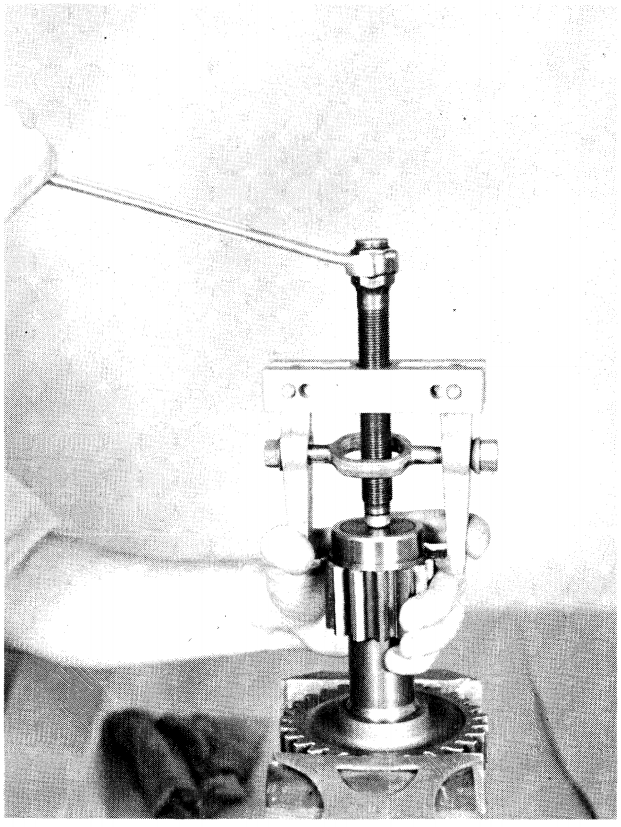


57. *Pulling countershafts forward and from housing.*

VI. AUXILIARY DISASSEMBLY

A. To Remove the Auxiliary Countershaft Assemblies.

1. Use pullers to remove bearing from front of tailshaft. Illustration No. 54.
2. Turn out capscrews and remove the rear bearing cover. Illustration No. 55.
3. If necessary remove the rear seal from cover.
4. Remove the speedometer gear or replacement spacer from tailshaft.
5. Remove the speedometer gear washer.
6. From inside housing, use long punch to move outer races of countershaft rear bearings to the rear; move races approximately one-half inch. Illustration No. 56.
7. Pull the countershafts forward and out of housing. Illustration No. 57.



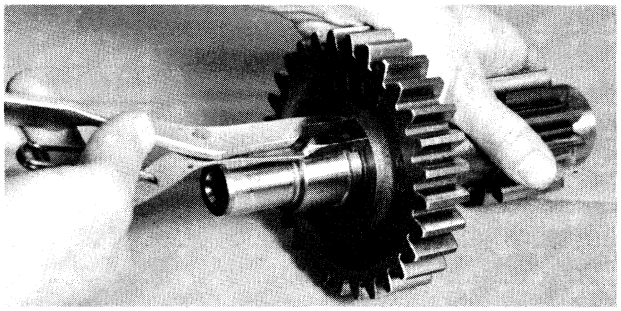
58. *Pulling bearing inner race from rear of countershaft.*

B. To Disassemble the Auxiliary Countershaft Assemblies.

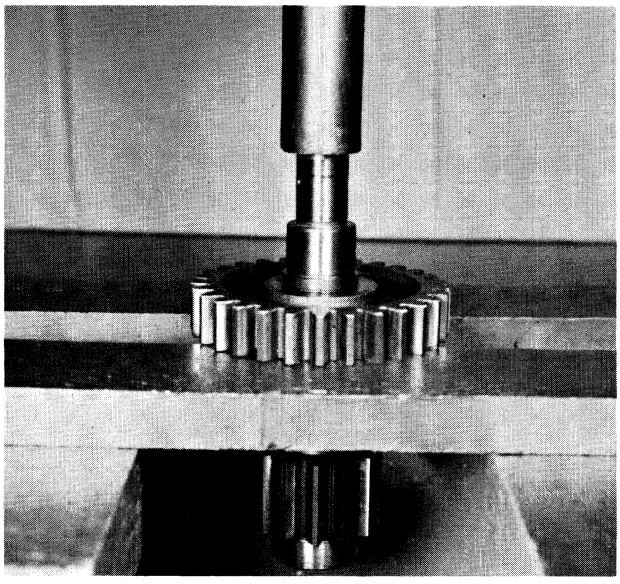
1. Pull bearing inner race from rear of countershaft. Illustration No. 58.

NOTE: *In new style models the drive gear is welded to the countershaft and can not be removed; further disassembly is not needed.*

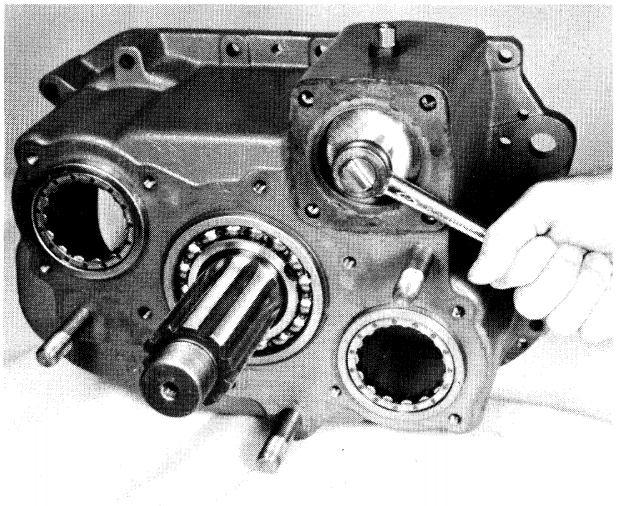
2. Remove snap ring from groove in front of shaft. Illustration No. 59 (old style only).
3. Press the drive gear forward and from shaft. Illustration No. 60 (old style only).
4. If necessary remove key from countershaft (old style only).



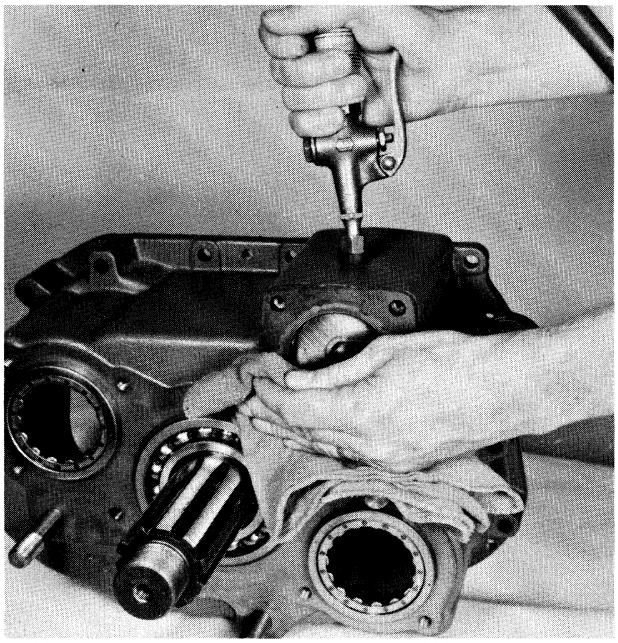
59. *Removing snap ring from groove in countershaft (old style only).*



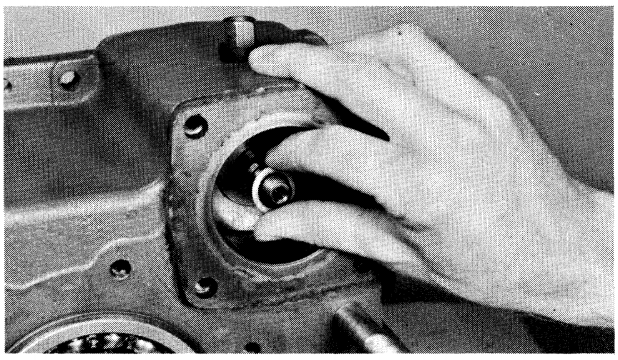
60. *Pressing drive gear from countershaft (old style only).*



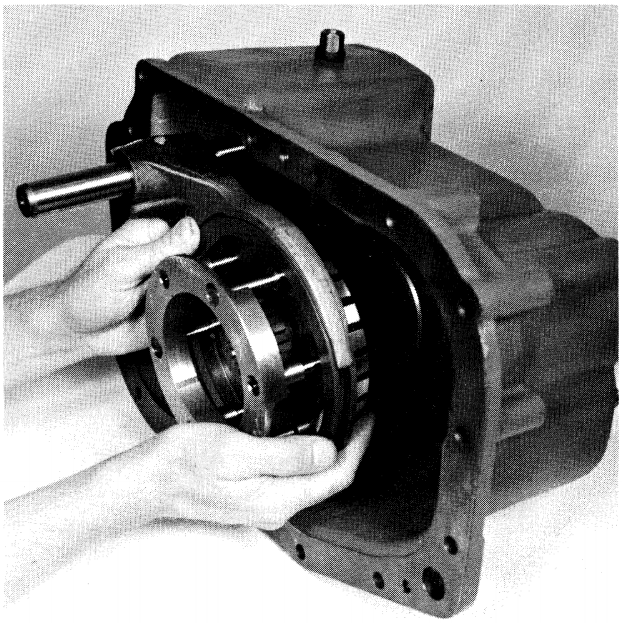
61. *Removing nut from piston shaft.*



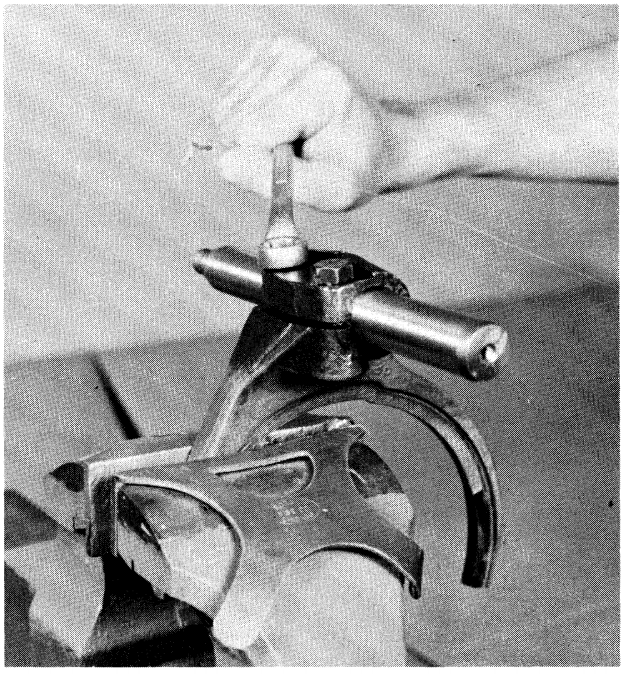
62. *Using air to remove piston.*



63. *Removing copper seal from piston shaft.*



64. *Removing the synchronizer assembly, the shifting yoke and piston shaft from the housing as a complete unit.*



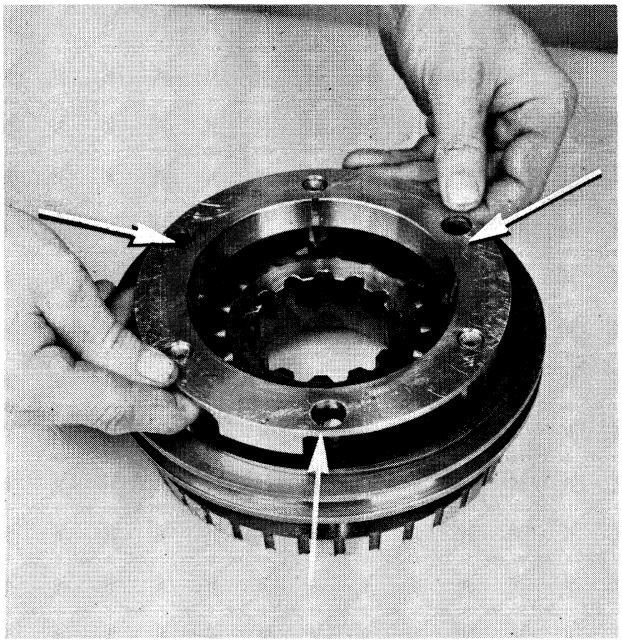
65. *Removing shifting yoke from piston shaft.*

C. To Remove the Range Shift Air Cylinder and Synchronizer Assemblies.

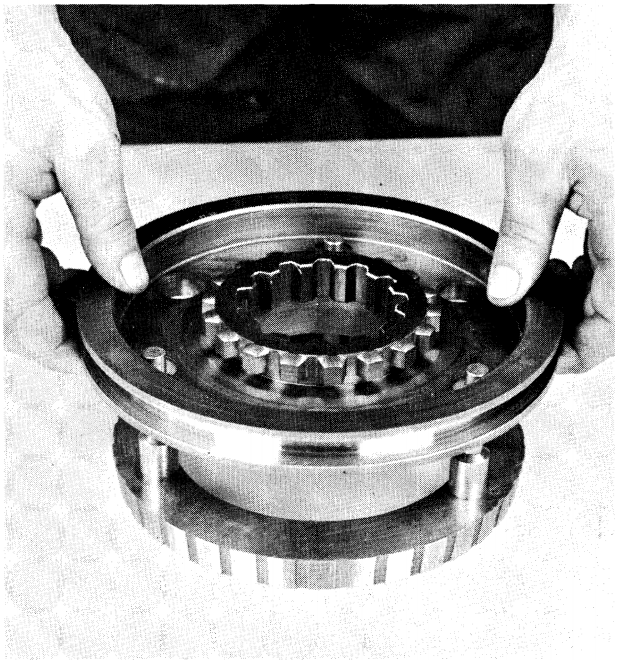
1. Turn out capscrews and remove the air cylinder cover.
2. Remove the nut and lockwasher from air cylinder piston shaft. Illustration No. 61.
3. Use air to remove piston. Illustration No. 62.
4. If necessary remove O-ring from OD of piston.
5. Remove the copper seal from shaft. Illustration No. 63.
6. Move the synchronizer assembly, shift yoke, and piston shaft forward and out of housing as a complete assembly. Illustration No. 64.
7. Remove the shaft and yoke from synchronizer assembly.
8. Cut lockwire, turn out the two lockscrews and remove yoke from shaft. Illustration No. 65.
9. Place the larger low range synchronizer ring on bench.
10. Turn and pull upward to remove the high range synchronizer from pins. Illustration No. 66.

    CAUTION: *There are three springs located in housing of high range synchronizer which will be released as high range synchronizer is removed from pins.*

11. Remove the sliding clutch from low range synchronizer pins. Illustration No. 67.



66. *Removing the high range synchronizer. This will free the three springs located in high range synchronizer.*



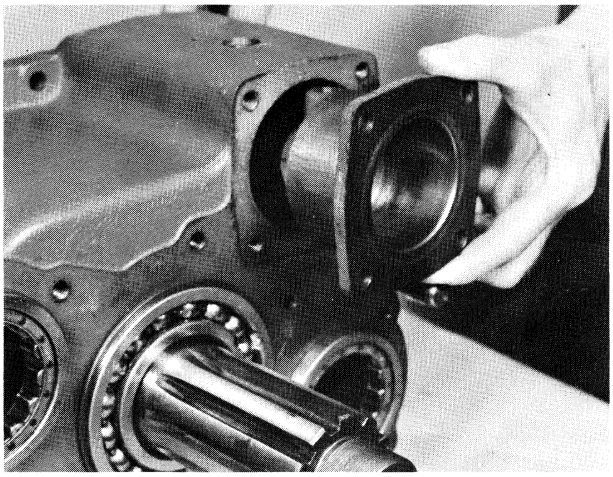
67. *Removing the sliding clutch gear.*

D. To Remove and Disassemble the Air Cylinder Assembly.

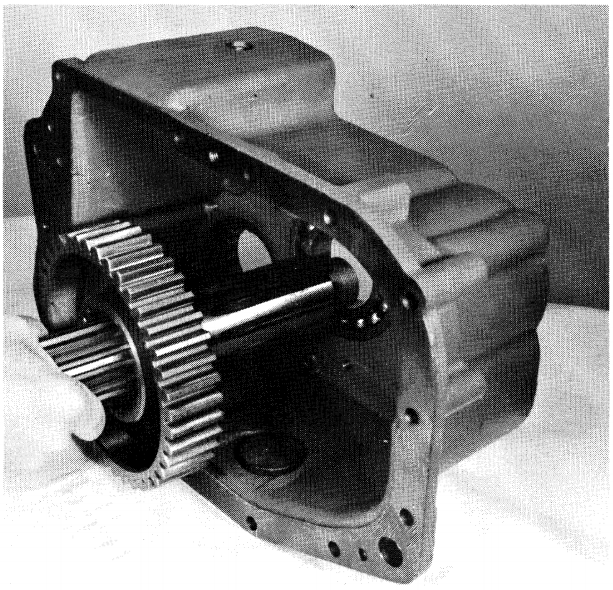
1. Important: Remove the dust seal, and air port extension from top of housing. Illustration No. 68.
2. Remove cylinder from housing. Illustration No. 69.
3. Remove O-ring from small bore in cylinder, if necessary.

E. To Remove and Disassemble the Low Speed Gear and Tailshaft Assembly.

1. Drive or press against rear of tailshaft to move assembly forward and from rear bearing. Illustration No. 70.
2. Remove the rear washer and the low speed gear from rear of shaft. Illustration No. 71.
3. Remove spline washer from hub of low speed gear.
4. Move the mainshaft rear bearing to the rear and out of housing.
5. Use bearing driver to remove the countershaft rear bearings from housing.



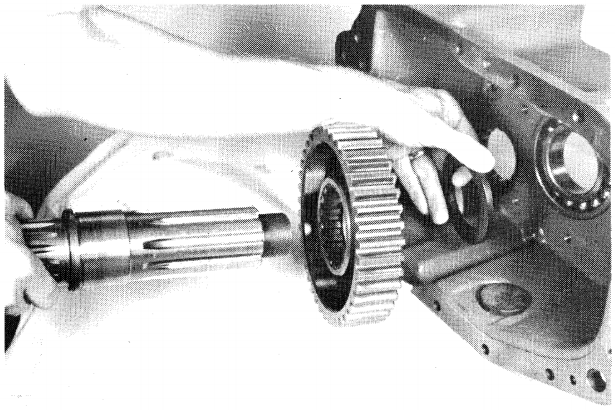
69. *Removing air cylinder from housing.*



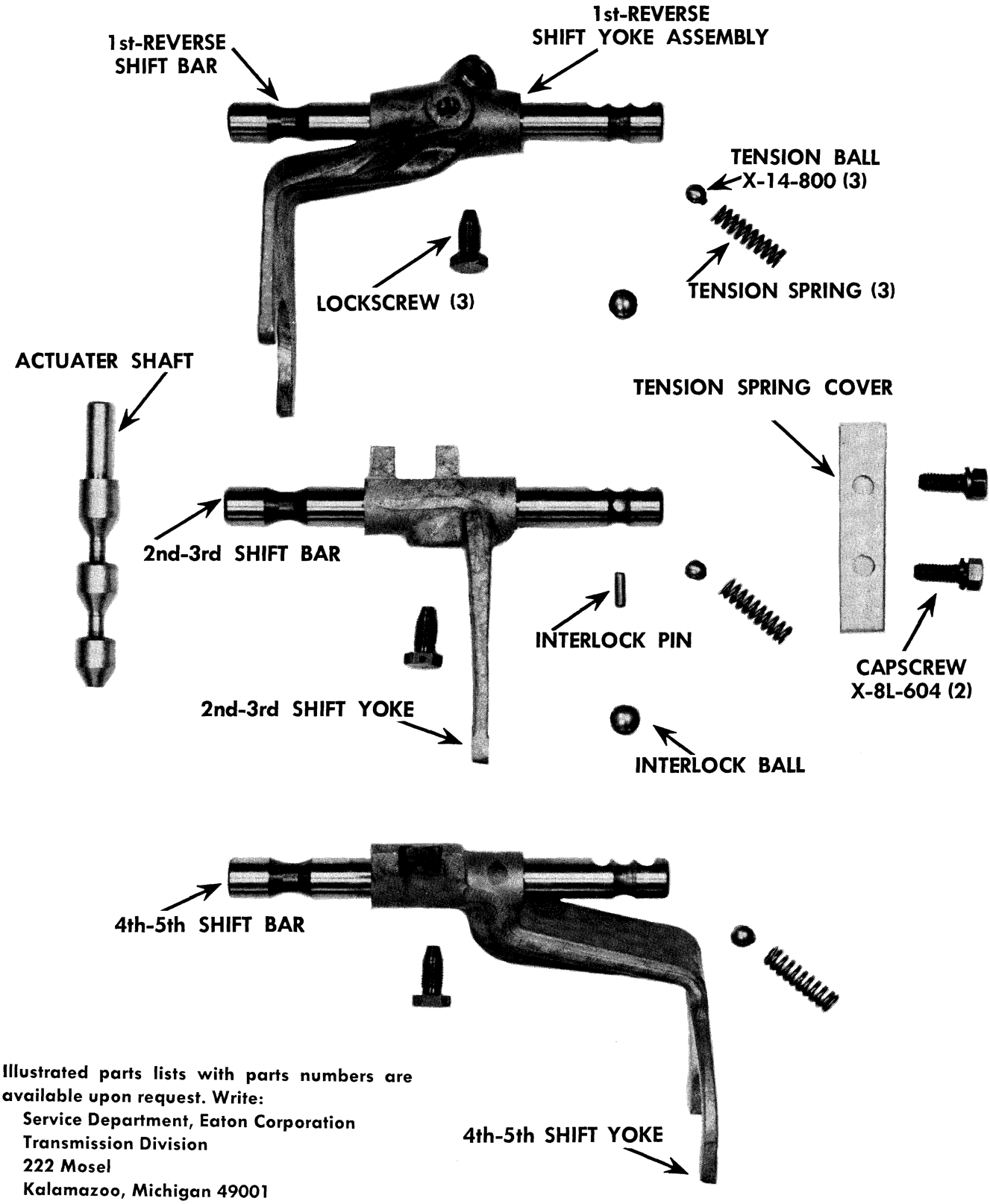
70. *Removing the low speed gear and tailshaft assembly from housing.*



68. *Removing the extension and dust seal from housing.*



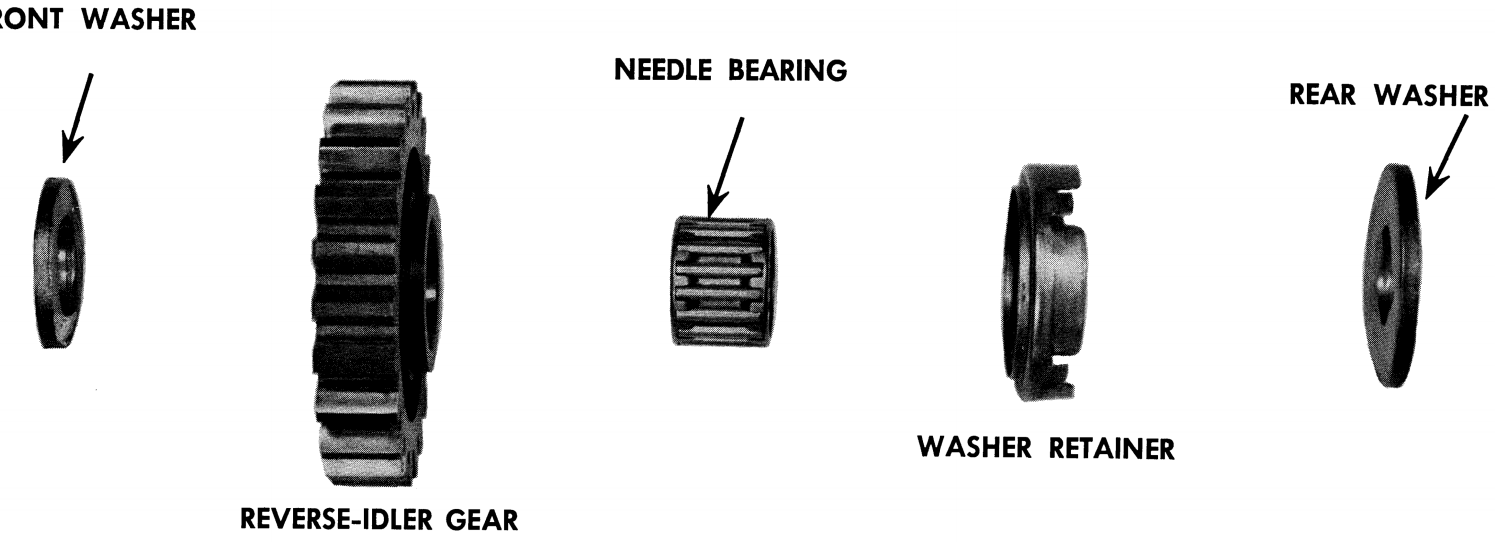
71. *Removing low speed gear and rear washer from tailshaft.*

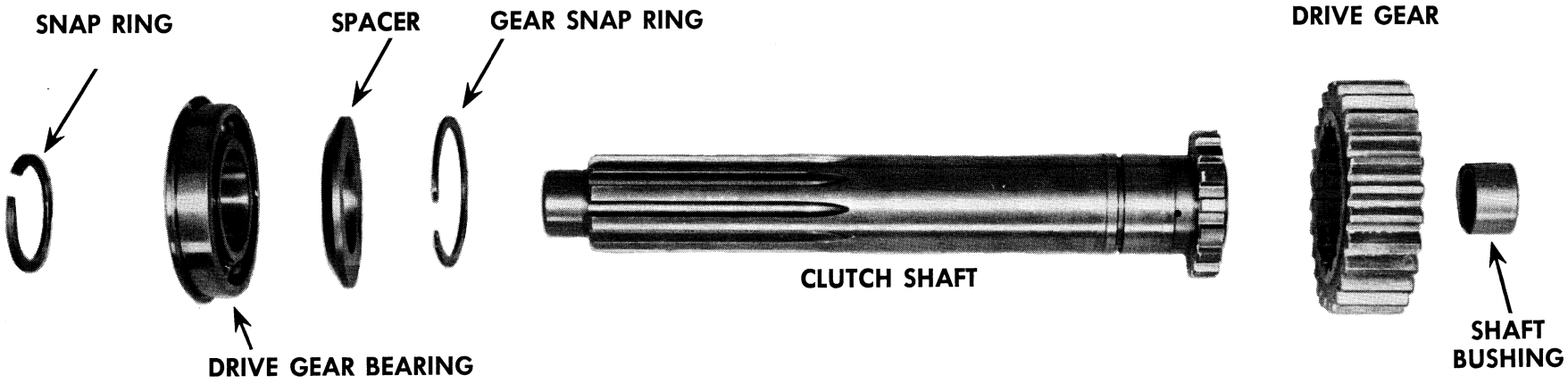


Illustrated parts lists with parts numbers are available upon request. Write:

Service Department, Eaton Corporation
Transmission Division
222 Mosel
Kalamazoo, Michigan 49001

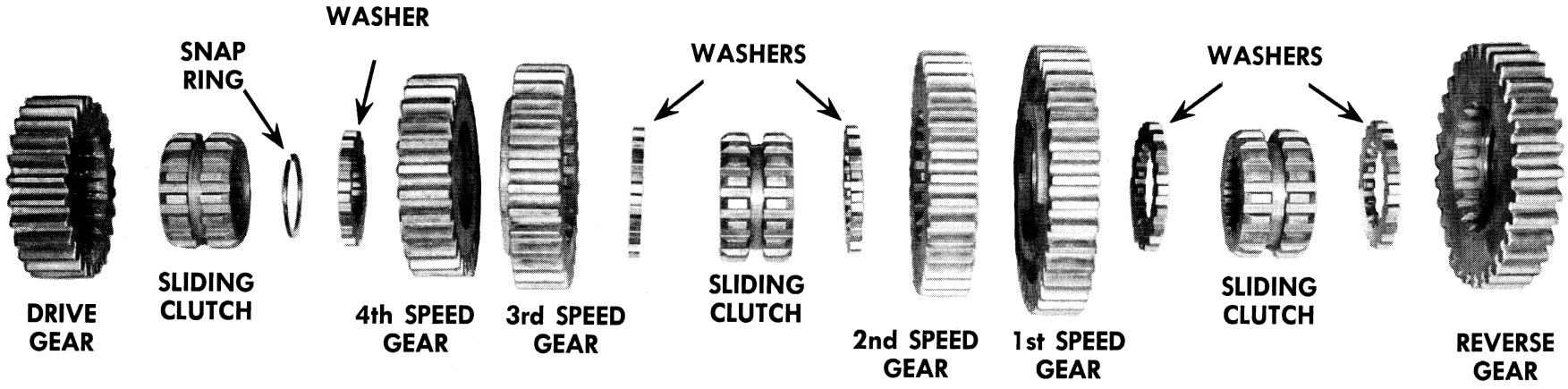
REVERSE-IDLER GEAR ASSEMBLY

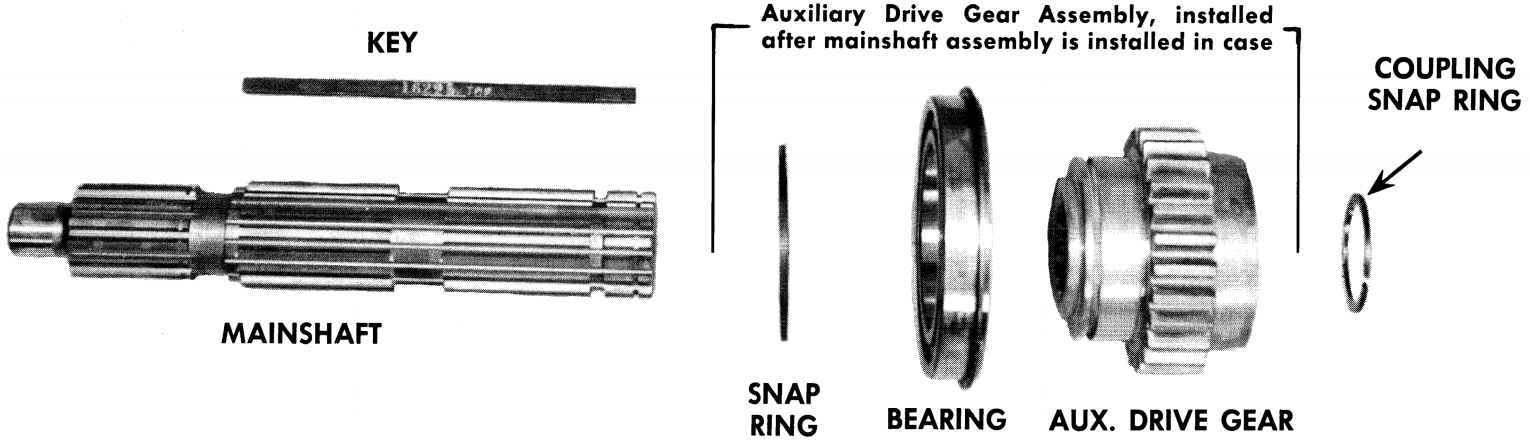


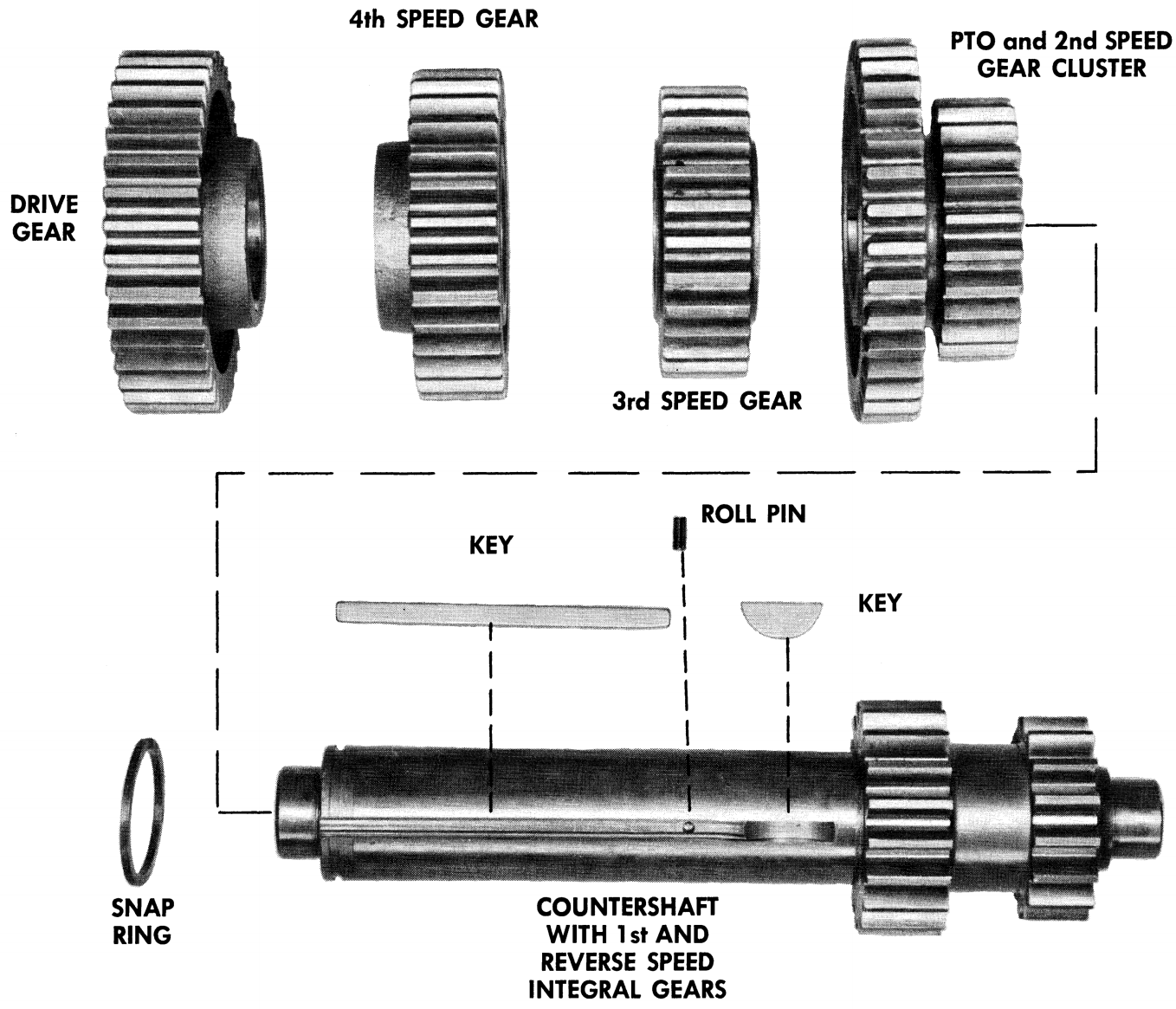


DRIVE GEAR ASSEMBLY

MAINSHAFT AND AUXILIARY DRIVE GEAR ASSEMBLIES





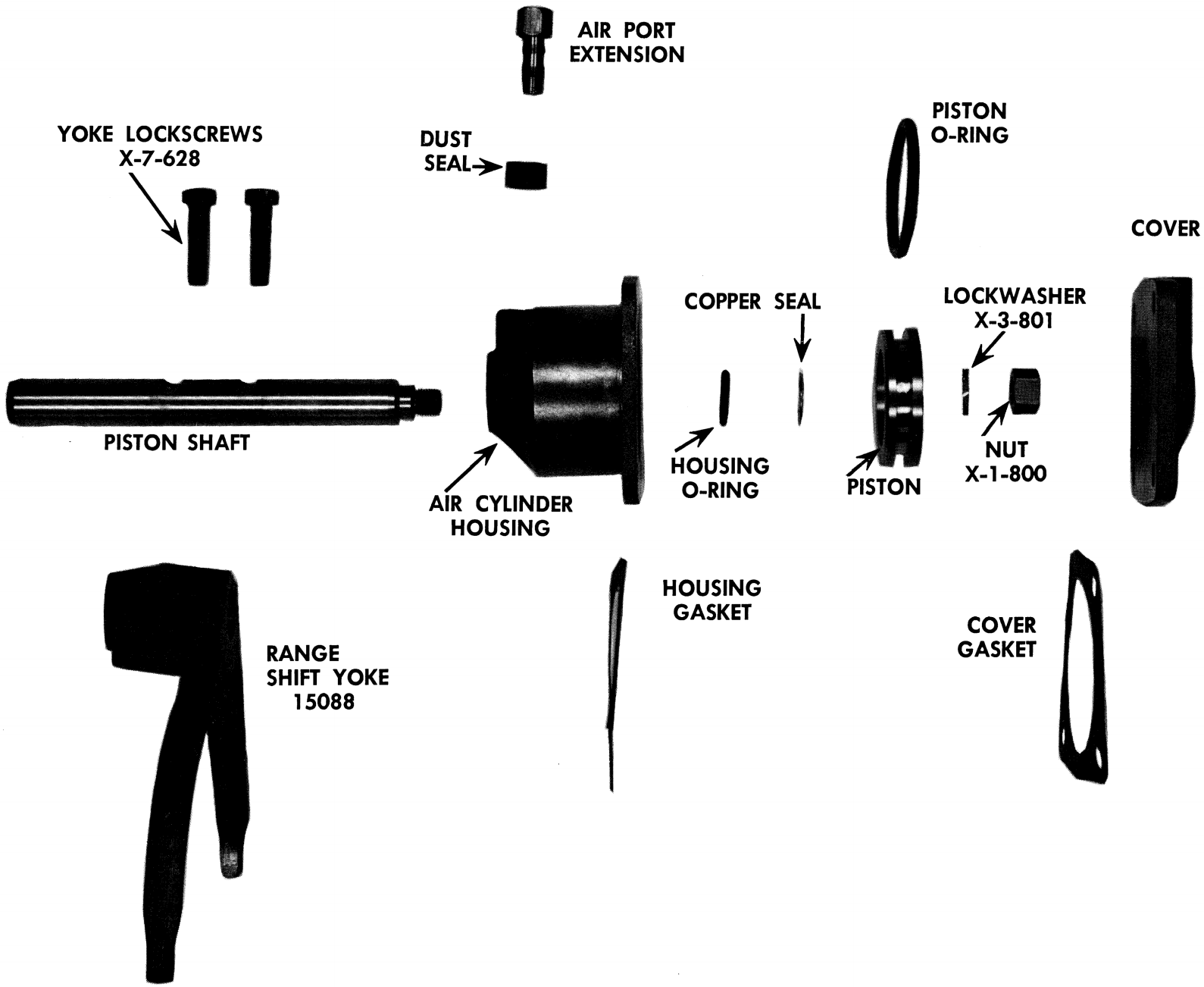


COUNTERSHAFT ASSEMBLY, FRONT SECTION

COUNTERSHAFT ASSEMBLY, AUXILIARY

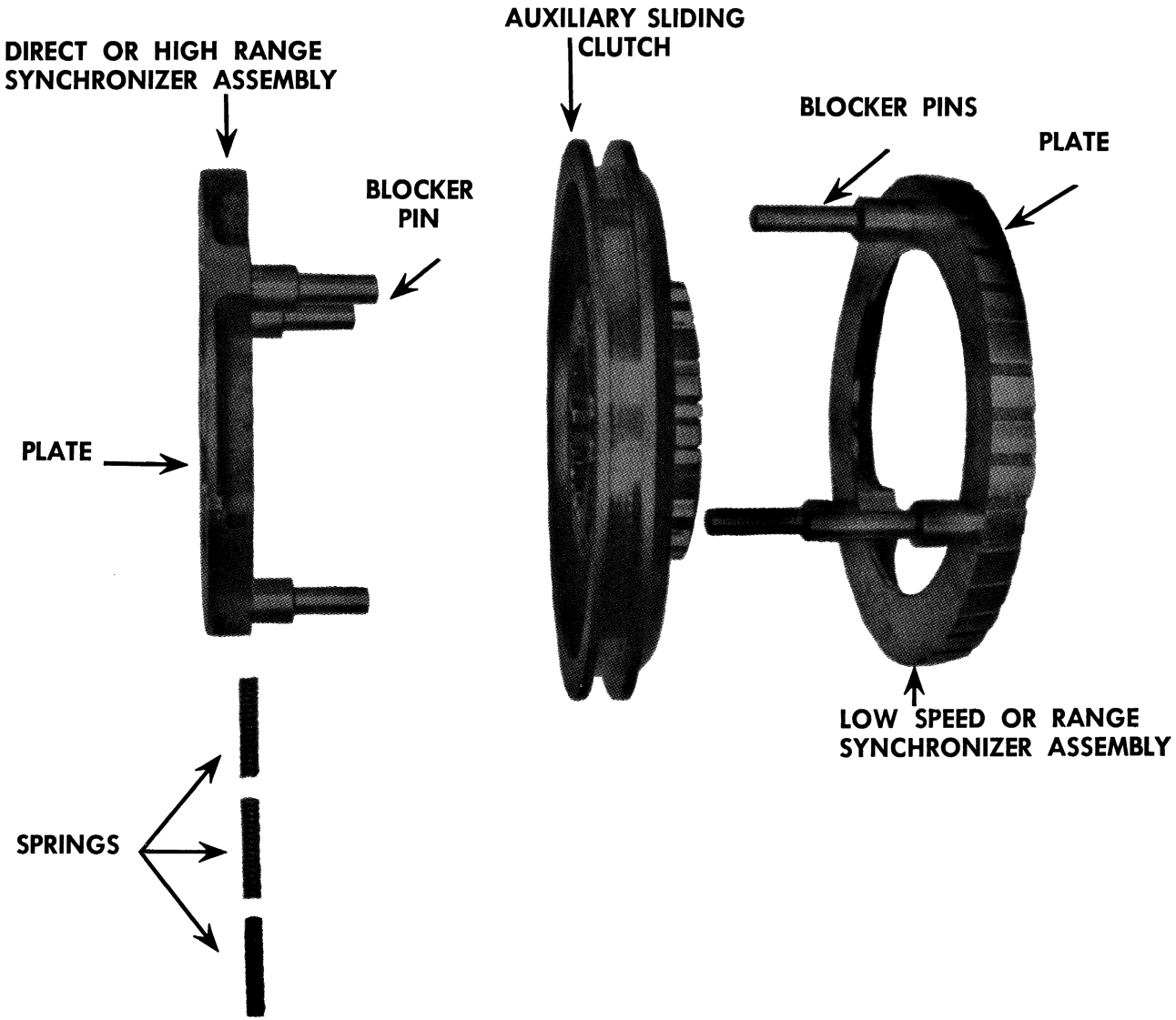
NOTE: *The earlier model countershaft assembly shown below has been replaced by a welded countershaft assembly; the drive gear is welded to the countershaft and the key and snap ring are omitted from the assembly.*

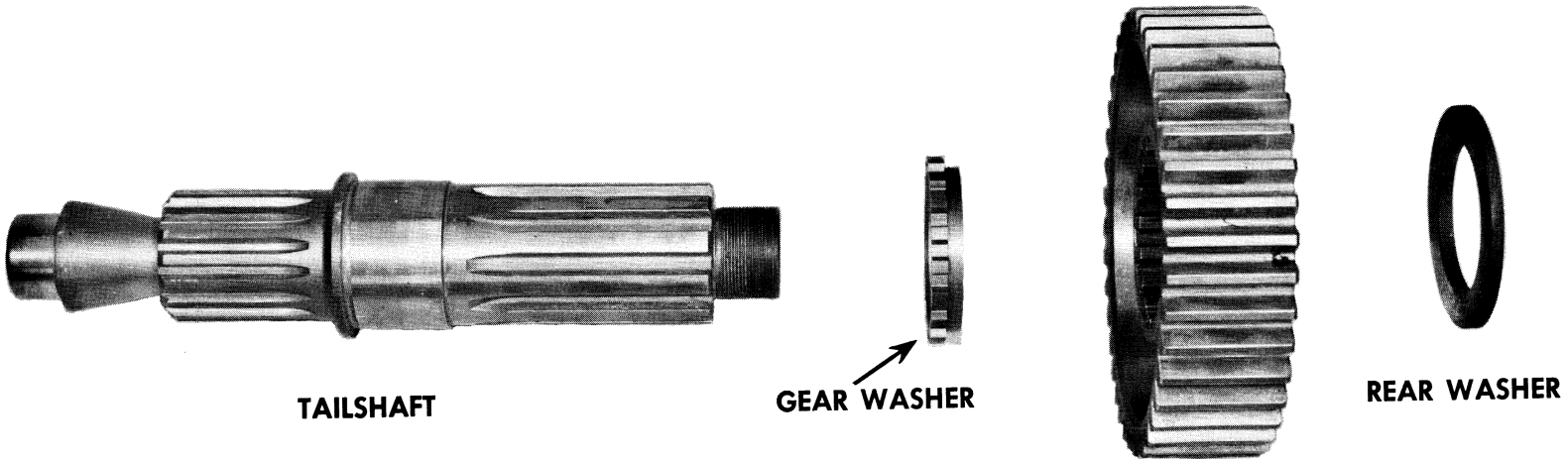




RANGE SHIFT AIR CYLINDER ASSEMBLY

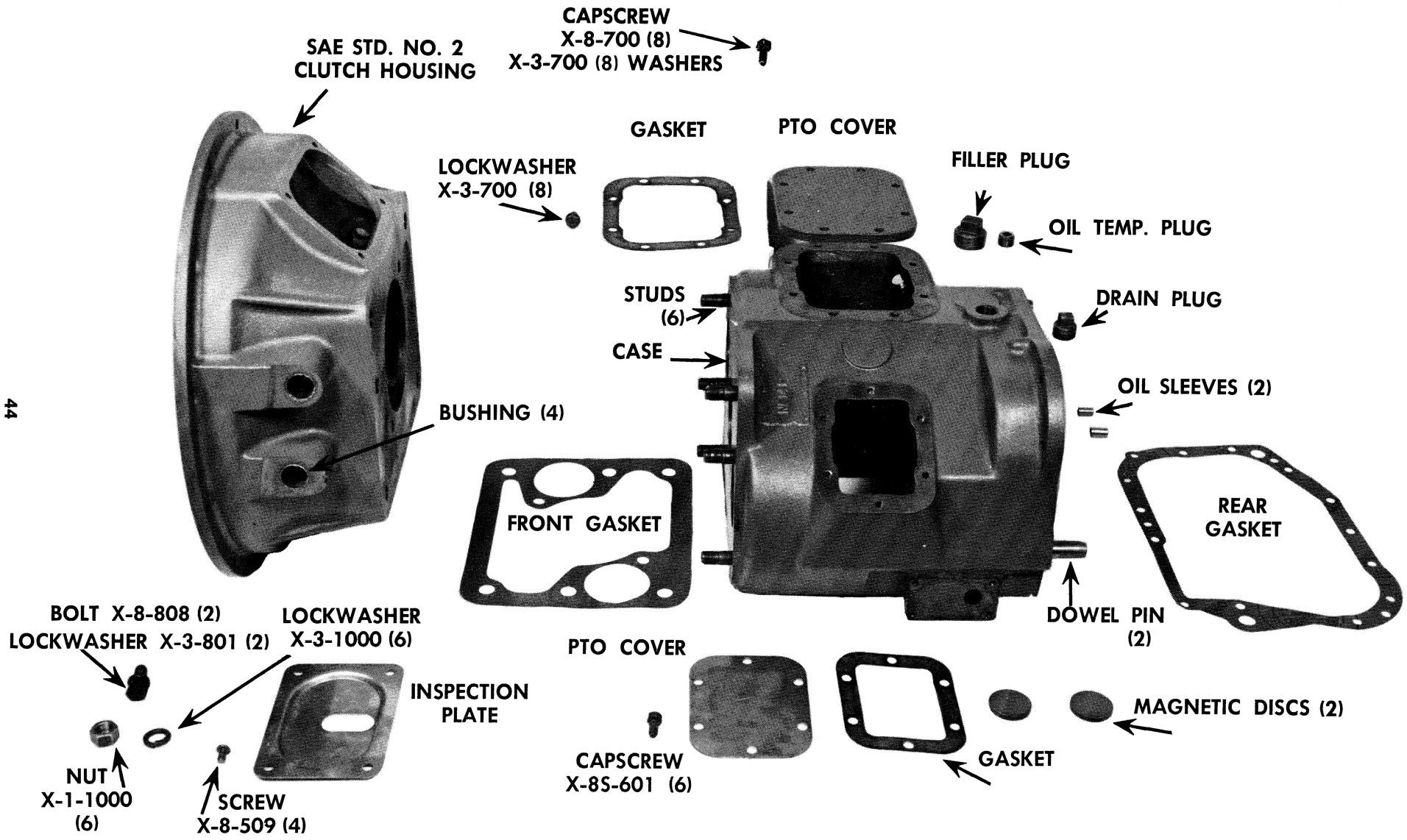
SYNCHRONIZER AND SLIDING CLUTCH ASSEMBLY

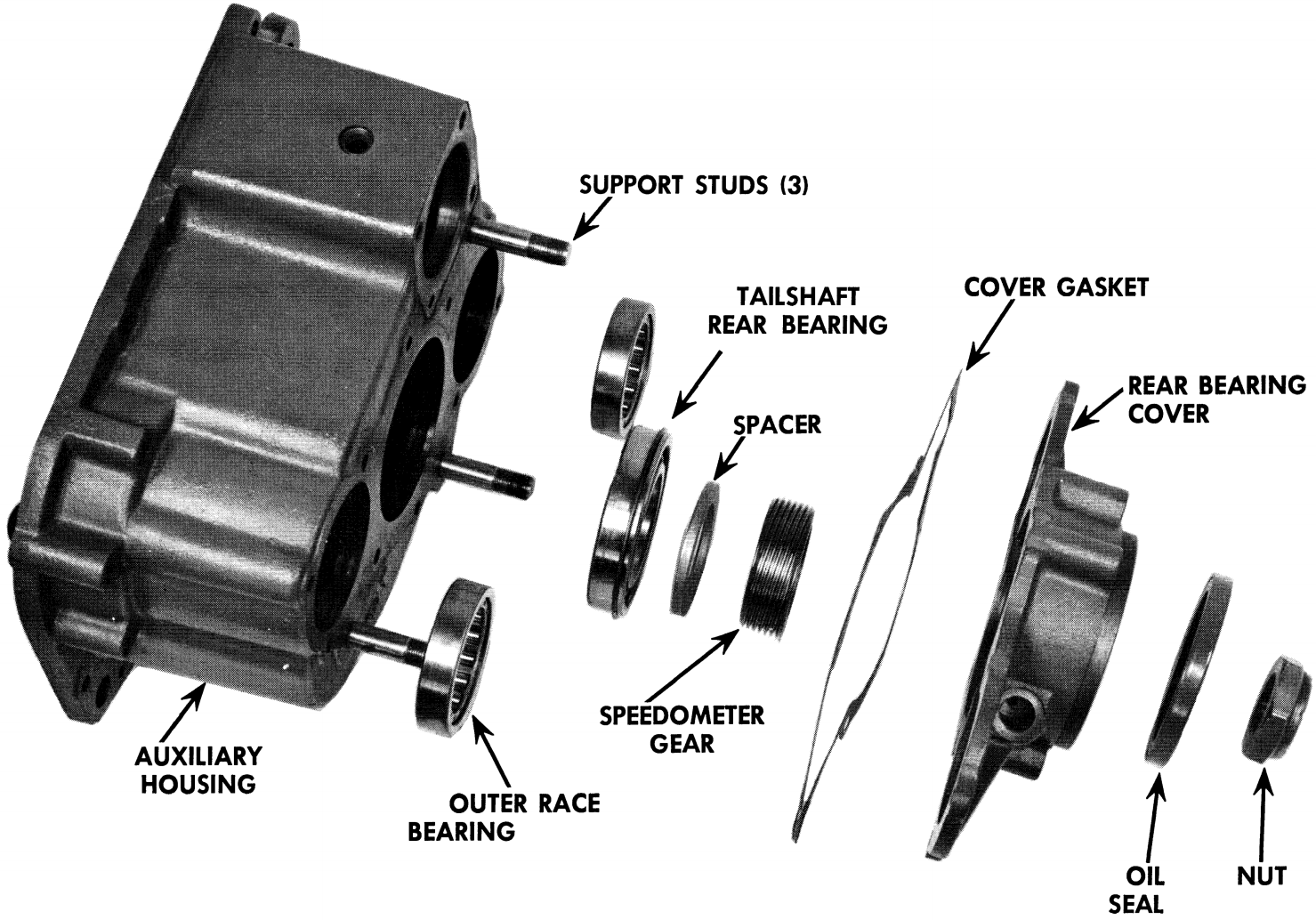




LOW SPEED GEAR AND TAILSHAFT ASSEMBLY

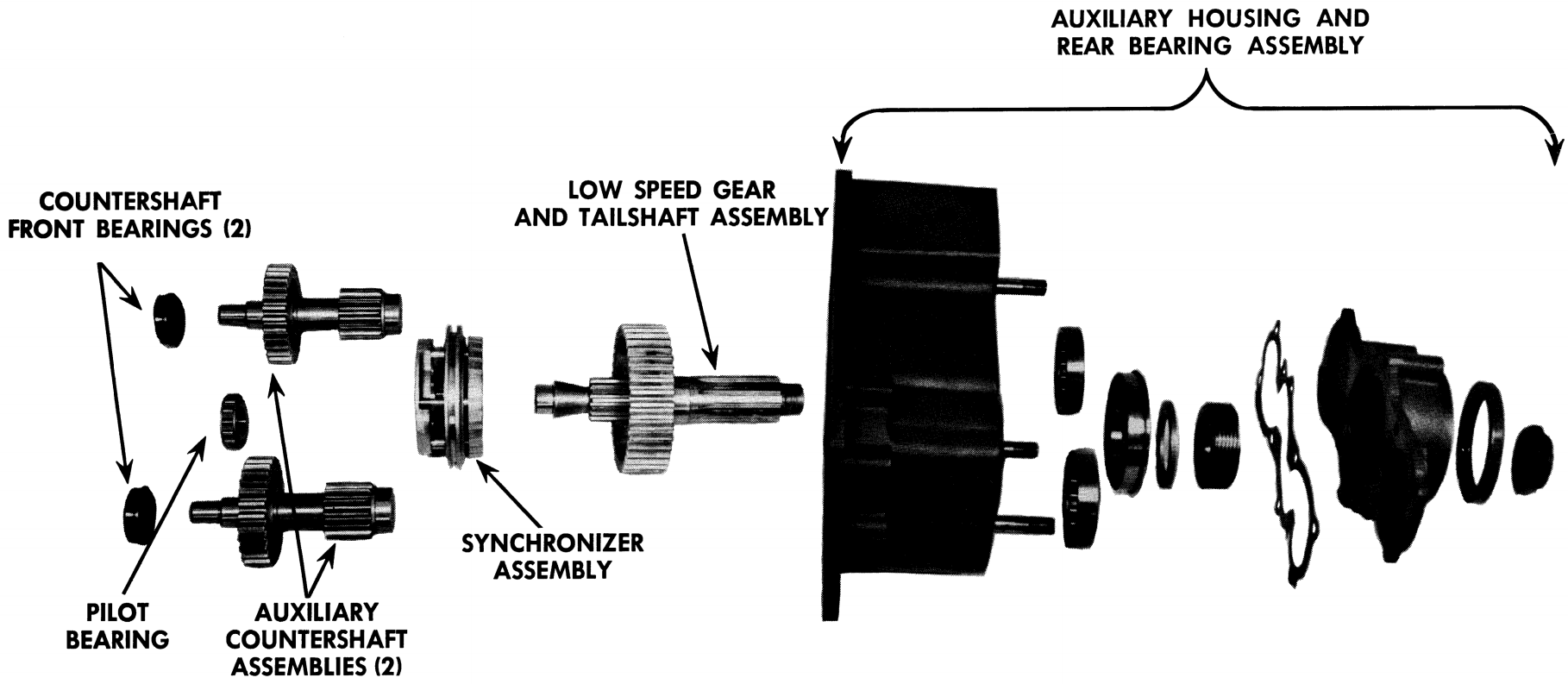
CASE AND CLUTCH HOUSING ASSEMBLY

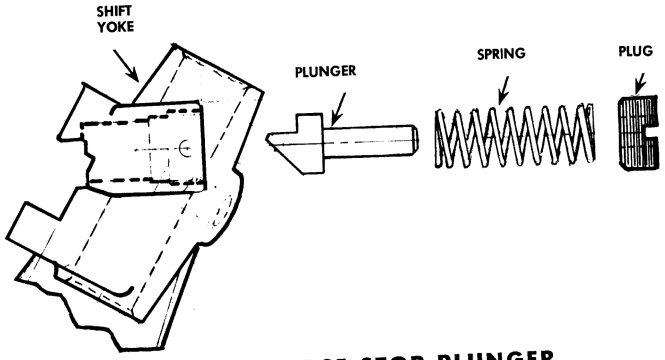




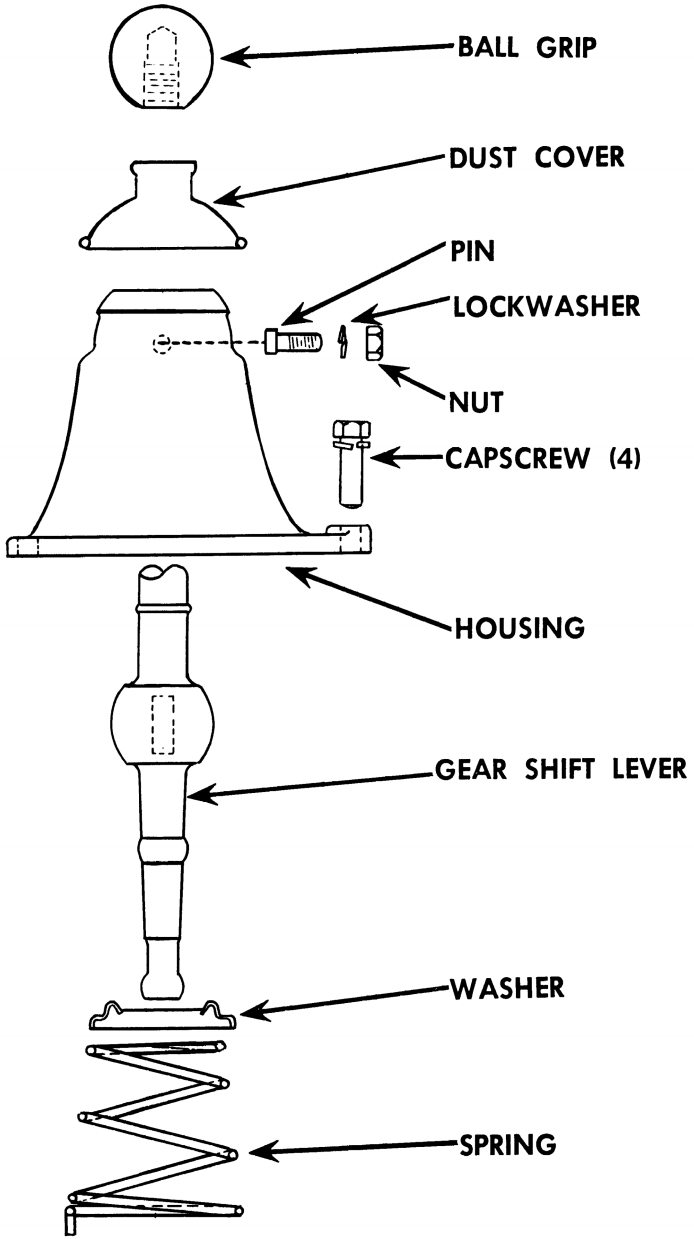
AUXILIARY HOUSING AND REAR BEARING ASSEMBLY

AUXILIARY SECTION





REVERSE STOP PLUNGER



MISC.-REVERSE STOP PLUNGER & GEAR SHIFT LEVER HOUSING

PREVENTIVE MAINTENANCE CHECK CHART

CHECKS WITHOUT PARTIAL DISASSEMBLY OF CHASSIS OR CAB

1. Air System and Connections

a. Check for leaks, worn air lines, loose connections and capscrews. See Air System section.

2. Clutch Housing Mounting

a. Check all capscrews in bolt circle of clutch housing for looseness.

3. Clutch Release Bearing

a. Remove hand hole cover and check radial and axial clearance in release bearing.

b. Check relative position of thrust surface of release bearing with thrust sleeve on push type clutches.

4. Clutch Pedal Shaft and Bores

a. Pry upward on shafts to check wear.

b. If excessive movement is found, remove clutch release mechanism and check bushings in bores and wear on shafts.

5. Gear Lubricant

a. Change at specified service intervals.

b. Use only gear oils as recommended. See Lubrication section.

6. Filler and Drain Plugs

a. Remove filler plugs and check level of lubricant at specified intervals. Tighten filler and drain plugs securely.

7. Gear Shift Lever

a. Check for looseness and free play in housing. If lever is loose in housing, proceed with Check No. 8.

8. Gear Shift Lever Housing Assembly

a. Remove air lines at air valve and remove the gear shift lever housing assembly from transmission.

b. Check tension spring and washer for set and wear.

c. Check the gear shift lever pivot pin and pivot pin slot for wear.

d. Check bottom end of gear shift lever for wear and check slot of yokes and blocks in shift bar housing for wear at contact points with shift lever.

CHECKS WITH DRIVE LINE DROPPED

9. Universal Joint Companion Flange Nut (Not Shown)

a. Check for tightness. Tighten to recommended torque.

CHECKS WITH UNIVERSAL JOINT COMPANION FLANGE REMOVED

10. Splines on Output Shaft

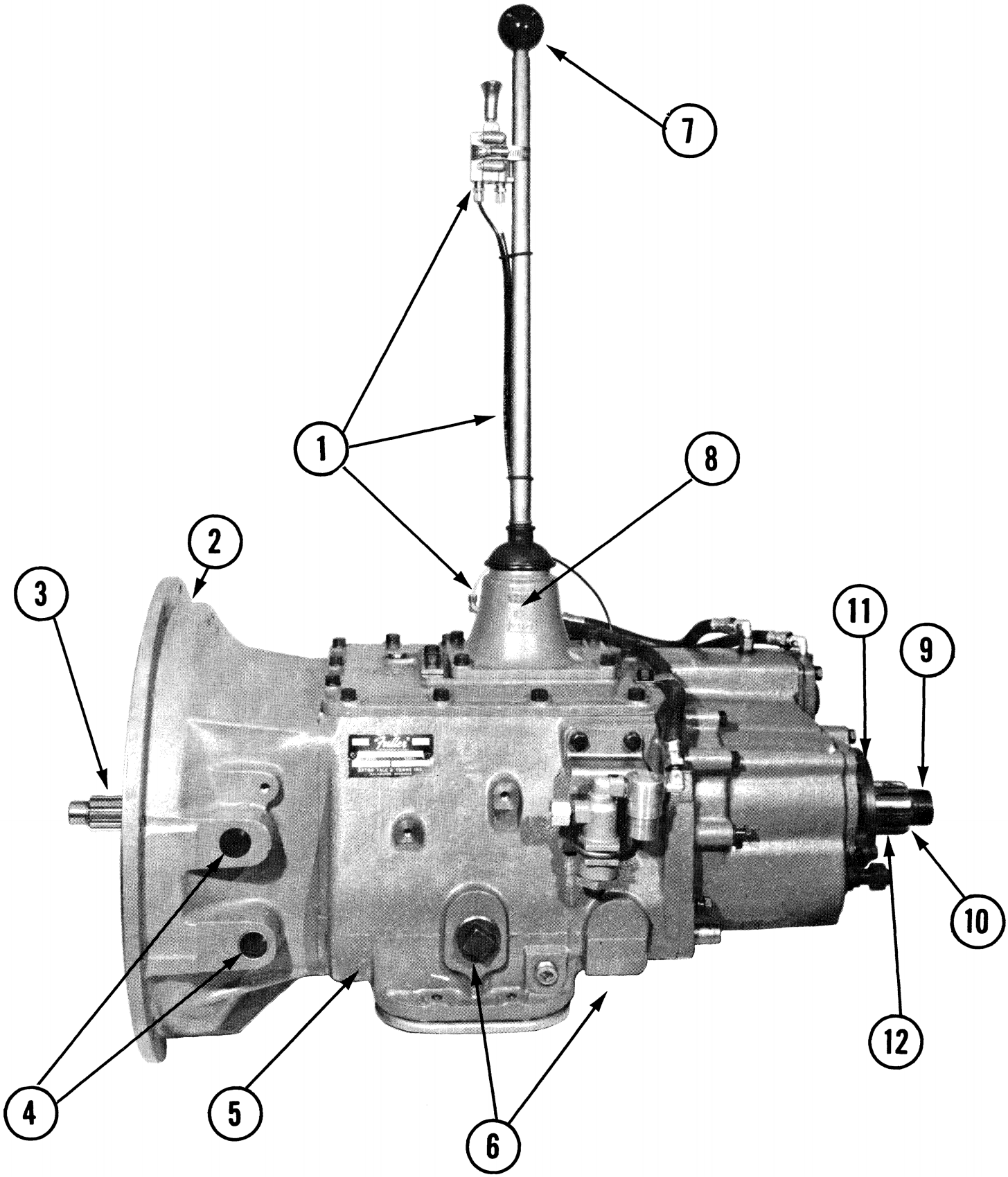
a. Check for wear from movement and chucking action of the universal joint companion flange.

11. Mainshaft Rear Bearing Cover

a. Check oil seal for wear.

12. Output Shaft

a. Pry upward against output shaft to check radial clearance in mainshaft rear bearing.


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INSPECTION

Before reassembling the transmission, the individual parts should be carefully checked to eliminate those damaged from previous service. This inspection procedure should be carefully followed to insure the maximum of wear life from the rebuilt unit.

The cost of a new part is generally a small fraction of the total cost of down time and labor, should the use of a questionable part make additional repairs necessary before the next regularly scheduled overhaul.

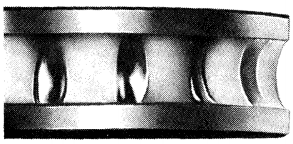
Recommended inspection procedures are set forth in the following checklist:

A. Bearings

1. Wash all bearings in clean solvent. Check balls, rolls and races for pits and spalled areas. Replace bearings which are pitted or spalled.



SPALLED BEARING — EXTREME LOAD



FALSE BRINNELLING — VIBRATION WITHOUT ROTATION

2. Lubricate bearings which are not spalled or pitted and check for axial and radial clearances. Replace bearings with excessive clearances.

3. Check fits of bearings in case bores. If outer races turn freely in the bores, the case should be replaced.

B. Gears

1. Check operating gear teeth for pitting on the tooth faces. Gears with pitted teeth should be replaced.

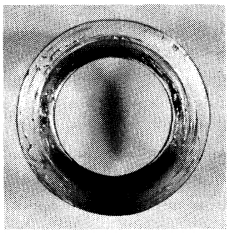
2. Check all engaging gear teeth. Gears with teeth worn, tapered or reduced in length from clashing in shifting should be replaced.

3. Check axial clearance of gears. Where excessive clearance is found, check gear snap ring, washer, spacer and gear hub for excessive wear.

C. Splines

1. Check splines on all shafts for wear. If sliding clutch gears, companion flange or clutch hub have worn into the sides of the splines, the shafts in this condition should be replaced.

D. Thrust Washers



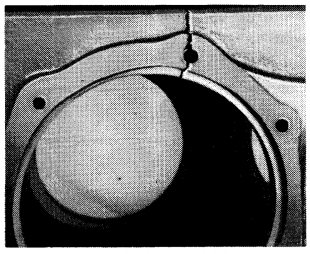
1. Check surfaces of all thrust washers. Washers scored or reduced in thickness should be replaced.

E. Reverse Gear Assembly

1. Check bearing surface for wear from action of roller bearings. Check washers for wear.

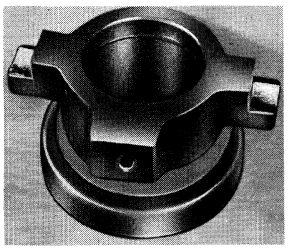
F. Gray Iron Parts

1. Check all gray iron parts for cracks and breaks. Replace or repair parts found to be damaged. Heavy castings may be welded or brazed providing the cracks do not extend into bearing bores or bolting surfaces.



G. Clutch Release Parts

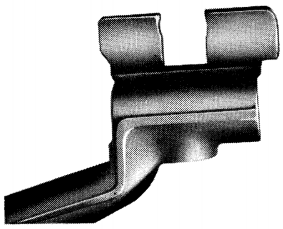
1. Check clutch release parts. Replace yokes worn at cam surfaces and bearing carrier worn at contact pads.



2. Check pedal shafts. Replace those worn at bearing surfaces.

H. Shifting Bar Housing Assembly

1. Check yokes and blocks for wear at pads and lever slot. Replace worn parts.



2. Check yokes for alignment. Straighten those which are sprung.

3. Check lockscrews in yokes and blocks. Tighten and rewire those found loose.

4. If housing has been dismantled, check neutral notches of shifting bars for wear from interlock balls. Bars indented at points adjacent to the neutral notch should be replaced.

I. Gear Shift Lever Housing Assembly

1. Check spring tension on shift lever. Replace tension spring and washer if lever moves too freely.

2. If housing is dismantled, check pivot pin and corresponding slot in lever for wear. Replace both parts if worn.

J. Bearing Covers

1. Check covers for wear from thrust of adjacent bearing. Replace covers worn and grooved from thrust of bearing outer race.

2. Check bores of covers for wear. Replace those worn oversize.

K. Oil Return Threads and Seals

1. Check oil return threads in front bearing cover. If sealing action of threads has been destroyed by contact with input shaft, replace the cover.

2. Check oil seal in rear bearing cover. If sealing action of lip has been destroyed, replace seal.

L. Synchronizers

1. Check high and low range synchronizers for burrs, uneven and excessive wear at contact surface.

2. Check blocker pins for excessive wear or looseness.

3. Check synchronizer contact surfaces on the high and low range gears for excessive wear.

TORQUE RATINGS

Recommended torque ratings, location and thread sizes of capscrews and nuts are listed below. Capscrew lengths are given for reference purposes as a guide for installation at proper locations.

Correct torque application is extremely important to assure long transmission life and dependable performance. Over-tightening or under-tightening can result in a loose installation and in many instances, eventually cause damage to transmission gears, shafts or bearings. Do not torque capscrews dry.

CAPSCREWS

Location	Qty.	Thread Size & Length	Torque Foot-Pounds
Air Filter	2	1/4-20 x 1/2	15-20
Air Valve	4	1/4-20 x 1-3/4	15-20
Air Filter to Case	2	3/8-16 x 3/4	20-25
* PTO Cover, Right (used with oil filter)	6	3/8-16 x 3/4	* 12-15
Bearing Retainer	4	3/8-16 x 1	35-45
Rear Bearing Cover	6	3/8-16 x 1	
Front Bearing Cover, Top	2	3/8-16 x 1-1/4	
Front Bearing Cover, Bottom	2	3/8-16 x 1-1/4	
Air Cylinder Cover	4	3/8-16 x 1-1/2	
Shift Lever Housing	4	3/8-16 x 1-1/4	
Tension Spring Cover	2	3/8-16 x 1-1/4	
Auxiliary to Transmission	8	3/8-16 x 1-1/4	
Shift Bar Housing	11	3/8-16 x 1-1/4	
Auxiliary to Transmission	7	3/8-16 x 1-1/4	
Rear Bearing Cover	4	3/8-16 x 2-3/4	
PTO Cover, Bottom	8	7/16-14 x 1-1/4	50-65
Clutch Housing to Case	2	1/2-13 x 1-1/4	70-75

NUTS

Location	Qty.	Thread Size & Length	Torque Foot-Pounds
Clutch Housing Studs	6	5/8-18	170-180
Rear Support Studs	3	5/8-18	170-180
Air Piston	1	1/2-20	60-70
Output shaft	1	1-1/2-18	400-450

*When not using oil filter, cover should be torqued to 18 - 23 ft. lbs. Excessive torquing will result in oil leakage.

LOCATION OF GASKETS

Seat gasket with shellac on part to be installed. Use new gaskets when reassembling tranmission. Gaskets are located as follows:

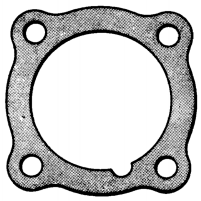
Part No.	Location
1642	Gear Shift Lever Housing
1684	PTO, Right
10733	Air Valve
11634	PTO, Bottom
15059	Front Bearing Cover
15060	Clutch Housing
15061	Between Auxiliary and Front Section
15062	Auxiliary Shift Cylinder Cover
150659	Auxiliary Shift Cylinder
16240	Auxiliary Rear Bearing Cover
15091	Auxiliary Shift Bar (Brass)
15133	Tension Spring Cover
15605	Shift Bar Housing

GENERAL PRECAUTIONS FOR REASSEMBLY

IMPORTANT: Read this section before starting the detailed reassembly procedures.

Make sure that interiors of case and housings are clean. It is important that dirt be kept out of transmission during reassembly. Dirt is abrasive and can damage polished surfaces of bearings and washers. Use certain precautions, as listed below, during reassembly.

1. **GASKETS** — Use new gaskets throughout the transmission as it is being rebuilt. Make sure all gaskets are installed, as omission of gasket can result in oil leakage or misalignment of bearing covers. See "Location of Gaskets" heading.



2. **CAPSCREWS** — To prevent oil leakage, use shellac on all capscrews. See torque rating chart for recommended torque.

3. **O-RINGS** — Coat all O-rings with Dow-Corning 200 lubricant, 50,000 cs. L-45.

4. **BEARING RETAINING NUTS** — Use Loctite, type AVV on threads of all drive gear bearing nuts.

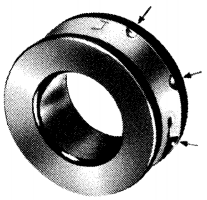
5. **INITIAL LUBRICATION** — Coat all thrust washers and splines of shafts with Lubriplate during installation to provide initial lubrication, preventing scoring and galling.

6. **AIR SYSTEM** — Use Loctite hydraulic sealant on all air fittings; coat air cylinder bores with Tectyl Valvoline rust preventive #502-C.

7. **AXIAL CLEARANCES**

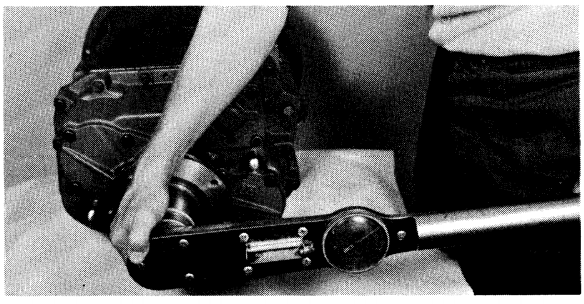
Mainshaft Forward Speed Gears	.005 to .011
Mainshaft Reverse Speed Gear	.011 to .032
Reverse Idler Gears	.011 to .032

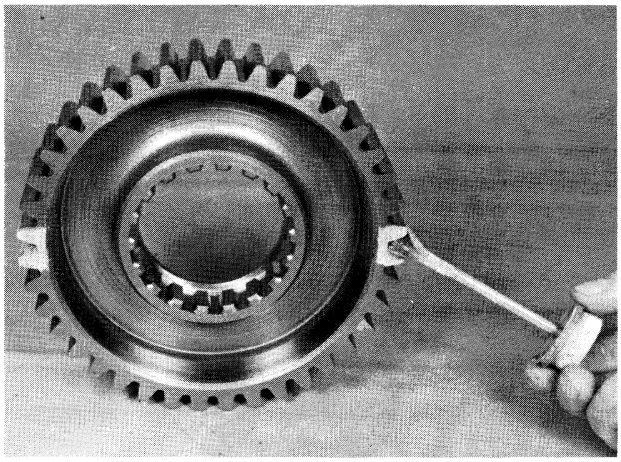
8. **BEARINGS** — Use of flanged-end bearing drivers is recommended for the installation of bearings. These drivers apply equal force to both races of bearing, preventing damage to balls and races and maintaining correct bearing alignment with shaft and bore. If tubular or sleeve type driver is used, apply force only to inner race.



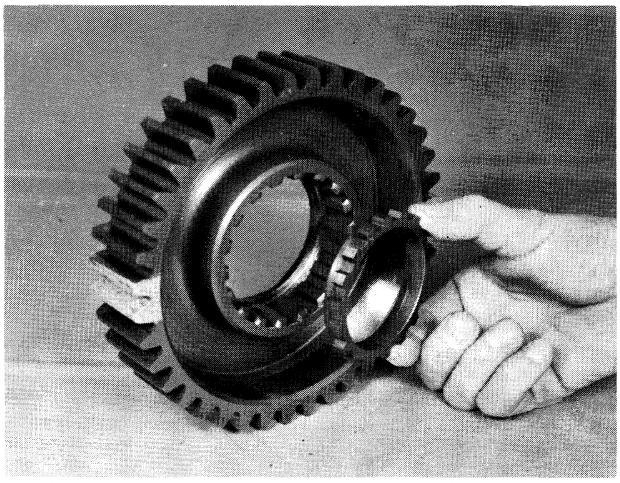
BALL DEPRESSIONS, CAUSED BY OFF-CENTER BLOW

9. **UNIVERSAL JOINT COMPANION FLANGE** — Pull the companion flange tightly into place with the tailshaft nut, using 400-450 foot-pounds of torque. Make sure the speedometer gear has been installed. If a speedometer gear is not used, a replacement spacer of the same width must be used. Failure to pull the yoke or flange tightly into place will permit the shaft to move axially with resultant damage to rear bearing.

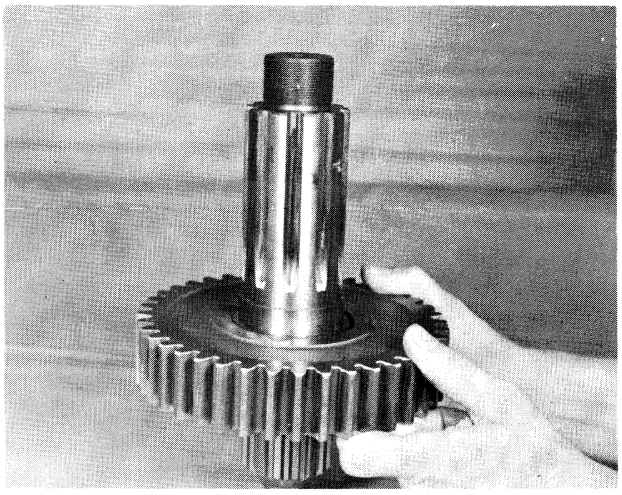




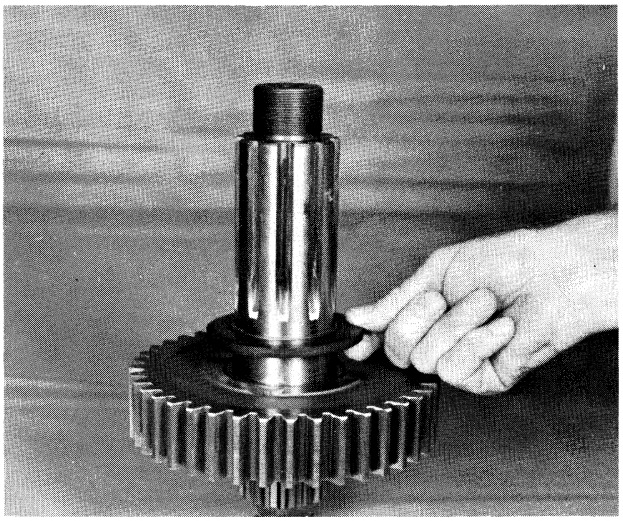
72. *Marking teeth on low speed gear for timing purposes.*



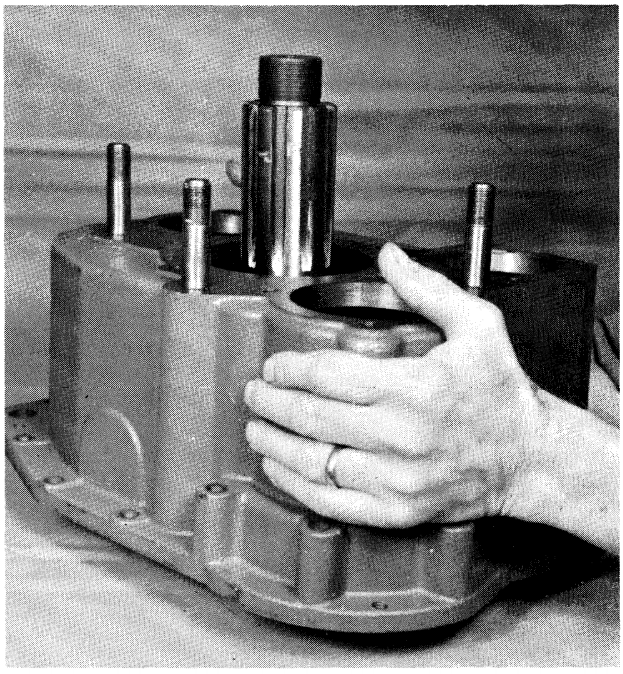
73. *Installing splined spacer in hub of low speed gear.*



74. *Installing low speed gear with splined spacer on tailshaft.*



75. *Installing rear washer on shaft, chamfer to the rear.*



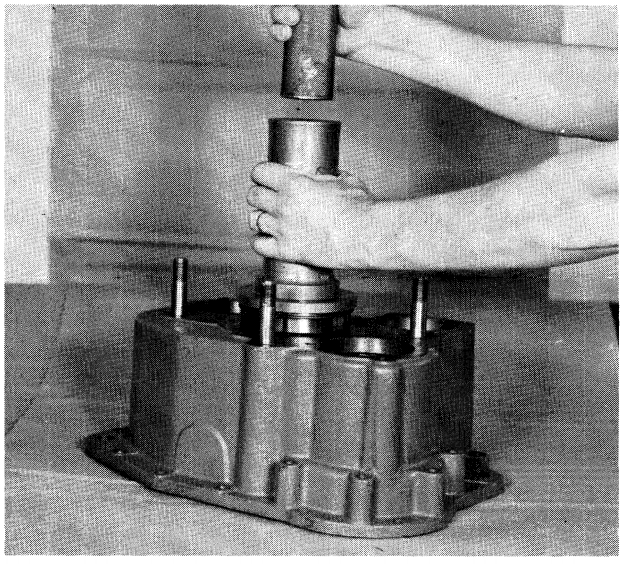
76. *Placing auxiliary housing over tailshaft.*

DETAILED DISASSEMBLY INSTRUCTIONS

I. AUXILIARY REASSEMBLY

A. To Reassemble and Install the Low Speed Gear and Tailshaft Assembly.

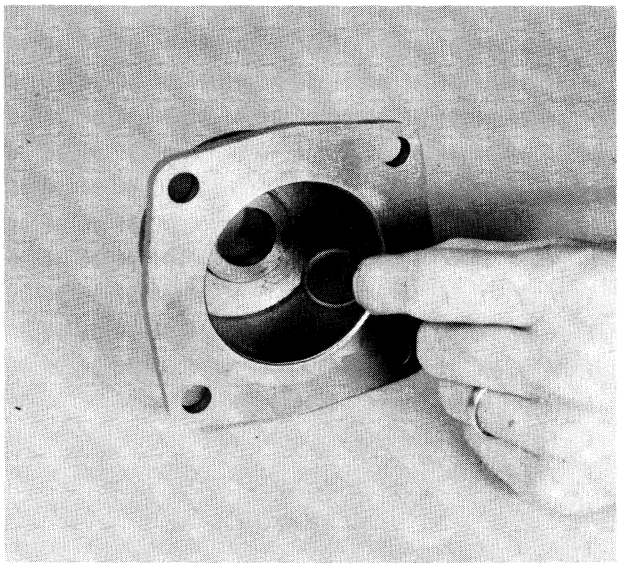
1. Make sure magnetic cleaner is installed in recess in auxiliary case.
2. IMPORTANT: Mark timing teeth on the low speed gear.
   a. Mark any two adjacent gear teeth on low speed gear.
   b. Then, mark the two adjacent teeth which are directly opposite the first set marked. There should be the same number of teeth between the markings on each side of the gear. Illustration No. 72.
3. Place splined spacer in hub of low speed gear, shoulder toward rear. Illustration No. 73.
4. Install the low speed gear and spacer over rear of shaft and against shoulder. Clutching teeth to the front. Illustration No. 74.
5. Install the low speed gear rear washer on shaft and against gear, chamfer to the rear. Illustration No. 75.
6. Set the tailshaft with the forward end down and place auxiliary housing over rear of shaft so that shaft extends through rear bore. Illustration No. 76.
7. Seat mainshaft rear bearing securely on shaft and in bore. Illustration No. 77.



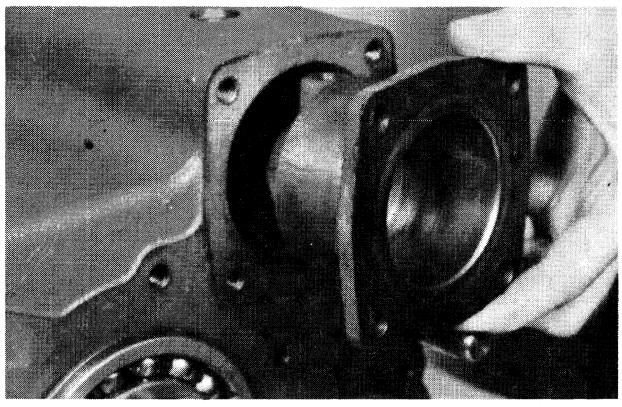
77. *Seating rear bearing on shaft and in housing bore.*

B. To Install the Range Shift Air Cylinder.

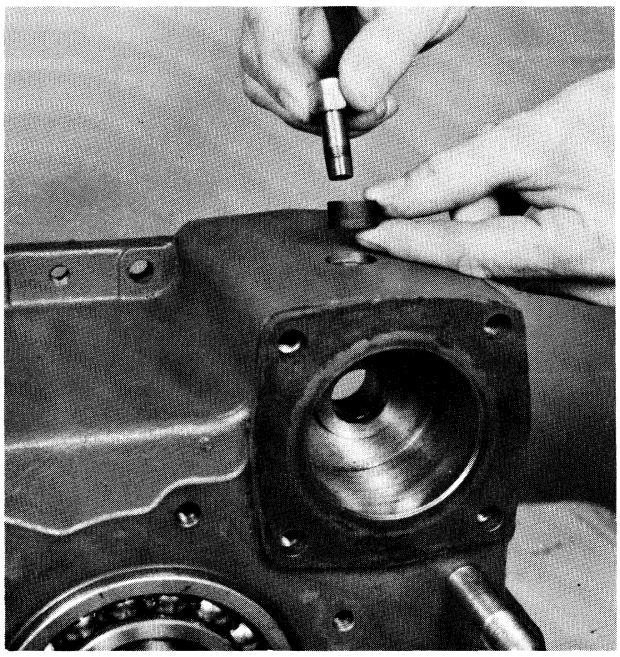
1. Install O-ring in slot in small bore in cylinder. Illustration No. 78.
2. Install cylinder in housing with small bore in cylinder aligned with air port in top of auxiliary. Illustration No. 79.



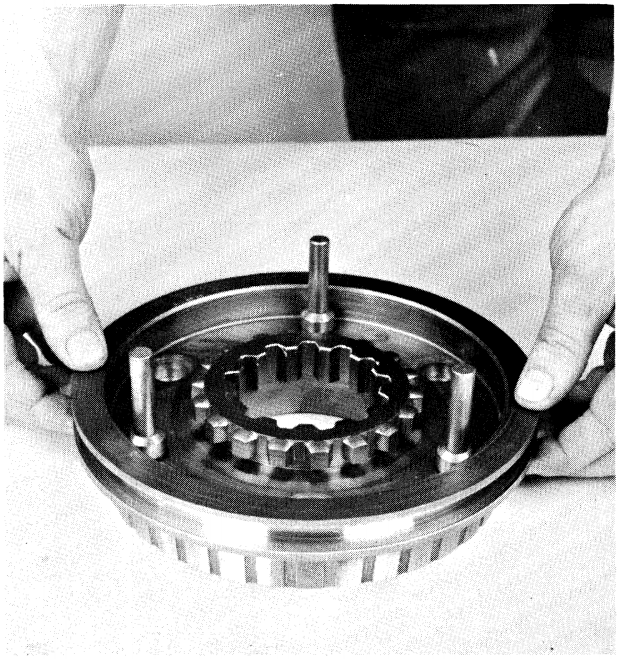
78. *Installing O-ring in small diameter bore in air cylinder.*



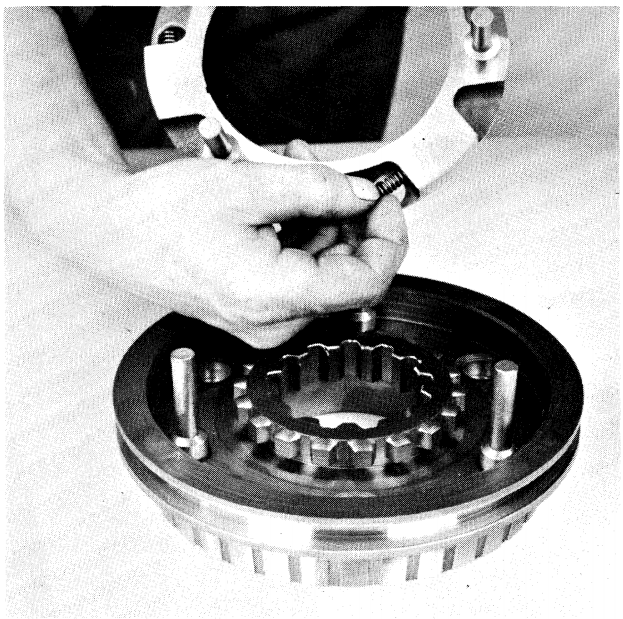
79. *Placing air cylinder in housing.*



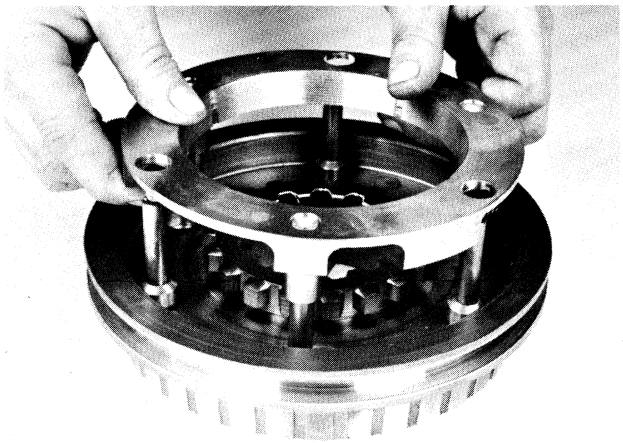
80. *Installing dust seal and air-port extension in housing and air cylinder.*



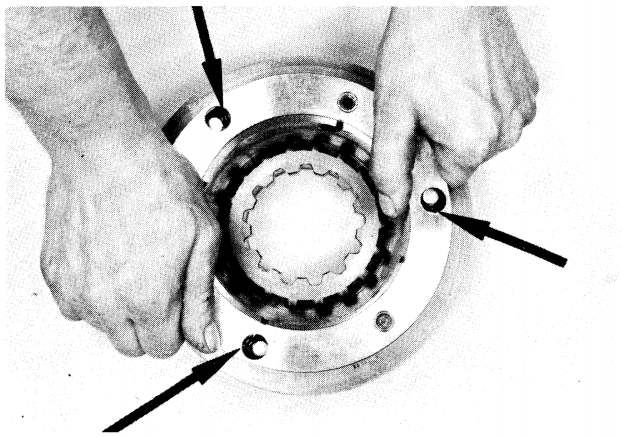
81. *Placing sliding clutch gear on pins of low range synchronizer.*



82. *Placing springs in high range synchronizer.*



83. *Placing high range synchronizer ring over pins of low speed synchronizer ring.*



84. *Springs compressed against pins of low range synchronizer.*

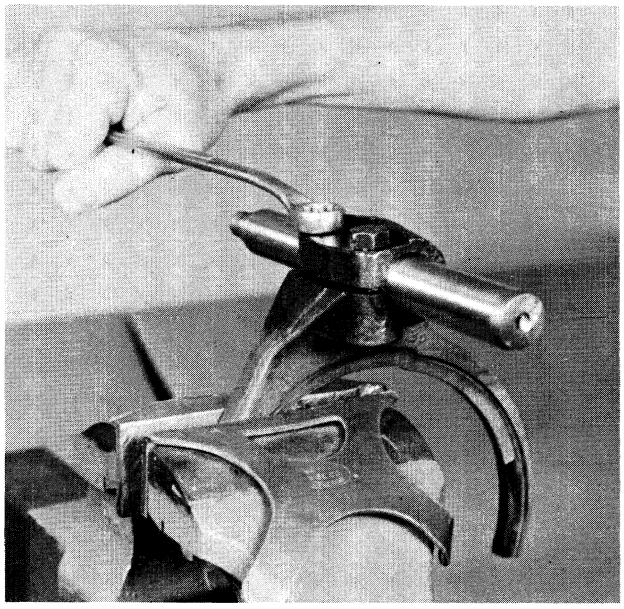
3. Install dust cover and air port extension through housing and into bore of air cylinder. Illustration No. 80.

C. To Reassemble the Synchronizer Assembly.

1. Place the larger low range synchronizer ring face down on bench with pins up.
2. Place the sliding clutch, recessed side up, on pins of low range synchronizer. Illustration No. 81.
3. Install the three springs in bores in high range synchronizer ring. Illustration No. 82.
4. Place the high range synchronizer ring over pins of the low speed synchronizer ring, seating springs against pins. Illustration No. 83.
5. Apply pressure to high range synchronizer ring to compress springs and seat pins of low range synchronizer fully into bores of high range synchronizer ring. Illustration No. 84.

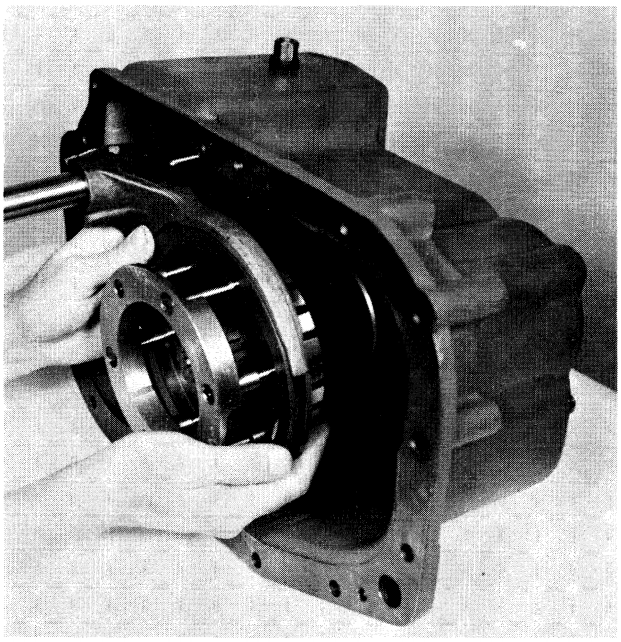
D. To Install the Synchronizer and Range Shift Air Cylinder Assemblies.

1. Place the shifting yoke on piston shaft, fork towards thread end.
2. Align slots in shaft with bores in yoke hub and install the two lockscrews, secure with safety wire. Illustration No. 85.

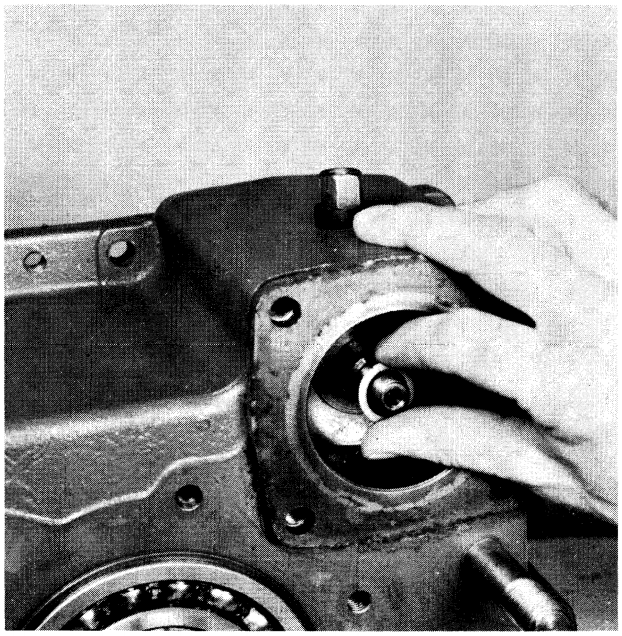


85. *Installing shifting yoke on piston shaft.*

3. Place yoke in slot of sliding clutch; thread end of piston shaft is towards the larger low range synchronizer.
4. Place the entire assembly into auxiliary housing, threading splined sliding clutch on tailshaft and inserting piston shaft through cylinder bore. Illustration No. 86.
5. Install copper seal on thread end of piston shaft. Illustration No. 87.



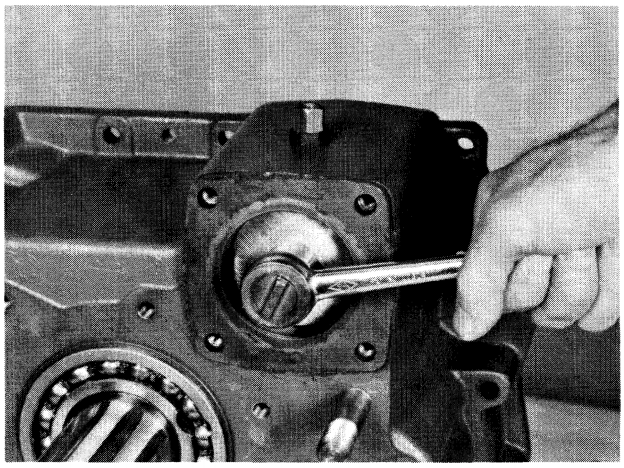
86. *Installing synchronizer assembly, yoke and piston shaft as a unit into housing.*



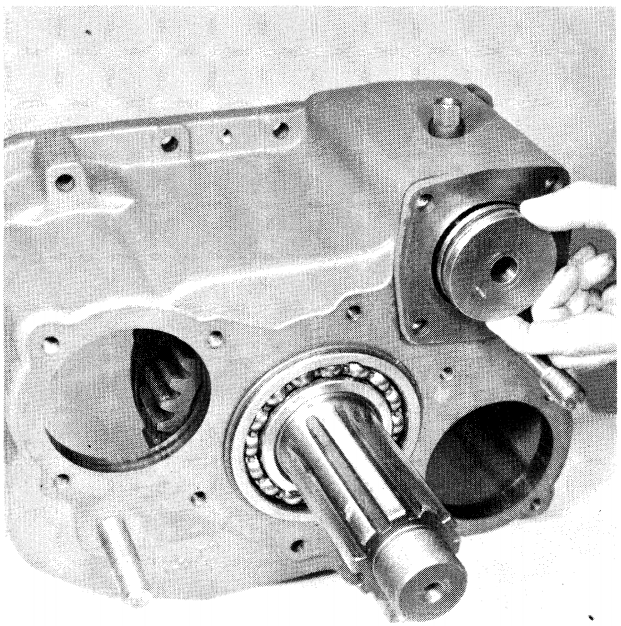
87. *Installing copper seal on piston shaft.*



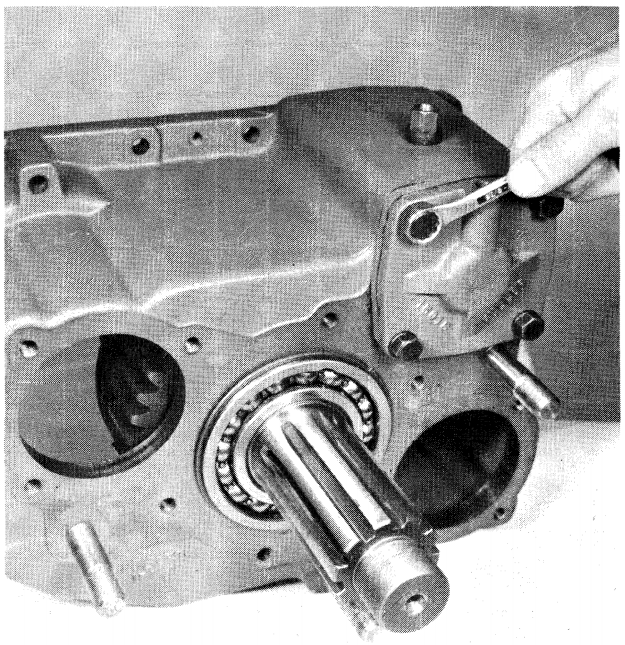
88. *Installing O-ring on OD of piston.*



90. *Installing nut on piston shaft.*



89. *Installing piston on shaft and into air cylinder.*



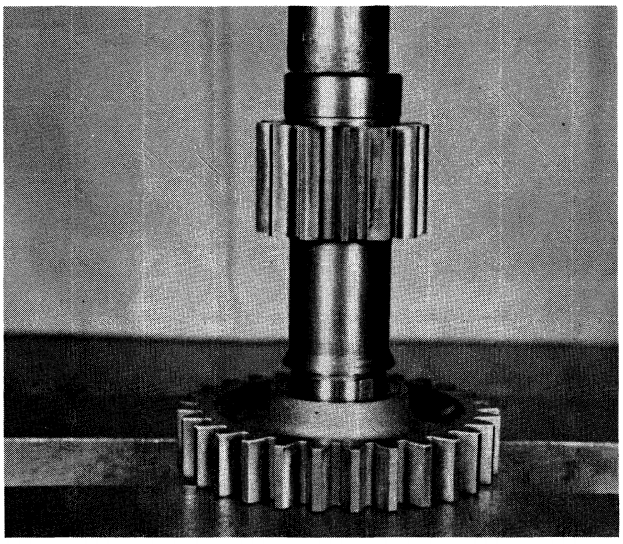
91. *Installing air cylinder cover.*

6. Install O-ring on OD of piston. Illustration No. 88.
7. Install piston on shaft and against copper washer, flat side of piston out. Illustration No. 89.
8. Install lockwasher and nut on shaft to secure piston. Illustration No. 90.
9. Install gasket and cylinder cover, tighten the four capscrews securely. Illustration No. 91.

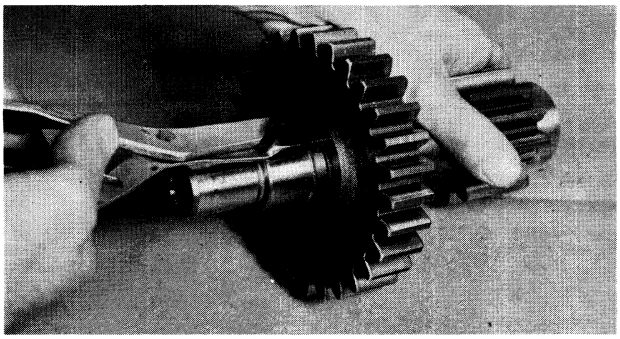
E. To Reassemble the Countershaft Assemblies.

NOTE: *In new style models the drive gear is welded to the countershaft and can not be removed; disassembly and reassembly of the countershaft assemblies is not necessary.*

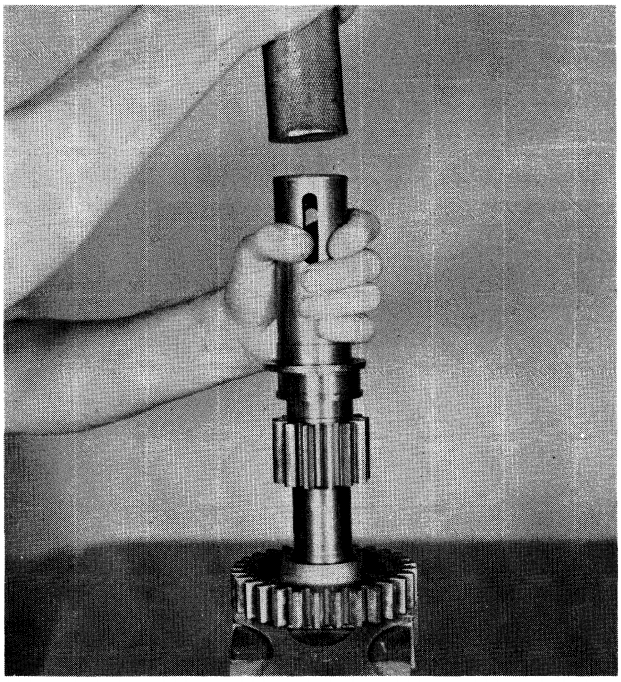
1. If previously removed, install key in keyway in countershaft. (Old style only.)
2. Press drive gear on countershaft, long hub to the rear. Illustration No. 92. (Old style only.)
3. Install snap ring in front of countershaft. Illustration No. 93. (Old style only.)
4. Install bearing inner race on rear of countershaft. Illustration No. 94.
5. **IMPORTANT:** *To mark countershaft gear teeth for timing.*
   Mark the tooth on the countershaft low speed gear which is aligned with the keyway in drive gear. This gear tooth will be stamped with an "O". Illustration No. 95.



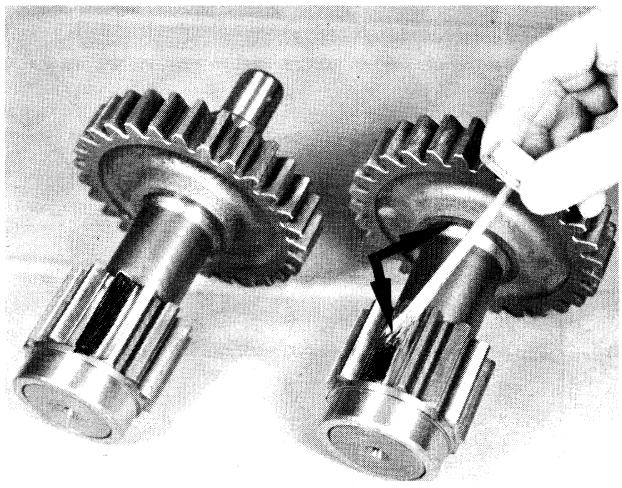
92. *Pressing drive gear on auxiliary countershaft. (Old style only.)*



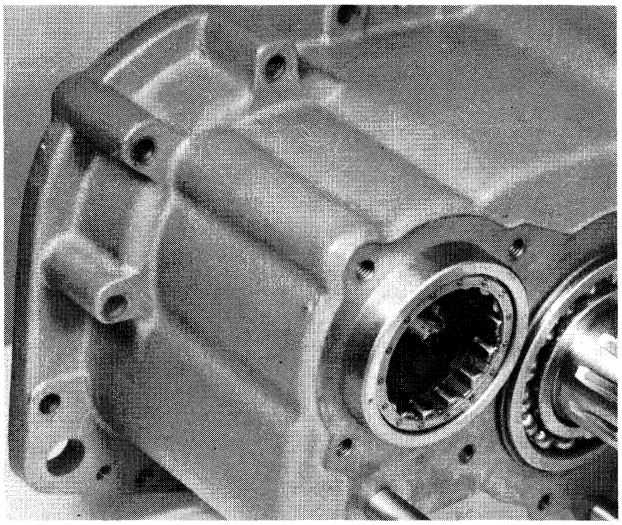
93. *Installing snap ring on countershaft. (Old style only.)*



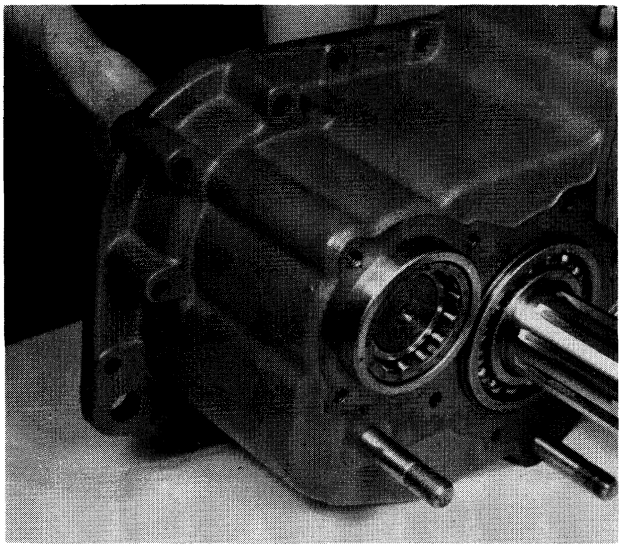
94. *Installing rear bearing inner race on countershaft.*



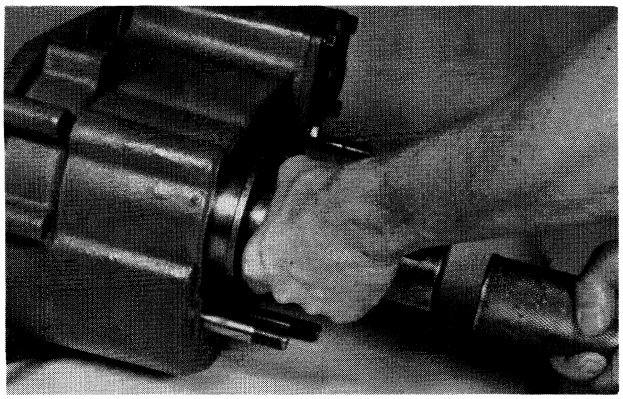
95. *Marking timing tooth on low speed gear which is aligned with keyway in drive gear.*



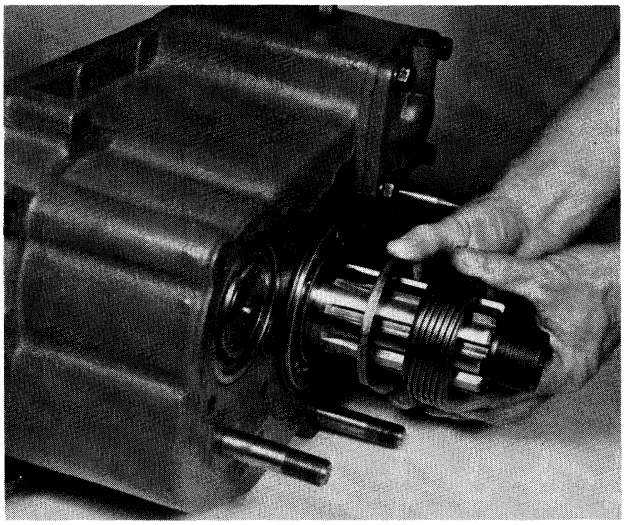
96. *Outer races of countershaft rear bearings partially installed in housing bores.*



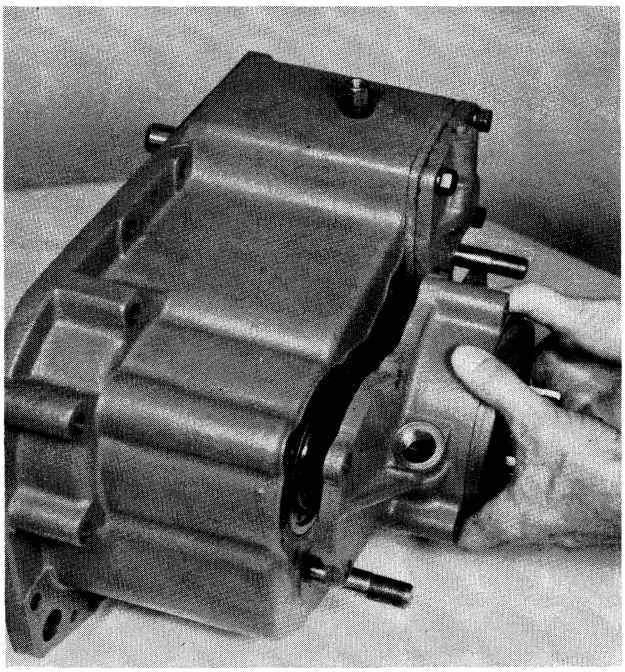
97. *Placing countershafts into position in housing. At the same time, mesh timing tooth on each countershaft between timing teeth of low speed gear.*



98. *Seating countershaft rear bearing fully into bore and on shaft.*



99. *Installing washer and speedometer gear on tailshaft.*

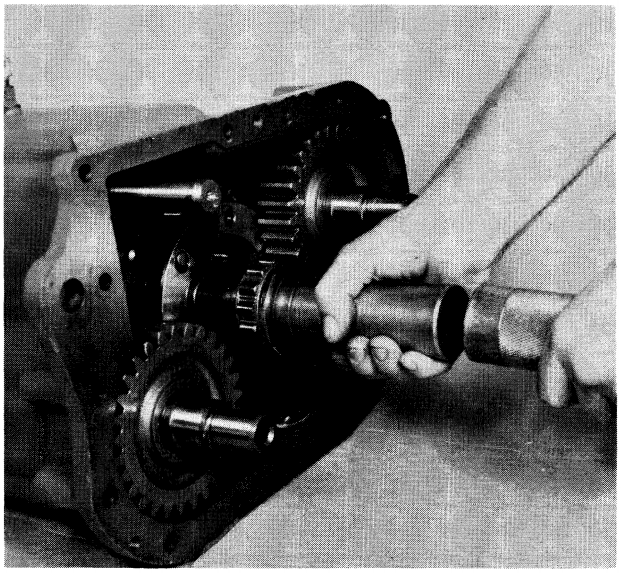


100. *Installing the rear bearing cover housing.*

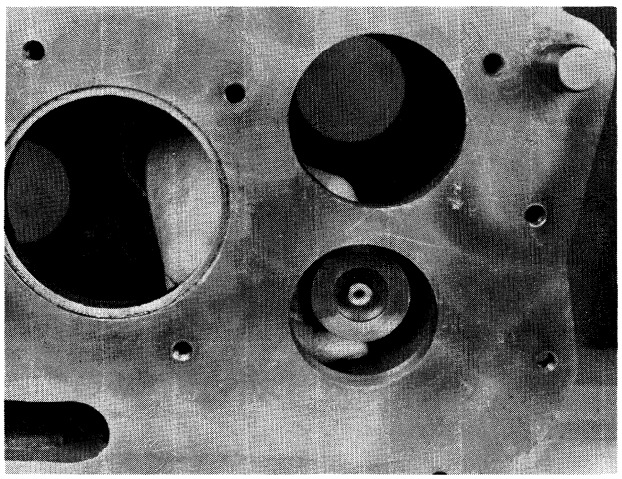
F. To Install the Countershaft Assemblies.

1. Seat the outer races of the countershaft rear bearings only partially in bores, just far enough to stay in place. Illustration No. 96.
2. Place countershafts into position in auxiliary housing, inserting inner races into the partially installed outer races. Illustration No. 97.

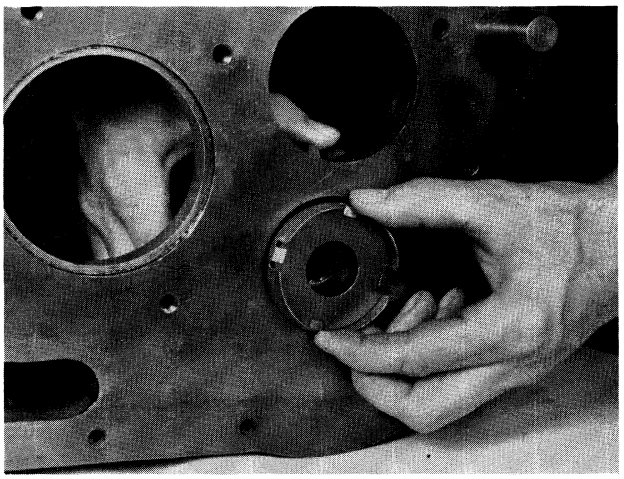
   IMPORTANT: *Timing countershaft gears with low speed gears. As the countershafts are installed, mesh the marked low speed gear tooth on each countershaft between each set of marked gear teeth on the low speed gear.*
3. With countershafts in position, complete the installation of the countershaft rear bearings on shaft and into case bore. Seat securely. Illustration No. 98.
4. Install the speedometer gear rear washer on tailshaft and against bearing, champhered ID towards bearing, and install the speedometer gear or replacement spacer on shaft and against washer. Illustration No. 99.
5. If previously removed, install oil seal in rear bearing cover, lip of seal to the rear.
6. Install the rear bearing cover with the speedometer bore up and to the left, tighten cap screws securely. Illustration No. 100.
7. Install bearing on front of tailshaft. Illustration No. 101.



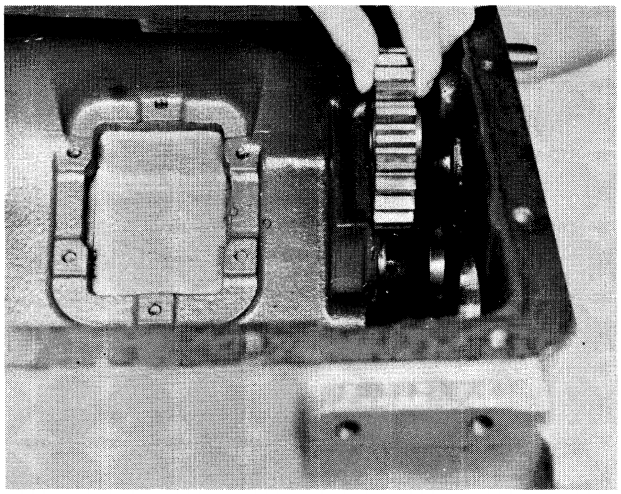
101. *Installing pilot bearing on front of tailshaft.*



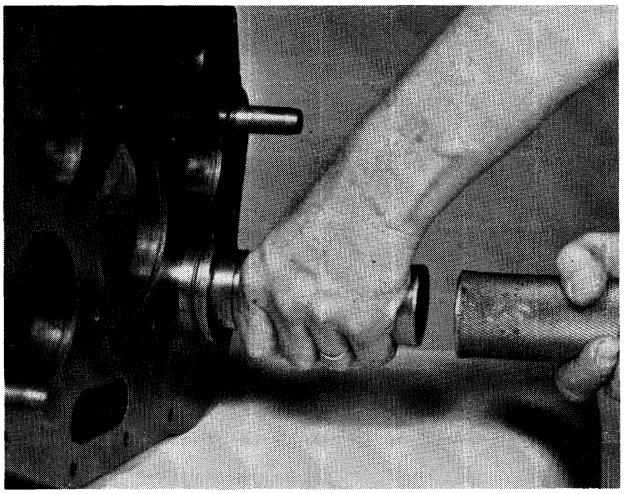
102. *Installing the reverse-idler gear front washer on pin in case.*



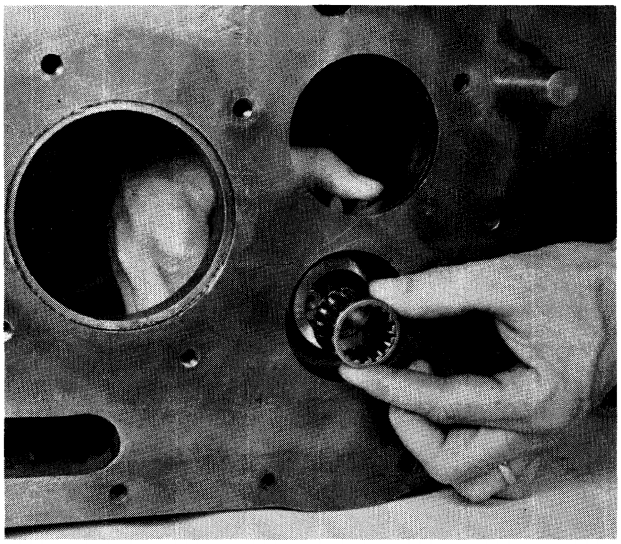
105. *Placing the reverse-idler gear rear washer and holder into case bore.*



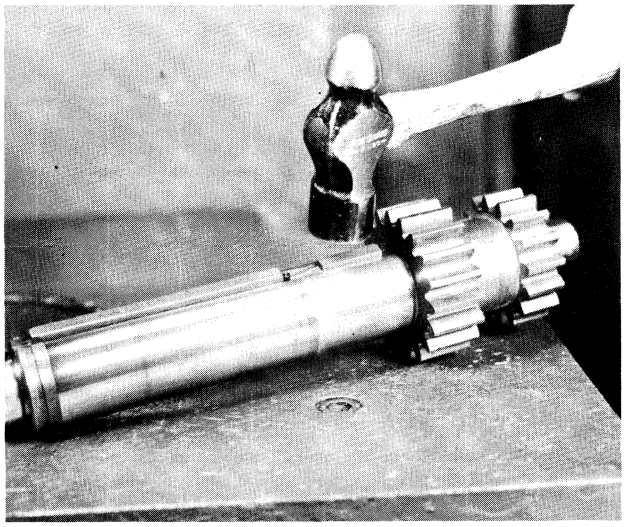
103. *Placing the reverse-idler gear into position in case.*



106. *Installing the auxiliary countershaft front bearing into the reverse-idler bore.*



104. *Installing needle bearing in hub of reverse-idler gear.*



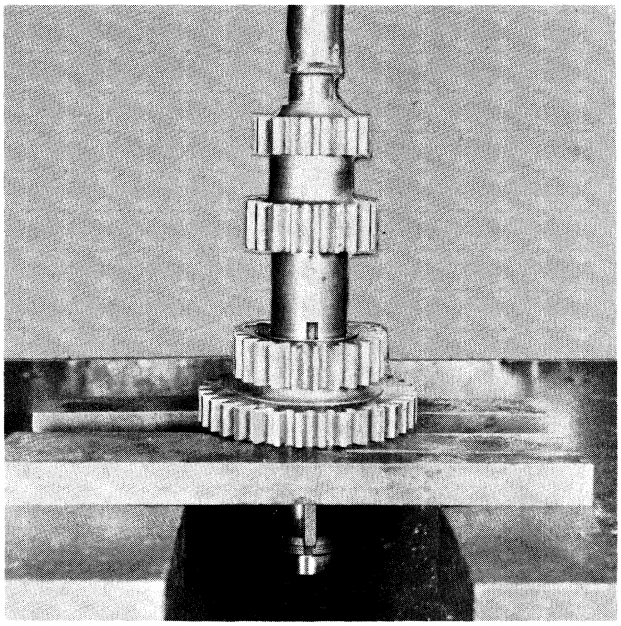
107. *Installing keys in countershaft.*

II. FRONT SECTION REASSEMBLY

A. To Install the Right Reverse Idler Gear Assembly.

1. Install the small, flat reverse-idler gear front washer on pin in lower right of case. Illustration No. 102.
2. Set reverse gear in position next to washer, machined surface of gear hub to the rear. Illustration No. 103.
3. Install needle bearing through rear bore and into hub of reverse gear. Illustration No. 104.
4. Place rear washer in holder if previously removed, oil slot down, and bend lugs to secure washer.
5. Place washer and holder into reverse gear case bore, oil slots toward gear, holder flange to the rear. Illustration No. 105.
6. Install the auxiliary countershaft front bearing into the reverse gear case bore to hold the reverse idler gear assembly in position. Illustration No. 106.

   NOTE: *The front portion of the auxiliary countershaft is used as a journal for the reverse idler gear.*

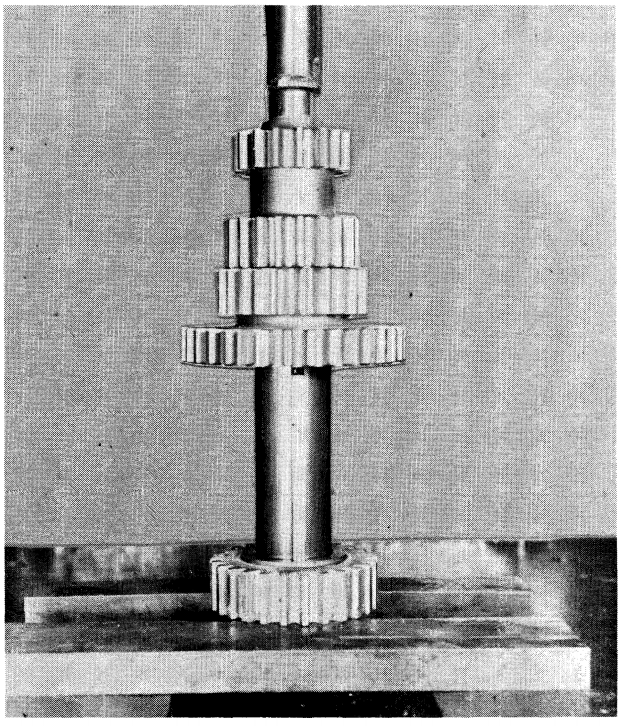


108. *Pressing the PTO-2nd speed gear cluster on countershaft.*

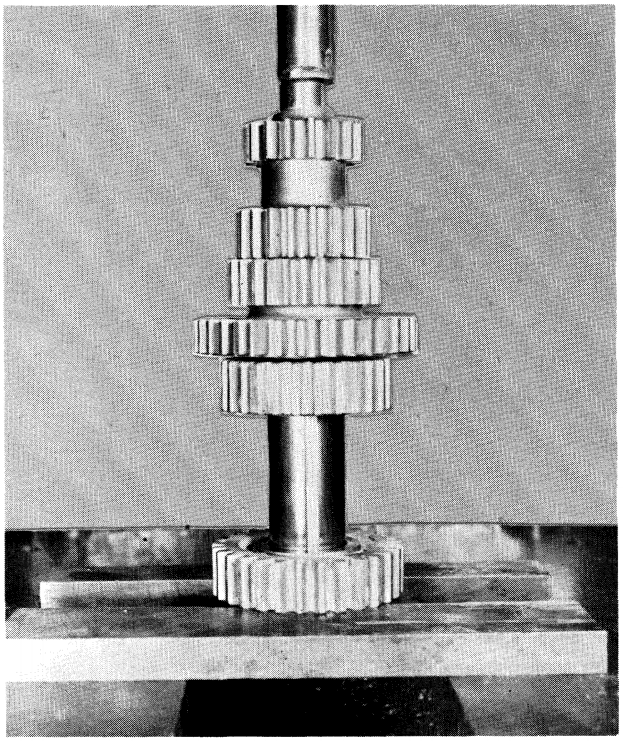
B. To Assemble the Countershaft Assemblies.

NOTE: *Countershafts are identical and are assembled in the same manner.*

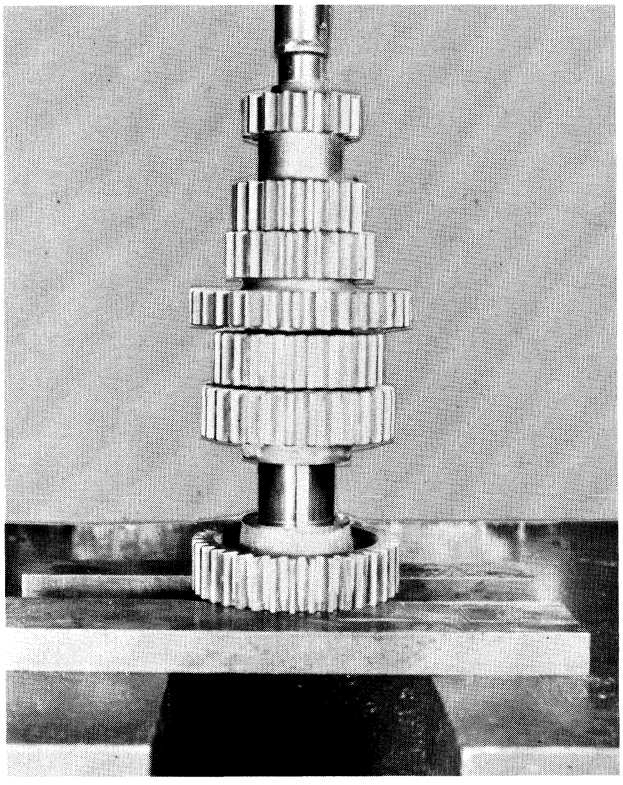
1. If previously removed, install roll pin, long key and woodruff key in slots in countershaft. Illustration No. 107.
2. Press the PTO-2nd speed gear cluster on countershaft, PTO gear to the front. Illustration No. 108.
3. Press the 3rd speed gear on shaft, long hub to the rear. Illustration No. 109.



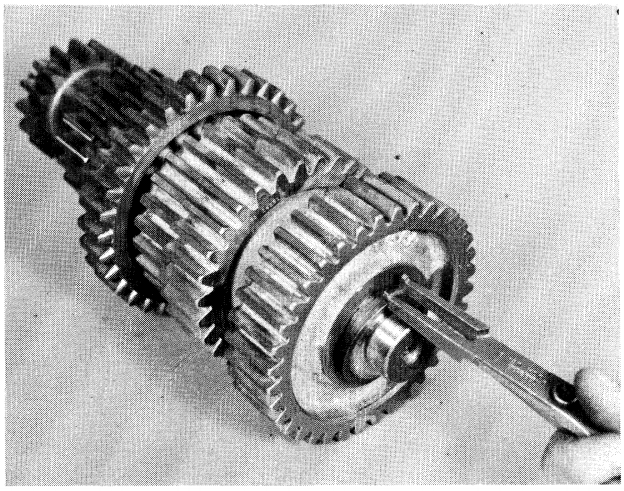
109. *Pressing the 3rd-speed gear on countershaft.*



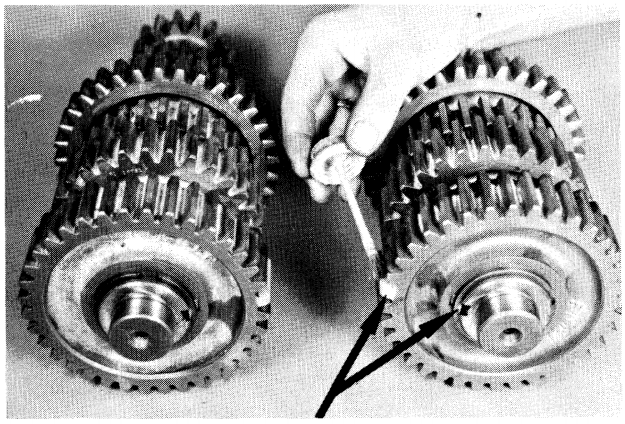
110. *Pressing the 4th-speed gear on countershaft.*



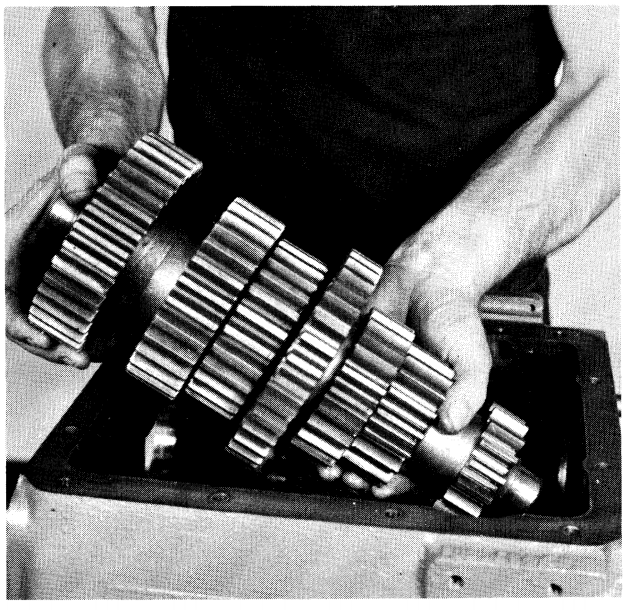
111. *Pressing the drive gear on countershaft.*



112. *Installing snap ring in groove at front of countershaft.*



113. *Marking timing tooth on countershaft drive gear. This tooth is aligned with keyway in shaft.*



114. *Installing the left countershaft.*

4. Press the 4th speed gear on shaft, long hub to the front. Illustration No. 110.
5. Press drive gear on shaft, long hub to the rear. Illustration No. 111.
6. Install snap ring in groove at front of shaft. Illustration No. 112.

C. To Mark Timing Teeth and Position Countershaft Assemblies.

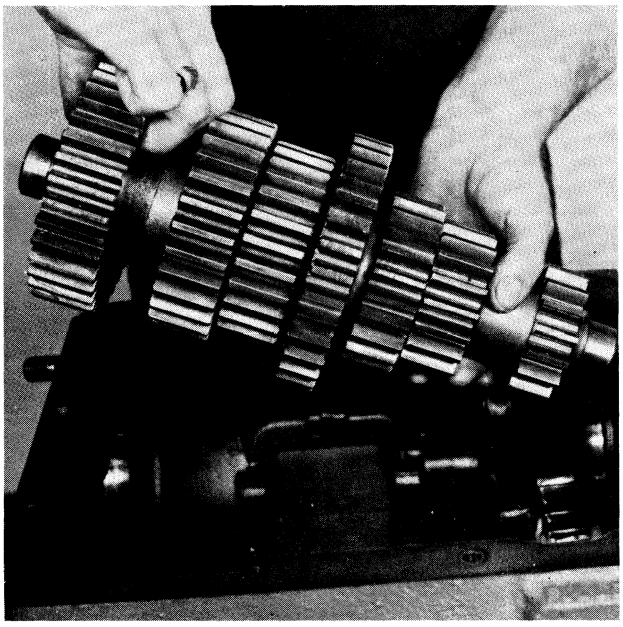
1. On the drive gear of each countershaft mark the gear tooth which is aligned with the keyway in shaft. This tooth will be stamped with an "O". Illustration No. 113.
2. Place the left countershaft into position in case — do not install bearings. Illustration No. 114.
3. Place the right countershaft into position in case — do not install bearings. Illustration No. 115.

D. To Reassemble the Mainshaft Assembly.

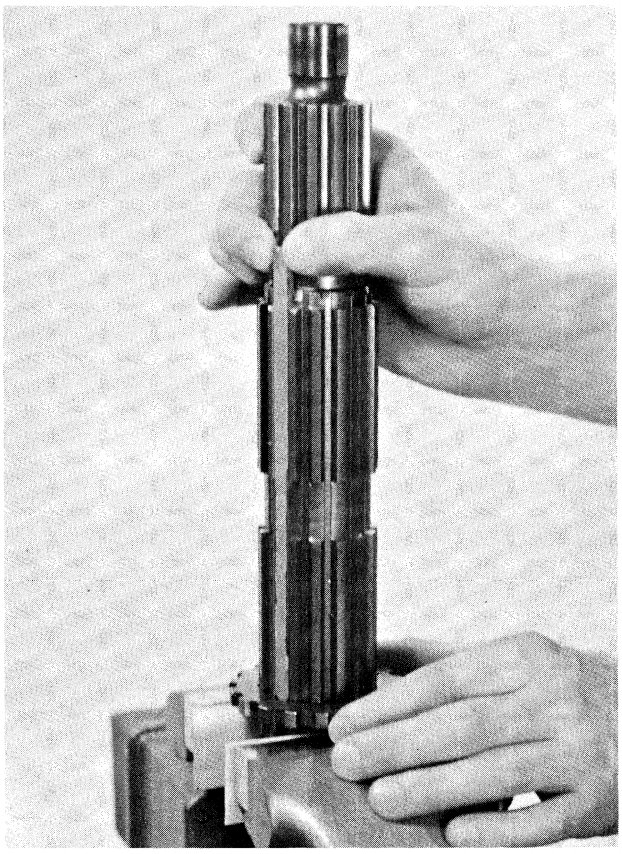
1. Place the mainshaft in a vise with the pilot end up. Keep keyway in mainshaft clear for insertion of key.

   NOTE: *Each mainshaft gear is held in position by locking the gear splined washer to the mainshaft with key. There is one splined washer for each gear. Splined washers for the reverse, 1st, 2nd, and 3rd speed gears are identical; the 4th speed gear splined washer is of smaller diameter.*
2. Install reverse gear splined washer in groove near rear of mainshaft.
3. Install long key, from the top, in keyway in mainshaft to lock reverse gears splined washer to mainshaft. Illustration No. 116.

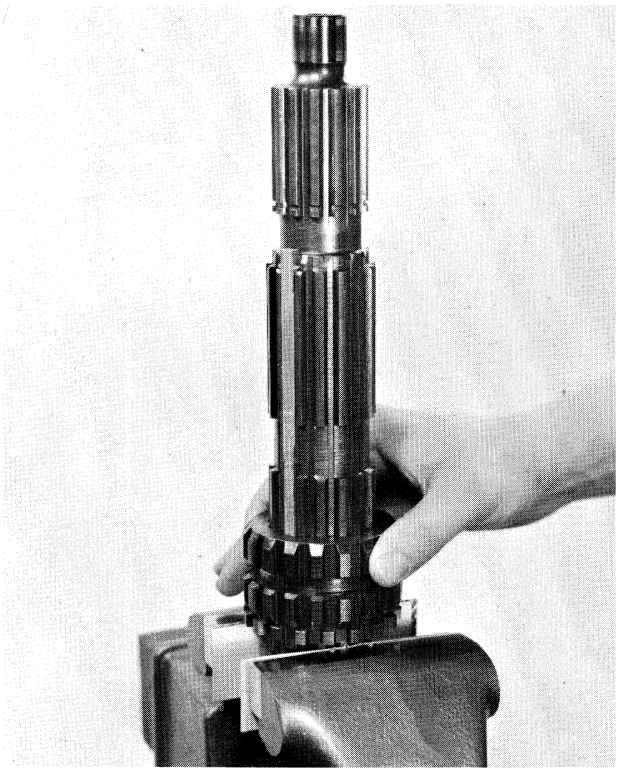
   NOTE: *Make sure long key is positioned with the word "top" on key to the outside. During reassembly the long key will be removed and re-installed to assure that washers stay in position.*



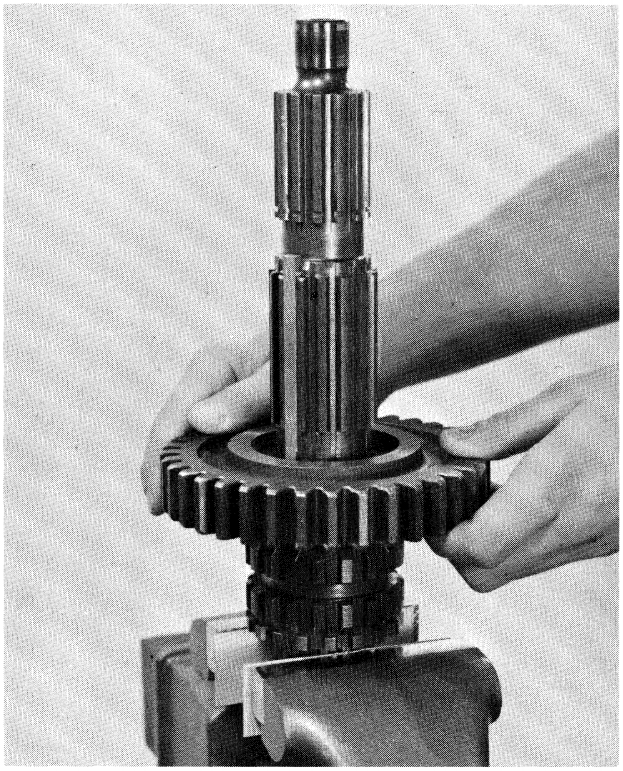
115. *Installing the right countershaft.*



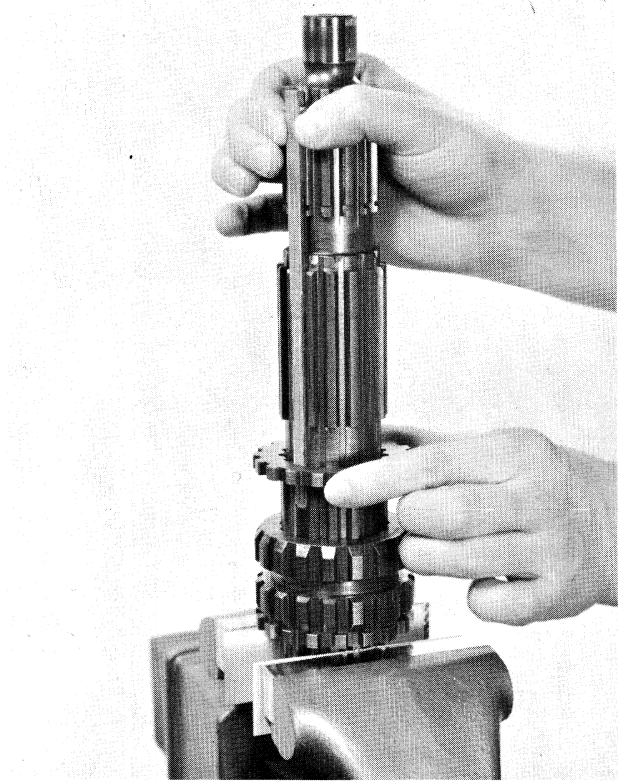
116. *Locking the reverse gear splined washer to mainshaft with key.*



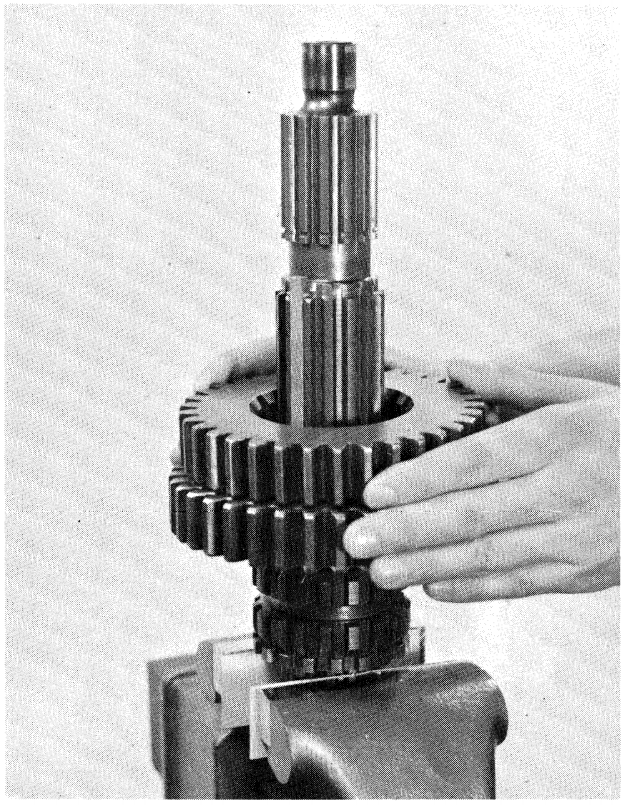
117. *Installing the 1st-reverse sliding clutch.*



119. *Installing the 1st-speed gear on mainshaft.*

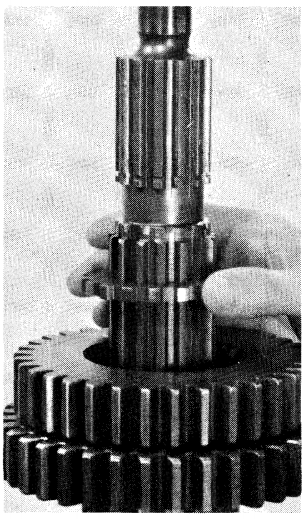


118. *Locking the 1st-speed gear splined washer on mainshaft with key.*

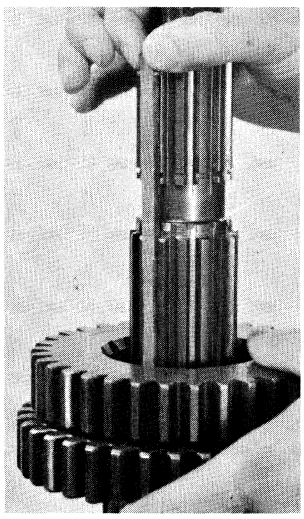


120. *Installing the 2nd-speed gear on mainshaft.*

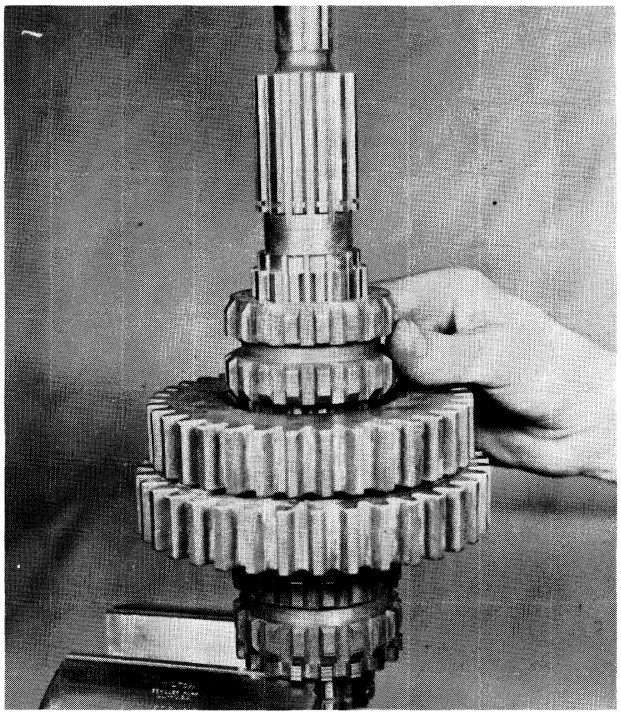
4. Install the 1st-reverse clutch over front of mainshaft and against reverse gear splined washer. Align slot in sliding clutch with key. Illustration No. 117.
5. Remove long key from keyway in mainshaft.
6. Install 1st speed gear splined washer on mainshaft at 1st speed gear location and re-install the long key to lock splined washer to shaft. Illustration No. 118.
7. Install 1st speed gear on mainshaft, clutching teeth down, fitting gear splines on those of washer. Illustration No. 119.
8. Install 2nd speed gear on mainshaft, clutching teeth up, and against 1st speed gear. Illustration No. 120.
9. Remove the long key from keyway in mainshaft.
10. Install 2nd speed gear splined washer on mainshaft and into hub of 2nd speed gear. Illustration No. 121.
11. Install long key in keyway in mainshaft to lock washer to shaft. Illustration No. 121-A.
12. Install the 2nd-3rd speed sliding clutch, aligning slot in sliding clutch with key; engage with 2nd speed gear. Illustration No. 122.
13. Install 3rd gear splined washer on mainshaft at 3rd speed gear location. It will be necessary to pull long key upward slightly in order to fit splined washer over key cross pin and to fit key in keyway. Re-position key so that cross pin rests on top of washer. Illustration No. 123.



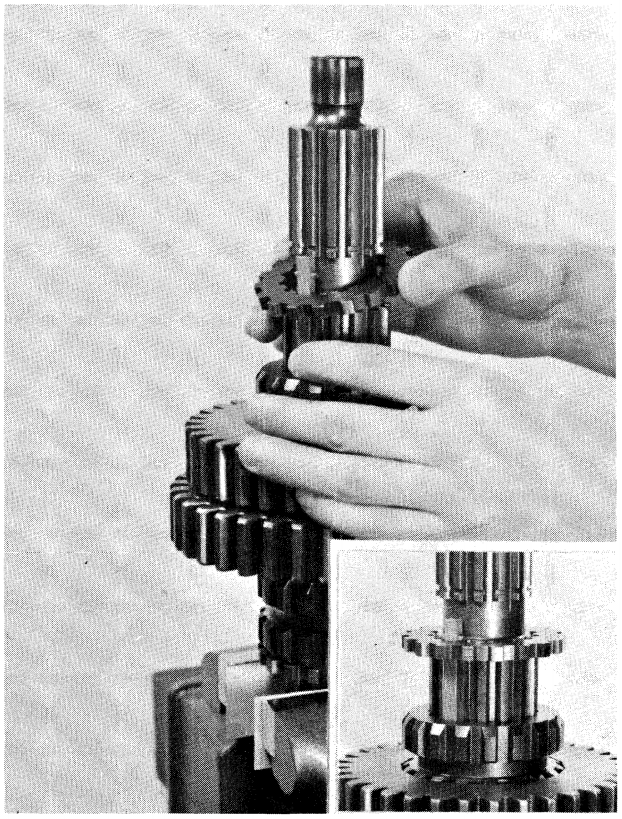
121. *Installing the 2nd-speed gear splined washer on mainshaft and into hub of 2nd-speed gear.*



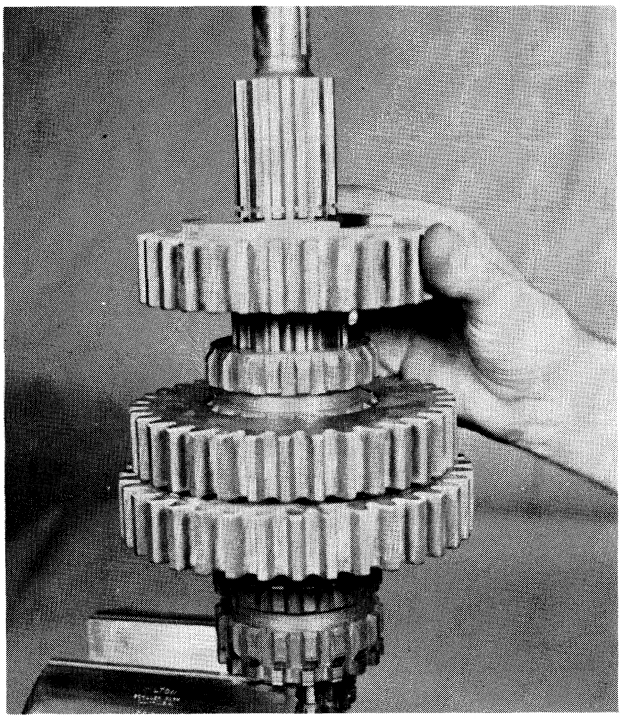
121-A. *Install long key in keyway in mainshaft.*



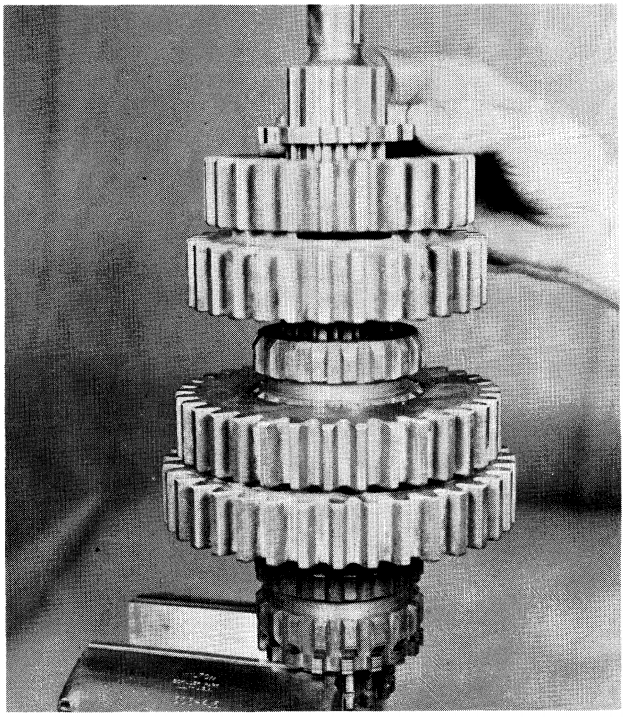
122. *Install the 2nd-3rd speed sliding clutch gear.*



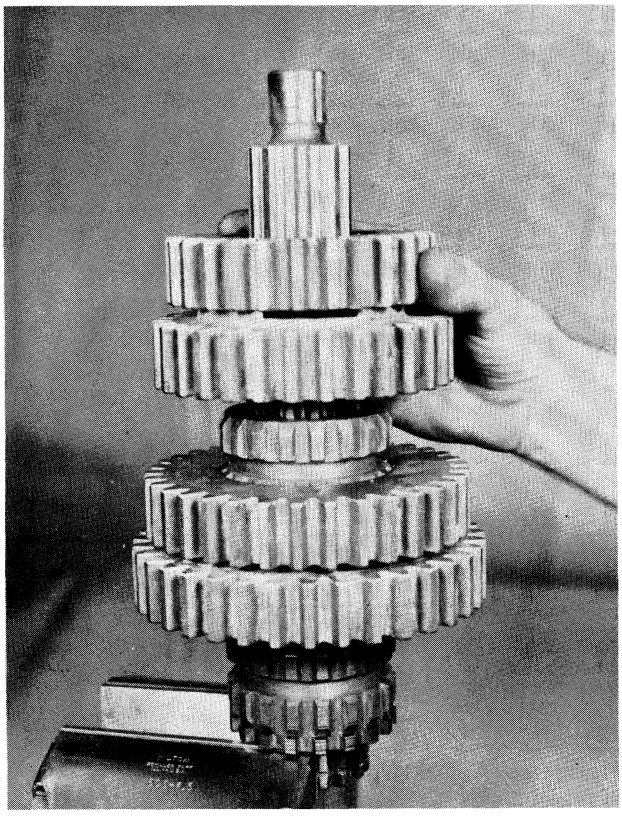
123. *Lifting the key and installing the 3rd speed gear splined washer. Insert shows key and washer properly installed.*



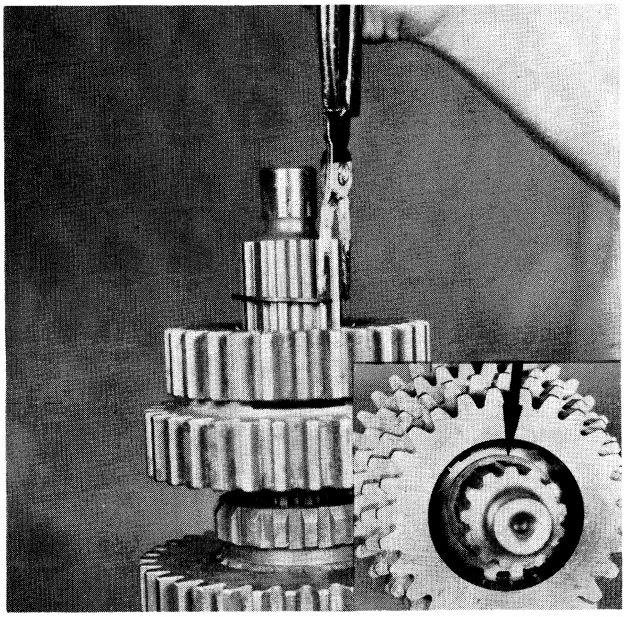
124. *Installing the 3rd-speed gear on mainshaft.*



126. *Installing the 4th-speed gear washer on mainshaft and in hub of 4th-speed gear.*

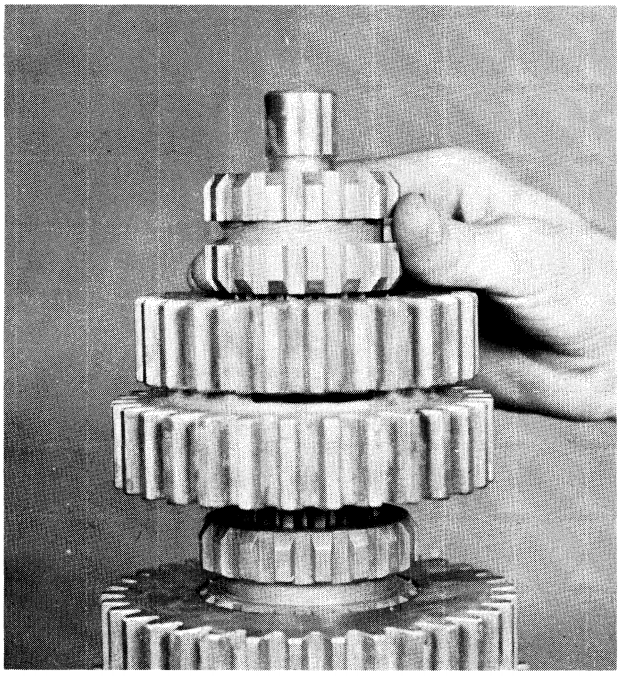


125. *Installing the 4th-speed gear on mainshaft.*

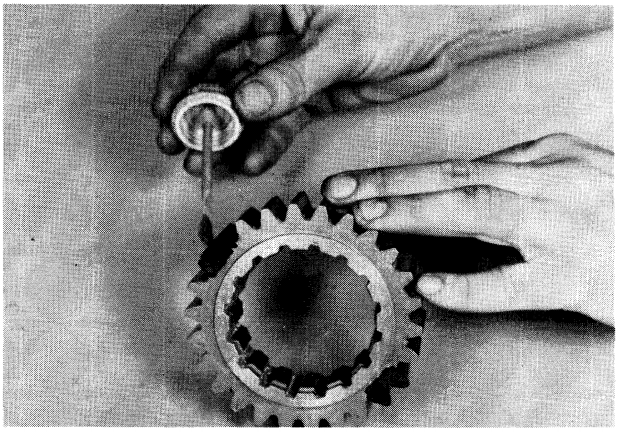


127. *Installing gear retaining snap ring on mainshaft and in groove.*

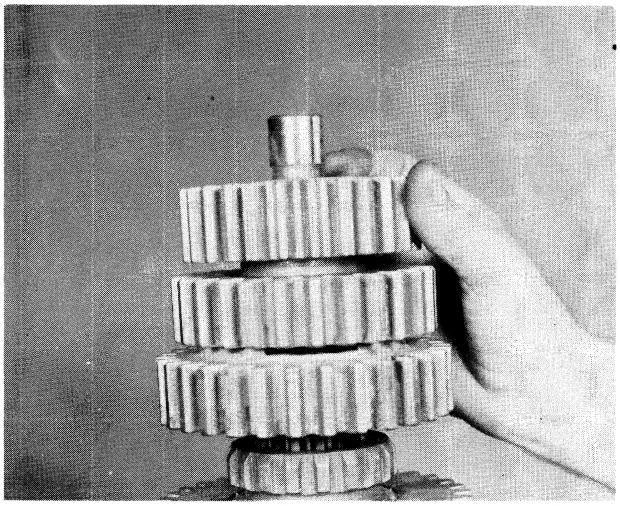
14. Install the 3rd speed gear on mainshaft, fitting gear splines on those of washer. Illustration No. 124.
15. Install the 4th speed gear on mainshaft (clutching teeth up) and against 3rd speed gear. Illustration No. 125.
16. Install the 4th speed gear splined washer on mainshaft and in hub of 4th speed gear. Illustration No. 126.
17. Install snap ring in groove in mainshaft which will hold the 4th speed gear in position on shaft. Illustration No. 127.
18. Install the 4th-5th speed sliding clutch on mainshaft, place in engagement with 4th speed gear. Illustration No. 128.
19. **IMPORTANT:** Mark timing teeth on drive gear (5th speed gear).
    a. Mark two adjacent teeth on drive gear.
    b. Mark the two adjacent teeth on drive gear which are directly opposite the first set marked. There should be the same number of teeth between markings on each side of gear. Illustration No. 129.
20. Install the drive gear on mainshaft and against the 4th speed gear, snap ring groove in drive gear to the front. Illustration No. 130.
21. Remove the assembly from vise and install the reverse gear on rear of mainshaft, engaging splines of gear with those of splined washer on mainshaft. Illustration No. 131.



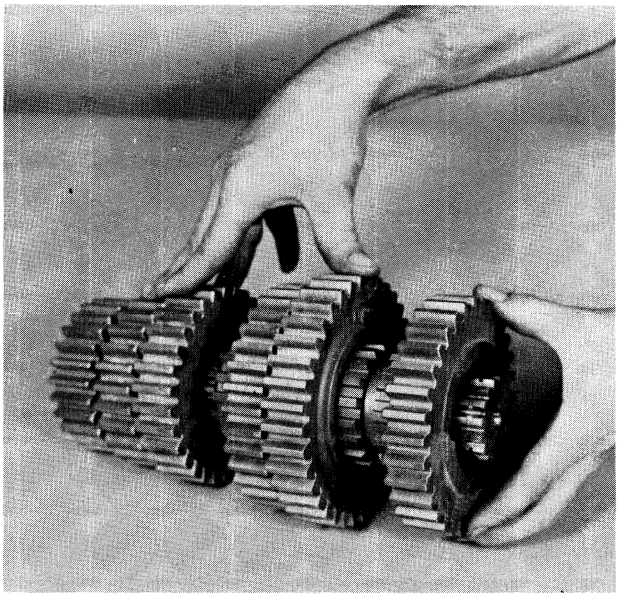
128. *Installing the 4th-5th speed sliding clutch.*



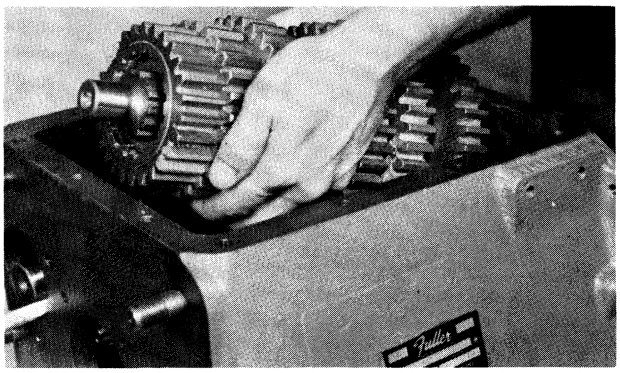
129. *Marking timing teeth on drive gear.*



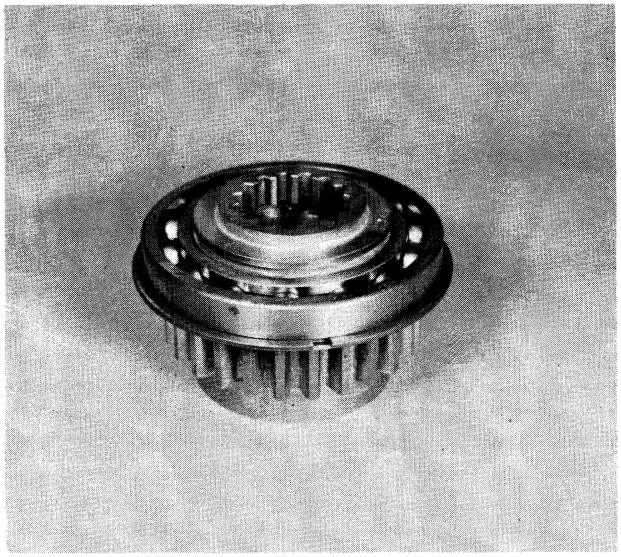
130. *Installing the drive gear on mainshaft.*



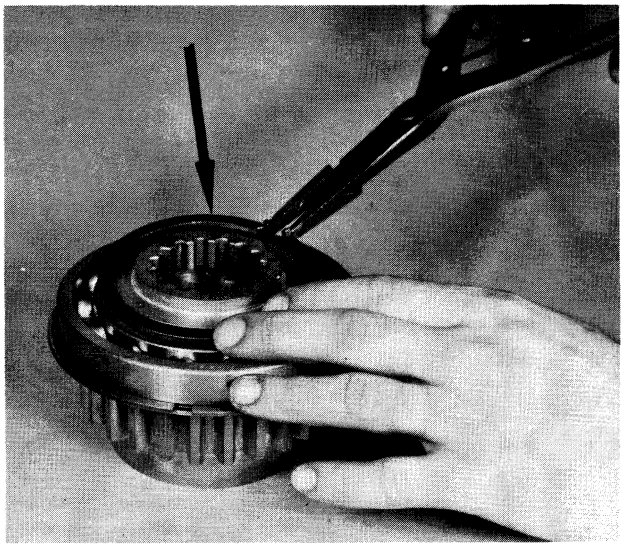
131. *Installing the reverse gear on mainshaft.*



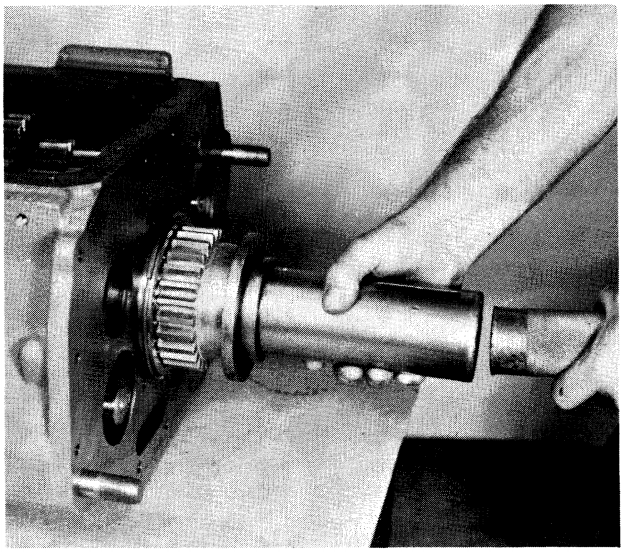
132. *Placing mainshaft into position in case.*



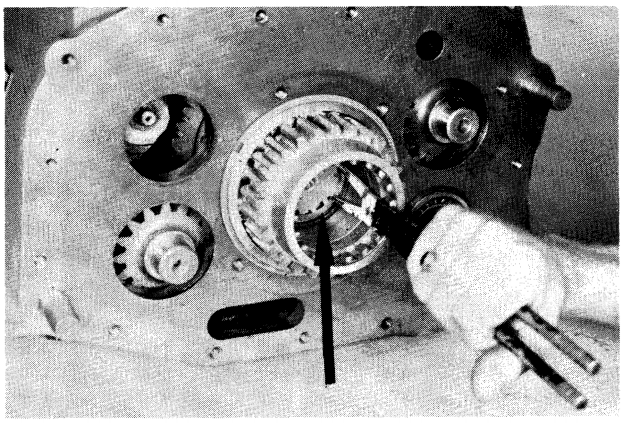
133. *Auxiliary drive gear bearing correctly seated on gear.*



134. *Installing bearing retaining snap ring in groove in drive gear shoulder.*



135. *Seating auxiliary drive gear bearing in rear bore of case.*



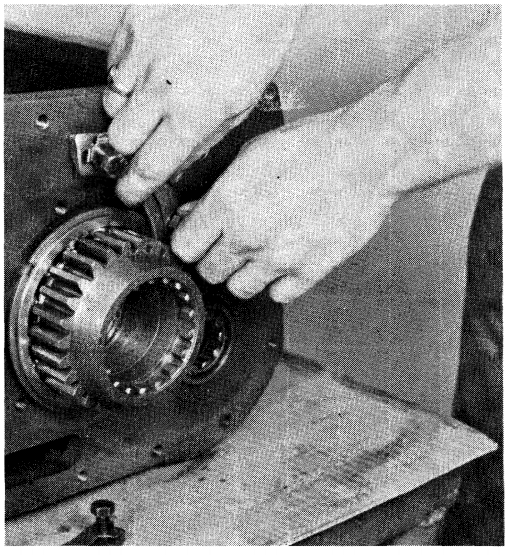
136. *Installing the coupling snap ring in groove in mainshaft.*

E. To Install Mainshaft Assembly.

1. Move both countershafts toward case wall as far as possible.
2. Place the mainshaft assembly in position in case; block under front of mainshaft to center in front bore of case. Illustration No. 132.

F. To Install Auxiliary Drive Gear Assembly.

1. Press bearing on auxiliary drive gear, snap ring towards gear. Illustration No. 133.
2. Install bearing retaining snap ring in groove of auxiliary drive gear shoulder. Illustration No. 134.
3. Center mainshaft in rear bore of case and install auxiliary drive gear on splines of mainshaft.
4. Seat auxiliary drive gear bearing in rear bore of case. Illustration No. 135.
5. In hub of auxiliary drive gear, install the coupling snap ring in groove in mainshaft. Illustration No. 136.
6. Install the two bearing retainer plates on case. Illustration No. 137.

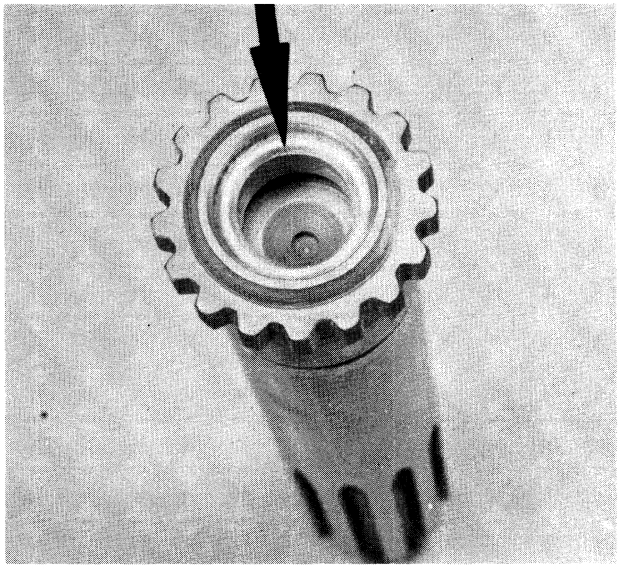


137. *Installing the two bearing-retaining plates on case.*

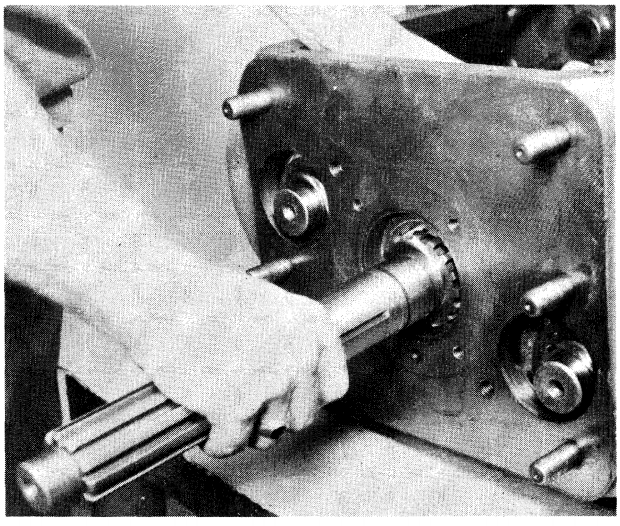
   a. Attach both upper and lower plates, using a double locking lug for each plate.
   b. Tighten capscrews securely and secure by bending locking lugs.

G. To Install the Main Drive Gear Assembly.

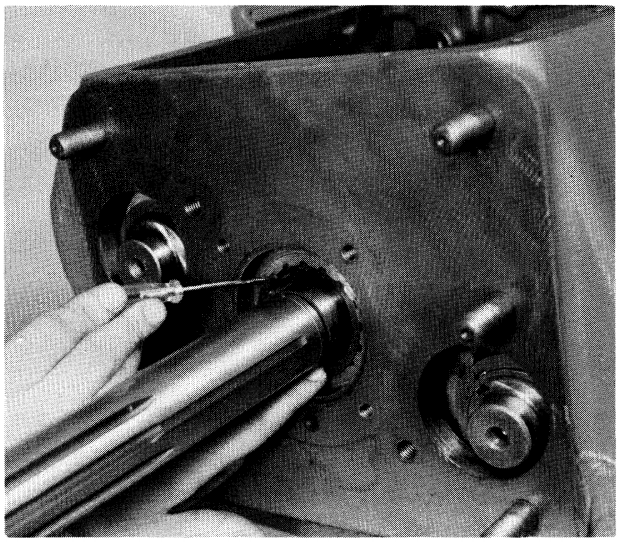
1. If previously removed, install bushing in pocket of clutch shaft; install flush with shaft, making sure that oil hole in shaft is not plugged. Illustration No. 138.
2. Install the clutch shaft in splines of drive gear, moving gear forward against inside wall of case. Illustration No. 139.



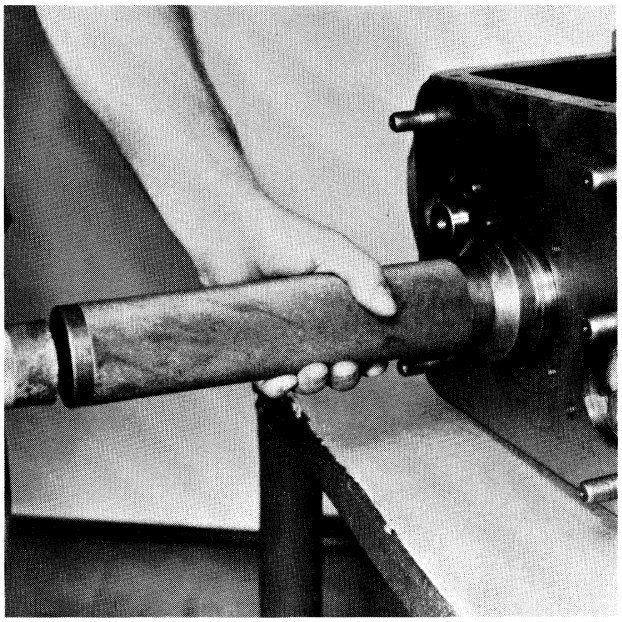
138. *If previously removed, install bushing in clutch shaft.*



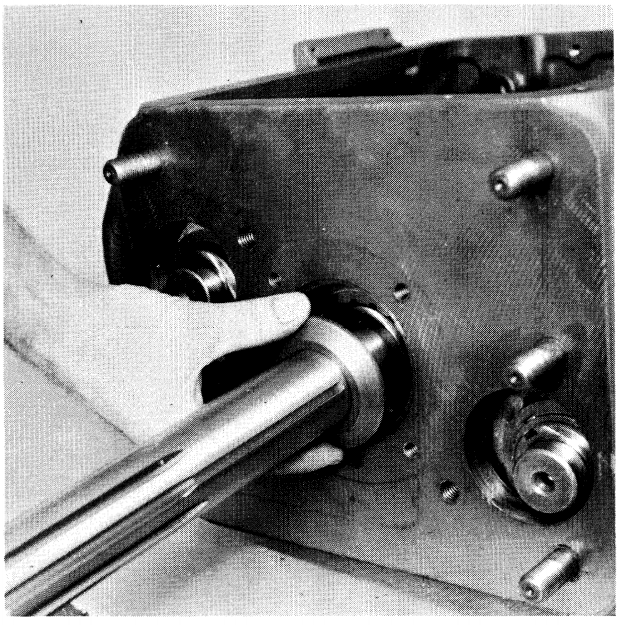
139. *Installing clutch shaft in splines of drive gear.*



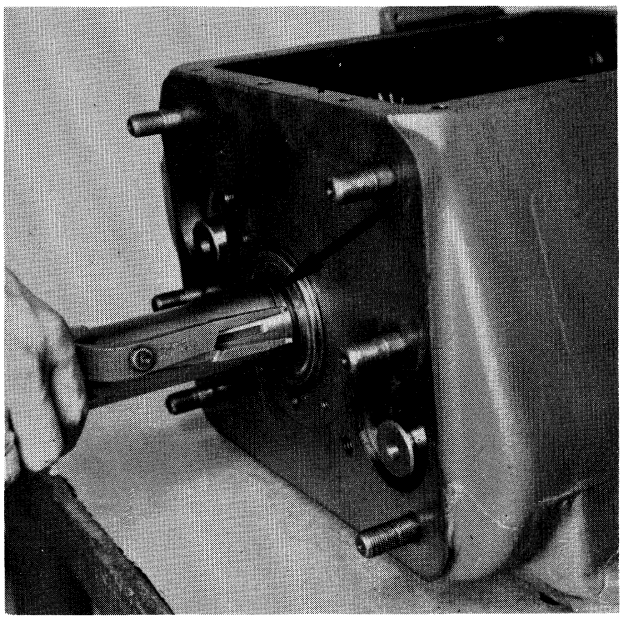
140. *Installing snap ring in groove in drive gear.*



142. *Installing the drive gear bearing on shaft and into case bore.*



141. *Installing spacer on shaft and against drive gear.*

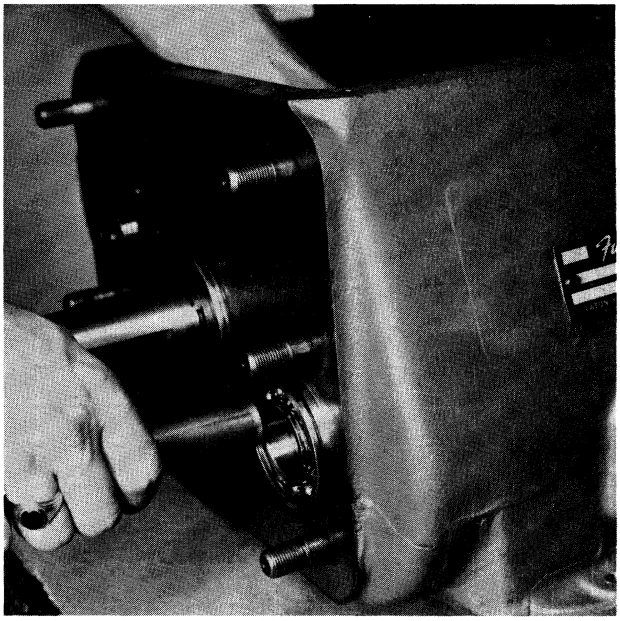


143. *Installing bearing retaining snap ring in groove of clutch shaft.*

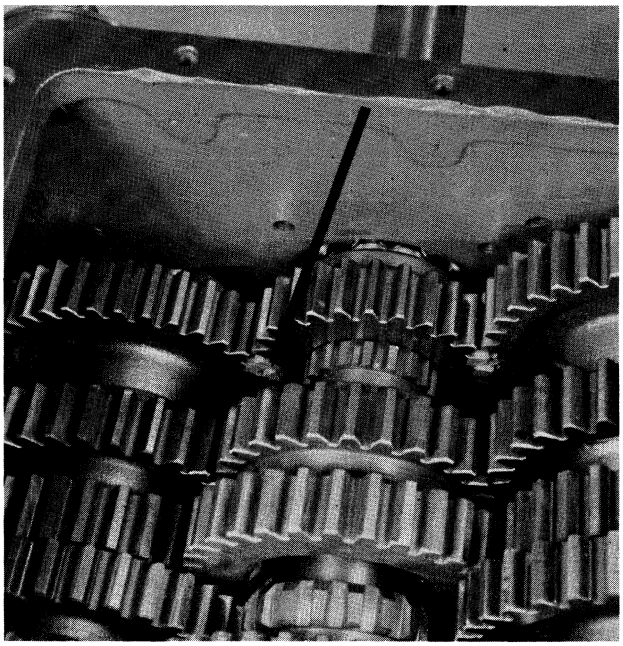
3. Install snap ring in groove in I.D. of drive gear. Illustration No. 140.
4. Install the drive gear spacer on shaft. Illustration No. 141.
5. Install the drive gear bearing on shaft and into case bore. Illustration No. 142.
6. Install bearing retaining snap ring in groove in clutch shaft, taper to the outside. Illustration No. 143.

H. To Time and Complete Installation of Countershaft Assemblies.

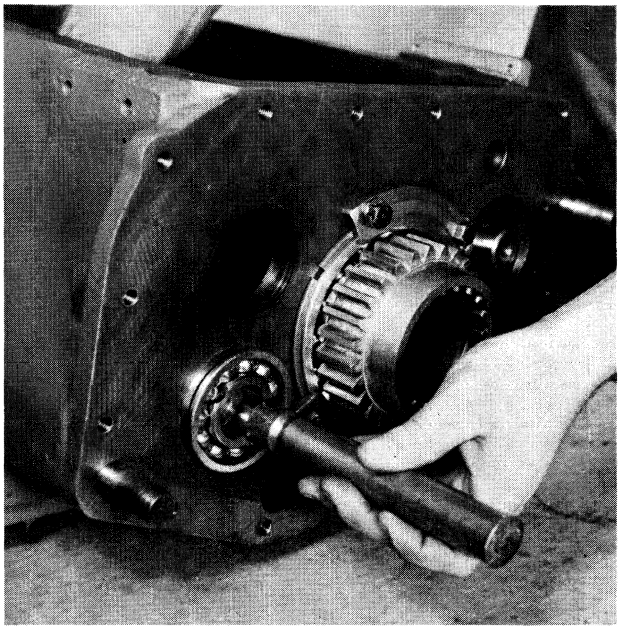
1. Place the left countershaft into mesh with mainshaft gears, placing the marked timing tooth on countershaft drive gear into proper mesh with the two marked timing teeth on main drive gear. Illustration No. 144.
2. Hold left countershaft in position and install front and rear bearings.
   a. Center rear of left countershaft in rear bore of case with wood block.
   b. Partially install front bearing on countershaft and in case bore. Illustration No. 145.
   c. Partially install rear bearing on countershaft and in case bore. Illustration No. 146.



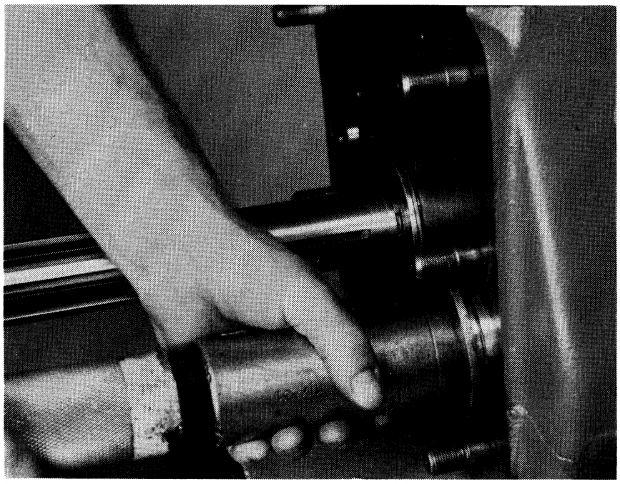
145. *Partially installing front bearing in case bore and on left countershaft.*



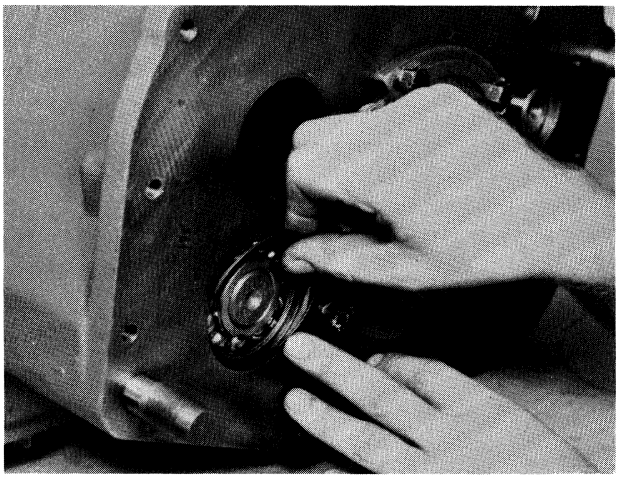
144. *Left countershaft timing tooth meshed with timing teeth on drive gear.*



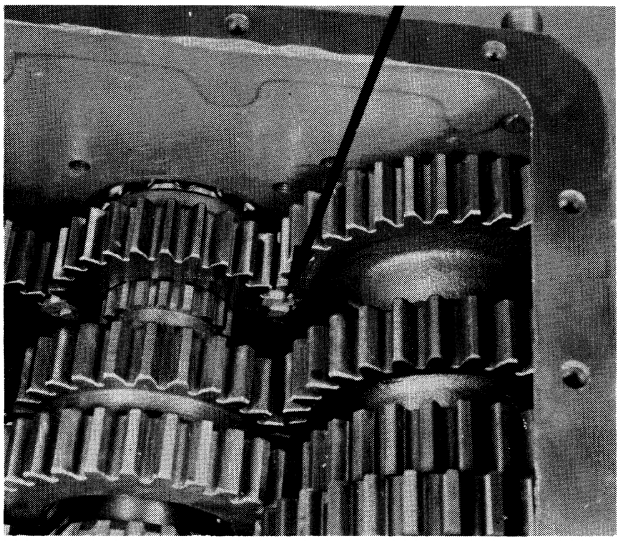
146. *Partially installing rear bearing in case bore and on left countershaft.*



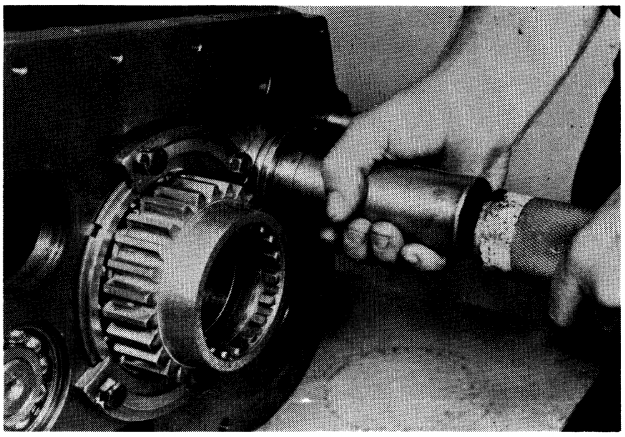
147. *Seating front and rear bearings in case bores to complete bearing installation.*



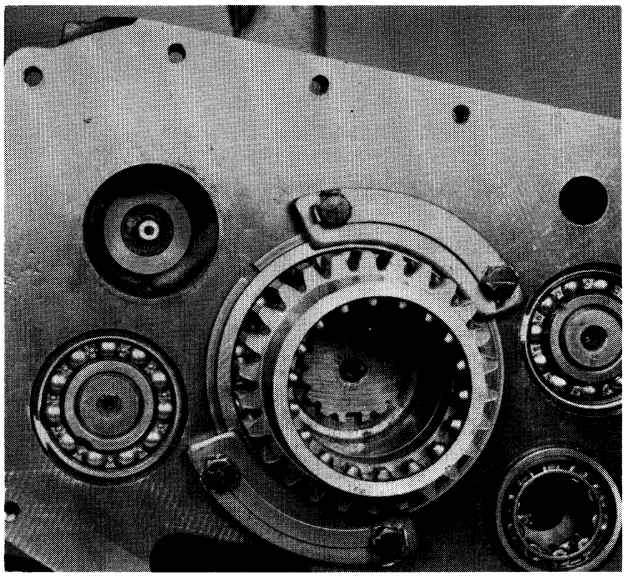
148. *Installing snap ring in groove in rear bearing bore.*



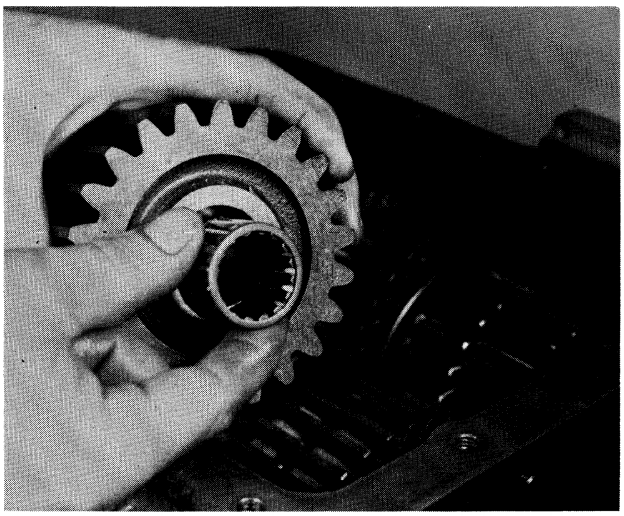
149. *Right countershaft timing tooth meshed with timing teeth on drive gear.*



150. *Completing installation of bearings on right countershaft.*



151. *Installing the reverse-idler gear front washer on pin in case.*



152. *Installing needle bearing in hub of reverse-idler gear.*

d. Use flanged bearing driver to complete seating both front and rear bearings .Illustration No. 147.

3. Install snap ring in groove in rear bore of case. Illustration No. 148.
4. Place the right countershaft into mesh with mainshaft gears, placing the marked timing tooth on countershaft drive gear into proper mesh with the two marked timing teeth on main drive gear. Illustration No. 149.
5. Hold right countershaft in position and install front and rear bearings in the same manner as installed on left countershaft. Illustration No. 150.
6. Install snap ring in groove in rear bore of case.

I. To Install the Left Reverse Idler Gear Assembly.

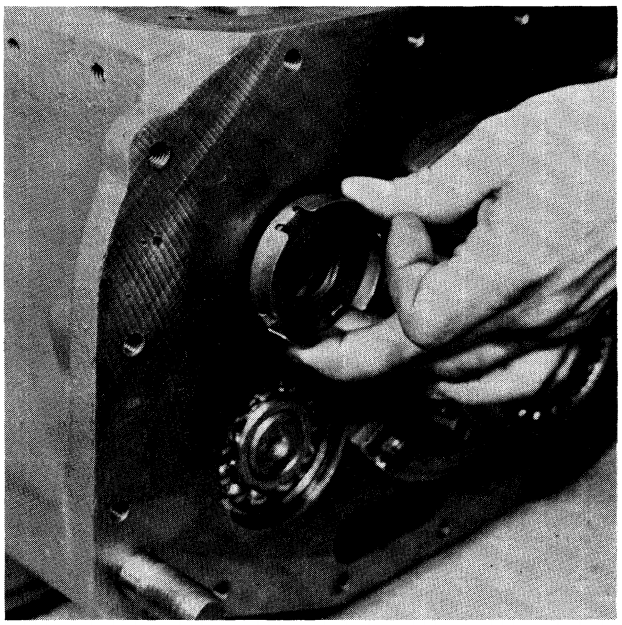
1. Install the reverse-idler gear front washer on pin in upper left of case. Illustration No. 151.
2. Install needle bearing in hub of reverse-idler gear. Illustration No. 152.
3. Set reverse-idler gear in position, machined surface of gear hub to the rear. Illustration No. 153.
4. Place rear washer in holder if previously removed, oil slot down, and bend lugs to secure washer.
5. Place washer and holder into reverse gear case bore, oil slots toward gear, holder flange to the rear. Illustration No. 154.



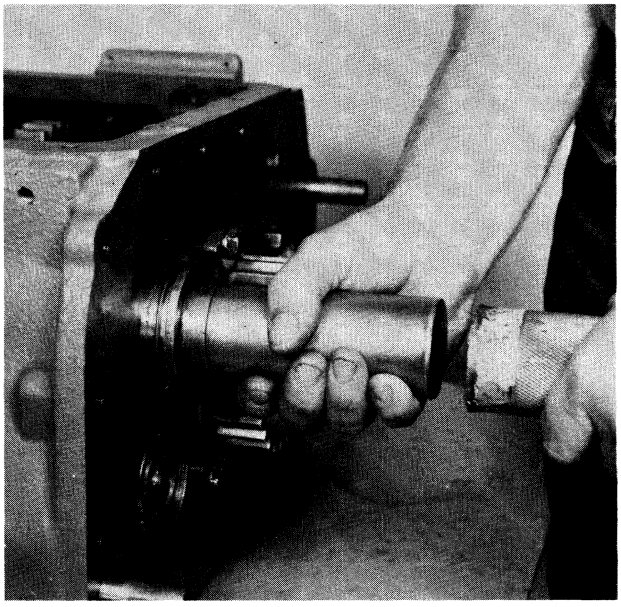
153. *Placing reverse-idler gear into position in case.*

6. Install the auxiliary countershaft front bearing into the reverse-gear case bore to hold the reverse idler gear assembly in position. Illustration No. 155.

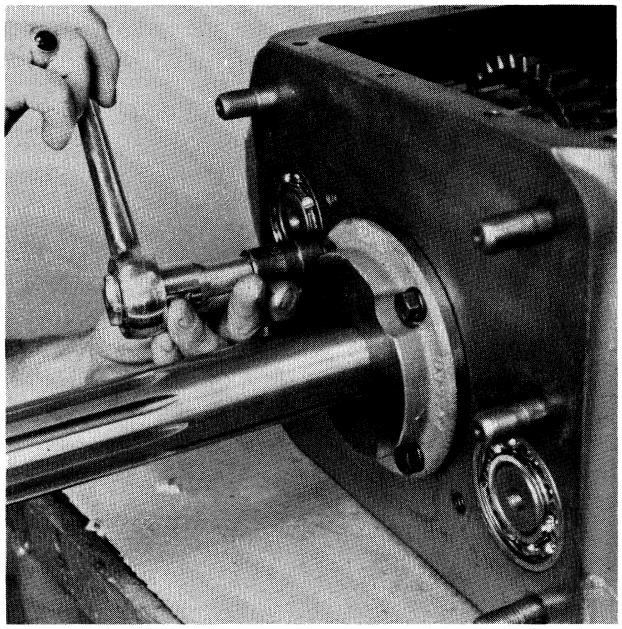
NOTE: *The front portion of the auxiliary countershaft is used as a journal for the reverse idler gear.*



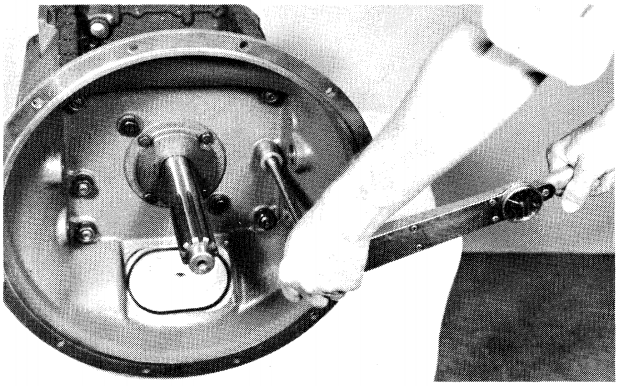
154. *Placing reverse-idler gear rear washer and holder into case bore.*



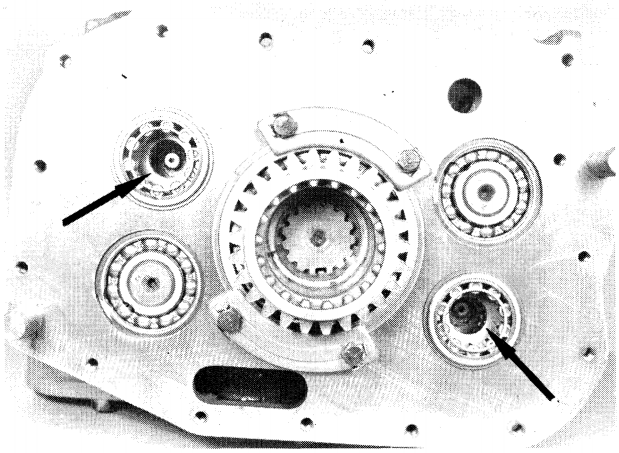
155. *Installing the auxiliary countershaft front bearing into reverse-idler bore.*



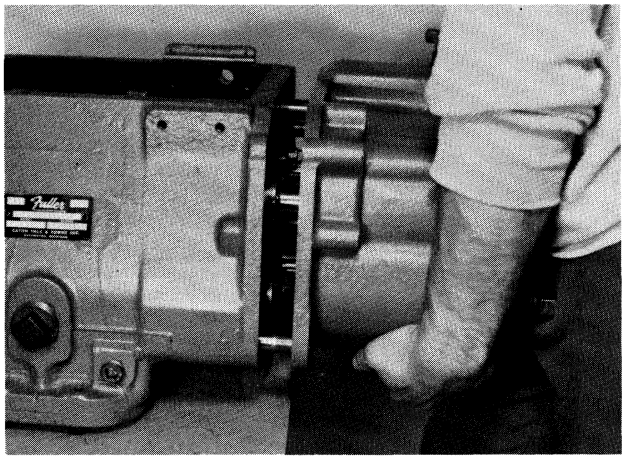
156. *Installing the front bearing cover.*



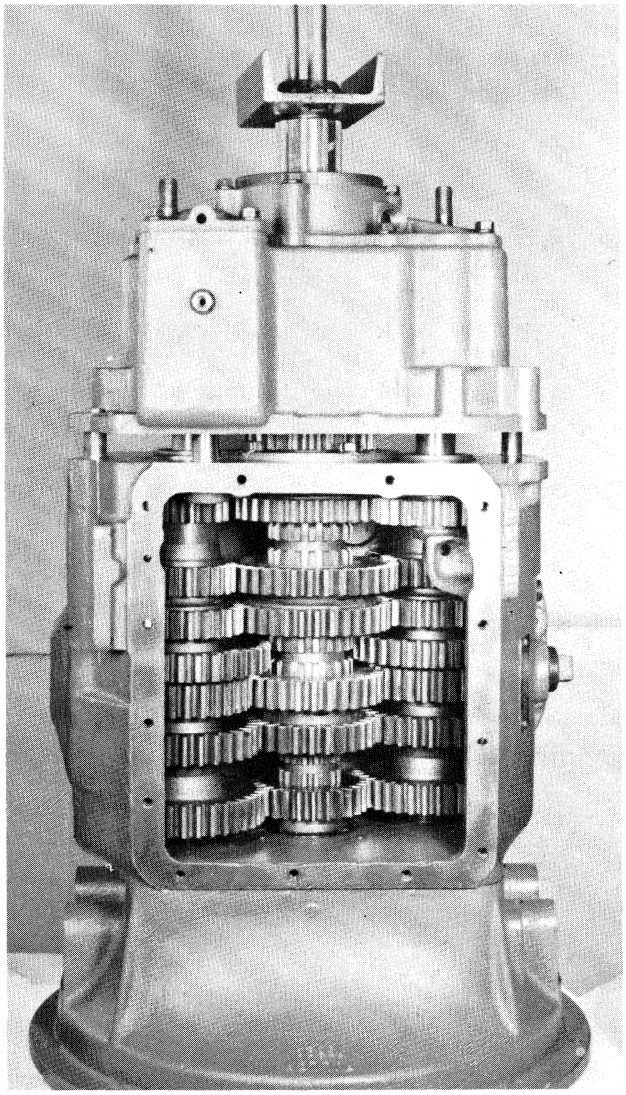
157. *Using torque wrench to install nuts and bolts which attach clutch housing to case.* *See page 52.*



158. *Reverse-idler gears and washers must be centered in bores to install auxiliary section.*



159. *Installing auxiliary section on front section.*



160. *Alternative method of installing auxiliary section on front section.*

III. CLUTCH HOUSING, AUXILIARY SECTION AND COMPANION FLANGE INSTALLATION

A. To Install the Clutch Housing.

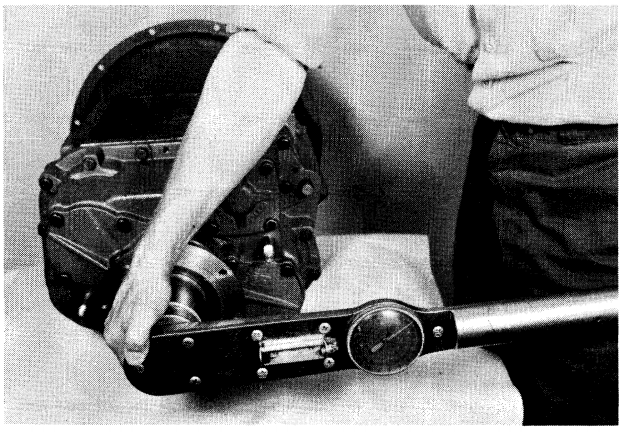
1. Install the drive gear bearing cover. Illustration No. 156.
2. Install the clutch housing, attaching securely with the six nuts and two bolts. Illustration No. 157.
3. If so equipped, install the clutch release mechanism.

B. To Install the Auxiliary Section.

NOTE: *The two reverse gears, including the washers, must be in perfect alignment with center of case bores as the front of the auxiliary countershafts must be inserted in these parts during auxiliary installation. A heavy grease or lubriplate will help hold washers in place. Aso check rear of front section to make sure all snap rings have been installed. Illustration No. 158.*

1. Install auxiliary section on front section, aligning auxiliary section on dowel pins and the extended portion of auxiliary countershafts with reverse idler gears. It may make assembly easier if someone slowly rotates clutch shaft during installation. Illustration No. 159.

   NOTE: *The auxiliary can also be installed with front section in a vertical position. Place clutch housing on blocks and use chain hoist to lower auxiliary section into position. Illustration No. 160.*
2. Secure the auxiliary with attaching capscrews.



161. *Using torque wrench to install the companion flange. See page 52.*

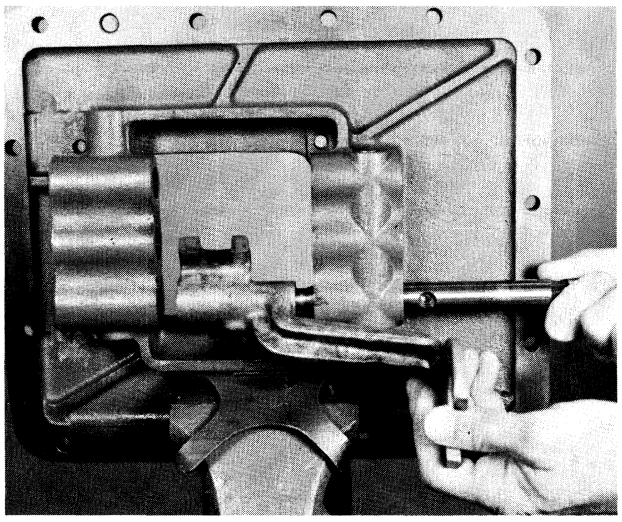
C. To Install the Companion Flange or Yoke.

1. Lock transmission by engaging two gears with the mainshaft sliding clutches.
2. Make sure the speedometer gear washer and the speedometer gear or replacement spacer are installed on tailshaft. (See Illustration No. 99.)
3. Install the companion flange on splines of tailshaft.
4. Install the companion flange nut. Tighten securely, using the correct torque rating. Illustration No. 161.

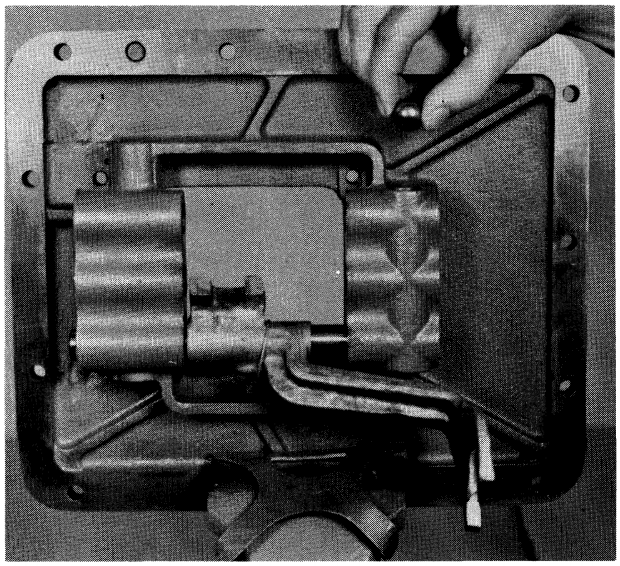
IV. SHIFTING BAR HOUSING

A. To Reassemble the Shifting Bar Housing Assembly.

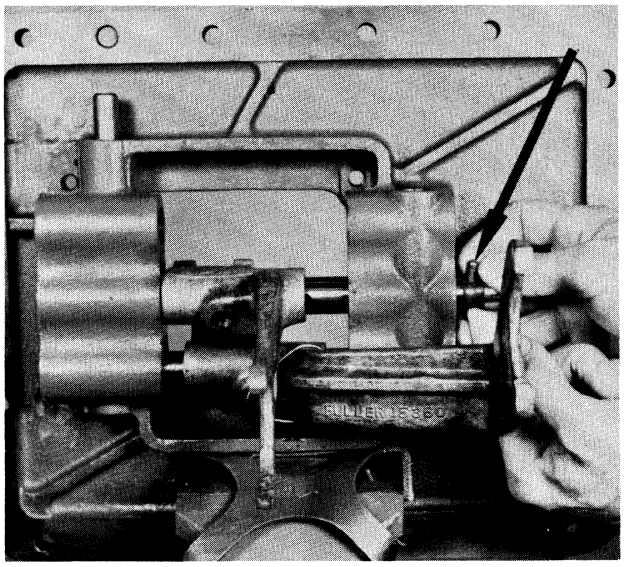
1. Place the housing in a vise with the front of housing to the right.
2. Install the 4th-5th speed shift bar in bottom bore with neutral notches to the front, installing yoke on bar, fork towards front. Illustration No. 162.



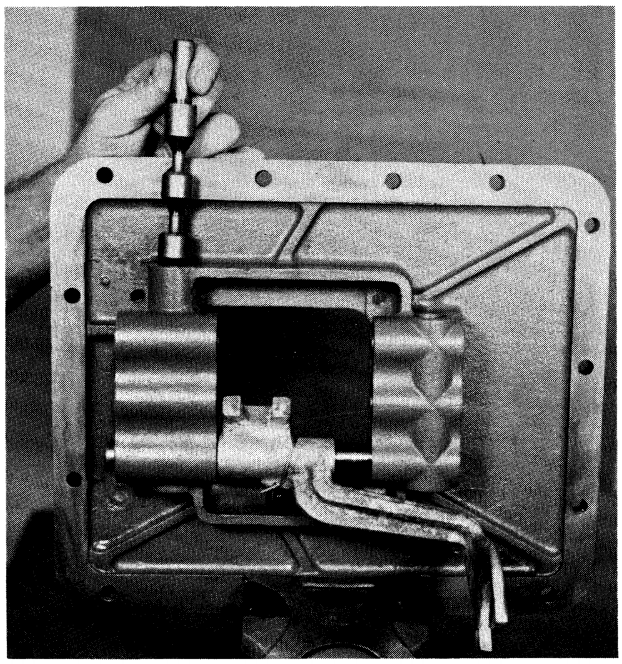
162. *Installing the 4th-5th speed shift bar and yoke.*



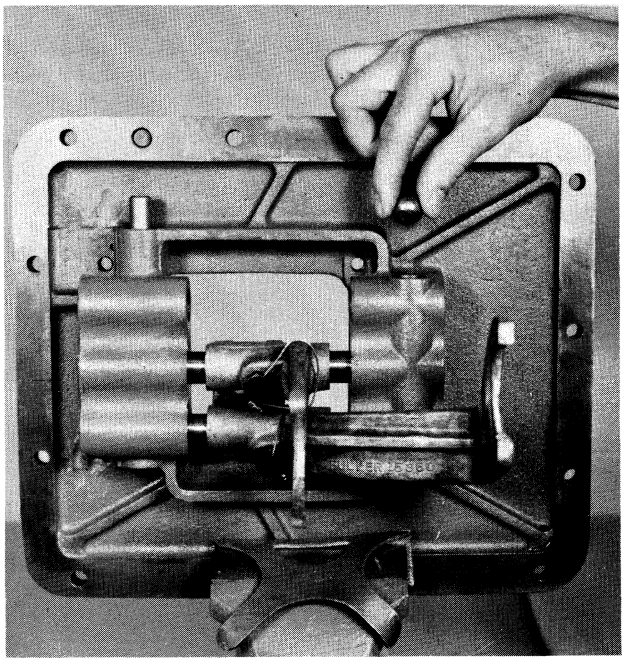
163. *Installing interlock ball in front web.*



165. *Installing the interlock pin in bore of neutral notch during installation of the 2nd-3rd speed shift bar and yoke.*

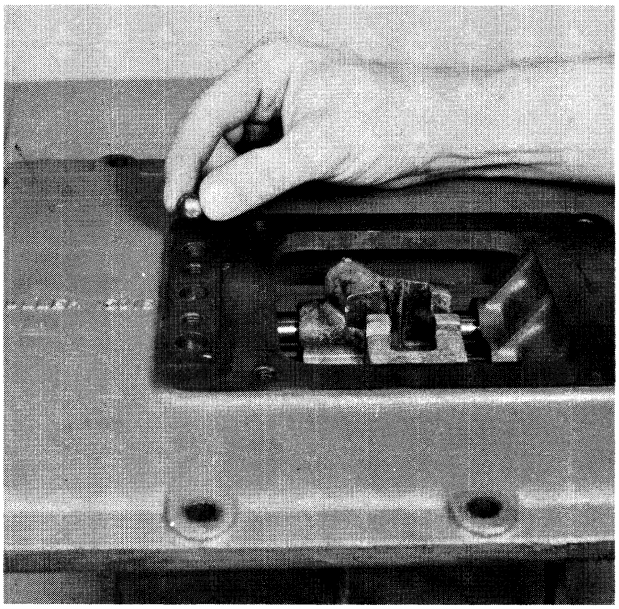


164. *Installing actuating plunger in rear web.*

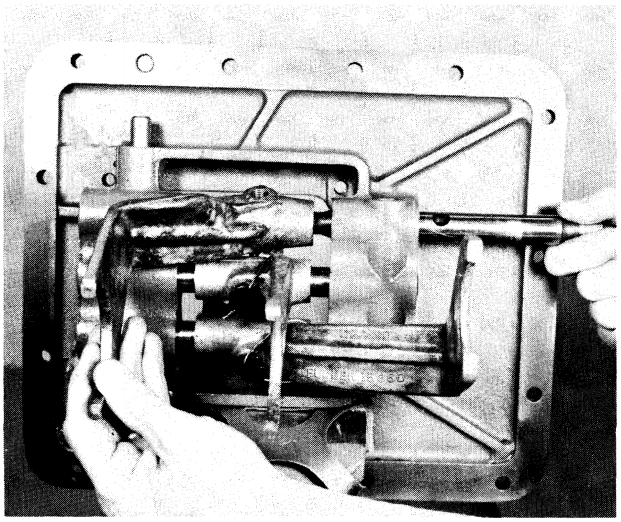


166. *Installing interlock ball in front web.*

3. Install yoke lockscrew and safety wire. Keep bar in neutral position.
4. Install interlock ball in vertical bore in front web. Illustration No. 163.
5. Install plunger in vertical bore in rear web. Illustration No. 164.
6. Install the 2nd-3rd speed shift bar in center bore, and install yoke on bar, lockscrew hole to the rear of fork; insert interlock pin in bore in neutral notch. Illustration No. 165.
7. Install yoke lockscrew and safety wire.
8. Install interlock ball in vertical bore in front web. Illustration No. 166.
9. Install first-reverse shift bar in upper bore, neutral notches to the front, installing yoke on bar, fork to the rear. Illustration No. 167.
10. Install yoke lockscrew and safety wire.
11. Remove assembly from vise and install the three tension balls, one in each bore in top of housing. Keep bars in neutral. Illustration No. 168.
12. Install the three tension springs, one in each bore in top of housing. Illustration No. 169.



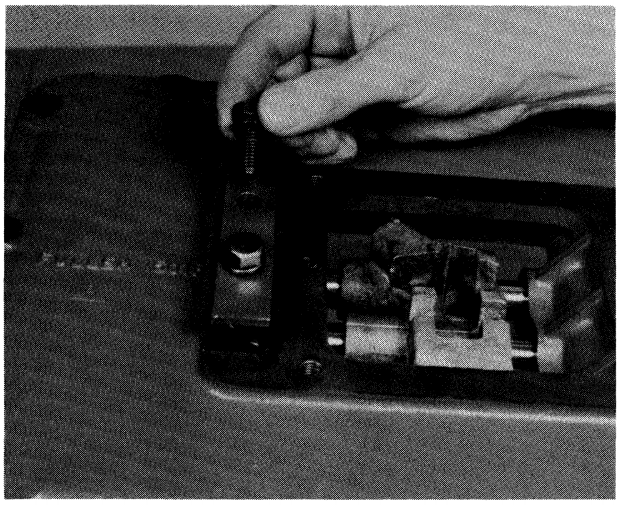
168. *Installing tension ball in bore in top of housing.*



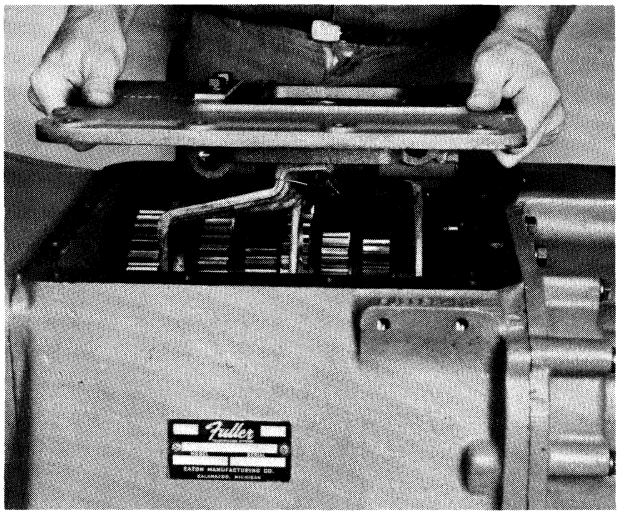
167. *Installing the 1st-reverse shift bar and yoke.*



169. *Installing tension springs in bores in top of housing.*



170. *Installing the tension spring cover.*



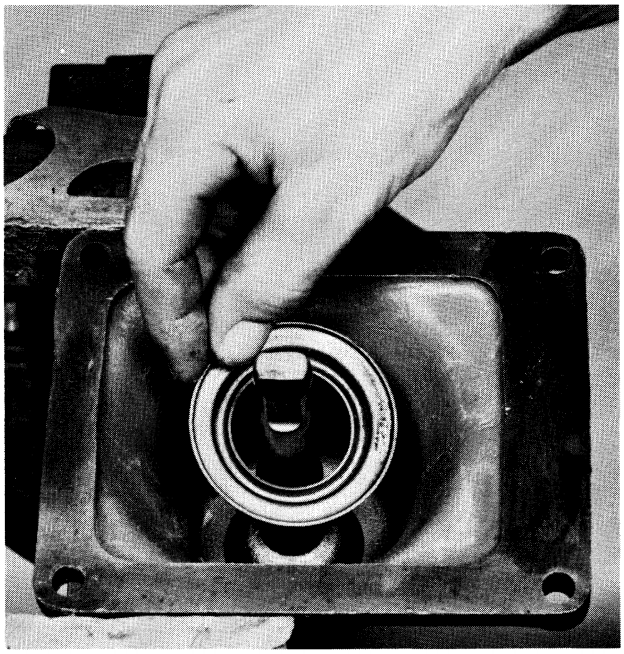
171. *Installing the shift bar housing on transmission case.*



172. *Installing lockwasher and nut to secure pivot pin.*



173. *Installing gear shift lever in housing.*



174. *Installing the tension spring washer.*

13. Install the tension spring cover. Tighten capscrews securely. Illustration No. 170.

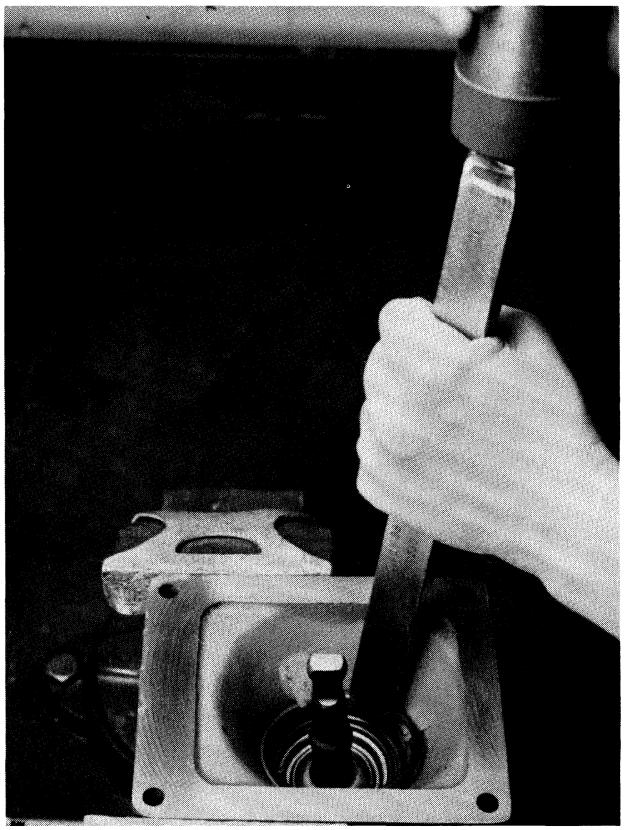
B. To Install the Shifting Bar Housing Assembly.

1. Make sure the shift bars are in the neutral position.
2. Place the sliding clutches on the mainshaft in the neutral position.
3. Install the shifting bar housing on transmission, fitting yokes into yoke slots of corresponding clutch gears. Illustration No. 171.
4. Install the attaching capscrews, tighten securely.

V. GEAR SHIFT LEVER HOUSING

A. To Reassemble the Gear Shift Lever Housing Assembly.

1. Install the pivot pin in bore in housing, thread end outward.

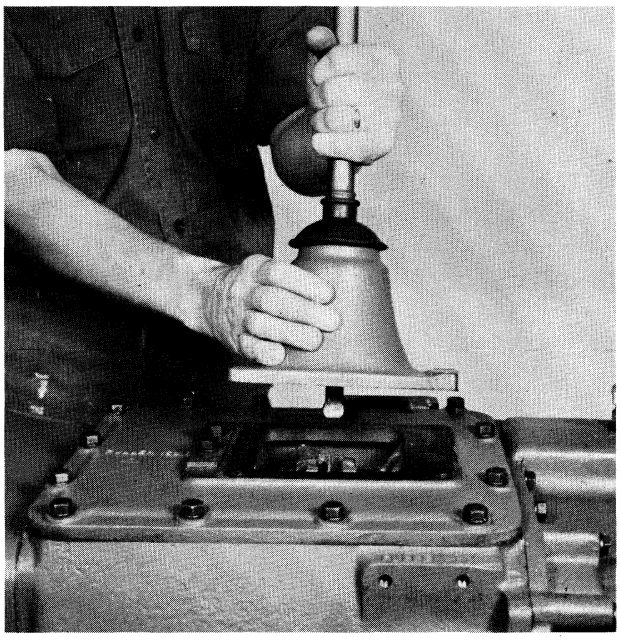


175. *Installing the tension spring.*

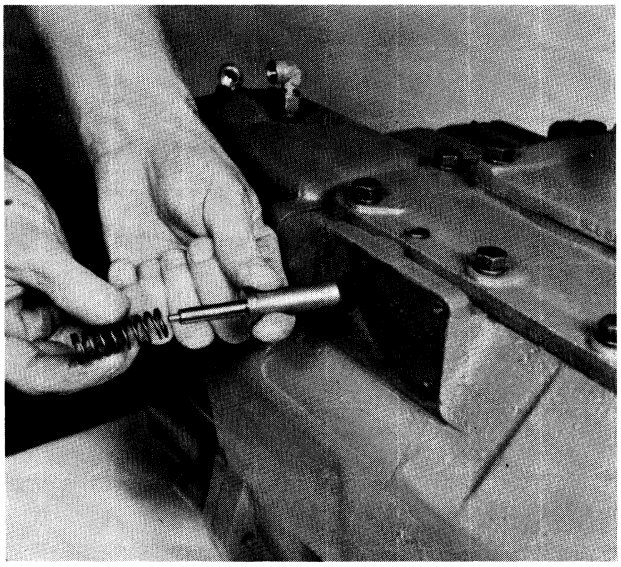
2. Install the lockwasher and nut on pivot pin. Illustration No. 172.
3. Mount the housing in a soft-jawed vise with the large, bottom opening upwards.
4. Insert the gear shift lever in housing, fitting slot in pivot ball of shift lever on pivot pin. Illustration No. 173.
5. Install the tension spring washer in housing. Illustration No. 174.
6. Install the tension spring in housing, seating spring under lugs cast inside the housing. Illustration No. 175.
7. Remove from vise and install the rubber dust protector over the gear shift lever and against neck of housing. (Do not install ball grip on lever until after the range control valve has been installed.)

B. To Install the Gear Shift Lever Housing Assembly.

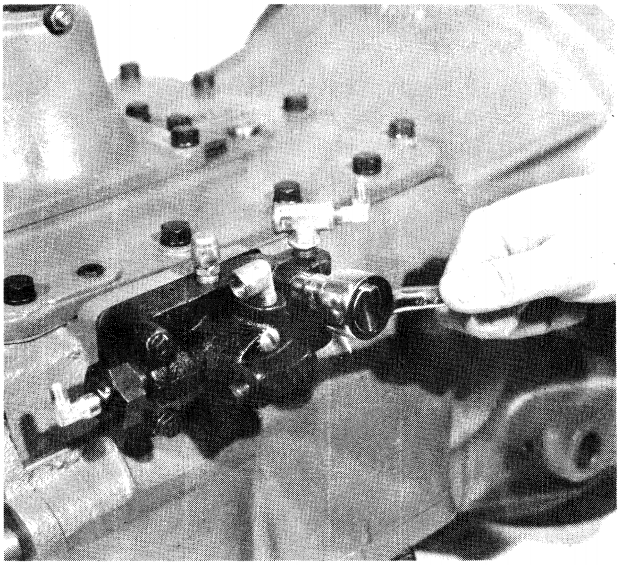
1. Make sure the shifting notches on bars in the shifting bar housing are aligned in the neutral position.
2. Install the gear shift lever housing on shifting bar housing, fitting lower end of lever into notches in shifting block and yokes. Illustration No. 176.
3. Install attaching capscrews, except capscrew at left-rear corner as this is used to secure air line.



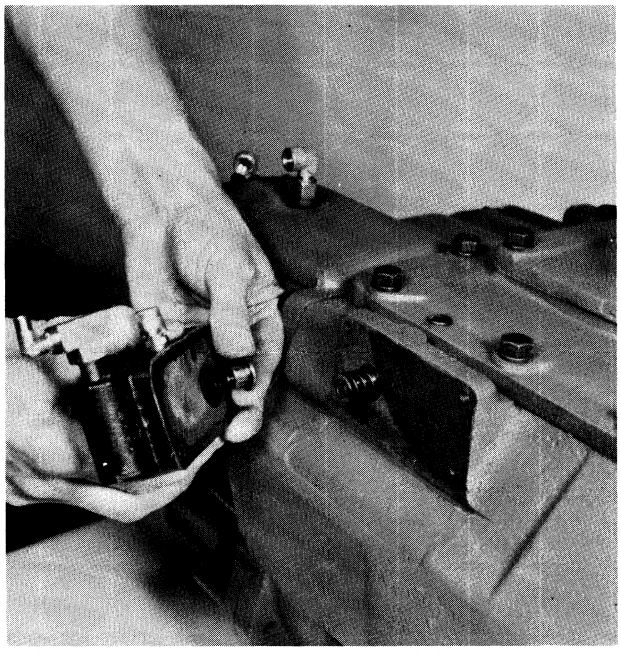
176. *Installing the gear shift lever housing.*



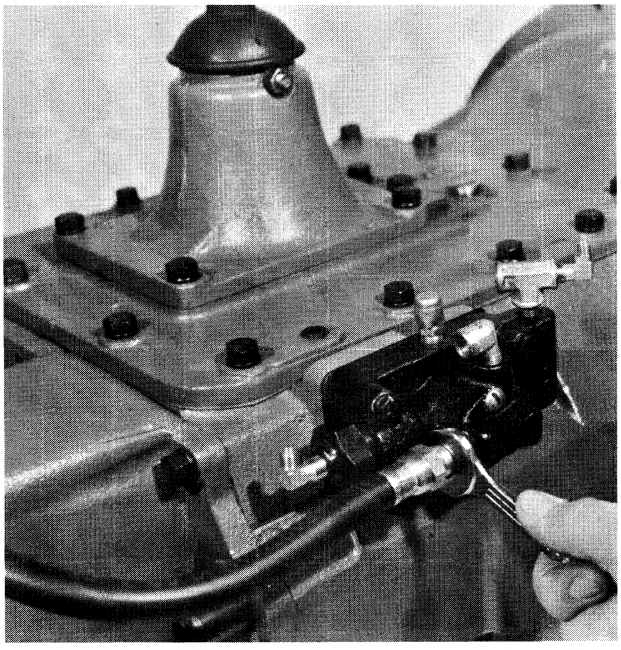
177. *Installing the actuating pin and spring at air valve location.*



179. *Installing the air valve on transmission.*



178. *Installing the alignment sleeve in air valve.*



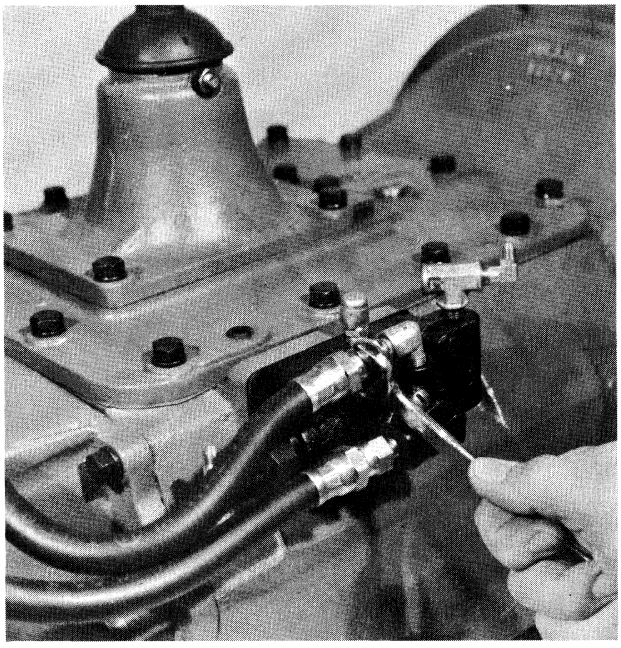
180. *Installing the high range air line.*

VI. RANGE SHIFT AIR SYSTEM

A. To Install the Air Valve.

1. If previously removed install fittings on air valve.
2. Install the actuating pin and spring in bore in transmission. Illustration No. 177.
3. Make sure the alignment sleeve is installed in air valve. Illustration No. 178.

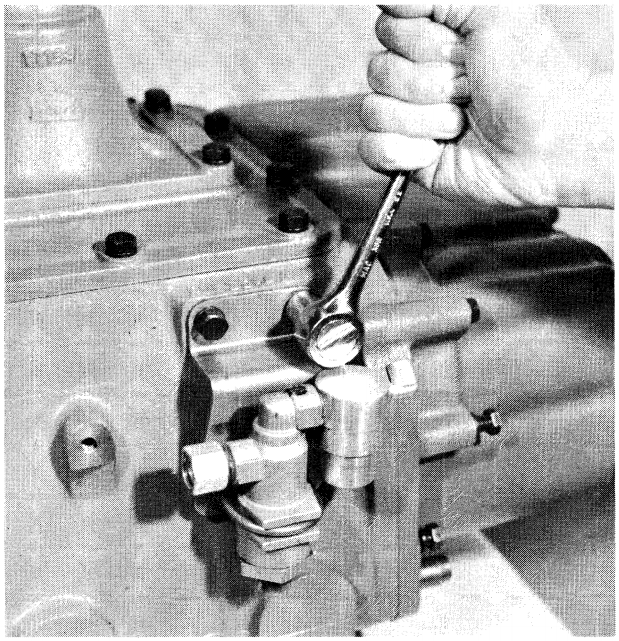
   NOTE: *Before installing alignment sleeve, check bore in air valve to make sure the piston is either in a forward or rear position. Piston can be moved with air or pencil.*
4. Install the air valve on transmission, tighten capscrews evenly and securely. Actuating plunger in case fits into alignment sleeve in air valve. Illustration No. 179.
5. Install fittings in shift cylinder, if previously removed. This consists of two 90° street ells.
6. Install the high range air line between the air port in the rear cover of the air cylinder and the side rear port of the air valve. Illustration No. 180.
7. Install the low range air line from air port in top of cylinder to the street ell in the top of the air valve side cap. Illustration No. 181.



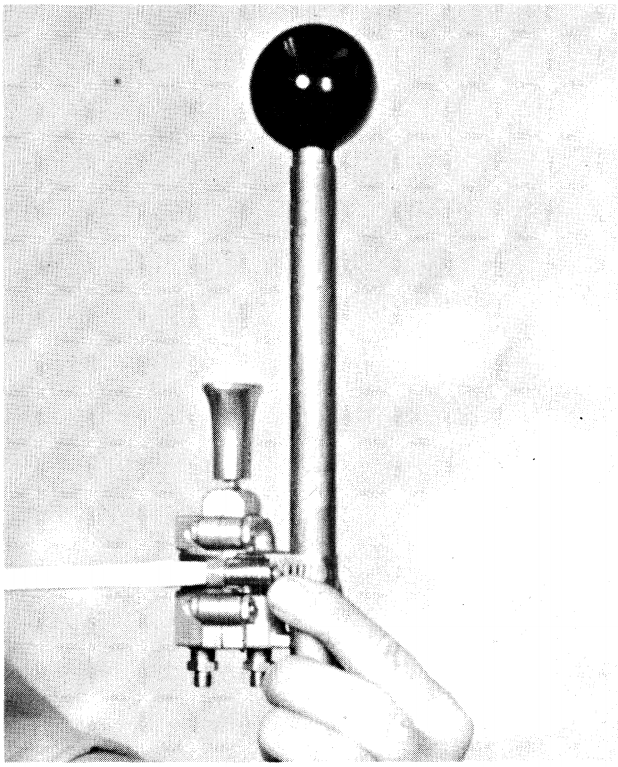
181. *Installing the low range air line.*

B. To Reassemble and Install the Air Regulator and Filter Assembly.

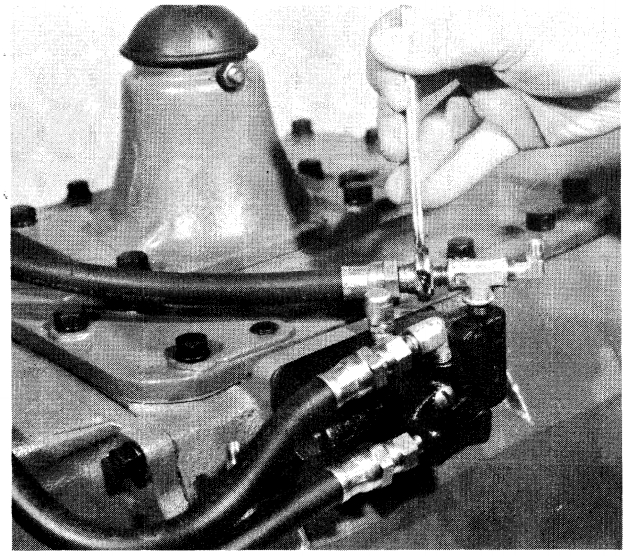
1. Install nipple in output port of air filter.
2. Attach bracket to top of filter with u-bolt.
3. Turn the regulator on nipple.
4. If previously removed, install bushing and 90° street ell in output port of air regulator. Street ell faces toward the gear shift lever housing when assembly is intalled.
5. Install the air regulator and filter assembly on mounting surface on left side of transmission, tighten capscrews securely. Illustration No. 182.
6. Install air line between output port of air regulator and the tee in supply port of air valve. Fasten hose with clamp at left-rear capscrews location on gear shift lever housing. Illustration No. 183.



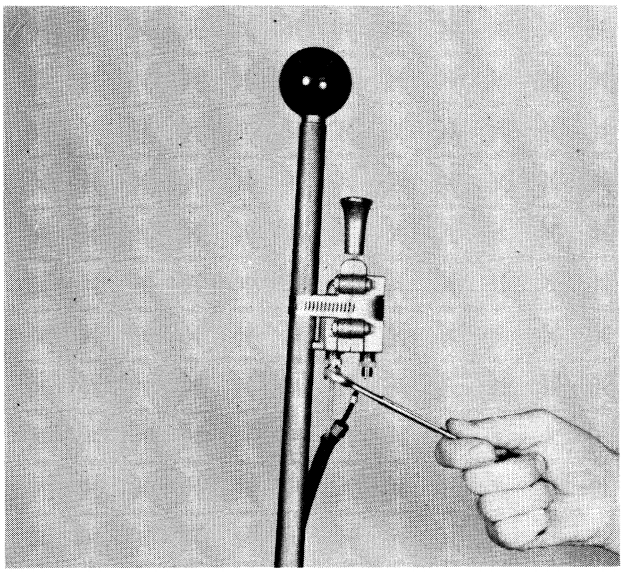
182. *Installing the air regulator and filter assembly.*



184. *Installing the range shift control valve.*



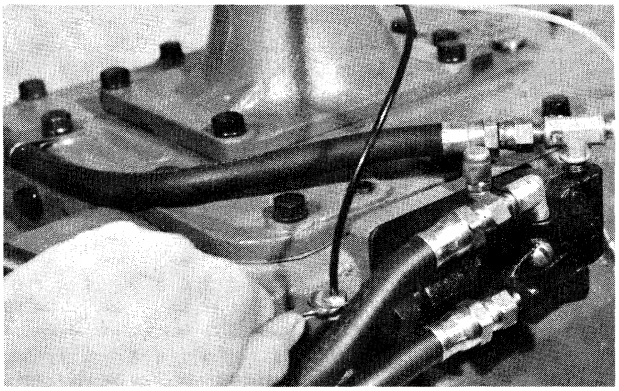
183. *Installing air line between tee in air valve and air regulator.*



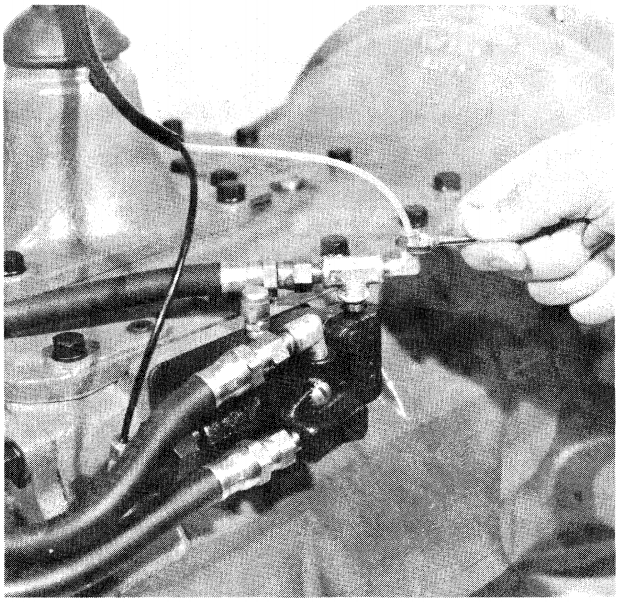
185. *Installing the ⅛" OD air lines.*

C. To Install the Range Control Valve.

1. Install O-ring clamp on gear shift lever.
2. Install the control valve on gear shift lever with clamp, and replace ball grip on gear shift lever. Position top of control valve button at least six inches below ball grip. Illustration No. 184.
3. If air lines are to be replaced, measure lines and sheathing for correct length.
4. Install sheathing on lines and draw under O-ring clamp on lever.
5. Connect the black nylon air line to the port marked "OUT" on the control valve and connect the white nylon air line to the port marked "IN" on the control valve. Illustration No. 185.
6. Install the black nylon air line from the "OUT" port of control valve to the air port in hexagonal end cap of air valve. Illustration No. 186.
7. Install the white nylon air line from the "IN" port of control valve to the tee in supply port of air valve. Illustration No. 187.



186. *Installing the black air line at end cap of air valve.*



187. *Installing the white air line at tee in air valve.*

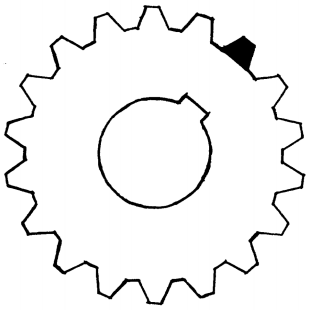
TIMING

It is essential that the two countershafts are timed. This assures that the countershaft gears will contact the mating mainshaft gears at the same instant, allowing the mainshaft gears to seek their equilibrium position. This prohibits the mainshaft gears from climbing out of position and prevents unequal tooth contact.

Timing one set of gears, the drive gear set, is all that is necessary. It is a simple procedure, consisting merely of marking the proper teeth prior to installation and meshing the teeth so marked.

A. Marking countershaft drive gear teeth.

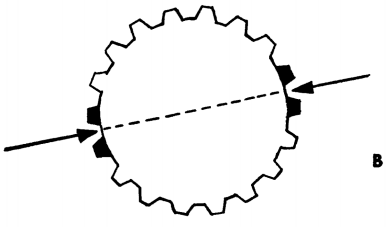
1. Prior to placing each countershaft assembly into case, clearly mark on each drive gear the gear tooth which is directly over the keyway in gear. (See Illustration A.) This tooth is stamped with an "O" to aid identification.



A TOOTH ON COUNTERSHAFT DIRECTLY OVER KEYWAY MARKED FOR TIMING

B. Marking drive gear teeth.

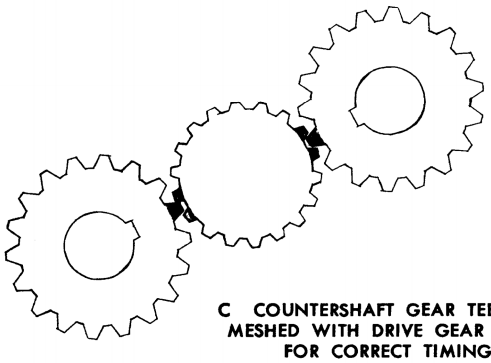
1. Mark *any* two adjacent teeth on the drive gear.
2. Mark the two adjacent teeth on the drive gear which are directly opposite the first set marked.There should be an equal number of teeth between the markings on each side of gear. (See Illustration B.)



B DRIVE GEAR TEETH CORRECTLY MARKED FOR TIMING

C. Meshing marked countershaft gear teeth with marked drive gear teeth. (After installing drive gear and mainshaft assemblies, the countershaft bearings are installed to complete countershaft installation.)

1. When installing bearings on the left countershaft, mesh the marked countershaft gear tooth between two marked teeth on the drive gear. Repeat the procedure when installing the right countershaft bearings. (See Illustration C.)



C COUNTERSHAFT GEAR TEETH MESHED WITH DRIVE GEAR TEETH FOR CORRECT TIMING

D. Timing auxiliary section.

(In the auxiliary section, the low speed gear set is marked for timing instead of the drive gear set.)

1. Mark any two adjacent teeth on the large mainshaft low speed gear, then mark the two adjacent teeth directly opposite — the same procedure as used when marking the front section drive gear.
2. On each auxiliary countershaft assembly, mark the tooth on the small low speed gear which is aligned with the keyway in the countershaft drive gear.
3. Install the low speed gear and tailshaft assembly in auxiliary housing.
4. Partially install outer races of countershaft rear bearings in case bores.
5. Place the auxiliary countershaft assemblies into position, meshing marked tooth on each countershaft gear between marked teeth on low speed gear. Countershafts will be partially seated in rear bearing.
6. Fully install rear bearings to complete auxiliary countershaft installation.

TOOL REFERENCE

Very few special tools are needed to repair the Fuller Twin Countershaft Transmissions. Ordinary socket wrenches, screwdrivers, etc., which are found in every mechanics tool box can be used. Other standard shop items are necessary, such as a press, bearing pullers, bearing drivers, mauls and soft bars.

Special tools which are needed consist mostly of snap ring pliers. Listed below are the illustrations which show these tools.

ILLUSTRATION	TOOL	HOW OBTAINED
28 - 143	Snap ring pliers, large	Tool Supplier
33 - 127 - 136	Snap ring pliers, medium (Needle-point type)	Tool Supplier
35 - 48 - 59 - 93 - 112 - 134	Snap ring pliers, medium	Tool Supplier
54 - 58	Bearing pullers, small	Tool Supplier
157	Torque Wrench, 200 ft.-lb. capacity	Tool Supplier
161	Torque Wrench, 1000 ft.-lb. capacity	Tool Supplier
142	Drive Gear Bearing Driver	Tool print of this can be obtained from Fuller Service Dept. No. T-18042-69

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