Service Manual

Fuller Heavy Duty Transmissions TRSM0502

June 2011

Powering Business Worldwide

BACKED BY Roadranger SUPPORT

Service Manual

- Operation
- Lubrication
- Maintenance
- Repair

RT-910, RT-915 Series

Fuller®
Twin Countershaft
Roadranger®
Transmissions

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MODEL DESIGNATIONS

RT-910 — **Roadranger** transmission, twin countershafts, 10 speeds.

RTO-910 — **Roadranger** transmission, twin countershafts, 10 speeds including an overdrive ratio.

RT-915 — **Roadranger** transmission, twin countershafts, 15 speeds.

RTO-915 — **Roadranger** transmission, twin countershafts, 15 speeds including an overdrive ratio.

"F" — Included in letter designation before numerals, such as RTF-910, etc., denotes forward position of the gear shift lever.

ILLUSTRATED PARTS LISTS WITH PART NUMBERS ARE AVAILABLE UPON REQUEST.

DESCRIPTION

The RT-910 and RT-915 transmissions are designed for medium to heavy-duty on-highway equipment. The twin countershaft design, which splits torque equally between the two shafts, provides a high torque capacity to weight ratio. Because of torque splitting, each gear set carries only half the load, greatly reducing the face width of each gear.

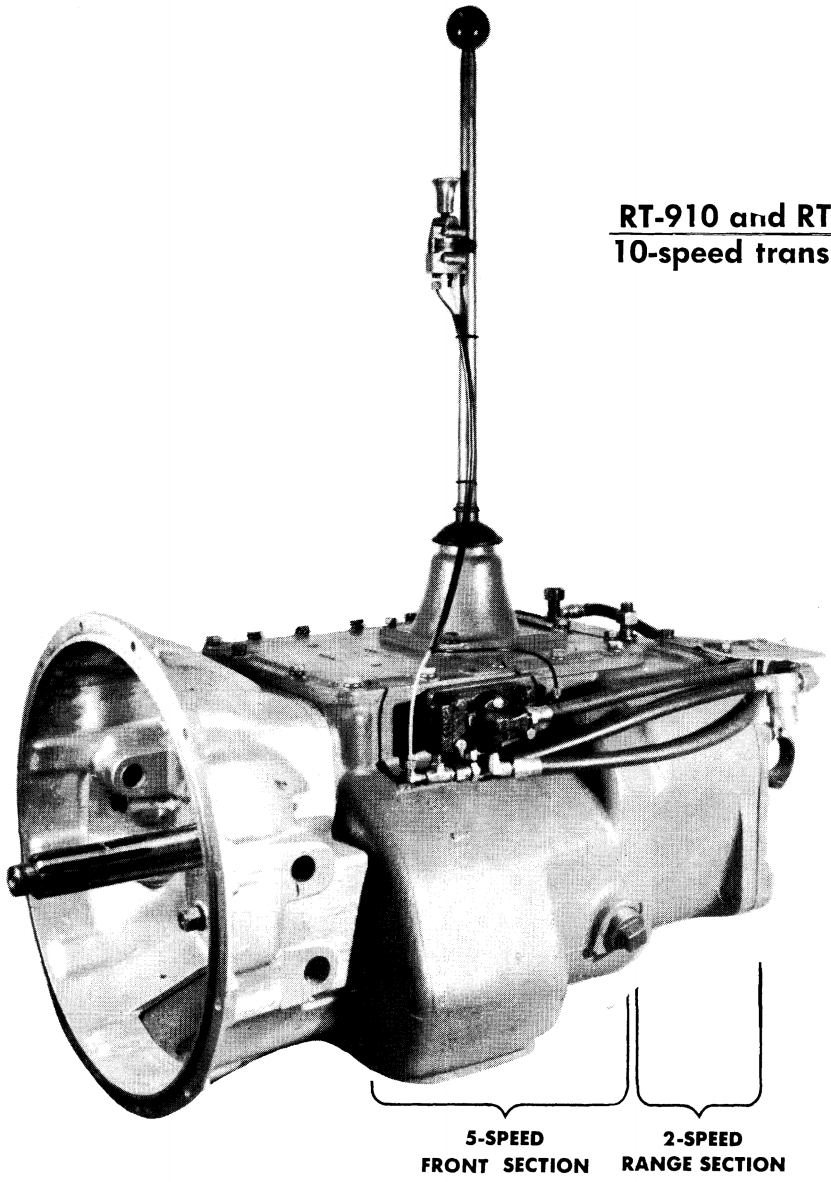
Another unique design feature is the floating gear principle. The mainshaft gears when not engaged "float" between the countershaft gears, eliminating the need for gear sleeves and bushings. All gears are in constant mesh and have spur type teeth.

The RT-910 transmissions have ten forward speeds and two reverse, consisting of a five-speed front section and a two-speed auxiliary or range section, both contained in one case. First through fifth speeds are obtained by using the five gear ratios in the front section through the low speed gear of the range section. Sixth through tenth speeds are obtained by using the five gear ratios in the front section through the high speed (direct drive) range gear. As in other Roadranger transmissions, the ratios are progressively spaced with an average 26 percent step between ratios.

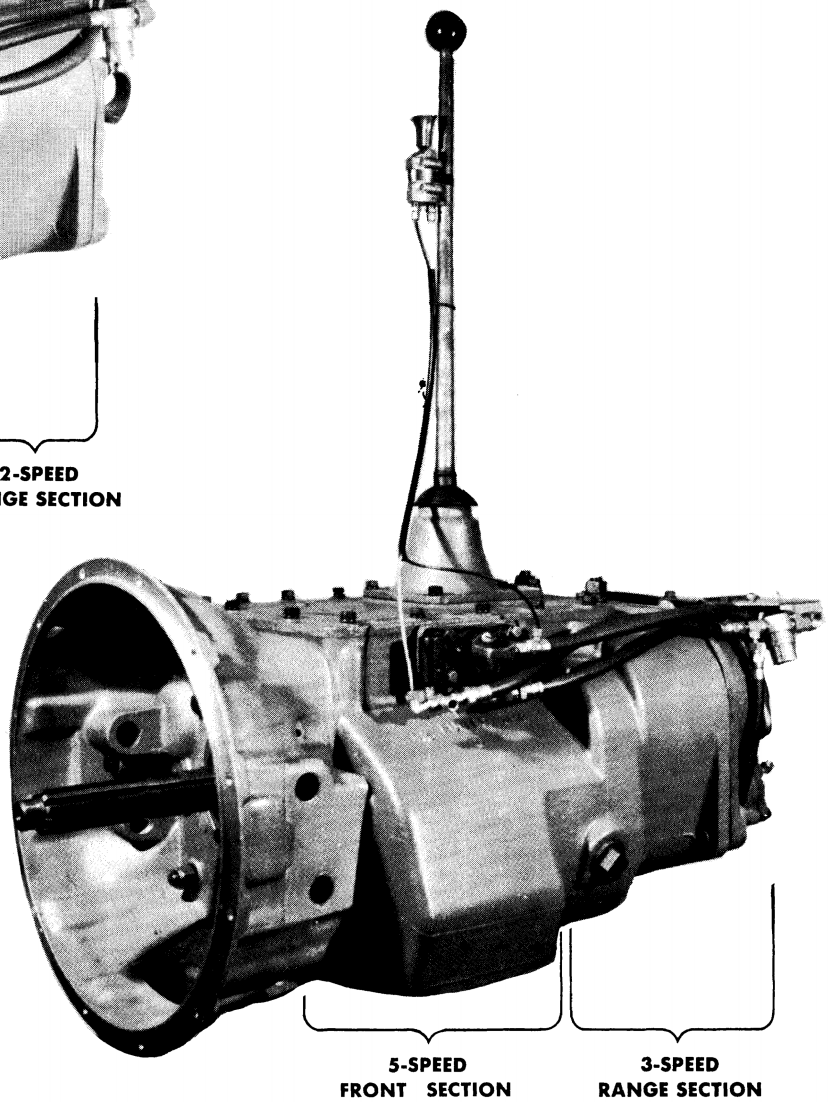
The RT-915 transmissions have 15 forward speeds and three reverse, consisting of a five-speed front section, which is identical to the RT-910 front section, and a three-speed auxiliary or range section. Both sections are contained in one case, the rear plate being extended to accommodate the extra set of gears. The 15 speeds are obtained by using the five speeds of the front section through direct drive (high range), through the low speed range gear, and through the hole gear of the auxiliary section. The hole gear provides for the deeper reduction. See Specifications page for gear ratios.

The range shift between low and high is made automatically by air upon pre-selection by the driver. The hole gear in the RT-915 Transmissions is engaged by air when selected by the driver.

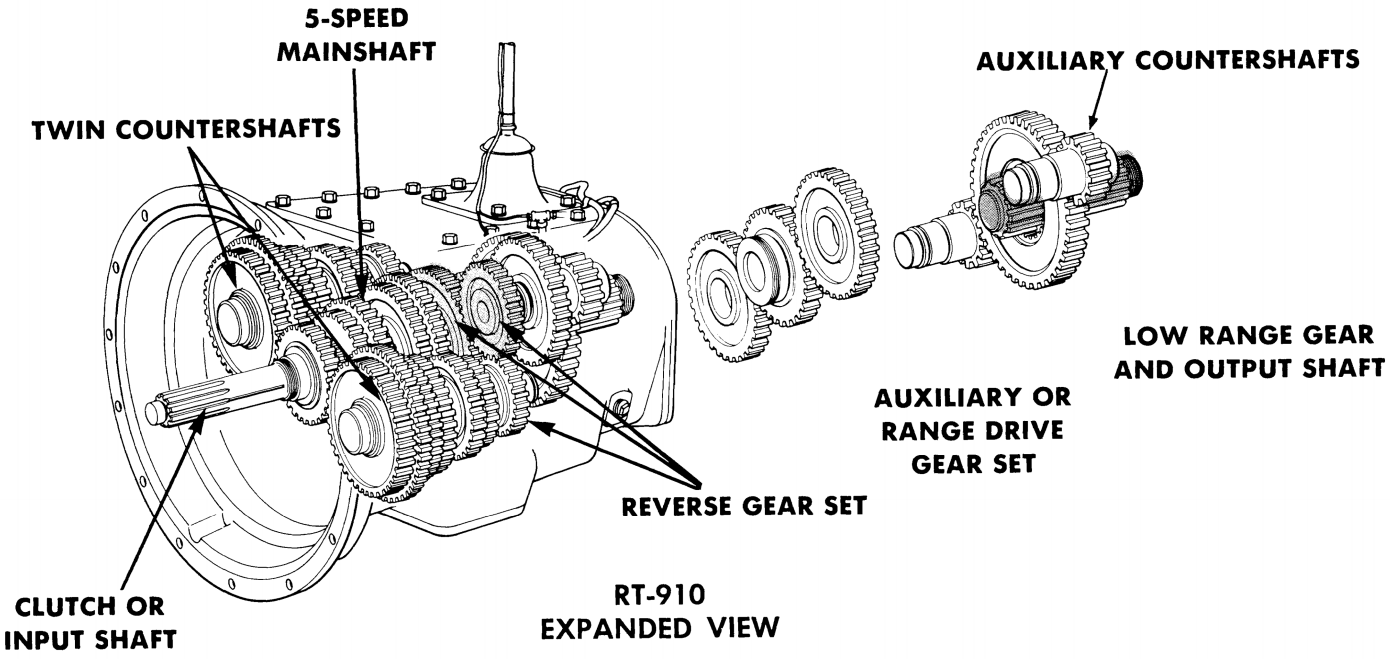
RT-910 and RTO-910
10-speed transmission



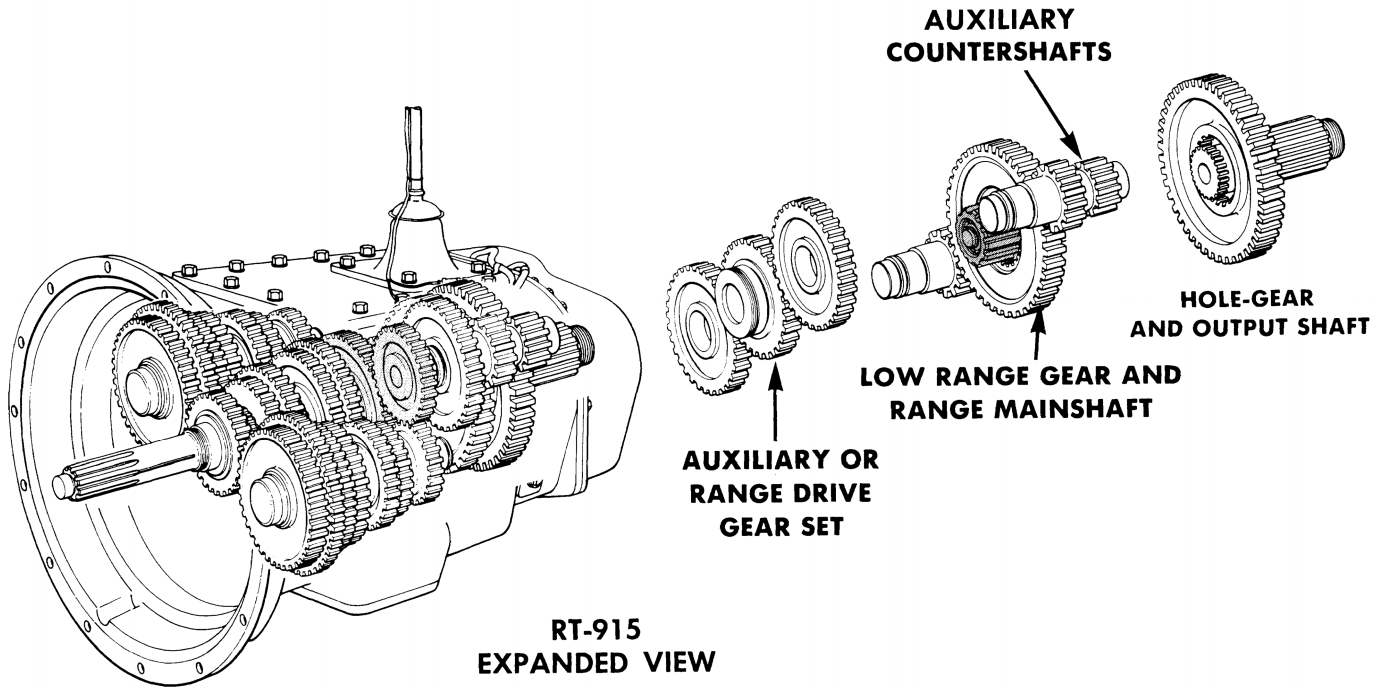
RT-915 and RTO-915
15-speed transmission



DESCRIPTION



RT-910
EXPANDED VIEW

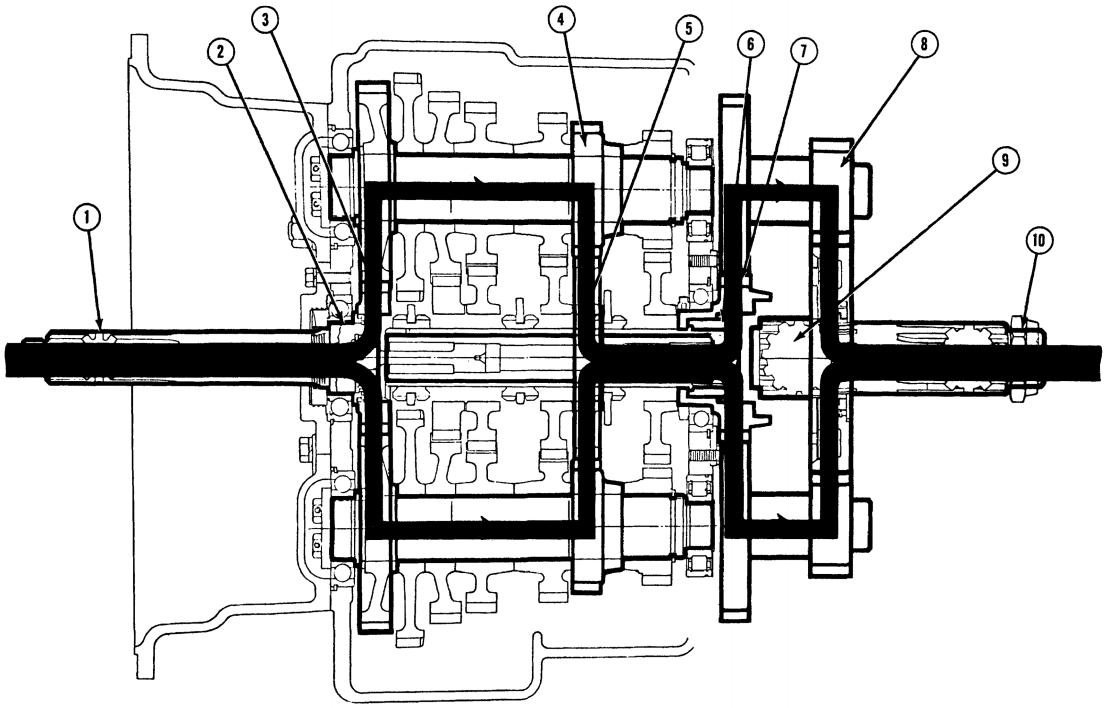


RT-915
EXPANDED VIEW

POWER FLOW OF THE RT-910

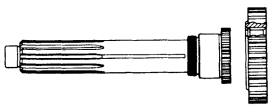
First Speed Gear Engagement

1. Power (torque) from the engine flywheel is transferred to the input shaft.
2. Splines on input shaft engage internal splines in hub of drive gear.
3. Torque is split between the two countershaft drive gears.
4. Torque delivered by two countershaft gears to mainshaft gear ratio which is engaged. Diagram shows first speed gear engaged.
5. Internal splines in hub of mainshaft gear transfers torque to mainshaft through sliding clutch gear.
6. Mainshaft transfers torque to range drive gear through a self-aligning coupling gear located in hub of range drive gear.
7. Torque is split between the two range countershaft drive gears. (In direct drive or high range, power is delivered to the output shaft from the range drive gear through a self-aligning sliding clutch gear.)
8. Torque is delivered by the two countershaft low speed gears to the range low speed gear.
9. Torque delivered to output shaft through self-aligning sliding clutch gear.
10. Output shaft attached to drive line.



DESIGN FEATURES

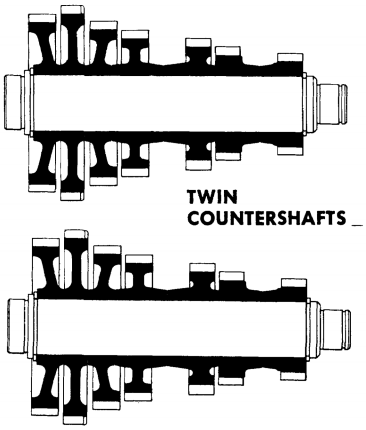
A. Input Shaft and Drive Gear



INPUT SHAFT AND DRIVE GEAR (NOT INTEGRAL)

1. Conventionally mounted with bearing in front wall of case.
2. Drive gear not integral with input shaft. Fourth and fifth speed gear sets are interchangeable.
3. Input shaft transfers torque to drive gear through internal splines in drive gear hub; even distribution of load on splines results in no radial loading on gear.
4. Equal loading on each side of gear, between countershafts, minimizes deflection.
5. Input shaft and drive gear can be changed individually.

B. Countershafts



TWIN COUNTERSHAFTS

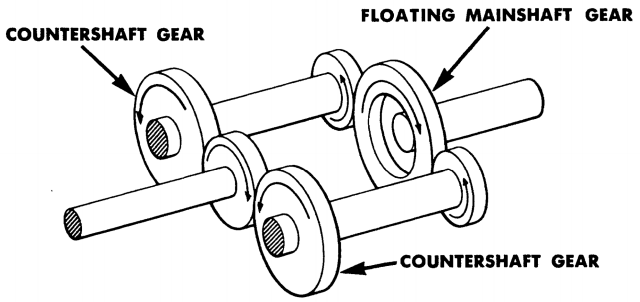
1. Identical except for power take-off gears.
2. Using even number of teeth on input shaft and mainshaft gears gives torque balance; countershaft gears can be odd or even numbered for better ratio determination, also helps maintain center position of mainshaft gears.
3. Keyways in countershaft broached in relation to teeth for proper timing with mainshaft gears.
4. Countershaft gear teeth are spur type.
5. Countershafts are short, due to split torque, thus deflections are at a minimum. Short shafts reduce length of unit.
6. Countershaft bearings are of relative low capacity due to split torque.

C. Mainshaft

1. Acts as torsion member, floating free, receives only minor radial loads.
2. Shaft displaces to conform to clutched gear position. This displacement is vertical and depends on tooth spacing, profile errors, keyway locations and eccentricity. Displacement does not exceed about .005 inches.

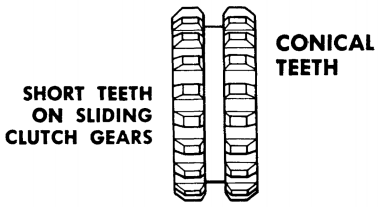
D. Mainshaft Gears

1. Located axially on mainshaft by washers, clearances are .005 to .012 inches.
2. Not journalled to mainshaft, .030 inches radial clearance.
3. No bushings.
4. Connected to shaft only when gear is engaged.



5. Equal tooth loading on each side of gear reduces pressure.
6. Constant mesh with countershaft gears.
7. In neutral, gears tend to float into tight mesh with one countershaft, eliminating rattle.
8. Internally splined hubs act as clutching members, reducing hub length compared with conventional gear.
9. Face width of each gear set reduced about 40 per cent due to split torque.
10. Narrow face gears reduce weight and length.
11. Gear teeth align on countershaft gears.

E. Clutching Gears

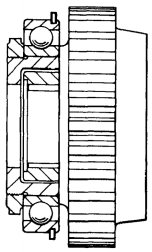


1. Short engagement length.
2. Short teeth allow self-alignment to compensate for slope due to mainshaft displacement.
3. Floating mainshaft provides even tooth bearing on clutching teeth, neutralizing effects of eccentricity.
4. Conical clutching teeth provide ease in shifting, less clashing.

F. Reverse Idlers

1. Load on needle bearings is small due to position of gears.
2. Internal oil channel in shaft lubricates bearing.

G. Range Drive Gear



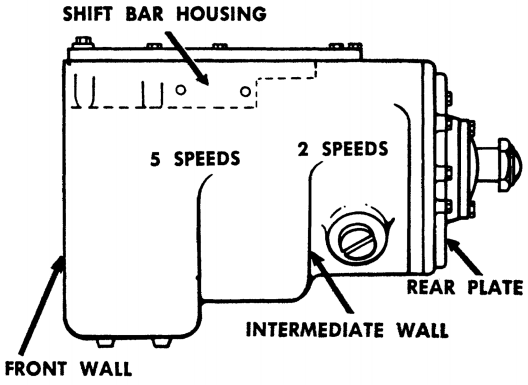
1. Fixed to intermediate wall with ball bearing.
2. Bearing does not carry radial load.
3. Bearing serves to locate range drive gear and receive thrust of high range synchronizer.
4. Self-aligning coupling gear transmits torque from mainshaft to drive gear, allowing mainshaft to float.

H. Auxiliary or Range Section

1. Reduction gear floats on output shaft, radially free.
2. Clutching gear is self-aligning.
3. Output shaft rigidly mounted by matched Timken bearing to absorb drive line effects.
4. Synchronizers are cone type to conserve length, require less capacity because of low mass of gears in range section and absence of large sliding gear on mainshaft.
5. Shift cylinder compactly mounted, air operated with same system as other ROADRANGERS.

I. Transmission Case

1. Centerline planes of the three shafts are not on horizontal line, but tilted. This allows front section countershaft rear bearings to be mounted in the same wall as the range countershaft front bearings, saving space.



2. Case depth relatively shallow. Bottom PTO opening provided without substantial decrease in ground clearance.
3. One piece case, houses both front section and range section, consists of front wall and intermediate wall. Rear is open and covered with a plate.
4. Rear plate can be modified, either dishing or bulging, to make model variations.
5. Shift bar housing mechanism sets below top of case, rather than above case as on conventional transmissions.

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.

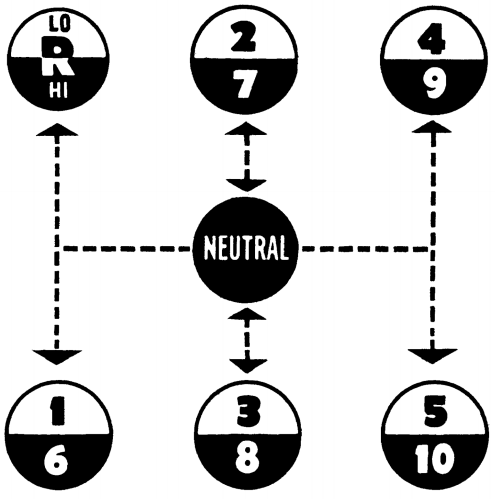
RT-910 and RTO-910 Operation

The RT-910 has ten selective ratios, evenly and 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.

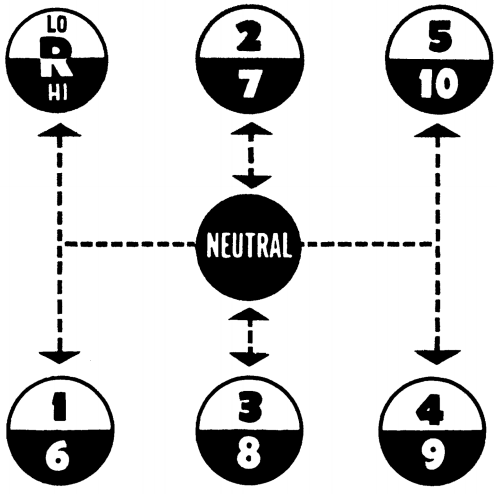
All shifts are made with one lever. The range control button is used one time only during an up shift sequence, and one time only during a down shift sequence.

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.

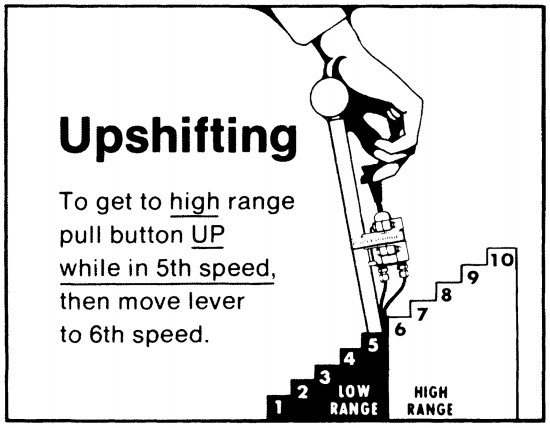
Ten speeds obtained with one gear shift lever and range control button.

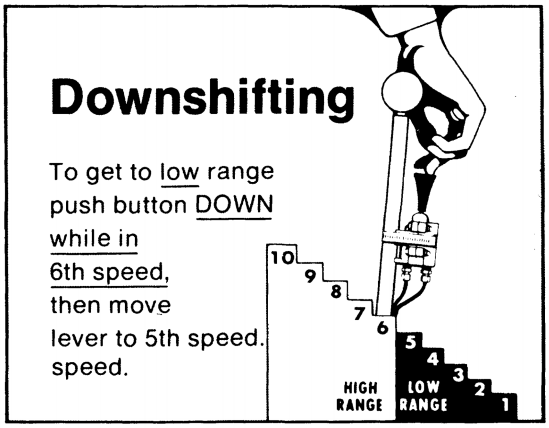


Shift pattern for the RT-910 model transmission.



Shift pattern for the RTO-910 model transmission.





Upshifting

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

2. Start the engine.

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

4. 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.

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

6. 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.

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

Driving tip: always start vehicle moving in first speed gear.

Downshifting

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

2. 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.

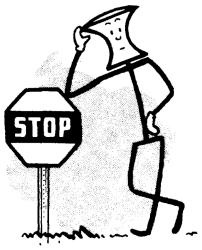
3. With the transmission in low range, shift downward through each of the four remaining steps.

"F" Models

The letter "F" in the model numbers, such as RTF-910 and RTOF-910, indicates forward position of the gear shift lever housing and does not affect the shift pattern. The RTF-910 shift pattern is the same as the RT-910, and the RTOF-910 shift pattern is the same as the RTO-910.

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.



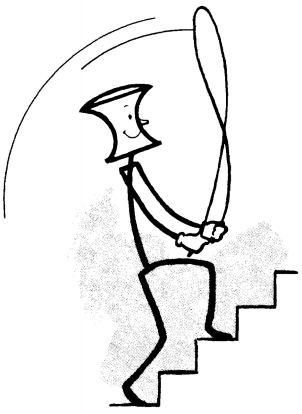
When necessary to slow or stop the vehicle, shift down through the individual short steps, allowing the compression of the engine to slow the vehicle. The life of chassis and trailer brakes can thus be prolonged.

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.

Shifts will be fast and short as the gear shift lever stroke is 2¼ inches between positions. Conical engagement teeth are standard on these transmissions, thus helping to eliminate gear clashing. Gear ratios average 26 per cent between ratio steps.

Skip Shifting

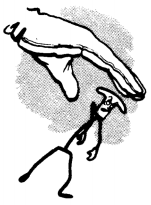
After becoming proficient in shifting this transmission, the operator may wish to skip some of the gear ratios to offset a particular operating condition. Skip shifting can be done when up shifting providing the range control button is pulled up to the high range position before making any shift which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

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.

A metal shift diagram is furnished with each transmission and should be installed on the vehicle dashboard. If it has been misplaced, new metal shift diagrams can be purchased from the Service Department, Transmission Division, Eaton Corporation, Kalamazoo, Michigan.

RT-915 and RTO-915 Operation

The RT-915 transmission, like the RT-910, has a five-speed front section and a two-speed auxiliary or range section which enables the driver to select 10 forward speeds, evenly and progressively spaced. However, the RT-915 models have an additional five speeds obtained through a deep reduction gear (hole-gear).

The 10 ratios in high and low range are obtained with one lever and a range control button. The five speeds in deep reduction are obtained with the same gear shift lever and a Deep Reduction Valve which controls the "IN" or "OUT" position of the reduction gear.

The five ratios in deep reduction are evenly and progressively spaced. These five ratios, however, overlap the low range ratios and are not progressively spaced in relation to the low range ratios.

The deep reduction gear should be used only when operating under adverse conditions and only when the transmission is in LOW RANGE with the control valve button down. Never move the Deep Reduction Valve to "IN" when in high range. When the valve is moved to "IN" the reduction ratios will be engaged regardless of the position of the Range Control Button.

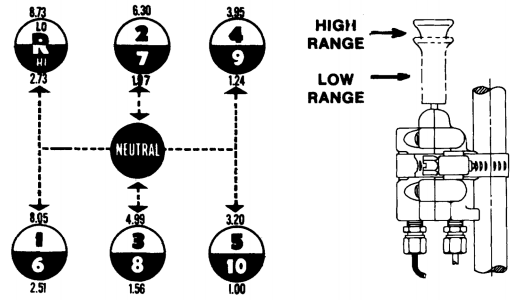
The RTO-915 is operated in the same manner as the RT-915 except for the reversal of the 4th and 5th gear shift lever positions.

Up Shift Through Low and High Range

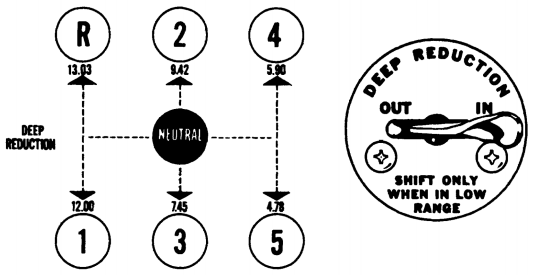
Shift upward through the 10 speeds of low and high range in the same manner as up shifting the RT-910 or RTO-910 model transmissions. MAKE SURE THE DEEP REDUCTION VALVE IS IN THE "OUT" POSITION AT ALL TIMES during the low and high range shifts.

SHIFTING DIAGRAM OF THE RT-915

Fifteen speeds obtained with one gear shift lever, a Range Control Button and a Deep Reduction Valve. (Ratios shown with each gear shift lever position.)



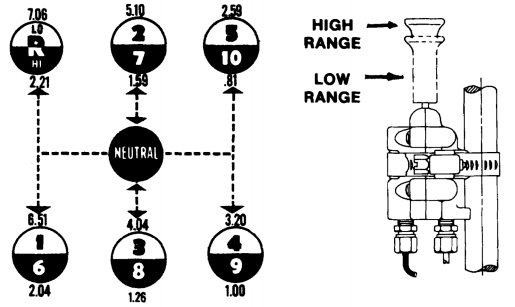
One through 10 speeds . . . with Range Control Button . . . and Deep Reduction gear disengaged.



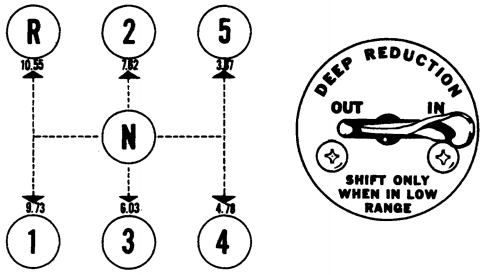
Five additional ratios . . . with Deep Reduction gear engaged.

SHIFTING DIAGRAM OF THE RTO-915

Fifteen speeds obtained with one gear shift lever, a Range Control Button and a Deep Reduction Valve. (Ratios shown with each gear shift lever position.)

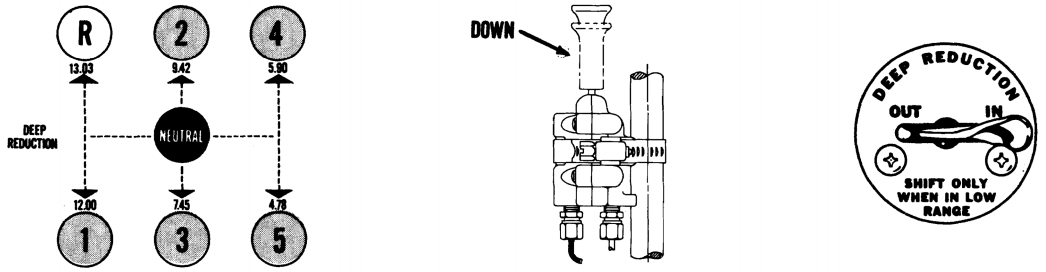


One through 10 speeds . . . with Range Control Button . . . and Deep Reduction gear disengaged.

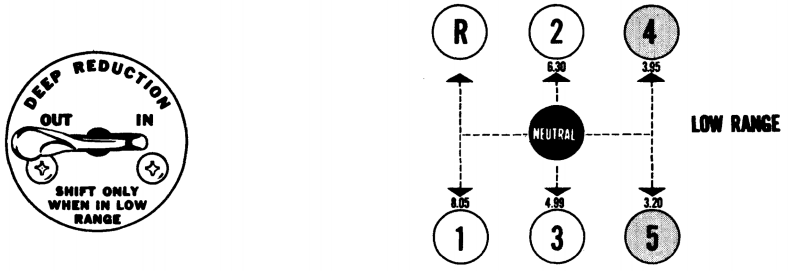


Five additional ratios . . . with Deep Reduction gear engaged.

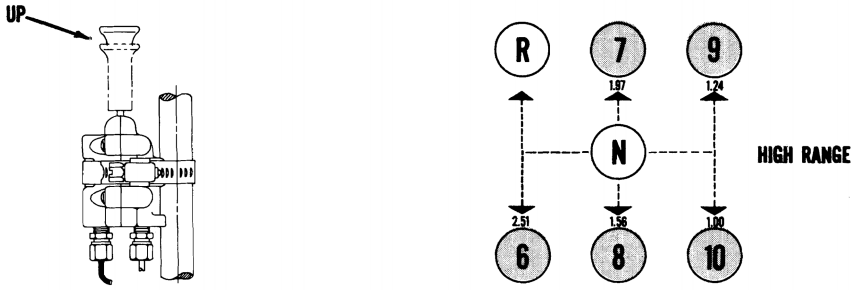
SUGGESTED SHIFT PATTERN FOR THE RT-915 THROUGH REDUCTION AND LOW AND HIGH RANGE
(Ratios shown next to each gear shift lever position)



Shift 1 through 5 with range control button down and deep reduction valve to "IN"



Move deep reduction valve to "OUT" while in 5th reduction . . . and shift through 4th & 5th of low range



Pull range control button up while in 5th of low range . . . and shift 6th through 10th of high range

Up Shift Through Deep Reduction, Low and High Range

There are several patterns of up shifting depending upon conditions of road and load. Check gear ratios to determine the best ratio split for your particular condition. The following instructions are recommended for average conditions:

1. With the gear shift lever in neutral, the engine started and air system pressure normal, PUSH THE RANGE CONTROL BUTTON TO THE DOWN POSITION.
2. Move the Deep Reduction Valve to the "IN" position to engage the deep reduction gear.
3. Start the vehicle and shift progressively from 1st through 5th of the shift pattern.
4. When in 5th speed position and ready for the next up shift, move the Deep Reduction Valve to the "OUT" position and shift to the 4th speed position, thus shifting out of the reduction ratios to low range ratios. Torque will

keep the reduction gear engaged until the shift out of fifth position is made. Remember, although the shift lever is moved from 5th to 4th, this is an up shift and accelerator must be moved accordingly. There will be no automatic range shift as the transmission already is in low range.

5. Shift through the 4th and 5th speed positions of low range.
6. When ready for the next up shift, pull the Range Control Button up while in the 5th speed position of low range and shift the lever to the first speed position of the shift pattern. As the lever passes through neutral, the transmission will automatically shift from low to high range.
7. Shift progressively upward from 6th through 10th in high range.

NOTE:

The above is for the RT-915. The RTO-915 shift from reduction to low range would differ, according to the ratios desired.

Important Procedures

1. When making the shift from a reduction ratio to a low range ratio, move the Deep Reduction Valve from "IN" to "OUT" IMMEDIATELY BEFORE making the shift. This is not a preselect valve and only torque will hold the reduction gear after the lever is moved to "OUT"; the shift cylinder will make the shift by air as soon as torque is released.

2. Never move the Deep Reduction Valve lever with the transmission in high range (range control button up) as the reduction gear bypasses both the low and high range sections, regardless of the position of the range control button.

3. When down shifting it should not be necessary to shift into deep reduction ratios. The reduction in low range should be sufficient in most operating conditions.

All instructions pertaining to the Range Control Button, skip shifting and general precautions of the ten speed shift pattern of the RT-910 apply as well to the RT-915.

SPECIFICATIONS

	RT-910			RTO-910		
	Speed	Gear Ratio	% Step	Speed	Gear Ratio	% Step
HIGH RANGE	10th	1.00		10th	.81	
	9th	1.24	23.5	9th	1.00	23.5
	8th	1.56	26.0	8th	1.26	26.0
	7th	1.97	26.5	7th	1.59	26.5
	6th	2.51	27.5	6th	2.04	27.5
	RANGE SHIFT		27.5	RANGE SHIFT		27.5
LOW RANGE	5th	3.20		5th	2.59	
	4th	3.95	23.5	4th	3.20	23.5
	3rd	4.99	26.0	3rd	4.04	26.0
	2nd	6.30	26.5	2nd	5.10	26.5
	1st	8.05	27.5	1st	6.51	27.5
High Range Reverse		2.73			2.21	
Low Range Reverse		8.73			7.06	

	RT-915			RTO-915		
	Speed	Gear Ratio	% Step	Speed	Gear Ratio	% Step
HIGH RANGE	10th	1.00		10th	.81	
	9th	1.24	23.5	9th	1.00	23.5
	8th	1.56	26.0	8th	1.26	26.0
	7th	1.97	26.5	7th	1.59	26.5
	6th	2.51	27.5	6th	2.04	27.5
	RANGE SHIFT		27.5	RANGE SHIFT		27.5
LOW RANGE	5th	3.20		5th	2.59	
	4th	3.95	23.5	4th	3.20	23.5
	3rd	4.99	26.0	3rd	4.04	26.0
	2nd	6.30	26.5	2nd	5.10	26.5
	1st	8.05	27.5	1st	6.51	27.5
DEEP REDUCTION RATIOS	5th	4.78		5th	3.87	
	4th	5.90	23.5	4th	4.78	23.5
	3rd	7.45	26.0	3rd	6.03	26.0
	2nd	9.42	26.5	2nd	7.62	26.5
	1st	12.00	27.5	1st	9.73	27.5
High Range Reverse		2.73			2.21	
Low Range Reverse		8.73			7.06	
Deep Reduction Reverse		13.03			10.55	

CLUTCH RELEASE MECHANISM

Clutch release bearing carrier, release bearing, extended front bearing cover, release yoke and pedal shafts furnished with transmission for use with single or two-plate, push-type clutches. Flat-type front bearing cover furnished for use with single or two-plate, pull-type clutches.

POWER TAKE-OFF

Openings

Bottom: SAE standard heavy-duty type, short length.

Right Side: SAE standard regular-duty type, short length.

PTO Drive Gear

Bottom: A 47-tooth, 6/8 pitch gear on the left countershaft.

Right Side: A 45-tooth, 6/8 pitch gear on the right countershaft.

PTO Drive Gear Speeds

RT-910, 915: Both turning at .700 engine speed.

RTO-910, 915: Both turning at .865 engine speed.

REAR SUPPORT

Two 5/8″ vertical mounting studs with nuts and lockwashers furnished in top rear of transmission case for attachment of flexible rear support.

SPEEDOMETER DRIVE

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

MAGNETIC OIL CLEANERS

Three magnetic discs are installed in bottom of case to catch and hold metallic particles deposited in the oil.

Weight	
RT-910, RTO-910	626 lbs.
RT-915, RTO-915	696 lbs.
Length	
RT-910, RTO-910	30 7/8″
RT-915, RTO-915	34 1/16″
Torque Capacity	950 ft. lbs.
Clutch Housing Size (deep).	SAE No. 1 or 2
Oil Capacity	
RT-910, RTO-910	App. 25 pts.
RT-915, RTO-915	App. 28 pts.

Depending on inclination of transmission and motor.

Proper Lubrication . . . the Key to long transmission life

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

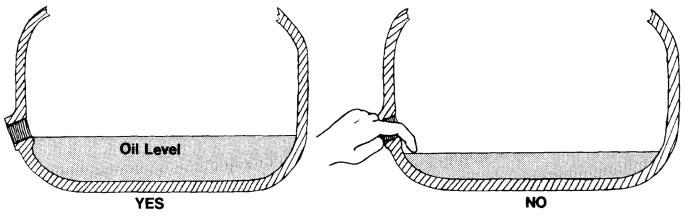
Type	Grade	Temperature
Heavy Duty Engine Oil MIL-L-2104C, or MIL-L-46152, or API-SE, or API-CC	SAE 50 or SAE 40 SAE 30	Above + 10°F. (—12.5°C.) Below + 10°F.
Mineral Gear Oil R and O Type	SAE 90 SAE 80W	Above + 10°F. Below + 10°F.
OFF-HIGHWAY		
Heavy Duty Engine Oil MIL-L-2104C, or MIL-L-46152, or API-SE, 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.

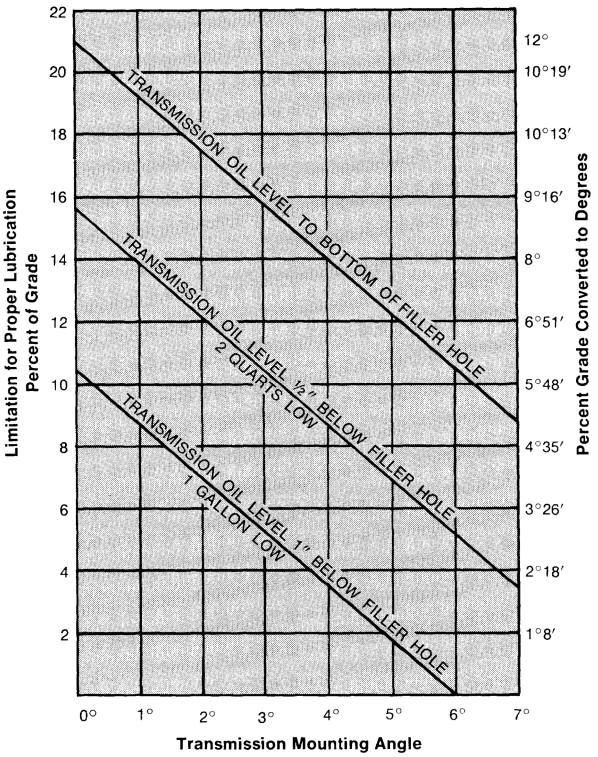
Operating Temperature

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 SYSTEMS

Range Shift Air System—All Models

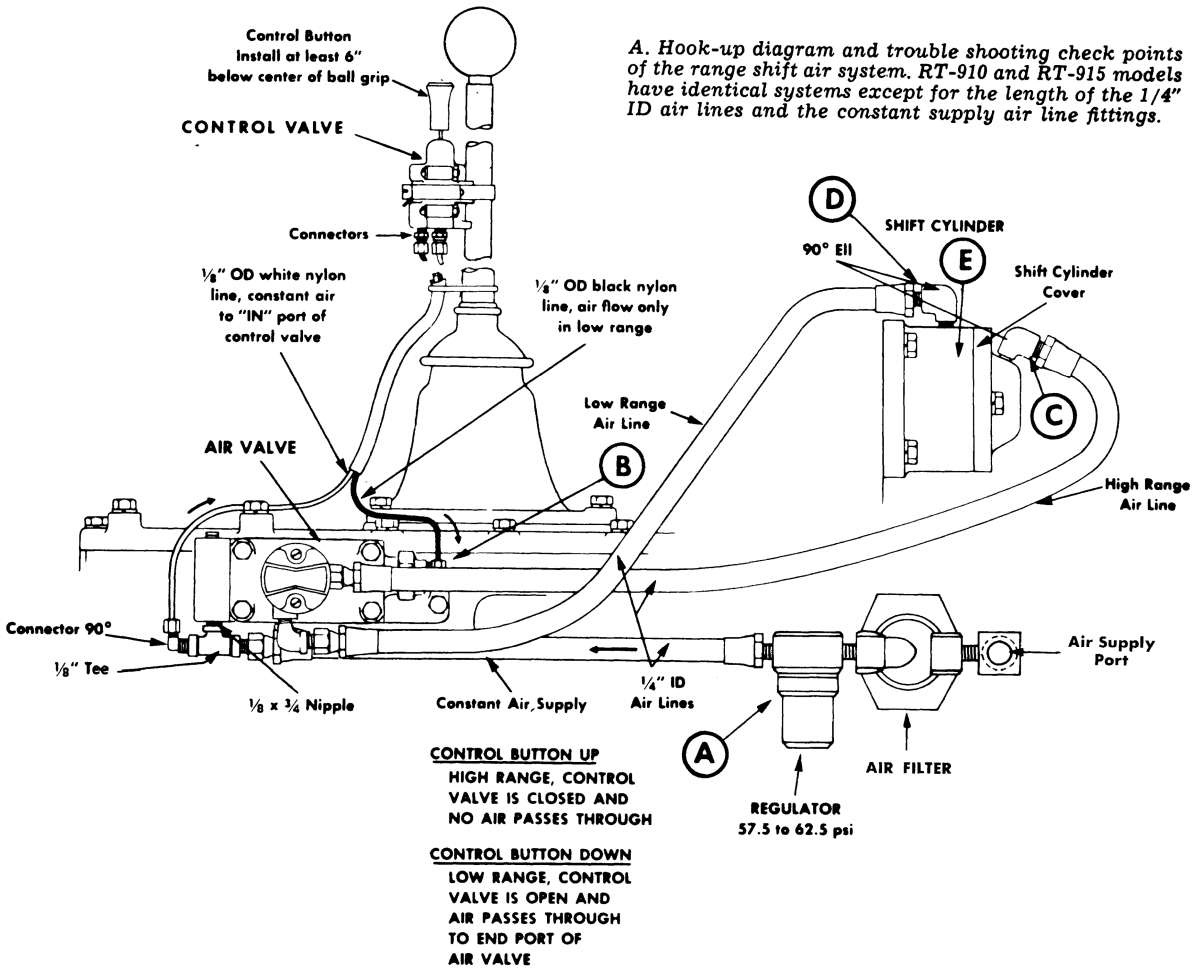
This system consists of an air filter, regulator, air valve, control valve, shift cylinder, fittings and connecting lines. See Illustration A.

Constant regulated air is supplied to the bottom port of the air valve and to the "IN" port of the control valve. With the control button down, air passes through the control valve and to the end port of the air valve. This permits air from the constant supply to flow through the low range port in bottom, side cap of air valve and to the shift cylinder air port. Air on this port moves the shift piston and bar 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 air from the constant supply to flow through the high range port in rear, side cap of air valve and to the shift cylinder cover air port. Air on this port moves the shift piston and bar forward to engage the high range 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.

On some transmissions the air valve may be installed in a 180° position from that shown in Illustration A. The porting on these models, however, remains the same. The bottom port in the side cap is always the low range port.



A. Hook-up diagram and trouble shooting check points of the range shift air system. RT-910 and RT-915 models have identical systems except for the length of the 1/4" ID air lines and the constant supply air line fittings.

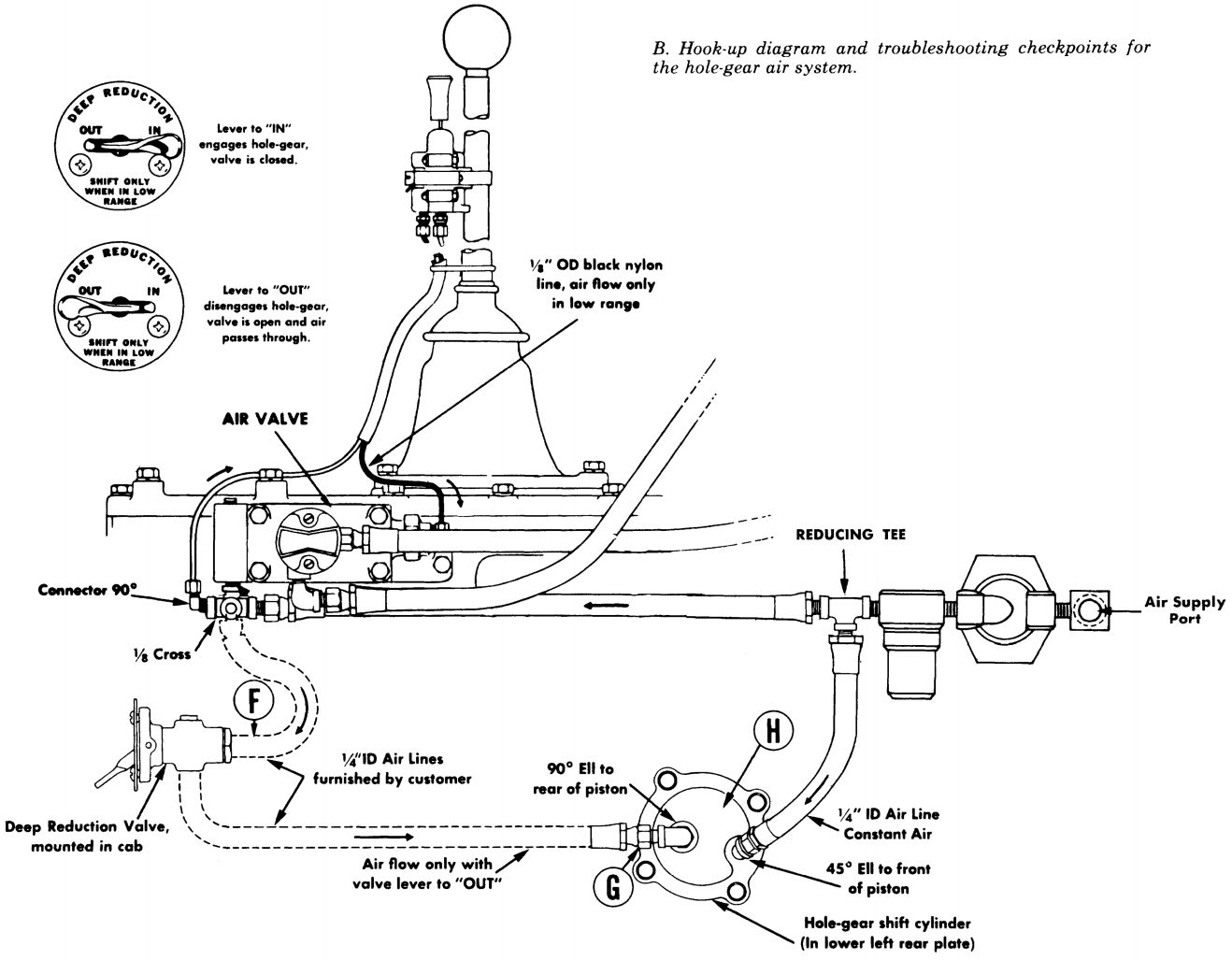
Hole-Gear Air System— RT-915, RTO-915

This system uses the air filter and regulator of the range shift air system, plus a Deep Reduction Valve, mounted in the vehicle's cab, and a hole-gear shift cylinder. See Illustration B.

Constant regulated air is supplied to the end port of the deep reduction valve and to the air port in the lower, right side of the hole-gear shift cylinder cover.

The deep reduction valve lever has two positions, "IN" and "OUT". With the lever moved to the "IN" position the valve is off. Thus, constant air channeled through the shift cylinder and cover to the front of the shift piston moves the piston and shift bar to the rear to engage the hole-gear. As the hole-gear is engaged the range mainshaft is disengaged from the output shaft, removing the low and high range sections from the power flow.

With the deep reduction valve lever moved to the "OUT" position air flows out the side port of the valve and to the air port near the center of the hole-gear shift cylinder cover. This air, pushing against a larger piston area than the constant air supply, moves the shift piston and bar forward to disengage the hole-gear. As the hole-gear is disengaged, the range mainshaft is engaged to the output shaft, permitting use of the low and high range sections.

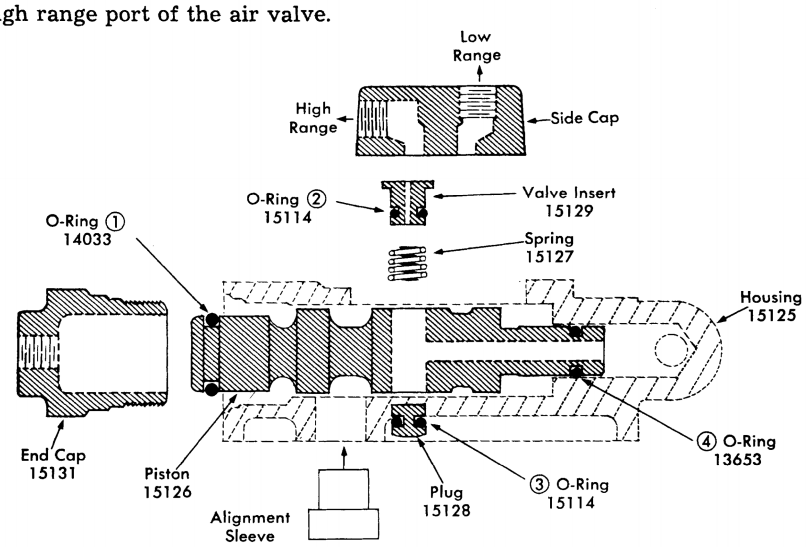


B. Hook-up diagram and troubleshooting checkpoints for the hole-gear air system.

Air Valve Operation

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.



C. 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.

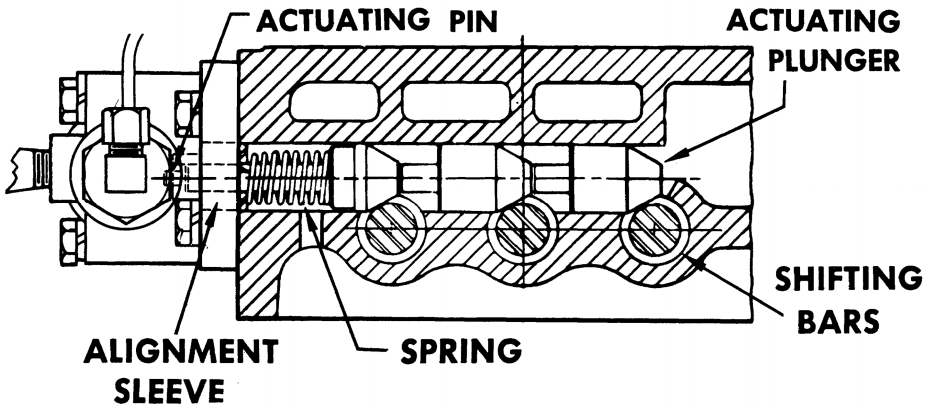
Defective O-Rings	RESULT
1	Constant leak through exhaust in low range only.
2 or 3	Constant leak through exhaust in both ranges.
4	Constant leak through exhaust in high range; steady but low volume leak through exhaust in low range.

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.

Air Valve Pre-Selection

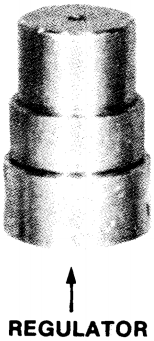
An actuating pin protruding from the shifting bar housing prevents the actuating piston in the air valve from moving while the gear shift lever is in a gear position and releases the piston when the lever is moved to or through neutral. See detailed installation of air valve for installation precaution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



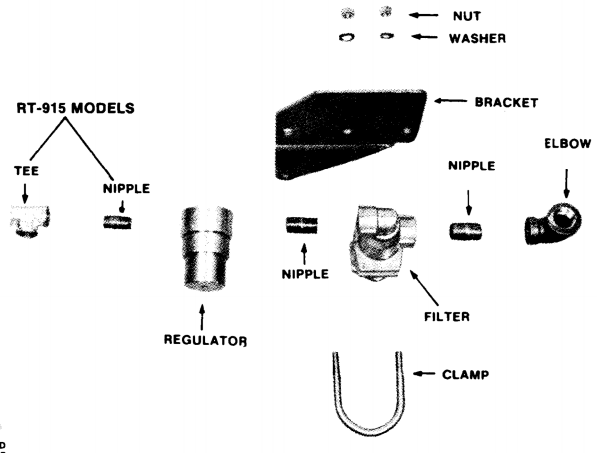
D. Cross-section of actuating pin and plunger assembly.

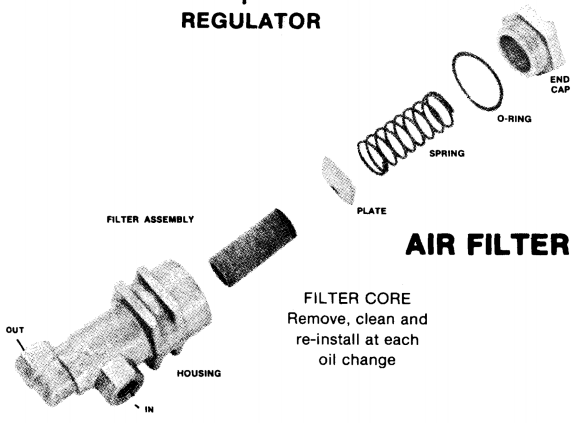
AIR REGULATOR

The air regulator is not serviceable. If defective replace the air regulator unit. Reading at output of air regulator should be 57 to 62 psi.



AIR FILTER & REGULATOR ASSEMBLY

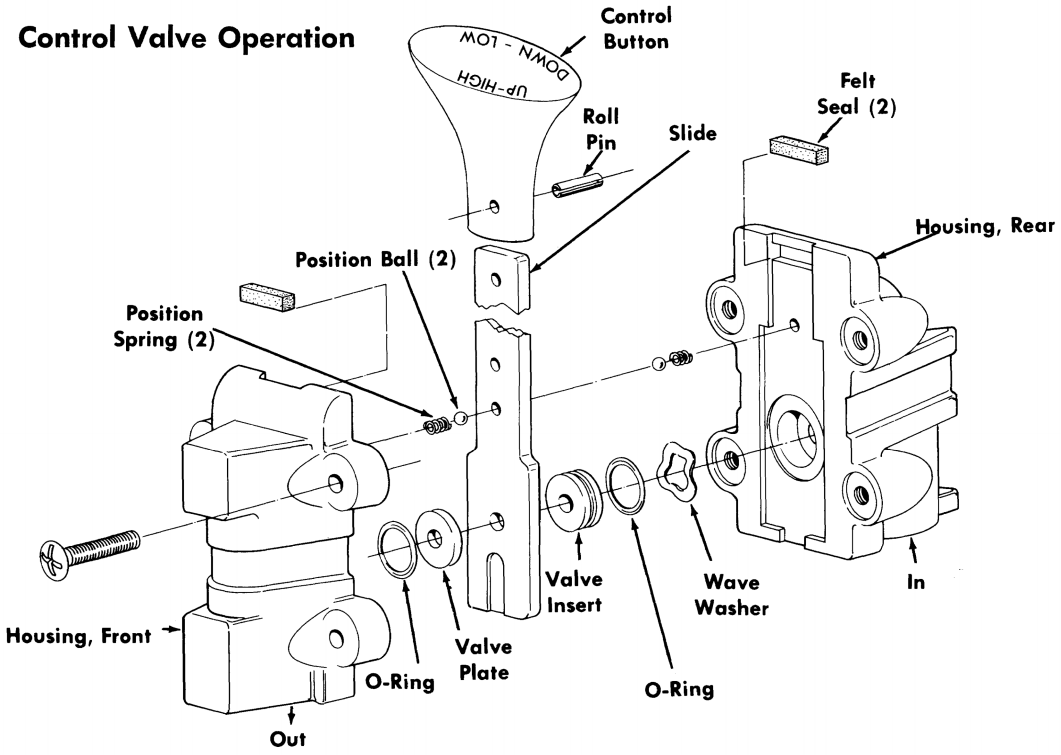




AIR FILTER

FILTER CORE
Remove, clean and re-install at each oil change

Control Valve Operation



E. Exploded view of control valve. The "IN" port is constant supply. The "OUTLET" port is connected by ⅛" O.D. 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 part.

To Disassemble the Control Valve

1. 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 Valve O-Ring sizes, III. C			
Qty.	**Location**	**ID**	**Width**
2	Valve Insert and Plug	.208	.070
1	Piston	.549	.103
1	Piston	.364	.070
Control Valve O-Ring sizes, III. E			
1	Valve Insert	.301	.070
1	Housing	.375	.062

TROUBLE SHOOTING

RANGE SHIFT AIR SYSTEM—ALL MODELS

The following checks are to be made with normal vehicle air pressure but with the engine off. Refer to Illustration A for check points.

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 top exhaust in control valve if button is held 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 (see Ill. F, Check Point E).

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

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

3. Air Regulator, Check Point A

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

If there is a steady leak from exhaust port, this indicates a defective air regulator and should be replaced.

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.

If correct pressure readings are not obtained, replace regulator.

4. Control Valve, Check Point B

With the gear shift lever in neutral, pull the control button up to high range and disconnect the ⅛" black nylon air line at air valve.

a. When control button is pushed down a steady blast of air should flow from the disconnected line. Air will shut off when button is pulled up. This indicates that control valve is operating correctly. Reconnect air line. If control valve does not operate correctly, check for leaks, restrictions and defective O-rings.

5. High Range, Check Point C

With the gear shift lever in neutral, push the control button down and disconnect the high range air line from the shift cylinder cover.

a. Pull the control button up. There should be a steady flow of air from the high range air line. 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 line. Move the gear shift lever to neutral; there should now be a steady flow of air from the high range line. Push button down to shut off air and reconnect line.

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

6. Low Range, Check Point D

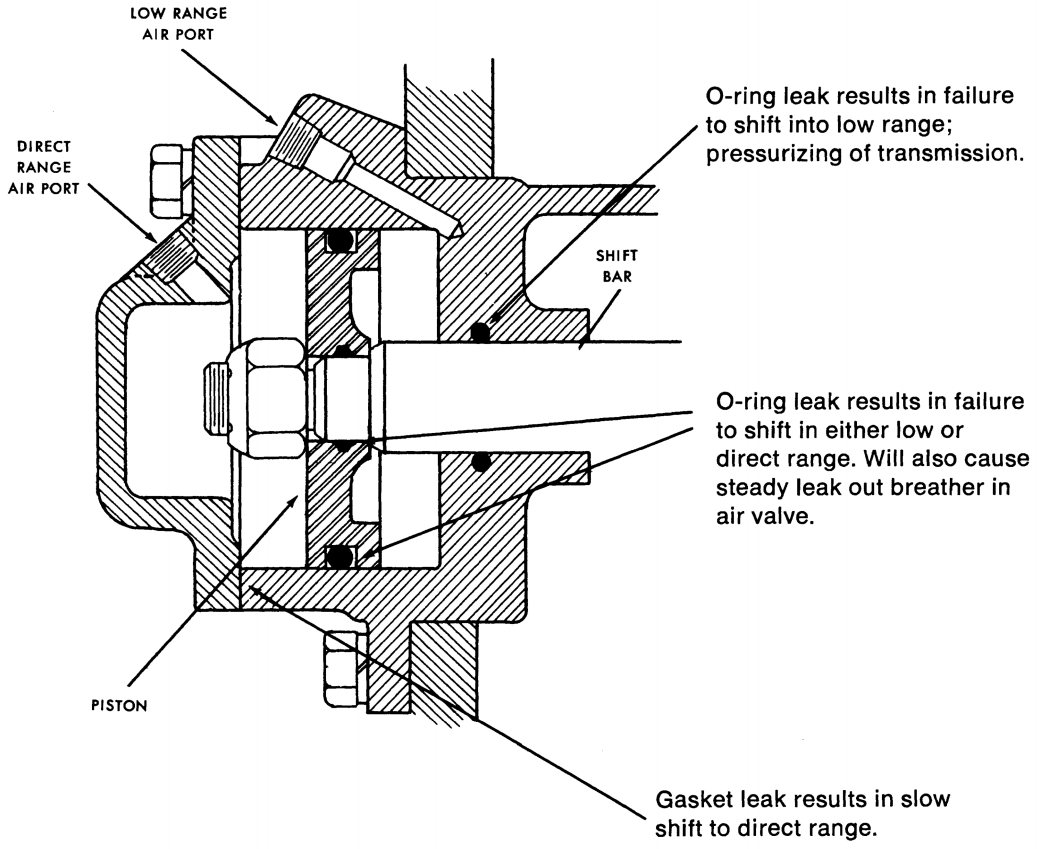
With the gear shift lever in neutral, pull the control button up and disconnect the low range air line at shift cylinder.

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

7. Range Shift Cylinder— 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, of course, will govern the degree of failure, from slow shift to complete failure to shift.

Refer to illustration "F" for location of seals. Make sure cylinder bore is clean to prevent damage to piston seal. Use only a very light amount of shellac or Permatex on cover gasket to prevent clogging cylinder. Tighten cover capscrews securely.



F. Range Shift Cylinder — All Models

HOLE-GEAR AIR SYSTEM
RT-915 AND RTO-915 TRANSMISSIONS

The following checks are to be made with normal vehicle air pressure but with the engine off. It is assumed air lines have been checked for leaks and the air regulator has been checked and the correct reading obtained. Refer to Illustration B for check points.

1. Air Input—Check Point F

With gear shift lever in neutral and normal vehicle air pressure, loosen the connection at input (end port) of the deep reduction valve until it can be determined that there is a constant flow of air at this point. Reconnect line.

If there is no air at this point, there is a restriction in the line between the deep reduction valve and air valve. Also check to make sure this line is connected to constant supply.

2. Deep Reduction Valve—Check Point G

With the deep reduction valve lever to "IN", remove the line from the deep reduction valve at the port in hole-gear shift cylinder; there should be no air at this point.

Move the deep reduction valve lever to "OUT". There should now be a constant air flow from line. Move lever to "IN" to shut off air. If the above conditions do not exist, deep reduction valve is faulty or there is a restriction in air line.

3. Hole-Gear Shift Cylinder—Check Point H

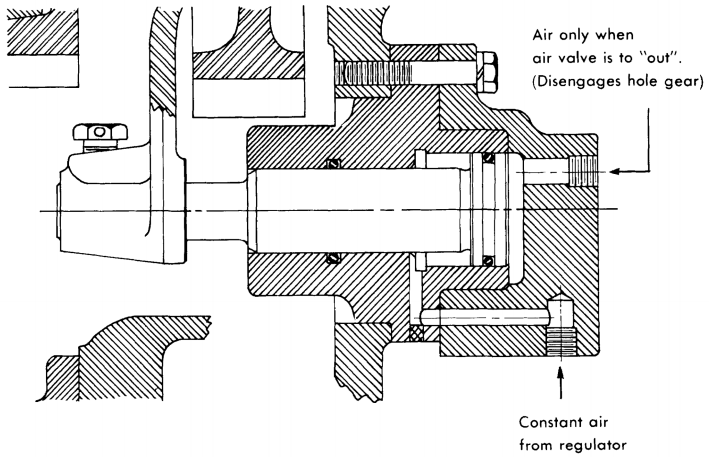
If any of the seals in the hole-gear shift cylinder are defective the hole-gear shift will be affected. The degree of lost air, of course, will govern the degree of failure, from slow shift to complete failure to shift.

Refer to Illustration G. for location of seals:

Leak at seal A .....Failure to engage hole-gear; pressurizing of transmission; hole-gear can be disengaged.

Leak at seal B .....Failure to engage hole-gear; leak from deep reduction valve exhaust port when valve is "IN".

G. Cutaway. Deep Reduction Shift Cylinder. (RT-915 models)

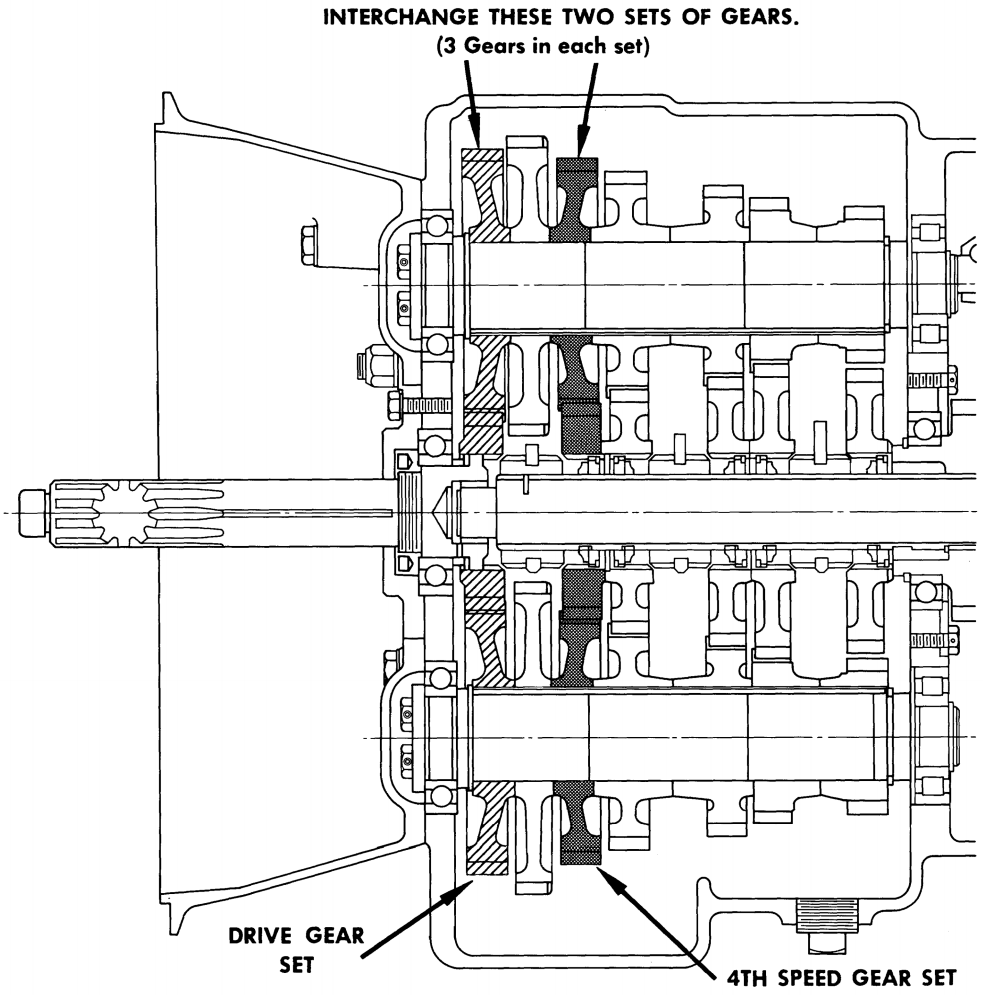


TO CONVERT FROM RT-910 TO RTO-910, or RT-915 TO RTO-915

To convert from an RT-910 or RT-915 to an overdrive model RTO-910 or RTO-915 the fourth speed gear on the mainshaft and mating gears, one on each countershaft, are interchanged with the main drive gear and mating countershaft drive gears.

The transmission front section must be completely disassembled to make the change as the drive gear on each countershaft must be removed. **When reassembling make sure gear hubs are in the right position as described in the detailed reassembly section of this manual.**

Extra parts, other than gaskets, are not needed to make the conversion. A new drive gear bearing nut may be needed as this part may be damaged during removal.



FRONT SECTION OF RT-910 AND RT-915

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 Systems, page 21.

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 plug 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

a. Check for tightness. Tighten to recommended torque.

CHECKS WITH UNIVERSAL JOINT COMPANION FLANGE REMOVED

10. Splines on Output Shaft

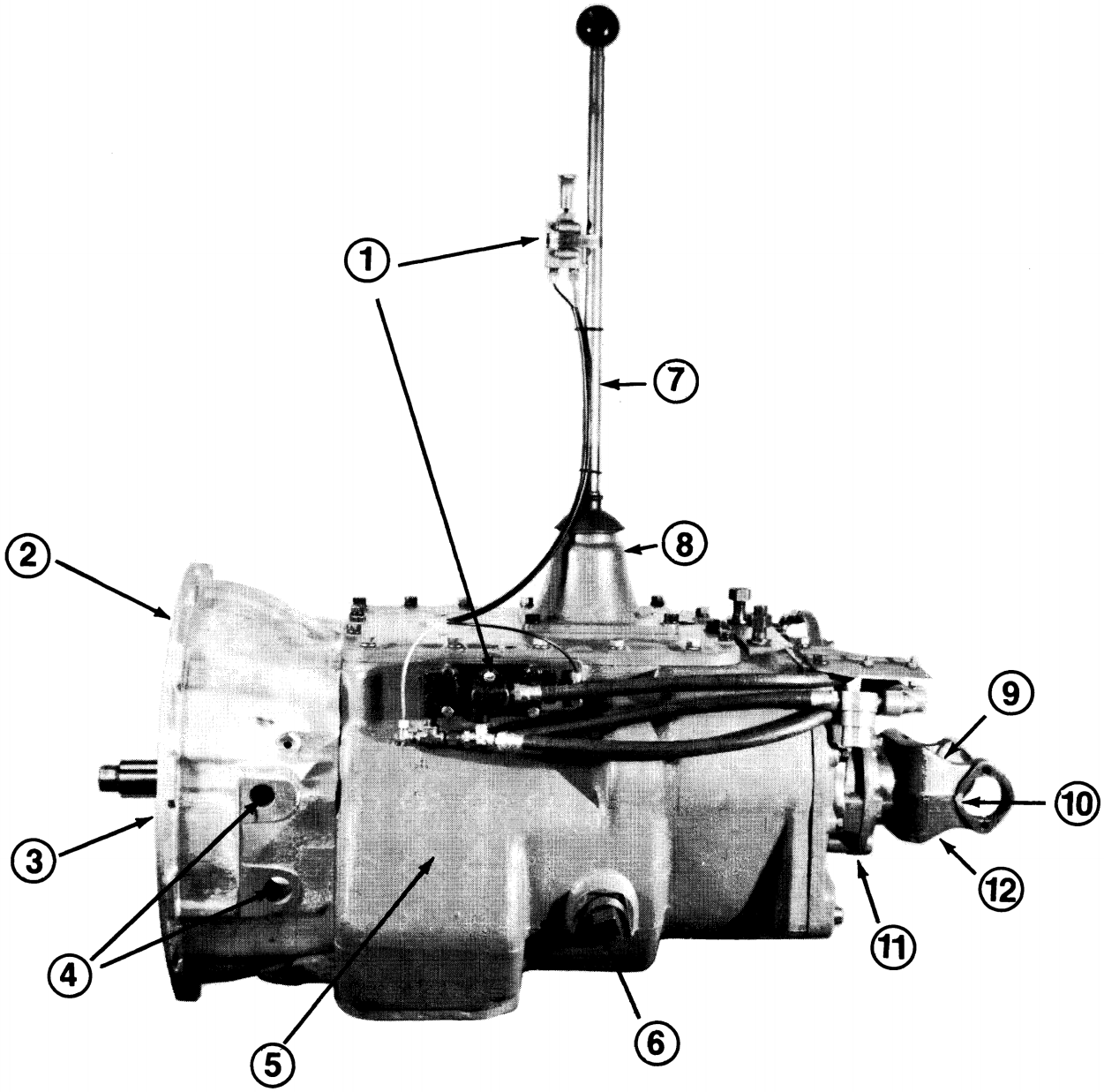
a. Check for wear from movement and chucking action of the universal joint companion flange.

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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SPECIAL PROCEDURE FOR CHANGING CLUTCH (INPUT) SHAFT

In some cases in field repair it may be necessary to replace only the input shaft due to clutch wear on the splines.

In these instances the input shaft can be removed without disassembling the transmission other than removing the shifting bar housing. Removal of the clutch housing is optional. Following is the detailed procedure:

Disassembly

1. Remove gear shift lever housing and shift bar housing from transmission.
2. Remove the front bearing cover.
3. Engage the mainshaft sliding clutches in two gears and remove the drive gear bearing nut.
4. Move the drive gear assembly as far forward as possible and remove the drive gear bearing.
5. Remove the washer from input shaft.
6. From the front, remove the snap ring from ID of drive gear.
7. Pull the input shaft forward and from splines of drive gear.

Reassembly

1. Install new input shaft into splines of drive gear just far enough to expose snap ring groove in ID of drive gear.
2. Install snap ring in ID of drive gear.
3. Install washer on shaft.
4. Move the fourth-fifth speed sliding clutch gear forward to contact end of input shaft in hub of drive gear. Block between rear of sliding clutch and front of the fourth speed gear. When installing bearing this will hold input shaft in position to seat the bearing properly.
5. Install drive gear bearing on shaft and into case bore, making sure blocking remains in place.
6. Remove blocking from mainshaft and install the drive gear bearing nut, left-hand thread. Use Loctite sealant on threads of nut and shaft.
7. Peen nut into milled slots in shaft.
8. Re-install front bearing cover, shifting bar housing and gear shift lever housing.

NOTE:

The above instructions are for changing the input shaft only. To change the drive gear, complete disassembly of the front section must be made.

GENERAL PRECAUTIONS FOR DISASSEMBLY

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

It is assumed in the detailed disassembly instructions that the lubricant has been drained from the transmission, the necessary linkage and air lines removed 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.

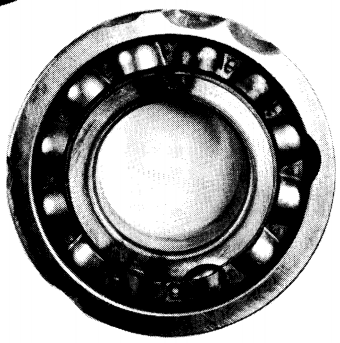
On RT-915 and RTO-915 models, air lines from the hole-gear switch in cab must be disconnected at the transmission before removing unit from vehicle.

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. Remove all bearings with pullers designed for this purpose—do not remove bearings with hammer and punch.

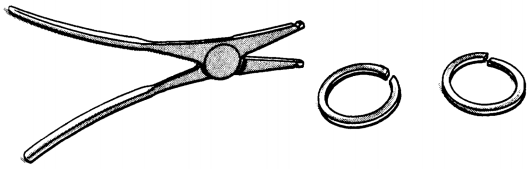


BEARING REMOVED WITH PUNCH, DAMAGED SHIELD.



BEARING REMOVED WITH CHISEL, DAMAGED OUTER RACE.

2. **MAINSHAFT**—In the following instructions, two procedures for removing the front section mainshaft are given. The first method is given to facilitate field repair where only partial disassembly is contemplated; it provides for the removal of the mainshaft without removing the clutch housing or countershaft bearings. In the second procedure, the mainshaft can be easily lifted from case; however, the clutch housing must be removed along with countershaft bearings.



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

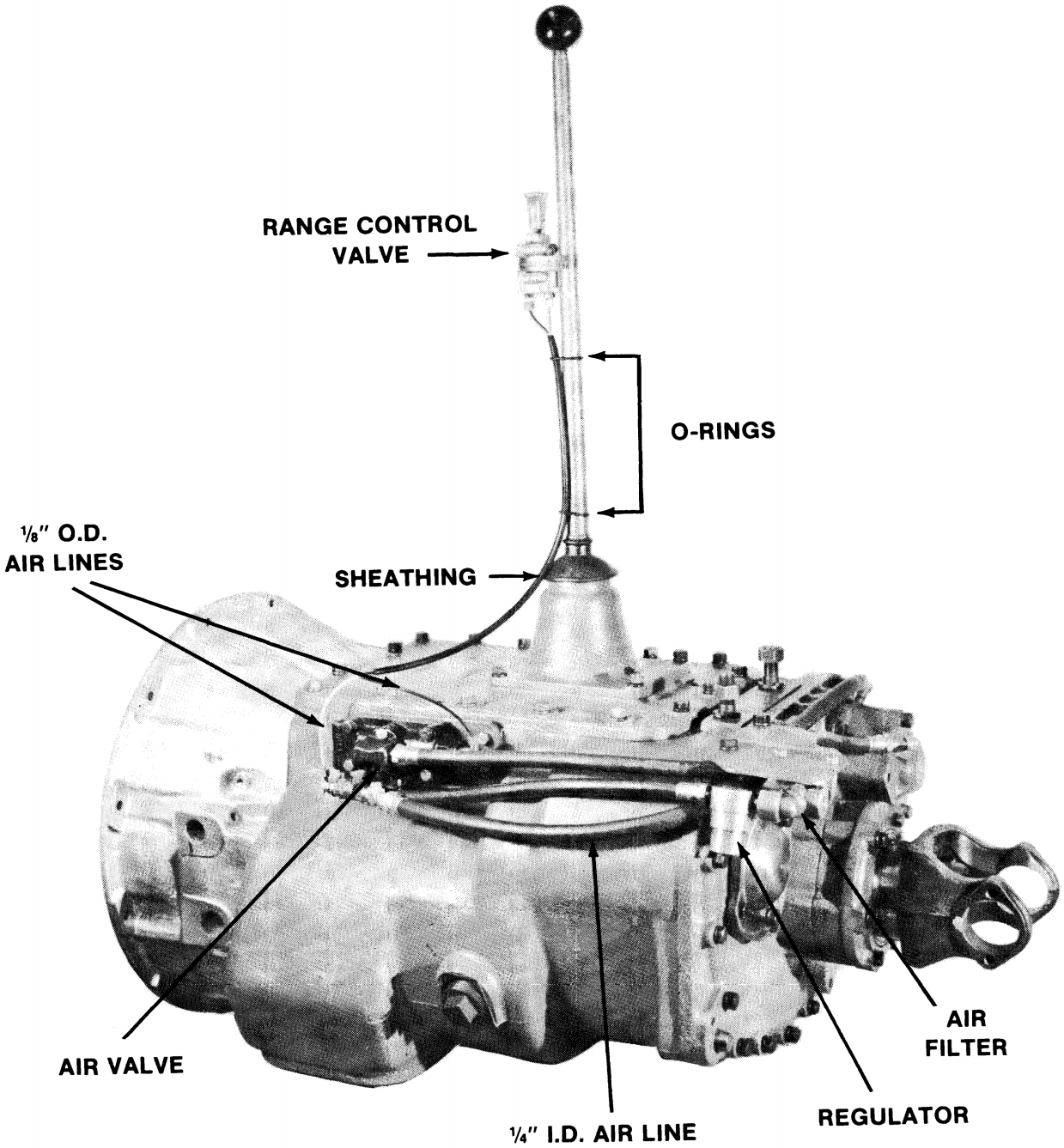
4. **INPUT SHAFT**—The clutch or input shaft can be removed on most models without removing the countershafts, mainshaft or drive gear. See page 135.

5. **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, sleeves and bushings.

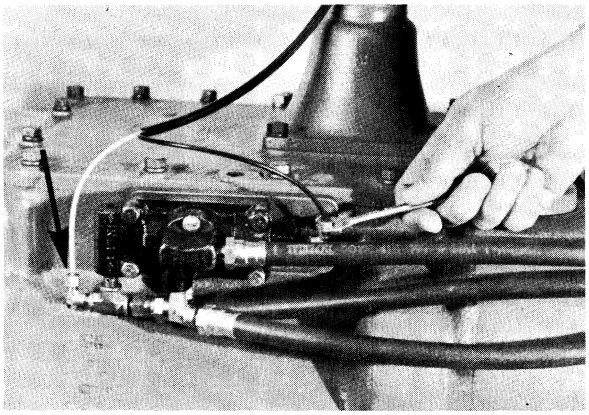
6. **WHEN DRIVING**—Apply force to shafts, housings, etc., with restraint. Movement of some parts is restricted. Do not apply force after the part being driven stops solidly. Use soft hammers and bars for all disassembly work.

DISASSEMBLY INSTRUCTIONS

I. RANGE SHIFT AIR SYSTEM

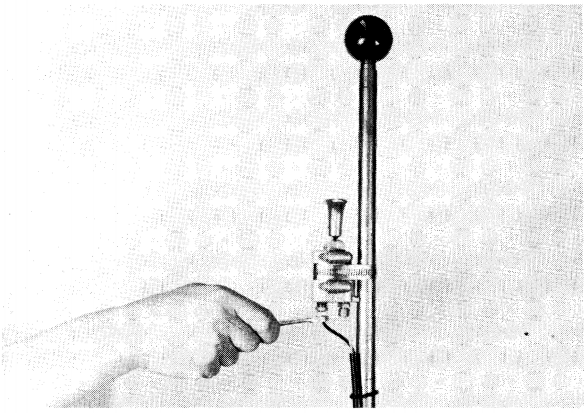


A. Removal of the Range Shift Control Valve

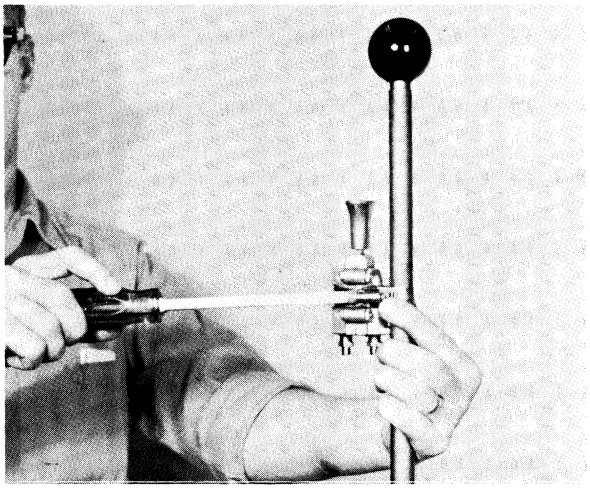


1. Disconnect the two 1/8″ OD air lines at the air valve on the transmission.

NOTE: If desired, the gear shift lever housing assembly can now be removed from the transmission.



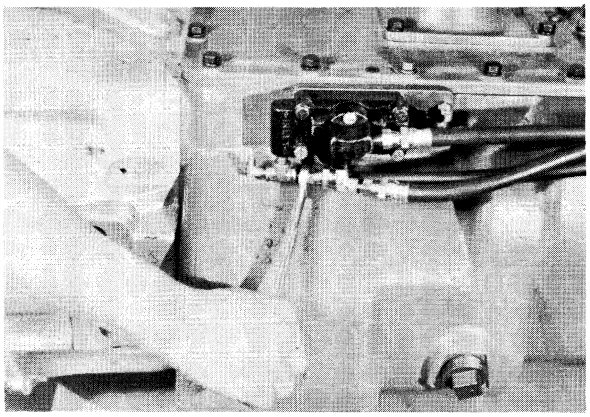
2. Disconnect the two 1/8″ OD air lines at the control valve on the gear shift lever.



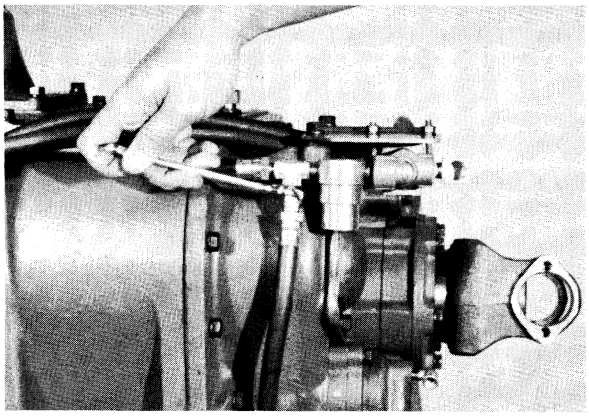
3. Loosen the mounting clamp and remove the control valve and clamp from the lever. Remove the ball grip, air lines, sheathing and O-rings from the lever.

NOTE: For disassembly of the control valve refer to page 25.

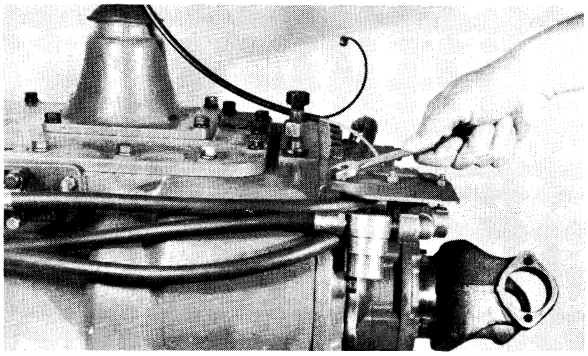
B. Removal of the Air Filter and Regulator Assembly



1. Disconnect the 1/4″ ID air line between the air valve and the regulator.



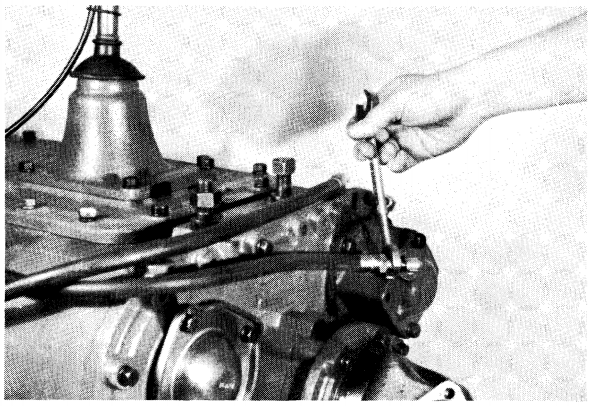
2. (RT-915 Models) Remove the 1/4″ ID air line between the filter/regulator assembly and the deep reduction shift cylinder.



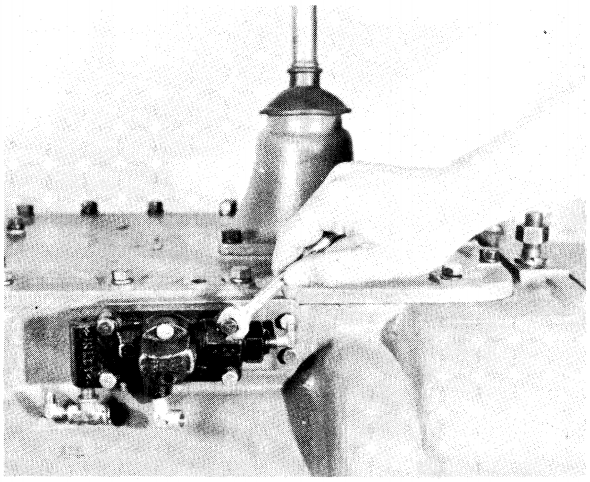
3. Turn out the two capscrews and remove the filter/regulator assembly from the transmission.

NOTE: For further disassembly of the filter/regulator assembly refer to page 24.

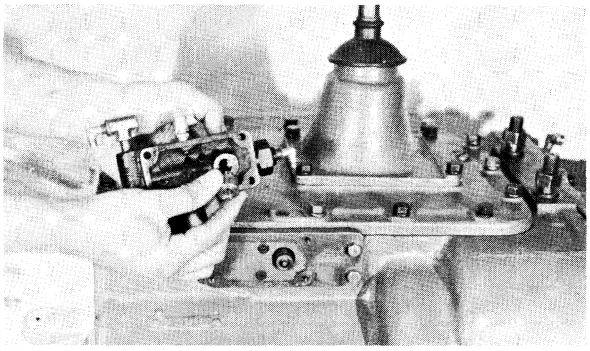
C. Removal of the Air Valve



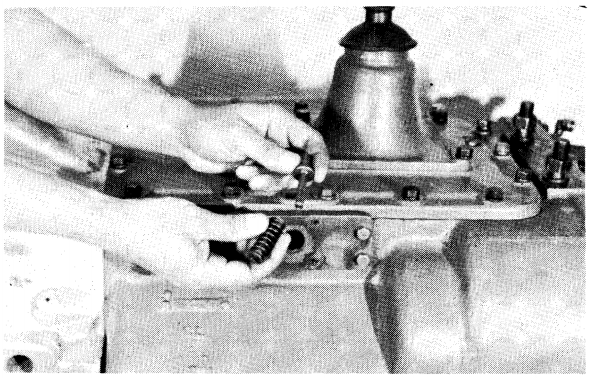
1. Disconnect the two 1/4" ID air lines between the air valve and the range shift cylinder. If necessary, remove the fittings from the shift cylinder.



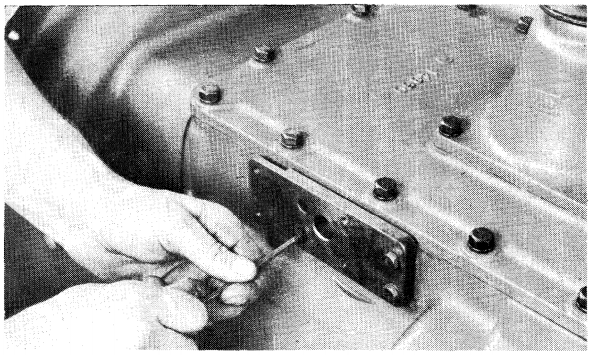
2. Turn out the four capscrews and remove the air valve from the adapter plate.



3. Remove the alignment sleeve from the air valve or bore in the adapter plate.



4. Remove the spring and actuating plunger from the bore in the adapter plate.

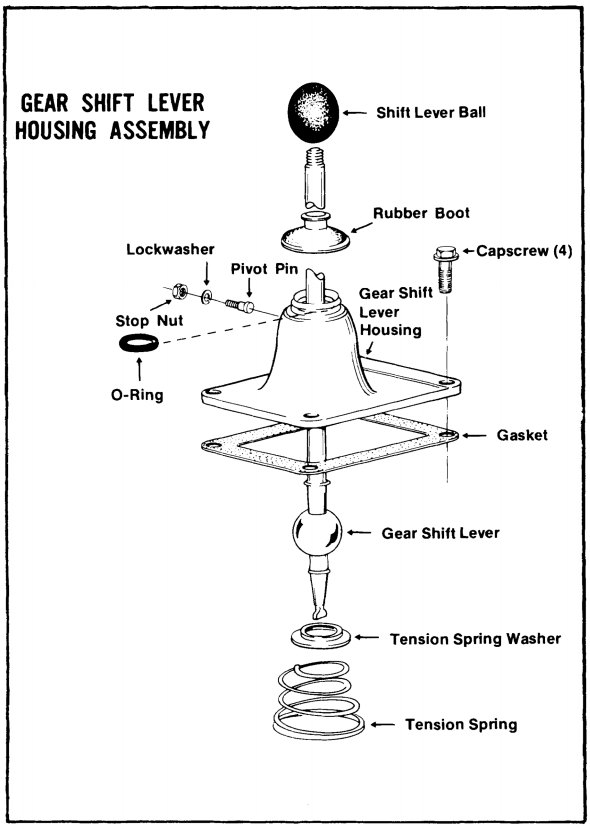


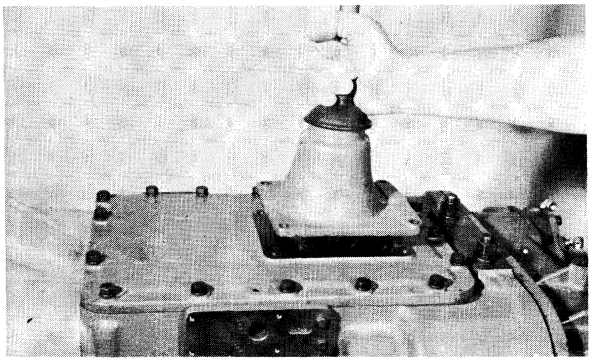
5. Turn out the two capscrews and two Allen head screws and remove the adapter plate from the transmission. If necessary, remove the fittings from the air valve.

NOTE: For further disassembly of the air valve, refer to page 23.

II. GEAR SHIFT LEVER HOUSING ASSEMBLY

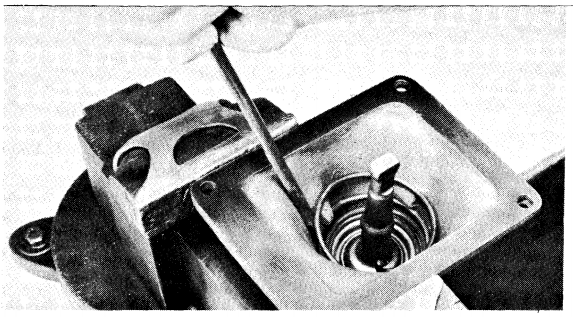
A. Removal of the Gear Shift Lever Housing



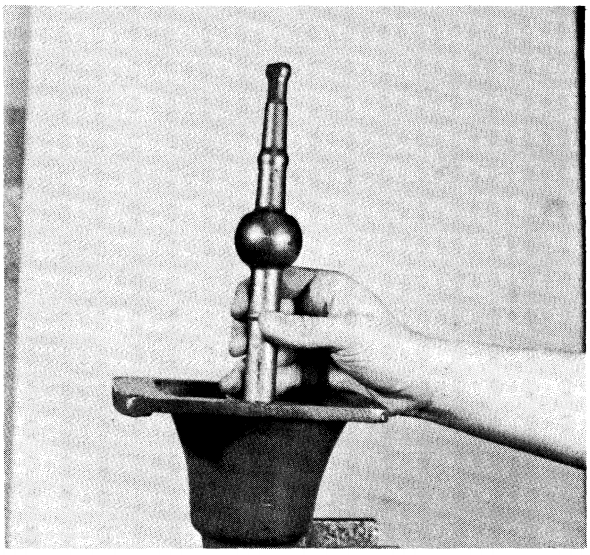


1. Turn out the four capscrews, jar lightly to break the gasket seal and lift the housing from the transmission.

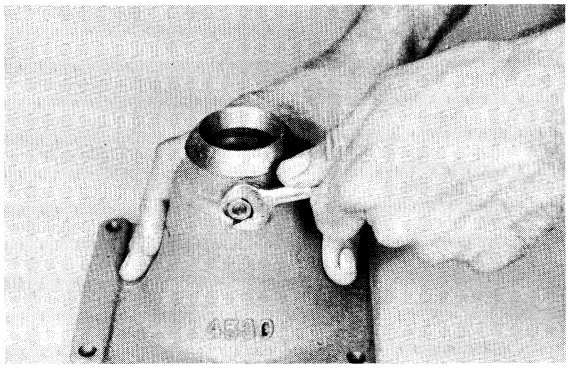
B. Disassembly of the Gear Shift Lever Housing Assembly



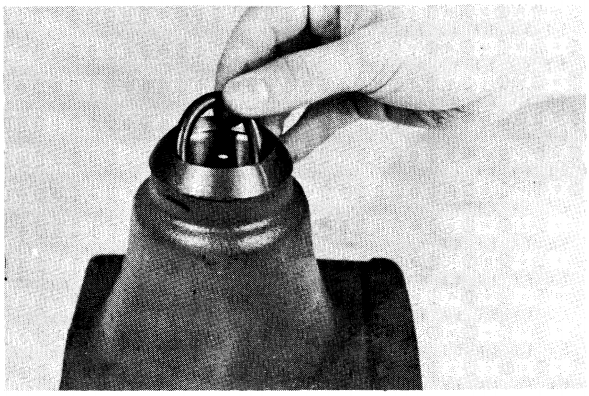
1. Remove the rubber dust cover from the lever and mount the assembly in a vise by the housing with the bottom up. Free the tension spring by twisting a heavy screwdriver between the spring and housing, forcing the spring from under the lugs in the housing.



2. Remove the tension spring and washer from the housing. Pull the lever upwards and from the housing.



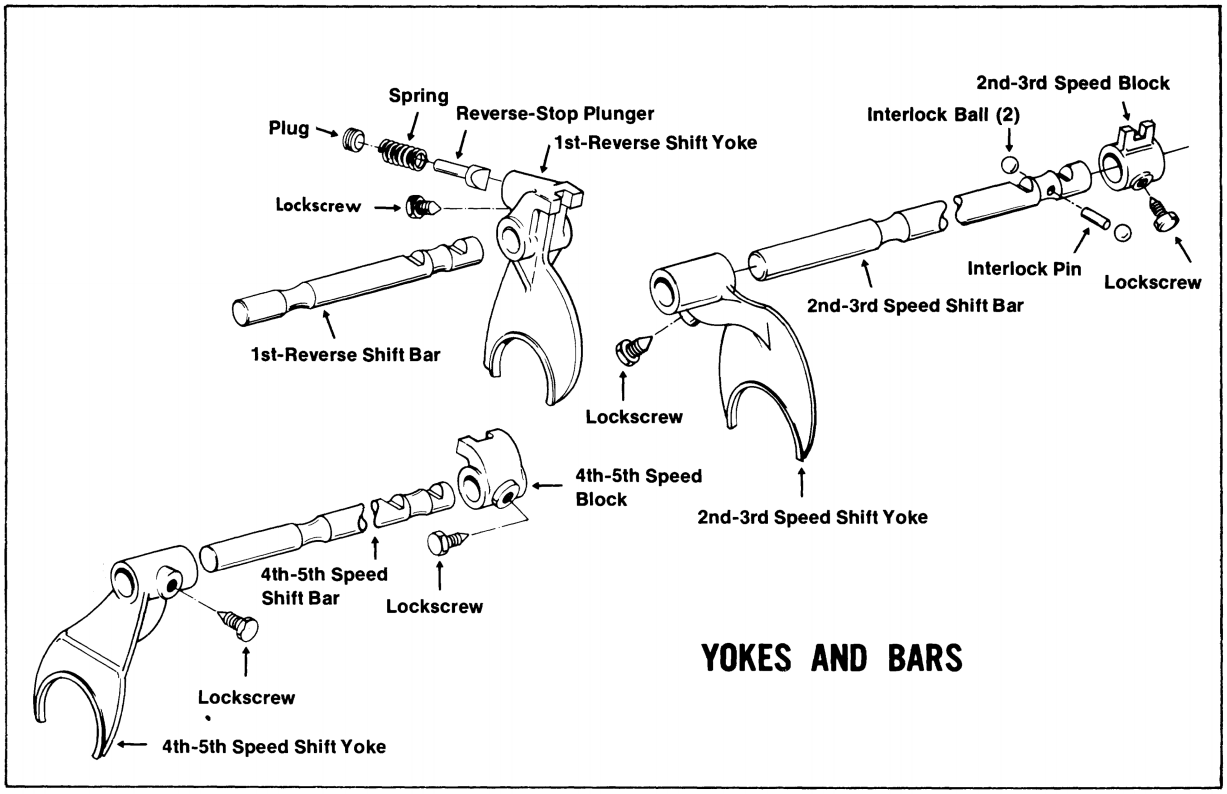
3. Turn out the nut and remove the pivot pin from the housing if necessary.

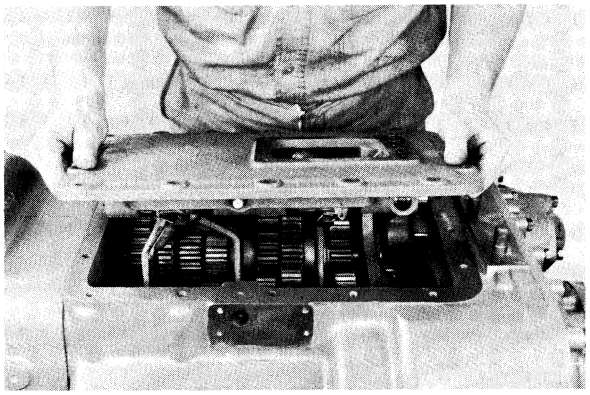


4. If so equipped, remove the O-ring from the groove in the housing.

III. SHIFTING BAR HOUSING ASSEMBLY

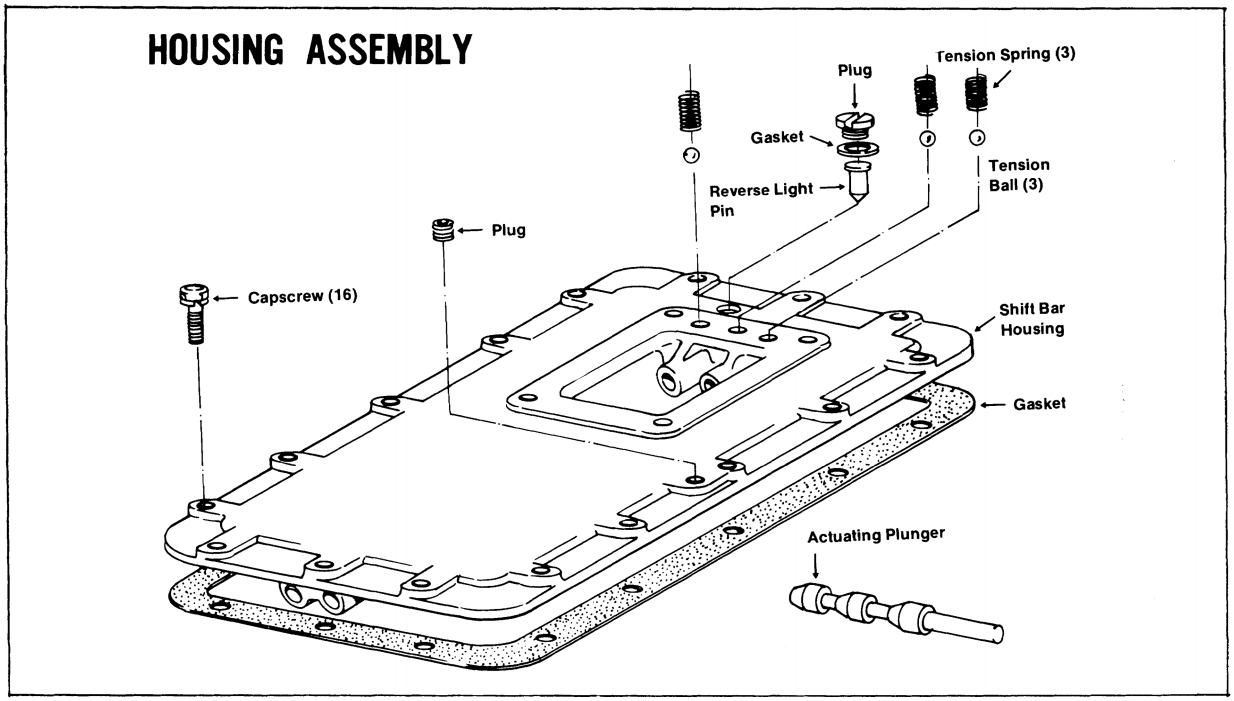
A. Removal of the Housing



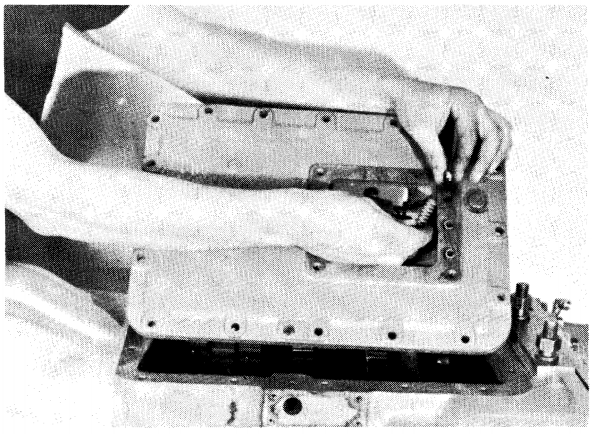


1. Turn out the attaching capscrews, jar to break gasket seal and lift the housing from the transmission.

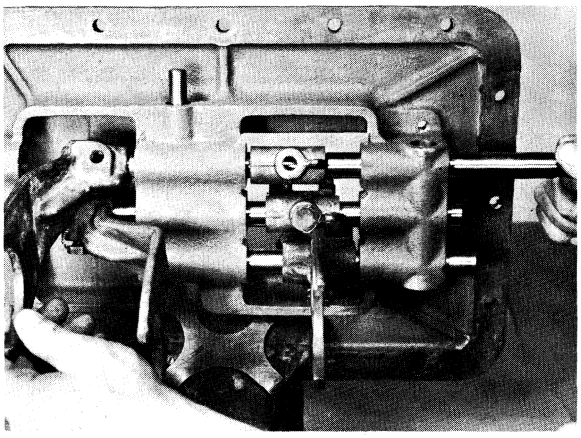
B. Disassembly of the Shifting Bar Housing Assembly



NOTE: Lay all parts on a clean bench in order of removal to facilitate reassembly. Bars not being removed must be kept in the neutral position or interlock parts will lock bars, preventing removal.

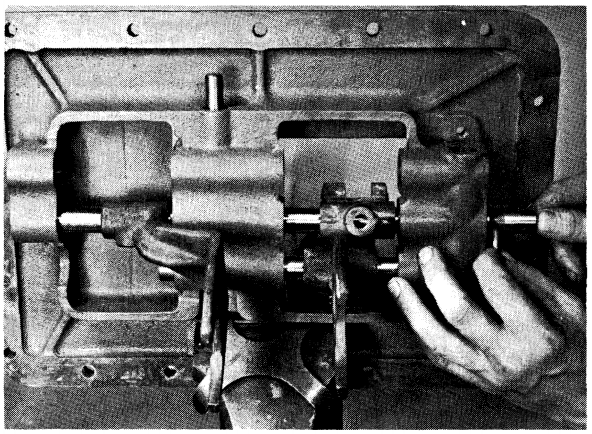


1. Tilt the housing and remove the three sets of tension springs and balls in the top of the housing. Secure the housing in a vise with the plunger side up. Starting with the upper bar, move all bars to the rear and out of the housing as detailed in the following instructions. Cut lockwire and turn out lockscrews from each bar just prior to its removal.

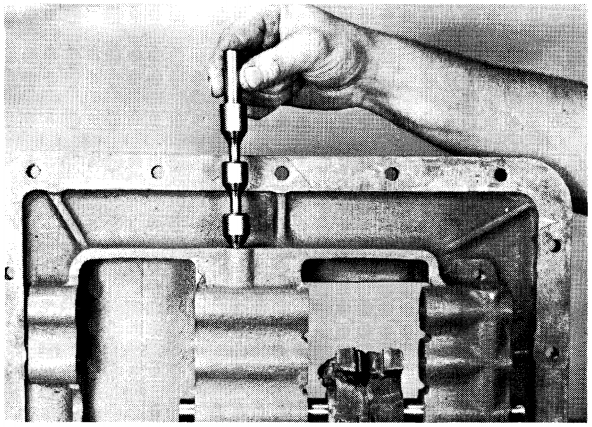


2. Move the 4th-5th speed shift bar (top) to the rear and out of housing, removing the shifting yoke and block from the bar.

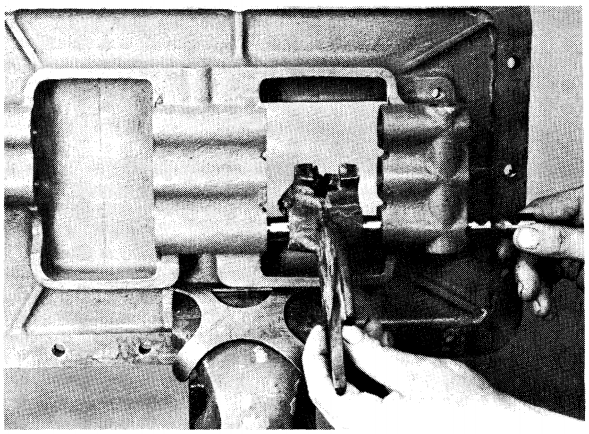
DISASSEMBLY-SHIFTING BAR HOUSING



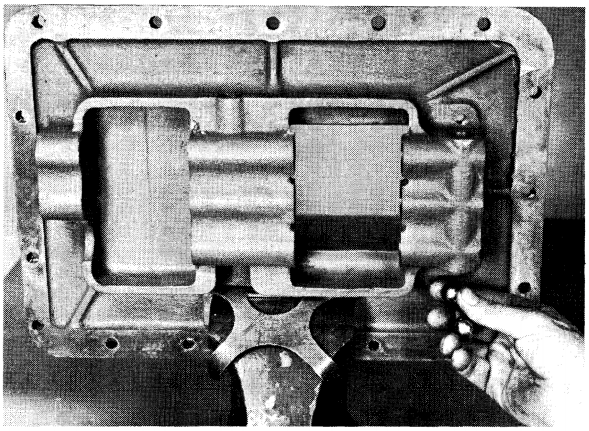
3. Move the 2nd-3rd speed shift bar (center) to the rear and out of housing, removing yoke and block from bar. As the neutral notch clears the housing boss, remove the interlock pin from the notch.



4. Remove the actuating plunger from the bore in the housing.



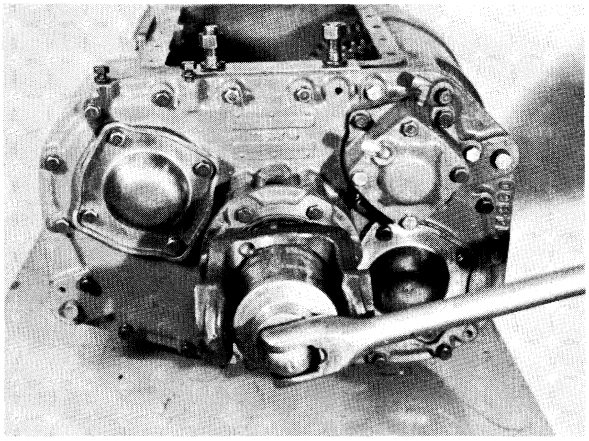
5. Move the 1st-reverse speed shift bar (lower) to the rear and out of housing, removing the yoke from the bar.



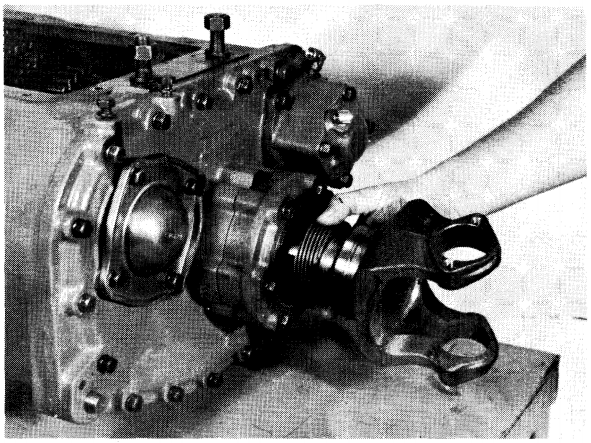
6. As the 1st-reverse bar is removed, two interlock balls will fall from the opening in the side of the housing.

IV. COMPANION FLANGE, AUXILIARY SECTION AND CLUTCH HOUSING

A. Removal of the Universal Joint Companion Flange or Yoke



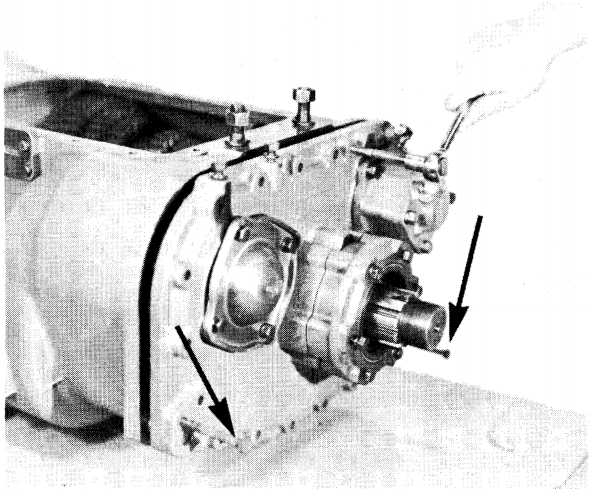
1. Lock the mainshaft in two gears and turn the elastic stop nut from the output shaft.



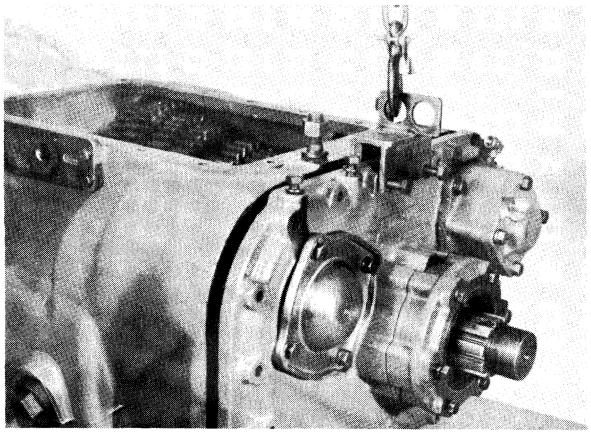
2. Pull the flange or yoke straight to the rear and off the shaft and remove the speedometer drive gear or replacement spacer from the hub of the flange or yoke.

B. Removal of the Auxiliary Section

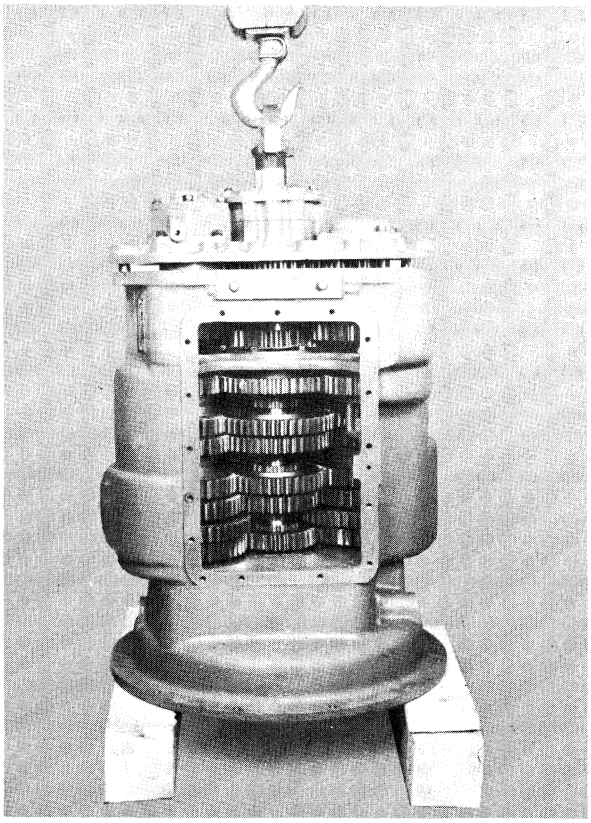
NOTE: The RT-910 auxiliary section is used in the following steps but removal procedure is the same for the RT-915 auxiliary section.



1. Turn out the attaching capscrews and insert three puller screws in the tapped holes in the rear housing. Tighten the puller screws evenly and move the housing far enough away from the front section to break the gasket seal.



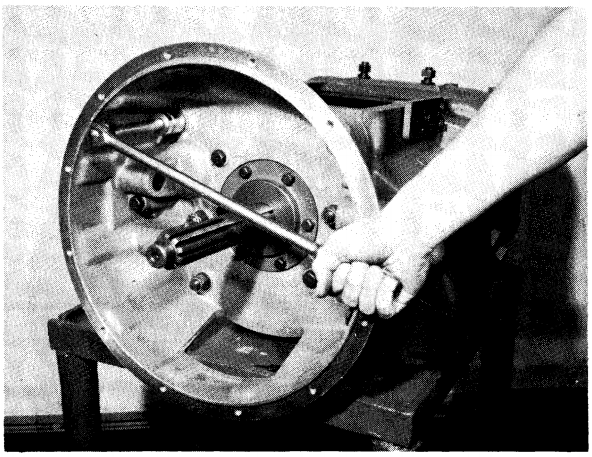
2. Attach a chain hoist to the rear housing and move the assembly to the rear until free of the transmission.



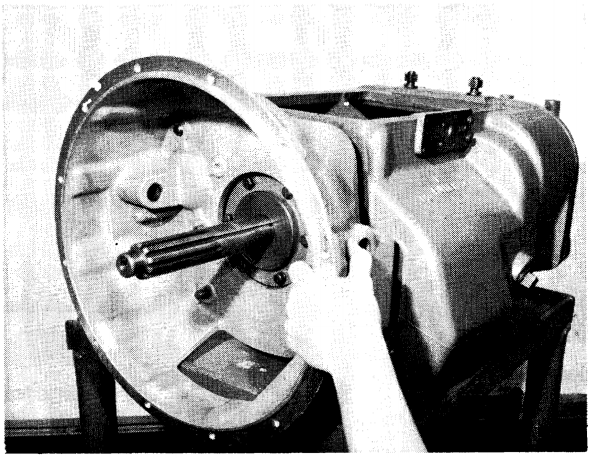
3. Transmission can also be set vertically to remove the rear housing. Block under the clutch housing to prevent damage to the input shaft and lift the auxiliary housing upwards and from the front section.

C. Removal of the Clutch Housing

NOTE: The clutch housing need not be removed unless the countershafts or drive gear are to be removed from the transmission. The mainshaft can be removed without the removal of the clutch housing.



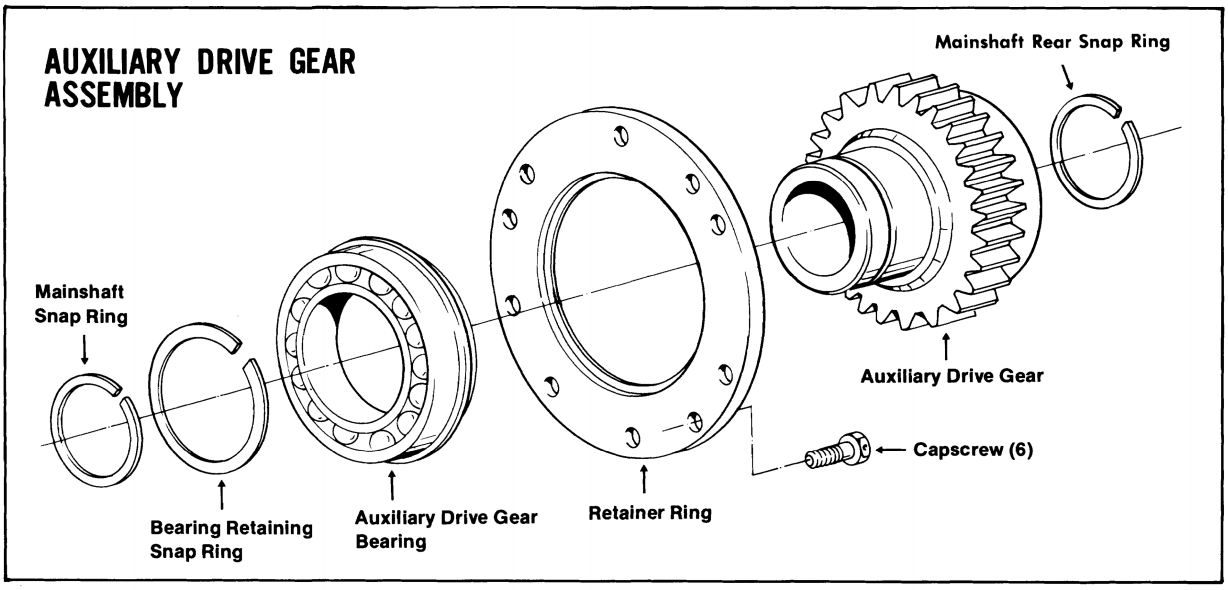
1. If so equipped, remove the clutch release mechanism and turn the four bolts and six nuts from the clutch housing.

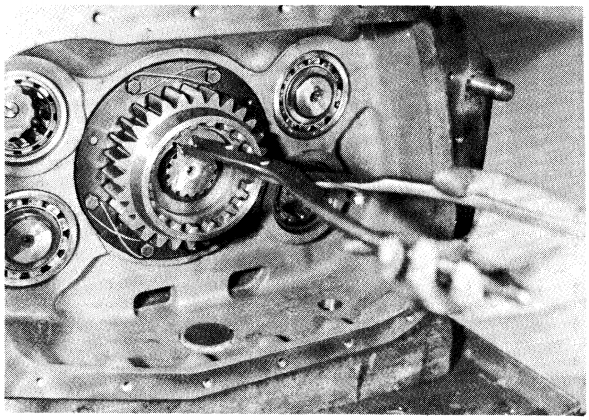


2. Pull the clutch housing straight forward and off the case. It will be necessary to break the gasket seal by jarring the housing with a soft hammer. The clutch housing is piloted on the drive gear bearing cover.

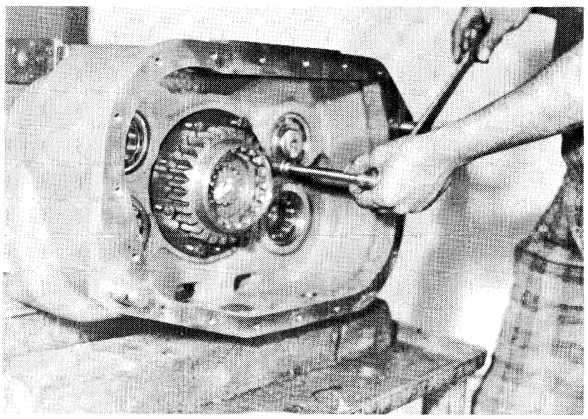
V. FRONT SECTION

A. Removal and Disassembly of the Auxiliary Drive Gear Assembly

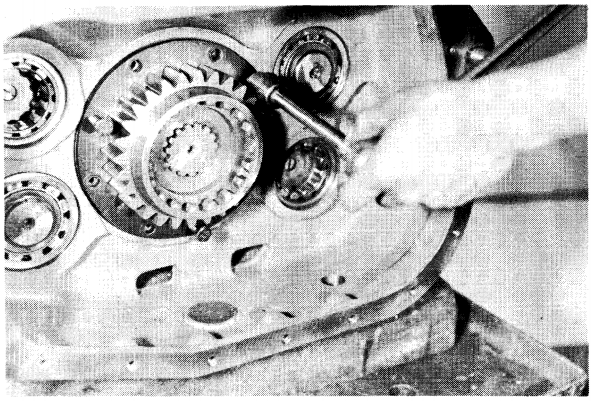




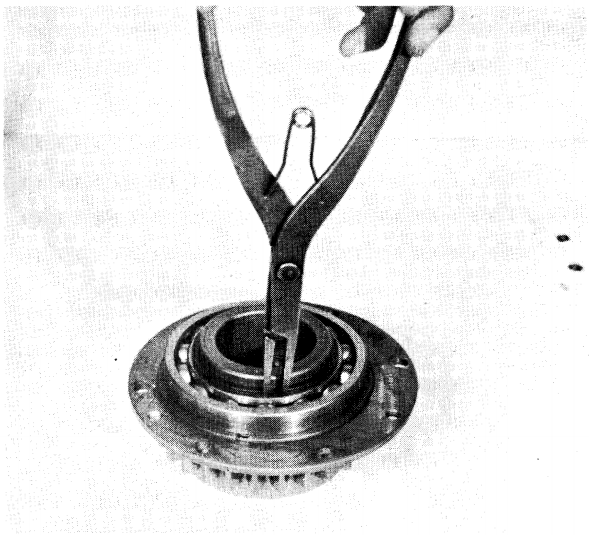
1. Remove the mainshaft rear snap ring from the groove in the mainshaft.



2. Cut the lockwire and remove the six capscrews from the bearing retainer ring.

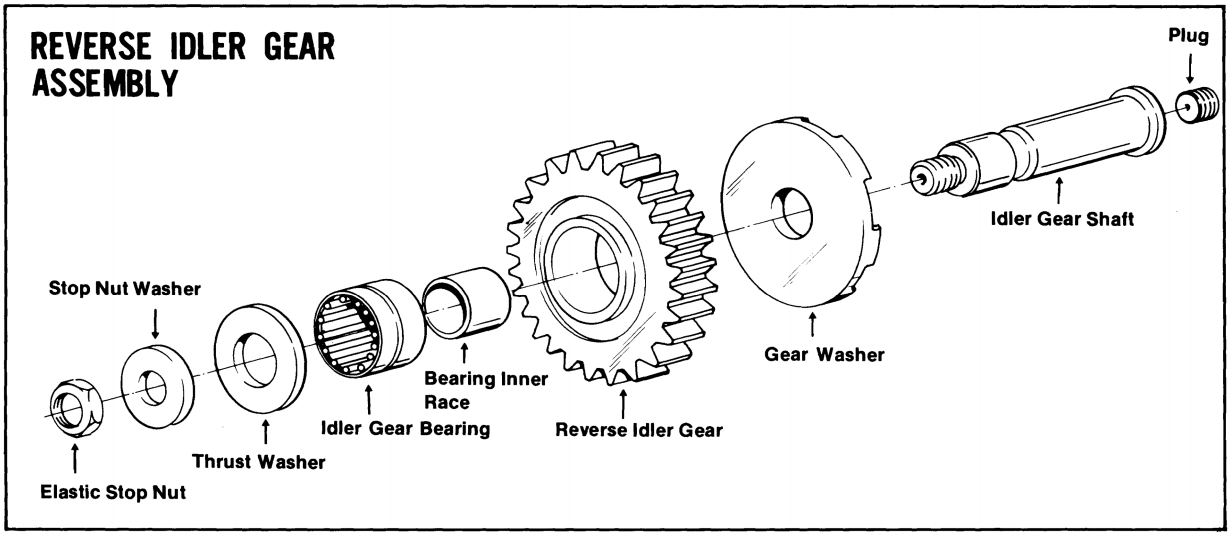


3. Use three puller screws to pull the assembly from the case bore.

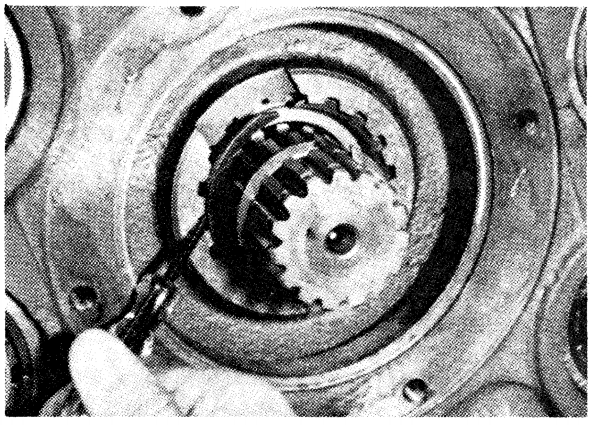


4. Remove the snap ring from the hub of the auxiliary drive gear; press retainer ring and bearing from drive gear.

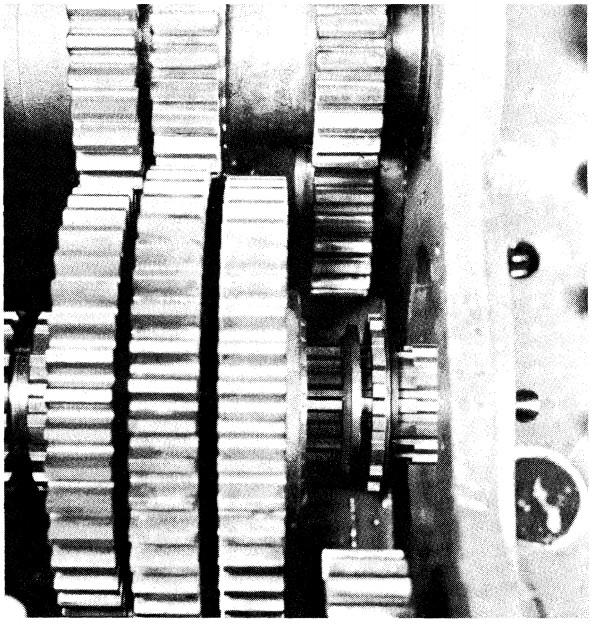
B. Removal and Disassembly of the Left Reverse Idler Gear Assembly



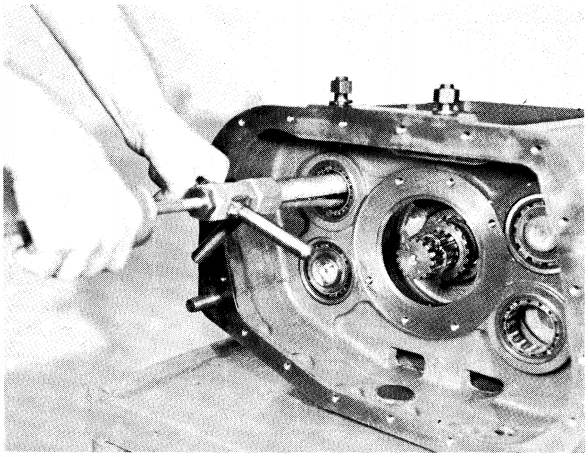
NOTE: To remove the left reverse idler gear, the reverse gear on the mainshaft must be moved forward to provide the necessary clearance; this procedure is included in the following instructions.



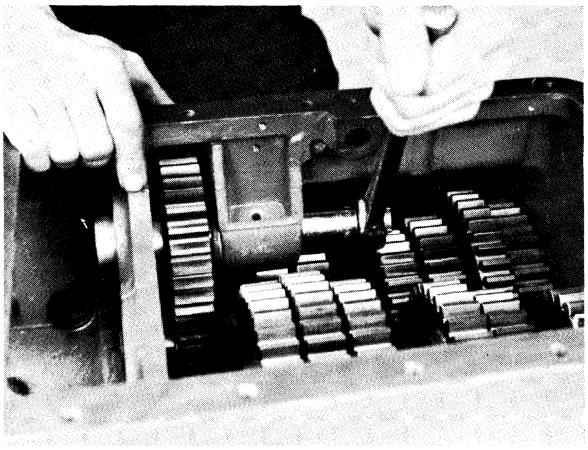
1. Move the mainshaft reverse gear to the rear as far as possible and remove the snap ring from the ID of the gear.



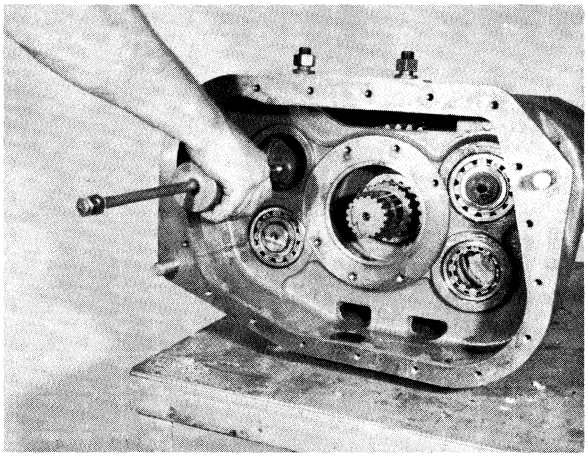
2. Move the reverse gear forward and against the low speed gear, engaging the splines of the sliding clutch gear.



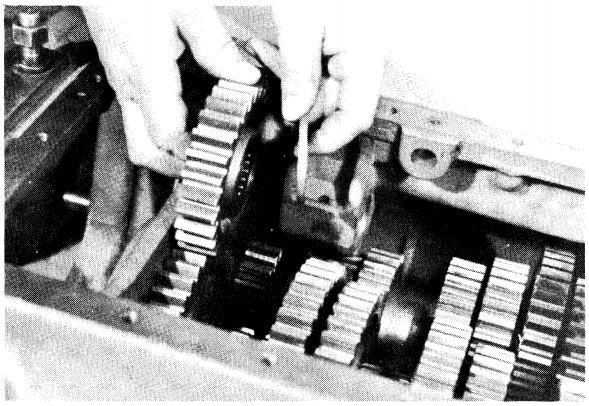
3. Remove the auxiliary countershaft front bearing from left reverse idler gear bore; use inside jaw pullers.



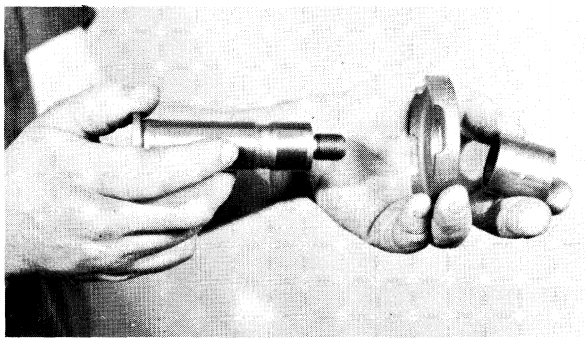
4. Inside the case, turn the elastic stop nut from the idler shaft and remove the washer.



5. Remove the plug from the bore in the rear of the idler shaft, insert an impact puller (threaded ½-13) and remove the idler shaft.

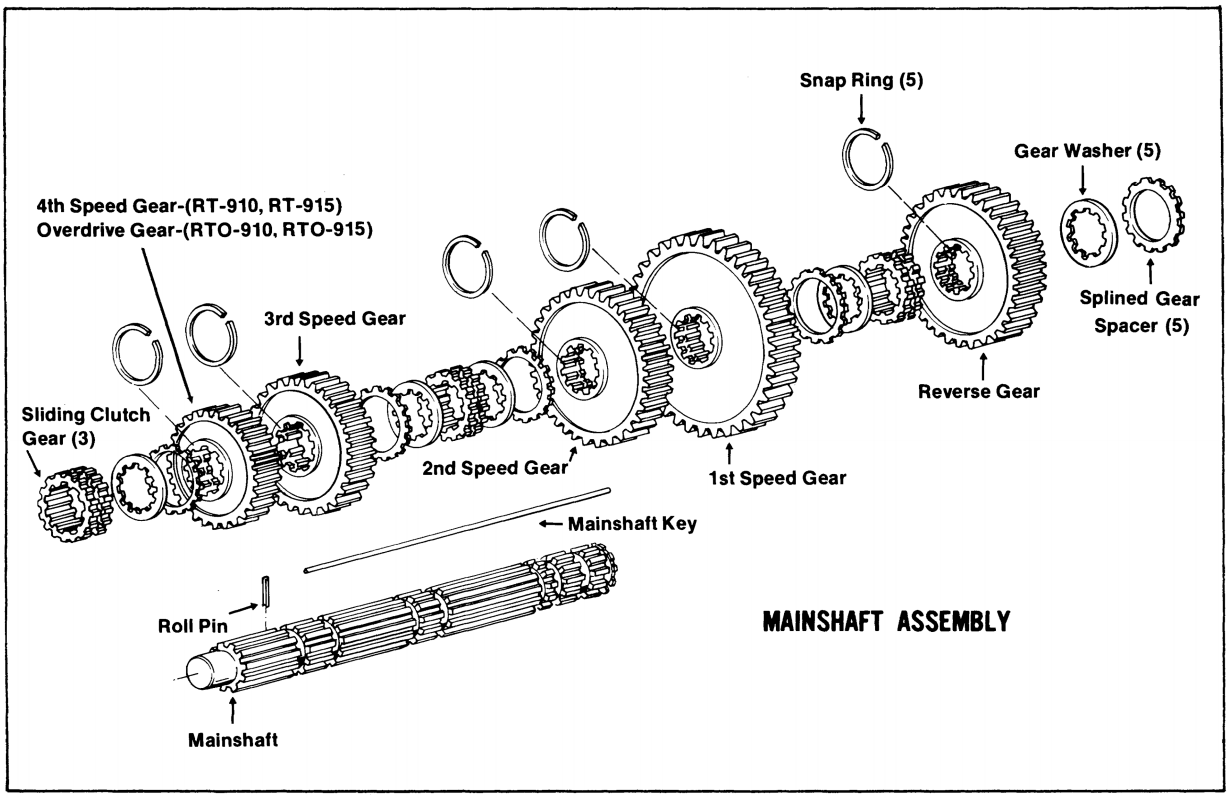


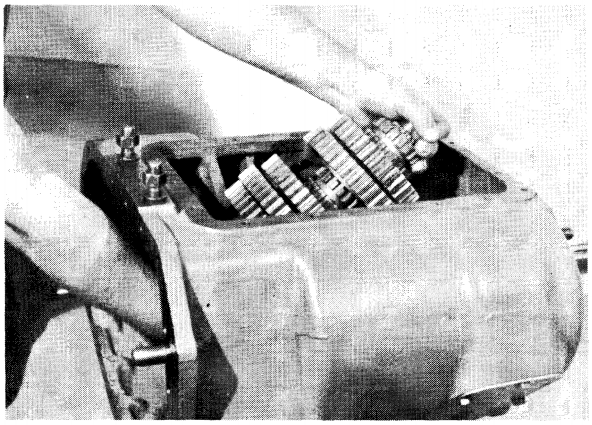
6. As the shaft is moved to the rear, remove the gear and washer from the shaft and case.



7. If necessary, remove the bearing inner race and rear washer from the shaft. This is a slip fit. If necessary, press the bearing from the bore of the reverse idler gear.

C. Removal of the Mainshaft Assembly

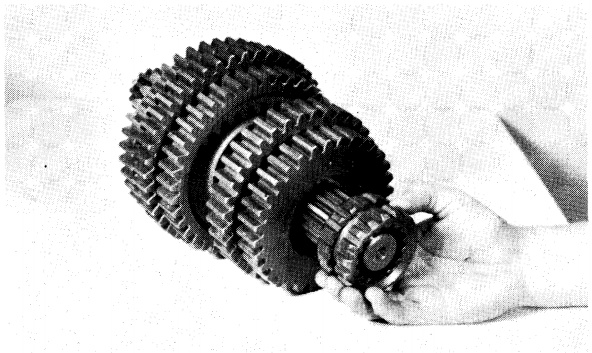




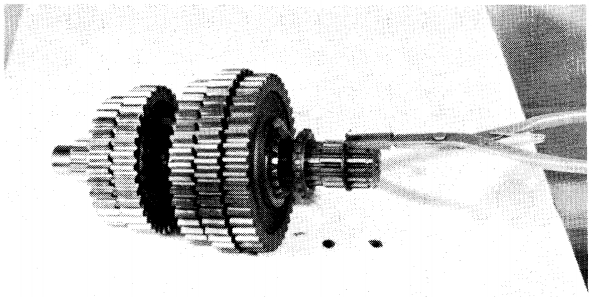
1. Move the mainshaft assembly to the rear as far as possible to unmesh the mainshaft gears from the countershaft gears. Tilt the front of the mainshaft up and remove the assembly through the top of the case. It will be necessary to work the assembly past the countershaft gears and reverse idler boss in the case. Keep mainshaft to the rear as far as possible and reverse gear next to the first speed gear for full clearance.

NOTE: Use caution during removal as the reverse gear is free and can fall from the assembly.

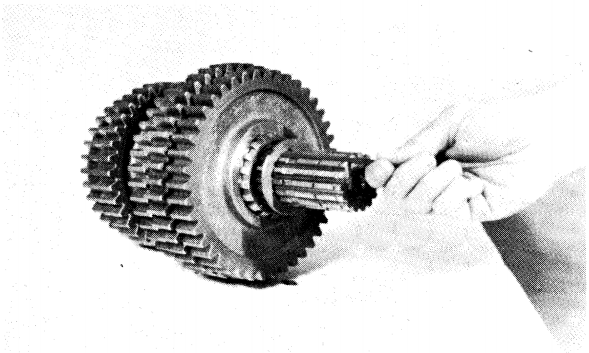
D. Disassembly of the Mainshaft Assembly



1. Remove the 4th-5th speed sliding clutch.

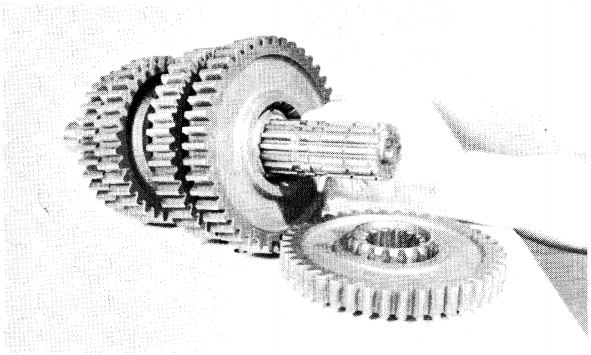


2. Remove the snap ring from the rear of the mainshaft.



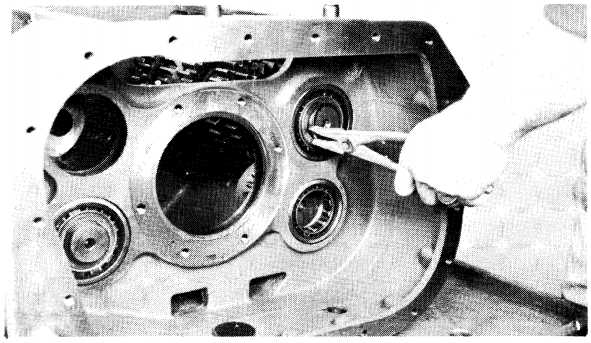
3. Remove the reverse gear and spacer and pull the key to the rear and from the mainshaft.

NOTE: When removing washers, spacers and gears, note their location to facilitate the reassembly of the mainshaft. Keep washers and spacers with the gear from which they were removed; there is one spacer and one washer for each gear. The spacers have external splines and the washers have internal splines.



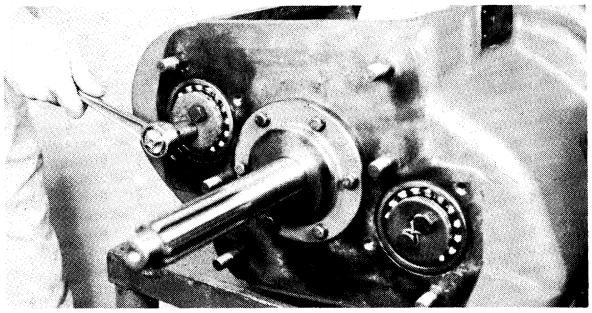
4. Work washers, spacers and gears from the mainshaft. It will be necessary to turn washers, located under each gear, to align with splines of mainshaft. If necessary, remove snap rings from ID of each gear.

E. Removal of the Countershaft Bearings

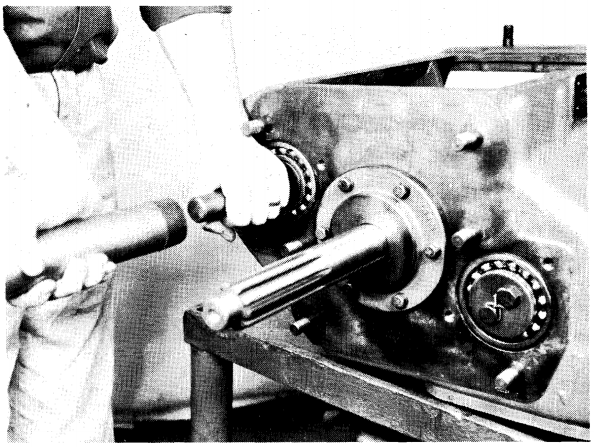


1. Remove the snap ring from the rear of the countershaft and using a blunt punch from inside the case, move the countershaft rear bearing to the rear and off the shaft.

NOTE: Removal procedures will most likely damage the bearing and removal of the bearing should not be attempted unless replacement is planned.

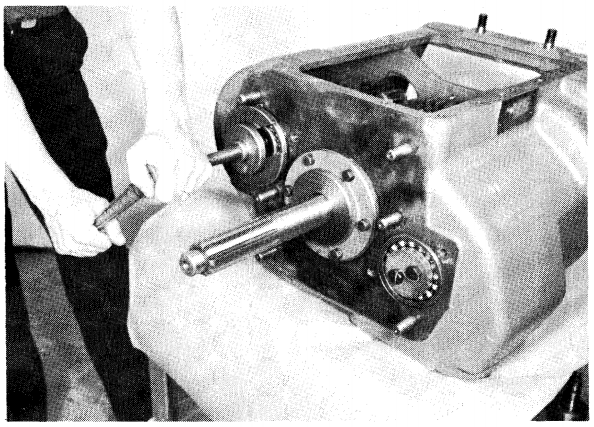


2. Cut the lockwire, turn out the two capscrews and remove the bearing retainer plate from the front of the countershaft.



3. Move the right countershaft to the rear as far as it will go, using a soft bar and mall against the front of the countershaft. This will partially unseat the front bearing from the shaft and unseat the rear bearing from the bore.

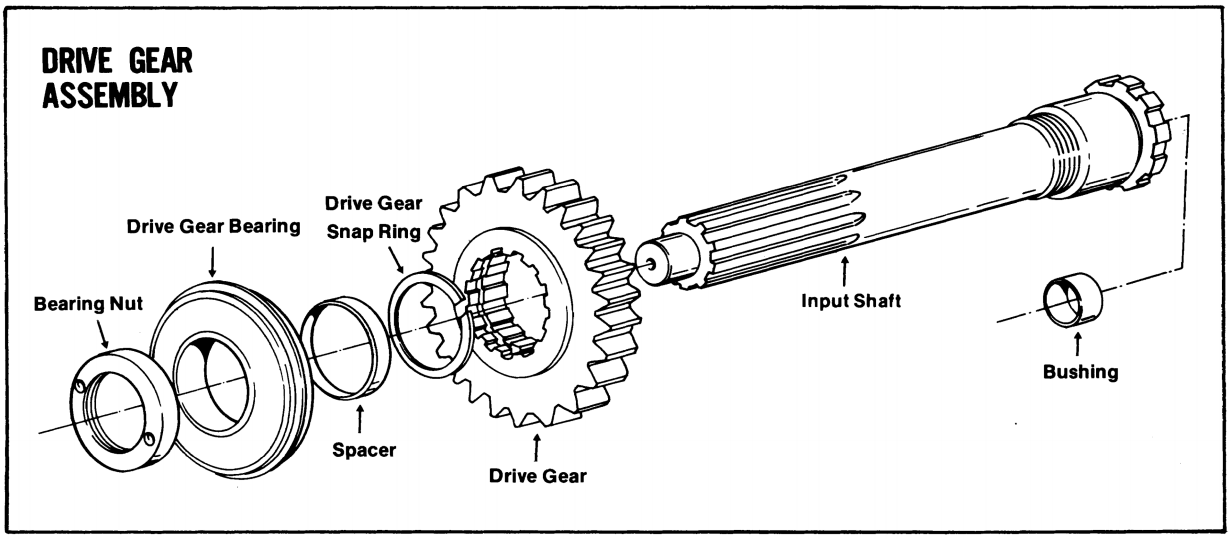
CAUTION: Use a soft bar with a large, flat end to prevent damage to the capscrew holes in the front of the countershaft.



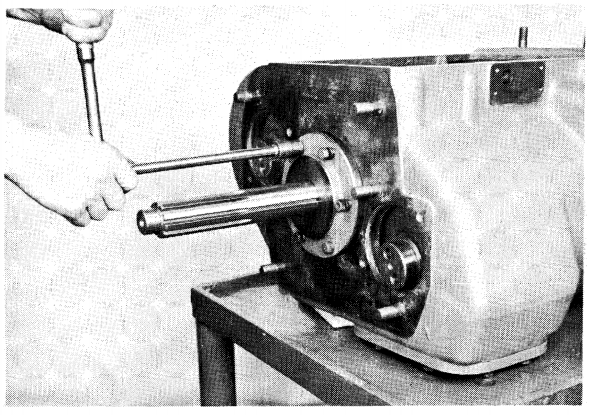
4. Move the countershaft forward until the front bearing is clear of the case and pull or pry the front bearing from the shaft.

NOTE: Remove the retainer plate and bearings from the left countershaft in the same manner as those removed from the right.

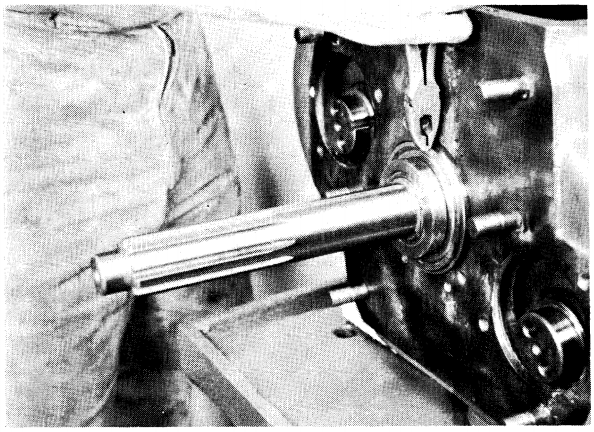
F. Removal of the Drive Gear Assembly



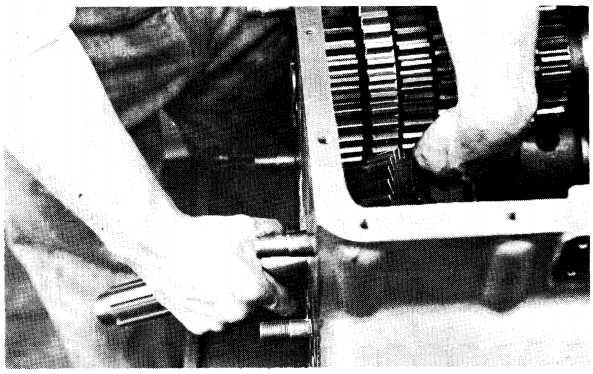
NOTE: See page 32 for procedure to remove input shaft without removal of the drive gear, countershafts or mainshaft.



1. Turn out the capscrews from the front bearing cover and from inside the case, move the drive gear forward, removing the cover as the gear pushes it forward. Use a soft bar and mall to move the drive gear.

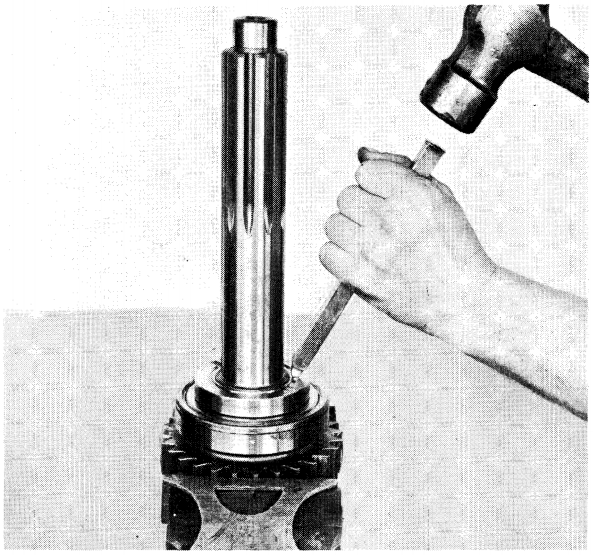


2. Remove the snap ring from the drive gear bearing.

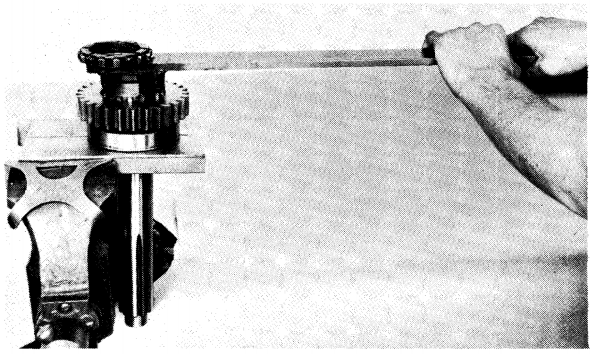


3. Move the drive gear to the rear and into the case and remove from the case, working past the countershaft gears.

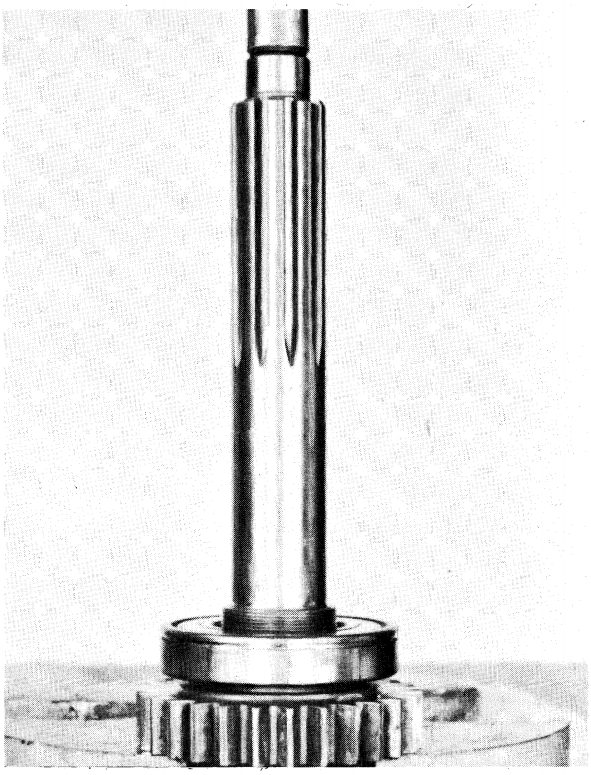
G. Disassembly of the Drive Gear Assembly



1. Relieve the drive gear bearing nut at the points where it is peened into the milled slots of the shaft.

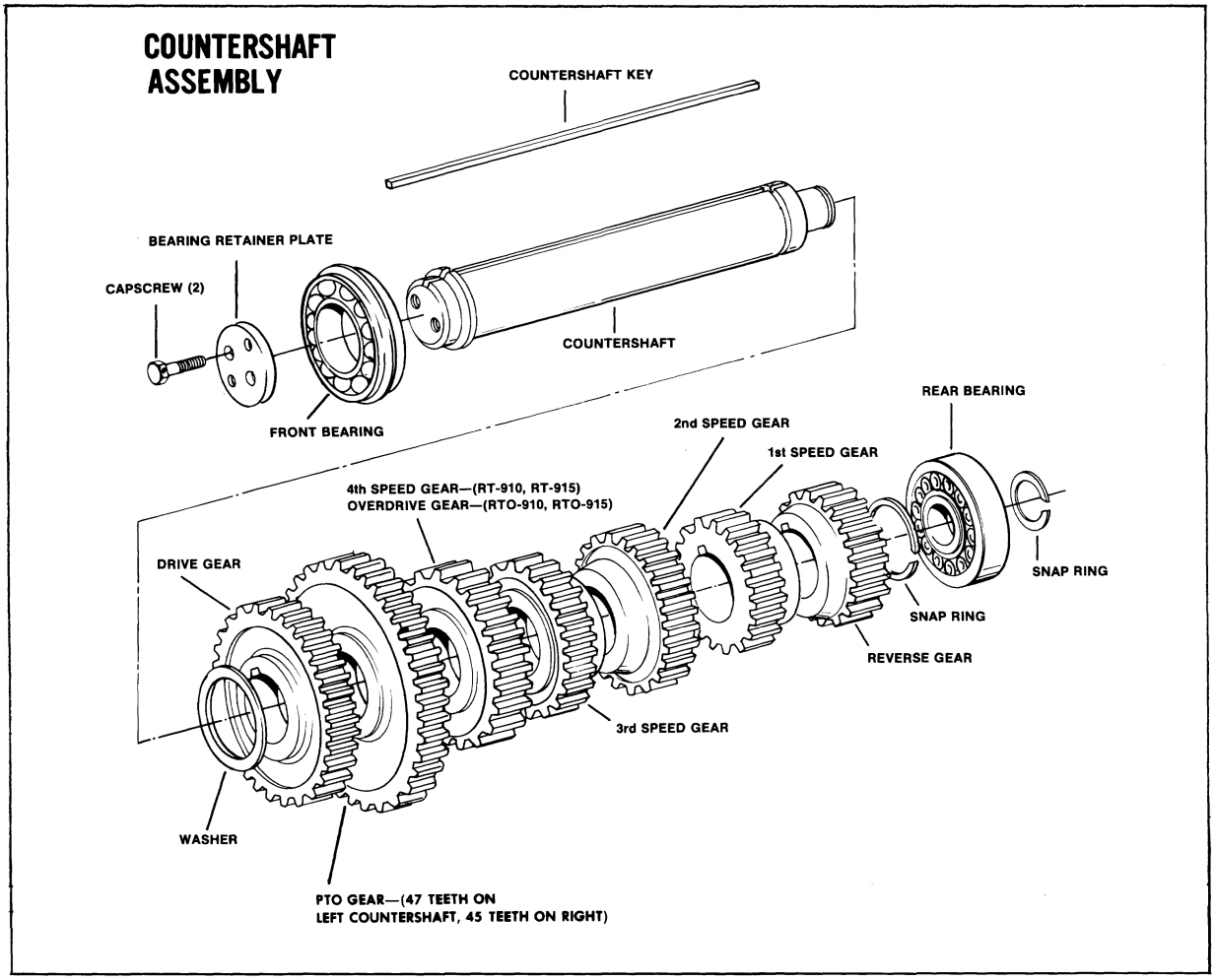


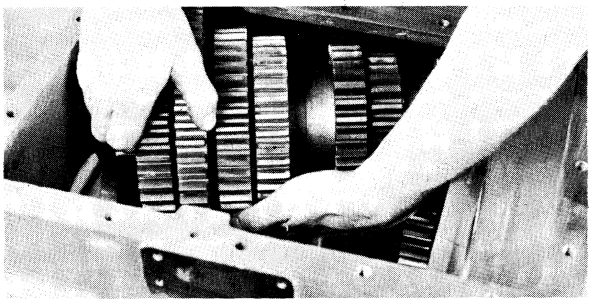
2. Turn the bearing nut from the shaft. (LH thread)



3. Using the rear face of the drive gear as a base, mount the assembly in a press and press the shaft through the gear to unseat the bearing from the shaft. This will free the bearing, spacer and drive gear from the shaft. If necessary, remove the snap ring from the ID of the drive gear.

H. Removal of the Countershaft Assemblies

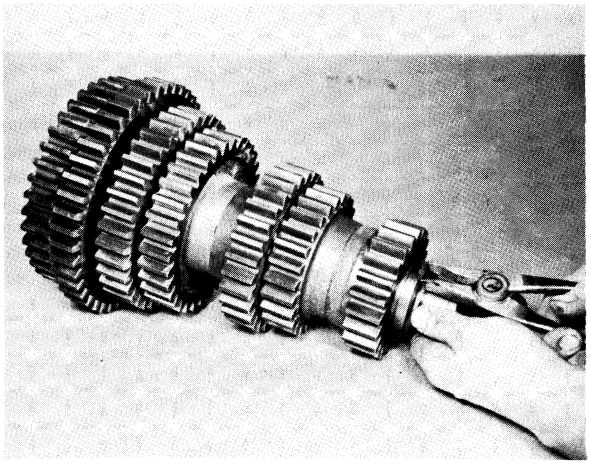




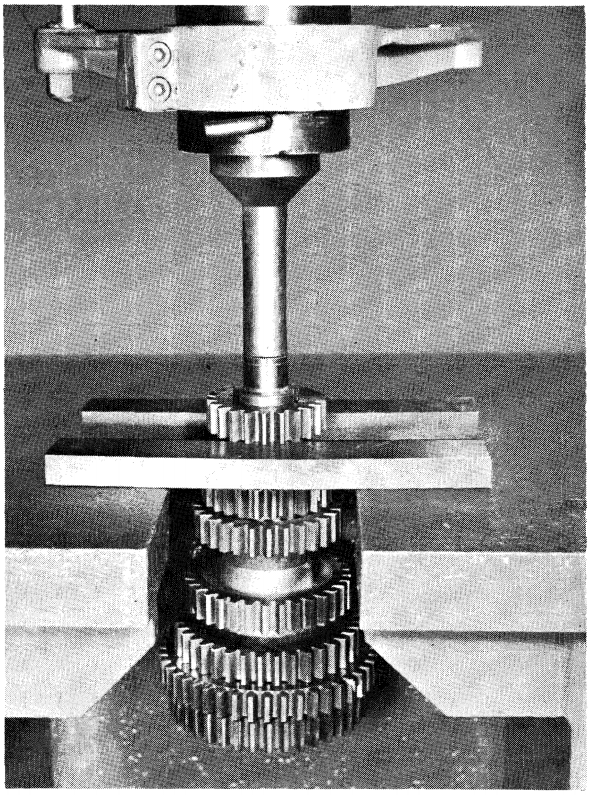
1. Move the front of the right countershaft towards the center of the case and upwards and remove from the case. Repeat procedure for the left countershaft.

I. Disassembly of the Countershaft Assemblies

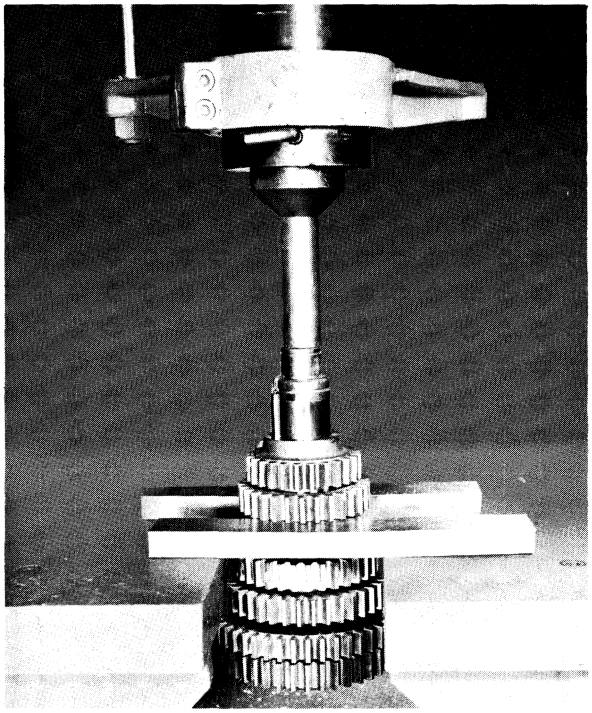
NOTE: Except for the number of teeth on the PTO gear, both countershafts are identical and disassembled in the same manner.



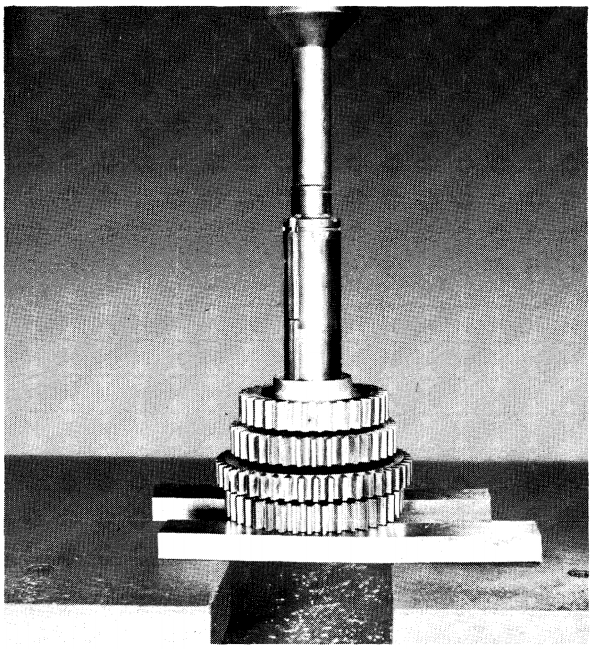
1. Remove the snap ring from the rear of the countershaft.



2. Press the reverse gear from the countershaft.



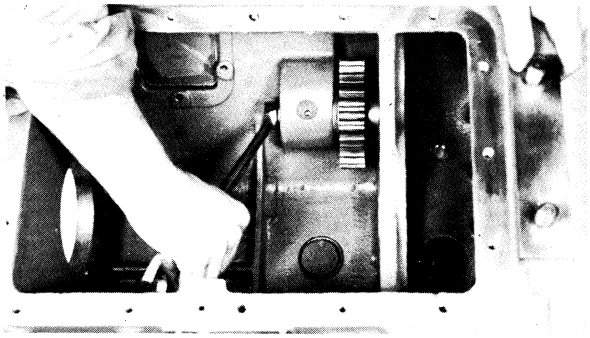
3. Press the 1st and 2nd speed gears from the shaft.



4. Press the remainder of the gears from the shaft. This will require a press of at least 25 ton capacity. Use metal shield on press as a safety precaution. If necessary, remove key and front spacer from countershaft.

J. Removal and Disassembly of the Right Reverse Idler Gear Assembly

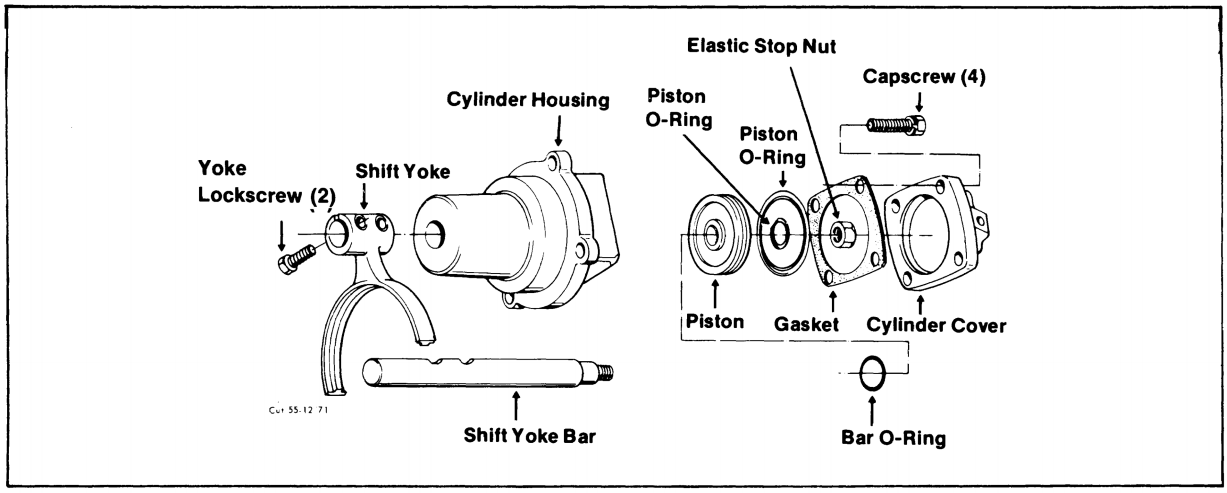
NOTE: The right reverse idler gear assembly is identical to the left and disassembled in the same manner.

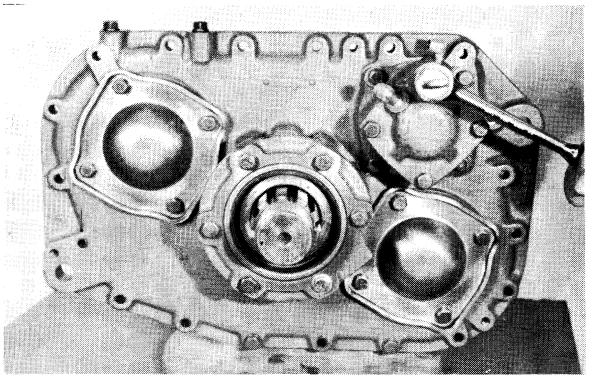


1. Remove nut and washer from end of idler shaft. Complete removal and disassembly in the same manner as the left reverse idler gear assembly, see page 49.

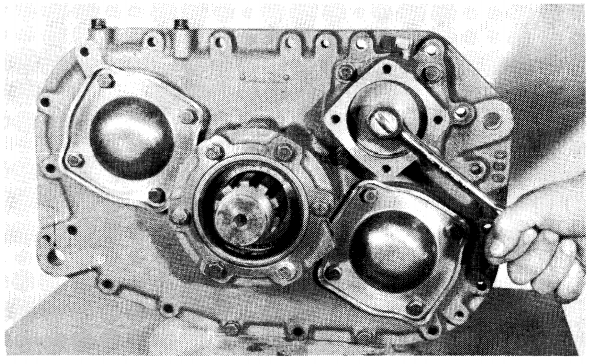
VI. AUXILIARY SECTION, RT-910 MODELS

A. Removal and Disassembly of the Range Shift Cylinder Assembly

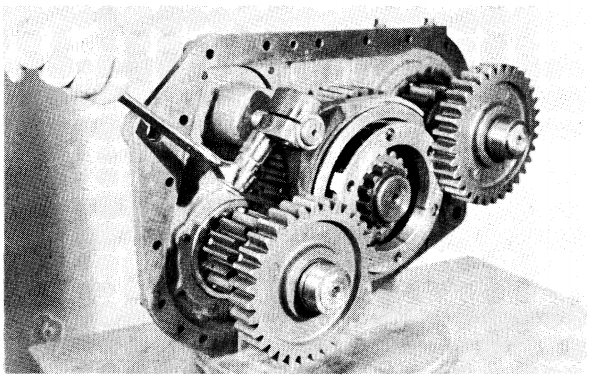




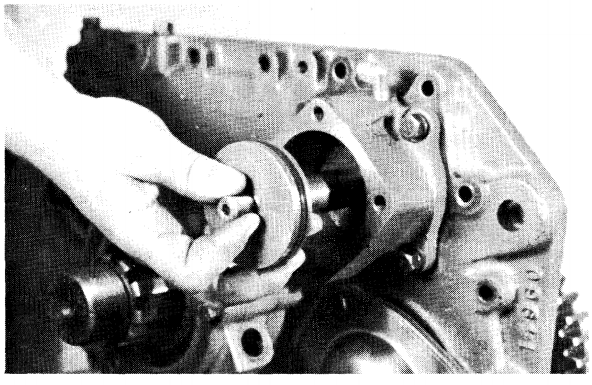
1. For ease of disassembly, mount the auxiliary section upright in a vise. Turn out the capscrews and remove the range shift cylinder cover.



2. Turn the elastic stop nut from the end of the shifting shaft.



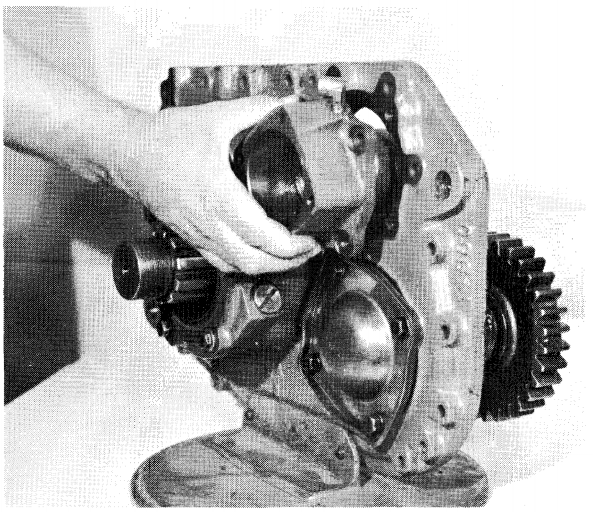
3. Cut the lockwire and turn out the two yoke lockscrews.



4. Push the shaft and piston to the rear and out of the shift cylinder. Remove the piston from the shaft.

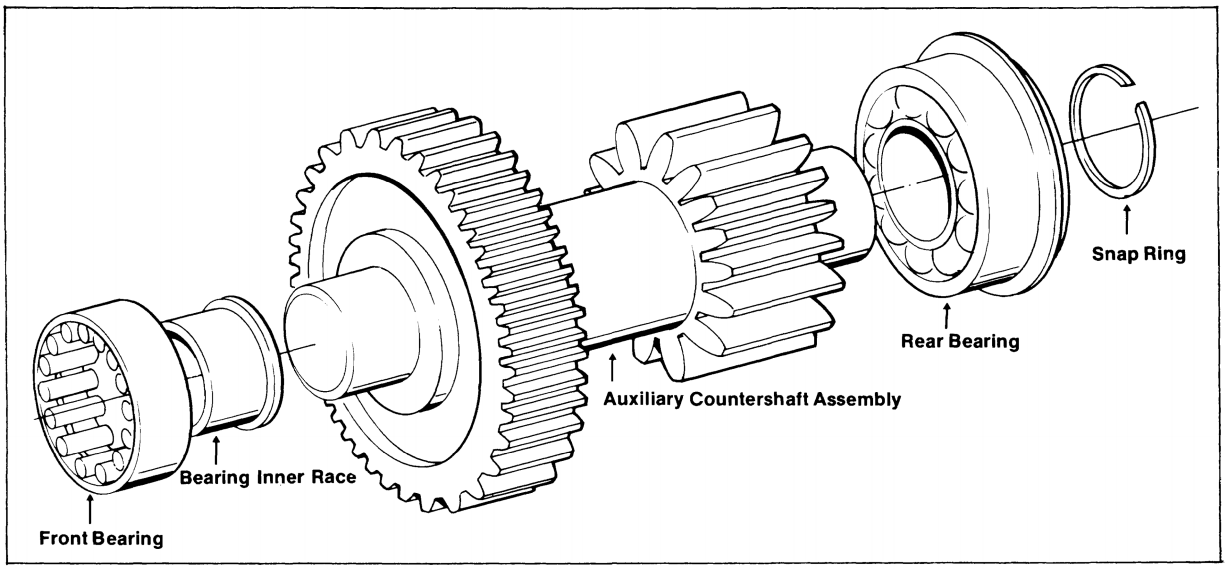


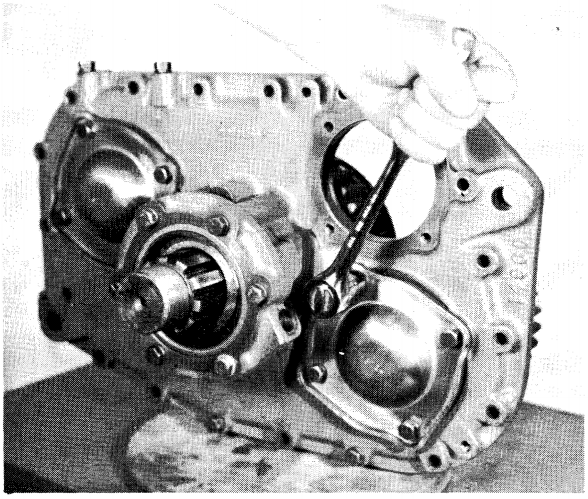
5. Remove the O-rings from the OD and ID of the piston and from the bore in the shift cylinder.



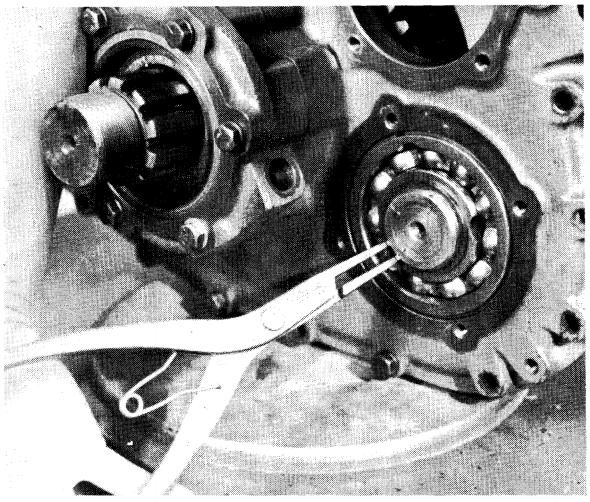
6. Turn out the capscrews and remove the shift cylinder housing. Remove the shift yoke from the sliding clutch gear of the synchronizer. If necessary, remove O-ring from bore in cylinder housing.

B. Removal of the Auxiliary Countershaft Assemblies

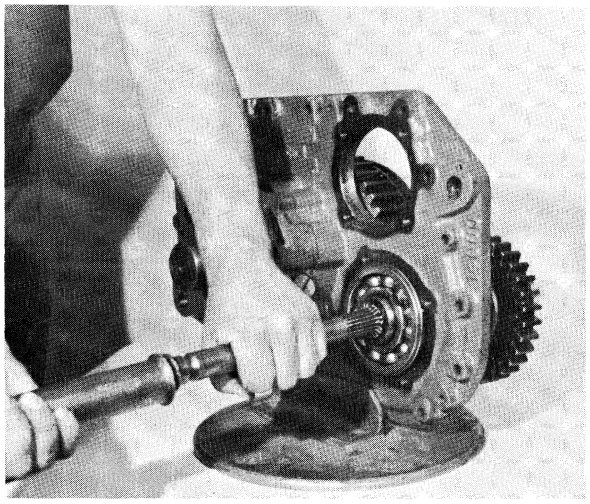




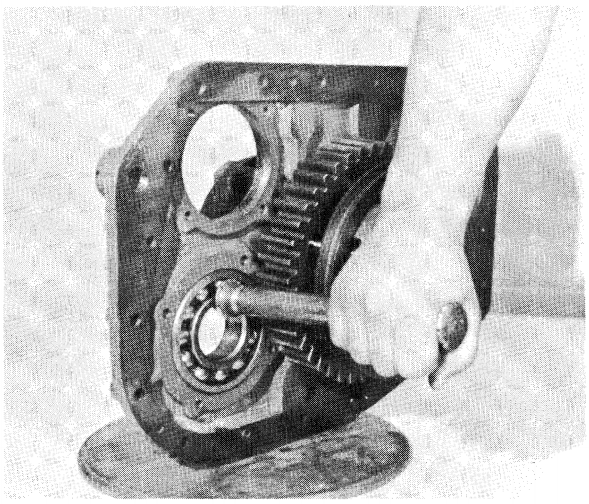
1. Turn out the capscrews and remove the two rear bearing covers.



2. Remove the snap ring from the rear of each countershaft.



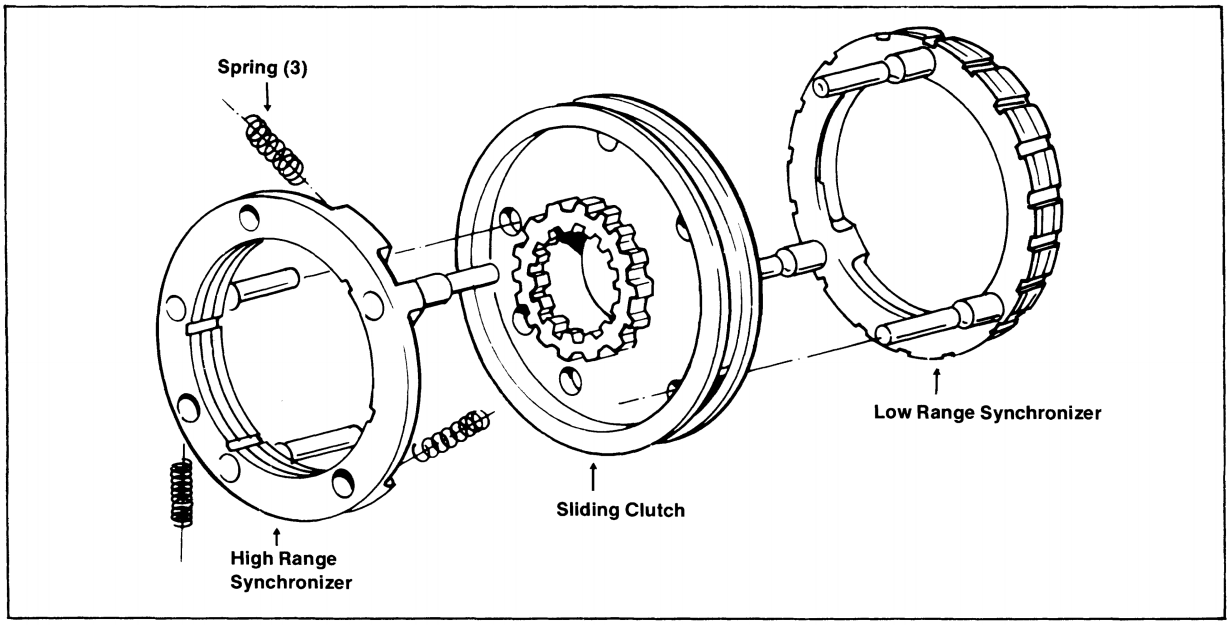
3. Use a soft bar and mall to drive the countershafts forward and from the rear bearings.

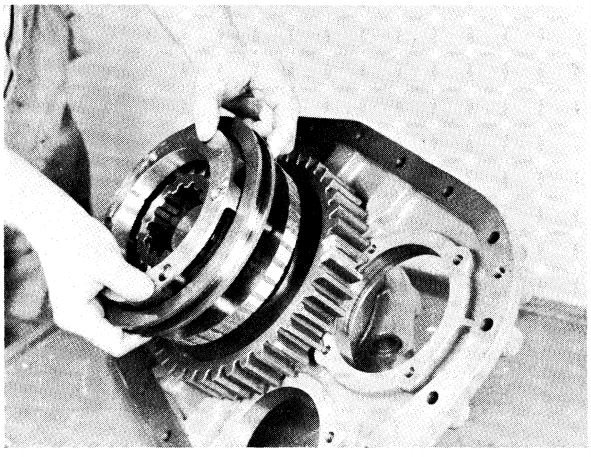


4. Remove the bearings from bores by tapping lightly and evenly to the rear with a soft bar.

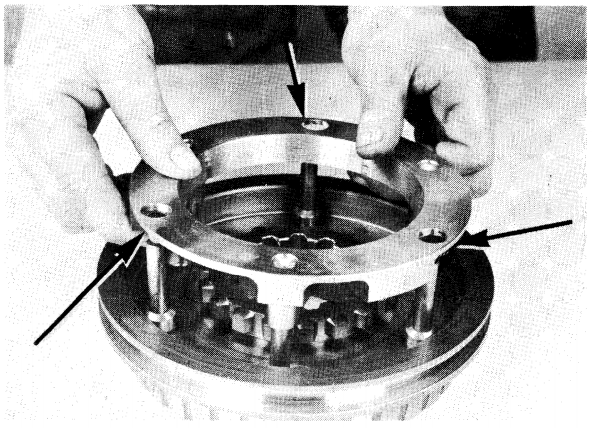
NOTE: Check bearing inner races on front of each countershaft. If worn or damaged, remove with pry bars or appropriate jaw pullers.

C. Removal and Disassembly of the Synchronizer Assembly

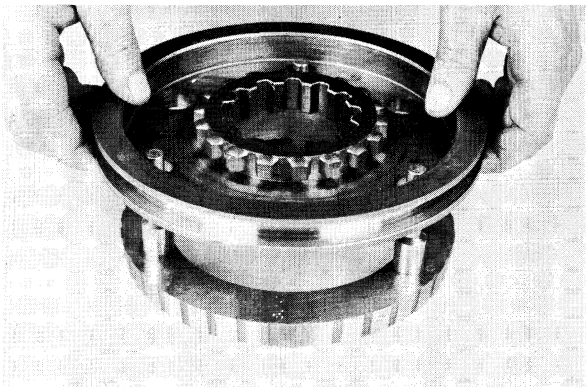




1. Pull the synchronizer assembly from the splines of the output shaft.

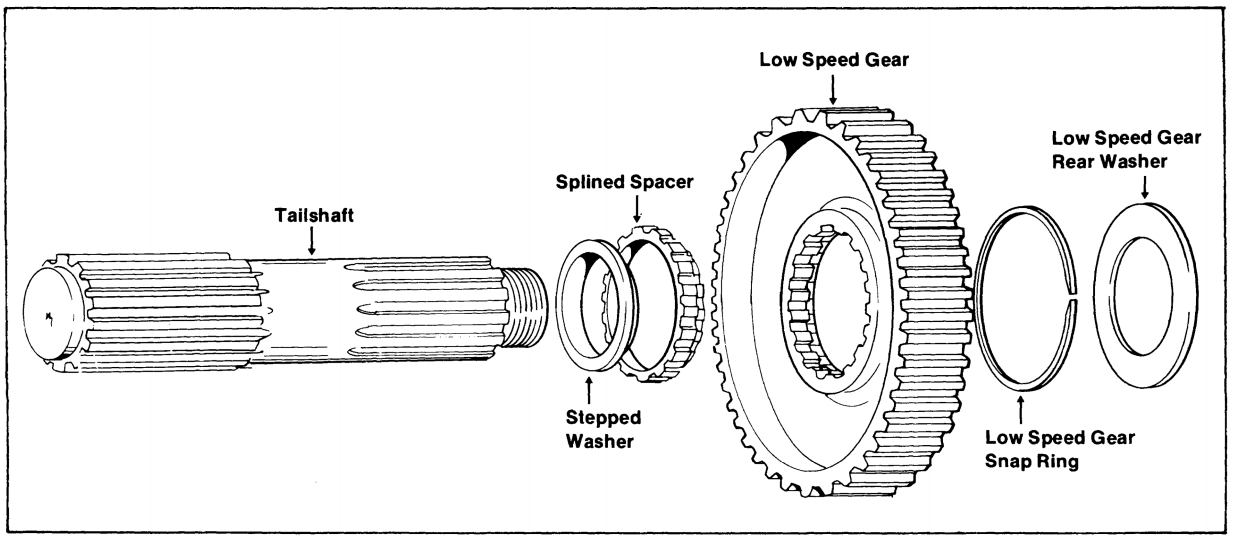


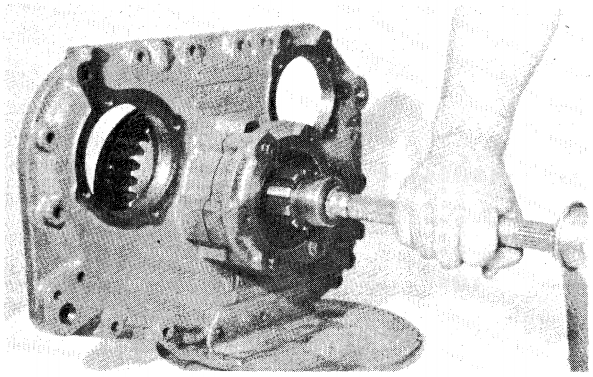
2. Pull the direct (high range) cone synchronizer from the pins of the low speed synchronizer ring. Cover with a cloth as the three springs will be released at the blocker pin locations.



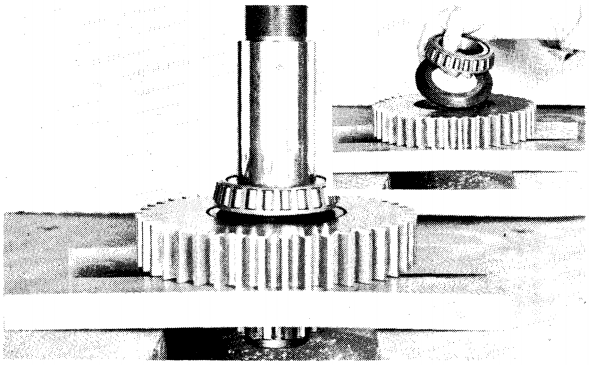
3. Remove the sliding clutch gear from the pins of the low speed synchronizer.

D. Disassembly of the Low Speed Gear and Tailshaft Assembly

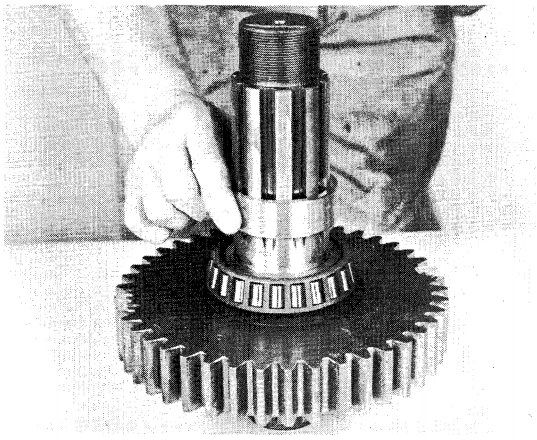




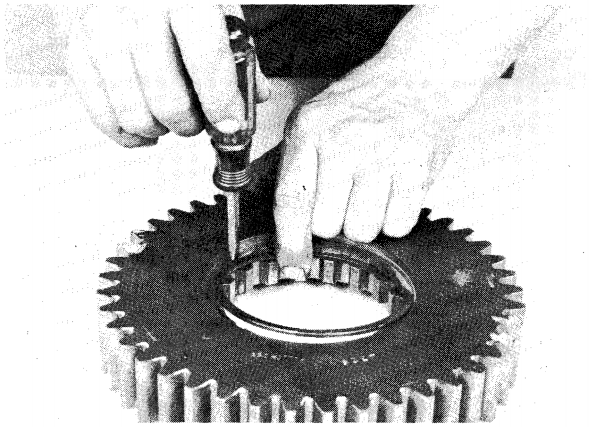
1. Use a soft bar and mall to drive the output shaft forward and through the rear bearing.



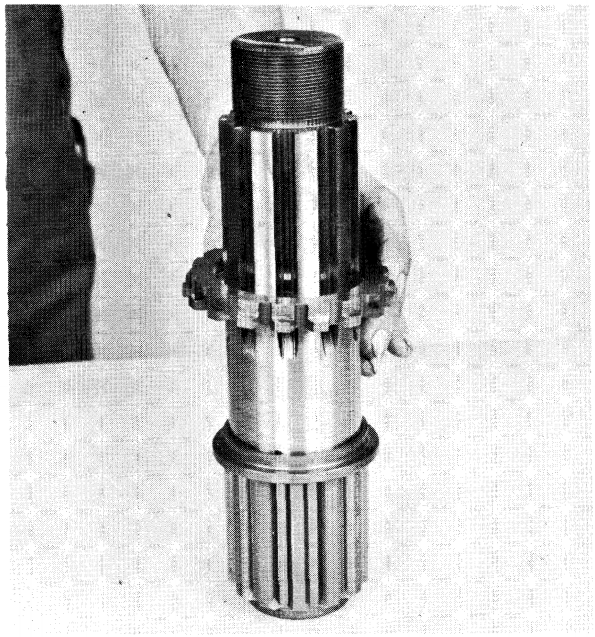
3. Using the front face of the low speed gear as a base, press the shaft through the gear and bearing, freeing bearing, washer and gear from shaft.



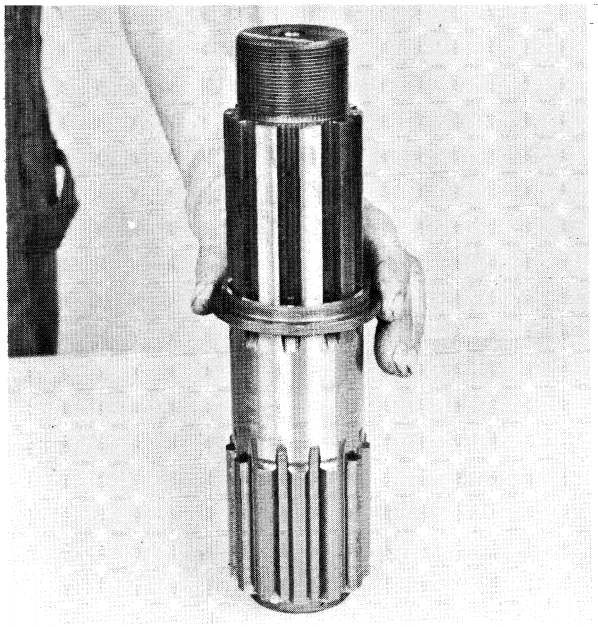
2. Remove the bearing inner spacer from the shaft.



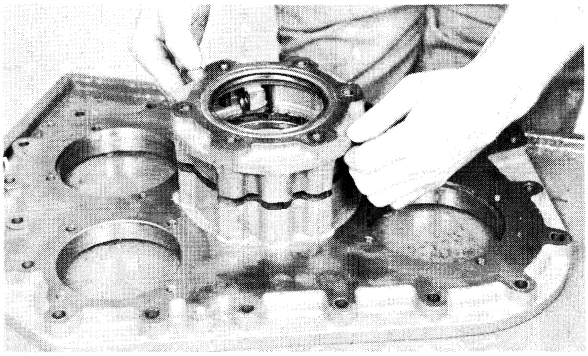
4. If necessary, remove snap ring from the ID of the low speed gear.



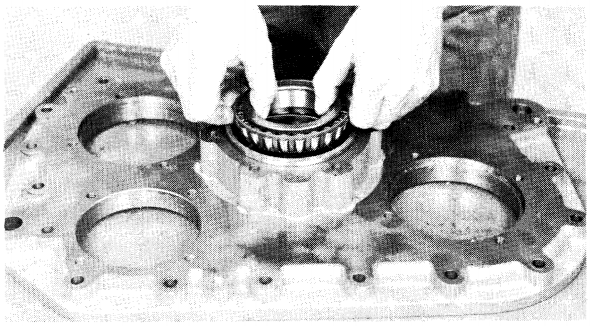
5. Remove the splined spacer from the shaft.



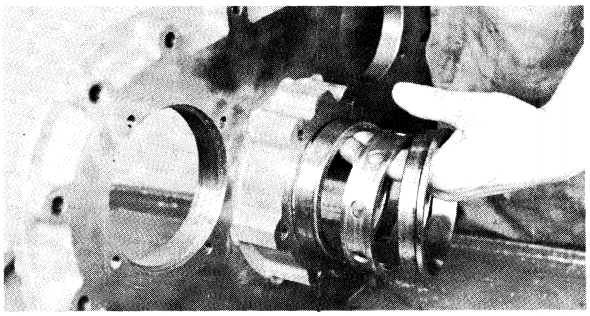
6. Remove the stepped washer from the shaft.



7. Turn out the capscrews and remove the rear bearing cover. If necessary, remove the oil seal from the cover.



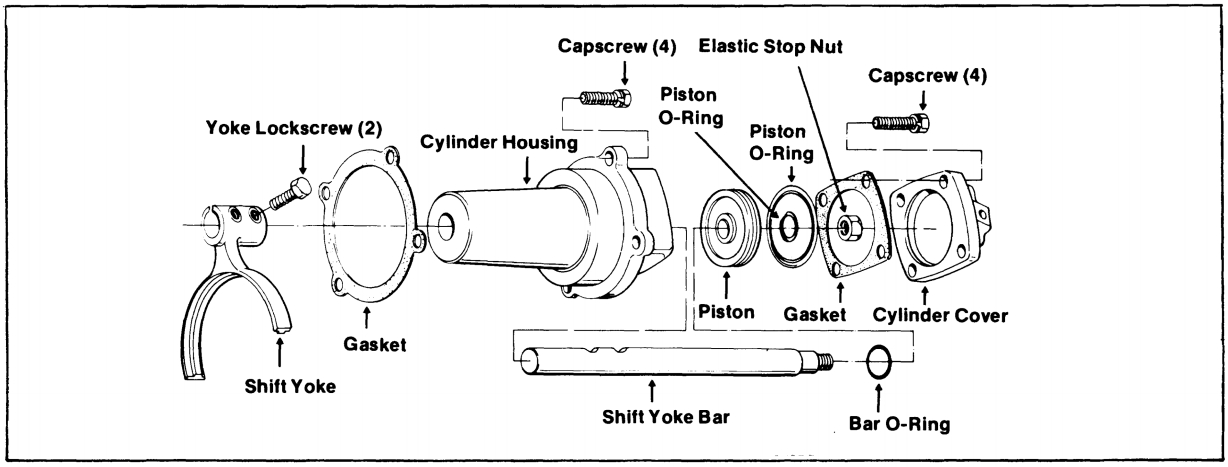
8. Remove the bearing rear cone from the housing.

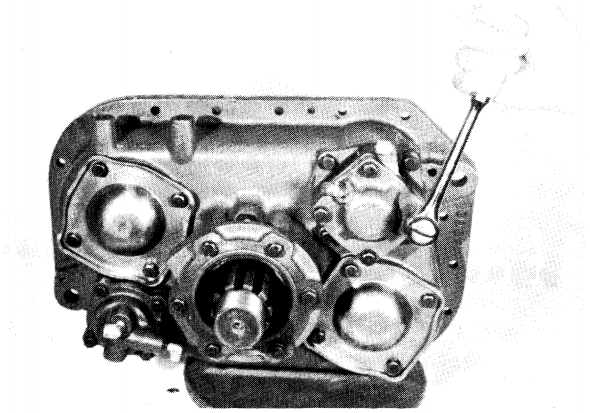


9. Remove the two bearing cups and outer spacer from the housing bore.

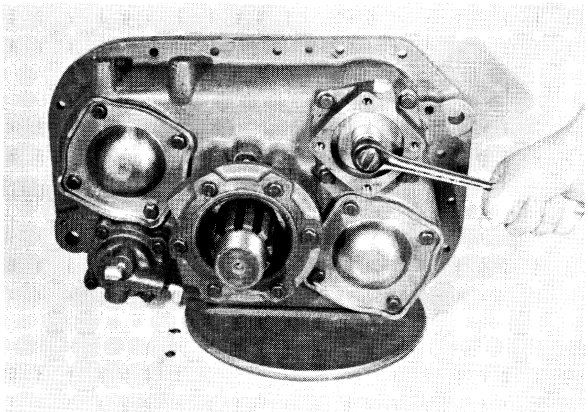
VII. AUXILIARY SECTION RT-915 MODELS

A. Removal and Disassembly of the Range Shift Cylinder Assembly

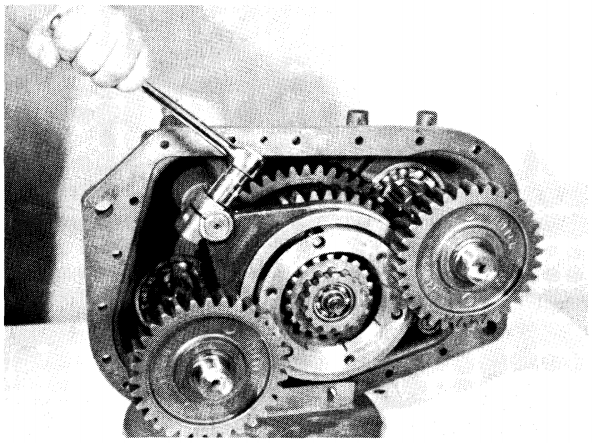




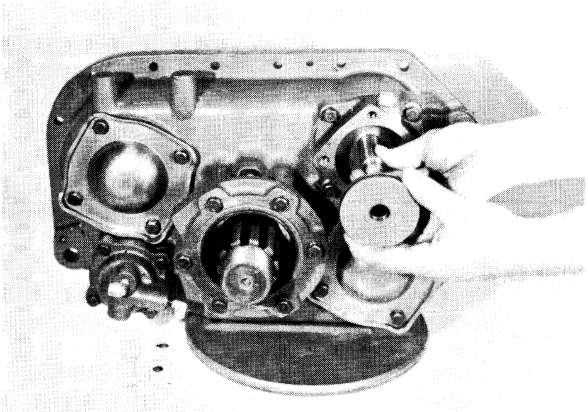
1. For ease of disassembly, mount the housing upright in a vise. Turn out the capscrews and remove the cylinder cover.



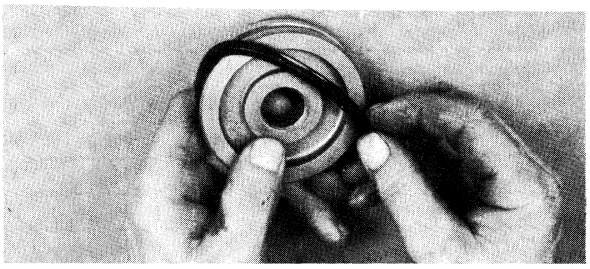
2. Turn the elastic stop nut from the end of the shift shaft.



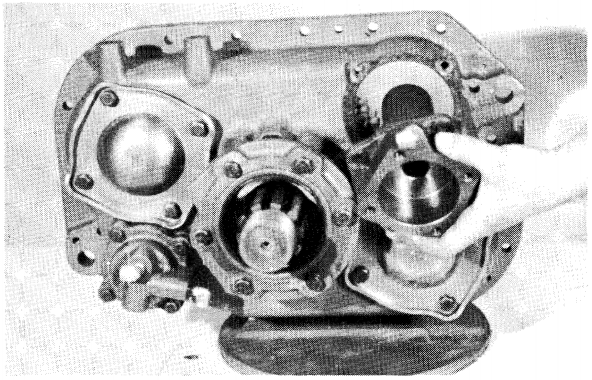
3. Cut the lockwire and turn out the two yoke lockscrews.



4. Push the shaft and piston to the rear and out of the shift cylinder. Remove the piston from the shaft.

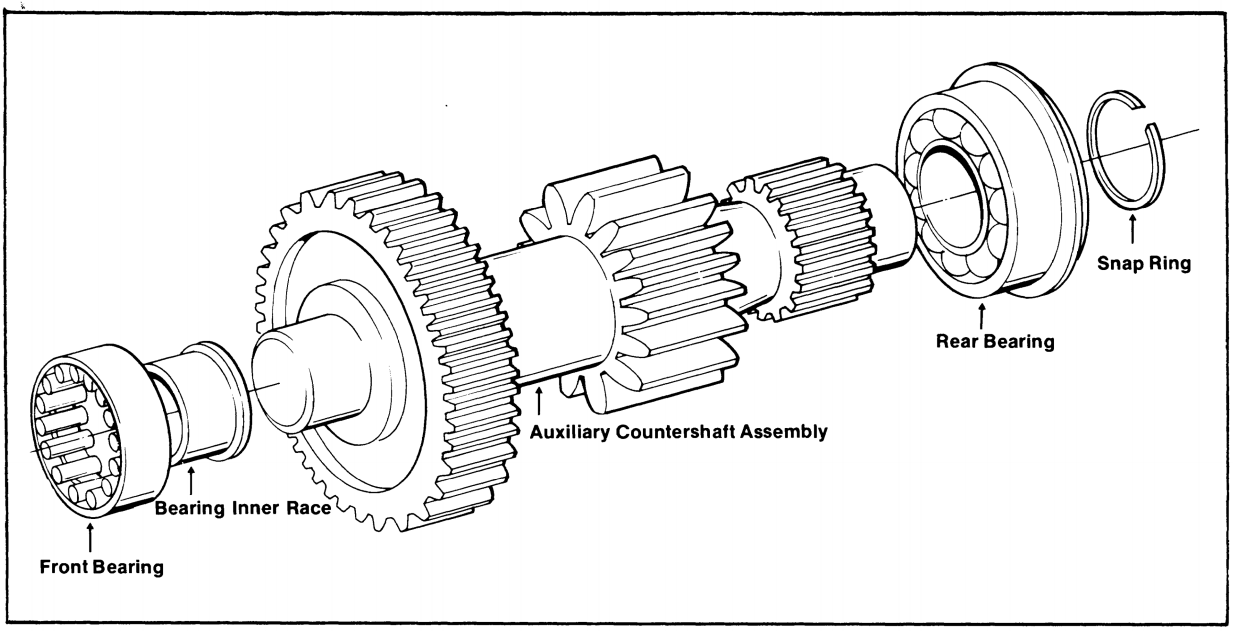


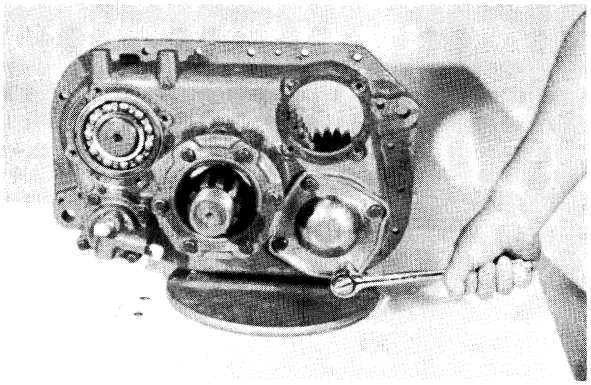
5. Remove the O-rings from the ID and OD of the piston and from the bore in the shift cylinder.



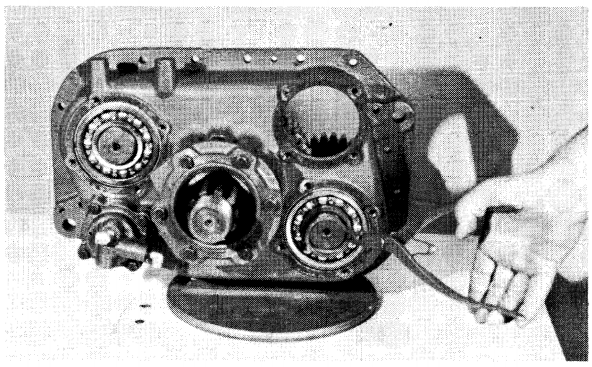
6. Turn out the capscrews and remove the shift cylinder housing. Remove the yoke from the sliding clutch gear of the synchronizer.

B. Removal of the Auxiliary Countershaft Assemblies

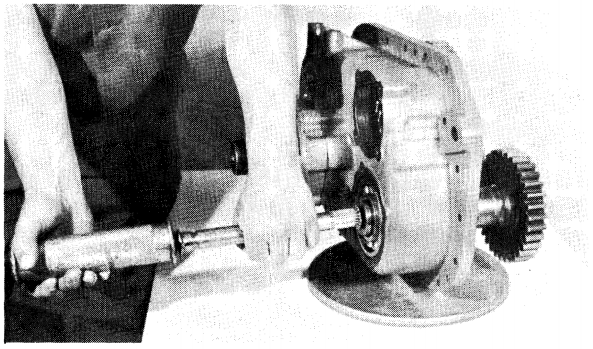




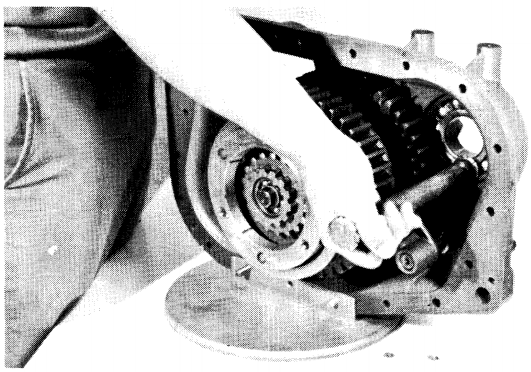
1. Turn out the capscrews and remove the two rear bearing covers.



2. Remove the snap ring from the rear of both countershafts.

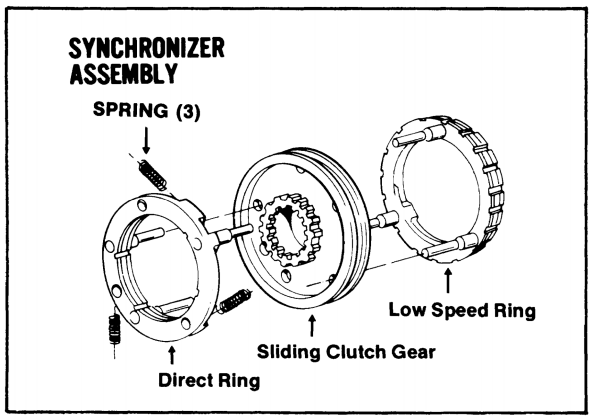


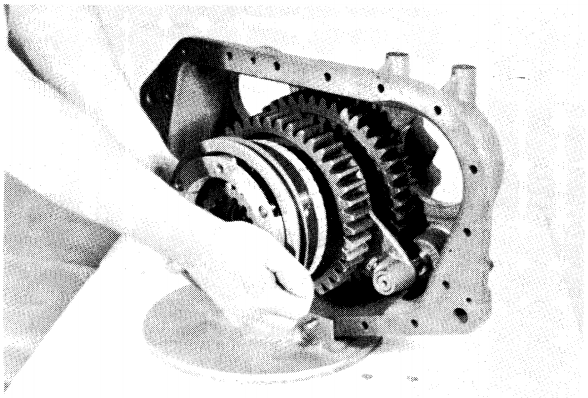
3. Use a soft bar and mall to drive the countershafts forward and from the rear bearings.



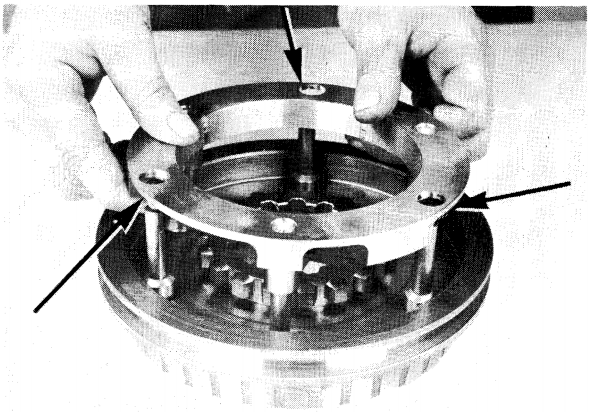
4. Remove the rear bearings by tapping lightly and evenly to the rear with a soft bar.

C. Removal and Disassembly of the Synchronizer Assembly

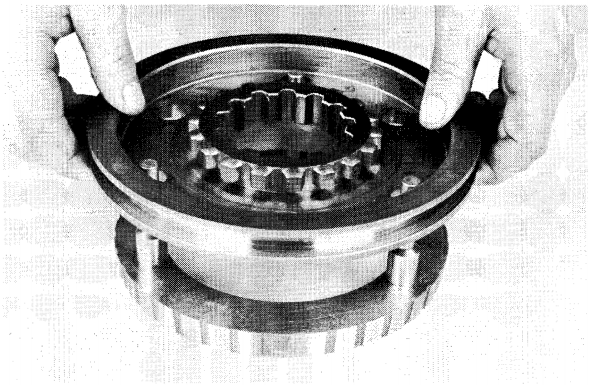




1. Pull the synchronizer assembly from the splines of the range mainshaft.

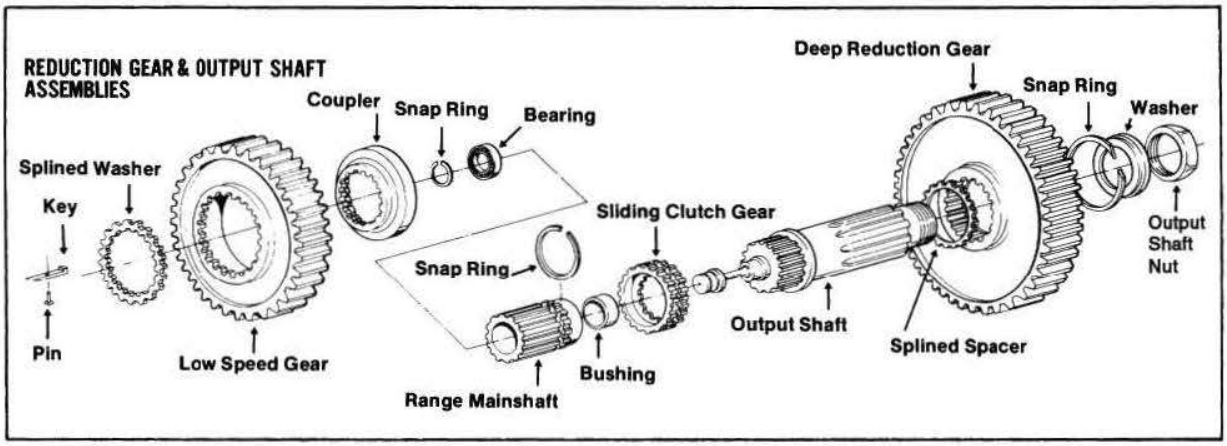


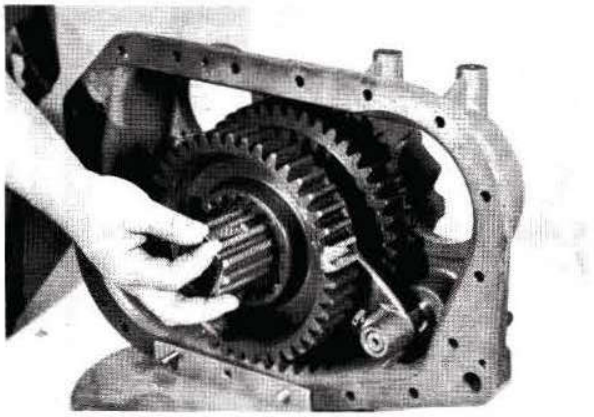
2. Pull the direct (high range) ring from the blocker pins of the low speed ring. Cover with a cloth as the three springs will be released at the blocker pin locations.



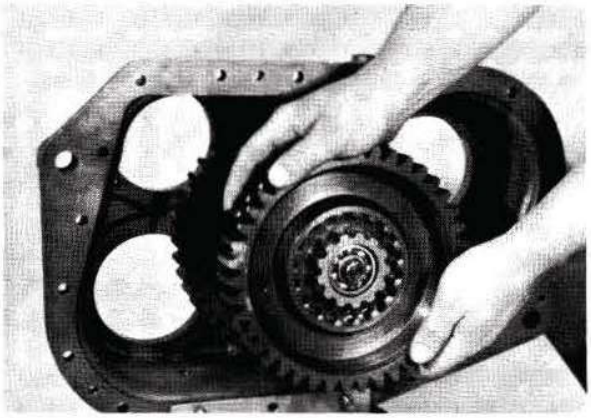
3. Remove the sliding clutch gear from the pins of the low speed ring.

D. Removal of the Low Range Gear



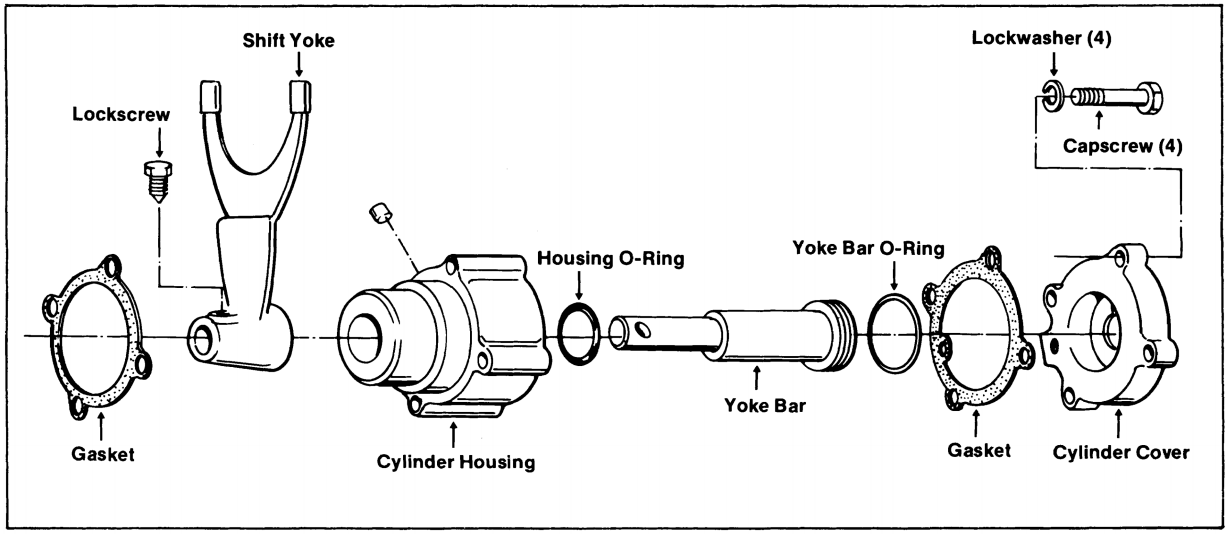


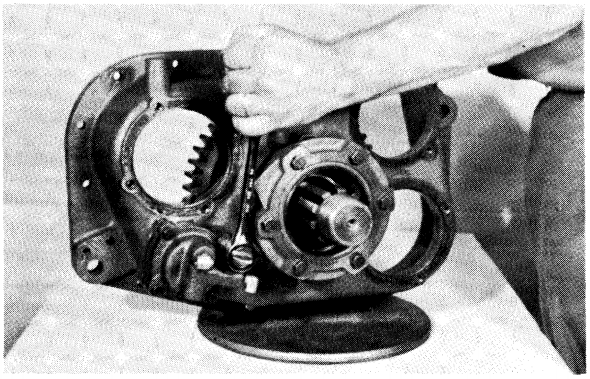
1. Remove the key from the keyway between the splines of the range mainshaft.



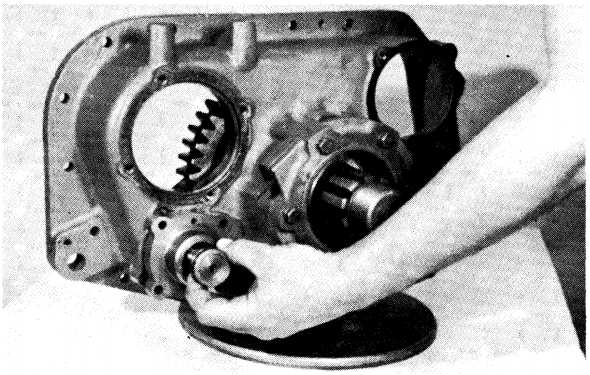
2. Turn the splines of the low speed gear washer, located in the hub of the gear, to align with the splines of the shaft. Remove the gear, washer and coupler from the shaft.

E. Removal and Disassembly of the Deep Reduction Shift Cylinder

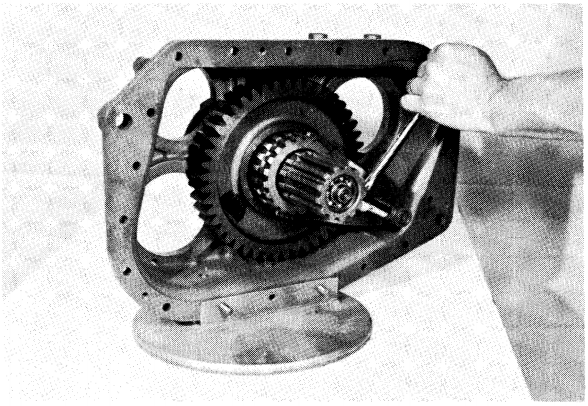




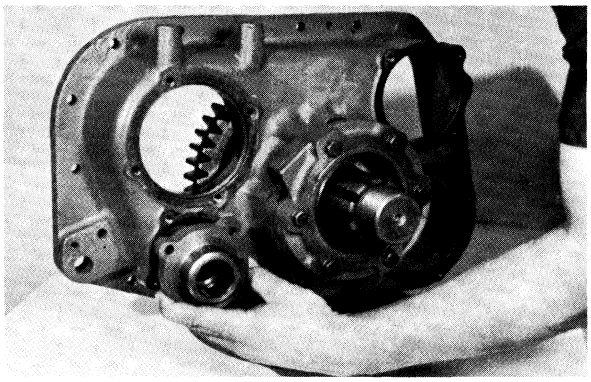
1. Remove the cover from the shift cylinder.



3. Push the yoke bar to the rear and remove from the housing. If necessary, remove the O-ring from the large OD of the bar.

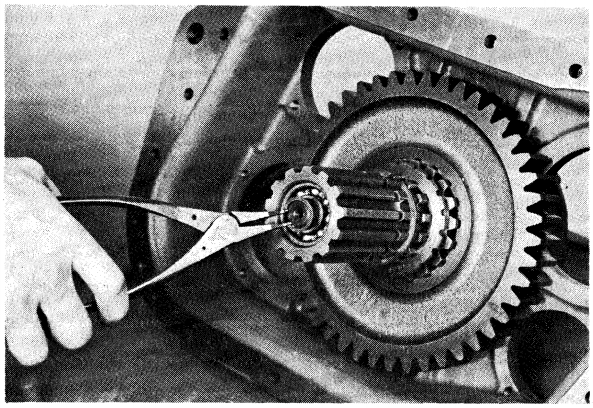


2. Cut the lockwire and turn out the lockscrew from the shift yoke.

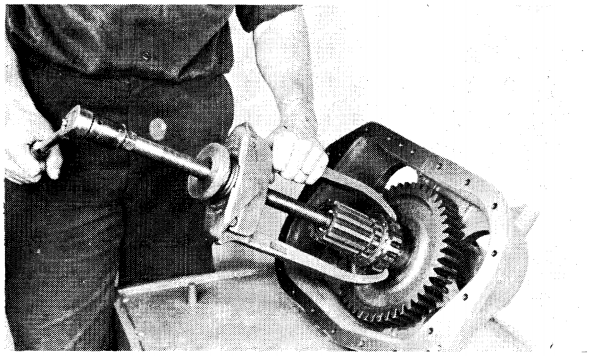


4. Remove the shift yoke and cylinder housing from the rear housing. If necessary, remove the O-ring from the bore in the cylinder housing.

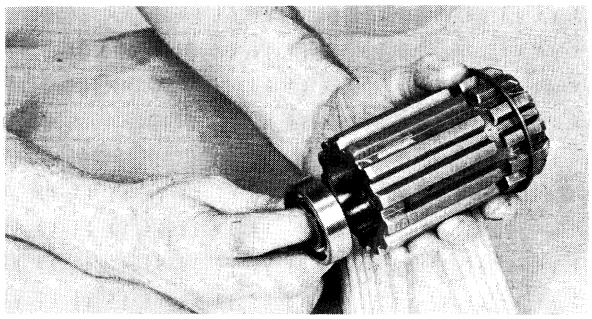
F. Removal of the Range Mainshaft



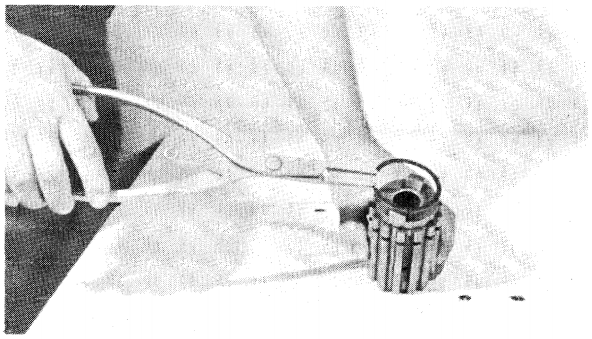
1. Remove the snap ring from the front of the quill.



2. Move the sliding clutch forward and against the snap ring of the range mainshaft. Insert jaws of puller behind sliding clutch gear and pull the mainshaft from the quill.

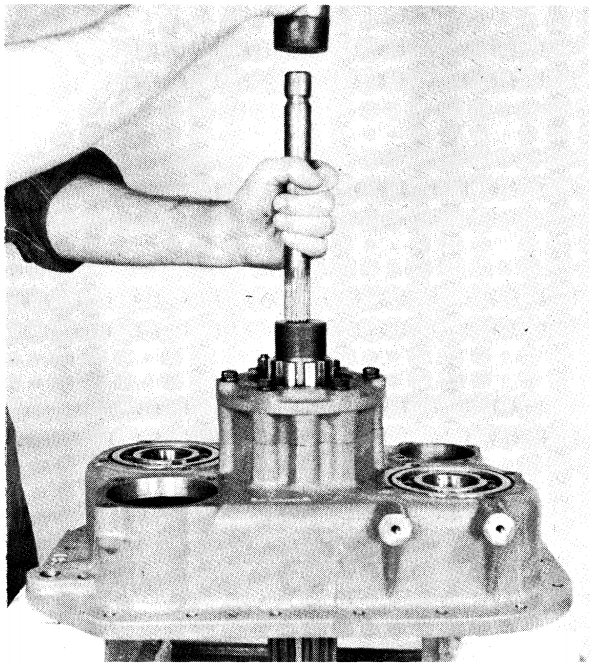


3. Remove the front bearing from the shaft. If necessary, use an inside jaw impact puller.

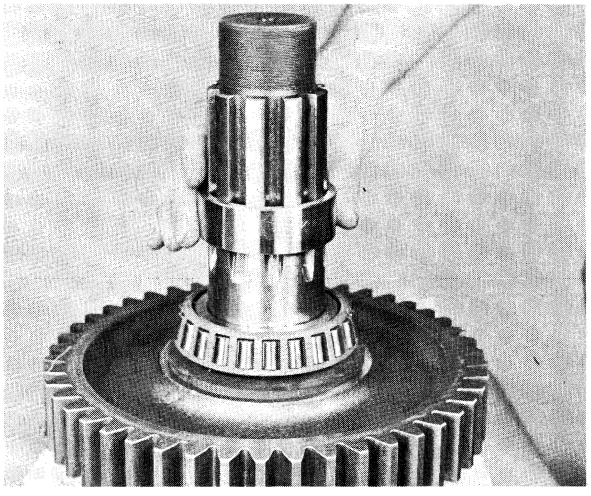


4. Remove the snap ring from the OD of the mainshaft and, if necessary, press the bushing from the mainshaft.

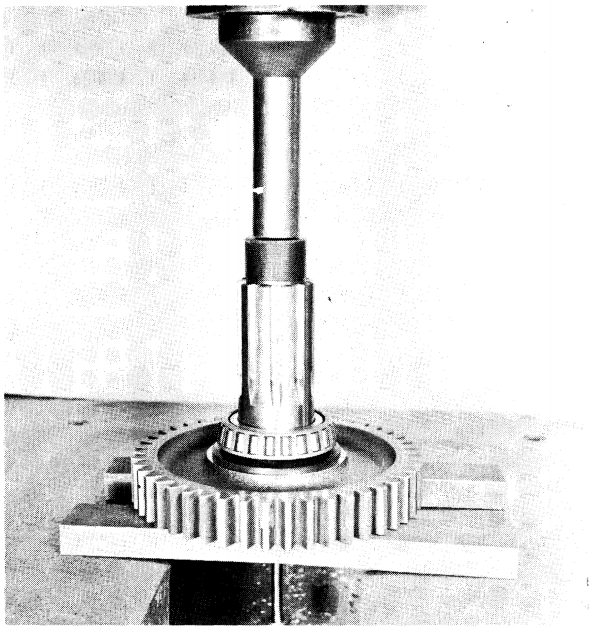
G. Disassembly of the Deep Reduction Gear and Output Shaft Assembly



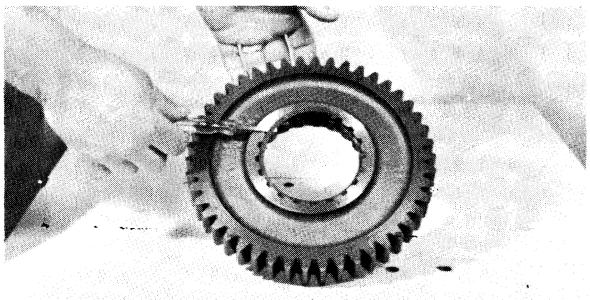
1. Use a soft bar and mall to drive the output shaft forward and from the rear bearing.



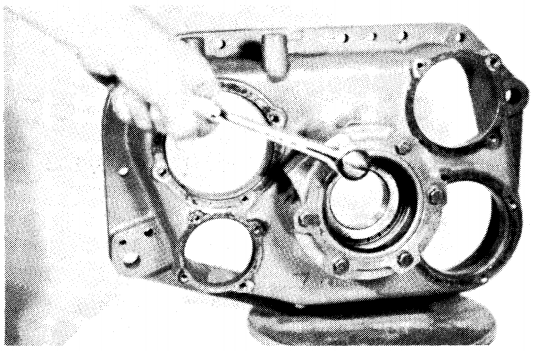
2. Remove the bearing inner spacer from the shaft.



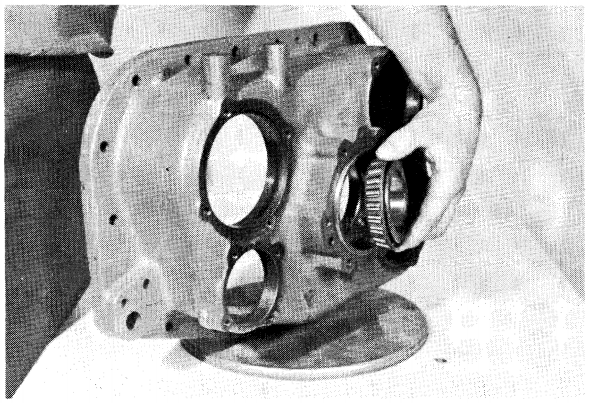
3. Using the front face of the deep reduction gear as a base, press the shaft through the gear and bearing, freeing the bearing, washer and gear.



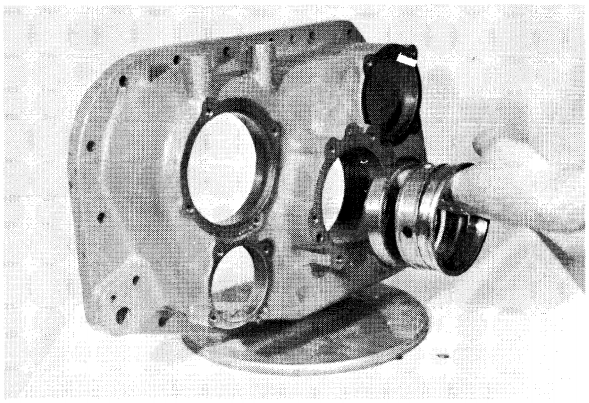
4. If necessary, remove the snap ring from the ID of the gear.



5. Turn out the capscrews and remove the rear bearing cover. If necessary, remove the oil seal from the cover.



6. Remove the bearing rear cone from the rear housing.



7. Remove the two bearing cups and outer spacer from the housing.

INSPECTION

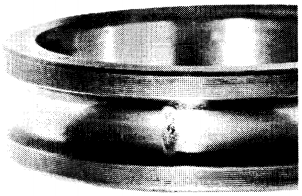
Before reassembling the transmission, the individual parts should be carefully checked to eliminate those damaged from previous service. This inspection procedure should be carefully followed to insure the maximum of wear life from the rebuilt unit.

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.

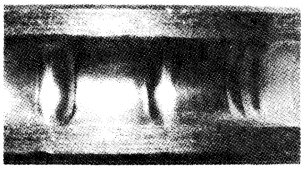
Recommended inspection procedures are set forth in the following check list:

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.

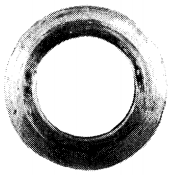
B. Gears

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 clearances of gears. Where excessive clearance is found, check gear snap ring, washer, spacer and gear hub for excessive wear. Maintain .005 to .012 axial clearance of mainshaft gears.

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



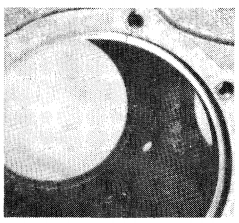
1. Check surfaces of all thrust washers. Washers scored or reduced in thickness should be replaced.

E. Reverse Gear and Shaft

1. Check bearing sleeve for wear from action of roller bearings.

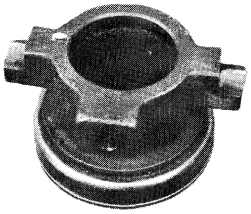
F. Gray Iron Parts

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

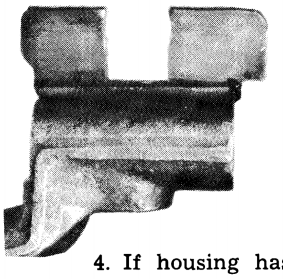
1. Check clutch release parts. Replace yokes worn at cam surfaces and bearing carrier worn at contact pads.



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 mainshaft 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 And Length**	**Torque Rating Foot-Pounds**
Air Valve	4	1/4-20 x 1-3/4	15-20
Air Valve Adapter Plate	2	1/4-20 x 7/8	15-20
Filter Bracket	2	3/8-16 x 3/4	20-25
*PTO Cover, small	6	3/8-16 x 3/4	18-23 (12-15 with oil filter)
Hole-Gear Shift Cylinder (RT-915 only)	4	5/16-18 x 1-7/8	20-25
Aux. Drive Gear Retainer Ring	6	3/8-16 x 1	
Range Shift Cylinder	4	3/8-16 x 1	
Range Shift Cylinder Cover (RT-910 only)	4	3/8-16 x 1	
Range Shift Cylinder Cover (RT-915 only)	4	3/8-16 x 1-1/4	35-45
Shift Bar Housing	16	3/8-16 x 1-1/4	
Gear Shift Lever Housing	4	3/8-16 x 1-1/4	
Front Bearing Cover	6	3/8-16 x 1-1/4	
Countershaft Rear Bearing Covers	8	3/8-16 x 1-1/4	
Rear Plate to Case (RT-910 only)	18	3/8-16 x 2	
	1	3/8-16 x 1-3/4	
Rear Plate to Case (RT-915 only)	18	3/8-16 x 1-1/2	
	1	3/8-16 x 2	
Mainshaft Rear Bearing Cover	6	3/8-16 x 2-3/4	
PTO Cover, large	8	7/16-14 x 1-1/4	50-65
Clutch Housing to Case	2	1/2-13 x 1-1/2	70-75
	2	1/2-13 x 3-1/2	70-75
C/S Front Bearing Retainers	4	1/2-20 x 1	50-65
Aux. C/S Rear Bearing Retainers	4	1/2-20 x 1	50-65

***NOTE:** Installing the capscrews with more than 23 ft-lbs. of torque will force the corners of the PTO cover away from the case with resultant oil leakage.

NUTS			
	Qty.	Thread Size	Torque Rating Foot-Pounds
Reverse Idler Shafts	2	5/8-18	75-80
Range Shift Piston	1	5/8-18	80-90
Hole-Gear Shift Piston (RT-915)	1	7/16-20	45-50
Clutch Housing to Case	6	5/8-18	170-185
Drive Gear	1	2-1/8-16	250-300
Aux. Drive Gear	1	2-1/8-16	250-300
Output Yoke	1	2-16	650-700

LOCATION OF GASKETS

Seat gasket with shellac on part to be installed. Use new gaskets throughout when reassembling transmission. Gaskets are located between the following parts:

RT-910

1. Gear shift lever housing and shift bar housing.
2. Shift bar housing and case.
3. Air valve adapter plate and case.
4. Air valve and adapter plate.
5. Clutch housing and case.
6. Front bearing cover and case.
7. Rear plate and case.
8. Mainshaft rear bearing cover and rear plate.
9. Aux. range shift cylinder cover and cylinder.
10. Aux. range shift cylinder and rear plate.
11. Right aux. countershaft rear bearing cover and rear plate.
12. Left aux. countershaft rear bearing cover and rear plate.
13. Large PTO cover and case.
14. Small PTO cover and case.

RT-915

To the above list add:

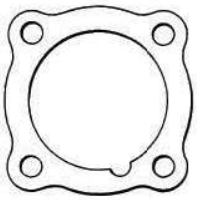
1. Hole-gear shift cylinder cover and cylinder.
2. Hole-gear shift cylinder and case.

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 sleeves, bushings, 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.



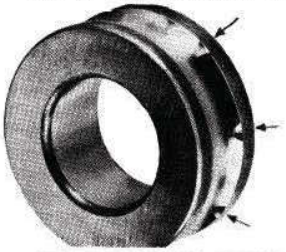
2. **CAPSCREWS**—To prevent oil leakage, use shellac on all capscrews. See torque rating chart for recommended torque.

3. **O-RINGS**—Lubricate all O-rings with "Dow Corning 200 Fluid," 50,000 cs.

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

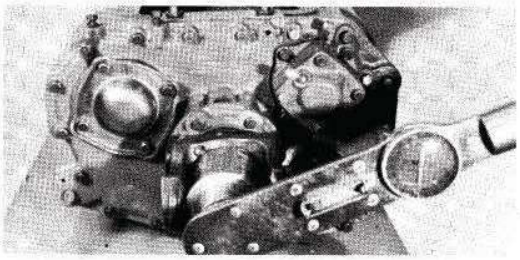
5 **AXIAL CLEARANCES**—Maintain original axial clearances of mainshaft forward speed gears of .005" to .012". Mainshaft reverse gear clearance is .005" to .012"

6. **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.



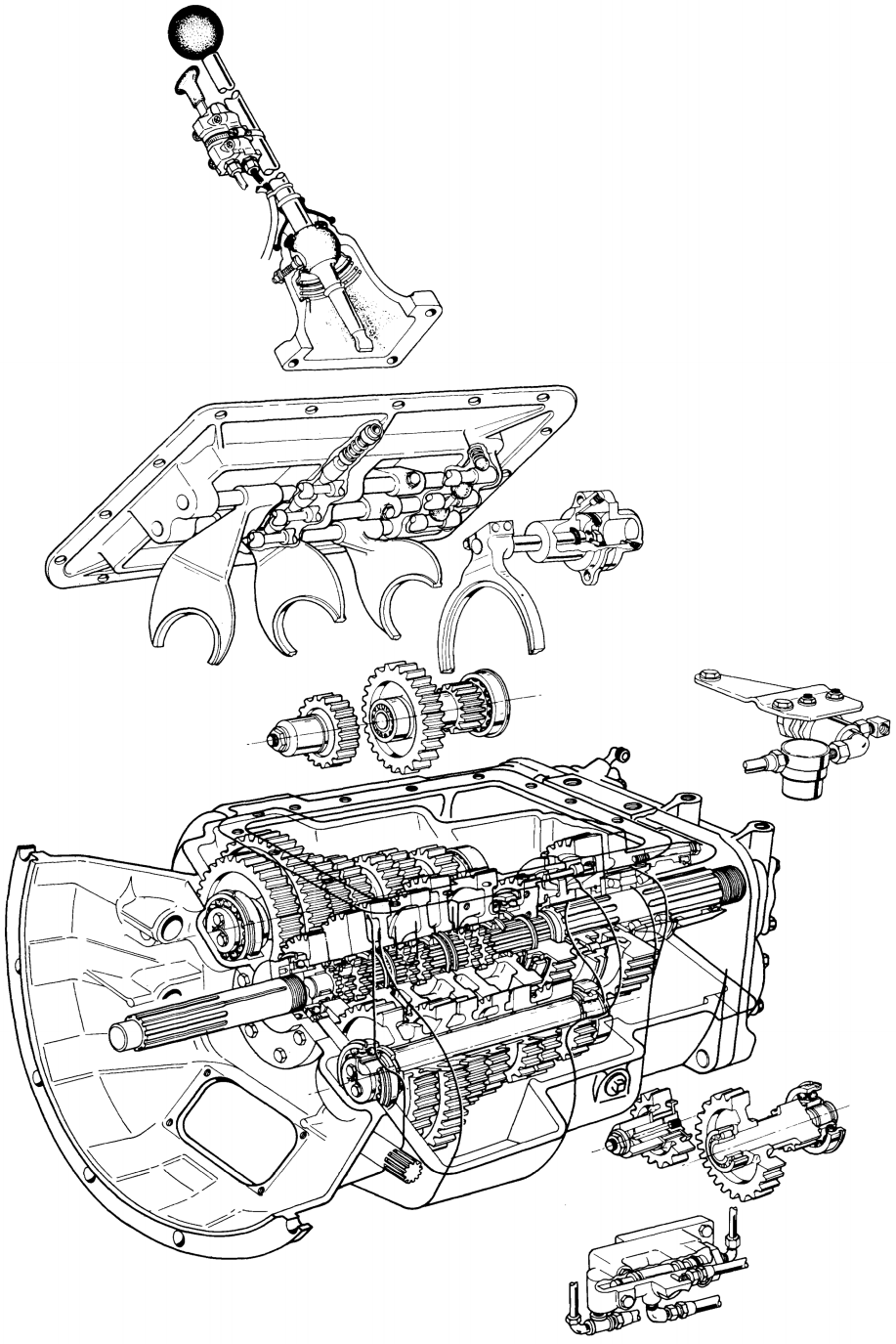
BALL DEPRESSIONS, CAUSED BY OFF-CENTER BLOW

7. **UNIVERSAL JOINT COMPANION FLANGE**—Pull the companion flange tightly into place with the output shaft nut, using 650-700 foot-pounds torque. Make sure the speedometer



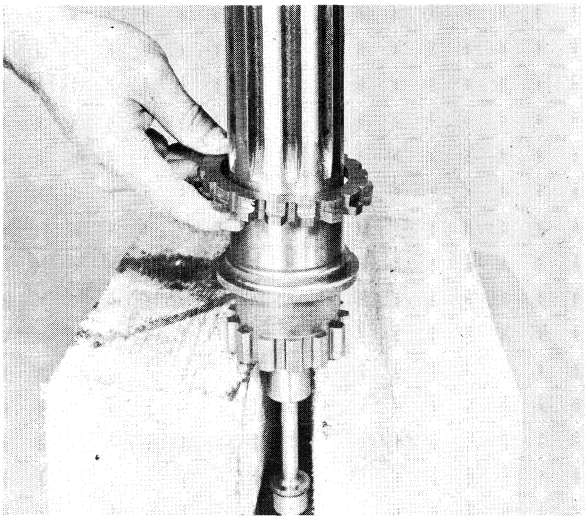
gear has been installed on yoke. If a speedometer gear is not used, a replacement spacer of the same width must be used. Failure to pull the yoke or flange tightly into place will permit the shaft to move axially with resultant damage to rear bearing.

REASSEMBLY INSTRUCTIONS

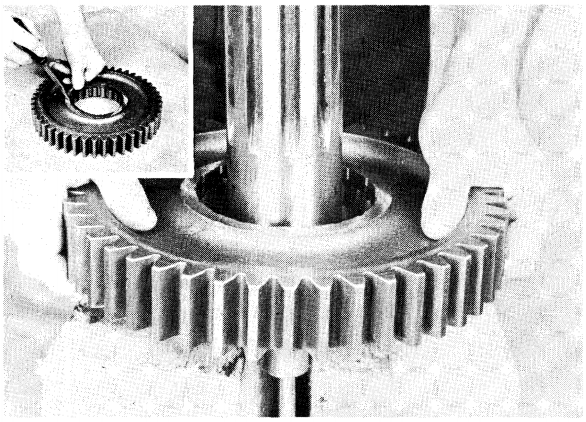


I. AUXILIARY SECTION RT-915 MODELS

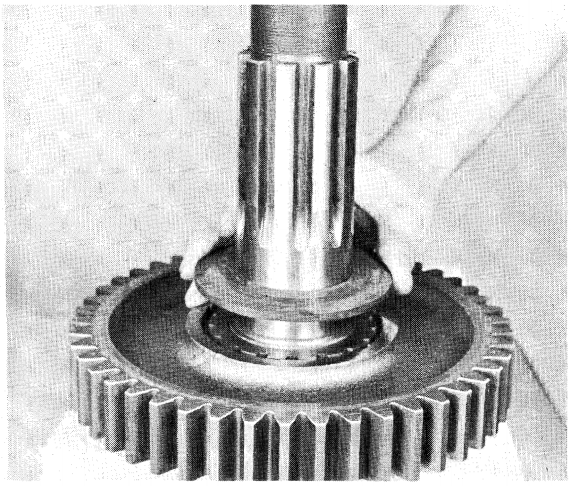
A. Reassembly of the Deep Reduction Gear and Output Shaft Assembly



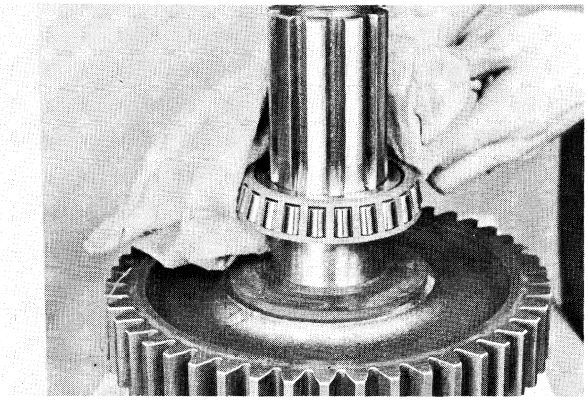
1. Place the output shaft, threaded end up, on blocks to protect the quill and install the splined spacer on shaft, large diameter down.



2. If previously removed, install the snap ring in the groove in deep reduction gear and install the gear on the shaft, snap ring towards the threaded end.

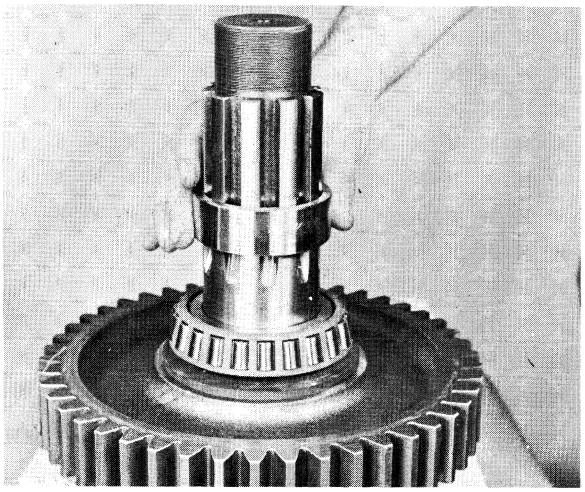


3. Install the rear washer on the shaft, stepped side towards the gear.

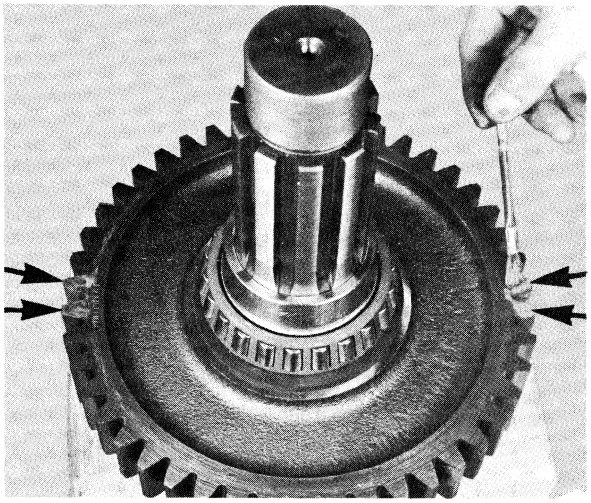


4. Install the front bearing cone on the shaft and against the rear washer. This is a matched bearing; make sure the correct cone and cup are matched.

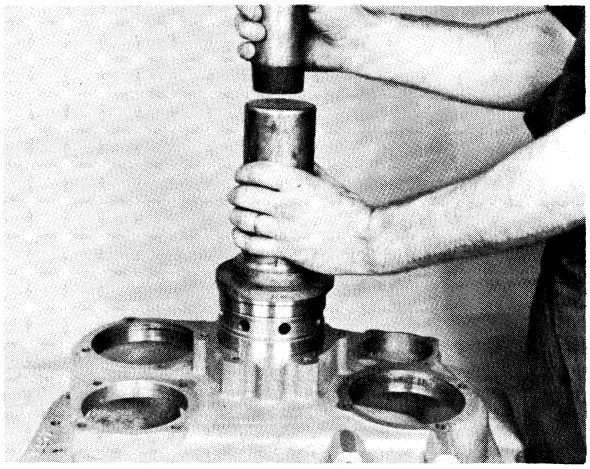
NOTE: Heating of the bearing cones for installation is recommended, provided the bearing is not heated over 275° F.



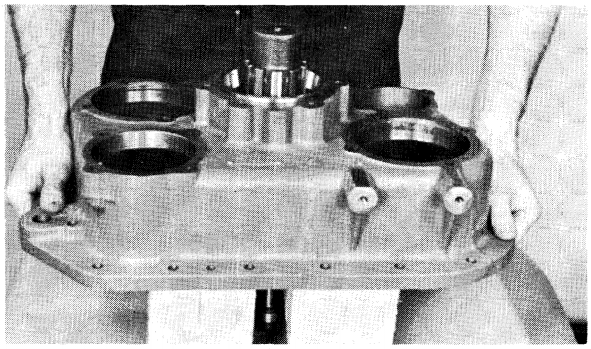
5. Install the bearing inner spacer on the shaft and against the bearing cone.



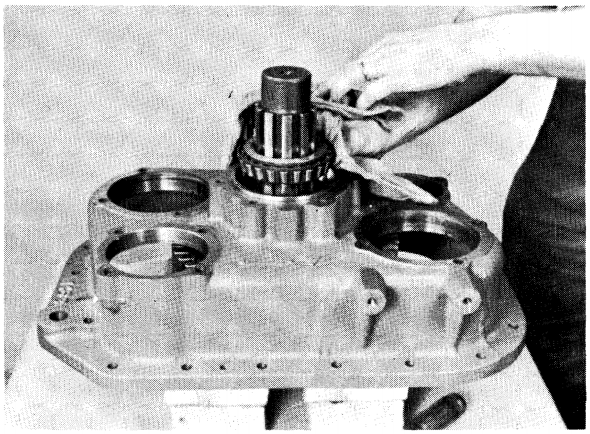
6. Mark any two adjacent teeth on the deep reduction gear and then mark the two teeth directly opposite.



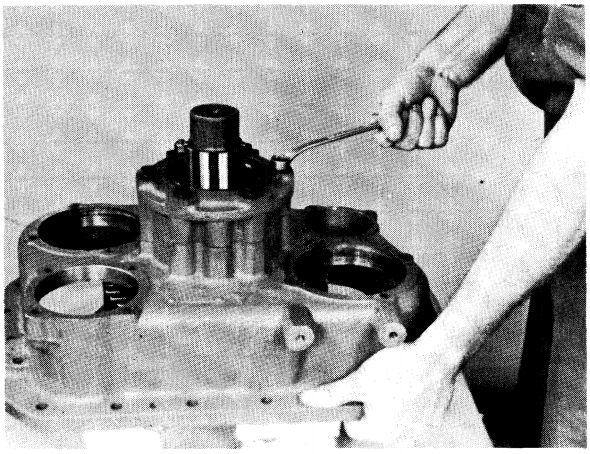
7. Start the front bearing cup into the bore in the rear housing, taper to the inside, and place the outer spacer and rear cup on the front cup and tap the three evenly into the bore until the lip of the rear cup seats against the housing.



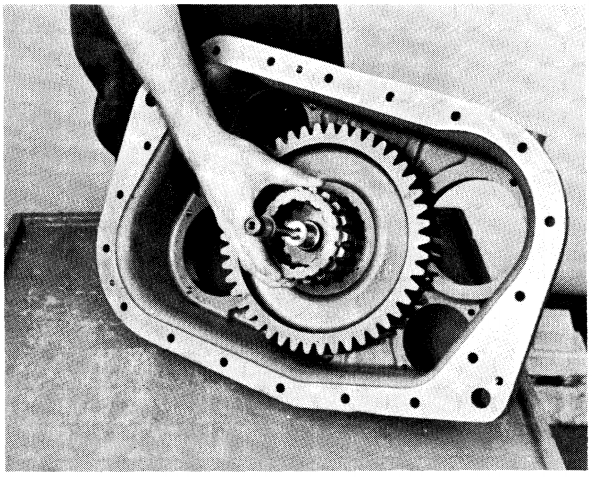
8. Place the rear housing over the output shaft.



9. Heat the rear bearing cone and install cone on the shaft and into the rear cup.

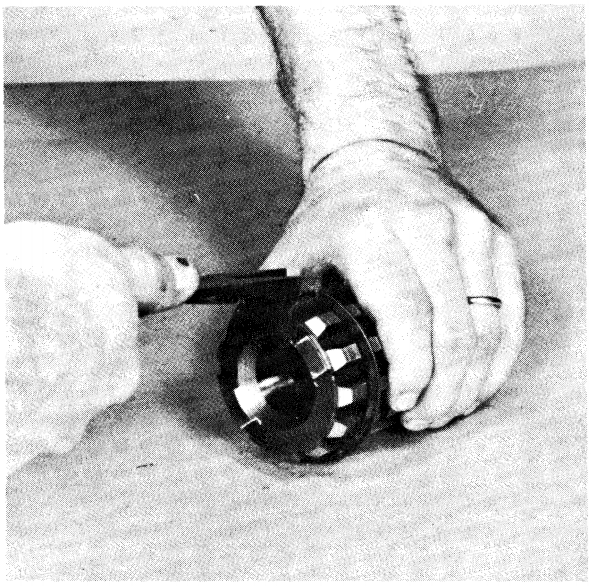


10. If previously removed, install the oil seal in the rear bearing cover and install the cover on the housing, using a brass washer at the speedometer bore.

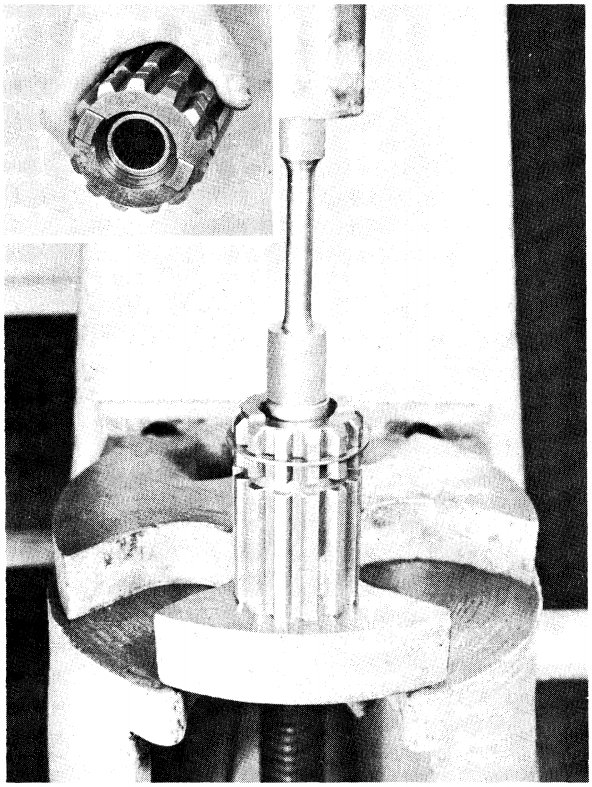


11. Install the sliding clutch gear on the front of the shaft, yoke slot towards the front.

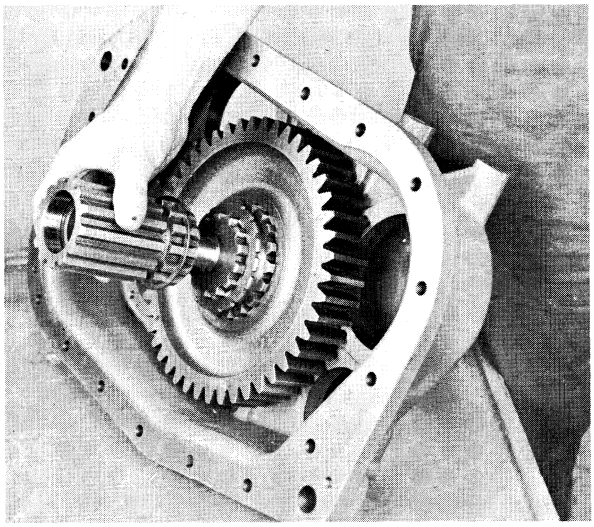
B. Installation of the Range Mainshaft Assembly



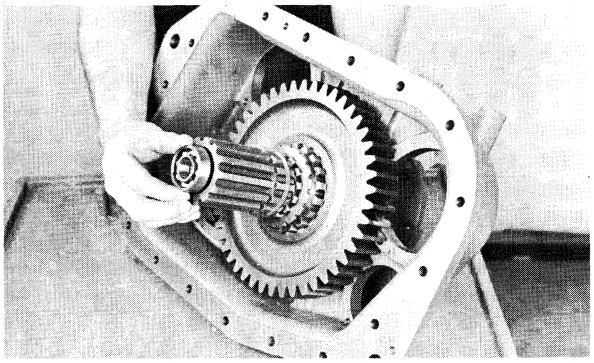
1. Install the snap ring in the groove in the OD of the mainshaft.



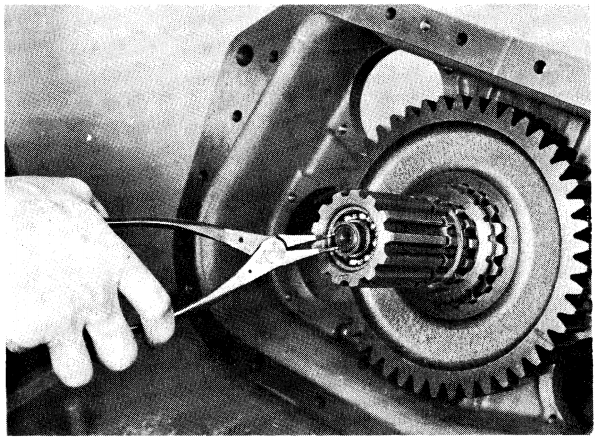
2. Install the bushing in the shaft, positioning halfway on the rear bearing surface. The distance between top of bushing and lug on rear mainshaft should be 7/16".



3. Install the mainshaft on the quill of the output shaft, seating the bushing on the bearing surface of the quill.

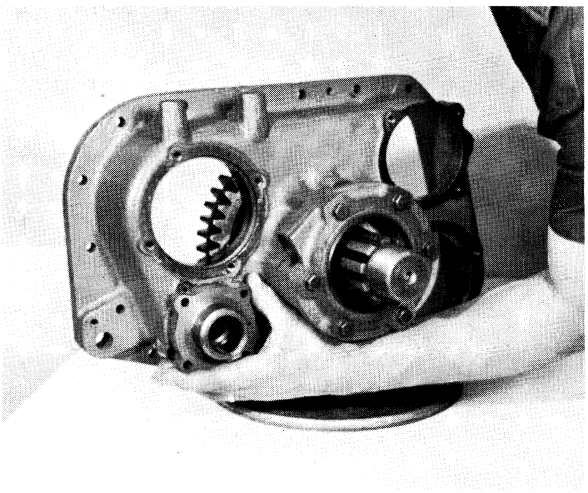


4. Install the front bearing in the mainshaft and on the quill. Seat with a sleeve driver with a diameter slightly larger than the ID of the bearing inner race.

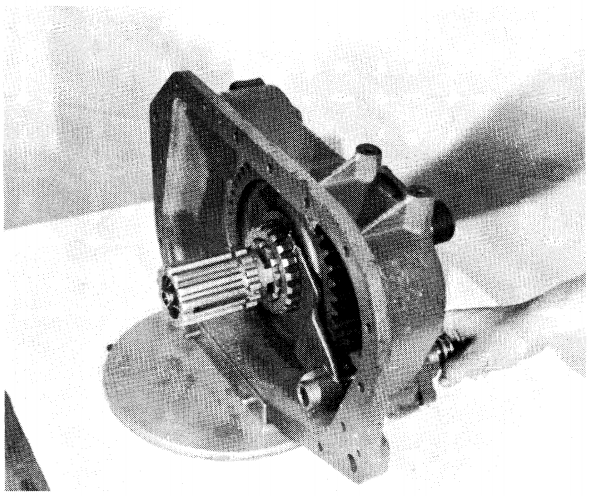


5. Install the snap ring in the groove in the front of the quill.

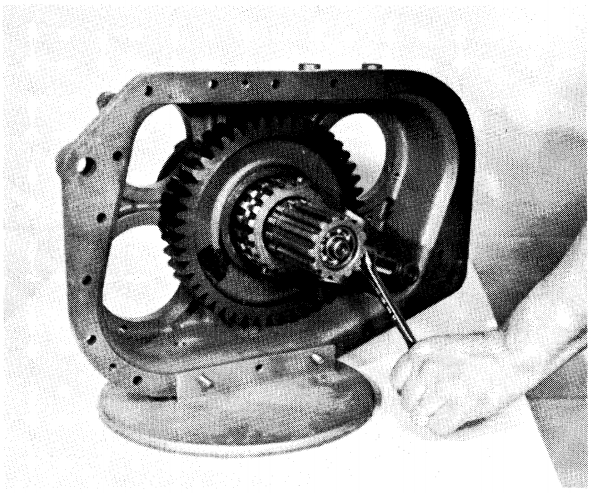
C. Reassembly and Installation of the Deep Reduction Shift Cylinder.



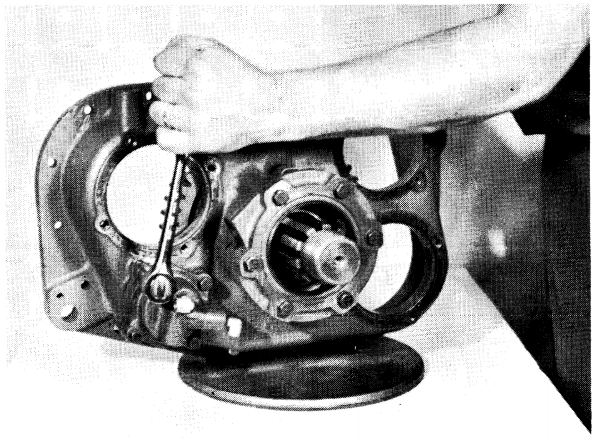
1. Install the O-ring in the bore of the shift cylinder and install the cylinder housing into the auxiliary housing with the small air channel to the right.



2. Install the shift yoke on the sliding clutch with the lockscrew hole to the front and insert the yoke bar from the rear through the shift cylinder and yoke, aligning the indentation in the bar with the lockscrew hole in the yoke.

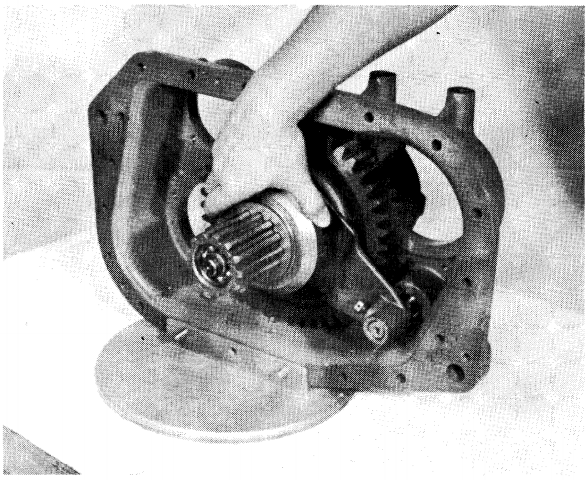


3. Install the yoke lockscrew; tighten and wire securely.

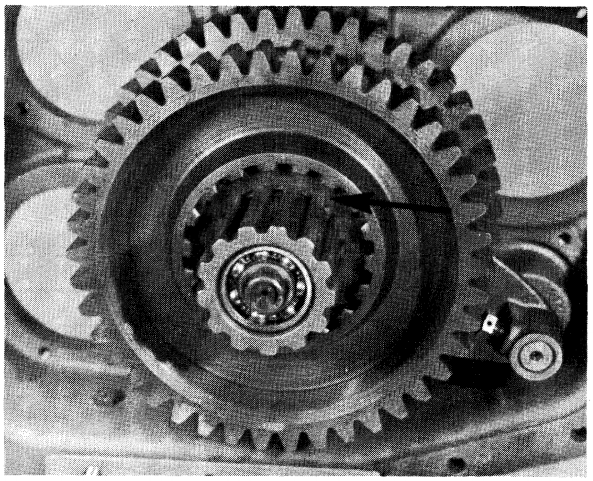


4. Install the cylinder cover, aligning the air channel with the channel in the cylinder housing.

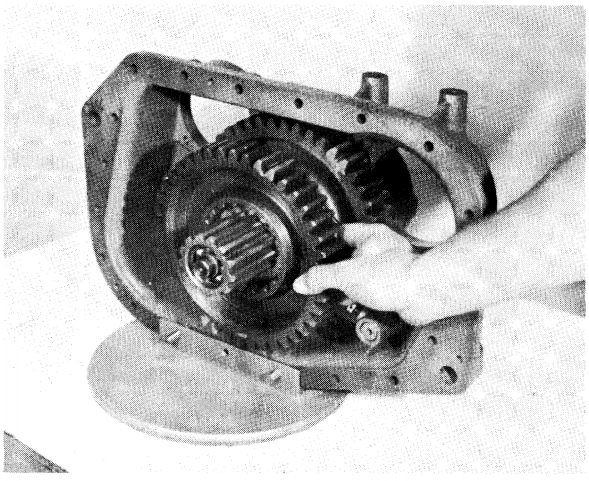
D. Installation of the Low Range Gear



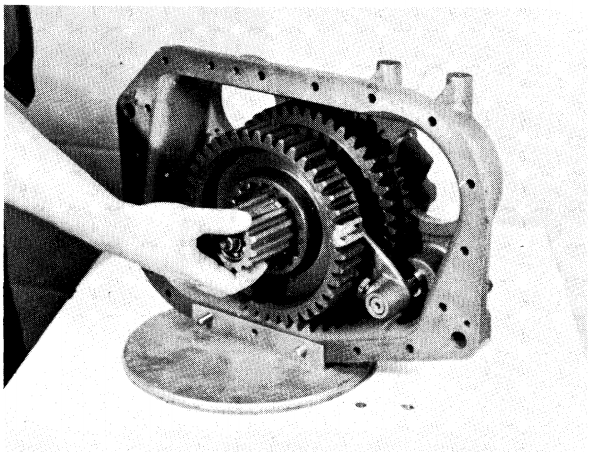
1. Install the coupler on the shaft, large diameter to the rear.



3. Install the low speed gear splined washer on the shaft and against the snap ring in the hub of the gear. Turn the washer to lock the gear on the shaft.

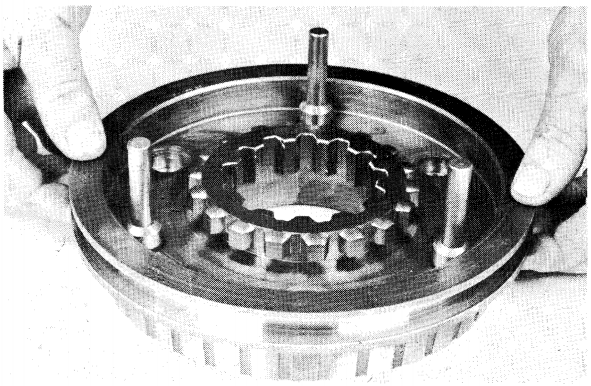


2. If previously removed, install the snap ring in the ID of the low speed gear and install the gear on the shaft and against the coupler, dished side to the front.



4. Install the key in the keyway, inserting the thick end between the splines of the washer.

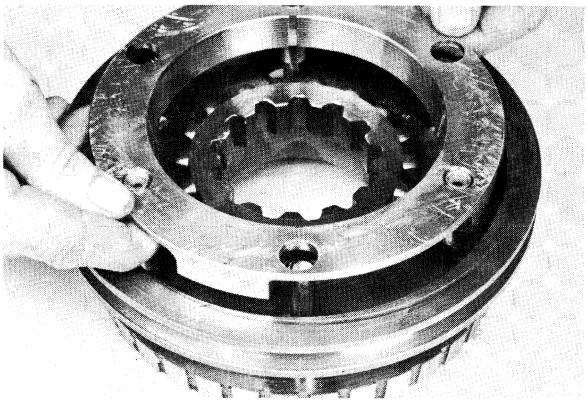
E. Reassembly and Installation of the Synchronizer Assembly



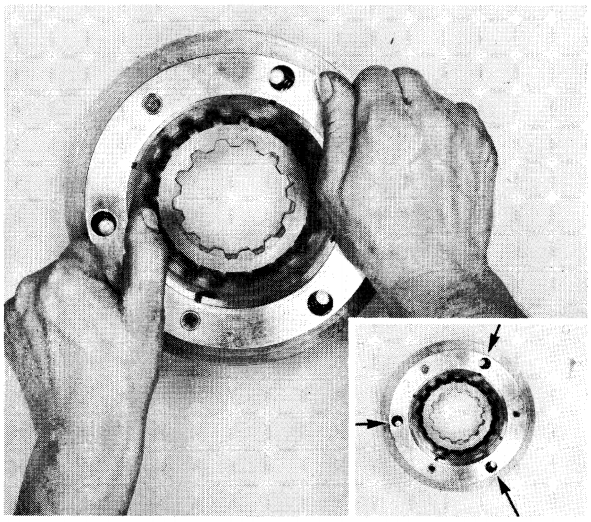
1. Place the larger low speed ring on a workbench with the pins facing up and install the sliding clutch on the pins with the protruding clutching teeth down.



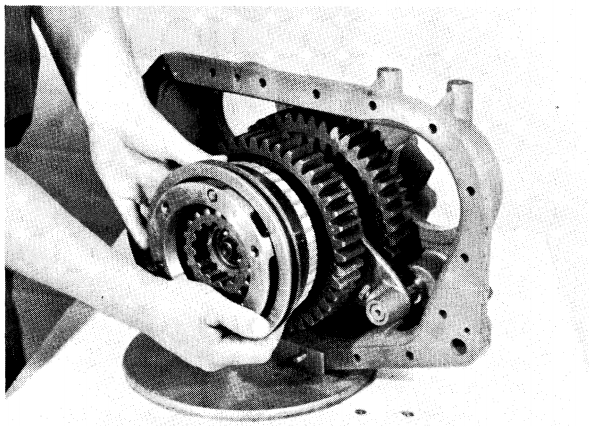
2. Install the three springs in the bores of the direct ring.



3. Place the ring, flat side up, over the pins of the low speed ring.

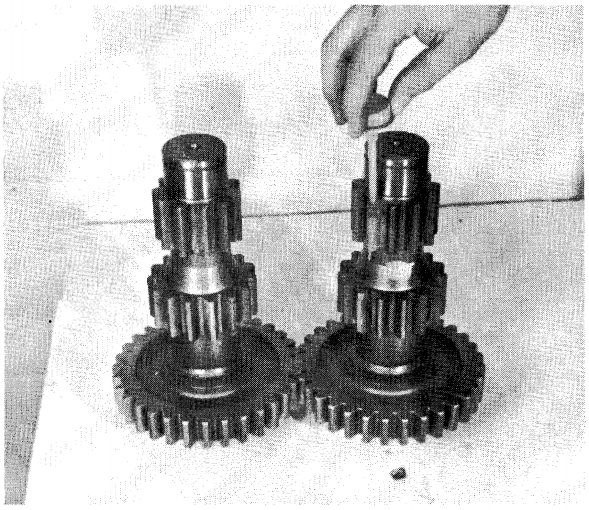


4. Apply pressure to the direct ring so as to compress the springs and seat the pins of the low speed ring into the bores of the direct ring.

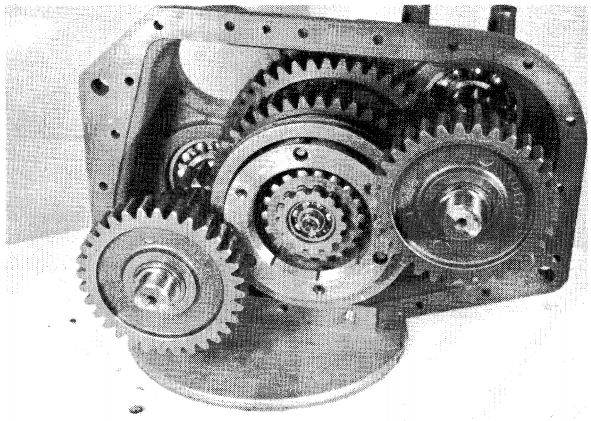


5. Place the synchronizer on the range mainshaft, fitting the low range cone into the mating cone of the low range gear.

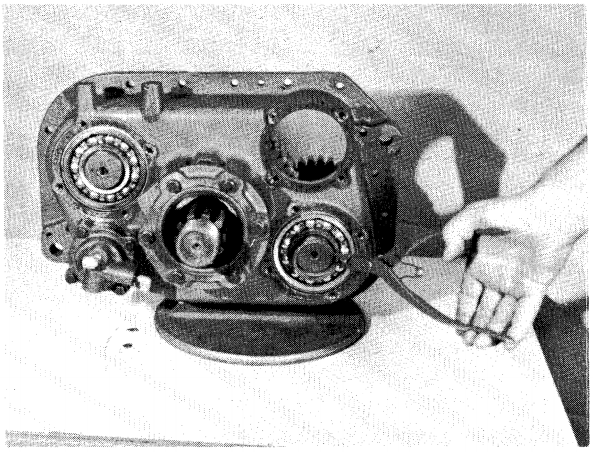
F. Timing and Installation of the Auxiliary Countershafts



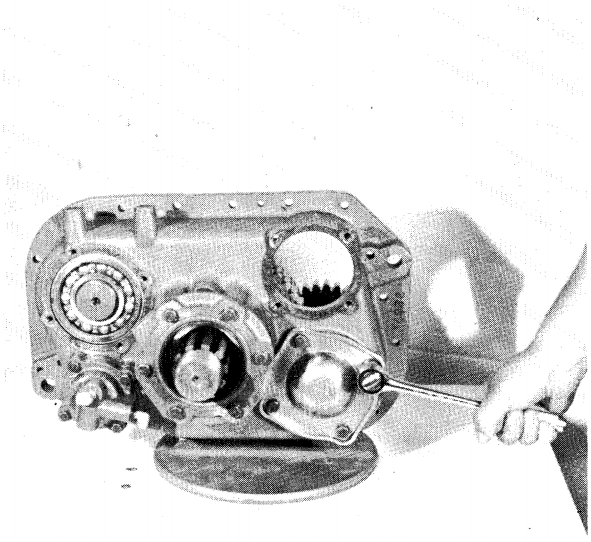
1. On the smallest diameter gear of each countershaft, mark the tooth which is stamped with an "O".



2. Place the countershafts into position, meshing the marked tooth on each countershaft between two of the marked teeth on the deep reduction gear. Block against the front of the countershafts and tap the rear bearings evenly onto the shafts and into the case bores to hold countershafts in position. Use a bearing driver to complete installation of the bearings.

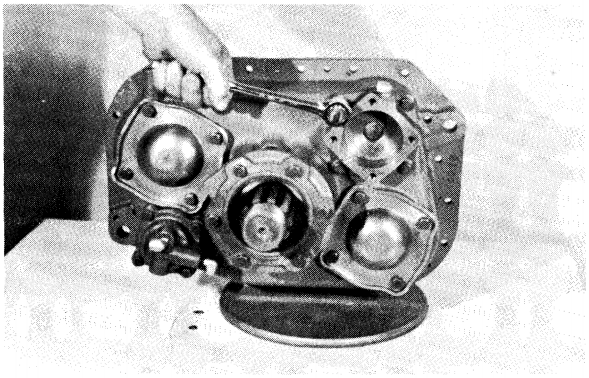


3. Install the snap ring in the groove on the rear of each countershaft.

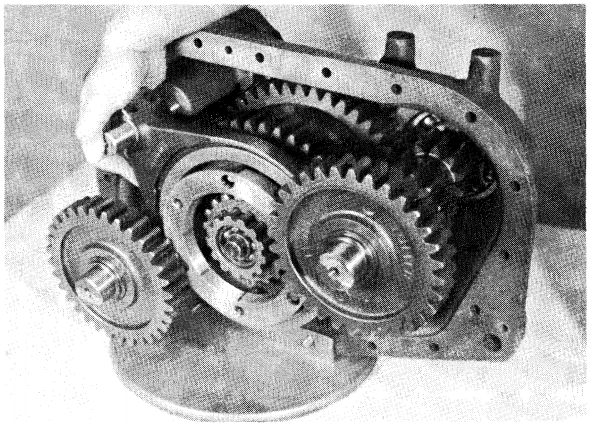


4. Install the two rear bearing covers.

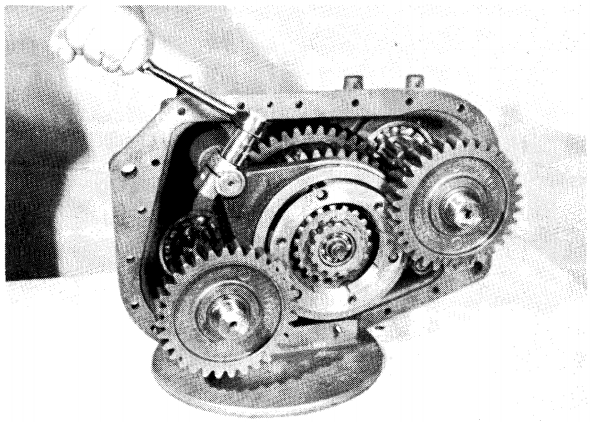
G. Reassembly and Installation of the Range Shift Cylinder



1. Install O-ring in bore of shift cylinder and install the cylinder housing in the rear housing bore with the air line fitting to the top. Secure with the four capscrews.



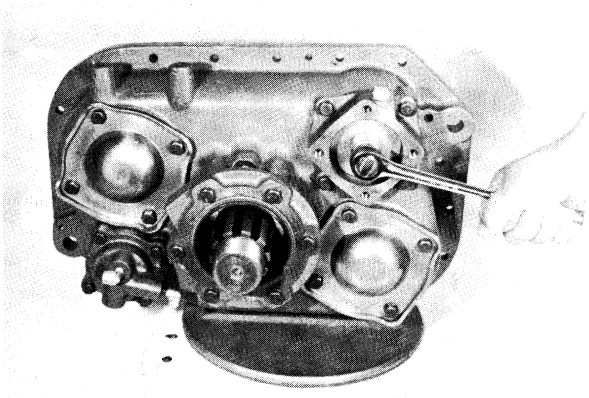
2. Hold the shift yoke in position on the sliding clutch with the long hub to the rear and insert the shift shaft, threaded end first, through the hub and shift cylinder, aligning the slots in the shaft with the lockscrew bores in the yoke hub.



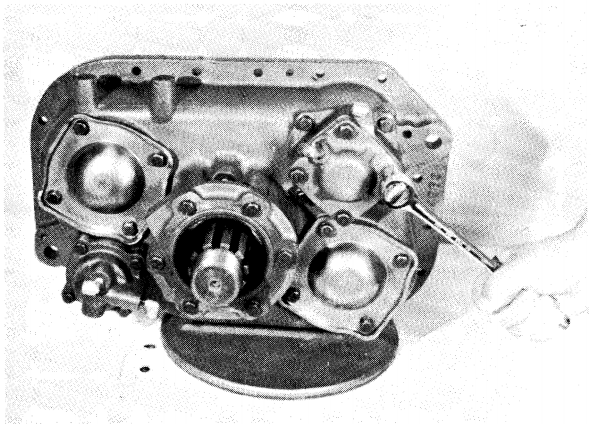
3. Install the two yoke lockscrews; tighten and wire securely.



4. Install O-rings in the OD and ID of the piston and install the piston on the shaft, flat face out.



5. Install the elastic stop nut on the end of the shaft; tighten securely with 80-90 ft./lb. of torque.

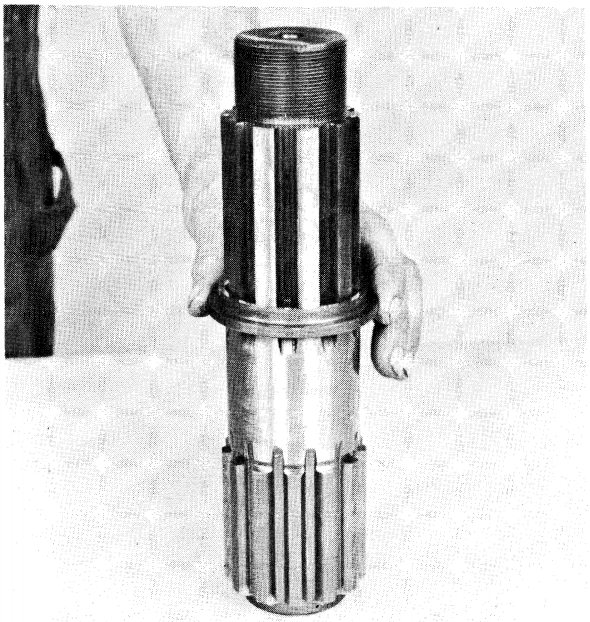


6. Install the cover on the shift cylinder with the air line fitting to the top left.

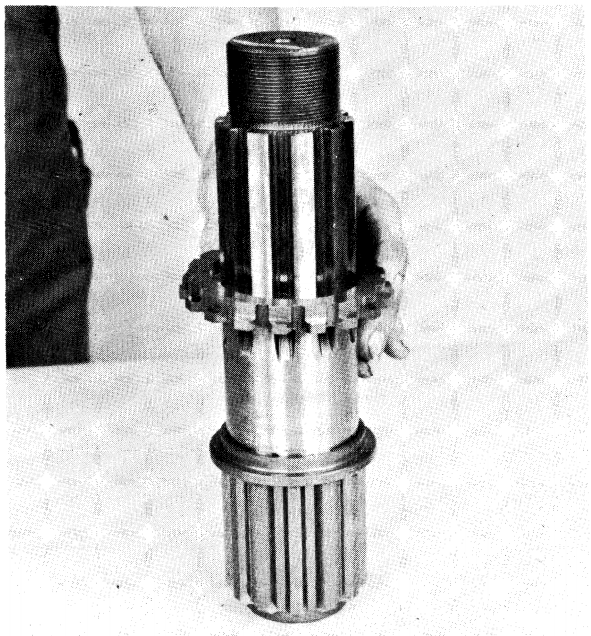
CAUTION: If a gasket is used which requires shellac or permatex, USE ONLY A VERY SMALL AMOUNT to prevent clogging of cylinder air ports or damage to O-rings.

II. AUXILIARY SECTION RT-910 MODELS

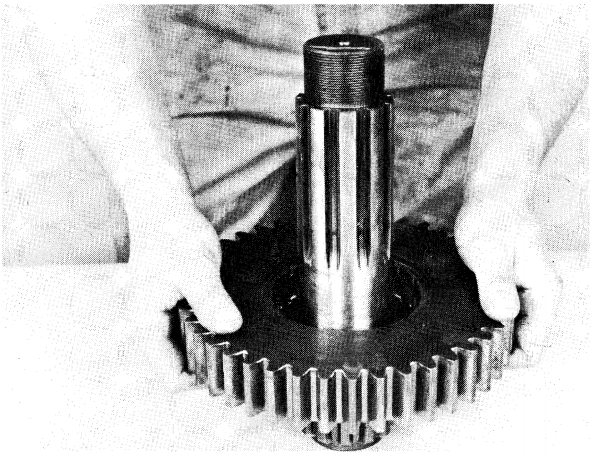
A. Reassembly of the Low Speed Gear and Rear Bearing Assembly



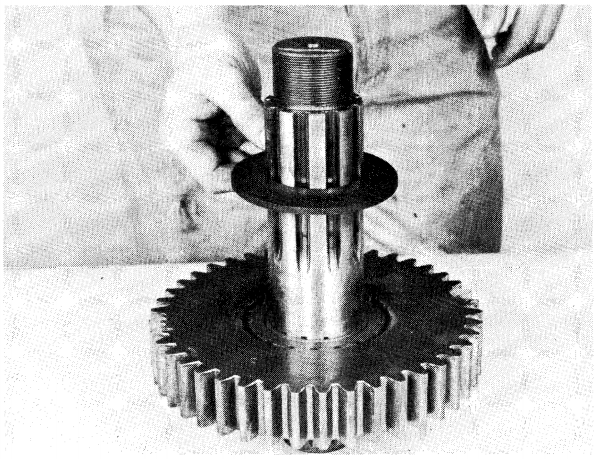
1. Set the output shaft on bench with threaded end up and install the stepped washer, large diameter down.



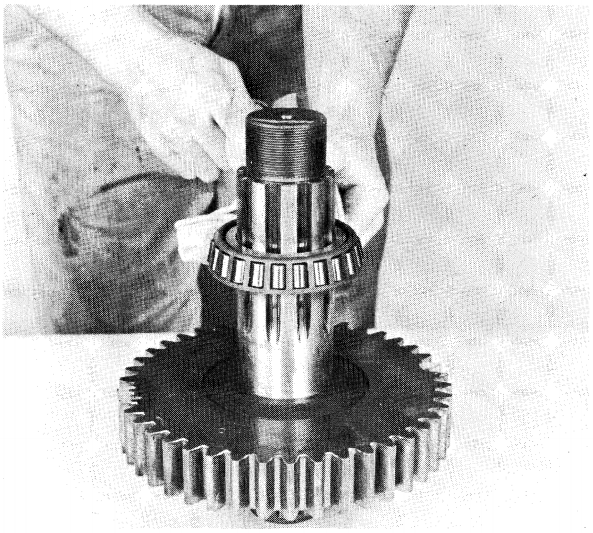
2. Install the splined spacer on the shaft, large diameter down.



3. If previously removed, install the snap ring in the ID of the low speed gear and install the gear on the shaft, flat side up.

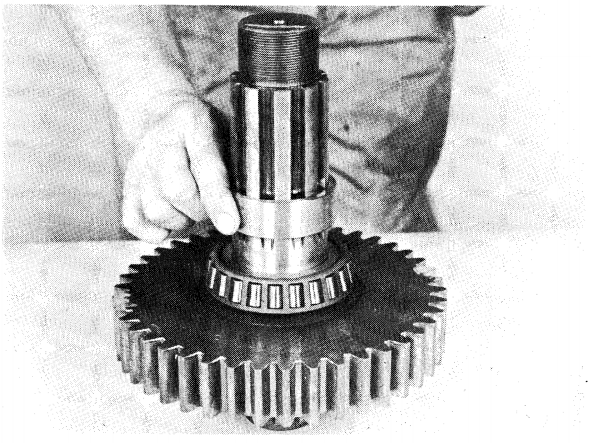


4. Install the washer on the shaft.

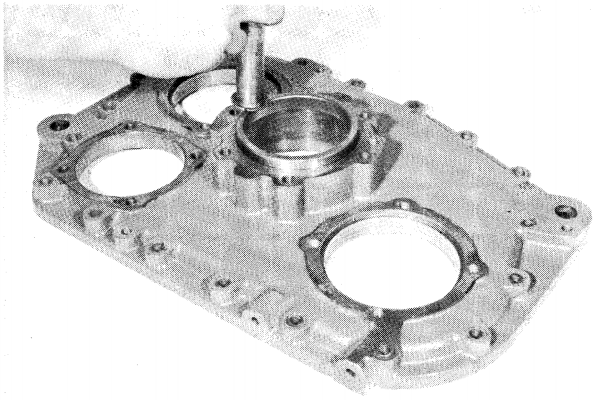


5. Install the front bearing cone on the shaft and against the washer, taper up. Bearing is a matched set; make sure correct cone for cup is used as indicated by markings.

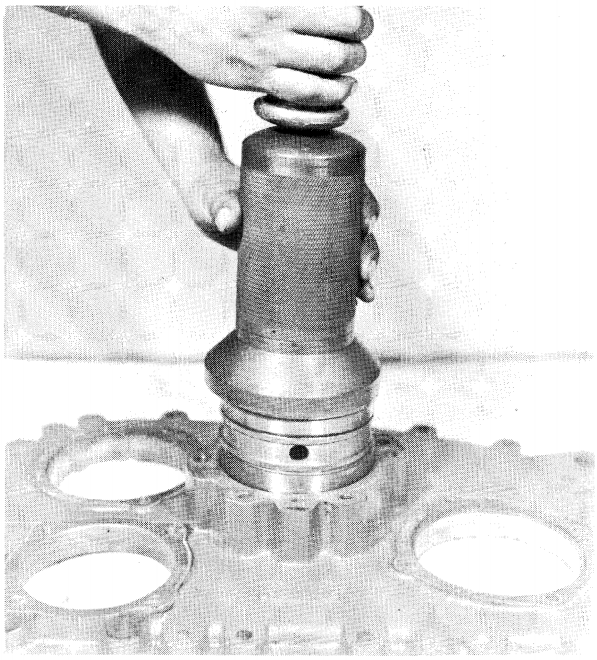
NOTE: Heating of bearing cones for installation is recommended, provided the bearing is not heated over 275° F. Heat lamps are recommended as heat source.



6. Install the bearing inner spacer on the shaft.

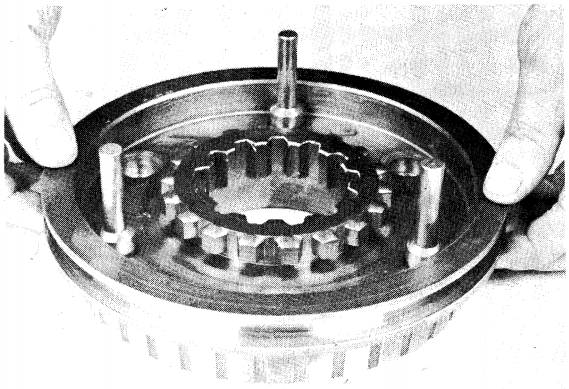


7. Place the front cup of the rear bearing into the rear of the housing bore, taper to the inside.

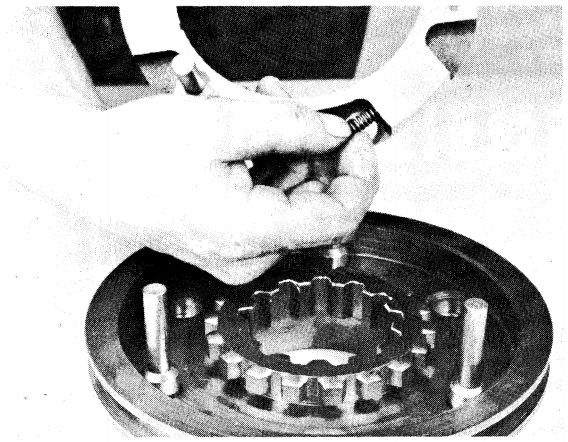


8. Place the bearing outer spacer on the cup and place rear cup on the spacer. Tap the two cups and spacer evenly into the rear bore until the lip of the rear cup seats on the housing.

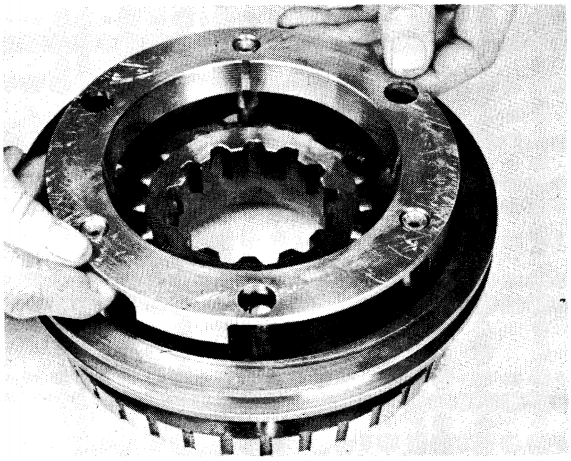
B. Reassembly and Installation of the Synchronizer Assembly



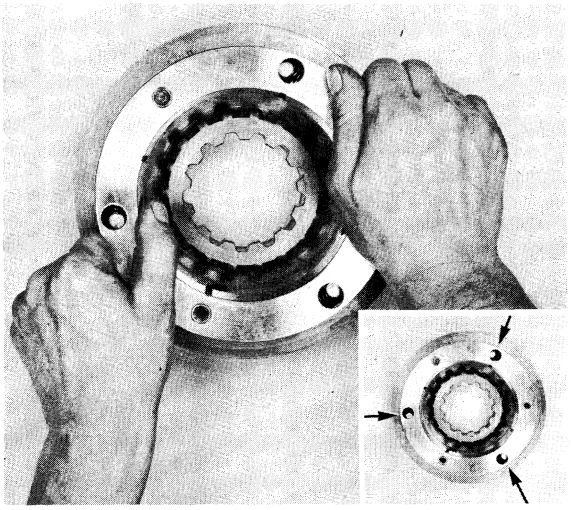
1. Place the larger low speed ring on the bench with the pins upward and install the sliding clutch on the ring, protruding clutching teeth down.



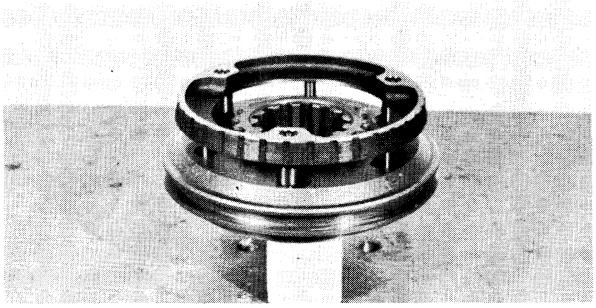
2. Install the three springs in the direct ring.



3. Install the direct ring on the low speed ring pins, seating the springs against the pins.

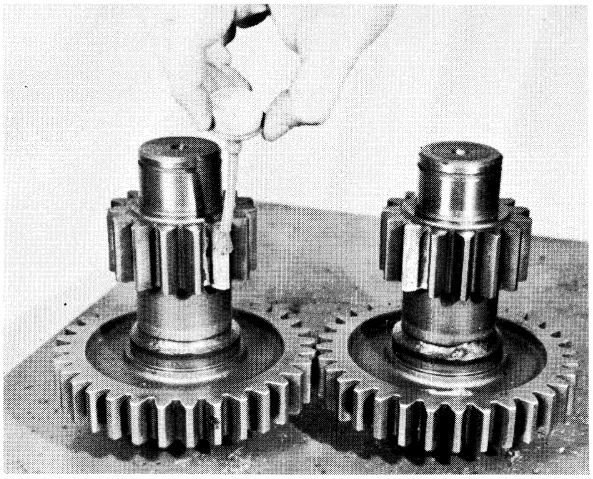


4. Apply pressure to the direct ring while twisting counterclockwise to fully seat the direct ring on the low speed ring pins.

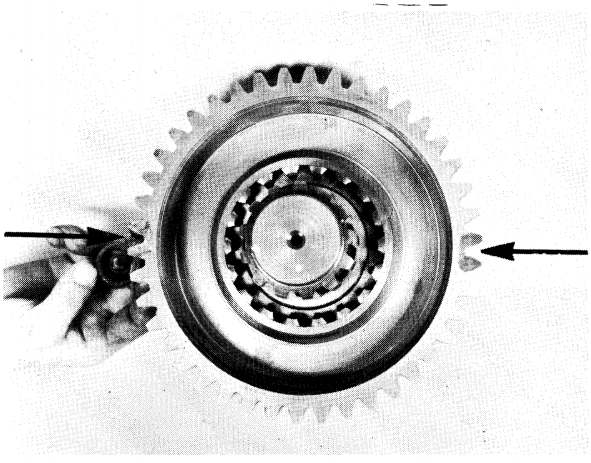


5. Set the synchronizer assembly on blocking approximately 2″ high on a bench large enough to accommodate the rear housing.

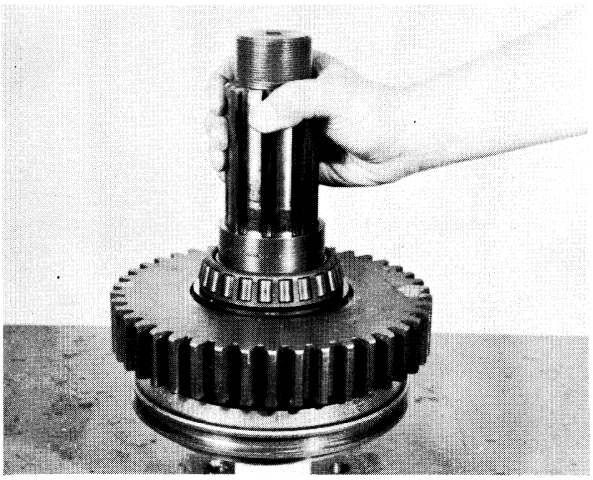
C. Timing and Installation of the Auxiliary Countershafts and Output Shaft



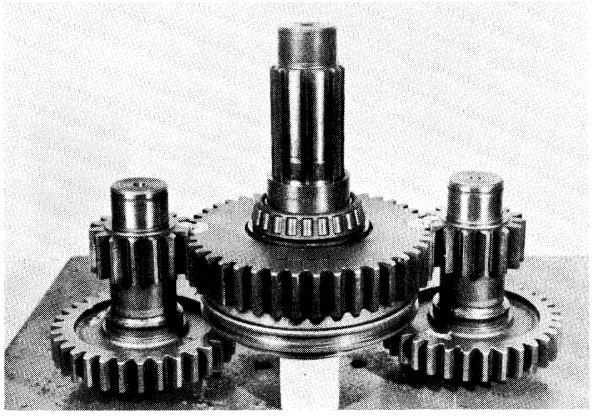
1. On the small diameter low range gear of each countershaft, mark the tooth which is stamped with an "O".



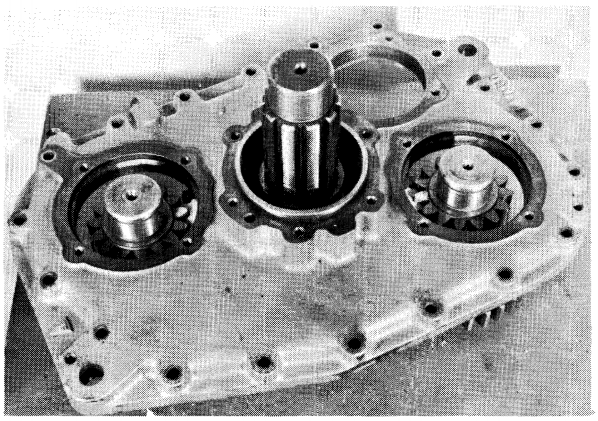
2. Mark any two adjacent teeth on the low speed gear and then mark the two teeth directly opposite.



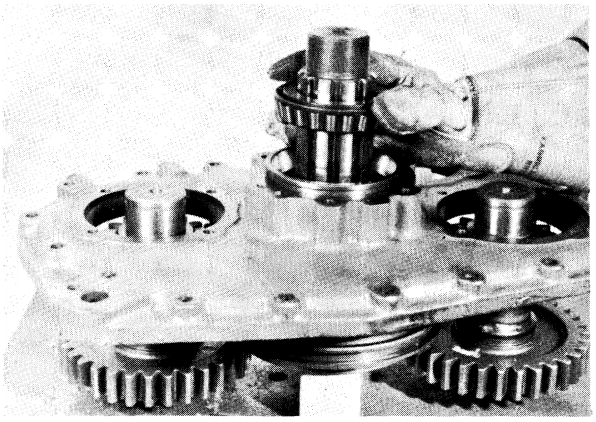
3. Install the output shaft assembly on the synchronizer, meshing the splines of the shaft with the synchronizer.



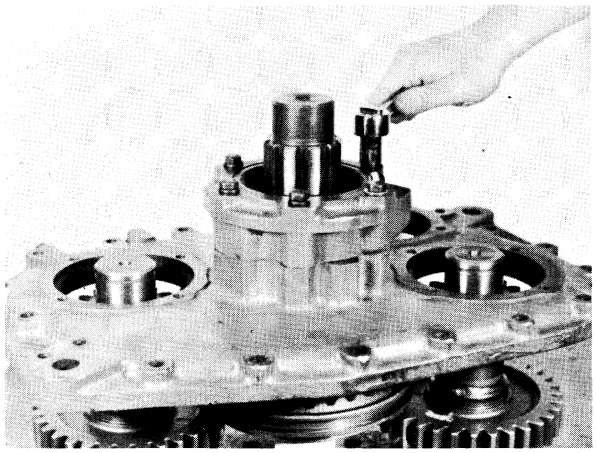
4. Place the countershafts into position against the output shaft, meshing the marked tooth on each countershaft between a set of marked teeth on the low speed gear.



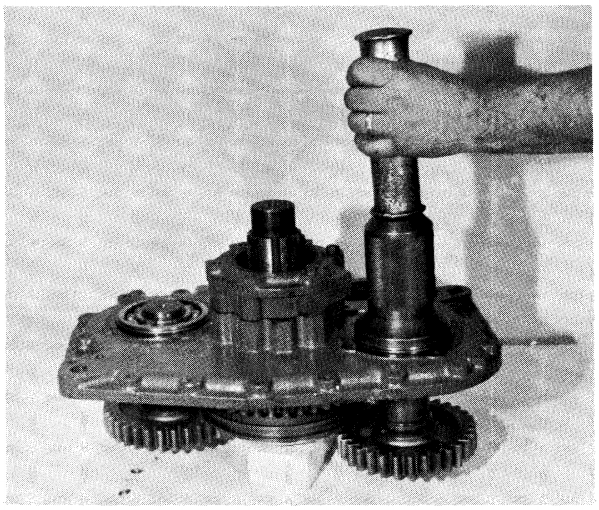
5. Place the auxiliary housing down over the assembly, centering the countershafts in the rear bearing bores.



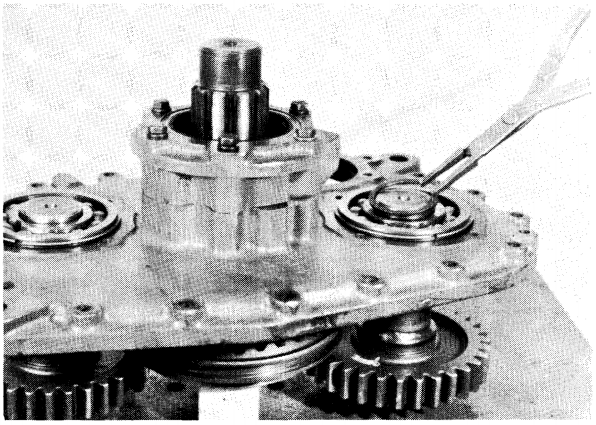
6. Heat the rear bearing cone and install it on the output shaft, taper facing down.



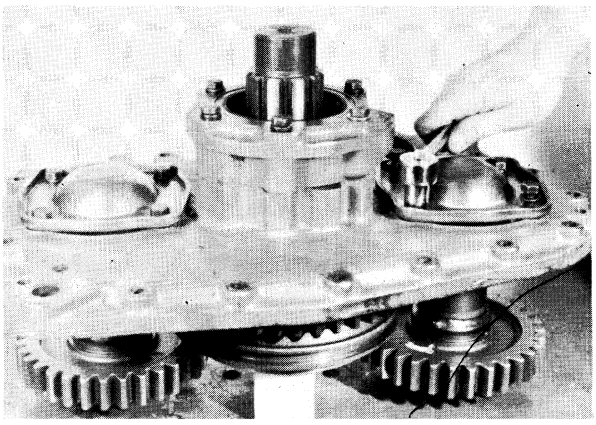
7. If previously removed, install the oil seal in the rear bearing cover and install the cover on the rear housing. The capscrew with the brass washer is installed in the hole intersecting the speedometer bore.



8. Install the countershaft rear bearings on the shafts and in the bores.

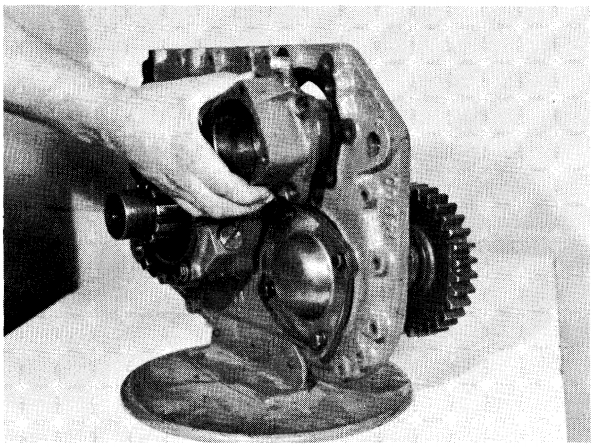


9. Install the snap ring in the rear of each countershaft.

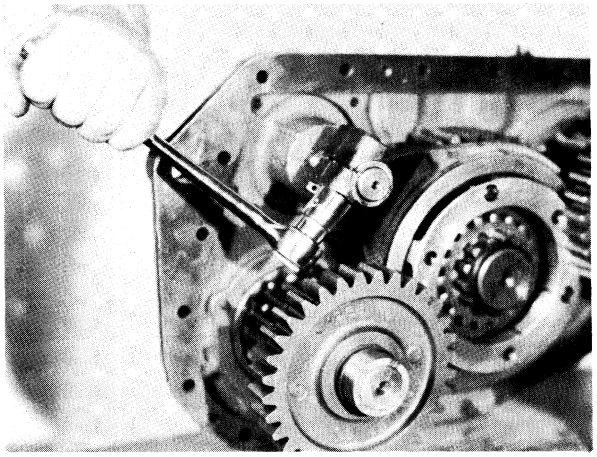


10. Install the rear bearing covers.

D. Installation of the Range Shift Cylinder Assembly



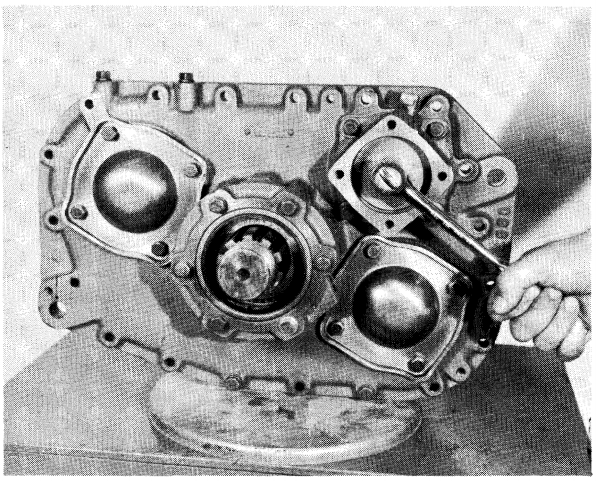
1. Install the housing in a vise in the upright position. Install O-ring in the cylinder bore and secure the housing to the rear housing with four capscrews. The air line fitting is to the top.



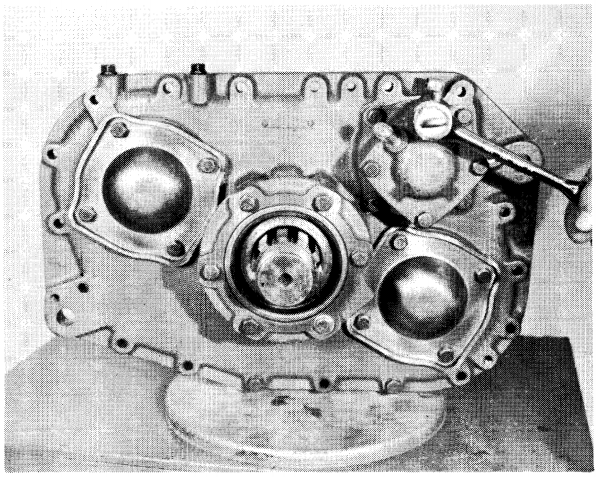
2. Hold the shift yoke in position in the sliding clutch slot, long hub to the front, and insert the shift shaft through the yoke hub and shift cylinder threaded end first. Align the slots in the shaft with the lockscrew bores in the yoke hub. Insert two yoke lockscrews; tighten and wire securely.



3. Install the O-rings in the OD and ID of the piston.



4. Install the piston on the shaft, flat side out, and secure with the elastic stop nut.

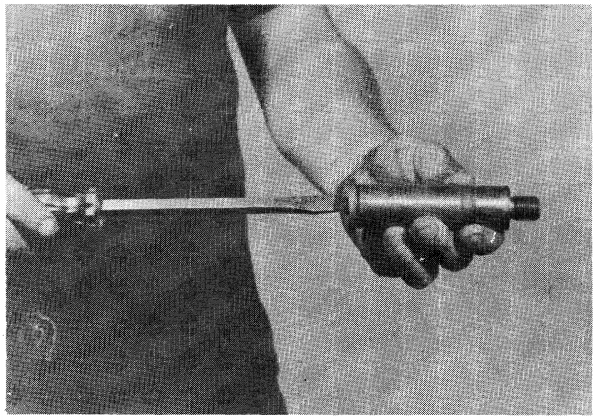


5. Install the shift cylinder cover with the air line fitting to the top left.

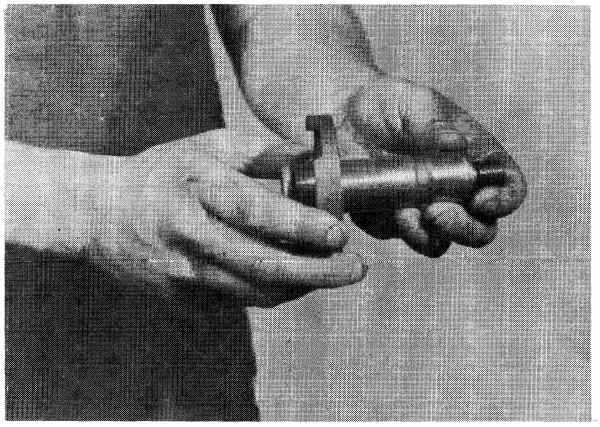
III. FRONT SECTION

A. Reassembly and Installation of the Right Reverse Idler Gear Assembly

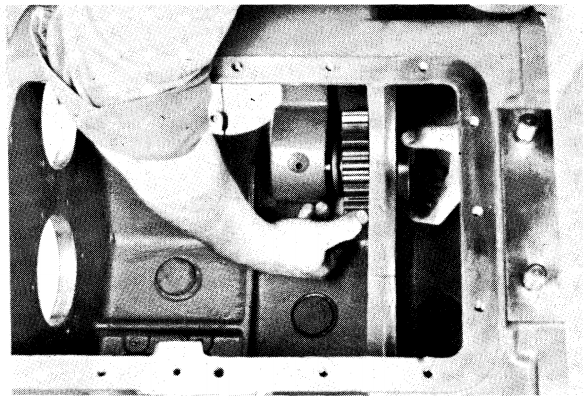
NOTE: Before starting reassembly, check to make sure that all three magnetic discs are solidly in place in the bottom of the case. These can be installed with "3M Brand" adhesive, No. EC 1300.



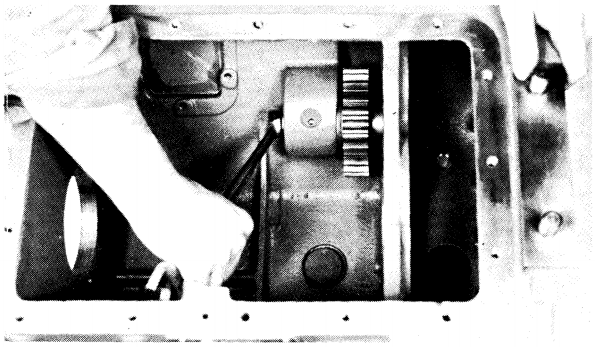
1. Install the plug in the end of the reverse idler shaft.



2. Install the idler gear washer on the shaft and if previously removed, press the needle bearing into the bore of the idler gear.



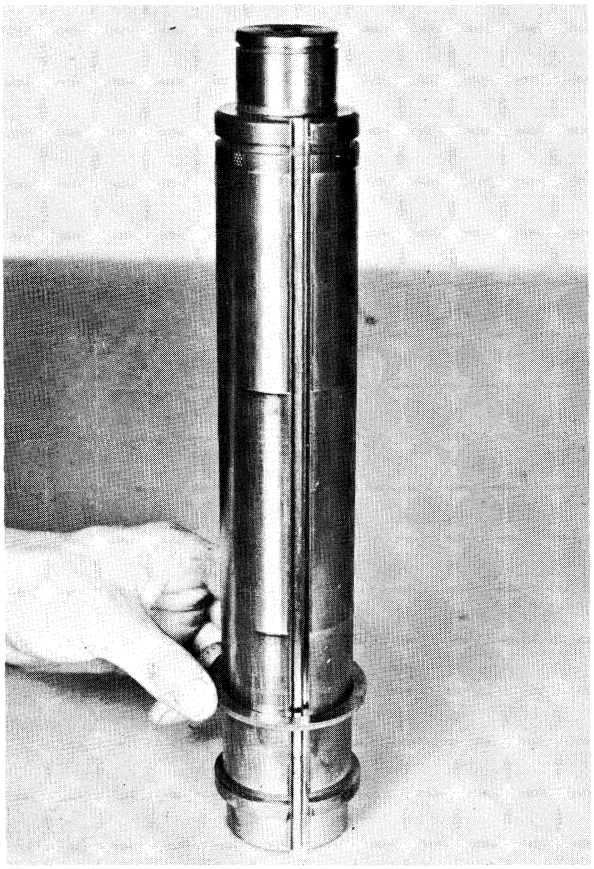
3. If previously removed, install the bearing inner race on the shaft and insert the shaft, threaded end first, into the lower right wall of the case. As the shaft is moved forward, install the reverse idler gear and thrust washer on the shaft, seating the gear on the bearing inner race. Washer is positioned between the gear and the boss in the case.



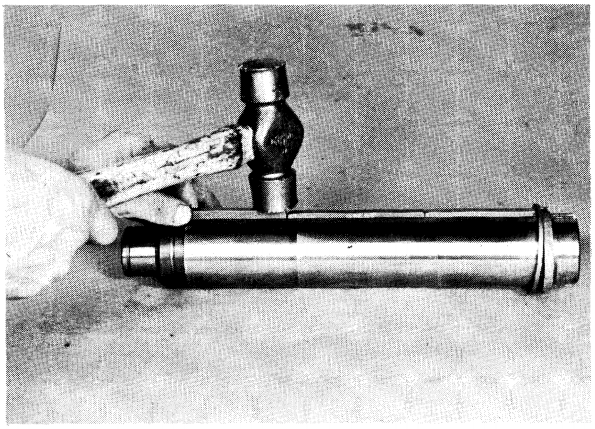
4. Seat shaft securely in the bore - MAKE SURE NEEDLE BEARINGS ARE LOCATED ON INNER RACE BEFORE MOVING THE SHAFT FORWARD. Secure the shaft with the washer and elastic stop nut.

B. Reassembly of the Countershaft Assemblies

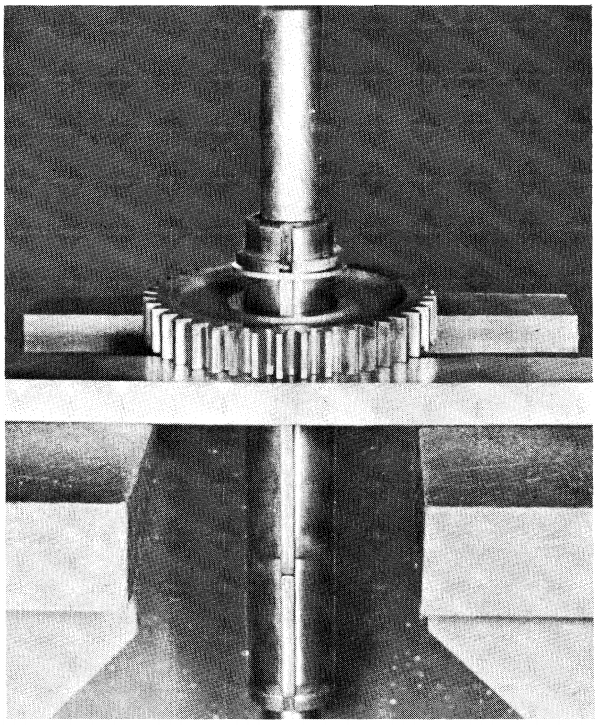
NOTE: Except for the number of teeth on the PTO gears, countershafts are identical and assembled in the same manner.



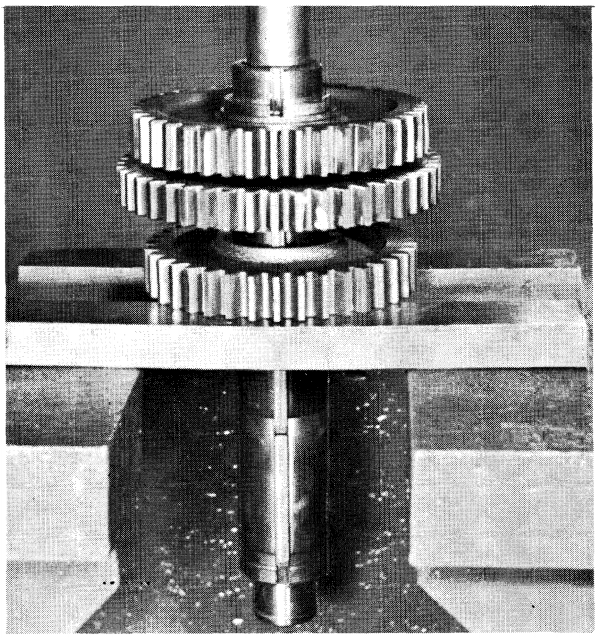
1. Install the spacer over the rear of the countershaft and move forward against the shoulder at the front of the shaft.



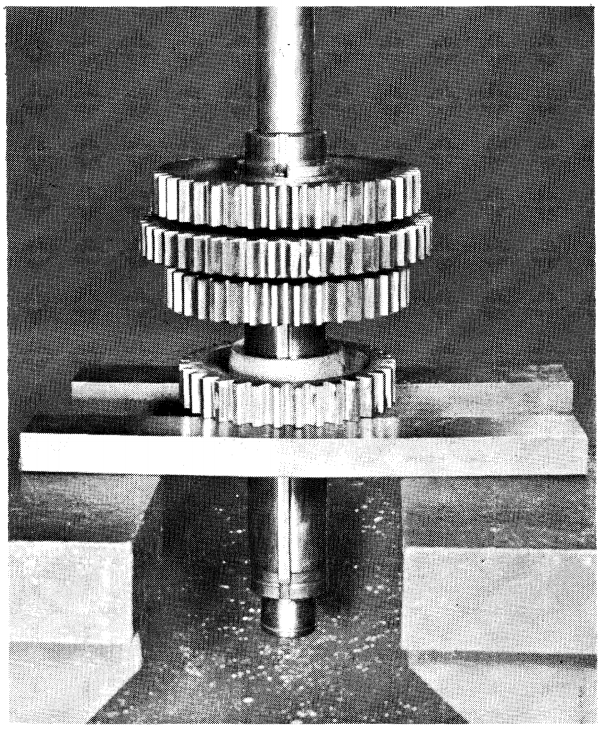
2. Install the key in the slot in the shaft.



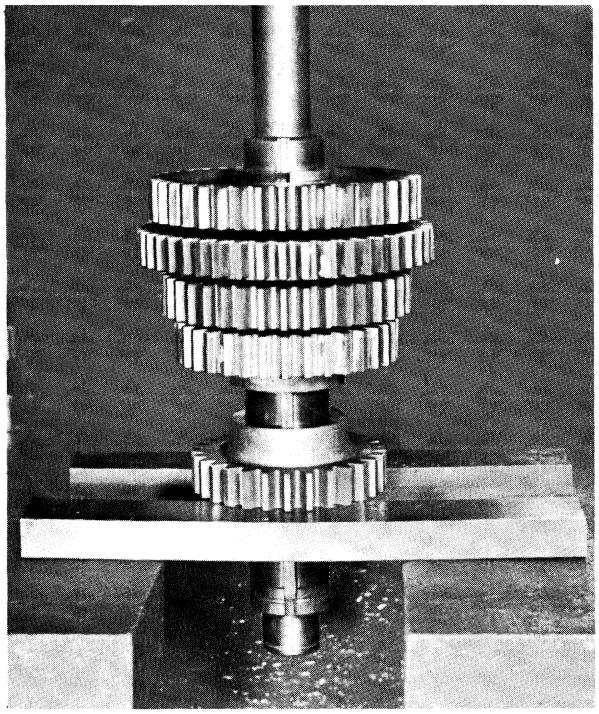
3. Align the keyway in the gear with the key and press the drive gear on the shaft. Seat against the spacer with the long hub of the gear to the rear.



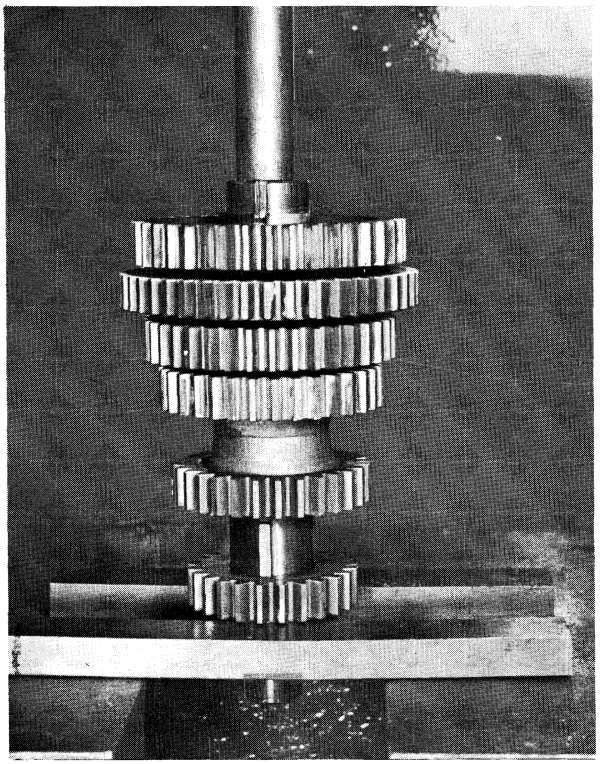
4. Press the PTO gear on shaft, bullet nose of the teeth to the rear and press the 4th speed gear on the shaft, long hub to the front.



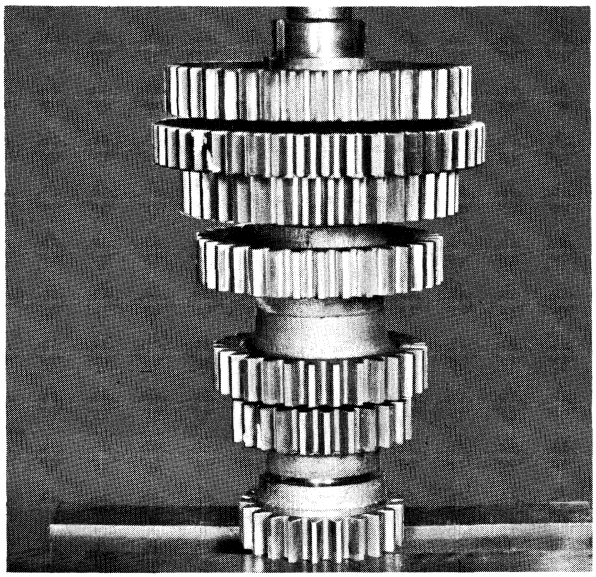
5. Press the 3rd speed gear on the shaft, long hub to the rear.



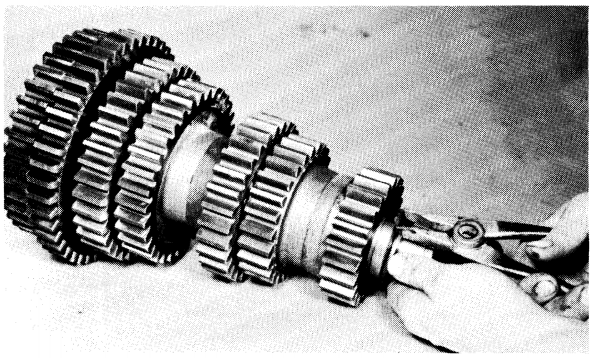
6. Press the 2nd speed gear on the shaft, long hub to the front.



7. Press the 1st speed gear on the shaft, long hub to the rear.

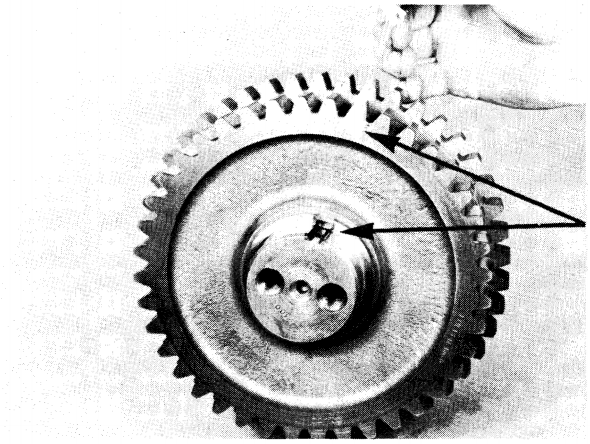


8. Press the reverse gear on the shaft, long hub to the front.



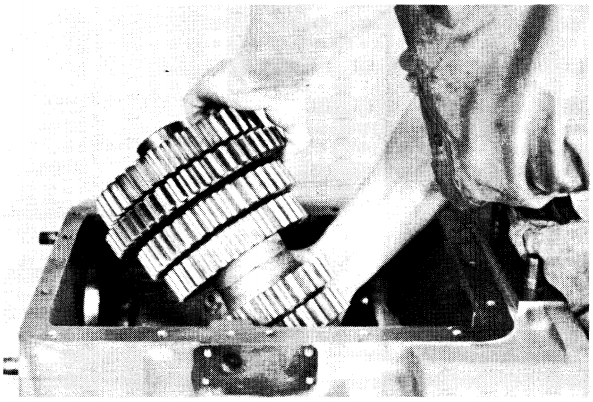
9. Install the snap ring in the groove at the rear of the countershaft.

C. Timing and Installation of the Countershaft Assemblies

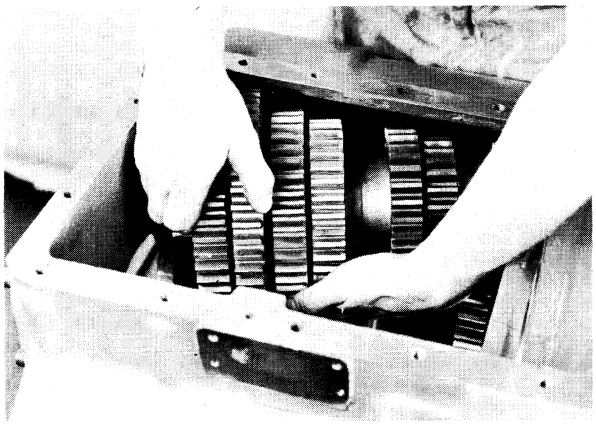


1. On the drive gear of each countershaft, mark the gear tooth which aligns with the keyway in the shaft. This tooth will be stamped with an "O".

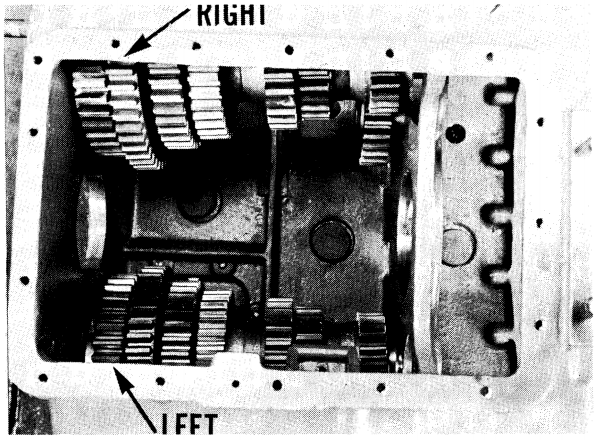
NOTE: The left-side countershaft takes a 47-tooth PTO gear; the right side countershaft takes a 45-tooth PTO gear.



2. Place the left countershaft into position in the case, but do not install bearings. Make sure the left countershaft has the larger 47-tooth PTO gear.

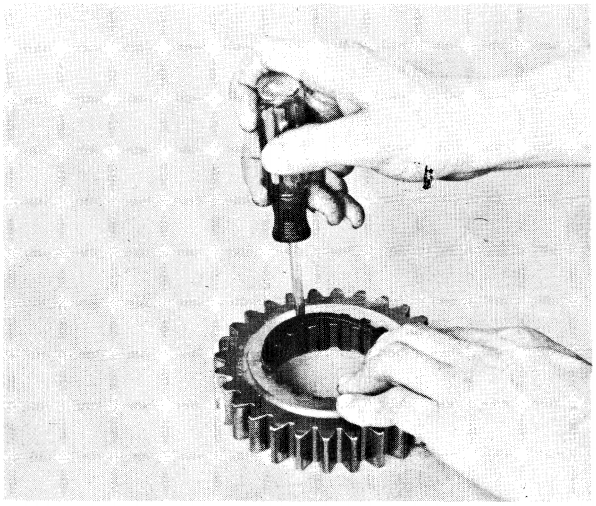


3. Place the right countershaft into position in the case, but do not install bearings. Make sure that the right countershaft has the smaller 45-tooth PTO gear.

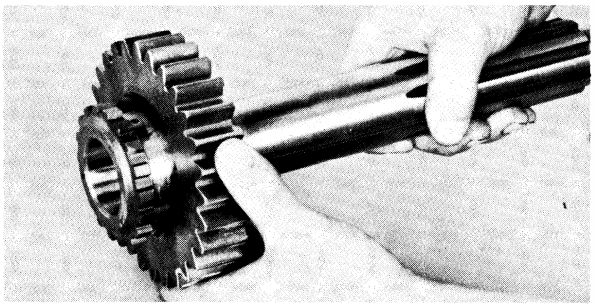


4. Countershafts will now be in approximate position but without bearings.

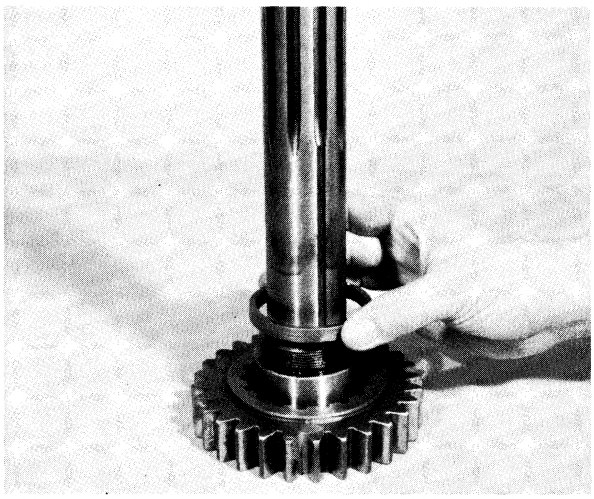
D. Reassembly of the Drive Gear Assembly



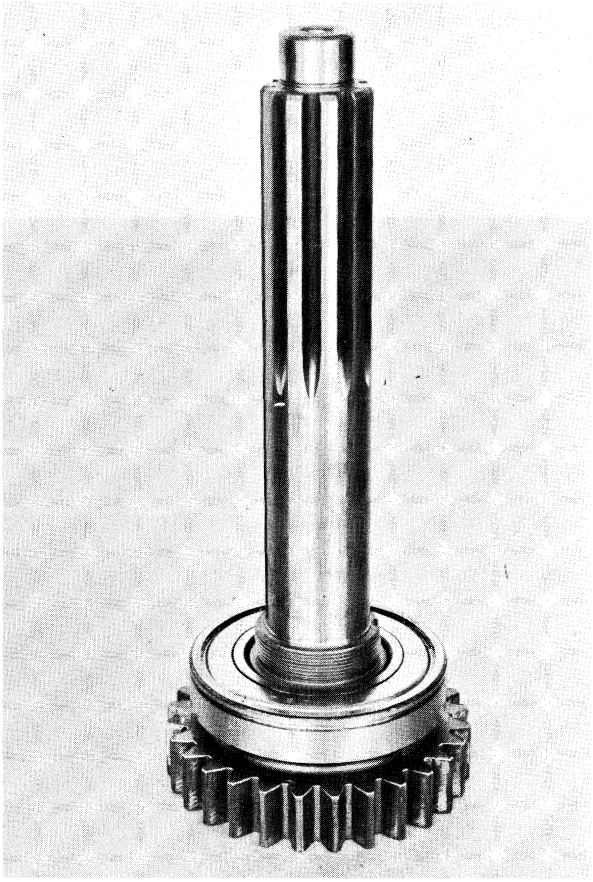
1. Install the snap ring in the groove in the ID of the drive gear.



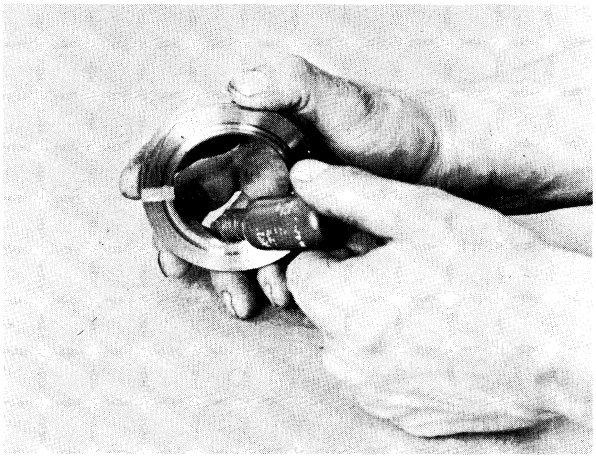
2. Install the drive gear on the shaft, engaging the internal splines of the gear with the teeth on the shaft, snap ring of gear towards the front.



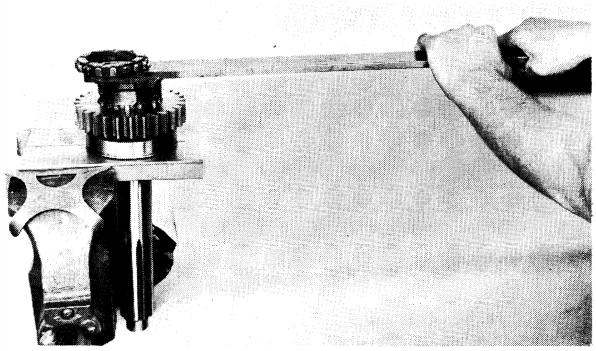
3. Install the drive gear spacer on the shaft and against the gear.



4. Press the drive gear bearing on the shaft with the shield to the front.

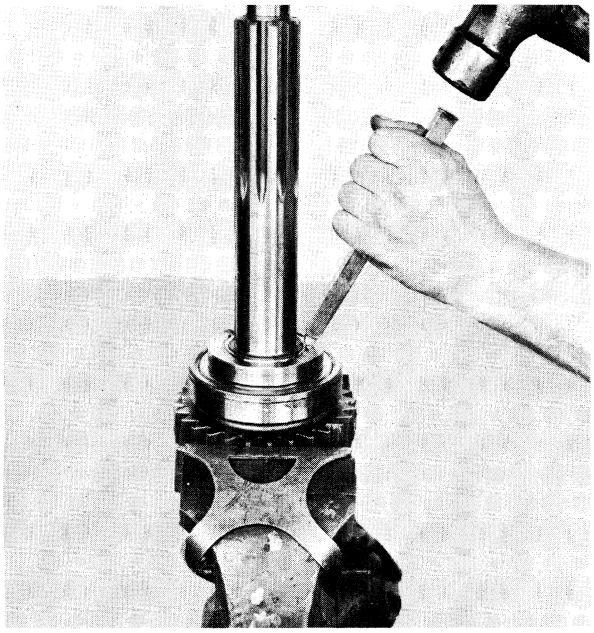


5. Apply Grade AV Loctite to the threads of the shaft and nut.



6. Install the bearing nut on the shaft, LH thread, with 250-300 ft.-lbs. of torque. Wipe off excess Loctite.

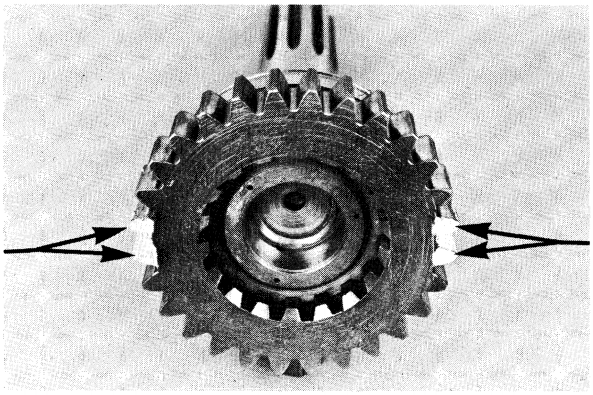
NOTE: If torque wrench is not available, torque can be approximated by multiplying the pounds of pull times the length of the wrench handle. For example: If there are 150 pounds of pull on a wrench with a two foot handle, multiply 150 × 2 which equals 300 ft.-lbs. of torque. Ordinary pull scales can be used to measure pounds of pull.



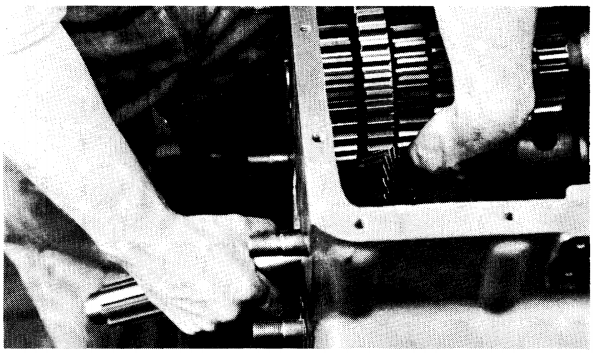
7. Peen the nut into the two milled slots of the shaft.

NOTE: To hasten hardening of the Loctite, place the assembly under heat lamps 10 to 15 minutes.

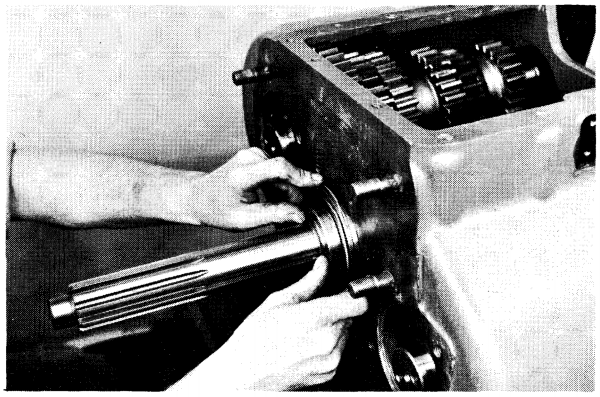
E. Timing and Installation of the Drive Gear Assembly



1. Mark any two adjacent teeth on the drive gear and then mark the two teeth directly opposite.

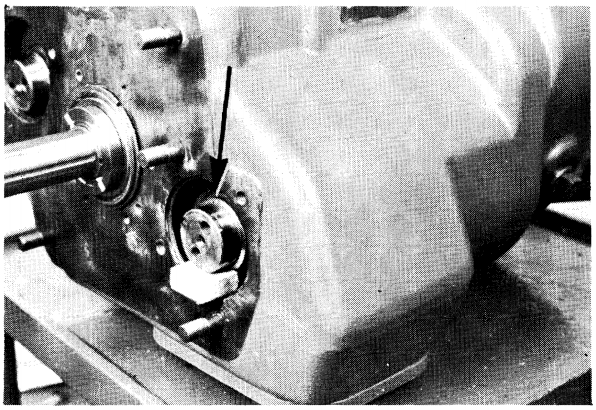


2. Make sure that the snap ring is removed from the drive gear bearing and insert the drive shaft from inside the case through the front bore and move as far forward as possible to expose the snap ring groove in the bearing. It will be necessary to work the drive gear past the countershaft PTO gears.

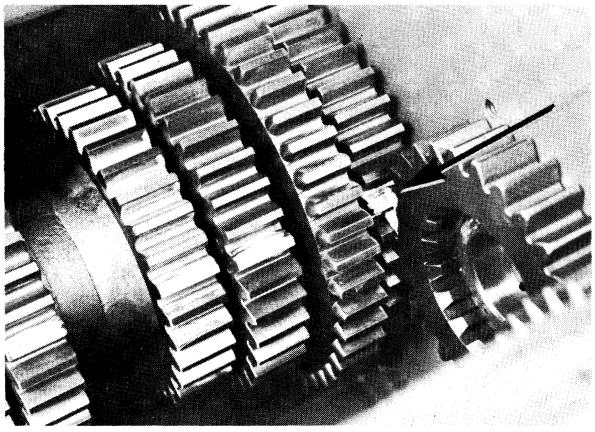


3. Install the snap ring in the groove in the drive gear bearing. Leave the drive gear in the forward position as installation is not completed until the countershaft bearings are installed.

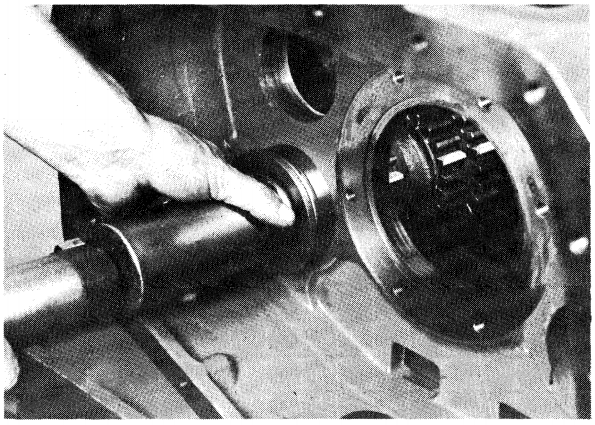
F. Timing of the Left Countershaft Assembly



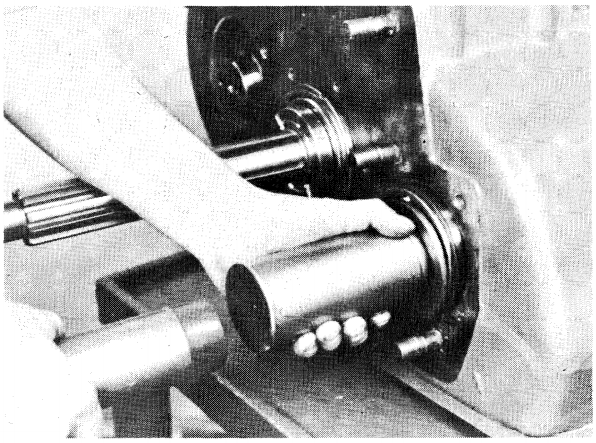
1. Use blocking to center the front of the left countershaft in the case bore.



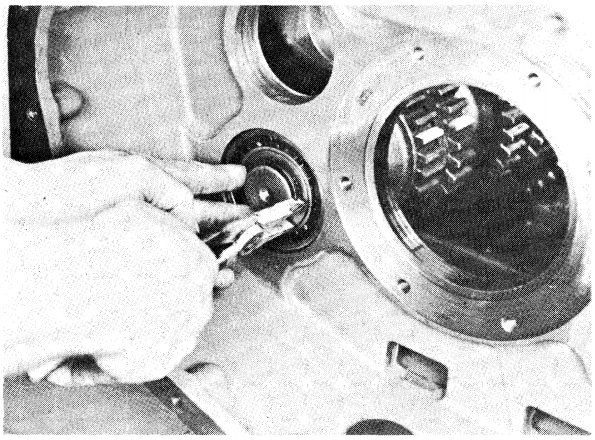
2. Mesh the marked tooth of the left countershaft drive gear with two of the marked teeth of the main drive gear.



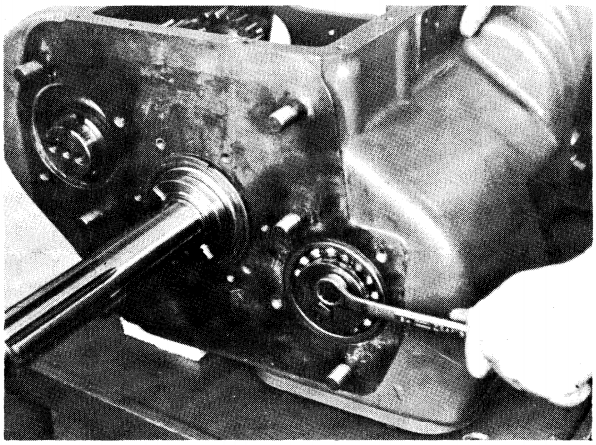
3. With the countershaft as far to the rear as possible, start the rear bearing on the shaft. Center and install the rear bearing on the shaft and in the case bore, seating the bearing against the shoulder of the shaft.



4. Remove blocking and install the front bearing on the countershaft and in the case bore. Make sure that the timing teeth are still meshed.



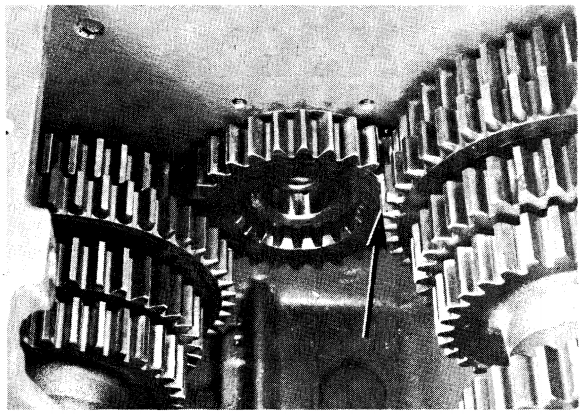
5. Install the snap ring on the rear of the countershaft.



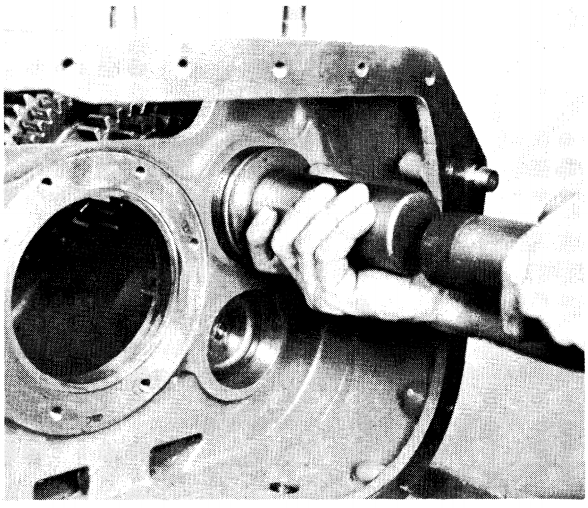
6. Install the bearing retainer plate on the front of countershaft. Tighten and wire capscrews securely.

G. Timing and Installation of the Right Countershaft Assembly

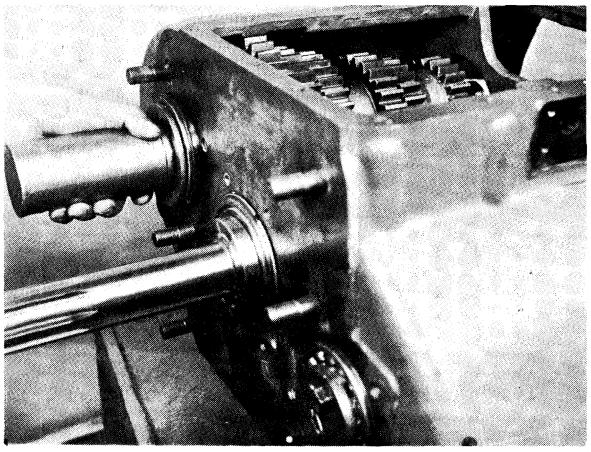
NOTE: One method of installing the mainshaft assembly is to position it between the two countershafts before installing the right countershaft bearings. With this procedure, the mainshaft assembly is centered in the rear bore and the corresponding gears of the mainshaft and left countershaft are meshed. The right countershaft is then rolled into position meshing with corresponding gears of the mainshaft. The right countershaft is held in place and the bearings installed. The countershaft drive gear must be timed with the main drive gear at the same time. In the following instructions the mainshaft assembly is installed after the countershaft bearings are installed.



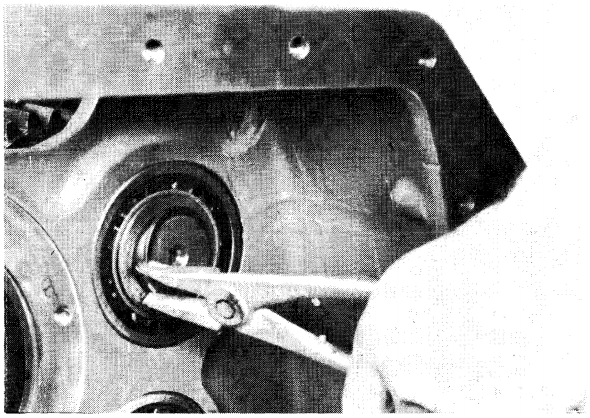
1. Use blocking to center the front of the right countershaft in the case bore and mesh the marked tooth on the countershaft drive gear between the two remaining marked teeth on the main drive gear.



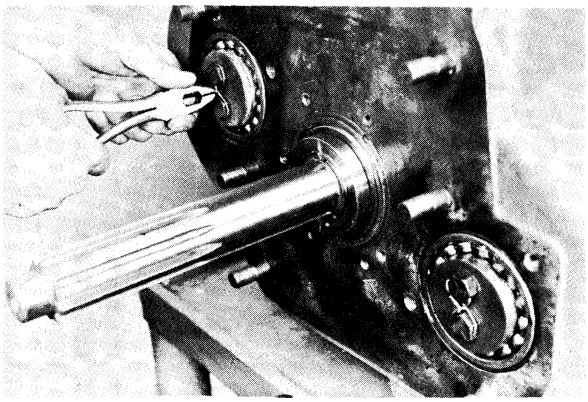
2. With the countershaft as far as possible to the rear, start the rear bearing on the shaft. Center and install the rear bearing on the shaft and in the case bore, seating the bearing against the shoulder of the shaft.



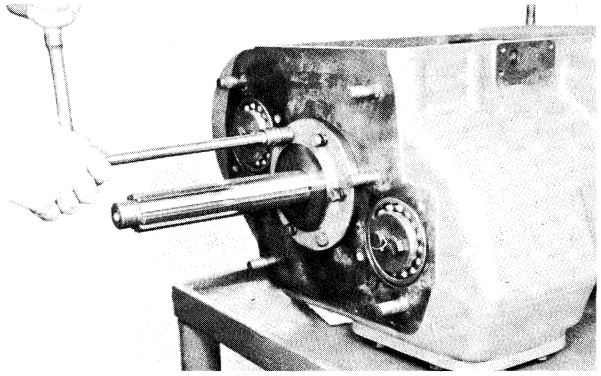
3. Remove the blocking and install the front bearing on the countershaft and into the case bore. Make sure that the timing teeth are still meshed.



4. Install the snap ring on the rear of the countershaft.



5. Install the bearing retainer plate on the front of the countershaft, tighten and wire the capscrews securely.



6. Complete installation of the drive gear assembly by moving into position and installing the front bearing cover on the drive gear.

SETTING CORRECT AXIAL CLEARANCES FOR MAINSHAFT GEARS

Axial Clearance (End Play) Limits Are:

Reverse speed gear —.005" to .038"

Forward speed gears —.005" to .012"

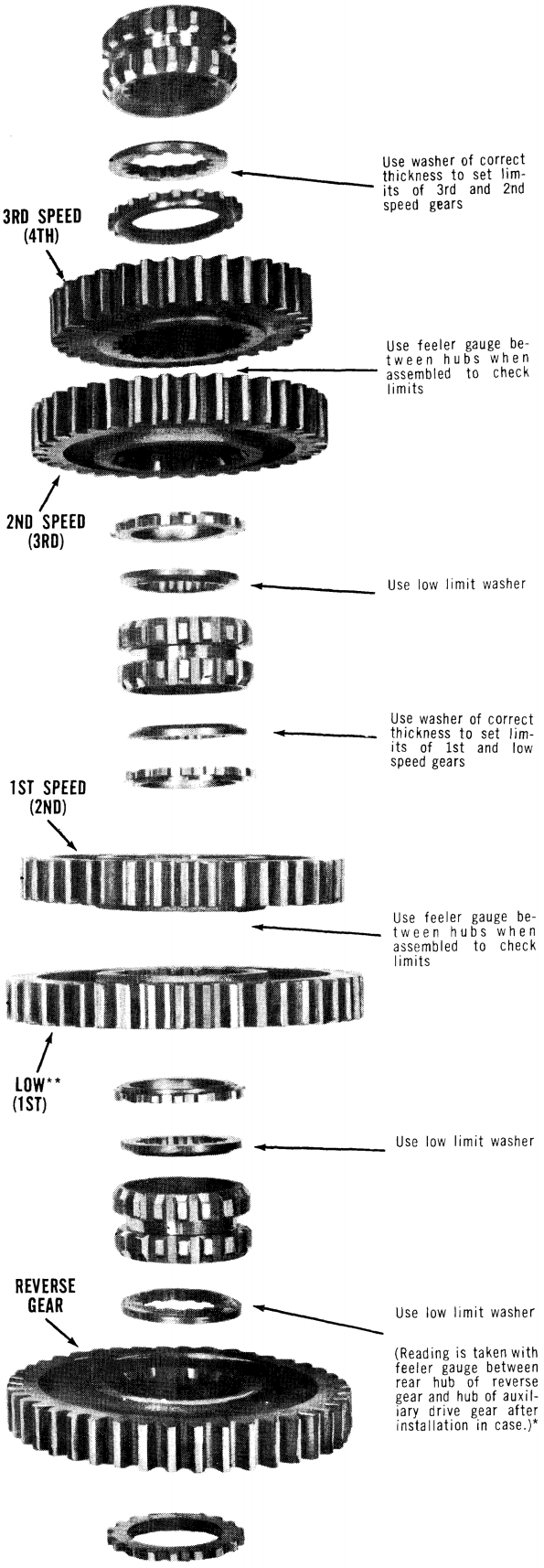
Washers are used to obtain the correct limits; six thicknesses are available as follows:

LIMITS	COLOR CODE
.248—.250	White
.253—.255	Green
.258—.260	Orange
.263—.265	Purple
.268—.270	Yellow
.273—.275	Black

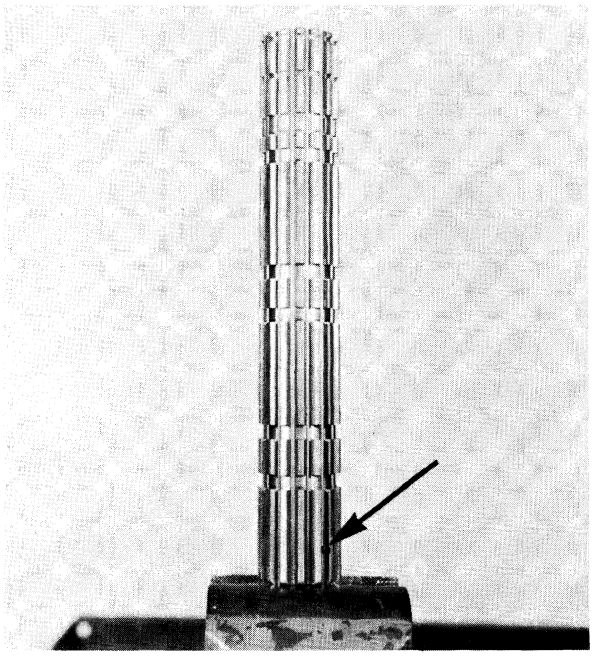
Always use the low limit washer in the REVERSE, LOW GEAR and 2nd SPEED GEAR positions as shown at right. Refer to the service manual covering mainshaft reassembly for method of assembling parts.

*In most cases, when setting up the reverse gear clearance, the low limit washer will give the correct clearance. However, if desired, this clearance can be measured before the mainshaft assembly is installed in the case. This is done by securing the reverse gear in position on mainshaft with the reverse gear snap ring and the front coupling snap ring; then, secure auxiliary drive gear assembly in position at rear of mainshaft with the rear coupling snap ring.

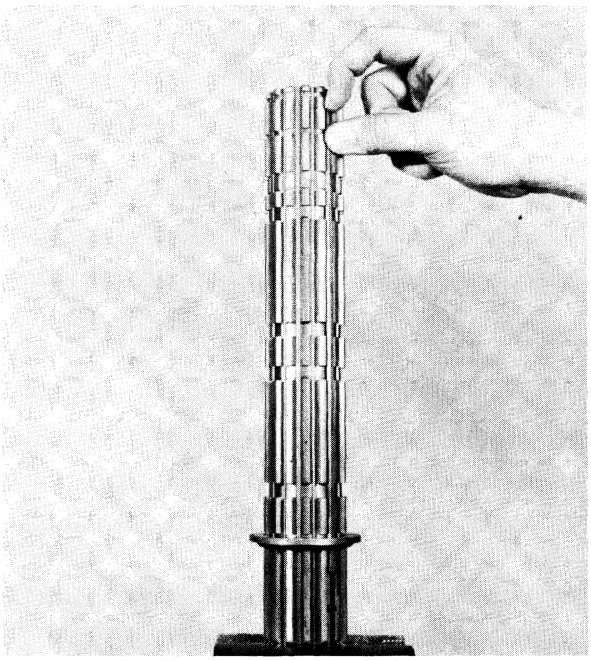
**The "LOW", "1st", "2nd" and "3rd" speed gear designations are the nomenclatures for 9- and 13-speed direct models. Gear speeds shown in parentheses are nomenclatures for 10- and 15-speed direct models. On overdrive models, the 3rd (or 4th) speed gear becomes 4th (or 5th) speed gear.



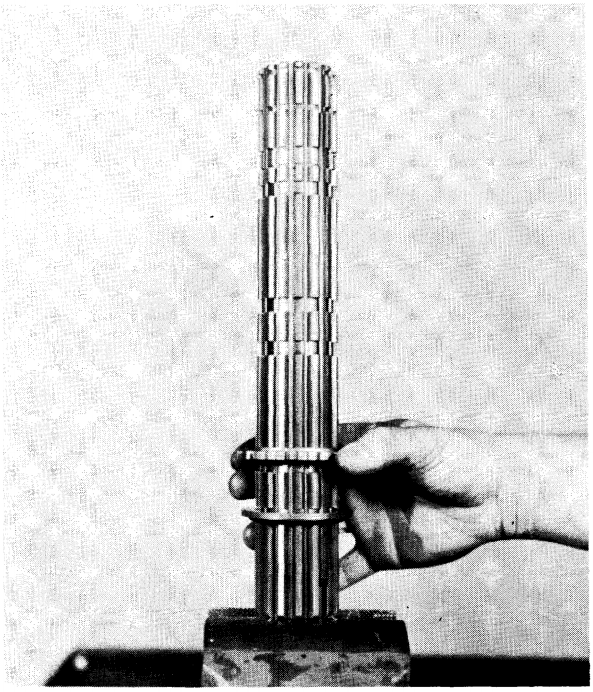
H. Reassembly of the Mainshaft Assembly



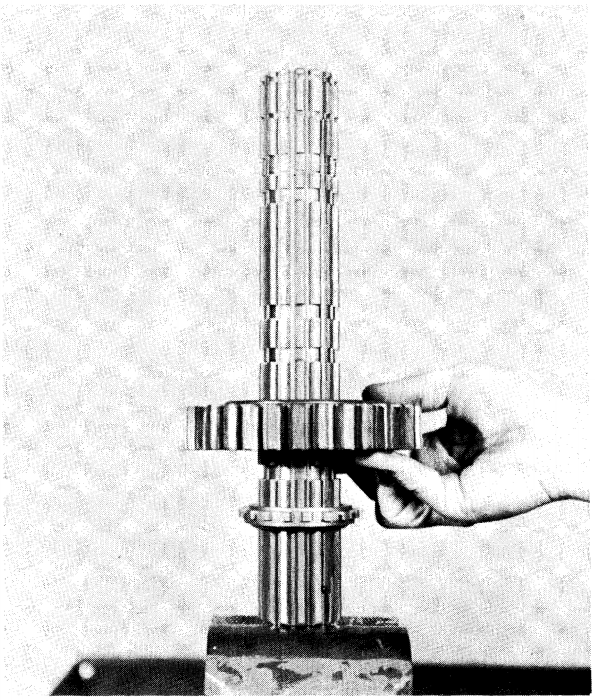
1. If previously removed, install the snap ring in the groove in ID of all mainshaft gears except the reverse gear and mount the mainshaft in a vise with the pilot (front) end down, making sure that the roll pin is in place in the keyway.



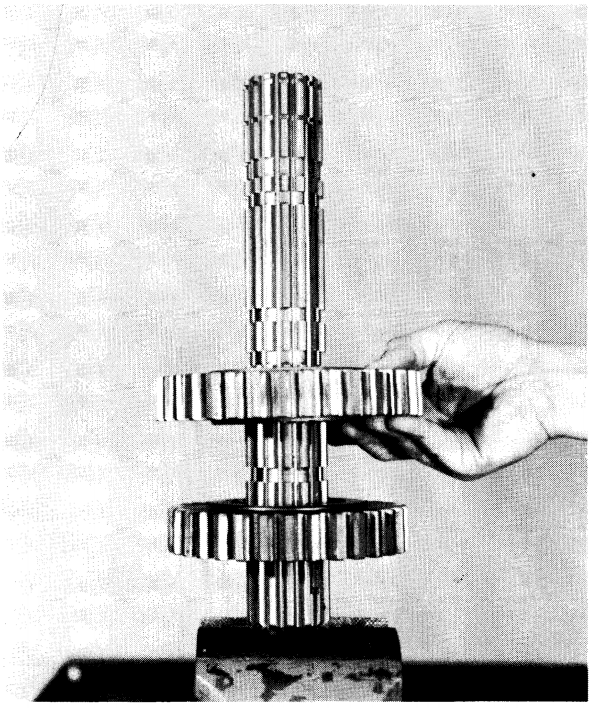
2. Install the 4th speed gear washer, flat side up, and lock in place with the key.



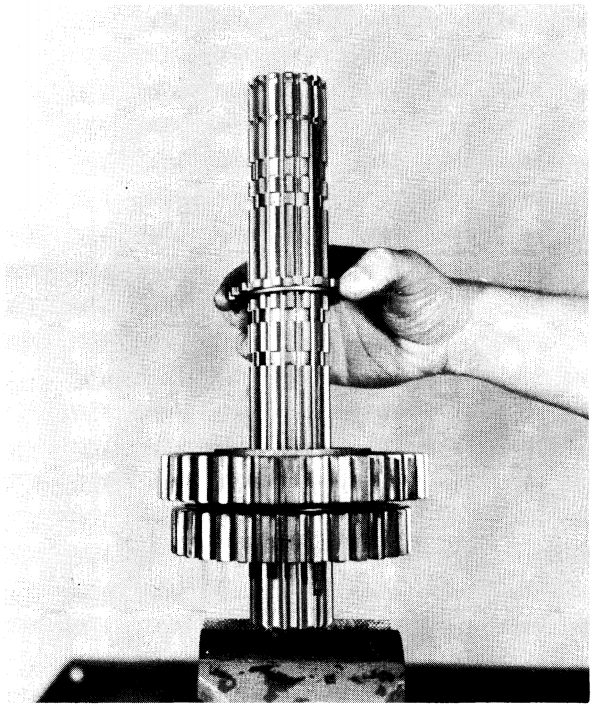
3. Install the spacer on the washer, stepped side up.



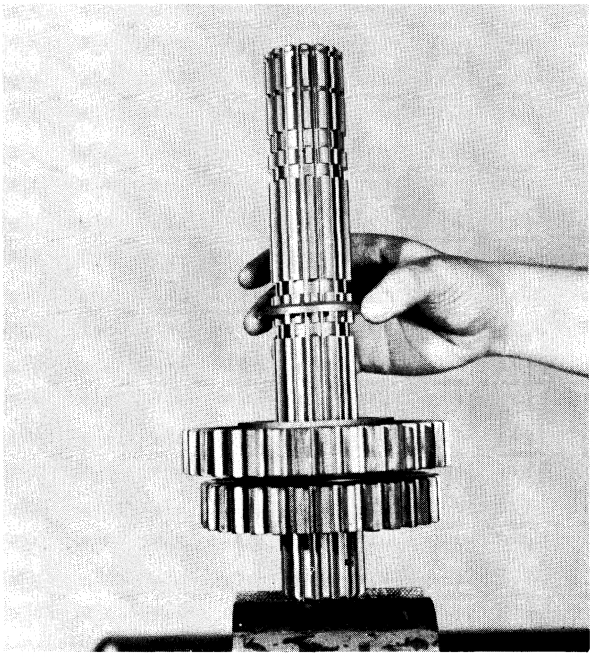
4. Install the 4th speed gear on the shaft with the clutching teeth down. Turn the gear until it engages the splines of the spacer.



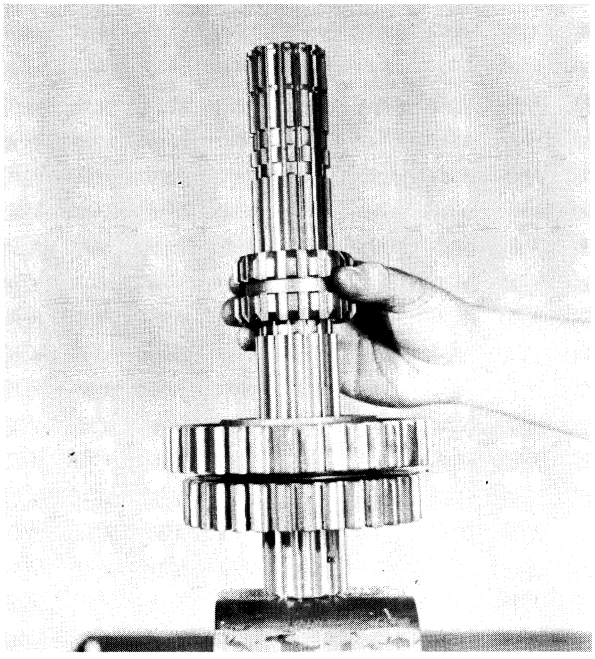
5. Install the 3rd speed gear on the 4th speed gear, clutching teeth up.



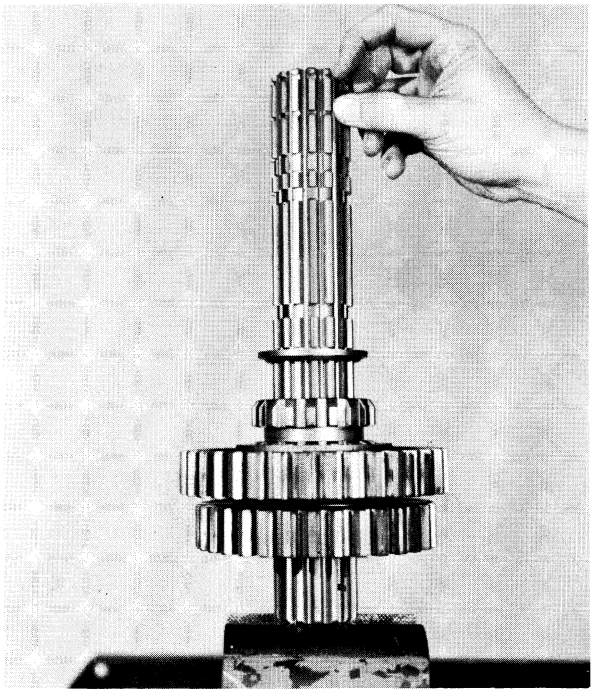
6. Install the spacer on the shaft and in the 3rd speed gear, stepped side down.



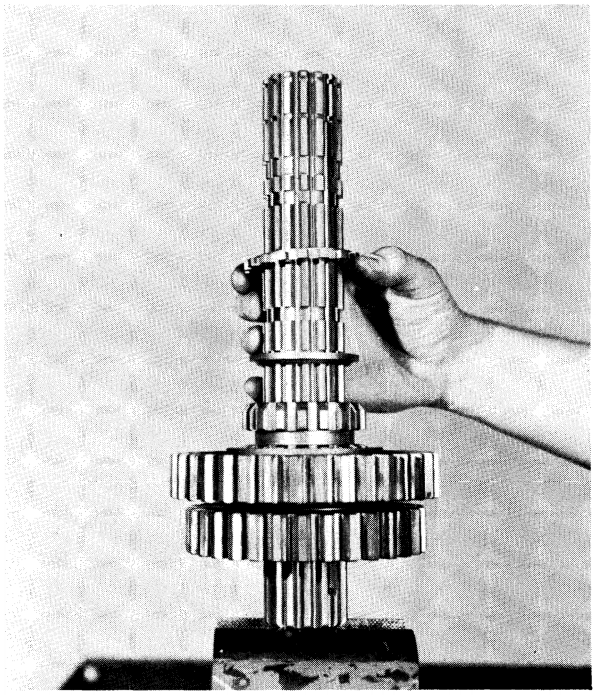
7. Remove the key and install the 3rd speed gear washer on the shaft and in the gear. Turn the washer to align the large slot with the keyway. Lock the washer in place with the key.



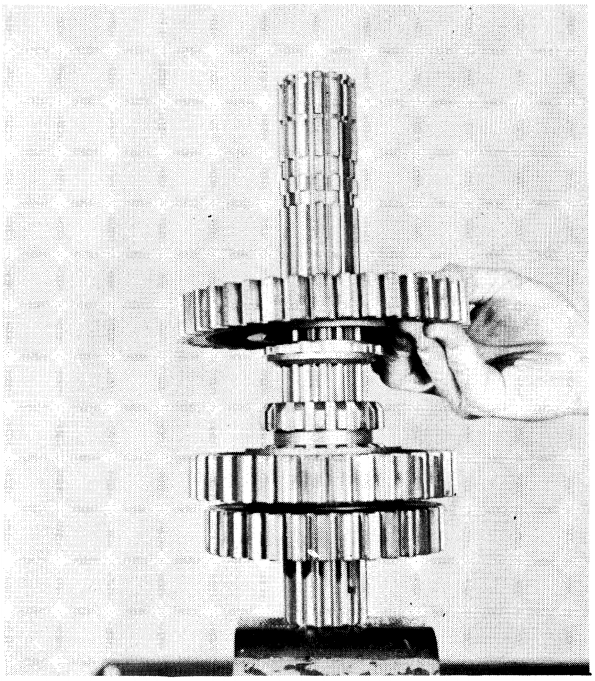
8. Install the 2nd-3rd speed sliding clutch on the shaft, aligning the large groove in the clutch with the keyway. Remove the key.



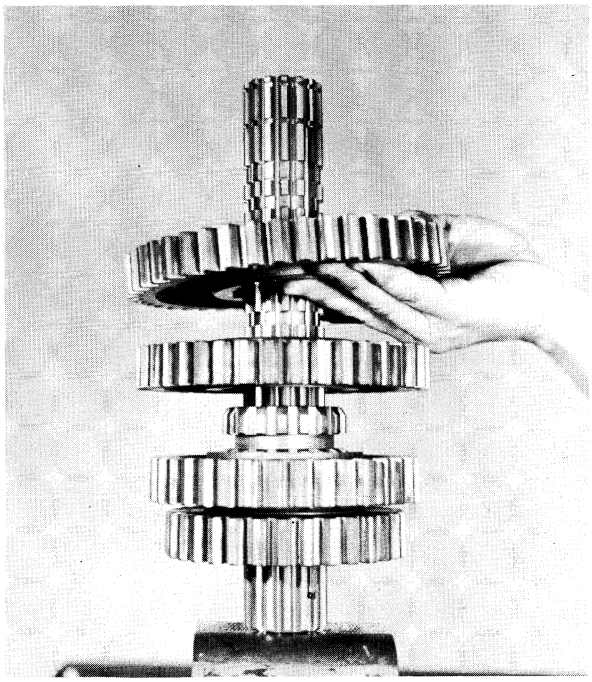
9. Install the 2nd speed gear washer on the shaft, flat side up, turn to align the large slot with the keyway and lock in position with the key.



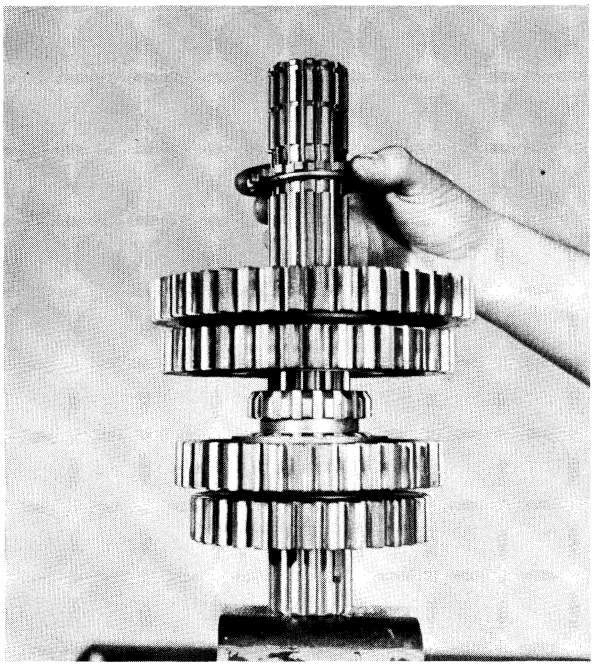
10. Install the stepped spacer on the washer, flat side down.



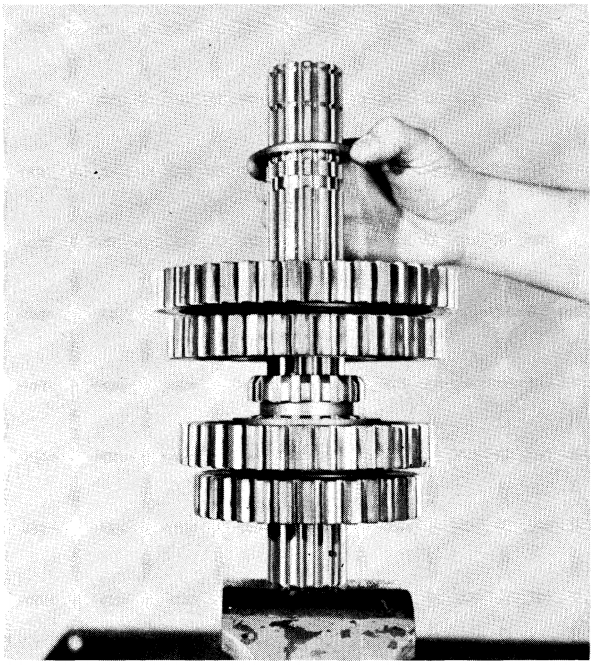
11. Install the 2nd speed gear on the shaft against the stepped spacer, clutching teeth down. Turn the gear until its splines engage with the splines of the spacer.



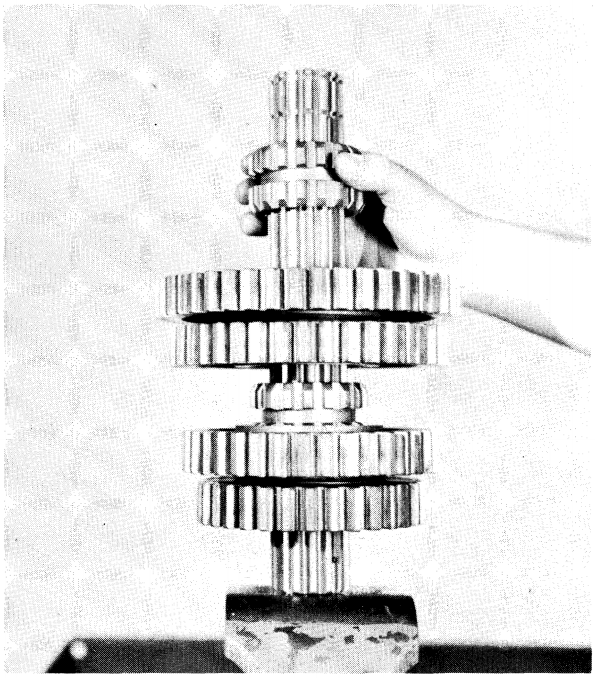
12. Install the 1st speed gear on the shaft against the 2nd speed gear, clutching teeth up.



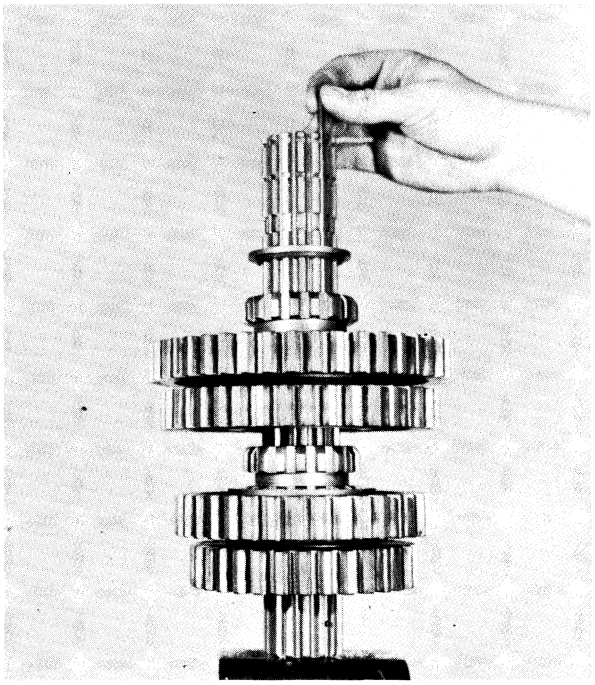
13. Install the 1st speed gear spacer on the shaft and in the gear, flat side up.



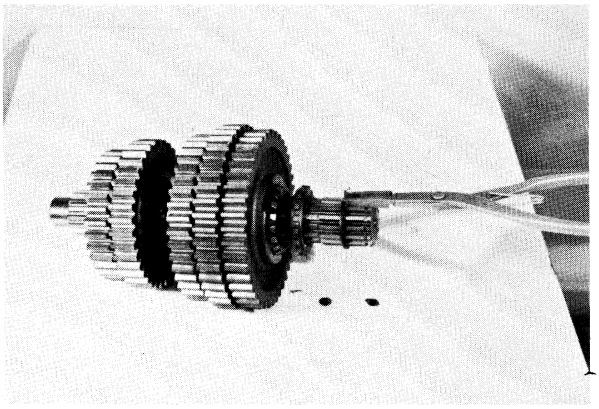
14. Remove the key and install the 1st speed gear washer on the shaft, flat side down. Align the large slot in the washer with the keyway and lock in position with the key.



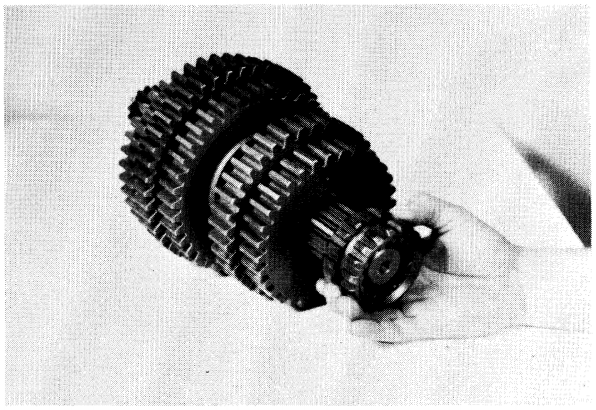
15. Align the large slot with the keyway and install the 1st-reverse speed sliding clutch.



16. Remove the key and install the reverse gear washer on the shaft. Align the large slot in the washer with the keyway and lock in position with the key.

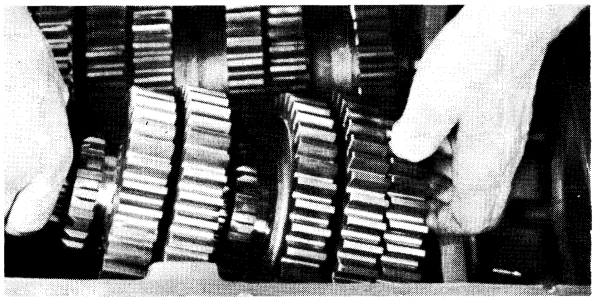


17. Install the reverse gear on shaft and against the 1st speed gear, engaging splines of the sliding clutch gear. Remove the assembly from the vise and install the reverse gear spacer on the shaft, flat side forward. Install the snap ring in the groove at the end of the key on the shaft.

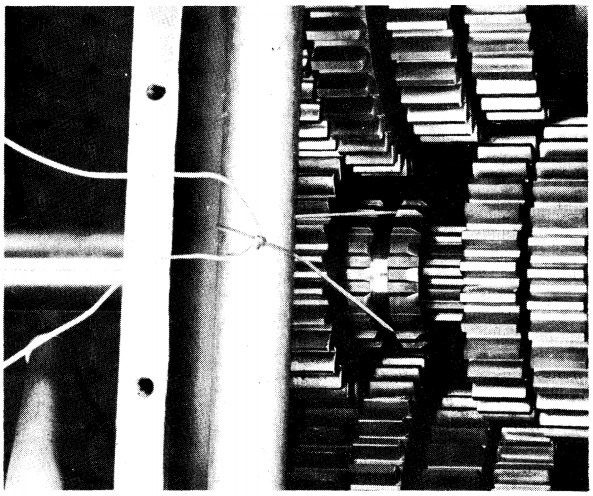


18. Install the sliding clutch gear on the front of the mainshaft.

I. Installation of the Mainshaft Assembly



1. With the reverse gear as far forward as possible, insert the rear of the mainshaft into the case and through the rear bearing bore. Keep mainshaft as far to the rear as possible in the case.



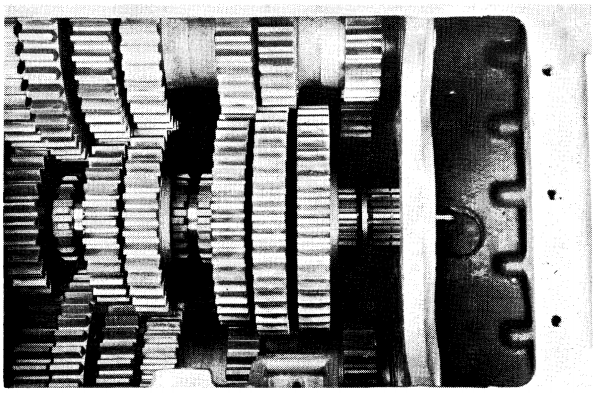
2. Place a bar across the top of the case and insert a supporting wire under the forward sliding clutch gear to exactly center the front of the mainshaft with the pocket of the drive gear.



3. Move the mainshaft forward until the mainshaft gears are stopped by the corresponding speed gears on the countershafts. Keep the rear of the mainshaft centered in the rear bore.



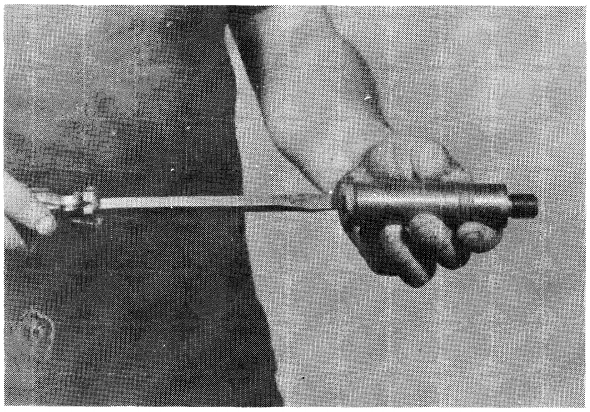
4. Align the gear teeth on the mainshaft gears with the corresponding gears of the countershafts so that all gears will properly mesh.



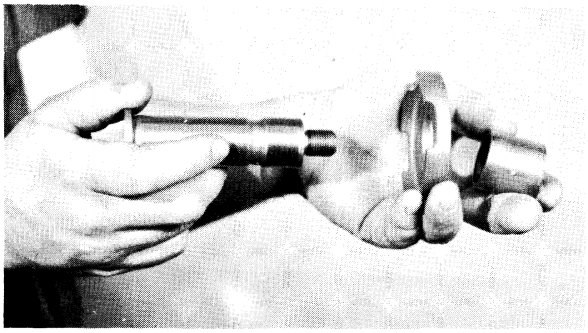
5. Move the mainshaft forward into proper position, seating the front of the mainshaft in the drive shaft bushing and meshing all gears. Remove the wire and bar.

NOTE: Keep the mainshaft in the forward position during reassembly of the left reverse idler gear so that the gears will not slip out of mesh.

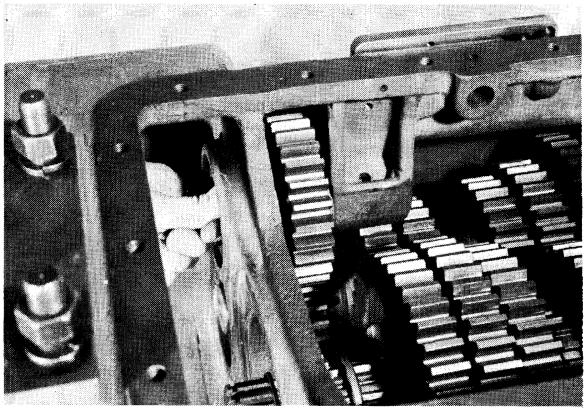
J. Reassembly and Installation of the Left Reverse Idler Gear



1. Install plug in reverse idler shaft.

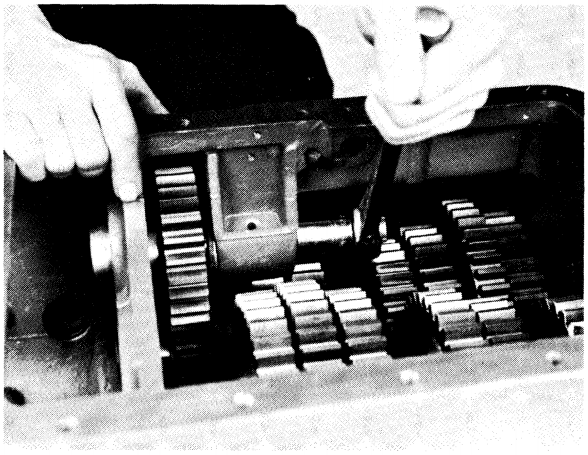


2. Install the rear washer and bearing inner race on the shaft. If previously removed, press the needle bearing in the bore of the gear.



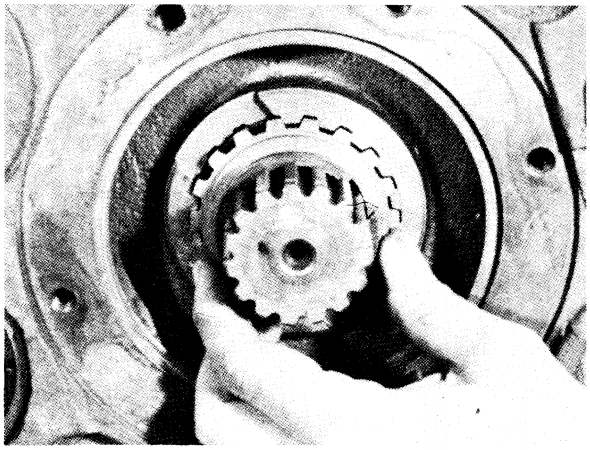
3. Hold the gear and thrust washer in place in the case with the thrust washer between the gear and housing boss and the idler gear meshed with the teeth of the countershaft reverse gear. Insert the idler shaft through the bore in the rear case wall, the gear and washer and the housing boss.

NOTE: Do not force the shaft into the gear, as this will result in damage to the bearing. Check the needle bearing to make sure that all the rollers are in place.

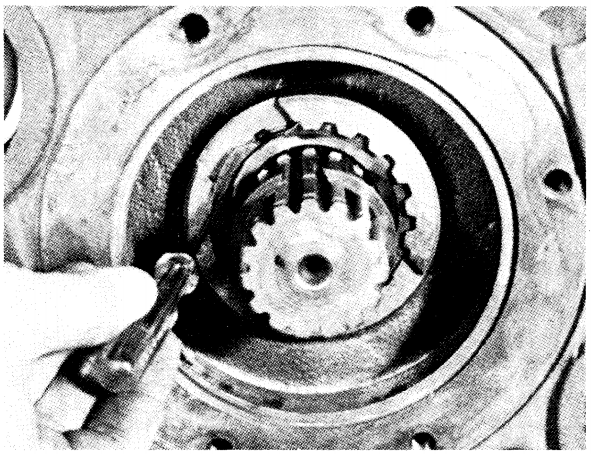


4. Secure the shaft with the washer and elastic stop nut.

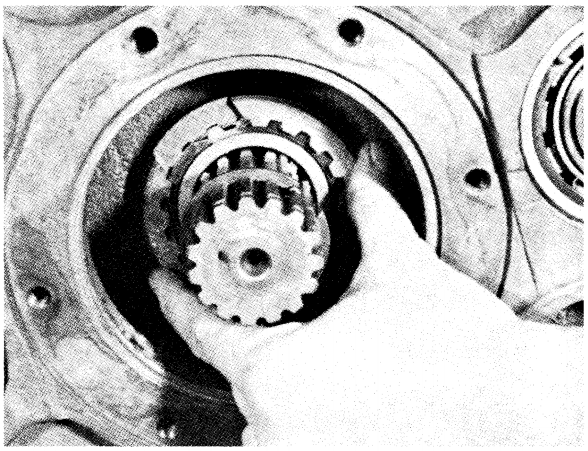
K. Final Installation of the Mainshaft Assembly



1. Move the reverse gear as far as possible to the rear, against the wall of the case and mesh teeth with those of the reverse idler gears. Slide the reverse gear spacer forward and into the reverse gear.

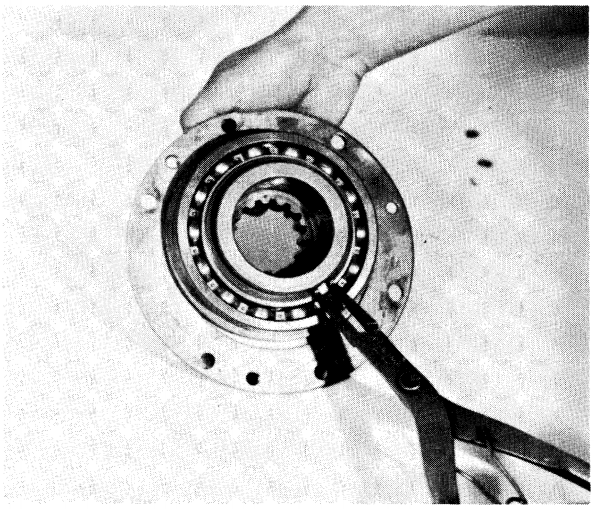


2. Install the snap ring in the hub of the reverse gear.

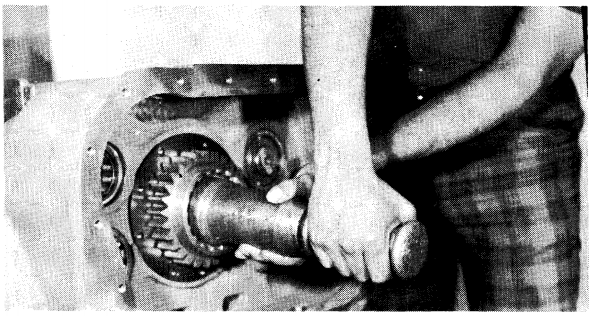


3. Move the reverse gear forward on the shaft and into correct position.

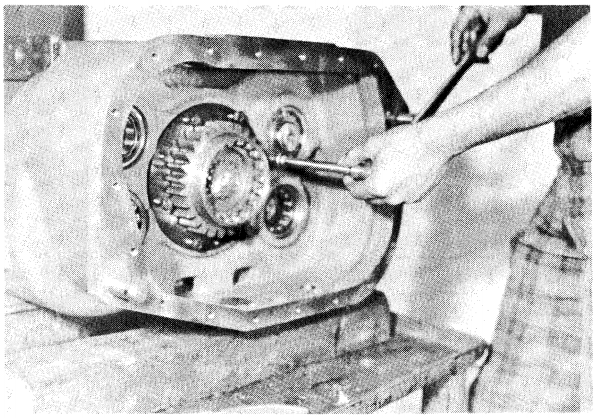
L. Reassembly and Installation of the Auxiliary Drive Gear Assembly



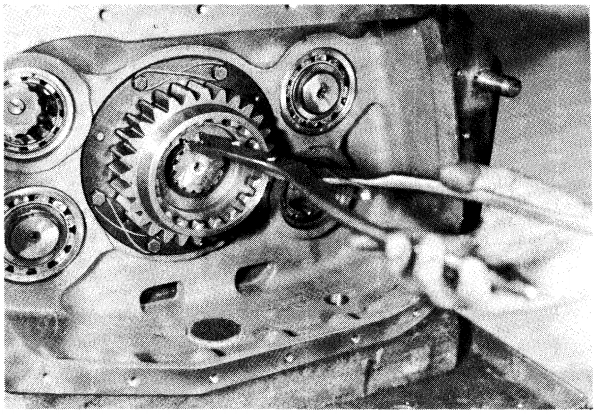
1. If previously removed, install the retainer ring on the auxiliary drive gear and press the bearing, snap ring towards retainer, on the auxiliary drive gear. Install the snap ring in the auxiliary drive gear.



2. Install the auxiliary drive gear assembly into the rear case bore, fitting over the rear of the mainshaft and seating the bearing in the case bore.



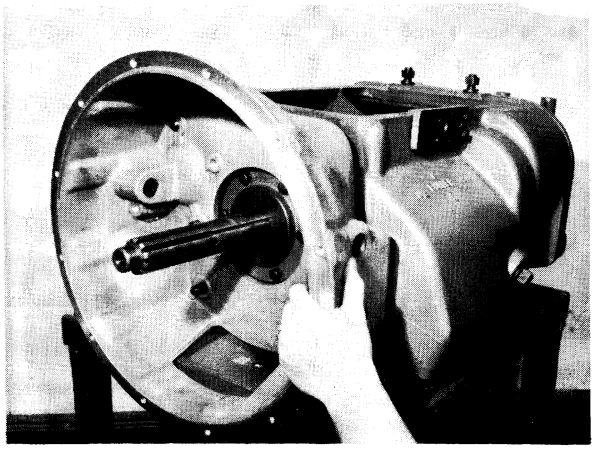
3. Install the six capscrews which attach the retainer ring to the case. Wire the capscrews in groups of three.



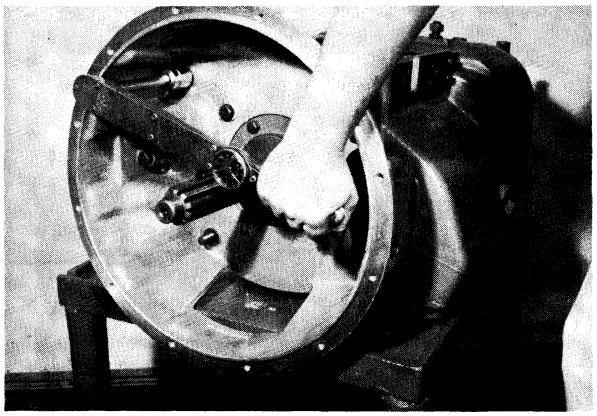
4. Install the mainshaft rear coupling snap ring on the rear of the mainshaft.

IV. COMPANION FLANGE, CLUTCH HOUSING AND AUXILIARY SECTION

A. Installation of the Clutch Housing

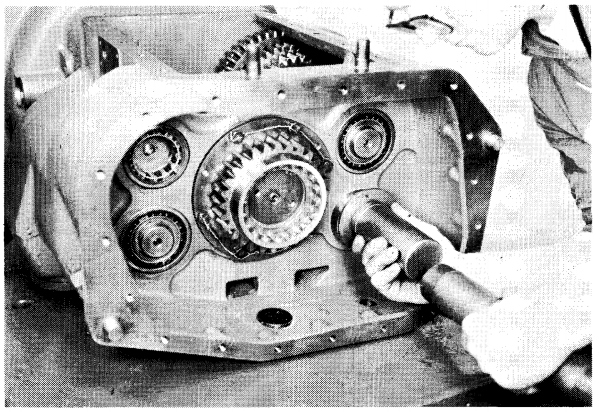


1. Install the clutch housing on the six studs on the front of the case. Move evenly against the case as the drive gear bearing cover pilots the clutch housing on the case.

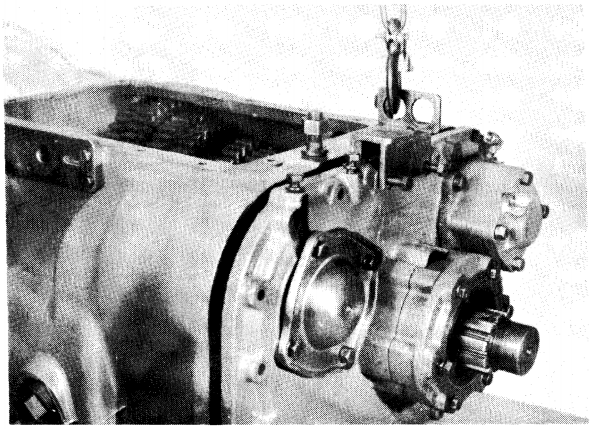


2. Install lockwashers and nuts on the studs, and install the four bolts in the housing. Secure the nuts with 180-190 ft./lbs. of torque, and secure the bolts with 90-100 ft./lbs. of torque.

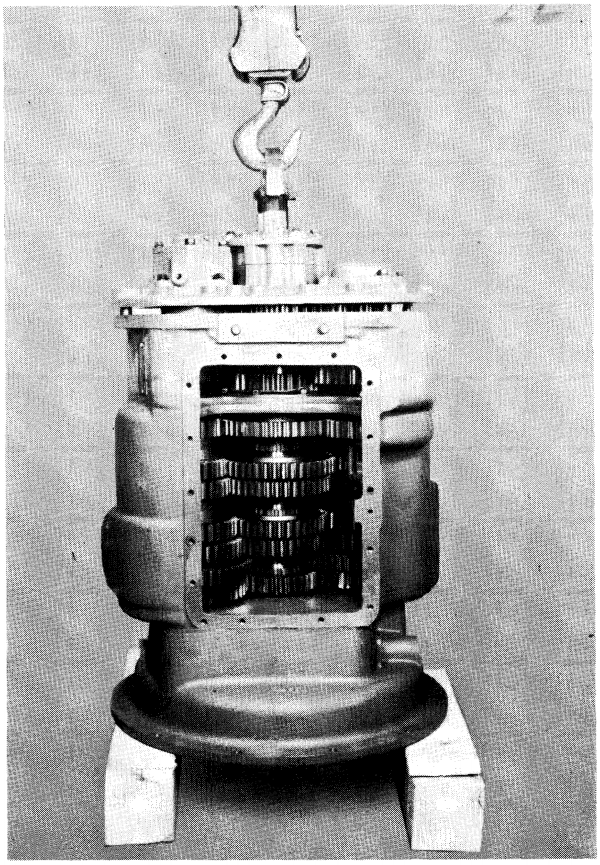
B. Installation of the Auxiliary Section



1. If not previously done, install the auxiliary countershaft front bearings into the bores in the rear wall of the front case which contain the reverse idler gear shafts.

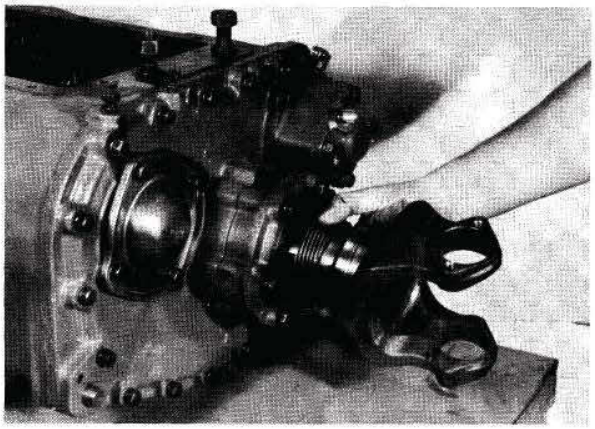


2. Place a chain hoist on the auxiliary section to properly balance and hold its weight. Move the auxiliary section evenly onto the rear of the front case. The two countershaft drive gears will mesh with the auxiliary drive gear and the front of both countershafts will seat in the two bearings installed in the front section. Move assembly evenly, rotating drive gears if necessary to properly mesh the gears.

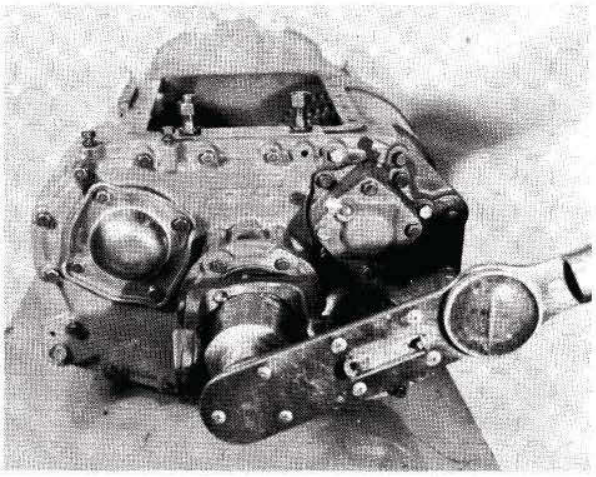


3. Auxiliary section can also be installed by setting the front section vertically on wood blocks and by lowering the auxiliary evenly on transmission. Install the attaching capscrews and tighten securely.

C. Installation of the Universal Joint Companion Flange or Yoke



1. Lock the mainshaft in two speeds and install the speedometer drive gear or the replacement spacer on the flange or yoke. Install the flange or yoke on the splines of the output shaft.

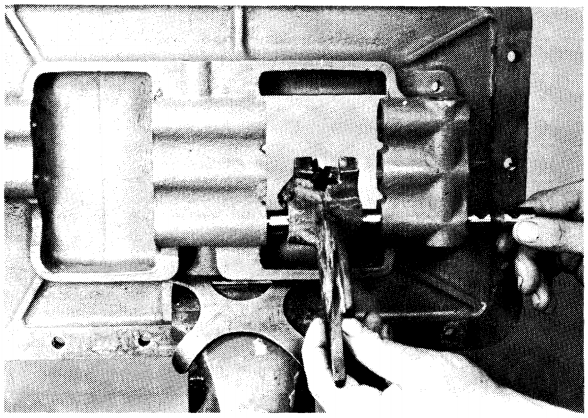


2. Secure the flange or yoke with the output shaft nut, tightening with a torque wrench to 650-700 lb-ft of torque.

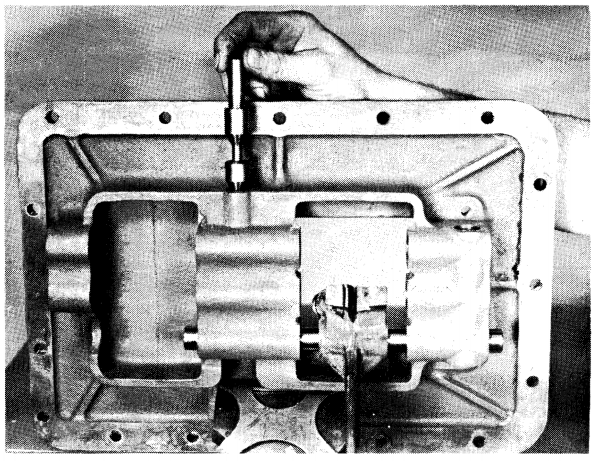
V. SHIFT BAR HOUSING ASSEMBLY

A. Reassembly of the Shift Bar Housing Assembly

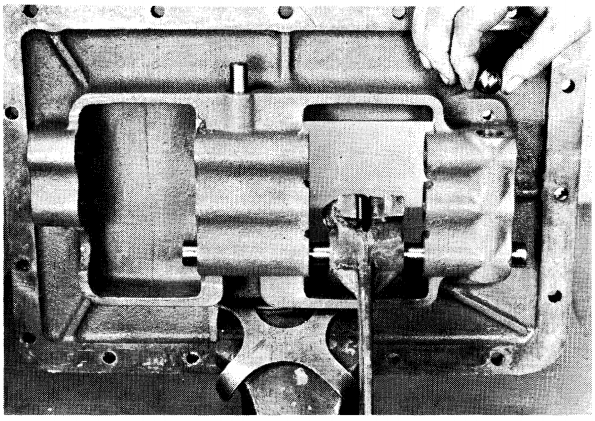
NOTE: If previously disassembled, install the reverse-stop plunger, spring and plug in the bore until 1½ to 2 threads protrude. Make sure that the plunger can fully depress into the bore at the yoke slot. Stake the plug through the small hole in the yoke.



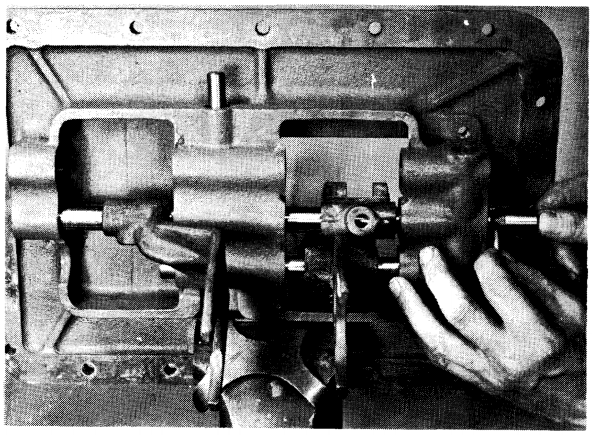
1. Install the housing in a vise with the hole for the actuating plunger facing up. Install the short 1st-reverse shifting bar into the housing in the lowest bore, installing the shifting yoke on the bar. Install the yoke lockscrew; tighten and wire securely.



2. Install the actuating plunger in the bore at the top of the housing, flat end facing out.

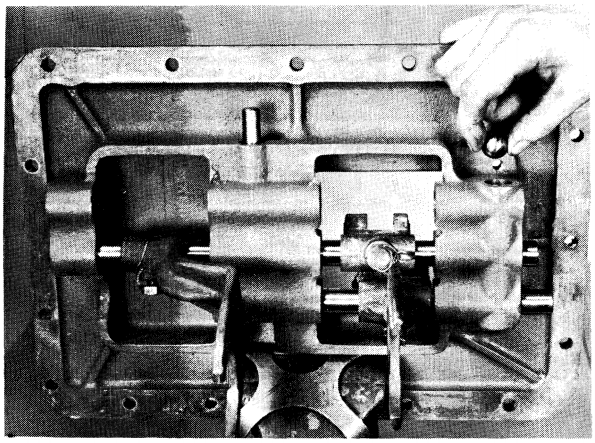


3. Install one ¾" interlock ball in the bore in the rear boss. This ball rides between the 1st-reverse shift bar and the 2nd-3rd speed bar.

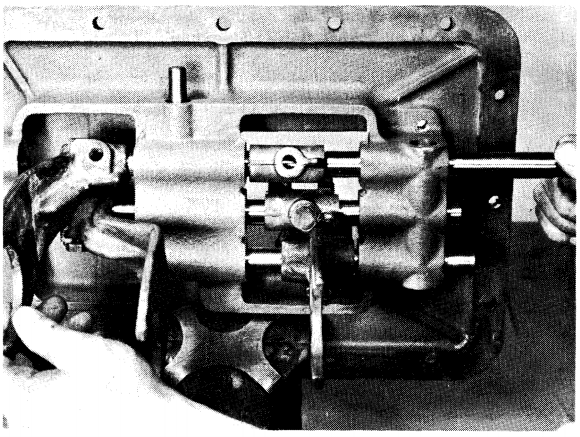


4. Install the 2nd-3rd speed shift bar through the center bore in the housing, through the shift block, center boss and the 2nd-3rd speed shift yoke. At the same time install the interlock pin in the bore in the neutral notch of the bar as the notch enters the housing. Install the block and yoke lockscrews; tighten and wire securely.

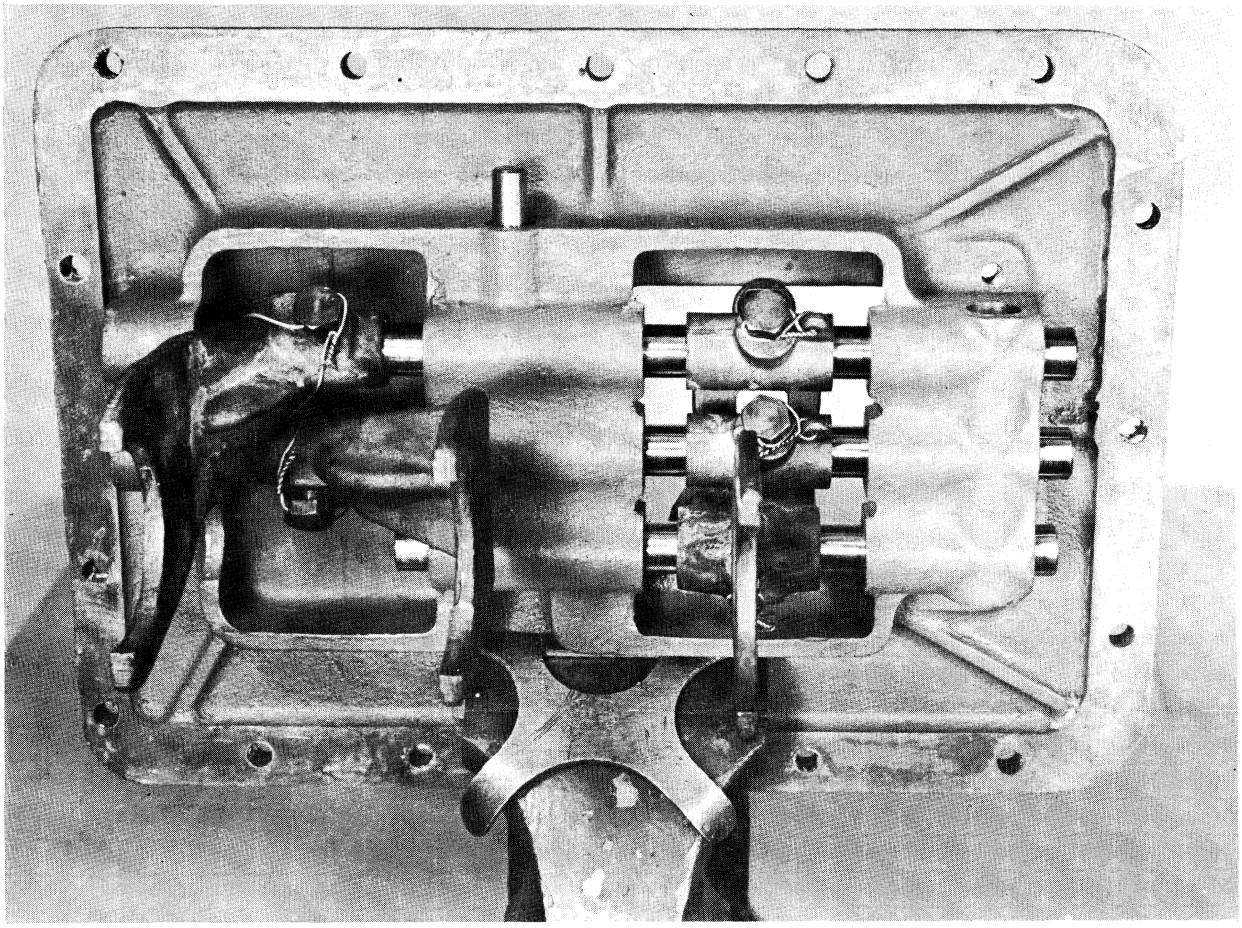
NOTE: Keep the bar so that the interlock pin remains in a vertical position during the remainder of the assembly. Rotation of the bar will allow the interlock pin to jam in the tension spring bores.



5. Install the ¾" interlock ball in the bore in the rear boss. This ball rides between the 2nd-3rd speed shift bar and the 4th-5th speed bar.

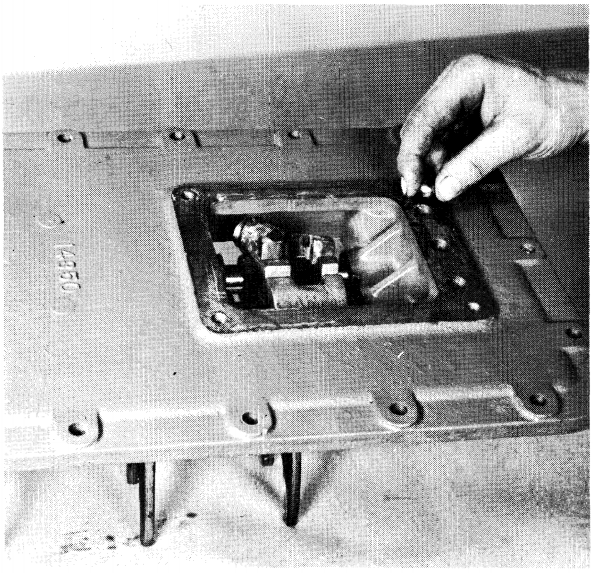


6. Install the 4th-5th speed shift bar in the top bore of the housing, the shifting block, center boss and the shift yoke. Install the yoke and block lockscrews; tighten and wire securely.

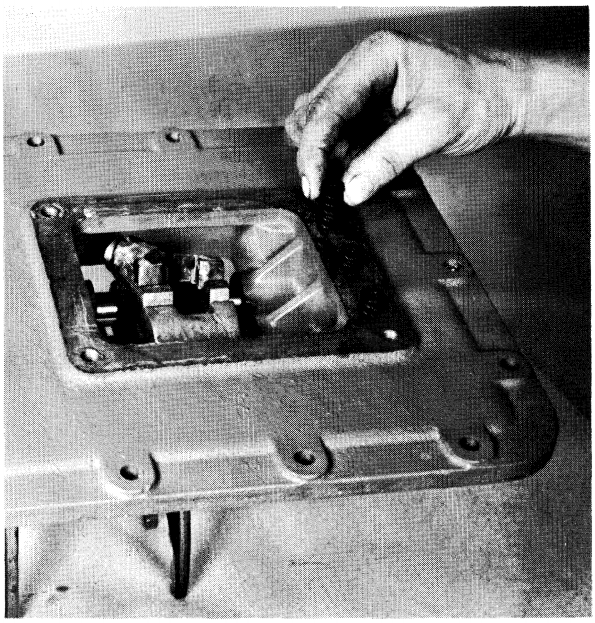


7. All shift bars, blocks and yokes installed correctly.

REASSEMBLY-SHIFTING BAR HOUSING

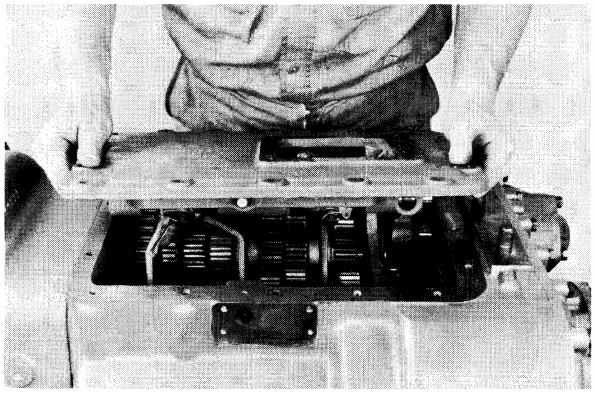


8. Place the assembly upright on a bench and install the three tension balls in the bores in the top of the housing.



9. Install the three tension springs on top of the balls.

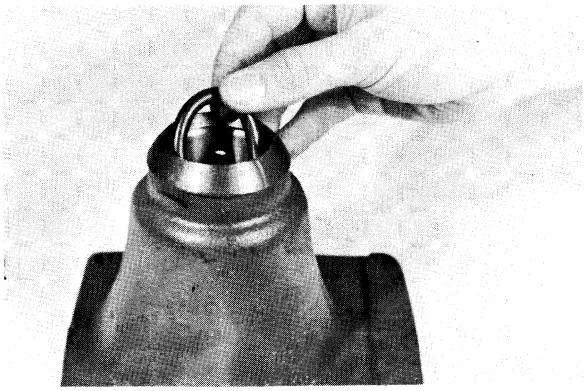
B. Installation of the Shift Bar Housing Assembly



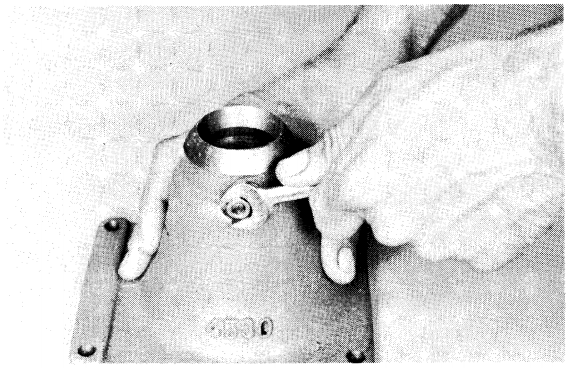
1. Make sure that the shift bar housing and sliding clutch gears in the transmission are in the neutral position and install the housing on the transmission, fitting yokes into the yoke slots of the corresponding clutch gears. Install the retaining capscrews.

VI. GEAR SHIFT LEVER HOUSING ASSEMBLY

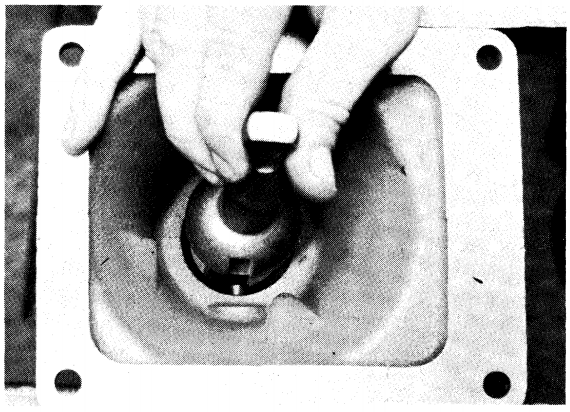
A. Reassembly of the Gear Shift Lever Housing Assembly



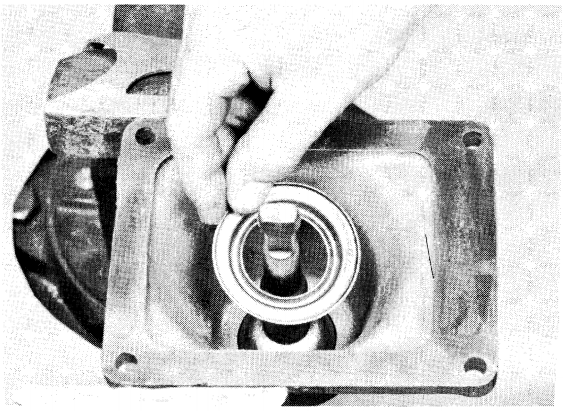
1. If so equipped, install the O-ring in the top of the housing.



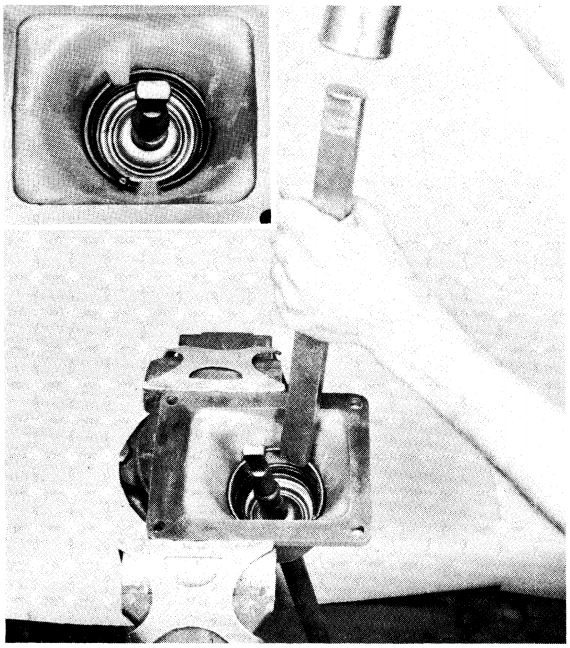
2. Install the pivot pin in the housing, threaded end out, and secure with the nut and lockwasher.



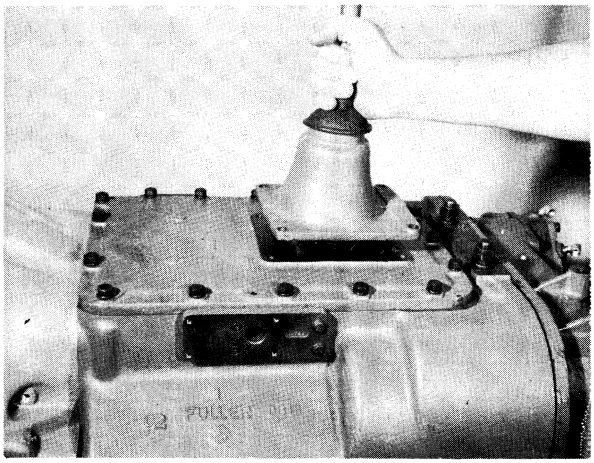
3. Install the housing in a soft-jawed vise with the bottom facing up and insert the shift lever in the housing, fitting the slot in the pivot ball of the lever with the pivot pin.



4. Install the tension spring washer in the housing.



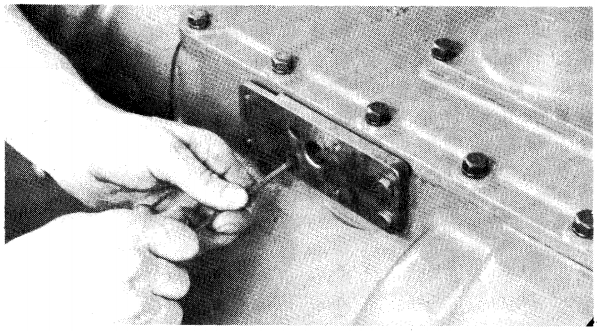
5. Install the tension spring in the housing, seating the spring under the lugs cast in the housing.



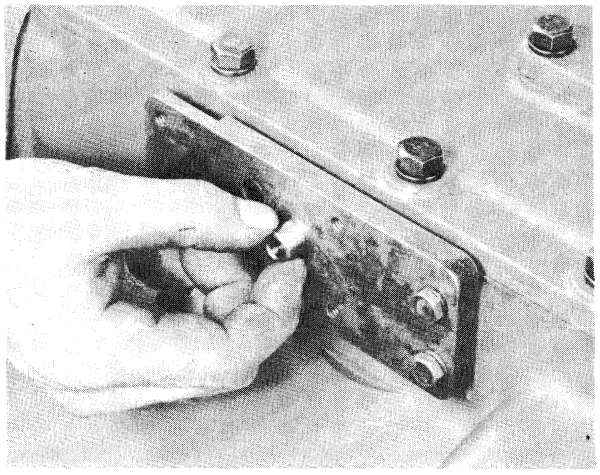
6. Remove the assembly from the vise and install the rubber dust protector over the lever and against the neck of the housing. Make sure the shift bar housing is in the neutral position and install the gear shift lever housing. Secure with the four capscrews.

VII. RANGE SHIFT AIR SYSTEM

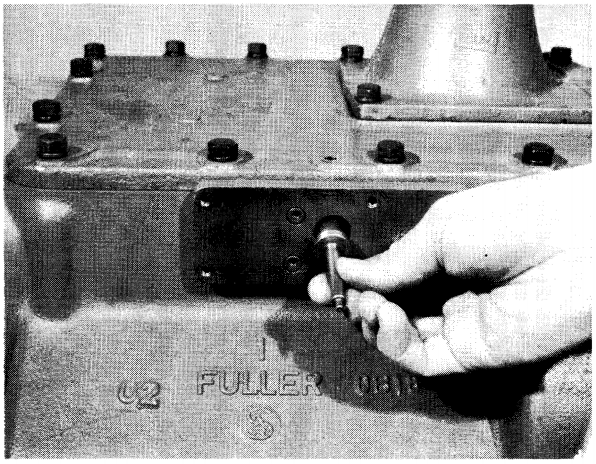
A. Installation of the Air Valve



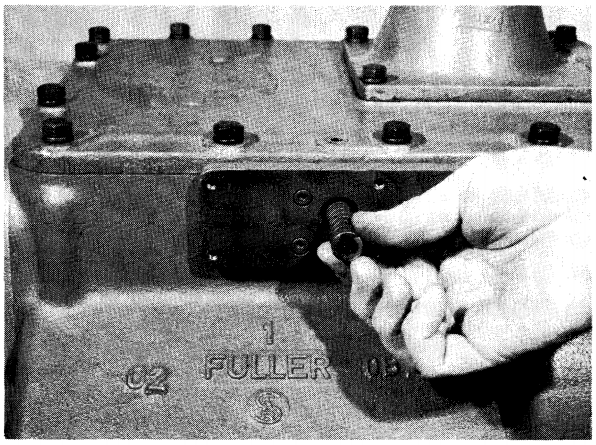
1. If previously removed, install the fittings of the air valve and install the adapter plate on the transmission, aligning the large bore in the plate with the bore in the transmission. Secure with two capscrews at the rear and two Allen-head screws at the front.



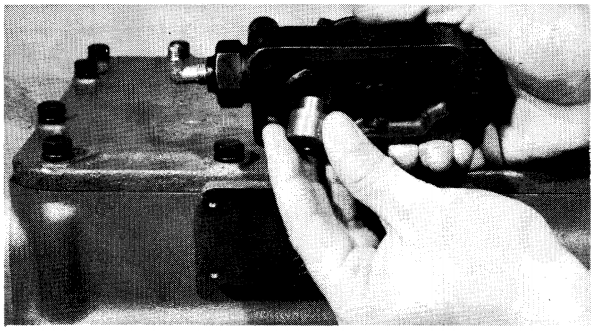
2. Use the small alignment sleeve to check the plate bore alignment with the case bore. If not properly aligned, loosen the capscrews and Allen-head screws and reposition the adapter plate.



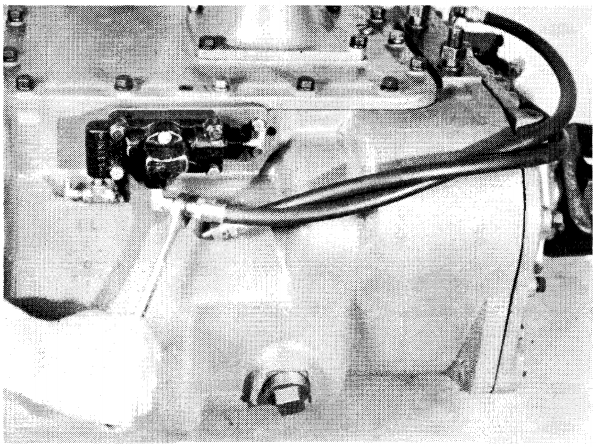
3. Install the actuating pin in the bore in the adapter plate.



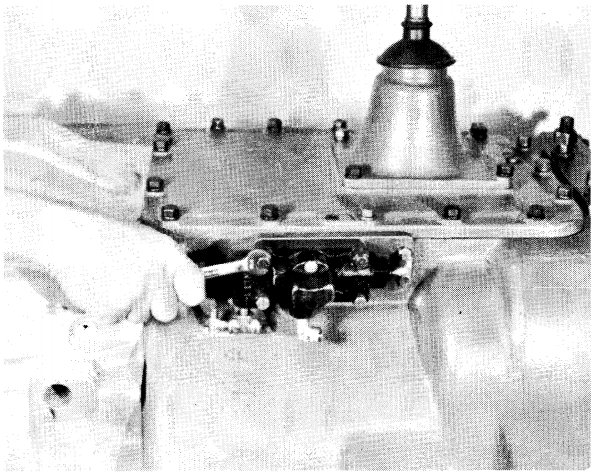
4. Install the spring on the pin in the bore.



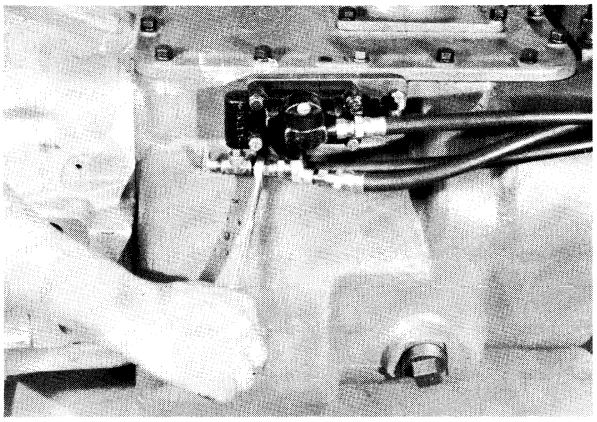
5. Check to make sure that the piston in the air valve is either all the way forward or to the rear and install the alignment sleeve in the bore.



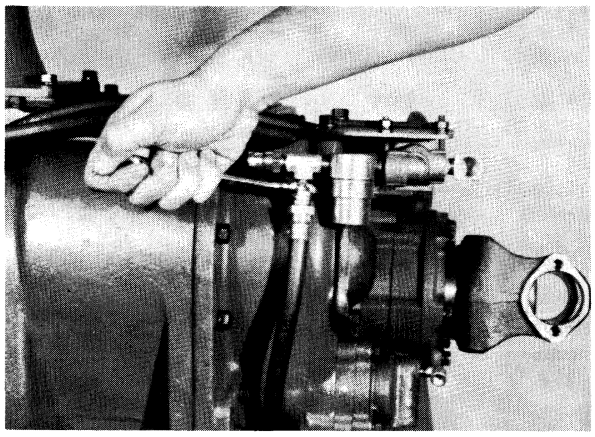
7. If previously removed, install the fittings in the range shift cylinder and install the two ¼" ID air lines between the shift cylinder and the air valve. The air line from the forward fitting of the shift cylinder is connected to the bottom fitting of the air valve side cap, and the air line from the rear fitting of the shift cylinder is connected to the rear bore of the side cap on the air valve.



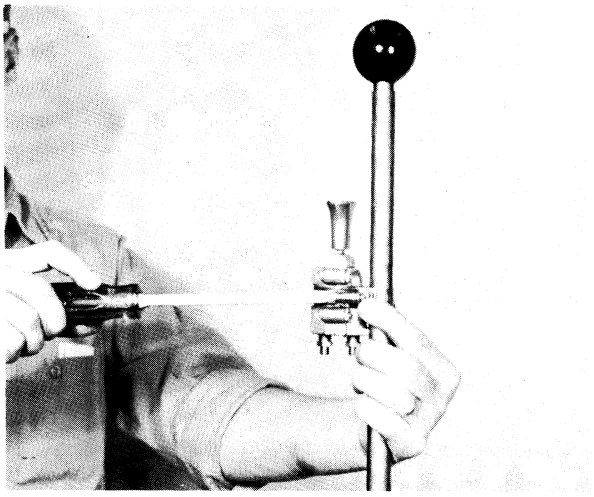
6. Install the air valve on the adapter plate, tightening the four capscrews evenly.



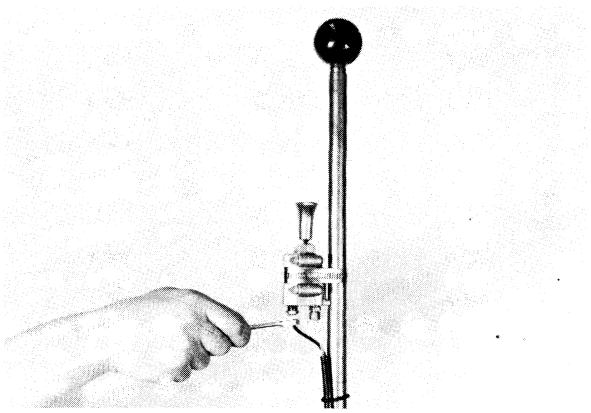
8. Secure the air filter/regulator assembly to the rear housing with the two capscrews and connect the ¼" ID air line between the regulator and the tee fitting on the air valve.



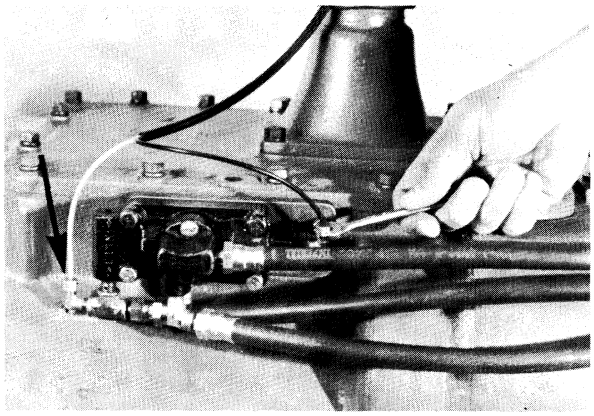
9. (RT-915 Models) Connect the ¼" ID air line between the filter/regulator assembly and the deep reduction shift cylinder.



10. Install the air lines, sheathing, O-rings, range control valve and shift lever ball on the gear shift lever. Range control is secured in desired position by tightening the screw on the clamp.



11. Connect the two ⅛" OD air lines to the range control valve: Black line to the front and white line to the rear.



12. Connect the two ⅛" OD air lines at the air valve: White air line at the front fitting and the black air line at the rear of the air valve.

TOOL REFERENCE

Some illustrations in this manual show the use of specialized tools. These tools are recommended for transmission repair as they make repair easier, faster and prevent costly damage to critical parts.

Some of these tools can be obtained from a regular tool supplier, while others can be made either from prints or from dimensions as required by the individual user.

Listed below are illustrations which show these specialized tools, the tool name and how it can be obtained. Prints are available for tools which have a Fuller tool number; send requests to the Service Department, Fuller Transmission Division, Eaton Yale & Towne Inc., Kalamazoo, Michigan.

Also available upon request is a tool booklet which gives in detail the use and description of suggested specialized tools for rebuilding Fuller Transmissions.

Illustration	Tool	How Obtained
No. 5, Pg. 49	Impact puller	Make from 18″ steel rod, threaded ½-13 one end, attach end block and sliding block
No. 1, Pg. 46	Snap ring pliers, medium	Tool supplier
No. 2, Pg. 72	Jaw pullers, medium	Tool supplier
No. 2, Pg. 54	Special slotted plate and tool	Make plate from Fuller tool print T-15765; weld used sliding clutch to ⅜″ steel lever
No. 7, Pg. 82	Flanged-end bearing driver	Make from Fuller tool print T-10324
No. 3, Pg. 104	Flanged-end bearing driver	Make from Fuller tool print T-7551
No. 4, Pg. 104	Flanged-end bearing driver	Make from Fuller tool print T-10064
No. 2, Pg. 119	Torque wrench, 1000 cap.	Tool supplier
No. 2, Pg. 117	Torque wrench, 150 cap.	Tool supplier
No. 5, Pg. 124	Tension spring driver	Make from Fuller tool print T-11938

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