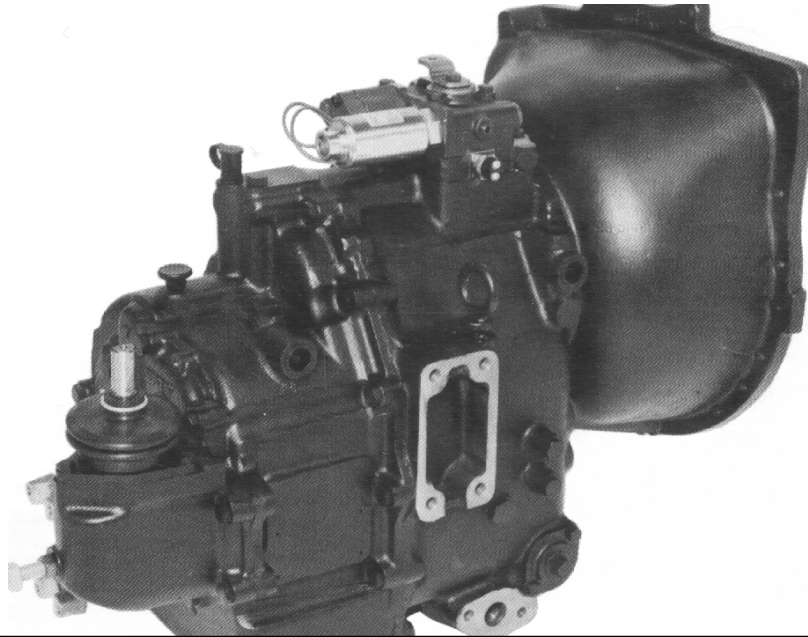


WINGET

TURNER
POWERTRAIN SYSTEMS



**WINGET LIMITED CANNOT ASSIST USERS OF EQUIPMENT THAT WAS
MANUFACTURED BY OTHER OEM'S**

**WINGET LIMITED WILL ONLY OFFER PARTS AND SERVICE ASSISTANCE
TO USERS OF EQUIPMENT MANUFACTURED BY WINGET LIMITED**

**PLEASE BE AWARE THAT SOME TRANSMISSION PARTS ARE NO
LONGER AVAILABLE**

COMPACT SHUTTLE SERVICE MANUAL

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INTRODUCTION

The COMPACT SHUTTLE is a powershift reversing shuttle with an integral 4-speed fully synchronised mechanical transmission. Designed for use in a variety of mobile off-highway applications, the COMPACT allows in-motion shifting between forward and reverse without braking.

Easily adaptable to take a variety of torque converters and fluid couplings, it is suitable for use with engines up to 66 kW (90 HP) rating. It will also accept a wide range of auxiliary units, such as transfer gear boxes.

The hydraulic clutches are operated by a soft shift control valve having mechanical or electrical dump, or inching control as standard. If required, a 4th gear lockout arrangement is available as an option. (Not used on transmissions fitted to Winget Equipment)

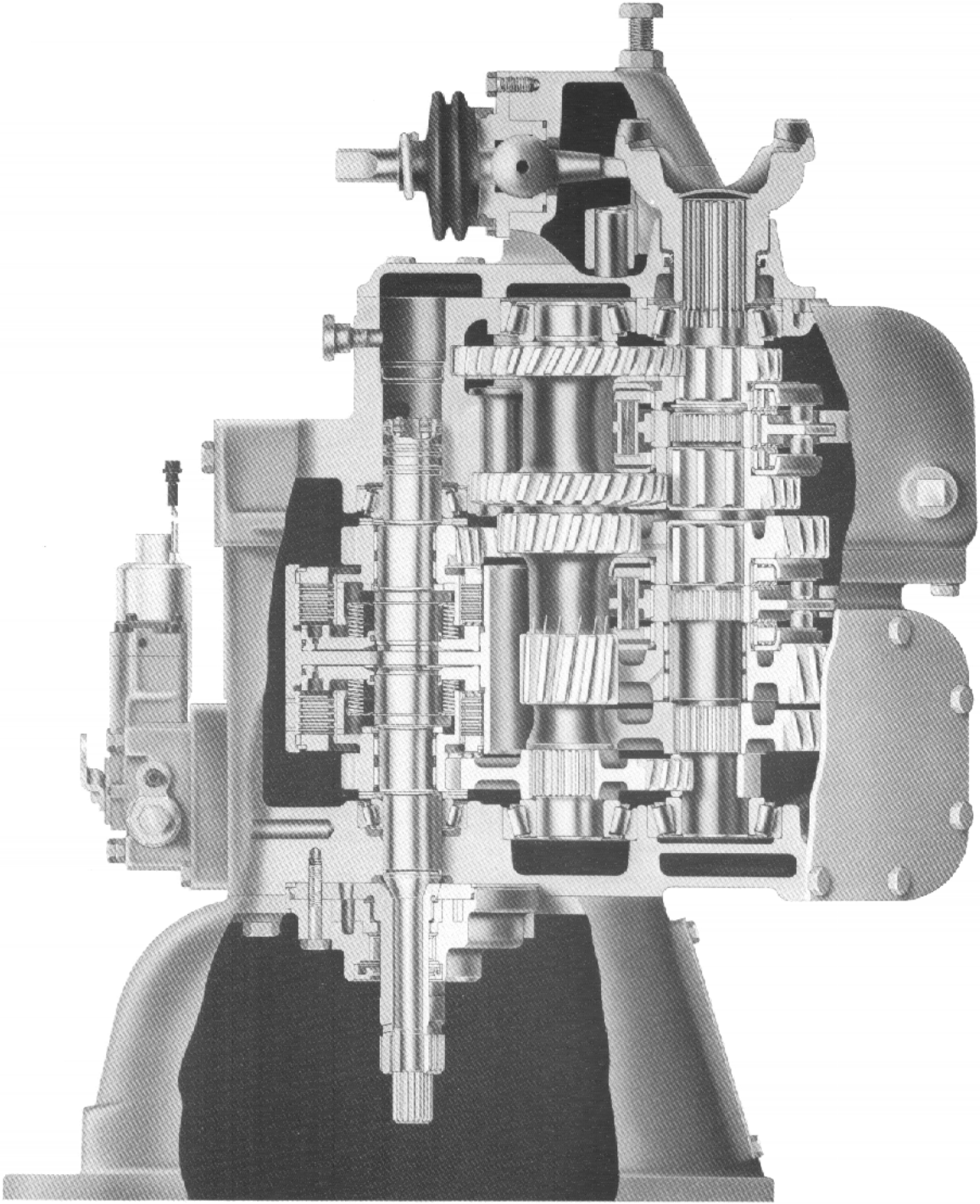
Pressure lubrication is provided by a self contained gear pump. Both the replaceable filter and the facility for 'high flow' cooling are provided as standard.

Although also not a feature on transmissions installed in Winget equipment two types of 4WD units are available as bolt on options. One is a hydraulic system employing multi-pack clutch plates. The other being a mechanical arrangement with dog clutch engagement.

Other options available include a live drive P.T.O. arrangement and various converter housings. Early transmissions installed in Winget equipment are fitted with a SAE 4 Converter Housing whilst later transmissions are fitted with the shorter SAE 3 Converter Housing.

The contents of this manual although correct at the time of publication, may be subject to alteration by the manufacturers without notice and Winget Limited can accept no responsibility for any errors or omissions contained within the following pages. Nor can Winget Limited accept any liability whatsoever arising from the use of this manual howsoever caused.

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COMPACT SHUTTLE TRANSMISSION

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SECTION ONE

INSTALLATION

In order to provide a satisfactory axis for the driveline of any vehicle it is imperative that an alignment check is carried out prior to connecting the driveline components. Failure to observe this will result in premature bearing failures, vibration and other related problems.

When taking readings rotate engine by hand, do not crank engine with starter. Engine may be rotated by pulley nut at front end of crankshaft. To ensure accurate readings release engine compression and apply constant pressure.

Position a suitable dial indicator on the flywheel mounting spigot with the indicator in the twelve O'clock position, then using a suitable pry bar lift the flywheel spigot to determine the crankshaft bearing clearance. Record the reading in the table on line A. THIS FIGURE WILL ALWAYS BE POSITIVE.

Starting with the indicator in the 6 O'Clock position set the dial to zero and rotate the crankshaft recording the readings at the 9, 12, and 3 O'Clock positions in the table on line B. It is important to note whether the reading is positive or negative (positive is furthest from the centre).

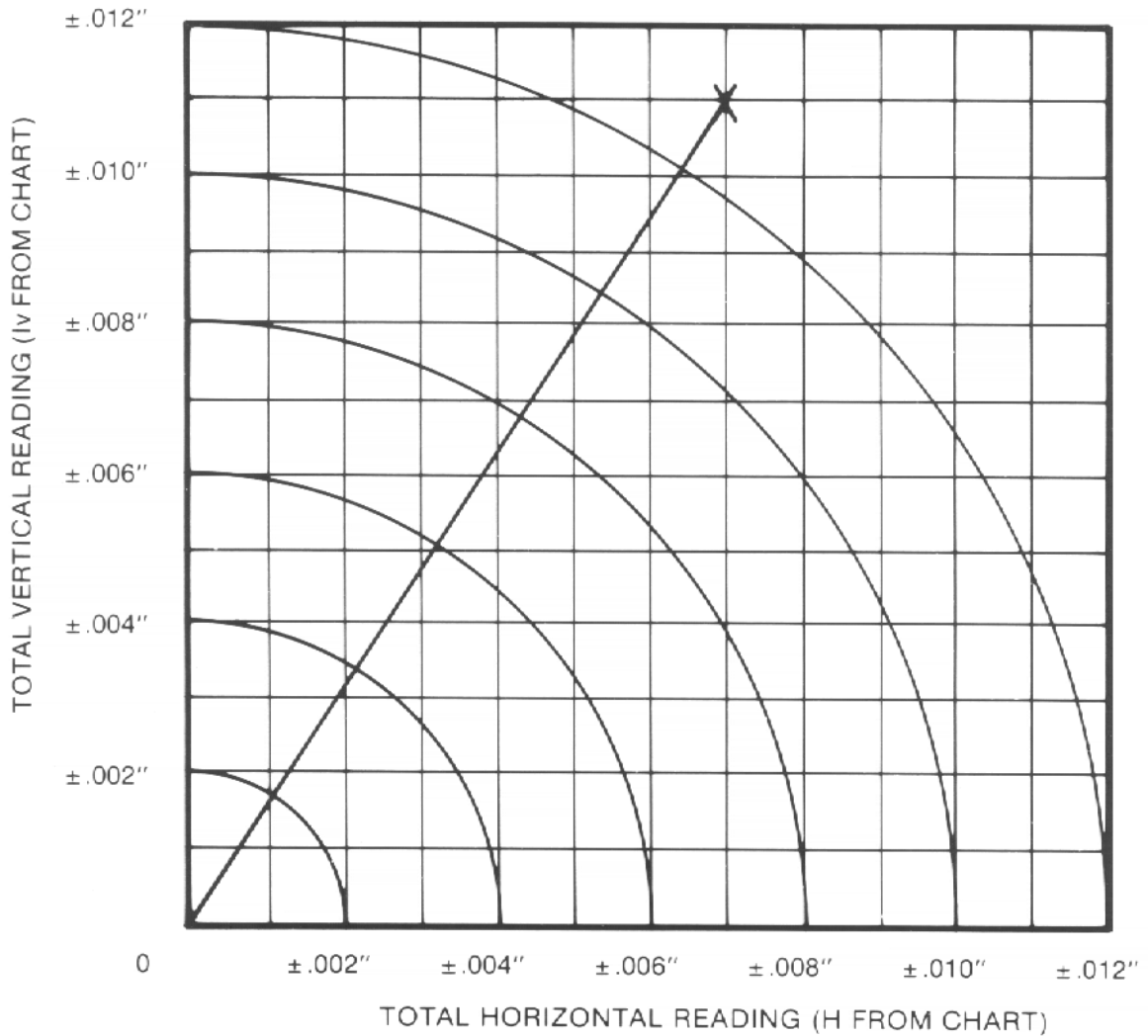
	6 O'Clock	9 O'Clock	12 O'Clock	3 O'Clock
A. BEARING CLEARANCE	_____	_____	A =	_____
B. INDICATOR READING	0	B1 =	B2 =	B3 =
C. CORRECTED VERTICAL READING	_____	_____	$Iv = A - B2 =$	_____
D. CORRECTED HORIZONTAL READING	_____	$H1 = B1 + \frac{1}{2}A$ =	_____	$H3 = B3 + \frac{1}{2}A$ =
E. TOTAL HORIZONTAL READING	_____	$H = H1 - H3 =$	_____	_____

Taking the figures for Iv and H plot the intersection on chart 1, then read off the resultant total indicator reading. Actual eccentricity is half of the resultant total indicator reading.

Total permissible eccentricity for flywheel housings is 0.2 mm (.008") for S.A.E. No's. 1, 2 & 3 housings.

INSTALLATION

Chart 1
RESULTANT TOTAL INDICATOR READING



SCALE 10 mm = .001"

1. PLOT INTERSECTION ON GRAPH.
2. MEASURE DISTANCE FROM NEAREST RING BELOW.
3. CONVERT FIGURE OBTAINED IN No. 2 ON SCALE INTO THOUSANDTHS OF AN INCH.
4. ADD THIS TO THE FIGURE OF THE NEAREST RING.

EXAMPLE

NEAREST RING = .012"
 DISTANCE FROM RING = 10 mm
 CONVERT 10 mm = .001"
TOTAL READING = .013"

EXAMPLE

An S.A.E. No. 3 housing is measured and the following results were obtained:-

H = .007"

Iv = .011"

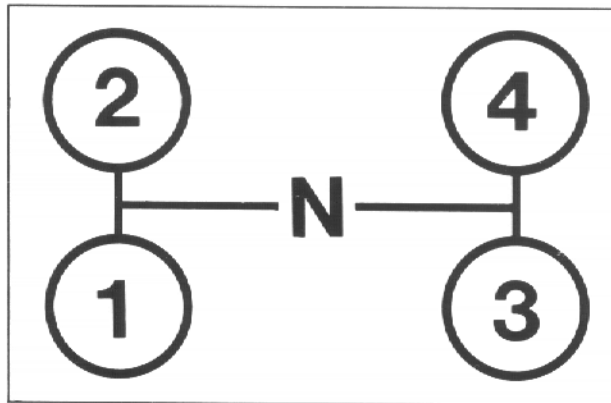
Resultant from graph = .013". Eccentricity = $\frac{.013}{2} = .0065$ ".

GEAR RATIOS & FRONT WHEEL DRIVE DATA

GEAR RATIOS

MODEL NUMBER	RATIOS							
	FORWARD				REVERSE			
	1	2	3	4	1	2	3	4
COM - T4 - 2011	6.285	3.325	1.834	1.031	6.251	3.307	1.825	1.026
COM - T4 - 2012	6.285	3.325	1.710	1.086	6.251	3.307	1.701	1.080

SHIFT PATTERN



Pattern as seen at the stub lever from the rear of the transmission.

NOTE

Due to legal requirements certain applications have 4th gear blanked off in order to reduce the maximum speed of the vehicle.

FRONT WHEEL DRIVE DATA

Ratios identical to main transmission ratios.

LUBRICATION

Recommended Lubricants

ALL TEMPERATURES
MOBIL DELVAC 1300, SHELL DONAX TM,
B.P. AUTRAN C3, ESSO TORQUE FLUID 47,
CASTROL TFC 310 OR MULTIPLANT
TEXACO TORQUE FLUID C3 OR URSATEX
TOTAL H.T.F TYPE C3
OR EQUIVALENT

To ensure proper lubrication and operating temperatures in this unit it is most important that the proper lubricants are used and that correct oil levels be maintained.

Oil Changes

We recommend an initial oil change and flush after the transmission is placed in actual service. This change should be made any time following 25 hours but should not exceed 100 hours, when changing the oil it is essential to renew the external oil filter and clean the suction strainer.

There are many factors that influence the following oil change periods and we have not specified a definite interval.

In general it is suggested that a drain and flush period should be scheduled every 750 hours of operation. It is necessary to replace the oil filter at this time. The oil level should be checked daily using the dipstick at the side of the transmission, and topped up as necessary.

Refill

First remove all dirt from around the dipstick, then refill with clean new oil as recommended until the oil reaches the maximum level as indicated on the dipstick with the engine idling and the transmission at normal operating temperature.

Grease

On reassembly of the output shaft, it is essential to coat all fluted bearing diameters with molycote grease prior to reassembly.

Overfilling

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

The object in draining the transmission oil is to eliminate possible bearing surface abrasion and attendant wear. Minute particles of metal, the product of normal wear in service are deposited in and circulate with the oil. When changing the oil, it is best carried out when the transmission is thoroughly warm. After draining, flushing is desirable.

CAUTION

TOWING precautions when towing vehicles equipped with Spicer transmissions

To prevent oil starvation to the transmission whilst towing the vehicle, it is imperative that the propeller shaft is disconnected completely from the vehicle.

Failure to observe this precaution may result in extensive internal damage to the transmission.

GENERAL INFORMATION

Maintenance Information

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

Tools

This transmission can be repaired with ordinary mechanics hand tools however this procedure is not only slow but may damage otherwise serviceable parts. To reduce maintenance costs and vehicle downtime, we recommend that the special tools listed in this manual be procured from a tool manufacturer, as stated.

Rebuild Facilities

A suitable holding fixture or overhaul stand is desirable but not essential to rebuild this unit. The flat surfaces on the transmission provide a suitable working platform when the unit is placed on a sturdy shop table.

For easier working conditions the table height should be 28-30".

Cleanliness

Transmission should be steam cleaned externally prior to disassembly. Seal all openings before cleaning to prevent entry of dirt and water which can damage serviceable parts. Dirt is abrasive and will cause premature wear and failure of clutch plates, hydraulic valves and bearings.

Due to the nature of operation of the hydraulic system cleanliness is of prime importance and the following guidelines should be observed.

1. No lint or cotton rags should be used in order to prevent any possible clogging.
2. When fitting new clutch plates they should be soaked in clean new oil as recommended for 3 hours.
3. All parts should be thoroughly cleaned and lubricated with new oil prior to reassembly.

Bearings

When a transmission is removed at relatively low mileage, bearings should be removed with pullers designed for the purpose. Wrap the bearings to keep out dirt. Clean, inspect and lubricate all bearings just prior to reassembly. If accumulated mileage is over 1500 hours we suggest that all bearings be replaced.

Replacement Parts

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

Shims

When inserting shim packs, it is essential that the thinnest shims are placed between the thicker shims to prevent any possible damage to the shims.

NOTES ON MAINTENANCE

- 1 When replacement parts are required, always ensure that the correct parts are obtained, e.g. in the case of gear replacements, always check the part number stamped on the gear, and the number of teeth.
- 2 When ordering replacement parts, quote the details on the plate fixed to the side of the transmission gear case, see below.
- 3 It is essential that all gaskets, and seals removed while dismantling, should be renewed on reassembly.
- 4 On reassembly care should be taken that all parts are correctly replaced since any component omitted or incorrectly assembled can lead to a complete transmission failure.
- 5 Lubricants should comply with the recommended list as provided on page 1:4 of this manual. It is important to adhere to the oil changing procedure.
- 6 It is advisable to lightly lubricate with a recommended lubricant, parts such as gears, shafts, thrust washers and oil seals during reassembly.

MODEL No.
SERIAL No.
CUST. PT. No.
SPICER TRANSMISSION DIVISION WOLVERHAMPTON, ENGLAND.

SPECIAL TOOLS

TOOL NUMBER	DESCRIPTION	USED WITH
MS 47	Handpress	—
18G 47 AK	Front & rear countershaft and output shaft bearing remover	MS 47
18G 47 AT	Front & rear input shaft bearing remover	MS 47
18G 191	Dial indicator with magnetic base	—
7066	Circlip pliers	—
TM 119	Piston seal sizing ring	—
TM 121	Piston spring retainer snap ring replacer	—

These tools are manufactured and supplied by:

Messrs. V.L. Churchill & Co. Limited, P.O. Box 3, London Road, Daventry, Northants. Tel: (0327) 704461.

RECOMMENDED TUBE SIZES FOR REPLACING BEARINGS

	Tube Bore	Tube O/D
Countershaft & Output shaft bearings	41.5 mm	48 mm
Input shaft bearings	36 mm	41.5 mm
Output shaft 1st gear sleeve	50.5 mm	More than 55 mm
4WD main bearings	38 mm	45 mm
Hydraulic 4WD bearing sleeve	42 mm	More than 50 mm

TORQUE WRENCH GUIDE

	Kgm	lb ft
Control assembly screws	1.8 – 3.2	13 – 23
Drain plugs	3.5 – 5.5	25 – 40
Oil filter housing screws	4.5 – 6.5	33 – 47
Reverse idler shaft nut	12.4 – 13.8	90 – 100
Front to rear case screws	4.5 – 6.5	33 – 47
Rear cover to rear case screws	4.5 – 6.5	33 – 47
Detent plugs	4.1 – 5.5	30 – 40
Neutral start switch	4.8 – 5.5	35 – 40
Selector mechanism screws	1.8 – 3.2	13 – 23
Suction strainer housing screws	1.8 – 3.2	13 – 23
Oil pump screws	1.8 – 3.2	13 – 23
Converter housing screws	8.3 – 11.0	60 – 80
Handhole cover screws	0.8 – 1.7	6 – 12
Dipstick cover screw	8.3 – 11.0	60 – 80
Suction pipe screw	1.8 – 3.2	13 – 23
Interlock plate screws	0.8 – 1.7	6 – 12
Oil pressure point plugs	4.1 – 5.5	30 – 40
Front wheel drive cover screws	4.5 – 6.5	33 – 47
Shift fork lockscrews	1.8 – 2.5	13 – 18
Oil transfer pipe banjo bolts	3.5 – 4.1	25 – 30 + Loctite 638

SPECIFICATION AND REPAIR DATA

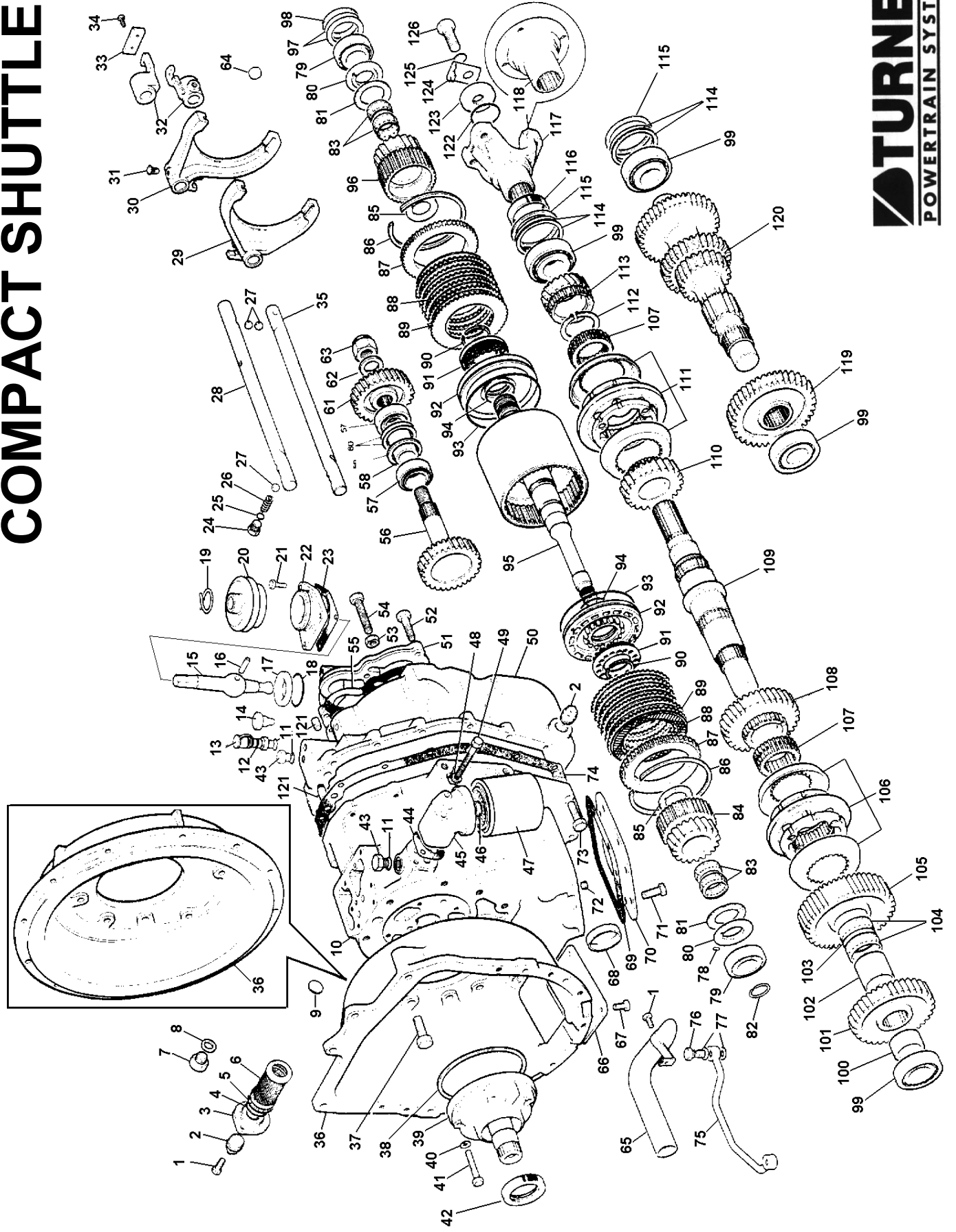
Output Shaft Gears

	mm	in
1st gear endfloat	0.33 - 0.50	0.013 - 0.020
2nd gear endfloat	0.36 - 0.56	0.014 - 0.022
3rd gear endfloat	0.38 - 0.84	0.015 - 0.033
4th gear endfloat	0.30 - 0.56	0.012 - 0.022
Reverse idler bearing condition	0.003 - 0.006" Preload	
Output shaft bearing condition	0.001 - 0.003" Endfloat	
Input shaft bearing condition	0.001 - 0.003" Endfloat	
Countershaft bearing condition	0.001 - 0.003" Endfloat	
4WD bearing condition	0.001 - 0.003" Endfloat	

KEY TO TRANSMISSION COMPONENTS

No.	Description	No.	Description	No.	Description
1.	Screw	43.	Plug	85.	Thrust Washer
2.	Drain Plug	44.	Gasket	86.	Spring Ring
3.	Cover	45.	Filter Housing	87.	Retainer
4.	Support Washer	46.	Adaptor	88.	Clutch Disc 1st/2nd
5.	'O' Ring	47.	Oil Filter	89.	Friction Disc 1st/2nd
6.	Suction Strainer	48.	Washer	90.	Spring Ring
7.	Plug	49.	Screw	91.	Spring Retainer
8.	Washer	50.	Rear Case	92.	Piston
9.	Expansion Plug	51.	Rear Cover	93.	Outer Seal
10.	Front Case	52.	Screw	94.	'O' Ring
11.	'O' Ring	53.	Nut	95.	Input Shaft
12.	Nipple Assembly	54.	Screw	96.	Reverse Primary Gear
13.	Dust Cover	55.	Gasket	97.	Shims
14.	Breather	56.	Reverse Idler Gear	98.	Spacer
15.	Stub Lever	57.	Idler Bearing	99.	Bearing
16.	Pin	58.	Spacer	100.	Spacer
17.	Lower Seating	59.	Spacer	101.	4.W.D. Drive Gear
18.	'O' Ring	60.	Shim	102.	Bearing Sleeve
19.	Hose Clip	61.	Reverse Idler Gear	103.	Spacer
20.	Dust Cover	62.	Washer	104.	Bearing
21.	Screw	63.	Nut	105.	1st Gear
22.	Upper Seating	64.	Plug	106.	1st/2nd Synchro
23.	Gasket	65.	Suction Pipe	107.	Shift Hub Sleeve
24.	Plug	66.	Handhole Cover	108.	2nd Gear
25.	'O' Ring	67.	Screw	109.	Output Shaft
26.	Spring	68.	Core Plug	110.	3rd Gear
27.	Ball	69.	Gasket	111.	3rd/4th Synchro
28.	3rd/4th Shift Rod	70.	Cover Plate	112.	Circlip
29.	1st/2nd Shift Fork	71.	Screw	113.	4th Gear
30.	3rd/4th Shift Fork	72.	Plug	114.	Shim
31.	Screw	73.	Screw	115.	Spacer
32.	Shift Lug	74.	Gasket	116.	Oil Seal
33.	Interlock Plate	75.	Oil Transfer Pipe	117.	Output Yoke
34.	Screw	76.	Banjo Screw	118.	Output Flange
35.	1st/2nd Shift Rod	77.	Washer	119.	Drive Gear
36.	Converter Housing	78.	Pin	120.	Countershaft
37.	Screw	79.	Bearing	121.	Dowel
38.	Sealing Ring	80.	Thrust Washer	122.	'O' Ring
39.	Oil Pump	81.	Thrust Washer	123.	Washer
40.	Washer	82.	Sealing Ring	124.	Tab Washer
41.	Screw	83.	Bearing	125.	'O' Ring
42.	Oil Seal	84.	Forward Primary Gear	126.	Screw

COMPACT SHUTTLE



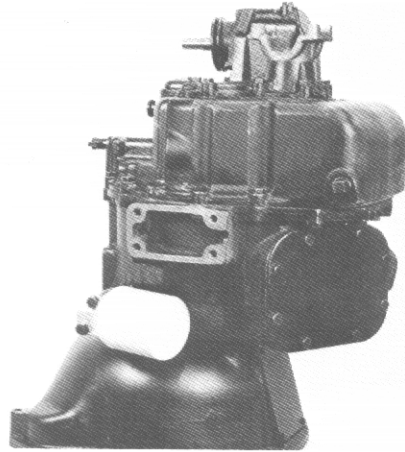
SECTION TWO

TRANSMISSION DISASSEMBLY

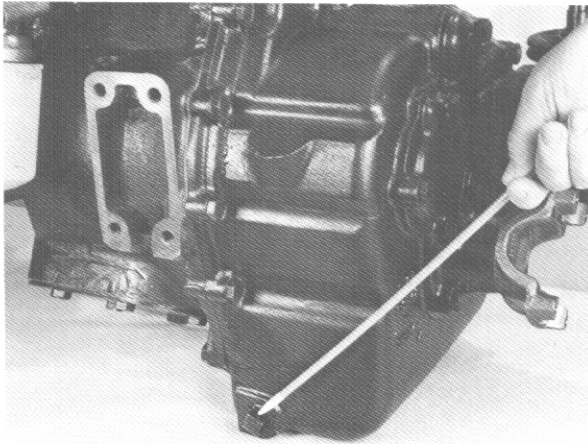
Before commencing any dismantling procedure it is essential to thoroughly clean the transmission and work area.

Note . . .

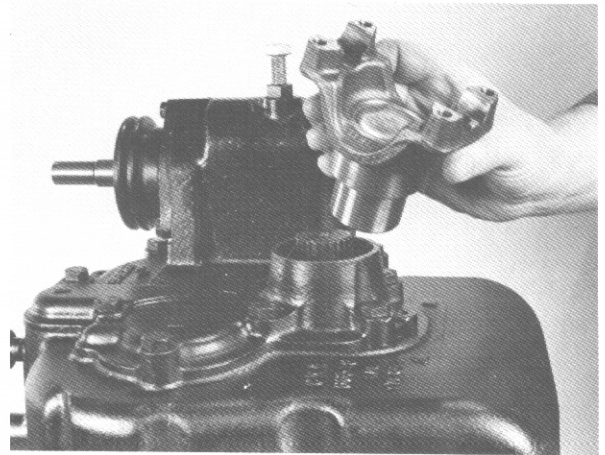
It is **IMPORTANT** to mark all shims, bearing shells and synchronisers for reassembly.



3. Invert the transmission as shown.



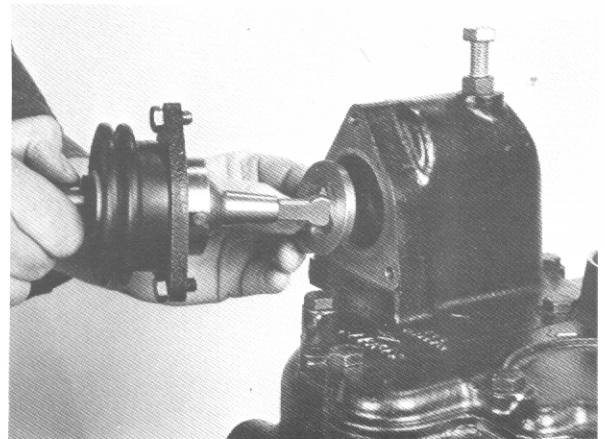
1. Drain the lubricating oil from the transmission into a suitable container by removing the drain plug.



4. Withdraw the output coupling.
Note:- Some models may have the coupling secured by means of a bolt, washer and tab washer.



2. Remove the screws, then withdraw the control valve assembly, gasket, adaptor and gasket.

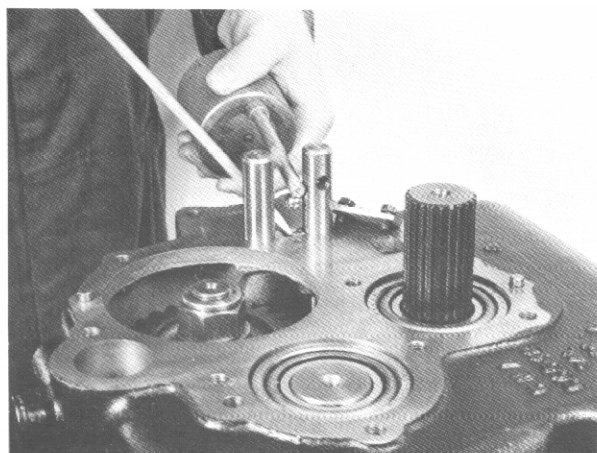


5. Remove the screws, withdraw the control assembly and gasket, taking care not to lose the anti-rotation pin. Then remove the lower seating and 'O' ring.

TRANSMISSION DISASSEMBLY



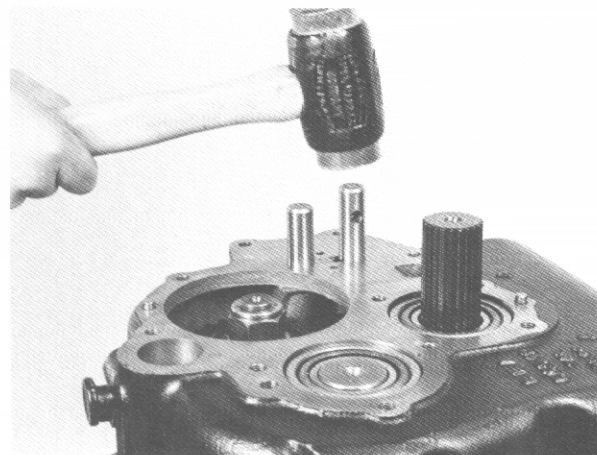
6. Remove the screws, then withdraw the rear cover and gasket.



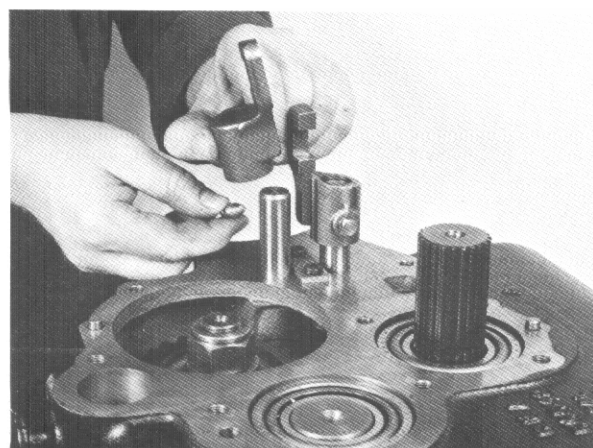
9. Remove the screws, then the interlock plate. Remove the two interlock balls using a suitable magnet.



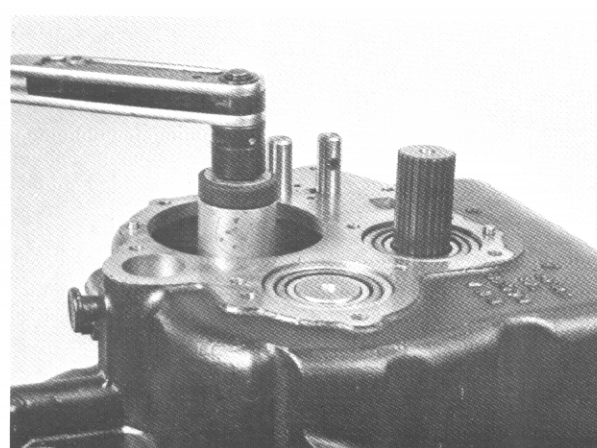
7. Withdraw the countershaft and output shaft shim packs keeping the appropriate shims together for reassembly.



10. Engage two gears by tapping down the shift rods.

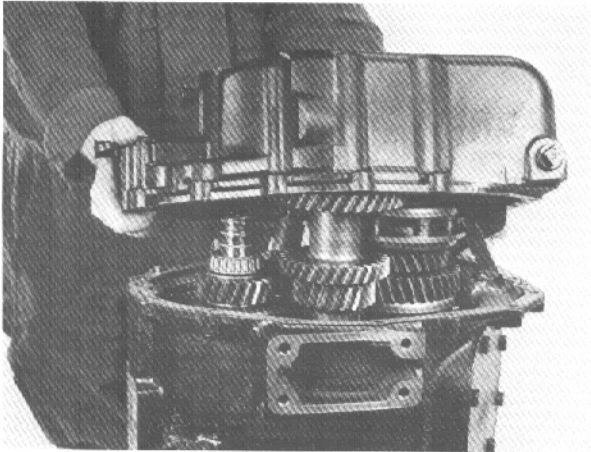


8. Remove the lock screws, then withdraw the shift lugs.

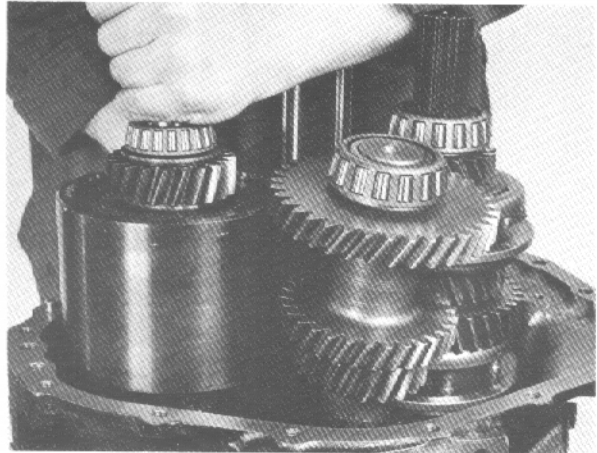


11. Remove the reverse idler nut and washer.

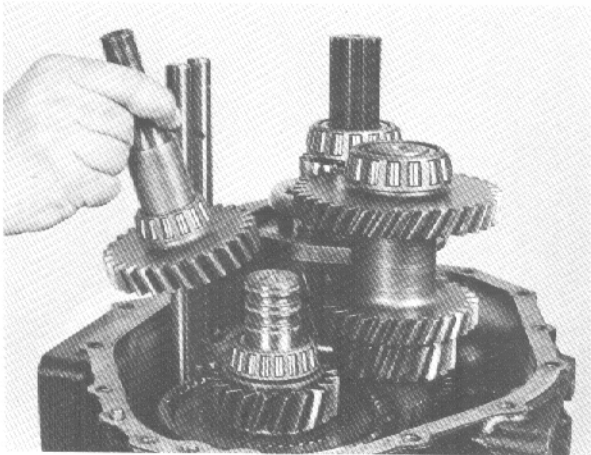
TRANSMISSION DISASSEMBLY



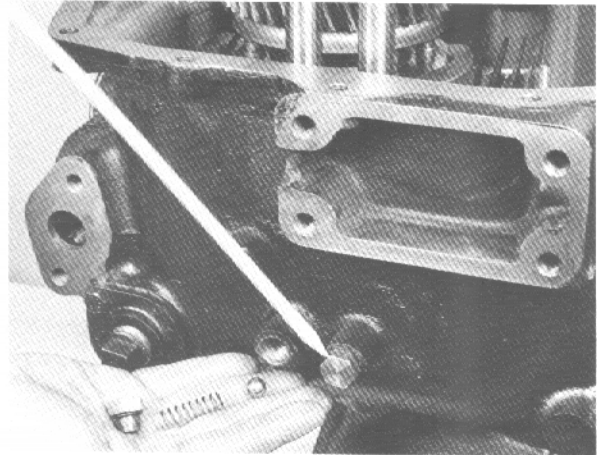
12. Using a soft metal drift tap the idler shaft to free the spline, then remove the screws and withdraw the rear case, gasket, idler gear and bearing.



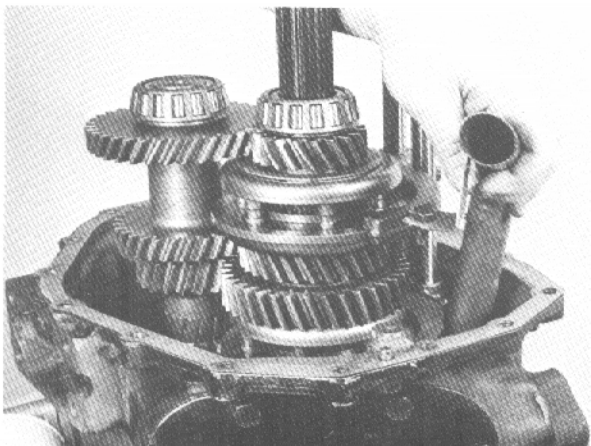
15. Lift and tilt the countershaft and withdraw the input shaft assembly, then relocate the countershaft.



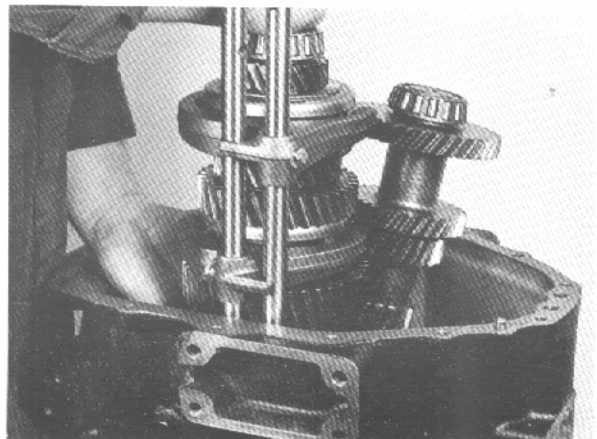
13. Withdraw the idler pinion, bearing, spacer and any main bearing shells remaining.



16. Remove the detent plugs, springs and balls.

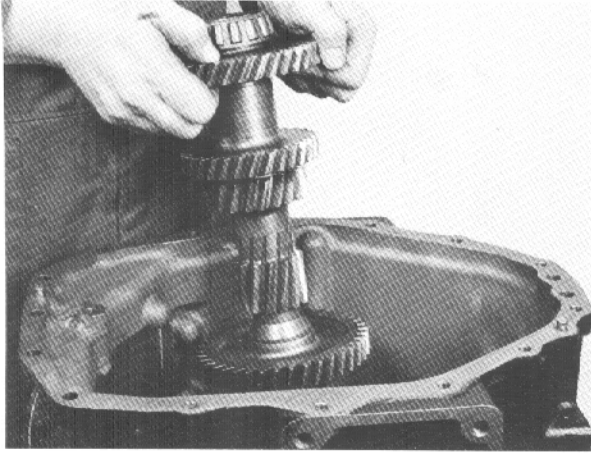


14. Flatten the tab washer, remove the screw and withdraw the suction pipe.

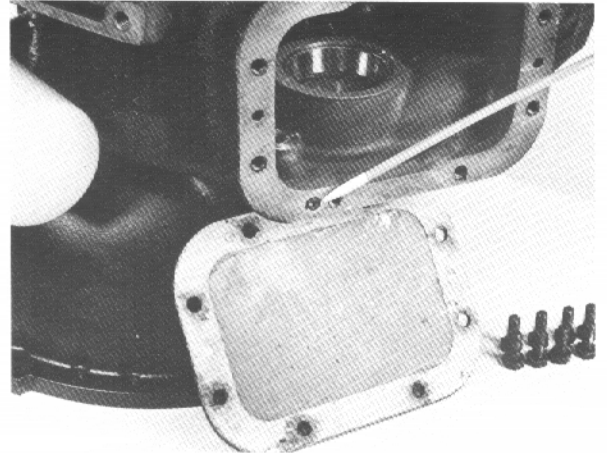


17. Lift and tilt the countershaft then withdraw the output shaft and shift fork assembly.

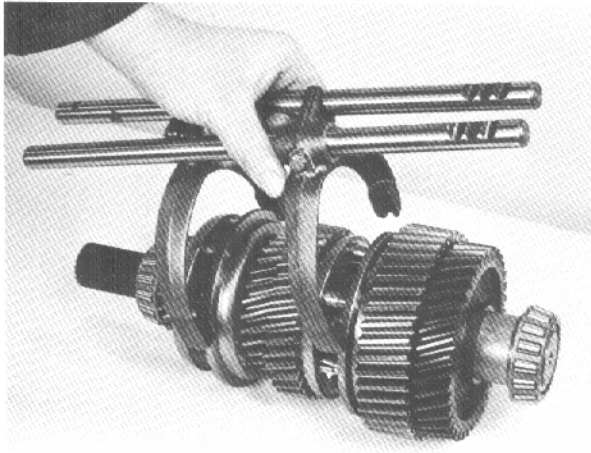
TRANSMISSION DISASSEMBLY



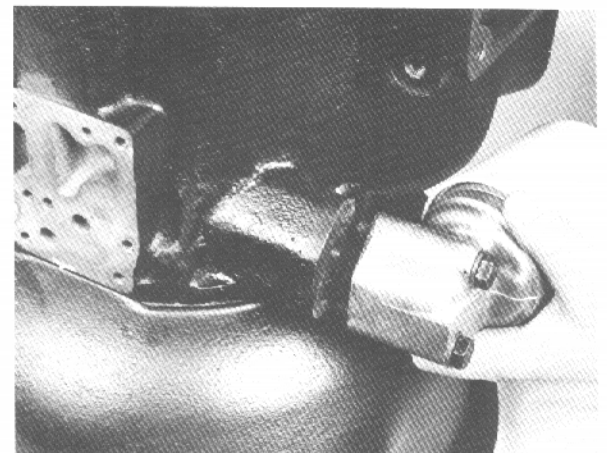
18. Withdraw the countershaft.



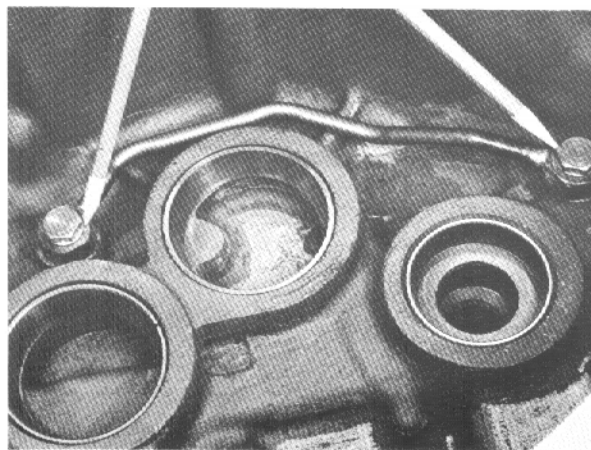
21. Remove the screws, withdraw the front wheel drive aperture plate and gasket, then remove the oil feed plug.



19. Remove the shift forks and rods. Note the positions of the forks if removed from the rods.



22. Remove the screws and washers, then the oil filter housing and gasket.

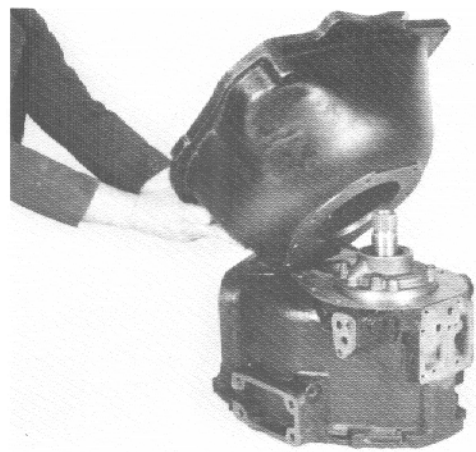


20. Remove the oil feed pipe.

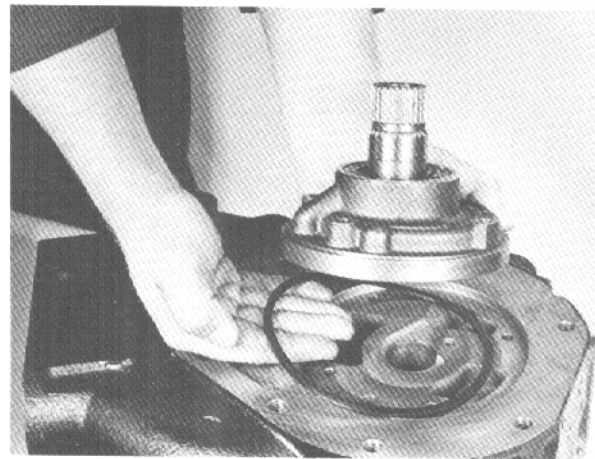


23. Remove the screws, then the oil strainer retaining plate, 'O' ring and oil strainer.

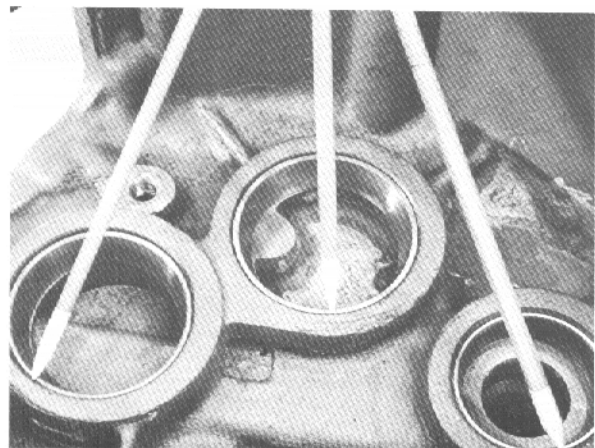
TRANSMISSION DISASSEMBLY



24. Remove the screws and withdraw the converter housing.



25. Remove the screws and washers, then withdraw the oil pump and sealing ring.

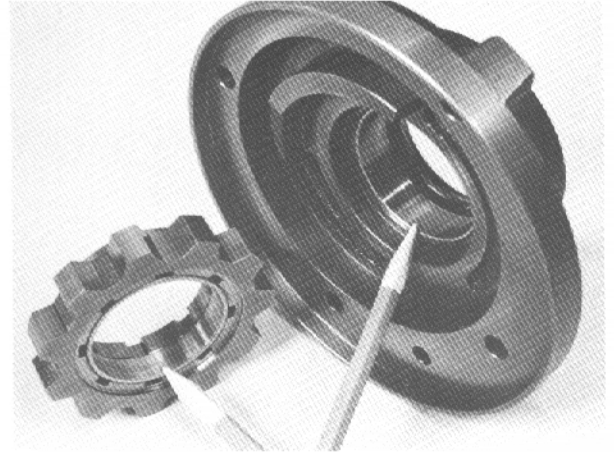


26. Remove any remaining bearing shells.

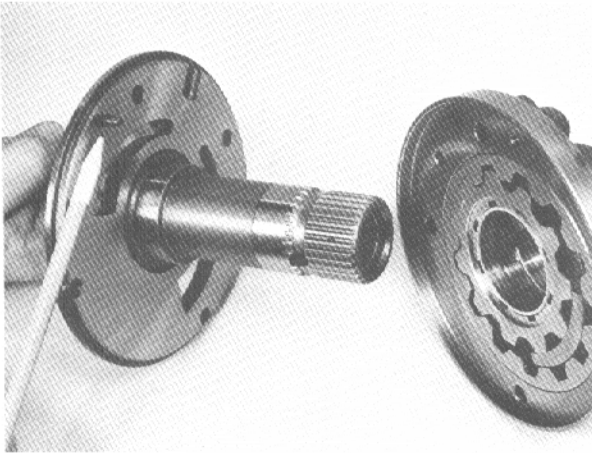
DISASSEMBLY AND REASSEMBLY OF THE OIL PUMP

NOTE

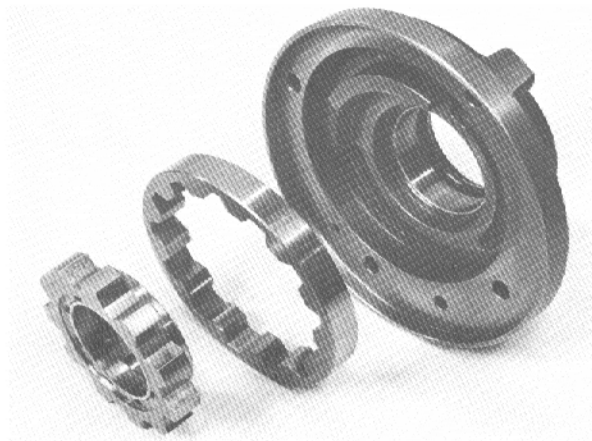
Disassembly of the oil pump is not generally recommended since individual components are non-serviceable, but may be dismantled for cleaning purposes.



3. Remove the oil seal and bushes as necessary. Reassemble in the reverse order.

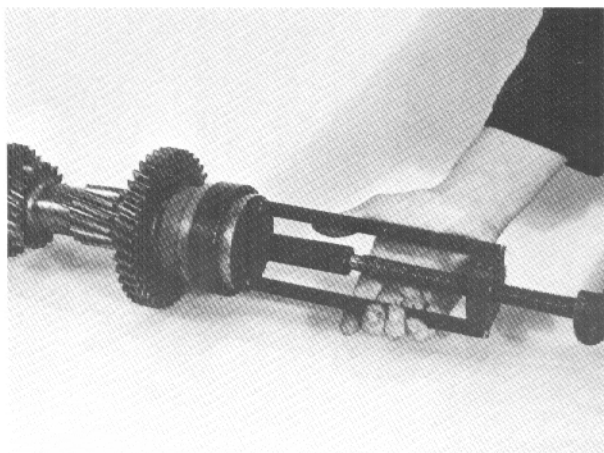


1. Remove the socket screw and withdraw the torque converter coupling.

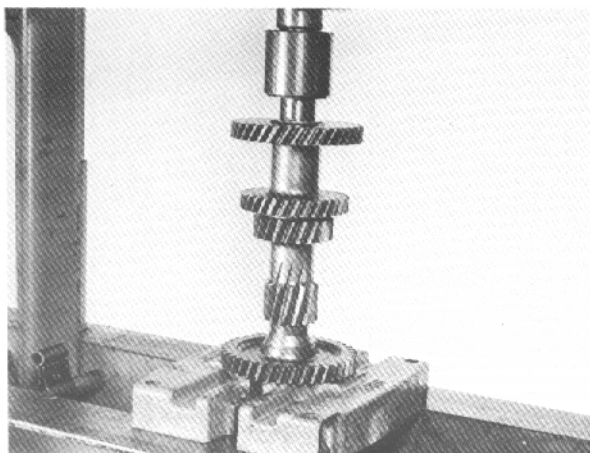


2. Withdraw the drive gear and driven gear.

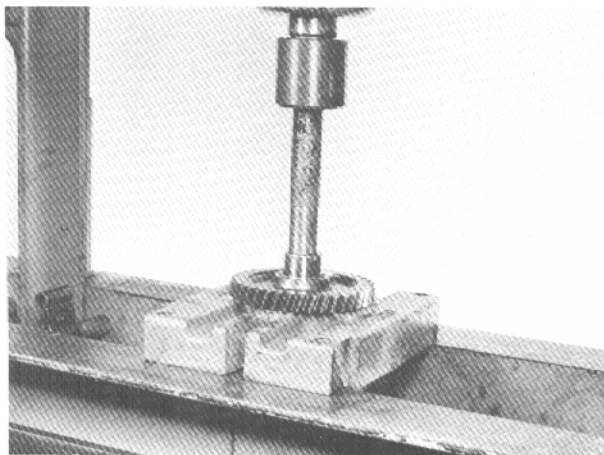
DISASSEMBLY AND REASSEMBLY OF THE COUNTERSHAFT



1. Support the shaft adequately then using the appropriate tools remove the countershaft front and rear bearings.



1. Apply a coating of Loctite grade 638 Splinelock or equivalent to the splines and press the gear onto the shaft.

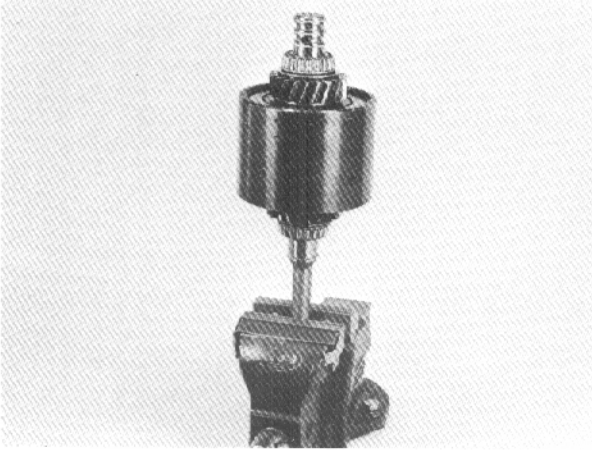


2. Using a press with a minimum capacity of 10 tonnes press the shaft through the drive gear.

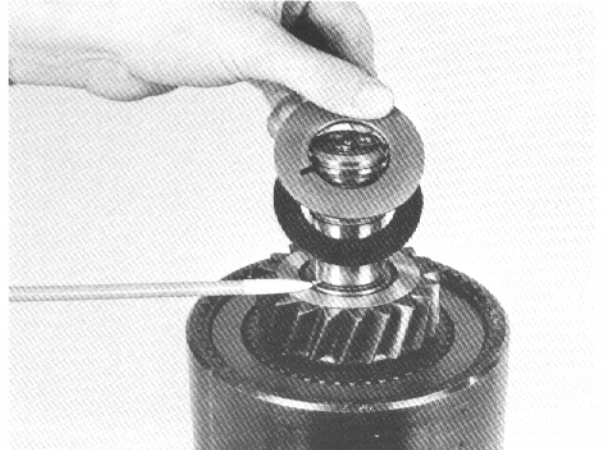


2. Using a suitable tool replace the front and rear bearings.

INPUT SHAFT DISASSEMBLY



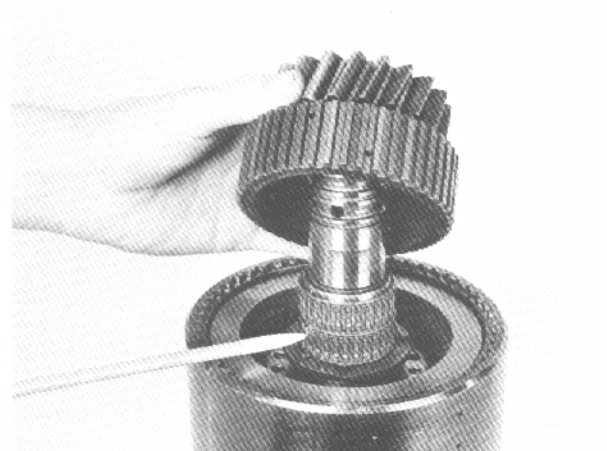
1. Position the shaft in a soft jawed vice as shown.



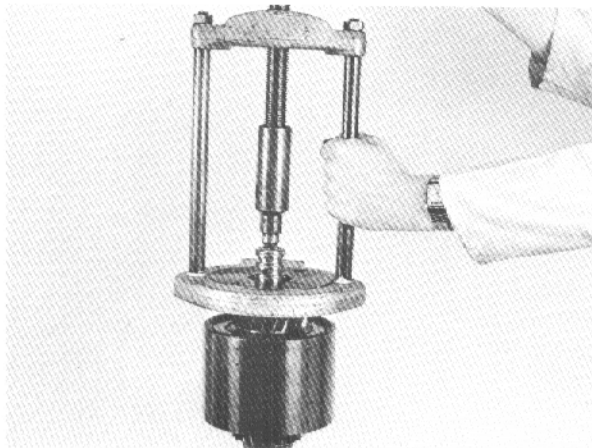
4. Remove the thrust washers and anti-rotation pin.



2. Remove the sealing rings.



5. Remove the reverse primary gear and bearings.

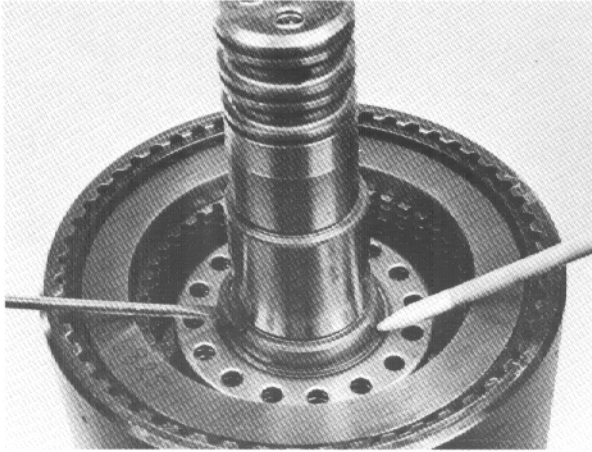


3. Using the appropriate tools remove the rear bearing.

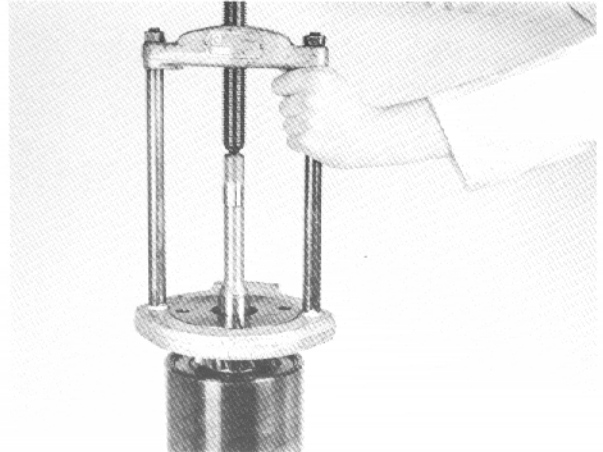


6. Remove the thrust washer and anti-rotation pin.

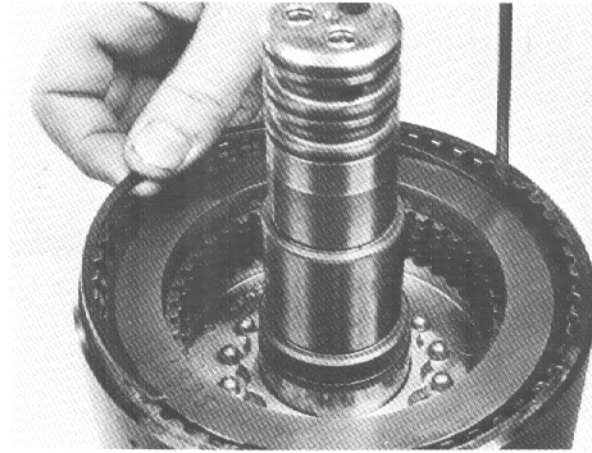
INPUT SHAFT DISASSEMBLY



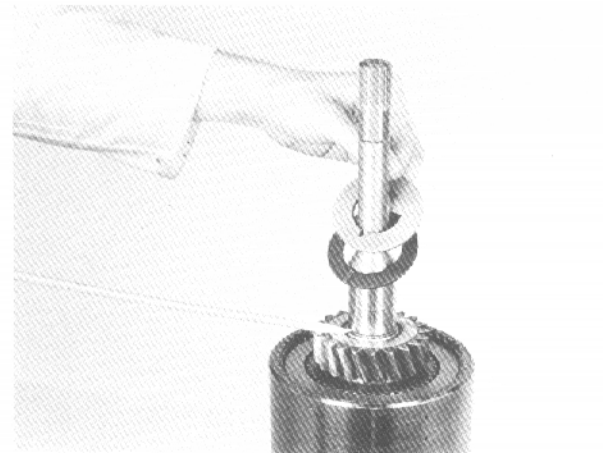
7. Using a suitable tool remove the snap ring and withdraw the spring pack.
Note:- The snap ring must not be re-used.



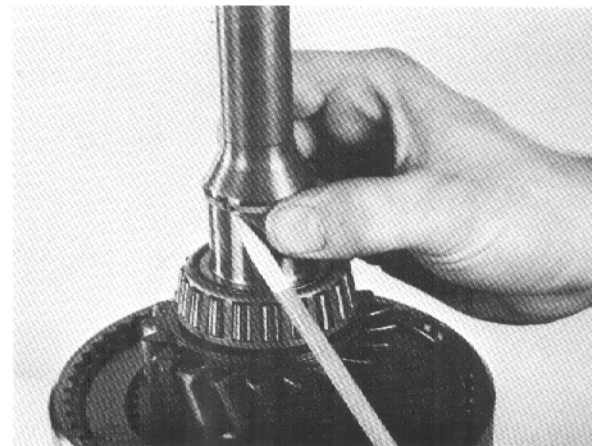
10. Using the appropriate tools remove the bearing.



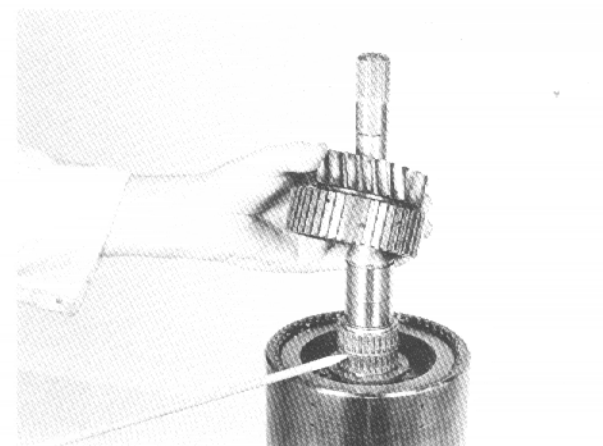
8. Remove the spring ring, then the retainer and clutch plates.



11. Remove the thrust washers and anti-rotation pin.



9. Invert the shaft and remove the sealing ring.

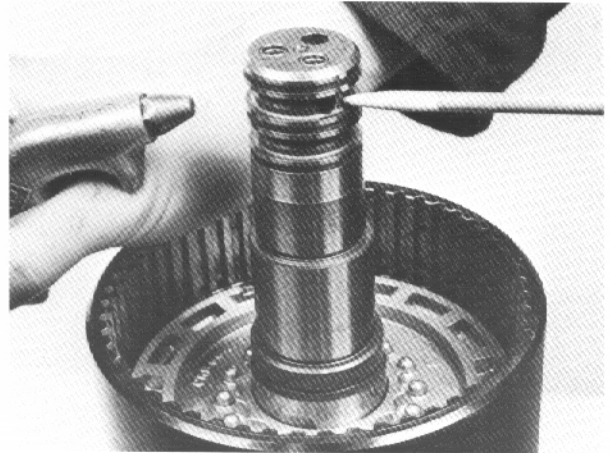


12. Remove the forward primary gear and bearings.

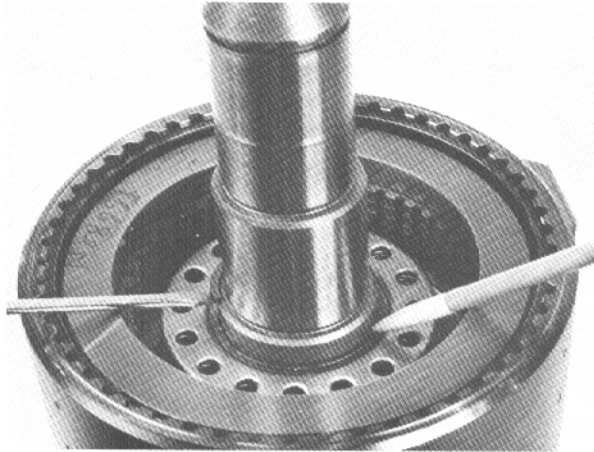
INPUT SHAFT DISASSEMBLY



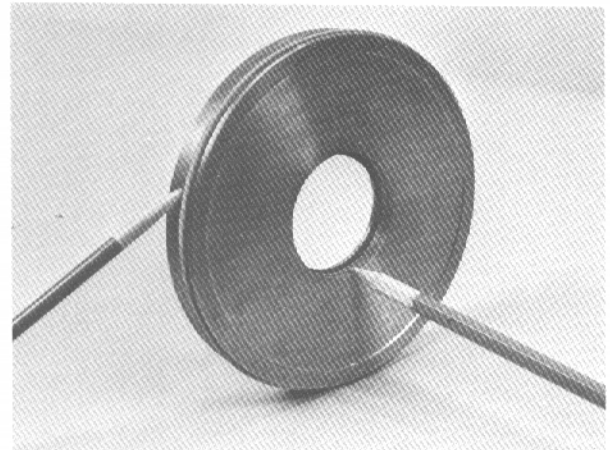
13. Remove the thrust washer and anti-rotation pin.



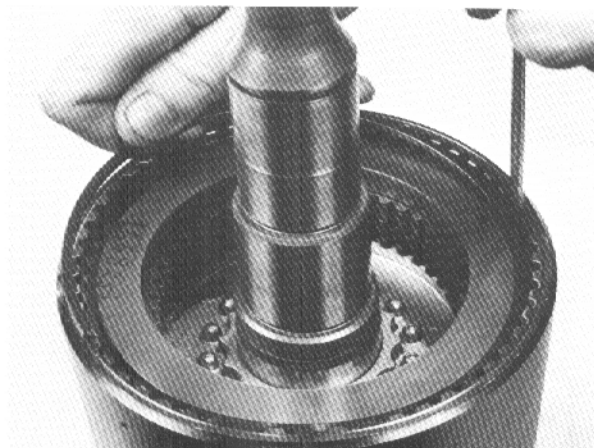
16. Using a suitable source of compressed air at the hydraulic ports, remove the forward, then the reverse piston.



14. Using a suitable tool remove the snap ring, then withdraw the spring pack.
Note:- The snap ring must not be re-used.



17. Replace the 'O' rings and sealing rings as necessary.



15. Remove the spring ring, then the retainer and clutch plates.

INPUT SHAFT REASSEMBLY

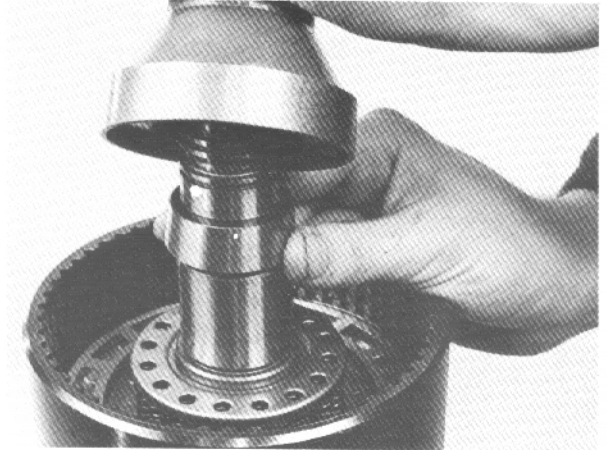
Before reassembly the following procedure must be observed. Soak the clutch plates in clean, new oil as recommended for a minimum of 3 hours.



1. If previously removed replace the 'O' rings, then the seals, before attempting to replace the seal, warm the seal in lukewarm water.



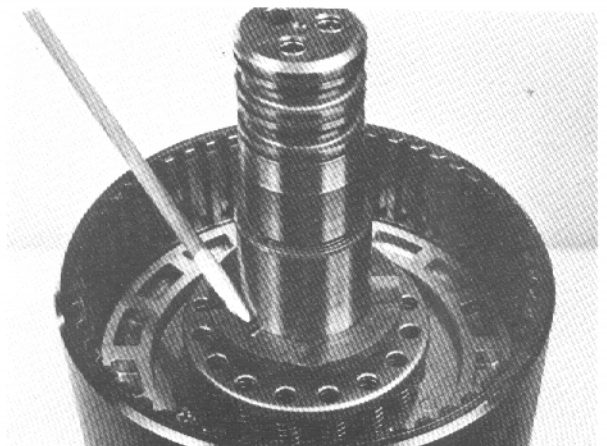
2. Using the appropriate tool compress the piston seals, leave the seals in the tool for approx 30 min, then remove the pistons and replace them into the clutch drum.



3. Replace the spring pack, then using a suitable tool secure the spring pack with a new snap ring.

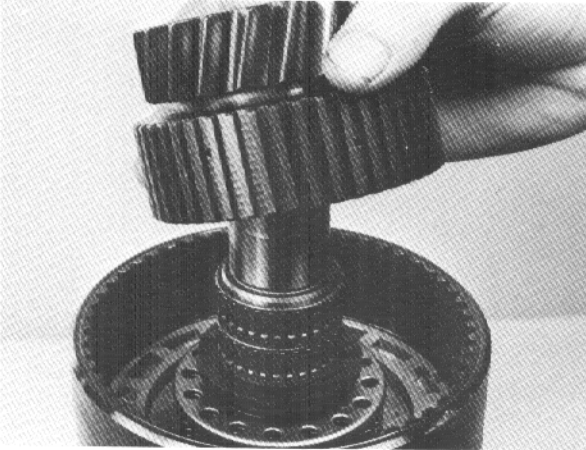


4. Repeat the above operation for the reverse spring pack.

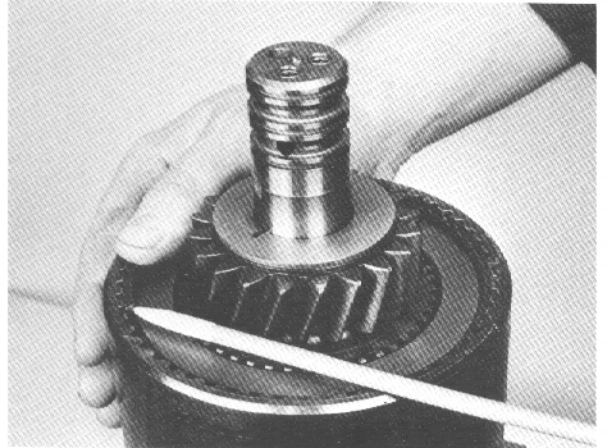


5. Replace the anti-rotation pin and thrust washer with the oil grooves facing up.

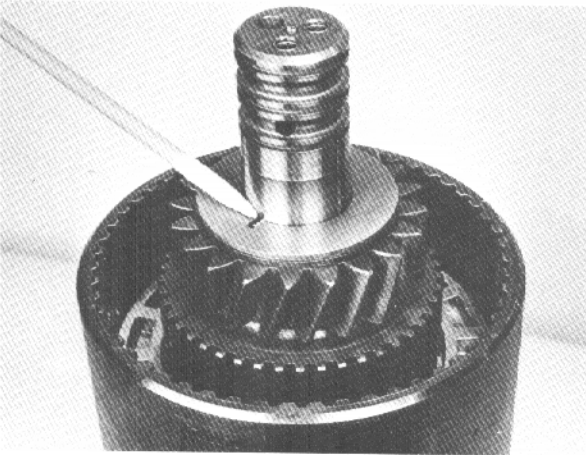
INPUT SHAFT REASSEMBLY



6. Replace the reverse gear bearings and gear.



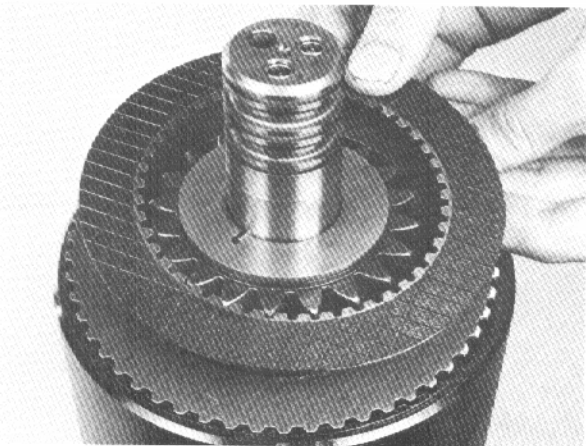
9. Replace the retainer as shown with the recess uppermost and secure with a snap ring.



7. Replace the anti-rotation pin, then the plastic washer, and the metallic washer with the boss located inside the plastic washer.



10. Using a suitable tool replace the bearing.

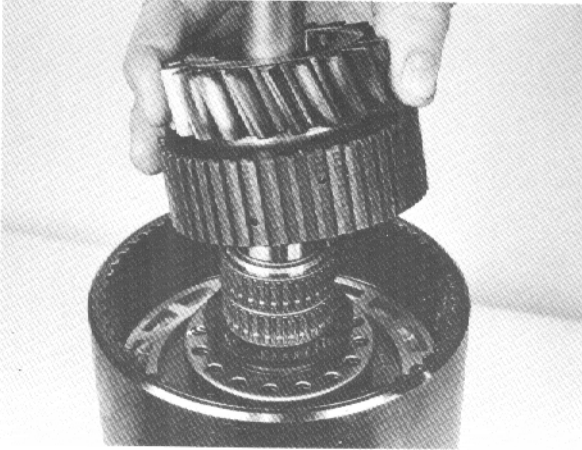


8. Replace an externally splined, then an internally splined clutch disc until six of each have been replaced.



11. Invert shaft, then replace the anti-rotation pin and thrust washer with the oil grooves facing up.

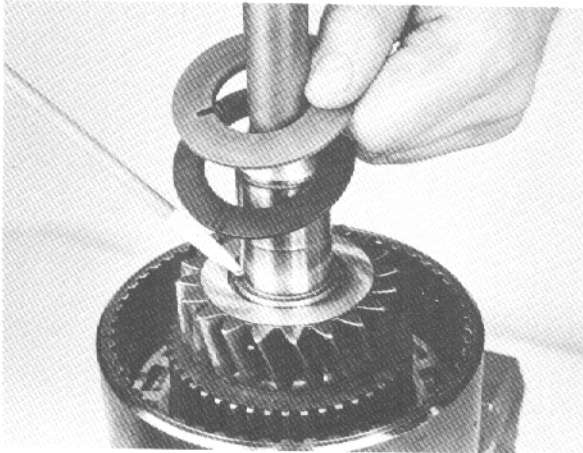
INPUT SHAFT REASSEMBLY



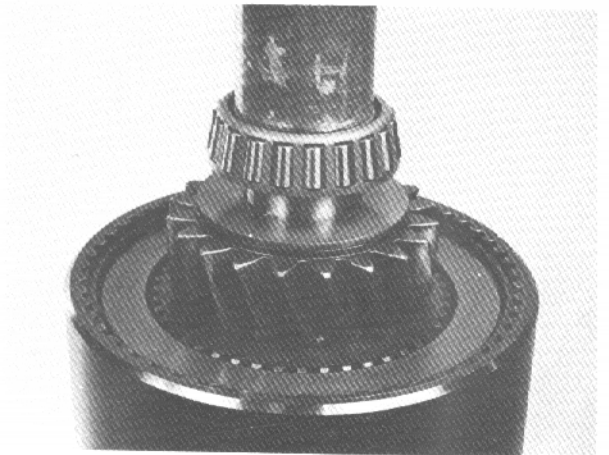
12. Replace the forward gear bearings and gear.



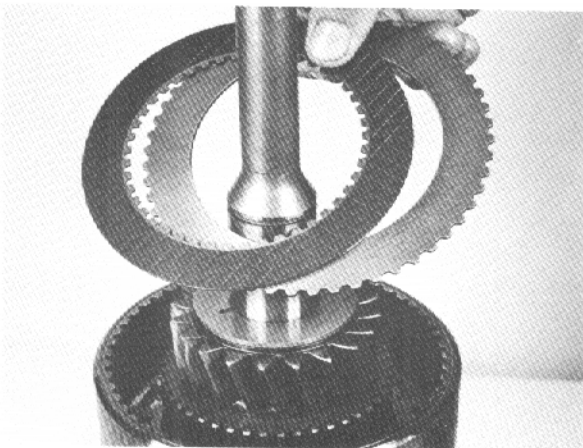
15. Replace the retainer as shown with the recess uppermost and secure with a snap ring.



13. Replace the anti-rotation pin, then the plastic washer, and the metallic washer with the boss located in the plastic washer.



16. Using a suitable tool replace the bearing.

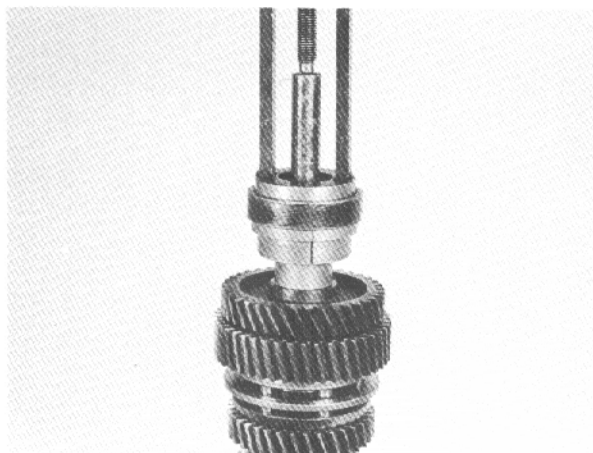


14. Replace an externally splined, then an internally splined clutch disc until six of each have been replaced.



17. Replace the front and rear sealing rings.

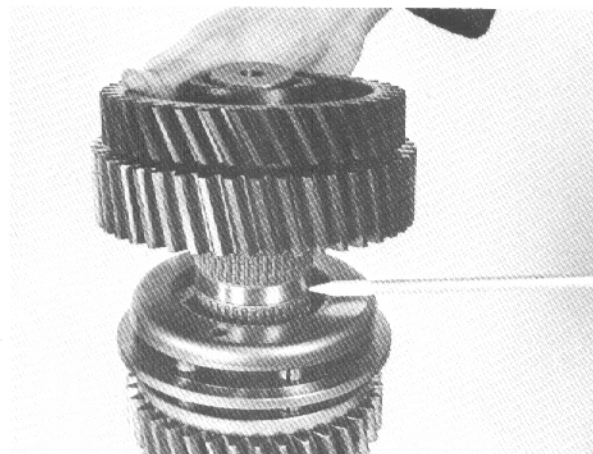
OUTPUT SHAFT DISASSEMBLY



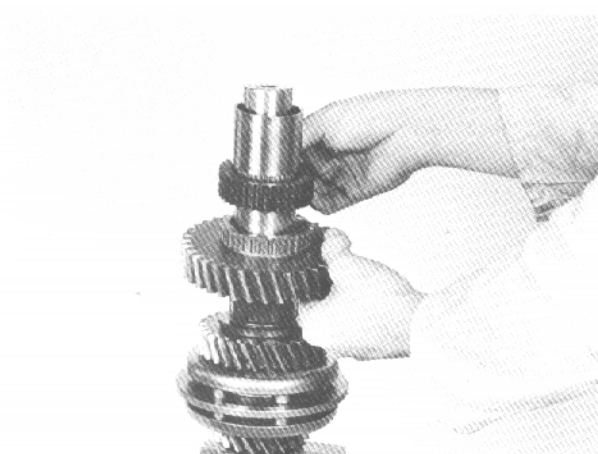
1. Position the shaft vertically as shown, then using the appropriate tools remove the bearing and spacer.



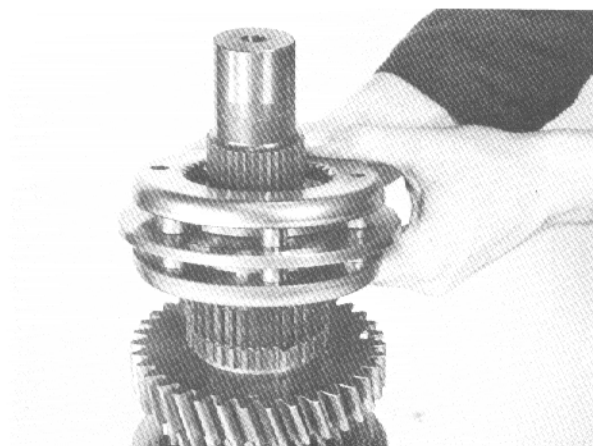
4. Using a suitable puller under the 2nd gear, remove the 1st gear bearing sleeve.



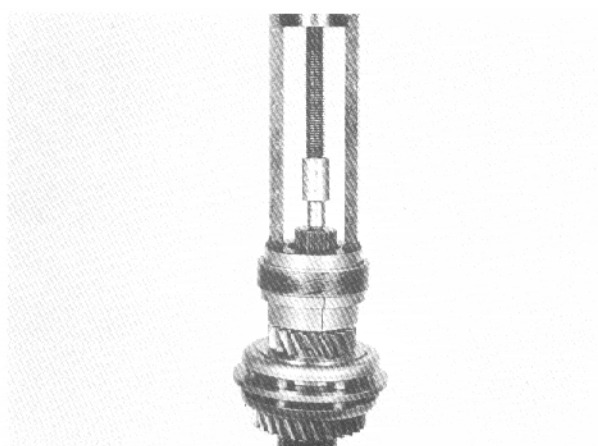
2. Remove the drive gear, 1st gear, bearings and spacer.



5. Withdraw the bearing sleeve, then remove the synchro sleeve and 2nd gear.

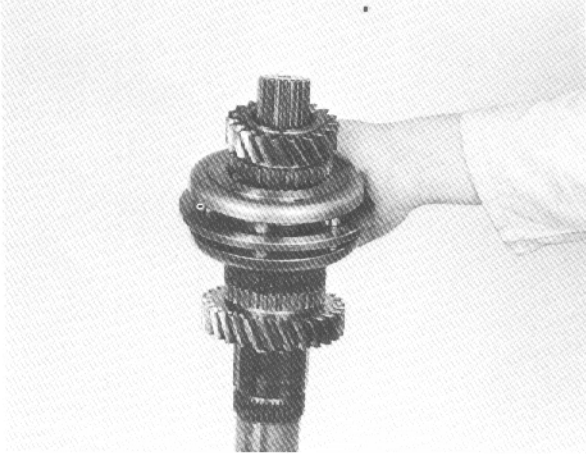


3. Withdraw the 1st/2nd synchroniser assembly.

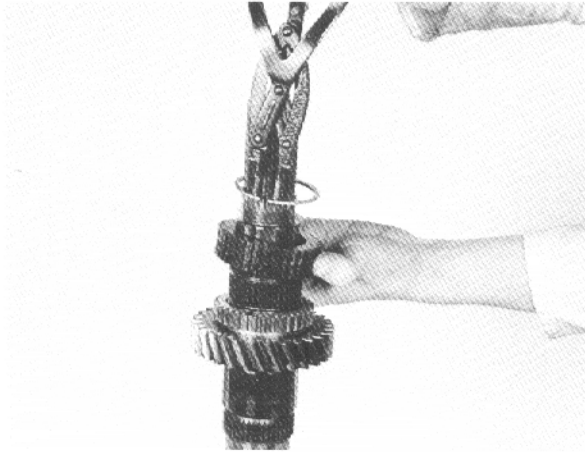


6. Invert the shaft, then using the appropriate tools remove the bearing.

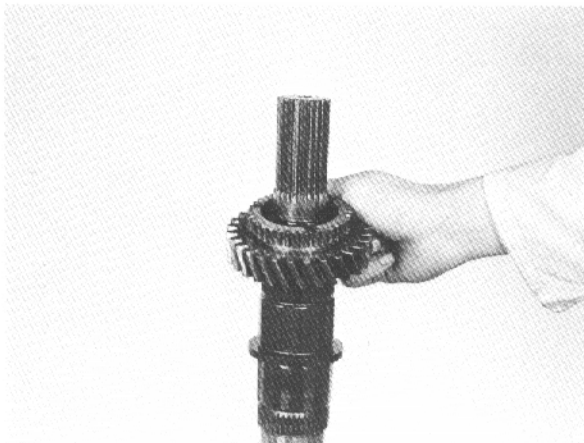
OUTPUT SHAFT DISASSEMBLY



7. Remove the 4th gear, 3rd/4th synchroniser and cups.

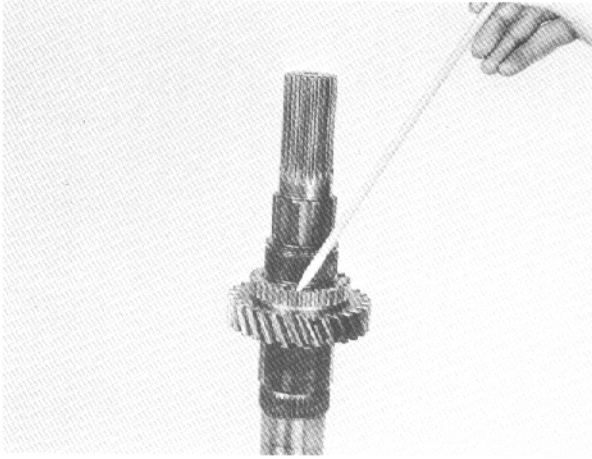


8. Remove the circlip, then the 3rd/4th synchroniser sleeve.

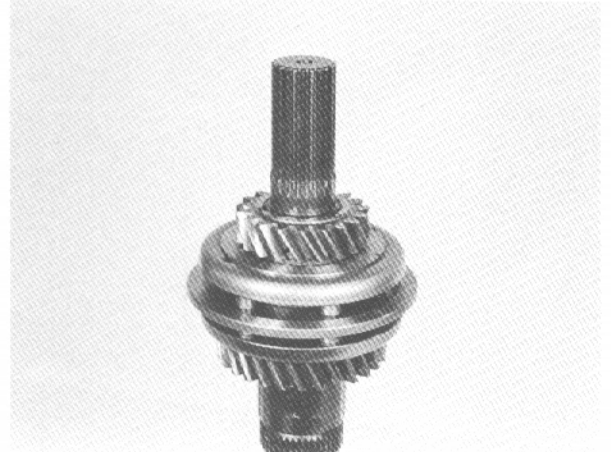


9. Remove the 3rd gear.

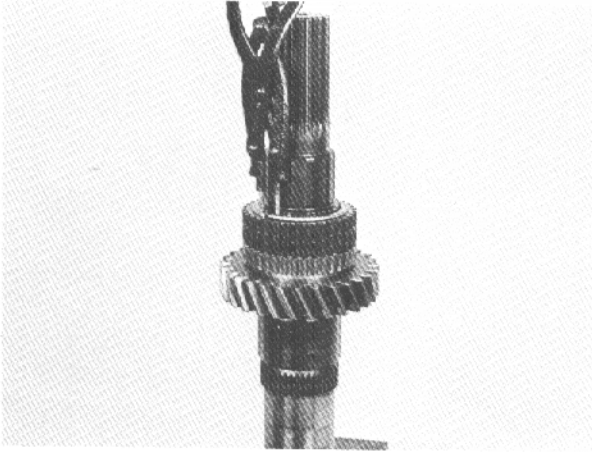
OUTPUT SHAFT REASSEMBLY



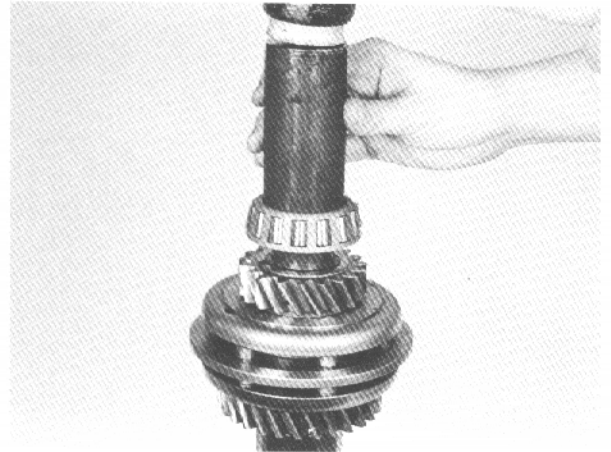
1. Replace the 3rd gear with the dog teeth facing up.



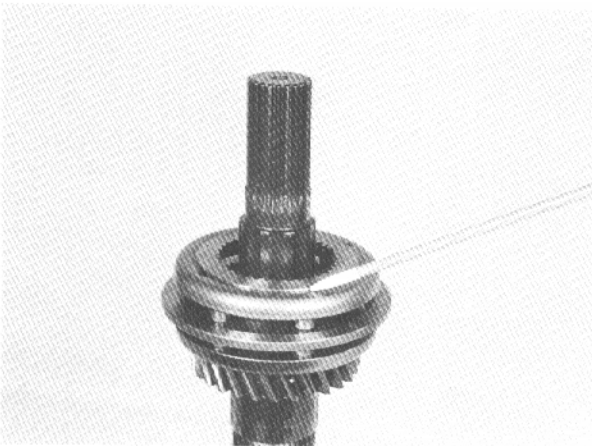
4. Replace the 4th gear with the dog teeth facing down.



2. Replace the synchroniser sleeve and circlip.



5. Using a suitable tool replace the bearing.

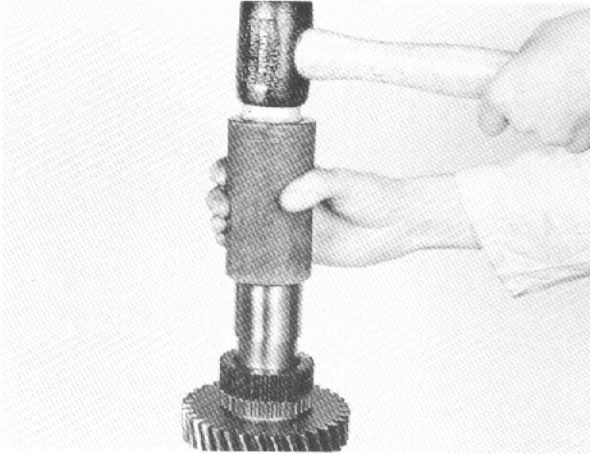


3. Replace the 3rd/4th synchroniser with the extended cup uppermost.

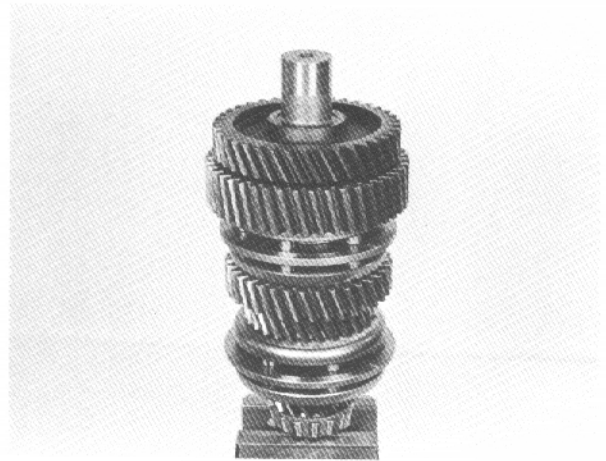


6. Invert the shaft, then replace the 2nd gear with the dog teeth facing up.

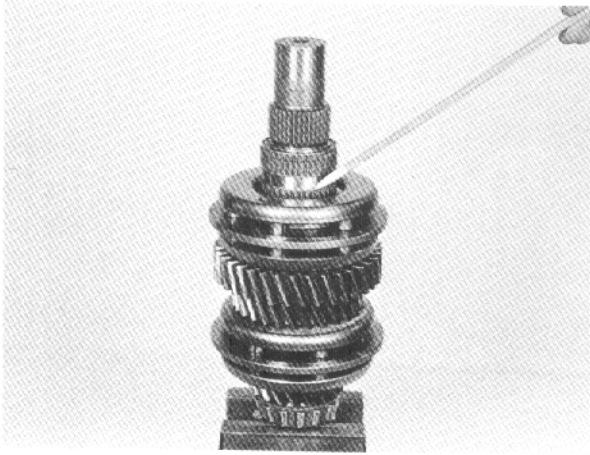
OUTPUT SHAFT REASSEMBLY



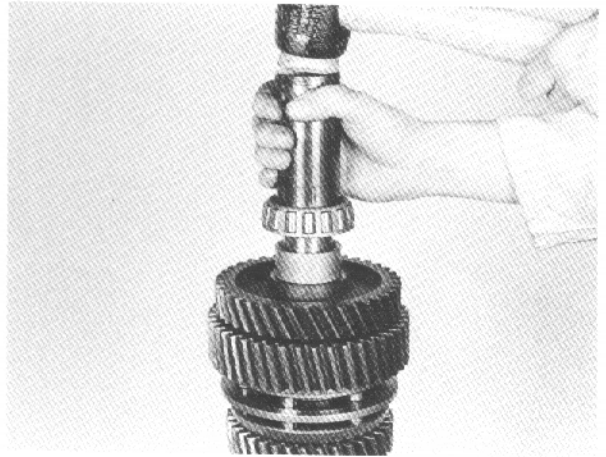
7. Replace the 1st/2nd synchroniser sleeve, then using a suitable tool replace the bearing shell.



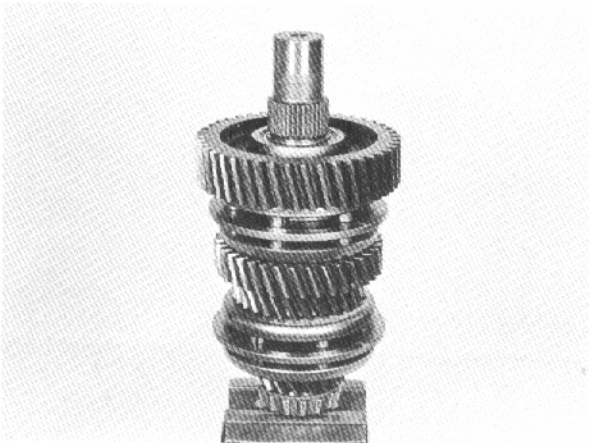
10. Replace the drive gear with the oil grooves facing down.



8. Replace the 1st/2nd synchroniser assembly, 1st gear bearings and spacer.

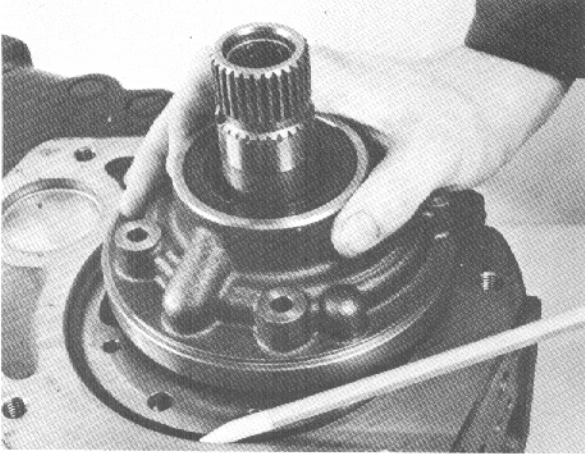


11. Replace the spacer then the bearing using a suitable tool.

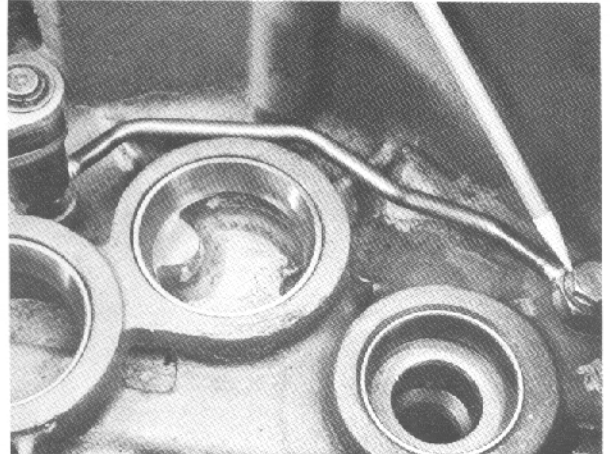


9. Replace the 1st gear with the dog teeth facing down.

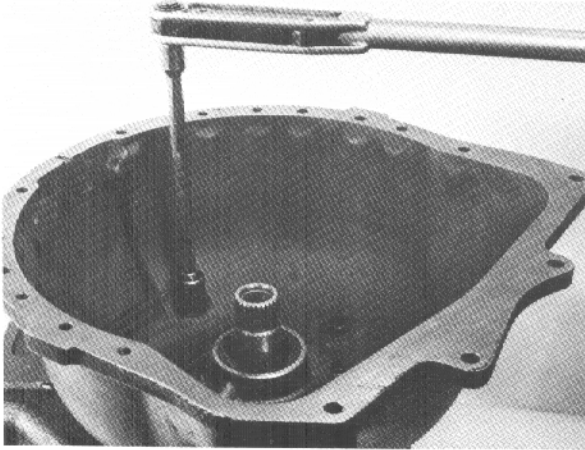
TRANSMISSION REASSEMBLY



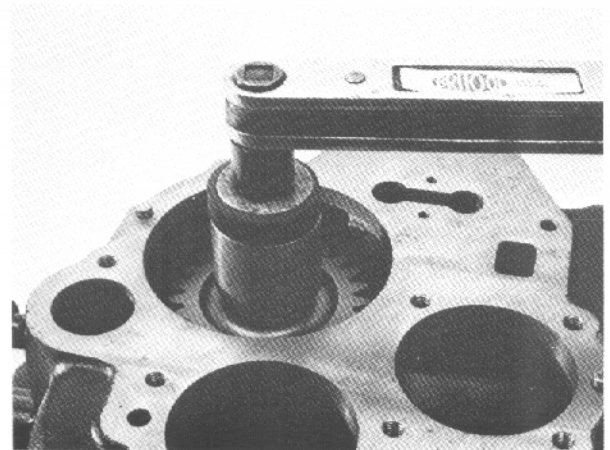
1. Replace the sealing ring then the oil pump secured with screws and washers to a torque of 13-23 lb ft (1.8-3.2 Kgm).



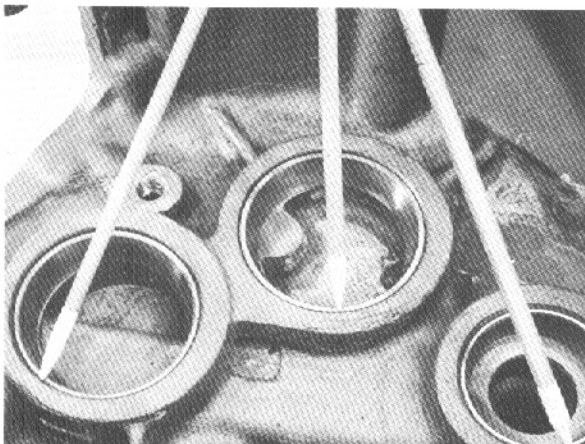
4. Replace the oil feed pipe and washers secured with banjo bolts coated with Loctite grade 638, and secure to a torque of 25-30 lb ft (3.5-4.1 Kgm).



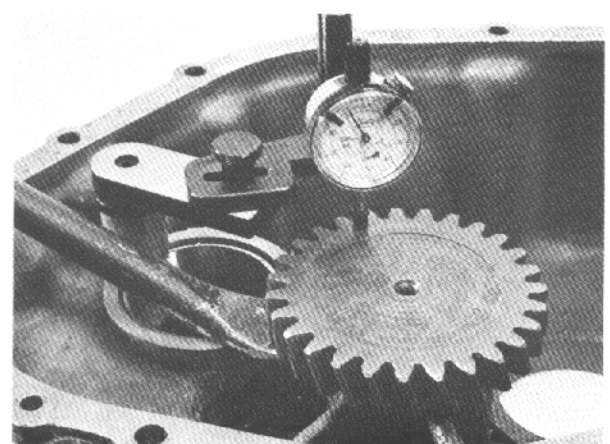
2. Replace the converter housing, secured with screws to a torque of 60-80 lb ft (8.3-11 Kgm).



5. Replace the idler pinion, spacer, bearings, gear and washer secured with a nut to a torque of 90-100 lb ft (12.4-13.8 Kgm).

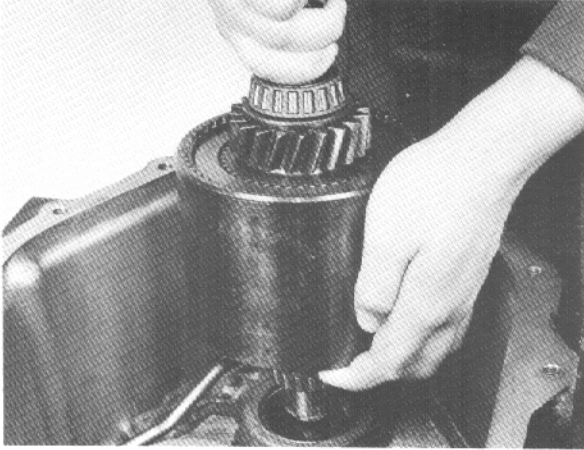


3. Invert the case as shown, replace the front bearing shells and ensure they are correctly seated.

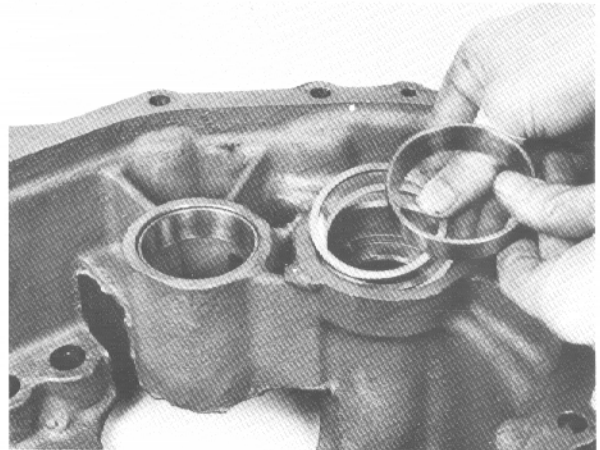


6. Measure the idler shaft end float and select a suitable shim pack to give .003-.006" (.076-.152 mm) **preload**, then remove the idler assembly.

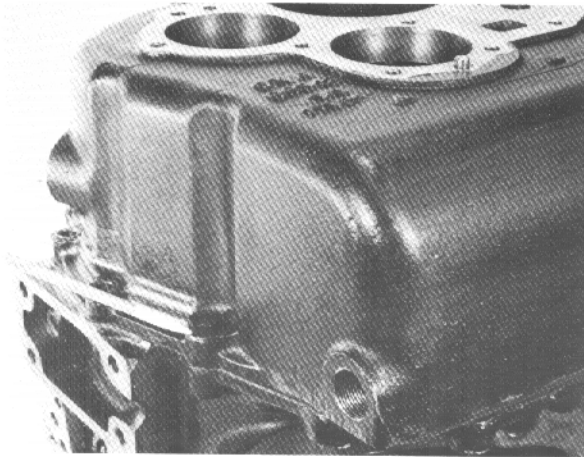
TRANSMISSION REASSEMBLY



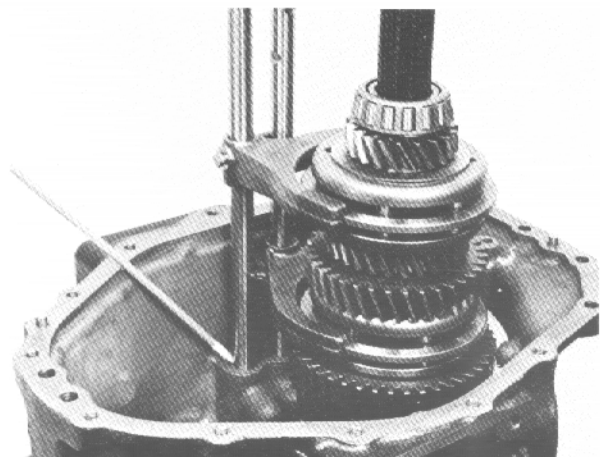
7. Replace the input shaft assembly in the front case.



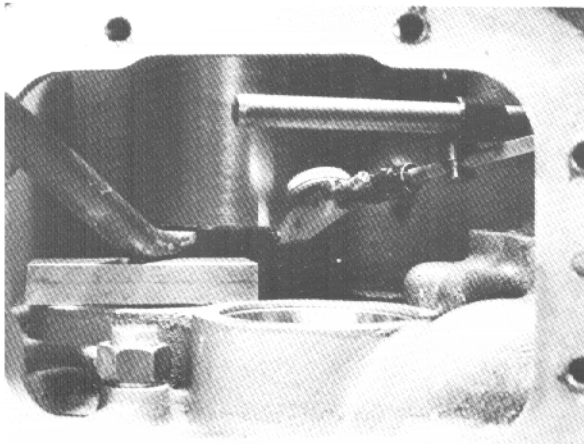
10. Remove the rear case and insert the shim pack below the bearing shell then remove the input shaft.



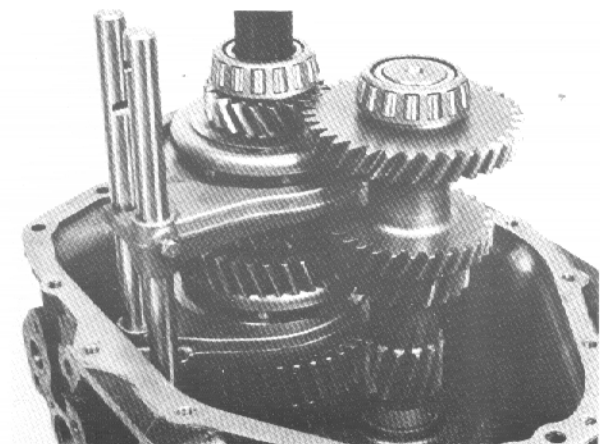
8. Replace the input shaft bearing shell into the rear case, then replace the gasket and rear case secured with several screws.



11. Replace the shift forks to the output shaft, then replace the assembly.

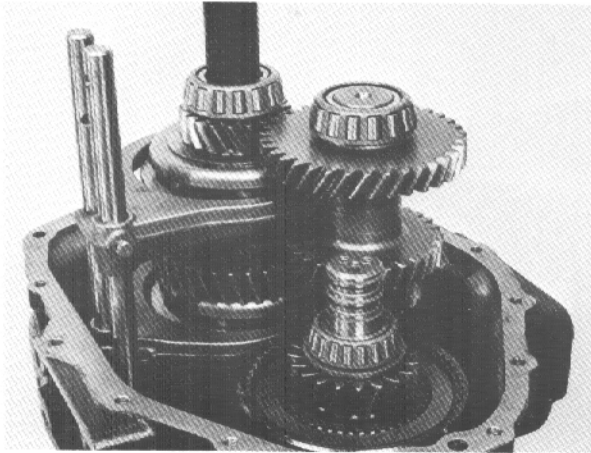


9. Measure the input shaft end float as shown and select a suitable shim pack to give .001-.003" (.025-.076 mm) **end float**.

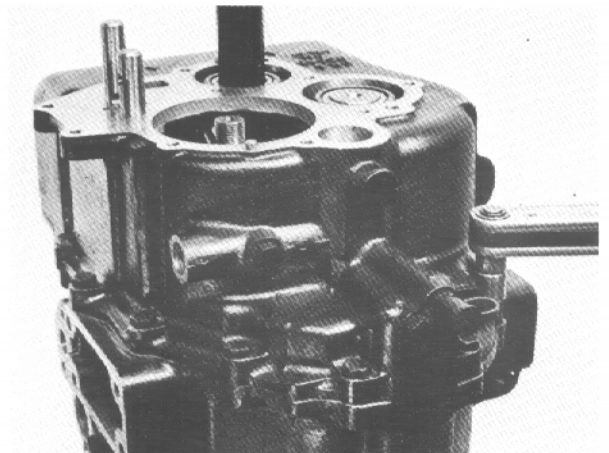


12. Replace the countershaft.
Note:- It will be necessary to lift the output shaft slightly.

TRANSMISSION REASSEMBLY



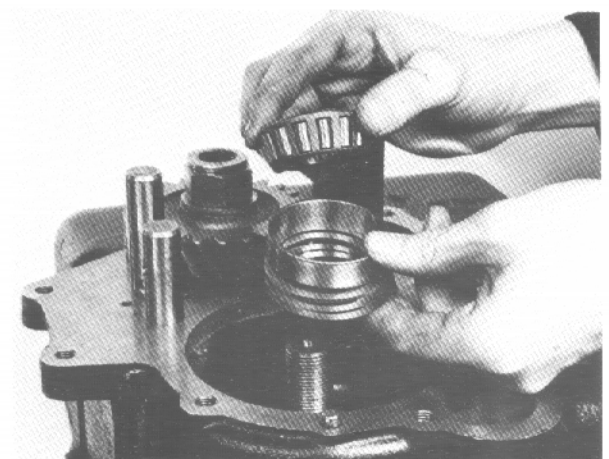
13. Replace the input shaft.



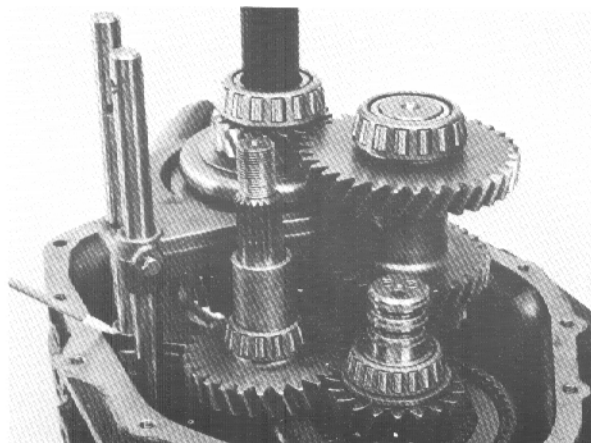
16. Using a coating of a suitable jointing compound replace the gasket, then the rear cover secured with screws to a torque of 33-47 lb ft (4.5-6.5 Kg).



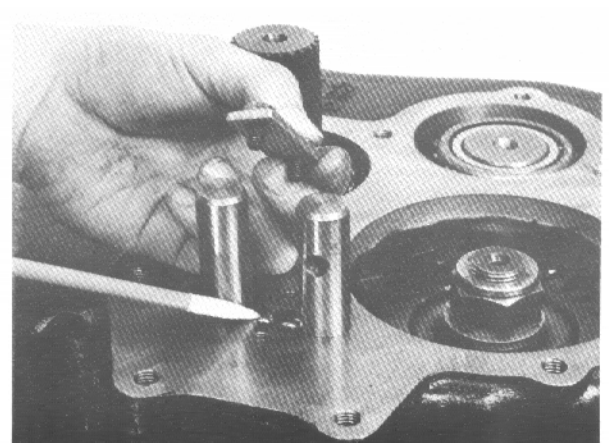
14. Replace the oil suction pipe and secure with a screw to a torque of 13-23 lb ft (1.8-3.2 Kg) then lock by means of the locking tab.



17. Replace the reverse idler shims, spacers, bearing, gear, washer and secure with a nut to a torque of 90-100 lb ft (12.4-13.8 Kg).

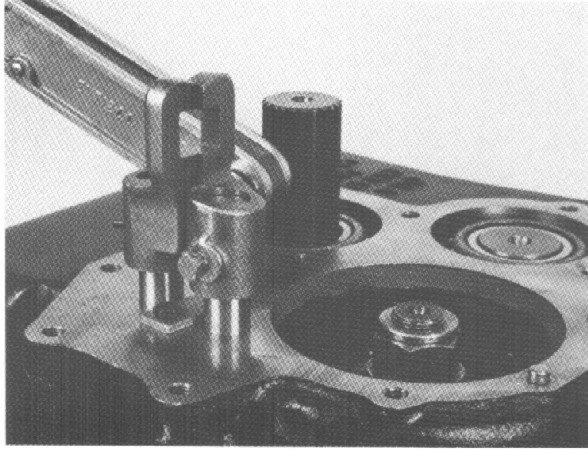


15. Engage 2nd gear as shown, then position the idler pinion, bearing and spacer on the input shaft and shift fork.

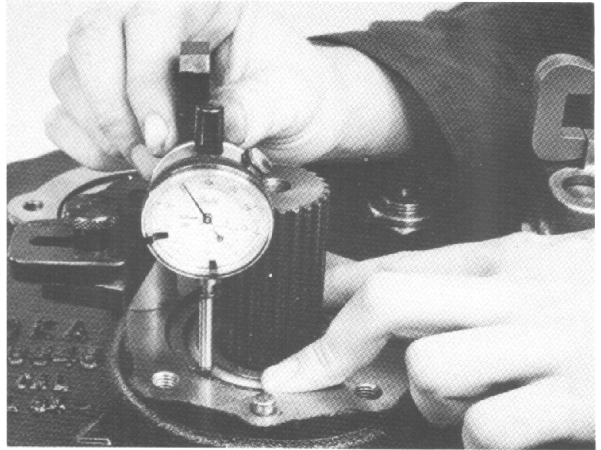


18. Replace the interlock balls, return the transmission to neutral, then replace the interlock plate secured with screws to a torque of 6-12 lb ft (0.8-1.7 Kg).

TRANSMISSION REASSEMBLY



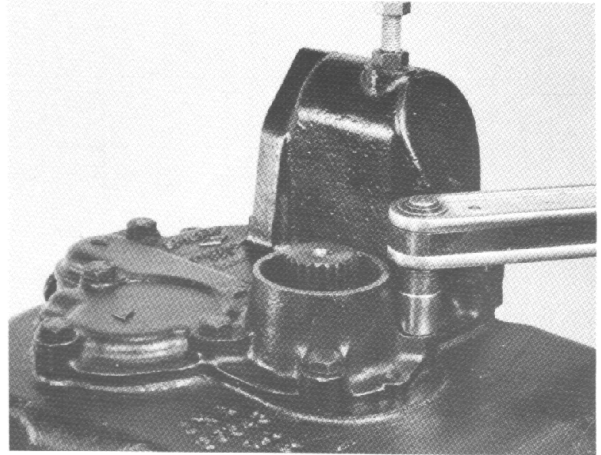
19. Replace the 1st/2nd and 3rd/4th shift lugs secured with screws to a torque of 13-18 lb ft (1.8-2.5 Kgm).



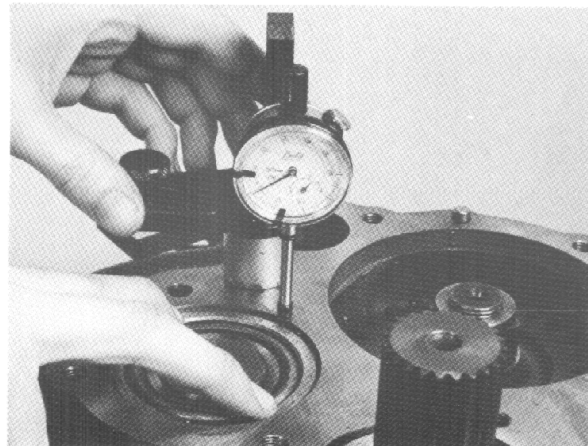
22. Repeat operation number 21 for the output shaft.



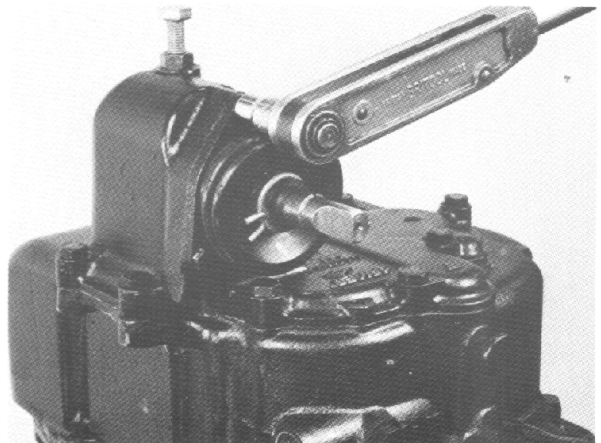
20. Replace both rear bearing shells, using a soft metal drift.



23. Using a coating of a suitable jointing compound, replace the gasket, rear cover and secure with screws to a torque of 33-47 lb ft (4.5-6.5 Kgm).

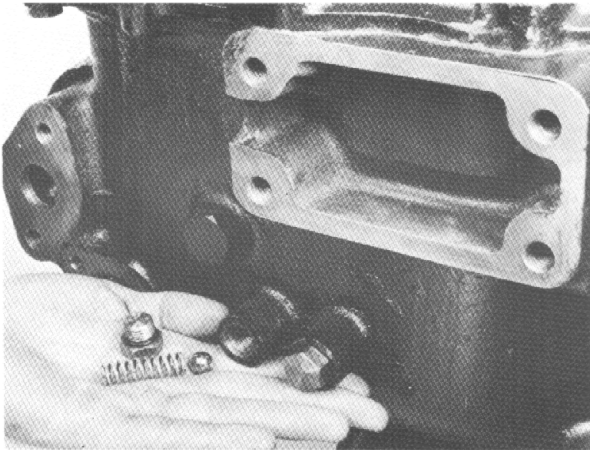


21. Using a suitable depth gauge measure the depth of the bearing shell from the case. Add .005" to this figure and select a suitable shim pack to give .001-.003" (.025-.076 mm) **end float.**

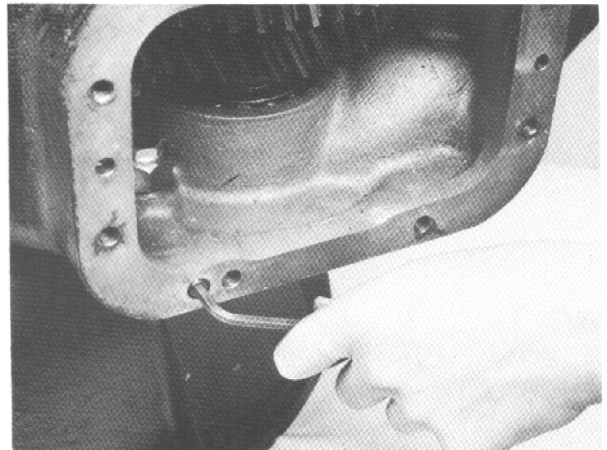


24. Replace the 'O' ring, lower seating, then using a coating of a suitable jointing compound gaskets to give free movement of the lever with no end play. The upper seating secured with screws to a torque of 13-23 lb ft (1.8-3.2 Kgm).

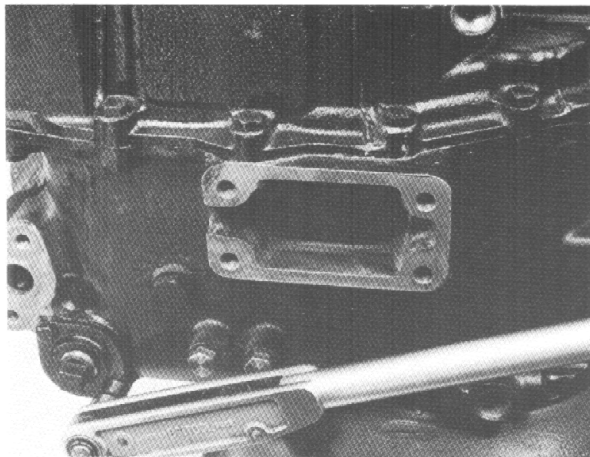
TRANSMISSION REASSEMBLY



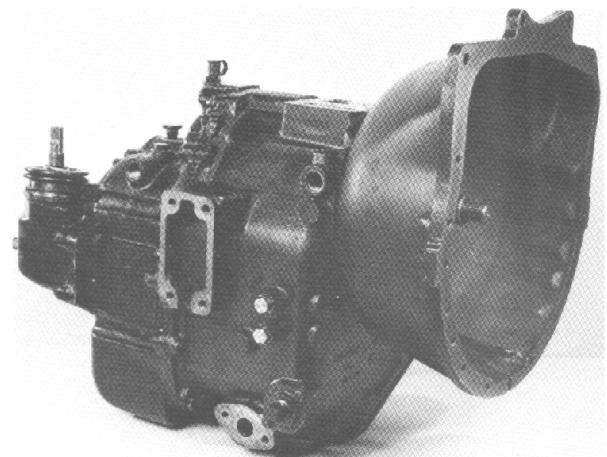
25. Replace the detent balls and springs, secured with 'O' rings and plugs to a torque of 30-40 lb ft (4.1-5.5 Kgm).



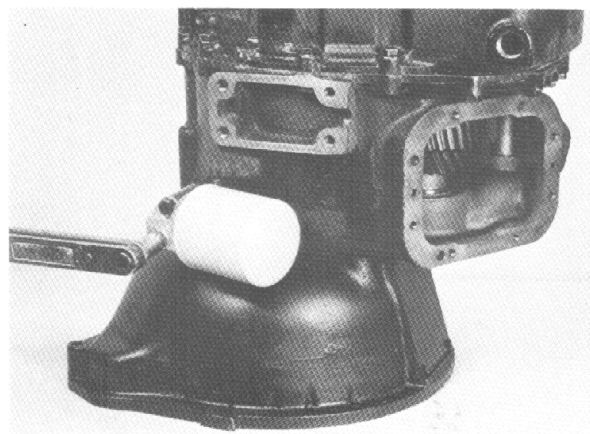
28. Replace the plug, then using a coating of a suitable jointing compound replace the gasket, 4 wheel drive aperture cover secured with screws to a torque of 33-47 lb ft (4.5-6.5 Kgm).



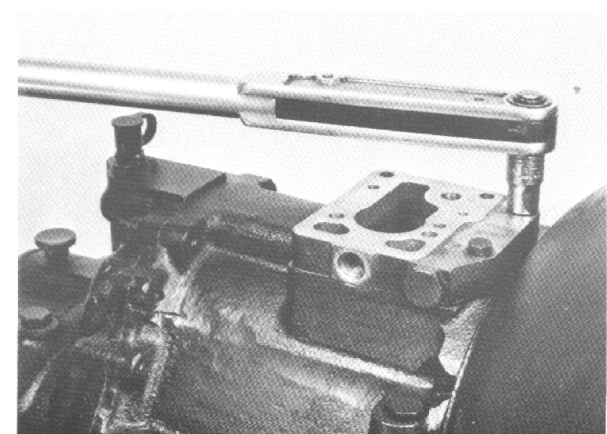
26. Replace the suction strainer 'O' ring, washer and retaining plate secured with screws to a torque of 13-23 lb ft (1.8-3.2 Kgm).



29. Reposition the transmission horizontally.

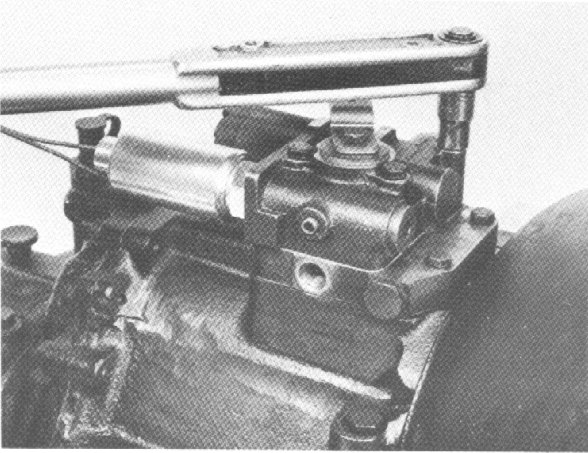


27. Using a coating of a suitable jointing compound replace the gasket then the oil filter housing secured with screws and washers to a torque of 33-47 lb ft (4.5-6.5 Kgm).

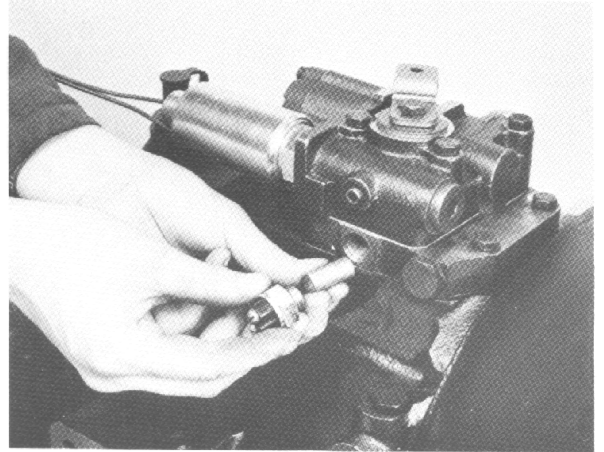


30. Using a coating of a suitable jointing compound replace the gasket, then the adaptor plate secured with screws to a torque of 13-23 lb ft (1.8-3.2 Kgm).

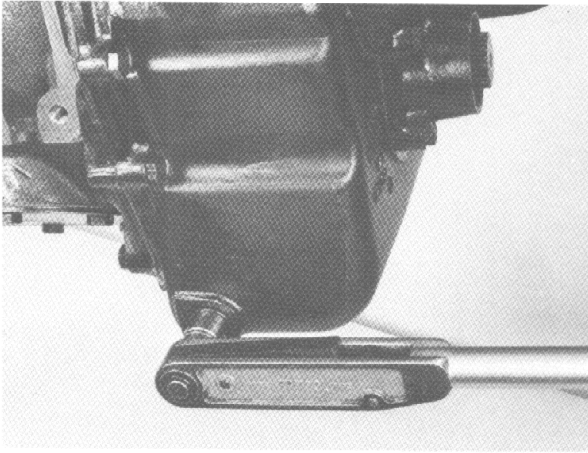
TRANSMISSION REASSEMBLY



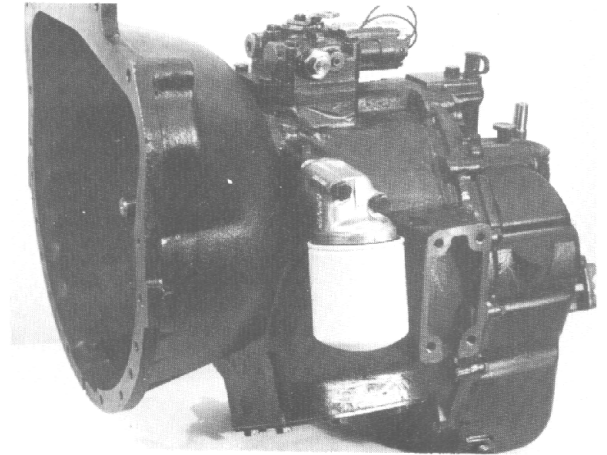
31. Using a coating of a suitable jointing compound replace the gasket then the control valve assembly secured with screws to a torque of 13-23 lb ft (1.8-3.2 Kgm).



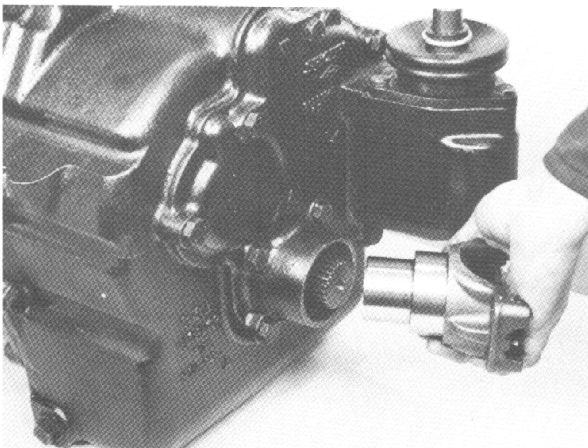
34. Replace the neutral plunger, switch and secure to a torque of 35-40 lb ft (4.8-5.5 Kgm).



32. Replace the oil drain plug to a torque of 25-40 lb ft (3.5-5.5 Kgm).



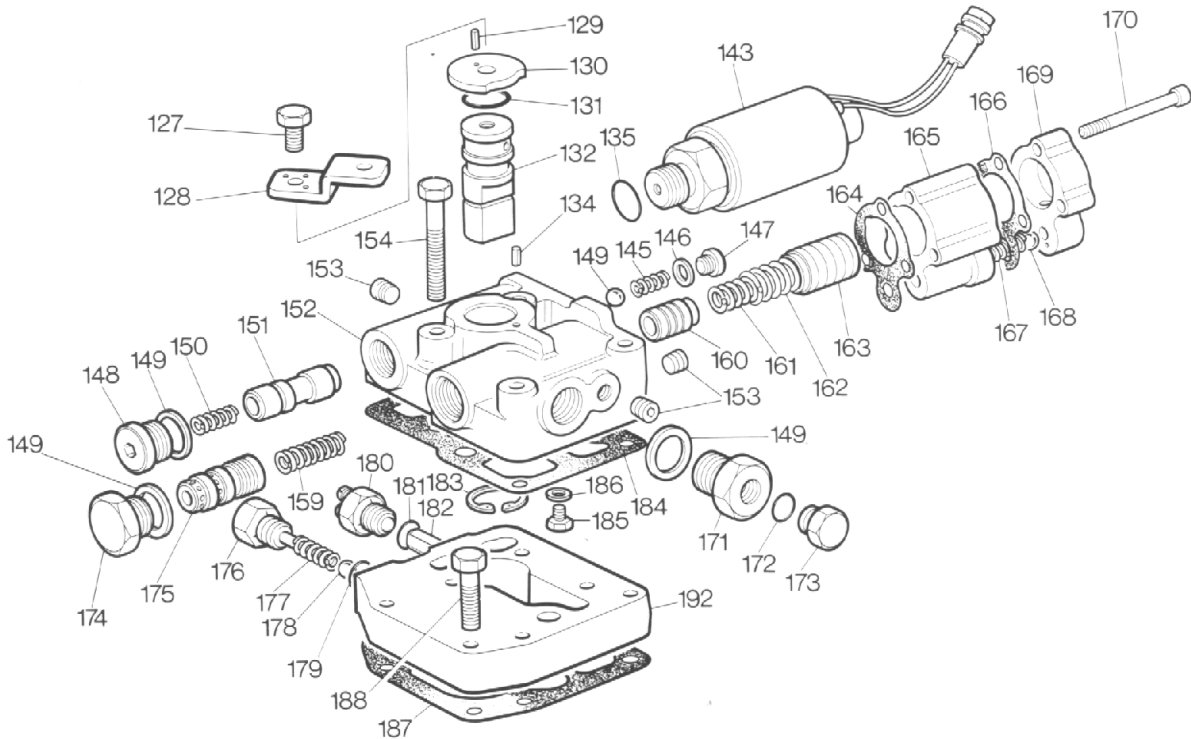
35. Completed transmission assembly.



33. Replace the output coupling taking care not to damage the oil seal. Secure with washers and screws where fitted.

SECTION THREE

EXPLODED DRAWING OF CONTROL VALVE



NOTE

Please note some items listed in the key refer to other control variations which are not detailed above.

KEY

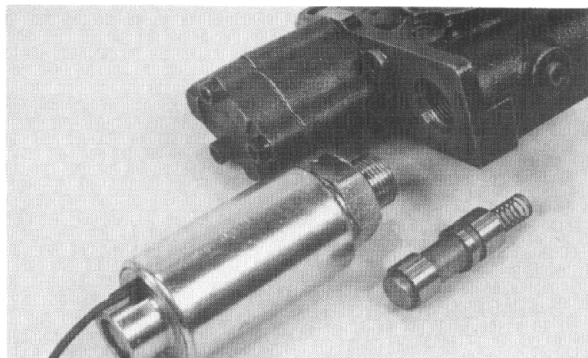
127	Screw	149	Washer	171	Adaptor
128	Selector Lever	150	Spring	172	'O' Ring
129	Tension Pin	151	Dump Spool	173	Plug
130	Selector Stop	152	Valve Housing	174	Plug
131	'O' Ring	153	Taper Plug	175	Spool Valve
132	Selector Valve	154	Screw	176	Spring Guide
133	Transfer Plug	155	Inching Spool	177	Spring
134	Tension Pin	156	Inner Spring	178	Ball
135	'O' Ring	157	Outer Spring	179	'O' Ring
136	Spacer	158	Spacer	180	Neutral Start Switch
137	Inching Valve	159	Spring	181	'O' Ring
138	Spring	160	Piston	182	Actuating Pin
139	Gasket	161	Inner Spring	183	Circlip
140	Housing	162	Outer Spring	184	Gasket
141	Screw	163	Piston Housing	185	Screw
142	Oil Seal	164	Gasket	186	Washer
143	Solenoid	165	Valve Body	187	Gasket
144	Ball	166	Gasket	188	Screw
145	Spring	167	Spring	189	'O' Ring
146	Washer	168	Ball	190	Solenoid
147	Plug	169	End Cover	191	Spool
148	Plug	170	Screw	192	Adaptor

CONTROL VALVE DISASSEMBLY

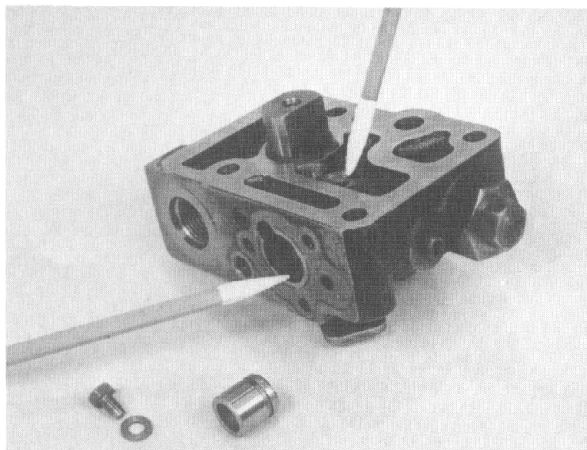
NOTE

The control valve should not be dismantled unless absolutely essential.

This unit should be securely held in a soft jawed vice if disassembly is required, the vice is not shown on the illustrations for reasons of clarity.



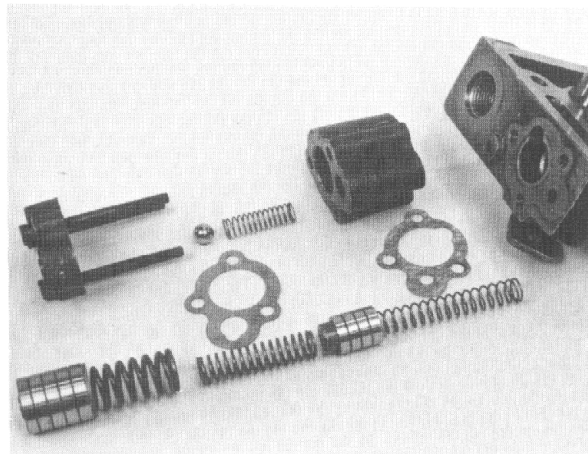
1. Remove the solenoid, spool valve and spring.



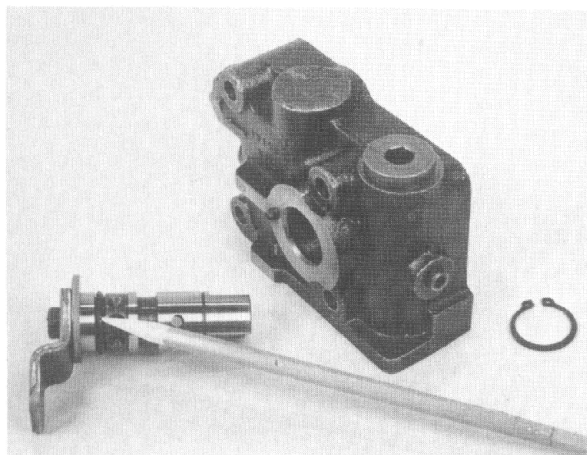
4. Remove the guide screw and washer, then remove the flow dividing valve.

NOTE

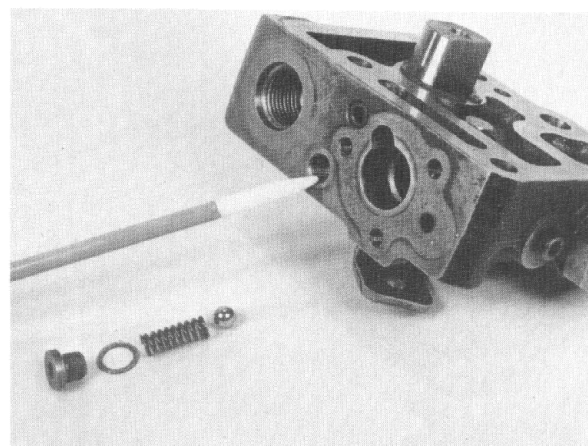
Later Models will have a different design valve.



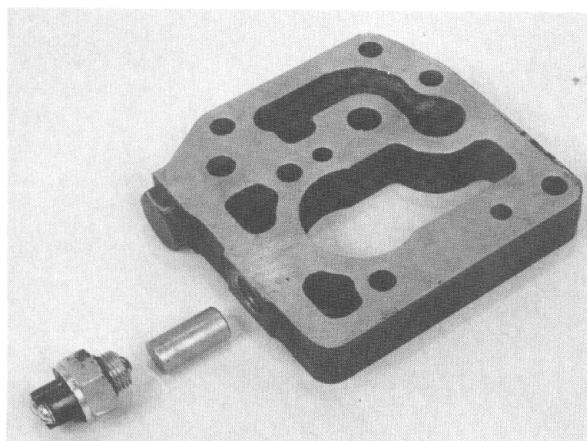
2. Remove the capscrews, then withdraw the end cover, ball, springs, body, valves, and gasket.



5. Remove the circlip and remove the selector assembly. Replace the 'O' ring if necessary.

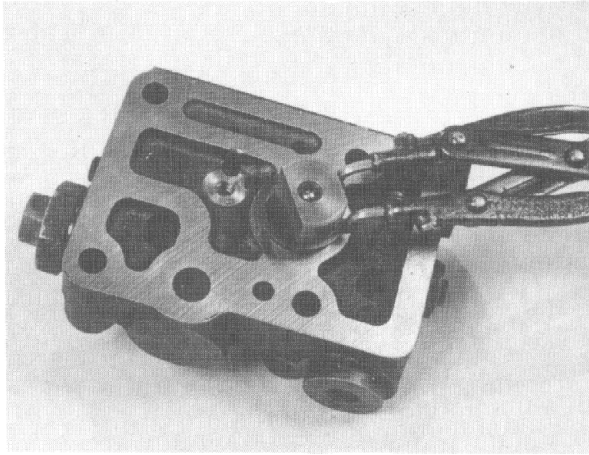


3. Remove the detent plug, washer, spring and ball.

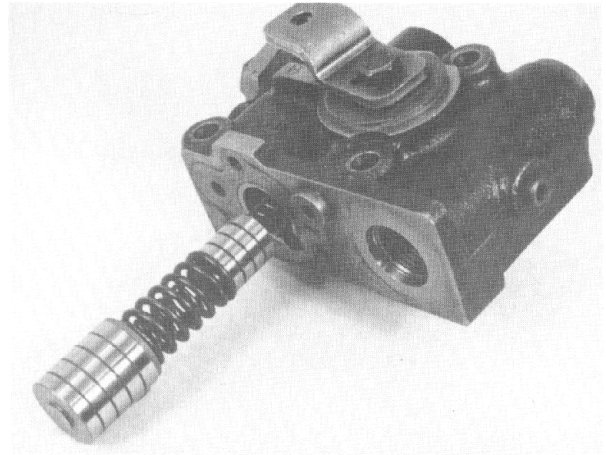


6. Remove the neutral switch and plunger from the adaptor plate. Remove the plug, spring and ball if necessary.

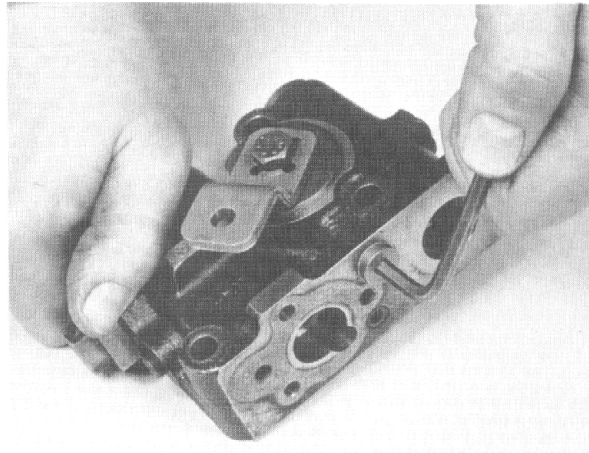
CONTROL VALVE REASSEMBLY



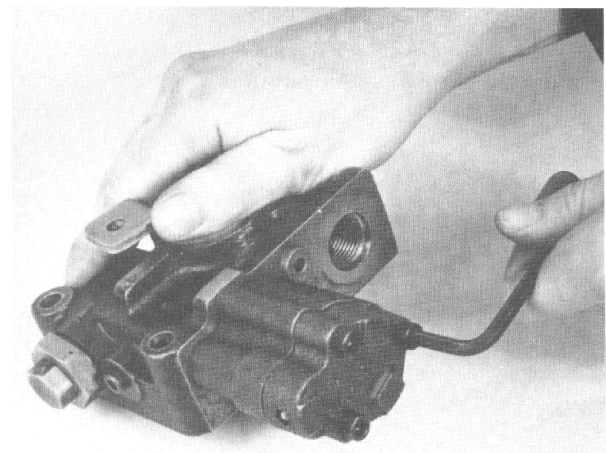
1. Replace the selector assembly and secure with a circlip.



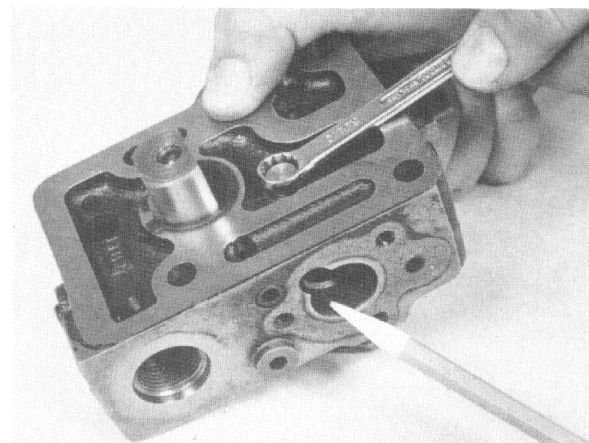
4. Replace the spring, then the pressure valve, inner and outer springs and piston housing.



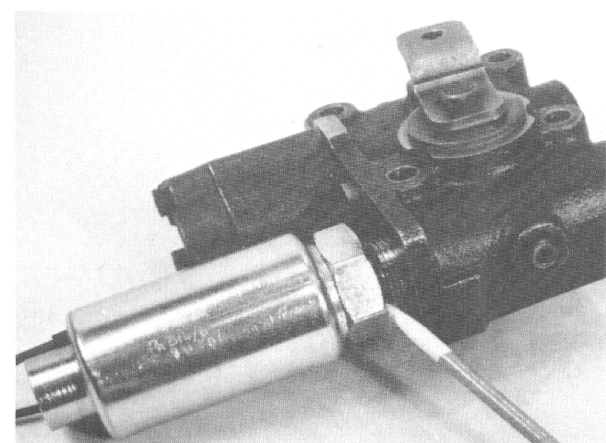
2. Replace the detent ball and spring secured with a cap screw and washer to a torque of 20 lb ft (3.7 Kgm).



5. Ensure that the components are correctly seated, then compress the springs until the valve body, end cover, gaskets, springs, and ball can be replaced, then secure with screws

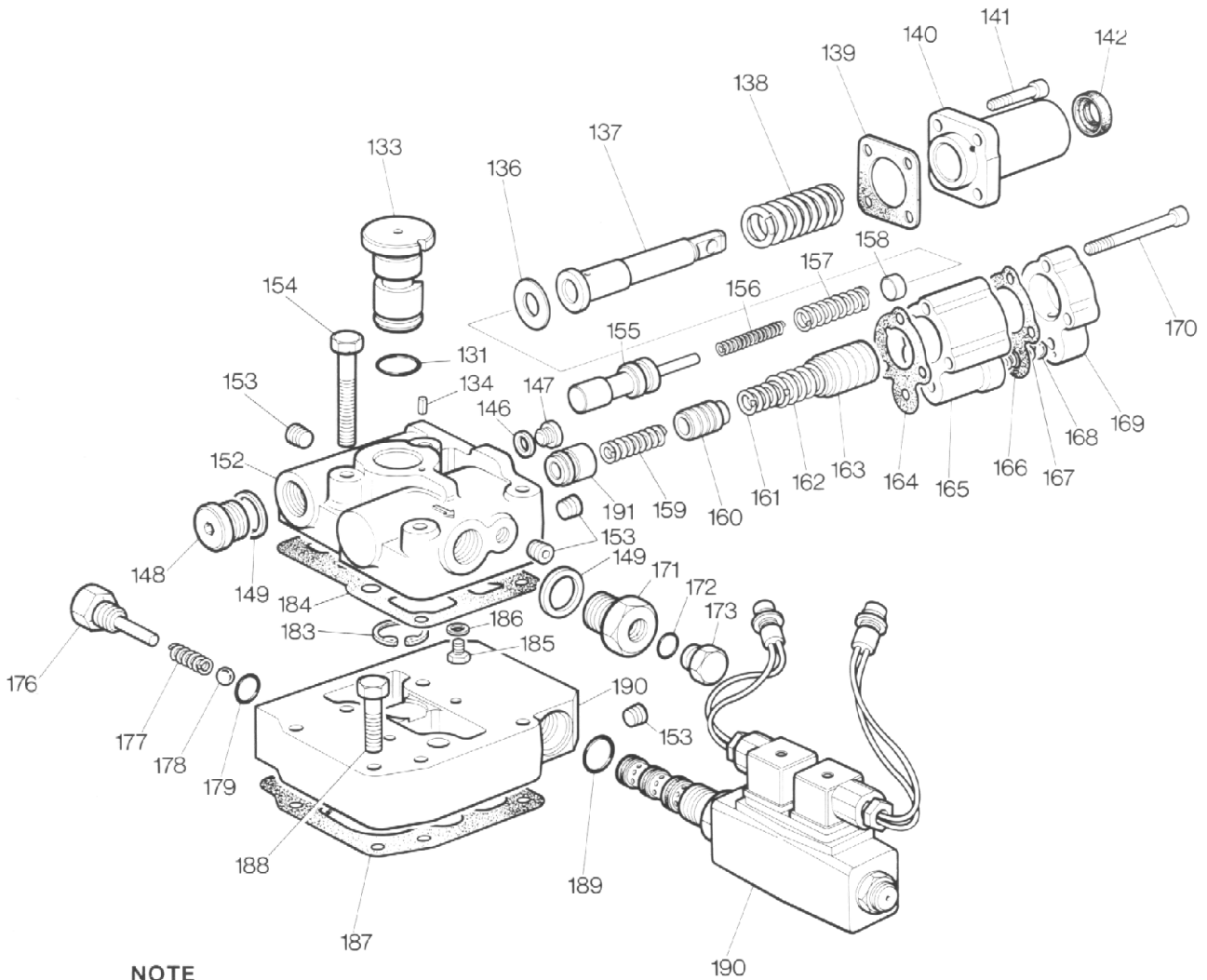


3. Replace the flow dividing valve with the spring location uppermost, then replace the washer and guide screw secured to a torque of 3 lb ft (0.5 Kgm).



6. Replace the spring, then the spool valve and secure the solenoid to a torque of 25-40 lb ft (4.6-7-3 Kgm). Ensure the 'O' ring is correctly seated.

EXPLODED DRAWING OF CONTROL VALVE



NOTE

Please note some items listed in the key refer to other control variations which are not detailed above.

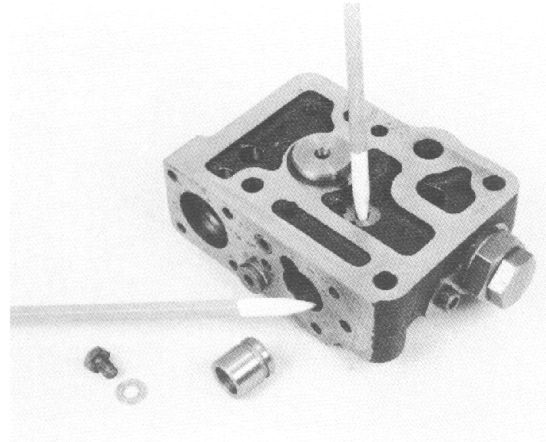
KEY

127	Screw	149	Washer	171	Adaptor
128	Selector Lever	150	Spring	172	'O' Ring
129	Tension Pin	151	Dump Spool	173	Plug
130	Selector Stop	152	Valve Housing	174	Plug
131	'O' Ring	153	Taper Plug	175	Spool Valve
132	Selector Valve	154	Screw	176	Spring Guide
133	Transfer Plug	155	Inching Spool	177	Spring
134	Tension Pin	156	Inner Spring	178	Ball
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136	Spacer	158	Spacer	180	Neutral Start Switch
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138	Spring	160	Piston	182	Actuating Pin
139	Gasket	161	Inner Spring	183	Circlip
140	Housing	162	Outer Spring	184	Gasket
141	Screw	163	Piston Housing	185	Screw
142	Oil Seal	164	Gasket	186	Washer
143	Solenoid	165	Valve Body	187	Gasket
144	Ball	166	Gasket	188	Screw
145	Spring	167	Spring	189	'O' Ring
146	Washer	168	Ball	190	Solenoid
147	Plug	169	End Cover	191	Spool
148	Plug	170	Screw	192	Adaptor

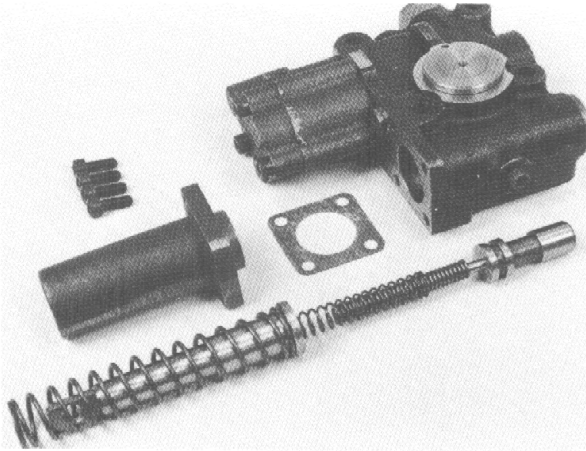
CONTROL VALVE DISASSEMBLY

NOTE

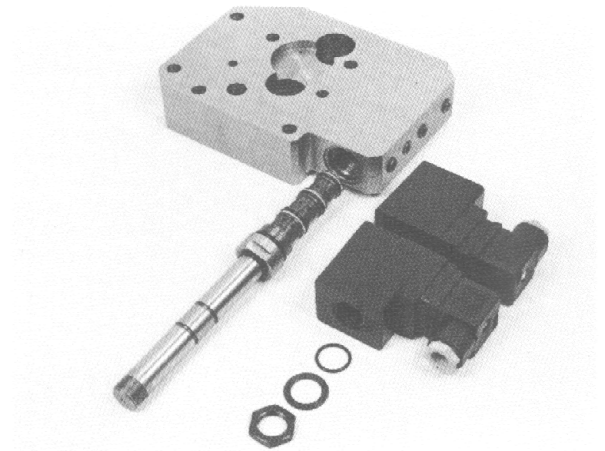
The control valve should not be dismantled unless absolutely essential. If disassembly is required, it should be held securely in a soft jawed vice. The vice has not been shown on these illustrations for reasons of clarity.



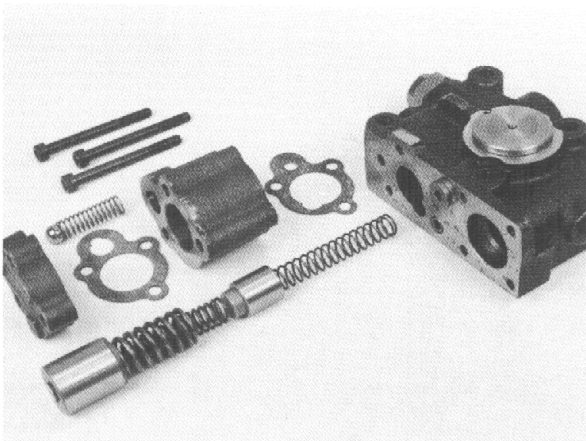
3. Remove the limit screw and washer, then remove the flow divider spool.



1. Remove the screws, then the cover, gasket and inching spool mechanism.



4. Remove the solenoid assembly by removing the outer nut and unscrewing the spool.

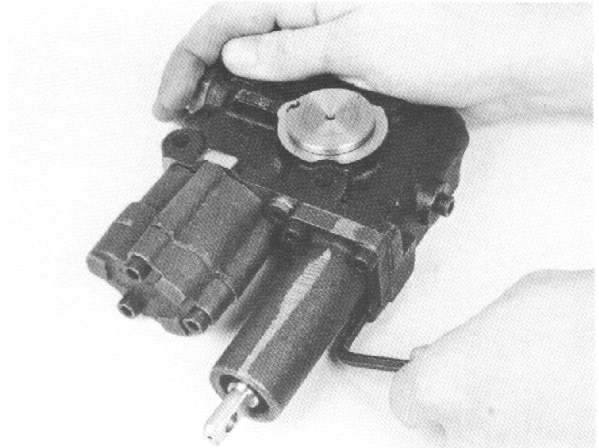


2. Remove the screws, covers, gaskets, pressure regulator and springs.

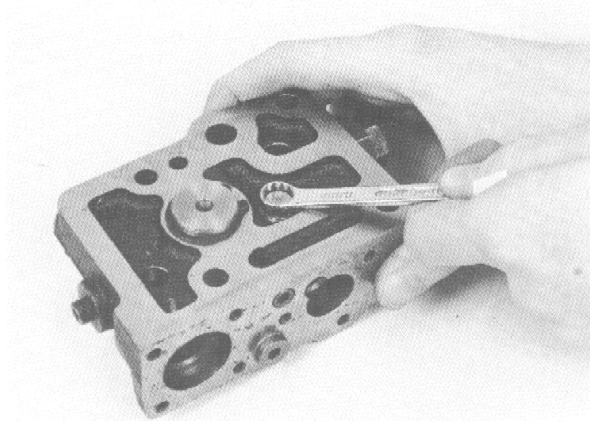
CONTROL VALVE REASSEMBLY

NOTE

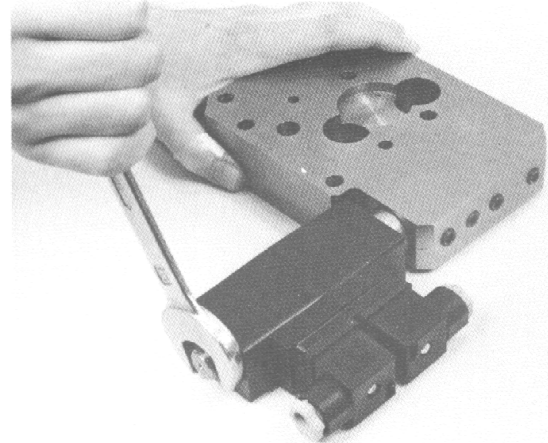
Prior to reassembly it is important to renew all oil seals and gaskets with new.



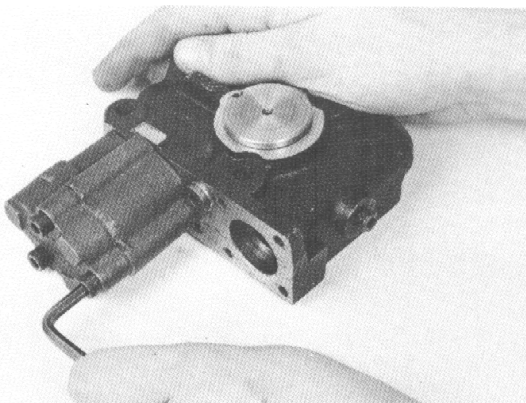
3. Replace the spool, inner and outer springs, actuating rod and spring, then replace the gasket and housing secured with screws to a torque of 11 lb ft (2 Kgm).



1. Replace the flow divider spool with the bore uppermost, then secure with the limit screw and washer to a torque of 3 lb ft (0.5 Kam).



4. Replace the solenoid assembly and secure with a nut to a torque of 11 lb ft (2 Kgm).



2. Replace the spring, pressure valve, inner and outer spring, retained by the spring housing. Carefully replace the gasket, the valve body, spring and ball. Secure the assembly by replacing the gasket and end cover secured with screws to a torque of 11.5 lb ft (2.1 Kgm). See operation No. 2 (valve disassembly) to assist reassembly.

SECTION FOUR

**(NOT APPLICABLE ON
TRANSMISSIONS FITTED TO
WINGET EQUIPMENT)**

SECTION FIVE

TEST PROCEDURE

If malfunction of the transmission is indicated a systematic checking procedure should be followed in order to assist in determining the fault. This check should be carried out while the transmission is still in the vehicle so that true operating conditions are created. This check is essential in that some failure with the hydraulic system will not be easily traceable when the transmission is stripped down on a bench. In order to test for satisfactory operation follow the instructions as detailed below.

Transmission fails to drive in either direction

1. Low or no oil.
2. Low main oil pressure – see test 1.
3. Mechanical failure in the transmission.
4. Worn or broken sealing rings.
5. Dump or other valve stuck.

Transmission drives in one direction only

1. Low oil pressure to clutch – see test 3 & 4.
2. Clutch pack in question excessively worn.
3. Leakage at Piston/Shaft seals.
4. Mechanical failure in the transmission.

Loss of power – slow take up of drive

1. Other external fault on vehicle – brakes binding etc.
2. Poor engine performance.
3. Low oil level.
4. Low oil pressure at converter – see test 2.
5. Low oil pressure at clutch packs – see test 3 & 4.
6. Both clutch packs worn.
7. Internal oil leak.

Transmission gets hot

1. Oil level incorrect (too high or too low).
2. Restriction in cooler slow.
3. Low oil pressure – see test 1.
4. Low oil flow to converter – see test 2.
5. Excessive inching operation.
6. Excessive stall operation.

High stall speed

1. Low oil level.
2. Air in oil.
3. Forward/reverse clutch slipping.
4. Torque converter failure.

Low stall speed

1. Poor engine performance.
2. Torque converter clutch defective.

Oil pressure at port 1 low

If the oil pressure at port 1 is found to be low then the pressure should be low at all other points in the system since this is the main feed from the pump.

Reason

Either pump failure or seal failure around the pump area. Valve sticking in control valve, blocked strainer, or blockage in system between the pump and filter.

Oil pressure at port 1 high

If the oil pressure at port 1 is found to be high, ensure normal operating temperature has been achieved, if this is correct then there is a valve sticking in the control valve.

Reason

Oil gallery blockage.

Oil pressure at port 2 low

If the oil pressure at port 2 is found to be low then the problem could lie in the control assembly, or in the torque converter supply passages.

Reason

Gasket, or 'O' ring leaking in control valve allowing oil to be returned to the sump. Oil pressure regulator stuck or sticking allowing oil to return to the sump. Seal leaking on passage to torque converter.

Oil pressure at port 2 high

If the oil pressure at port 2 is found to be high then the problem lies with the control valve oil pressure regulator.

Reason

Control valve oil pressure regulator stuck in the open position causing excessive oil to pass to the converter and thus the cooler.

Oil pressure at port 3 low

If the oil pressure at port 3 is found to be low then no drive will occur in reverse.

Reason

Solenoid stuck in open position. (This condition would give no drive in either direction since all oil would be returned directly to the sump). Direction control valve stuck in forward. Gasket or 'O' ring in control valve leaking. Piston seal or 'O' ring leaking in the reverse piston assembly.

Oil pressure at port 3 high

If the oil pressure at port 3 is found to be high then there is a problem in the control valve assembly.

Reason

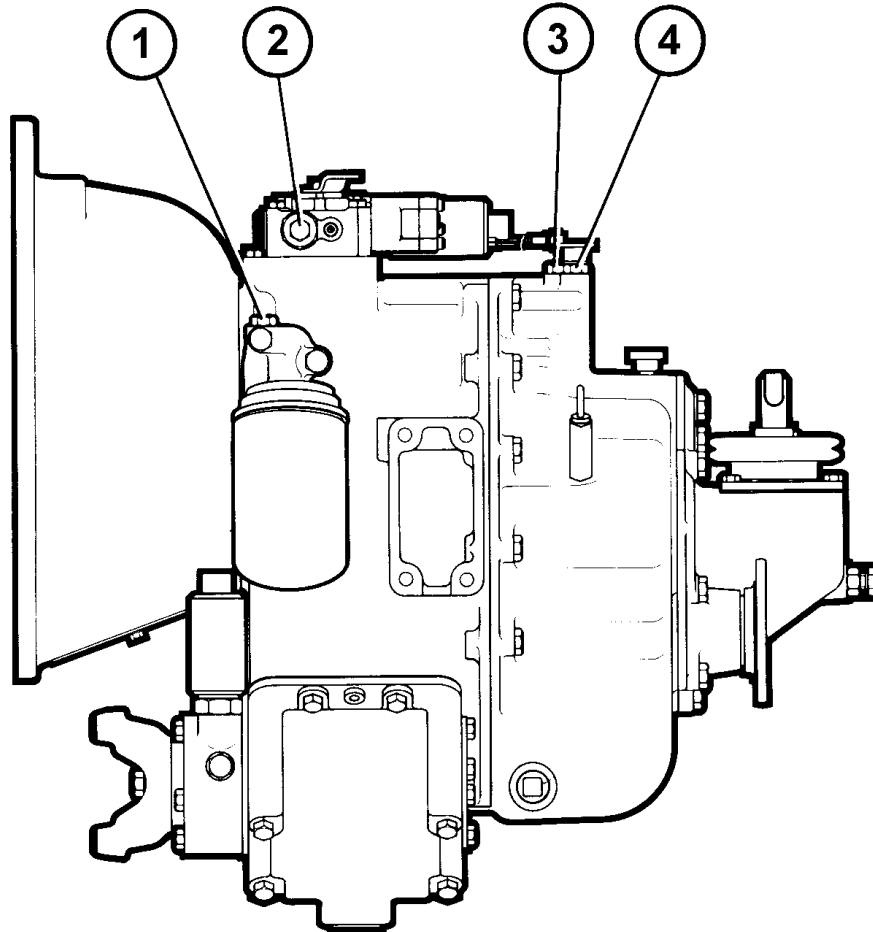
Oil gallery blockage or pressure or flow valve stuck in the control valve.

Oil pressure at port 4

As for port 3 only forward not reverse.

TEST PROCEDURE

During the test it is important that the engine speed is maintained at 2000 R.P.M. constantly with the change speed lever in neutral and the direction control selected in either forward or reverse depending on the test being carried out. A false reading will be obtained for the main pump pressure if the direction control is in the neutral position. The oil temperature should be at 80-85°C.



1)	OIL PUMP PRESSURE	PSI 150 - 200	BAR 10.5 - 13.8
*2)	CONVERTER RELIEF PRESSURE	70 - 125	4.8 - 8.6
3)	FORWARD CLUTCH PRESSURE	130 - 170	9.0 - 11.7
4)	REVERSE CLUTCH PRESSURE	130 - 170	9.0 - 11.7
	LUBRICATION PRESSURE	15 - 24	1.0 - 1.7
	TRANSMISSION FLOW RATE	30-35 Litre per minute @ maximum engine revs of 2400.	
	*CONVERTER PRESSURE @ 1000 R.P.M.	30 psi (2.06 bar) minimum	

TROUBLE SHOOTING - MECHANICAL CHECKS

Important Procedure

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

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

Check Functioning Prior to Disassembly:

Many times the answer to the trouble is apparent when the unit is inspected prior to disassembly, but this evidence is often lost when parts are separated. If possible, check the unit prior to disassembly, bear in mind that a careful inspection of the unit should be made as each disassembly step is performed.

Further, if remote controls are used, a careful check of the remote and connecting linkage to transmission and auxiliary must be made. The remote units and linkage must be in good working order if the transmission and auxiliary are expected to shift satisfactorily.

Inspect Thoroughly During Disassembly:

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

Repair or Replace Defective Parts:

Many times the parts or critical adjustments that have caused the trouble are not replaced or corrected because the mechanic will only inspect and replace parts that have failed completely. All pieces should be accurately examined because the broken parts are often just the result and not the cause of the trouble. All parts that are broken or worn and no longer meet specifications should be replaced. On large units, like a transmission, it is suggested that a mechanic replace parts that are

worn to the extent that they do not have a long service life remaining. This avoids another teardown on the unit in the near future. It is also good practice, at this time, to make the changes or modifications recommended to bring the transmission up to date and increase the service life of the unit.

Noisy Operation:

Noise is usually very elusive and generally not the fault of the transmission; therefore, mechanics should road test to determine if the driver's complaint of noise is actually in the transmission.

In numerous instances, drivers have insisted that the noise was in the transmission, however, investigations reveal the noise to be caused by one of the following conditions:

- (a) Fan out of balance or blades were bent.
- (b) Defective vibration dampers.
- (c) Crankshafts out of balance.
- (d) Flywheels out of balance.
- (e) Flywheel mounting bolts loose.
- (f) Engine rough at idle producing rattle in gear train.
- (g) Engine mounts loose or broken.
- (h) Universal joints worn out.
- (i) Propeller shafts out of balance.
- (j) Universal joint angles out of plane or at excessive angle.
- (k) Centre bearings in drive line dry - not mounted properly, etc.
- (l) Wheels out of balance.
- (m) Tyre treads humming or vibrating at certain speeds.
- (n) Air leaks on suction side of induction system - especially with turbo-chargers.

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

- (a) **Growl and humming**, or more serious, a grinding noise. These noises are caused by worn, chipped, rough or cracked gears. As gears continue to wear, the grinding noise will be noticeable, particularly in the gear position that throws the greatest load on the worn gear.
- (b) **Hissing**, or more serious, a thumping or bumping-type noise. Hissing noises could be caused by bad bearings. As bearings wear and retainers start to break up, etc., the noise could change to thumping or bumping.
- (c) **Metallic rattles** within the transmission usually result from a variety of conditions. Engine torsional vibrations are transmitted to the transmission, so a rattle, particularly in neutral is common with diesel equipment.

TROUBLE SHOOTING - MECHANICAL CHECKS

In general, engine speeds should be 600 r.p.m. or above to eliminate objectionable rattles and vibration during the idle. A defective or faulty injector would cause a rough or lower idle speed and a rattle in the transmission. Rattle could also be caused by excessive backlash in front wheel drive units.

- (d) **Improper lubricants** or lack of lubricant can produce noises. Transmissions with low oil levels sometimes run hotter than normal as there is insufficient lubricant to cool and cover the gears.
- (e) **Squealing**, particularly when the transmission is operating at higher speeds, could be caused by one of the free running gears seizing on the thrust face or bearing diameter temporarily and then letting go. In general, a mild seizure will clear itself up and the transmission will continue to operate very satisfactorily without this defect being known. See (g).
- (f) **Gear seizure** usually accompanied with loud squealing noise. This type of seizure is readily apparent to the driver since the unit will suddenly slow down as if the brakes were being applied.
- (g) **Vibration**. Gear seizures of thrust faces or bearing diameters are usually caused by vibrations in the power train - this could be engine, propeller shafts, joint angle, rear axle, differentials, etc.
- (h) **Gear whine** is usually caused by lack of backlash between mating gears - usually improper shimming of front wheel drive units.

Noise in Neutral:

Possible causes:

- (a) Misalignment of transmission.
- (b) Worn flywheel pilot bearing.
- (c) Worn or scored countershaft bearings.
- (d) Worn or rough reverse idler gear.
- (e) Sprung or worn countershaft.
- (f) Excessive backlash in gears.
- (g) Worn mainshaft pilot bearing.
- (h) Scuffed gear tooth contact surface.
- (i) Insufficient lubrication.
- (j) Use of incorrect grade of lubricant.

Noise in Gear:

Possible causes:

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

Oil Leaks:

Possible causes:

- (a) Oil level too high.
- (b) Wrong lubricant in unit.
- (c) Seals defective or omitted from bearing cap.

- (d) Transmission breather omitted, plugged internally, etc.
- (e) Bolts loose, omitted, or missing from remote control, shifter housing, bearing caps, or covers, etc.
- (f) Welch "seal" plugs loose or missing entirely from machine openings in case.
- (g) Oil drain-back openings in bearing caps or case plugged with varnish, dirt, covered with gasket material, etc.
- (h) Broken gaskets, gaskets shifted or squeezed out of position, pieces still under bearing caps, clutch housing, and covers etc.
- (i) Cracks or holes in castings.
- (j) Drain plug loose.

Walking or Jumping out of Gear:

If remote controls are used, the mechanic must satisfy himself that the remote units are satisfactory and that transmission is actually at fault. One other point that should be noted is whether the unit walks out of gear under drive (while pulling a load) or on a coast load. Also, does the gear hop occur on smooth or only on rough roads. A number of items that would prevent full engagement of gears are:

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

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

- (a) Use of heavy shift lever extensions.
- (b) Shift rod poppet springs broken.
- (c) Shift rod poppet notches worn.

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- (d) Shift rod bent or sprung out of line.
- (e) Shift fork pads not square with shift rod bore.
- (f) Excessive end-play in drive gear, mainshaft or countershaft, caused by worn bearings, retainers, etc.
- (g) Thrust washers or faces worn excessively, missing, etc.

Hard Shifting:

- (a) No lubricant in remote control units. Forward remote is isolated and is often overlooked. However, many remote controls used on transmissions and auxiliaries required separate lubrication.
- (b) No lubricant in (or grease fittings on) U-joints or swivels of remote controls.
- (c) Lack of lubricant or wrong lubricant used, causing build up of sticky varnish and sludge deposits on splines of shaft and gears.
- (d) Badly worn or bent shift rods.
- (e) Improper adjustment of shifter linkage.
- (f) Sliding clutch gears tight on splines of shaft.
- (g) Clutch teeth burred over, chipped or badly mutilated due to improper shifting.
- (h) Binding or interference of shift lever with other objects or rods inside the cab or near the remote control island.
- (i) Driver not familiar with proper shifting procedure.

Bearing Failures:

More than 90% of all bearing failures are caused by dirt, which is always abrasive.

Dirt may enter the bearings during assembly of the units or be carried into the bearing by the lubricant while in service. Dirt may enter through seals, breather or even dirty containers used for addition or change of lubricant.

Softer material such as dirt, dust, etc., usually form abrasive paste or lapping compounds within the bearings themselves since the unit pressure between the balls/rollers and raceways makes a perfect pulverizer. The rolling motion tends to entrap and hold the abrasives. As the balls/rollers and raceways wear, the bearings become noisy. The lapping action tends to increase rapidly as the fine steel from the balls/rollers and rollway adds to the lapping material.

Hard, coarse material such as chips, etc., may enter

the bearings during assembly from the hammers, drifts, power chisels, etc., or be manufactured within the unit during service from raking teeth, etc. These chips produce small indentations in balls/rollers and races. Jamming of these hard particles between balls/rollers and races may cause the inner race to turn on shaft, or the outer race to turn in the housing.

Corrosion:

Water, acid and corrosive materials formed by deterioration of lubricant, will produce reddish-brown coating and small etched holes over outer and exposed surfaces of race. Corrosive oxides also act as lapping agent.

Brinelling caused by improper assembly or removal, usually hammering with off-centre blows. Use tubes, preferably under a press or extractor.

Fatigue:

All bearings are subject to fatigue and must be replaced eventually. Your own operating experience will dictate mileage replacement of bearings showing only normal wear.

Shaft Fits:

Excessive looseness under load is very objectionable because it produces a creeping or slipping of the inner ring on the rotating shaft. This causes the surface metal of shafts to scrub or wear off.

Bearing fits on rotating shafts are usually specified as tight. When play or looseness, even .001", exists between the bearing and shaft, there is a very powerful force tending to rotate the inner race on the shaft; this force is caused by the looseness or lost motion between the parts and disappears when no looseness exists.

Removal of Bearings:

It is far more difficult to remove bearings from a shaft than to put them on. It is necessary to remove the bearings by using the correct tools, otherwise damage may be sustained to the balls/rollers or races. Since such damage is seldom visible, it does not become known until after complete reassembly. It is good P.M. to replace most bearings during the overhaul period. If a bearing is not going to be replaced, avoid removal during low mileage rebuild.

Interchangeability:

All bearings, whether manufactured here or abroad, are interchangeable in regard to standardized dimensions, tolerances and fits. However, for a given shaft size, there are standard bearings for light, medium and heavy-duty service.

Number and symbols stamped on inner and outer races of bearings designate size and type.