TECHNICAL MANUAL

DIRECT AND GENERAL SUPPORT MAINTENANCE MANUAL TRANSMISSION, AUTOMATIC, 2520-066-4240 (ALLISON DIV., GMC MODEL TX 100-1)

HEADQUARTERS, DEPARTMENT OF THE ARMY

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DIRECT AND GENERAL SUPPORT MAINTENANCE MANUAL

TRANSMISSION, AUTOMATIC (2520-066-4240)

(ALLISON DIV., GMC MODEL TX 100-1)

***This manual, together with TM 9-2520-254-35P, 19 December 1968, supersedes TM 9-2520-254-35, 14 August 1964.**

LIST OF ILLUSTRATIONS

LIST OF TABLES

CHAPTER 1

INTRODUCTION

Section I. GENERAL

1-1. Scope

a. Maintenance Information. This technical manual contains instructions for direct and general support maintenance for the Model TX 100-1 (GM-Allison) transmission (P/N 8355951-19207). The transmission is illustrated in figures 1-1 and 1-2. Included are descriptions of the transmission and components, procedures for disassembly, cleaning, inspection, troubleshooting, repair, rebuild, assembly, and test, and repair and overhaul (rebuild) standards.

b. Chapters 1 Through 4. General information, description, and tabulated data are given in chapter 1. Chapter 2 contains detailed descriptions and explanations of the operation of components, subassemblies, and hydraulic system, and traces the torque paths through the transmission. Chapter 3 covers requisition of repair parts and gives detailed information on special tools and equipment required for direct and general support maintenance operations. Chapter 4 covers troubleshooting and includes a chart to assist in location and correction of troubles.

c. Chapter 5 for Repair and Overhaul (Rebuild).

(1) Chapter 5 covers disassembly of the transmission, overhaul (rebuild) of subassemblies, and assembly of the transmission.

(2) The disassembly and assembly instructions are presented in a pictorial step-by-step manner, in graphic and easy-to-follow instructions. There is a picture, in operation sequence. for every main step in the disassembly and assembly of the transmission. In addition to the figure number, each pictorial step is identified by *its* step number. Other sections of the manual are compiled in the paragraph-outline style.

d. Chapter 6 for Standards. Chapter 6 covers repair and overhaul (rebuild) standards, and includes a tabulation of wear limits with direct and general support standards. Wear limit tables are keyed to referenced figures.

e. Appendix and Index. Following chapter 6 is appendix A. Appendix A is a list of publications which relate to the materiel or its maintenance. Following appendix A is an alphabetical index of maintenance subjects.

f. Reporting Errors and Omissions. The direct reporting of errors, omissions, and recommendations for improving this equipment manual by the individual user is authorized and encouraged. DA Form 2028 (Recommended Changes to Publications) will be used for reporting these improvements. DA Form 2028 will be completed in triplicate and forwarded by the individual using the manual. The original and one copy will be forwarded direct to Commanding General, U. S. Army Tank-Automotive Command, ATTN: AMSTA-MAP, Warren, Mich., 48090. One information copy will be provided to the individual's immediate supervisor.

g. Operating Instruction Manual. The end item operator's manual contains instructions for the TX 100-1 transmission, as well as all maintenance operations allocated to the operators in performing maintenance work within their scope.

h. Lubrication Instructions. The end item lubrication order contains instructions, locations, intervals, and materials for lubricating the materiel covered herein.

i. Maintenance TM. The end item organizational manual contains instructions for the maintenance of the TX 100-1 transmission within the scope of organizational maintenance.

j. Repair Parts. TM 9-2520-254-35P lists repair parts for Model TX 100-1 transmission.

1-2. Direct and General Support Maintenance Allocation

Refer to the maintenance allocation chart in the end item organizational manual.

1-3. Forms, Records, and Reports

For current and complete listing of all authorized forms. refer to the current issue of DA pamphlet 310-2. TM 38-750 contains instructions on use of forms for records and reports.

Section II. GENERAL DESCRIPTION AND DATA

1-4. Description

a. General Description.

(1) The Model TX 100-1 transmission (fig. 1-1 and 1-2) is a full powershift, torque converter, planetary gear transmission for military vehicles. It is a compact unit which may be bolted to the vehicle engine to form a unitary power pack, or may be bolted to a transfer case in the power train.

(2) Power flows in a straight line from front to rear of the transmission, passing in succession through the torque converter, turbine shaft, and transmission output shaft. Operations in reverse, neutral, low, intermediate, and high ranges are provided.

(3) An automatic lockup clutch in the torque converter gives direct drive from engine to range gearing at higher engine speeds. With the lockup clutch engaged during high-range operation, the transmission input and output speeds are equal. Power takeoff mountings are provided at both sides of the transmission.

b. Definition of Locational and Directional Tcrms.

(1) Locational terms, used in describing the transmission, are front, rear, right, and left. The input, or torque converter end, is the front. The output end is the rear. Right and left are toward the viewer's right and left when the transmission is viewed from the rear.

NOTE

These directional terms may not agree with those applicable to certain vehicles because of different attitudes in which the transmission may be installed.

(2) Rotational terms (clockwise and counterclockwise) will be established by references in the text, or by the viewer's position when using an illustration.

c. Transmission Components. The main components of the transmission are identified in the cross-section view (fig. 2-1). Chapter 2 covers in detail the description and operation of all components.

1-5. Driving Instructions

Refer to end item operator's manual for driving instructions for vehicles using the Model TX 100-1 transmission.

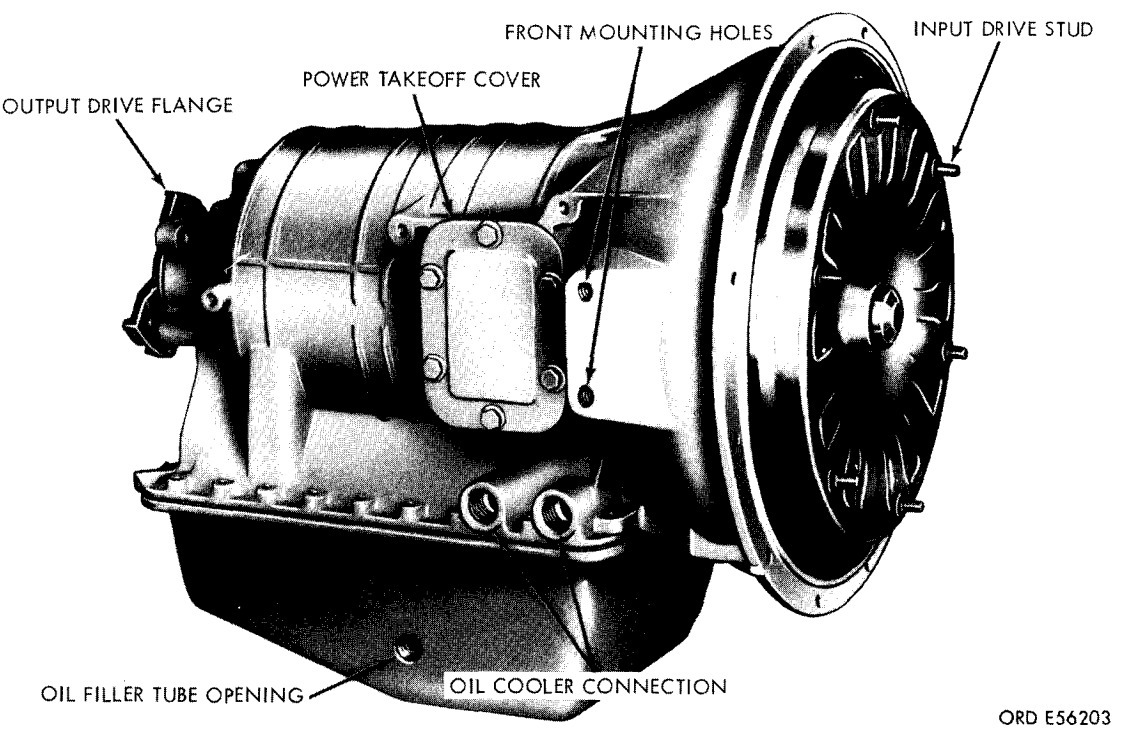


Figure 1-1. Model TX 100-1 transmission assembly—right front view.

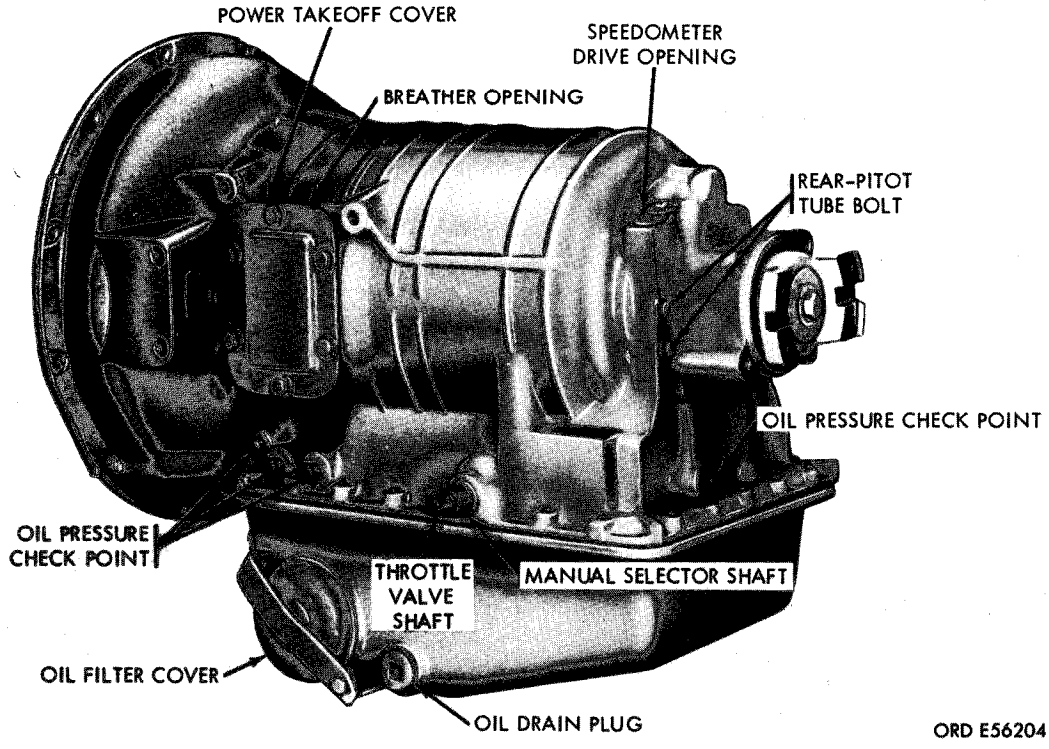


Figure 1-2. Model TX 100-1 transmission assembly—left rear view.

1-6. Transmission Oil

Oil may be considered the life blood of a hydraulic transmission. The use of proper oil. and attention to keeping the oil clean. is of paramount importance. The proper oil level must be maintained in the transmission to obtain maximum performance. Check the oil level regularly. Change oil and filters at the specified intervals. Refer to end item operator's manual and lubrication order for procedures to be followed in checking the oil level and for changing the oil in the Model TX 100-1 transmission.

1-7. Tabulated Data

The following table cover technical data applicable to the Model TX 100-1 transmission.

Table 1-1. Tabulated Data

Manufacturer	Allison Division, GMC
Model	TX 100-1
Type	straight-through, torque converter, planetary gear, automatic
Weight, dry	309 lb
Overall dimensions:	
Length (from converter housing-to-output flange faces)	25.38 in.
Width, overal	17.76 in.
Height, overall	21.42 in.
Name plate location	lower-rear-left side of housing
Serial number locations (2)	on name plate, and stamped on upper rear of transmission housing
Rating:	
Maximum input torque	325 lb ft
Maximum input speed	4, 000 rpm
Rotation:	
Input (viewing front of transmission)	clockwise
Output (viewing front of transmission during forward operation)	clockwise

Table 1-1. Tabulated Data—Continued

Drive ranges (manually selected)	reverse, neutral, 2-3, 1-2-3, 1-2, 1
(Gears included in each range are automatically selected within the range)	
Torque converter	3-element, single-stage, multiple phase
Model	TC 350
Lockup clutch	single-plate, hydraulic-applied, automatic
Range clutches	multiplate, oil-cooled, hydraulic-applied, spring-released, automatic wear compensation
Range gearing (constant-mesh)	straight-cut, 10-pitch, planetary
Control (range selection):	
External	manual
Internal	hydraulic, automatic
Torque multiplication ratios:	
Torque converter (maximum at stall)	3.50:1
Overall transmission ratios	see chart below

Transmission ratios (input to output):

Gear range	*Planetary ratio*	*Converter torque ratio (at stall)*	*Overall ratio (at converter stall)*	*Overall ratio In lockup*
Low	3.81:1	3.50:1	13.34:1	3.81:1
Intermediate	1.93:1	3.50:1	6.76:1	1.93:1
High (clutch)	1.00:1	*	*	1.00:1
Reverse	4.35:1	3.50:1	15.23:1	4.35:1

*Due to automatic downshift, converter is stalled in second gear.

Power takeoff drive (one at each side):	
Location	left and right center of housing
Drive	converter driven, 6/8-pitch, 57-tooth gear
Mounting	SAE, 6-bolt, regular duty
Speed	rotates at turbine speed
Rating	300 lb ft, 100 hp
Oil pumps (2):	
Input driven	eccentric gear, positive displacement
Output driven	eccentric gear, positive displacement
Oil system:	
Capacity, initial fill	5 US gal
Capacity, refill (filter change)	4 US gal
Filter	full flow, replaceable element
Oil specifications	hydraulic transmission fluid, MIL-L-2104B, grade 10

Main oil pressure schedule (psi):	N	1	2	3	Rev
Gear					
Closed throttle—converter operation (at stall)	250-280	250-280	250-280	*	250-280
Closed throttle—lockup operation	80	95-115	95-115	95-115	
Full throttle (through detent)-converter operation (at stall)		295-325	295-325	*	295-325
Full throttle (through detent)-lockup operation		120-135	120-135	120-135	—

*Due to automatic downshift, converter is stalled in second gear.

Oil temperatures (to cooler):	
Normal	180° to 200° F.
Maximum permissible	300° F.

CHAPTER 2

DESCRIPTION AND OPERATION

Section I. DESCRIPTION AND OPERATION OF TRANSMISSION COMPONENTS

2-1. Torque Converter and Lockup Clutch

a. Torque Converter Components (fig. 2-1).

(1) The torque converter consists mainly of three cast aluminum elements: a converter pump (8), converter turbine (6), and a stator and cam assembly (7). In addition, there are other parts in the group which house and support these main elements.

(2) The converter pump assembly (8) is the driving element. It rotates on a ball bearing assembly (9) supported by a converter ground sleeve (10) which is stationary and a component of the diaphragm assembly (12). The pump is bolted to a cover assembly (4) which rotates with the engine crankshaft.

(3) The converter turbine assembly (6) is the driven element. It is splined to a turbine shaft (59) which transmits torque to a high-range clutch housing (16), intermediate-range sun gear (53), and a low-range sun gear (46). The turbine hub (2) is splined to a lockup clutch plate (5).

(4) The stator and cam assembly (7) is the reaction element. It is mounted on an over-running clutch on a freewheel roller race (63) which is splined to a ground sleeve (10). The stator is free to rotate in the direction of engine rotation but locks up in the opposite direction.

b. lockup Clutch Components (fig. 2-1).

(1) The lockup clutch piston assembly (64) is a spring steel diaphragm with a clutch apply plate at its outer circumference. It is mounted on the inner hub of the converter pump cover assembly (4). and retained by a snap ring. Recesses in the piston engage the heads of the converter drive bolts, and prevent rotation of the piston relative to the pump cover.

(2) The lockup clutch plate (5) is a non-metallic, internal-splined plate. It is splined to the converter turbine hub and located between the piston (64) and the lockup clutch back plate (62).

(3) The lockup clutch back plate (62) is a pressed steel ring against which the plate (5) reacts when the lockup clutch is applied. Its outer diameter is held between the converter pump cover (4) and tbe pump (8) which are bolted together.

c. operation of Torque Converter and Lockup Clutch (fig. 2-1).

(1) The actions of the torque converter and lockup clutch are interrelated. When the lockup clutch is released, the torque converter must transmit engine power to the transmission. When the lockup clutch is engaged, there is no converter action and torque is transmitted directly from engine to transmission because the input drive components and converter turbine (6) are locked together.

(2) When the lockup clutch is released, the torque converter (which is constantly filled with oil) transmits torque by hydraulic action. The blades of the pump (8) throw oil against the blades of the turbine (6), causing the turbine to rotate in the same direction as the pump. Higher pump speeds cause the oil to be thrown with more force, causing a greater rotating force in the turbine. At engine idle speed, the force of the oil, and consequently the torque transmitted, is negligible. This characteristic of hydraulic drive permits the torque converter to take the place of a friction clutch between the engine and transmission.

(3) The turbine vanes direct the oil toward the center of the turbine (6), where the oil leaves the turbine in a direction opposite to pump rotation. The stator (7) redirects the flow of oil to change its direction to that of pump rotation. Unexpended energy in the oil reentering the pump (8) assists the pump. This is the key to torque multiplication.

(4) Thus, the torque converter is a torque multiplier as well as a fluid coupling. Torque multiplication is highest when the turbine (6) is stalled and the pump (8) is rotating at full speed. It is lowest when the pump is rotating at its lowest speed relative to the turbine.

(5) The oil, leaving the inner ends of the turbine vanes, strikes the curved vanes of the stator and is deflected into the pump vanes. It is the reaction of the oil, as it is forced to change direction, which locks the stator against rotation opposite to pump and turbine rotation. When turbine speed approaches pump speed, the oil leaving the turbine strikes the back sides of the turbine vanes and causes the stator to freewheel on the rollers (61).

(6) When torque multiplication is no longer required to provide sufficient power to the vehicle drive line and vehicle speed is great enough, the lockup clutch automatically engages. In lockup operation there is no hydraulic slippage. The result is economy in operation and improvement in operating characteristics.

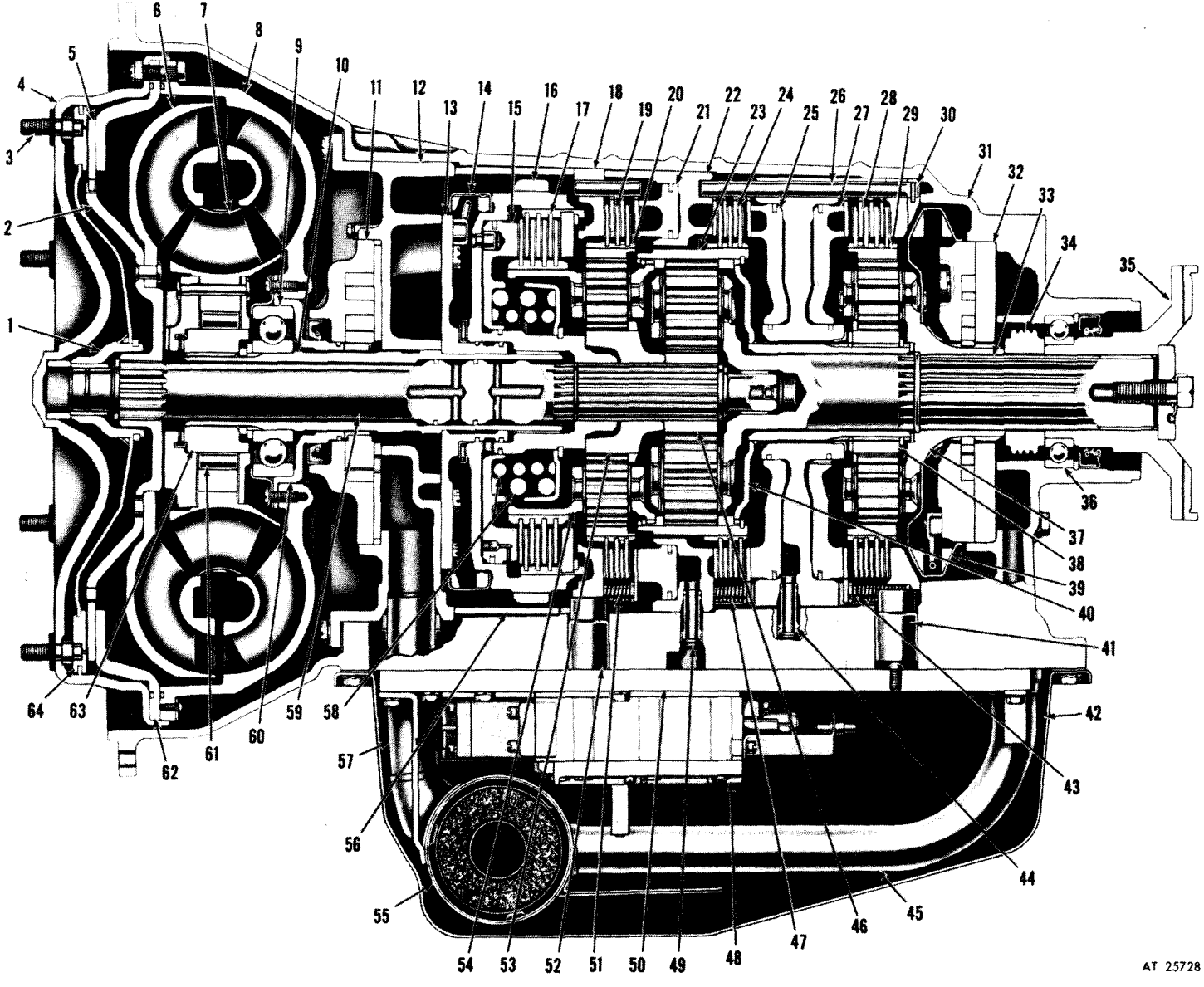


Figure 2-1. Model TX 100-1 transmission—cross-section view.

1 Converter pump cover hub
2 Turbine hub
3 Converter pump cover drive stud
4 Converter pum p cover assembly
5 Lockup clutch plate
6 Converter turbine assembly
7 Converter stator and cam assembly
8 Converter pump assembly
9 Pum p hub ball bearing assembly
10 Converter ground sleeve
11 Front oil pump
12 Diaphragm assembly
13 H igh-range clutch housing support flange
14 Front fluid velocity governor
15 H igh-range clutch piston
16 High-range clutch housing assembly
17 High-range clutch plate
18 Intermediate-range clutch back plate
19 I ntermediate-ra nge clutch plate
20 Intermediate-range ring gear
21 I ntermediate-range clutch piston
22 Intermediate-range clutch piston housing assembly
23 Low-range ring gear
24 Low-range clutch plate
25 Low-range clutch piston
26 Low- and reverse-range clutch piston housing assembly
27 Reverse-range clutch piston
28 Reverse-range clutch plate
29 Reverse-range ring gear
30 R everse-range clutch back plate
31 Transm ission housing
32 Rear oil pump
33 Transmission output shaft
34 Speedometer drive gear
35 Transm ission output flange
36 Output flange ball bearing
37 Reverse-range carrier assembly
38 Reverse-range sun gear
39 Rear fluid velocity governor
40 Reverse-range sun gear shaft
41 Low- and reverse-range clutch anchor pin
42 Oil pan
43 Reverse-range clutch return spring
44 Oil transfer tube
45 Rear oil pump intake tube
46 Low-range sun gear
47 Low-range clutch return spring
48 Control valve assembly
49 Oil transfer tube retaining ring
50 Oil transfer plate
51 Intermediate-range clutch return spring
52 Intermediate-range clutch anchor pin
53 Intermediate-range sun gear
54 Intermediate-range carrier assembly
55 Oil filter
56 Back plate spacer
57 Front oil pump intake tube
58 High-range clutch piston return spring
59 Converter turbine shaft
60 Pump hub
61 Freewheel roller
62 Lockup clutch back plate
63 Freewheel roller race
64 Lockup clutch piston assembly

2-2. High-Range Clutch and Power Takeoff (fig. 2-l).

a. High-Range Clutch Components (fig. 2-1).

(1) The high-range clutch consists mainly of housing (16), piston (15), piston return springs (58), four internal-splined, bronze-faced steel clutch plates, three external-tanged steel plates (17), and a steel reaction plate.

(2) The housing (16) has a 6/8-pitch, 57-tooth power takeoff drive gear, integrally machined at its outer circumference. The housing has internal splines in the hub which connects it to the turbine shaft (59).

(3) The external-tanged clutch plates (17) engage the housing (16). The internal-splined plates engage a hub which is integral with the intermediate-range planetary carrier (54).

b. Operation of High-Range Clutch (fig. 2-1).

(1) Power from the turbine (6) is transmitted to the clutch housing (16) through the turbine shaft (59) and the hub splines. When the clutch is released, the housing and three external-tanged clutch plates rotate but do not drive the four internal-splined plates. When the clutch is applied, hydraulic pressure pushes the piston (15) rearward and compresses all seven clutch plates against the clutch reaction plate. This grips the internal-splined plates and causes them to rotate with the external-tanged plates and housing. The internal-splined plates drive the intermediate-range planetary carrier.

(2) The housing (16) rotates when the turbine shaft (59) rotates. The shaft (59) rotates when the turbine (6) rotates. Thus, the housing (16) can rotate in neutral, reverse gear, or any forward gear when engine power is applied through the converter by speeding up the engine. For this reason the power takeoff drive gear is part of the housing. Its teeth mesh with a driven gear in the power take-off assembly (or assemblies) which may be mounted on either side of the housing (31).

(3) In high-range operation, torque is transmitted at the same speed from the turbine shaft (59) to the intermediate-range planetary carrier assembly (54). The intermediate-range planetary carrier (54) is attached to the low-range ring gear (23). The low-range sun gear (46) is splined to the turbine shaft (39). Thus, two members of the low-range gear set are rotating at the same speed as the high-range clutch. The third member (low-range planetary carrier) is meshed with these two and, therefore. must also rotate at the same speed. This results in the transmission output shaft (33) being driven at the same speed as the turbine shaft (59).

2-3. Intermediate-Range Clutch and Planetary

a. Intermediate-Range Clutch Components (fig. 2-1). The intermediate-range clutch includes a stationary back plate assembly (18), piston (21), three internal-splined, and two external-tanged clutch plates (19), and ten return springs (51). The piston housing assembly (22) serves also as a reaction plate for the low-range clutch.

b. Intermediate-Range Planetary Gears (fig. 2-1).

(1) A 31-tooth sun gear (53), 59-tooth (internal) ring gear (20), and a carrier assembly (54) with four 14-tooth pinions make up the intermediate-range gear set. The sun gear is the driving member, the ring gear is the reaction member, and the carrier assembly is the driven member.

(2) The sun gear (53) is splined to the turbine shaft (59) and meshes with the carrier pinions. The carrier assembly (54) includes splines at the front which engage the internal-splined, high-range clutch plates (17), and splines at the rear which engage the low-range ring gear (23). The carrier pinions mesh with both the sun gear (53) and ring gear (20). The ring gear internal teeth mesh with the carrier pinions. Its external splines engage the intern al-splined clutch plates (19). A retainer at the outer circumference of the ring gear (20) prevents the gear moving forward or rearward.

c. Operation of Intermediate-Range Clutch and Planetary Gears (fig. 2-1).

(1) When the intermediate-range clutch (19) is applied. the clutch piston compresses the clutch plates against the back plate (18). This holds the ring gear (20) stationary. The sun gear (53) drives the carrier assembly (54) and low-range ring gear (23) at reduced speed. The low-range sun gear (46) (rotating at the same speed as the intermediate-range sun gear (53) and the low-range ring gear (23) (rotating at a lower speed) combine to drive the low-range planetary carrier and transmission output shaft at a different rate of speed.

(2) The actual speed reduction ratio in the intermediate-range gear set is 2.90 to 1. However, when this ratio is combined with that of the low-range gear set. the overall speed reduction ratio is 1.93 to 1. The interaction of two planetary gear sets to produce a desired ratio is called compounding.

(3) When hydraulic pressure is exhausted from the intermediate-range clutch piston housing, springs (51) return the piston (21) into the housing bore. Released, the internal-splined clutch plates rotate independently of the stationary, external-tanged plates.

2-4. Low-Range Clutch and Planetary

a. Low-Range Clutch Components (fig. 2-1). The low-range clutch (24) includes 3 external-tanged plates, 3 internal-splined plates, and 12 return springs (47). The intermediate-range housing assembly (22) serves as the low-range clutch back plate. The low- and reverse-range housing assembly (26) serves jointly for the low- and reverse-range clutches. Pins in the housing assembly anchor the low-range, external-tanged clutch plates, as well as the reverse-range, external-tanged plates, against rotation.

b. Low-Range Planetary Gears (fig. 2-1).

(1) A 21-tooth sun gear (46), 59-tooth (internal) ring gear (23), and a carrier assembly and transmission output shaft with four 19-tooth pinions make up the low-range gear set. The sun gear is the driving member, the ring gear is the reaction member, and the carrier assembly and output shaft is the driven member.

(2) The sun gear (46) is splined to the turbine shaft (59) and meshes with the carrier pinions. The carrier assembly is integral with the transmission output shaft (33). The carrier pinions mesh with both the sun gear (46) and ring gear (23). The ring gear internal teeth mesh with the carrier pinions. The ring gear external splines engage the low-range, internal-splined plates. At the front, the ring gear (23) is attached to the intermediate-range carrier (54). At its rear, the ring gear is attached to the reverse-range sun gear shaft (40).

c. operation of Low-Range Clutch and Planetary Gears (fig. 2-1).

(1) When the low-range clutch (24) is applied, the clutch piston compresses the clutch plates against the housing (22). This holds the ring gear (23) stationary. The sun gear (46) drives carrier assembly and output shaft (33) at reduced speed.

(2) The speed reduction in the low-range planetary is 3.81 to 1 for low-range operation. The low-range gears have another role in reverse-range operation. They are compounded with the reverse-range gears (para 2-5).

(3) When the low-range clutch is released. springs (47) push the piston (25) back into the housing (26). This permits the low-range, internal-splined plates to rotate independently of the stationary . external-tanged plates.

2-5. Reverse-Range Clutch and Planetary

a. Reverse-Range Clutch Components (fig. 2-1). The reverse-range clutch includes a stationary back plate (30), piston (27). 4 internal-splined and 3 external-tanged clutch plates (28), and 12 return springs *(43).* The piston housing assembly (26) serves jointly for the reverse- and low-range clutches. Pins in the housing assembly anchor the reverse-range, external-tanged clutch plates, as well as the low-range, external-tanged clutch plates, against rotation.

b. Reverse-Range *Planetary Gears* (fig. 2-1).

(1) A 31-tooth sun gear (38), 59-tooth (internal) ring gear (29), and a planetary carrier assembly (37) with six 14-tooth pinions make up the reverse-range gear set. The sun gear is the driving member, the ring gear is the reaction member, and the carrier assembly is the driven member.

(2) The sun gear (38) is splined to reverse-range sun gear shaft (40) which, in turn, is splined to the low-range ring gear (23) which meshes with the low-range carrier pinions. The carrier assembly (37) is splined to the transmission output shaft (33). Its pinions mesh with both the ring gear (29) and sun gear (38). The ring gear (29) has external splines which engage the reverse-range, internal-splined plates. A retainer at the outer circumference of the ring gear (29) prevents the gear moving forward or rearward.

c. Operation of Reverse-Range Clutch and Planetary Gears (fig. 2.1).

(1) When the reverse-range clutch (28) is applied, the clutch piston (27) compresses the clutch plates against the reaction plate (30). This holds the ring gear (29) stationary. The sun gear (38) drives the carrier assembly (37) at a reduced speed but in the same direction as the sun gear (38). To actually obtain reverse rotation which the sun gear and carrier must have, the reverse-range gears are compounded with the low-range gears.

(2) Reversing actually takes place in the low-range gear set and its output (ring gear (23)) transmits reverse rotation to the input (sun gear (38)) of the reverse-range gear set. The overall reverse-rotation speed reduction ratio is 4.35 to 1.

(3) When hydraulic pressure is exhausted from the clutch piston housing, springs (43) push the piston (27) back into the housing (26). This permits the reverse-range, internal-splined plates to rotate independently of the stationary, external-tanged clutch plates.

2-6. Oil Pumps

a. Components of Front and Rear Oil Pumps (fig. 2-1).

(1) The front oil pump (11) includes a pump body, cover. 19-tooth drive gear, and a 22-tooth driven gear. The drive gear has external teeth and the driven gear has internal teeth. Both gears have 6-pitch teeth.

(2) The rear oil pump (32) includes a pump body, cover, 26-tooth drive gear, and a 30-tooth driven gear. The drive gear has external teeth and the driven gear has internal teeth. Both gears have 8-pitch teeth.

(3) In both oil pumps, the driven gear is mounted eccentrically in mesh with the drive gear. The gears are separated at their unmeshed side by a crescent-shaped partition which is part of the pump body. The width of the front pump gears is more than twice the width of the rear pump gears, giving the front pump greater pumping capacity.

b. Operation of Oil Pumps (fig. 2-1).

(1) The front oil pump (11) is driven by the torque converter pump hub. It supplies oil to the hydraulic system at any time the vehicle engine is running. Oil is picked up (through the oil filter (55)) from the oil pan (42).

(2) The rear oil pump (32) is driven by the reverse-range planetary carrier (37) at any time the vehicle is moving forward. Oil is picked up (through the oil filter (55)) from the oil pan (42). Oil flow produced by the rear pump supplements that of the front pump during vehicle forward operation. It is the only source of oil flow and pressure during push or tow starting.

2-7. Fluid Velocity-Type Governors

a. Components of Front and Rear Governors (fig. 2-1).

(1) There are two governors in the transmission for controlling the automatic functions. The front governor (14) is located at the front of the high-range clutch housing (16). The rear governor (39) is located at the rear of the reverse-range planetary (37).

(2) Each governor includes a collector ring which rotates with the component to which it is attached, and a pitot tube which is stationary. Each collector ring has a channel around the inside of its rim. There are radial vanes at close intervals in the channel. A port supplies oil to keep the channel filled. When the collector ring is rotating, the channel remains full due to centrifugal force acting to retain the oil.

(3) The vanes in the channel keep the oil moving at virtually the same speed as the channel. The pitot tube is a simple tube, stationarily positioned in the oil which fills the channel. The open end of the tube faces against the direction of oil travel. The other end of the tube connects to passages leading to control valves.

b. operation of Fluid Velocity-Type Governors (fig. 2-1).

(1) The fluid velocity governors (14 and 39) derive their name from the fact that governor pressure is dependent upon the velocity of fluid in the channels of the collector rings. When the collector rings rotate, oil is thrown directly into the open ends of the pitot tubes.

(2) The front governor collector ring is welded to the high-range clutch housing and rotates with it. Since the clutch housing is connected to the torque converter turbine by the turbine shaft (59), front governor pressure is proportional to turbine speed. Front governor pressure is called G1 pressure.

(3) The rear governor collector ring is riveted

to the reverse-range planetary carrier and rotates with it. Since the carrier is splined to the transmission output shaft, rear governor pressure is proportional to transmission output speed. The rear governor functions only during vehicle forward movement. Rear governor pressure is called G2 pressure.

2-8. Transmission Housing

The transmission housing (31, fig. 2-1) is an alum inure casting. The one-piece housing is machined to provide a mounting which mates with either the engine flywheel housing or a mounting face on a transfer housing. It is open at the front and machined internally to receive all of the range gearing and clutches, and rear oil pump. Openings are provided at each side, with machined pads for mounting power takeoff units. The bottom of the housing is machined for the oil transfer plate and oil pan.

2-9. Oil Filter and Oil Pan

a. Oil Filter Components (fig. 2-1). A pressed steel oil filter can assembly (55) is bolted beneath the valve body assembly (48). This assembly encloses a throw-away filter element assembly. Oil enters the can assembly through a horizontal pickup tube located near the bottom of the oil pan. Oil, after passing from the outside to the inside of the filter element, leaves the can assembly through tubes (4.5 and 57) leading to the front and rear oil pumps. The filter element is accessible from the left-front side of the oil pan.

b. Transmission Oil Pan (fig. 2-1). The oil pan (42) is pressed steel and serves as the transmission oil sump. It is attached to the bottom of the transmission housing by 26 bolts which pass through a flared rim. The oil pane encloses an oil filter (55) and can, control valve assembly (48), and oil transfer plate (50). Fittings are provided for the oil filler, drain plug, and for retaining the oil filter element.

2-10. Transmission Shafts

a. Converter Turbine Shaft (fig. 2-1). The transmission has two shafts which transmit all torque. The turbine shaft (59) is the longer shaft. It is splined at both ends and has drilled passages. The front passage directs lockup pressure to the lockup clutch. The rear passage carries lubricating oil. The converter turbine (6) is splined to the front of the shaft. The high-range clutch housing (16), intermediate-range sun gear (53), and the low-range sun gear (46) are splined to the rear. The turbine shaft transmits torque from the turbine to the range-gear section of the transmission.

b. output Shaft (fig. 2-1). The transmission output shaft (33) is an integral part of the low-range planetary carrier and output shaft assembly. The carrier is the large, front portion of the assembly. The shaft is splined for approximately one half its length at the rear. The reverse-range planetary carrier assembly (37), speedometer drive g-ear (34), and the output drive flange (35) are splined to the shaft. A bushing at the front supports the rear of the turbine shaft (59).

2-11. Oil Transfer Plate, Valve Body, and Controls

a. Oil Transfer Plate (fig. 2-1). A cast aluminum plate (50), bolted to the bottom of the transmission housing (31), provides a mounting for the control valve body assembly (48). Holes and passages in the transfer plate route oil flow and pressure between the transmission housing and various valves in the valve body. A secondary function of the oil transfer plate is the retention of the two range clutch anchor pins.

b. Control Value Body Assembly (fig. 2-1). The control valve body assembly (48) is mounted on the oil transfer plate (50) within the oil pan (42). The assembly includes a system of valves and control devices, all of which operate automatically with the exception of the manual selector valve and throttle valve (TV). Pressure regulation, shifts between ranges, lockup control, and clutch apply regulation are the functions of this assembly.

c. Manual Controls. The manual selector valve and throttle valve in the control valve body assembly are actuated by two lever and shaft assemblies. The levers are inside the oil pan area. The shafts are integral with the levers and extend through a single opening to the outside of the transmission housing at the left side. The selector valve shaft is the larger and is hollow. The small throttle valve (TV) shaft is solid, and passes through the hollow center of the selector valve shaft. Seal rings prevent oil leakage. Snap rings retain the shafts. Splines at the outer ends of the shafts provide points for attaching external control levers.

d. operation of Value Body and Controls. Because of the importance and complexity of the valve body and controls, and their interrelation with other components of the transmission, a separate section in this chapter is devoted to the hydraulic system. Refer to paragraphs 2-12 through 2-21.

Section II. OPERATION OF HYDRAULIC SYSTEM

2-12. Hydraulic Schematics

a. Full and Partial Schematics. A schematic diagram of the entire hydraulic system is illustrated in figure 2-2. Eight partial schematics in color (fig. 2-3 through 2-10) illustrate the operation of the hydraulic system under various conditions explained in paragraphs 2-14 through 2-21.

b. Valve Positions.

(1) In the partial schematics (fig. 2-3 through 2-10). valves and other moving parts are shown in their proper positions for the conditions illustrated. Some valves will be at either one extreme or the other of their movement, while others are at some intermediate position. Thus, those at intermediate positions show only the approximate degree of movement under certain conditions.

(2) It must be remembered that input speed, output speed. throttle opening, selector position, and oil temperature and viscosity will affect the degree of movement and positions of certain valves.

c. Colors Indicate Hydraulic Circuits. Separate colors or color combinations indicate each hydraulic circuit. Color blocks on the partial schematics identify each circuit. Areas not colored are usually filled with oil which is neither flowing nor under pressure. Such areas are inactive, contribute nothing to hydraulic action, and may be disregarded.

2-13. Torque Converter or Lockup Drive

The torque converter and lockup clutch must be considered as part of the hydraulic system since both require oil for operation. Therefore, in all explanations of transmission operation, keep in mind that the input drive may be direct (through the applied lockup clutch) or hydraulic (through the torque converter). These terms are reduced to "lockup" and "converter" operation in the explanations which follows.

2-14. Hydraulic System — Neutral Operation

a. *Main Pressure Circuit* (red—fig. 2-3).

(1) *Engine idling.* Figure 2-3 illustrates neutral operation of the transmission while the engine is idling and the engine throttle is closed. The transmission is in converter operation.

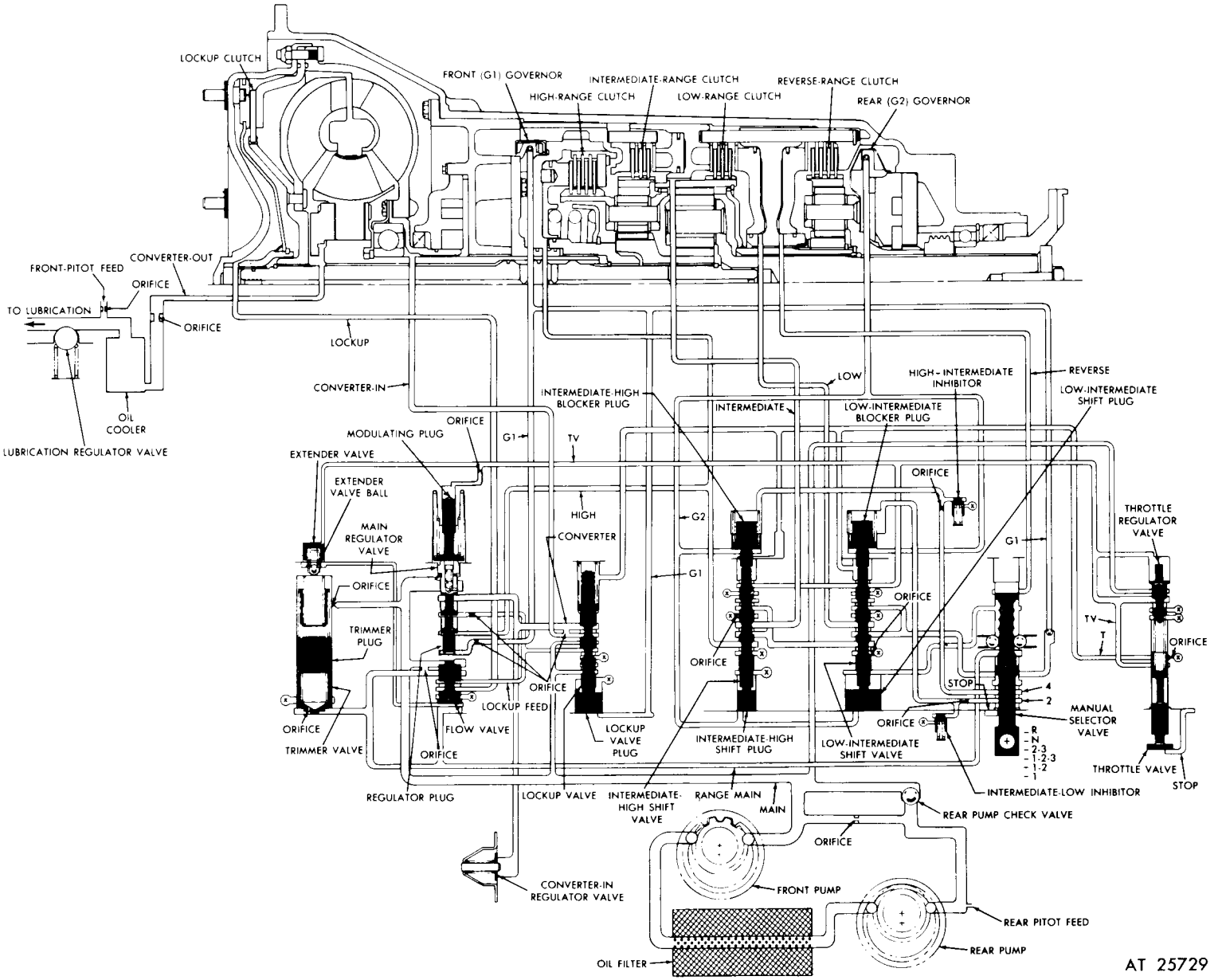


Figure 2-2. Model TX 100-1 transmission hydraulic system—schematic diagram.

(2) Neutral. In neutral, only the front oil pump is rotating. Oil is picked up from the sump through the oil filter element and pumped into main pressure circuit. Through various branches of the main pressure circuit, oil is directed to the throttle regulator valve, manual selector valve, low-intermediate shift valve, lockup valve, flow valve, main regulator valve, and trimmer valve.

(3) *Throttle regulator valve.* At the throttle regulator valve, main pressure is blocked because the valve is downward (when engine throttle is closed, throttle valve is against the stop). Opening the throttle will move the throttle valve upward against a spring. The spring will push the throttle regulator valve upward and allow oil to flow into the throttle valve (TV) circuit. Further movement will allow oil to flow into the throttle (T) circuit. T and TV are regulated pressures which increase as the throttle is opened. Their effects will be explained in subsequent paragraphs.

(4) *Manual selector valve.* At the manual selector valve, main pressure fills the valve bore at the valve detent area. In neutral position of the manual selector valve, main pressure flows only to the area above the low-intermediate shift plug. This holds the low-intermediate shift plug downward and the low-intermediate shift valve and blocker plug upward. This action is of no consequence during neutral operation.

(5) *Lockup valve.* At the lockup valve, main pressure is available for lockup but is blocked because the valve is downward. The valve will remain downward in neutral because no front governor (G1) pressure is available in neutral or reverse (c below).

(6) *Flow valve.* At the flow valve, main pressure enters the valve bore at three points. In neutral, pressure at these three points is equal. Pressure at the middle point is blocked. The lower surface area of the valve is slightly greater than the upper surface area. As a result, the valve is held upward against its stop. The action of the flow valve is dependent upon a significant flow of oil through the orifice at the left of the valve (para 2-16a(1)). A branch of main pressure extends from the flow valve bore, when the flow valve is upward, to the area between the extender valve and the extender valve ball above the trimmer.

(7) *Main regulator valve.* At the main regulator valve, pressure acting against the lower surface area of the valve's large land raises the valve against spring pressure. This produces main pressure and provides oil for charging the torque converter (b below).

(8) *Trimmer valve.* At the trimmer valve, main pressure enters the valve bore at two points. Oil passing into the bore at the lower end of the trimmer valve flows also through the valve's orifice. This pressure is exerted against the bottom of the trimmer plug but, due to main pressure plus spring pressure above the plug, cannot lift it. Oil entering the right side of the trimmer valve bore through an orifice cannot escape past the extender valve ball because main pressure plus spring pressure holds the ball seated. The trimmer is inactive during neutral operation but is set for operation and will act when any shift (except lockup) manual or automatic occurs. Refer to paragraph 2-16i, for trimmer operation.

(9) *Rear pump check valve.* The rear pump check valve ball is seated during neutral operation (when vehicle is standing) because the rear pump is not operating. Oil from the main pressure circuit passes through an orifice between the front and rear pump output lines and supplies oil, through a second orifice, to fill the rear governor pitot ring.

b. Converter-In Circuit (yellow—fig. 2-3).

(1) The converter-in circuit is supplied from oil escaping at the main regulator valve. The volume of this oil varies with engine speed (and vehicle speed when vehicle is moving forward). Slight and / or temporary changes in volume will be caused by shifting, action of the throttle valve, lockup valve, trimmer valve, or inhibitor valves. However, in neutral, only the throttle valve can be actuated.

(2) Converter-in oil flows to three points. Trhese are an orifice to the converter-in line, the lockup valve, and the converter-in regulator valve: In neutral, or at any other time the lockup valve is downward (converter operation), the orifice is ineffective. It is ineffective because oil can flow unrestricted to the converter-in line through the lockup valve bore. The branch leading downward to the converter-in regulator valve exhausts excessive oil to the sump when the valve opens.

(3) The converter-in regulator valve opens when the pressure in the circuit exceeds a predetermined value. Input speed (and output speed) and position of the lockup valve influences its opening and degree of opening. It is shown in the closed position in neutral because the engine is idling, only the front pump is supplying oil, and there is unrestricted flow to the converter.

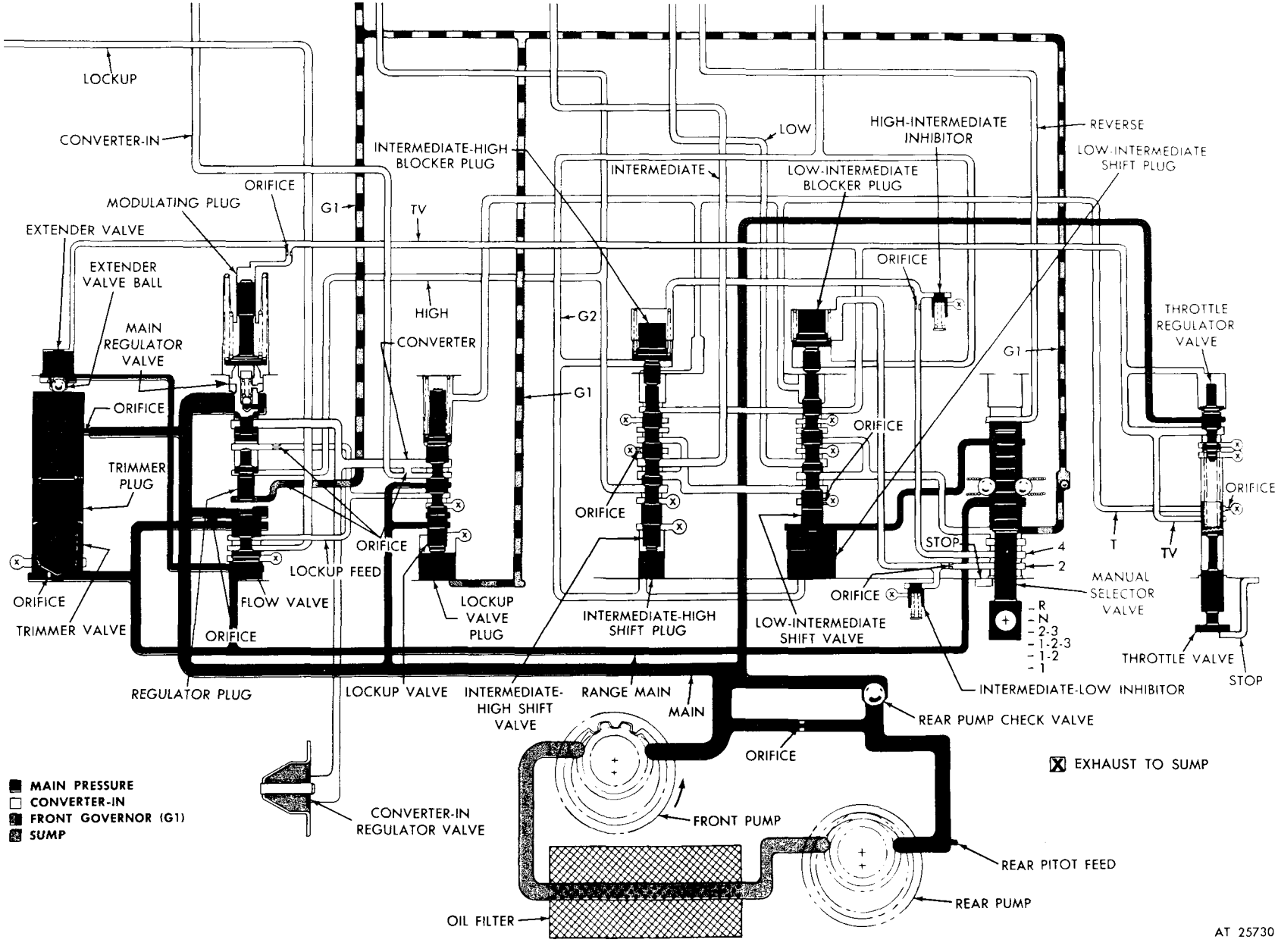


Figure 2-3. Hydraulic system, neutral operation—schematic view.

c. Front Governor (Gl) Circuit (blue, black— fig. 2-3).

(1) Pressure or flow in the front governor circuit is caused by the front fluid velocity governor (para 2-7). The three branches of the circuit connect with the main regulator plug, lockup valve plug, and a ball check valve at the right of the manual selector valve.

(2) In neutral (and reverse) the ball check valve is always open (downward) because there is no pressure below the ball to seat it (upward). The line, below the ball, exhausts around the manual selector valve stem. Thus, there is a flow, but no pressure in the front governor circuit. As a result, the main regulator plug and lockup valve plug remain down. Main pressure is not modulated by front governor pressure, and lockup cannot occur in neutral operation.

2-15. Hydraulic System—Low-Range Operation

a. Main Pressure Circuit (red—fig. 2-4).

(1) Figure 2-4 illustrates low-range operation of the transmission while engine throttle is open and the lockup clutch is engaged. The explanations of circuits and components, below, will refer to previous explanations where applicable.

(2) Oil is pumped into the main pressure circuit by both oil pumps (when vehicle is moving forward) in low-range operation. The rear pump check valve is open (upward) when the rear pump is rotating. Oil is distributed as described in paragraph 2-14a (2).

(3) At the throttle valve, during full-throttle operation as illustrated, the throttle valve (TV) and throttle (T) circuits are charged. Refer to *f* and *g* below for explanations of these circuits.

(4) At the manual selector valve, main pressure is directed to four points. These are the front governor check valve ball, low-intermediate shift valve. high-intermediate inhibitor circuit, and intermediate-low inhibitor circuit. Main pressure seats the check valve ball (upward) in the front governor (G1) passage and prevents governor pressure from exhausting.

(5) At the low-intermediate shift valve, main pressure divides to two branches. The upper branch is blocked but the pressure exerted against valve lands of different diameters exerts a downward force on low-intermediate shift valve. This pressure acts only when the valve is downward and prevents cycling of the valve. A similar downward force, resulting from unequal valve land diameters, is exerted in the lower branch. These forces act only when the valve is downward. The lower branch connects. when the low-intermediate shift valve is downward, with the low-range clutch (e below).

(6) Oil flowing to the high-intermediate inhibitor circuit is restricted by an orifice before it reaches the inhibitor valve and the intermediate-high blocker plug. Refer to paragraph 2-20a for an explanation of the high-intermediate inhibitor circuit.

(7) Oil flowing to the intermediate-low inhibitor circuit is restricted by an orifice before it reaches the inhibitor valve and low-intermediate blocker plug. Refer to paragraph 2-21a for an explanation of the intermediate-low inhibitor circuit.

(8) At the lockup valve, which is in lockup position (upward), main pressure divides to two branches. The lower branch is still blocked as in converter operation. The upper branch is open to lockup feed. Lockup feed also divides to two branches. The upper branch directs pressure, through an orifice, to the area between the main regulator valve and regulator plug. Here, main pressure forces the plug downward, and forces the main regulator valve upward. This decreases main pressure.

(9) The lower branch of lockup feed enters the flow valve bore and supplies pressure for lockup operation (except when flow valve is downward). Refer to *i* below for explanation of the lockup circuit.

(10) Main pressure enters the flow valve bore and acts as described in paragraph 2-14a (6).

(11) At the main regulator valve, main pressure raises the valve as described in paragraph 2-14a (7). However, the valve is moved farther upward in the bore than shown in figure 2-3, allowing oil to escape to the sump as well as to the converter-in circuit. Refer to *b* below for explanation of the converter-in circuit during lockup operation.

(12) At the trimmer valve, main pressure enters the valve bore at two points. At the upper point (orifice at right side of bore), oil fills the area above the trimmer plug. Main pressure is at full value in this area because no oil can escape past the extender valve ball held downward by main pressure.

(13) At the lower end of the trimmer valve, main pressure enters the trimmer valve bore, connects with the area within the valve through an orifice. and exerts equal pressure above and below the valve. The springs above and below the trimmer plug hold the trimmer plug and valve in the positions illustrated. The trimmer is set for action when in this condition. Refer to paragraph 2-16i for explanation of trimmer operation.

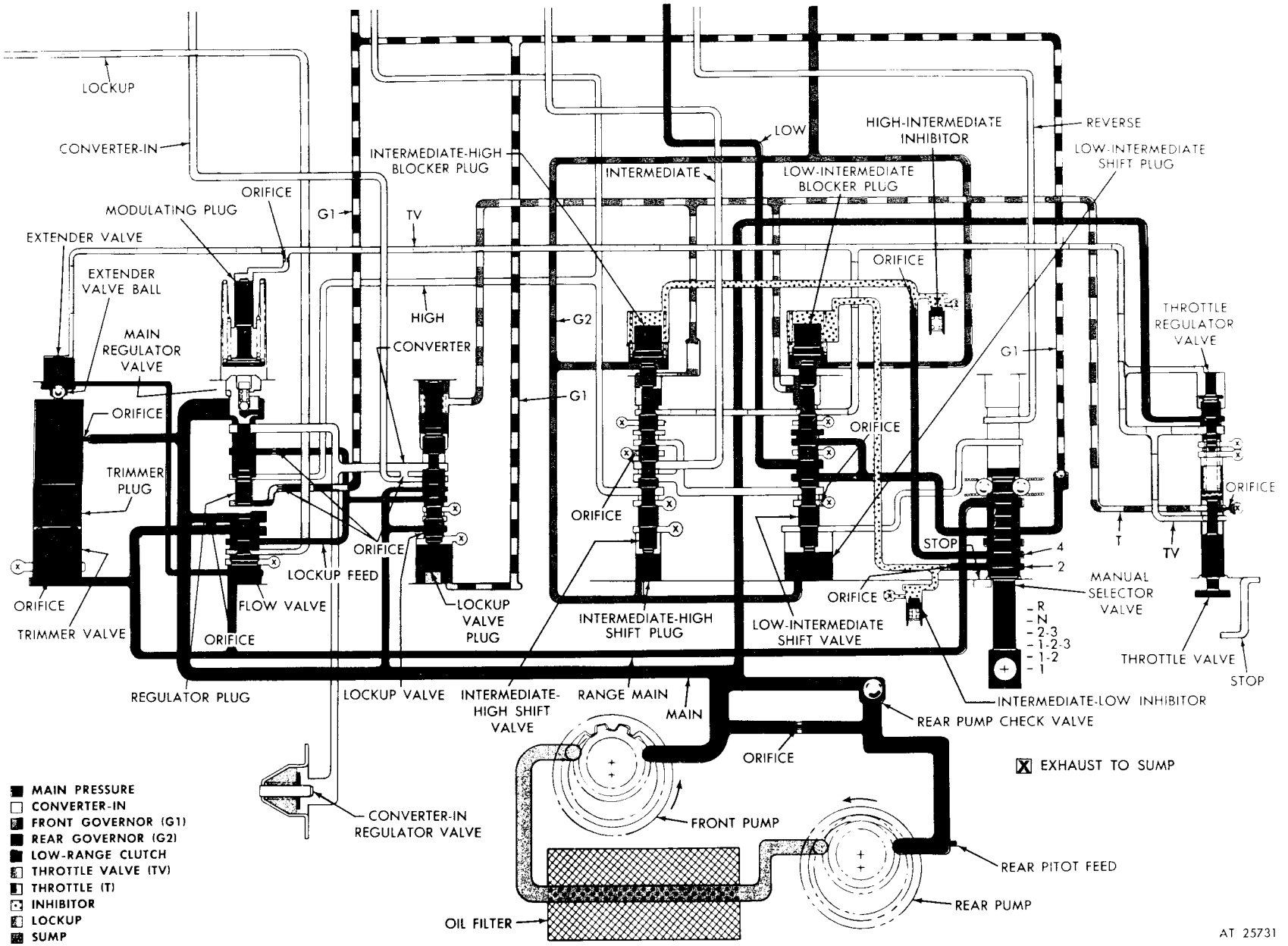


Figure 2-4. Hydraulic systemm low-range operation—schematic view.

b. Converter-In Circuit (yellow—fig. 2-4).

(1) The converter-in circuit functions as described in paragraph 2-14b, except for two conditions shown in figure 2-4 which differ from those shown in figure 2-3. In lockup operation, the flow of oil to converter-in line must pass through the orifice near the left side of the lockup valve. Also, the converter-in regulator valve is shown in an open position, allowing excess oil to return to the transmission sump.

(2) In lockup operation, the torque converter does not require a flow of oil as great as that required during converter operation, hence the oil is directed through an orifice. When the flow to the converter is reduced, the converter-in regulator valve may open to discharge excess oil and limit the pressure in the converter-in circuit.

c. Front Governor (Gl) Circuit (blue, black—fig. 2-4).

(1) In low-range operation, the G1 circuit is operative (para 2-14c (1)).

(2) Pressure is prevented from bleeding off past the ball check valve at the right of the manual selector valve. When governor pressure is sufficient to overcome spring pressure (plus throttle (T) pressure) above the lockup valve, it will force the lockup valve plug and valve upward. This will charge the lockup feed line.

(3) At the main pressure regulator plug, pressure is exerted against the lower surface area of the plug. This tends to raise the plug. But, when the lockup valve is upward, main pressure above the plug keeps it from moving. When the lockup valve is downward (converter operation), the regulator plug moves upward to reduce main pressure as governor pressure rises. The orifice in the governor pressure line restricts flow to prevent movement of the plug being too rapid when it does move.

d. Rear Governor (G2) Circuit (green, black-fig. 2-4).

(1) Rear governor (G2) pressure is produced by the rear fluid velocity-type governor (para 2-2). This pressure is directed to four points and is the primary control force for all automatic upshifts and downshifts between ranges.

(2) G2 pressure is directed to the lower surface areas of the low-intermediate blocker plug and the low-intermediate shift plug. This produces an upward force at each plug. The low-intermediate blocker plug is shown in its downward position, being unable to move against its spring and inhibitor pressure. The shift plug (and shift valve) are shown in their downward positions. They have not moved upward, in this instance, because throttle (T) pressure, spring pressure, and inhibitor pressure is sufficient to prevent upshift.

(3) G2 pressure is directed also to the lower surface areas of the intermediate-high blocker plug and the intermediate-high shift plug. This produces an upward force at each plug. These plugs and the intermediate-high shift valve are prevented from rising by spring pressure, inhibitor pressure, and throttle (T) pressure opposing their movement.

e. *Low-Range Clutch Circuit* (red, black—fig. 2-4). The low-range clutch circuit directs oil to the low-range clutch when the low-intermediate shift valve is downward. When the shift valve is upward, the low-range clutch exhausts through a port at the right side of the low-intermediate shift valve bore.

f. Throttle Valve (TV) Circuit (blue, yellow—fig. 2-4).

(1) Throttle valve (TV) pressure originates at the throttle regulator valve when the throttle is initially opened. It increases as the throttle is opened farther. This pressure is directed to areas near the upper ends of the low-intermediate and intermediate-high shift valves, to the main pressure modulating plug, and to the extender valve.

(2) At the low-intermediate and intermediate. high shift valves, TV pressure exerts a downward force which retards upshifting. Thus, the more the vehicle engine throttle is opened, the later upshifting occurs. When the valves have upshifted, TV pressure is blocked.

(3) At the main regulator modulating plug, downward pressure increases main pressure by moving the main regulator valve downward. Thus, as throttle opening progresses, main pressure is boosted.

(4) At the extender valve, TV pressure tends to push the extender valve downward. In figure 2-4, the valve is upward because both spring pressure and main pressure oppose downward movement. The effect of downward movement is an increase in pressure required beneath the extender valve ball to unseat it. This action influences trimmer operation (para 2-16i).

(5) TV pressure actually connects into the throttle (T) pressure circuit while either the low-intermediate shift valve or the intermediate-high shift valve is downward. This connection occurs in the valve bore areas near the upper ends of the valves. Thus, there is pressure in the T pressure circuit prior to upward movement of the throttle valve to a point which connects the TV and T circuits. This pressure retards the upward movement of the lockup valve and delays lockup. However, when the low-intermediate and intermediate-high shift valves are both upward, there can be no connection of the two circuits except at the throttle valve.

g. Throttle (T) Pressure Circuit (green, yellow—fig. 2-4).

(1) At approximately $^{5}/_{8}$ inch of throttle opening (upward movement of throttle valve),

throttle valve (TV) pressure is connected to the throttle (T) pressure circuit. From this point, and throughout the remaining throttle opening movement, TV and T pressures are equal. Both increase as the throttle is opened. Throttle (T) pressure is directed to the upper surface areas of the low-intermediate shift valve, intermediate-high shift valve, and the lockup valve.

(2) At the low-intermediate shift valve, T pressure is exerted downward on the shift valve and upward on the blocker plug. This pressure tends to hold the shift valve downward against the low-intermediate shift plug which is being pushed upward by G2 pressure. Thus, throttle opening delays upshifting. The greater throttle opening is, the greater is upshift delay.

(3) At the intermediate-high shift valve, the effect of T pressure is identical to that described in (2) above. However, the transmission speed range (and G2 pressure range) within which the movement of each of the shift values occurs is different. This difference is caused by the difference in spring loads and plug areas against which G2 pressure works. Thus, the low-intermediate shift valve, working with the lighter spring and greater plug area, will upshift at a lower vehicle speed (and G2 pressure) than will the intermediate-high shift valve.

(4) At the lockup valve, T pressure delays the upward movement of the lockup valve and thus delays lockup. The delay varies with throttle opening. Should the throttle be closed completely while the transmission is in low range, there would be no T pressure or TV pressure to inhibit the upward movement of the lockup valve.

(5) Throttle (TP) pressure can cause a downshift at full throttle under certain conditions as well as preventing an upshift under some conditions. T pressure can also cause a change from lockup operation to converter operation by moving the lockup valve downward. Input and output speed and governor (G1 and G2) pressures influence the point at which upshifts, downshifts, or lockup occur when the throttle is manipulated.

h. Inhibitor Pressure Circuit (dotted red—fig. 2-4).

(1) In low-range operation, the intermediate-low and high-intermediate inhibitor circuits are charged. The only function of these pressures in low-range operation is to prevent the upshifting of either shift valve.

(2) In the intermediate-low inhibitor circuit, oil enters (from main) through an orifice and exerts pressure against the upper surface areas of the inhibitor valve and the blocker plug. The inhibitor valve moves downward against its spring and allows oil to escape from the exhaust port at the left side of the valve bore. The escape of oil at the exhaust port, coupled with the limited flow caused by the restriction in the feed line, causes a reduced pressure in the inhibitor circuit. This reduced pressure is calibrated against the downward force required to downshift the low-intermediate shift valve at a specific vehicle speed (and specific G2 pressure).

(3) In the high-intermediate inhibitor circuit, hydraulic action is identical to that described in (2) above, except that calibration of the pressure is to that required to downshift the intermediate-high shift valve.

(4) In low range, oil escapes continuously at the exhaust ports in the inhibitor bores.

i. Lockup Clutch Circuit (blue, white—fig. 2-4). When the lockup valve is upward, main pressure supplies the lockup feed line. When the flow valve is upward, pressure in the lockup feed line supplies oil to the lockup clutch circuit. Lockup pressure applies the lockup clutch.

2-16. Hydraulic System—Intermediate-Range Operation

a. Main Pressure Circuit (red—fig. 2-5).

(1) The main pressure circuit in intermediate range functions as described in paragraph 2-15a for low-range operation except for the differences outlined in *(a)* through (e) below.

(a) Main pressure is cut off from the passage (line 2) leading to the intermediate-low inhibitor circuit.

(b) Main pressure is extended from the low-intermediate shift valve bore to the intermediate-high shift valve bore.

(c) Because a clutch (intermediate range) is in the initial stage of being charged, there is a rapid flow of oil through the orifice at the left side of the flow valve. This reduces the pressure downstream of the orifice and causes the flow valve to move downward.

(d) The downward position of the flow valve temporarily releases lockup clutch pressure. In addition, main pressure is cut off from the line leading to the area above the extender valve ball. This permits pressure above the trimmer plug to escape past the extender valve ball and to exhaust finally through the same port at the right of the flow valve bore through which lockup pressure exhausts.

(e) Release of pressure above the trimmer plug permits the trimmer plug to move upward. This, in turn, permits the trimmer valve to move upward until main pressure escapes at the exhaust port at the left of the trimmer valve bore.

(2) The results of the differences in the main pressure circuit are explained in the various circuit explanations which follow.

b. *Converter-In Circuit* (yellow—fig. 2-5). The converter-in circuit functions as described in paragraph 2-15b.

c. Front Governor (Gl) Circuit (blue, black—fig. 2-5). The front governor (G1) circuit functions as described in paragraph 2-15c

d. Rear Governor (G2) Circuit (green, black—fig. 2-5). The rear governor (G2) circuit functions as described in paragraph 2-15d except that increased G2 pressure, in the absence of intermediate-low inhibitor pressure, has forced the low-intermediate shift plug, shift valve, and blocker plug upward. This allows main pressure to be directed to the intermediate-high shift valve bore. Low-range clutch pressure is exhausted when the low-intermediate shift valve is upward.

e. Intermediate-Range Clutch Circuit (red, yellow—fig. 2-5). At the intermediate-high shift valve, main pressure. is connected to the intermediate-range clutch pressure line. This applies the clutch.

j. Throttle Valve (TV) Circuit (blue, yellow—fig. 2-5). The throttle valve (TV) circuit functions as describe in paragraph 2-15f.

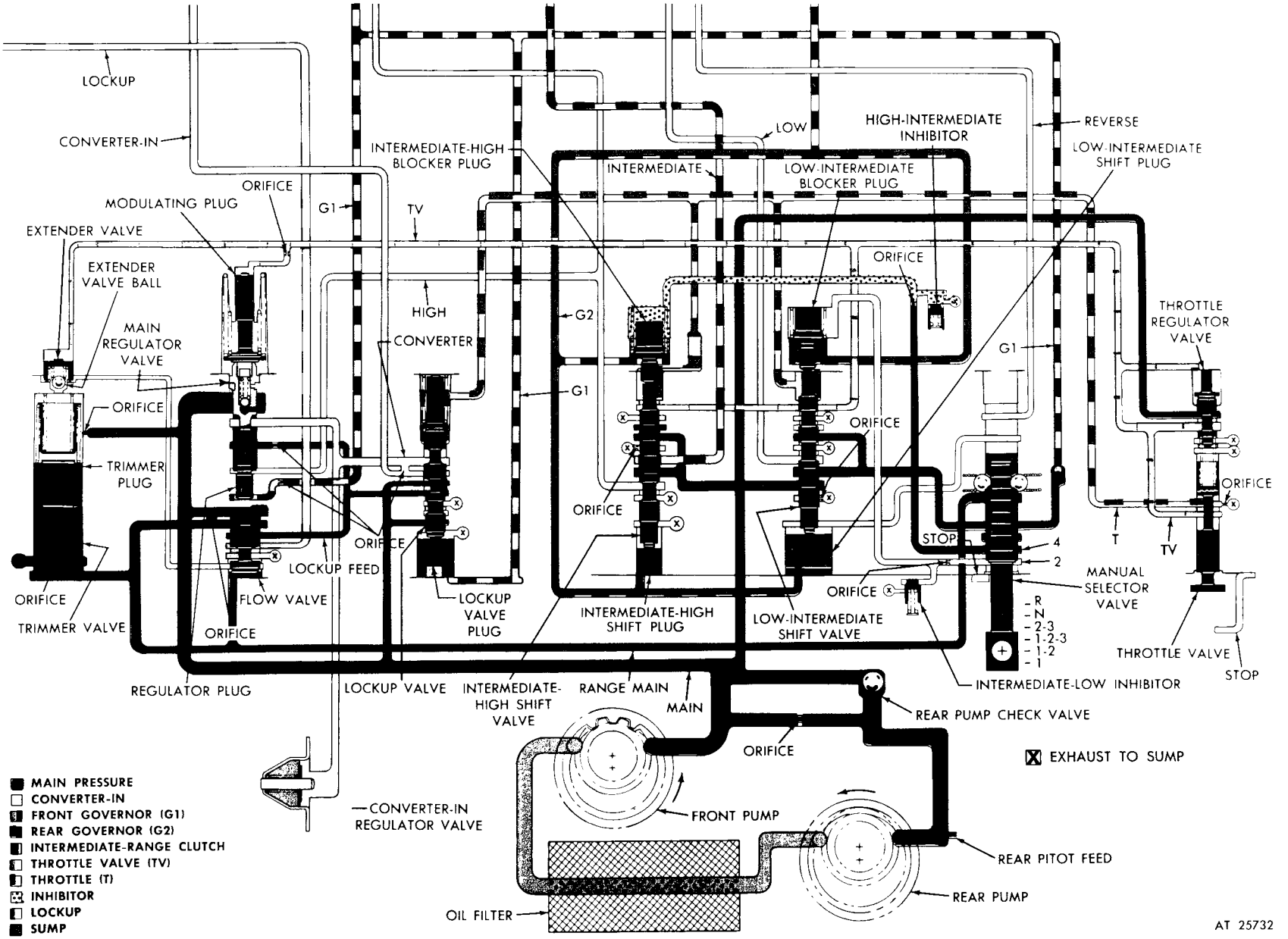


Figure 2-5. Hydraulic system, intermediate-range operation—schematic view.

g. Throttle (T) Circuit (green, yellow — fig. 2-5). The throttle (T) circuit functions as described in paragraph 2-15g.

h. Inhibitor Pressure Circuit (dotted red—fig. 2-5). In intermediate range (selector at 1-2 position), only the high-intermediate downshift inhibitor circuit is charged. It functions as described in paragraph 2-15 *h*.

i. Lockup Clutch Circuit (blue, white—fig. 2-5).

(1) The flow valve controls the lockup clutch circuit when a shift from one range to another occurs automatically or is made manually. In figure 2-5, the change can be considered as a manual change from selector position 1 to selector position 1-2, or it can be considered as an automatic upshift from 1 to 2 within selector position 1-2.

(2) The downward movement of the flow valve (a (1) (c) and (d) above) releases the lockup clutch temporarily and triggers the action of the trimmer valve. The flow valve moves downward when the shift has just occurred. It will stay downward until the oncoming clutch (intermediate range) is partially pressurized.

(3) When the flow valve is downward, lockup pressure is released. This is only temporary until the oncoming range clutch is filled and main pressure above and below the flow valve equalizes.

(4) Main pressure below the trimmer valve quickly lifts the trimmer valve until oil escapes through the exhaust port at the left. This reduces main pressure flowing to the clutch being applied. With negligible pressure above the trimmer plug, main pressure flowing through the orifice *in* the bottom of the trimmer valve forces the trimmer plug upward, away from the trimmer valve. The speed of its movement upward is influenced by throttle valve (TV) pressure being faster at closed throttle (para. 2-15 f(4)). The speed of its movement likewise influences clutch apply pressure initially. The higher TV pressure is, the higher initial clutch pressure is.

(5) The trimmer valve remains open (oil exhausting at left side) until the trimmer plug reaches the top of its stroke. When the trimmer plug stops, oil continues to flow upward through the orifice in the bottom of the trimmer valve. When pressure above and below the trimmer valve is equalized, spring pressure pushes the trimmer valve downward. This closes the exhaust port. Main pressure increases significantly below the flow valve to return the flow valve to its upward position and lockup pressure is restored. Main pressure is restored, at the same time, to the area above the extender valve ball.

(6) When the extender valve ball is seated, further flow of oil from tbe upper area of the trimmer valve bore is prevented. Then, oil entering the bore (from main), through an orifice, forces the trimmer plug to the lower end of its bore. Then main pressure increases to full value.

(7) The overall action of the trimmer is to reduce clutch apply pressure momentarily after a gear change to prevent shift shock. It does this by gradually applying main pressure at a rate which is influenced by throttle opening. The temporarily reduced main pressure allows the clutch to slip when it is initially applied.

2-17. Hydraulic System—High-Range Operation (Selector at 1-2-3 Position

a. Main Pressure Circuit (red—fig. 2-6.)

(1) Main-pressure circuit in high-range (selector at 1-2-3 position) is the same as that for intermediate-range (para 2-16a) except that line 4 is not charged, and the trimmer is not in operation.

(2) The absence of pressure in the high-intermediate inhibitor circuit (fed by line 4) permits the intermediate-high blocker plug, shift valve, and shift plug to move upward. This connects main pressure, at the intermediate-high shift valve, to the high-range clutch line.

(3) When tbe trimmer is not acting, the flow valve is upward and the trimmer is charged as explained in paragraph 2-15a (12) and (13), above.

b. Converter-In Circuit (yellow—fig. 2-6). The converter-in circuit functions as described in paragraph 2-15b.

c. *Front Governor (G1) Circuit* (blue, black—fig. 2-6). The front governor (G1) circuit functions as described in paragraph 2-15c.

d. Rear Governor (G2) Circuit (green, black—fig. 2-6). The rear governor (G2) circuit functions as described in paragraph 2-15d, except that increased G2 pressure, in the absence of both intermediate-low and high-intermediate inhibitor pressure, has shifted the transmission to high range. This occurred when G2 pressure forced the low-intermediate and intermediate-high blocker plugs, shift valves, and shift plugs upward in their bores.

e. High-Range Clutch Circuit (red, green—fig. 2-6). The high-range clutch circuit is charged by the main pressure circuit at the intermediate-high shift valve bore when the valve is in its upward position. Intermediate-range clutch pressure is exhausted through an orifice which relates the rate of disengagement of the intermediate-range clutch.

f. Throttle Valve (TV) Circuit (blue, yellow—fig. 2-6) The throttle valve (TV) circuit functions as described in paragraph 2-15f

g. *Lockup Clutch Circuit (blue,* white—fig. 2-6). The lockup clutch circuit functions as described in paragraph 2-15i

2-18. Hydraulic System—High-Range Operation (Selector at 2-3 Position)

a. Low-Range Locked Out (fig. 2-7). When the

manual selector is at the 2-3 position, the transmission cannot downshift to low range. This is prevented by a main pressure branch, at the top, left side of the manual selector valve bore, which directs main pressure to the upper area surface of the low-intermediate shift plug, and to the lower end of the shift valve. This pressure holds the low-intermediate shift valve upward as long as the manual selector is at 2-3 position.

b. Other Functions Same as 1-2-3 Operation (fig. 2-7). In high-range (2-3) operation, the other circuits operate as described in paragraph 2-17 for high-range (1-2-3) operation.

2-19. Hydraulic System—Reverse-Range Operation

a. *Main-Pressure Circuit* (red—fig. 2-8).

(1) In reverse-range operation, the main pressure circuit functions as described in paragraph 2-15a, except for the distribution of oil at the manual selector valve. Here, the valve is at its extreme upward position. This permits oil to flow into the reverse-range clutch circuit. When the valve is at any other position, the reverse-range clutch exhausts into the manual selector valve bore above the selector valve.

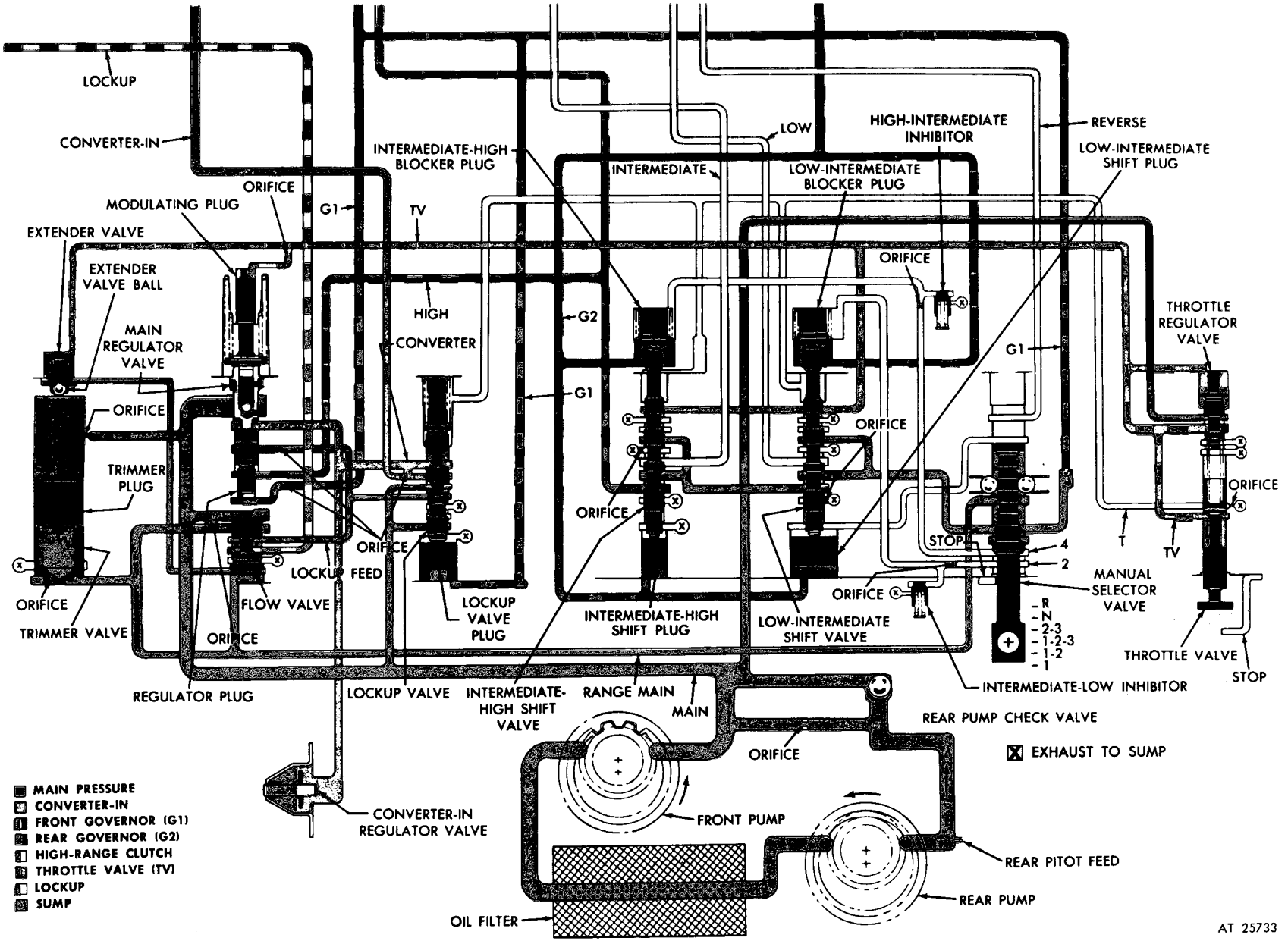


Figure 2-6. Hydraulic system, high-range operation, selector at 1-2-3 position—schematic view.

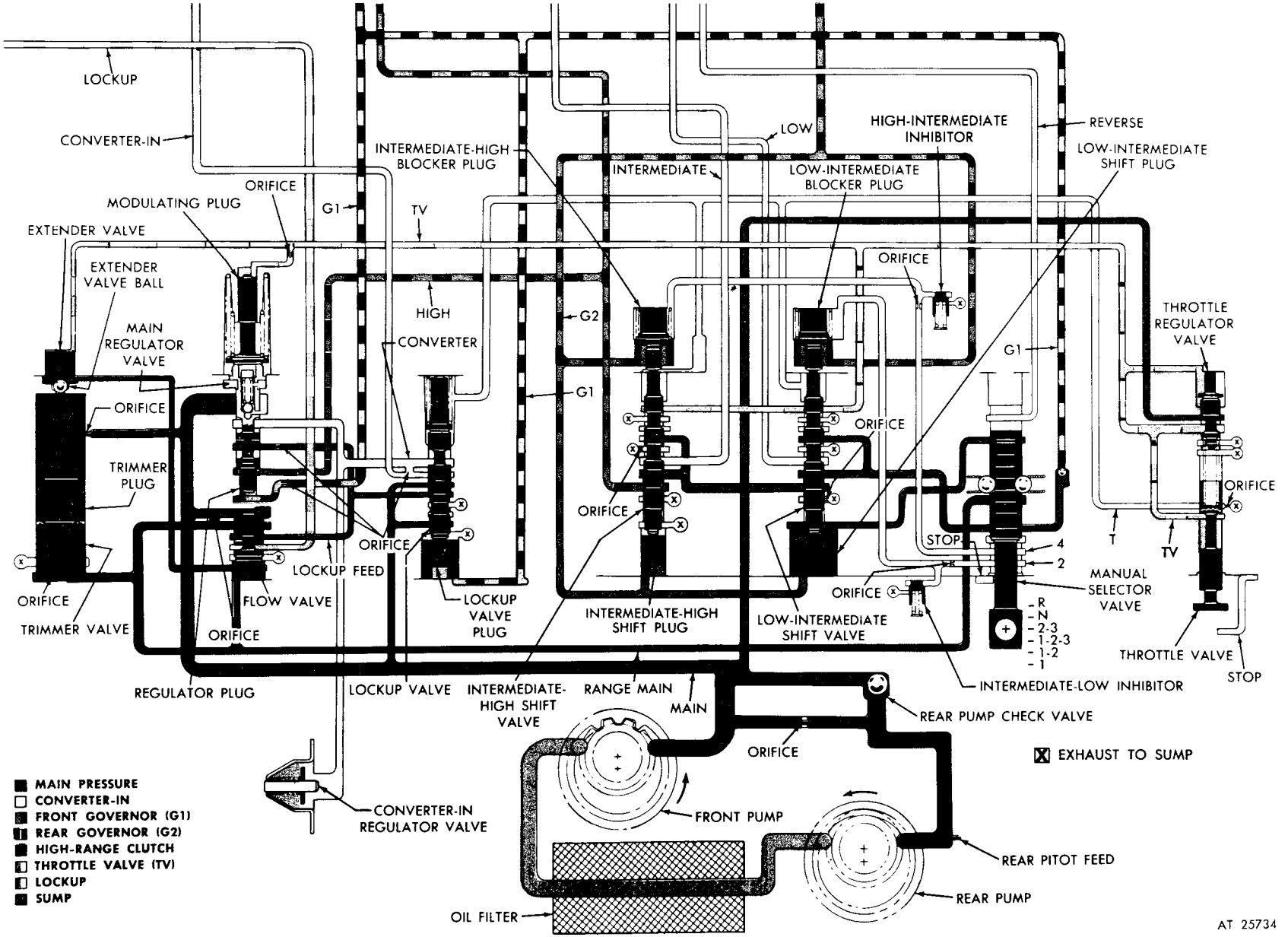


Figure 2-7. Hydraulic system, high-range operation, selector at 1-2 position—schematic view.

(2) The rear oil pump rotates in the reverse direction and allows a small volume of oil to return to the sump. This oil must come through the orifice connecting the front and rear oil pump output lines. Oil passing through this same orifice keeps the rear fluid velocity governor supplied.

b. Converter-In Circuit (yellow—fig. 2-8). In reverse-range operation, the converter-in circuit functions as described in paragraph 2-14b.

c. Front Governor (Gl) Circuit (blue, black—fig. 2-8). In reverse-range operation, the front governor circuit functions as described in paragraph 2-14 *c.*

d. *Reverse-Range Clutch Circuit* (blue, red—fig. 2-8). The reverse-range clutch circuit is supplied, at the manual selector valve, by main pressure.

e. Throttle Valve (TV) Circuit (blue, yellow—fig. 2-8). In reverse-range operation, the throttle valve (TV) circuit functions as described in paragraph 2-15f.

2-20. Hydraulic System—High-Range Operation (Manual Selector at 1-2—High-Intermediate Inhibitor Acting)

NOTE

Inhibitors are safety devices which provide some measure of protection against engine overspeed if the operator inadvertently downshifts above prescribed speed.

a. Inhibitor Prevents 3-2 Downshift at Excessive Speed (fig. 2-9).

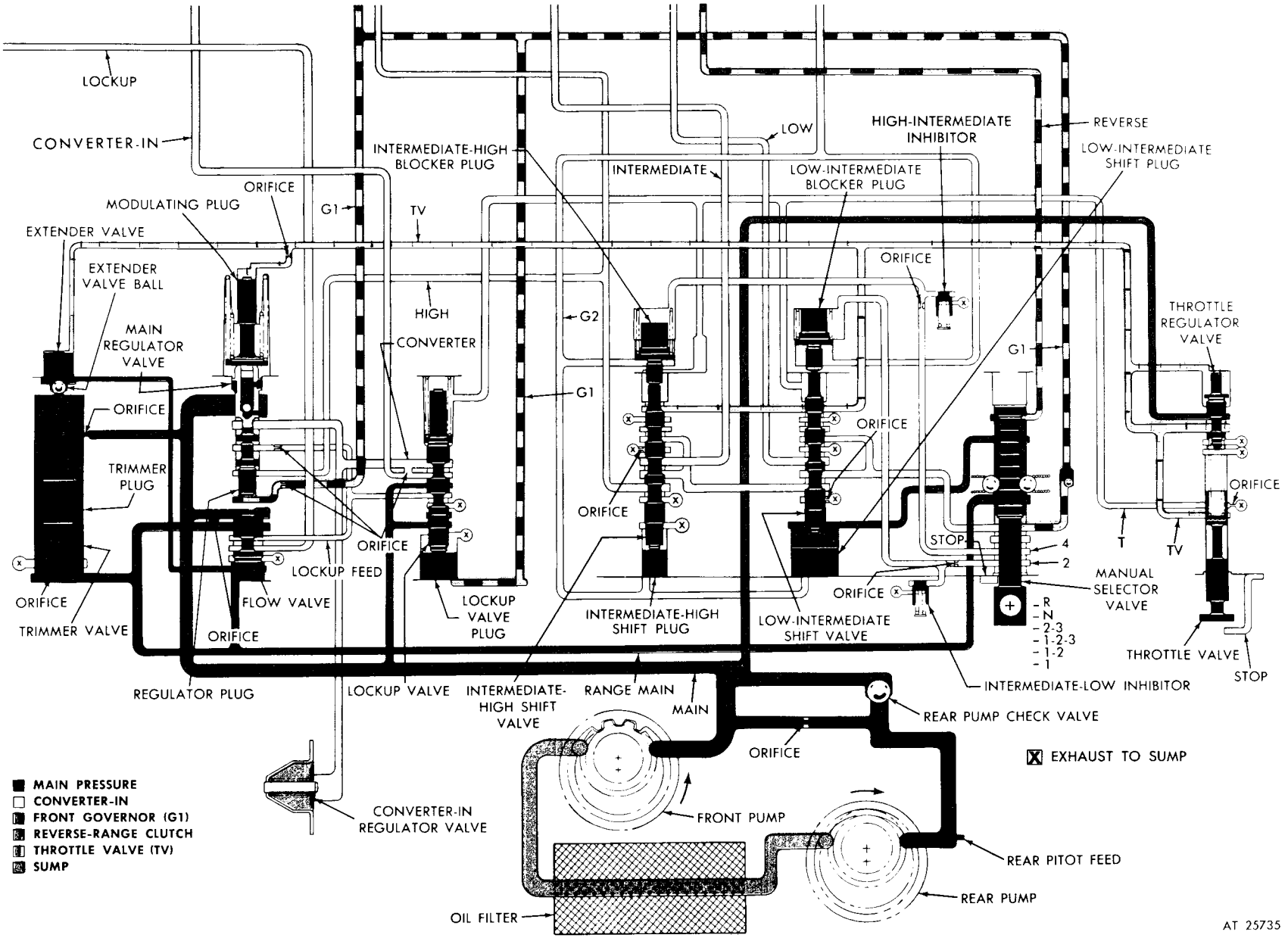


Figure 2-8. Hydraulic system, reverse-range operation—schematic view.

(1) Figure 2-9 illustrates the hydraulic system in high-range operation even though the manual selector has been moved to a position which does not indicate high-range operation. This condition results when vehicle (transmission output) speed is too great for safe operation in intermediate-range at the time a manual downshift is made.

(2) When the manual downshift is made, rear governor (G2) pressure is sufficient to continue holding the intermediate-high shift plug, shift valve, and blocker plug upward against spring force and inhibitor pressure. This extends high-range operation of the transmission during the period the vehicle is moving at excessive speed.

(3) When vehicle speed decreases, G2 pressure also decreases. When G2 pressure falls to a value which will no longer hold the intermediate-high shift plug and valve upward against spring force and inhibitor pressure, the downshift to intermediate range will occur. This is an automatic shift, which lags behind the manual shift.

b. Other Functions Same as 1-2-3 Operation (fig. 2-9). In high-range operation (selector at 1-2 position), the circuits not involved in action of the high-intermediate inhibitor operate as described in paragraph 2-17 for high-range (1-2-3) operation.

2-21. Hydraulic System—Intermediate-Range Operation (Manual Selector at 1—Intermediate-Low Inhibitor Acting)

NOTE

Inhibitors are safety devices which provide some measure of protection against engine overspeed if the operator inadvertently downshifts above prescribed speed.

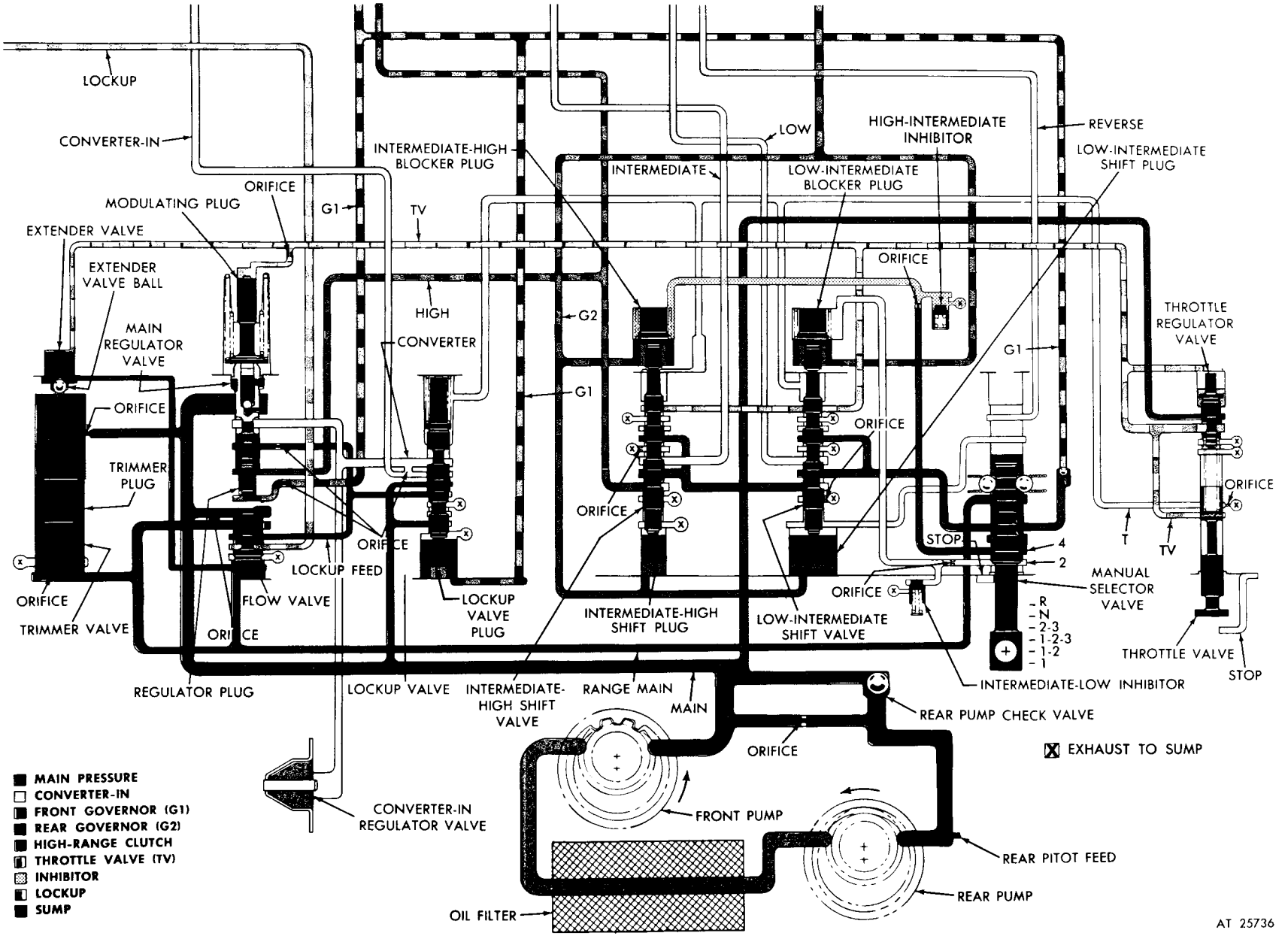


Figure 2-9. Hydraulic system, high-intermediate inhibitor acting—schematic view.

a. Inhibitor Prevents 2-1 Downshift at Excessive Speed (fig. 2-10).

(1) Figure 2-10 illustrates the hydraulic System in intermediate-range operation even though the manual selector has been moved to a position which does not indicate intermediate-range operation. This condition results when vehicle (transmission output) speed is too great for safe operation in low range at the time a manual downshift is made.

(2) When the manual downshift is made, rear governor (G2) pressure is sufficient to continue holding the low-intermediate shift plug, shift valve, and blocker plug upward against spring force and inhibitor pressure. This extends intermediate-range operation of the transmission during the period the vehicle is moving at excessive speed.

(3) When vehicle speed decreases, G2 pressure also decreases. When G2 pressure falls to a value which will no longer hold the low-intermediate shift plug, valve, and blocker plug upward against spring force and inhibitor pressure, the downshift to low range will occur. This is an automatic shift, which lags behind the manual shift.

b. Other Functions Same as Low-Range operation (fig. 2-10). In intermediate-range operation (selector at 1-position), the circuits not involved in action of the intermediate-low inhibitor operate as described in paragraph 2-15 for low-range operation.

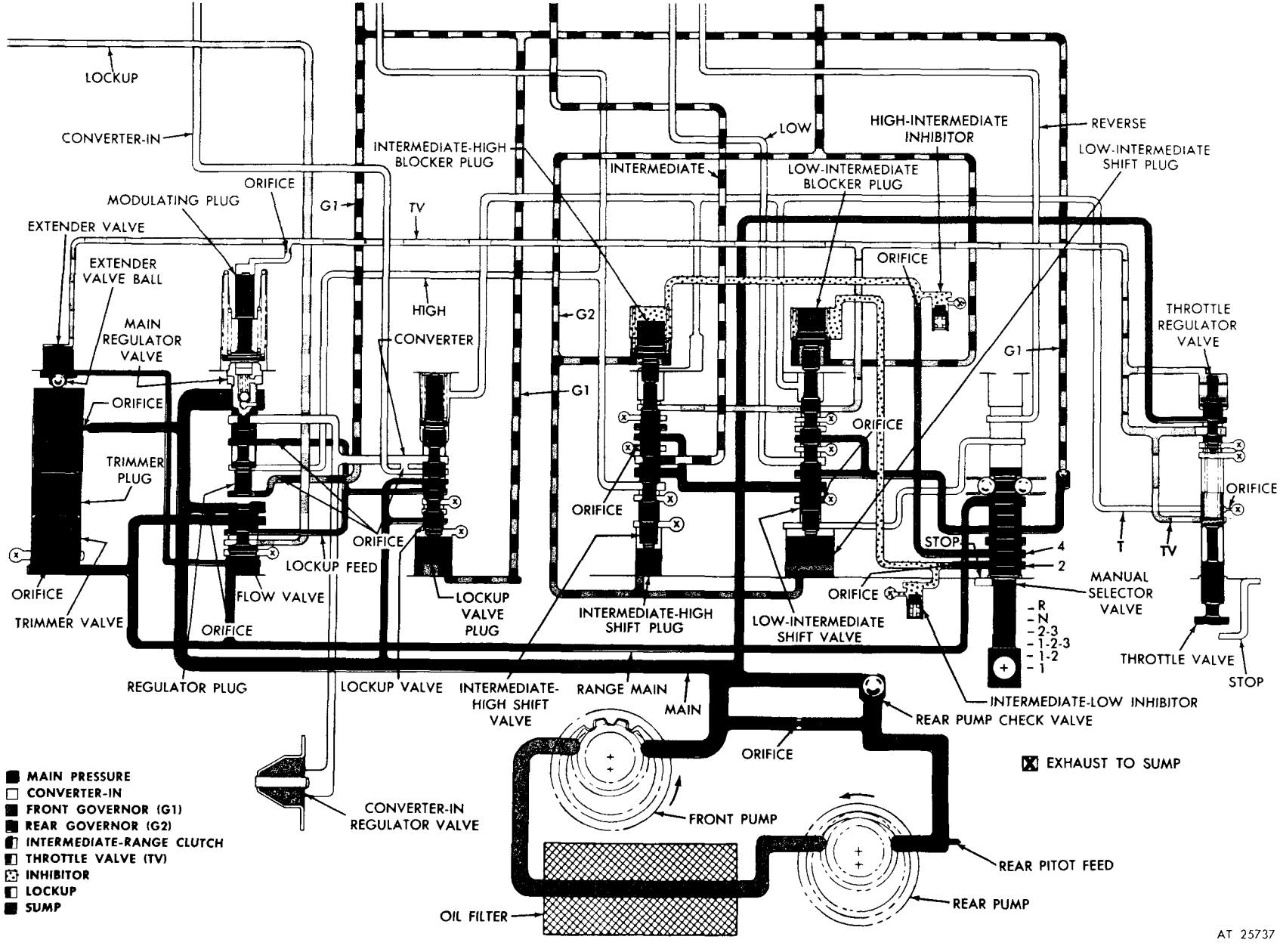


Figure 2-10. Hydraulic system, intermediate-low inhibitor acting—schematic view.

Section III. TORQUE PATHS THROUGH TRANSMISSION

2-22. Torque Path—Neutral (fig. 2-11)

a. In neutral, drive from the vehicle engine to the Transmission range gearing is always through the oil in the torque converter. Lockup cannot occur in neutral. The converter turbine drives the turbine shaft and the components which are attached to it.

b. The components attached to the turbine shaft include the high-range clutch housing, intermediate-range planetary sun gear, and the low-range planetary sun gear. The power take-off drive gear, being integral with the high-range clutch housing, is driven and can drive the power takeoff, if the transmission is so equipped.

c. No clutches are engaged. Thus, no drive, except that to a power takeoff, extends beyond the turbine shaft. The torque multiplication capabilities and hydraulic drive characteristics of the torque converter are available to drive the power takeoff.

2-23. Torque Path—Low Range (fig. 2-12)

a. Lockup operation (direct drive through the torque converter) is shown in figure 2-12. However, converter operation is equally applicable and is always in effect until turbine shaft speed (and front governor speed) is sufficient to cause lockup. Thus, the vehicle always starts in converter operation regardless of the selector position used.

b. In low range (first gear), the low-range clutch is engaged. This holds the low-range planetary ring gear stationary. The low-range planetary sun gear drives the pinions of the low-range planetary carrier. The pinions must rotate within the stationary ring gear. Their rotation within the ring gear causes the low-range carrier to rotate in the same direction as the turbine shaft but at reduced speed. The carrier, integral with the transmission output shaft, drives the output shaft.

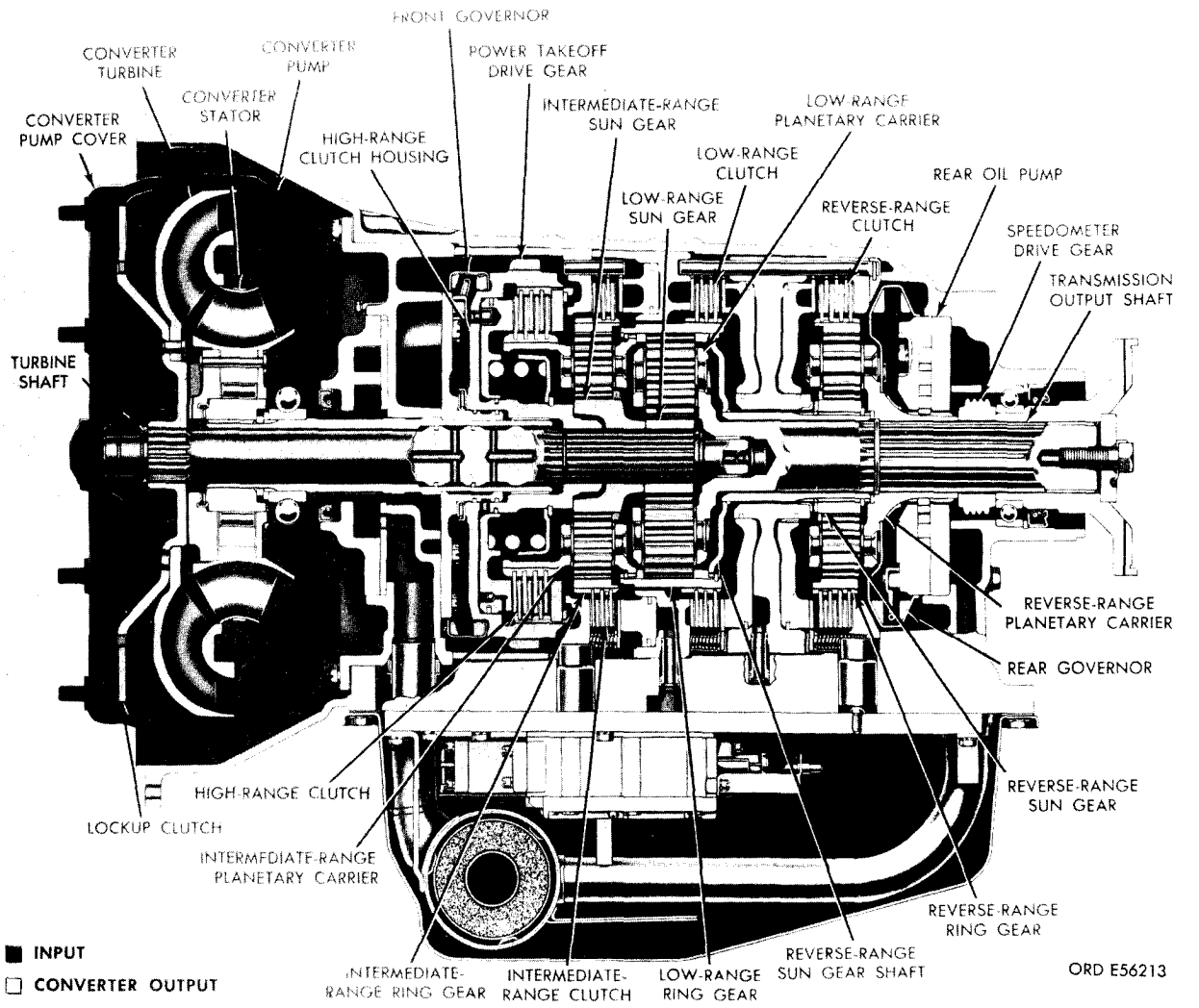


Figure 2-11. Neutral torque path, converter operation.

c. The transmission output shaft drives the rear governor, rear oil pump, and speedometer drive gear. The speed reduction ratio from turbine shaft to transmission output shaft is 3.810 to 1.

2-24 Torque Path - Intermediate Range

(fig. 2-13)

a. Torque converter and lockup operation in intermediate range (second gear) is the same as in low (para 2-23 *a*).

b. In intermediate range, the intermediate-range clutch is engaged. This holds the intermediate-range planetary ring gear stationary. The intermediate-range planetary sun gear drives the pinions of the intermediate-range planetary carrier. The pinions must rotate within the stationary ring gear, causing the intermediate-range carrier to rotate in the same direction as the turbine shaft but at reduced speed. The carrier is attached to and drives the low-range planetary ring gear.

c. The low-range ring gear drives the low-range pinions which are also in mesh with the low range sun gear. Thus, the output of the intermediate-range planetary does not drive the transmission output shaft directly. Instead, it must drive the low-range pinions which, in turn, drive the low-range carrier and output shaft. The interconnection of two planetary gear sets to produce the desired ratio is called compounding (para 2-3 *c* (2)).

d. The transmission ouput shaft drives the rear governor, rear oil pump, and speedometer drive gear. The speed reduction ratio from turbine shaft to transmission output is 1.93 to 1.

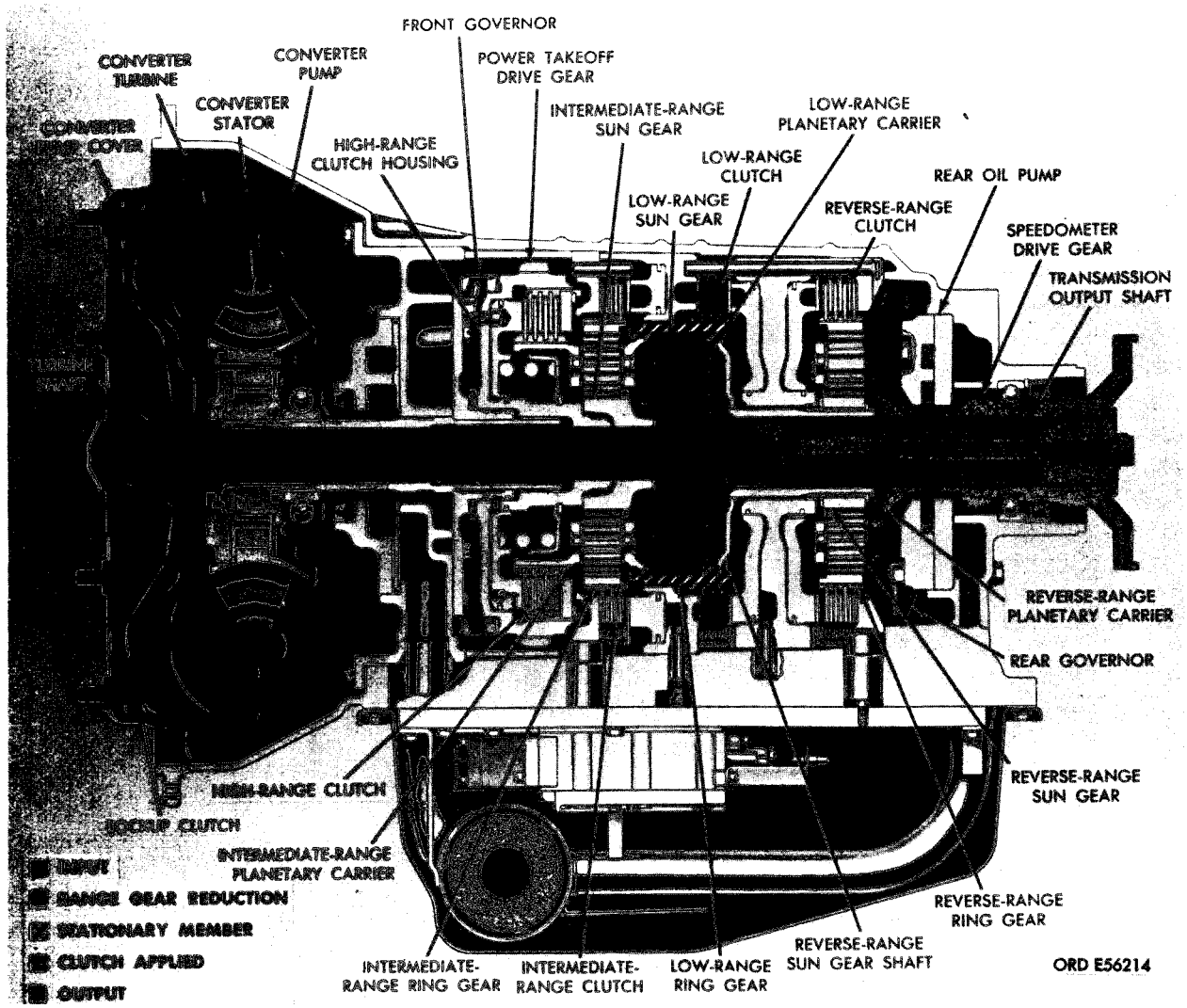


Figure 2-12. Low-range torque path, lockup operation

2-25. Torque Path - High Range
(fig 2-14)

a. Torque converter and lockup operation in high range (third gear) is the same as in low or intermediate range (para 2-23 *a*).

b. In high range, the high-range clutch is engaged. This locks the intermediate-range planetary carrier to the high-range clutch housing, forcing the carrier to rotate with the housing. The intermediate-range carrier is attached to the low range planetary ring gear, causing it also to rotate at the same speed as the high-range clutch housing.

c. Thus, the low-range ring gear and sun gear both rotate at the same speed and in the same direction. This drives the low-range planetary carrier and transmission output shaft at the same speed and in the same direction as the turbine shaft. The high-range clutch and all of the range planetary gears rotate as a unit and have no relative rotation to each other.

d. The transmission output shaft drives the rear governor, rear oil pump, and speedometer drive gear. The speed ratio between the turbine shaft and transmission output is 1.00 to 1 (direct drive).

2-26. Torque Path - Reverse Range
(fig. 2-15)

a. In reverse range, drive from the vehicle engine to the transmission range gearing is always through the oil in the torque converter. Lockup cannot occur during reverse operation. The converter turbine drives the turbine shaft and components which are attached to it. The low-range planetary sun gear is the member which drives the range gearing in a way which produces reverse gear as outlined below.

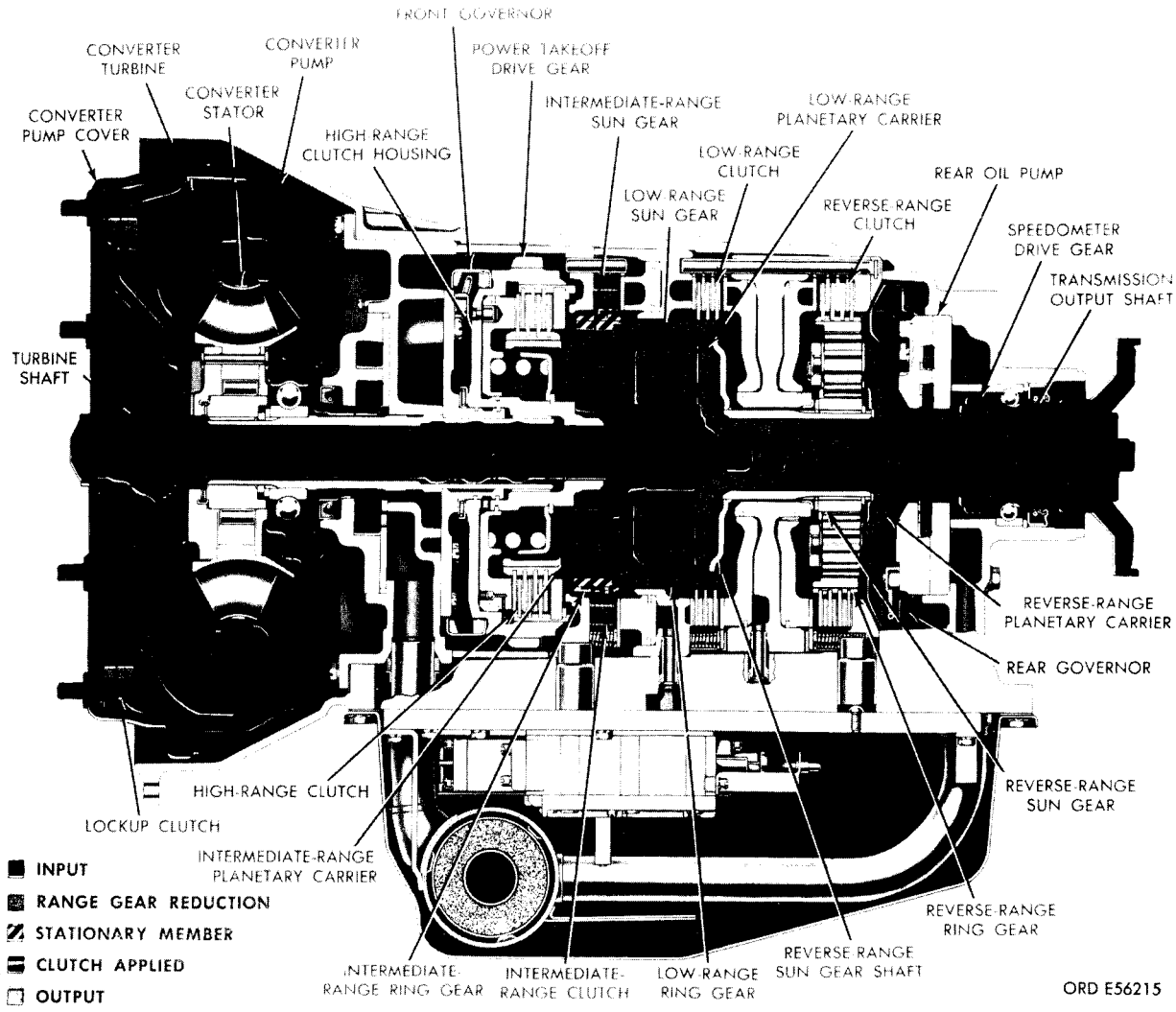


Figure 2-13. Intermediate-range torque path, lockup operation.

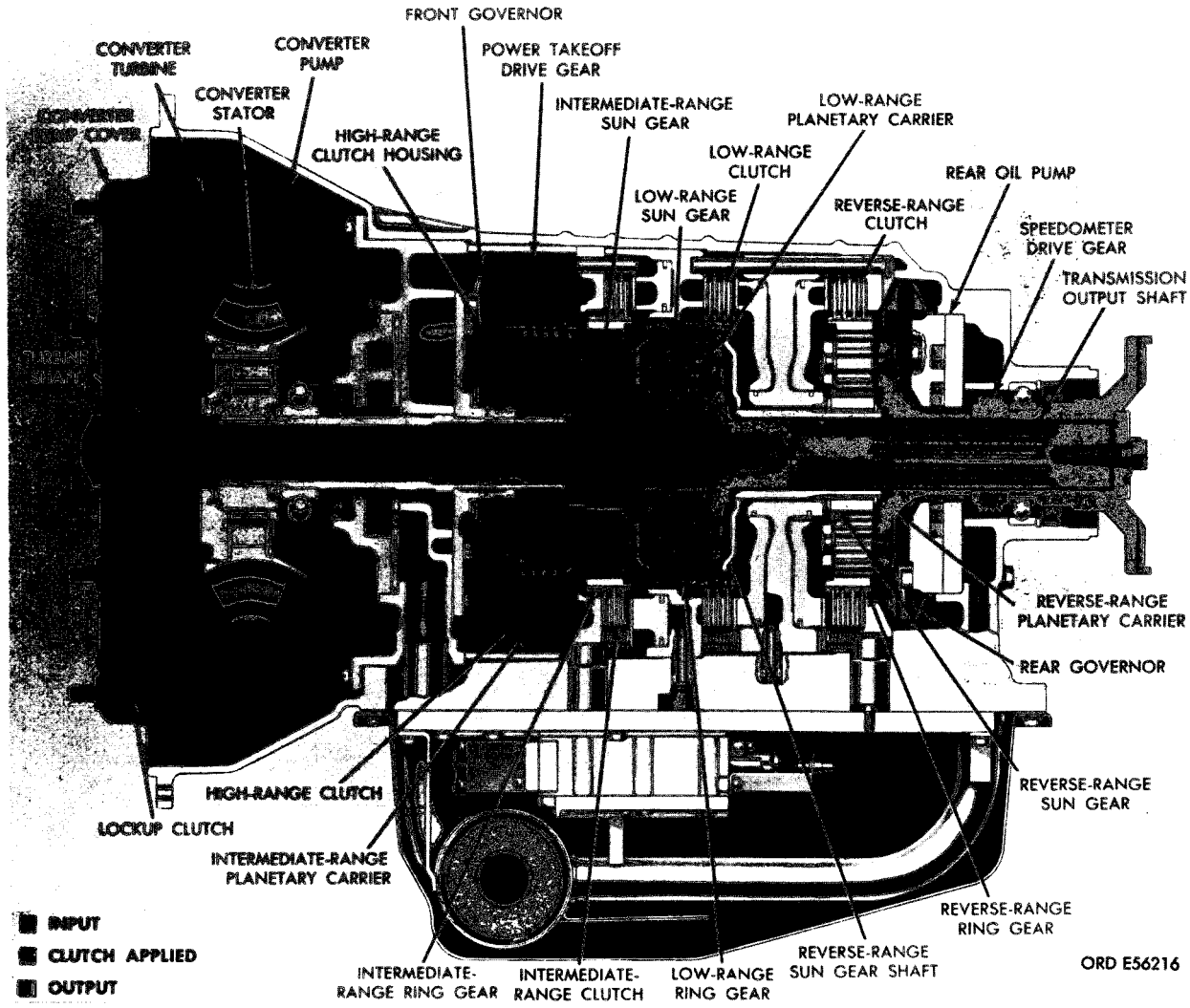


Figure 2-14. High-range torque path. lockup operation.

b. In reverse range, the reverse-range clutch is engaged. This holds the reverse-range planetary ring gear stationary. The reverse-range planetary sun gear is driven (in reverse rotation) by the low-range planetary ring gear. The low-range ring gear is rotated by the low-range pinions. The low-range pinions are rotated by the low-range sun gear which is splined to the turbine shaft.

c. This combination of two planetary gear sets to produce the desired ratio and direction of rotation is called compounding (para 2-5c). Reversing actually takes place in the low-range planetary gear set and final speed reduction takes place in the reverse-range planetary gear set.

d. The primary input of the compound system is the low-range sun gear. The reaction member in the low-range gear set is the low-range planetary carrier, even though it rotates. The output member of the low-range gear set, connected to the input member of the reverse-gear set, is the low-range ring gear. The input member of the reverse-range gear set is the reverse-range sun gear. The primary output is the reverse-range planetary carrier. The prim ary reaction member of the compound system is the reverse-range ring gear. The reverse-range plan etary carrier transmits torque to the transmission output shaft to which it is splined.

e. In reverse range, the rear governor. rear oil pump, and speedometer drive gear are driven in reverse direction. Thus they are ineffective; no rear-governor pressure is produced and no oil is pumped by the rear oil pump. The reverse-direction speed reduction ratio between con verter shaft and transmission output is 4.35 to 1.

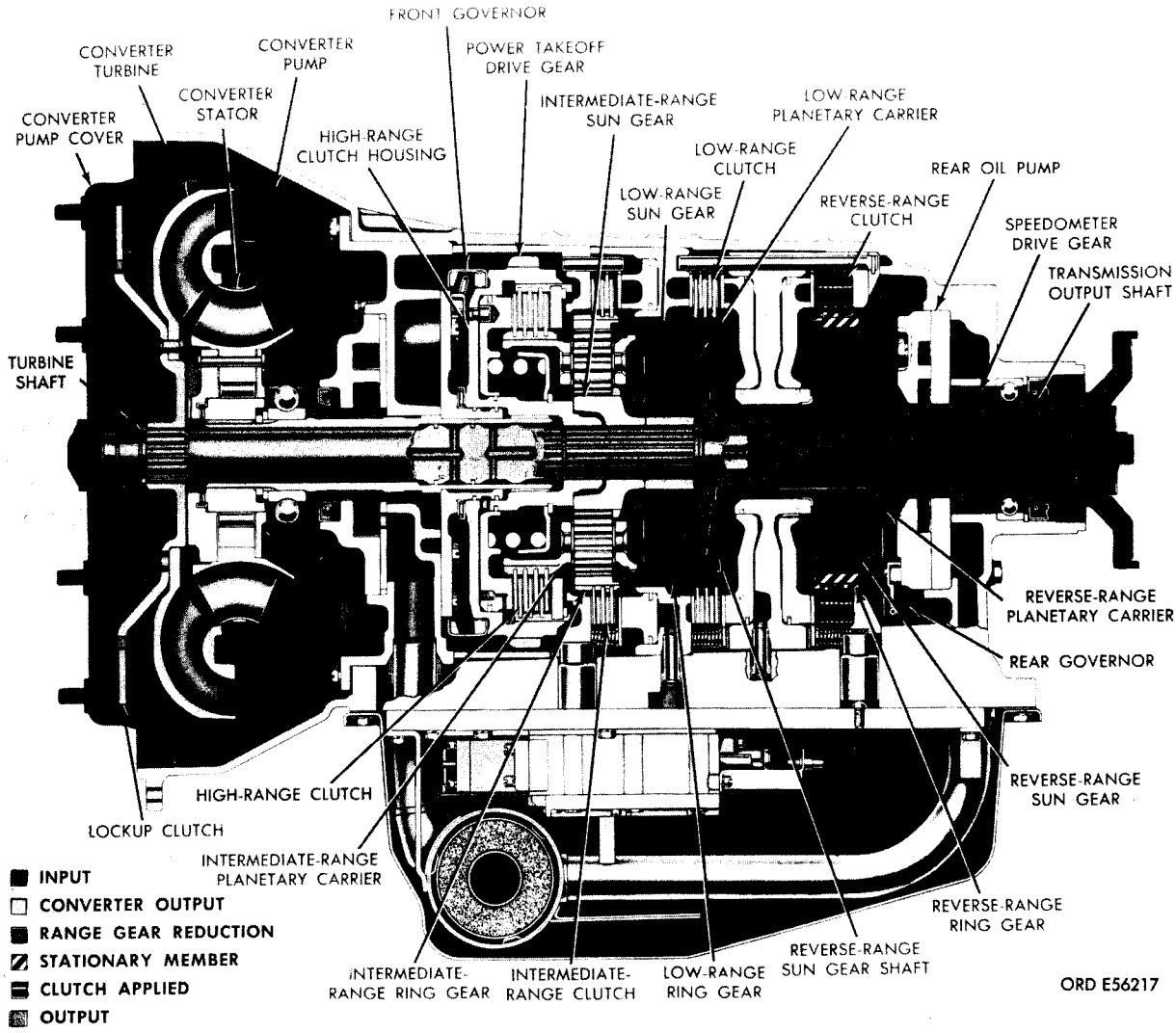


Figure 2-15. Reverse-range torque path, converter operation.

CHAPTER 3

PARTS, SPECIAL TOOLS, IMPROVISED TOOLS, AND EQUIPMENT FOR DIRECT AND GENERAL SUPPORT AND DEPOT MAINTENANCE

3-1. General Tool Information

Tools and equipment and maintenance parts over and above those available to the using organization are supplied to Army (Ordnance) direct and general support maintenance units for maintaining, repairing, overhauling, and rebuilding the materiel.

3-2. Repair Parts

Maintenance repair parts for the Model TX 100-1 transmission are listed in TM 9-2520-254-35P.

3-3. Common Tools and Equipment

Standard and commonly used tools and equipment, having general application to this teriel, are authorized for issue by TA and TOE and listed in pertinent type "SC" publications.

3-4. Special Tools and Equipment

The special tools shown in figures 3-1, 3-2, and 3-3, and listed in table 3-1 are tools which are necessary to perform the operations described in this technical manual. Refer to TM 9-2520-254-35P for complete listing of special tools and their issue allowances.

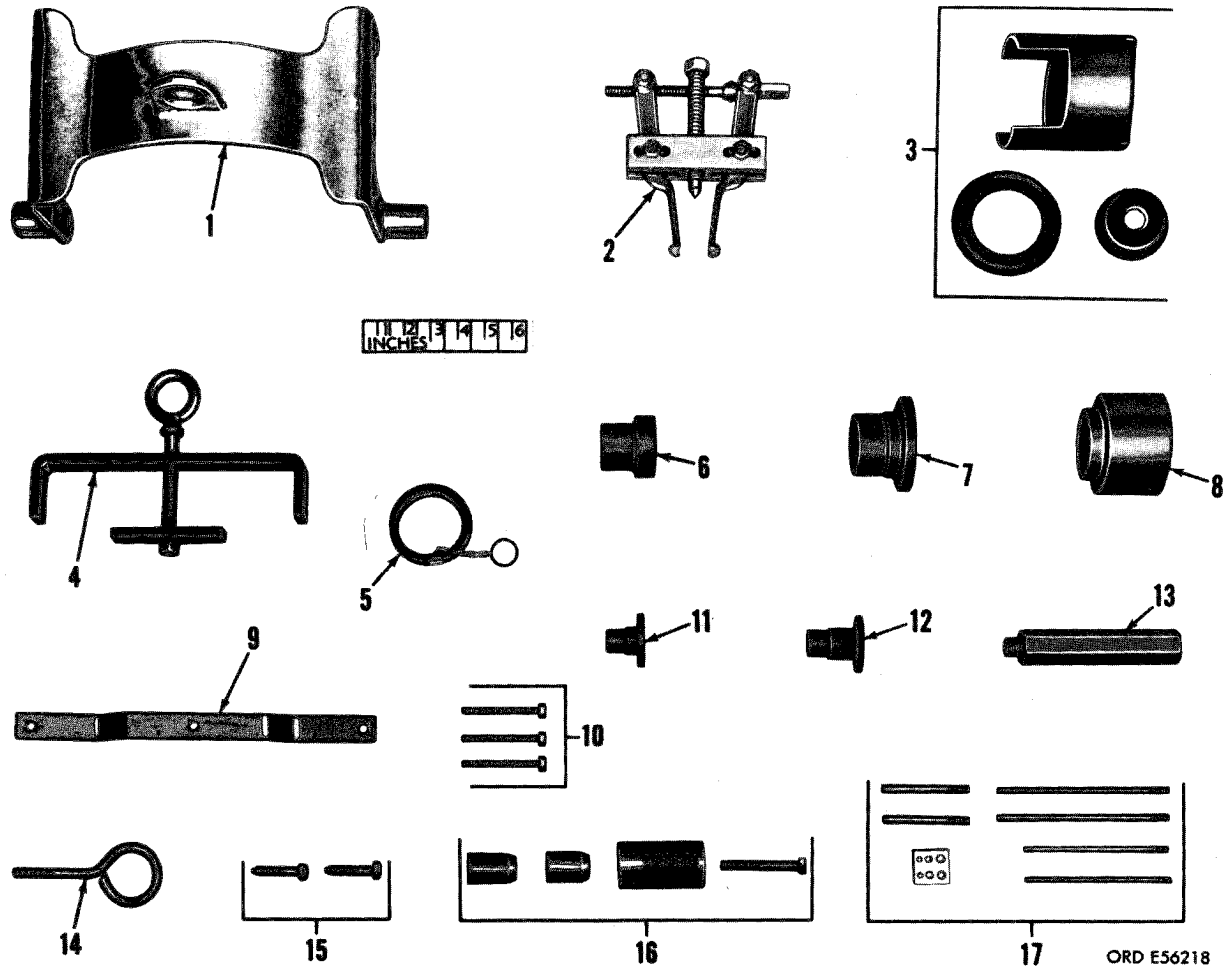


Figure 3-1. Special Tools

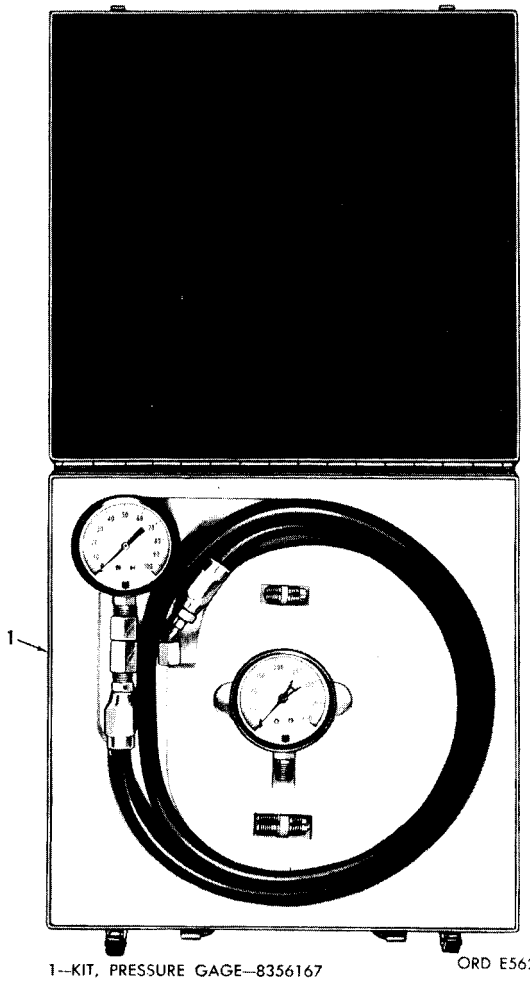


Figure 3-2. Pressure gage kit—4910-572-8701.

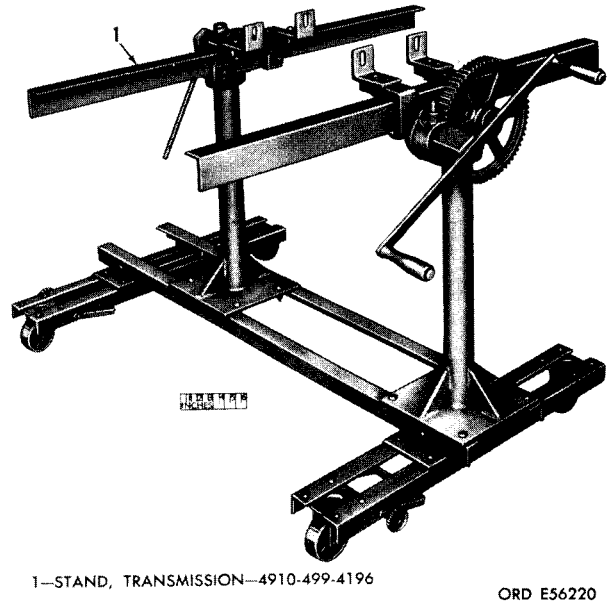


Figure 3-3. Transmission stand—4910-499-4196

3-5. Improvised Tools

The dimensional detailed drawings of the tools shown in figures 3-4, 3-5, and 3-6, and listed in table 3-2, apply only to direct and general support units maintenance shops. These maintenance organizations can fabricate the tools locally, if desired. These tools are not essential for maintenance and are not available for issue.

Table 3-1. Special Tools and Equipment for Direct and General Support Maintenance

	Ref		Identifying numbers	Use reference		Use
	Item	Fig.		Figure	Par.	
BOLT (2)	15	3-1	4910-572-8701 8356186 (19207)	5-30 5-105 5-108	5-6 5-58 5-58	To hold intermediate clutch back plate in position during buildup and disassembly.
BOLT, puller (3)	10	3-1	4910-572-8699 8356200 (19207)	5-32 5-109	5-6 5-58	To remove ground sleeve diaphragm assembly.
COMPRESSOR	4	3-1	4910-572-8643 8356187 (19207)	5-36 5-44 5-95 5-102	5-6 5-6 5-58 5-58	To compress and hold low, reverse, and intermediate clutch package during installation and removal, and compress reverse clutch pack to remove or install holding pins.
EYE, lifting	14	3-1	4910-673-3801 10865773(19207)	5-20 5-34 5-106 5-120	5-6 5-6 5-58 5-58	To lift high-range clutch package and converter drive cover; used with strap 4910-572-8608.
GUIDE BOLT SET	17	3-1	4910-572-8710 8356165 (19207)	5-65 5-88 5-91 5-108 5-111	5-16 5-58 5-58 5-58 5-58	To position front and rear oil pumps, and front and rear pitot tubes and diaphragm.
HANDLE	13	3-1	5120-316-9182 7950864 (19207)	5-57 5-64 5-69 5-79 5-85 5-87	5-11 5-16 5-21 5-41 5-58 5-58	To install front oil pump seal, install high clutch housing bushing, install output bearing and seal, install converter drive cover bushing and output shaft bushing; used with replacers 5120-572-8660, 5120-.572 -8658, 5120-572-8615, 5120-572-8656, and 5120-759-5415.
HOLDER ASSEMBLY	5	3-1	4010-572-8688 8356195 (19207)	5-60	5-11	To hold stator freewheel rollers and springs in place to assemble race.
KIT, pressure gage	—	3-2	4910-572-8612 8356176 (19207)	5-143 5-44	5-62 5-62	To check transmission oil pressures.
KIT, remover and replacer	3	3-1	5180-572-8607 8356170 (19207)	5-68 5-70 5-71	5-18 5-21 5-21	To install and remove clutch piston return spring retaining ring.
KIT, snap ring	16	3-1	3120-572-8663 8356191 (19207)	5-73 5-117 5-118	5-21 5-58 5-58	To install turbine shaft snap rings.
PULLER ASSEMBLY	2	3-1	5120-572-8712 8356201 (19207)	5-17	5-6	To remove output seal.
REPLACER	7	3-1	5120-572-8660 8356173 (19207)	5-64	5-16	To install front oil pump seal: used with handle .5120 -316-9182.
REPLACER	6	3-1	5120-572-8658	5-69	5-21	To install high clutch housing bushing: used with handle 5120-310-9182.
REPLACER	8	3-1	5120-572-8615 8356185 (19207)	5-85	5-58	To install output bearing and oil seal; used with handle ,5120-316-9182.
REPLACER	12	3-1	5120-572-8656 8356202 (19207)	5-57	5-11	To install converter drive cover bushing: used with handle .5120 -316-9182.
REPLACER	11	3-1	5120-759-5415 8356204 (19207)	5-79	5-41	To install output shaft bushing: used with handle .5120 -316-9182.
SLING	1	3-1	4910-572-8614 8356184 (19207)	5-1 5-140	5-6 5-58	To lift transmission and to mount transmission in stand.
STAND		3-3	4010-499-4196	5-2 5-3 5-140	5-6 5-6 5-58	To hold and position transmission for teardown and build up.
STRAP, lifting	9	3-1	4910-572-8608 8356175 (19207)	5-20 5-120	5-6 5-58	To remove or install converter drive cover. and check mounting space; used with lifting eye 4910-673-3801.

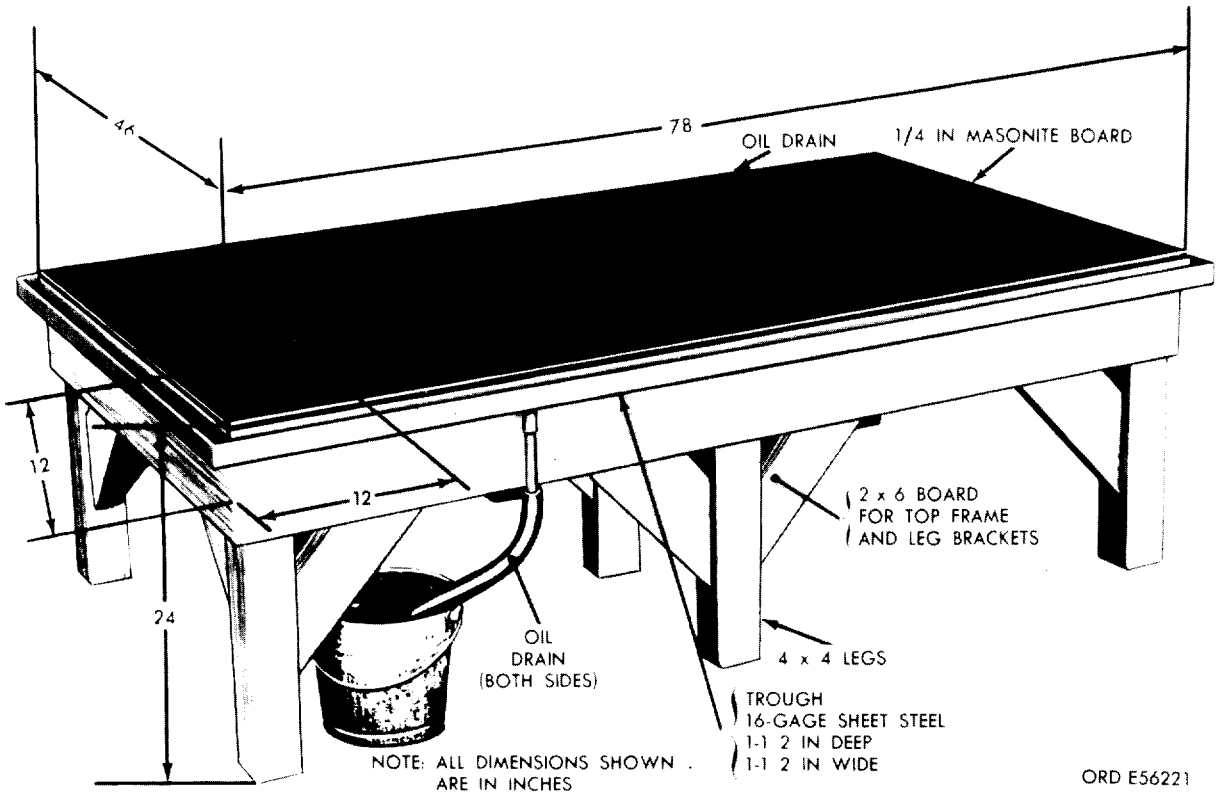


Figure 3-4. Improvised transmission disassembly and assembly table.

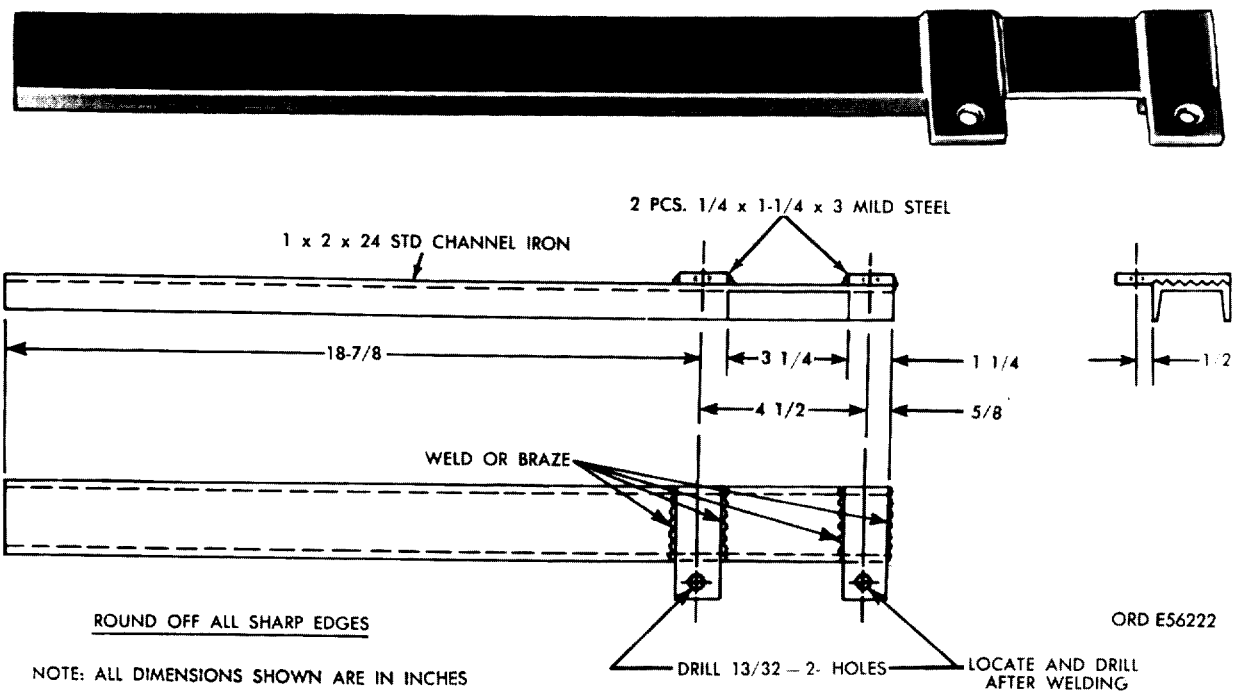


Figure 3-5. Improvised output flange holding tool.

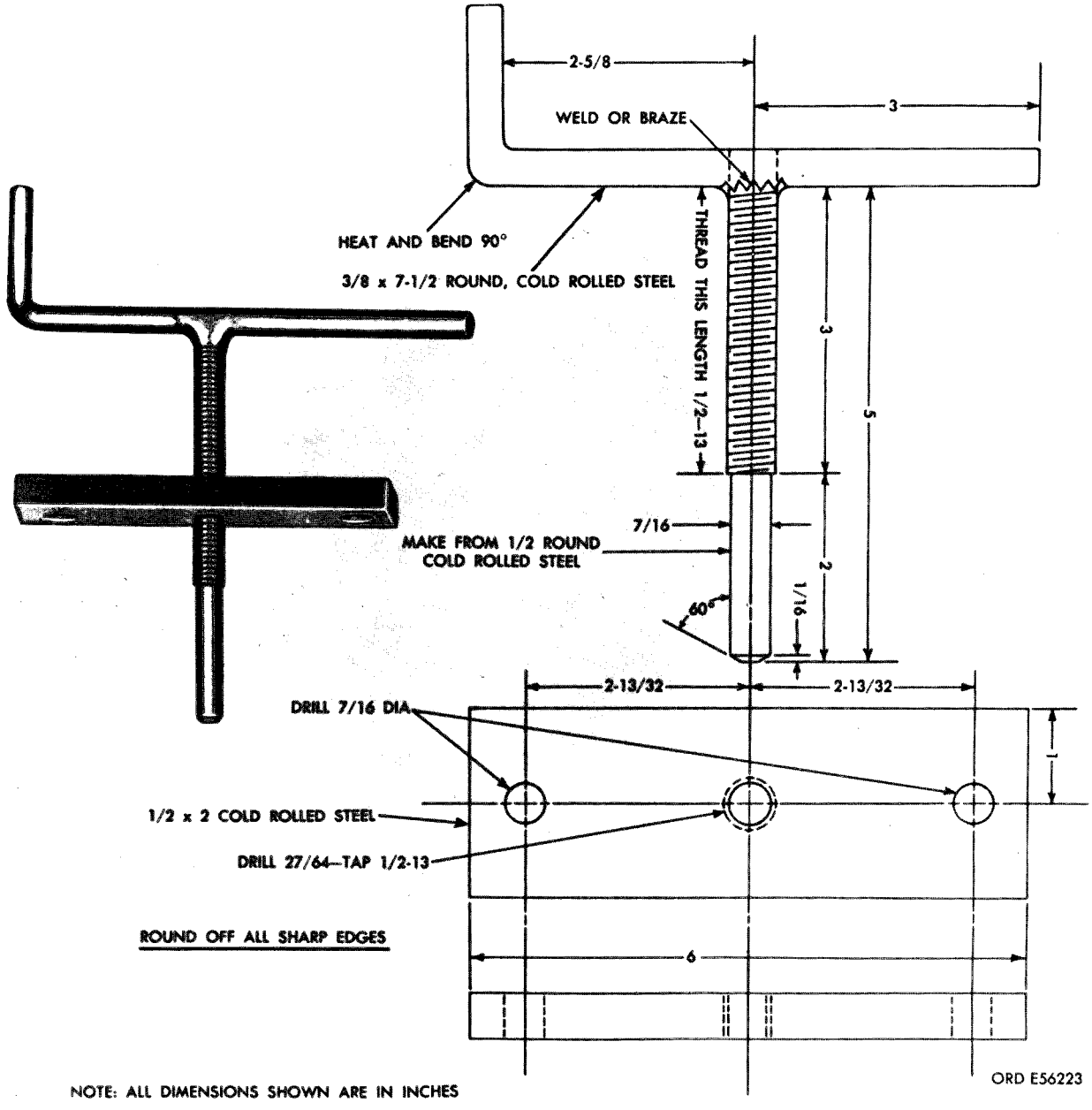


Figure 3-6. Improvised output flange remover.

Table 3-2. Improvised Tools and Equipment for Direct and General Support Maintenance

Item	References		Use
	Fig.	Par.	
OUTPUT FLANGE HOLDING TOOL	3-5 5-15 5-124	3-5 5-6 5-58	To hold output flange while removing flange bolt or torquing flange bolt.
OUTPUT FLANGE REMOVING TOOL	3-6 5-16	3-5 5-6	To remove output flange from shaft.
TABLE, disassembly and assembly	3-4 5-39	3-5 5-6	Assembling and disassembling transmission and subassemblies.

CHAPTER 4

TROUBLESHOOTING

4-1. Purpose and General Instructions

NOTE

Information in this chapter is for use of Ordnance maintenance personnel, in conjunction with and as a supplement to the troubleshooting section of end item organization manual. It provides continuation of instruction where a remedy in the organizational maintenance manual refers to Ordnance maintenance personnel for corrective action.

a. Operation of a deadlined vehicle without a preliminary examination can cause further damage to a component and possible injury to personnel. By careful inspection and troubleshooting, such damage and injury can be avoided. In addition, the cause of faulty operation of a vehicle or component can often be determined without extensive disassembly.

NOTE

This chapter contains inspection and troubleshooting procedures to be performed while a disabled component is still mounted in the vehicle as well as after it has been removed.

b. The inspections made while the component is mounted in the vehicle are, for the most part, visual and are to be performed before attempting to operate the vehicle. The object of these inspections is to determine the condition of the component and, if found defective, to take precautions to prevent further damage.

c. The troubleshooting performed while the component is mounted in the vehicle is that which is beyond the normal scope of the using organization. Check the troubleshooting section of end item organizational manual, then proceed as outlined in this chapter.

d. If the component alone is received by the Ordnance establishment, inspection should be performed to verify the diagnosis made when the component was in the vehicle. This inspection, to uncover further defects, or to determine malfunctions, is particularly important because it is often the only means of determining the malfunction without complete disassembly of the component.

4-2. Operating Characteristics

To perform effective troubleshooting, the mechanic must have a thorough knowledge of—

a. Construction Features. Refer to paragraphs 2-1 through 2-11 for description and function of the transmission components.

b. Functions of Components. Refer to paragraphs 2-12 through 2-26 for explanations of hydraulic operations and power flow through the transmission components.

c. Operating Instructions. Refer to end item operator's manual for instructions on operating the transmission while driving the vehicle in which it is installed.

d. Oil Supply. Refer to paragraph 1-6 for oil supply information.

e. Adjustments. Refer to paragraph 5-63 for adjustment procedures.

f. Oil Pressures. Refer to table 1-1, paragraph 1-7, for oil pressures.

4-3. Troubleshooting—Before Removal or Operation

a. Do not operate the vehicle prior to completing the procedures described in this paragraph. Refer to paragraph 4-1 for the purpose of these inspections. *Inspect for oil leakage.* Visually inspect all split-lines, connections, covers, output shaft, and plugs for oil leaks. Oil leakage at split-lines may be caused by loose bolts or defective gaskets. Tighten bolts where leakage is found. If leaks continue, install new gaskets.

NOTE

Inspect transmission again for oil leakage after starting vehicle engine (para 4-4).

b. Inspect transmission assembly for loose components and loose, disconnected, or damaged linkage. Check linkage and operator's controls for damage, wear, binding, or improper adjustment. Proper adjustment and operation of shift and throttle control linkage are essential to efficient performance of the transmission.

4-4. Troubleshooting—Before Removal and During Operation

a. General. If the inspections in paragraph 4-3 do not reveal the cause of failure, and the vehicle is operable, further troubleshooting is necessary. Do not remove the transmission from the vehicle until the causes of trouble listed in table 4-1 are checked. Refer to paragraph 4-3 for the purposes and scope of these troubleshooting procedures. To make a thorough check of transmission performance, be sure the vehicle engine is properly tuned and that the transmission oil level is correct (para 1-6). Inspect again for oil leaks after starting engine.

b. Troubleshooting Table. This condensed troubleshooting information will assist mechanics in diagnosing and correcting malfunctions in the

transmission assembly. Use table 4-1 in conjunction with paragraph 5-62, tests, and paragraph 5-63, adjustments. In table 4-1, the letters opposite the malfunction indicate the probable causes of trouble. The instructions in the last column are to be followed in correcting the malfunction.

4-5. Troubleshooting Tests

All tests prescribed after assembly (para 5-58) may be applied to the transmission assembly in which a malfunction is suspected.

4-6. Troubleshooting—TX 100-1 Transmission Removed from Vehicle

When the malfunction has not been determined before removal from the vehicle, the transmission should be mounted on a test stand and checked. Refer to paragraphs 5-60 through 5-62. Particular attention should be given to correct adjustment and proper oil level in every test.

Table 4-1. Troubleshooting

Malfunction	Probable Cause	Corrective Action
1. Lockup clutch does not engage.	*a.* Lockup valve or plug sticking in bore.	*a.* Overhaul (rebuild) or replace control valve assembly (para 5-52 through 5-56).
	b. Seal ring on lockup clutch piston failed or omitted.	*b.* Install new seal ring (para 5-7 through 5-11).
	c. Hook-type seal ring (11, fig. 5-62) broken or missing.	*c.* Replace seal ring or overhaul transmission (para 5-17 through 5-21).
	d. Front governor (G1) pressure low.	*d.* Refer to item 14 below.
	e. Flow valve sticking in bore. Valve toward larger diameter of bore.	*e.* Overhaul (rebuild) or replace control valve assembly (para 5-52 through 5-56)
	f. Lockup clutch plate failed.	*f.* Replace clutch plate (fig. 5-119).
2. Lockup clutch engages at too low speed.	*a.* Lockup valve spring weak or broken.	*a.* Overhaul (rebuild) or replace control valve assembly (para 5-52 through 5-56).
	b. Throttle valve linkage disconnected or improperly adjusted.	*b.* Repair, replace and / or adjust linkage (para 5-63).
3. Lockup clutch engages at too high speed.	*a.* Throttle valve linkage improperly adjusted.	*a.* Adjust linkage (para 5-63).
	b. Front governor (G1) pressure low.	*b.* Refer to item 14 below.
	c. Lockup valve spring load excessive.	*c.* Check spring load (table 6-2); replace spring (para 5-52 through 5-56).
4. Automatic shift from low to intermediate occurs at too low speed.	Low-intermediate shift valve spring broken or weak	Check spring load (table 6-2); replace spring (para 5-52 through 5-56).
5. Automatic shift from low to intermediate occurs at too high speed.	*a.* Rear governor (G2) pressure low.	*a.* Refer to item 15 below.
	b. Throttle valve linkage improperly adjusted.	*b.* Adjust linkage (para 5-63).
	c. Low-intermediate shift valve spring load excessive.	*c.* Check spring load (table 6-2); replace spring (para 5-52 through 5-56).
6. Transmission does not shift automatically out of low range.	*a.* Rear governor (G2) pressure low.	*a.* Refer to item 15 below.
	b. Low-intermediate shift plug, shift valve, or blocker plug sticking.	*b.* Overhaul (rebuild) or replace control valve assembly (para 5-52 through 5-56).
	c. Shift linkage disconnected (manual selector valve at 1-position).	*c.* Connect and adjust linkage para 5-63).
7. Transmission does not shift manually out of low range.	*a.* Shift linkage disconnected (manual selector valve at 1-position).	*a.* Connect and adjust linkage para 5-63).
	b. Low-intermediate shift valve or blocker plug sticking.	*b.* Overhaul (rebuild) or replace control valve assembly (para 5-52 through 5-56).
	c. Manual selector valve sticking at 1-position.	*c.* Overhaul (rebuild) or replace control valve assembly (para 5-52 through 5-56).

Table 4-1. Troubleshooting-Continued

Malfunction	Probable Cause	Corrective Action
Transmission does not shift automatically from intermediate to high range.	*a.* Rear governor (G2) pressure low.	*a.* Refer to item 15 below.
	b. Intermediate-high shift plug, shift valve, or blocker plug sticking (in intermediate position).	*b.* Overhaul (rebuild) or replace control valve assembly (para 5-52 through 5-56).
	c. Intermediate-h igh shift valve spring load excessive.	*c.* Check spring load (table 6-2; replace spring (para 5-52 through 5-56).
	d. Shift linkage disconnected or improperly adjusted.	
	e. Manual selector valve sticking in 1-2 position (operator's control will not move).	
9. Throttle position does not influence lockup or range shifts, or main pressure.	*a.* Throttle valve linkage disconnected.	*a* Connect and adjust linkage (para 5-63).
	b. Throttle regulator valve sticking in bore.	*b.* Overhaul (rebuild) or replace control valve assembly (para 5-52 through 5-56).
	c. Throttle valve spring missing.	*c.* Replace spring (para 5-52 through 5-56).
10. Transmission downshifts from high to low range, misses intermediate.	*a.* Intermediate-high shift plug, shift valve, or blocker plug sticking bore (in high position).	*a.* Overhaul (rebuild) or replace control valve assembly (para 5-52 through 5-56).
	b. Intermediate-high shift valve spring missing.	*b.* Replace spring (para 5-52 through 5-56).
11. Transmission upshifts from low to high range, misses intermediate.	*a.* Intermediate-high shift plug, shift valve, or blocker plug sticking in bore (in high position).	*a.* Replace spring (para 5-52 through 5-56).
	b. Intermediate-high shift valve spring missing.	*b.* Replace spring (para 5-52 through 5-56).
12. Low- or intermediate-range clutch slips.	*a.* Main pressure low	*a.* Refer to item 16 below.
	b. Clutch plates failed	*b.* Overhaul transmission (para 5-1 through 5-63).
	c. Clutch piston seals leaking.	*c.* Overhaul transmission (para 5-1 through 5-63).
	d. Internal leakage in hydraulic system.	*d.* Overhaul transmission (para 5-1 through 5-63).
	e. Oil transfer tube to affected clutch not seated.	*e.* Install tubes properly (fig. 5-127).
13. High-range clutch slips.	*a.* Refer to item 12*a* through *e* above.	*a* Refer to item 12*a* through *e* above.
	b. Intermediate-high shift valve sticking; does not move full length of stroke.	*b.* Overhaul (rebuild) or replace control valve assembly (para 5-52 through 556)
	c. Hook-type seal rings (21, fig. 5-62) broken or missing.	*c.* Overhaul transmission (para 5-1 through 5-63).
14. Low fron governor (G 1) pressure.	*a.* Front pitot tube damaged or loose.	*a.* Overhaul transmission (para 5-1 through 5-63)
	b. Front governor ring damaged.	*b.* Overhaul transmission (para 5-1 through 5-63).
	c. Internal oil leakage·	*c.* Overhaul transmission (para 5-1 through 5-63)
	d. Check valve ball and / or retainer (76 and 75 fig. 5-82) damaged, missing, or fouled.	*d.* Overhaul (rebuild) or replace oil transfer plate assembly (para 5-47 through 5-51).
	e. Loss of oil supply to governor ring.	*e.* Check oil supply orifice (item 16, fig. 5-62).
15. Low rear-governor (G2) pressure.	*a.* Rear pitot tube damaged or loose.	*a.* Tighten bolts, disassemble transmission if tube is damaged (para 5-1 through 5-63).
	b. Rear governor ring damaged.	*b.* Overhaul transmission (para 5-1 through 5-63).
	c. Internal oil leakage.	*c.* Overhaul transmission (para 5-1 through 5-63).
	d. Loss of oil supply to governor ring.	*d.* Check oil supply orifice (item 5, fig. 5-81).

Table 4-1. Troubleshootng- Continued

Malfunction	Probable Cause	Corrective Action
16. Low main oil pressure.	*a* Oil level low	*a*. Check oil level and add oil (para 1-6).
	b. Oil filter clogged	*b*. Replace filter element (para 1-6)..
	c. Internal leakage	*c*. Overhaul transmission (para 5-1 tllrt)ugh 5-63).
	d. Main pressure regulator valve sticking in bore.	*d*. Overhaul (rebuild) or replace control valve assembly (para 5-52 tl)ro[lgll 5-56).
	e. Main pressure regulator valve spring broken or weak.	*e*. Overhaul (rebuild) or replace control valve assembly (para 5-52 through 5-56).
	f. Trimmer valve sticking in bore.	*f*. Overhaul (rebuild) or replace control valve assembly (para 5-52 tl)r~)ugh 5-56).
	g. Front oil pump failed or worn.	*g*. Overhaul transmission (para 5-1 through 5-6).
17. Transmission overheats.	*a* Cooler clogged internally	*a*. Clean cooler. Refer to vehicle technical manuals.
	b. Cooler oil lines kinked or clogged.	*b*. Replace or clean oil lines. Refer to vehicle technical manuals.
	c. Low oil level	*c*. Check oil level and add oil (para 1-6).
	d High oil level	*d*. Check oil level and drain to proper level (para 1-6).
	e. Transmission clutch slippage.	*e*. Refer to items 12 and 13 above.
	f. Torque converter stator locked up (does not freewheel).	*f*. Overhaul transmission (para 5-1 through 5-63).
	g. Water side of oil cooler clogged.	*g*. Clean water side of oil cooler. Refer to vehicle technical manuals.
18. Transmission upshifts to a range higher than that indicated at manual shift control.	*a* Inhibitor valve sticking in open position.	*a*. Overhaul (rebuild) or replace control valve assembly (para 5-52 tlln)ugll 5-56).
	b Inhibitor valve spring weak or broken.	*b*. Overhaul (rebuild) or replace control valve assembly (para 5-52 through 5-56).
19. Shifting rough	*a* Throttle valve linkage improperly adjusted.	*a*. Adjust linkage (para 5-63).
	b Trimmer valve sticking in bore.	*b*. Overhaul (rebuild) or replace control valve assembly (para 5-52 through 5-56).
	c. Flow valve sticking in bore.	*c*. Overhaul (rebuild) or replace control valve assembly (para 5-52 tllrt)tlgil 5-56).
	d. Throttle regulator valve sticking in bore	*d*. Overhaul (rebuild) or replace control valve assembly (para 5-52 tl]roilgh 5-56).
20. Transmission does not drive vehicle.	*a*. Shift linkage disconnected or broken.	*a*. Repair or replace and adjust linkage (para 5-63).
	b. Main pressure low	*b*. Refer to item 16 above.
	c. Internal failure	*c*. Overhaul transmission (para 5-1 through 5-63).
	d Oil level low	*d*. Check oil level and add oil (para 1-6).
	e. Vehicle drive components locked up or failed.	*e*. Refer to vehicle technical manuals.
21. Stall speed too low.	Engine not producing full power.	Check engine technical manual. Tune engine.
22. Stall speed too high.	Clutch slipping	Check main pressure (para 5-61)

CHAPTER 5

REPAIR AND OVERHAUL (REBUILD)

Section I. PRELIMINARY INSTRUCTIONS FOR TRANSMISSION OVERHAUL (REBUILD)

5-1. General

a. Equipment Needed. Proper equipment must be available before disassembly is started. This equipment includes a suitable hoist of at least $^{1}/_{2}$ ton capacity. proper hand tools and special tools, improvised tools. receptacles for small parts, wood blocks. wiping cloths, and an arbor press. Refer to paragraphs 3-4 and 3-5 for lists of special and improvised tools.

b. Parts to *Discard.* Cotter pins, lock wires, lock strips, and gaskets should be discarded at transmission disassembly. New parts should always be supplied in such cases.

c. Avoiding Component Damage. Care must be used to avoid damage to transmission components during disassembly, cleaning, inspection, repair, and reassembly. Scratches. nicks, and dents caused by careless handling may cause oil leakage or improper functioning and could result in transmission failure. All defective parts must be replaced.

d. Torque Requirements. All standard torquing requirements for bolts, screws, and nuts are tabulated in table 6-1. Where special torque requirements apply. they will be found in the applicable text.

5-2. Cleaning Recommendations

a. Importance of Cleanliness. Cleanliness is of paramount importance in servicing the transmission. All components must be thoroughly cleaned and kept clean throughout the rebuild process. The presence of dirt can cause malfunction and possible failure of the transmission. Refer to TM 9-208-1 and TM 9-208-2.

WARNING

Forewarn personnel in the immediate area when using compressed air for cleaning. Compressed air. coming into contact with the human skin or causing flying metal chips. can cause serious injury.

b. *Cleaning Parts.*

(1) Every component should be thoroughly cleaned after the transmission is disassembled. Cleaning is necessary to insure effective inspection for wear, damage, and serviceability of components.

(2) The utmost care should be used in handling of parts during cleaning and overhaul (rebuild) operation. Nicks, scratches, dents, or burs can prevent proper assembly or cause malfunction after assembly. This is especially true of valves and valve body parts.

(3) Abrasives, files, scrapers, wire brushes, and sharp tools should never be used on surfaces where finish is important to the operation or sealing of parts, except where specifically recommended.

(4) Gum or varnish may be removed by soaking in dry cleaning solvent or mineral spirits paint thinner and by the use of a soft bristle brush. Crocus cloth may be used to remove minor surface irregularities. Lapping compound may be used, if required, in valve body bores to prevent valves from sticking. Clean thoroughly to remove compound after use.

(5) A soft wire (brass or copper) may be used to clean oil passages. Always flush such passages thoroughly after cleaning.

(6) If steam cleaning is used, dry the cleaned parts immediately with compressed air, and apply a film of oil to prevent rusting. Never use lye or caustics which will corrode or etch metal surfaces.

(7) Do not clean the lubricant from new bearings. Keep new bearings wrapped until they are to be installed. Soak bearings which have been in service in dry cleaning solvent or mineral spirits paint thinner to loosen deposits of dirt. Do not spin bearings during cleaning or drying. After cleaning, turn bearings by hand and note any evidence of grit. Reclean them if grit is present. Refer to TM 9-214 for further information on cleaning bearings.

5-3. Inspection and Repair Recommendations

a. Castings. Forgings. and Machined Surfaces.

(1) Inspect all castings and forgings for breaks, cracks, and wear or scoring that would impair serviceability. Remove nicks and small surface irregularities with crocus cloth or a soft stone.

(2) Inspect all oil passages for obstructions and dirt. Reclean passages if necessary.

(3) Inspect mounting faces for nicks, scratches, and scores. Remove minor defects with crocus cloth or a soft honing stone. Replace any parts in

whicoh defects which cannot be corrected will impair the operation of the transmission.

(4) Inspect threaded openings for damaged threads. Chase damaged threads with correct size tap.

(5) Replace housings or other cast parts that are cracked or broken.

b. *Roller or Ball Bearings.* Refer to TM 9-214 for proper cleaning and inspection procedures.

c. Needle-Type Roller Bearings.inspect bearings for free and smooth rotation, broken or missing rollers. and tightness of fit in bore. If defects are found, replace bearing, using proper replacer.

NOTE

Do not remove needle bearings unless replacement is necessary, since removal usually results in destruction of the bearings.

d. Bushings. Bushing-Type Bearings, and Thrust Washers.

(1) Inspect bushings and bushing-type bearings for size, scoring and out-of-roundness, burs, sharp edges, and evidence of seizing. Minor scores, scratches, and sharp edges may be removed with crocus cloth. Out-of-round, deeply scored, or worn parts should be discarded.

NOTE

Do not remove bushings and bushing-type bearings unless replacement is necessary, as removal usually damages these parts.

(2) Remove bushings and bushing-type bearings by using a puller or press when possible. Bushings in blind holes may require removal by sawing or the use of a narrow cape chisel.

CAUTION

If necessary to cut out a bushing, do not damage the bore into Which it fits.

(3) Inspect thrust washers for wear, distortion, scores and burs. Correct minor defects. Replace parts that are worn, deformed, or scored.

e. Oil Seals. Performed Packings. and Gaskets.

(1) Inspect hook-type seal rings for wear, distortion, and broken hooks. Replace defective seal rings.

(2) Inspect composition-type seal rings or packings for wear. brittleness. cracks, cuts, deformation, and deterioration. Replace defective seals.

(3) Inspect lip-type seals for cracks, wear, cuts, and brittleness. Inspect springs and seal shells. Replace any seal found defective. Use a non-hardening sealing compound on the outside diameter of the seal to prevent leakage.

NOTE

Removal of a seal will usually damage it; inspect rigidly before reusing.

(4) Replace all flat-type gaskets.

f. Gears.

(1) Inspect gears for burs, wear. broken teeth, and pitting at tooth contact areas.

(2) Inspect bores of planetary pinions for wear and pitting of bearing contact areas.

(3) Remove burs, using a soft honing stone. Replace gears that are excessively worn or pitted.

g. Splined Parts.

(1) Inspect splined parts for twisted or broken splines, burs, and excessive wear.

(2) Remove burs. using a soft honing stone. Replace parts which have twisted or broken splines or excessive wear.

h. Clutch Plates.

(1) Inspect nonmetallic plates for excessive wear, cracks, breaks, and deep scoring. Replace plates if such defects are found.

(2) Inspect bronze-faced steel plates for burs, imbedded metal particles, severely pitted faces. excessive wear. cracks, distortion, and damaged spline teeth. Remove burs, using a soft honing stone. Replace plates which have other defects.

(3) Inspect steel plates for burs, scoring, excessive wear, distortion, imbedded metal, galling, cracks, breaks, and damaged spline teeth. Remove burs and minor surface irregularities, using a soft honing stone. Replace plates which have other defects.

i. Threaded Parts.

(1) Inspect all threaded parts for burs and stripped or damaged threads.

(2) Replace all parts which have stripped threads or damage which cannot be repaired by chasing the threads with a tap or die of the proper size.

j. Snap Rings. Inspect snap rings for nicks. burs. distortion, and wear. Discard snap rings which are defective.

k. Springs. Inspect springs for wear, distortion, breaks. evidence of overheating, and loss of tension or compression. Discard defective springs. Refer to table 6-2 for spring specifications.

1. *Shafts and Spindles.*

(1) Inspect shafts and spindles for excessive wear. bending. scores. cracks, burs, and obstructed oil passages.

(2) Remove burs and minor surface irregularities with crocus cloth or a soft honing stone. Remove obstructions by probing with soft wire or with compressed air. Discard parts with other Defects.

m. Ball-Type Valves.

(1) Inspect steel balls for rust. pitting. and grooving. Inspect nylon balls for nicks, scratches, grooving, and chipping, Discard balls which will not seat properly.

(2) Inspect ball seats for wear and pitting. Reseat by lapping with the proper size ball. On seats where a nylon ball is used, a steel ball of the same size may be used for lapping. Discard parts in which the seats cannot be restored.

n. Spool-Type Valves.

(1) Inspect valves for wear, burs, scoring, and evidence of sticking. Try valves in their bores. All valves should move in their bores by their weight alone. Do not force valves.

(2) Inspect edges of all valve lands. All edges should be square and sharp. Do not destroy these sharp edges in cleaning or repair operations. These sharp edges help prevent the accumulation of substances which might cause the valve to stick in its bore.

(3) Remove burs with a soft honing stone. Reclean valves if necessary to remove gum and dirt. Discard all valves which have other defects.

o. Sheet Metal Parts.

(1) Inspect sheet metal parts for bends, cracks, distortion, interference with adjacent parts, and loose-welded points.

(2) Straighten bent parts. Weld cracks or loose welds.

(3) Discard governor oil collector rings if any damage is evident.

p. Installation of Teflon Seals and Expanders.

(1) Install expander into seal ring groove so that its ends bend toward bottom of groove.

NOTE

Some expanders may require additional bending to cause them to point toward the bottom of the groove.

(2) While holding expander in groove, start seal ring into groove at a point diametrically opposite expander ends. No lubrication is necessary for installation.

(3) Install seal by hand. Tools or instruments might damage seal. Do not stretch seal any more than is necessary for installation.

(4) Center piston in piston bore when installing it, to prevent seal damage. Be extremely careful to avoid scratching, nicking, or distorting a Teflon seal.

WARNING

Do not destroy discarded Teflon seals by burning; toxic gases are produced.

5-4. Repair and Overhaul and (Rebuild) Standards

a. Clearances and Wear Limits. Refer to paragraph 6-2 and 6-3 for data covering the sizes and fits of new parts and wear limits information.

b. Torque Specifications. Refer to table 6-1 for general torque specifications for bolts, screws, and nuts. Special torque specifications are given in the text where applicable.

c. *Spring Specifications.* Refer to table 6-2 for spring specifications.

Section II. DISASSEMBLY OF TRANSMISSION INTO SUBASSEMBLIES

5-5 General

a. Pictorial Steps. This section is arranged in consecutive pictorial steps, completely illustrating the disassembly of the transmission. Directly beneath each picture are simple disassembly instructions, keyed to the picture.

b. Transmission Component Groups. See appropriate exploded view of major component groups for parts identification and assembly sequence.

5-6. Disassembly Steps

Drain oil from transmission, if it was not drained before transmission was removed from vehicle. Refer to end item lubrication order to draining procedures. See figure 5-1 through 5-52 for disassembly steps.

NOTE

Refer to end item organizational manual for instructions on removing the transmission from the vehicle and separating the transmission from the power pack.

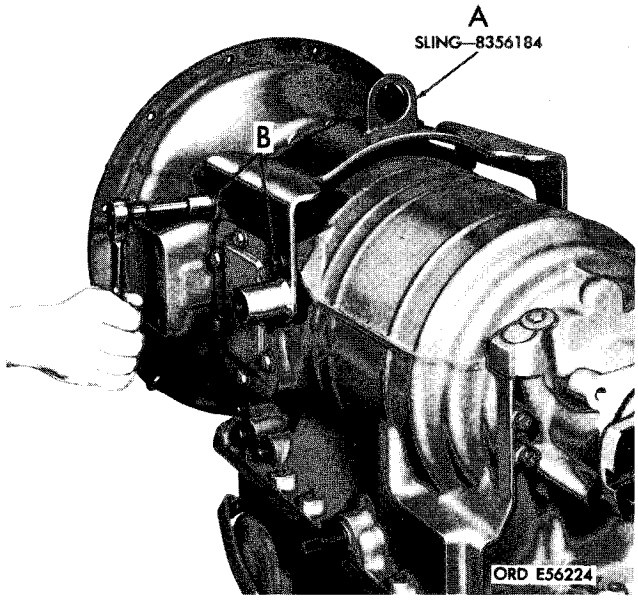


Figure 5-1 (Step 1).

Attach lifting sling 4910-572-8614 (8356184) (A) to transmission, using four $^{3}/_{8}$-16 x 1 bolts and plain washers (B).

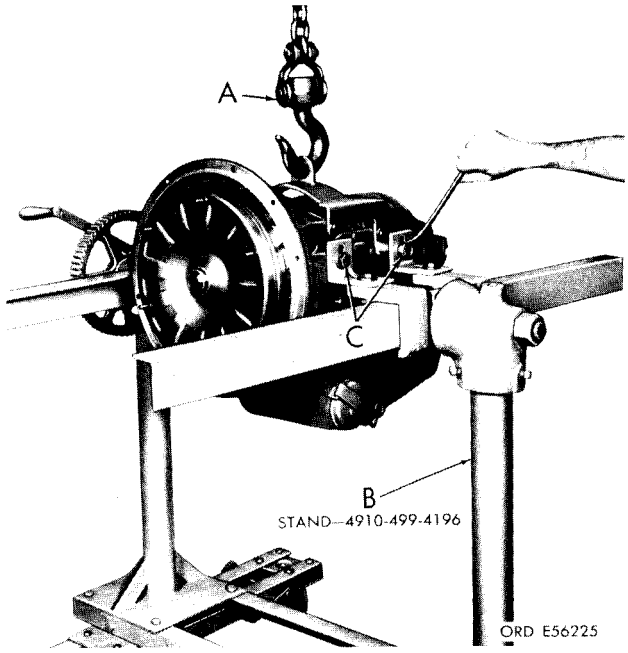


Figure 5-2 (Step 2).

Using hoist (A), position transmission in stand (B), and install four $^{5}/_{8}$11 bolts (C) removed from front transmission mounting pads.

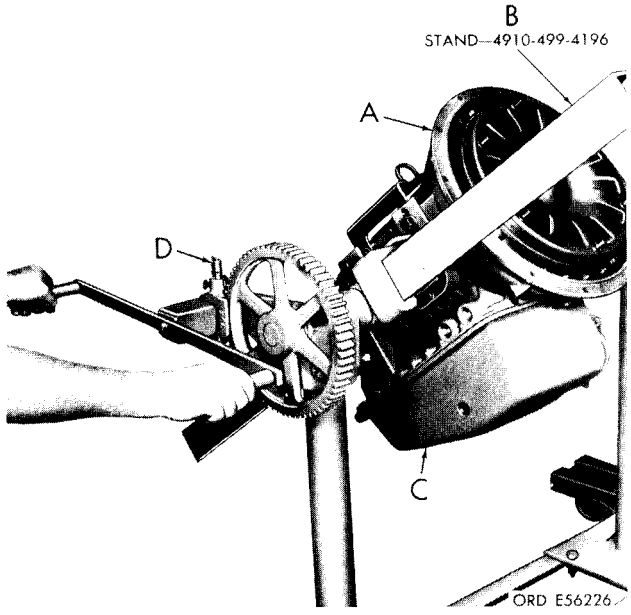


Figure 5-3 (Step 3).

Rotate transmission (A) in stand 4910-499-4196 oil pan (C) will be upward. Use lock pin (D) to lock stand after positioning.

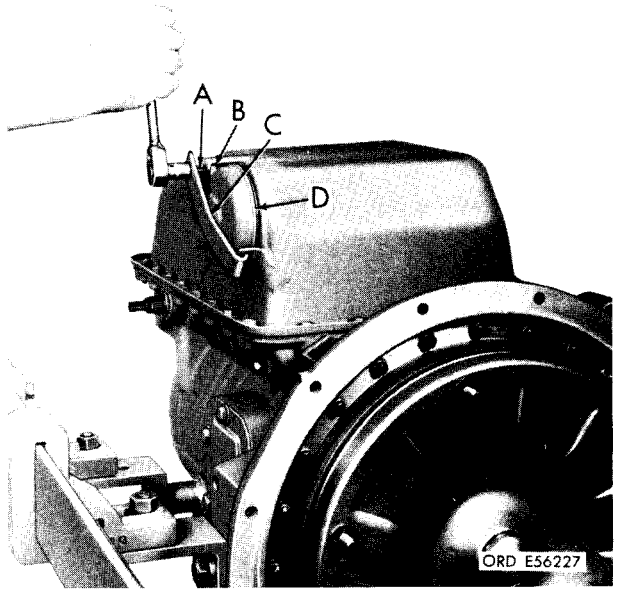


Figure 5-4 (Step 4).

Using a $^{1}/_{2}$-inch wrench, remove bolt (A), nut (B), and strap (C) from oil filter cover assembly (D).

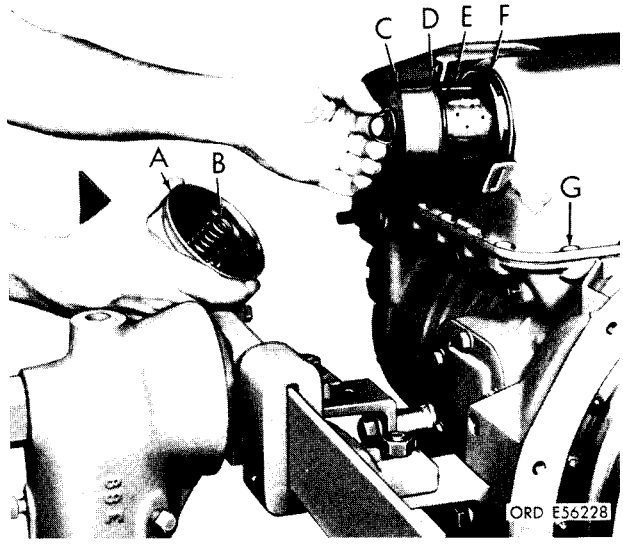


Figure 5-5 (Step 5).

Reemove cover assembly (A) with spring (B), and remove spring from cover assembly. Remove retainer (C) with seal ring (D), and remove seal ring. Remove oil filter element assembly (E) and seal ring (F). L-sing a $^{1}/_{2}$-inch wrench, remove 26 bolts (G) from oil pan.

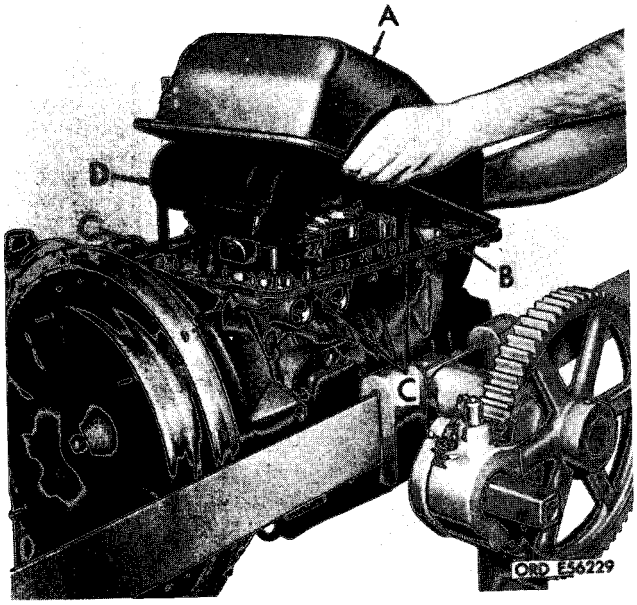


Figure 5-6 (Step 6).

Remove oil pan (A) and gasket (B). Using a 7/16-inch wrench, remove three bolts (C) and three lockwashers from filter can (D).

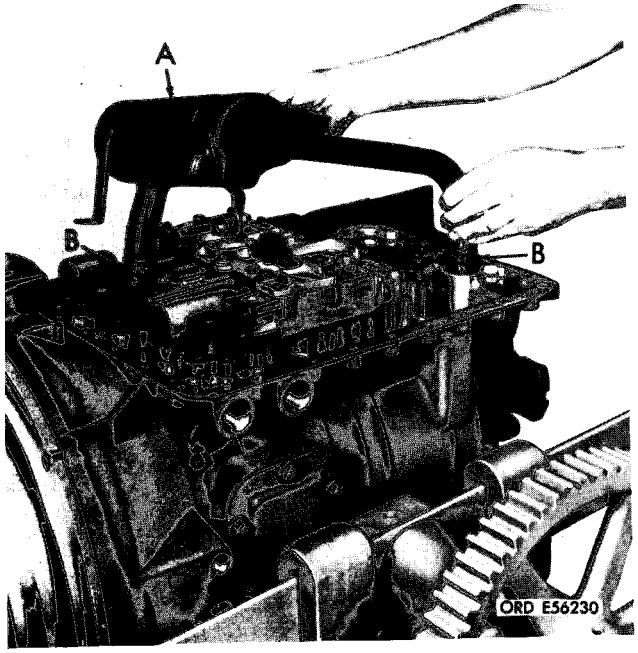


Figure 5-7 (Step 7).

Remove oil filter can (A) and two seal rings (B). Remove seal rings (B) from filter can (A).

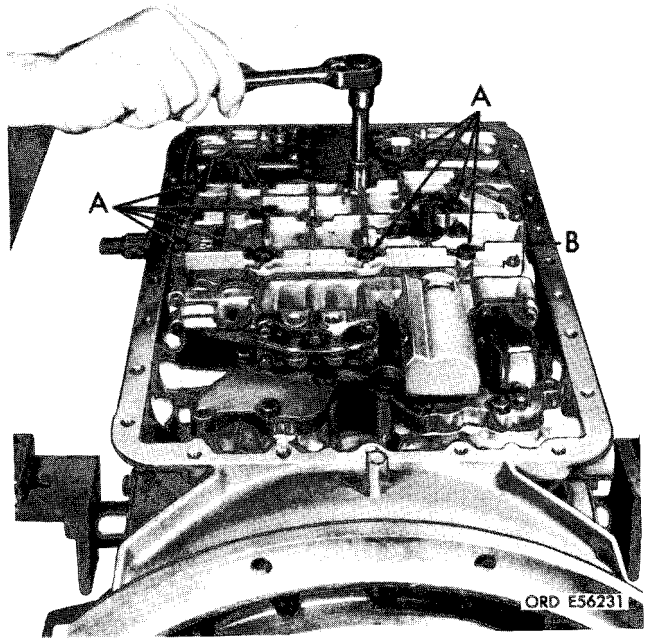


Figure 5-8 (Step 8).

Using a 7/16-inch wrench, remove nine bolts (A) and nine lockwashers securing valve body (B).

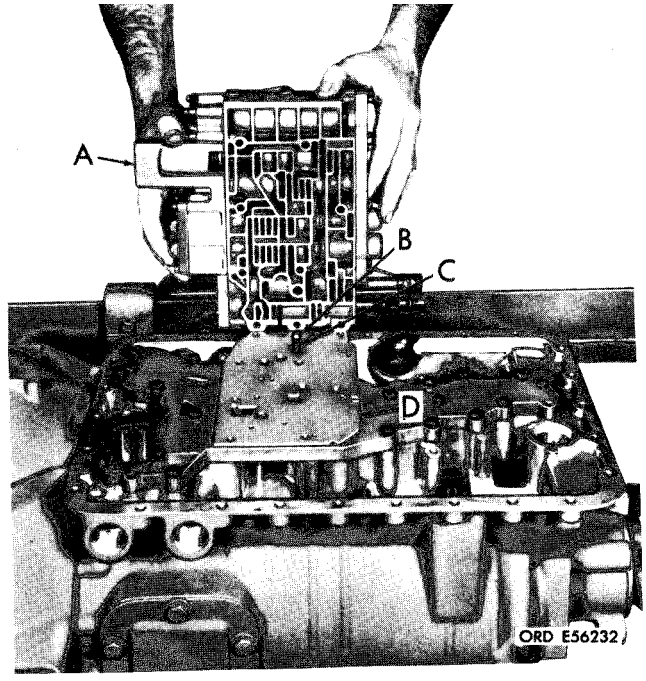


Figure 5-9 (Step 9).

Remove valve body assembly (A), detent ball (B), spring (C), and separator plate (D).

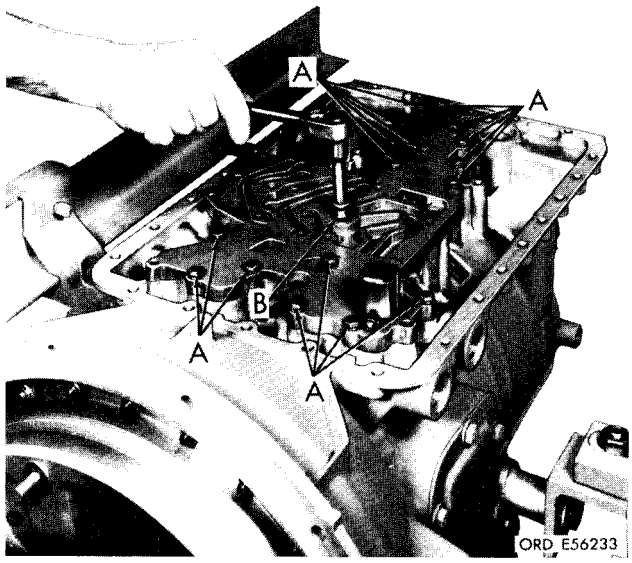


Figure 5-10 (Step 10).

Remove 17 long bolts (A) and lockwashers. Remove two short bolts (B) and lock washers.

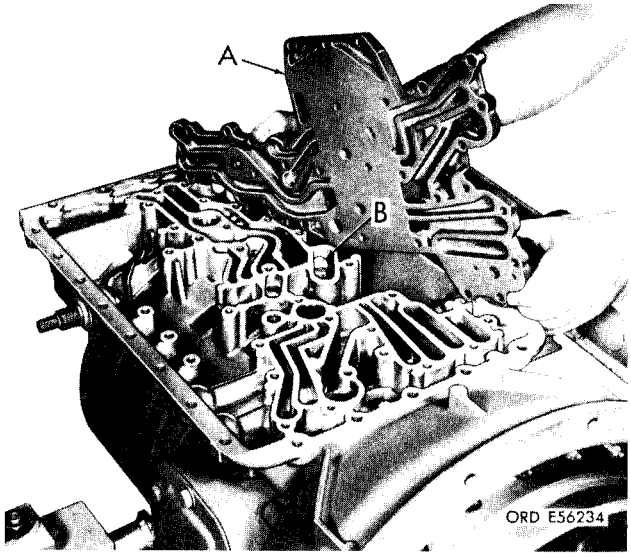


Figure 5-11 (Step 11).

Remove oil transfer plate assembly (A) and rear pump check ball (B).

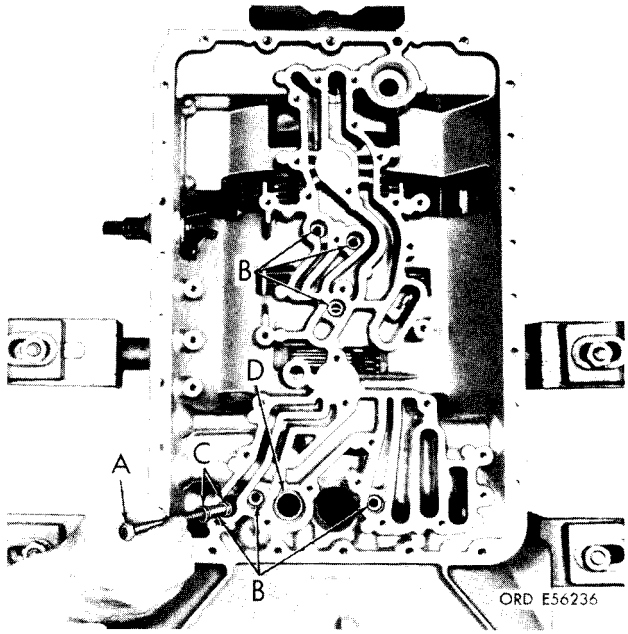


Figure 5-12 (Step 12).

Remove six snap rings (A) securing six small jumper tubes.

Note. Snap rings are not in grooves, merely snug in bore.

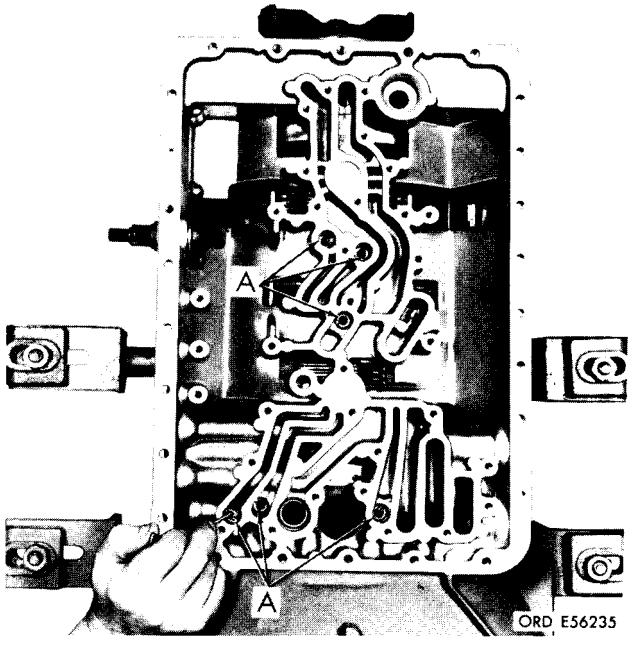


Figure 5-13 (Step 13).

Using a 5/16 bolt (A) threaded into jumper tubes (B), remove 6 jumper tubes (B) and 12 seal rings (C), and remove seal rings from jumper tubes. Remove one large jumper tube (D) and two seal rings, and remove seal rings from jumper tube.

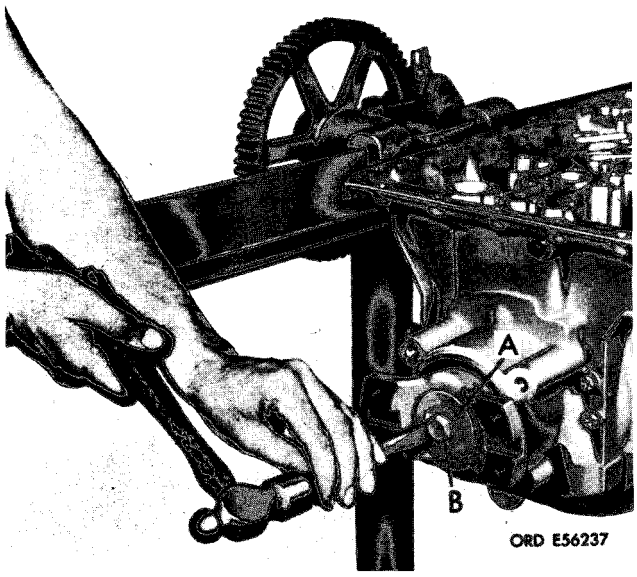


Figure 5-14 (Step 14).

Flatten washer (A) securing flange bolt (B)

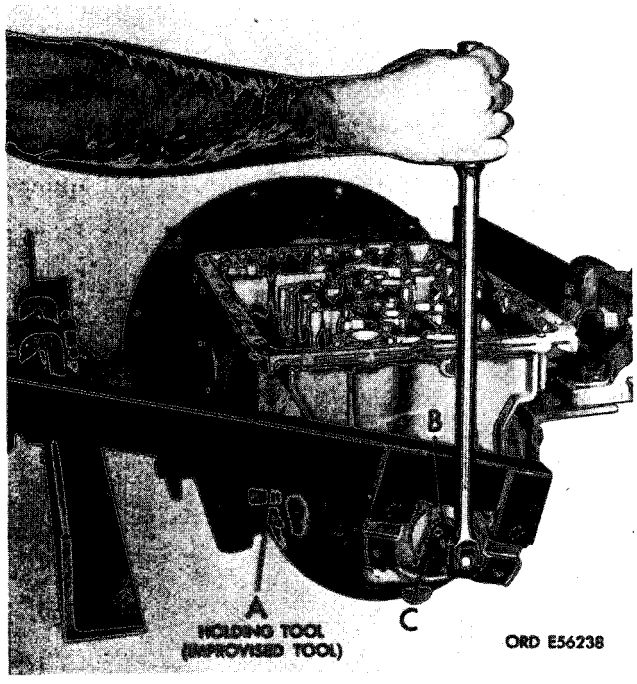


Figure 5-15 (Step *15).*

Using a 3/4 inch wrench and an improvised holding tool (A), remove flange bolt (B), flat washer (C), and seal ring (under washer).

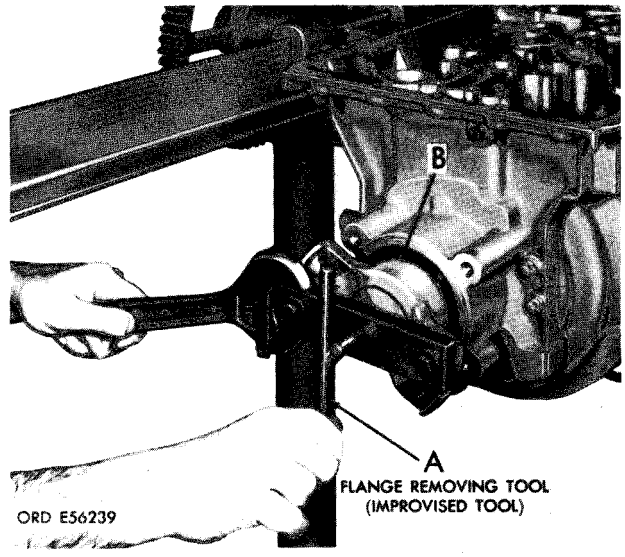


Figure 5-16 (Step 16).

Using improvised output flange removing tool (A) attached to output flange (B), hold tool (A) to keep flange stationary, and pull flange from shaft.

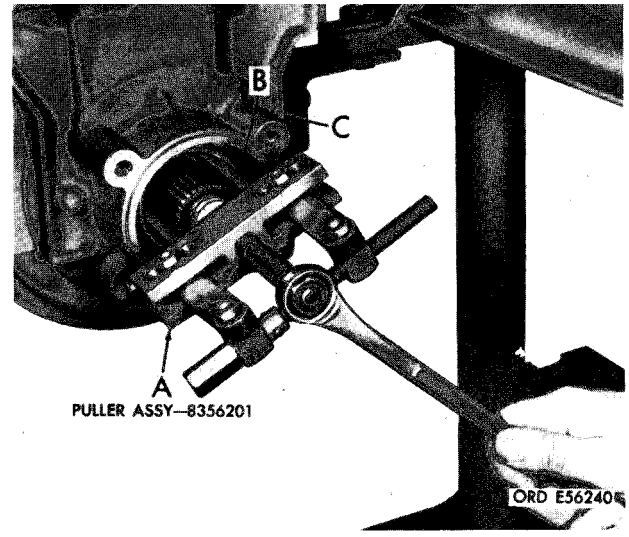


Figure 5-17 (Step 17).

Using puller assembly 5120-572-8712 (8356201) pull rear output oil seal (B) from bore in housing (C).

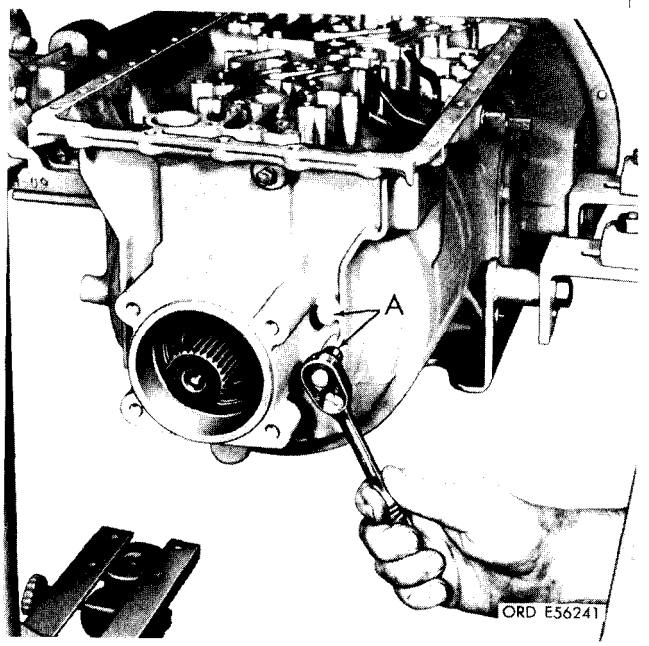


Figure 5-18 (Step 18).

Using a 7/16-inch wrench, remove two bolts and two plain washers from rear pitot tube.

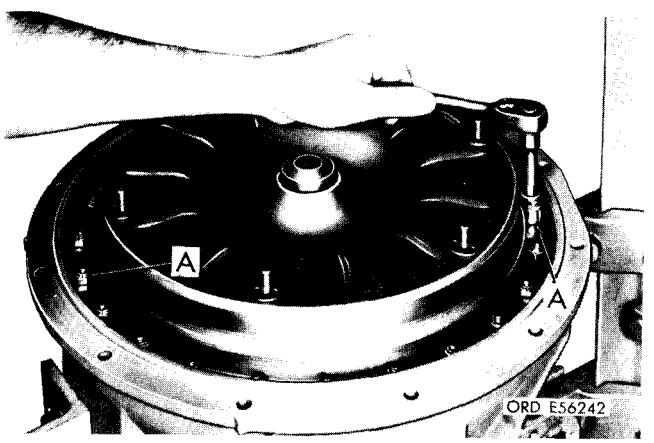


Figure 5-19 (Step 19).

Position transmission with converter-end up, and lock stand in position. Using a 1/2-inch wrench, remove 24 converter pump cover nuts (A)

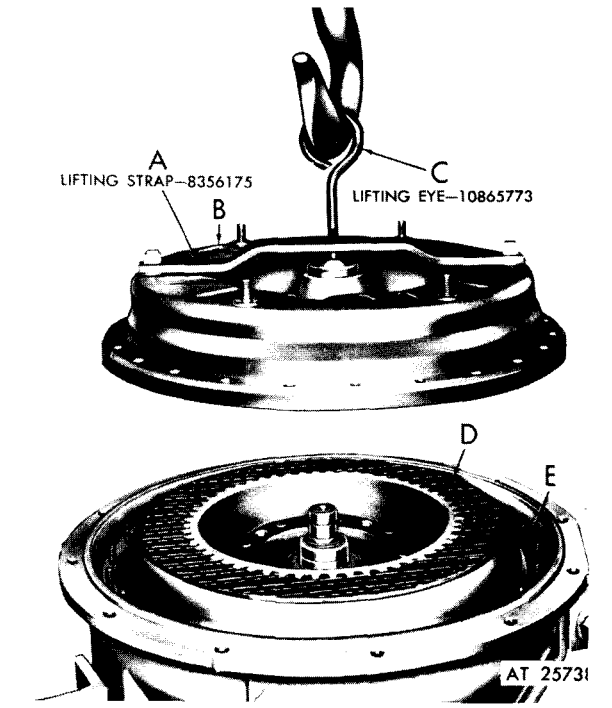


Figure 5-20 (Step 20).

Attach lifting strap 4910-572-8608 (8356175) to pump cover (B). Screw lifting eye 4910-673-3801 (10865773) (C) into lifting strap (A). Remove pump cover (B) with lockup clutch piston as an assembly. Remove lockup clutch plate (D) and seal ring (E).

Figure 5-21. (Step 21).

Remove lockup clutch back plate (A) and seal ring (B).

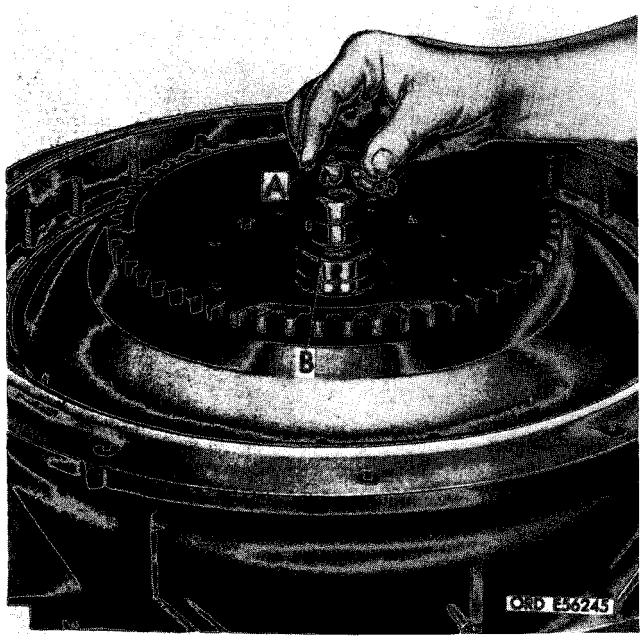


Figure 5-22 (Step 22).

Remove hook-type seal ring (A) and turbine snap ring (B).

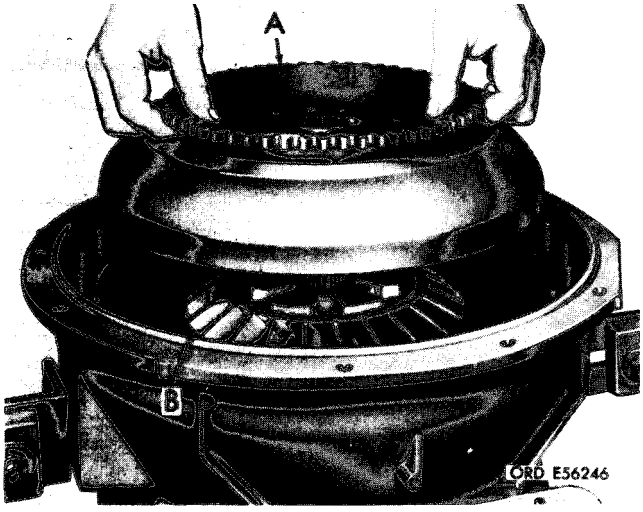


Figure 5-23 (Step 23).

Remove turbine assembly (A). Twist converter stator and cam assembly (B) counterclockwise to lock it to freewheel roller race.

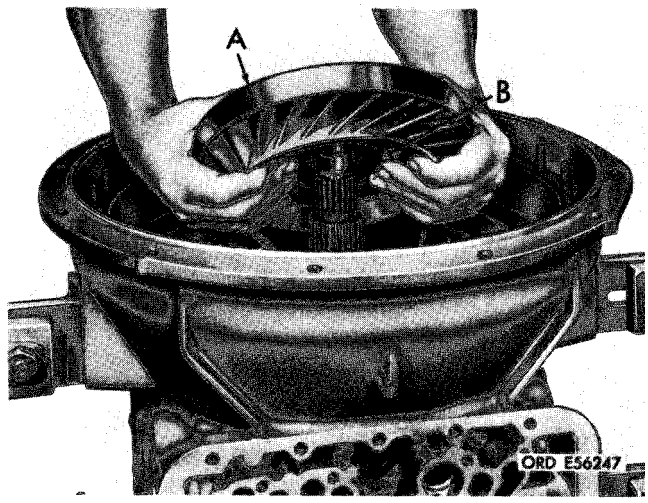


Figure 5-24 (Step 24).

Remove stator and cam assembly (A) while supporting freewheel roller race (B) with the fingers.

Note. Should freewheel roller race separate from stator and cam assembly and allow rollers and springs to fall into converter pump, remove rollers and springs before continuing disassembly.

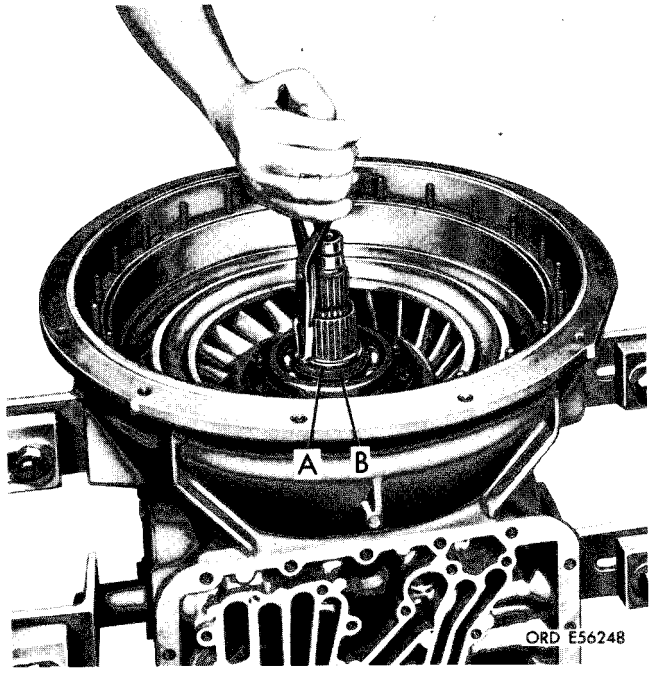


Figure 5-25 (Step 25).

Remove ground sleeve snap ring (A) and splined spacer (B).

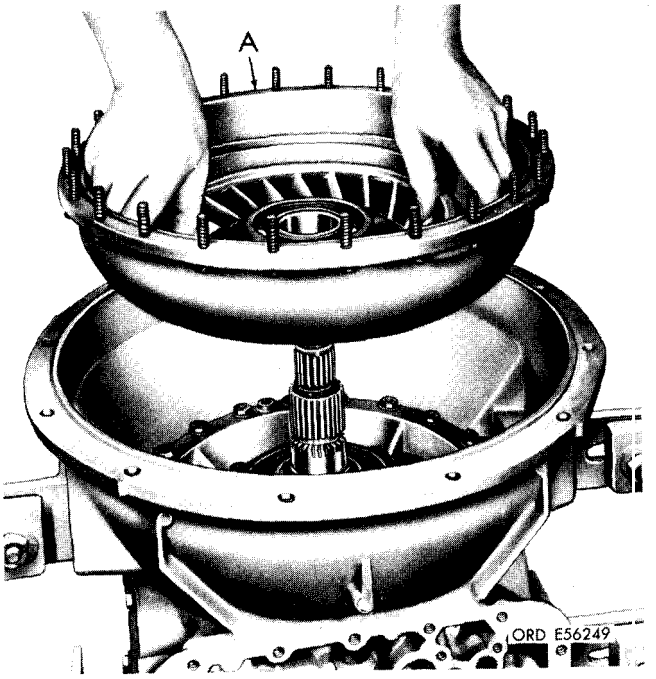


Figure 5-26 (Step 26).

Remove converter pump assembly (A).

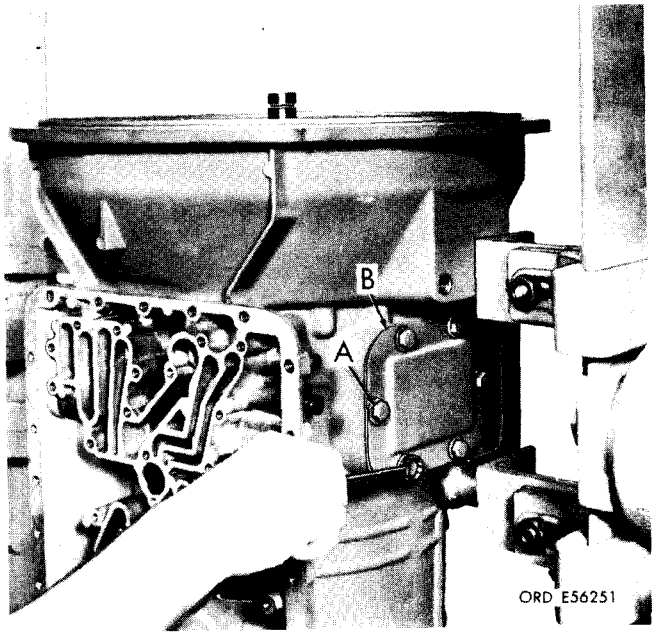


Figure 5-28 (Step 28).

Using a 9/16-inch wrench, remove six bolts (A) and six plain washers from right and left power takeoff covers (B).

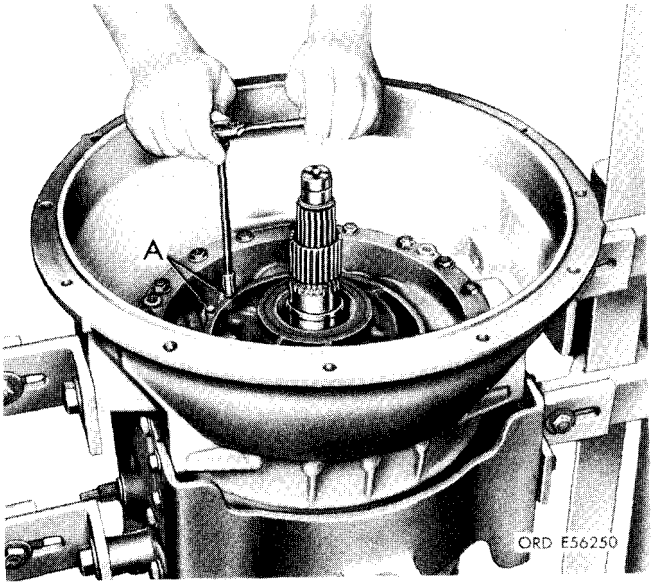


Figure 5-27 (Step 27).

Using a 5/16-inch wrench, remove two bolts (A) and two plain washers from front pitot tube.

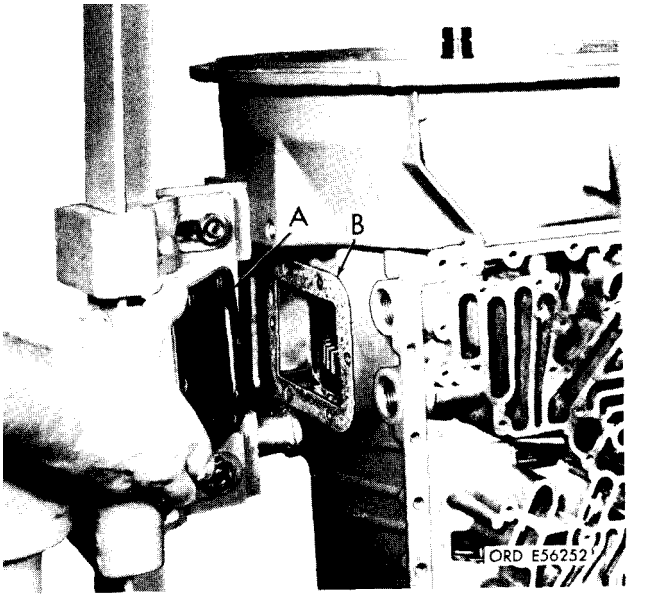


Figure 5-29

Remove right and left power takeoff covers (A) and gaskets (B).

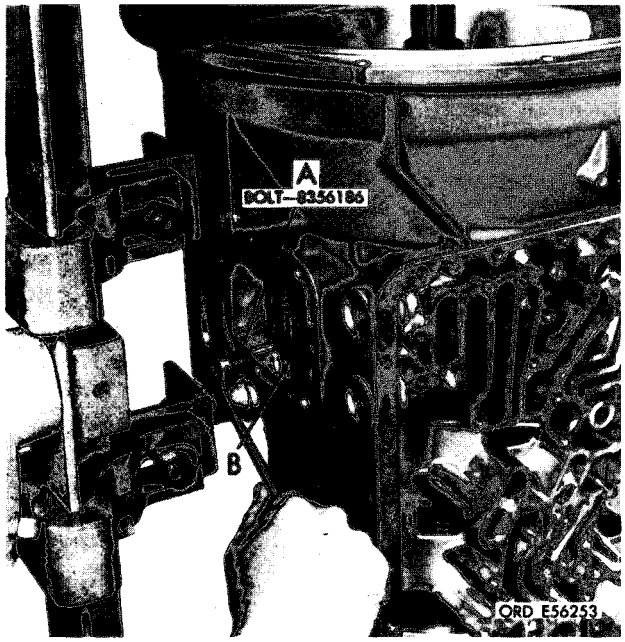


Figure 5-30 (Step 30).

Install two special bolts 4910-572-8701 (8356186) (A) each side, through upper-rear bolt holes in power takeoff pads. Tighten bolts to 10 to 12 pound-feet torque. These bolts secure intermediate clutch back plate (B) during disassembly.

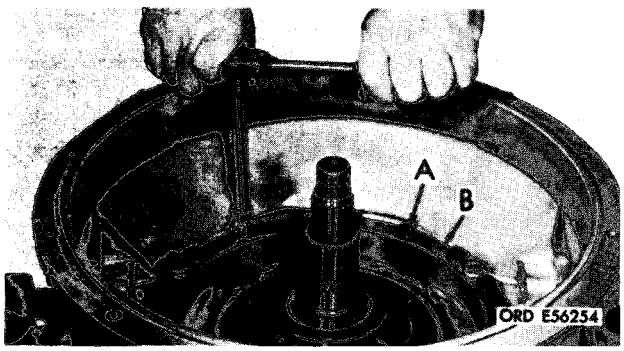


Figure 5-31 (Step 31).

Using a ½-inch wrench, remove 19 bolts (A) and 19 plain washers from diaphragm assembly (B).

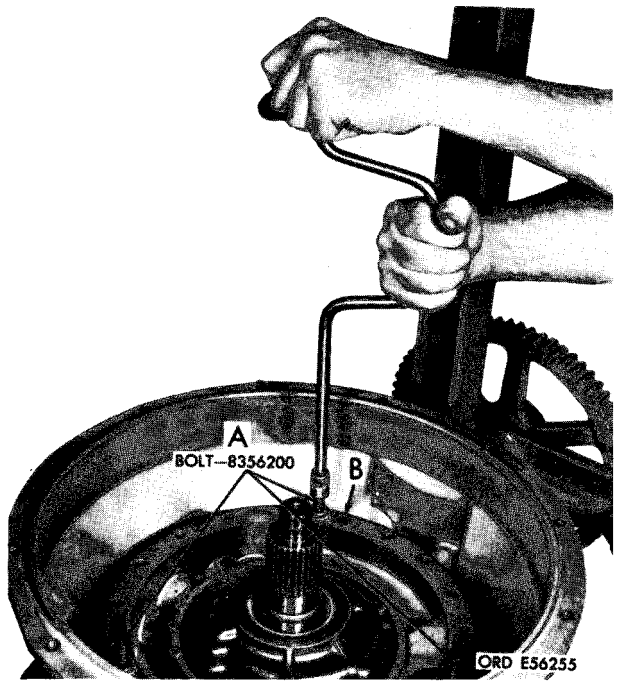


Figure 5-32 (Step 32).

Using three puller bolts 4910-572-8699 (8356200) (A) loosen and remove diaphragm assembly (B). Remove shims (under diaphragm).

CAUTION

Tighten puller bolts (A) evenly to avoid cramping diaphragm (B) in its bore.

NOTE

A needle bearing assembly and washer may come off with diaphragm assembly. If they did, inspect underside of diaphragm, and remove them.

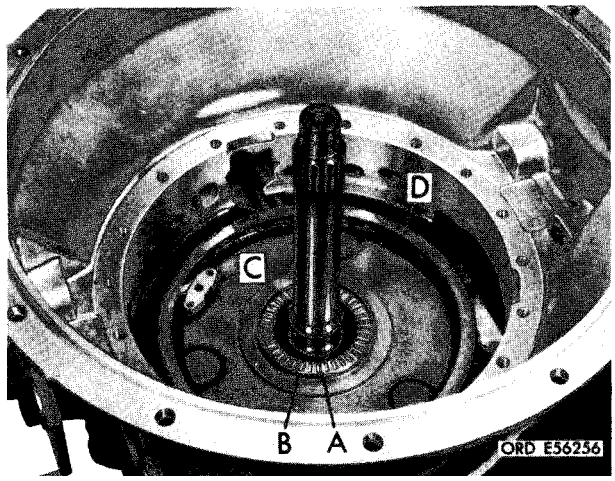


Figure 5-33 (Step 33).

If needle thrust bearing assembly (A) and washer (B) did not come off with diaphragm assembly, remove them. Remove front pitot tube (C) from pitot collector ring (D).

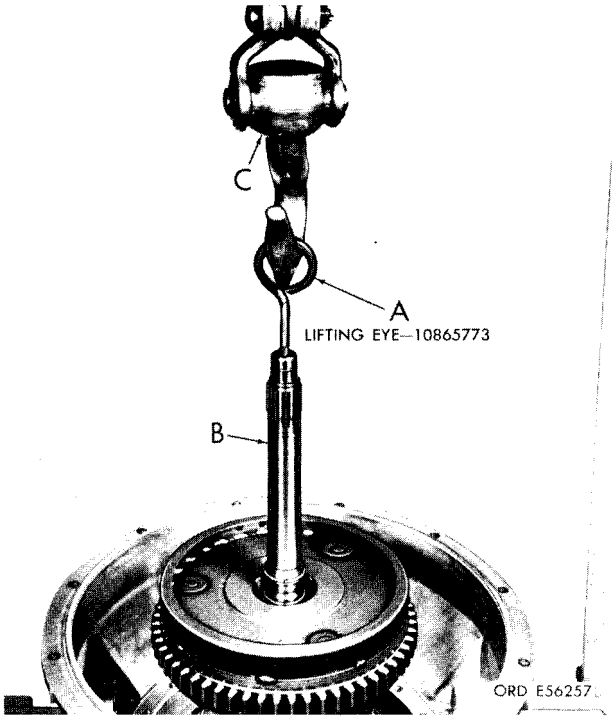


Figure 5-34 (Step 34).

Install lifting eye 4910-673-3801 (10865773) (A) into end of turbine shaft (B). Using hoist (C), remove turbine shaft (B), high-range clutch assembly, and intermediate- and low-range sun gears as a unit.

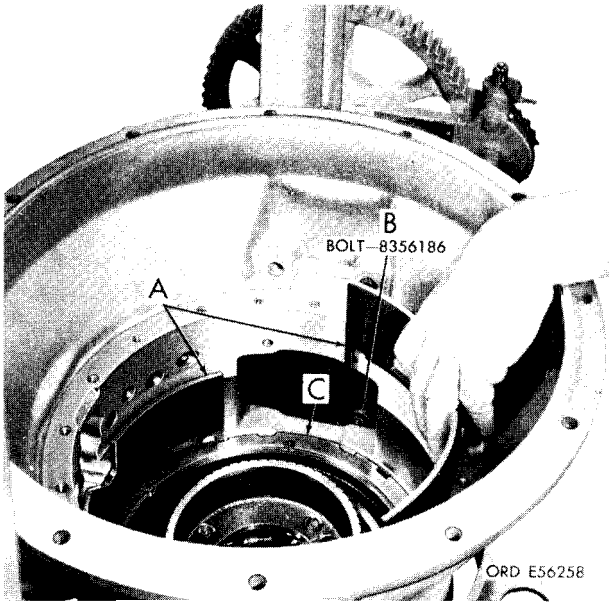


Figure 5-35. (Step 35).

Remove two spacers (A).

NOTE

Special bolt 4910-572-8701 (8356186) (B) securing clutch pack (C) is seen through power takeoff opening.

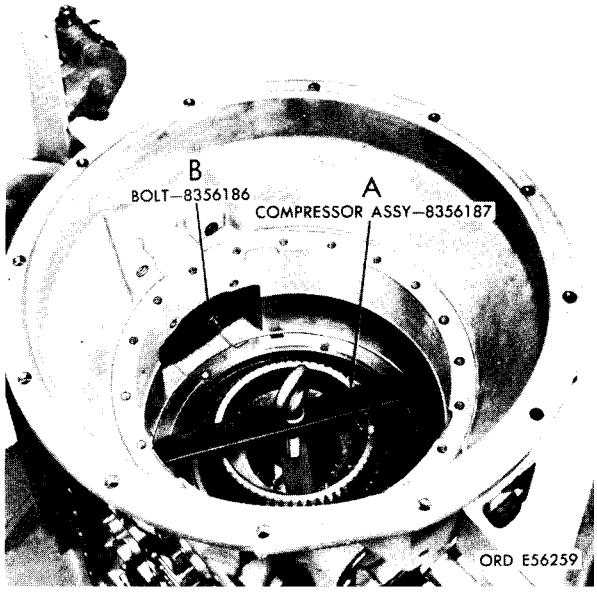


Figure 5-36

Install lifting eye 4910-673-3801 (10865773 (A) to compress intermediate, low, and reverse clutch pack. Remove two special bolts 4910-572-8701 (8356186) (B) (one each side) securing Clutch packs.

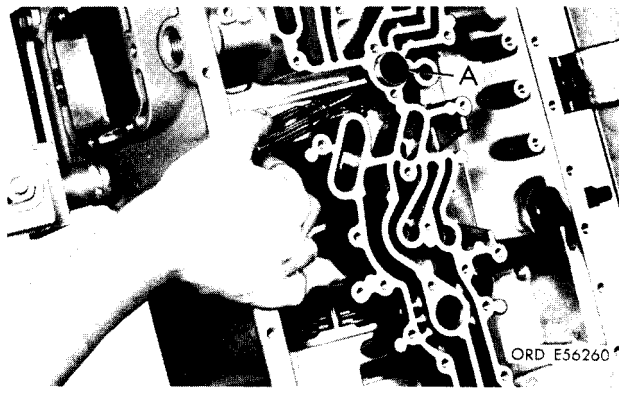


Figure 5-37 (Step 37).

Remove intermediate clutch anchor pin (A) by prying under its inner end with a small screwdriver.

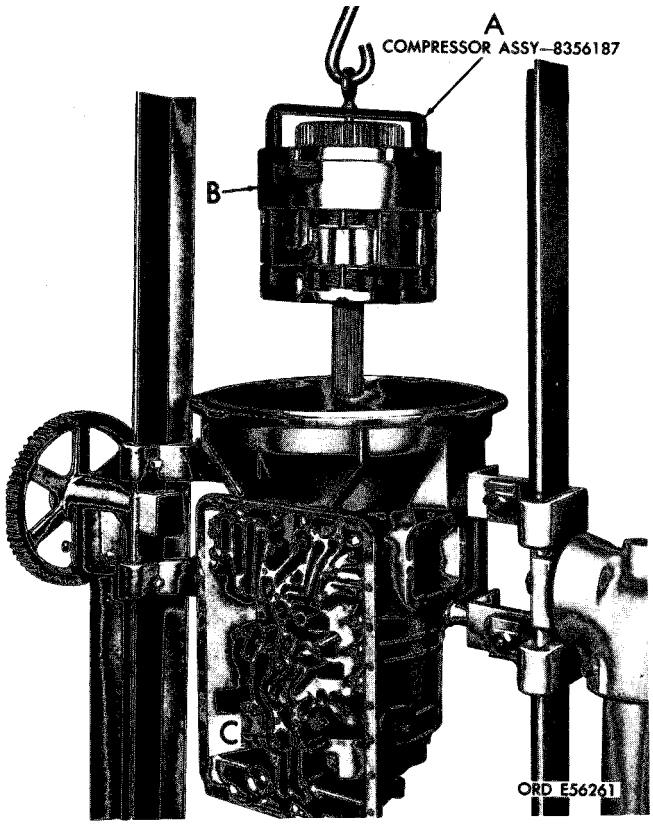


Figure 5-38 (Step 38).

Using a hoist attached to compressor assembly 4910-572-8643 (8356187) (A) remove intermediate, low, and reverse clutch pack (B) output shaft and associated parts as a unit. Remove low and reverse clutch anchor pin (C).

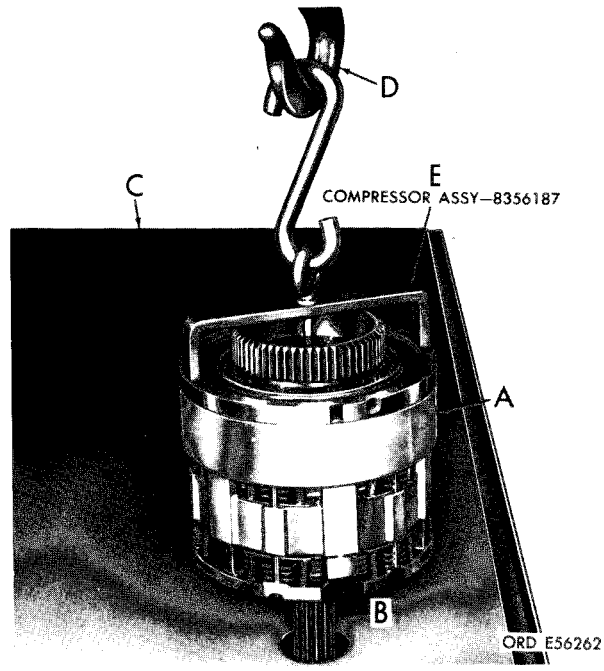


Figure 5-39 (Step 39).

Lower clutch pack assembly (A) so that output shaft (B) passes through hole in disassembly table (C). Remove hoist (D) and compressor assembly 4910-572-8643 (8356187) (E).

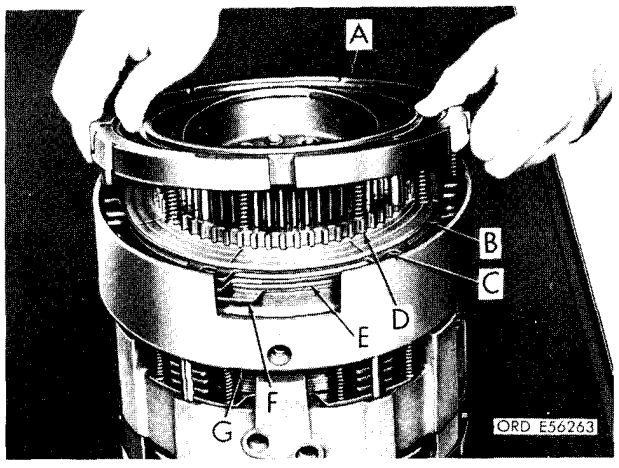


Figure 5-40 (Step 40).

Remove intermediate back plate assembly (A). Remove two internal-splined plates (B) and two external-tanged plates (C). Remove intermediate-range ring gear (D), and remaining inter nal-splined late (E) and apply plate (F). Remove in-termed iate-range clutch piston housing (G) and piston assembly.

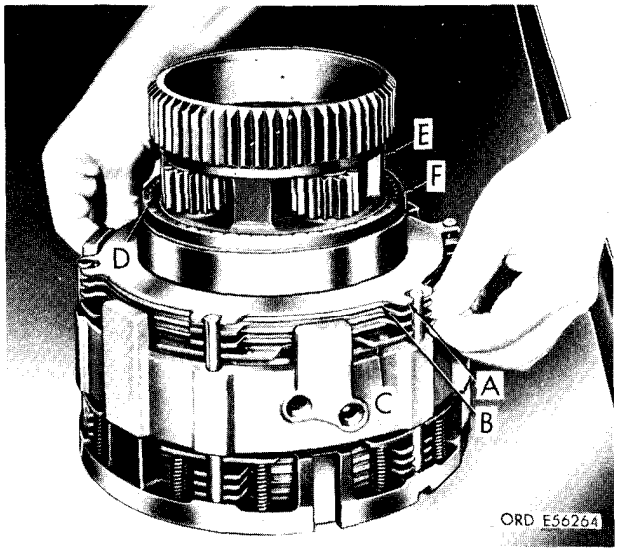


Figure 5-41 (Step 41).

Remove three external-tanged plates (A), three intern al-splined plates (B), and apply plate (C). Remove snap ring (D) securing intermediate carrier (E) in low-range ring gear (F). Remove intermediate carrier (E).

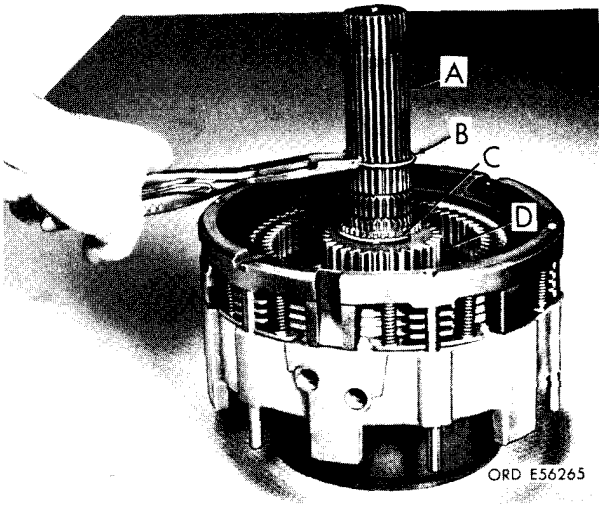


Figure 5-42 (Step 42).

Position remaining assembly with output shaft (A) up. Remove wire-type locating snap ring (B) from output shaft (A). Remove snap ring (C) securing reverse sun gear (D). Remove reverse sun gear (D), splined thrust washer, and spacer (under sun gear).

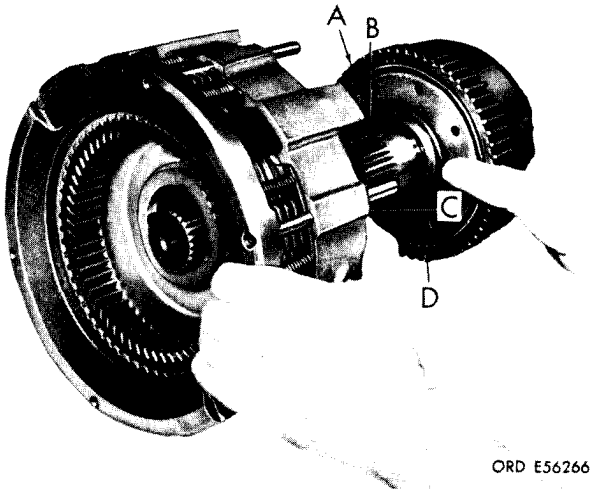


Figure 5-43 (Step 43).

Remove low-range planetary assembly, ring gear (A). and reverse sun gear shaft (B) from reverse clutch assembly (C). Remove snap ring (D). Remove reverse sun gear shaft (B) from ring gear (A).

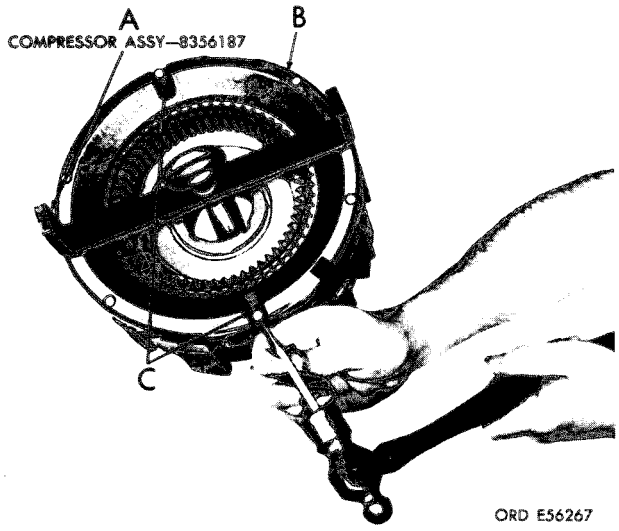


Figure 5-44 (Step 44).

Install compressor assembly 4910-572-8643 (8356187) (A) cm reverse clutch assembly (B) to compress springs. Remove two roll pins (C). Remove compressor assembly.

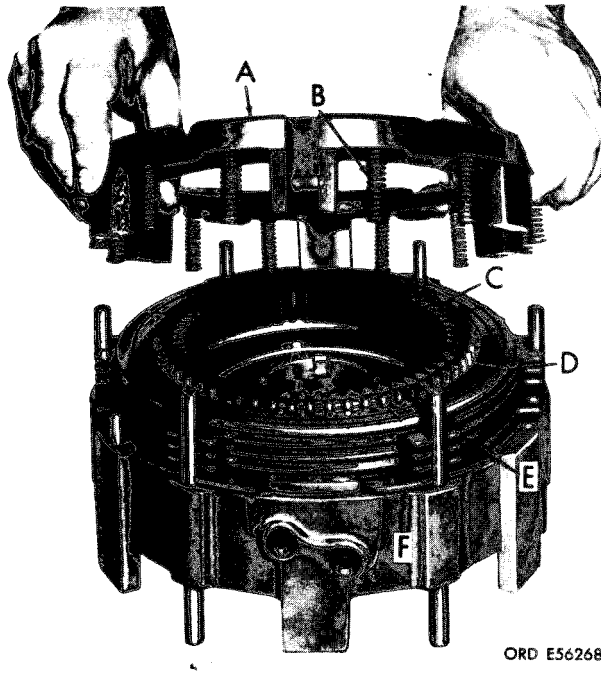


Figure 5-45 (Step 45).

Remove reverse back plate assembly (A). Remove 12 springs (B) from back plate (A) only if replacement is necessary. Remove reverse ring gear (C). four internal-splined plates (D), three external-tanged plates (E), and apply plate (F) as a unit, and separate parts.

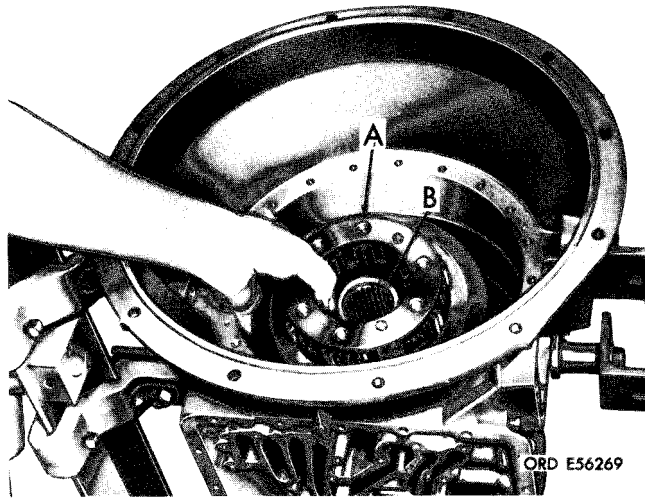


Figure 5-46

Remove reverse planetary carrier and pitot oil collector assembly (A). Remove thrust washer (B) from counterbore of carrier.

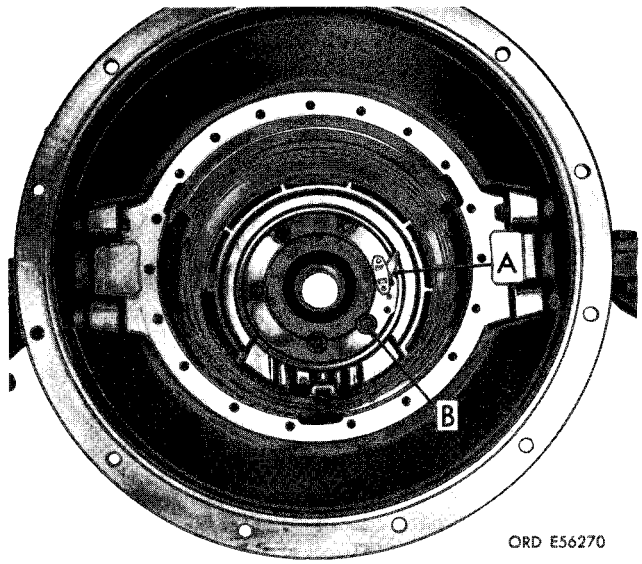


Figure 5-47 (Step 47).

Remove rear pitot tube (A). Using a 1/2-inch wrench, remove five rear oil pump bolts (B) and five washers.

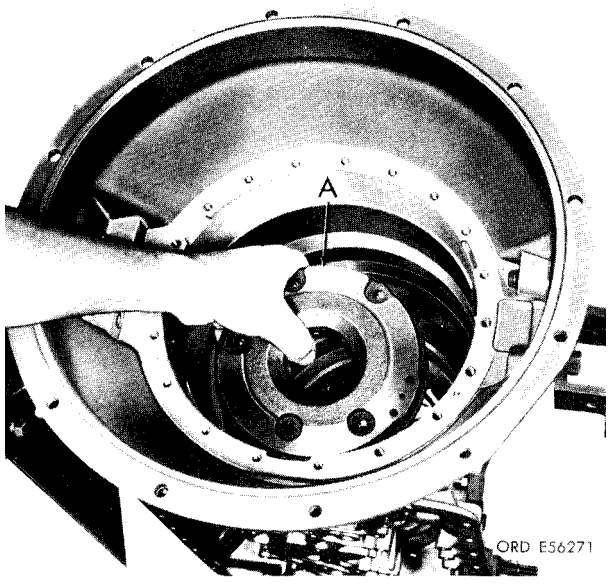


Figure 5-48 (Step 48).

Remove rear oil pump assembly (A)

NOTE

Do not separate oil pump parts for cleaning and inspection until gears are marked to show which side is front or rear.

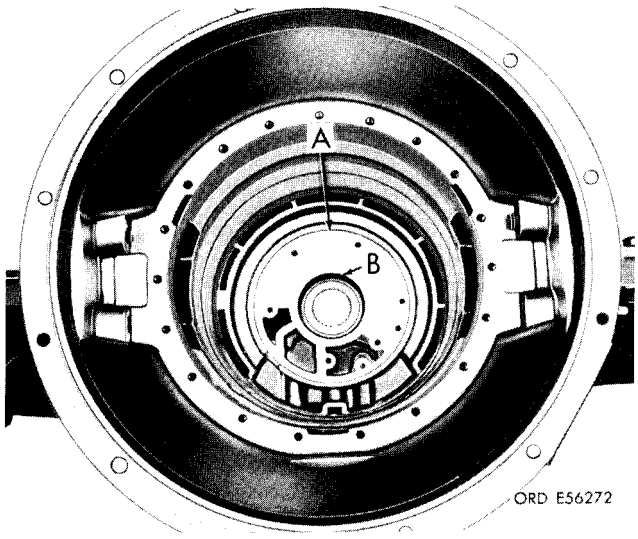


Figure 5-49 (Step 49).

Remove aluminum gasket (A) and speedometer drive gear (B)

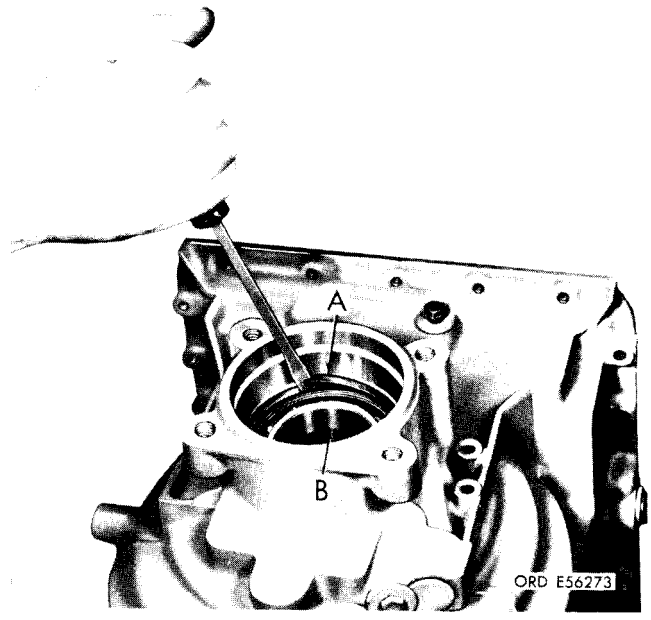


Figure 5-50 (Step 50).

Reposition transmission, rear end upward. Remove snap ring (A) and rear bearing (B)

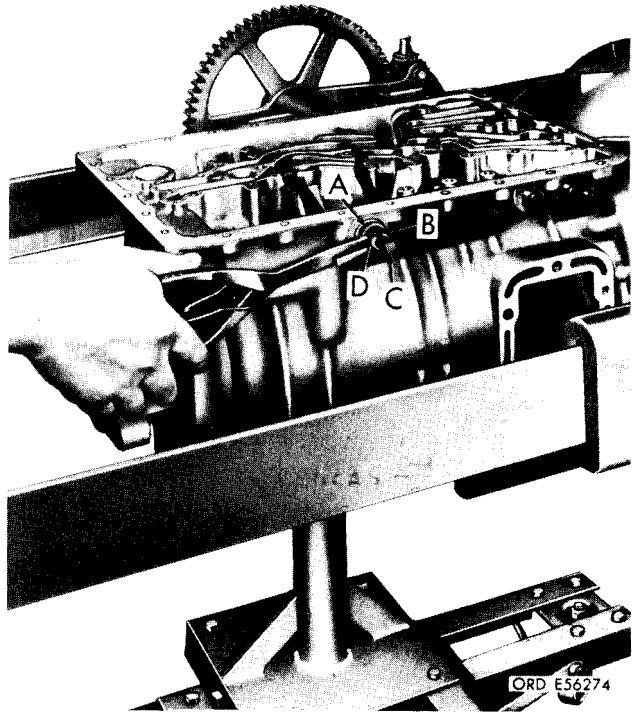


Figure 5-51 (Step 51).

Reposition transmission, bottom upward. Remove selector shaft snap ring (A) and throttle shaft snap ring (B). Remove throttle shaft (C) and selector shaft (D) from housing. Remove housing from repair stand.

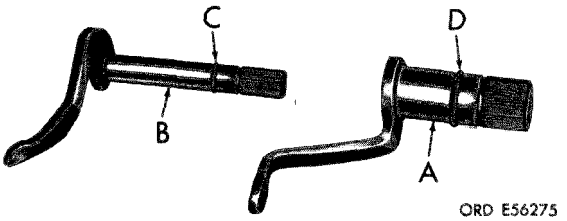


Figure 5-52 (Step 52).
Separate selector shaft (A) and throttle shaft (B). Remove seal ring (C) from throttle shaft (B) and seal ring (D) from selector shaft (A).

Section III. OVERHAUL (REBUILD) OF LOCKUP CLUTCH AND TORQUE CONVERTER

5-7. Description

Refer to paragraph 2-1 for description of lockup clutch components.

5-8. Disassembly

(fig. 5-53)

NOTE

All related items not covered in *a* through *c* below were removed from transmission as outlined in paragraph 5-6, steps 19 through 26 (fig. 5-19 through 5-26). No further disassembly of those parts is required.

a. Lockup Clutch (fig. 5-53).

(1) Remove snap ring (9) securing lockup clutch piston (8).

(2) Turn converter pump cover assembly (4) over with lockup clutch piston down, and bump cover sharply on wood blocks to remove piston (8).

(3) Lift out lockup clutch piston (8), and remove seal ring (10) from groove in piston outer diameter.

(4) Remove oil seal ring (7) and seal retainer (6) from hub of converter pump cover assembly (4).

(5) Remove converter pump cover bushing (5) only if replacement is necessary. Refer to paragraph 5-3d.

b. Converter Stator and Cam Assembly (fig. 5-53).

(1) Position stator and cam assembly (16) on bench so that freewheel roller race (35) is upward.

(2) Remove freewheel roller race by rotating it clockwise while lifting it out of converter stator and cam assembly (fig. 5-54).

(3) Remove 10 rollers and 10 springs from stator and cam assembly (fig. 5-54).

(4) Check needle bearing assembly (fig. 5-54). Do not remove it. Wash and flush needle bearing assembly thoroughly with dry cleaning solvent or mineral spirits paint thinner, dry, and lubricate with transmission oil. Rotate bearing while pressing upon rear thrust washer. If there is no roughness or binding, the bearing assembly and stator and cam assembly may be reused. Do not mistake dirt *or* grit for a damaged needle bearing. Reclean and re-oil needle bearing if dirt is suspected (TM 9-214).

(5) Do not attempt further disassembly of stator and cam assembly. If damaged or worn beyond reuse limits, install a new assembly (para 5-3a, *d,* and g.

c. *Converter Pump Assembly* (fig. 5-53).

(1) Remove hook-type seal ring (25) from pump hub (24).

(2) Remove any loose or damaged bolts (30) from flange of converter pump (29).

NOTE

If balance weights are loose or are removed, the same weights must be installed in the same locations.

(3) Flatten lock tabs and, using a 7/16-inch wrench, remove four tabs and eight bolts (fig. 5-55).

(4) Remove converter pump hub bearing retainer (fig. 5-56), converter pump hub, and converter pump hub gasket (under hub).

(5) Separate ball bearing assembly (23) and converter pump hub (24).

LEGEND to fig. 5-53.

1 Converter stack control spacer:
  0.027 to 0.029 thk (AR)
  0.045 to 0.047 thk (AR)
  0.063 to 0.065 thk (AR)
  0.081 to 0.083 thk (AR)
  0.099 to 0.101 thk (AR)
2 Stack control spacer retainer (6)
3 Pump cover nut (24)
4 Pump cover assembly
5 Cover hub bushing
6 Lockup clutch piston seal retainer
7 Lockup clutch piston seal ring
8 Lockup clutch piston assembly
9 Lockup clutch piston snap ring
10 Lockup clutch piston seal ring
11 Lockup clutch plate
12 Converter cover assembly seal
13 Lockup clutch back plate
14 Turbine retainer snap ring
15 Converter turbine assembly
16 Converter stator and cam assembly
17 Thrust needle bearing assembly
18 Stator freewheel roller (10)
19 Stator freewheel roller spring (10)
20 Converter pump hub bolt (8)
21 Pump hub bolt lock tab (4 I
22 Pump hub bearing retainer
23 Pump hub ball bearing
24 Converter pump hub
25 Pump hub hook-type seal ring
26 Converter pump hub gasket
27 Lockup clutch back plate seal
28 Converter pump assembly
29 Converter pump
30 Converter pump bolt (24)
31 Converter balance weight (AR)
32 Pump balance weight drive screw (AR)
33 Splined thrust washer
34 Snap ring
35 Freewheel roller race
36 Front oil pump assembly
37 Front oil pump seal
38 Front oil pump body
39 Front oil pump driven gear
40 Front oil pump drive gear
41 Front oil pump cover
42 Front oil pump seal ring

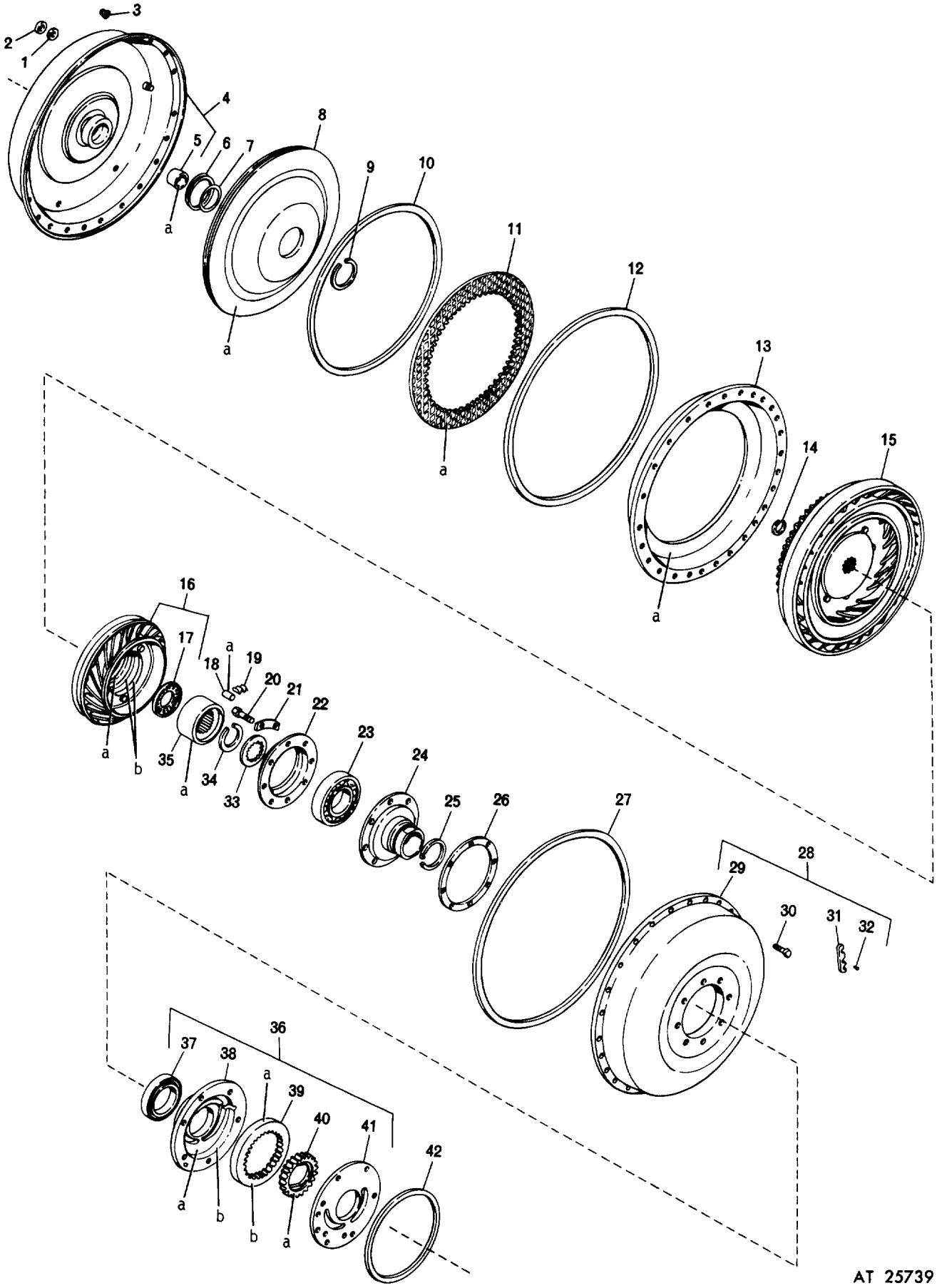


Figure 5-53. Lockup clutch. torque converter. and front oil pump-exploded view.

5-9. Cleaning

Refer to paragraph 5-2 for cleaning recommendations.

5-10. Inspection and Repair

Refer to paragraph 5-3 for general inspection and repair recommendations. Repair and overhaul (rebuild) points of measurement for fits, clearances, and wear limits are indicated by small letters in figure 5-53. Refer to paragraph 6-3 and table 6-3 for wear limits information.

5-11. Assembly

All items not covered in *a* through *c* below are installed as outlined in paragraph 5-58, steps 31 through 38 (fig. 5-114 through 5-121). No overhaul (rebuild) of such components is required or recommended.

a. Lockup Clutch Assembly (fig. 5-53).

(1) If bushing (5) in converter pump cover hub was removed, use replacer 5120-572-8656 and handle 5120-316-9182 (fig. 5-57) to install new bushing.

(2) Install seal retainer (6) on converter pump cover (4) hub with larger diameter toward open end of cover. Install oil seal ring (7).

(3) Install piston seal ring (10) in groove of lockup clutch piston (8) outside diameter.

(4) Insert lockup clutch piston (fig. 5-58) into converter pump cover with stamped balance marks (if any) alined so that piston guide pins will enter nearest holes in piston.

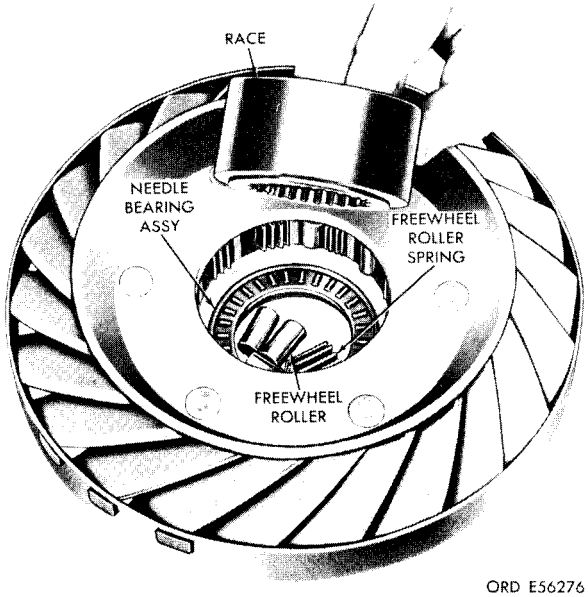


Figure 5-54. Removing freewheel roller race.

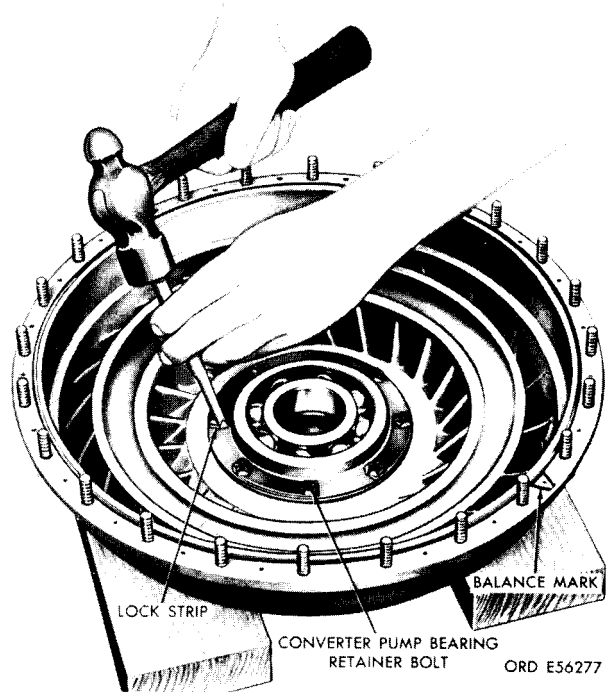


Figure 5-55.-Flattening lock strip tab.

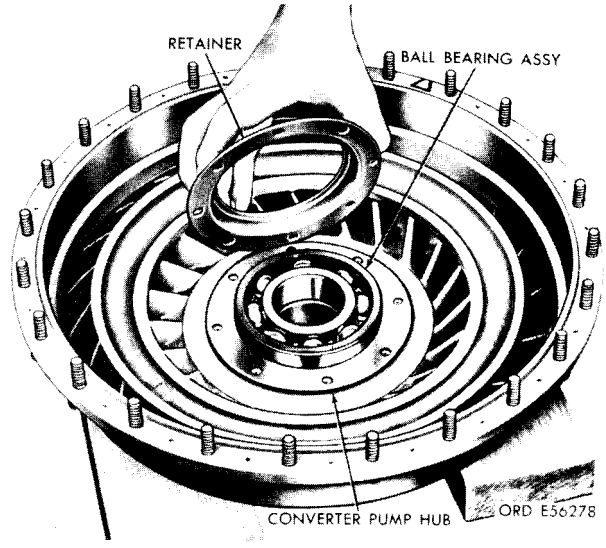


Figure 5-56. Removing or installing converter pump bearing

NOTE

To make installation of lockup clutch piston assembly easier, put a pencil mark in line with pin nearest orifice in piston (when balance marks are alined as in figure 5-58). Then, when piston assembly is being installed, use pencil mark as a guide to location of pin beneath orifice. One recessed hole in piston is concentric with orifice. Rotate piston slightly, if necessary, during installation to insure that piston engages pins. To make certain that piston is properly seated, measure distance from pump cover mounting surface to piston; this distance should be approximately $1^{1}/_{2}$ inches.

CAUTION

Lockup clutch will not release if piston is not engaged with pins.

(5) Install snap ring (9) on converter pump cover (4) hub.

b. Converter Stator and Cam Assembly (fig. 5-53).

(1) Position converter stator and cam assembly (fig. 5-59) with largest inside diameter up. Install 10 springs in cam pockets. Ends of springs must be toward center of stator and cam assembly and in deep end of cam pockets. Relative position of spring and roller is shown.

(2) Install holder assembly 4910-572-8588 (fig. 5-60) in converter stator and cam assembly. Install 10 rollers in cam pockets. Lubricate rollers and springs with transmission oil.

(3) Install freewheel roller race (35), counterbored side facing away from stator and cam assembly (16). into stator and cam assembly. Rotate freewheel roller race in a clockwise direction while installing, and seat on holder assembly.

(4) Hold freewheel roller race in place, and turn stator and cam assembly over (fig. 5-61). Remove holder assembly 4910-572-8688 by pulling on chain provided.

(5) Seat freewheel roller race (35) on needle bearing assembly (17). Position stator and cam assembly so freewheel roller race is upward until read y for installation.

c. Converter Pump Assembly (fig. 5-53).

(1) Position new converter pump hub gasket (26) on mounting face of converter pump (29).

(2) Install ball bearing (23) in converter pump hub (24).

(3) Install pump hub in converter pump bore, and aline holes.

(4) Place converter pump bearing retainer (22) over ball bearing, and aline holes (fig. 5-56).

(5) Install eight bolts (20) through four new tab locks (21). Tighten bolts to 9 to 11 pound-feet torque.

(6) Bend pointed corners of lock tabs up against flat sides of bolt heads to lock bolts.

(7) Replace converter pump flange bolts (30), as necessary, and make sure weights (31) (if any) are in place if pump bolts have been removed.

(8) Install hook-type seal ring (25) on pump hub (24).

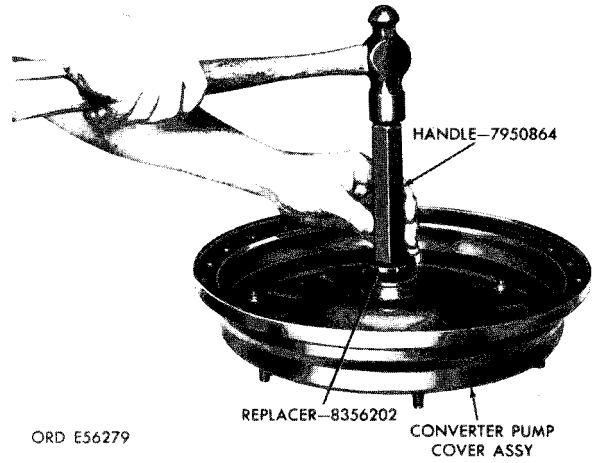


Figure 5-57. Installing bushing into hub of converter pump cover using handle 5120-316-9182 (7950864) and replacer 5120-572-8656 (8356202).

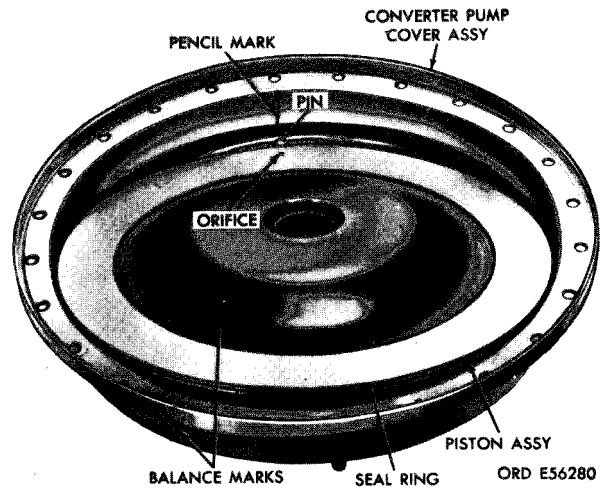


Figure 5-58. Positioning lockup clutch piston assembly for installation.

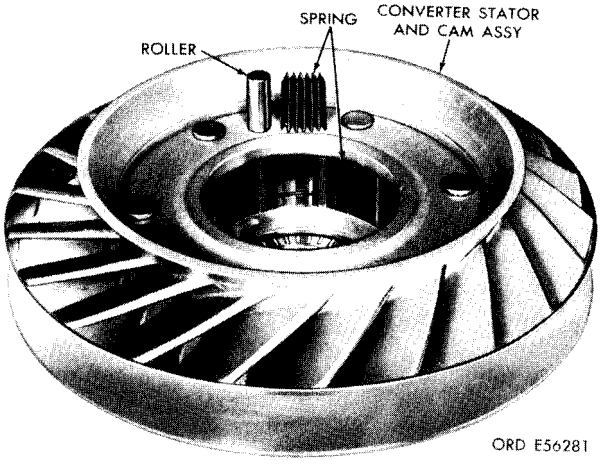


Figure 5-59. Converter stator and cam assembly, showing relation of components.

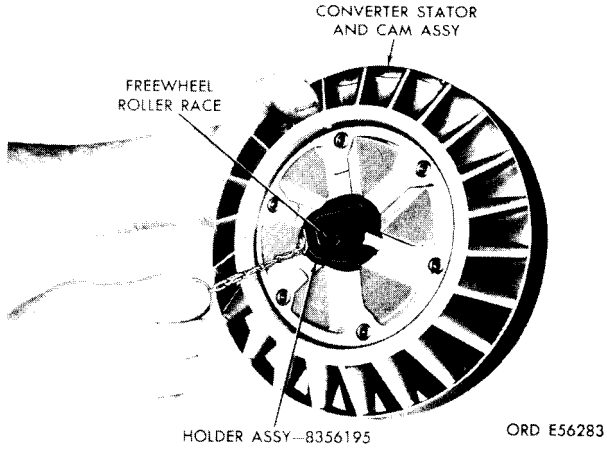


Figure 5-61. Removing roller holder assembly 4910-572-8688 (8356195).

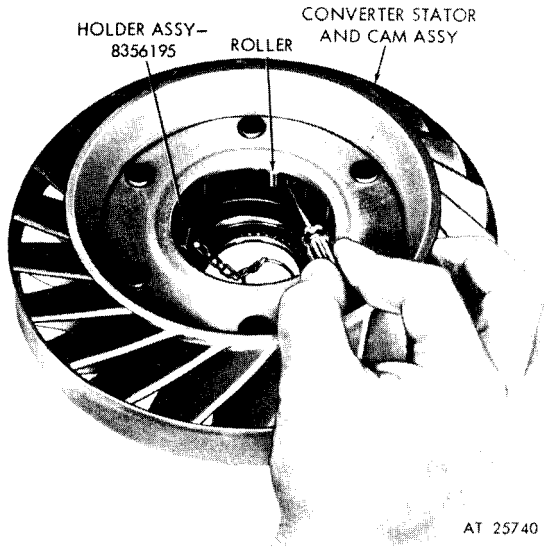


Figure 5-60. Installing freewheel roller using holder assembly 4910-572-8688 (8356195).

Section IV. OVERHAUL (REBUILD) OF FRONT OIL PUMP AND DIAPHRAGM ASSEMBLY

5-12. Description

Refer to paragraph 2-6 for description of front oil pump components and diaphragm assembly.

5-13. Disassembly

NOTE

All related items not covered in *a* and *b* below were removed from transmission as outlined in paragraph 5-6, steps 27 through 32 (fig. 5-27 through 5-32). No further disassembly of those parts is required.

a. Diaphragm Assembly (fig. 5-62).

(1) Remove two hook-type seal rings (fig. 5-63) from flange, and remove thrust washer,

(2) Using a $^{1}/_{2}$inch wrench, remove four oil pump bolts, leaving two bolts diametrically opposite each other. Loosen these two remaining bolts, enough so that by tapping on them, oil pump

(36, fig. 5-53) will be loosened in diaphragm. Remove two remaining bolts, and remove oil pump assembly.

(3) Using a 7/16inch wrench, remove six flange bolts (fig. 5-63), and remove flange.

(4) Do not attempt to remove central sleeve from sleeve and diaphragm assembly (5).

(5) Inspect oil pump side of diaphragm, and if seal ring (42, fig. 5-53) and cover (41, fig. 5-53) do not come out, remove them.

b. Front Oil Pump Assembly (fig. 5-53).

(1) Disassemble oil pump (36) into component parts. Identify front or rear sides of oil pump gears (39 and 40), to assure reinstallation in the same way.

(2) If necessary to remove oil seal (37), drive it out front of body (38).

LEGEND to fig. 5-62.

1 Front pitot tube washer (2)
2 Front pitot tube bolt (2)
3 Flat washer (19)
4 Self-locking bolt (19)
5 Sleeve and diaphragm assembly
6 Diaphragm gasket:
0.012 thk (AR)
0.016 thk (AR)
0.021 thk (AR)
7 Hook-type seal ring
8 Converter turbine shaft assembly
9 Converter turbine shaft
10 Lubrication orifice plug
11 Turbine shaft hook-type seal ring (2)
12 Turbine shaft snap ring
13 Back plate spacer (2)
14 High-range clutch housing support flange
15 Support flange bolt (6)
16 Front oil pump bolt (6)
17 Front pitot tube
18 Thrust washer
19 Thrust needle bearing assembly
20 Thrust washer
21 Hook-type seal ring (2)
22 High-range clutch housing assembly
23 High-range clutch housing bushing
24 High-range clutch housing hook-type seal ring
25 Piston teflon seal ring
26 Piston seal ring expander
27 High-range clutch piston assembly
28 High-range clutch piston return outer spring
29 High-range clutch piston return inner spring
30 Return spring retainer
31 Piston return spring retainer snap ring
32 High-range clutch rotating plate
33 High-range clutch stationary plate
34 High-range clutch rotating plate
35 High-range clutch stationery plate
36 High-range clutch rotating plate
37 High-range clutch stationery plate
38 High-range clutch rotating plate
39 High-range clutch stationary plate
40 Snap ring
41 Intermediate-range sun gear
42 Low-range sun gear
43 Low-range sun gear snap ring

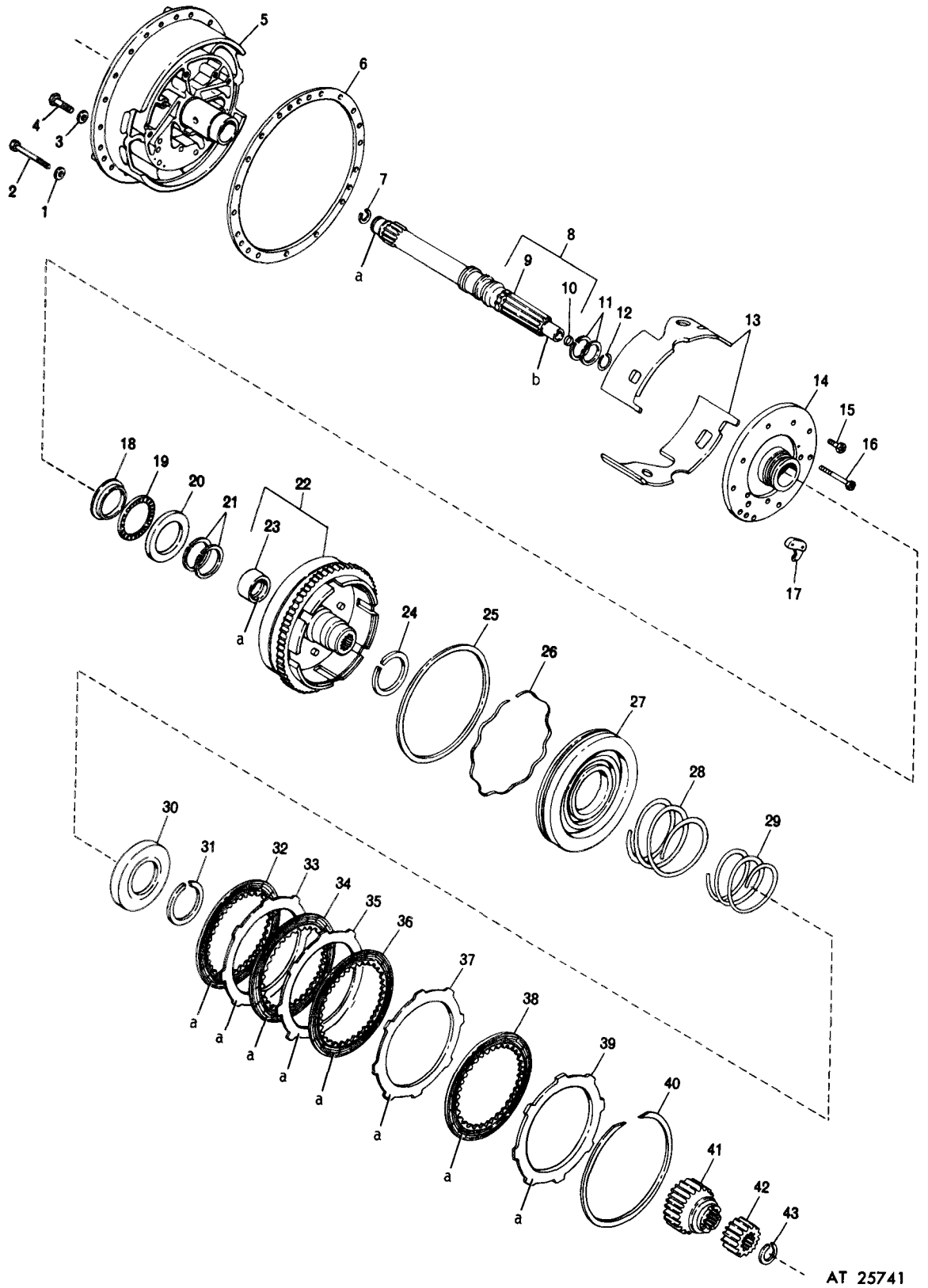


Figure 5-62. Diaphragm assembly, turbine shaft, and high-range clutch—exploded view.

5-14. Cleaning

Refer to paragraph 5-2 for cleaning recommendations.

5-15. Inspection and Repair

Refer to paragraph 5-3 for general inspection and repair recommendations. Repair and overhaul (rebuild) points of measurement for fits, clearances, and wear limits are indicated by small letters in figure 5-53 and figure 5-62. Refer to paragraph 6-3 and table 6-3 for wear limits information.

5-16. Assembly

NOTE

All items not covered in *a* and *b* below are installed as outlined in paragraph 5-58, steps 25 through 30 (fig. 5-108 through 5-113). No overhaul (rebuild) of such components is required or recommended.

a. Diaphragm Assembly (fig. 5-62).

(1) Install support flange (14) onto sleeve and diaphragm assembly (5).

(2) Install six self-locking bolts (15) into flange. Tighten bolts to 9 to 11 pound-feet torque.

(3) Install thrust washer (fig. 5-63) and two hook-type seal rings on flange.

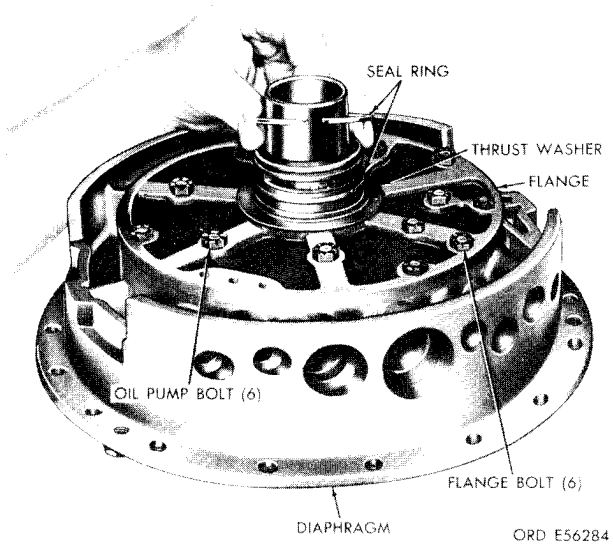


Figure 5-63. Removing or install support flange hub seal ring.

b. Front Oil Pump Assembly (fig. 5-53).

(1) If oil seal (37) was removed from body (38), install new seal using replacer .5120 -.572-8600 and handle 5120-316-9182 (fig. 5-64). Set body on a solid, firm surface when installing seal. Drive seal until replacer reaches supporting surface.

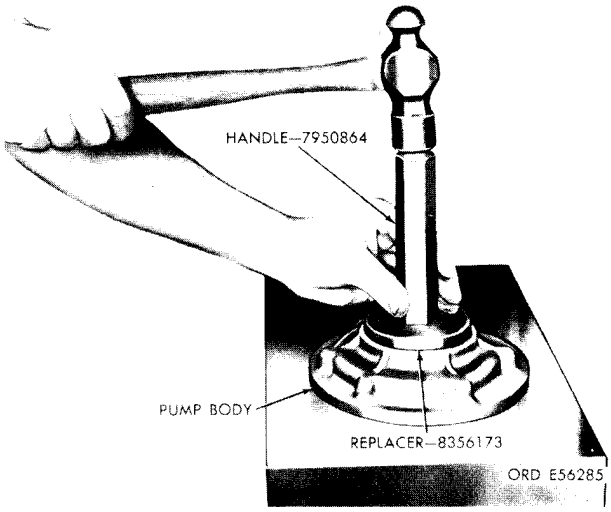
(2) Install pump gears (39 and 40) in body in same position as when removed.

(3) Install cover (41). and new seal ring (42).

(4) Install two guide bolts, part of set 4910-572-8710, in oil pump diametrically opposite each other.

(5) Install guide bolts in proper holes in diaphragm (fig. 5-65), and seat pump in place.

(6) Install four 5/16-18 X $2^{1}/_{2}$-inch bolts (fig. 5-63) into pump. Remove guide bolts (fig. 5-65), and install remaining two bolts. Tighten bolts to 17 to 20 pound-feet torque.



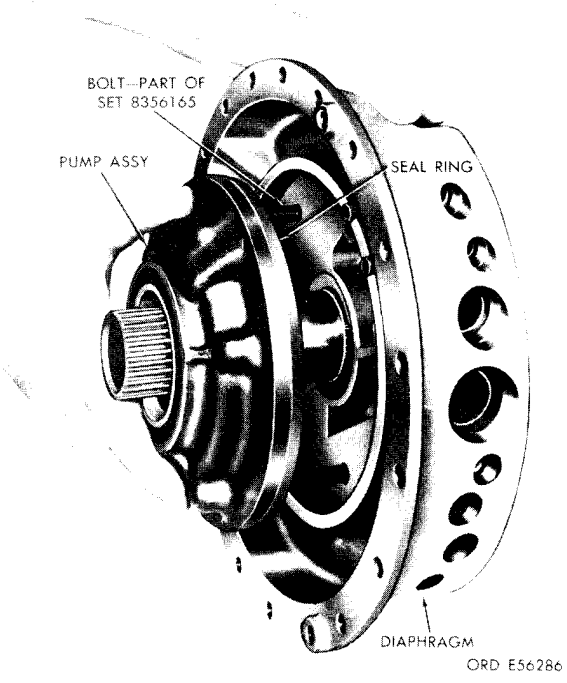


Figure 5-65. Installing front oil pump assembly (bolt is part of set 4910-572-8710 (8356165)).

Section V. OVERHAUL (REBUILD) OF HIGH-RANGE CLUTCH ASSEMBLY AND CONVERTER TURBINE SHAFT

5-17. Description

Refer to paragraph 2-2 for high-range clutch description and to paragraph 2-10 for converter turbine shaft description.

5-18. Disassembly

(fig. 5-62)

NOTE

All related items not covered in *a* and *b* below were removed from the transmission as outlined in paragraph 5-6, steps 33 through 35 (fig. 5-33 through 5-35). No further disassembly of those parts is required.

a. Converter Turbine Shaft (fig. 5-62).

(1) Remove snap ring (fig. 5-66) from converter shaft.

(2) Remove low-range sun gear and intermediate-range sun gear from converter shaft.

(3) Remove converter shaft from high-range clutch assembly.

(4) Remove retainer snap ring (12) and two hook-type seal rings (11) from converter turbine shaft assembly (8).

b. High-Range Clutch Assembly (fig. 5-62).

(1) Remove snap ring (fig. 5-67) from high-range clutch housing assembly.

(2) Remove reaction plate and four internal-splined and three external-tanged clutch plates.

(3) Using sleeve, part of kit 5180-572-8607, and a press, remove snap ring from high-range clutch housing hub (fig. 5-68).

(4) Remove return spring retainer (30) and springs (28 and 29) from housing (22).

(5) Remove high-range clutch piston assembly (2) from housing by tapping housing with a soft hammer.

(6) Remove Teflon seal ring (25) and seal ring expander (26) from piston (27)

(7) Remove hook-type seal ring (24) from housing.

(8) Remove bushing (23) from housing only if replacement is necessary.

WARNING

Do not dispose of Teflon seals by burning; toxic gases are produced.

5-19. Cleaning

Refer to paragraph 5-2 for cleaning recommendations.

5-20. Inspection and Repair

(fig. 5-62)

Refer to paragraph 5-3 for general inspection and repair recommendations. Also make certain that oil passages and orifice plug (10) are open and clean in converter turbine shaft (9). Inspect piston (27) to make certain that the two balls in clutch piston are free and that staking is satisfactory. Repair and overhaul (rebuild) points of measurement for fits, clearances, and wear limits are indicated by small letters in figure 5-62. Refer to paragraph 6-3 and table 6-3 for wear limits information.

5-21. Assembly

(fig. 5-62)

NOTE

All items not covered in *a* and *b* below are installed as outlined in paragraph 5-58, step 24 (fig. 5-106). No overhaul (rebuild) of such components is required or recommended.

a. High-Range Clutch Assembly (fig. 5-62).

(1) If bushing (23) was removed, install new bushing using replacer 5120-572-8658 and handle 5120-316-9182 (fig. 5-69).

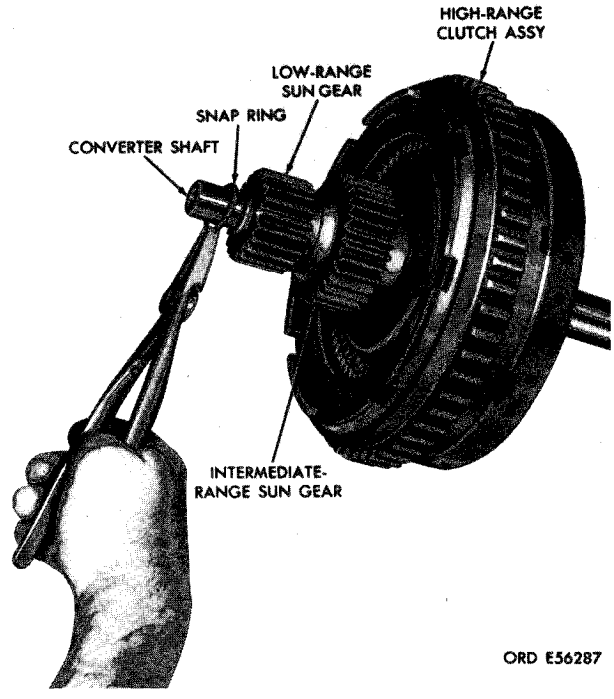


Figure 5-66. Removing low-range sun gear snap ring.

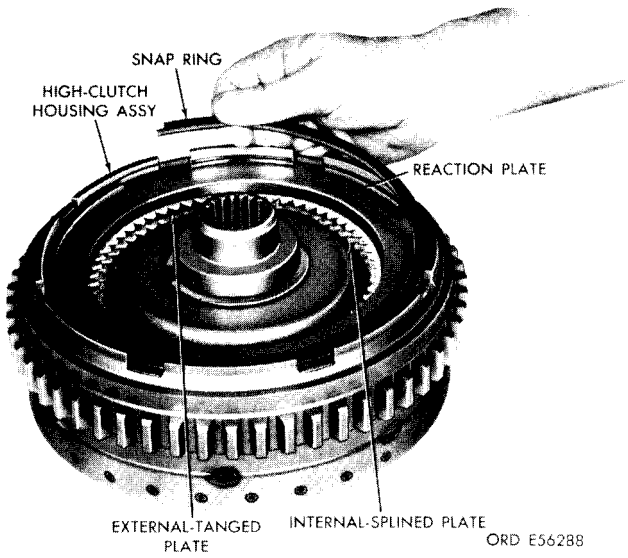


Figure 5-67. Removing or installing high-range clutch reaction plate snap ring.

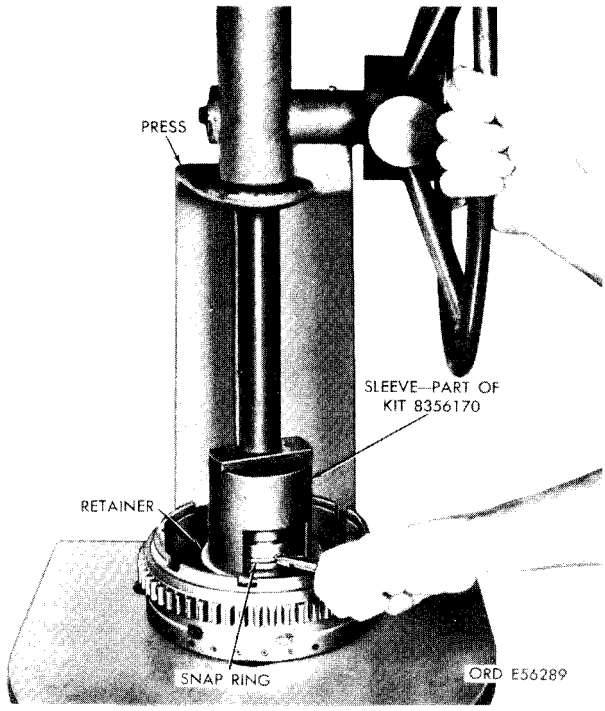


Figure 5-68. Removing high-range clutch spring retainer snap ring using sleeve (part of kit 5180-572-8607 (8356170)).

(2) Install hook-type seal ring (24) in housing (22).

(3) Install ring expander (26) and seal ring (25) on piston (27).

NOTE

Refer to paragraph 5-31a for proper method of installing expander and seal ring.

(4) Install high-range clutch piston assembly (27) into housing (22). Make certain that piston engages three drive pins in housing.

(5) Install inner and outer return springs (28 and 29) and retainer (30) in housing (fig. 5-70).

(6) Position guide, part of kit 5180-572-8607, on housing hub. Position snap ring over guide, and ring, part of kit 5180-572-8607, over snap ring (fig. 5-70).

(7) Place sleeve, part of kit 5180-572-8607, on ring and using a press, install snap ring in place (fig. 5-71).

(8) Starting with an internal-splined plate, alternately install four internal-s plined and three external-tanged plates (fig. 5-67).

(9) Install reaction plate and snap ring (fig. 5-67).

b. Converter Turbine Shaft (fig. 5-62).

(1) Install two hook-type seal rings (11) and retainer snap ring (12) on shaft assembly (8).

(2) Insert long splined end of converter turbine shaft assembly (8) in pitot collector side of high-range clutch housing assembly (22).

(3) Install intermediate-range sun gear and low-range sun gear on converter shaft (fig. 5-72).

(4) Using guide and driver, part of kit 2120-572-8663, install snap ring to secure sun gear on shaft (fig. 5-73).

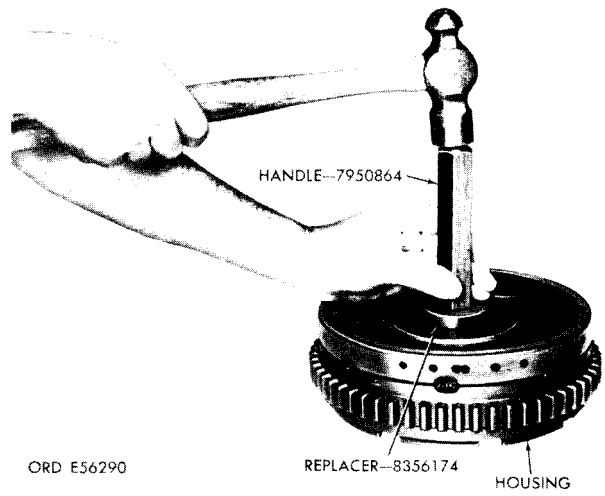


Figure 5-69. Installing high-range clutch housing bushing using handle 5120-316-9182 (7950864) and replacer 5120-572-8658 (8356174).

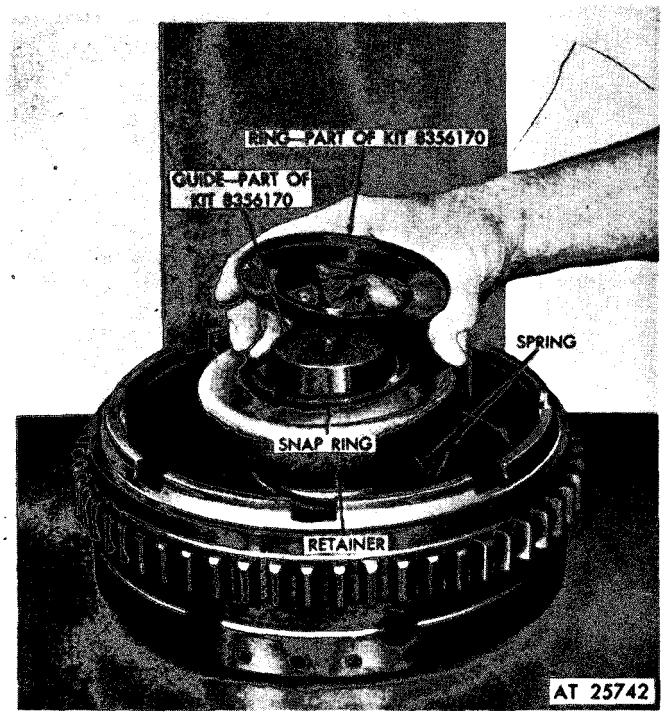


Figure 5-70. Positioning snap ring and replacer components on high-range clutch assembly using ring and guide (part of kit 5180-572-8607 (8356170)).

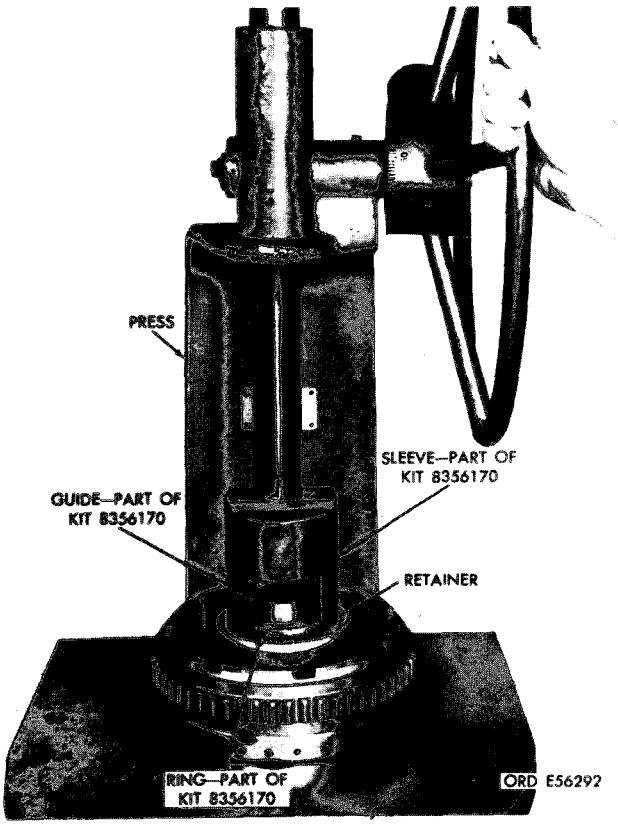


Figure 5-71. Installing high-range clutch spring retainer snap

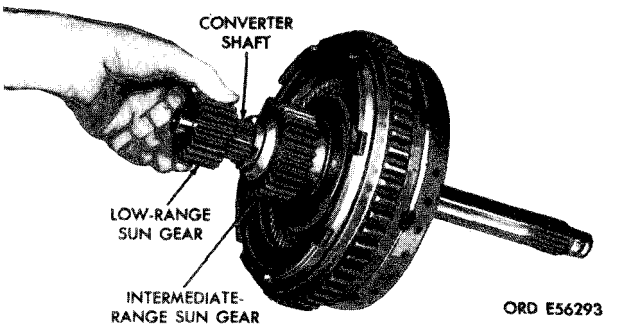


Figure 5-72. Installing low-range sun gear.

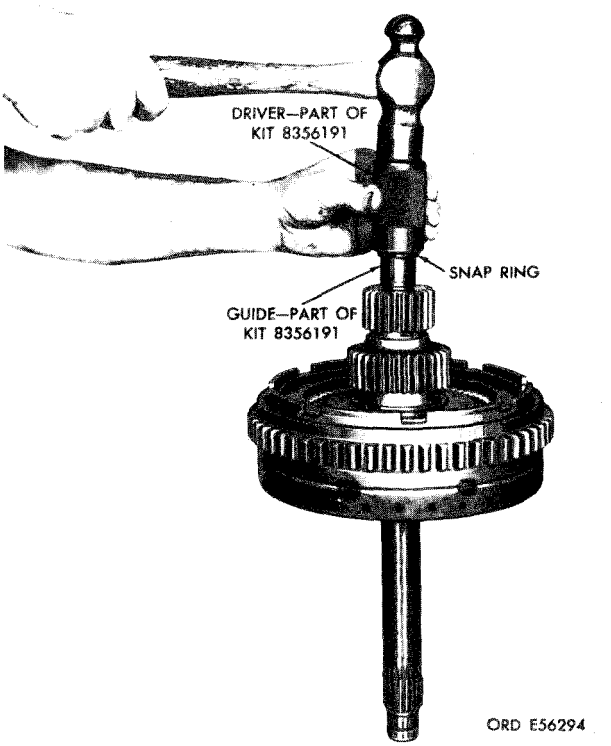


Figure 5-73. Installing low-range sun gear snap ring using driver and guide (part of kit-5120-572-8663 (8356191)).

Section VI. OVERHAUL (REBUILD) OF INTERMEDIATE-RANGE CLUTCH BACK PLATE ASSEMBLY

5-22. Description

Refer to paragraph 2-3 for description of intermediate-range clutch back plate assembly.

5-23. Disassembly

(fig. 5-74)

NOTE

All related items not covered in *a* and *b* below were removed from the transmission as outlined in paragraph 5-6, steps 36 through 40 (fig. 5-36 through 5-40). No further disassembly of those parts is required.

a. Remove ten springs (19) from back plate assembly (16) only if replacement is necessary.

b. If any of six anchor pins (18) need replacement, press them out of plate (16).

LEGEND TO FIG. 5-74.

1 Snapring
2 In termediate-ra nge planetary carrier assembly
3 Carrier spindle (4)
4 Pinion washer (4)
5 Pinion (4)
6 Pinion roller (80)
7 Pinion washer (4)
8 Intermediate-range planetary carrier
9 Intermed iate-range clutch rotating plate
10 Intermediate-range clutch stationary plate
11 Intermediate-ra nge clutch rotating plate
1 2 Intermediate-range ring gear assembly
1 3 Intermediate-range clutch stationary plate
14 Intermediate-range clutch rotating plate
1 5 Intermediate-range clutch apply plate
16 Intermediate-range clutch back plate assembly
17 Clutch back plate
18 Back plate anchor pin
19 Clutch piston return spring (1 0)
20 C lutch piston (outer) teflon seal
21 Clutch piston seal (outer) expander
22 Intermediate-range clutch piston assembly
23 Clutch piston seal (inner) expander
24 Clutch piston (inner) teflon seal
25 Intermediate-range clutch piston housing assembly
26 Low-range ring gear
27 Low-range clutch stationary plate
28 Low-range clutch rotating plate
29 Low -range clutch stationary plate
30 Low -range clutch rotating plate
3 1 Low-range clutch stationary plate
32 Low -range clutch rotating plate
33 Low-range clutch stationary plate
34 Clutch piston return spring (12)
35 Transm ission output shaft and low-range carrier assembly
36 Transmission output shaft and low-range planetary carrie
37 Thrust washer (4)
38 Thrust washer (4)
39 Pinion roller (88)
40 Pinion (4)
41 Thrust washer (4)
42 Thrust washer (4)
43 Spindle (4)
44 Output shaft bushing
45 Reverse-range sun gear shaft assembly
46 Snap ring
47 Low-range clutch piston
48 Clutch piston seal ring expander
49 Clutch piston teflon seal ring
50 Low -range clutch piston hook-t ype seal ring
5 1 Clutch piston housing assembly
52 Clutch piston housing
53 Clutch piston housing anchor pin (2)
54 Clutch piston housing anchor pin (6)
55 R everse-range clutch piston hook-type seal ring
56 Thrust spacer

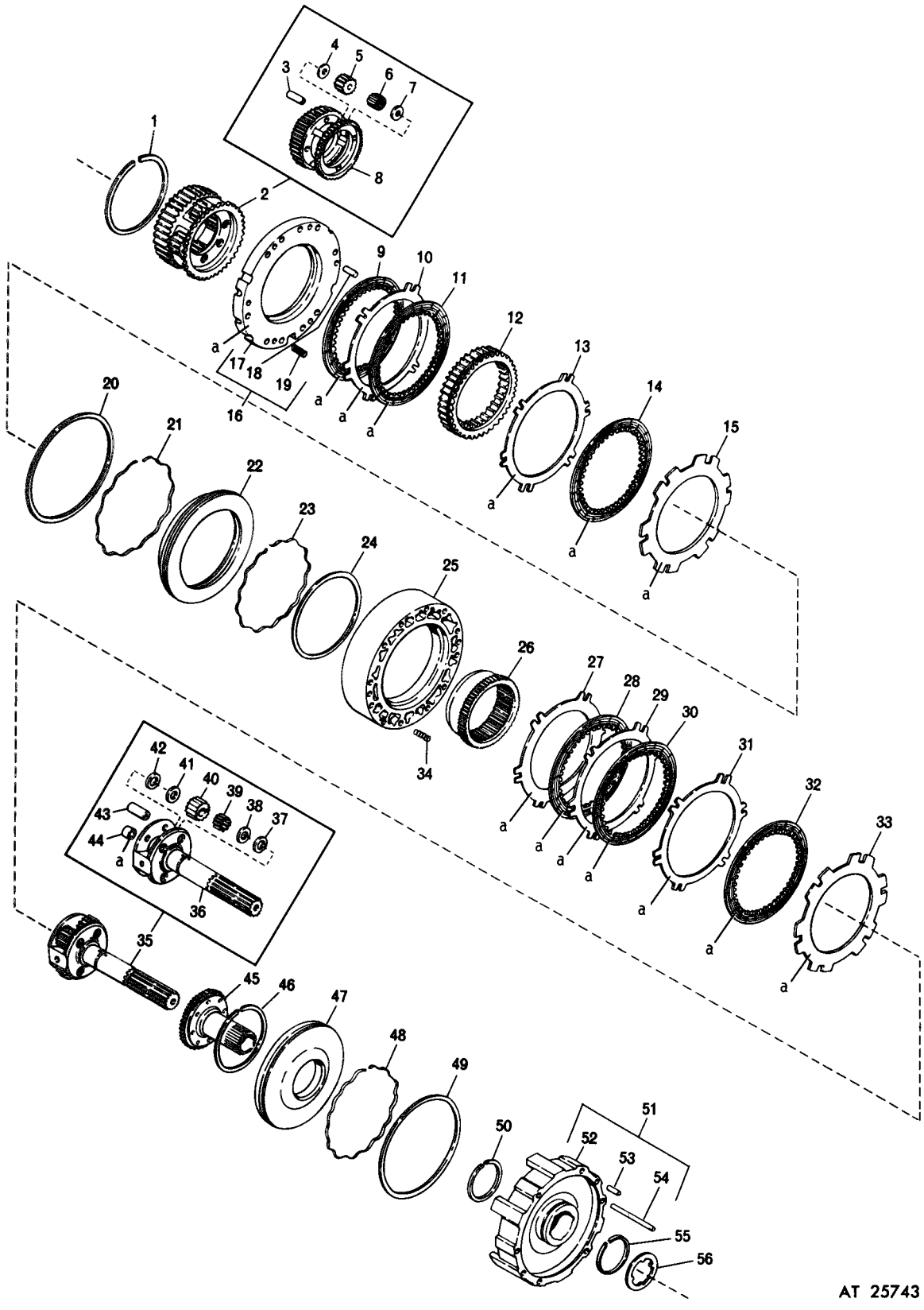


Figure 5-74. Intermediate, low-range clutches and planetaries—exploded view.

5-24. Cleaning

Refer to paragraph 5-2 for cleaning recommendations.

5-25. Inspection and Repair

Refer to paragraph 5-3 for general inspection and repair recommendations. Repair and overhaul (rebuild) points of measurement for fits, clearances, and wear limits are indicated by small letters in figure 5-74. Refer to paragraph 6-3 and table 6-3 for wear limits information.

5-26. Assembly

(fig. 5-74)

a. If any anchor pins (18) are being replaced, press them into flat side of plate (16) until ends of pins project 0.880 inch from flat side.

b. Install ten springs (19) in plate, and make certain they are properly seated in holes.

Section VII. OVERHAUL (REBUILD) OF INTERMEDIATE-RANGE CLUTCH PISTON HOUSING AND LOW- AND REVERSE-RANGE CLUTCH PISTON HOUSING ASSEMBLIES

5-27. Description

Refer to paragraphs 2-3 through 2-5 for description of the intermediate-range clutch piston housing and low-and reverse-range clutch piston housing assemblies.

5-28. Disassembly

(fig. 5-74)

NOTE

All related items not covered in *a* and *b* below or in separate rebuild sections, were removed from the transmission as outlined in paragraph 5-6, steps 40 through 45 (fig. 5-40 through 5-45). No further disassembly of those parts is required.

a. Intermediate-Range Clutch Piston Housing Assembly (fig. 5-74).

(1) Remove 12 springs (34) from housing assembly (25) only if replacement is necessary.

(2) Tap housing assembly to loosen piston assembly (22), and remove piston assembly.

(3) Remove outer seal ring (20) and expander (21) from outer groove of piston.

WARNING

Do not dispose of Teflon seals by burning; toxic gases are produced.

(4) Remove inner seal ring (24) and expander (23) from inner groove of piston.

b. Low- and Reverse-Range Clutch Piston Housing Assemblies (fig. 5-74).

(1) Tap housing assembly (fig. 5-76) lightly to loosen low-range clutch piston assembly, and remove piston assembly.

(2) Remove reverse-range clutch piston (47) in the same manner.

(3) Remove outer seal ring (49) and expander (48) from low-range clutch piston.

(4) Remove outer seal ring (1, fig. 5-75) and expander (2, fig. 5-75) from reverse-range clutch piston (3, fig. 5-75).

(5) Remove low-range clutch piston hook-type seal ring (50) and reverse-range clutch piston hook-type seal ring (55) from housing (52).

(6) If either of two anchor pins (53) need replacing, pull pins from housing (52).

(7) If any of six anchor pins (54) need replacing, press pins from housing (52).

LEGEND to, fig. 5-75.

1 Clutch piston teflon seal ring
2 Clutch piston seal ring expander
3 Reverse-range clutch piston
4 Reverse-range clutch apply plate
5 Reverse-range clutch rotating plate
6 Reverse-range ring gear assembly
7 Reverse-range clutch stationery plate
8 Reverse-range clutch rotating plate
9 Reverse-range clutch stationary plate
10 Reverse-range clutch rotating plate
11 Reverse-range clutch stationary plate
12 Reverse-range clutch rotating plate
13 Clutch piston return spring (12)
14 Reverse-range clutch back plate
15 Anchor pin retainer roll-type pin (2)
16 Thrust washer
17 Reverse-range sun gear
18 Sun gear snap ring
19 Sun gear shaft thrust washer
20 Output shaft snap ring
21 Reverse-range planetary carrier assembly
22 Spindle (6)
23 Pinion thrust washer (6)
24 Pinion thrust washer (6)
25 Pinion (6)
26 Pinion roller (120)
27 Pinion thrust washer (6)
28 Pinion thrust washer (6)
29 Rear pitot collector ring
30 Collector ring rivet (3)
31 Collector ring washer (3)
32 Reverse-range planetary carrier
33 Rear pitot tube
34 Rear oil pump bolt (5)
35 Lockwasher (5)
36 Rear oil pump assembly
37 Pump body
38 Driven gear
39 Drive gear
40 Pump cover
41 Gasket

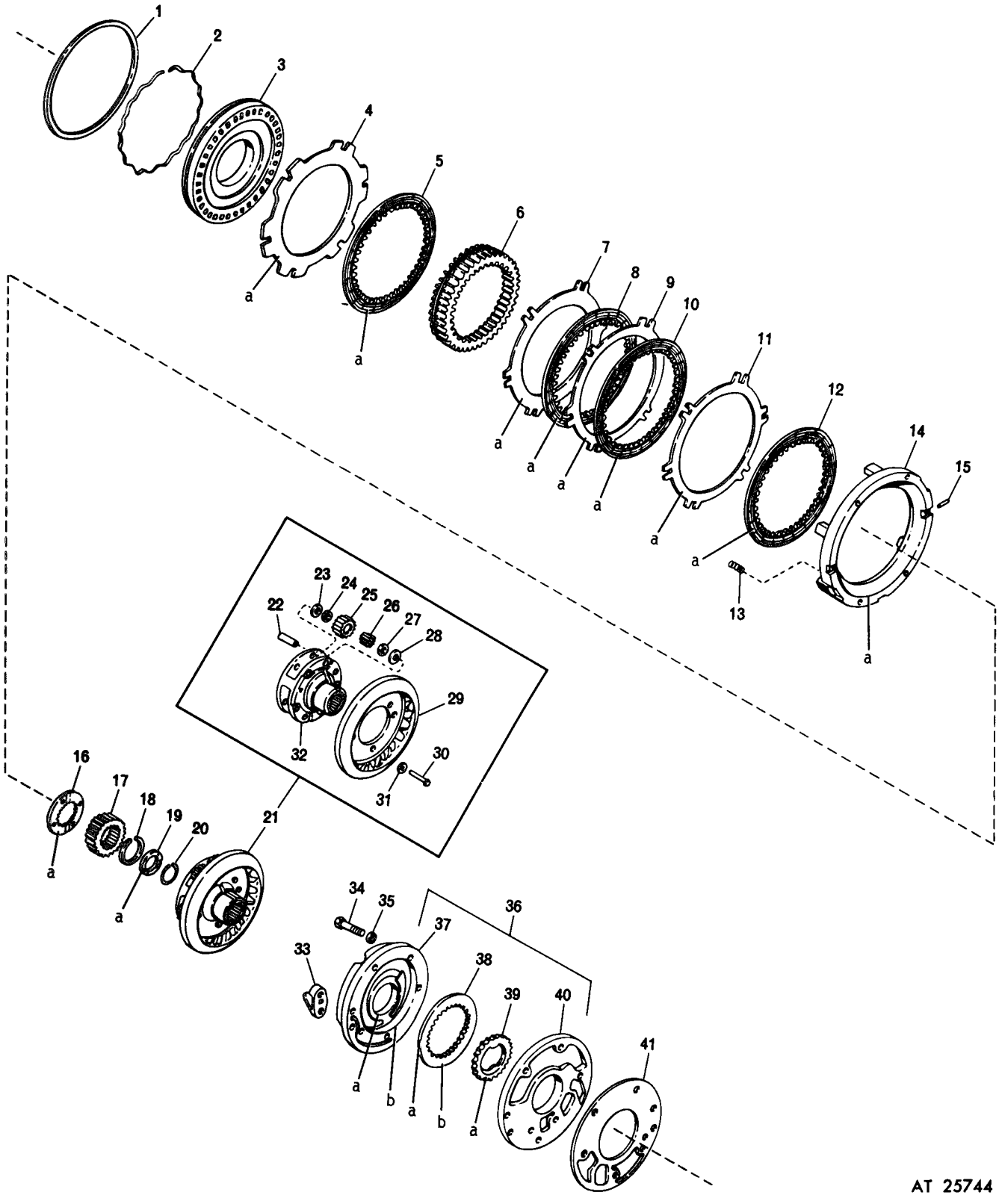


Figure 5-75. Reverse-range clutch and planetary, and rear oil pump—exploded view.

5-29. Cleaning

Refer to paragraph 5-2 for cleaning recommendations.

5-30. Inspection and Repair

Refer to paragraph 5-3 for general inspection and repair recommendations. Repair and overhaul (rebuild) points of measurement for fits, clearances, and wear limits are indicated by small letters in figure 5-74. Refer to paragraph 6-3 and table 6-3 for general wear limits information. Do not scuff, cut, tear, or distort Teflon seal ring.

5-31. Assembly

(fig. 5-74)

NOTE

All items not covered in *a* and *b* below or in separate rebuild sections, are installed as outlined in paragraph 5-58, assembly steps 11 through 20 (fig. 5-93 through 5-102). No overhaul (rebuild) of such components is required or recommended.

a. Intermdiate-range Clutch Piston Housing Assembly (fig. *5-74).*

(1) Install seal expander (fig. 5-77) into outer groove in piston.

NOTE

Both ends of seal expander must be as shown in figure 5-77 when it is coiled. Ends must curve away from seal ring so that they will not gouge seal.

(2) Starting at a point *opposite* open ends of expander, install seal ring in groove. It will be necessary to stretch outer seals slightly to get them into the groove.

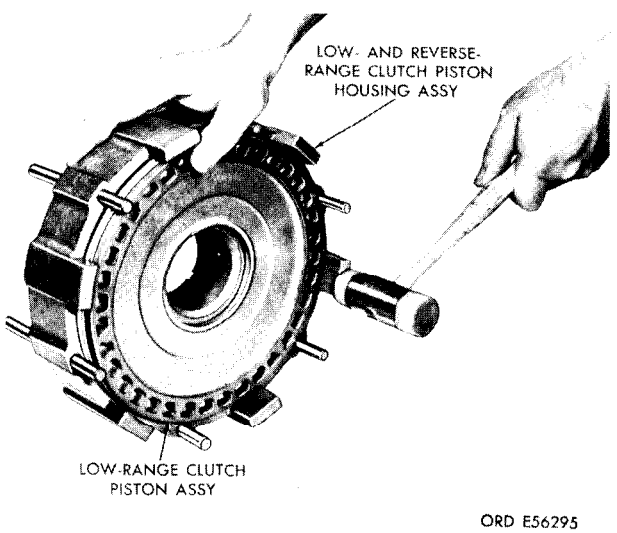


Figure 5-76. Removing low-range clutch piston assembly.

NOTE

Do not stretch seal any more than is absolutely necessary.

(3) Install seal expander (fig. 5-78) into inner groove of piston.

NOTE

Both ends of seal expander must be as shown in figure 5-78 when it is coiled. Ends must curve away from seal ring so that they will not gouge seal.

(4) Starting at a point *opposite* open ends of expander, install seal into groove.

(5) Center piston in piston housing, and push evenly into piston bore. The broader, flat side of piston goes toward housing bore.

(6) Install 12 springs (34) in housing assembly (25).

b. Low-and Reverse-Range Clutch Piston Housing Asspembly (fig. 5-74).

(1) If necessary to replace any of six anchor pins (54), press pin(s) into housing (52) until end of pin with hole projects 1.85 inches from flat side of housing. Hole in end of pin must point approximately toward center of housing.

(2) If necessary to replace two anchor pins (53), press them in until end of pin(s) projects 0.62 inch from flat side of housing.

(3) Install reverse-range clutch piston hook-type seal ring (55) and low-range clutch piston hook-type seal ring (50).

(4) Install seal expander (2, fig. 5-75) on reverse-range clutch piston (3, fig. 5-75) in same manner as instructed in *a* (1) above.

(5) Install reverse-range clutch piston seal ring (1 , fig. 5-75) in same manner as instructed in *a* (2) above.

(6) Install seal expander (48) on low-range clutch piston (47) in same manner as instructed in *a* (l) above.

(7) Install low-range clutch piston seal ring (49) in same manner as instructed in *a* (2) above.

(8) Center reverse-range clutch piston (3, fig. 5-75) and low-range clutch piston (47) in their respective bores in housing (52), and push each evenly into bores in housing. The broader, flat sides of pistons go toward housing bores.

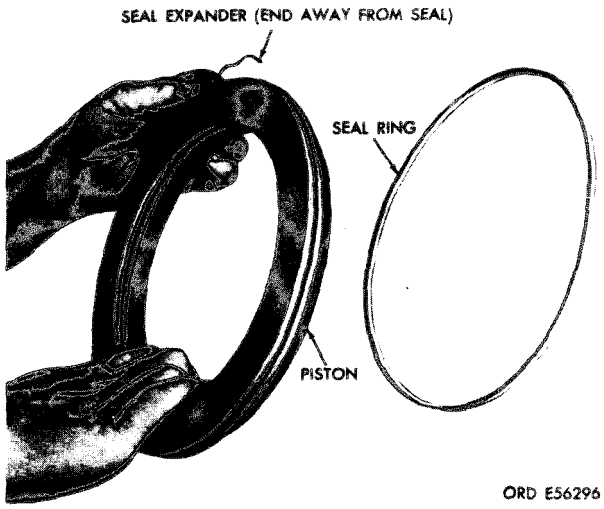


Figure 5-77. Installing piston external seal expander.

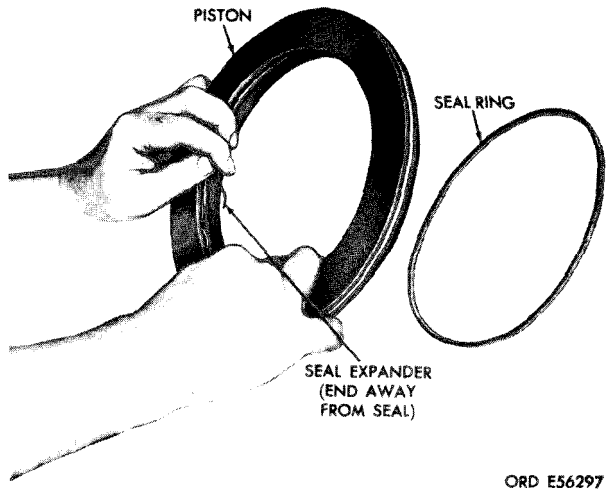


Figure 5-78. Installing piston internal seal expander.

Section VIII. OVERHAUL (REBUILD) OF REVERSE-RANGE PLANETARY CARRIER ASSEMBLY

NOTE

If the assembly is worn or damaged such that the operations below will not restore it to serviceable on, replace entire assembly.

5-32. Description

Refer to paragraph 2-5 for description of the reverse-range planetary carrier assembly.

5-33. Disassembly

(fig. 5-75)

NOTE

All items not covered below were removed from the transmission as outlined in paragraph 5-6, steps 46 through 50 (fig. 5-46 through 5-50). No further disassembly of those parts is required. If rear pitot collector ring (29) is damaged in any way, press out three riveta (30), and remove collector ring and three washers (31) from reverse-range planetary carrier (32).

5-34. CIeaning

Refer to paragraph 5-2 for cleaning recommendations.

5-35. Inspection and Repair

Refer to paragraph 5-3 for general inspection and repair recommendations. Repair and overhaul (rebuild) points of measurement for fits, clearances, and wear limits are indicated by small letters in figure 5-75. Refer to paragraph 6-3 and table 6-3 for general wear limits information.

5-36. Assembly

(fig. 5-75)

NOTE

All items not covered in *a* through c below are installed as outlined in paragraph 5-58, steps 3 through 10 (fig. 5-85 through 5-92). No overhaul (rebuild) of such components is required or recommended.

a. If rear pitot collector ring (29) is being replaced, place ring on hub side of carrier (32) with large opening up.

b. Install three washers (31) on three rivets (30), and insert rivets through collector ring and into carrier.

c. Support rivet heads and, using a press, cold-form head on flat side of carrier to 0.030-inch minimum height with approximately 6 tons press load per rivet.

d. Using oil-soluble grease to retain it, install thrust washer (19) into counterbore at front of carrier assembly (21).

Section IX. OVERHAUL (REBUILD) OF TRANSMISSION OUTPUT SHAFT ASSEMBLY

NOTE

If the assembly is worn or damaged such that the operation below will not restore it to serviceable condition, replace entire assembly.

5-37. Description

Refer to paragraph 2-10 for description of the transmission output shaft assembly.

5-38. Disassembly

(fig. 5-74)

NOTE

All items not covered below were removed from the transmission as outlined in paragraph 5-6, steps 42 and 43 (fig. 5-42 and 5-43). No further disassembly of those parts is required. If bushing (44) is worn or damaged such that replacement is necessary, remove bushing from bore. Do not damage bushing bore when removing bushing.

5-39. Cleaning

Refer to paragraph 5-2 for cleaning recommendations.

5-40. Inspection and Repair

Refer to paragraph 5-3 for general inspection and repair recommendations. Repair and overhaul (rebuild) points of measurement for fits, clearances, and wear limits are indicated by sm all letters in figure 5-74. Refer to paragraph 6-3 and table 6-3 for general wear limits information.

5-41. Assembly

(fig. 5-74)

NOTE

All items not covered below are installed as outlined in paragraph 5-58, steps 14 through 16 (fig. 5-96 through 5-98). No overhaul (rebuild) of such components is required or recommended. If bushing (44), was removed, install new bushing using replacer 5120-759-5415 and handle 5120-316-9182. Drive until replacer bottoms against output shaft (fig. 5-79).

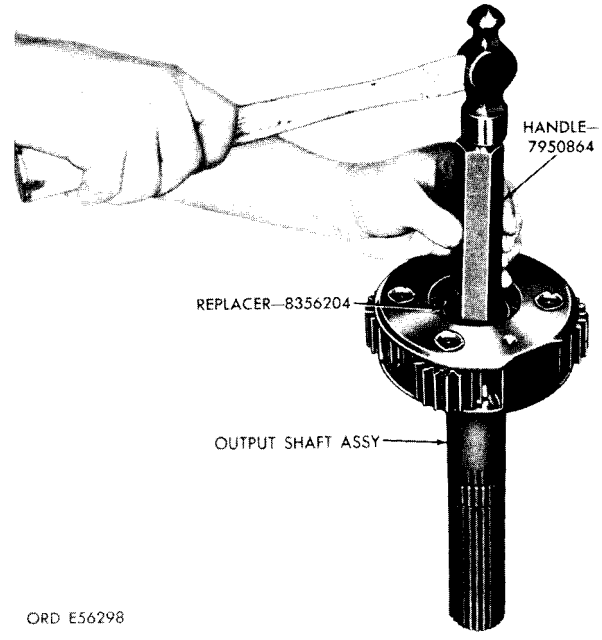


Figure 5-79. Installing bushing into transmission output shaft using handle 5120-316-9182 (7950864) and replacer 5120-759-5415 (8356204).

Section X. OVERHAUL (REBUILD) OF TRANSMISSION HOUSING ASSEMBLY

5-42. Description

Refer to paragraph 2-8 for description of the transmission housing assembly.

5-43. Disassembly

(fig. 5-81)

NOTE

All items not covered in sand *b* below were removed from the transmission as outlined in paragraph 5-6, steps 50 and 51 (fig. 5-50 and 5-51). No further disassembly of those parts is required.

a. Do not remove shift lever sleeve (fig. 5-80) from transmission housing unless replacement is necessary. If necessary, remove by driving sleeve from inside of housing to outside. Be careful not to damage sleeve bore.

b. Do not remove speedometer bushing (6) from transmission housing (8) unless replacement is necessary. If necessary to remove bushing, be careful not to damage bushing bore. In some transmission this bushing will not be used because a speedometer drive is not required.

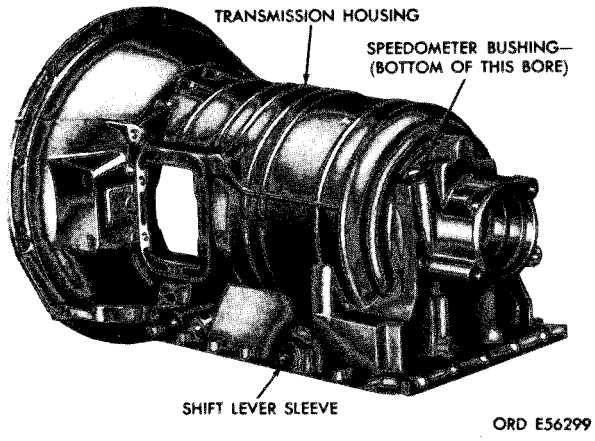


Figure 5-80. Transmission housing assembly.

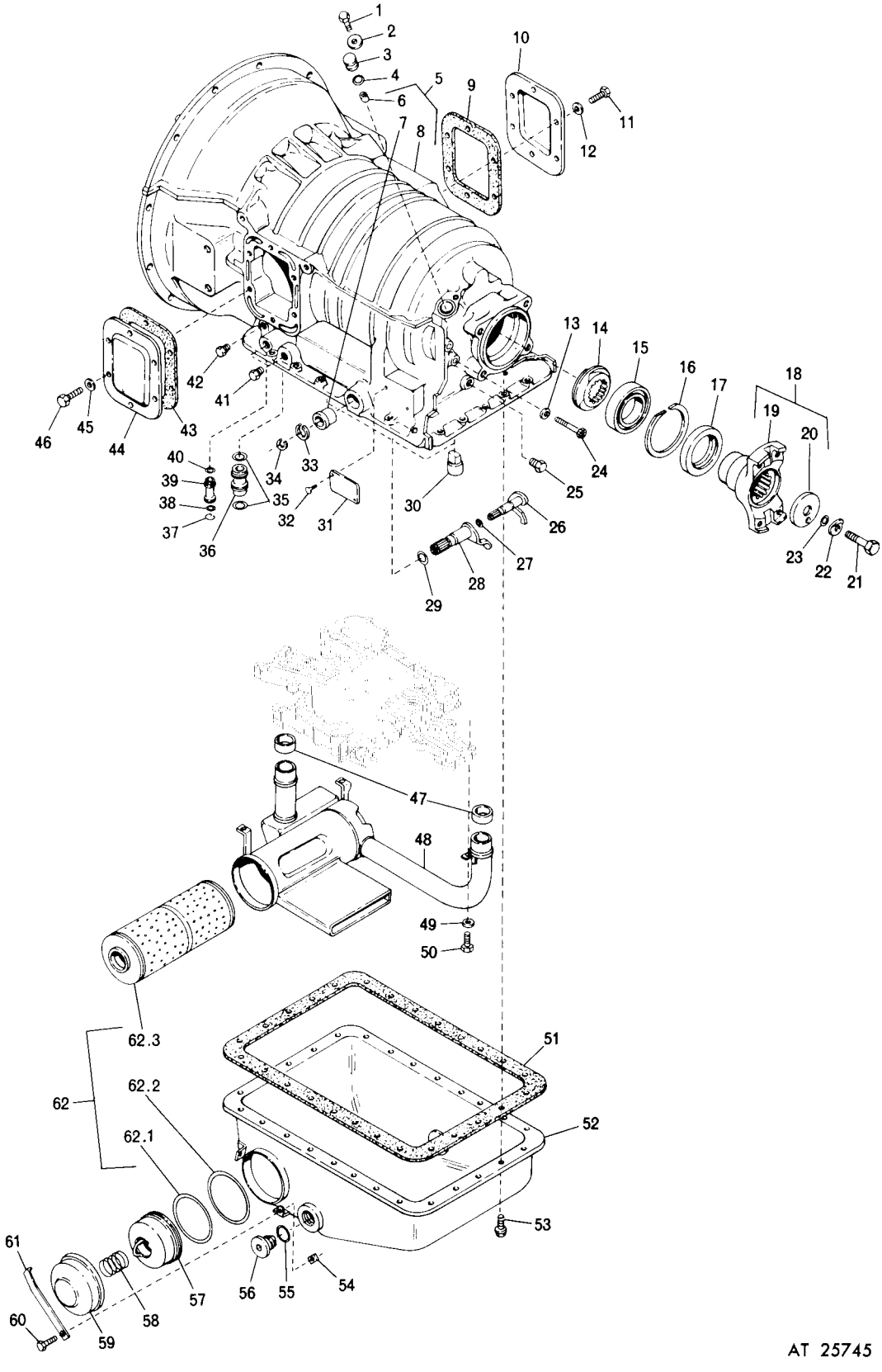


Figure 5-81. Transmission housing, oil filter, and oil pan—exploded view.

LEGEND to fig. 5-81.

1 Bolt
2 Flat washer
3 Speedometer drive plug
4 Plug gasket
5 Transmission housing assembly
6 Speedometer bushing
7 Shift lever sleeve
8 Transmission housing
9 Power takeoff cover gasket
10 Power takeoff cover
11 Cover bolt (6)
12 Cover bolt washer (6)
13 Rear pitot tube washer (2)
14 Speedometer drive gear
15 Output flange bearing
16 Bearing retainer snap ring
17 Output flange oil seal
18 Output flange assembly
19 Transmission output flange
20 Output flange retainer washer
21 Flange bolt
22 Flange bolt lock tab
23 Flange bolt seal ring
24 Rear pitot tube self-locking bolt
25 Rear governor pressure check plug
26 Throttle valve control shaft assembly
27 Control shaft seal ring
28 Manual control selector shaft assembly
29 Selector shaft seal ring
30 Anchor pin (2)
31 Transmission name plate
32 Transmission name plate drive screw (4)
33 Selector shaft snap ring
34 Throttle valve shaft snap ring
35 Oil transfer tube O-type seal ring
36 Oil transfer tube
37 Tube retainer ring (6)
38 Tube seal ring (6)
39 Oil transfer tube (6)
40 Oil transfer tube O-type seal ring
41 Main pressure check plug
42 Lockup pressure check plug
43 Power takeoff cover gasket
44 Power takeoff cover
45 Cover bolt plain washer (6)
46 Cover bolt (6)
47 Oil suction tube seal ring (2)
48 Oil filter can
49 Lockwasher (3)
50 Bolt (3)
51 Oil pan gasket
52 Transmission oil pan
53 Oil pan self-locking bolt (26)
54 Plain nut
55 Drain plug gasket
56 Oil drain plug
57 Oil filter element retainer
58 Oil filter spring
59 Oil filter cover assembly
60 Oil filter strap bolt
61 Oil filter strap
62 Oil filter parts kit
62.1 Oil filter seal ring
62.2 Oil filter seal ring
62.3 Oil filter element assembly

5-44. Cleaning

Refer to paragraph 5-2 for cleaning recommendations.

5-45. Inspection and Repair

Refer to paragraph 5-3 for general inspection and repair recommendations. Refer to paragraph 6-3 and table 6-3 for general wear limits information.

5-46. Assembly (fig. 5-81)

NOTE

All items not covered in *a* and *b* below are installed as outlined in paragraph 5-58, steps 2 through 5 (fig. 5-84 through 5-87). No overhaul (rebuild) of such components is required or recommended.

a. If speedometer bushing (6) was removed, insert new bushing in bore, and drive in until outer end is flush with bore face.

b. If shift lever sleeve was removed, insert new sleeve in bore, and drive from outside in until head is seated firmly against bore face.

NOTE

Outer end of sleeve has a very slightly larger diameter.

Section XI. OVERHAUL (REBUILD) OF OIL TRANSFER PLATE ASSEMBLY

5-47. Description

Refer to paragraph 2-11 for description of the oil transfer plate assembly.

5-48. Disassembly (fig. 5-82

NOTE

All items not covered in *a* through *d* below were removed from the transmission as outlined in paragraph 5-6, steps 8 through 13 (fig. 5-8 through 5-13). No further disassembly of those parts is required.

a. Do not remove governor pressure check valve retainer (75) and ball (76) unless replacement is necessary.

b. Do not remove slotted spring pin (78) unless replacement is necessary.

c. Do not remove drive screw (80) unless replacement is necessary.

d. Remove two converter relief valve retainer screws (85), and remove retainer (84), spring (83), washer (82), and ball (81) from oil transfer plate (77).

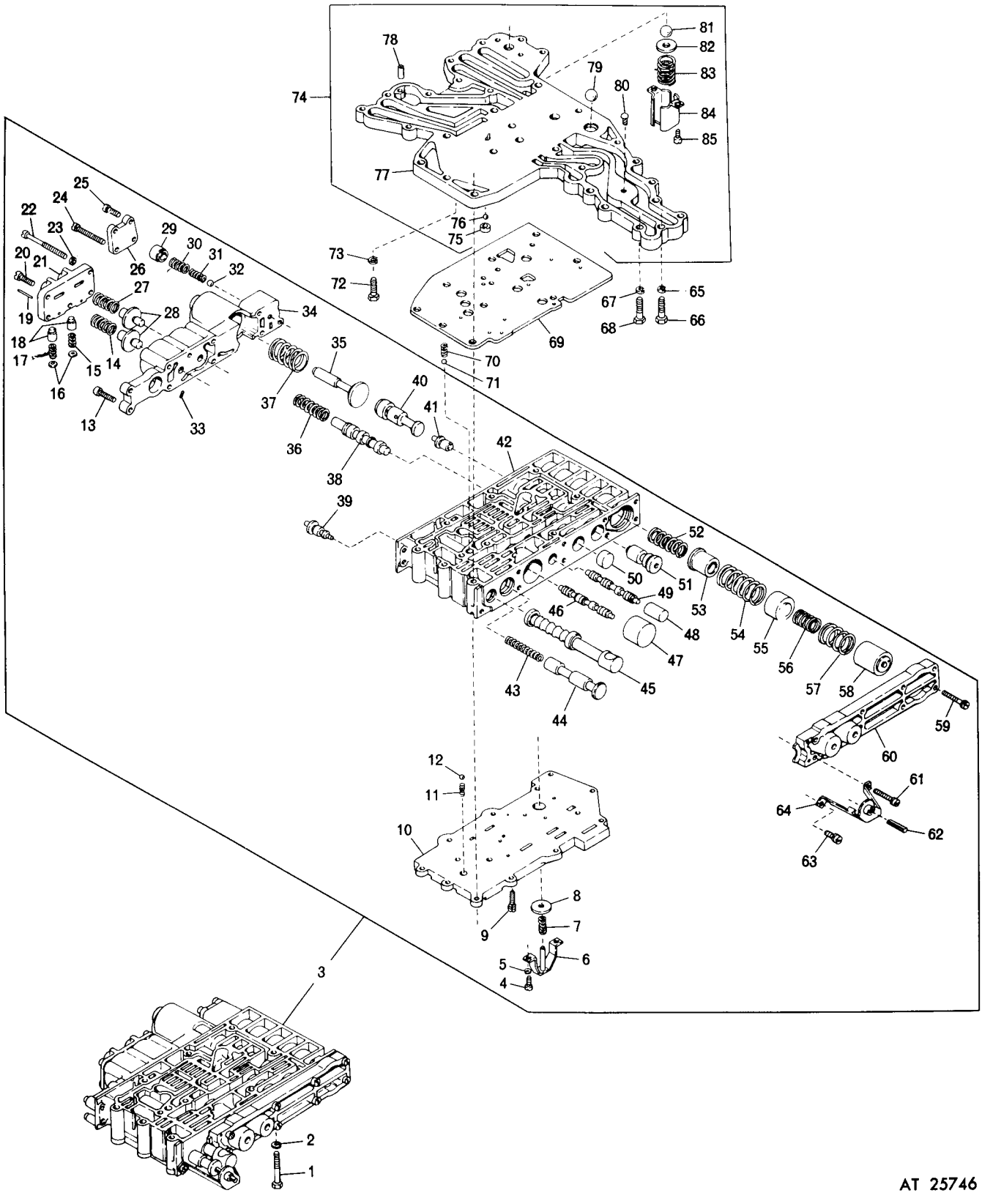


Figure 5-82. Oil transfer plate, separator plate, and control valve assembly—exploded view.

LEGEND to fig. 5-82.

1 Main control valve bolt (9)
2 Main control valve lock washer (9)
3 Main control valve assembly
4 Regulator valve retainer screw (2)
5 Retainer screw lock washer (2)
6 Valve retainer assembly
7 Regulator valve spring
8 Converter pressure regulator valve
9 Valve body bottom cover screw (6)
10 Valve body bottom cover
11 Manual selector valve detent spring
12 Manual selector valve detent ball
13 Valve body front cover screw (2)
14 Low- to intermediate-range shift valve spring
15 High- to intermediate-range inhibitor valve spring
16 Spring retainer washer (2)
17 Intermediate- to low-range inhibitor valve spring
18 Inhibitor valve (2)
19 Inhibitor valve dowel pin (2)
20 Inhibitor valve body screw
21 Inhibitor valve body
22 Inhibitor valve body screw (4)
23 Inhibitor valve body lockwasher (4)
24 Extender valve cover screw (3)
25 Extender valve cover screw
26 Extender valve cover
27 Intermediate- to high-range shift valve spring
28 Blocker plug (2)
29 Extender valve
30 Extender valve outer spring
31 Extender valve inner spring
32 Extender valve ball
33 Front cover setscrew
34 Valve body front cover
35 Regulator valve plug
36 Lockup shift valve spring
37 Main regulator valve spring
38 Lockup shift valve
39 Throttle regulator valve
40 Main regulator valve
41 Front governor valve
42 Control valve body
43 Throttle valve spring
44 Throttle valve
45 Manual selector valve
46 Low- to intermediate-range shift valve
47 Low- to intermediate-range shift valve plug
48 Intermediate- to high-range shift valve plug
49 Intermediate- to high-range shift valve
50 Lockup shift plug
51 Flow valve
52 Trimmer valve secondary spring
53 Trimmer stop
54 Trimmer valve primary spring
55 Trimmer valve plug
56 Trimmer valve return inner spring
57 Trimmer valve return outer spring
58 Trimmer valve
59 Rear cover screw (7)
60 Valve body rear cover
61 Rear cover screw
62 Throttle valve adjusting screw
63 Throttle valve retainer screw
64 Throttle valve retainer
65 Oil transfer plate lockwasher (17)
66 Oil transfer plate bolt (17)
67 Oil transfer plate lockwasher (3)
68 Oil transfer plate bolt (3)
69 Separator plate
70 Manual selector valve detent spring
71 Manual selector valve detent ball
72 Oil transfer plate bolt (2)
73 Lockwasher (2)
74 Oil transfer plate assembly
75 Governor pressure check valve retainer
76 Check valve ball
77 Oil transfer plate
78 Oil transfer plate slotted spring pin
79 Rear oil pump check valve ball
80 Drive screw
81 Converter relief valve check ball
82 Retainer washer
83 Converter relief valve spring
84 Converter relief valve retainer
85 Relief valve retainer screw (2)

5-49. Cleaning

Refer to paragraph 5-2 for cleaning recommendations.

5-50. Inspection and Repair

Refer to paragraph 5-3 for cleaning recommendations. Refer to paragraph 6-3 and table 6-3 for general wear limits information.

5-51. Assembly

(fig. 5-82)

NOTE

All items not covered in *a* through *d* below are installed as outlined in paragraph 5-58, steps 43 through 48 (fig. 5-126 through 5-131). No overhaul (rebuild) of such components is required or recommended.

a. Place oil transfer plate (77) on a table, bottom side up, and install ball (81), washer (82), spring (83), and retainer (84). Install two screws (85) in retainer and plate. Tighten screws to 24 to 36 pound-inches torque.

b. If drive screw (80) was removed, install new screw.

c. If slotted spring pin (78) was removed, install new pin by driving it in place until end projects 0.400 inch from plate surface.

d. If retainer (75) and ball (76) were removed, install new parts. Press in until flush, to below flush, with plate surface.

Section XII. OVERHAUL (REBUILD) OF MAIN CONTROL VALVE ASSEMBLY

5-52. Description

Refer to paragraph 2-11 for description of the main control valve assembly.

5-53. Disassembly

(fig. 5-82)

NOTE

All items not covered in a through c below were removed from the transmission as outlined in paragraph 5-6, steps 4 through 13 (fig. 5-4 through 5-13). No further disassembly of those parts is required.

a. Items Removed from Bottom of Control Valve Assembly.

CAUTION

Valve retainer (6) is spring loaded and must be held compressed while removing screws.

(1) Place main control valve assembly (3) on a table with top side down. Remove two screws (4) and lockwashers (5) from retainer (6), and remove retainer, spring (7), and valve (8).

(2) Remove six screws (9).

(3) Remove bottom cover (10), detent spring (11), and ball (12).

b. Items Removed from Front of Control Valve Assembly.

(1) Remove two screws (13).

CAUTION

Inhibitor valve body (21) is spring loaded and must be held compressed while removing screws.

(2) Remove screw (20), four screws (22), and washers (23) and remove inhibitor valve body (21).

(3) Drive two dowel pins (19) from valve body (21), and remove two washers (16), two springs (15 and 17), and two inhibitor valves (18) from valve body.

(4) Remove two springs (14 and 27) and two blocker plugs (28) from front cover (34).

CAUTION

Front cover 34 is spring loaded and must be held compressed while removing screws (24 and 25).

(5) Remove three screws (24).

(6) Remove front cover (34) but do not remove setscrew (33) from cover.

(7) Remove plug (35) from cover (34).

(8) Remove spring (36) and shift valve (38) from control valve body (42).

(9) Remove spring (37), main regulator valve (40), and front governor valve (41) from valve body (42).

(10) Remove throttle regulator valve (39) and spring (43) from valve body (42).

(11) Remove screw (25), cover (26), extender valve (29), springs (30 and 31), and ball (32).

c. Items Removed from Rear of Control Valve Assembly.

(1) Remove screws (61 and 63), and remove throttle valve retainer (64). Do not remove adjusting screw (62) from retainer.

(2) Remove throttle valve (44) from control valve body (42).

Caution: Rear cover (60) is spring loaded and must be held compressed while removing screws.

(3) Remove seven screws (59) from rear cover (60), and remove cover.

(4) Remove trimmer valve (58), springs (56 and 57), plug (55), spring (54), trimmer stop (53), and spring (52).

(5) Remove manual selector valve (45).

(6) Remove shift plug (47) and shift valve (46) from valve body (42).

(7) Remove shift plug (48) and shift valve (49) from valve body (42).

(8) Remove shift plug (50) and flow valve (51) from valve body (42).

5-54. Cleaning

Refer to paragraph 5-2 for cleaning recommendations.

5-55. Inspection and Repair

Refer to paragraph 5-3 for general inspection and repair recommendations. Refer to paragraph 6-3 and table 6-3 for general wear limits information.

5-56. Assembly

(Fig. 5-82)

NOTE

All items not covered in *a* through *c* below are installed as outlined in paragraph 5-58, steps 43 through 53 (fig. 5-126 through 5-136). No overhaul (rebuild) of such components is required or recommended.

NOTE

It is absolutely essential that springs are not interchanged. Refer to table 6-2.

a. Items Installed at Bottom of Control Valve Assembly.

(1) Place main control valve assembly (3) on a table with top side down. Install manual selector valve (45) into valve body (42).

(2) Install detent ball (12) and spring (11) in valve assembly, and install bottom cover (10).

(3) Install six screws (9). Tighten screws to 24 to 36 pound-inches torque.

(4) Install spring (7) and regulator valve (8) on retainer (6). Install two screws (4) and lock-

washers (5) in retainer and cover. Tighten screws to 24 to 36 pound-inches torque.

b. Items Installed in Rear of Control Valve Assembly.

NOTE

When a replacement valve body assembly (3) *or* valve body (42) must be installed, readjustment of throttle valve adjusting screw (62) is necessary. Refer to paragraph 5-63 for adjustment procedures.

(1) Install shift valve (46) and shift plug (47) in valve body (42).

(2) Install shift valve (49) and shift plug (48) in valve body (42).

(3) Install shift plug (50) and flow valve (51) in valve body (42).

(4) Install spring (52) and trimmer stop (53), large diameter end first.

(5) Install spring (54) and plug (55).

(6) Install springs (56 and 57) and trimmer valve (58), open end first.

(7) Install rear cover (60) and seven screws (59). Tighten screws to 24 to 36 pound-inches torque.

(8) Install throttle valve (44) in valve body (42).

(9) Install throttle valve retainer (64) and screws (61 and 63). Tighten screws to 24 to 36 pound-inches torque.

c. Items Installed in Front of Control Valve Assembly.

(1) Install spring (43) and throttle regulator valve (39) in valve body (42).

(2) Install shift valve (38) and spring (36) in valve body (42).

(3) Install front governor valve (41) and main regulator valve (40) in valve body (42).

(4) Install valve plug (35) and spring (37) in front cover (34).

(5) Install ball (32), springs (31 and 30), and extender valve (29) in front cover (34).

(6) Install extender valve cover (26) and screw (25).

(7) Install three retaining screws (24) and two screws (13), and secure front cover (34) to valve body (42).

(8) Install two inhibitor valves (18), springs (15 and 17), and washers (16) into inhibitor valve body (21). Compress washers against springs far enough to allow installation of dowel pins (19). Drive dowel pins in far enough to allow for staking of body metal over dowel pins.

NOTE

Do not interchange springs (15 and 17). These springs have different ratings and must be installed into their proper bores.

(9) Install two blocker plugs (28) and two springs (14 and 27) into front cover (34).

(10) Install inhibitor valve body (21) on front cover, and install screw (20), and four washers (23), and four screws (22). Tighten screws to 24 to 36 pound-inches torque.

Section XIII. ASSEMBLY OF TRANSMISSION FROM SUBASSEMBLIES

5-57. General

a. Pictorial Steps. The assembly procedures are arranged in successive pictorial steps. Simple instructions are given below each procedure illustration. These instructions are keyed to the illustrations by letter callouts.

b. Instructions Before Assembly. Refer to paragraphs 5-1 through 5-4 for general instructions before beginning assembly of the transmission.

c. Exploded Views. See appropriate exploded view and figures 5-83 through 5-140 for assembly sequence and parts identification.

d. Tool Information. Refer to paragraphs 3-1 through 3-5 for special and improvised tool information.

5-58. Assembly Steps

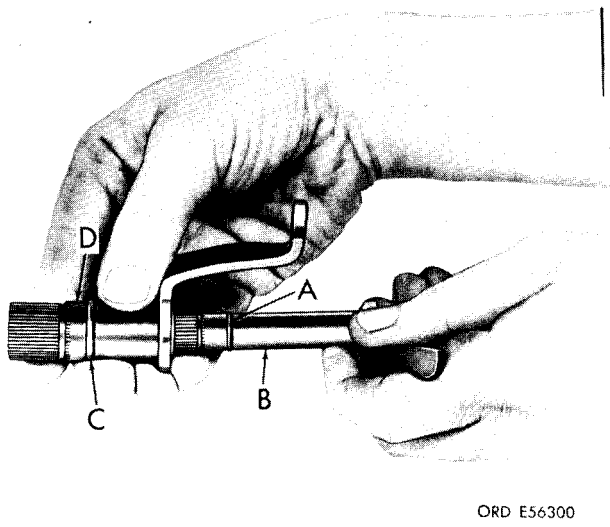


Figure 5-83 (Step 1).

Install seal ring (A) on throttle shaft (B) and seal ring (C) on selector shaft (D). Install throttle shaft (B) into selector shaft (D).

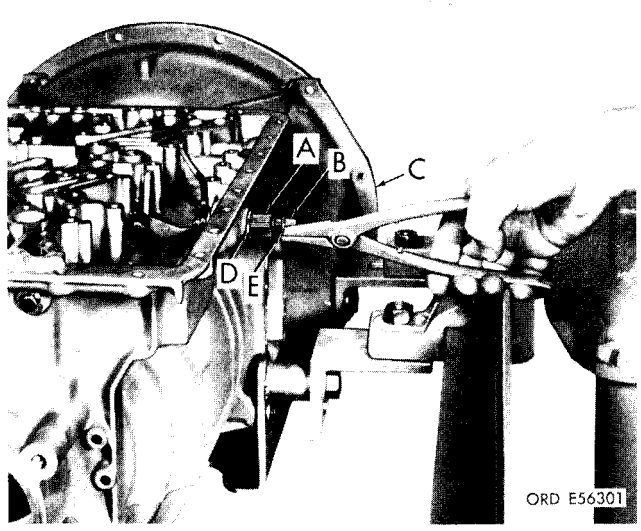


Figure 5-84 (Step 2).

Install selector shaft (A) and throttle shaft (B) into transmission housing (C). Install snap ring (D) on selector shaft (A) and snap ring (E) on throttle shaft (B).

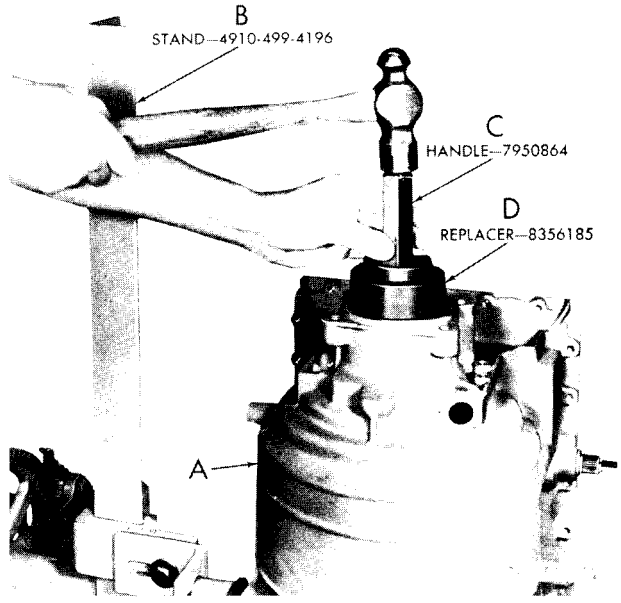


Figure 5-85 (Step 3).

Position transmission housing (A) in work stand 4910-499-4196 (B) with rear end up. Using handle—5120-316-9182 (7950864) (C), and replacer 5120-572-8615 (8356185) (D), install rear bearing into transmission housing (A).

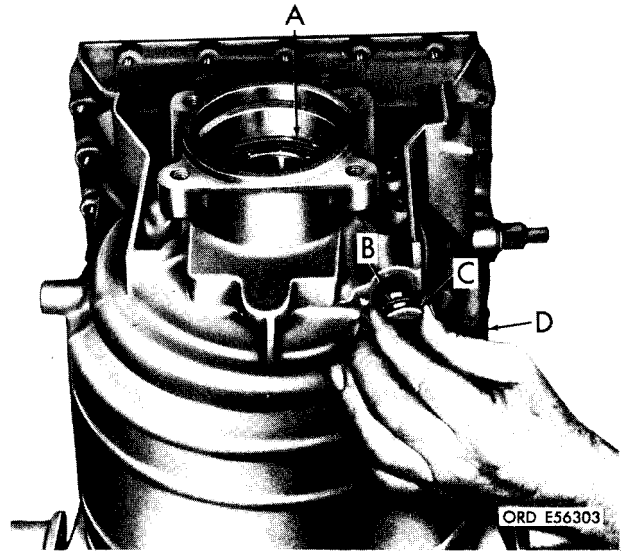


Figure 5-86 (Step 4).

Install bearing snap ring (A). Install seal (B) on speedometer drive plug (C), and install assembly into transmission housing (D).

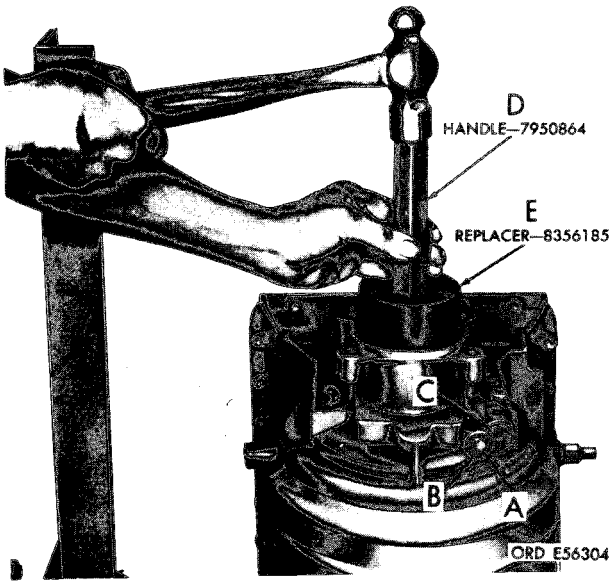


Figure 5-87 (Step 5).

Install bolt (A) and washer (B) on speedometer drive plug (C). Install rear oil seal using handle 5120-316-9182 (7950864) (D) and replacer 5120-572-8615 (8356185) (E). Seat seal lightly against rear bearing snap ring.

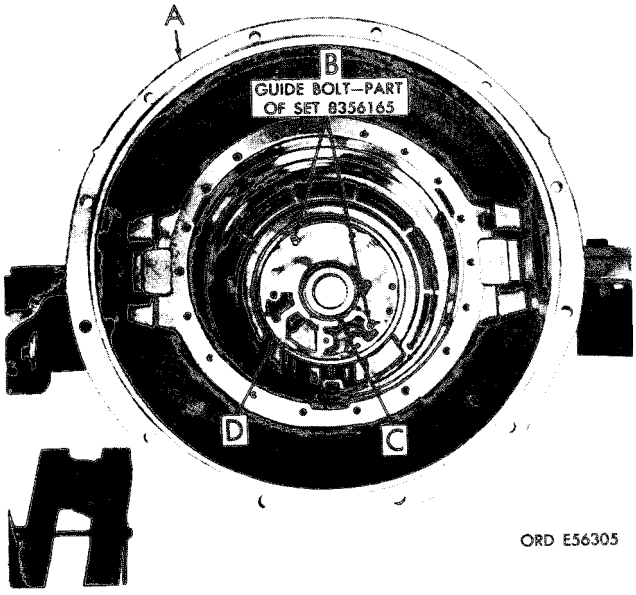


Figure 5-88 (Step 6).

Position transmission housing (A) so that front end is up. Install oil pump guide bolts (B), speedometer drive gear (C), and oil pump gasket (D). (Guide bolts are part of set 4910-572-8710 (8356165).)

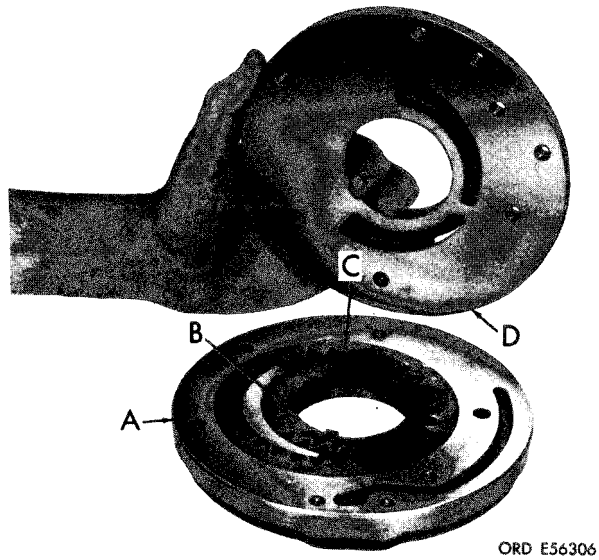


Figure 5-89 (Step 7).

Assemble rear oil pump (A) as illustrated. Lubricate gears (B) and (C), and install cover (D).

NOTE

Gears B and C should be installed in same position as removed.

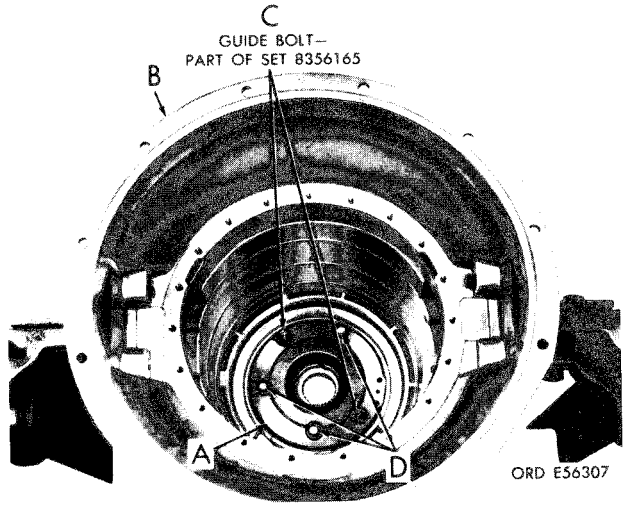


Figure 5-90 (Step 8).

Install rear oil pump assembly (A) into housing (B) using guide bolts (C). Install three bolts (D) and three lockwashers. Remove guide bolts, and install remaining two bolts and lockwashers. Tighten bolts to 13 to 16 pound-feet torque. (Guide bolts are part of set 4910-572-8710 (8356165)).

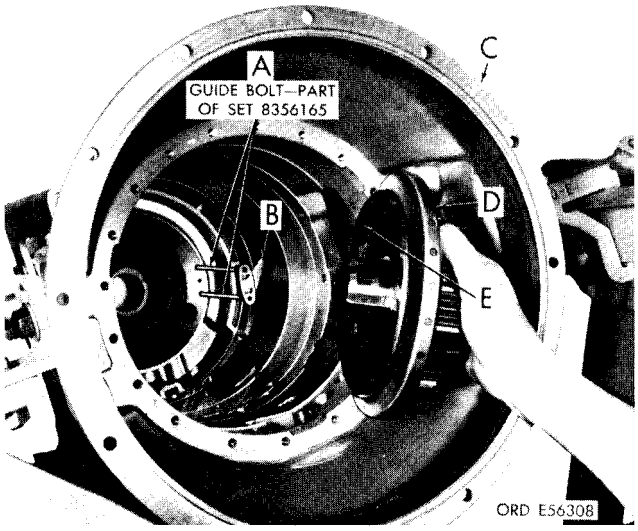


Figure 5-91 (Step 9).

Install two guide bolts (A) into pitot tube (B), and insert guide bolts into housing (C). Install reverse planetary carrier and pitot collector ring assembly (D) so that pitot tube (B) will be located in collector ring at position shown by arrow head (E) between vanes. (Guide bolts are part of set 4910-572-8710 (8356165).)

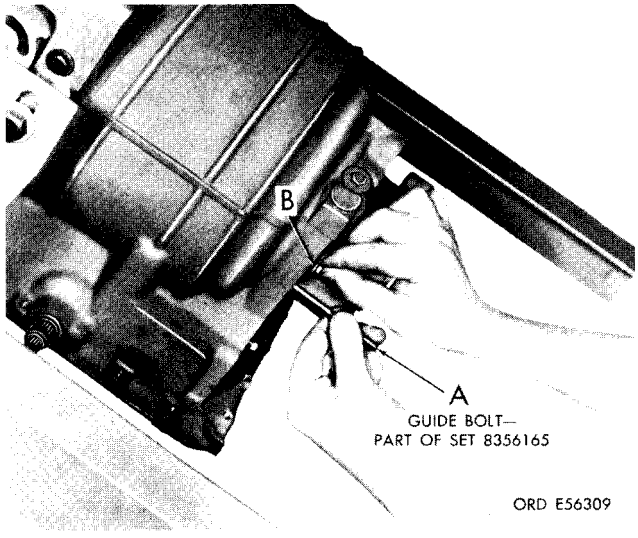


Figure 5-92 (Step 10).

Remove one guide bolt (A), and install a $^{1}/_{4}$-28 x $2^{3}/_{4}$ bolt (B) and plain washer to hold pitot tube in place. Remove other guide bolt, and install other bolt and washer. Tighten bolts to 8 to 10 pound-feet torque. (Guide bolts are part of set 4910-572-8710 (8356165).)

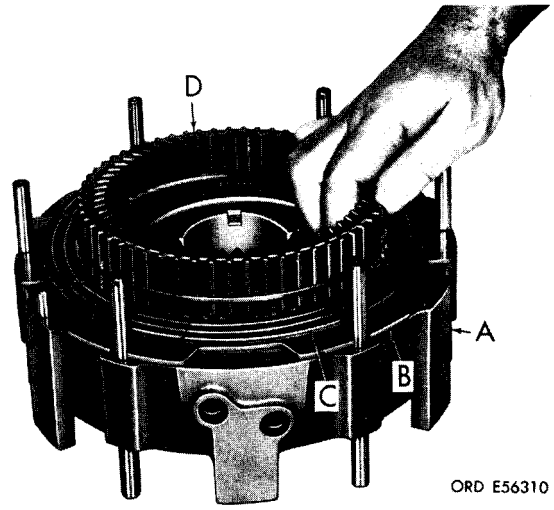


Figure 5-93 (Step 11).

Place low and reverse piston housing assembly (A) on work table, reverse end up. Install reverse clutch apply plate (B), one internal-splined plate (C), and reverse ring gear (D).

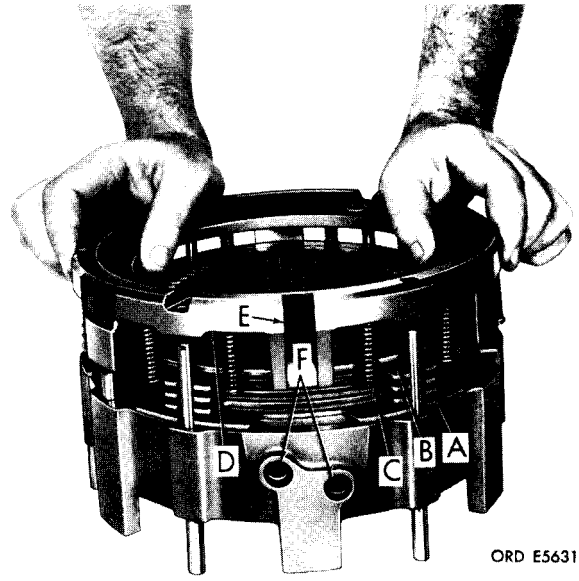


Figure 5-94 (Step 12).

Alternately install three external-tanged (A) and three internal-splined (B) clutch plates. Install 12 springs (C) into reaction plate (D). Install reverse clutch reaction plate assembly (D).

NOTE

Aline anchor pin slot (E) with clutch apply oil holes (F).

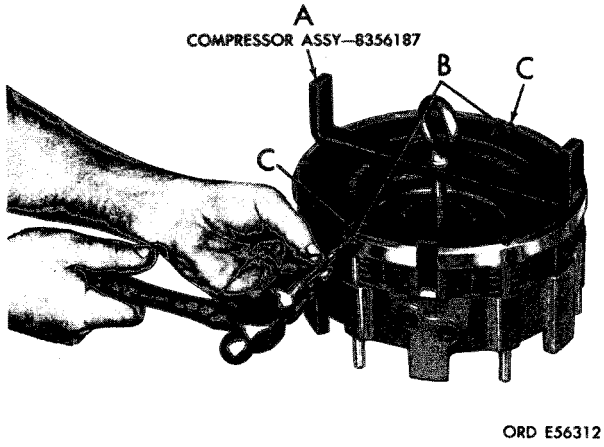


Figure 5-95 (Step 13).

Install compressor assembly 4910-572-8643 (8356187) (A), and compress reaction plate against its springs. Install two roll pins (B) in pins (C) so that roll pins extend $^{1}/_{8}$ inch from pins toward center. Remove compressor assembly.

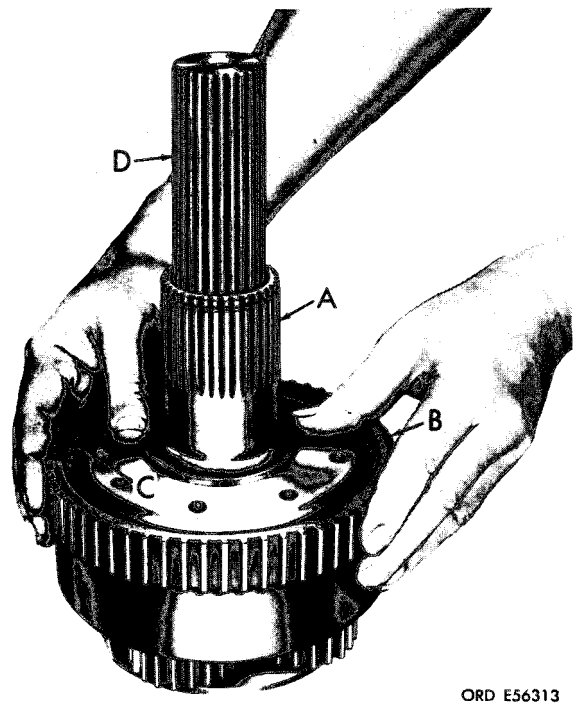


Figure 5-96 (Step 14)

Install reverse-range sun gear shaft (A) in low-range ring gear (B), and install snap ring (C). Install assembly on output shaft (D).

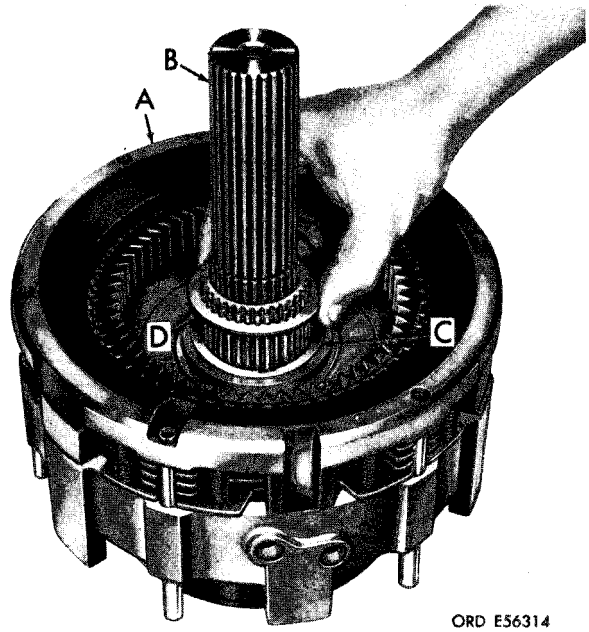


Figure 5-97 (Step 15).

Install reverse-range clutch assembly (A) over output shaft (B). Install spacer (C) and internal-splined thrust washer (D).

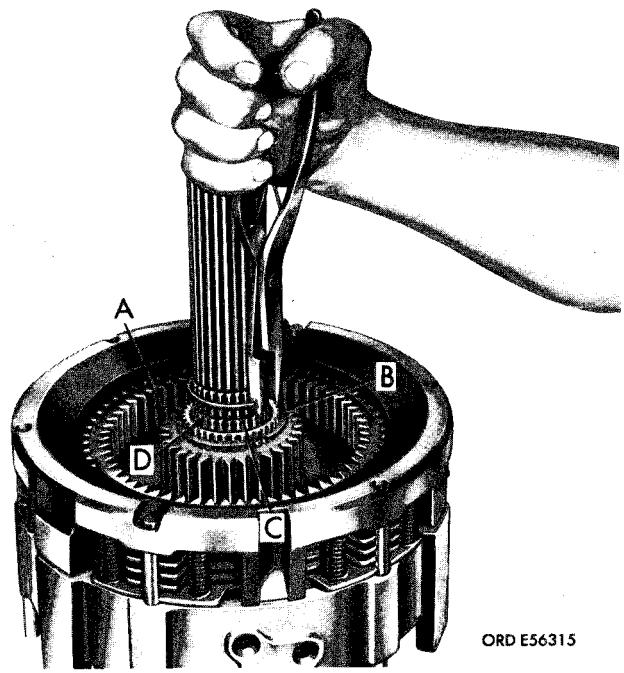


Figure 5-98 (Step 16).

Install reverse sun gear (A). Install snap ring (B) and wire-type snap ring (C) in groove (D).

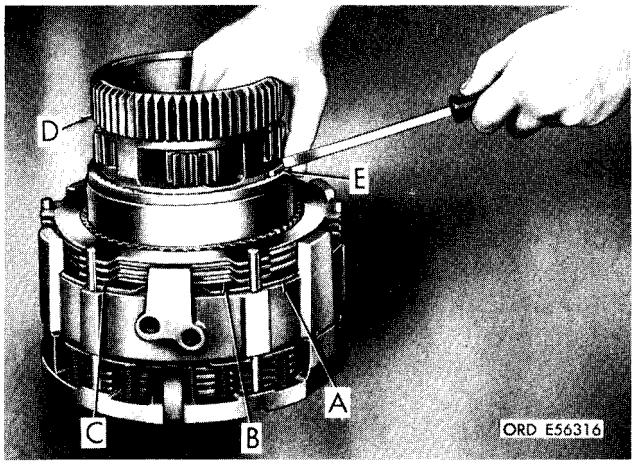


Figure 5-99 (Step 17).

Turn assembly over, and position output shaft through hole in table. Install low-range apply plate (A), and alternately install three internal-splined (B) and three external-tanged plates (C). Install intermediate-range planetary carrier (D) and snap ring (E).

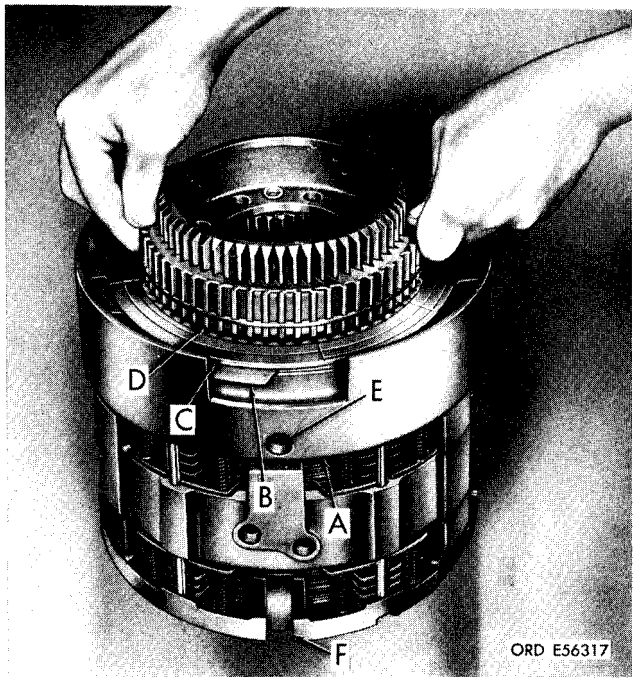


Figure 5-100 (Step 18).

Install intermediate-range piston housing assembly (A), apply plate (B), one internal-splined plate (C), and intermediate-range ring gear (D). Note alinement of clutch apply oil hole (E) with anchor pin slot (F).

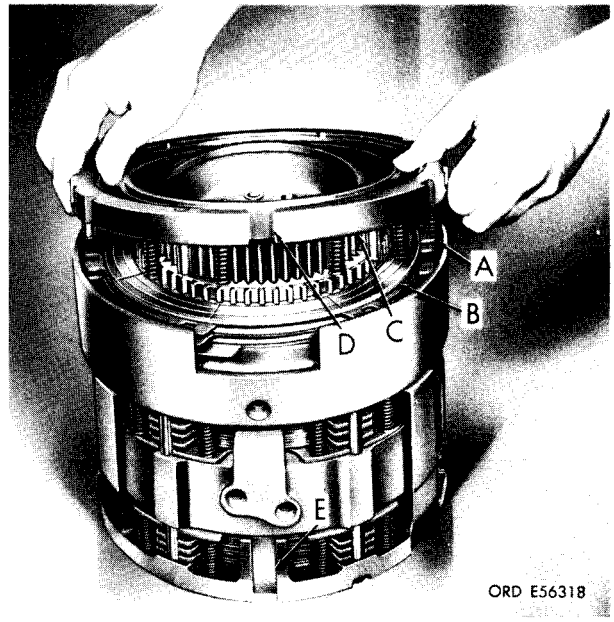


Figure 5-101 (Step 19).

Install two external-tanged plates (A) and two intern al-splined plates (B). Install intermediate-range reaction plate assembly (C) with notch (D) alined with notch (E).

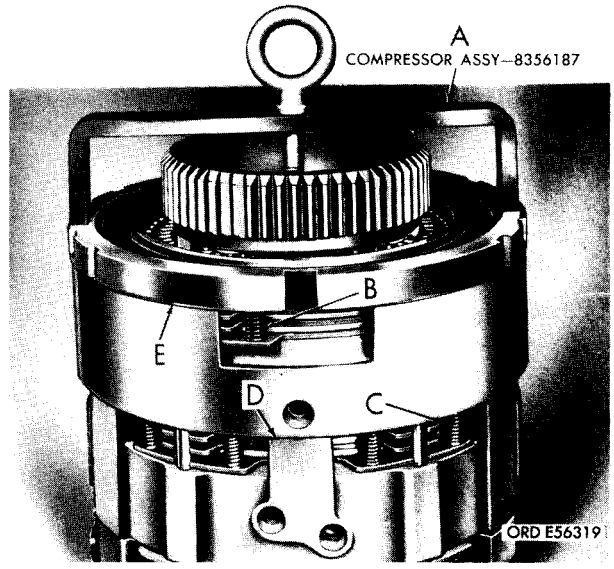


Figure 5-102 (Step 20).

Install compressor assembly 4910-572-8643 (8356187) (A), to compress low-range (B) and intermediate-range clutch springs (C). When properly assembled and compressed, there will be no clearance (opening) at points (D) and (E).

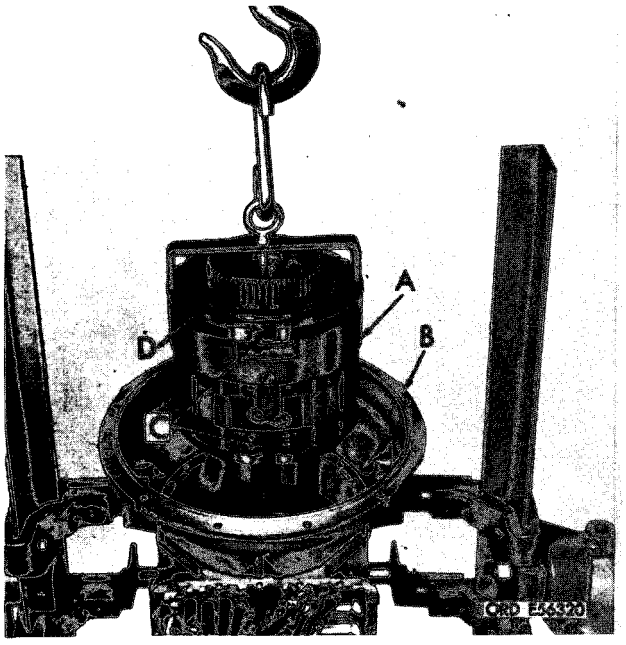


Figure 5-103 (Step 21).

Install reverse-, intermediate-, and low-range clutch pack (A) into housing (B) with slots (C) toward bottom of housing.

NOTE

When properly installed, front (upper) surface (D) of intermediate clutch reaction plate should aline with rear surfaces of power takeoff openings.

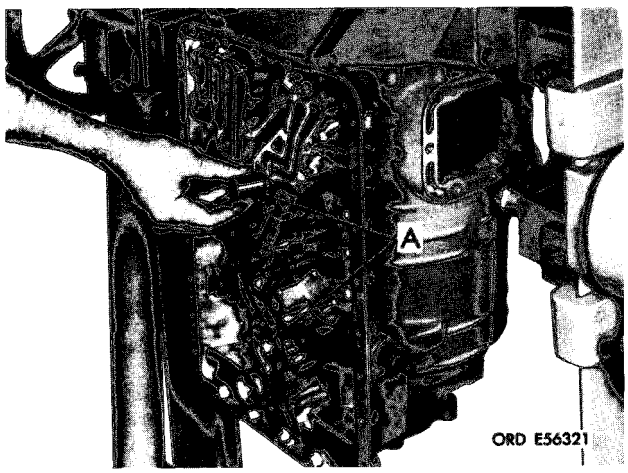


Figure 5-104 (Step 22).

Install two clutch anchor pins (A). Flats on pins must seat in slots in clutch pack.

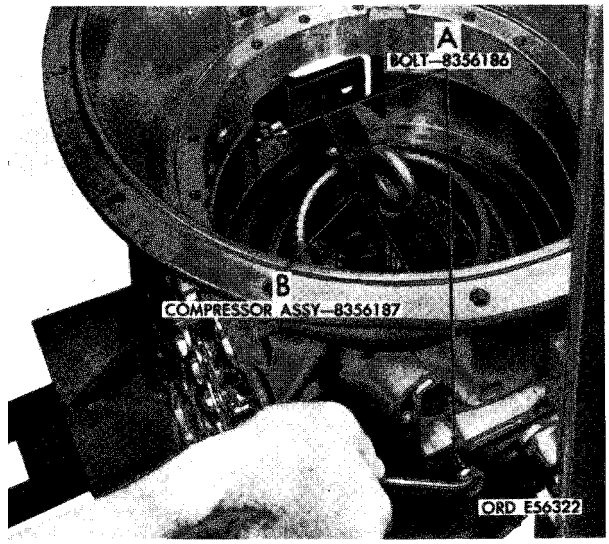


Figure 5-105 (Step 23).

Note position of top of clutch pack relative to transmission housing when seated. Install two bolts 4910-572-8701 (8356186) (A) to lock clutch pack in compressed position. Tighten bolts to 10 to o12 pound-feet torque. Remove compressor assembly 4910-572-8643 (8356187) (B).

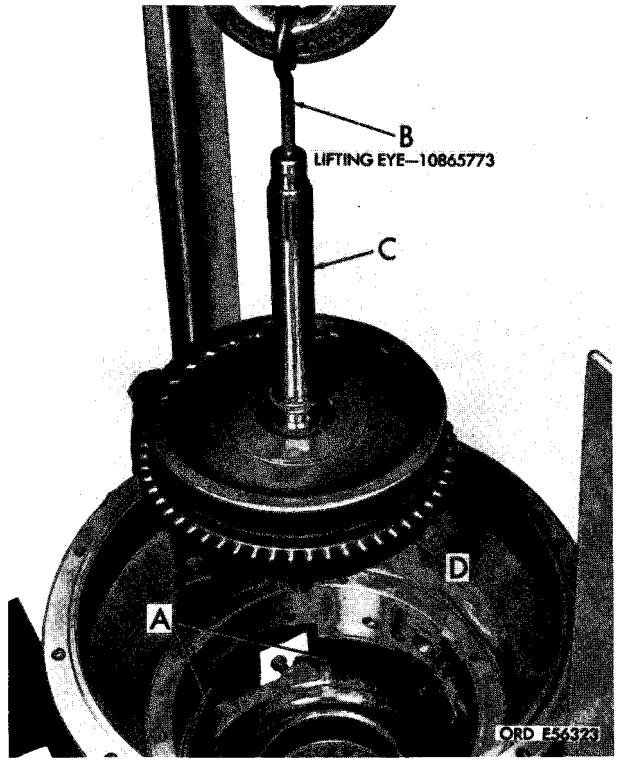


Figure 5-106 (Step 24).

Install two spacers (A). Using lifting eye 4910-673-3801 (10865773), (B) install turbine shaft (C) and high-range clutch assembly (D) as rebuilt in paragraphs 5-17 through 5-21.

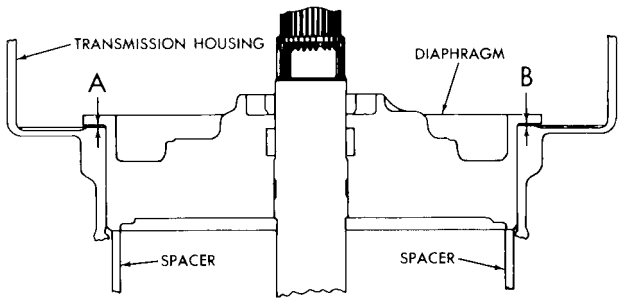


Figure 5-107. Measurement for shim pack thickness.

NOTE

In step 25 (fig. 5-108), measurements for selection of proper diaphragm gaskets are being made. Figure 5-107 illustrates points at which measurements are made. The diaphragm, when install, must compress the entire clutch pack. The selection of proper gaskets depends upon the measurements taken in step 25 (fig. 5-108). To determine gasket pack to be installed in step 28 (fig. 5-111), average the two measurements obtained in step 25 (fig. 5-108). Then choose gaskets as follows:

(1) If average measurement is 0.010 to 0.015-use one 6774406 (73342) (0.012 thk) gasket

(2) If average measurement is 0.016 to 0.021—use one 6774407 (73342) (0.016 thk) gasket

(3) If average measurement is 0.022 to 0.027—use one 6774408 (73342) (0.021 thk) gasket

(4) If average measurement is 0.028 to 0.033—use one each 6774406 (73342) (0.012 thk) and 6774407 (73342) (0.016 thk) gasket

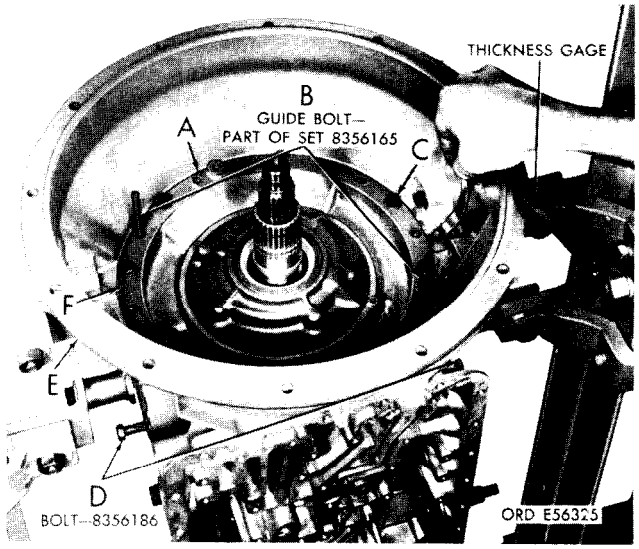


Figure 5-108 (Step 25).

Install diaphragm (A) over guide bolts (B). Tap diaphragm until it seats against spacers. Install six 5/16-18 x 1-inch bolts and washers (C), evenly spaced. Tighten all six bolts to 10 pound-inches torque. Using a thickness gage, measure clearance between diaphragm (A) and housing (E) and (F) and opposite side as shown. See figure 5-107. Record both dimensions. Retighten two bolts 4910-572-8701 (8356186) (D), and remove nine bolts and washers (C). The average of the two dimensions will be the required gasket thickness. (Guide bolts are part of set 4910-572-8710 (8356165).)

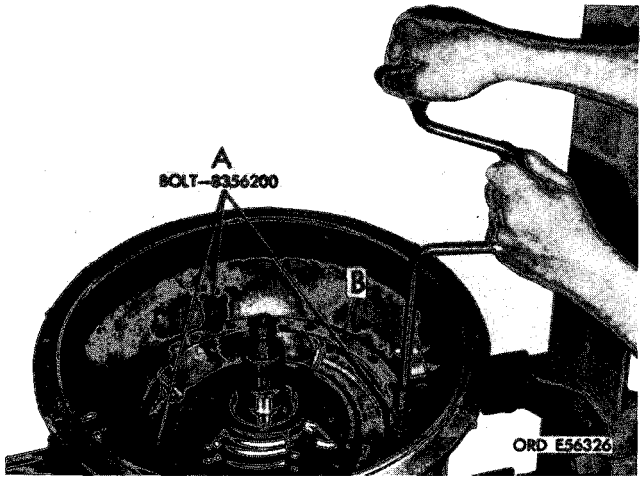


Figure 5-109 (Step 26).

Insert three puller bolts 4910-572-8699 (8356200) (A) in diaphragm (B) and remove diaphragm.

NOTE

Turn bolts evenly to avoid cracking diaphragm flange.

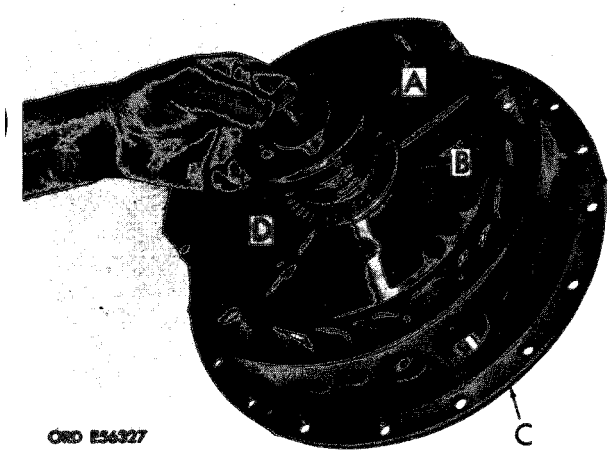


Figure 5-110 (Step 27).

Install needle assembly (A) in washer (B) on diaphragm (C). Install washer (D) on needle assembly with washer lip toward needle assembly

NOTE

Use oil-soluble grease to hold needle assembly and washer on diaphragm while installing diaphragm in step 28 (fig. 5-111).

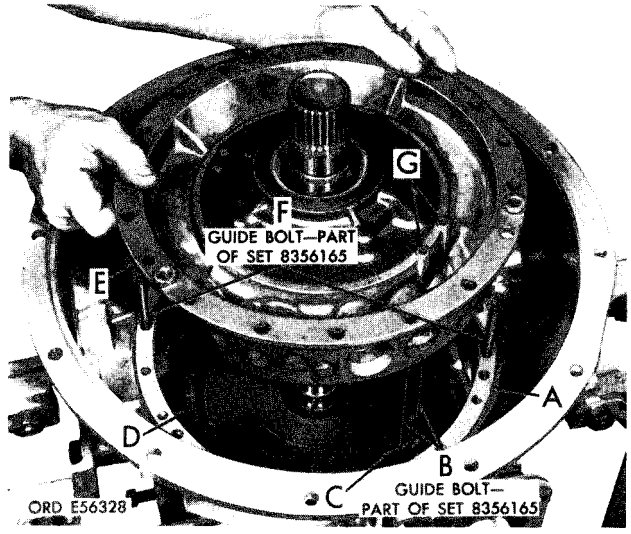


Figure 5-111 (Step 28).

Install gasket(s) (A), selected in step 25 (fig. 5-107). Install guide bolts (B) in pitot tube (C), and set pitot tube in place in pitot collector ring (D). Install diaphragm (E), alining with bolts (F) in flange and bolts (B) in pitot tube bolt holes (G). (Guide bolts are part of set 4910-572-8710 (8356165).)

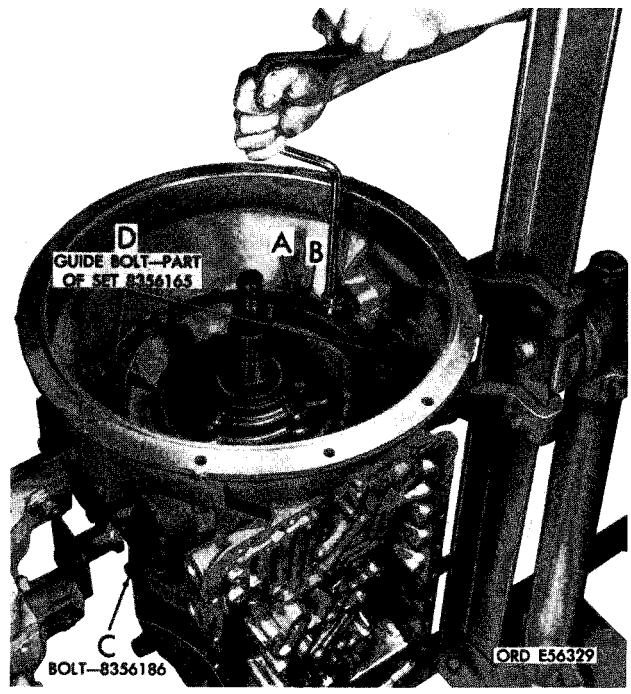


Figure 5-112 (Step 29).

Install seventeen bolts and washers (A), and seat diaphragm (B) against spacers. Remove two bolts (C). Tighten bolts (A) to 17 to 20 pound-feet torque. Remove diaphragm guide bolts (D). (Guide bolts are part of set 4910-572-8710 (8356165).)

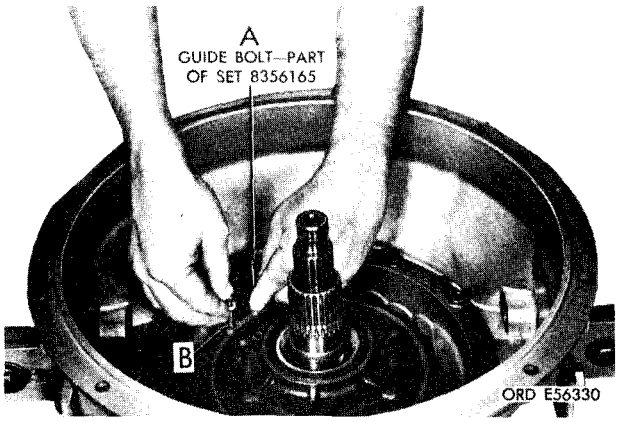


Figure 5-113 (Step 30).

Install two remaining diaphragm bolts and washers. Tighten bolts to 17 to 20 pound-feet torque. Remove one pitot tube guide bolt (A), and install pitot tube bolt and washer (B) finger-tight. Remove remaining guide bolt, and install other pitot tube and washer. Tighten bolts to 2.5 to 4.5 pou rid-feet torque. (Guide bolts are part of set 4910-572-8710 (8356165).)

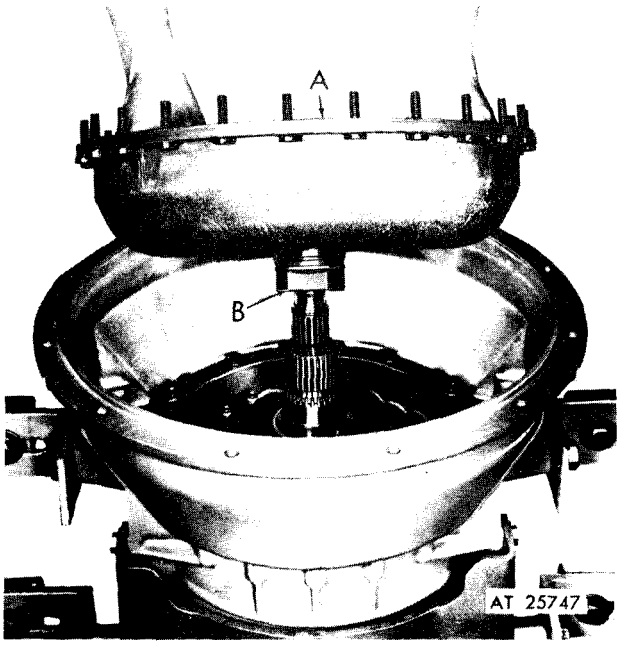


Figure 5-114 (Step 31).

Install converter pump assembly (A), and make certain that flats (B) on converter pump hub engage flats in front oil pump drive gear.

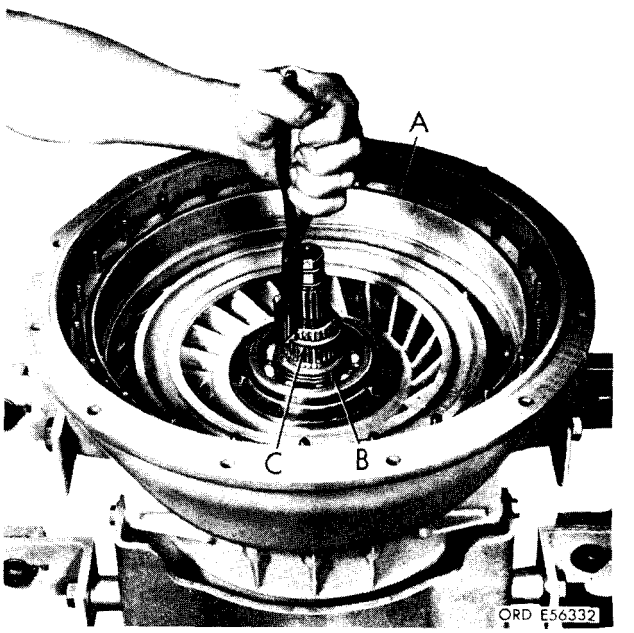


Figure 5-115 (Step 32).

Install pump seal (A), splined spacer (B), and snap ring (C).

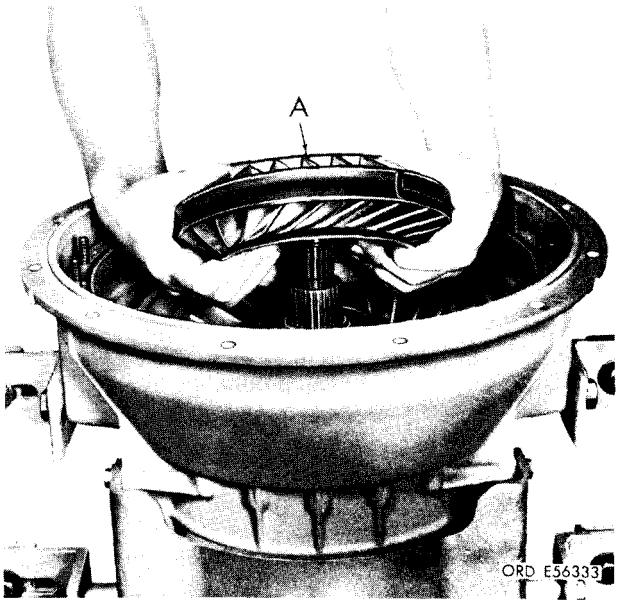


Figure 5-116 (Step 33).

Install stator assembly (A) with roller race counterbore down.

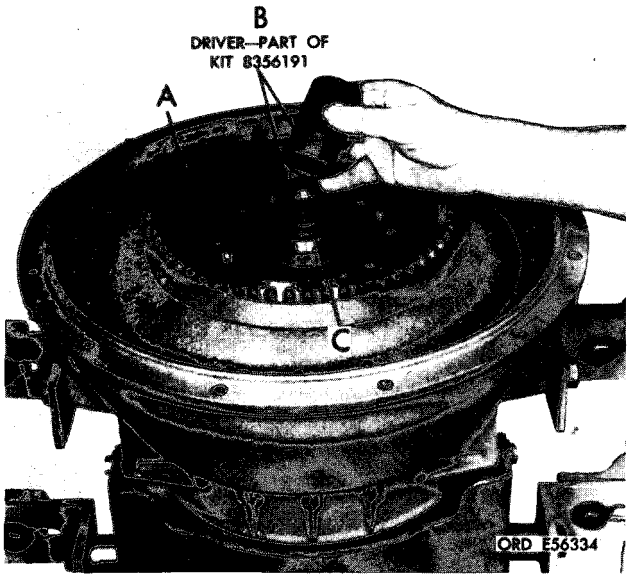


Figure 5-117 (Step 34).

Install turbine assembly (A). Install coned part of snap ring driver (B) on end of turbine shaft. Install snap ring (C) on driver. Install knurled cap of snap ring driver (B). (Driver is part of kit—5120-572-8663 (8356191)).

Figure 5-118 (Step 35).

Install bolt (A), and tighten it against cap (B) until snap ring (C) snaps into groove (D). Remove driver kit parts. (Bolt and cap are part of kit—5 120-572-8663 (8356191)).

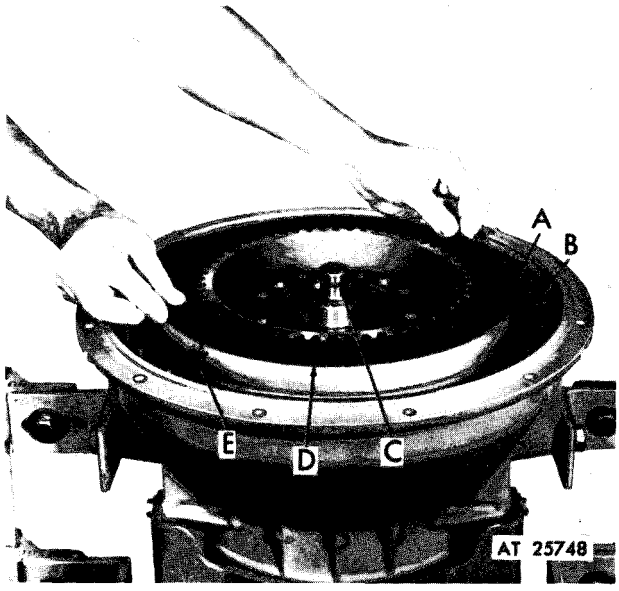


Figure 5-119 (Step 36).

Install lockup clutch back plate (A), seal ring (B), hook-type seal ring (C), and lockup clutch plate (D).

NOTE

Aline balance marks (E) on converter pump and back plate.

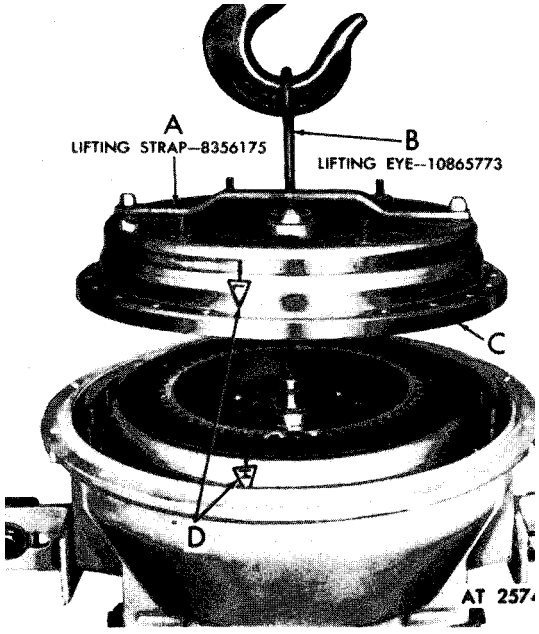


Figure 5-120 (Step 37).

Using lifting strap 4910-572-8608 (8356175) (A) and lifting eye 4910-673-8301 (10865773) (B), install pump cover assembly (C). Do not remove strap (A) and eye (B) at this time.

NOTE

Aline balance marks (D).

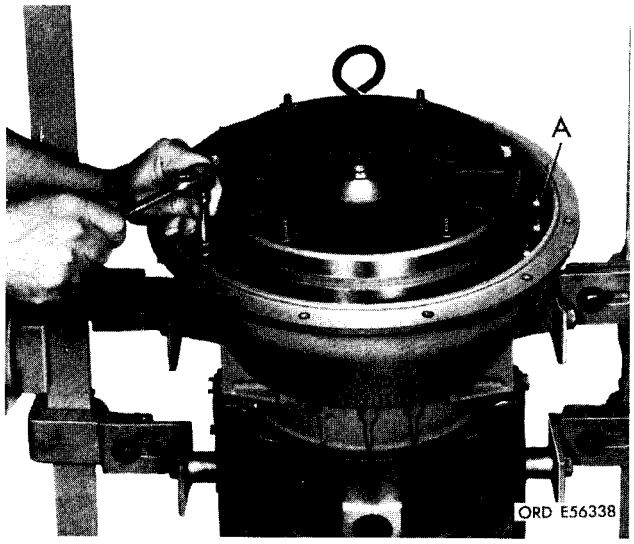


Figure 5-121 (Step 38).

Install twenty-four self-locking nuts (A). Tighten nuts evenly to 19 to 23 pound-feet torque.

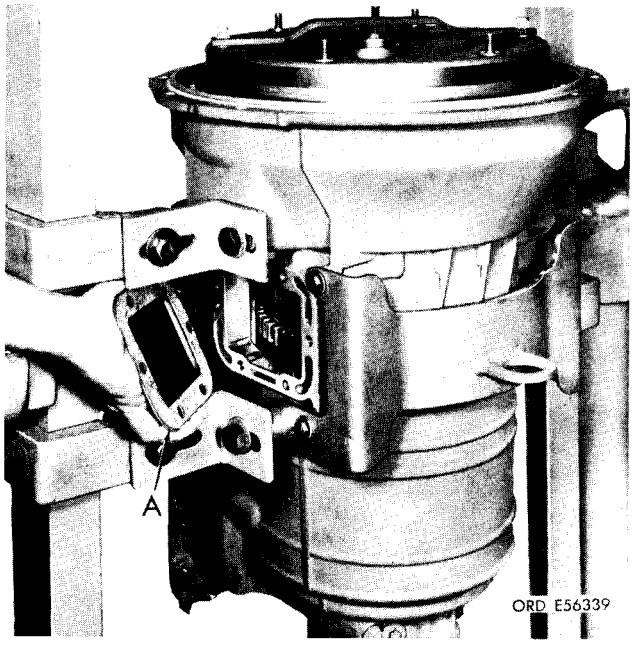


Figure 5-122 (Step 39).

Install right and left power takeoff covers and gaskets (A). Secure each cover with six bolts and six plain washers. Tighten bolts to 15 to 20 pound-feet torque.

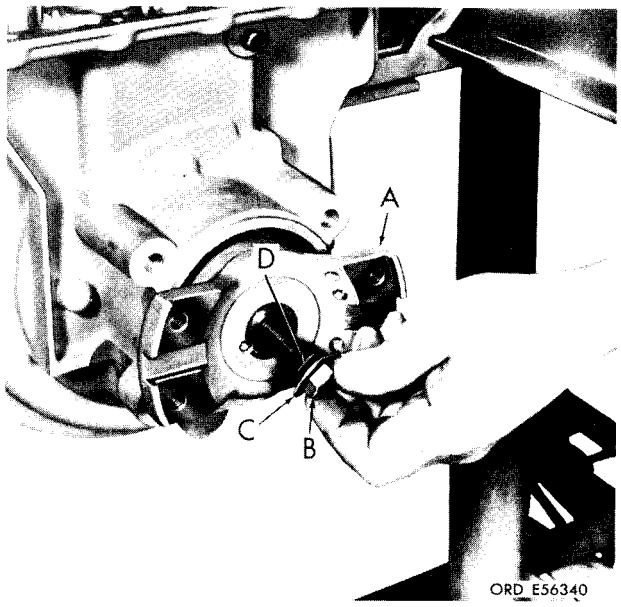


Figure 5-123 (Step 40).

Reposition transmission, bottom side up. Install output flange (A), bolt (B), locktab (C), and seal ring (D).

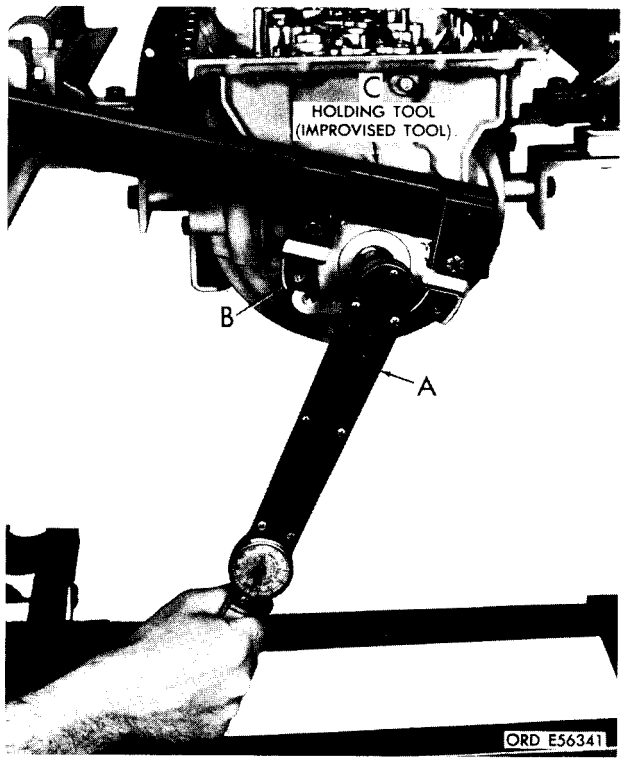


Figure 5-124 (Step 41).

Using torque wrench (A), tighten bolt to 83 to 100 pound-feet torque while holding flange (B) with tool (C). Remove tool (C).

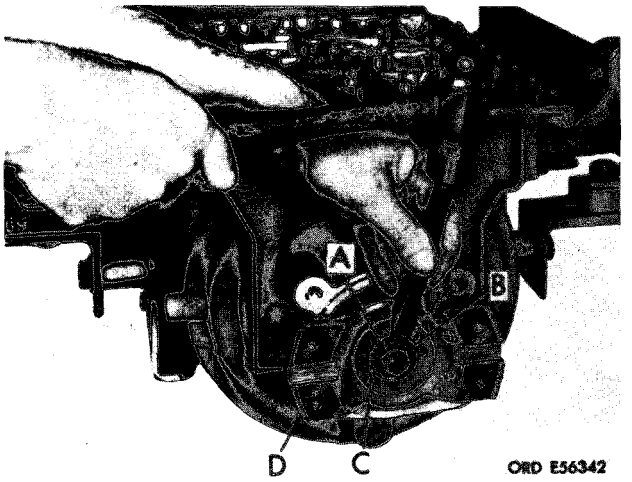


Figure 5-125 (Step 42).

Lock output flange bolt (A) by bending lock tab (B) against a flat side of bolt head. Stake edge of washer into hole (C) in flange (D).

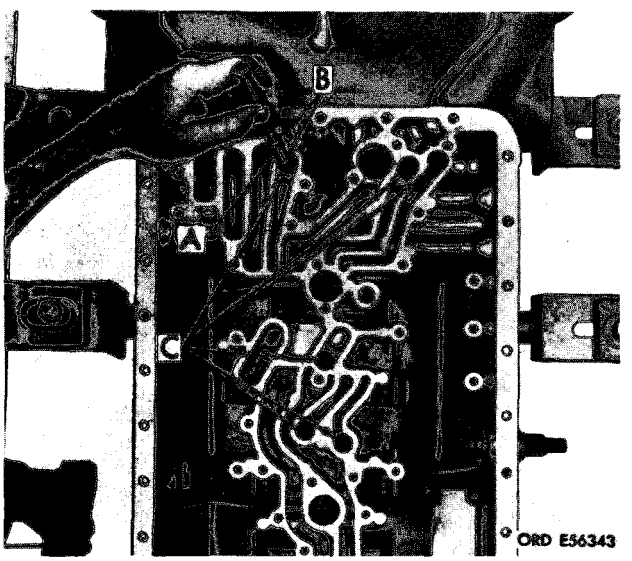


Figure 5-126 (Step 43).

Install six small jumper tubes (A) with seal rings (B) at six places (C).

NOTE

Do not interchange seal rings on ends of tubes since there is a difference in size.

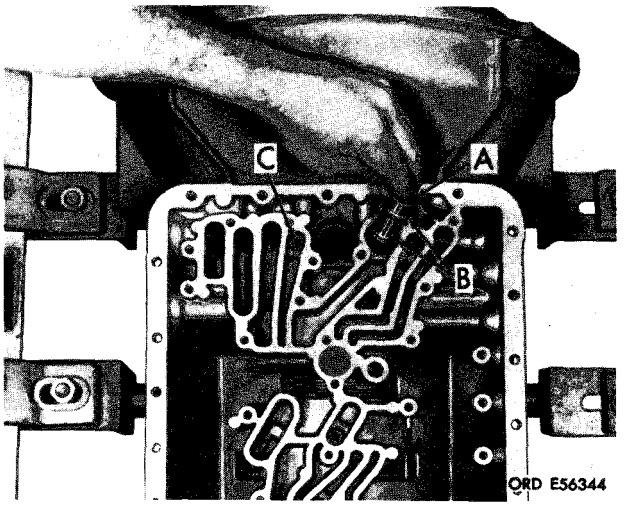


Figure 5-127

Install large jumper tube (A) and seal rings (B). Install a retaining ring (C) in each of six small jum per tube holes.

NOTE

There are no grooves; seat retaining rings against jumper tubes.

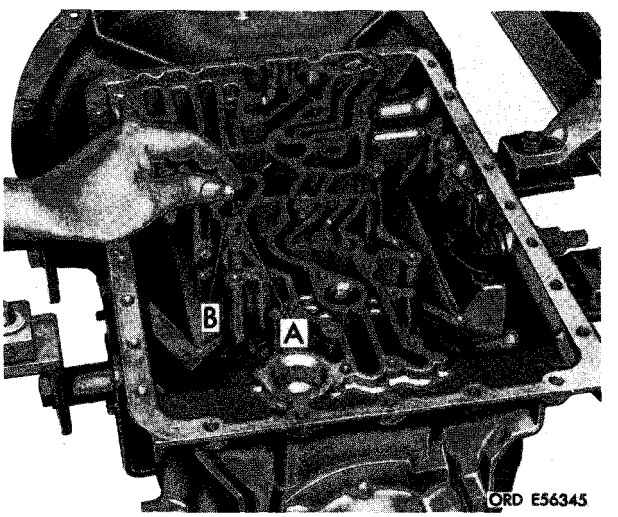


Figure 5-128 (Step 45).

Install rear pump check ball (A) (nylon) in cavity (B) in transmission housing.

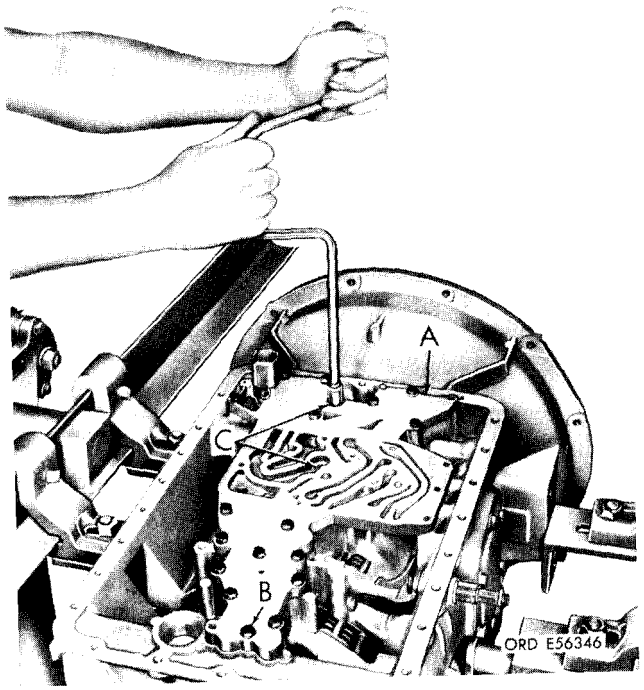


Figure 5-129 (Step 46).

Install transfer plate assembly (A). Install seventeen $^{1}/_{4}$-20 x 1 $^{1}/_{8}$-inch bolts and lockwashers (B). Install two $^{1}/_{4}$-20 x $^{3}/_{4}$-inch bolts and lockwashers in holes at (C). Tighten bolts to 6 to 8

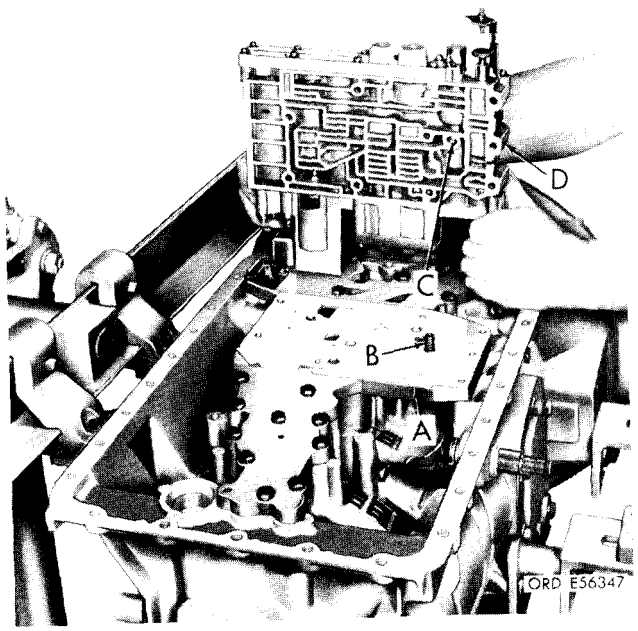


Figure 5-130 (Step 47).

Install separator plate (A), detent spring (B), detent ball (C), and control valve assembly (D) Use oil-soluble grease to hold detent ball (C) in place during installation.

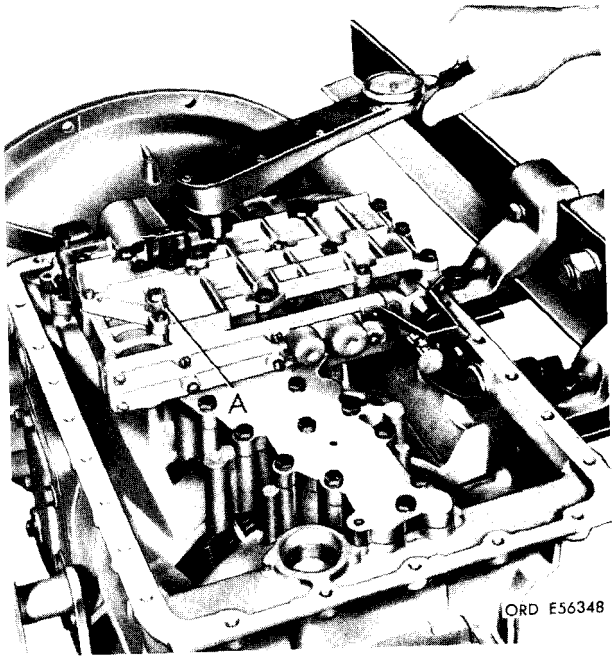


Figure 5-131 (Step 48).

Install nine $^{1}/_{4}$20 x 3-inch bolts and lockwashers (A). Tighten bolts to 6 to 8 pound-feet torque.

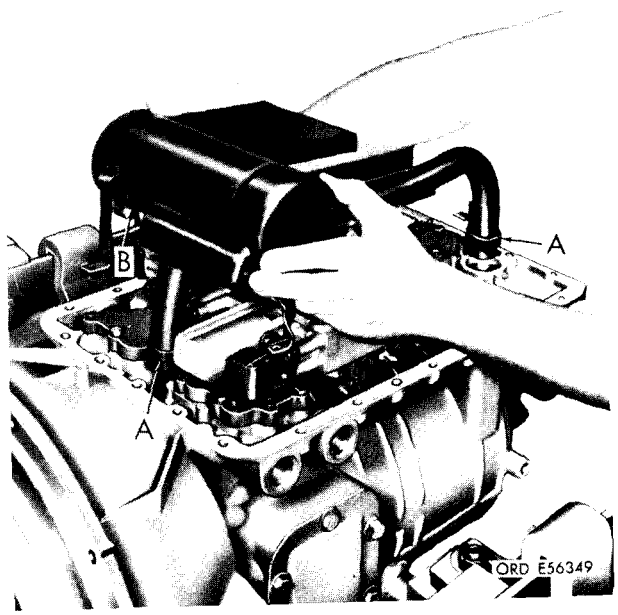


Figure 5-132 (Step 49).

Install seal rings (A) on oil filter can (B). Install oil filter can (B).

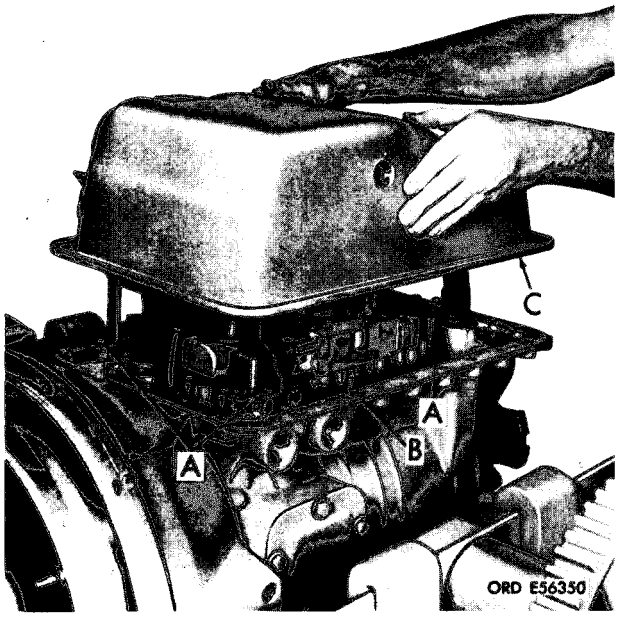


Figure 5-133 (Step 50).

Install three oil filter can ¼ -20 x 1¼-inch bolts and lock washers (A). Tighten bolts to 6 to 8 pound-feet torque. Install gasket (B) and oil pan (C).

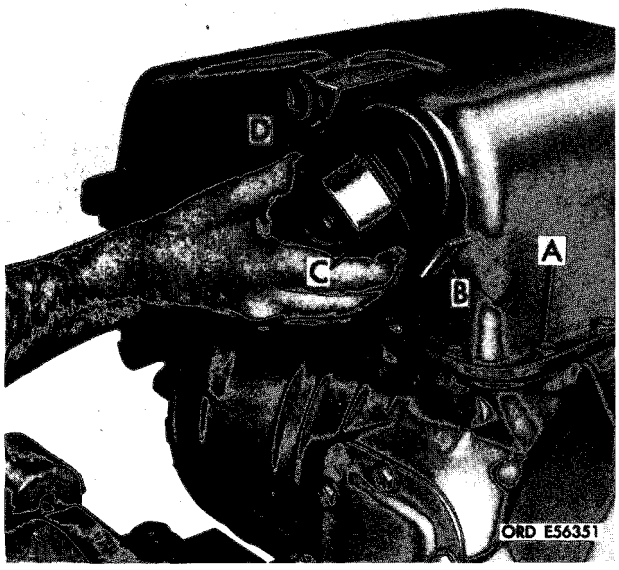


Figure 5-134 (Step 51).

Install twenty-six self-locking bolts (A). Tighten bolts to 15 to 18 pound-feet torque. Install oil filter element assembly (B). Install seal ring (C) on retainer (D), and install retainer assembly, pushing it into opening in oil pan.

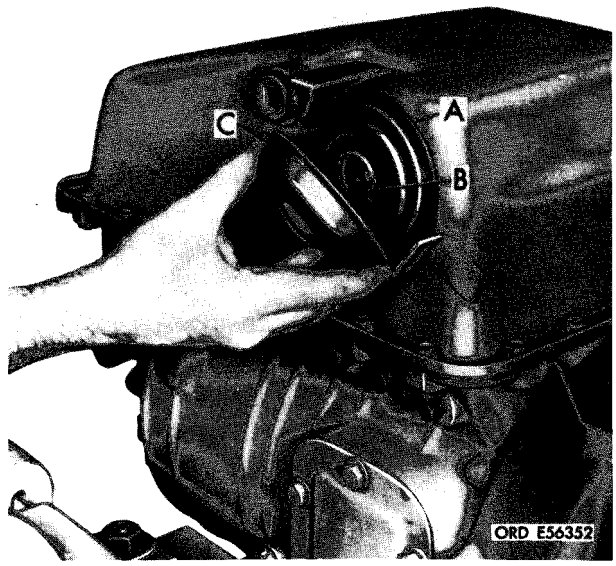


Figure 5-135 (Step 52).

Install seal ring (A). Install spring (B) into cover assembly (C), and install cover assembly.

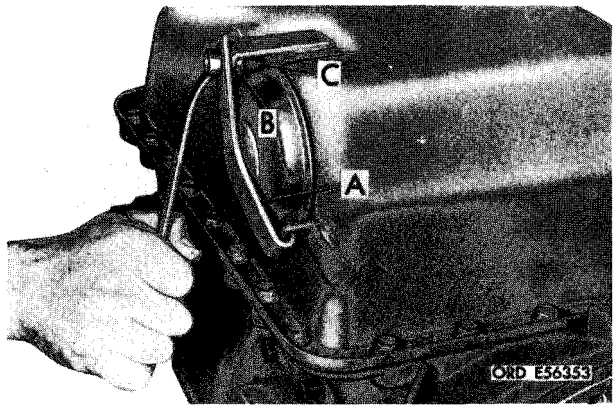
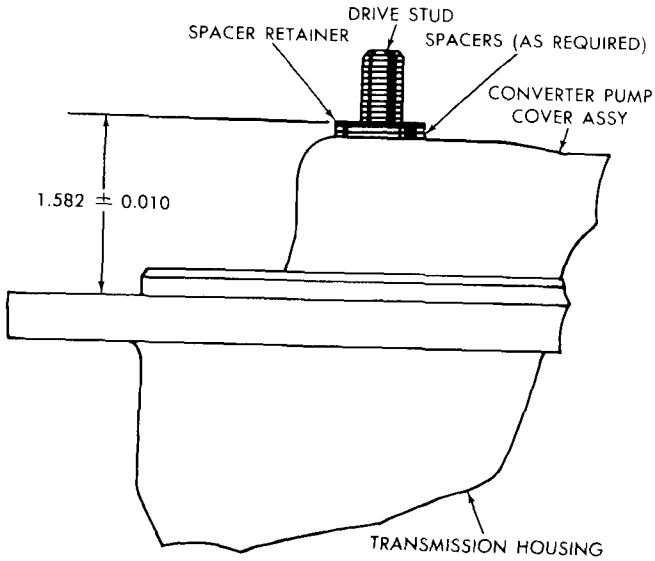


Figure 5-136 (Step 53).

Install strap (A), nut (B), and bolt (C). Tighten bolt to 19 to 23 pound-feet torque.



Stack control spacers are available in thicknesses and color codes as follows:

Thickness	Color Code
0.027 - 0.029	Gold
0.045 - 0.047	Silver
0.063 - 0.065	Copper
0.081 - 0.083	Black
0.099 - 0.101	Plain

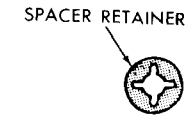


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Figure 5-137. Converter stack—control dimension.

NOTE

The procedures outlined in step 54 (fig. 5-138) are necessary to space the transmission properly in relation to the transmission driving disk (on engine or input drive transfer gear). If correct spacing is not established, the driving disk will be subject to strains which will cause its failure and possible transmission damage. Figure 5-137 shows the correct spacing, stack control spacers, and spacer retainers. Step 54 (fig. 5-138) outlines the methods for establishing the required spacing.

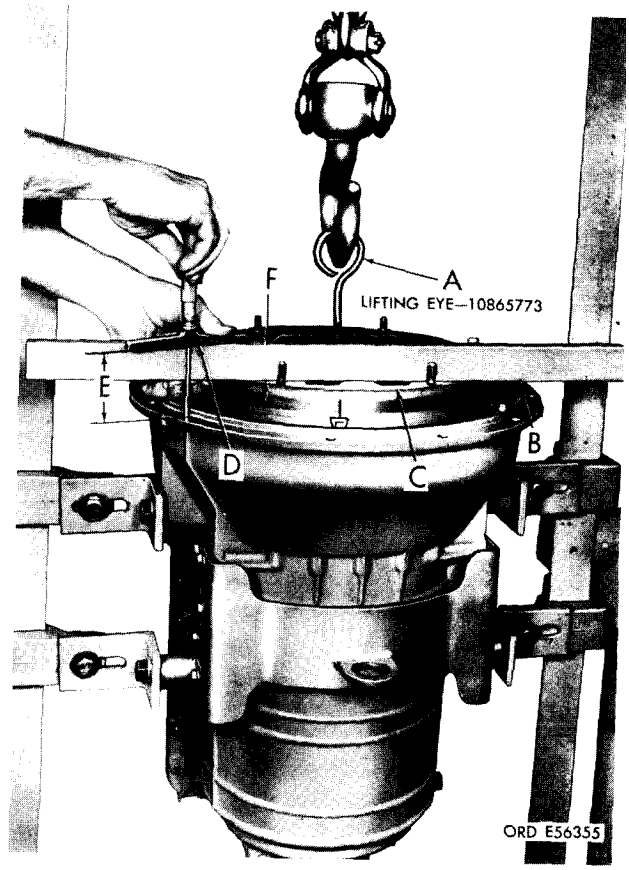

Figure 5-138. (Step 54).

Attach a hoist to lifting eye 4910-673-3801 (10865773) (A) and apply sufficient lifting force (50 to 100 lb) to eliminate all end play. Position straight-edge (B) on converter pump cover (C), as shown. Using a micrometer depth gage (D), measure and record dimension (E). Subtract height of straight-edge (dimension F) from dimension (E), and record the difference. Subtract this difference from 1.566 inches. Select spacers which will equal (within ±0.010) inch the resulting dimension. This is the proper spacer thickness to be used at the drive stud.

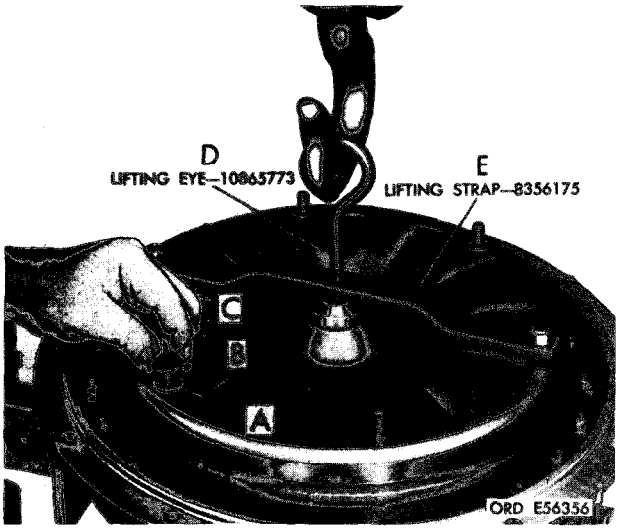

Figure 5-139 (Step 55).

Install spacer(s) (A) and retainer (B) on each of six drive studs (C), after removing lifting eye 4910-573-3801 (10865773) (D) and strap 4910-572-8608 (8356175) (E).

NOTE

Spacers selected to meet the 1.566 dimension, plus retainer thickness of approximately 0.016 inch, will meet the 1.582 dimension in figure 5-137.

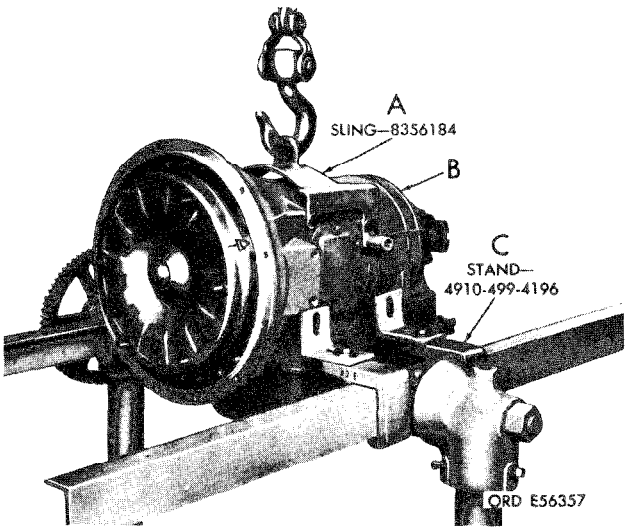

Figure 5-140 (Step 56).

Using a hoist in sling 4910-572-8614 (8356184), (A) remove transmission (B) from stand 4910-499-4196 after four $^{5}/_{8}$-11 bolts are removed.

Section XIV. TESTS AND ADJUSTMENTS

5-59. General

a. The tests in this section will determine if the functional operation of the transmission is satisfactory. The tests may be made after overhaul (rebuild) or to determine the condition of the transmission at any time. The tests may be made while the assembly is installed in the vehicle or on a properly equipped test stand.

b. These tests will determine whether or not the clutches, gearing, and hydraulic system are performing properly.

c. Adjustments of the transmission assembly components and control linkages must be correct when tests are performed. When tests are made in the vehicle, the engine must be properly tuned and performing efficiently. Refer to the engine technical manual for engine tests and adjustments. Refer to paragraphs 5-62 and 5-63 for transmission tests and adjustments.

5-60. Test Equipment

a. 'Transmission Installed in Vehicle. The following equipment is required when testing the transmission assembly in the vehicle.

(1) Tachometer to indicate transmission input speed.

NOTE

To convert engine speed readings, for the M113A1 family of vehicles, to transmission input speed, multiply engine speed by 1.286.

(2) Gages for reading oil pressures. Refer to table 3-1 for pressure gage kit 4910-572-8612.

(3) Tachometer to indicate transmission output speed (drive line disconnected at output).

(4) A bulb-type temperature indicator which will read to 400°F., with fittings to install bulb into oil line carrying oil to cooler.

(5) A spring to hold engine throttle linkage in closed position while accelerator linkage is disconnected from engine.

b. Transmission Installed on Test Stand. The following equipment is required for testing the transmission on a test stand.

(1) The equipment listed in *a* (1) through (4) above is required for testing the transmission out of the vehicle. In addition, a test stand and other equipment is needed.

(2) The test stand must include means for driving the transmission, instruments and controls for measuring and regulating the input torque and speed, an oil cooler which can be connected to the transmission, and linkage to control the manual selector and throttle lever shafts.

(3) A suitable method of locking the transmission output shaft must be provided.

c. Transmission Test Data Log Sheet. A simple transmission test log sheet for recording performance data is illustrated in figure 5-141.

5-61. Oil Pressure Readings

Use the oil pressures listed in table 5-1 as normal values in testing the transmission.

NOTE

Certain pressures vary over a wide range because they are influenced by several factors; speed, range in operation, lockup or converter operation, and position of transmission throttle lever influence pressures. All pressures are based on normal (180° to 200° F.) transmission operating temperature.

5-62. Tests

a. Warmup.

TRANSMISSION TEST DATA LOG SHEET

Model No. _____ Serial No. _____ Sheet No. _____

TEST		ACTUAL	SPECIFIED
1	Stall test (refer to par. 5-62c) - (engine speed)		1900-2100 rpm
2	Throttle valve (TV) linkage setting (refer to par. 5-62d(l) Upshift from second gear lockup to third gear converter - engine speed		2750 rpm
3	Main pressure, intermediate range (refer to table 5-1)		
	Closed throttle, converter		225-270 psi
	Closed throttle, lockup		100-120 psi
	Full throttle "at detent, " converter		270-315 psi
	Full throttle "at detent, " lockup		115-135 psi
	Full throttle "through detent, " converter		280-325 psi
	Full throttle "through detent, " lockup		120-140 psi
4	Front governor (G1) pressure (refer to table 5-1)		
	At 1850 to 1900 rpm (engine speed)		50 psi
	At 2300 to 2400 rpm (engine speed)		80 psi
5	Rear governor (G2) pressure (refer to table 5-1)		
	At 2275 rpm (output speed)		50 psi
	At 3025 rpm (output speed)		80 psi
6	Lubrication pressure (refer to table 5-1)		
	At 2350 rpm (engine speed)		10 to 30 psi
7	Upshifts (refer to par. 5-62d)		
	Full throttle "at detent" (First lockup to second converter		2640-2800 rpm
	(Second lockup to third converter		2740-2780 rpm
	(Third converter to third lockup		2150-2350 rpm
8	Downshifts (refer to par. 5-62d)		
	Full throttle "at detent" (Third converter to second lockup		1900-2000 rpm
	Second converter to first lockup		1900-2000 rpm
	(First lockup to first converter		1500-1700 rpm

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Figure 5-141. Transmission test data log sheet.

Table 5-1. Hydraulic Pressure Chart

Mail Pressure (psi):

Range	Selector position	Throttle setting		
		Closed	Full, at detent	Full, through detent
Low (converter) (lockup)	1	225-270	270-315	280-325
	1	100-120	115-135	120-140
Int. (converter) (lockup)	1-2	225-270	270-315	280-325
	1-2	100-120	115-135	120-140
High (converter) (lockup)	2-3	135-180	180-225	190-235
	2-3	100-120	115-135	120-140

NOTE

Lockup pressures should be measured at 1,900 to 2,000 rpm engine speed. Use the vehicle service brakes, if necessary, while measuring full throttle "at detent" or "through detent" pressures. converter pressures for low range (first gear) and intermediate range (second gear) "at detent" or "through detent" should be measured while the transmission output is stalled.

Front Governor (Gl) Pressure:

Front governor pressure is measured during lockup while operating in selector position 1.

G1 pressure	*Engine speed*
50 psi	1,850 to 1,900 rpm
80 psi	2,300 to 2,400 rpm

Rear Governor (G2) Pressure:

Rear governor pressure is measured during operation in high range (third gear) lockup when the engine speed is measured. It may be measured during converter operation if transmission output speed is measured.

G2 pressure	*Engine speed*	*Output speed*
50 psi	1,750 rpm	2,275 rpm
80 psi	2,350 rpm	3,025 rpm

Lubrication Pressure:

Transmission lubrication pressure is checked at the cooler return line.

Gear	*Throttle position*	*Engine speed*	*Pressure*
High (3d lockup)	"Through detent"	2,350 rpm	10 to 30 psi

(1) With manual selector control at neutral (N), start engine and run it until transmission temperature reaches normal (180° to 200° F.). Shift through all gears to fully charge hydraulic system with oil.

NOTE

It may be necessary to shift to high-range position and operate transmission at 1,200 to 1,500 rpm (1,000 rpm engine speed) while applying vehicle brakes (or locking transmission output) to reach norm a 1 operation temperature.

CAUTION

Do not allow converter-out (cooler) oil temperature to exceed 300° F.

(2) Check transmission and external oil lines for leakage.

(3) Before any oil pressure tests are made, check engine idling speed. Engine idling speed is 500 to 600 rpm. Refer to note following (1) above.

b. Oil Pressure.

NOTE

Do not attempt to connect or disconnect pressure gages while engine is operating.

(1) There are four pressure check points on the transmission (fig. 5-142). Three are on the lower-left side of the transmission housing. The remaining one is at the lower-rear of the housing. These points have plugs which are removed to attach pressure gages as follows:

Lockup pressure check point ($^1/_8$ NPTF)—0-400 psi gage from kit 4910-572-8612.

Main pressure check point (¼ NPTFT)—0-400 psi gage from kit 4910-572-8612.

Front governor (Gl) pressure check point (¼ NPTF)—0-100 psi gage from kit 4910-572-8612.

Rear governor (G2) pressure check point ($^1/_8$ NPTF)—0-100 psi gage from kit 4910-572-8612.

(2) The 0-400 psi gage, hose, and fittings from oil gage kit 4910-572-8612, and the method of attaching are shown in figure 5-143.

(3) The 0-100 psi gage, hose, and fittings from oil gage kit 4910-5'72-8612, and the method of attaching are shown in figure 5-144.

(4) The tapped holes in the transmission housing, to which the oil cooler lines connect, are shown in figure 5-145. Oil temperature, converter-out pressure, and lubrication pressure may be measured by installing suitable fittings, and connecting gages to the lines which attach at these openings.

(5) When connecting gages into lines attached to the openings shown in figure 5-145, the converter-out pressure and temperature gages both must be connected into the oil line which attaches at the rear opening. The lubrication pressure may be taken at the line which attaches at the forward opening.

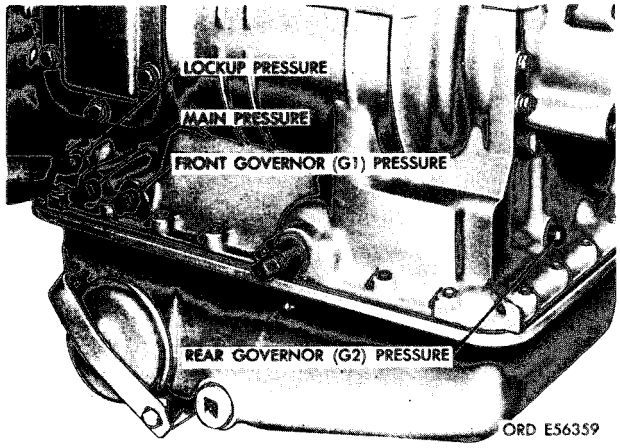

Figure 142. Transmission oil pressure check points.

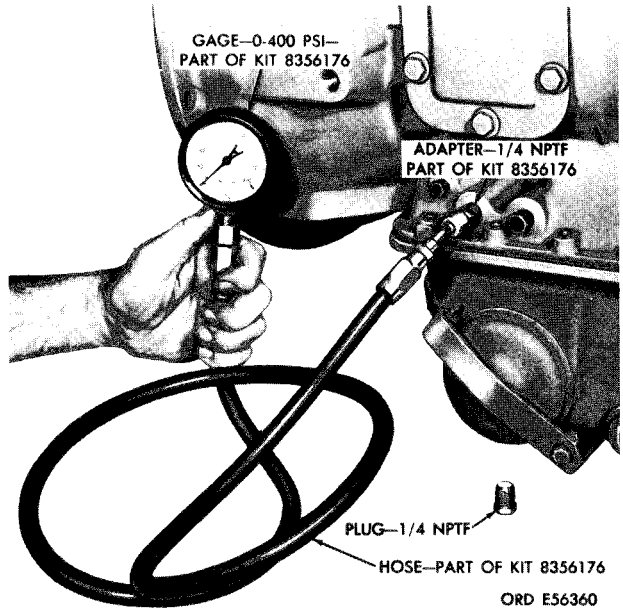

Figure 5-143. Pressure gage attached to ¼ NPTF pressure check point (gage, adapter, and hose are part of kit 4910-572-8612 (8356176)).

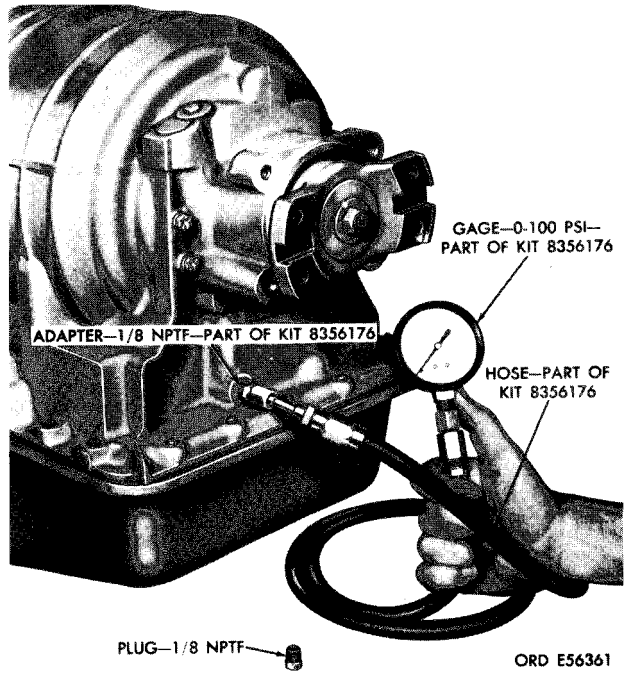

Figure 5-144. Pressure gage attached to ⅛ NPTF pressure check point (gage, adapter, and hose are part of kit 4910-572-8612 (8356176)).

Shift	Engine speed at full throttle	
	At detent	Through detent
Third lockup to third converter (At closed throttle, this downshift should occur at 1,200 to 1,300 rpm.)	1,500 to 1,700 rpm	1,700 to 1,800 rpm
Third converter to second lockup	1,900 to 2,000 rpm	1,950 to 2,150 rpm
Second lockup to second converter	1,500 to 1,700 rpm	1,700 to 1,800 rpm
Second converter to first lockup	1,900 to 2,000 rpm	1,950 to 2,100 rpm
First lockup to first converter	1,500 to 1,700 rpm	1,700 to 1,800 rpm

(At closed throttle a downshift from third converter to first converter occurs at 600 to 800 rpm engine speed.)

NOTE

To convert engine speed readings, for the M113A1 family of vehicles, to transmission input speed, multiply engine speed by 1.286.

e. Lockup Shift Points. During full-throttle operation "at detent," the lockup clutch should engage when front governor (G1) pressure reaches 44 psi.

NOTE

All tests in *d* and e above are based on proper adjustment of the throttle valve (TV) linkage.

f. Inhibitor Functional Check, 3-2 Downshift.

(1) Disconnect transmission output from vehicle. drive line.

(2) Disconnect throttle valve linkage, and rotate throttle valve lever on transmission counterclockwise until it reaches its internal stop.

(3) Place manual selector control in 1-3 position, and accelerate engine to 2,000 rpm.

(4) Shift to 1-2 position, and slowly decrease engine speed. The 3-2 automatic downshift should occur at 1,560 to 1,830 rpm engine speed.

(5) If the 3-2 automatic downshift occurs at a speed higher than 1,830 rpm, it is an indication that the high-to-intermediate inhibitor valve is sticking in its bore and not opening. If the downshift speed point is lower than 1,560 rpm, it is an indication that the valve is either sticking in its bore in an open position or that the inhibitor valve spring is faulty.

g. *Inhibitor Functional Check, 2-1 Downshift.*

(1) Perform steps (1) and (2) as directed in *f* above.

(2) place manual selector control in the 1-2 position, and accelerate engine to 2,000 rpm.

(3) Shift to l-position, and slowly decrease engine speed. The 2-1 automatic downshift should occur at 1,560 to 1,790 rpm engine speed.

(4) If the 2-1 automatic downshift occurs at a epeed higher than 1,790 rpm, it is an indication that the intermediate-to-low inhibitor valve is sticking in its bore and not opening. If the downshift speed point is lower than 1,560 rpm, it is an indication that the valve is either sticking in its bore in an open position or that the inhibitor valve spring is faulty.

NOTE

To convert engine speed readings, for the M113A1 family of vehicles, to transmission input speed, multiply engine speed by 1.286.

5-63. Adjustments

a. Manual Selector Linkage. Proper adjustment of the manual selector linkage is important for proper vehicle performance. Refer to end item organizational manual for procedures.

b. Throttle Linkage Underscored. There are two adjustments which must be made for throttle linkage. One is internal and must be made before the oil pan is installed. The other is external and is made after instilling the transmission in the vehicle. The internal adjustment concerns adjustment and locking of the headless screw in the throttle valve retainer at the rear of control valve assembly (fig. 5-146).

NOTE

This adjustment is necessary only when a replacement control valve assembly (3, fig. 5-82) or valve body (42, fig. 5-82) is installed. The adjustment, if required, is made as follows:

(1) On original control valve assembly, measure distance between rear of throttle valve (depressed until it bottoms) and front of throttle valve stop screw. Record this dimension (fig. 5-146).

(2) On new control valve assembly, adjust stop screw until distance between rear of depressed throttle valve and front of stop screw corresponds exactly with measurement made in (1) above.

(3) Lock stop screw by crimping threaded portion of retainer against flat side of stop screw (fig. 5-146).

(4) The external adjustment concerns the linkage connecting the accelerator pedal, engine fuel control, and transmission throttle lever. This adjustment is extremely important because it matches the transmission function to the engine

output. The position of the throttle lever controls throttle (T) and throttle valve (TV) pressures. These pressures, in turn, influence upshifts, downshifts, lockup, main pressure, and clutch trimmer action. Refer to end item organizational manual for adjustment procedures.

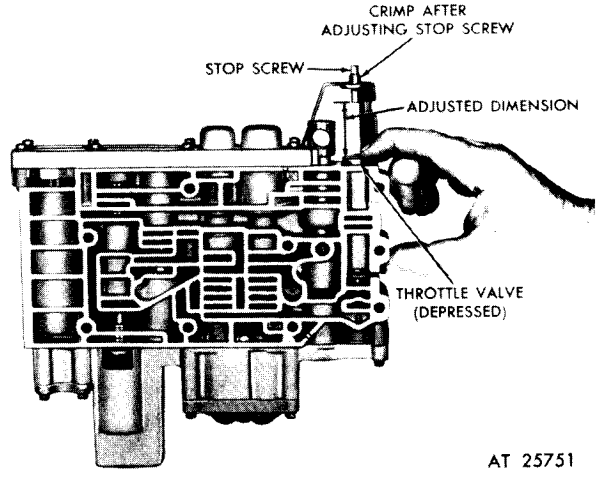

Figure 5-146. Throttle valve stop screw adjustment.

CHAPTER 6

REPAIR AND OVERHAUL (REBUILD) STANDARDS

6-1. Standard Torque Specifications

Refer to table 6-1 for standard torque specifications for bolts, nuts, and screws. Special torque specifications are included in applicable overhaul (rebuild) and assembly sections.

6-2. Spring Specifications

Refer to table 6-2 for specifications for all springs in the transmission.

6-3. General Wear Limits Information

a. Wear Limits Definition. The wear limits indicate the dimensions to which a part may wear before it must be replaced. Normally any part not worn beyond its wear limit will be approved for continued use, if it is not otherwise damaged.

b. Points of Measurement. Points of measurement of all critical dimensions are indicated by lower-case letters in the referenced figures.

c. Wear Limits Tabulation. All wear limits applicable to transmission parts are tabulated in paragraph 6-4 below.

d. Letters and Symbols in Tabulation. The "Size and Fit of New Parts" column indicates fit by T or L. T denotes a tight (interference) fit; L denotes a loose (clearance) fit.

6-4. Wear Limits

Refer to table 6-3 for wear limits for direct and general support, maintenance operations.

NOTE

Refer to paragraph 5-3 for inspection recommendations applicable to all transmission componets.

Table 6–1. Standard Torque Specifications

Size	Threads	Torque value in pounds–feet: Standard heat–treated bolts and screws	Special heat–treated, self–locking bolts and Allen–head screws	Nuts on studs
				
1/4	20	9-11	9-11	
	28	10-12	10-12	
5/16	18	13-16	17-20	
	24	14-18	19-23	14-18
3/8	16	26-32	36-43	
	24	33-40	41-49	
7/16	14	42-50	54-65	
	20	50-60	64-77	
1/2	13	67-80	81-97	
	20	83-100	96-115	

Table 6-2. Spring Specification

Fig.	Item	Spring	No. coils	Diameter of wire	Outside diameter	Free length	Length under load (lb)	
5-62	28	High-range clutch piston return (outer)	3.1	0.406	4.700	2.88	1.53	440 to 500 lb
5-62	29	High-range clutch piston return (inner)	3.7	0.345	3.800	3.016	1.53	323 to 373 lb
5-74	19	Intermediate-range clutch return	14.5	0.0625	0.448	1.51	1.19	13 to 15.8 lb
5-74	34	Low-range clutch return	18	0.0672	0.448	1.77	1.45	14.4 to 17.6 lb
5-75	13	Reverse-range clutch return	18	0.0672	0.448	1.77	1.45	14.4 to 17.6 lb
5-82	7	Lubrication regulator	13	0.0672	0.873	3.093	1.13	9 to 11 lb
5-82	11, 70	Shift valve detent	10	0.054	0.345	1.06	0.696	18 to 22 lb
5-82	14	Low-intermediate shift valve	14.5	0.0475	0.820	3.547	0.87	3.15 to 3.85 lb
5-82	15	High-intermediate inhibitor valve	12.5	0.0340	0.270	0.917	0.63	3.89 to 4.11 lb
5-82	17	Intermediate-low inhibitor valve	15	0.028	0.270	1.11	0.63	2.25 to 2.35 lb
5-82	27	Intermediate-high shift valve	12	0.0561	0.820	3.375	0.87	7.2 to 8.8 lb
5-82	30	Extender valve	7	0.032	0.426	1.059	0.45	2.85 to 3.15 lb
5-82	31	Extender valve ball	8.15	0.028	0.312	0.63	0.38	1.425 to 1.575 lb
5-82	36	Lockup shift valve	18.5	0.063	0.610	2.85	1.24	13.1 to 13.9 lb
5-82	37	Main regulator valve	14	0.113	1.080	3.841	1.98	39 to 41.4 lb
5-82	43	Throttle valve	15.3	0.041	0.397	1.84	0.78	6.96 to 7.24 lb
5-82	52	Trimmer primary	10	0.1055	0.70	1.88	1.59	28.5 to 31.5 lb
5-82	54	Trimmer secondary	9.5	0.1055	1.065	2.66	1.16	38.2 to 42.2 lb
5-82	56	Trimmer return inner	12	0.0475	0.667	3.26	2.22	2.76 to 3.36 lb
5-82	57	Trimmer return outer	15	0.0625	0.850	4.50	1.02	11.16 to 13.64 lb
5-82	83	Converter pressure regulator	13	0.0625	0.433	1.449	1.00	15.84 to 19.36 lb

Note. Values given are for new parts. No deviation for direct and general support and depot maintenance.

Table 6-3. Wear Limits

Fig.	Item	Point of measurement	Size and fit of new parts	DS	GS
5-53	5a	Bore in bushing (installed)	0.9900 to 1.0010		
5-62	9a	Diameter of turbine shaft	0.9975 to 0.9985		
		Fit of shaft 9a into bushing 5a	0.0005L to 0.0035L	0.0070L	0.0070L
5-53	8a	Thickness of piston apply area	0.3010 to 0.3050	No scoring	permissible
5-53	11a	Thickness of lockup clutch plate.	0.1800 to 0.1900	0.1750	0.1750
5-53	13a	Thickness of lockup clutch back plate.	0.2350 min	No scoring	permissible
5-53	16a	Thickness from front of thrust face to rear of needle bearing (on needles-bearing installed).	0.4460 to 0.4542	0.4350	0.4350
5-53	16b	Inside diameter of stator side plates.	2.8490 to 2.8530	2.8570	2.8570
5-53	18a	Diameter of freewheel rollers.	0.3748 to 0.3750	No scoring	permissible
5-53	35a	Outside diameter of freewheel race.	2.8425 to 2.8435	2.8410	2.8410
5-53	38a	Depth of body bore	0.6845 to 0.6870		
5-53	40a	Thickness of drive gear	0.6835 to 0.6860	*0.0030L	*0.0030L
		Side clearance of body 38a with gear 40a.	0.0005L to 0.0015L	*0.0030L	*0.0030L
				No scoring	permissible
5-53	38a	Depth of body bore	0.6845 to 0.6870		
5-53	39b	Thickness of driven gear	0.6830 to 0.6855		
		Side clearance of body 38a with gear 39b.	0.0010L to 0.0020L	*0.0030L	*0.0030L
				No scoring	permissible
5-53	38b	Bore of pump body	4.7930 to 4.7950		
		Outside diameter of gear	4.7870 to 4.7880		
		Fit of body 38b to gear 39a	0.0050L to 0.0080L	0.010L	0.0100L
				No scoring	permissible
5-75	4a	Thickness of clutch apply plate.	0.0910 to 0.0950	0.0050 cone	0.0050 cone
5-75	5a, 8a, 10a, 12a	Thickness of internal-splined clutch plate.	0.1500 to 0.1560	0.1450	0.1450
5-75	7a, 9a, 11a	Thickness of external-tanged tanged clutch plate.	0.0910 to 0.1950	0.0050 cone	0.0050 cone
5-75	14a	Thickness of clutch back plate at clutch surface.	0.7180 to 0.7220	No scoring	permissible
5-75	16a	Thickness of thrust washer	0.0910 to 0.0950	0.0850	0.0850
5-75	19a	Thickness of thrust washer	0.0910 to 0.0950	0.0850	0.0850
5-75	37a	Depth of body bore	0.3120 to 0.3145		
5-75	38b	Width of driven gear	0.3105 to 0.3130		
		Side clearance of gear in body.	0.0010L to 0.0020L	0.0030L	0.0030L
				No scoring	permissible
5-75	37b	Bore of pump body	4.7500 to 4.7520		
5-75	38b	Outside diameter of gear	4.7440 to 4.7450		
		Fit of gear 38a in body 37b	0.0050L to 0.0080L	0.0100L	0.0100L
				No scoring	permissible
5-75	37a	Depth of body bore	0.3120 to 0.3145		
		Width of drive gear	0.3105 to 0.3130		
		Side clearance of gear 39a with body 37a.	0.0010L to 0.0020L	0.0030L	0.0030L
5-62	9b	(listed with fig. 5-74, item 44a, below.)			
5-62	23a	Inside diameter of bushing	1.7485 to 1.7515		
		Fit of sleeve 14 into bushing 23a.	1.7460 to 1.7465		
			0.0020L to 0.0055L	*0.0080L	*0.0080L
5-62	32a, 34a, 36a, 38a	Thickness of internal-splined clutch plate.	0.1500 to 0.1540	0.1450	0.1450
5-62	33a, 35a, 37a	Thickness of external-tanged clutch plate.	0.0910 to 0.0950	0.0050 cone	0.0050 cone
5-62	39a	Thickness of clutch reaction plate.	0.2960 to 0.2980	0.0030 cone	0.0030 cone
5-74	9a, 11a, 14a	Thickness of internal-splined clutch plate.	0.1500 to 0.1560	0.1450	0.1450
5-74	10a, 13a	Thickness of external-tanged clutch plate.			
5-74	15a	Thickness of apply plate	0.0910 to 0.0950	0.0050 cone	0.0050 cone
5-74	17a	Thickness of clutch back plate.	0.7280 to 0.7320	No scoring	permissible
5-74	27a, 29a, 31a	Thickness of external-tanged plates.	0.0910 to 0.0950	0.0050 cone	0.0050 cone
5-74	28a, 30a, 32a	Thickness of internal-splined plates.	0.150 to 0.1560	0.1450	0.1450
5-74	33a	Thickness of apply plate	0.0910 to 0.0950	0.0050 cone	0.0050 cone
5-74	44a	Bore of bushing (installed)	0.8750 to 0.8770		
5-62	9b	Outside diameter of turbine shaft.	0.8725 to 0.8735		
		Fit of shaft 9b into bushing 44a.	0.0015L to 0.0045L	*0.0070L	*0.0070L

[1] Wear may be on either or both items so long as fit is maintained.

APPENDIX A

REFERENCES

1. Publication Indexes

The following index and the 310 series Department of the Army pamphlets should be consulted frequently for latest changes or revisions to references given in this appendix and for new publications relating to materiel covered in this technical manual.

Index of Army Films, Transparencies, GTA Charts, and recordings, . . DA Pam 108-1

2. Supply Manuals

The following Department of the Army Supply Manuals pertain to this materiel:

a. Repair and Overhaul (Rebuild).

Direct and General Support, and Depot Maintenance Repair Parts and Special Tool List:

Transmission, Automatic, W / Container, Assembly 2520-066-4239
Allison Div. GMC Model TX 100-1 . . . . . TM 9-2520-254-35P

b. Vehicles.

Carrier, Cargo, Tracked, 6-Ton, M548 . . . . . *TM 9-2350-247
Carrier, Command Post, Light, Tracked, M577A1 . . . . . *TM 9-2300-257
Carrier, Flame Thrower, Self-Propelled, M132A1 . . . . . * TM 9-2300-257
Carrier, Guided Missile Equipment, XM727 . . . . . * TM 9-1450-501
Carrier, Guided Missile Equipment, XM730 . . . . . * TM 9-1450-585
Carrier, Gun, Antiaircraft Artillery, 20-MM, Self-Propelled, XM741 . . . . . * TM 9-2300-257
Carrier, Mortar, 107-MM, Self-Propelled, M106A1 . . . . . * TM 9-2300-257
Carrier, Mortar, 81-MM, Self-Propelled, M125A1 . . . . . * TM 9-2300-257
Carrier, Personnel, Full Tracked, Armored, M113A1 . . . . . * TM 9-2300-257

3. Forms

a. Refer to DA Pamphlet 310-2 for listing of blank forms required for support of this materiel.

b. TM 38-750 contains instructions on use of applicable forms.

4. Other Publications

a. Vehicle (Operation and Maintenance).

Carrier, Cargo, Tracked, 6-Ton, M548 . . . . . *TM 9-2350-247
Carrier, Command Post, Light, Tracked, M577Al . . . . . *TM 9-2300-257
Carrier, Flame Thrower, Self-Propelled, M132Al . . . . . *TM 9-2300-257
Carrier, Guided Missile Equipment, XM727 . . . . . * TM 9-1450-501
Carrier, Guided Missile Equipment, XM730 . . . . . * TM 9-1450-585
Carrier, Gun, Antiaircraft Artillery, 20-MM Self-Propelled, XM741. . . . . * TM 9-2300-257
Carrier, Mortar, 107-MM, Self-Propelled, M106A1 . . . . . * TM 9-2300-257
Carrier, Mortar, 81-MM, Self-Propelled, M125A1 . . . . . * TM 9-2300-257
Carrier, Personnel, Full Tracked, Armored, Ml13A1 . . . . . * TM 9-2300-257

b. Miscellaneous (Maintenance, Overhaul, and Rebuild).

Command Maintenance Management Inspection (CMMI) . . . . . AR 750-8
Inspection, Care, and Maintenance of Antifriction Bearings . . . . . TM 9-214
Ordnance Corps Equipment Data Sheets . . . . . TM 9-500
organization, Policies, and Responsibilities for Maintenance operations . . . . . AR 750-5
Preservation, Packaging, and Packing of Military Supplies and Equipment (Vol. 1) . . . . . TM 38-230-1
preservation, Packaging, Packing, and Marking of Items of Supply . . . . . AR 700-15
Principles of Automotive Vehicles . . . . . TM 9-8000
Publications for Packaging Army General Supplies . . . . . SB 746-1
Report of Packaging and Handling Deficiencies . . . . . AR 700-58
The Army Maintenance Management System (TAMMS) . . . . . TM 38-750
Use and Care of Hand Tools and Measuring Tools . . . . . TM 9-243
Welding; Theory and Application . . . . . TM 9-237

*DA Pam 310-4 for listing of maintenance technical manuals and "P" Type supply Manuals.

By Order of the Secretary of the Army:

W. C. WESTMORELAND,
General, United States Army,
Chief of Staff.

Official:

VERNE L. BOWERS,
Major General, United States Army,
The Adjutant General.

DISTRIBUTION:

To be distributed in accordance with DA Form 12.32 Section II, Direct and General Support Maintenance requirements for Hawk and Chaparral Missile Systems and DA Form 12-37, Direct and General Support Maintenance requirements for Command Post, M577; M577A1, Flame Thrower, M132; M132A1, Mortar, M106A1 and M125A1.

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THE METRIC SYSTEM AND EQUIVALENTS

'NEAR MEASURE

. Centimeter = 10 Millimeters = 0.01 Meters = 0.3937 Inches
1 Meter = 100 Centimeters = 1000 Millimeters = 39.37 Inches
1 Kilometer = 1000 Meters = 0.621 Miles

'VEIGHTS

Gram = 0.001 Kilograms = 1000 Milligrams = 0.035 Ounces
1 Kilogram = 1000 Grams = 2.2 lb.
1 Metric Ton = 1000 Kilograms = 1 Megagram = 1.1 Short Tons

LIQUID MEASURE

1 Milliliter = 0.001 Liters = 0.0338 Fluid Ounces
1 Liter = 1000 Milliliters = 33.82 Fluid Ounces

SQUARE MEASURE

1 Sq. Centimeter = 100 Sq. Millimeters = 0.155 Sq. Inches
1 Sq. Meter = 10,000 Sq. Centimeters = 10.76 Sq. Feet
1 Sq. Kilometer = 1,000,000 Sq. Meters = 0.386 Sq. Miles

CUBIC MEASURE

1 Cu. Centimeter = 1000 Cu. Millimeters = 0.06 Cu. Inches
1 Cu. Meter = 1,000,000 Cu. Centimeters = 35.31 Cu. Feet

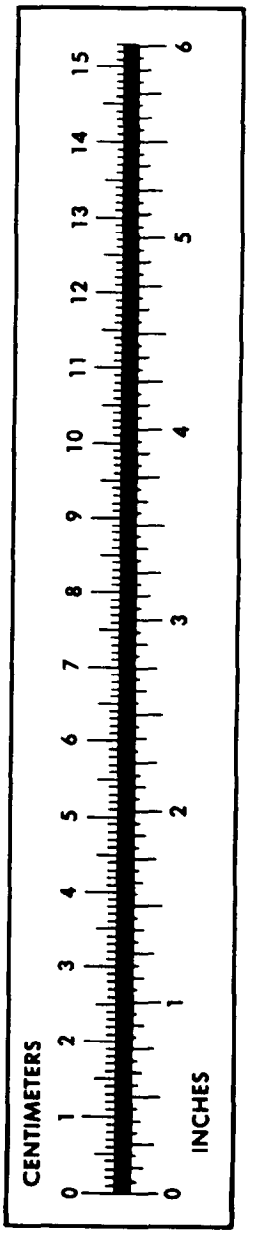
TEMPERATURE

5/9(°F - 32) = °C
212° Fahrenheit is evuivalent to 100° Celsius
90° Fahrenheit is equivalent to 32.2° Celsius
32° Fahrenheit is equivalent to 0° Celsius
9/5C° + 32 =°F

APPROXIMATE CONVERSION FACTORS

TO CHANGE	TO	MULTIPLY BY
Inches	Centimeters	2.540
Feet	Meters	0.305
Yards	Meters	0.914
Miles	Kilometers	1.609
Square Inches	Square Centimeters	6.451
Square Feet	Square Meters	0.093
Square Yards	Square Meters	0.836
Square Miles	Square Kilometers	2.590
Acres	Square Hectometers	0.405
Cubic Feet	Cubic Meters	0.028
Cubic Yards	Cubic Meters	0.765
Fluid Ounces	Milliliters	29.573
ıts	Liters	0.473
arts	Liters	0.946
allons	Liters	3.785
Ounces	Grams	28.349
Pounds	Kilograms	0.454
Short Tons	Metric Tons	0.907
Pound-Feet	Newton-Meters	1.356
Pounds per Square Inch	Kilopascals	6.895
Miles per Gallon	Kilometers per Liter	0.425
Miles per Hour	Kilometers per Hour	1.609

TO CHANGE	TO	MULTIPLY BY
Centimeters	Inches	0.394
Meters	Feet	3.280
Meters	Yards	1.094
Kilometers	Miles	0.621
Square Centimeters	Square Inches	0.155
Square Meters	Square Feet	10.764
Square Meters	Square Yards	1.196
Square Kilometers	Square Miles	0.386
Square Hectometers	Acres	2.471
Cubic Meters	Cubic Feet	35.315
Cubic Meters	Cubic Yards	1.308
Milliliters	Fluid Ounces	0.034
Liters	Pints	2.113
Liters	Quarts	1.057
ers	Gallons	0.264
ms	Ounces	0.035
ograms	Pounds	2.205
Metric Tons	Short Tons	1.102
Newton-Meters	Pounds-Feet	0.738
Kilopascals	Pounds per Square Inch	0.145
lometers per Liter	Miles per Gallon	2.354
meters per Hour	Miles per Hour	0.621



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