

# GROUP 5 AUTOMATIC TRANSMISSION

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## SECTION 5-A 4000-4100 AUTOMATIC TRANSMISSION, SPECIFICATIONS DESCRIPTION AND OPERATION

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### 5-1 AUTOMATIC TRANSMISSION GENERAL SPECIFICATIONS

#### a. Transmission Identification Number

A production identification number is stamped on the raised surface of the case, forward of the oil pan, left side.

The identification consists of a letter followed

by one or more digits. Since the production identification number furnishes the key to construction and interchangeability of parts in each transmission, the number should be used when selecting replacement parts as listed in the master parts list. The number should always be furnished on product reports, AFA forms, and correspondence with the Factory concerning a particular transmission.

#### b. General Specifications

Oil Capacity . . . . .	6 Quarts
Oil Quantity indicated between marks on gauge rod . . . . .	1 Pint
Oil Specification . . . . .	Automatic Transmission Fluid Type A, Suffix A
Drain and refill mileage recommendations . . . . .	25,000 mi.
Torque Multiplication	
Low Range and Drive Range Before Converter Clutch Engagement (Stall) . . . . .	3.6
Drive Range after Converter Clutch Engagement (Stall) . . . . .	1.5
Converter Clutch Engagement Control . . . . .	Governor and Throttle Opening
Planetary Gearing Type . . . . .	Dual Sun Gear
Number of Pinions . . . . .	4
Pump Pressure Regulation (Varied by throttle setting) . . . . .	70-123 PSI Low and Drive Range 108-185 PSI Reverse, Neutral and Park Range

**5-2 AUTOMATIC TRANSMISSION  
TIGHTENING SPECIFICATIONS**

Use a reliable torque wrench to tighten the attaching bolts or nuts of the parts listed below.

NOTE: These specifications are for clean and lubricated threads only. Dry or dirty threads produce increased friction which prevents accurate measurement of tightness.

Part	Application	Thread	Torque
Bolt Special	Case to Cylinder Block . . . . .	3/8 -16	30-35
Bolt	Cover pan to Cylinder Block . . . . .	5/16-18	8-12
Screw-Tapping	Cover pan to Transmission Case . . . . .	1/4 -20	-
Bolt	Oil pan to Transmission Case . . . . .	5/16-18	15-20
Screw	Filler Pipe Clamp to Case . . . . .	1/4 -20	4-8
Screw	Speedo Sleeve Clip to Case . . . . .	1/4 -20	4-8
Bolt	Converter to Flywheel . . . . .	5/16-18	18-25
Nut	Converter Pump to housing . . . . .	5/16-24	15-20
Bolt	Planet Set Ring Gear to Turbine . . . . .	5/16-18	15-20
Bolt	Reverse Clutch Housing to oil pump body . . . . .	5/16-18	15-20
Screw	Oil pump and Reverse Clutch housing to case . . . . .	5/16-18	20-24
Bolt	Valve Body to case . . . . .	1/4 -20	6-9
Nut	Selector inner lever to shaft . . . . .	1/4 -28	4-8
Nut	Throttle Valve Control Lever Clamp . . . . .	1/4 -28	4-8
Bolt	Parking Lock Bracket to case . . . . .	5/16-18	15-20
Bolt	Companion flange to Output Shaft . . . . .	3/8 -24	45-55

**5-3 4000-4100 AUTOMATIC  
TRANSMISSION MANUAL  
CONTROL MECHANISM****a. Manual Control Mechanism**

The 4000-4100 automatic transmission provides five different control or operating ranges which may be manually selected by the driver through movement of the control lever at top of the steering column. A pointer on the control shaft and a stationary dial on the control panel aid in locating the lever for each range. Letters on the dial, reading from left to right identify each range as follows:

P = Parking	L = Low
N = Neutral	R = Reverse
D = Drive	

It is necessary to raise the control lever against light spring pressure to shift into Reverse (R) or Parking (P). The control lever actuates a shaft in the steering column which is connected by levers and rods to a shift control valve in the transmission. A notched detent plate holds the mechanism in the selected position.

The control shaft also operates a neutral safety switch mounted on the column jacket. The switch, which is connected to the cranking motor electrical circuit, is closed only when the control lever is in Neutral (N) or Parking

(P) so that the engine may not be started in any of the driving ranges.

**b. Parking (P) Range**

Parking range is to be used with the hand parking brake to insure positive locking of the car on steep grades. The shift control lever must be raised when shifting into and out of parking position.

Parking range must never be entered when the car is in motion or serious damage to the transmission will result.

Parking range should always be used when it is desirable to run and accelerate the engine without possibility of car movement, such as when working on the car.

When in Parking range, a ratchet wheel on the transmission output shaft is engaged by a locking pawl mounted in the transmission case. Thus a positive lock is maintained on the propeller shaft. The locking pawl is applied through an apply spring which holds the parts against the ratchet wheel until engagement of these parts is accomplished. If the pawl does not engage a notch in the wheel when first applied, it will snap into place as the wheel turns when the car moves slightly.

**c. Neutral (N) Range**

Neutral range as well as Parking range may

be used when starting the engine. It is not necessary to shift into neutral when the car is temporarily stopped during normal driving operations. Neutral must always be used when towing the car with the rear wheels on the road.

Neutral may be used when it is desirable to run the engine without car movement, but Parking (P) is recommended for greater safety.

#### **d. Drive (D) Range**

Drive (D) range is to be used for all forward driving except as specified for Low (L) range.

During any acceleration from a stop the transmission starts in "Low". Upon attainment of sufficient speed for a given throttle opening, a converter clutch engages to change the engine's power flow through the transmission from 100% through the torque converter to approximately 64% through the torque converter and 36% through a mechanical connection to output shaft.

When the accelerator pedal is pushed to the floor at any car speed below 56 MPH the converter clutch is disengaged to provide full power flow through the torque converter for rapid acceleration.

#### **e. Low (L) Range**

Low range is used whenever the driver does not want the converter clutch to engage regardless of throttle opening or car speed. Low range may also be used for additional engine braking while descending steep grades.

#### **f. Reverse (R) Range**

Reverse range is used to move the car rearward. The shift control lever must be raised when shifting into reverse.

#### **g. Rocking Car Between Low and Reverse**

When the car is stuck in deep snow or mud, it often can be driven out by "rocking" the car back and forth by alternately using low and reverse until sufficient momentum is obtained to move the car out in desired direction.

When rocking is necessary, apply a light throttle pressure and shift back and forth between Low (L) and Reverse (R). Avoid racing the engine.

If the car is still stuck after two or three minutes, have the car pulled out to avoid overheating and possible damage to the transmission.

#### **h. Pushing Car to Start Engine**

The 4000-4100 series cars equipped with automatic transmission cannot have the engine started by pushing or pulling the car. A "booster" battery must be used instead.

#### **i. Towing Disabled 4000-4100 Automatic Transmission Equipped Car**

A disabled 4000-4100 automatic transmission equipped car must not be towed on rear wheels unless propeller shaft is disconnected at rear companion flange. Care must be taken to support propeller shaft to avoid damage to center universal joint.

### **5-4 PRINCIPLE SECTIONS OF 4000-4100 AUTOMATIC TRANSMISSION**

To simplify description of construction and operation of the 4000-4100 automatic transmission assembly, it will be divided into the following sections. See Figure 5-1.

#### **a. Transmission Case**

The transmission assembly is bolted to the engine crankcase through the converter housing section of the transmission case. The transmission case, converter housing and rear bearing retainer are one integral cast aluminum part.

#### **b. Torque Converter and Gear Set**

The torque converter is coupled to the engine and transmits engine torque hydraulically to a planetary gear set, the planet gear carrier of which is splined to the output shaft.

The torque converter automatically provides torque multiplication to meet varying driving conditions. Construction and operation of the torque converter are described in paragraph 5-6.

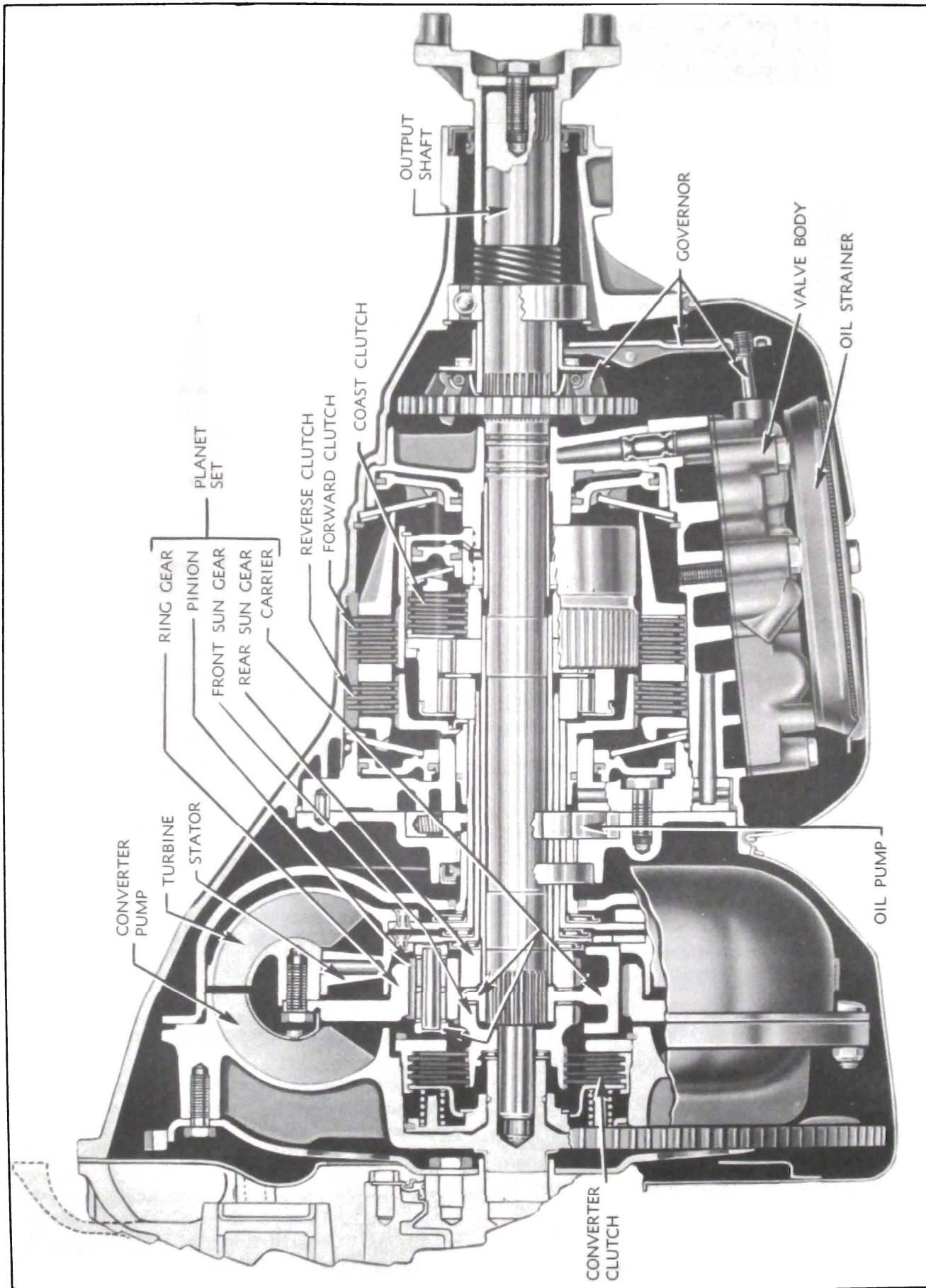


Figure 5-1—Side Sectional View of Automatic Transmission

**c. Converter Clutch**

The converter clutch, when engaged, transmits approximately 36% of the engine torque to the planetary gear set front sun gear. Thus part of the engine torque is transmitted mechanically to the output shaft.

**d. Forward Clutch**

The forward clutch is a multiple disc clutch which, when engaged, locks the cam of the stator and rear sun gear overrunning clutches to the transmission case. The forward clutch is engaged in Low and Drive ranges to allow the stator and rear sun gear to turn in one direction only (with the engine).

**e. Coast Clutch**

The coast clutch is a multiple disc clutch which, when engaged, locks the rear sun gear to the cam of the stator and rear sun gear overrunning clutches. The coast clutch also locks the overrunning clutch cam to part of the forward clutch discs. Thus, when both the coast clutch and forward clutch are engaged, the rear sun gear and overrunning clutch cam are locked to the transmission case. The coast clutch is engaged in all ranges except Drive range.

**f. Reverse Clutch**

The reverse clutch is a multiple disc clutch which, when engaged, locks the turbine and planet set ring gear to the transmission case. The reverse clutch is engaged in Reverse (R) range.

**g. Overrunning Clutches**

The rear of stator and rear sun gear shafts are splined to overrunning clutch races. The clutches are arranged to allow rotation with respect to the clutch cam in one direction only (with the engine). See Figure 5-10.

**h. Hydraulic Controls**

The hydraulic control system includes devices for controlling engagement of the disc clutches, filling the torque converter and circulation of oil for lubrication and heat transfer.

**5-5 TORQUE CONVERTER AND GEAR SET**

The torque converter is connected to the engine flywheel and serves as a hydraulic coupling through which engine torque (turning force), is transmitted to the output shaft. The torque converter steps up or multiplies engine torque whenever operating conditions demand greater torque than the engine alone can supply. In this respect it serves the same purpose as the selective reduction gears used in conventional automotive transmissions. Torque multiplication is always required when a car is started and accelerated at low speeds. Torque multiplication may be required when ascending steep grades, moving in deep sand, mud or snow. Torque requirements decrease as car speed increases and when a point is reached where engine torque is adequate, no torque multiplication is required. From this point, the converter functions as an efficient fluid coupling providing maximum economy.

The torque converter automatically provides the proper ratio of torque multiplication to meet the demands imposed by starting and driving under all ordinary conditions of load and grade. The transition through the various ratios from stall to cruise operation is smooth and virtually devoid of steps or shift points since it is accomplished without the use of selective gears.

The principle elements of the torque converter are described in subparagraphs a, b, c, and d. Operation of these elements is described in paragraph 5-9.

**a. Converter Pump**

The converter pump is bolted to the engine flywheel so it rotates whenever the engine is running. The converter pump and housing comprise a housing for all converter components. The converter pump assembly consists of an aluminum casting finned on its forward face for air cooling. Its rear face incorporates 30 vanes and a inner shell bolted to them to form a converter pump. The pump assembly also includes a converter clutch assembly. Description and operation of the converter clutch are discussed in paragraph 5-6.

The pump operates as a centrifugal pump, picking up oil at its center and discharging the oil at its rim. However, the pump is shaped to discharge the oil parallel to its axis in the



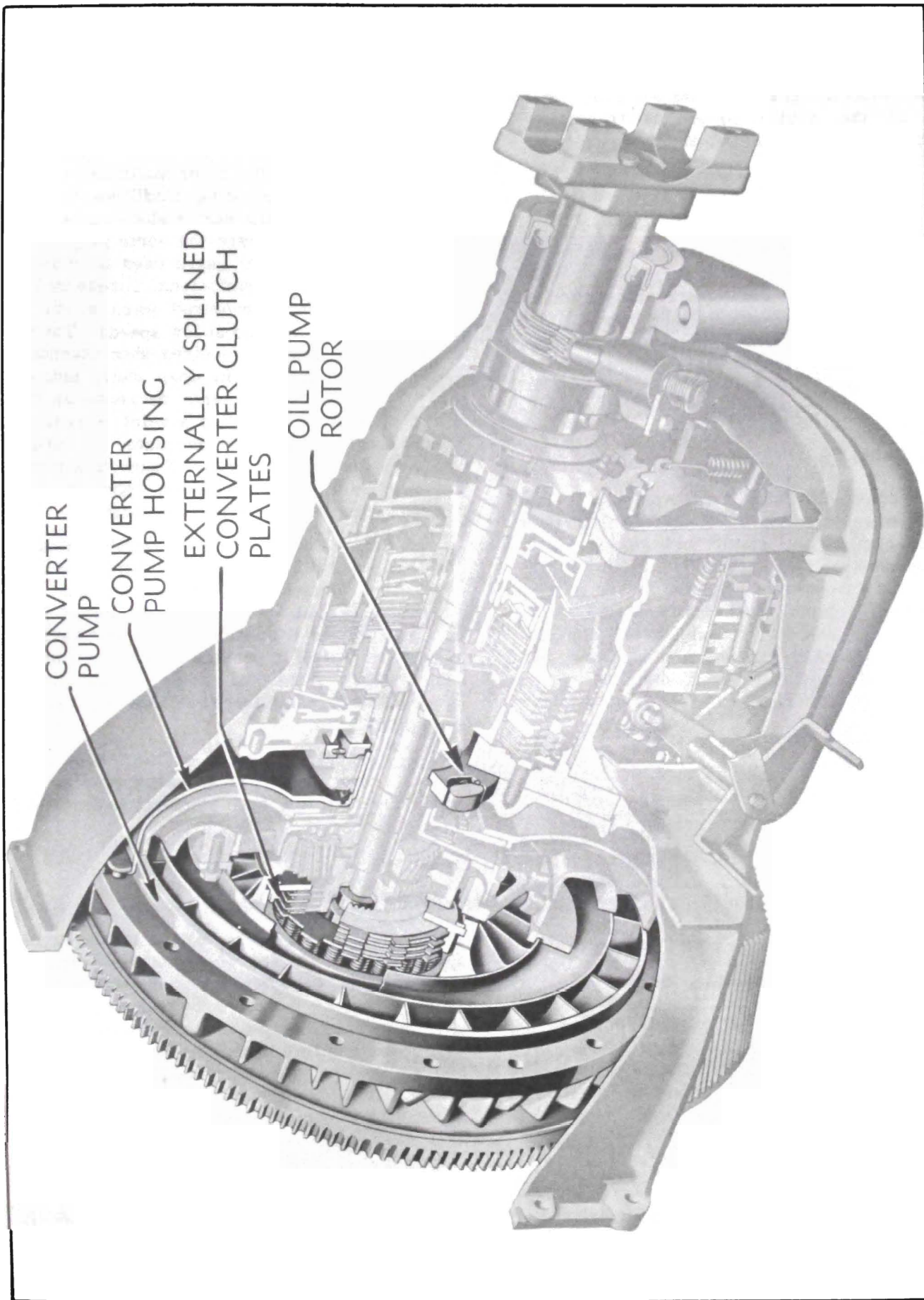


Figure 5-2—Converter Pump, Pump Housing, Externally Splined Converter Clutch Plates, and Oil Pump Rotor

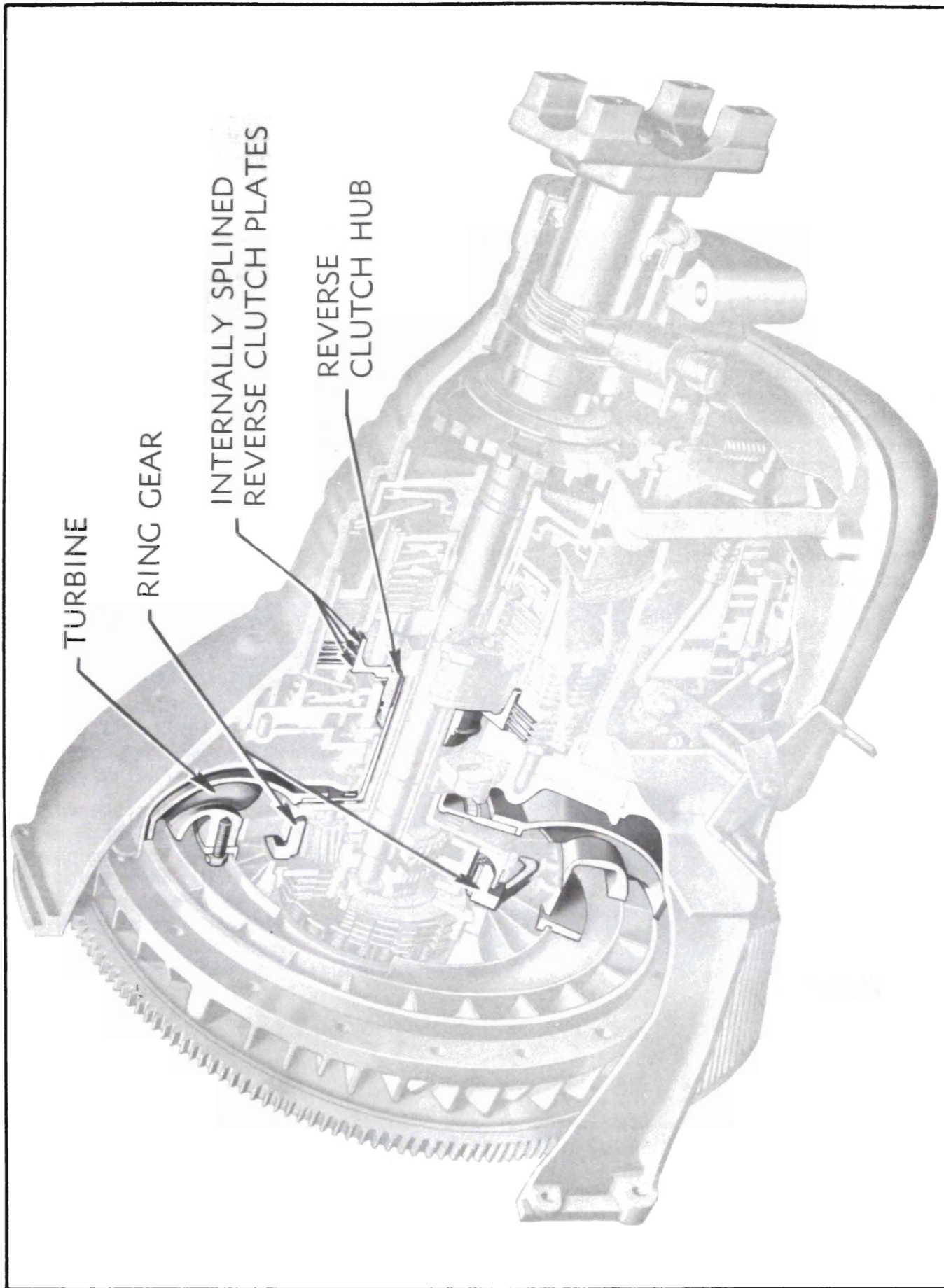


Figure 5-3—Turbine, Shaft, reverse clutch hub, and internally splined reverse clutch Plates.



Figure 5-4—Stator, Shaft and Overrunning Clutch Race



form of a spinning hollow cylinder. The function of the pump is to convert engine torque into an energy transmitting flow of oil to drive the converter turbine, into which the oil is projected. The pump is supported at its forward end by the engine crankshaft and at the rear by the converter housing hub which rides in a steel backed babbitt bushing in the oil pump body.

#### **b. Turbine**

The turbine is connected to the output shaft through a planetary gear set, the ring gear of which is bolted to the turbine, and planet pinion carrier of which is splined to the output shaft.

The turbine is riveted to a hollow shaft and flange, babbitted on its inner surface, which rides on the surface of the stator shaft. The rear of the turbine shaft is splined to the reverse clutch hub.

#### **c. Stator**

The stator is located between the turbine exit and converter pump entrance in position to receive and redirect the oil leaving the turbine. The stator is riveted to a hollow shaft and flange babbitted on its inner surface which is supported on the outer surface of the rear sun gear shaft. The rear end of the shaft is splined to the race of an overrunning clutch that allows rotation of the race in one direction only (with the engine).

The stator blades are curved to control the flow of oil between the turbine exit and the pump entrance when the turbine is stationary or at low speed relative to the converter pump. The stator blades alter the direction of flow so the oil approaches the pump at the proper angle to enter without opposing pump rotation. Thus energy remaining in the oil after it leaves the turbine is utilized to increase pump output. See Figure 5-4.

#### **d. Planetary Gear Set**

Output of the torque converter is transmitted to the output shaft through a planetary gear set housed inside the converter.

The converter is connected to the gear set through the ring gear, which is bolted to the converter turbine.

The gear set consists of a ring gear bolted to the converter turbine, four planet pinions, the carrier of which is splined to the output

shaft; and two sun gears. The front sun gear is splined on its forward end and may be connected to the converter pump through the converter clutch described in paragraph 5-7. The rear sun gear is splined to a hollow shaft babbitted on its inner surface, which is supported on the output shaft. The rear of the rear sun gear shaft is splined to an overrunning clutch race and the hub of the coast clutch.

### **5-6 CONVERTER CLUTCH**

The converter clutch is a multiple disc clutch housed in the center of the converter pump assembly and, when engaged, couples the engine driven converter pump to the front sun gear. Thus part of the engine torque can be transmitted directly to the planetary gear set, bypassing the torque converter. Engagement of the converter clutch is controlled by car speed and throttle opening. During light acceleration, the converter clutch will engage at approximately 16 MPH, while full throttle acceleration will delay engagement until the car has attained approximately 64 MPH. Acceleration at throttle openings between these extremes result in converter clutch engagement at a proportionally lower speed.

Engagement of the converter clutch is cushioned by 18 springs between the clutch piston and the apply plate. As the clutch is applied, oil pressure moves the piston rearward. Spring pressure forces the apply plate into contact with the friction plates splined to the front sun gear hub. Further movement of the piston allows the pegs on the piston rear face to contact the apply plate for positive application of the clutch. Simultaneously, converter charging pressure is lowered to aid the application of the clutch, which is applied against converter charging pressure. This cushioning provides smooth engagement of the converter clutch. See Figure 5-9.

### **5-7 FORWARD CLUTCH— COAST CLUTCH—REVERSE CLUTCH**

The forward, coast and reverse clutches are hydraulically engaged multiple disc clutches engaged by pistons operating through levers to increase piston apply pressure.

All three clutches utilize bellville springs bearing against the apply levers to insure positive disengagement upon release of piston apply pressure.

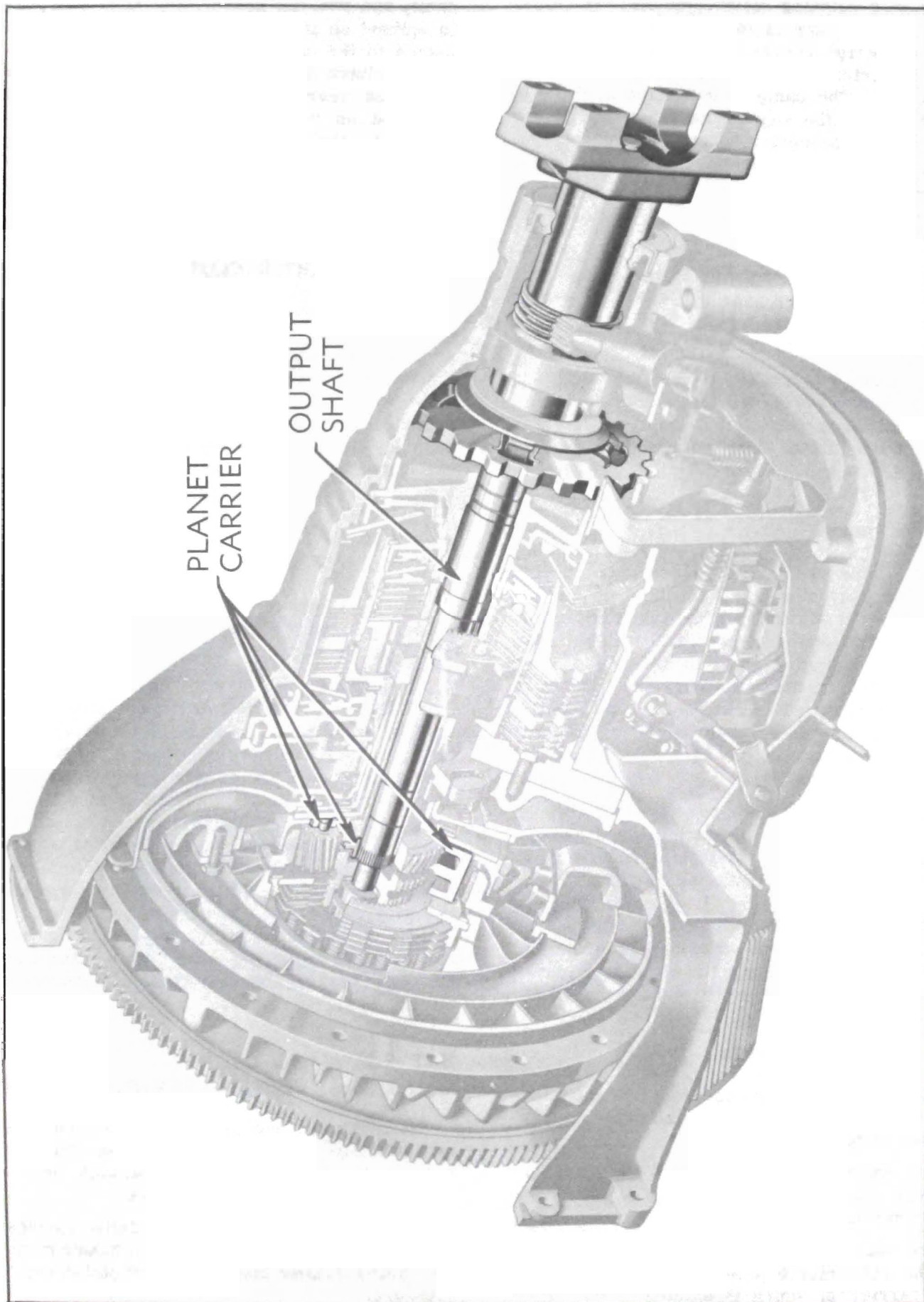


Figure 5-5—Planet Carrier and Output Shaft

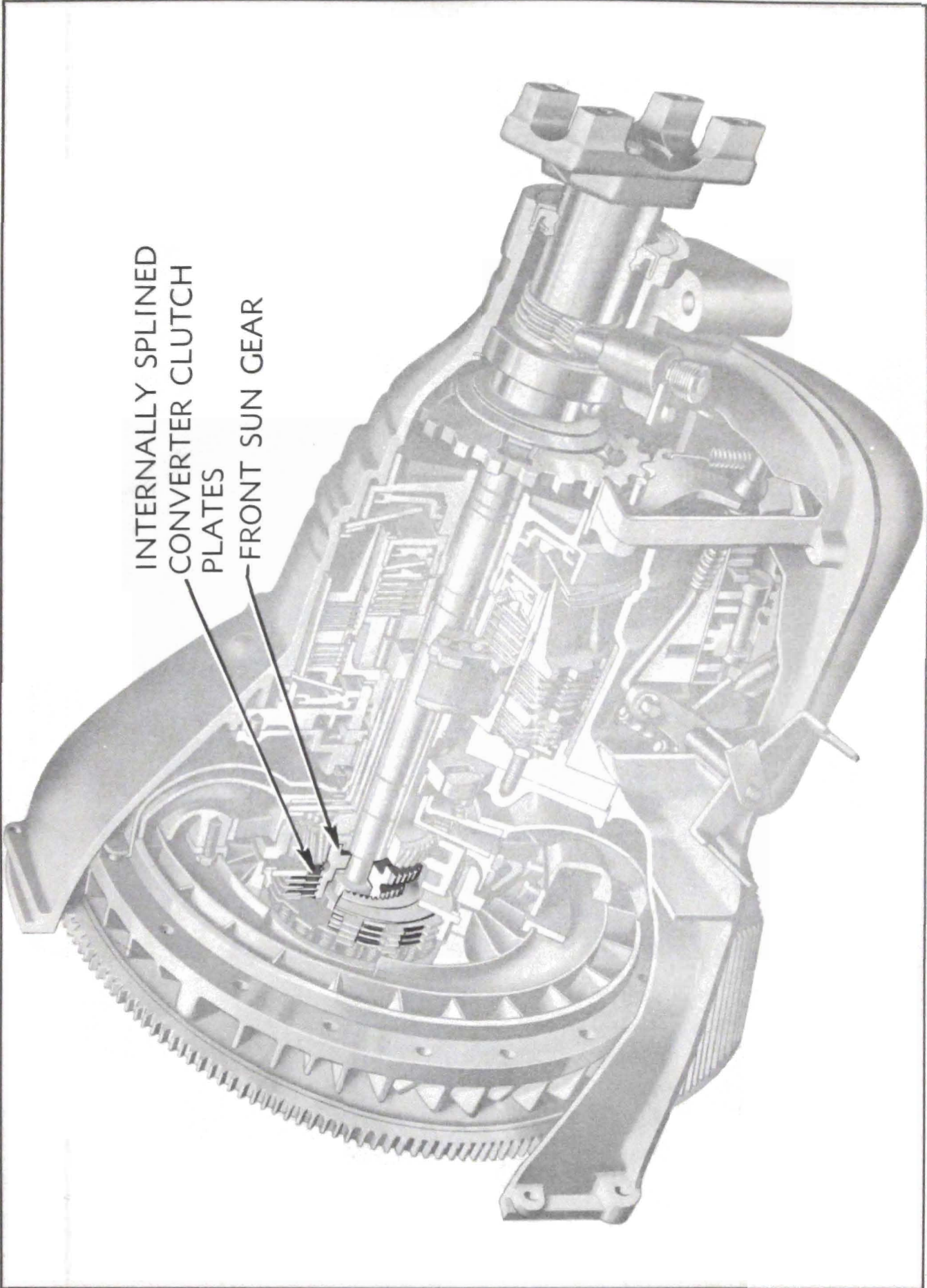


Figure 5-6—Front sun gear and converter clutch internally splined plates



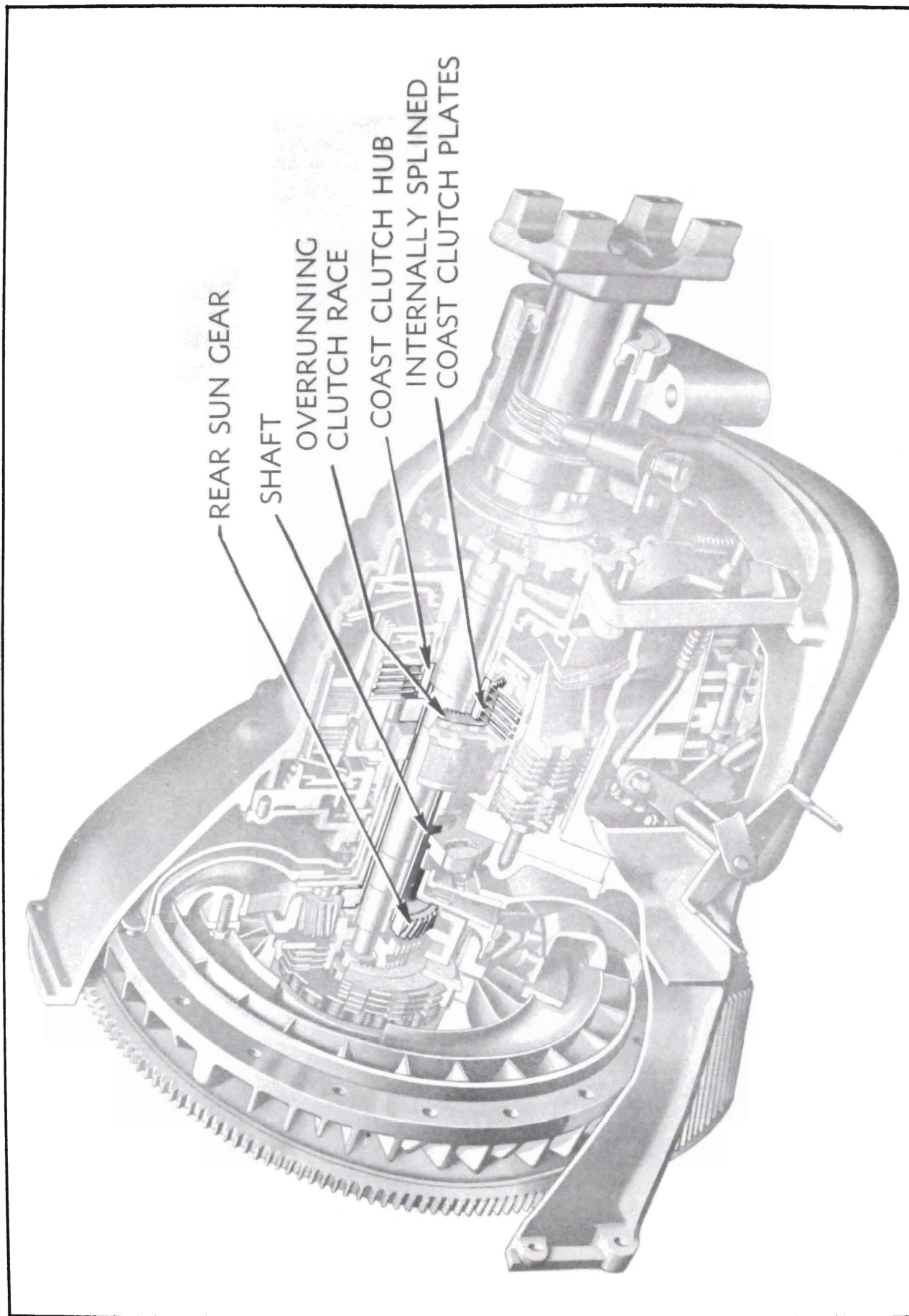
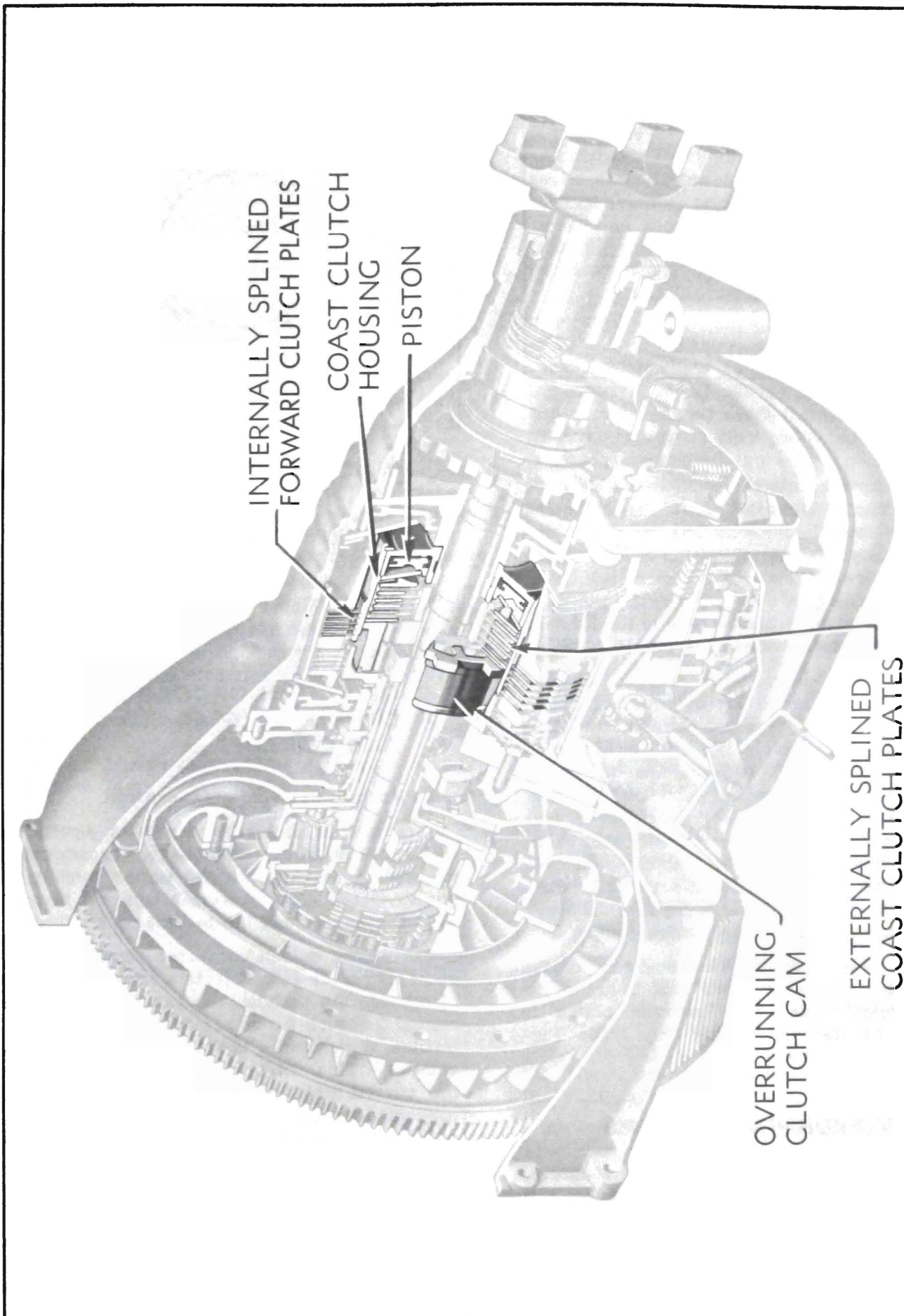


Figure 5-7—Rear sun gear, shaft, overrunning clutch race, coast clutch hub and coast clutch internally splined plates.





**Figure 5-8—Coast clutch housing, piston, overrunning clutch cam, coast clutch externally splined plates, and forward clutch internally splined plates.**

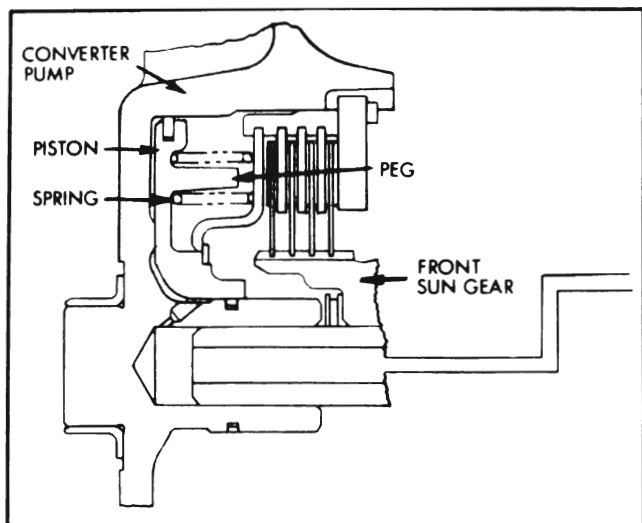


Figure 5-9—Converter Clutch

a. The forward clutch, when engaged (Drive and Low range) locks the cam of the stator and sun gear overrunning clutches to the transmission case. During operation in Low range, both the forward and coast clutch (subpar. b below) are engaged, coupling the rear sun gear through the coast clutch housing to the forward clutch and transmission case. See Figure 5-8.

b. The coast clutch, when engaged, couples the rear sun gear to the overrunning clutch cam. The externally splined plates in the coast clutch pack are splined to the coast clutch housing which also engages the internally splined plates of the forward clutch pack. Thus, as mentioned above, operation in Low range couples the rear sun gear and overrunning clutch cam to the transmission case through the coast clutch housing and forward clutch. The coast clutch is engaged in all operating ranges except Drive. See Figure 5-8.

c. The reverse clutch, when engaged, couples the turbine and planet set ring gear to the transmission case. The reverse clutch is engaged in Reverse range only. See Figure 5-3.

## 5-8 OVERRUNNING CLUTCHES

The stator and rear sun gear are connected by co-axial shafts to overrunning clutches that allow rotation of these parts in relation to the clutch cam in one direction only (with the engine). See Figure 5-10. The overrunning clutch cam is attached to the forward clutch internally splined plates and the coast clutch

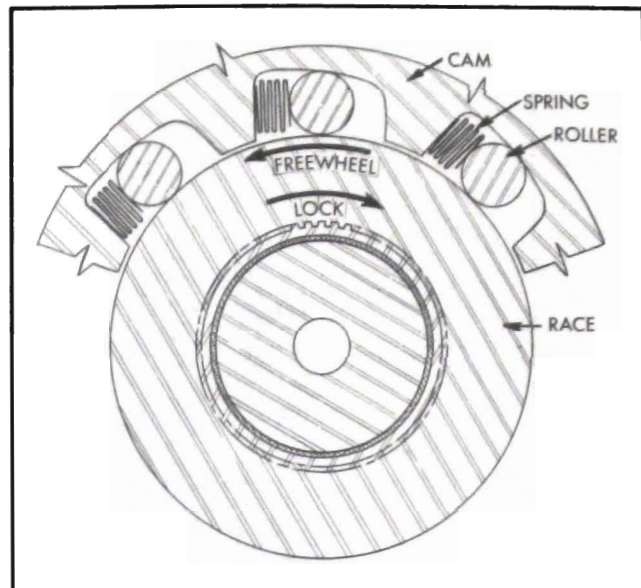


Figure 5-10—Overrunning Clutch Cross Section

externally splined plates so the cam may be locked to the transmission case (Drive and Low range) or coupled to the rear sun gear shaft through the coast clutch (all ranges except Drive).

## 5-9 OPERATION OF TORQUE CONVERTER, GEAR SET AND CLUTCHES

### a. Torque Converter Operation

Description of torque converter operation will begin with car stationary, transmission in Low or Drive range and engine running at idling speed. The converter pump is turning with the engine and the turbine is stationary.

The engine driven converter pump picks up oil at its center and projects a rotating cylinder of oil into the turbine, the vanes of which are curved in such a manner that oil leaving the turbine at its center is spinning opposite pump rotation. This oil leaving the turbine strikes the curved stator blades and as the stator is prevented from turning backwards by the stator overrunning clutch, the oil direction is changed so it enters the pump spinning in the same direction as pump rotation.

At idling speed the force of oil flow against the turbine vanes is not sufficient to move the turbine and the oil flows through the turbine and stator back into the pump without transmitting any appreciable amount of torque.

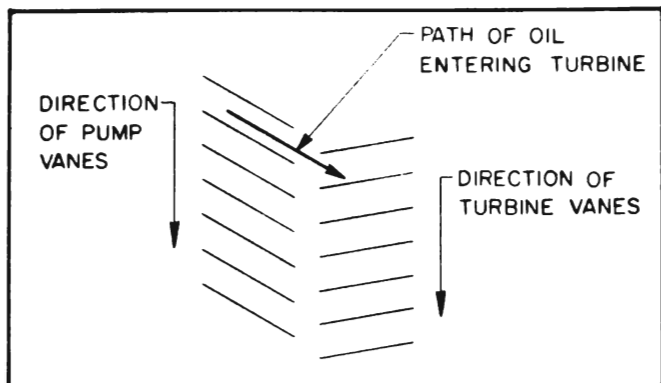


Figure 5-11—Oil Direction Entering Turbine

When the throttle is opened, the engine speeds up and with increased speed the pump projects a large volume of oil into the turbine at high rotary speed. This spinning cylinder of oil is similar to a flywheel in that it has stored energy (torque) which will be transferred to any object opposing its motion. Since the vanes of the turbine oppose the spinning flywheel of oil projected from the pump, the stored energy exerts a powerful impulsion force against the vanes, tending to rotate the turbine in the same direction as the pump. The oil flows through the turbine channels and as it does so its direction is changed. As oil enters the turbine at its rim oil direction is as shown in Figure 5-11.

As oil leaves the turbine at its center, oil direction is as shown in Figure 5-12.

As the oil leaves the turbine spinning in a direction opposite pump rotation it strikes the front face of the stator blades which redirect the oil into the converter pump spinning in the same direction as the pump.

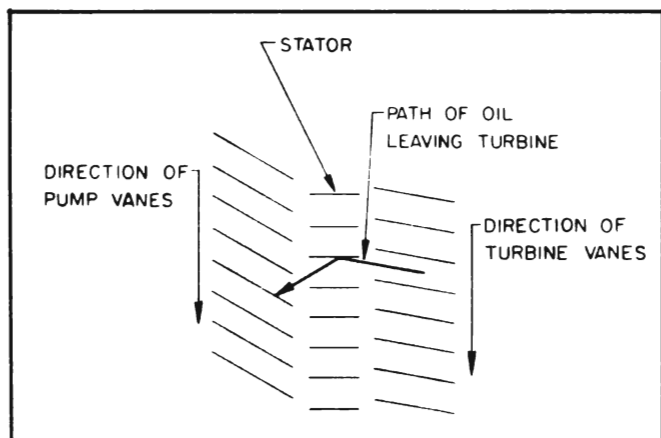


Figure 5-12—Oil Direction Leaving Turbine

A reaction (rearward force) is exerted by a fluid changing direction or being accelerated. It is reaction force which tends to move the nozzle of a fire hose when a stream of water emerges under pressure.

Thus, the oil projected from the pump exerts an impulsion force as it enters the turbine. And as its direction is changed in the turbine, this direction change exerts a reaction force on the turbine as the oil exits. Both forces tend to move the turbine in the same direction as pump rotation.

Engine torque applied to the converter pump generates a given amount of energy in the oil projected from the pump against the turbine vanes. When the turbine is stationary or moving slowly, the oil passes through the turbine and stator and returns to the pump with almost as much energy as when projected. The amount of energy in the oil thereafter projected from the pump becomes the sum of the energy in the returning oil plus the energy resulting from engine torque application; far more energy (expressed as torque) than the engine could generate alone. The greatly increased energy in the spinning flywheel of oil then projected into the turbine produces a corresponding increase in the impulsion and reaction forces acting on the turbine vanes.

The described build-up of forces produces a turning force or torque upon the turbine vanes which is greater than the torque produced by the engine, therefore, torque multiplication is accomplished. It would seem the torque multiplication would increase indefinitely as the cycle repeats itself, but mechanical factors limit the increase of torque multiplication beyond a definite ratio in any given torque converter design.

The build-up of forces against the turbine vanes causes the turbine to turn in the same direction as the converter pump. The turbine absorbs part of the energy transmitted by the oil stream and converts it to torque which is imparted to the planet set ring gear causing the planet pinions to turn and "walk" around the stationary sun gear.

As the car reaches cruising speed, torque requirements decrease so applied torque causes turbine speed to rapidly approach pump speed. As this occurs it is important for torque multiplication to taper off so car speed can be maintained at minimum engine speed. This tapering off occurs automatically because centrifugal force generated in the rotating mass of oil in the turbine creates an outward counter



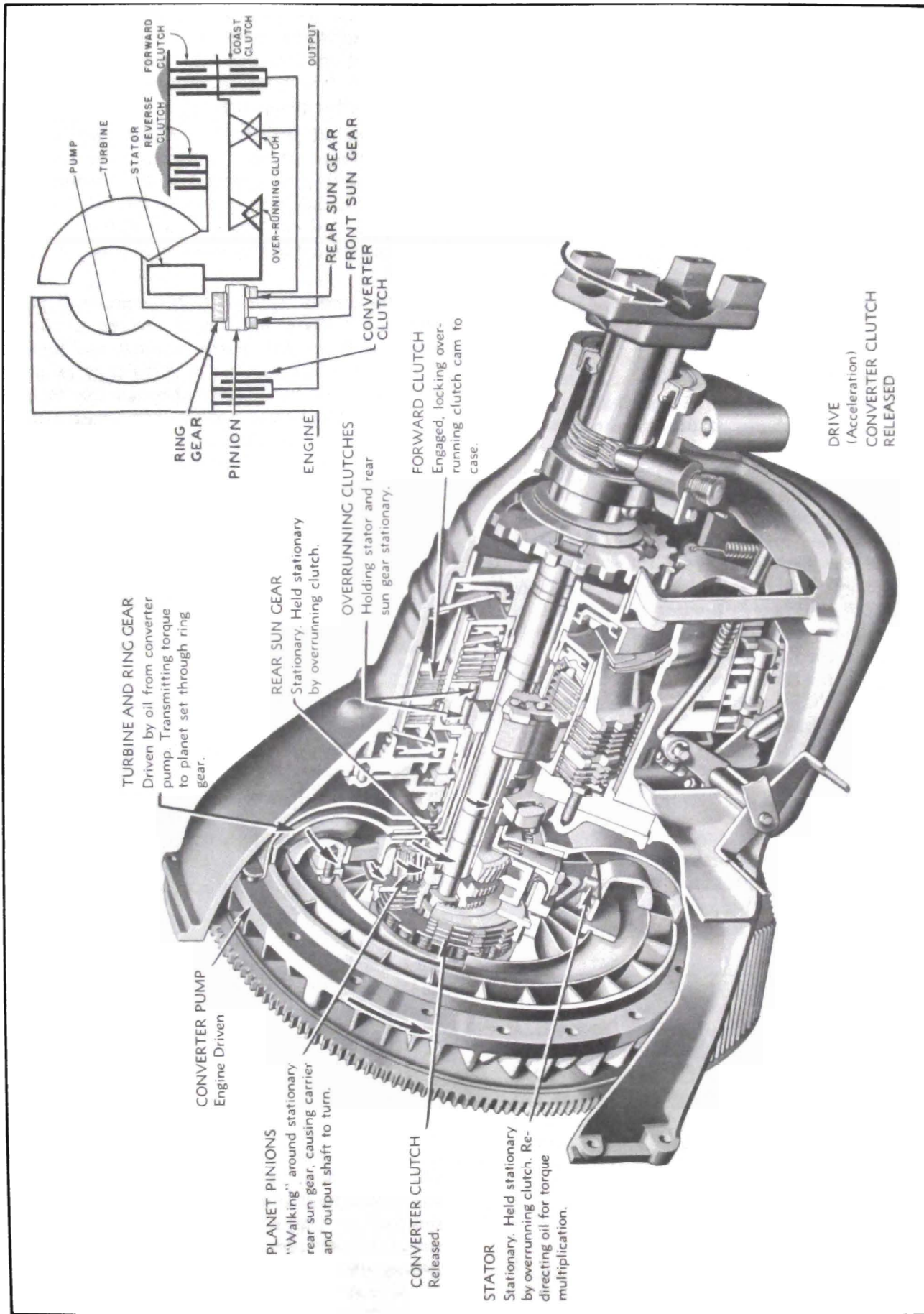


Figure 5-13—Operation of Components Accelerating in Drive Range, Converter Clutch Released



force which opposes the flow of oil from the pump.

Reduction in oil flow and pump output energy effects a decrease in impulsion and reaction forces on the turbine so torque multiplication rapidly tapers off as turbine speed increases.

As turbine speed approaches pump speed the angle at which oil leaves the turbine changes until it strikes the rear face of the stator blades causing the stator to freewheel. The stator then offers no resistance to oil flow from the turbine to the pump. At this point the converter functions as an efficient fluid coupling transmitting torque at a 1 to 1 ratio. However, sufficient speed differential remains between the turbine and pump to permit flow of oil from pump to turbine where the oil gives up energy and returns to the pump.

This tapering off of torque multiplication does not occur at any particular car speed. Rather, it is dependent on throttle opening, load (grade), and car speed. Any throttle opening that will just maintain car speed on a level road will produce virtually zero torque multiplication in the converter.

### **b. Operation of Components in Drive Range**

With engine idling and transmission control positioned in Drive range, the forward clutch is engaged and all other clutches are disengaged. Engagement of the forward clutch locks the cam of the stator and rear sun gear overrunning clutches to the transmission case.

As the throttle is opened and the build-up of forces described in subparagraph a occurs, the ring gear attached to the converter turbine turns and causes the planet pinions to turn and "walk" around the rear sun gear, held stationary by the sun gear overrunning clutch. In this manner engine torque is transmitted to planet pinion shafts and thence to the planet carrier which is splined to the output shaft. See Figure 5-13.

As car speed increases, governor weights mounted in the parking lock ratchet wheel move under centrifugal force to move the governor lever on its pivot and increase the pressure in the hydraulic circuit that tends to engage the converter clutch. A counter hydraulic circuit controlled by throttle opening also affects engagement of the converter clutch. Acceleration from a stop at light throttle will allow the governor pressure to cause engagement of the

converter clutch at relatively low car speeds, while heavy throttle accelerations will delay engagement till higher speeds are attained. Wide open throttle accelerations will delay converter clutch engagement until a speed of approximately 64 miles per hour is reached.

When the proper relationship between throttle opening and car speed exists, the hydraulic control system acts to engage the converter clutch. With the converter clutch engaged, the converter pump hub is connected to the front sun gear and approximately 36% of the engine torque is then transmitted mechanically to the gear set through the front sun gear, while the turbine continues to transmit torque to the gear set through the ring gear.

Under these conditions the front sun gear turns at engine speed and causes the planet pinion to turn and "walk" slowly around the ring gear which is turning at slightly less than engine speed (turbine speed). In effect, the converter and gear set are turning as a unit; with the benefit of cushioning provided by the relationship of the turbine and ring gear to the gear set.

Engine torque is thus transmitted through the gear set to the planet carrier which is splined to the output shaft. The rear sun gear overrunning clutch allows the rear sun gear to free wheel as it is turning with the engine and transmitting no torque. See Figure 5-14.

### **c. Operation of Components in Reverse Range**

With the transmission selector lever in Reverse range with engine running, the reverse and coast clutches are engaged and all other clutches are disengaged. Engagement of the reverse clutch locks the turbine to the transmission case, while coast clutch engagement couples the overrunning clutch cam to the rear sun gear. See Figure 5-15.

As the engine is accelerated, oil from the converter pump is projected into the stationary turbine. The oil passes through the turbine and is discharged at its center, spinning opposite engine rotation. See Figure 5-12. The oil then strikes the stator blades and causes the stator to turn opposite engine rotation. The stator overrunning clutch at the rear of the stator shaft, transmits torque to the overrunning clutch cam and coast clutch; and from the coast clutch to the rear sun gear through the rear sun gear shaft. Rotation of the rear sun gear opposite engine rotation causes the planet pinions

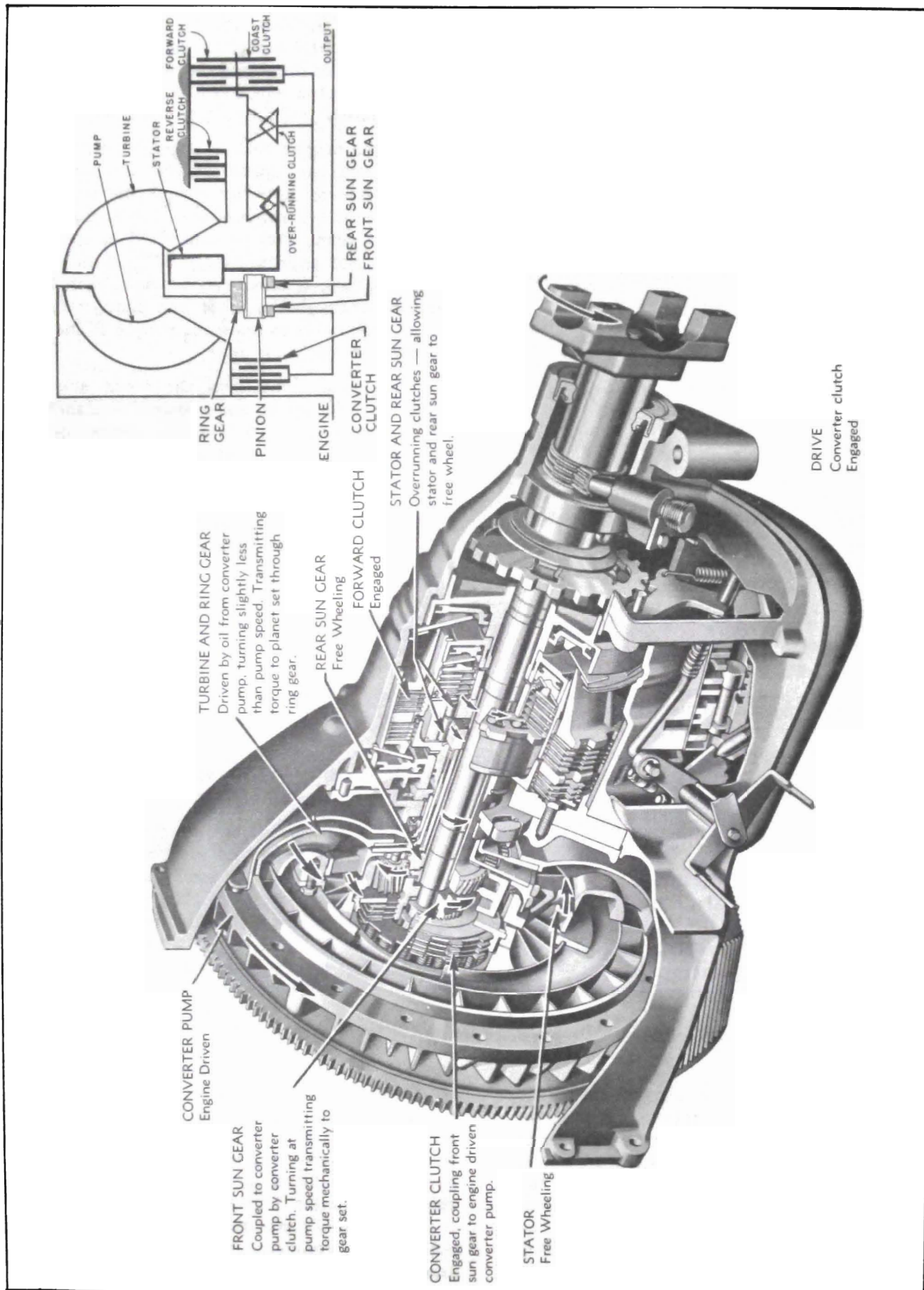


Figure 5-14—Operation of Components Accelerating in Drive Range, Converter Clutch Engaged

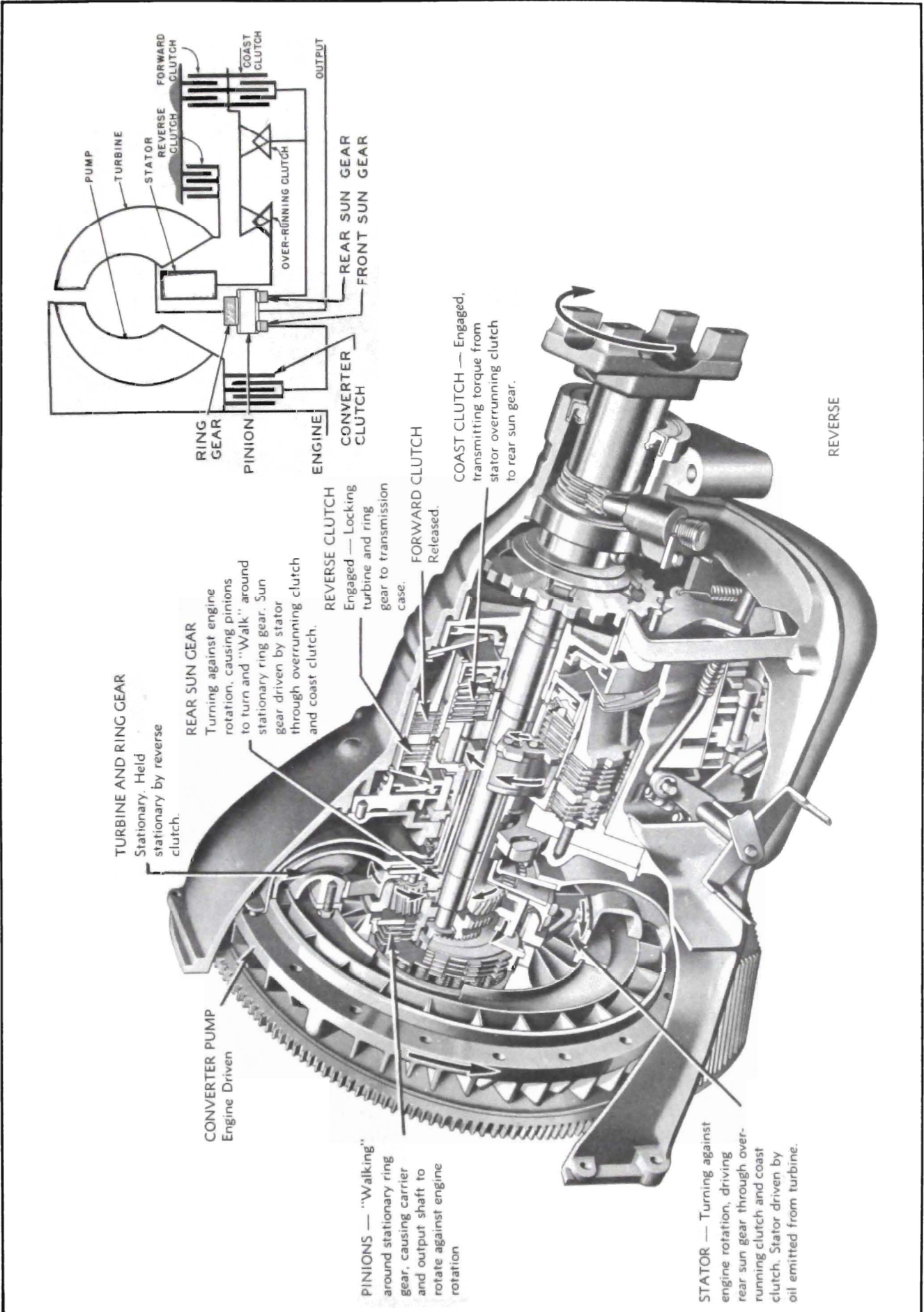


Figure 5-15—Operation of Components in Reverse Range



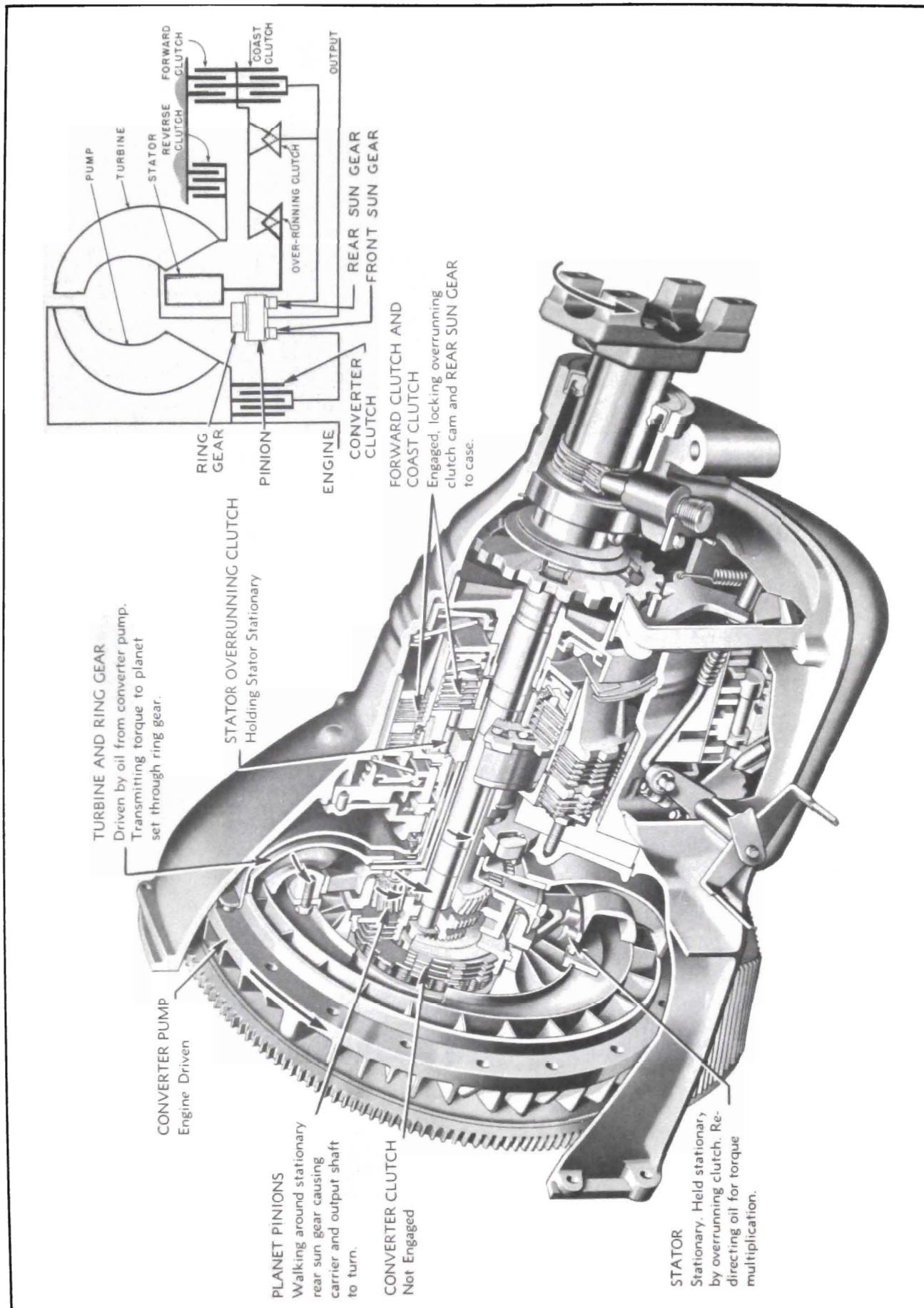


Figure 5-16—Operation of Components in Low Range



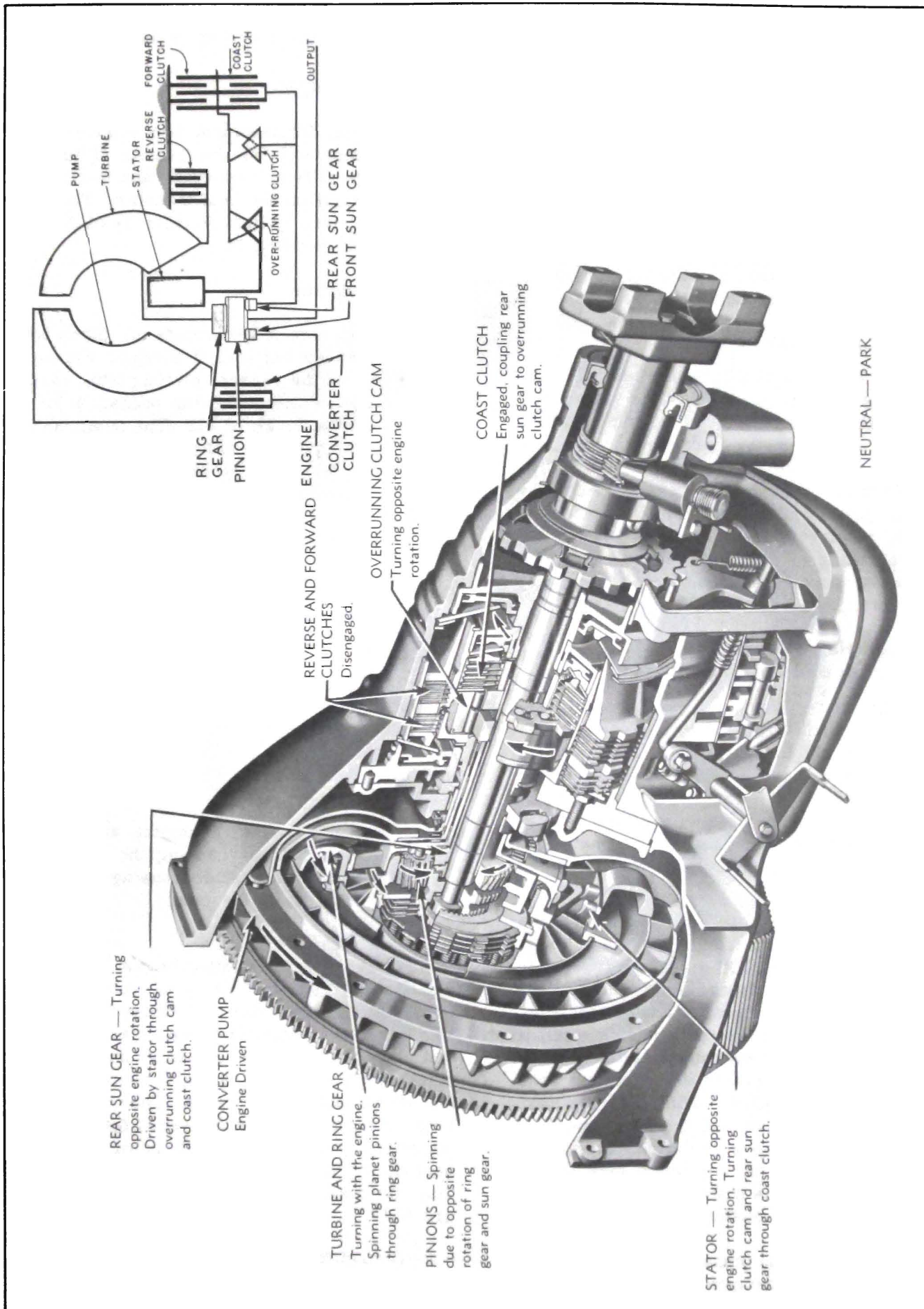


Figure 5-17—Operation of Components in Neutral or Park Range

to turn and "walk" around the stationary ring gear. As the pinions walk around the ring gear, torque is transmitted through the planet pinion shafts to the planet carrier which is splined to the output shaft.

#### **d. Operation of Components in Low Range**

With the transmission control lever in Low range and engine idling, the forward and coast clutches are engaged, while the reverse and converter clutches are not. Engagement of the forward and coast clutches locks the cam of the stator and rear sun gear overrunning clutches and the rear sun gear to the transmission case.

Torque is transmitted to the output shaft through the gear set in exactly the same manner as in Drive range before engagement of the converter clutch. In Low range, however, the converter clutch remains disengaged regardless of throttle opening or car speed. Also, the rear sun gear is prevented from free-wheeling even on deceleration. Thus Low range is an effective means of slowing the car under circumstances such as when descending steep grades, etc. See Figure 5-16.

#### **e. Operation of Components in Neutral and Park Range**

With the transmission control lever in Neutral or Park range, the coast clutch is engaged and all other clutches are not. In Park range, the parking lock pawl is engaged as described in paragraph 5-4, subparagraph b. Engagement of the coast clutch couples the rear sun gear to the overrunning clutch cam, preventing relative motion between the sun gear and the clutch cam.

With the engine running, oil projected from the converter pump turns the turbine and ring gear with the engine. Oil discharged from the turbine strikes the stator blades and causes the stator to turn opposite engine rotation. Rotation of the stator opposite engine rotation engages the stator overrunning clutch to turn the clutch cam and planet set rear sun gear opposite engine rotation. With the ring gear turning with the engine and the rear sun gear turning opposite engine rotation, the planet pinions are rotated at relatively high speed, but no engine torque is transmitted to the planet carrier and output shaft. See Figure 5-17.

Engagement of the coast clutch in Neutral and Park prevents damage to the stator overrunning clutch due to disengagement of the

rollers by centrifugal force and violent re-engagement when the engine is decelerated.

### **5-10 OIL PUMP**

A positive displacement two stage pump is used to supply oil for engagement of the disc clutches, to fill the converter and to circulate oil for lubrication and heat transfer. The pump is engine driven by lugs on the rear of the converter pump housing hub.

#### **a. Description**

The pump assembly consists of: pump body, rotor, seven spring loaded slippers driven by the rotor, and the reverse clutch piston housing which contains the ports and passages for the intake and discharge of oil. The pump body is bolted to the reverse clutch piston housing to form an enclosure in which the rotor and slipper assembly operates. The assembly is mounted in the transmission by bolts through the pump body to the case.

#### **b. Operation**

The pump rotor is offset with respect to the centerline of the pump body, so the cavities formed by the space between the slippers, the pump body, and the rotor increase and decrease as the rotor turns. Another smaller series of cavities formed by the space between the inner edge of the slippers and the rotor also increase and decrease as the rotor turns. See Figure 5-18.

Positive displacement pumping action is obtained by the cavities passing the intake port increasing in size and decreasing in size as they pass the discharge port.

##### **1. First Stage Operation**

When the engine is idling or just started, oil discharged from both sets of pump cavities passes the check valve and delivers oil to the line pressure regulator valve between the second and third lands of the valve and through a small orifice to the space between the third and fourth lands of the valve. Thus a relatively large volume of oil is delivered for filling the converter (which may leak down after long periods of standing idle) and engagement of disc clutches at low engine speeds. See Figure 5-19.

##### **2. Second Stage Operation**

As the engine is speeded up, the volume of oil leaving the pump increases until the pressure

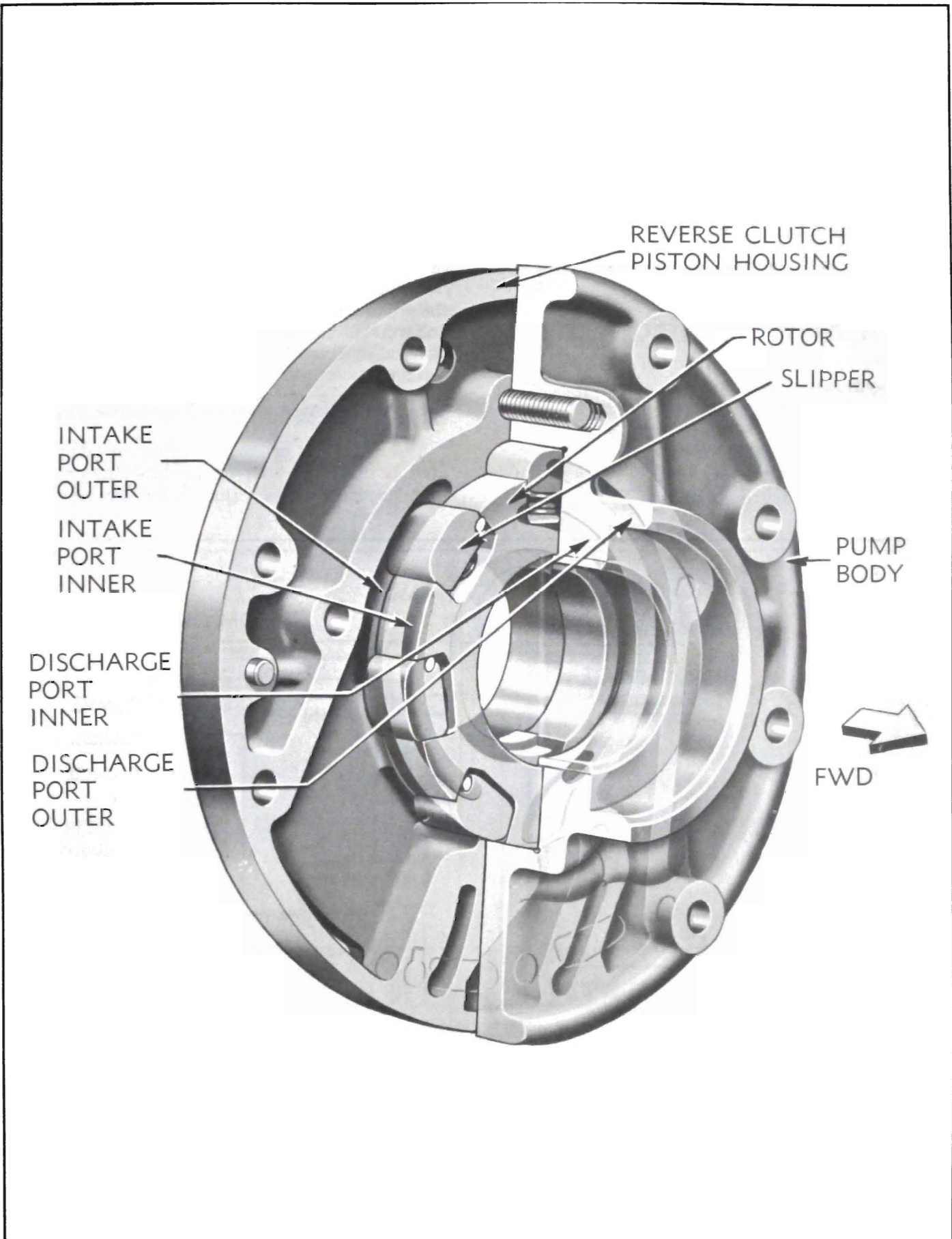


Figure 5-18—Phantom View of Two Stage Oil Pump

regulator valve moves to the position shown in Figure 5-20. With the valve in this position, the outer larger cavities discharge oil directly to the pump suction port between the first and second lands of the valve. The check valve then closes and oil pressure from the inner cavities then holds the check valve closed until such time as engine speed decreases or oil requirements cause the line pressure regulator valve to move back to the position shown in Figure 5-19 when again both portions of the pump supply oil.

## 5-11 HYDRAULIC CONTROLS

The hydraulic control system consists of the following main components:

Range Selector Valve  
Main Line Pressure Regulator Valve  
Converter Pressure Regulator Valve

Governor, Governor Valve and Second Stage Governor Valve  
Throttle Pressure Regulator Valve and Throttle Detent Valve  
Shift Valve  
Shift Regulator Valve

### a. Range Selector Valve

The range selector valve has four lands that serve to open and close the proper ports to determine the operating range of the transmission. The valve is connected by linkage to the transmission selector lever on the steering column. It can be set in five positions: Park, Neutral, Drive, Low and Reverse.

### b. Main Line Pressure Regulator Valve

The main line pressure regulator valve operates in the valve body to regulate line pressure to a predetermined value under any operating

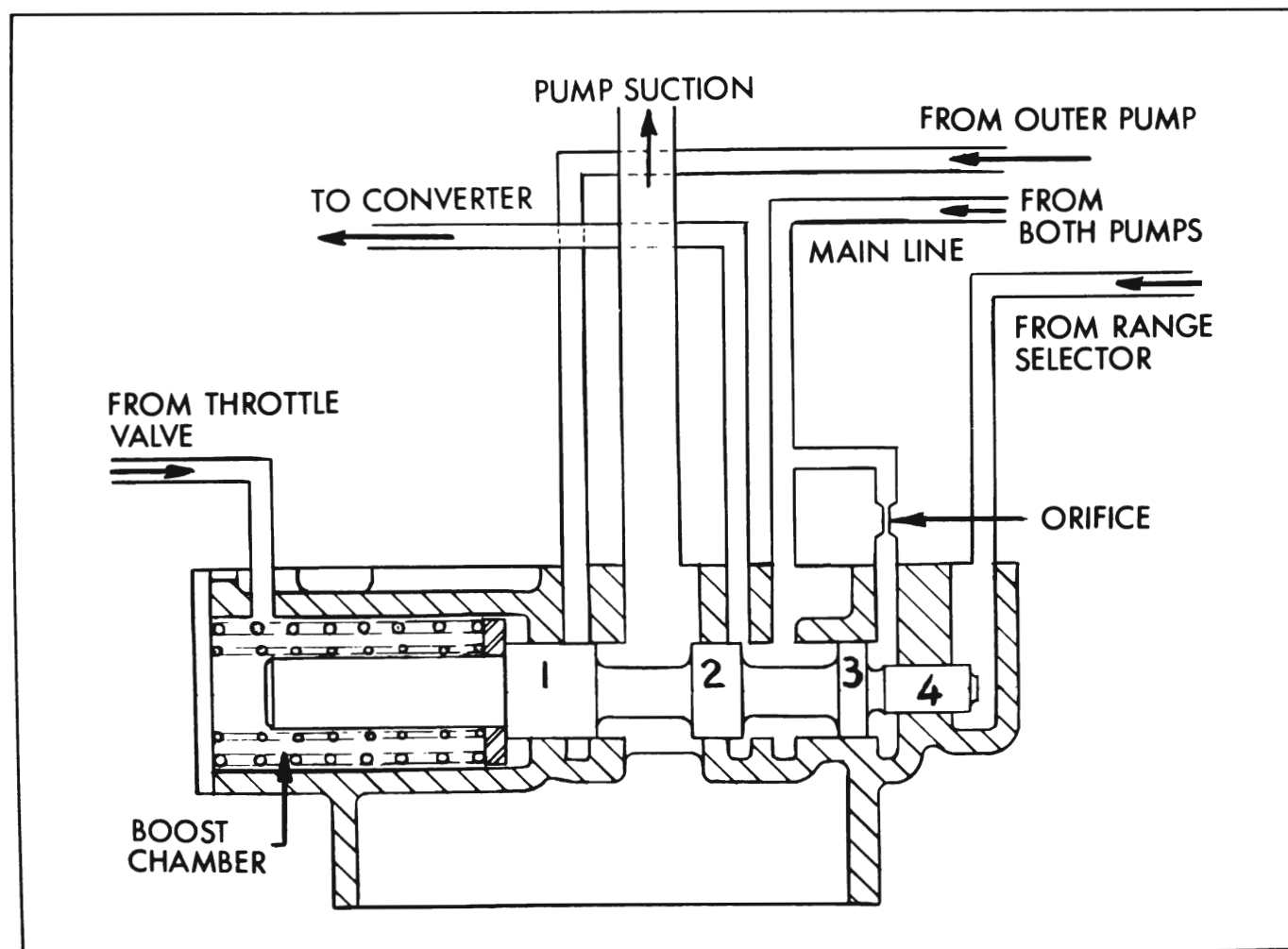


Figure 5-19—Main Line Pressure Regulator Valve - First Stage



condition, raising oil pressure during periods of wide throttle opening and lowering pressure to a safe minimum during cruise operation.

### 1. First Stage Regulation (Drive or Low Range)

Oil from the main line enters the area between the second and third lands and also flows through an orifice to the space between the third land and the valve body. Oil from the range selector valve (forward clutch apply line) also occupies the space between the fourth land and the end of the valve body. At zero or very light throttle (when main line pressure reaches approximately 70 pounds) oil pressure built up in the space between the third land and the valve body moves the valve against the springs to allow oil to escape past the second land of the valve to regulate main line oil pressure. Oil passing the second land of the valve flows to the converter pressure regulator valve, converter and lubrication system. See Figure 5-19.

### 2. Second Stage Regulation (Any Range)

As described in paragraph 5-11, sufficient engine speed will increase oil pump output to the extent that the valve is moved further against the springs till the port is opened connecting the larger (outer) pump section to pump suction. This action closes the pump check valve. The smaller (inner) section of the pump then supplies oil for the transmission requirements. See Figure 5-20.

### 3. Third Stage Regulation (Any Range)

Cold operation and or high speeds will move the valve against the springs till the entrance port between the second and third lands is partly open to pump suction, thus preventing excessive build-up of line pressures during cold or high speed operation. See Figure 5-21.

### 4. Throttle Valve Effect

In any range, main line pressure is increased as the throttle is opened. The spring of a

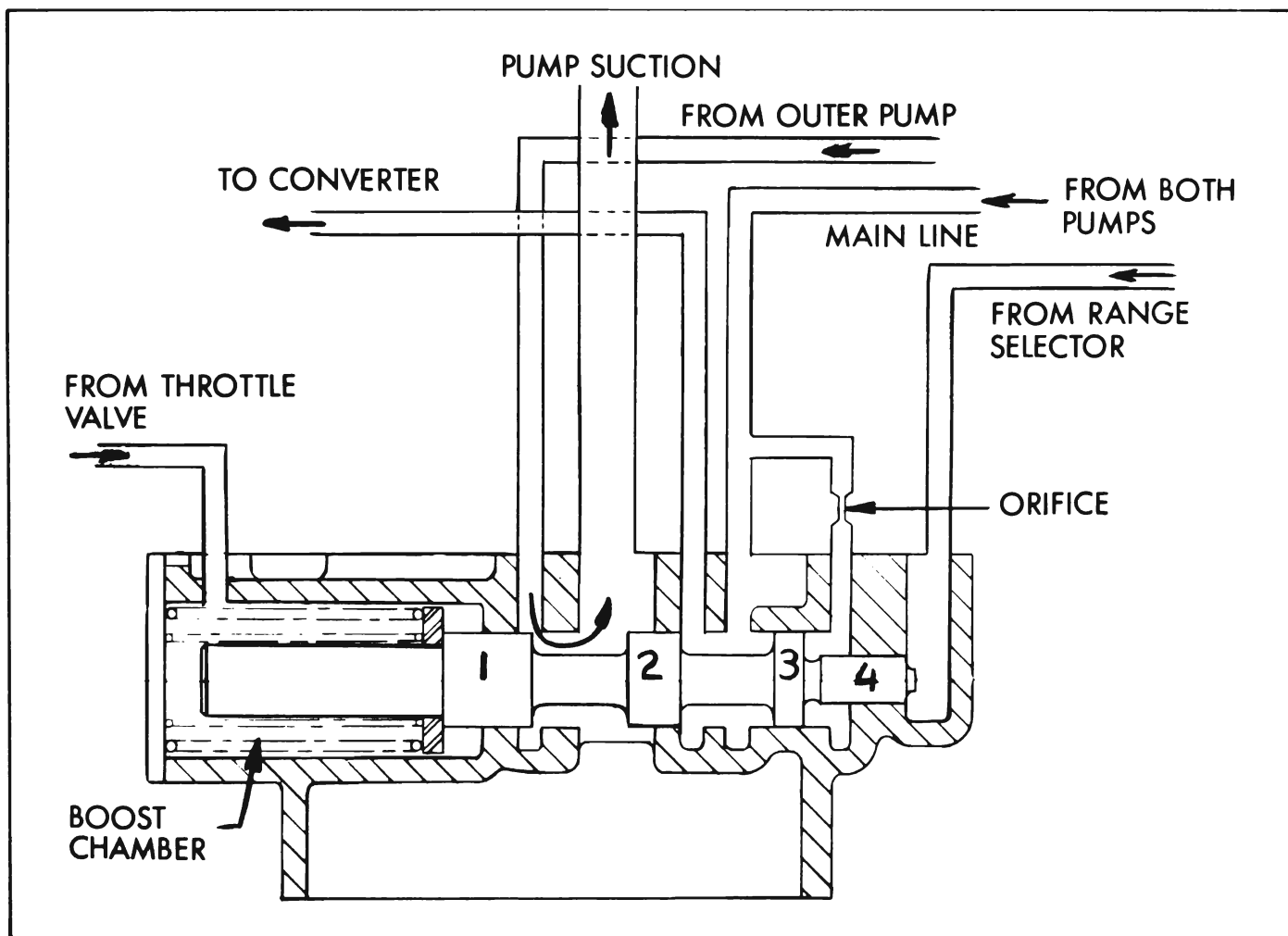


Figure 5-20—Main Line Pressure Regulator Valve - Second Stage

pressure regulator valve is compressed as the throttle is opened to increase pressure of oil regulated by this valve. Regulated oil from the throttle regulating valve is directed to a boost chamber on the spring side of the main line pressure regulator valve. Oil pressure in this chamber has the same effect as increasing spring pressure on the valve. As throttle valve pressure is increased, main line pressure is increased.

reverse, neutral or park range, no oil is directed to the space between the fourth land of the valve and the valve body. Thus, main line oil pressure is bearing on a lesser valve area to overcome valve spring pressure and greater pressure is required to move the valve. Main line oil pressure is thus increased to a minimum of approximately 108 pounds and, depending on throttle opening, a maximum of 185 pounds.

#### 5. Regulation in Reverse, Neutral and Park Range

With the range selector valve positioned in

#### c. Converter Pressure Regulator Valve

The converter pressure regulator valve regulates converter pressure between 14 and 185

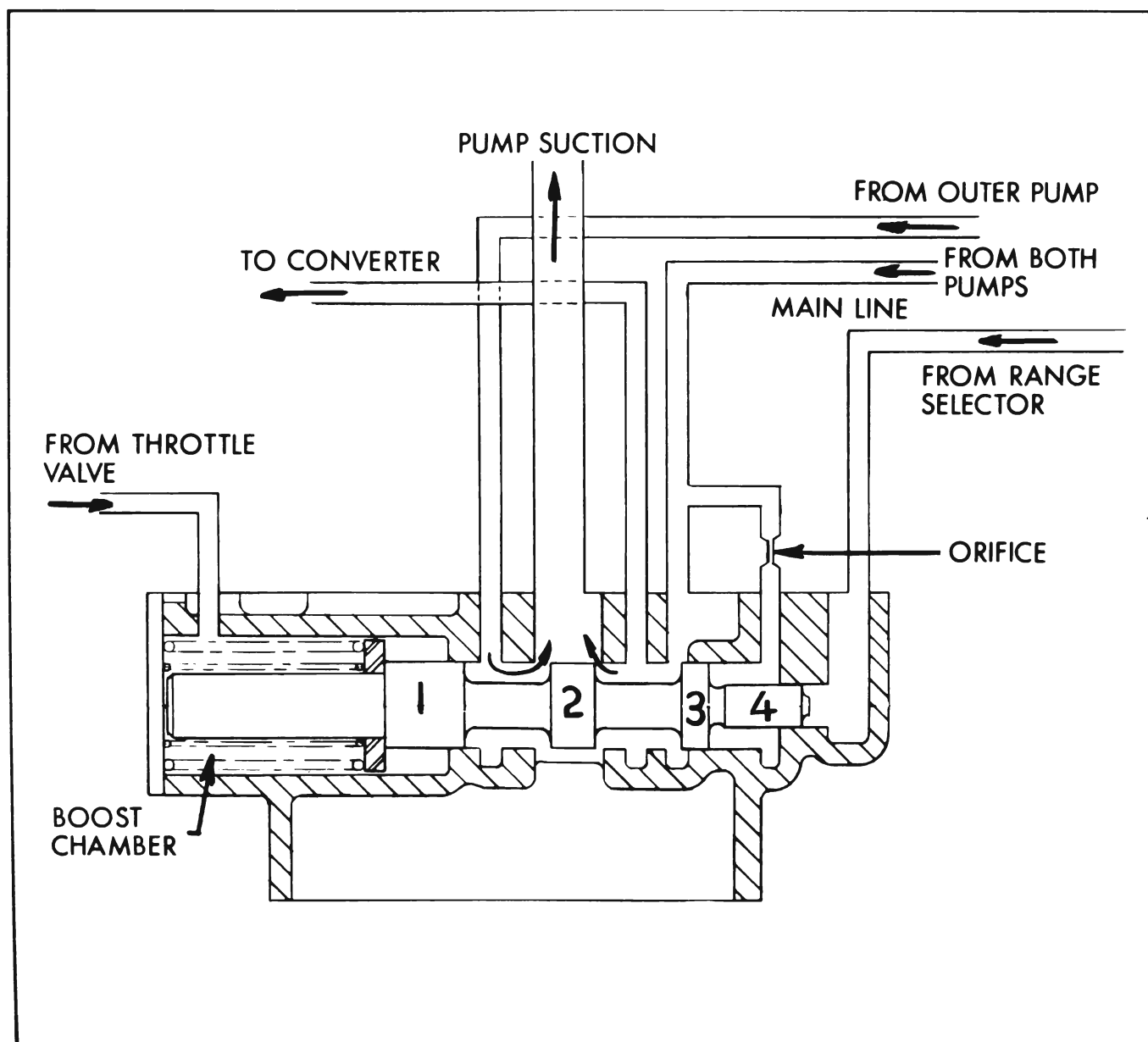


Figure 5-21—Main Line Pressure Regulator Valve - Third Stage

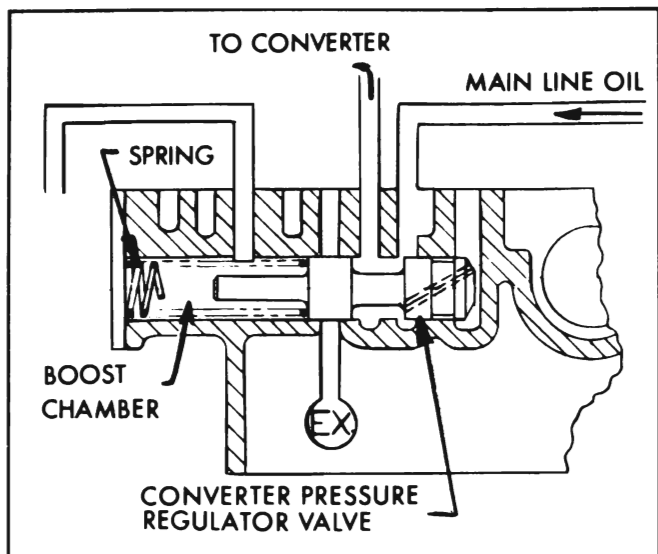


Figure 5-22—Converter Pressure Regulator Valve

pounds depending on operating range, throttle opening and converter clutch engagement. See Figure 5-22.

#### 1. Converter Clutch Engaged

Oil from the main line pressure regulator valve enters the converter pressure regulator valve between its lands, then flows through a hole connecting the space between the lands to the space between the second land and the valve body. Oil also exits from a port between the lands to the converter. Oil pressure between the end of the valve and the valve body moves the valve against spring pressure to restrict entry of oil, thus maintaining exit oil at regulated pressure.

#### 2. Converter Clutch Disengaged

In all ranges except drive, and in drive range when the converter clutch is disengaged, main line oil pressure is directed to the spring end of the valve. Line oil pressure on the spring end of the valve holds the valve against the valve body so oil entering between the lands is not regulated. Under these circumstances the converter is charged at main line pressure.

### d. Governor, Governor Valve and Second Stage Governor Valve

#### 1. Governor

Governor weights mounted in the parking

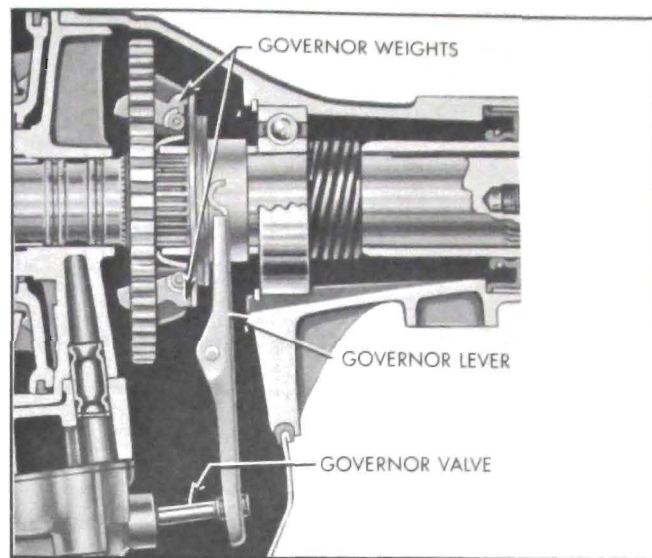


Figure 5-23—Governor Weights, Lever, and Valve

lock ratchet wheel exert pressure against the governor lever with increasing force as car speed increases; this force is transmitted through the lever to the end of the governor valve. Governor lever pressure is the regulating force against the governor valve, varying governor valve pressure as car speed varies. See Figure 5-23.

#### 2. Governor Valve

Main line oil from the range selector valve enters the governor valve between the valve lands and flows through a small hole in the first land to fill the space between the valve and governor valve sleeve. Oil pressure in the space between the sleeve and the end of the valve moves the valve against governor lever pressure to restrict entry of oil, thus maintaining regulated oil pressure in proportion to the pressure of the governor lever. Regulated oil exits from a port between the lands. See Figure 5-24.

#### 3. Second Stage Governor Valve

Oil leaving the governor valve enters a port which allows the oil to occupy the space between the valve body and the second stage governor valve. As governor valve pressure increases the second stage governor valve moves against its spring to press the second stage governor valve pin against the governor valve. This action modulates governor valve pressure to keep car speed and governor valve pressure proportional.



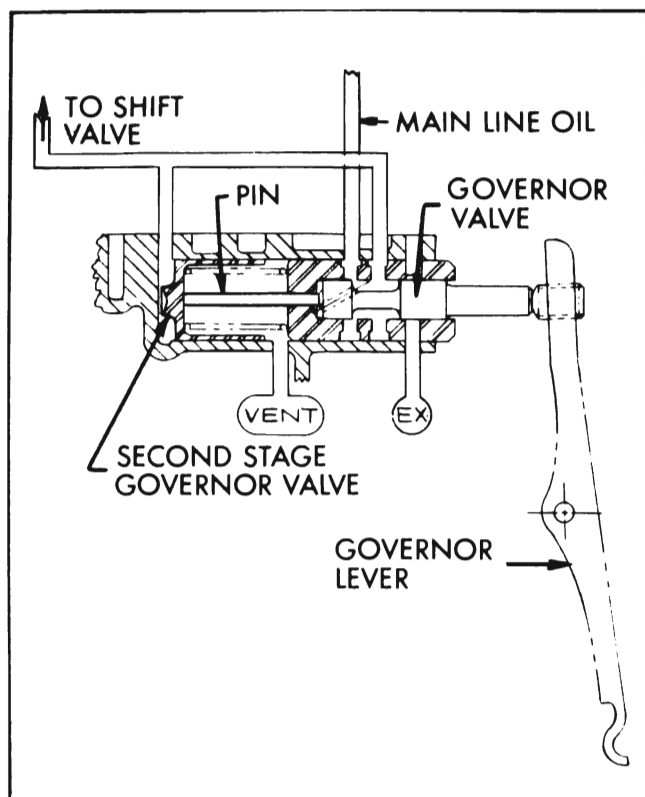


Figure 5-24—Governor Valve and Second Stage Governor Valve

### e. Throttle Pressure Regulator Valve and Throttle Detent Valve

Main line pressure is increased as throttle opening is increased by the throttle pressure regulator valve which is connected to the engine throttle linkage. The throttle regulator valve and throttle detent valve also serve as a regulating force controlling engagement of the converter clutch as described in subparagraph f below.

#### 1. Throttle Pressure Regulator Valve

Main line oil pressure enters the throttle pressure regulator valve between its lands and flows through a small hole to fill the space between the valve body and the end of the valve. Pressure in the space between the end of the valve and valve body moves the valve against spring pressure to restrict entry of oil to regulate main line oil pressure. Regulated oil exits at a port between the lands and is channeled to the main line pressure regulator valve boost chamber and the shift regulator valve. See Figure 5-27.

Spring pressure against the throttle pressure regulator valve is varied by throttle opening

so regulated pressure from the valve is increased as throttle opening is increased. Oil under pressure in the boost chamber of the main line pressure regulator valve has the same effect as increased spring pressure, requiring greater main line oil pressure to move the valve. Thus main line oil pressure is increased as throttle opening is increased.

#### 2. Throttle Detent Valve

Throttle valve oil pressure, present between the lands of the throttle detent valve, is ported from the detent valve to the space between the shift regulator valve and the shift valve only at wide open throttle. See Figure 5-27. Throttle valve pressure in the space between the shift valve and shift regulator valve bears directly upon the larger area of the shift valve, and can affect a down shift (disengagement of the converter clutch) if governor valve pressure (car speed) is sufficiently low. The function of the shift valve and the shift regulator valve is described in subparagraph f below.

### f. Shift Valve. Shift Regulator Valve (Drive Range)

The shift valve and shift regulator valve together control engagement and disengagement of the converter clutch. Their movement is controlled by varying pressures from the throttle valve and governor valve. See Figure 5-25.

#### 1. Part Throttle Up Shift.

At low car speeds the valves are positioned as shown in Figure 5-25. Oil from the throttle valve enters the space between the regulator valve and valve body, moves the valve sufficiently to open the port allowing oil to by-pass the regulator valve and occupy the space between the regulator valve and first land of the shift valve.

As car speed increases, governor valve pressure exerts an increasing counter force against the first land of the shift valve from the opposite side. When car speed is such that governor valve pressure overcomes throttle valve pressure and the shift valve spring, the shift valve moves to the position shown in Figure 5-26. With the valve in this position line pressure is directed to the converter clutch piston, converter boost pressure is cut off, and

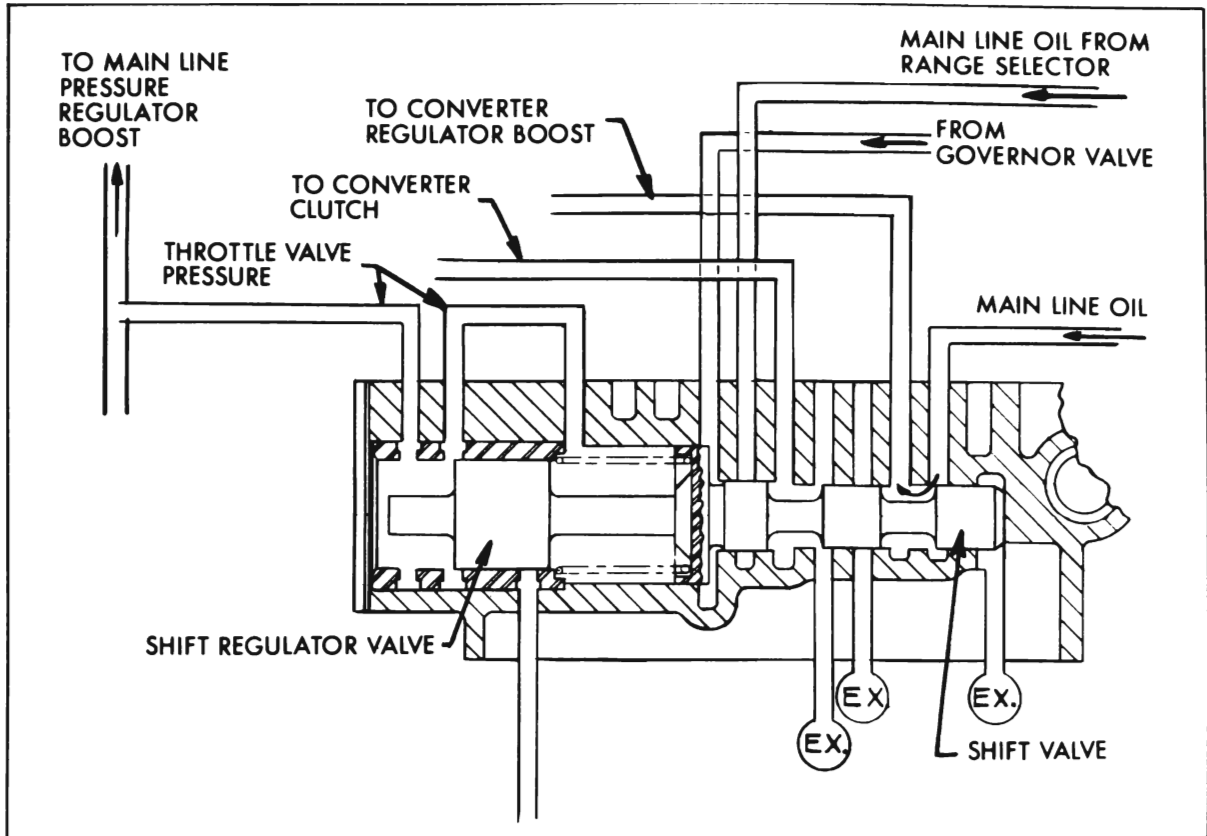


Figure 5-25—Shift Valve and Shift Regulator Valve in Converter Clutch Disengaged Position

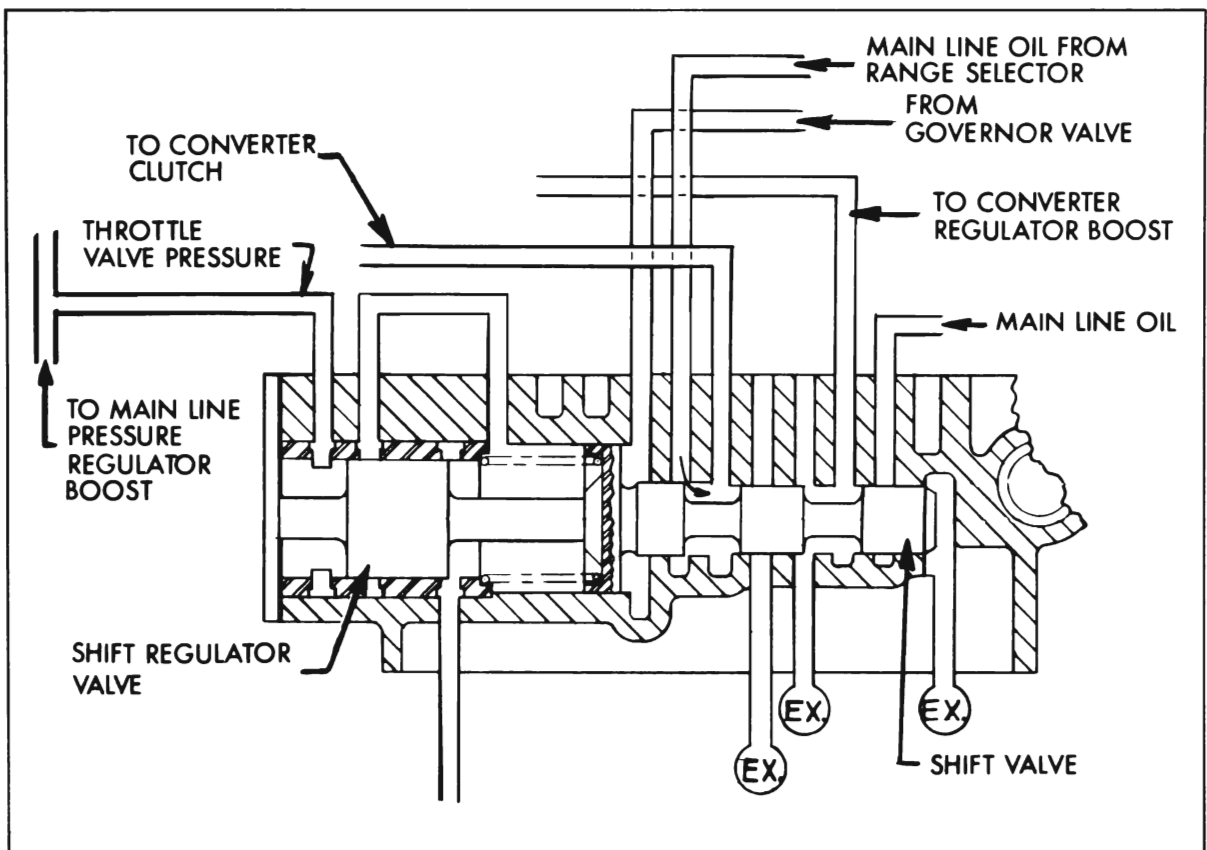


Figure 5-26—Shift Valve and Shift Regulator Valve in Converter Clutch Engaged Position

the port by-passing the regulator valve is closed. Throttle valve pressure is then bearing only on the regulator valve which has a smaller area than the first land of the shift valve. Thus throttle valve pressure has a lesser effect on the shift valve when bearing on regulator valve and the shift valve will remain in the position shown in Figure 5-26 (converter clutch engaged), until a full throttle down shift occurs, or car speed decreases sufficiently to allow throttle valve pressure to move the shift valve while bearing against the smaller area of the regulator valve. Thus car speed must decrease well below the speed at which the up shift occurred, to allow a down shift unless full throttle is reached as described below.

### 2. Full Throttle Down Shift.

At full throttle, the exit port of the throttle detent valve is opened (see Figure 5-27) directing oil at throttle valve pressure to the space between the regulator valve and the shift valve. Throttle valve pressure is then bearing on the larger diameter of the first land of the shift valve, and if car speed is below 56 MPH approx., the valve is moved to the position shown in Figure 5-27. With the valve in this position, main line oil to the converter clutch piston is cut off and converter pressure is boosted.

### 3. Full Throttle Up Shift After Down Shift.

When car speed reaches approx. 64 MPH,

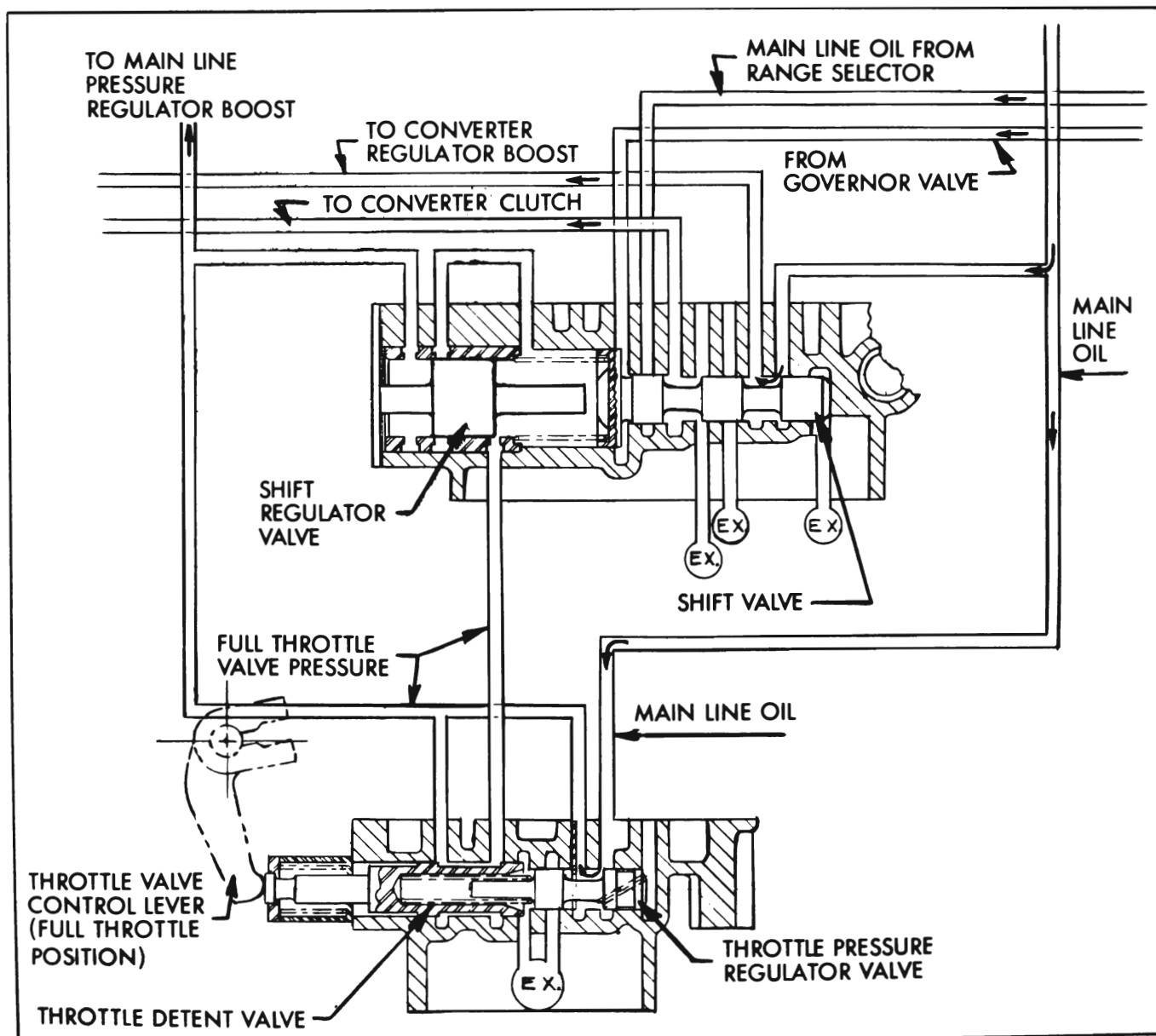


Figure 5-27—Throttle Valve and Shift Valve in Full Throttle Down Shift Position



regardless of throttle opening, governor valve pressure is sufficient to move the shift valve against throttle valve and spring pressure to the position shown in Figure 5-26. With the valve in this position, as in subparagraph 1 above, main line oil pressure is directed to the converter clutch piston and converter pressure regulator valve boost pressure is cut off.

**NOTE:** The pressures indicated on Figures 5-28, 5-29, 5-30, 5-31, 5-32, 5-33 are calculated pressures only. Due to manufacturing tolerances, these pressures may not be attained, although the transmission is functioning perfectly.

As soon as complete pressure test specifications are available, they will be published in a B.P.S. Bulletin.

#### **g. Operation of Hydraulic Controls in Neutral Range and Park Range**

During operation in Neutral, the range selector valve is positioned as shown in Figure 5-28. In Park range, the valve is positioned further to the left. In both Neutral and Park, oil supply to the reverse and forward clutches is cut off and an exhaust port is opened to disengage the clutches. The coast clutch is engaged in Neutral and Park range to couple the overrunning clutch cam to the rear sun gear.

Thus, the converter members are allowed to turn, but transmit no torque to the output shaft. See Figure 5-28.

#### **h. Operation of Hydraulic Controls in Low Range**

During operation in Low range, the range selector valve is positioned as shown in Figure 5-29. With the valve thus positioned, oil at line pressure is directed to the forward and coast clutches while the reverse clutch oil supply is cut off and an exhaust port is opened to disengage the clutch. No oil is directed to the governor valve; consequently the shift valve will remain in "converter clutch off" position. See Figure 5-29.

#### **i. Operation of Hydraulic Controls in Drive Range (Part Throttle Up Shift)**

During operation in Drive range, the range selector valve is positioned as shown in Figure 5-30. Oil at line pressure is directed to the forward clutch, while the supply to the reverse and coast clutch is cut off and an exhaust port opened to disengage the clutches. Oil at line pressure is directed to the governor valve and throttle valve where oil pressure is modulated

and directed to the shift valve and shift regulator valve. When sufficient car speed in relation to throttle opening is attained, governor valve pressure will move the shift valve to "converter clutch applied" position as shown in Figure 5-30. Oil pressure to the converter pressure regulator valve boost chamber is then cut off so converter charging pressure is lowered to approximately 14 psi.

#### **j. Operation of Hydraulic Controls in Drive Range (Full Throttle Down Shift)**

Full throttle down shift is accomplished when the accelerator is pressed to the floor at car speeds below approximately 56 MPH. When the accelerator is pressed to the floor the throttle detent valve is moved to its stop as shown in Figure 5-31. Full throttle valve pressure is then ported to the space between the shift regulator valve and shift valve to bear against the first land of the shift valve. The shift valve is then moved to "converter clutch off" position. With the valve in this position, oil supply to the converter clutch is cut off and a port opened to exhaust to allow disengagement of the clutch. Converter charging pressure is raised to main line pressure by the entrance of oil at line pressure into the converter pressure regulator valve boost chamber. See Figure 5-31.

#### **k. Operation of Hydraulic Controls in Drive Range (Full Throttle Up Shift After Down Shift)**

If, after a full throttle down shift, the throttle is held wide open, car speed will increase to the point where governor valve pressure reaches approximately 87 psi. Governor valve pressure will then overcome spring and throttle valve pressure even at wide open throttle. As this occurs, the shift valve is moved to "converter clutch on" position, converter charging pressure is lowered and oil is directed to the converter clutch piston, causing its engagement. See Figure 5-32.

#### **l. Operation of Hydraulic Controls in Reverse Range**

During operation in Reverse range the range selector valve is positioned as shown in Figure 5-33. Oil at line pressure is directed to the reverse and coast clutches while the oil supply to the forward clutch is cut off and an exhaust port opened to disengage the clutch. No oil is directed to the governor valve so the shift valve remains in "converter clutch off" position. See Figure 5-33.

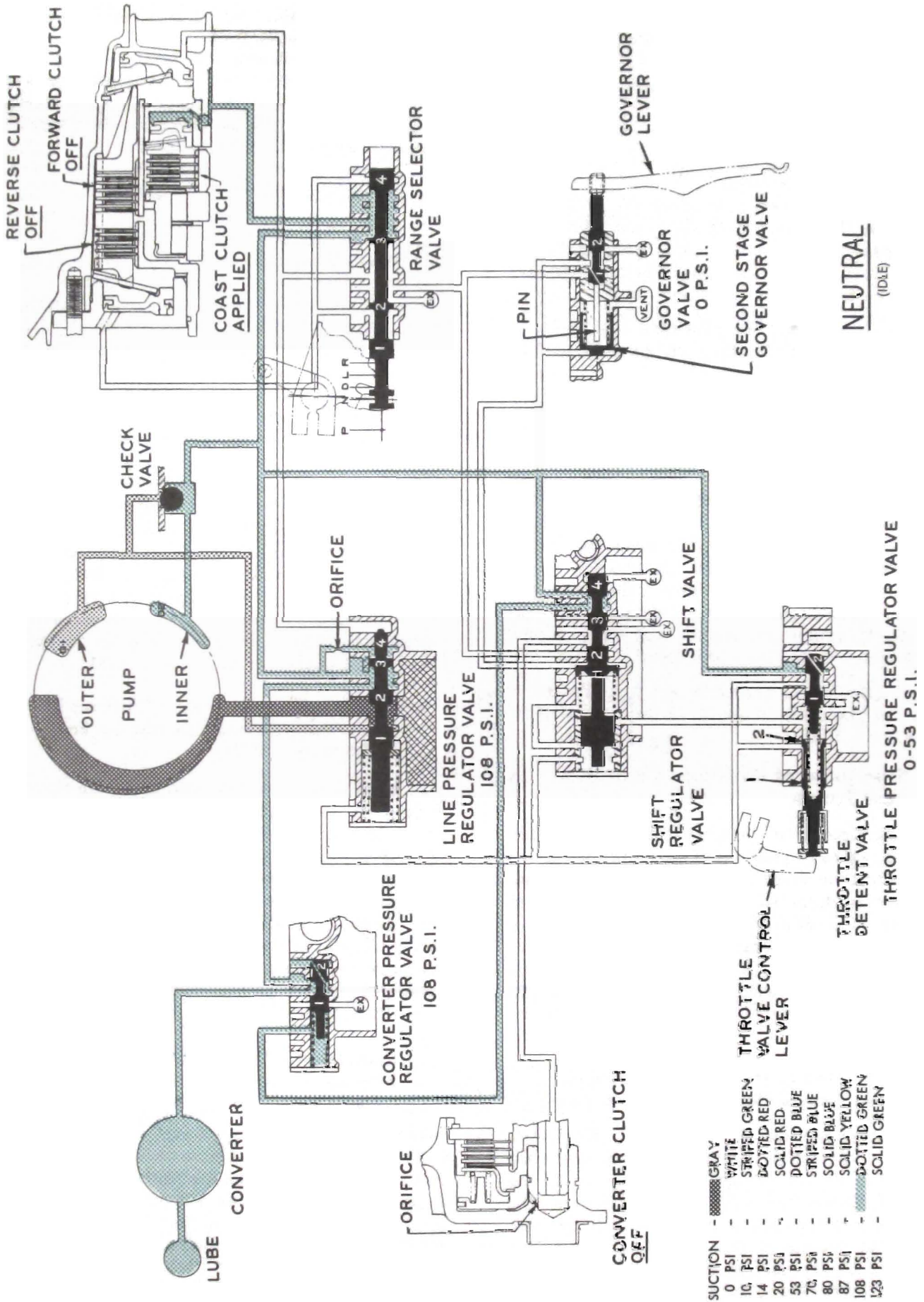


Figure 5-28—Oil Flow in Neutral and Park

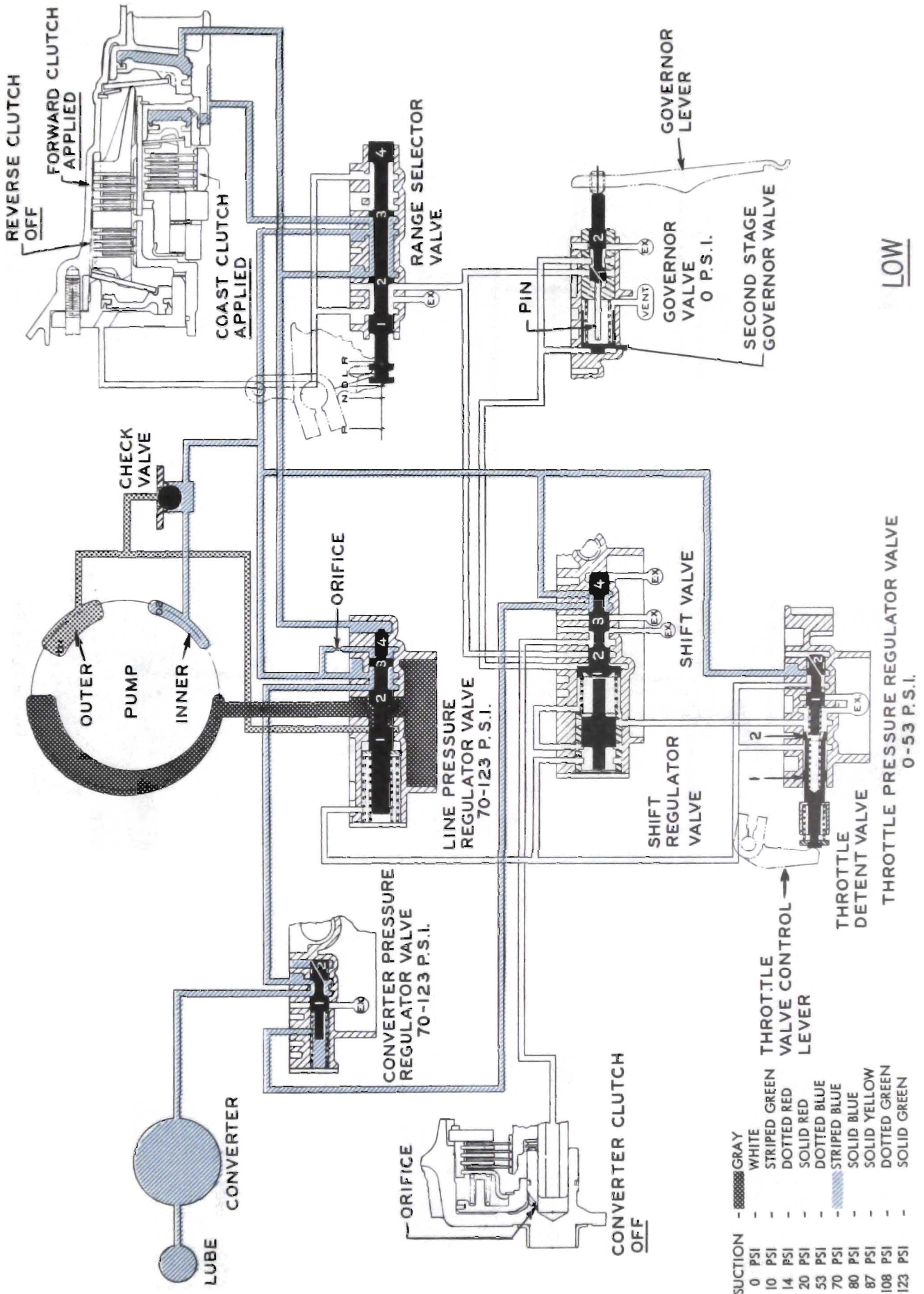


Figure 5-29—Oil Flow in Low Range



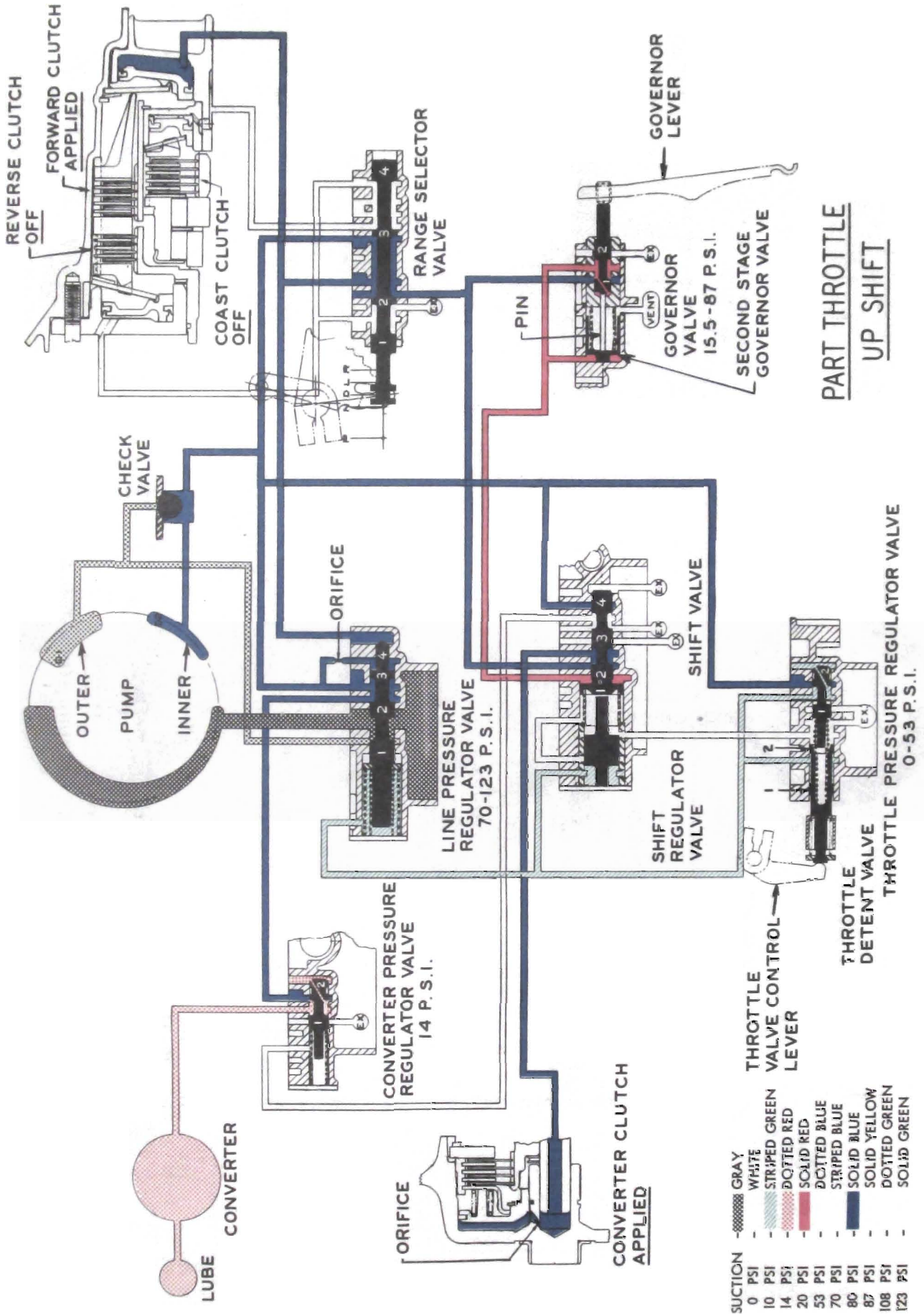


Figure 5-30—Oil Flow in Drive Range, Part Throttle Up Shift

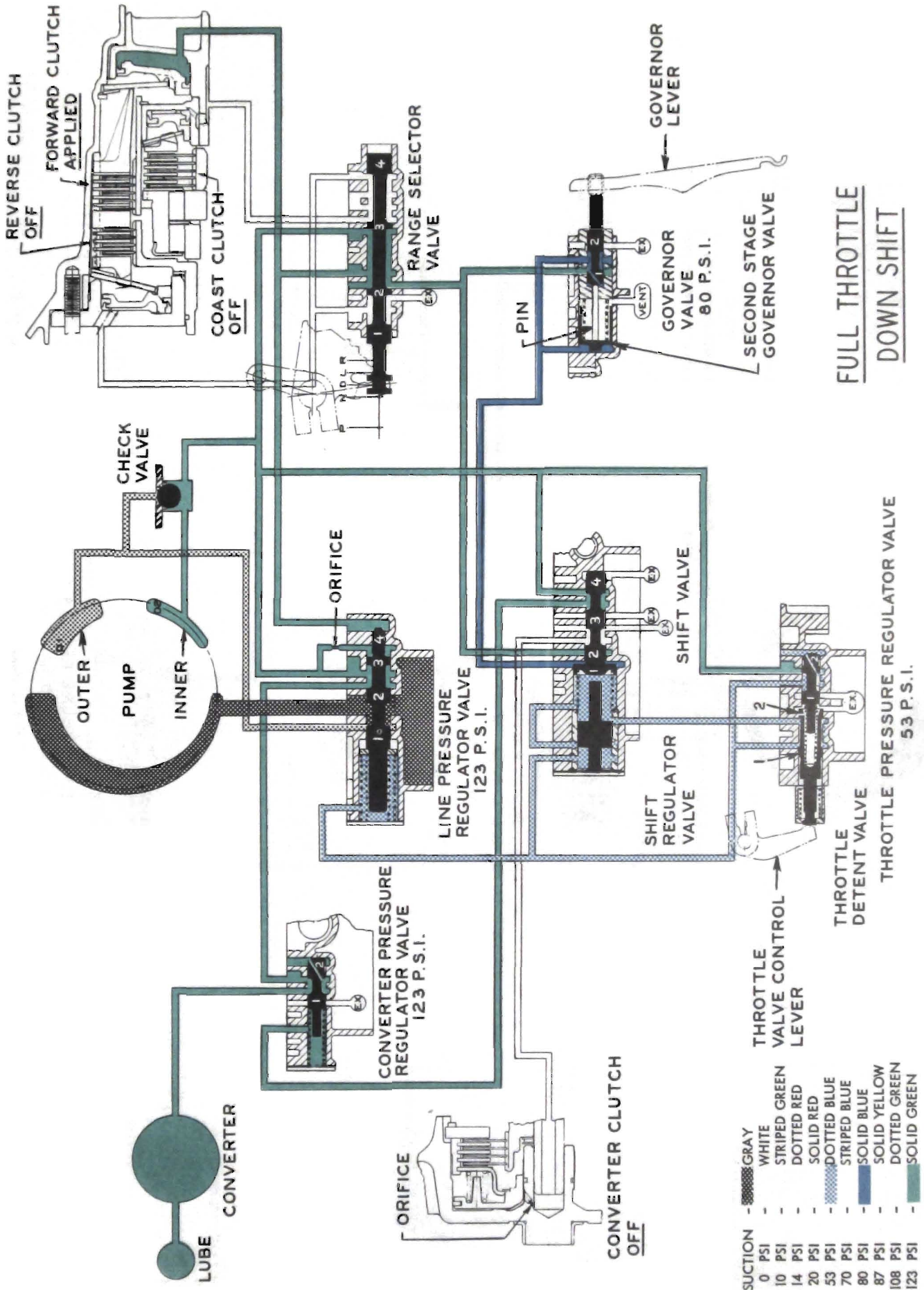


Figure 5-31—Oil Flow in Drive Range, Full Throttle Down Shift



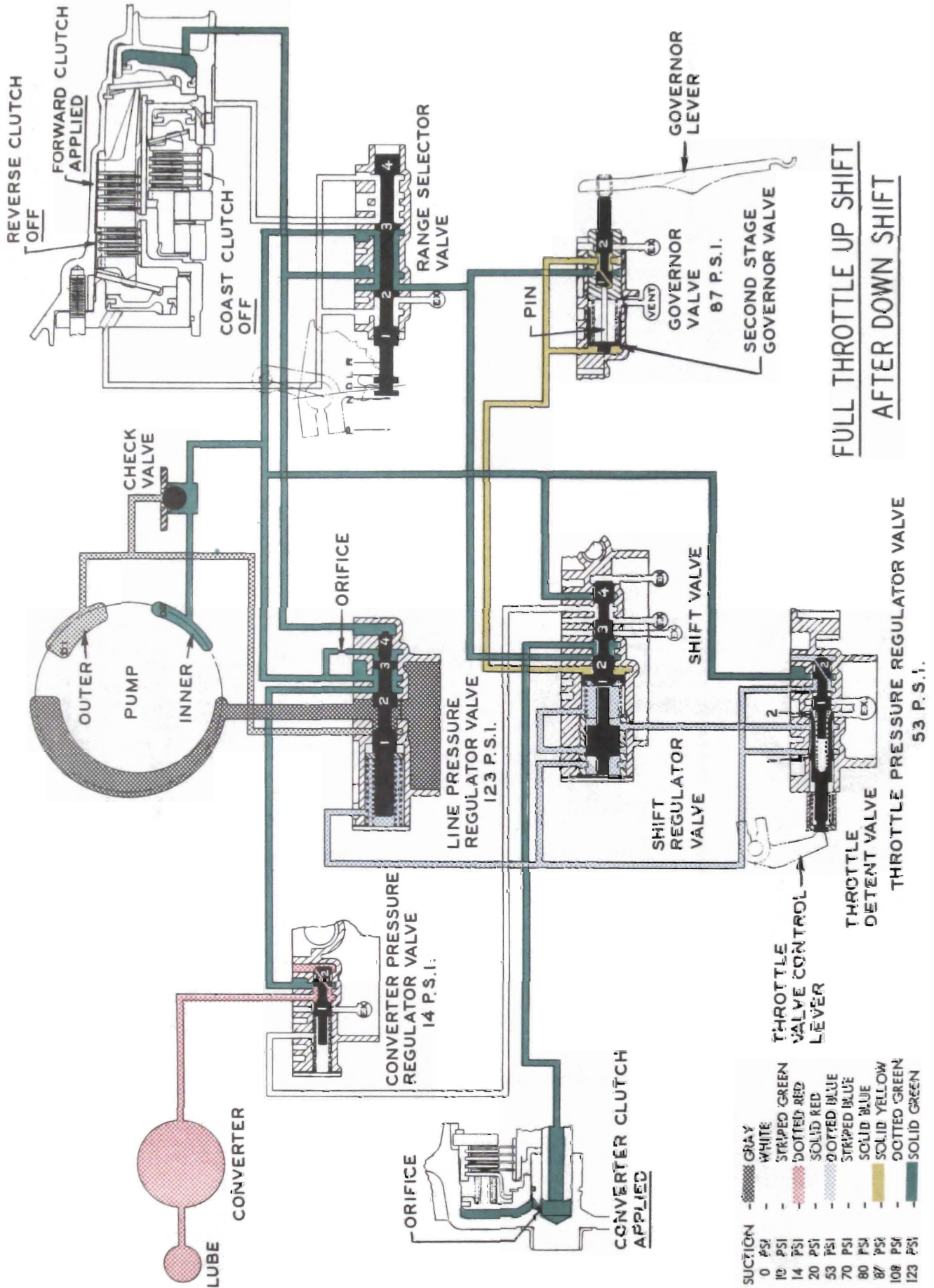


Figure 5-32—Oil Flow in Drive Range, Full Throttle Up Shift After Down Shift



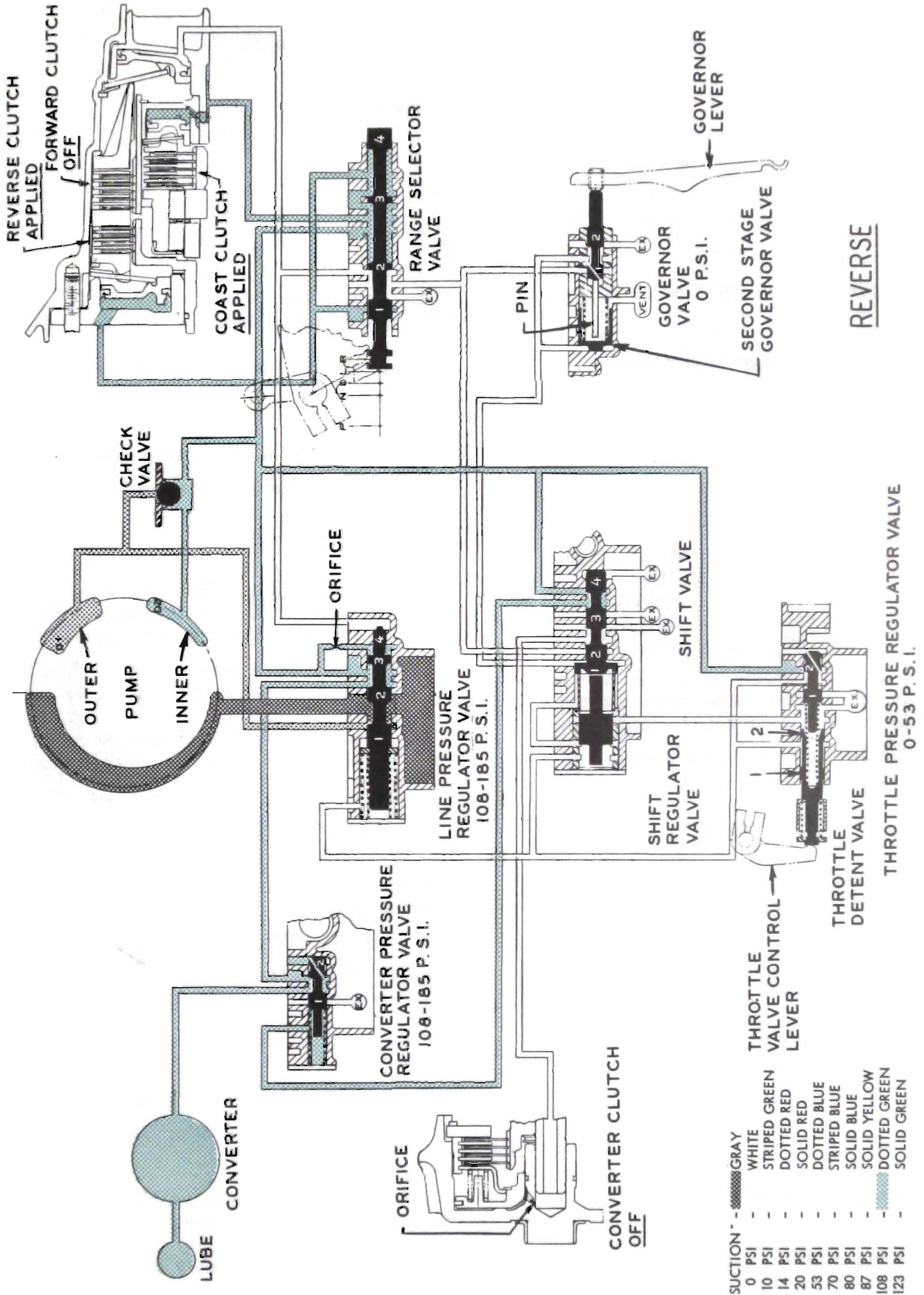


Figure 5-33—Oil Flow in Reverse