FUNDAMENTAL PRINCIPLES OF THE STRATO-FLIGHT HYDRA-MATIC TRANSMISSION

CONTENTS OF THIS SECTION

PURPOSE OF A TRANSMISSION

The purpose of a transmission is to provide suitable gear ratios between the engine and rear wheels for all driving conditions. Gear ratios are obtained through planetary gears in the Hydra-Matic transmission.

PLANETARY GEAR TRAIN

A planetary gear train (Fig. 3) consists of three members:

1. A center or "sun" gear.

2. A planet carrier with three or four planet pinion gears.

3. An internal gear.

The center or "sun" gear is surrounded by and meshes with the planet pinion gears, which rotate freely on pins attached to a common bracket called the "planet carrier." A ring with teeth machined on the inside circumference surrounds the assembly and meshes with the planet pinion gears. This is called the "internal" gear, because of its internal teeth.

ADVANTAGES OF A PLANETARY GEAR TRAIN

1. A planetary gear train is compact and sturdy because the load is distributed over several gears instead of only two as in the sliding gear type of gear train. Planetary gears are smaller and occupy less space, they can transmit more tooth load because there is more tooth area in contact at all times.

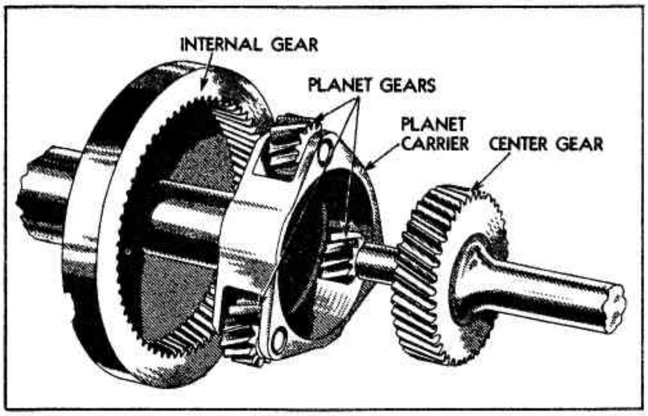

Fig. 3 Planetary Gear Train

2. Planetary gears are always completely in mesh, thus there is no possibility of tooth damage due to gear clash or partial engagement.

3. The common axis for all members of the planetary train makes the unit more compact and facilitates its use as a coupling when any two of its members are locked together.

OPERATION OF A PLANETARY GEAR TRAIN

1. A planetary gear train can be used to increase power and decrease speed in either of two ways.

a. One method of obtaining speed reduction (power multiplication) is to hold the internal gear stationary while power is applied to the center gear

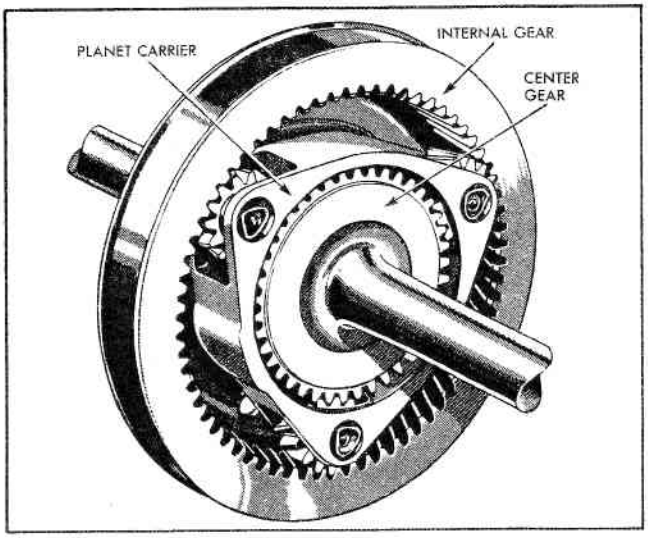

Fig. 4 Planetary Gears

(Fig. 4). As the center gear turns, the planet pinion gears, which are in mesh with it, rotate on their respective pins. Since they are also in mesh with the stationary internal gear, they must "rotate around" inside the internal gear, carrying the planet carrier with them in the same direction of rotation as the center gear. The planet carrier then rotates at a speed less than that of the center gear, and the planetary gear train functions as a power-increasing, speed-reducing unit.

b. The same result can be obtained by holding the center gear stationary and applying power to the internal gear. In this case, rotation of the internal gear causes the planet pinion gears to rotate on their respective pins and at the same time "rotate around" the center gear, thus rotating the planet carrier at a speed less than that of the internal gear. The gear train then functions as a power-increasing, speed-reducing unit.

2. A planetary gear train can be used to reverse direction of rotation when the planet carrier is held stationary. In this instance, if power is applied to the center gear, the planet pinion gears rotate on their respective pins; but since the carrier is stationary, they act merely as idlers, transmitting power to the internal gear and causing it to rotate in the opposite direction.

In all of the examples described, one member has been held stationary, the power applied to another member, and taken off the third member.

3. A planetary gear train can be used as a coupling for direct mechanical drive when any two members are locked together.

Under this condition movement can not take place between the gears and the entire gear train will rotate as a unit.

4. When none of the members are held or locked together the planetary gear train will not transmit power; therefore it is in neutral.

FLUID COUPLING

A fluid coupling is a hydraulic clutch used to transmit engine torque to the transmission. The use of the fluid coupling eliminates the need for a manual clutch and also provides a cushioning effect of the gear changes between the engine and the transmission.

A second and smaller fluid coupling is used in the front unit. When filled, this coupling locks two members of the planetary gear train together to provide direct drive.

The fluid coupling consists of two parts called "torus members" splined to independent shafts and located in a fluid-filled housing.

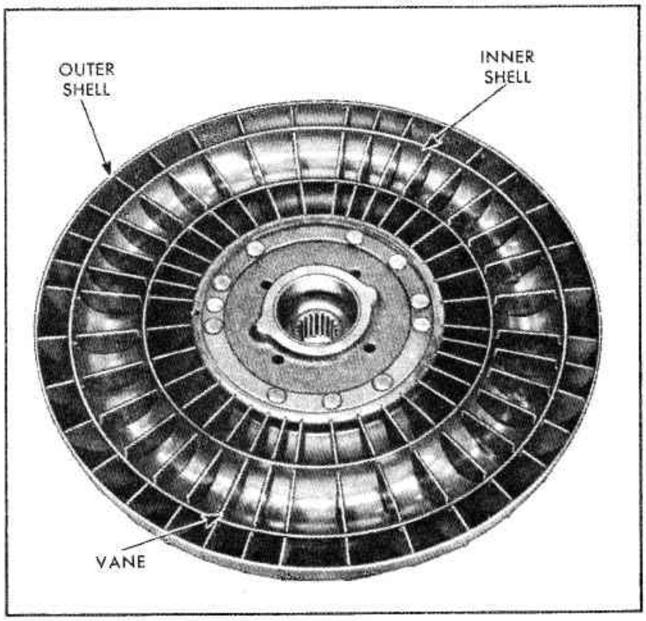

Fig. 5 Torus Member

The principal parts of each torus member (Fig. 5) are, the outer shell, hub, inner shell, and vanes interconnecting the shells. The two members of each coupling are identical in construction except for the hubs which are different in size to fit their respective shafts.

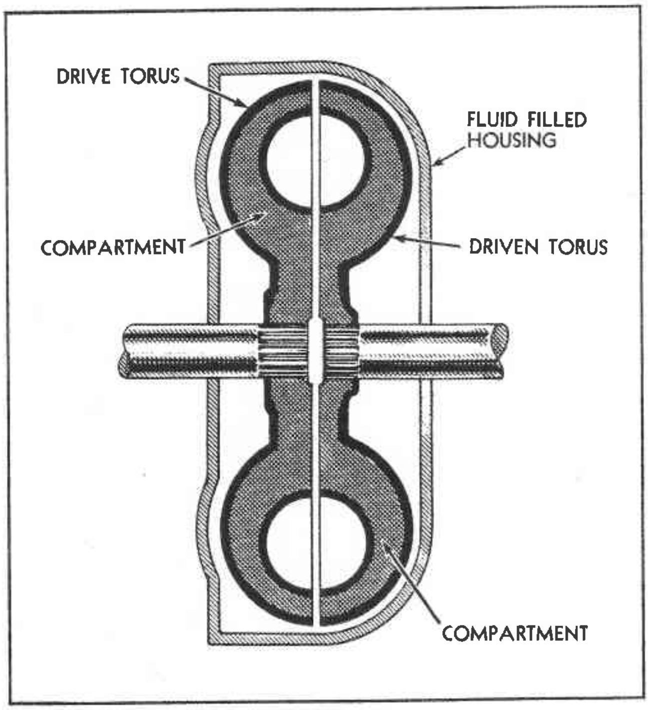

Fig. 6 Cross Section of Fluid Coupling

A schematic cross section of two torus members attached to independent shafts and located in a fluid-filled housing is illustrated in Fig. 6. The shape of the compartment formed by the vanes is shown shaded. NOTE: An actual illustration of the component parts which make up the main fluid coupling is shown in Fig. 7.

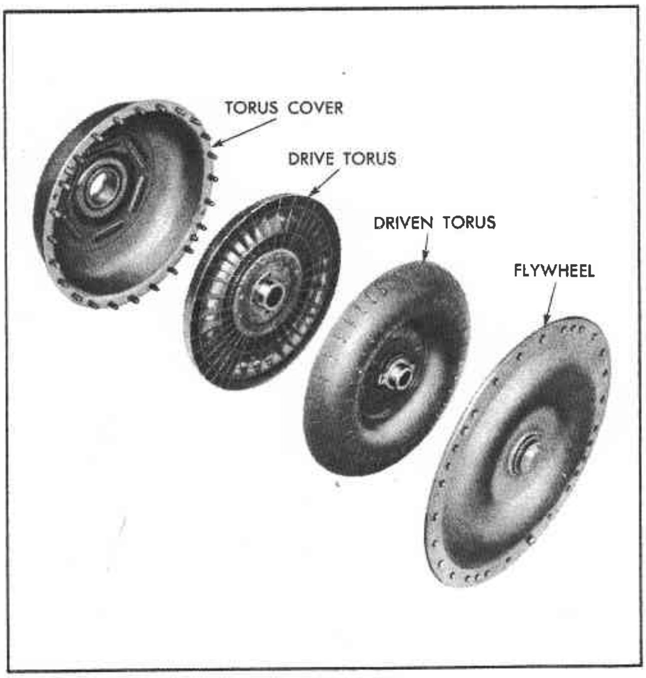

Fig. 7 Fluid Coupling Units

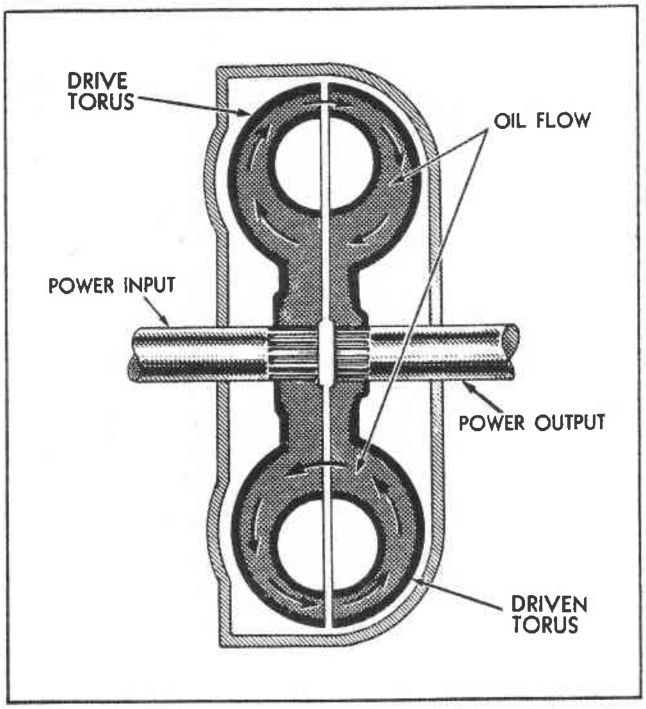

Fig. 8 Fluid Coupling in Operation

In operation, rotation of the drive torus member causes the fluid within that member to be forced radially outward. Fluid then crosses over and strikes the vanes of the driven torus member, causing it to rotate in the same direction as the drive member (Fig. 8).

The higher the speed of the drive member, the greater the centrifugal force exerted by the circulating fluid on the driven member. Consequently, a fluid coupling is:

Very efficient at high speed.

Less efficient at low speed.

Very inefficient at idle speed.

SPRAG CLUTCH

A sprag clutch is a device having irregular members wedged between two concentric members. It allows rotation of a unit in one direction and locks the unit from rotating in the opposite direction. Sprag clutches are used in the Strato-Flight Hydra-Matic to lock one member of each planetary gear set for reduction. In direct drive the sprag clutches allow free rotation.

The sprag clutch consists of three parts, the inner race, the sprag assembly, and the outer race (Fig. 9).

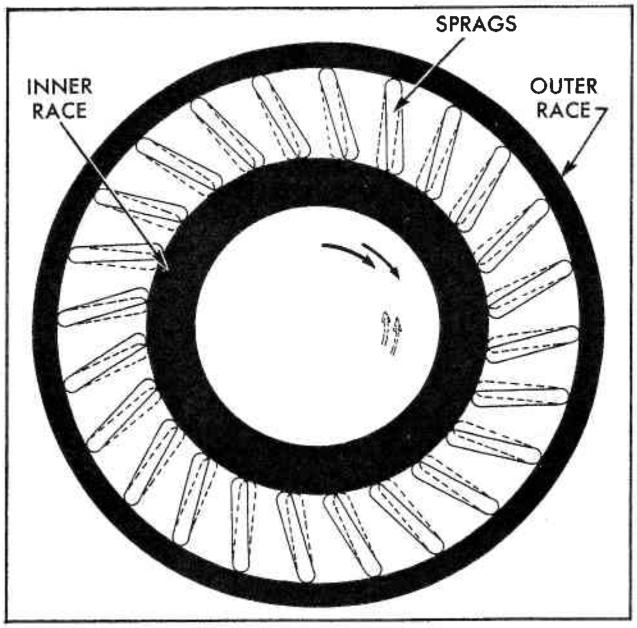

Fig. 9 Sprag Clutch

The inner race is connected to the part which is to be held for reduction, or allowed to rotate for direct drive. The outer race is fastened to the transmission case and is stationary.

When torque is applied to the inner race in a counterclockwise direction as indicated by the dotted arrows, the sprags will be wedged between the inner and outer races. This wedging action, shown by the dotted sprags, locks the inner race from turning.

When torque is applied to the inner race in a clockwise direction as indicated by the solid arrows, the sprags will fall free. When the sprags fall free as indicated by the solid sprags, the inner race is allowed to rotate freely in a clockwise direction.

STRATO-FLIGHT HYDRA-MATIC DRIVE COMPONENTS AND THEIR LOCATION

It is possible to obtain only two forward speeds, reduction and direct, from one planetary gear train or unit when applying power at the same source (for example, the "sun" or center gear). As a greater variation of speed ratios is required to satisfactorily operate a vehicle, the Hydra-Matic transmission contains two planetary gear trains arranged to provide four speeds forward. It also contains a third planetary gear train for reverse. In all forward speeds the reverse planetary unit has no function and simply revolves with the output shaft.

While the large torus members are actually located in front of the transmission, they are in effect between the front and rear planetary units. This is due to the fact that the drive torus (rear member) is part of the front unit planet carrier and the driven torus (front member) is splined on the main shaft, which includes the rear planetary unit center gear.

DRIVE TORUS SPEED REDUCTION

When the car is standing, with the engine running and the control lever in Drive, LO, or Reverse, the large drive torus of the main coupling rotates at 65% engine speed. This speed reduction of the large drive torus allows an engine idle of 460 RPM without the car "creeping" forward excessively. When the transmission shifts to second speed, the front planetary unit is locked in direct drive. The drive torus then turns at engine speed.

Power is transmitted from the flywheel to the torus cover, (Fig. 10) through the front planetary, which is in reduction, and then to the rear torus member. The rear torus of the main fluid coupling, is the drive member, while the front torus is the driven member.

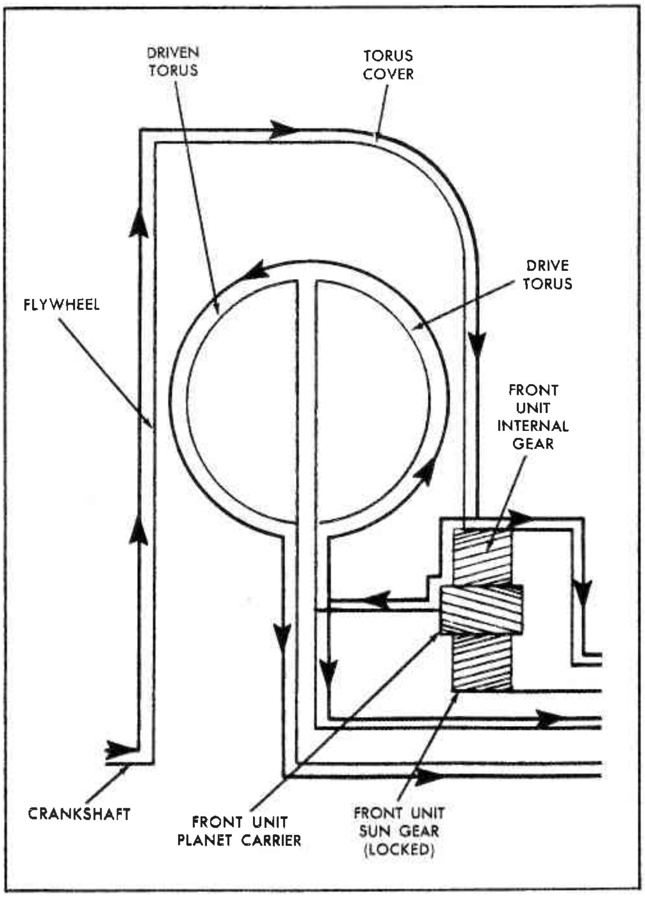

Fig. 10 Drive Torus Speed Reduction

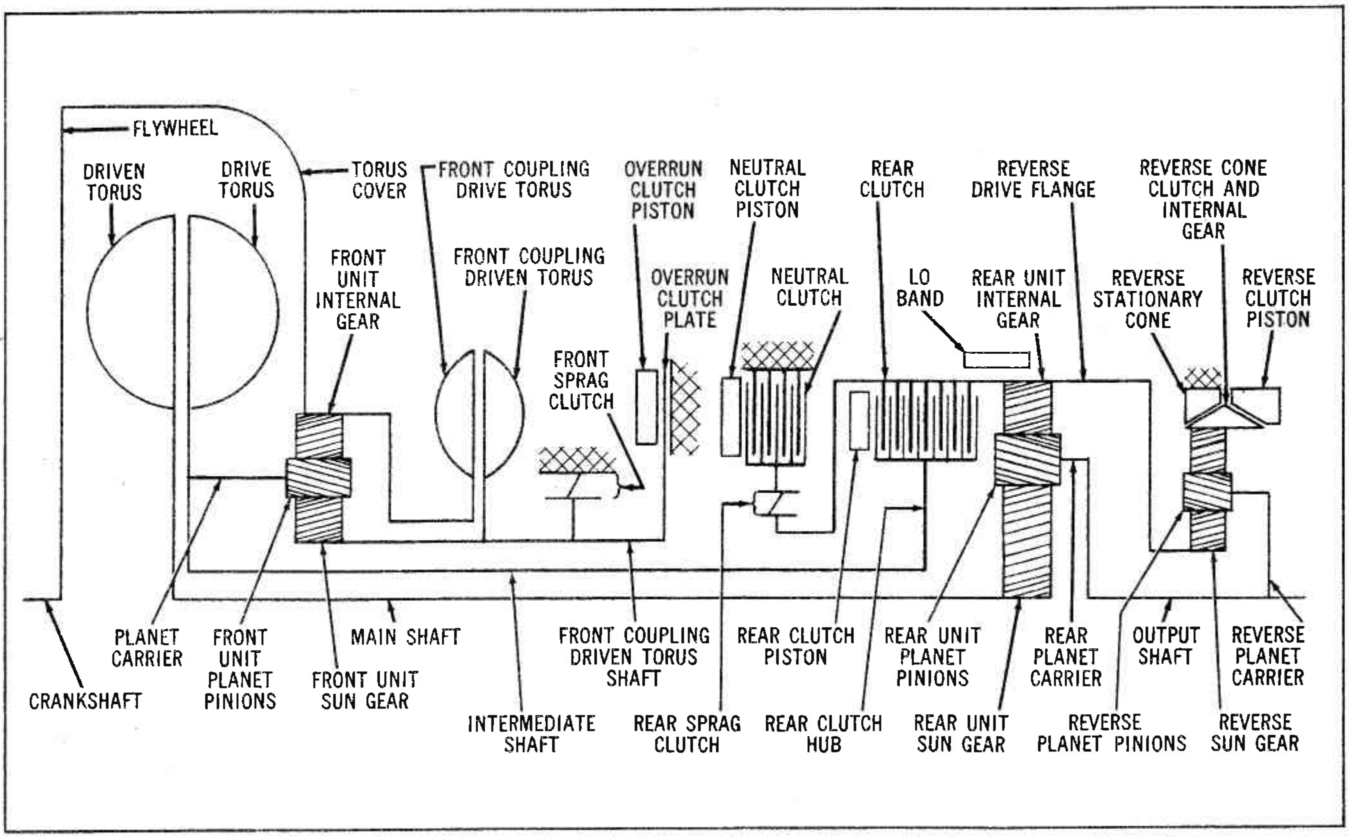

Fig. 11 Simplified Schematic of Strato-Flight Hydra-Matic

PRINCIPLES OF OPERATION OF STRATO-FLIGHT HYDRA-MATIC TRANSMISSION

Various parts of the Strato-Flight transmission used in obtaining reduction and direct drive are shown in the simple schematic illustration in Fig. 11. Each part is shown in its true relationship to other parts. All parts connected by a line in the illustration are actually connected together in the transmission. For example, the front unit planet carrier, the main drive torus member, the intermediate shaft and the rear clutch hub are all connected together and rotate as a unit. The simple schematic can be compared to Fig. 12 which is an actual cross section of the transmission.

RELATIONSHIP OF UNITS

The torus cover and flywheel are bolted to the engine flex plate and, therefore, rotate with the engine at all times. The front unit internal gear is connected to the torus cover and also to the drive torus of the front unit fluid coupling. Thus, the front unit internal gear and drive torus member always rotate with the engine crankshaft.

The front unit sun gear is mounted on the front end of the shaft of the front unit coupling driven torus. The rear end of this shaft is connected to the inner race of the front sprag clutch and to the overrun clutch plate. Therefore, the front coupling driven torus and the sun gear can turn in a clockwise direction, but the sprag will not allow them to turn counterclockwise. If the overrun clutch plate is applied, the sun gear cannot turn in either direction.

The planet carrier of the front unit is connected directly to the main drive torus which in turn is splined to the intermediate shaft. The rear unit clutch hub is splined to the rear end of the intermediate shaft and drives the rear clutch drive plates. Therefore, the main drive torus and the rear clutch hub and drive plates always rotate with the front unit planet carrier.

The main driven torus is splined to the front end of the main shaft. The sun gear of the rear unit is splined to the rear end of the main shaft. Thus, whenever the driven torus member rotates the sun gear of the rear unit rotates with it.

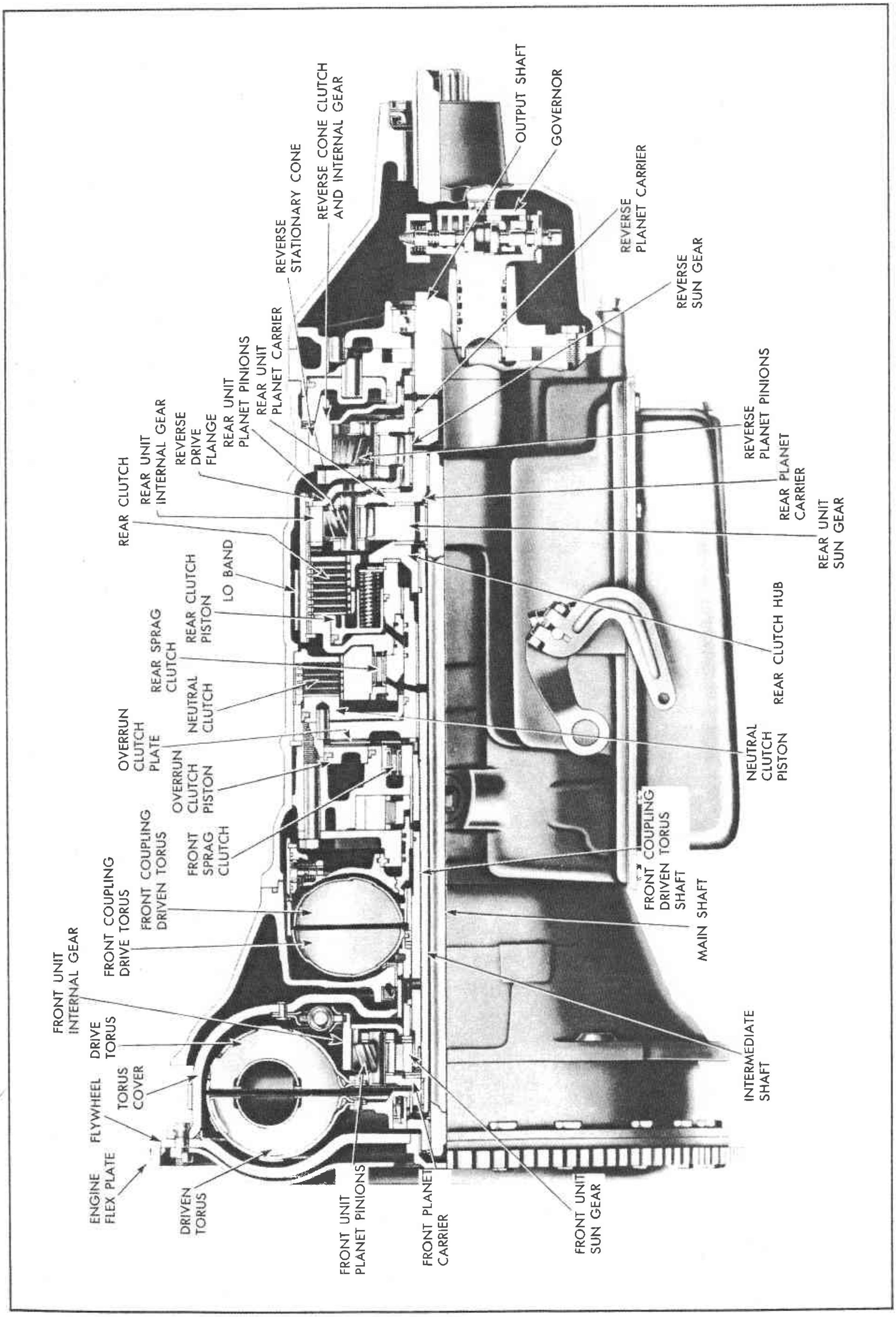

Fig. 12 Cross Section of Strato-Flight Hydra-Matic

The internal gear of the rear unit is connected to the rear clutch drum which in turn is connected to the rear clutch driven plates and to the rear sprag inner race. The reverse sun gear is also connected to the rear clutch drum by means of the reverse drive flange. Thus, the rear internal gear, rear sprag inner race, rear clutch driven plates and reverse sun gear turn as a unit.

The outer race of the rear sprag is connected to the case by means of the neutral clutch plates. When the neutral clutch is released the sprag outer race is free to rotate, but when the neutral clutch is applied the rear sprag outer race is locked to the case. The Lo band encircles the rear clutch drum and when applied, locks the drum to the case.

The rear unit planet carrier is an integral part of the output shaft of the transmission. The reverse planet carrier is splined to the output shaft. The rear unit planet carrier, reverse planet carrier and output shaft, therefore, operate as one unit.

The reverse internal gear is locked to the case when clamped between the reverse stationary cone and the reverse piston.

HYDRAULIC APPLICATION OF UNITS

Direct drive or reduction in each of the units is controlled hydraulically. Reduction in the front unit is obtained when the front unit coupling is empty. Direct drive is secured when the coupling is filled. Reduction in the rear unit is obtained when the rear clutch is released by spring pressure. Direct drive in the rear unit is obtained by hydraulically applying the rear clutch.

The overrun clutch, neutral clutch, LO band and reverse cone clutch are all applied, when necessary, by hydraulic pressure.

The hydraulic pressure is maintained by two oil pumps, a front pump and a rear pump. The front pump is driven by the front coupling drive torus whenever the engine operates and is the primary pump. The rear pump is driven by the output shaft and, therefore, operates only when the car is moving. This pump also supplies oil pressure to the large fluid coupling for push starting the engine.

Oil pressure is directed to the proper places in the transmission by means of a control valve assembly. When the driver places the selector lever in the desired range, the control valve is positioned to automatically direct oil to the proper places in the transmission.

POWER FLOW IN STRATO-FLIGHT HYDRA-MATIC TRANSMISSION

Before studying the following power flow illustrations and text, study Figs. 11 and 12 thoroughly to become familiar with the names of all parts. The power flow (parts that are rotating) for each transmission speed is indicated by a heavy black line on the illustration for that condition.

The front coupling driven torus shaft, the intermediate shaft, and the main shaft are all concentric. In other words, the mainshaft operates inside the hollow intermediate shaft which in turn operates inside the hollow front unit driven torus shaft. The sprag assemblies also are concentric with the shafts; thus, the inner race of each sprag is the one nearest the centerline of the transmission.

Areas or surfaces behind which cross-hatching appears are connected to the transmission case and are, therefore, stationary.

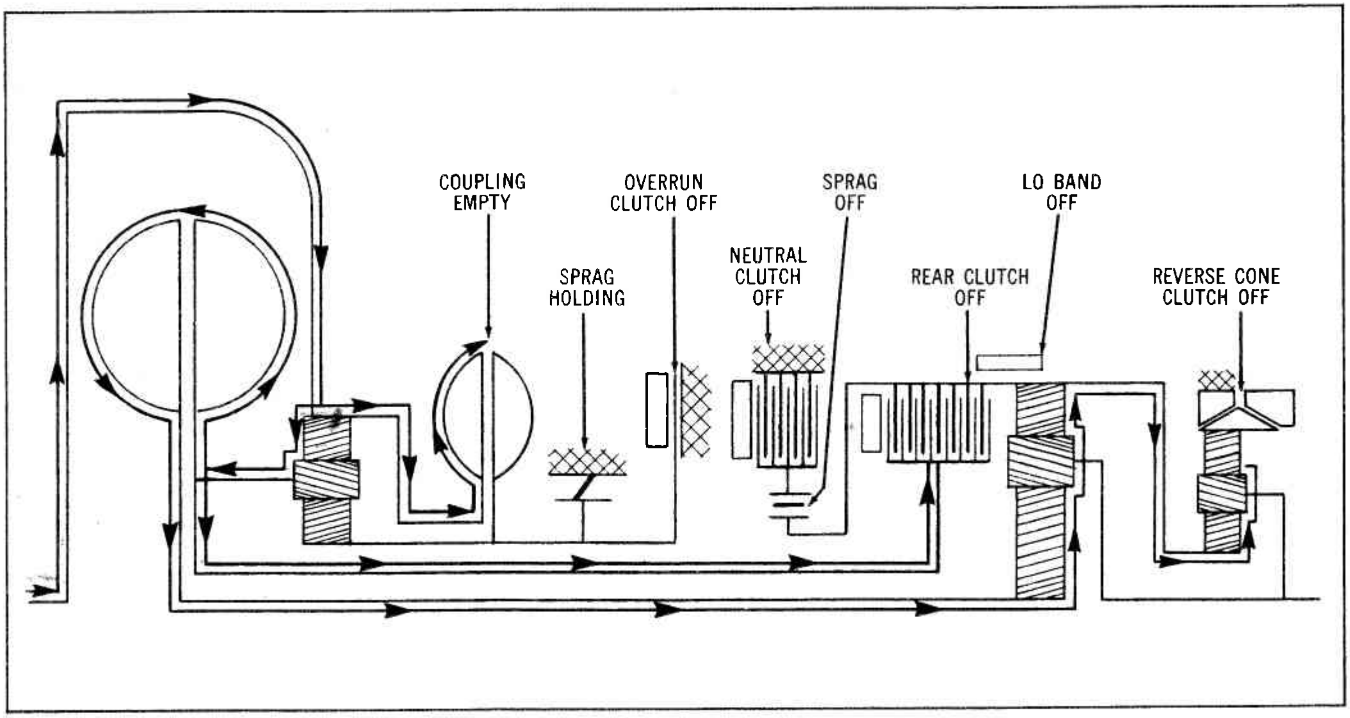

Fig. 13 Power Flow—Neutral—Engine Running

POWER FLOW — NEUTRAL — ENGINE RUNNING

Front Sprag	– Holding
Coupling (Front Unit)	– Empty
Rear Sprag	– Released
Neutral Clutch	– Off
Rear Clutch	– Off
Overrun Clutch	– Off
Lo Band	– Off
Reverse Cone Clutch	– Off

As the engine turns, power flows as follows (Fig. 13): From the flywheel to the torus cover to the front unit internal gear. The internal gear drives the front unit coupling drive torus but since the coupling is empty, it cannot transmit power to the driven torus. The rotation of the front unit internal gear causes the planet pinions to drive the front unit sun gear in the opposite direction or counterclockwise. This locks the front sprag holding the sun gear stationary. With the sun gear held from rotation by the sprag, the planet pinions will rotate around the sun gear. The planet carrier and all connecting parts will then turn (at reduced speed) in the direction of engine rotation. Power is then transmitted from the front planet carrier to the main drive torus where it will turn the intermediate shaft and the rear clutch hub. Since the rear clutch is released, no power can be transmitted though it. The rotation of the main drive torus causes rotation of the main driven torus, transmission main shaft and the rear unit sun gear.

The rear planet carrier which is part of the output shaft is held stationary by the weight of the vehicle. As the rear sun gear rotates, the rear planet pinions rotate opposite engine rotation, in turn driving the rear internal gear (which is free to rotate with the neutral clutch released) in a counterclockwise direction. Therefore, drive cannot be transmitted to the output shaft. The reverse sun gear being driven in a counterclockwise direction will, through the reverse planet pinions, drive the reverse internal gear clockwise. This is accomplished since the reverse planet carrier is splined to the output shaft that is held stationary by the weight of the vehicle. Power flow ends at the free-rotating reverse internal gear and the transmission is in Neutral.

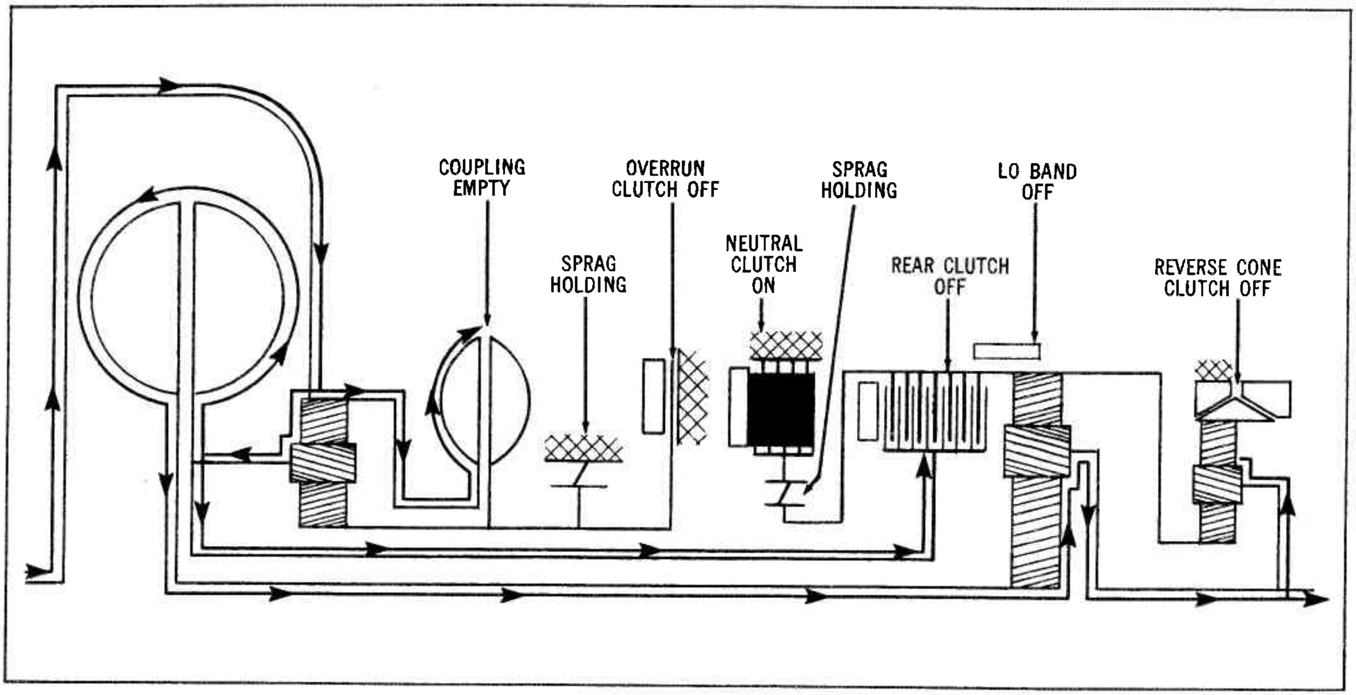

Fig. 14 Power Flow—First Speed—Drive Left

POWER FLOW — FIRST SPEED — DRIVE LEFT

Front Sprag	— Holding
Coupling (Front Unit)	— Empty
Rear Sprag	— Holding
Neutral Clutch	— On
Rear Clutch	— Off
Overrun Clutch	— Off
Lo Band	— Off
Reverse Cone Clutch	— Off

Power from the engine is transmitted through the flywheel and torus cover to the front unit internal gear. The internal gear drives the front unit coupling drive torus but since the coupling is empty, power cannot be transmitted through it (Fig. 14). The rotation of the front unit internal gear causes the planet pinions to try to drive the sun gear opposite engine rotation. The sprag assembly locks, holding the sun gear from rotation. The planet pinions will then rotate around the sun gear driving the planet carrier at reduced speed in the direction of engine rotation. As the planet carrier rotates, so does the intermediate shaft, rear clutch hub and main drive torus. Since the rear clutch is released, power cannot be transmitted through it. Power is transmitted to the main driven torus, transmission main shaft and the rear sun gear. Rotation of the rear sun gear causes the pinions to drive the rear internal gear opposite engine rotation. The rear sprag assembly locks (since the neutral clutch is applied) holding the rear internal gear from rotation. The rear planet carrier is then forced to turn at a reduced speed in the direction of engine rotation. The output shaft which is part of the rear planet carrier is forced to turn in the direction of engine rotation. Rotation of the output shaft causes the reverse planet carrier to turn, which also rotates the unheld reverse internal gear. Since both the front and rear units are in reduction, this is first speed. Total reduction 1.55 (front) x 2.55 (rear) = 3.97 to 1.

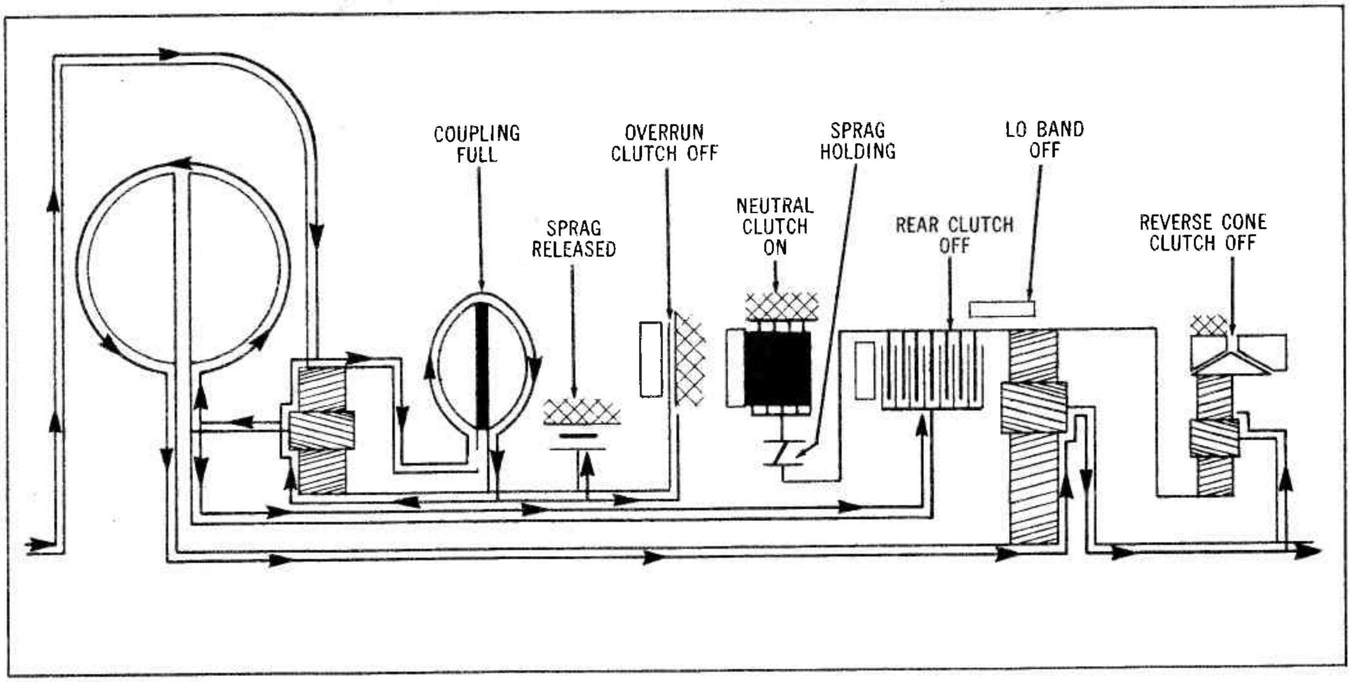

Fig. 15 Power Flow—Second Speed—Drive Left

POWER FLOW — SECOND SPEED — DRIVE LEFT

Front Sprag	– Released
Coupling (Front Unit)	– Full
Rear Sprag	– Holding
Neutral Clutch	– On
Rear Clutch	– Off
Overrun Clutch	– Off
Lo Band	– Off
Reverse Cone Clutch	– Off

Power from the engine is transmitted through the flywheel and torus cover to the front unit internal gear. The internal gear drives the drive torus of the front unit coupling. Since the coupling is now full, the driven torus will be driven at the same speed by the drive torus and will cause the front unit sun gear to rotate in the same direction and at the same speed as the internal gear (Fig. 15). (The sprag inner race is free to rotate in a clockwise direction.) With the internal gear and sun gear operating at the same speed, the planet gear set is locked and the planet carrier will then be carried around at the same speed. The front unit, therefore, is in direct drive.

The main drive torus, intermediate shaft and rear clutch hub are connected to the front planet carrier and will be driven at engine speed. Since the rear clutch is released, no power can be transmitted through it. The power from the main drive torus is transmitted to the driven torus and therefore to the transmission main shaft and rear sun gear. Rotation of the rear sun gear causes the pinions to drive the rear internal gear opposite engine rotation. The rear sprag assembly locks, holding the rear internal gear from rotation and the rear planet carrier is forced to turn at reduced speed in the direction of engine rotation. The output shaft, being part of the rear planet carrier, is forced to turn in the direction of engine rotation. The reverse planet carrier also turns, rotating the unheld reverse internal gear.

Since the front unit is in direct drive and the rear unit is in reduction, the output shaft is turning at a speed less than engine RPM but faster than in first speed. This is second speed. Total reduction 1.00 (front) x 2.55 (rear) = 2.55 to 1.

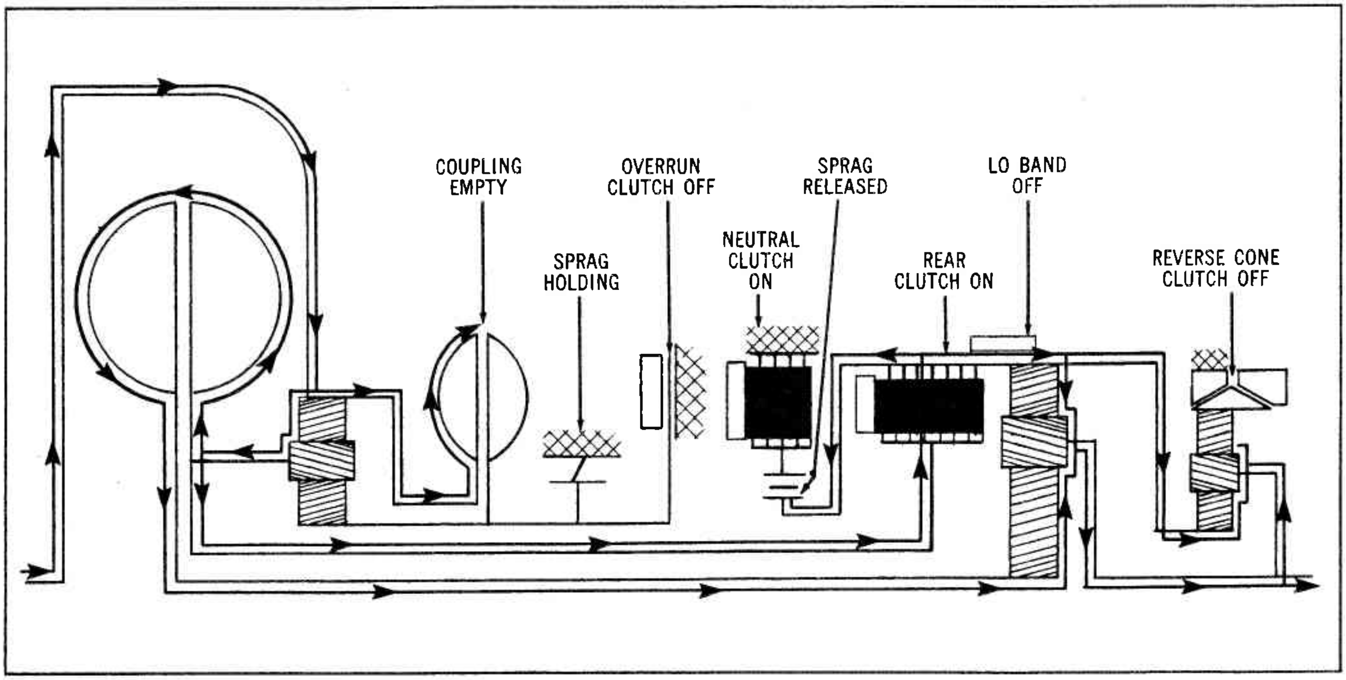

Fig. 16 Power Flow—Third Speed—Drive Left

POWER FLOW — THIRD SPEED — DRIVE LEFT

Front Sprag	— Holding
Coupling (Front Unit)	— Empty
Rear Sprag	— Released
Neutral Clutch	— On
Rear Clutch	— On
Overrun Clutch	— Off
Lo Band	— Off
Reverse Cone Clutch	— Off

Power from the engine is transmitted through the flywheel and torus cover to the front unit internal gear. The internal gear drives the front unit coupling drive torus, but since the coupling is empty, it cannot transmit power (Fig. 16). The rotation of the internal gear causes the pinions to drive the sun gear opposite engine rotation. The sprag assembly locks and prevents rotation of the sun gear. The planet carrier is forced to turn at reduced speed in the direction of engine rotation. The planet carrier then turns with the intermediate shaft, rear clutch hub and main drive torus. Since the rear clutch is applied, the rear sprag inner race is free to rotate and the rear unit internal gear rotates at the same speed as the intermediate shaft.

The power from the main drive torus is transmitted to the driven torus and, hence, to the transmission main shaft and rear unit sun gear. Since the rear internal gear and rear sun gear are turning at the same speed and in the same direction, the rear unit is in direct drive and will drive the planet carrier in the direction of engine rotation. Since the planet carrier is part of the output shaft, the output shaft must turn in the direction of engine rotation. The reverse planet carrier also turns, rotating the unheld reverse internal gear.

With the front unit in reduction and the rear unit in direct drive, the output shaft turns at a speed less than engine RPM, but faster than in second speed. This is third speed. Total reduction 1.55 (front) x 1.00 (rear) = 1.55 to 1.

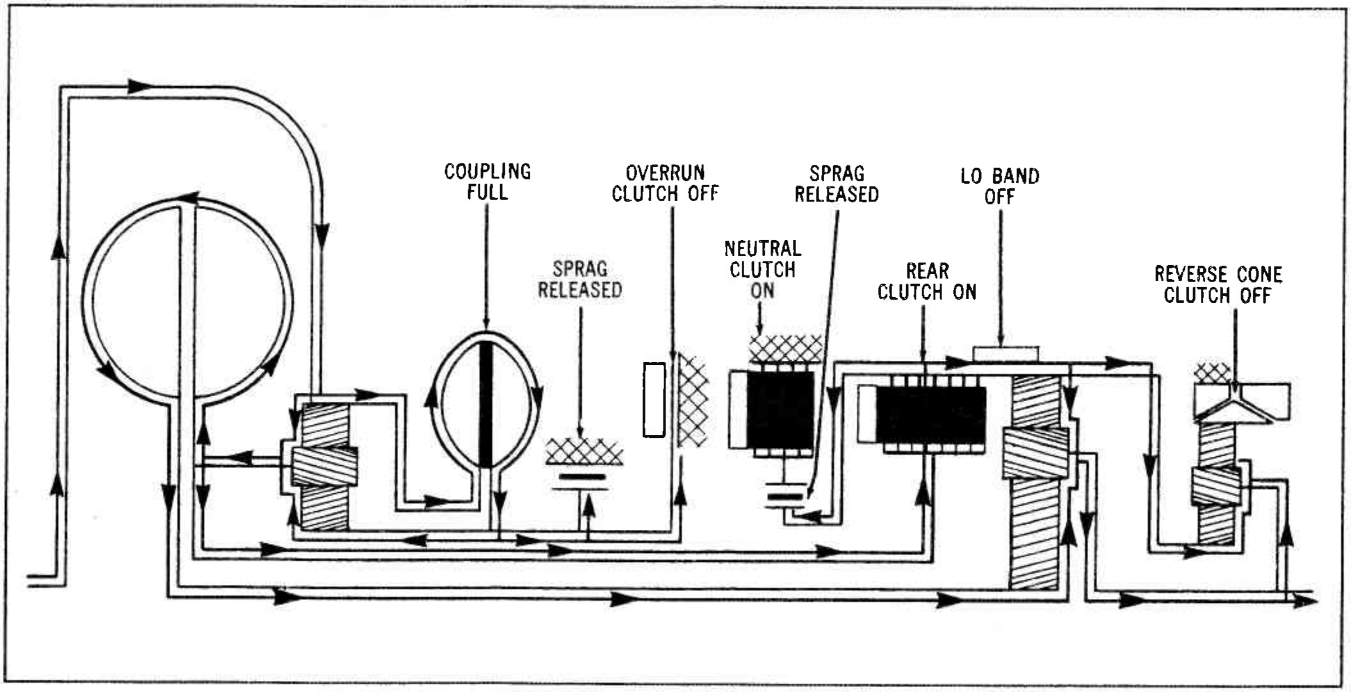

Fig. 17 Power Flow—Fourth Speed—Drive Left

POWER FLOW — FOURTH SPEED — DRIVE LEFT

Front Sprag	– Released
Coupling (Front Unit)	– Full
Rear Sprag	– Released
Neutral Clutch	– On
Rear Clutch	–On
Overrun Clutch	– Off
Lo Band	– Off
Reverse Cone Clutch	– Off

Power from the engine is transmitted through the flywheel and torus cover to the front unit internal gear. The internal gear drives the front unit coupling drive torus, and with the coupling full, this power is transmitted to the coupling driven torus (Fig. 17). The coupling driven torus then drives the front sun gear at the same speed and direction as the front internal gear. Since the front internal gear and front sun gear are turning at the same speed, the front unit is in direct drive. The front planet carrier is therefore driven in the direction of engine rotation and at engine speed.

The planet carrier drives the main drive torus, intermediate shaft, and rear clutch hub. Since the rear clutch is applied, the rear internal gear is caused to rotate.

Power from the main drive torus is transmitted to the driven torus, the transmission main shaft and the rear sun gear. Since the rear internal gear and rear sun gear are turning at the same speed, the rear unit is in direct drive. The rear planet carrier and output shaft turn in the direction of engine rotation and at engine speed. The reverse planet carrier also turns, rotating the unheld reverse internal gear.

The front unit and rear unit are in direct drive and the output shaft is turning at engine RPM. This is fourth speed. Total reduction 1.00 (Front) x 1.00 (Rear) = 1.00 (Direct Drive).

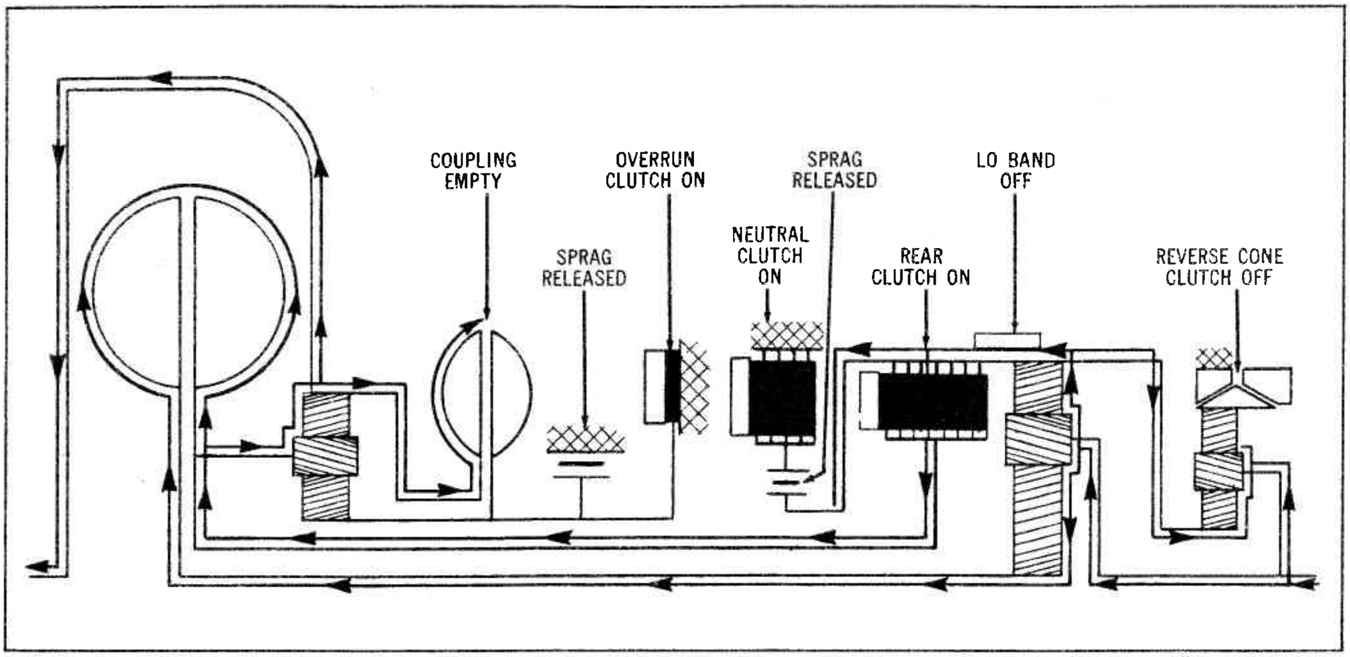

Fig. 18 Power Flow—Third Speed—Drive Right—Coasting

POWER FLOW — THIRD SPEED — DRIVE RIGHT — COASTING

The sprag clutches are designed to provide gear reduction when engine torque is applied to the transmission. If the torque is reversed which happens when the engine is used as a brake during coasting, the sprag will allow free rotation resulting in a neutral condition and no braking.

In fourth speed both units are in direct drive and engine braking will be obtained. When the transmission downshifts to third speed, the front unit goes into reduction and the front sprag will rotate freely. When the selector lever is in the Drive Right position, however, the overrun clutch is applied locking the front sprag inner race from turning in either direction. The hydraulic circuit to the overrun clutch is designed so that the overrun clutch will release if the front unit goes into direct drive and will apply when the front unit is in reduction. The power flow from the rear wheels to the engine during coasting in third speed is as follows:

Front Sprag	—Released
Coupling (Front Unit)	— Empty
Rear Sprag	— Released
Neutral Clutch	— On
Rear Clutch	— On
Overrun Clutch	— On
Lo Band	— Off
Reverse Cone Clutch	— Off

The output shaft and rear unit planet carrier are driven clockwise by the rear wheels (Fig. 18). (The unheld reverse internal gear is driven at output shaft speed by the planet carrier and reverse sun gear.) Since the rear clutch is applied locking the internal gear and sun gear together through the main fluid coupling, the planet carrier drives the internal gear and sun gear at the same speed. The rear clutch hub, intermediate shaft, main drive torus, and front planet carrier are then rotating at output shaft speed in a clockwise direction. Since the engine is acting as a brake, the front unit internal gear will act like a stationary member and the front unit planet pinions will drive the sun gear in a clockwise direction. In drive left range the front sprag will allow the sun gear to rotate freely clockwise (breaking the power flow between the rear wheels and the engine); however, in drive right range, with the overrun clutch applied, the sun gear is locked. The planet carrier and pinions, therefore, will rotate around the sun gear, thus turning the internal gear at a reduced speed. The internal gear turns the torus cover, flywheel and engine crankshaft. This provides engine braking for descending grades.

The front unit gear set is in reduction, the rear unit in direct drive and, therefore, the transmission is in third speed and is driving the engine.

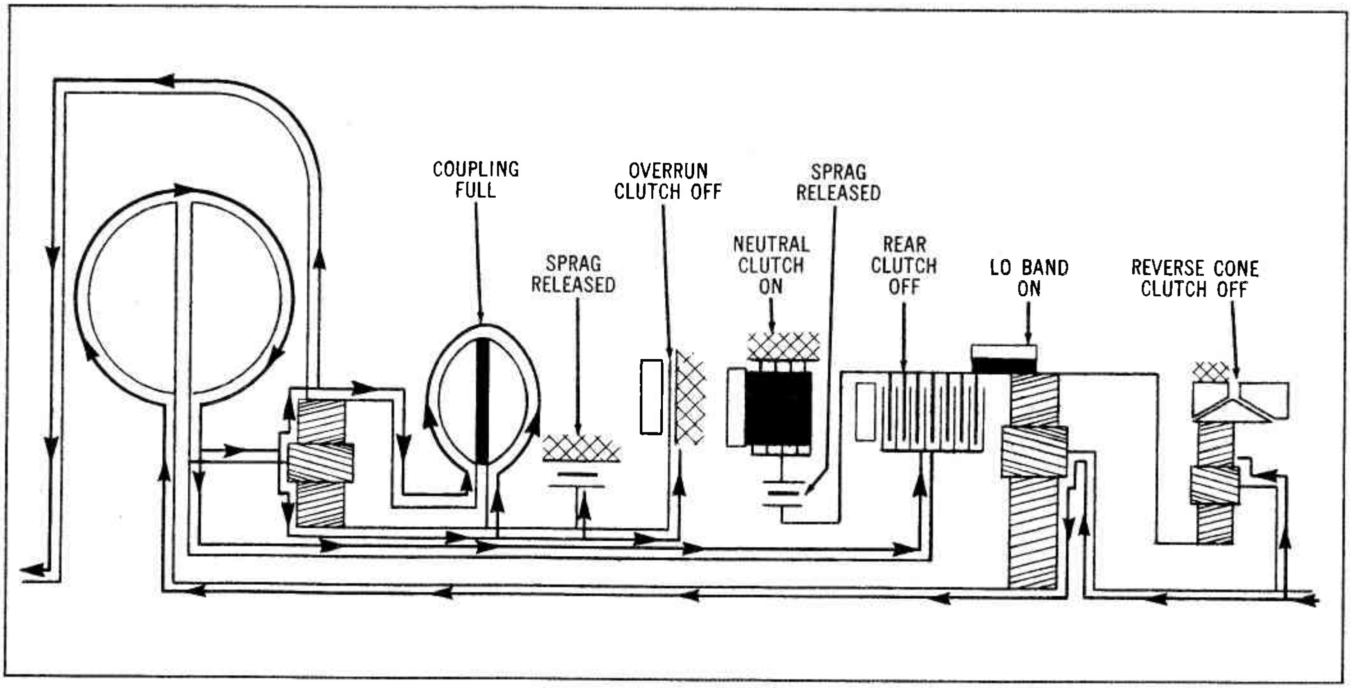

Fig. 19 Power Flow—Second Speed—Lo Range—Coasting

POWER FLOW – SECOND SPEED – LO RANGE –COASTING

In order to provide engine braking in Lo range, a Lo band is used to hold the rear internal gear stationary. The band is hydraulically applied when the selector lever is placed in Lo range. The hydraulic circuit is so designed that if the transmission should upshift to third, the band will automatically release. Power flow from the rear wheels to the engine when coasting in second speed is as follows:

Front Sprag	– Released
Coupling (Front Unit)	– Full
Rear Sprag	– Released
Neutral Clutch	– On
Rear Clutch	– Off
Overrun Clutch	– Off
Lo Band	– On
Reverse Cone Clutch	– Off

The output shaft and rear unit planet carrier are driven clockwise by the rear wheels. The free turning reverse internal gear is rotated by the reverse planet carrier and pinions rotating around the stationary reverse sun gear (Fig. 19). The rear unit sun gear tries to slow down due to engine braking and thereby acts as a stationary member. The planet pinions then rotate the internal gear in a clockwise direction. Since the clutch is released the internal gear would be free to rotate clockwise (the sprag freewheels clockwise), but the Lo band is applied holding the internal gear stationary. The planet pinions are then forced to rotate around the internal gear, driving the sun gear clockwise in reduction. The mainshaft and driven torus member are then driven in a clockwise direction. The main driven torus now becomes a driving member and drives the drive torus and front unit planet carrier clockwise. Since the front unit coupling is full, the sun gear and internal gear are locked together. The planet carrier thus drives the sun gear and internal gear in direct drive. The internal gear drives the torus cover and the flywheel and crankshaft. The transmission is in second speed and is driving the engine.

In first speed when in Lo range both the Lo band and the Overrun Clutch are applied and engine braking is achieved.

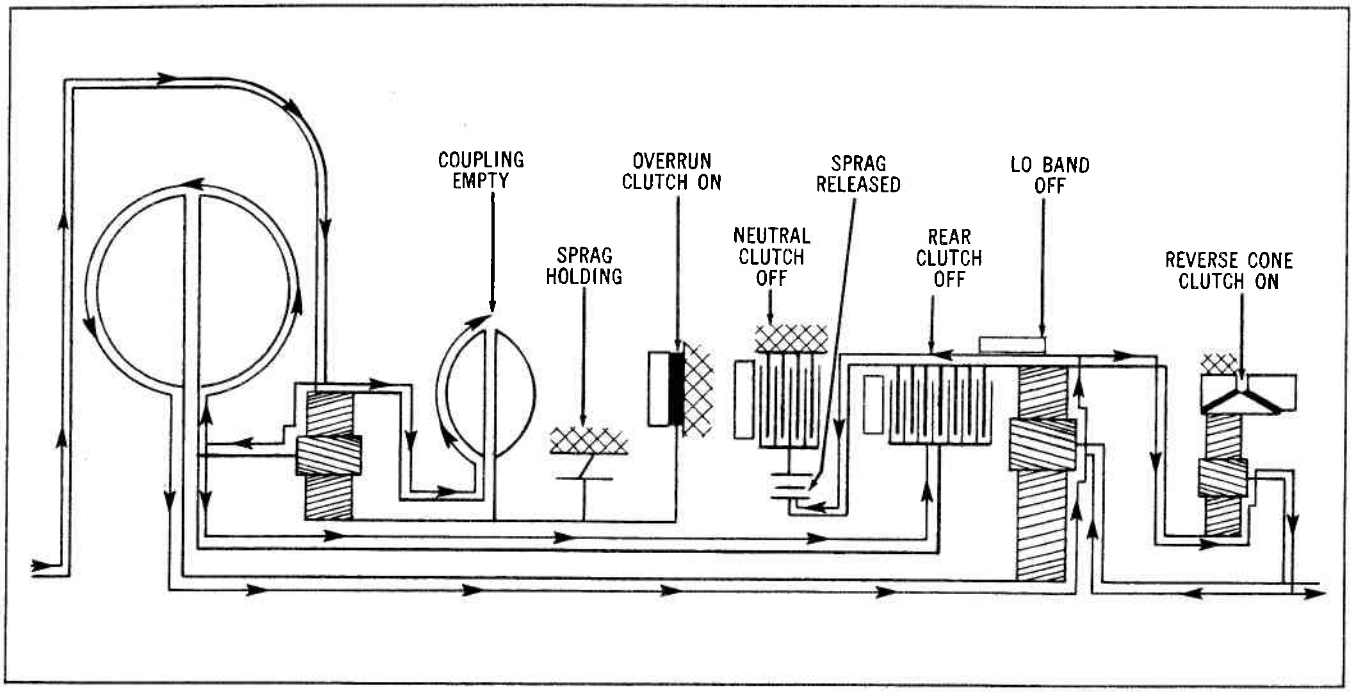

Fig. 20 Power Flow—Reverse

POWER FLOW — REVERSE

Front Sprag	– Holding
Coupling (Front Unit)	– Empty
Rear Sprag	– Released
Neutral Clutch	– Off
Rear Clutch	– Off
Overrun Clutch	– On
Lo Band	– Off
Reverse Cone Clutch	– On

Power from the engine is transmitted through the flywheel and torus cover to the front unit internal gear (Fig. 20). The internal gear drives the front unit coupling drive torus. Since the coupling is empty it cannot transmit power. Rotation of the front internal gear causes the pinions to drive the front sun gear opposite engine rotation. The sprag assembly locks and prevents rotation of the front sun gear. The front planet carrier is forced to turn at a reduced speed in the direction of engine rotation. The front planet carrier drives the main drive torus, intermediate shaft, and the rear clutch hub. Since the rear clutch is off, no power can be transmitted through it. The main drive torus transmits power to the driven torus and, therefore, the transmission main shaft and rear unit sun gear are turning at a gear reduction in the direction of engine rotation. As the rear sun gear turns, it causes the pinions to drive the rear internal gear opposite engine rotation since the neutral clutch is released. It should be noted that with the vehicle at rest, the rear planet carrier is held from rotation by vehicle weight. Thus, the pinions are acting as reverse idlers. The rotation of the rear internal gear causes the reverse sun gear to rotate opposite engine rotation. Since the reverse internal gear is held stationary by the reverse cone clutch, the reverse sun gear drives the reverse planet carrier at a reduced speed opposite engine rotation. The reverse planet carrier is splined to the output shaft, and therefore, the output shaft is turning in reverse. Total reduction 1.55 (front) x 2.78 (reverse) = 4.31 to 1.

REVIEW ACTION OF UNITS

In order to diagnose transmission difficulties it is very important to know what happens in each unit during each shift. The following list of speeds and conditions should provide an easy means of remembering this information.

SPEED OR CONDITION

Neutral

Front Unit—Reduction—Coupling empty, sprag holding.

Rear Unit—Neutral—Neutral clutch released, rear clutch released, lo band released.

Reverse Unit—Neutral—Reverse cone clutch released.

Drive Left

First Speed

Front Unit—Reduction—Coupling empty, sprag holding.

Rear Unit—Reduction—Neutral clutch applied, rear clutch released, sprag holding, lo band released.

Reverse Unit—Neutral—Reverse cone clutch released.

Second Speed

Front Unit—Direct drive—Coupling filled, sprag released.

Rear Unit—Reduction—Neutral clutch applied, rear clutch released, sprag holding, lo band released.

Reverse Unit—Neutral—Reverse cone clutch released.

Third Speed

Front Unit—Reduction—Coupling empty, sprag holding.

Rear Unit—Direct drive—Neutral clutch applied, rear clutch applied, sprag released, lo band released.

Reverse Unit—Neutral—Reverse cone clutch releasea.

Fourth Speed

Front Unit—Direct Drive—Coupling full, sprag released.

Rear Unit—Direct Drive—Neutral clutch applied, rear clutch applied, sprag released, lo band released.

Reverse Unit—Neutral—Reverse cone clutch released.

Drive Right

First Speed

Front Unit—Reduction—Coupling empty, sprag holding, overrun clutch applied.

Rear Unit—Reduction—Neutral clutch applied, rear clutch released, sprag holding, lo band released.

Reverse Unit—Neutral—Reverse cone clutch released.

Second Speed

Front Unit—Direct drive—Coupling filled, sprag released, overrun clutch released.

Rear Unit—Reduction—Neutral clutch applied, rear clutch released, sprag holding, lo band released.

Reverse Unit—Neutral—Reverse cone clutch released.

Third Speed

Front Unit—Reduction—Coupling empty, sprag holding, overrun clutch applied.

Rear Unit—Direct drive—Neutral clutch applied, rear clutch applied, sprag released, lo band released.

Reverse Unit—Neutral—Reverse cone clutch released.

Lo Range

First Speed

Front Unit—Reduction—Coupling empty, sprag holding, overrun clutch applied.

Rear Unit—Reduction—Neutral clutch applied, rear clutch released, sprag holding, lo band applied.

Reverse Unit—Neutral—Reverse cone clutch released.

Second Speed

Front Unit—Direct drive—Coupling filled, sprag released, overrun clutch released.

Rear Unit—Reduction—Neutral clutch applied, rear clutch released, sprag holding, lo band applied.

Reverse Unit—Reduction—Reverse cone clutch released.

Reverse

Front Unit—Reduction—Coupling empty, sprag holding, overrun clutch applied.

Rear Unit—Acting as reverse idler—Neutral clutch released, rear clutch released, sprag released.

Reverse Unit—Reduction—Reverse cone clutch applied.

REMEMBER

The front unit is in reduction when the coupling is empty, direct drive when the coupling is full.

The rear unit is in reduction when the clutch is released, direct drive when clutch is applied.

HYDRAULIC ACTION IN THE STRATO-FLIGHT HYDRA-MATIC TRANSMISSION

The proper shifting of the transmission is controlled by hydraulic oil pressure. The direction of this oil pressure to the proper places in the transmission is accomplished by the control valve assembly.

The diagrams and text on the following pages explain how the transmission is hydraulically controlled for each shift and operating condition.

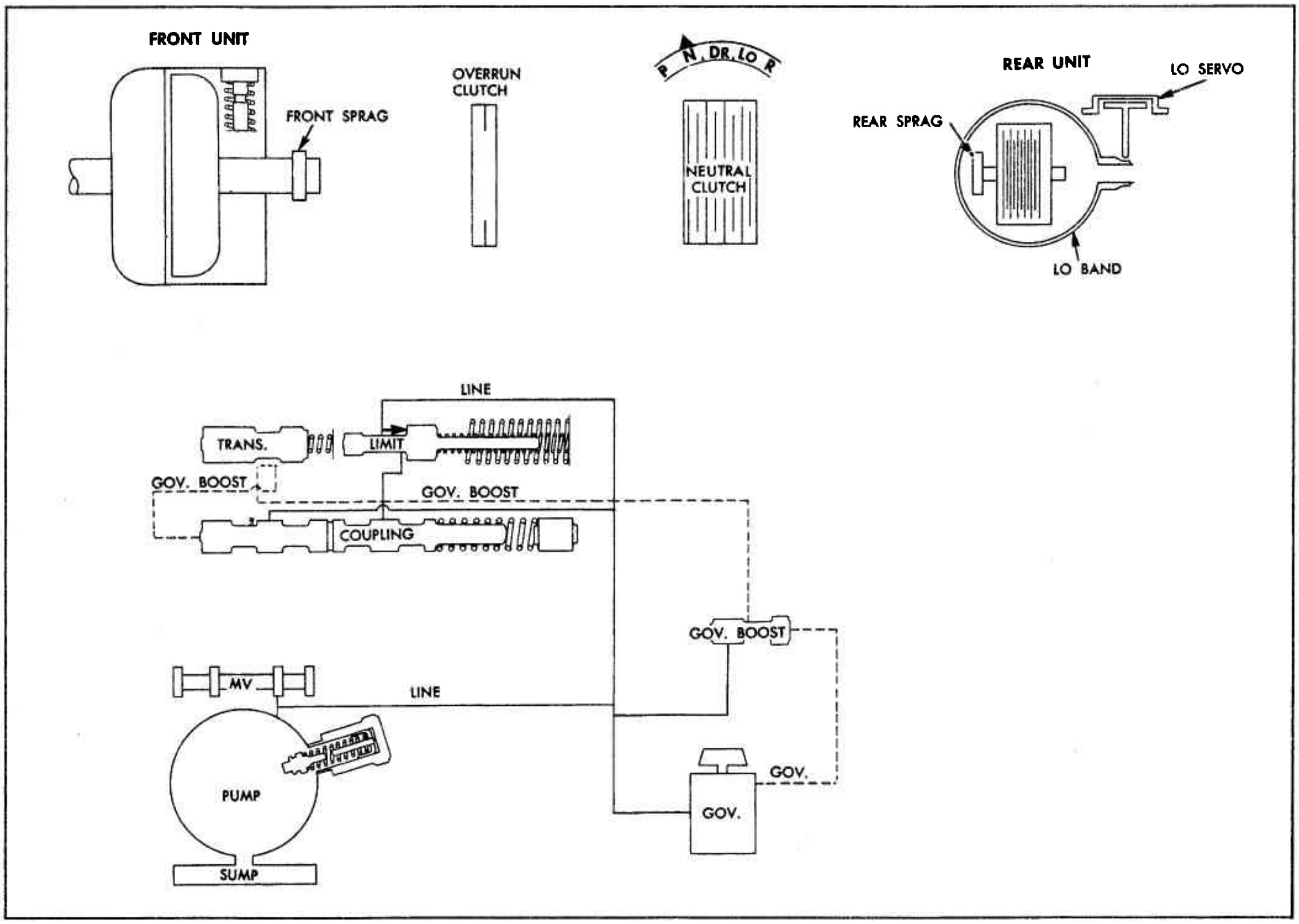

Fig. 21 Hydraulic Action in Neutral—Engine Running

NEUTRAL OR PARK

CAR STANDING—ENGINE RUNNING

When the engine is started, the front pump builds up oil pressure which is directed to: (Fig. 21) The manual valve; governor; governor boost valve; limit valve and one land of the coupling valve. When oil pressure builds up to about 55 psi, the limit valve is moved to the open position allowing main line pressure to be directed to a second land of the coupling valve. (Normally, main line pressure is always against two lands of the coupling valve.)

The governor is used to supply a graduated pressure which increases in proportion to car speed. At a stand still some governor pressure will exist because one governor plunger is partially opened by spring pressure. This pressure is directed to the governor boost valve.

The governor boost valve supplies a variable pressure to the coupling valve. This pressure varies in proportion to governor pressure but is always greater than governor pressure. Governor boost pressure to the coupling valve passes through a land of the transition valve so it can be cut off when not needed.

The neutral clutch is spring released and oil applied. Since no oil pressure is present, it is released. With the neutral clutch released, the rear unit can not transmit motion and the transmission is in neutral.

The hydraulic circuit is exactly the same with the selector in park position. In park position the transmission output shaft is mechanically locked to the transmission case by a pawl which engages the teeth on the reverse planet carrier. The car is, therefore, locked from moving when the selector lever is in the park position.

SUMMARY: Front unit coupling empty, front sprag holding—front unit in reduction.

Neutral clutch released, rear clutch released, rear sprag released—rear unit in neutral.

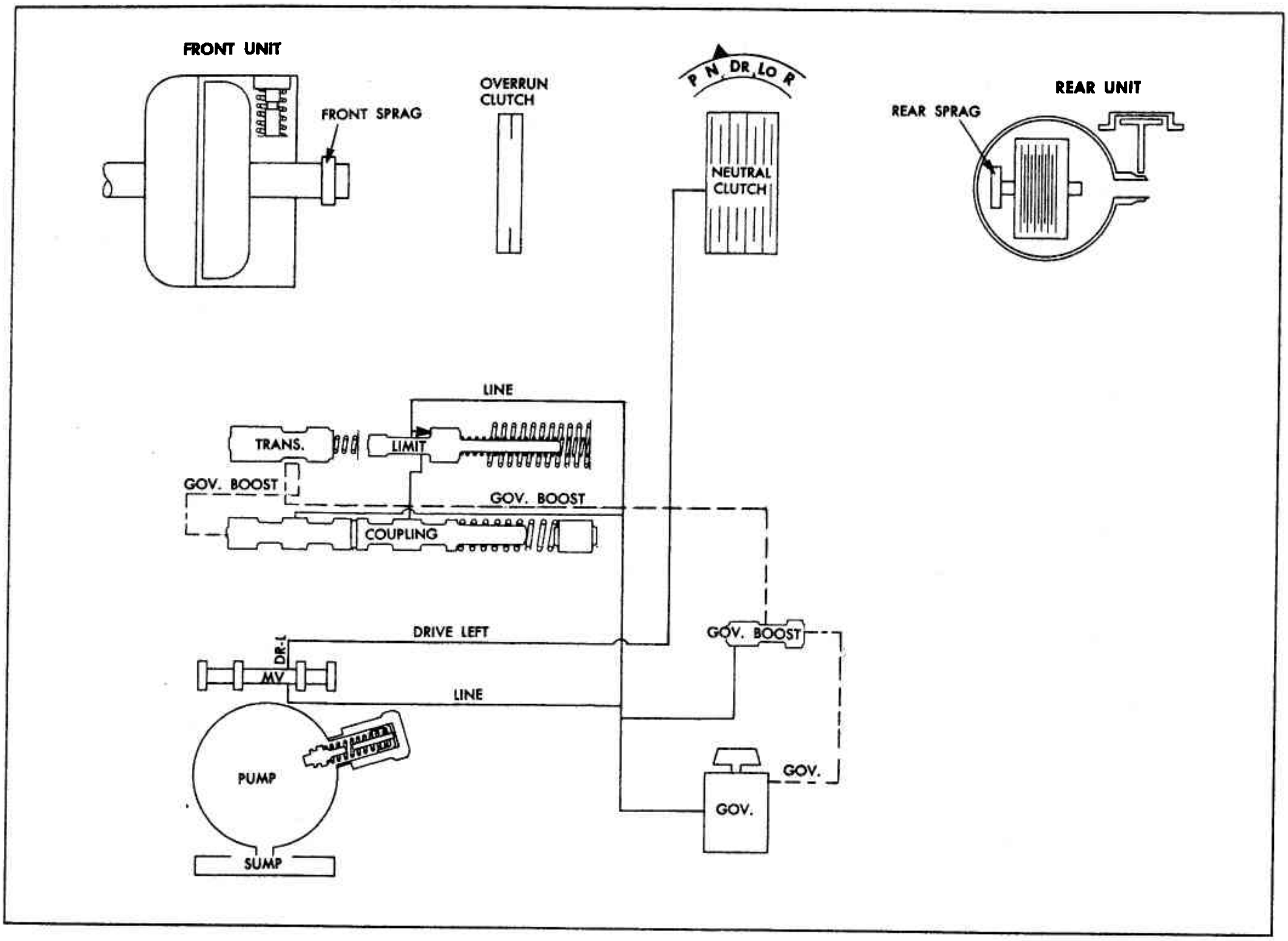

Fig. 22 Hydraulic Action in First Speed—Drive Left

FIRST SPEED—DRIVE LEFT

When the selector lever is placed in drive left position, main line pressure is directed from the manual valve to the neutral clutch (Fig. 22). (Main line pressure is also directed to the 2-3 and 3-4 shift valves which are not shown here.) The neutral clutch is thus applied, locking the outer race of the rear sprag to the transmission case.

The front unit is already in reduction, since the coupling is empty, and with the neutral clutch applied the rear unit is also in reduction through the rear sprag. The transmission is therefore in first speed and the car will begin to move if the accelerator is depressed.

SUMMARY: Front unit coupling empty, front sprag holding—front unit in reduction.

Neutral clutch applied, rear clutch released, rear sprag holding—rear unit in reduction.

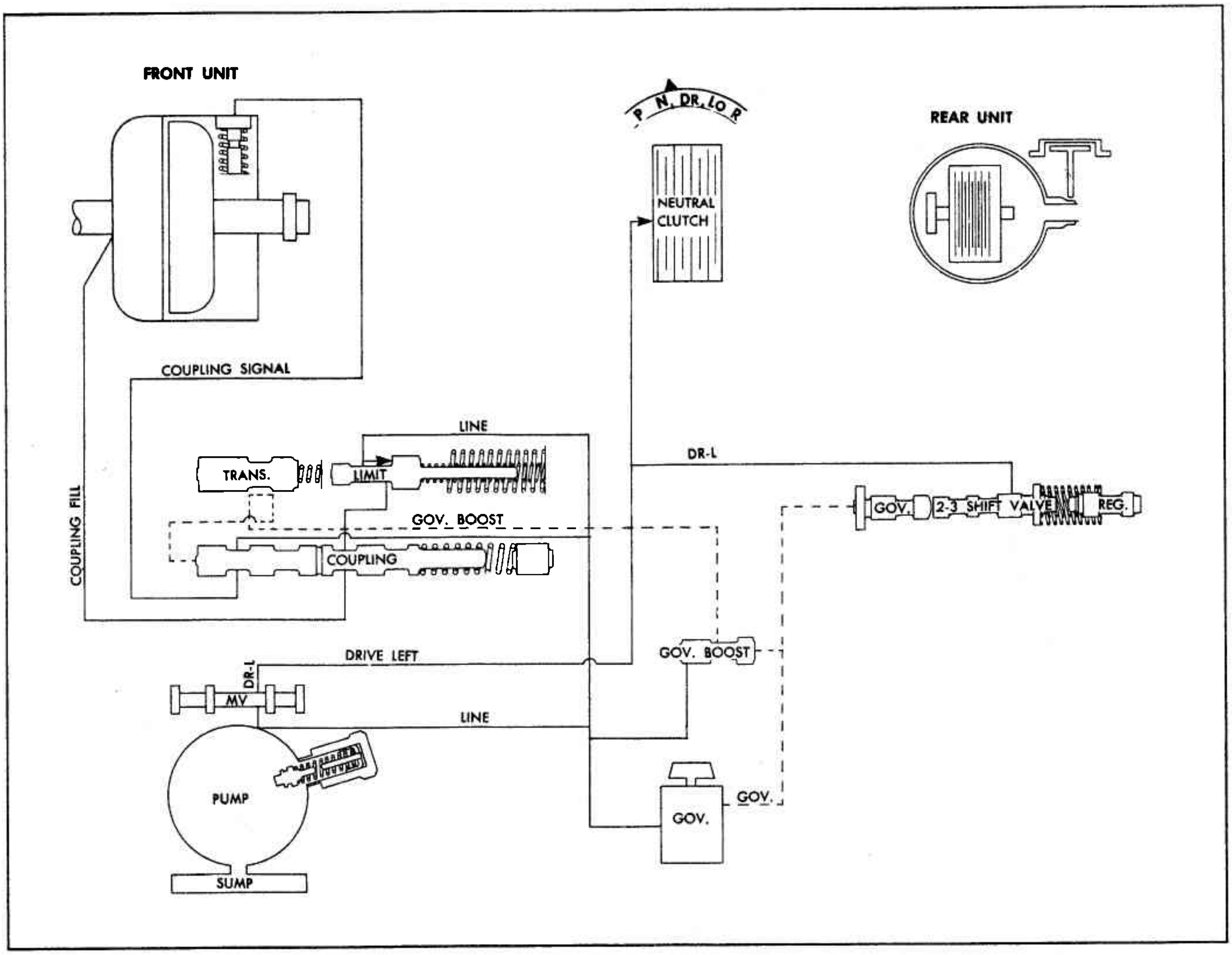

Fig. 23 Hydraulic Action in Second Speed—Drive Left

SECOND SPEED—DRIVE LEFT

As the car accelerates in first speed, governor pressure increases and governor boost pressure increases correspondingly. When governor boost pressure becomes sufficient, the coupling valve is moved against spring pressure to the open position (Fig. 23). Coupling signal oil passes through the land at the left end of the coupling valve and closes the exhaust valves in the front unit coupling. Coupling fill oil, supplied to the coupling valve through the limit valve, passes through another land of the coupling valve to fill the front unit coupling. As the coupling fills, the driven torus begins to rotate driving the front unit sun gear. When completely full, the sun gear and internal gear of the front unit are rotating at the same speed and the front unit is in direct drive.

The limit valve serves as a safety feature when the front coupling is filling. As mentioned earlier, approximately 55 psi is required to open the limit valve initially. If, due to a leak in the coupling fill circuit, the pressure drops below 55 psi, the limit valve will close preventing further drop in oil pressure.

The rear unit is unaffected and remains in reduction.

SUMMARY: Front unit coupling full, front sprag released — front unit in direct drive.

Neutral clutch applied, rear clutch released, rear sprag holding—rear unit in reduction.

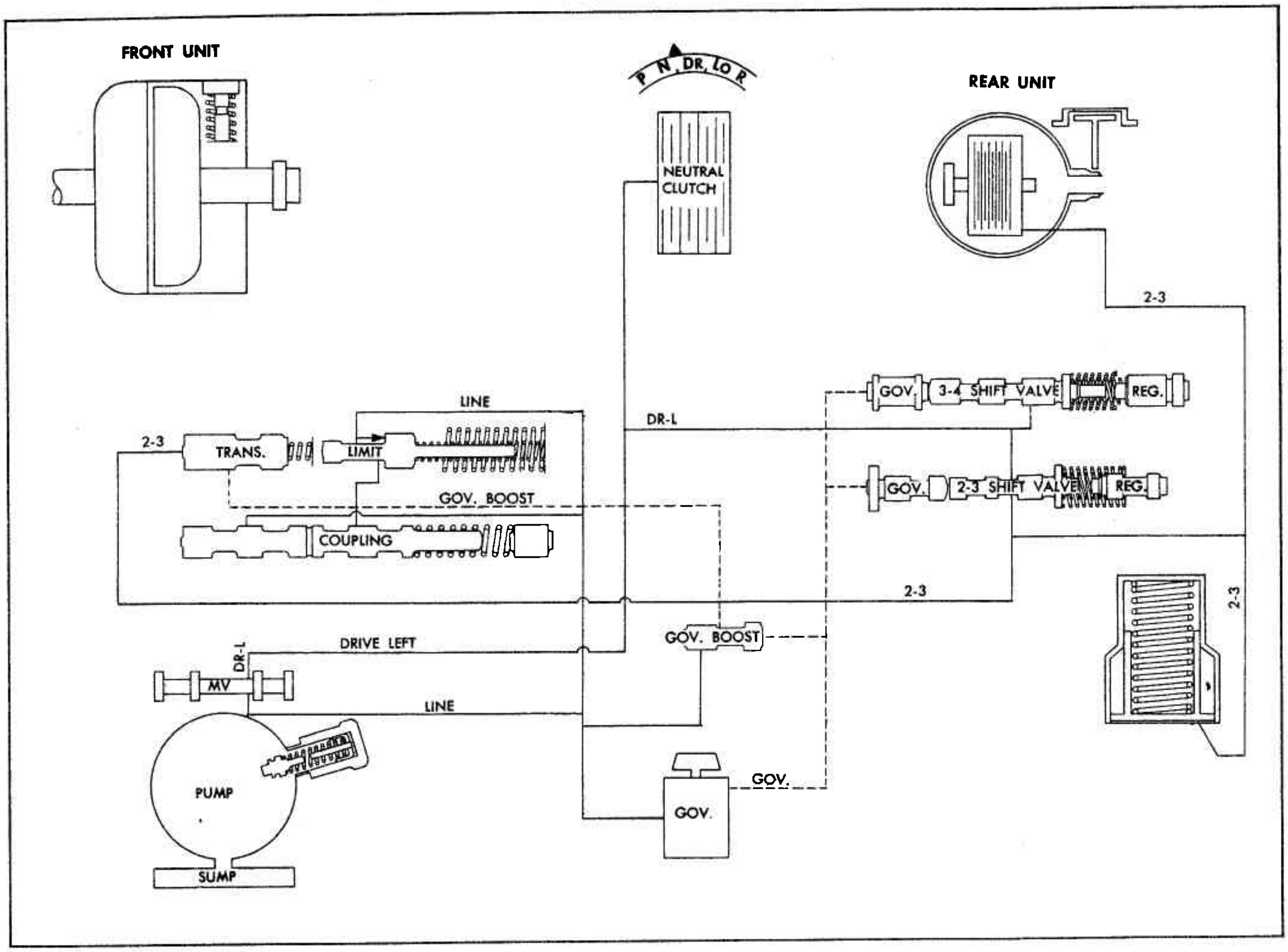

Fig. 24 Hydraulic Action in Third Speed—Drive Left

THIRD SPEED—DRIVE LEFT

As car speed increases in second speed, governor pressure increases. When governor pressure becomes sufficient, it moves the 2-3 shift valve to the open position against spring pressure (Fig. 24). Opening the 2-3 shift valve allows main line pressure to pass to the transition valve, rear clutch and accumulator. The action is as follows:

Main line pressure directed to apply the rear clutch must also compress the springs behind the accumulator piston. This action softens the rear clutch apply to provide a smooth 2-3 shift.

Simultaneously with the application of the rear clutch, 2-3 shift oil moves the transition valve to the right. This cuts off governor boost pressure which originally moved the coupling valve to the open position. The coupling valve spring then moves the coupling valve back to the closed position, cutting off coupling signal oil and coupling fill oil. The coupling then empties through the exhaust valves and the front unit goes into reduction.

With the rear clutch applied the rear unit is in direct drive, and with the front unit coupling empty, the front unit is in reduction. The transmission is, therefore, in third speed.

SUMMARY: Front unit coupling empty, front sprag holding—front unit in reduction.

Neutral clutch applied, rear clutch applied, rear sprag released—rear unit in direct drive.

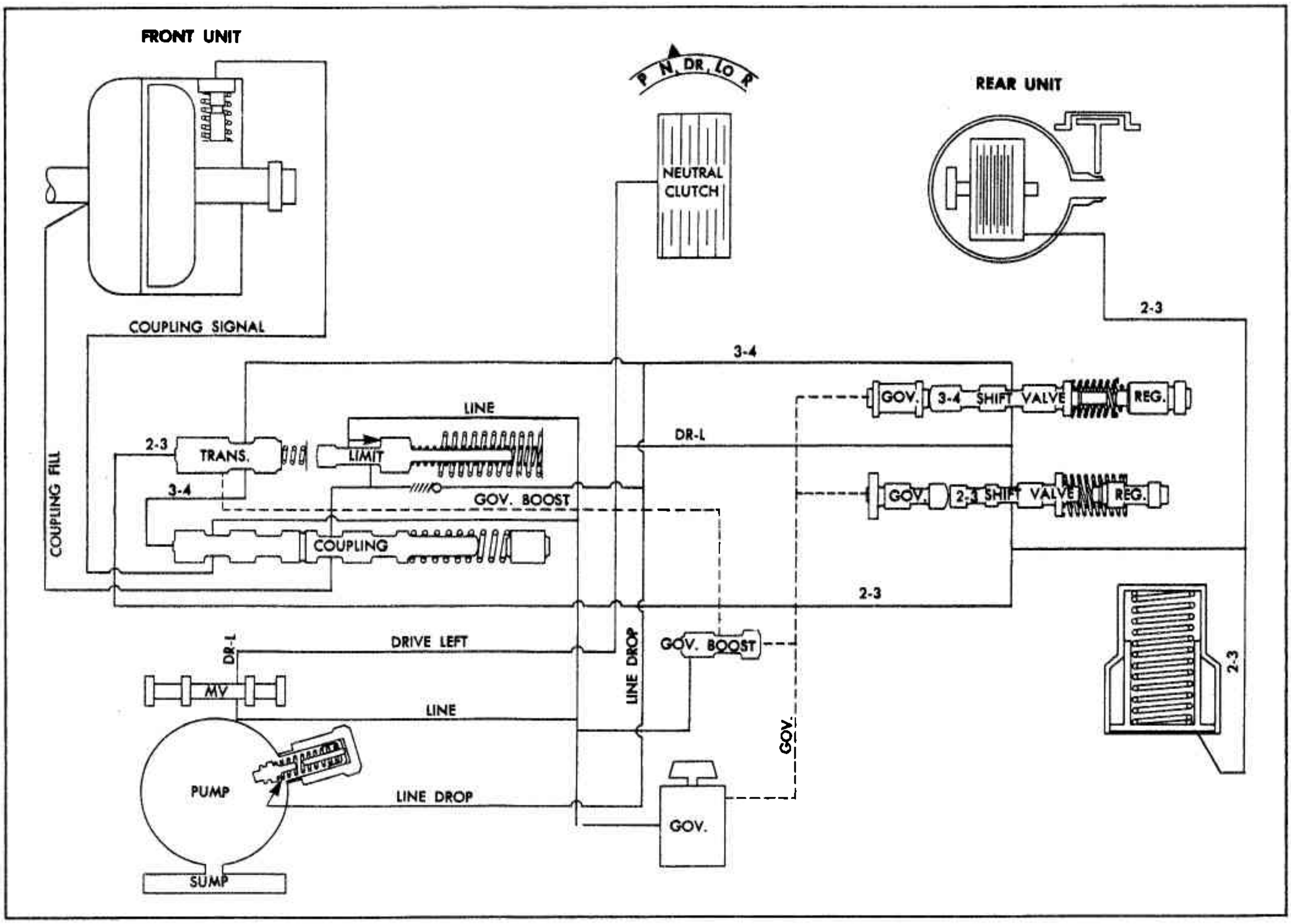

Fig. 25 Hydraulic Action in Fourth Speed—Drive Left

FOURTH SPEED—DRIVE LEFT

When car speed increases in third speed, governor pressure will become sufficient to move the 3-4 shift valve to the open position (Fig. 25). Main line pressure will then pass from the 3-4 shift valve to the transition valve.

With the transition valve still in its right hand position, main line pressure from the 3-4 shift valve can pass through the transition valve into the same passage which carried governor boost oil in 1st and 2nd gear. Thus main line pressure is directed to the left end of the coupling valve to move it to the open position.

Signal oil then passes from the coupling valve to close the front coupling exhaust valves. At the same time fill oil from the coupling valve enters and fills the coupling placing the front unit in direct drive. The rear unit remains in direct drive and the transmission is in fourth speed.

Main line pressure from the 3-4 shift valve also is directed to the pressure regulator. The purpose of this oil is to resist the pressure regulator spring and reduce main line oil pressure after the transmission has shifted into fourth speed. This "line drop oil" is also applied against a check ball located between the coupling fill passage and the line drop passage. The purpose of this connection is so that during the filling of the coupling, if coupling fill pressure drops below line pressure, line drop oil will pass into the coupling fill passage. This aids in filling the coupling and also delays the drop in line pressure until the coupling has been filled.

Not shown on the diagram is the fact that line drop pressure also is routed through the manual valve so that it is cut off in drive right and lo ranges.

SUMMARY: Front unit coupling full, sprag released—front unit in direct drive.

Neutral clutch applied, rear clutch applied, rear sprag released—rear unit in direct drive.

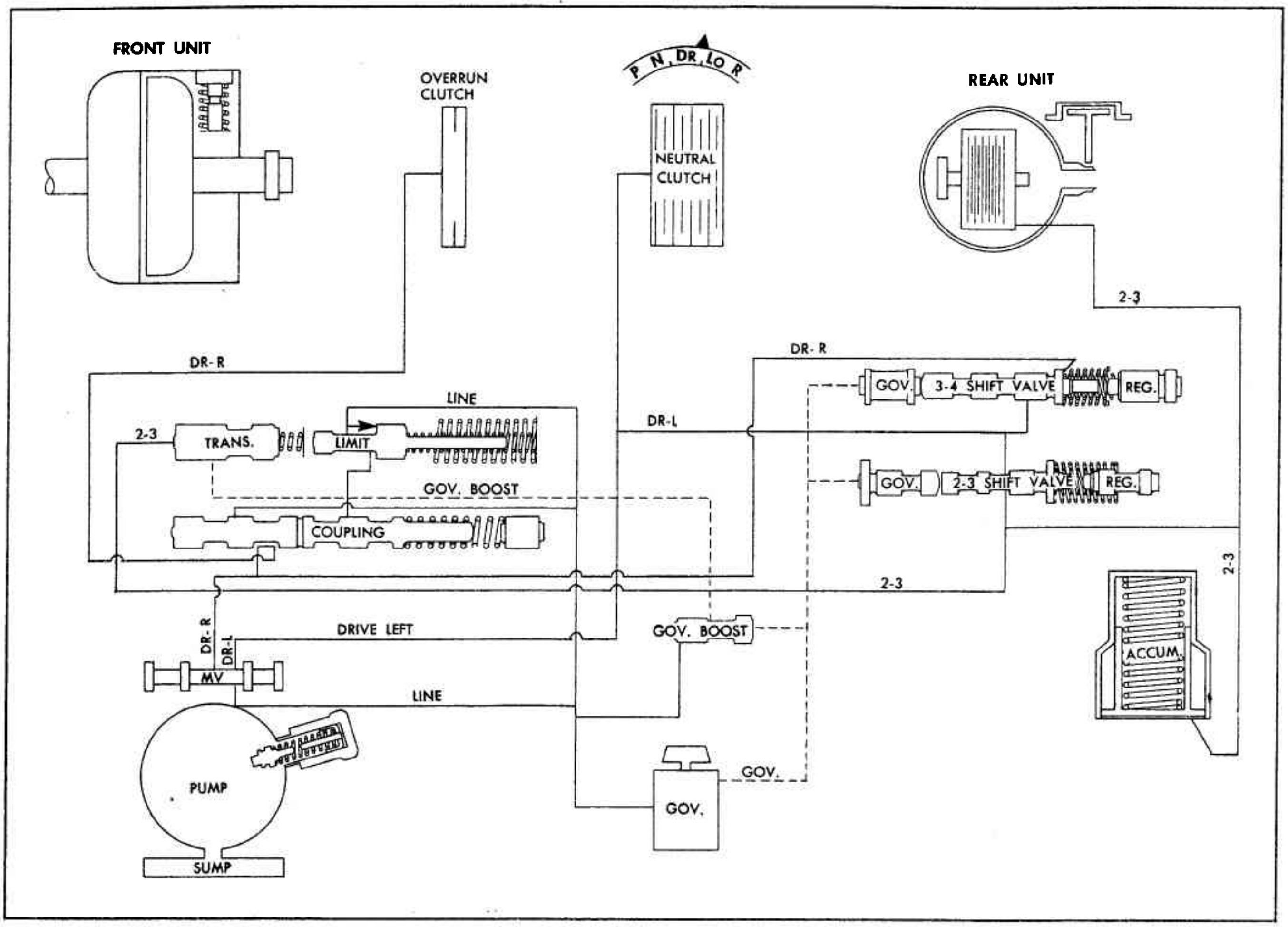

Fig. 26 Hydraulic Action in Third Speed—Drive Right

THIRD SPEED—DRIVE RIGHT

When the selector lever is moved to the drive right position, "drive left oil" is still directed to the same places as with the lever in drive left (Fig. 26).

In the drive right position, however, an additional passage is opened to direct main line pressure (drive right oil) from the manual valve to the back side of the 3-4 shift valve. This pressure normally prevents an upshift to fourth speed; however, at approximately 70 MPH governor pressure becomes great enough to overcome main line pressure and the 3-4 shift valve will open making a 3-4 upshift possible.

Drive right oil is also directed to apply the overrun clutch. Application of the overrun clutch is necessary to provide engine braking in third speed for descending long grades etc. Drive right oil to the overrun clutch is routed through the coupling valve so that when the front unit shifts into direct drive for second speed or fourth speed, the overrun clutch is released.

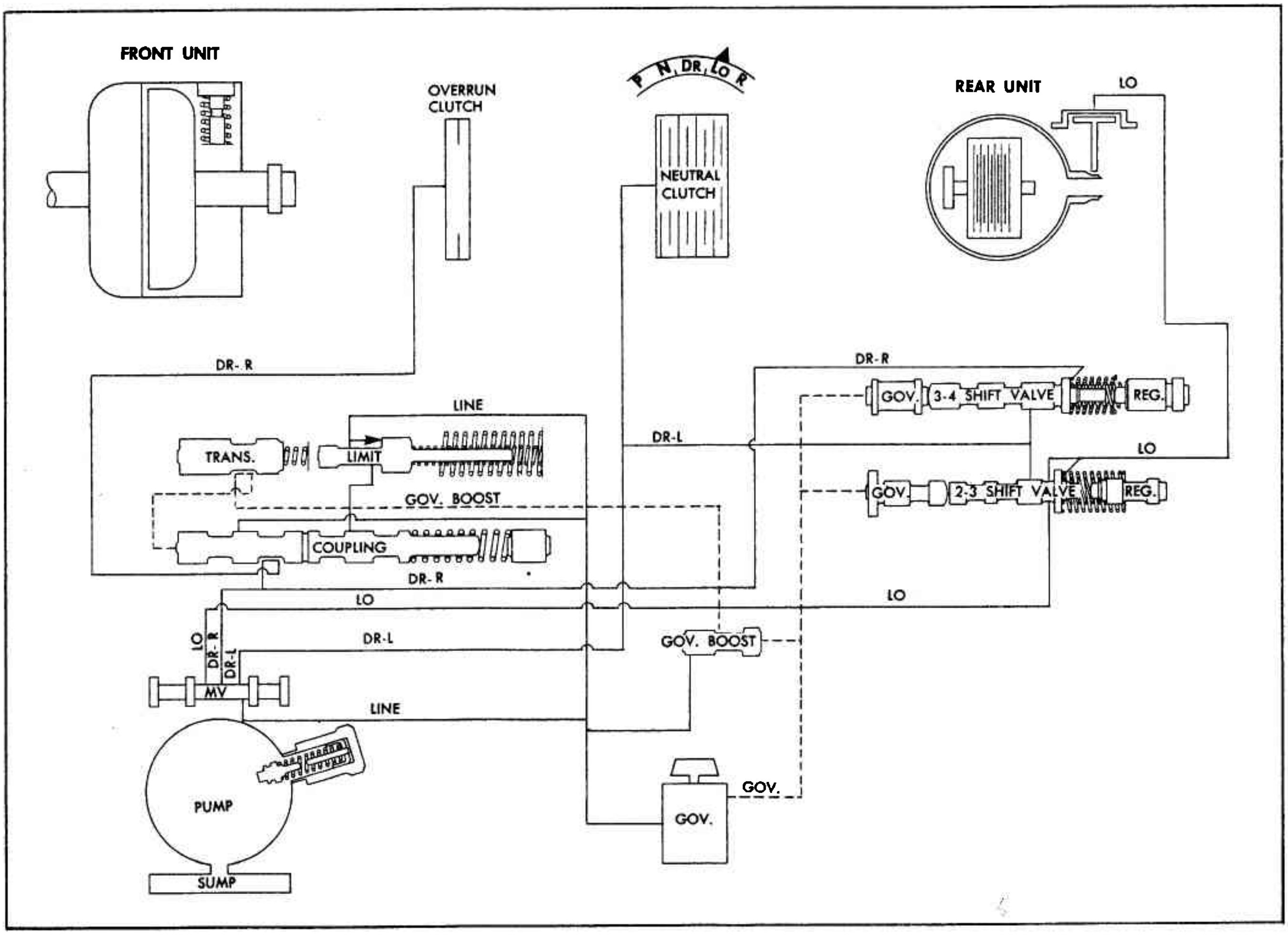

Fig. 27 Hydraulic Action in First Speed—Lo Range

FIRST SPEED—LO RANGE

When the selector lever is moved to the lo range position, main line pressure is directed into the lo range circuit in addition to the drive left and drive right circuit (Fig. 27). The transmission starts in first speed and shifts to second speed in exactly the same manner as in drive left or drive right.

Lo range oil is directed behind the 2-3 shift valve (to keep it closed) and through the 2-3 shift valve to apply the lo band.

The pressure behind the 2-3 shift valve prevents a 2-3 upshift unless car speed exceeds approximately 50 MPH. Application of the lo band provides engine braking when the car is descending grades in first or second.

"Lo oil" to the back side of the 2-3 shift valve and to the lo band is cut off when the shift valve opens. This releases the lo band when the car is driven fast enough to cause a 2-3 shift.

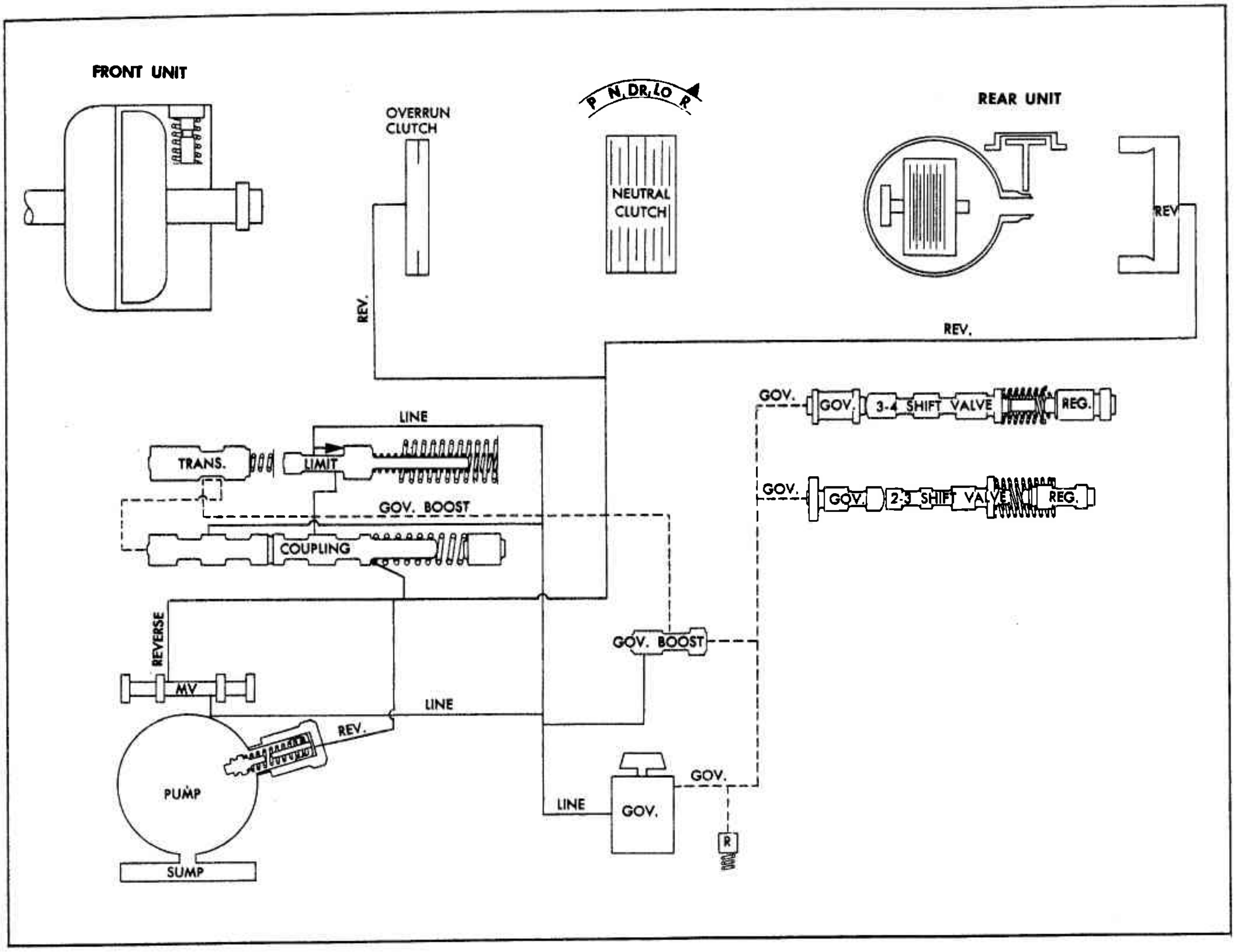

Fig. 28 Hydraulic Action in Reverse

REVERSE

When the selector lever is moved to the reverse position, drive left, drive right and lo range oils are all cut off and main line pressure is directed to the reverse passage (Fig. 28).

"Reverse oil" is directed to apply the reverse cone and the overrun clutch. In addition reverse oil is directed to the back of the coupling valve to prevent it from opening and to the reverse booster in the pressure regulator. Main line pressure in the pressure regulator increases main line pressure in reverse to assure positive application of the reverse cone clutch.

The reverse blocker is used to prevent accidental selection of reverse while the car is moving forward at speeds above 10 MPH. Governor pressure behind the blocker at higher speeds holds the blocker out to mechanically block the selector linkage from being moved into reverse. At speeds below 10 MPH the blocker piston spring overcomes governor pressure on the blocker piston and moves the piston out of the way.

SUMMARY: Front unit coupling empty, sprag released—front unit in reduction.

Neutral clutch released, rear clutch released, rear sprag released—rear unit acting as reverse idler.

Reverse cone clutch applied—reverse unit in reduction.

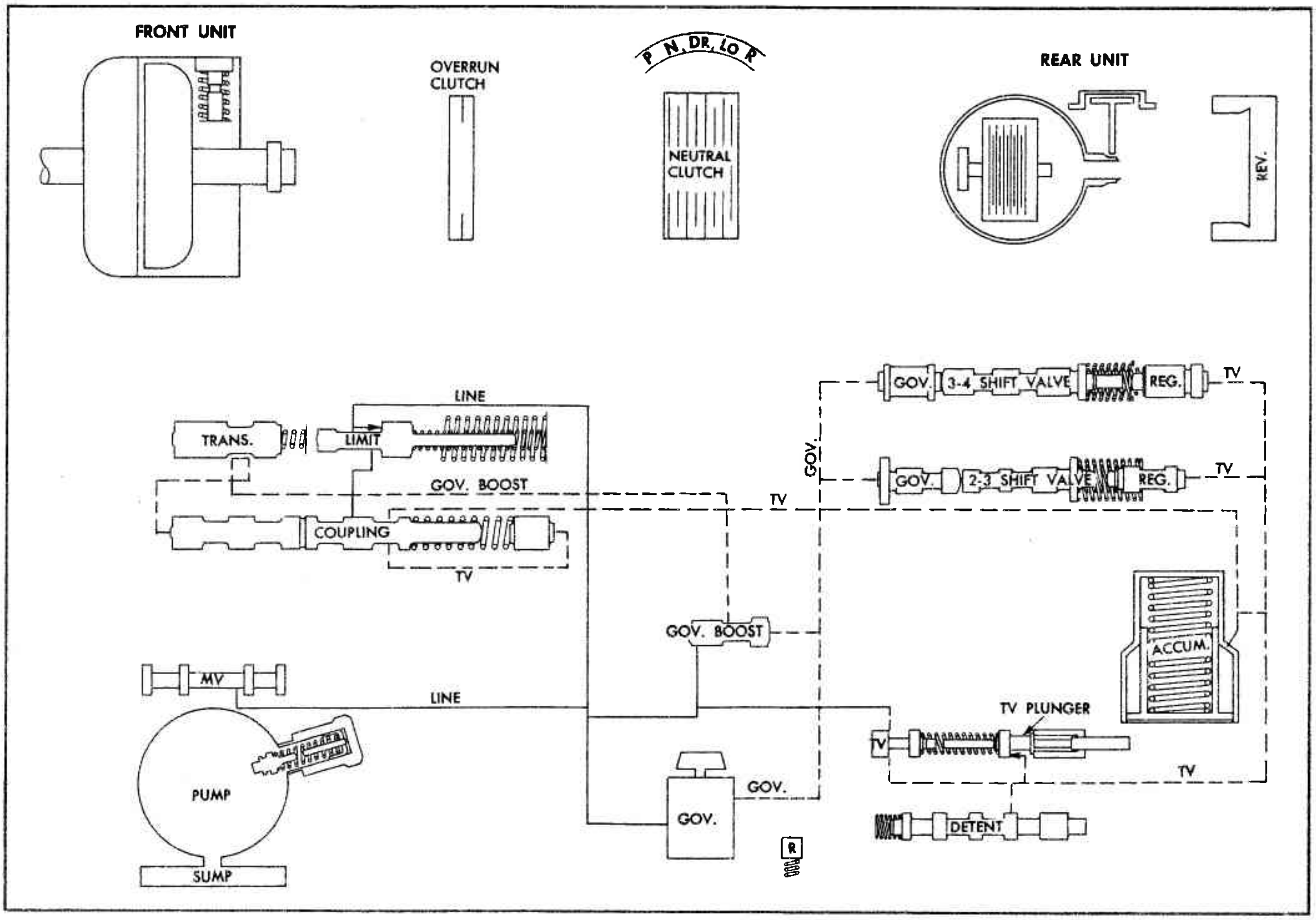

Fig. 29 TV Pressure

TV PRESSURE

With the control valve designed as outlined on the preceding pages, each shift would always occur at the same car speed because the movement of the valves is controlled only by governor pressure.

In order to provide greater acceleration or more pulling power, it is desirable to have the shifts delayed until higher car speeds are reached. This delay can be accomplished by opposing governor pressure with a pressure which varies according to throttle opening.

In the Strato-Flight Hydra-Matic such a pressure is provided by the throttle valve. This valve is connected by linkage to the accelerator pedal and provides a regulated pressure which increases as the accelerator pedal is depressed.

To decrease the force necessary to open the throttle valve and the resultant accelerator pedal pressure, TV pressure is directed against a land on the plunger to assist in opening the valve. However, this pressure alone cannot move the TV valve.

TV pressure is directed to the regulator plugs at the spring ends of the coupling valve, 2-3 shift valve and 3-4 shift valve (Fig. 29). By this means TV pressure assists the shift valve springs in holding the shift valves closed. Governor pressure (and car speed) must, therefore, be increased in order to move the valves to their open positions. The further the accelerator pedal is depressed, the higher TV pressure becomes and, therefore, the higher the speed required to attain the shifts.

TV pressure to the coupling valve regulator plug passes through a land of the valve. When the coupling valve opens, therefore, TV pressure to the coupling valve regulator plug is cut off.

TV pressure is also directed to the back of the accumulator piston to assist spring pressure in holding the piston extended. On light throttle acceleration when a soft apply of the rear clutch is necessary to give a smooth shift, only slight TV pressure plus the spring cushions the oil directed to the rear clutch. When more firm rear clutch apply is desired as on a heavy throttle 2-3 shift, high TV pressure plus the spring provide less cushioning action.

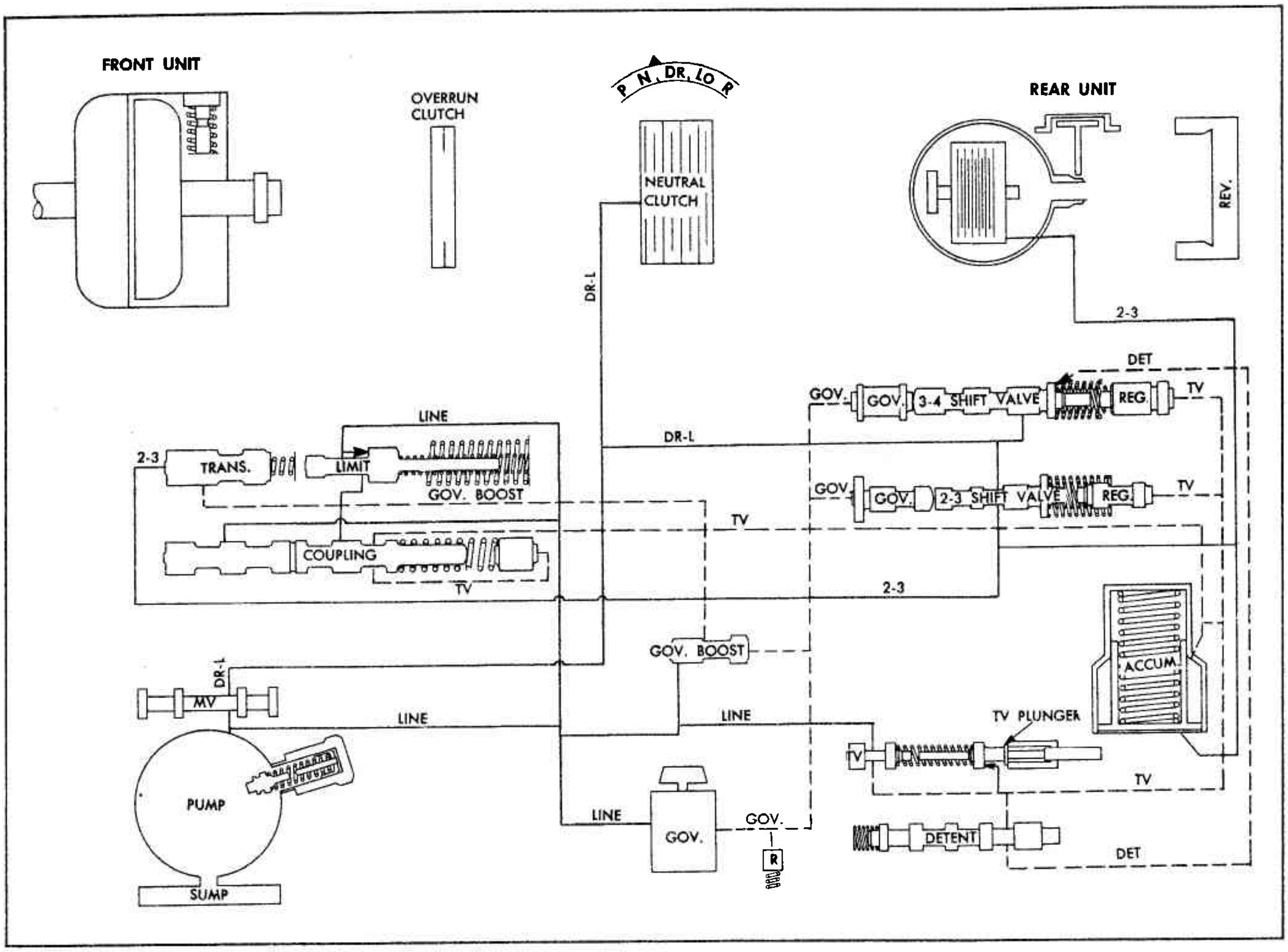

Fig. 30 Hydraulic Action During Forced 4-3 Downshift

FORCED 4-3 DOWNSHIFT

In order to get maximum acceleration while driving in fourth speed, it is sometimes desirable to shift down to third speed. To make this possible the detent valve has been incorporated. The detent valve is controlled by the accelerator pedal position so that when the accelerator is pushed to its maximum travel the detent valve will be opened. At the same time maximum TV pressure is secured which is equal to main line pressure.

With the detent valve opened, TV pressure is allowed to pass the detent valve into a passage where it is directed to the back of the 3-4 shift valve (Fig. 30). TV pressure which is equal to main line pressure with the throttle wide open, then closes the 3-4 shift valve forcing the transmission to downshift from fourth to third. At speeds above approximately 68 MPH governor pressure is high enough that this downshift cannot be made.

Line drop oil from the 3-4 shift valve to the pressure regulator is routed through the detent valve so that it will immediately be cut off on a forced 4-3 downshift. This assures that maximum line pressure will immediately be available for holding the neutral and rear clutches.

PART THROTTLE 4-3 DOWNSHIFT

When operating at speeds below approximately 35 MPH in fourth speed, depressing the accelerator part way to the floor will provide enough TV pressure against the 3-4 TV plug to overcome governor pressure and close the 3-4 shift valve (Fig. 30). How far the accelerator must be depressed depends upon car speed. At 25 MPH for instance the downshift is made with relatively little additional pedal travel while at 35 MPH the accelerator will have to be depressed nearly to the floor. This downshift provides improved acceleration at lower speeds without the necessity of opening the throttle wide open.

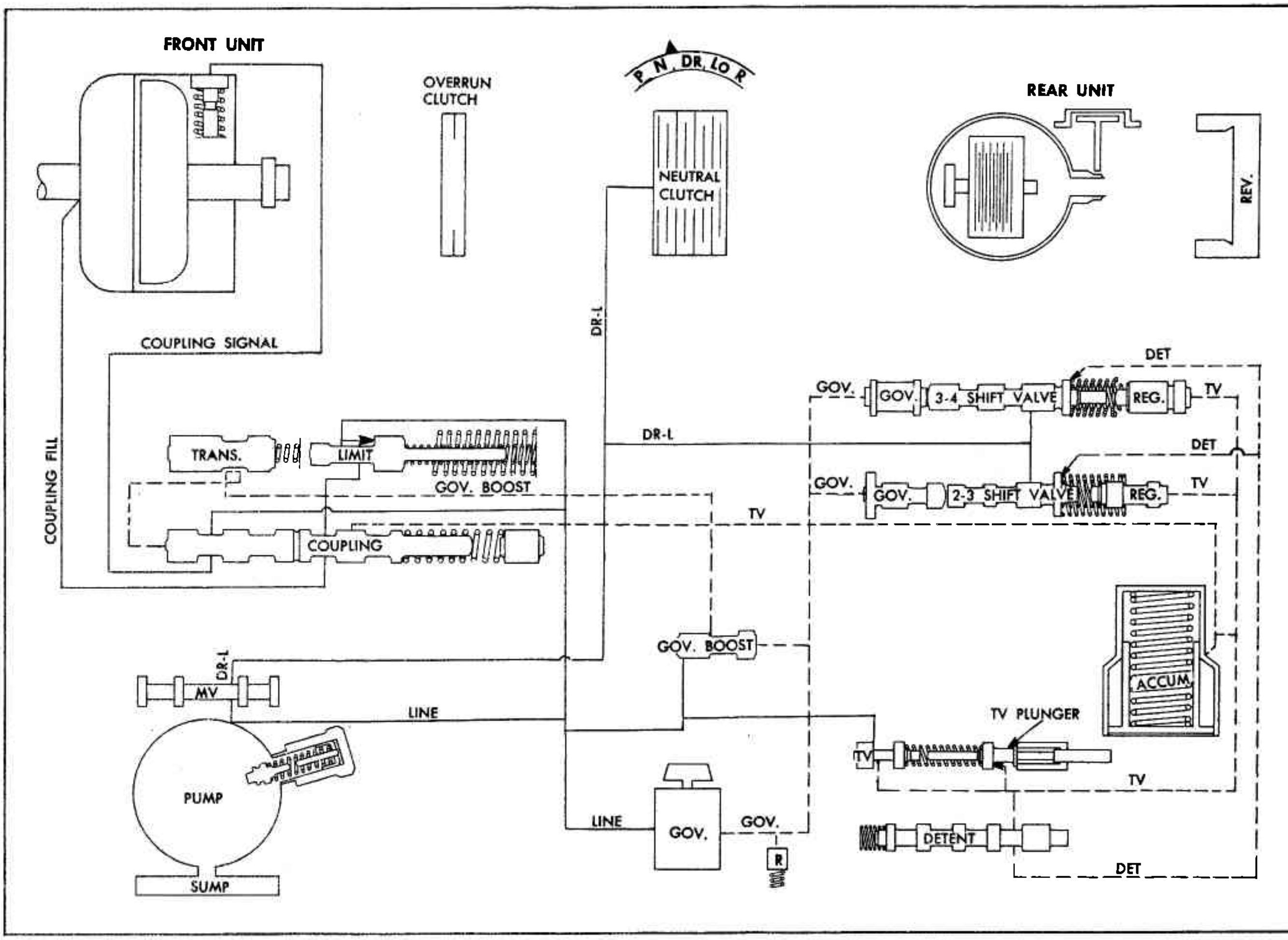

Fig. 31 Hydraulic Action During Forced 3-2 Downshift

FORCED 3-2 DOWNSHIFT

At car speeds below approximately 25 MPH, it is possible to force the transmission to shift from third back into second for more rapid acceleration. This shift is obtained by depressing the accelerator pedal to the floor to open the detent valve.

When the detent valve is opened, TV pressure (which is equal to main line pressure at full throttle) passes the detent valve into the detent passage (Fig. 31). This pressure, referred to as detent oil, is directed to the back of the 2-3 shift valve to force it back to the closed position. At car speeds above approximately 25 MPH, governor pressure is high enough to prevent this downshift.

LIMIT VALVE

The limit valve (Fig. 32) acts as a double safety device in the transmission.

First it regulates line pressure passing from the manual valve to the coupling valve and thence to fill the front unit coupling. When the engine is started the limit valve remains closed until main line pressure builds up to approximately 55 psi. When this pressure is reached, the small inner limit valve spring is compressed and the valve opens the passage to the coupling valve.

If, due to a severe leak in the front coupling, the pressure should drop below 55 psi. the limit valve will immediately close. It will then act as a pressure regulator keeping the pressure at 55 psi., thus protecting the neutral clutch and rear clutch from slipping and overheating.

The limit valve also acts as a relief valve. If main line pressure exceeds approximately 200 psi., the large (outer) spring behind the limit valve will be compressed and the limit valve will move far enough to open the exhaust port. Excessive output will then be dumped back into the sump relieving the excessive pressure.

TRIMMER VALVE

The purpose of the trimmer valve (Fig. 32) is to limit the TV pressure in the accumulator.

The purpose of the accumulator, as covered on page 26 is to cushion the application of the rear clutch on a 2-3 shift. The cushioning effect is reduced as AV pressure increases, since TV pressure assists the accumulator springs in resisting 2-3 apply oil. At full TV pressure, however, a hydro-static lock could occur, preventing any movement of the piston. The accumulator could, therefore, become ineffective and a harsh 2-3 shift would result.

To prevent this from occurring, the trimmer valve limits the maximum TV pressure in the accumulator to approximately 75 psi. Thus even with full TV pressure of about 95 psi. acting on the regulator plugs, the TV pressure in the accumulator will be limited or "trimmed" to 75 psi.

TIMING FRONT AND REAR UNITS FOR 2-3 UPSHIFT AND 3-2 FORCED DOWNSHIFT

The ⅛" check ball in the 2-3 oil passage at the transition valve and the TV check valve are both

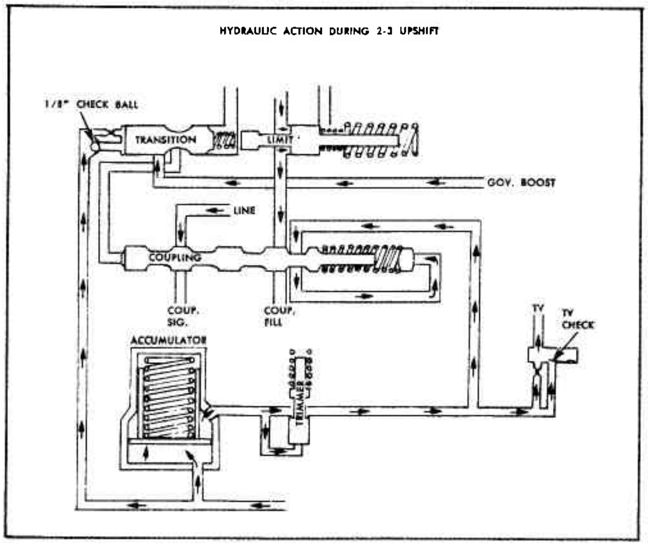

Fig. 32 Hydraulic Action During 2-3 Upshift

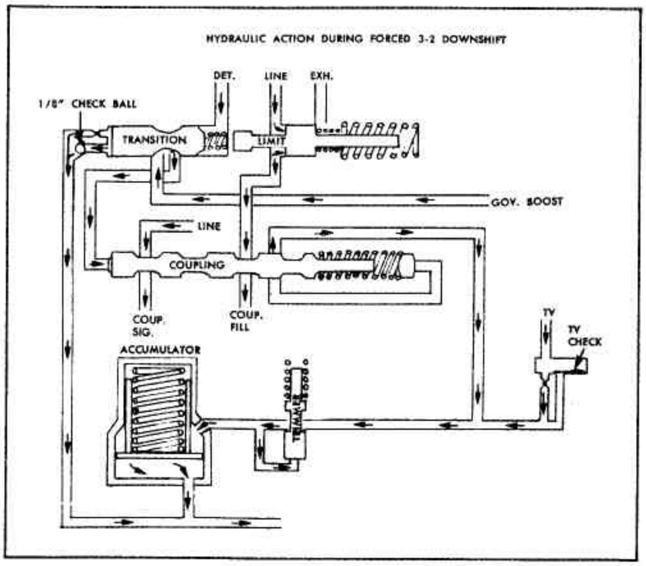

Fig. 33 Hydraulic Action During Forced 3-2 Downshift

used in timing the 2-3 upshift and the forced 3-2 downshift.

2-3 UPSHIFT

When the transmission shifts from second to third, the front unit coupling empties and the rear unit clutch applies (see page 26). In order to perform this transition smoothly, the two actions must take place at the same time.

Due to the necessity of filling the accumulator as the rear clutch applies it is necessary to slow up the exhaust of the front unit coupling. If this were not done, the front unit would go into reduction before the rear unit went into direct drive and the transmission would shift 2-1-3.

The delay in exhaust of the front unit coupling is accomplished as follows:

When the 2-3 shift valve opens, 2-3 oil directed to the transition valve seats the ball check (Fig. 32); therefore, 2-3 oil must meter through the orificed passage. This delays movement of the transition valve long enough for the rear clutch to begin to apply. When the transition valve moves, governor boost oil is cut off from the coupling valve. The spring immediately closes the coupling valve cutting off coupling signal oil and coupling fill oil. By the time the coupling is exhausted, the rear clutch is applied and the transmission is in third speed.

To insure rapid movement of accumulator piston, the TV oil behind the piston must be allowed to exhaust rapidly as the piston moves back. Rapid exhaust is assured by the TV check valve, a leaf type valve which allows TV oil to leave the accumulator rapidly, but restricts the flow of TV oil into the accumulator. TV oil passing out of the accumulator lifts the leaf type check valve providing unrestricted flow.

FORCED 3-2 DOWNSHIFT

When the transmission downshifts from third to second, the front unit coupling must fill (for direct drive) and the rear clutch must release (for reduction). In order for the coupling to fill rapidly, it is necessary to insure rapid movement of the coupling valve and transition valve after the 2-3 shift valve closes.

The transition valve is moved rapidly by directing detent oil against the spring end (Fig. 33). 2-3 oil at the opposite end of the transition valve exhausts rapidly by unseating the 1/8″ check ball.

Governor boost oil is thus directed immediately to the end of the coupling valve to open the coupling valve.

A momentary reduction in TV pressure behind the coupling valve is necessary to allow the coupling valve to be opened rapidly by governor boost pressure. The accumulator and TV check valve provide this momentary reduction in TV pressure as follows:

As soon as the 2-3 shift valve closes, 2-3 oil under the accumulator piston is opened to exhaust. This allows the accumulator piston to move down rapidly, causing a need for a considerable quantity of oil in the TV area on top of the piston. The TV check valve, however, is seated and TV pressure from the main TV line is metered into the accumulator slowly through the orifice. To supply the large quantity of oil required behind the accumulator piston, oil is drawn rapidly from the unrestricted coupling valve TV line. This causes an immediate drop in pressure in the coupling valve TV line.

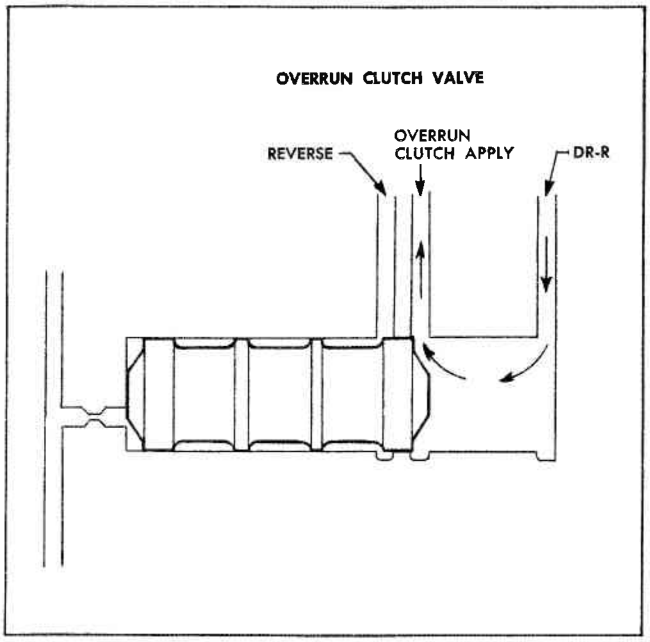

Fig. 34 Overrun Clutch Valve Position in Drive Right—First Speed or Third Speed

It is thus possible for governor boost pressure to rapidly open the coupling valve. Once the coupling valve is opened, TV pressure is cut off from the end of the coupling valve, insuring that it will not close the valve again.

OVERRUN CLUTCH VALVE

The overrun clutch valve has two functions: (a) to delay the application of the overrun clutch until after the front sprag has taken hold, when the selector lever is moved to drive right while the throttle is open in fourth speed. This prevents slipping the clutch causing excessive wear; (b) to provide a method of applying the overrun clutch in both drive left and reverse.

The overrun clutch valve functions as follows:

When the selector lever is placed in drive right while coasting there is no TV pressure (Fig. 34). The drive right oil then moves the overrun clutch valve to the extreme left position and drive right oil enters the overrun clutch apply passage.

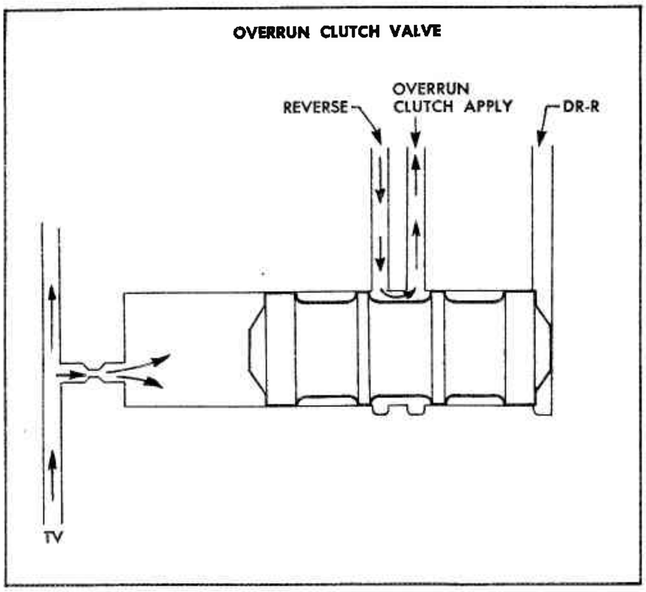

Fig. 35 Overrun Clutch Valve Position in Reverse

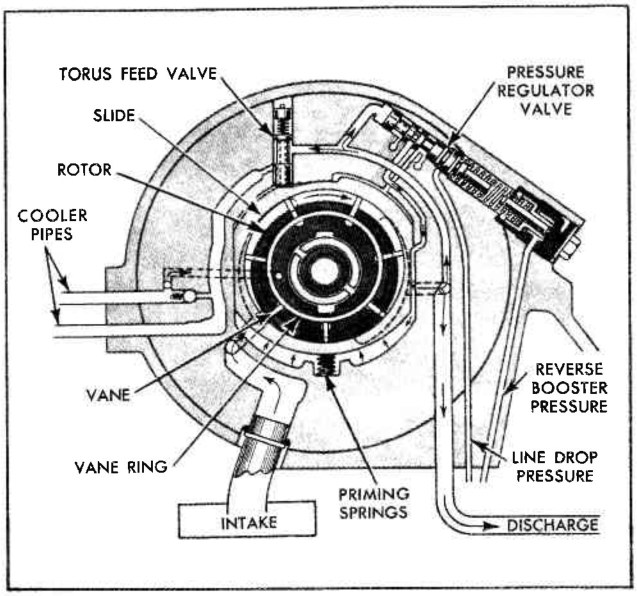

Fig. 36 Front Pump Delivering Maximum Output

When driving at constant speed or accelerating, the overrun clutch valve is held to the right by TV pressure. Under this condition when the selector is moved to drive right it is necessary to bleed this TV oil out of the cavity at the left of the valve before the drive right oil can be directed to the overrun clutch apply circuit. This delay assures that the coupling will empty and the sprag will be holding before the overrun clutch applies. When the selector lever is placed in reverse, reverse oil is directed to the overrun clutch apply passage since the overrun clutch piston is held to the right by TV pressure (Fig. 35).

OPERATION OF FRONT PUMP

The front pump is a large, variable capacity, vane type pump driven by the engine. A slide is incorporated in the pump that automatically regulates pump output according to the needs of the transmission. Maximum pump output is obtained when the slide is in the up position. As the slide moves down, pump output is lowered until zero output is reached. Further downward movement of the slide enables the front pump to act as a relief valve for excessive rear pump output.

Movement of the slide is accomplished by directing oil from the pressure regulator to the top or bottom of the slide. With the engine off, the pump is at rest and the slide is held in the up position by the priming springs (Fig. 36). As the pump rotor operates, its output is directed to the pressure regulator valve. When output pressure is low, the pressure regulator valve is held deep in its bore by the pres-

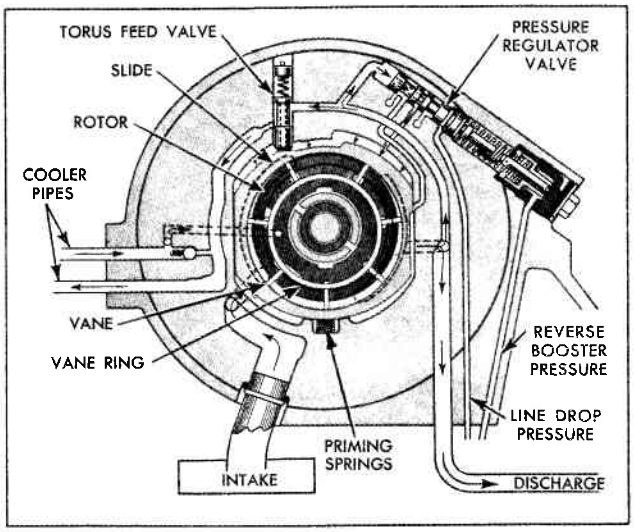

Fig. 37 Front Pump Exhausting Rear Pump Output

sure regulator valve spring. With the pressure regulator valve in this position, oil is directed below the slide to hold the slide up for maximum output. As the pump output pressure increases, the pressure regulator valve is moved outward, directing oil above the slide to push it down and decrease the output (Fig. 37).

Main line pressure as regulated by the pressure regulator valve is approximately 95 psi except in fourth speed with selector in drive left or in reverse. When the transmission shifts into fourth speed with the selector lever in drive left, line drop oil from the 3-4 shift valve is directed to the pressure regulator valve to push the valve outward. This reduces th pressure in fourth speed to approximately 65 psi thereby decreasing the amount of work performed by the pump during normal cruising. This makes more engine power available to drive the car and reduces the transmission operating temperature.

In reverse additional pressure is desirable to assure positive holding of the reverse cone clutch. To provide this additional pressure, reverse oil is directed to the reverse booster plug in the pressure regulator. Reverse booster pressure aids the pressure regulator spring in holding the pressure regulator valve into its bore, thereby increasing main line pressure to 145-190 psi.

Incorporated in the pump is the torus feed valve. Movement of the torus feed valve is controlled by slide position. With the slide up, (maximum output) the torus feed valve is closed (Fig. 36). As the slide moves downward, the torus feed valve moves down and opens the feed passages to supply oil to the cooler and to the main torus assembly (Fig. 37).

When the pressure in the main torus assembly reaches a predetermined value, the torus check valve (in the driven torus) opens allowing oil to pass into the transmission lubrication passages.

The oil cooler ball check valve is a safety device that will unseat and allow oil to pass directly to the main torus assembly if the oil cooler should become blocked.

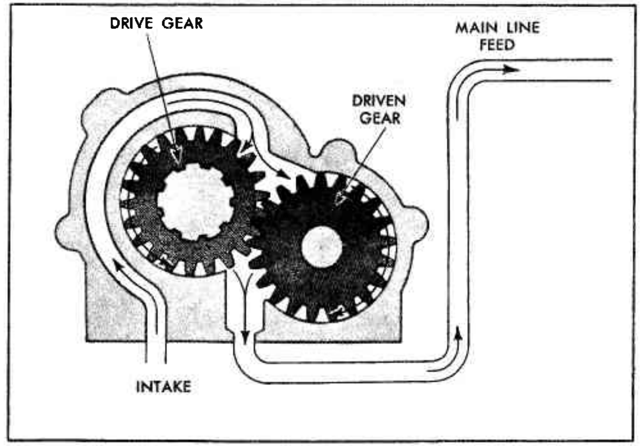

Fig. 38 Rear Pump

OPERATION OF REAR PUMP

The rear oil pump is an external gear type pump driven by the output shaft (Fig. 38). As the output shaft turns, the rear oil pump builds up pressure and rear pump oil flows with front pump oil. Since both front and rear pump oils become one, the pressure regulator controls the output of both pumps. This is accomplished by forcing the front pump slide down reducing its output as rear pump output increases due to increased car speed. The rear oil pump is incorporated into the transmission so that push starting of the vehicle can be accomplished if necessary.