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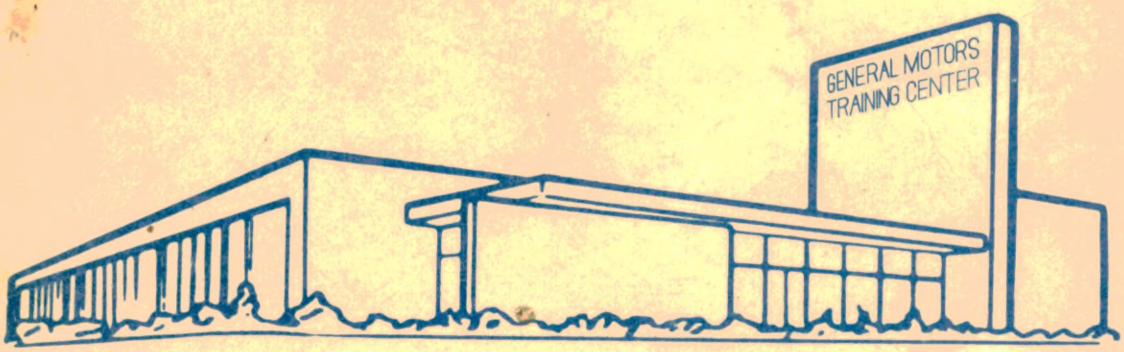
700-R4 AUTOMATIC TRANSMISSION



GM Product Service Training

17001.11-1A

THM 700-R4

PRINCIPLES OF OPERATION

SECOND EDITION

FOREWARD

This book is intended to give the reader a complete understanding of the principles of operation of the model THM 700-R4 Hydra-matic transmission. The mechanical function and the hydraulic operation are described in detail. This transmission has been designed and manufactured using the metric system of measurement.

We hope that this book will help you to become familiar with the operation of the unit, and as such, will serve as a useful tool to aid you in the service, diagnosis and repair of this unit.

Service Department
HYDRA-MATIC
Division of General Motors Corporation
Ypsilanti, Michigan 48197

LITHO IN U.S.A.

INDEX

HYDRA-MATIC
DIVISION OF GENERAL MOTORS
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OFFICE OF THE
GENERAL MANAGER

This manual explains the theory and operation of the THM 700-R4 automatic transmission. The detailed text and color illustrations will instruct the reader in mechanical power flow and hydraulic systems of this unit.

Hydra-matic Division is proud to add THM 700-R4 to our line of automatic transmission products. This fully automatic 4-speed (overdrive) transmission has been designed to meet the needs of today's high technology, computer controlled engines. Development of the THM 700-R4 utilized the most up to date engineering and testing techniques including computer design assistance.

Hydra-matic has been producing the world's finest automatic transmissions for over 40 years. This record of product leadership and excellence, however, could not be achieved without the "Hydra-matic Team" --- our employes, suppliers, those who service our products, and our community. We are very proud of this team, for it has helped us manufacture, sell and service a quality product.

We pledge ourselves to continue to supply products of the highest quality and superiority which will fulfill the standards of reliability, safety, efficiency and performance.

Thank you for your interest in our product, and I hope this book will answer any questions as to its operation.

George W. Griffith

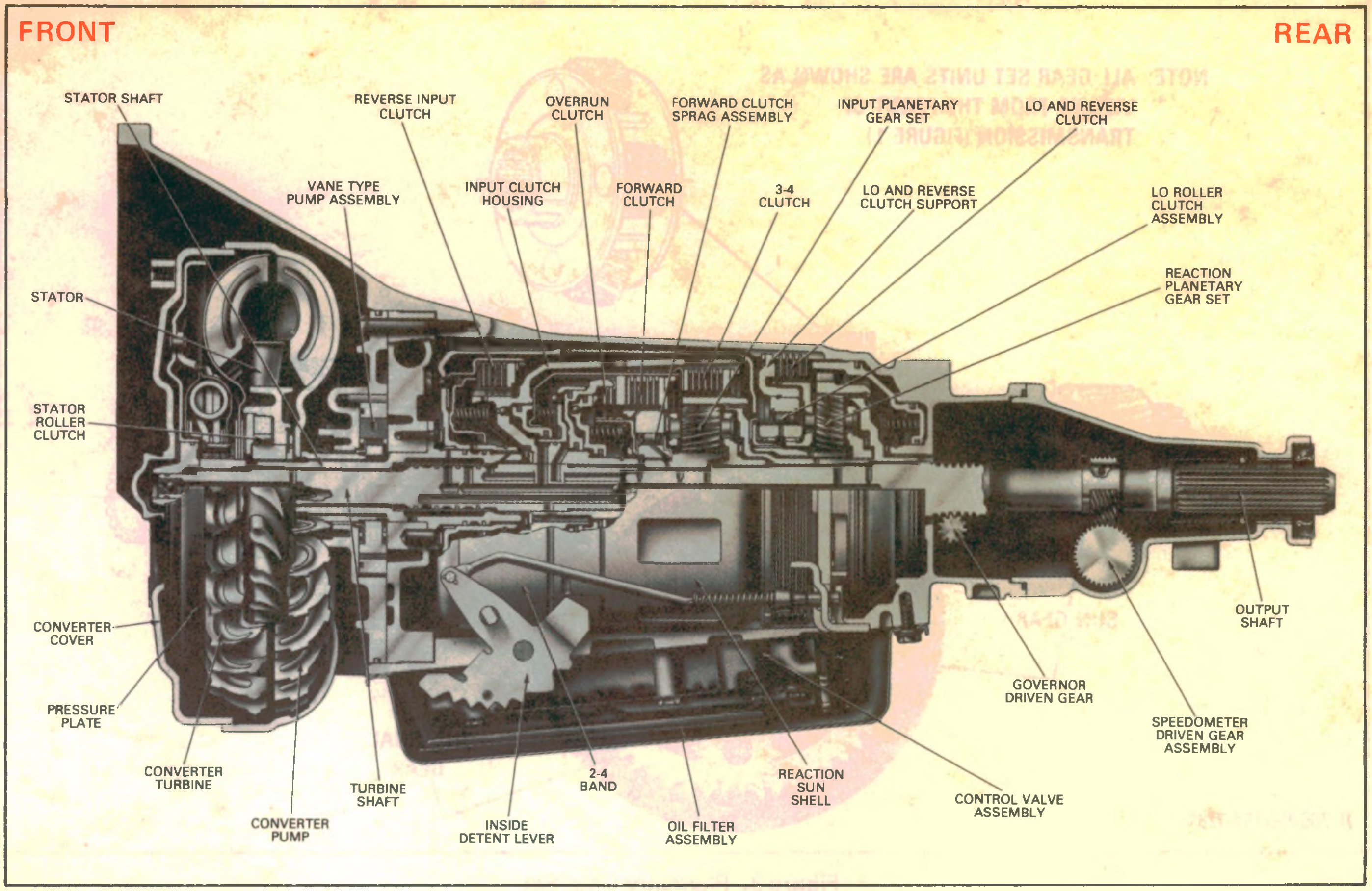

Figure 1 - Cut-Away View THM 700-R4 Transmission

GENERAL DESCRIPTION

The Model THM 700-R4 transmission is a fully automatic unit consisting primarily of a three element hydraulic torque converter with the addition of a converter clutch. Five multiple-disc clutches, one roller clutch, one sprag clutch, and a band provide the friction elements required to obtain the desired function of the compound planetary gear set (Fig. 1).

The torque converter smoothly couples the engine to the planetary gears and overdrive unit through oil, and hydraulically provides additional torque multiplication when required. The combination of the compound planetary gear set provides four forward ratios and one reverse.

The torque converter consists of a converter clutch, a driving member, driven member and a reaction member known respectively as the pressure plate and damper assembly, pump, turbine and stator. Changing of the gear ratios is fully automatic in relation to vehicle speed and engine torque. Vehicle speed and engine torque signals are constantly fed to the transmission to provide the proper gear ratio for maximum efficiency and performance at all throttle openings.

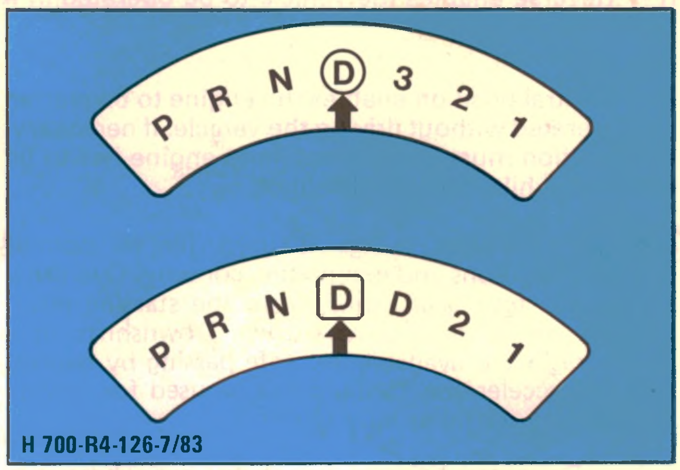

Figure 2 - Quadrant In Overdrive Position

The quadrant has seven positions indicated in the following order: P, R, N, D, 3, 2, 1 (Fig. 2).

P — Park position enables the transmission output shaft to be held — thus preventing the vehicle from rolling either forward or backward. (For safety reasons, the vehicle parking brake should be used in addition to the transmission "Park" position). Because the output shaft is mechanically locked by a parking pawl anchored in the case, the Park position should not be selected until the vehicle has come to a stop. The engine may be started in the Park position.

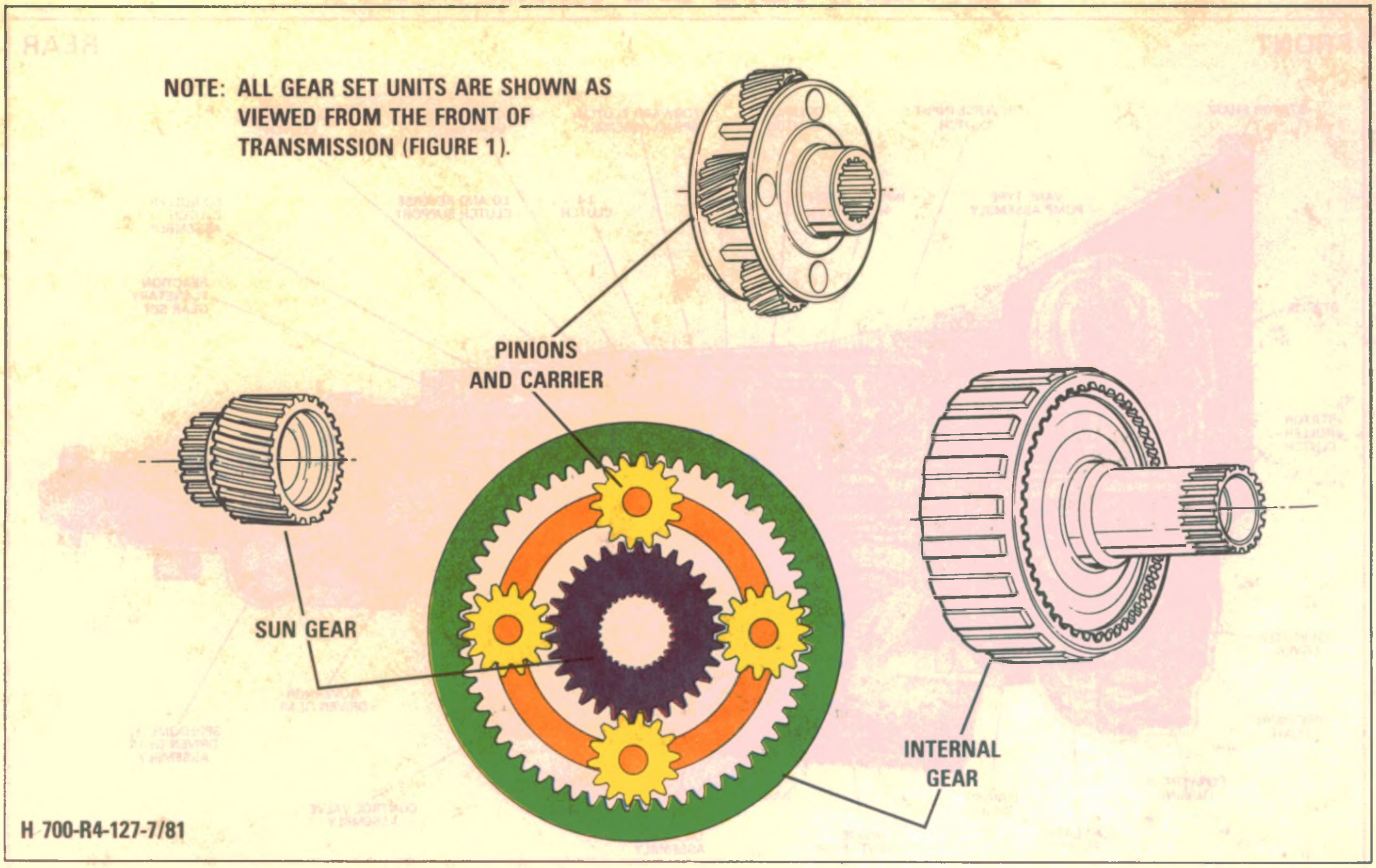

Figure 3 - Planetary Gear Set

R — Reverse enables the vehicle to be operated in a rearward direction.

N — Neutral position enables the engine to be started and operated without driving the vehicle. If necessary, this position must be selected if the engine has to be restarted while the vehicle is moving.

(D) (D)— Overdrive Range is used for all normal driving conditions and maximum economy. Overdrive Range has four gear ratios, from the starting ratio, through direct drive to overdrive. Downshifts to a higher ratio are available for safe passing by depressing the accelerator. (Should not be used for towing trailers, city traffic or hilly terrain.)

D/3 — Drive can be used for conditions where it is desired to use only three gears. This range is also useful for braking when descending slight grades. Upshifts and downshifts are the same as in Overdrive Range for first, second and third gears, but the transmission will not shift to fourth gear.

2 — Manual Second adds more performance. It has the same starting ratio as Manual Third Range, but prevents the transmission from shifting above second gear, thus retaining second gear for acceleration or engine braking as desired. Manual Second can be selected at any vehicle speed. If the transmission is in third or fourth gear it will immediately shift to Second Gear.

1 — Manual Lo can be selected at any vehicle speed. The transmission will shift to second gear if it is in third or fourth gear, until it slows below approximately 30 m.p.h. (48 km/h),* at which time it will downshift to first gear. This is particularly beneficial for maintaining maximum engine braking when descending steep grades.

*km/h (kilometer per hour) is a metric unit of measuring for speed.

PRINCIPLES OF OPERATION

The purpose of an automobile transmission is to provide neutral, reverse, and forward driving ranges that increase the torque or twisting force from the engine to the driving wheels as required for greater pulling power and performance.

Basically, an automobile transmission is a form of lever that enables the engine to move heavy loads with less effort. As the heavy load or vehicle begins to move, less leverage or ratio is required to keep it moving.

By providing a suitable number of levers or torque multiplying ratios, improved performance and economy are possible over the entire diving range. Changing the ratio automatically relieves the driver of the responsibility of selecting the best possible ratio for each condition and makes driving easier.

PLANETARY GEARS

Planetary gears are used in the THM 700 R4 transmission as the basic means of multiplying the twisting force or torque from the engine. Planetary gears are so named because of their physical arrangement. They are always in mesh and thus cannot "clash" like other gears that go in and out of mesh. The gears are designed so that several gear teeth are in mesh or in contact at once. This distributes the forces over several teeth for greater strength. Because the shafts generally used with planetary gear trains can be arranged on the same centerline, a very compact unit is obtained.

A planetary gear train consists of a center or sun gear, an internal gear (so called because of its internally cut teeth), and a planetary carrier assembly which includes and supports the smaller planet gears called pinions (Fig. 3).

A planetary gear train can be used to increase or decrease torque, increase or decrease speed, reverse the direction of rotation, or function as a coupling or connector for direct drive.

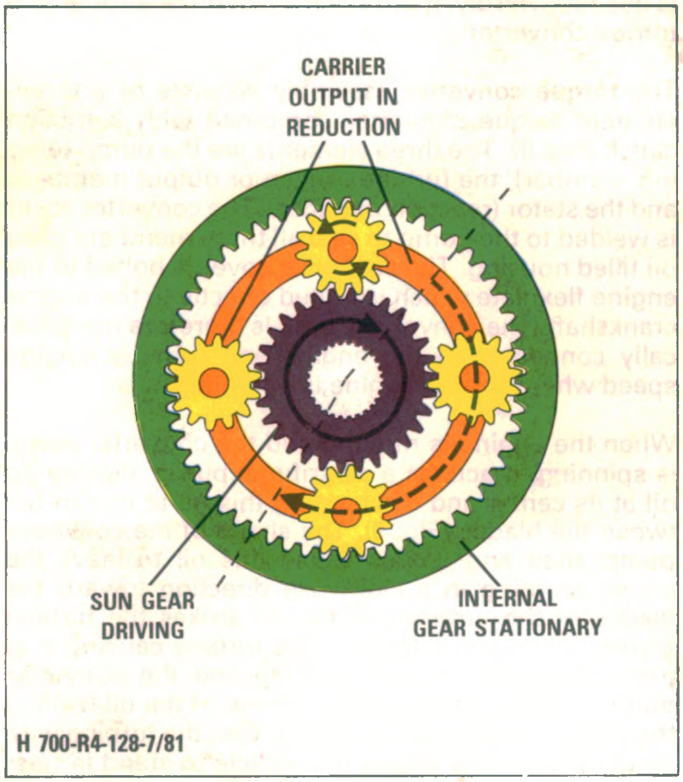

Figure 4 - Reduction

REDUCTION

Increasing the twisting force or torque, by means of a planetary gear set, is generally known as operating in reduction (Fig. 4), because there is always a decrease in the speed of the output member which is proportional to the increase in the output torque.

Stated in another way, with a constant input speed, the output torque increases as the output speed decreases.

When the internal gear is held stationary and power is applied to the sun gear in a clockwise direction, the planetary pinions rotate in a counterclockwise direction and "walk" around the stationary internal gear, thus rotating the carrier assembly clockwise in reduction (Fig. 4).

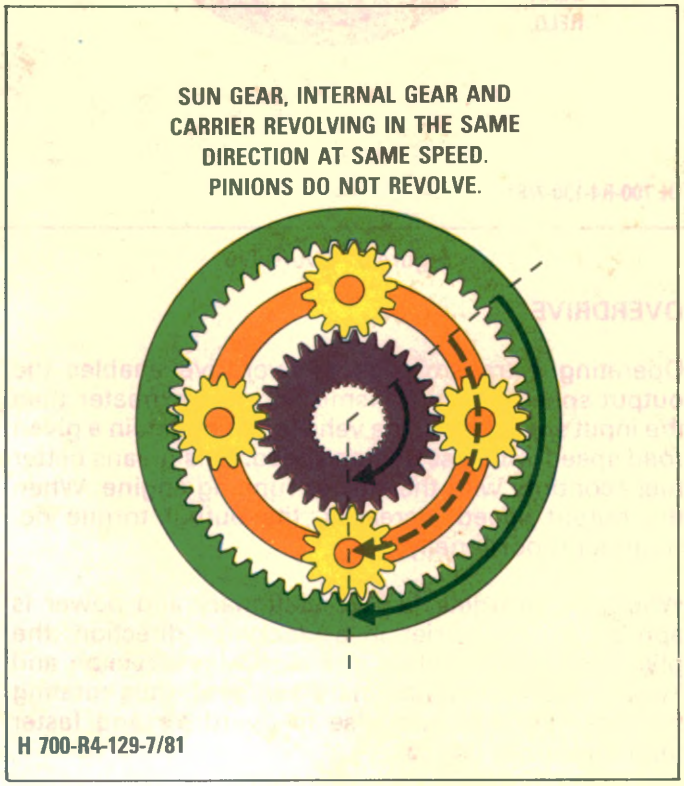

Figure 5 - Direct Drive

DIRECT DRIVE

Direct drive is obtained when any two members of the planetary gear train rotate in the same direction at the same speed. This forces the third member to turn at the same speed. In this condition, the pinions do not rotate on their pins, but act as wedges to drive the entire unit together as one rotating part (Fig. 5).

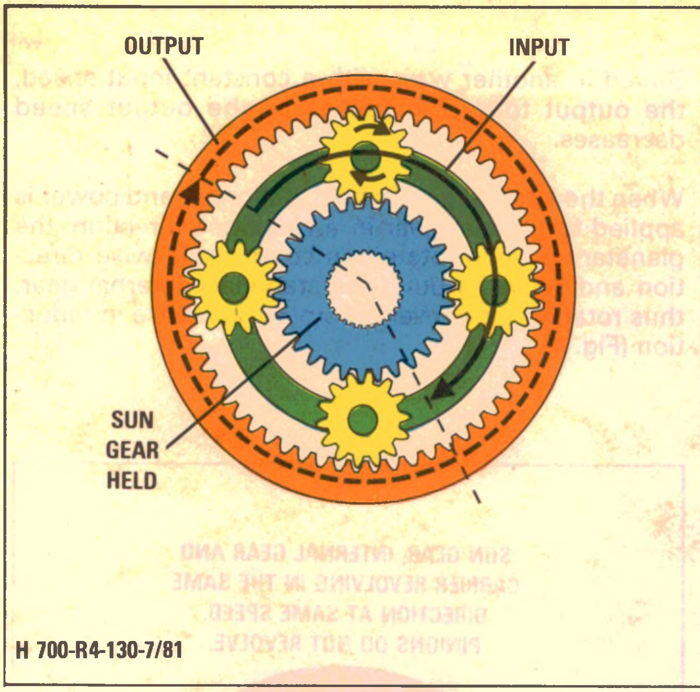

Figure 6 - Overdrive

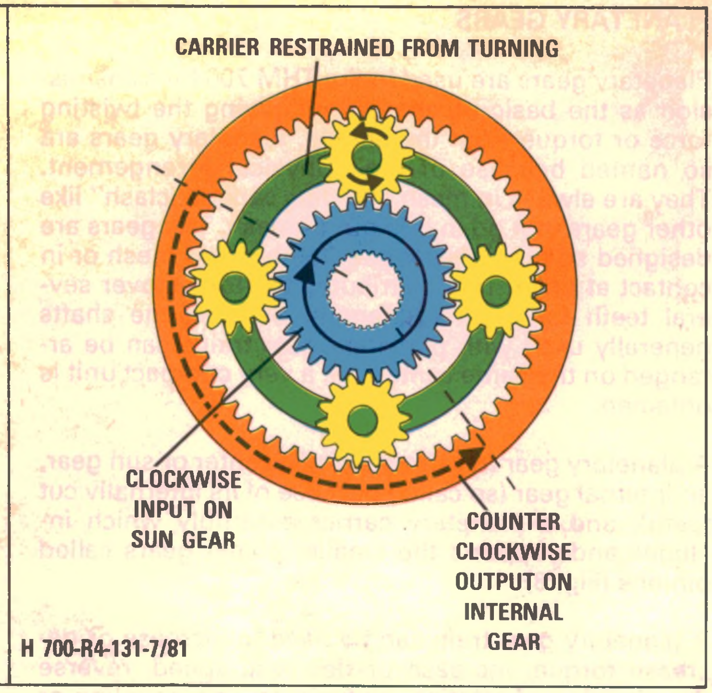

Figure 7 - Reversal Of Direction

OVERDRIVE

Operating a transmission in overdrive enables the output speed of the transmission to be greater than the input speed, thus, the vehicle can maintain a given road speed with less engine speed. This means better fuel economy with the slower running engine. When the output speed increases, the output torque decreases proportionally.

When the sun gear is held stationary and power is applied to the carrier in a clockwise direction, the planetary pinions rotate in a clockwise direciton and "walk" around the stationary sun gear, thus rotating the internal gear clockwise in overdrive and faster than the carrier (Fig. 6).

REVERSAL OF DIRECTION

A reversal of direction is obtained whenever the carrier is held from spinning free and power is applied to either the sun gear or internal gear. This causes the planet pinions to act as idlers, thus driving the output member in the opposite direction (Fig. 7).

In both cases, the output member is turning in a direction opposite the input member.

TORQUE CONVERTER

The torque converter assembly serves three primary functions. First, it acts as a fluid coupling to smoothly connect engine power through oil to the transmission gear train. Second, it multiplies the torque or twisting effort from the engine when additional performance is desired. Thirdly, it provides direct drive through the torque converter.

The torque converter assembly consists of a three-element torque converter combined with a friction clutch (Fig. 8). The three elements are the pump (driving member), the turbine (driven or output member), and the stator (reaction member). The converter cover is welded to the pump to seal all three members in an oil filled housing. The converter cover is bolted to the engine flexplate which is bolted directly to the engine crankshaft. The converter pump is therefore mechanically connected to the engine and turns at engine speed whenever the engine is operating.

When the engine is running and the converter pump is spinning, it acts as a centrifugal pump, picking up oil at its center and discharging this oil at its rim between the blades (Fig. 9). The shape of the converter pump shell and blades cause this oil to leave the pump spinning in a clockwise direction toward the blades of the turbine. As the oil strikes the turbine blades, it imparts a force to the turbine causing it to turn. When the engine is idling and the converter pump is not spinning fast, the force of the oil leaving the pump is not great enough to turn the turbine with great torque. This allows the vehicle to stand in gear with the engine idling. As the throttle is opened and pump speed increases, the force of the oil increases and more engine power is transmitted to the turbine member and the gear train.

After the oil has imparted its force to the turbine, it follows the contour of the turbine shell and blades so that it leaves the center section of the turbine spinning counterclockwise in a direction opposite to engine rotation.

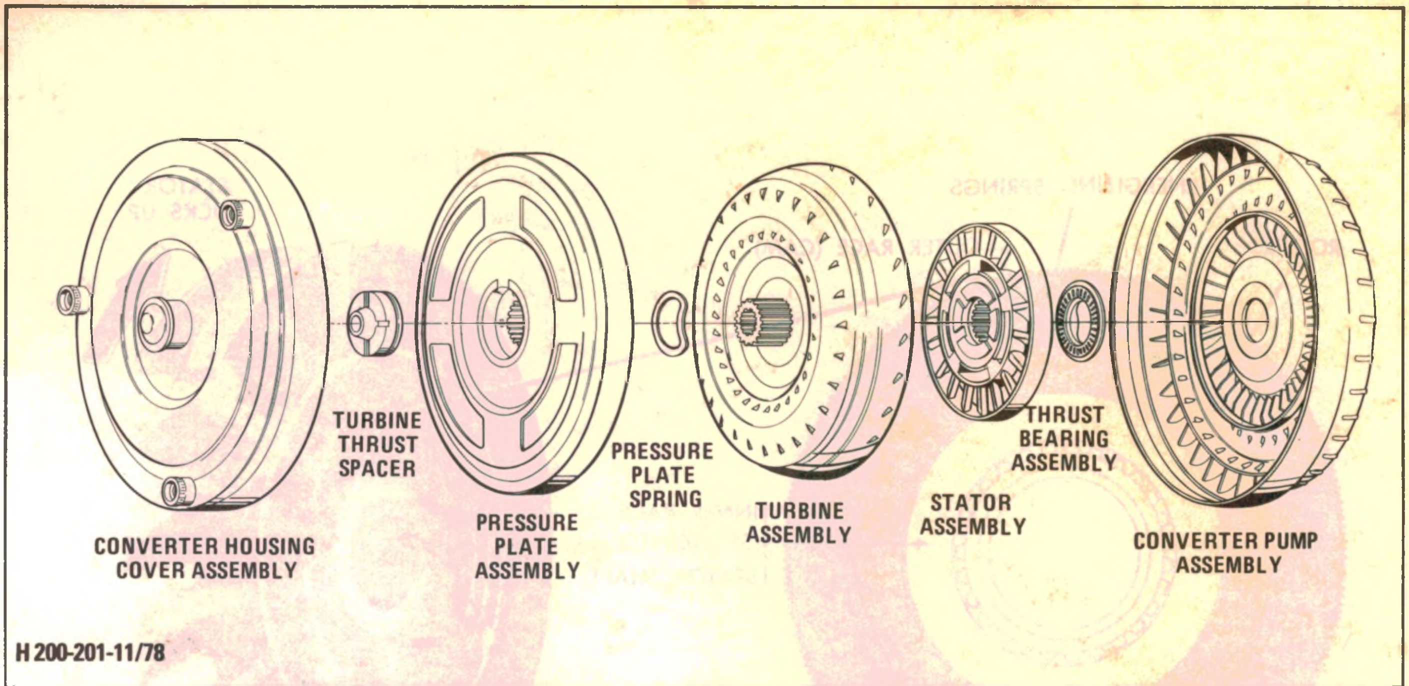

Figure 8 - Torque Converter Clutch Assembly

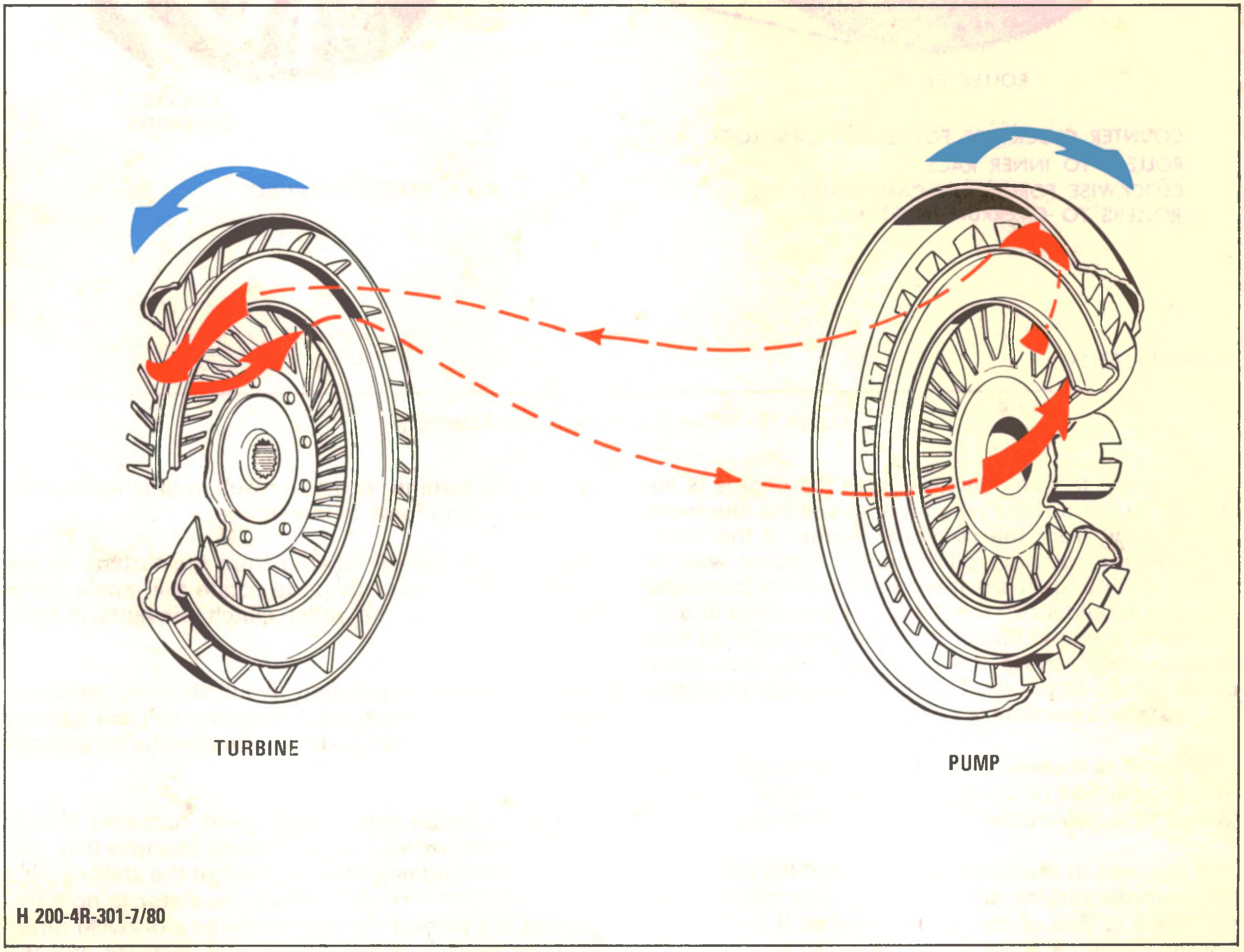

Figure 9 - Oil Flow Without Stator

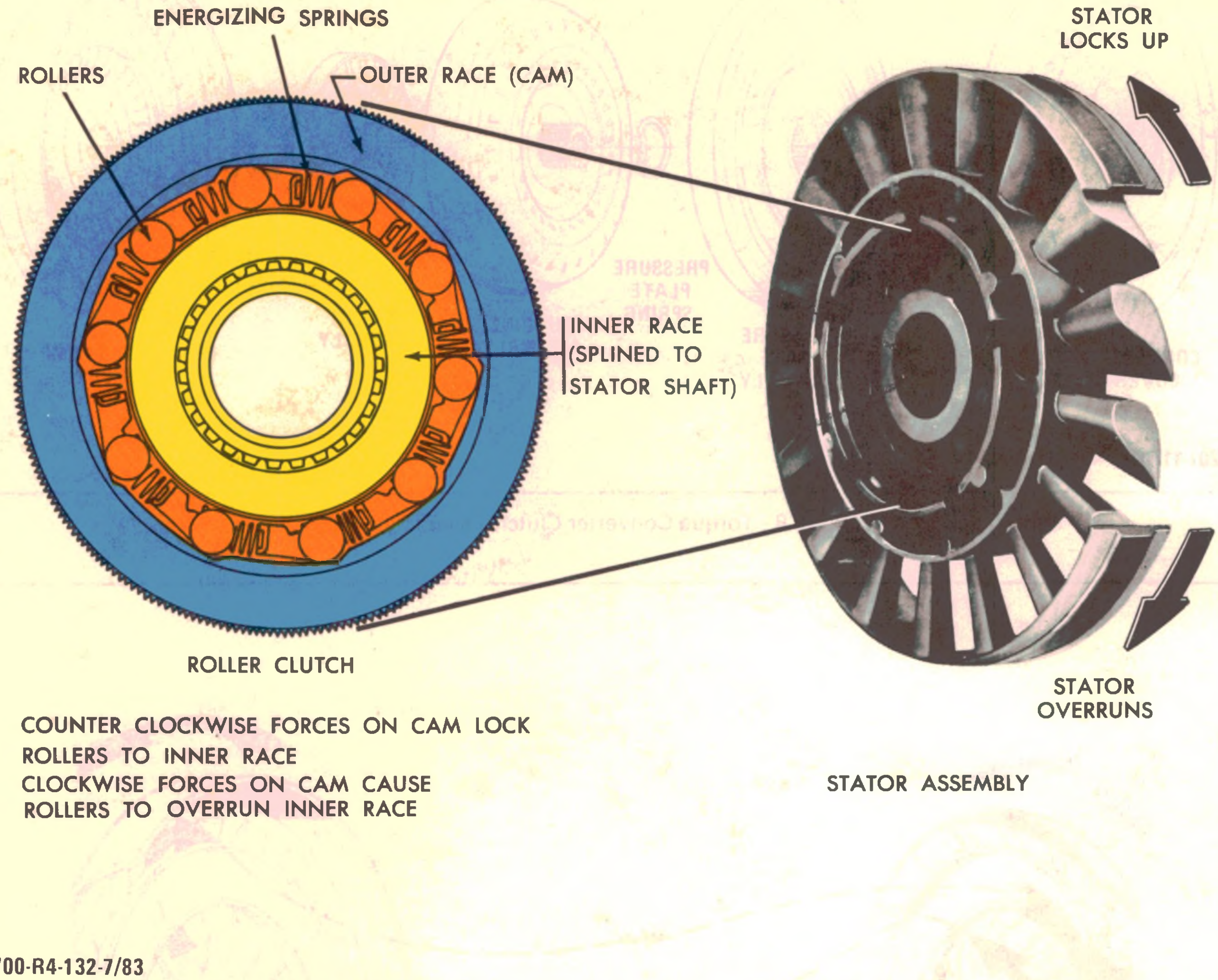

Figure 10 - Roller Clutch and Stator Assembly

The force or torque delivered from the engine is absorbed by the turbine when it reverses the clockwise spinning oil from the converter pump. If the counterclockwise spinning oil from the turbine was allowed to continue to the inner section of the converter pump, it would strike the blades of the pump in a direction that would hinder it and engine rotation, and consequently reduce the force the converter pump could deliver to the oil. To prevent this from happening, a stator assembly is added.

The stator is located between the pump and turbine and is mounted on a one-way roller clutch which allows it to rotate clockwise but not counterclockwise.

The purpose of the stator is to redirect the oil returning from the turbine and change its direction of rotation back to that of the pump member (Fig. 10). The energy in the oil is then used to assist the engine in turning the pump. This increases the force of the oil driving the turbine; and as a result, multiplies the torque or twisting force of the engine.

The force of the oil flowing from the turbine to the blades of the stator tends to rotate the stator counterclockwise, but the roller clutch prevents it from turning (Fig. 11).

With the engine operating at full throttle, transmission in gear, and the vehicle standing still, the converter is capable of multiplying engine torque by approximately 2.0:1.

As turbine speed and vehicle speed increases, the direction of the oil leaving the turbine changes (Fig. 12). The oil flows against the rear side of the stator vanes in a clockwise direction. Since the stator is now impeding the smooth flow of oil in the clockwise direction, its roller clutch automatically releases and the stator revolves freely on its shaft.

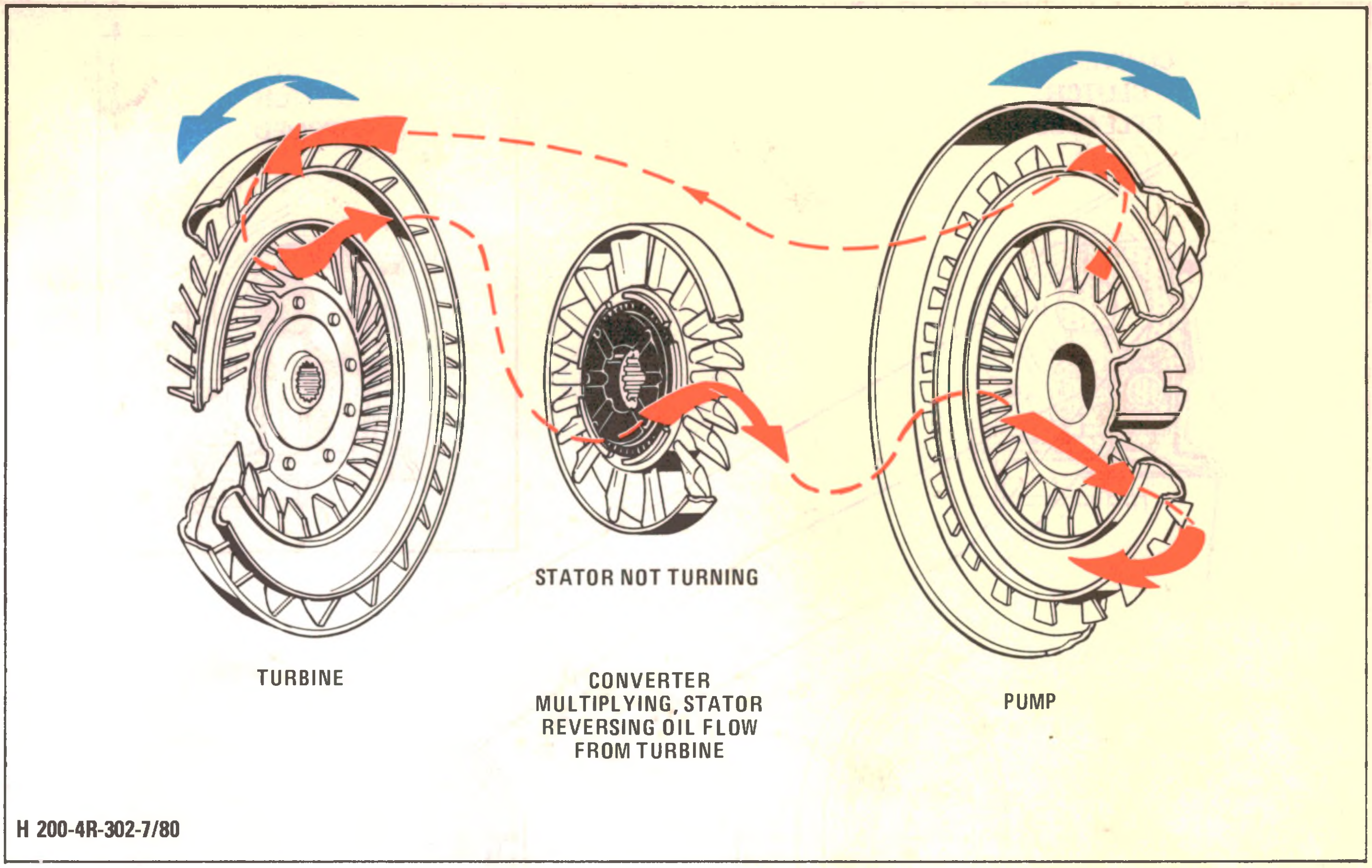

Figure 11 - Oil Flow With Stator Active

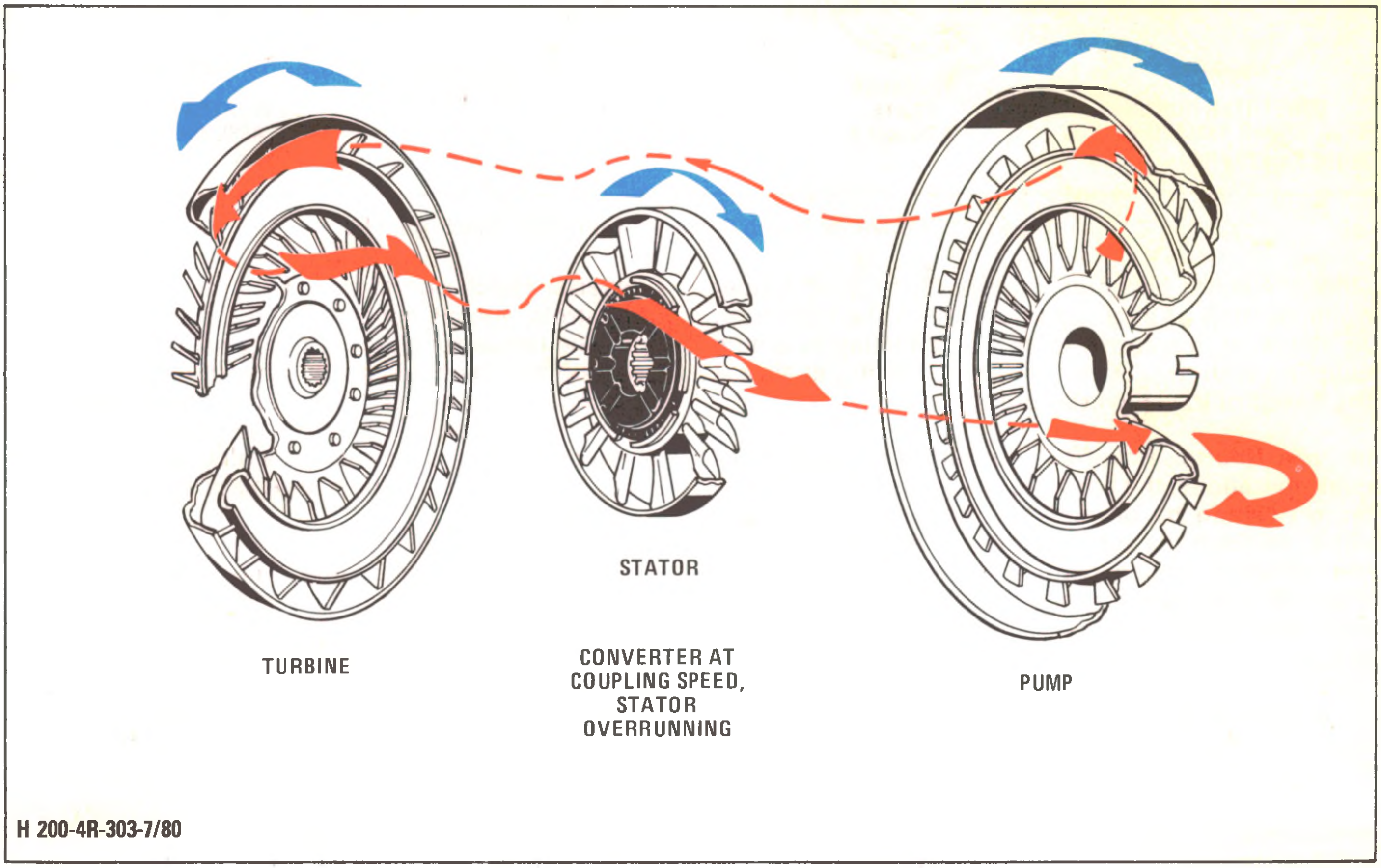

Figure 12 - Oil Flow With Stator Spinning

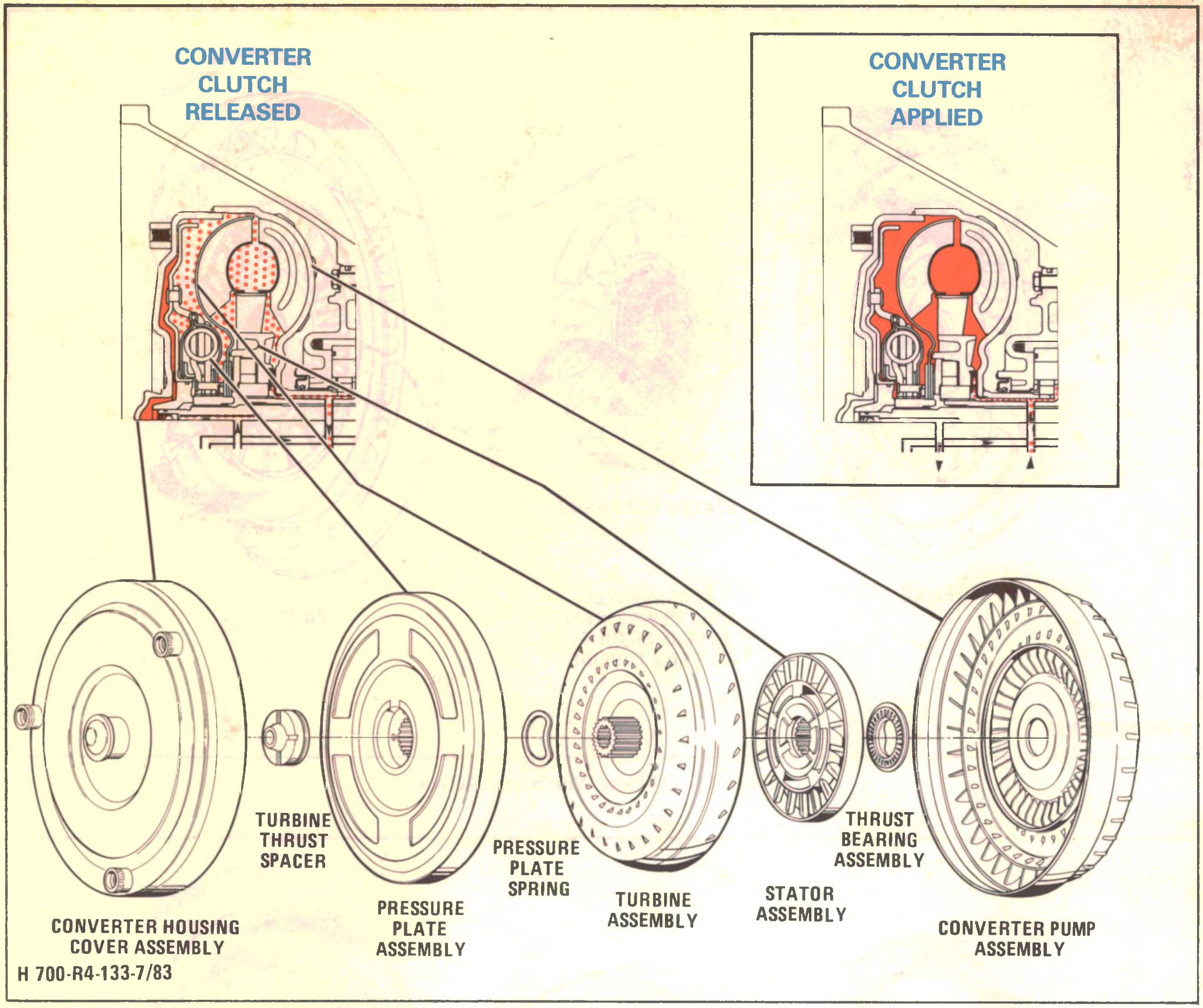

Figure 13 - Converter Clutch Released, Converter Clutch Applied

Once the stator becomes inactive, there is no further multiplication of engine torque within the converter. At this point, the converter is merely acting as a fluid coupling with the converter turbine turning at almost the speed of the converter pump.

In Park, Neutral, Reverse, and during some forward gear operations, the converter clutch is held in the release position by oil flowing from the clutch apply valve, through the turbine shaft, to a cavity between the converter clutch plate and the converter cover (Fig. 13). This moves the clutch pressure plate away from the converter cover, releasing the converter clutch.

To apply the converter clutch, the clutch apply valve redirects the oil to the apply circuit. The apply oil flows between the converter hub and the stator shaft to reverse the oil flow and push the converter clutch pressure plate against the converter cover creating a mechanical link between the engine and the turbine shaft (Fig. 13).

Converter clutch operation is determined by a series of controls, vehicle speed and by Drive Range selection. The converter clutch which is splined to the turbine hub applies against the converter cover providing a mechanical direct drive coupling of the engine to the planetary gears. To aid in reducing engine torsional pulsations, a damper assembly is incorporated in the converter clutch pressure plate.

The spring loaded damper assembly is splined to the converter turbine assembly. The converter clutch pressure plate is attached to the pivoting mechanism of the damper assembly. This rotating action allows the pressure plate to rotate independently of the damper hub, up to approximately 45°. The rate of independent rotation is controlled by the pivoting mechanisms acting on the springs in the damper assembly. The spring cushioning effect of the damper assembly aids in reducing the transfer of engine torque pulsation.

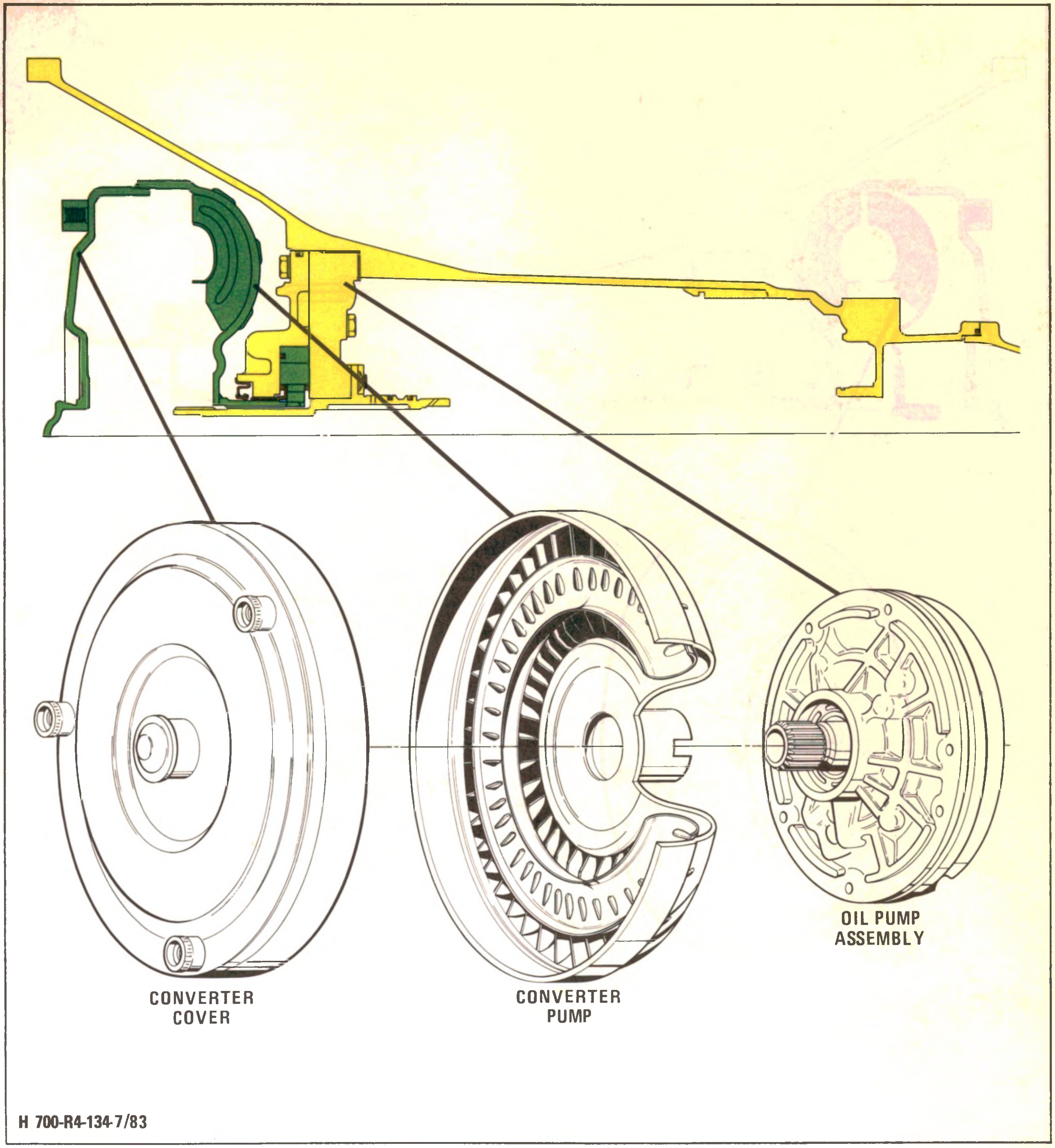

Figure 14 - Converter Cover and Pump, and Oil Pump

The power flow and the principles of operation of the THM 700-R4 transmission power train are most easily understood when each unit or component is considered separately with a part by part build up of the total unit.

TORQUE CONVERTER

To use the power available from the engine, the torque converter cover is bolted to the engine flexplate or flywheel (Fig. 14). The converter cover is welded to the converter pump member, thus providing a direct connection of the engine to the converter. The converter pump hub fits into the transmission oil pump and drives the oil pump in a clockwise direction when viewed from the front of the vehicle.

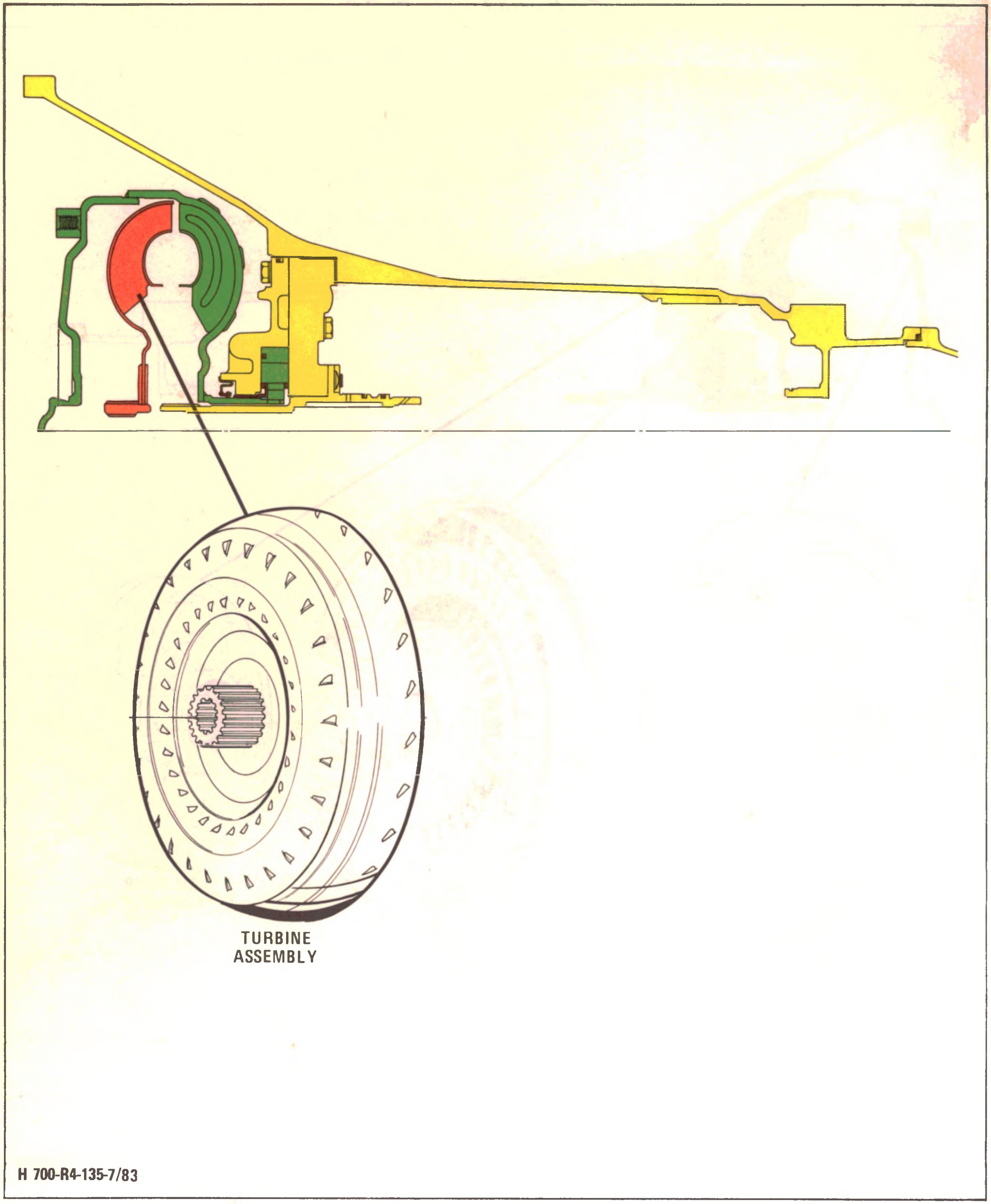

Figure 15 - Turbine Assembly

The converter driven member or turbine is located within the converter housing in front of the pump member (Fig. 15), and its blades face the pump blades. As the pump member turns with oil in the converter, the force of the oil from the pump strikes the blades of the turbine, thus imparting a driving force causing it to turn.

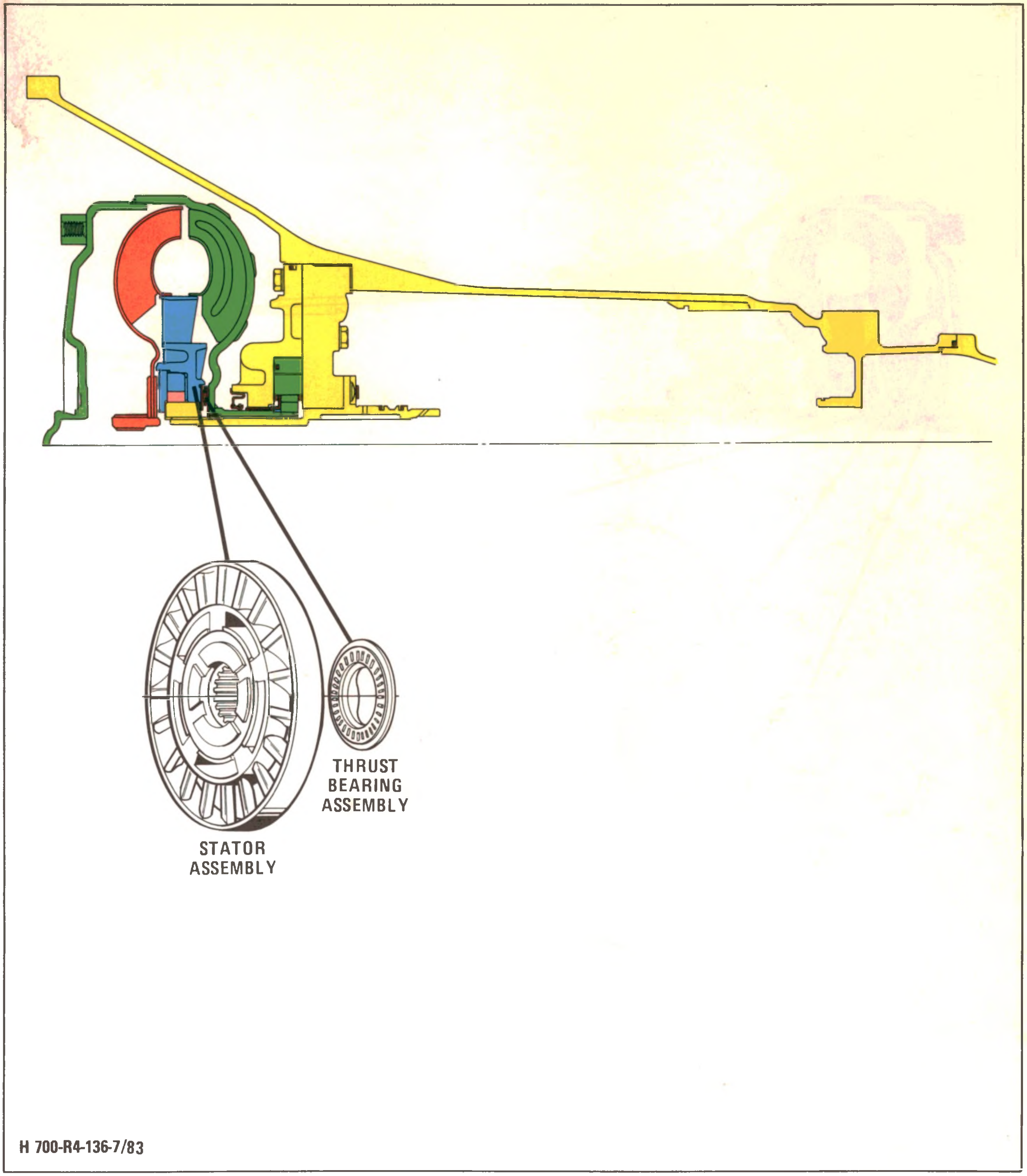

Figure 16 - Stator Assembly

The converter stator assembly is installed between the turbine and the pump member (Fig. 16). It is located so that its blades receive the oil as it passes from the turbine to the pump. A shaft, which is part of the transmission oil pump cover, supports the stator assembly and provides the support for the fixed or inner race of the roller clutch assembly.

The oil flow tends to rotate the stator counterclockwise, causing the roller clutch to hold and prevents the stator from rotating. Oil flow from the turbine that tends to turn the stator clockwise causes the roller clutch to overrun, allowing the stator to rotate freely with the oil.

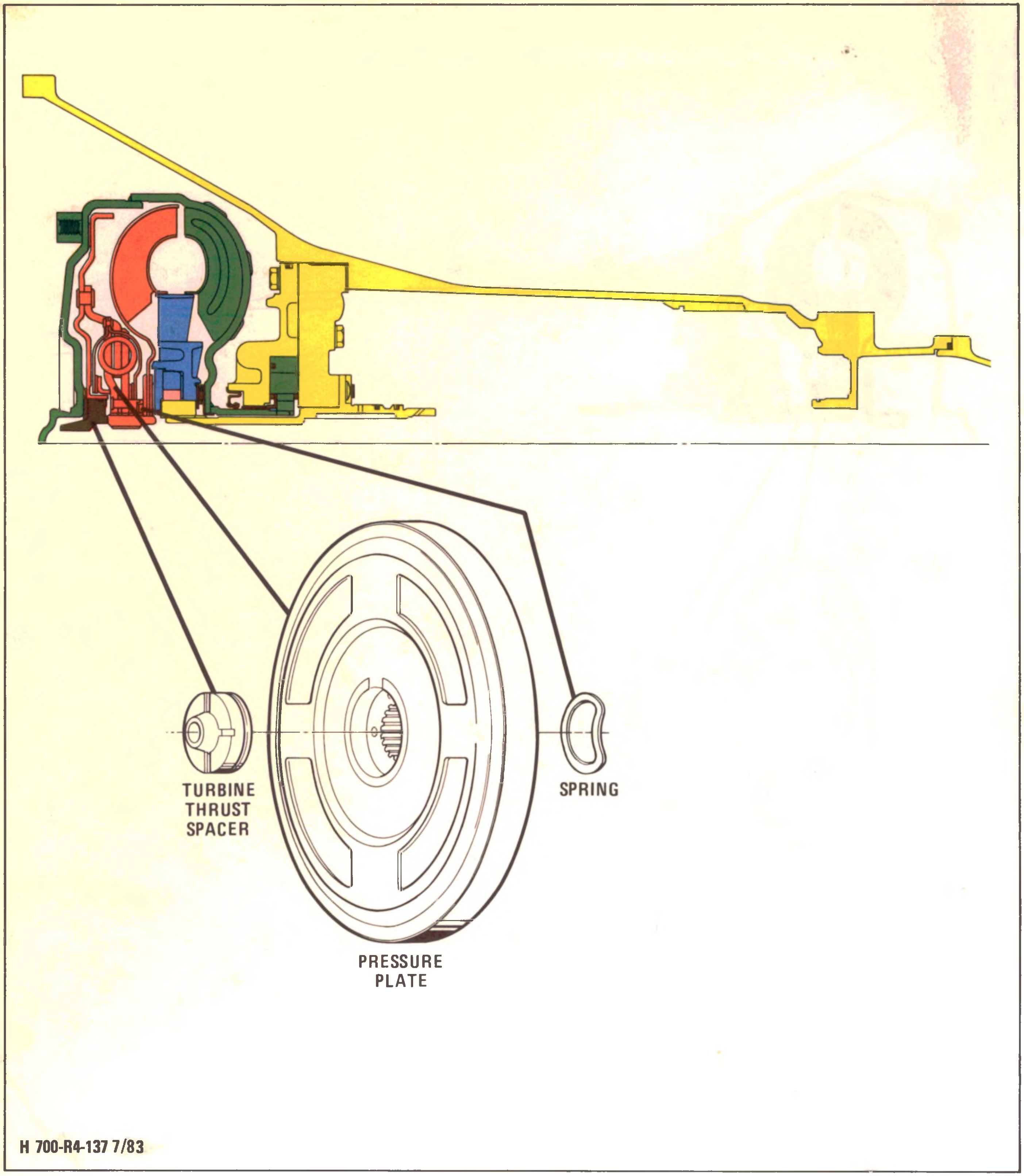

Figure 17 - Pressure Plate Assembly

The converter clutch pressure plate assembly is splined to the converter turbine assembly and is installed between the turbine assembly and the converter cover (Fig. 17). The apply of the pressure plate is controlled by oil flowing on the turbine side and exerting a force against the plate. The plate is seated against the surface of the converter cover and provides a mechanical direct drive coupling of the engine to the turbine shaft. As oil is redirected to the converter cover side of the pressure plate, it moves away from the converter cover releasing the converter clutch plate. The needs of the converter clutch operation are determined by a series of controls, vehicle speed, and by Drive Range selection.

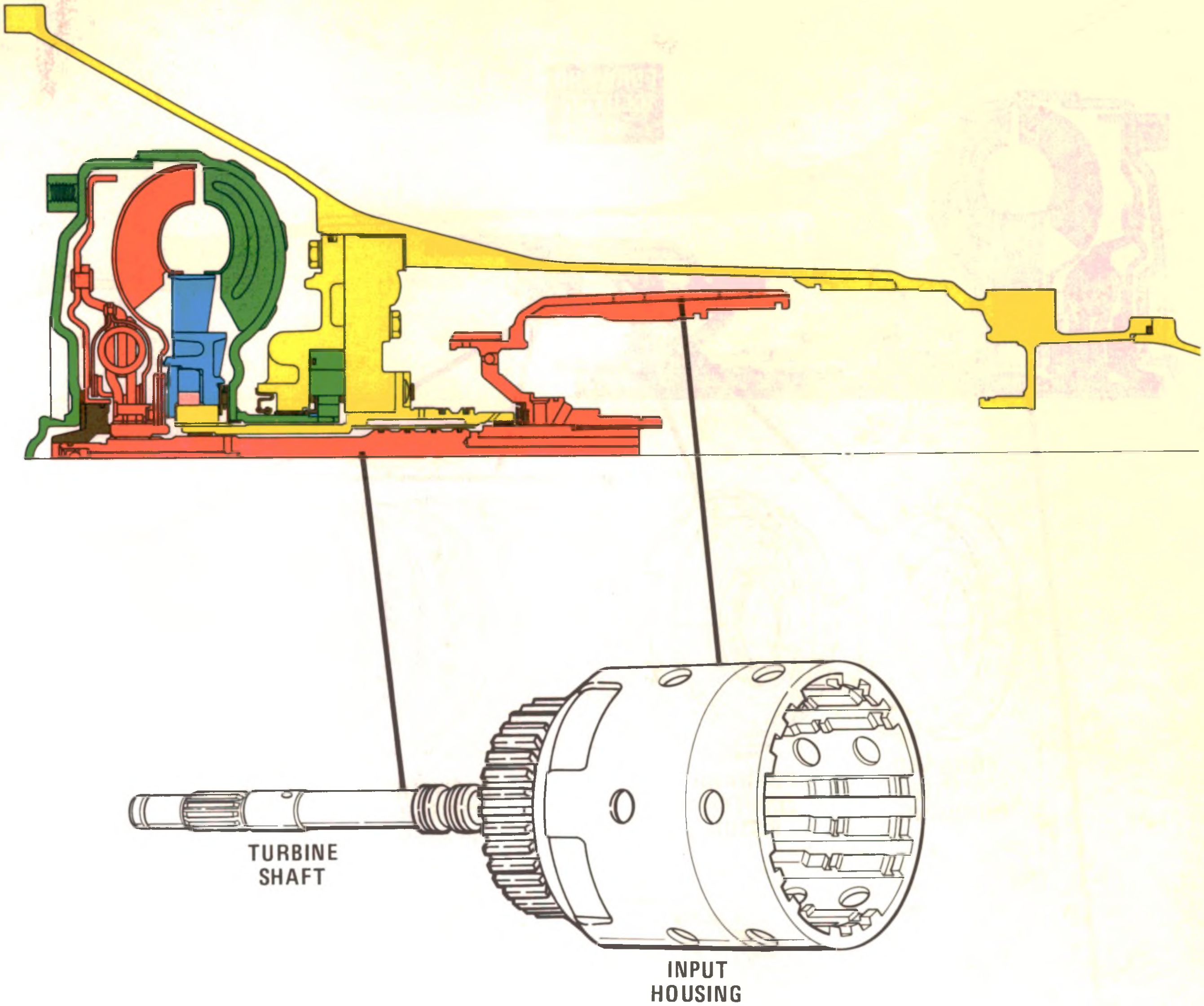

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Figure 18 - Turbine Shaft and Input Housing

To transfer power from the converter to the transmission gear sets, the turbine shaft and the input housing are used. The front of the turbine shaft is splined to the turbine and pressure plate and the back end is permanently attached to the input housing. (Fig. 18).

Actually, the torque converter and turbine shaft form a simple type of transmission in themselves as the converter pump is the input and the turbine shaft is the output. However, the automobile requires more from the transmission, in that some means of providing additional torque multiplication, reverse, and neutral are required.

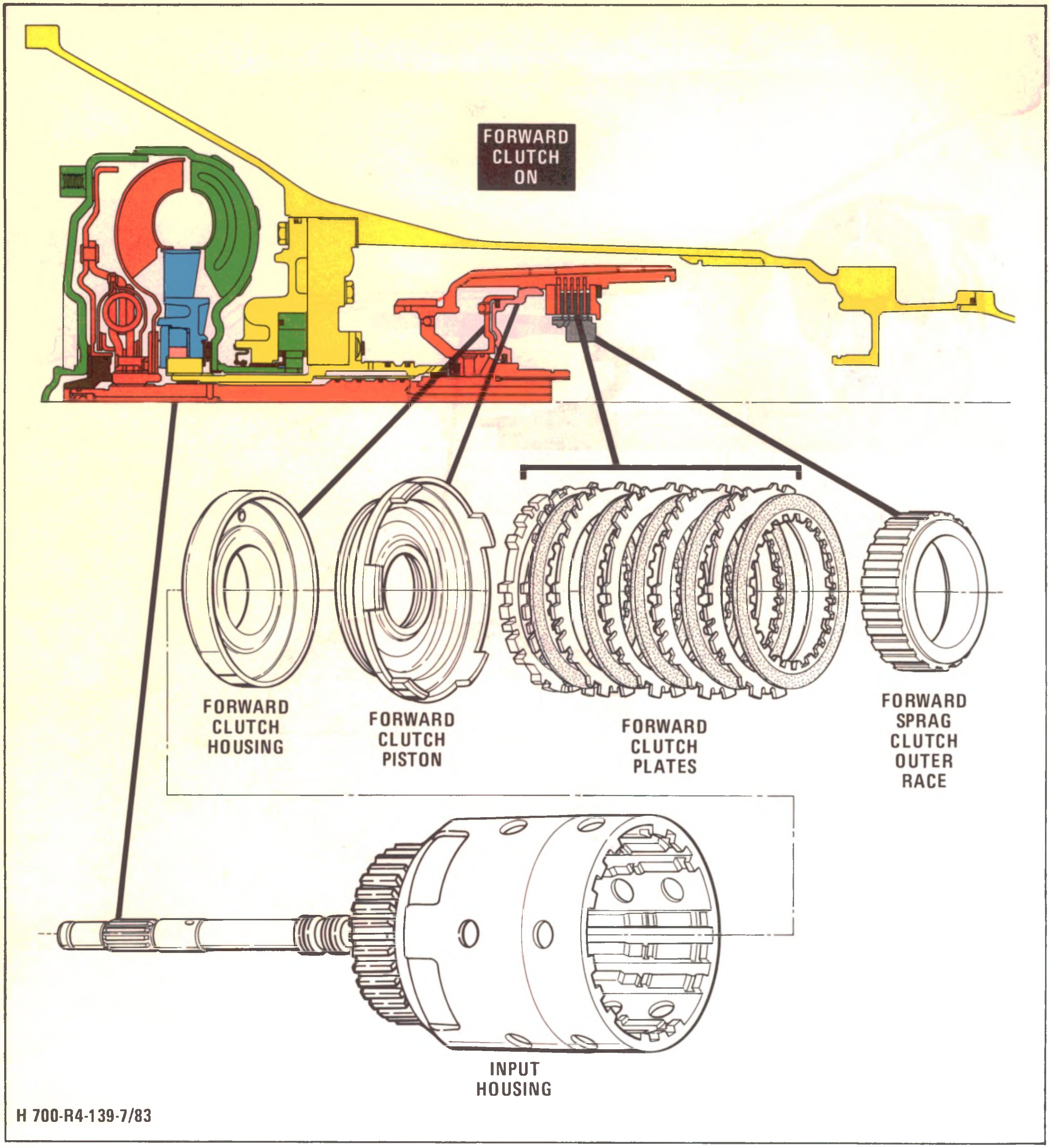


Figure 19 - Forward Clutch

FORWARD CLUTCH

To provide a means of connecting and disconnecting power input from the converter to the transmission gear train, a forward clutch is used (Fig. 19).

The forward clutch is composed of steel clutch plates, tanged to the input housing; composition faced clutch plates, splined to the forward clutch outer race; a forward clutch housing, and a clutch piston that hydraulically applies to hold the plates together.

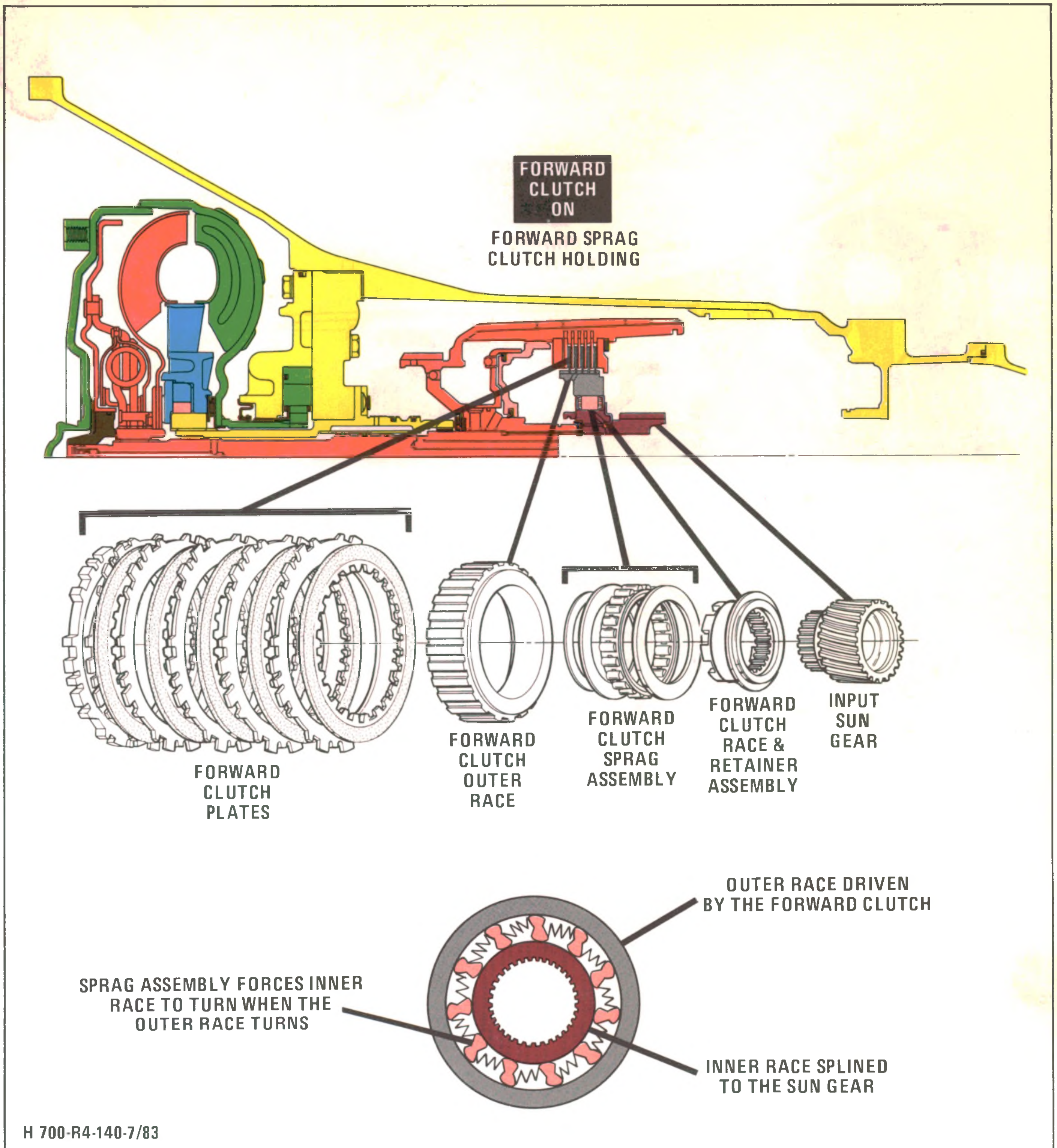


Figure 20 - Forward Sprag Clutch

INPUT CLUTCH ROLLER ASSEMBLY

As described on the previous page the forward clutch composition faced plates are splined to the forward sprag outer race. The race and retainer assembly is splined to the input sun gear (Fig. 20). A sprag clutch is a type of one-way clutch. In this application the sprag assembly is installed between the outer race and inner race in such a way that the inner race and sun gear are forced to rotate at least as fast as the input housing (when the forward clutch is applied). The sprag clutch, however, will allow the sun gear to rotate faster than the input housing when needed.

Whenever the forward clutch is applied, and the forward sprag clutch assembly is holding, power from the converter and turbine shaft is transferred to the input sun gear.

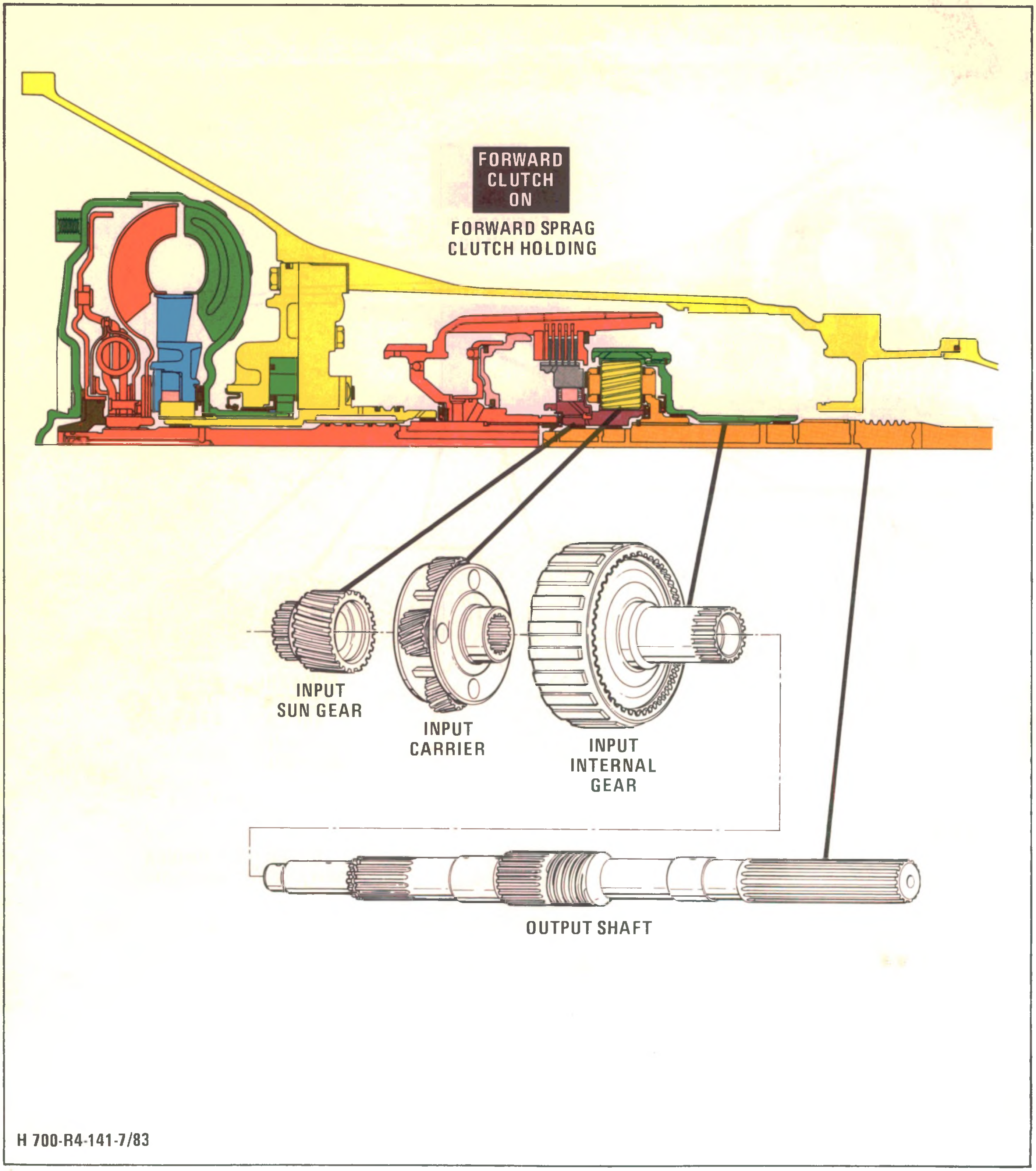


Figure 21 - Input Planetary Gear Set

INPUT PLANETARY GEAR SET

The input planetary gear set consists of an input sun gear, an input carrier and pinion assembly splined to the output shaft, and an input internal gear (Fig. 21). Power through the forward clutch and sprag assembly causes the input sun gear to turn in a clockwise direction. With the weight of the vehicle restraining the output shaft and input carrier from turning, the input sun gear will try and turn the input internal gear counterclockwise. To make the input gear set effective in driving the vehicle, the input internal gear must be prevented from rotating counterclockwise.

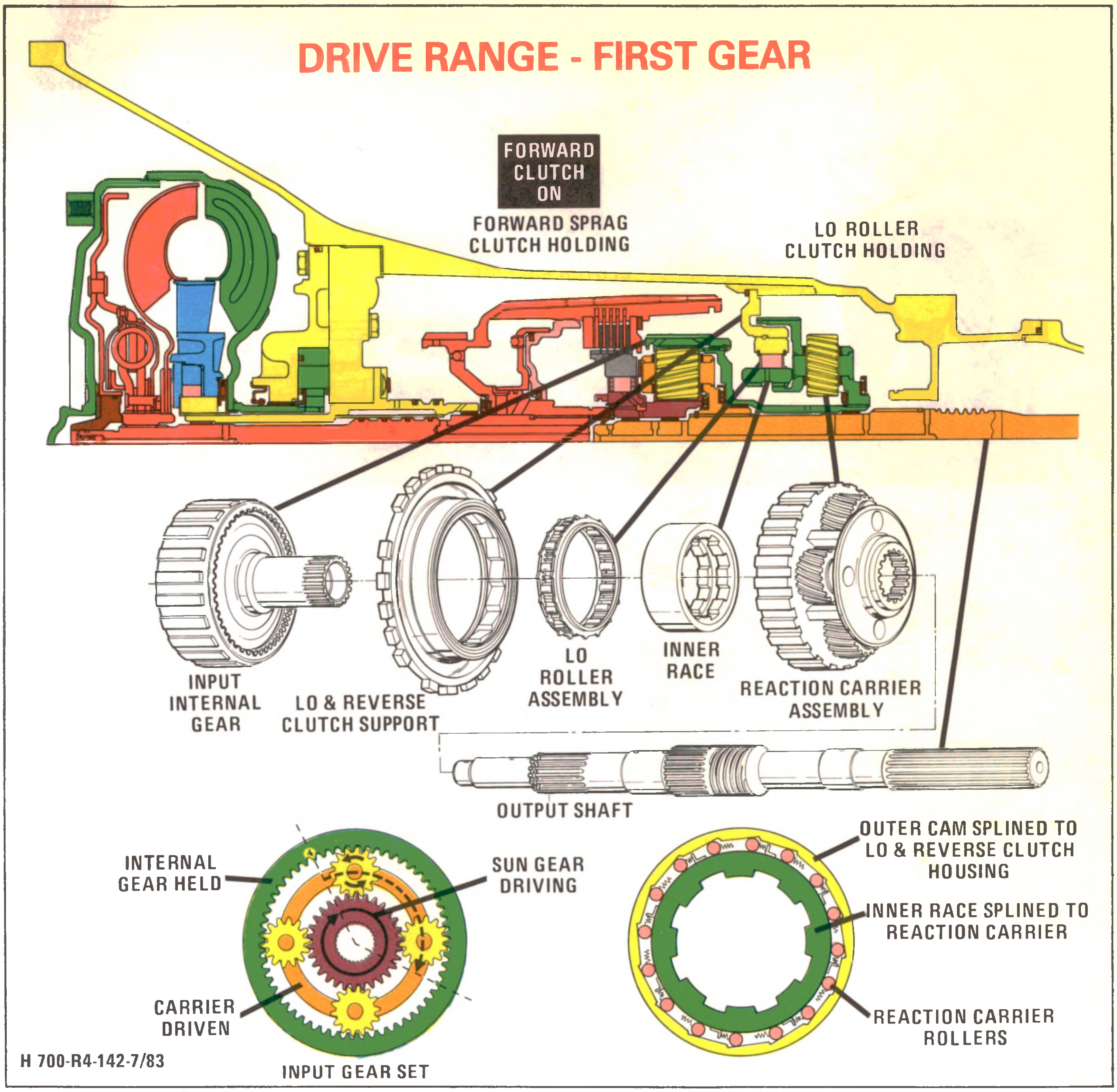


Figure 22 - Lo Roller Clutch

LO ROLLER CLUTCH

To prevent the input internal gear from turning in a counterclockwise direction it is splined to the reaction carrier. The reaction carrier is splined to the inner race of the lo roller clutch. The outer cam is held stationary by the lo and reverse clutch support, which is held stationary by the case (Fig. 22).

The rollers are installed between the race and cam in such a way that they prevent the reaction carrier and input internal gear from turning counterclockwise. With the sun gear driving clockwise and the internal gear restrained from turning counterclockwise the input carrier is forced to drive the output shaft in reduction at a ratio of approximately 3.06:1. This gear reduction combined with the maximum converter torque multiplication of approximately 2.0:1, gives an overall transmission first gear starting ratio of approximately 6.12:1 (6.12 input to 1 output).

The high gear ratio in first gear provides the torque multiplication necessary to start the vehicle moving. The engine's efficiency is dependent upon it maintaining it's speed (R.P.M's) in a narrow range. As vehicle speed increases, less torque multiplication is needed for maximum efficiency. Thus, it is desirable to shift the transmission to a lower ratio or second gear.

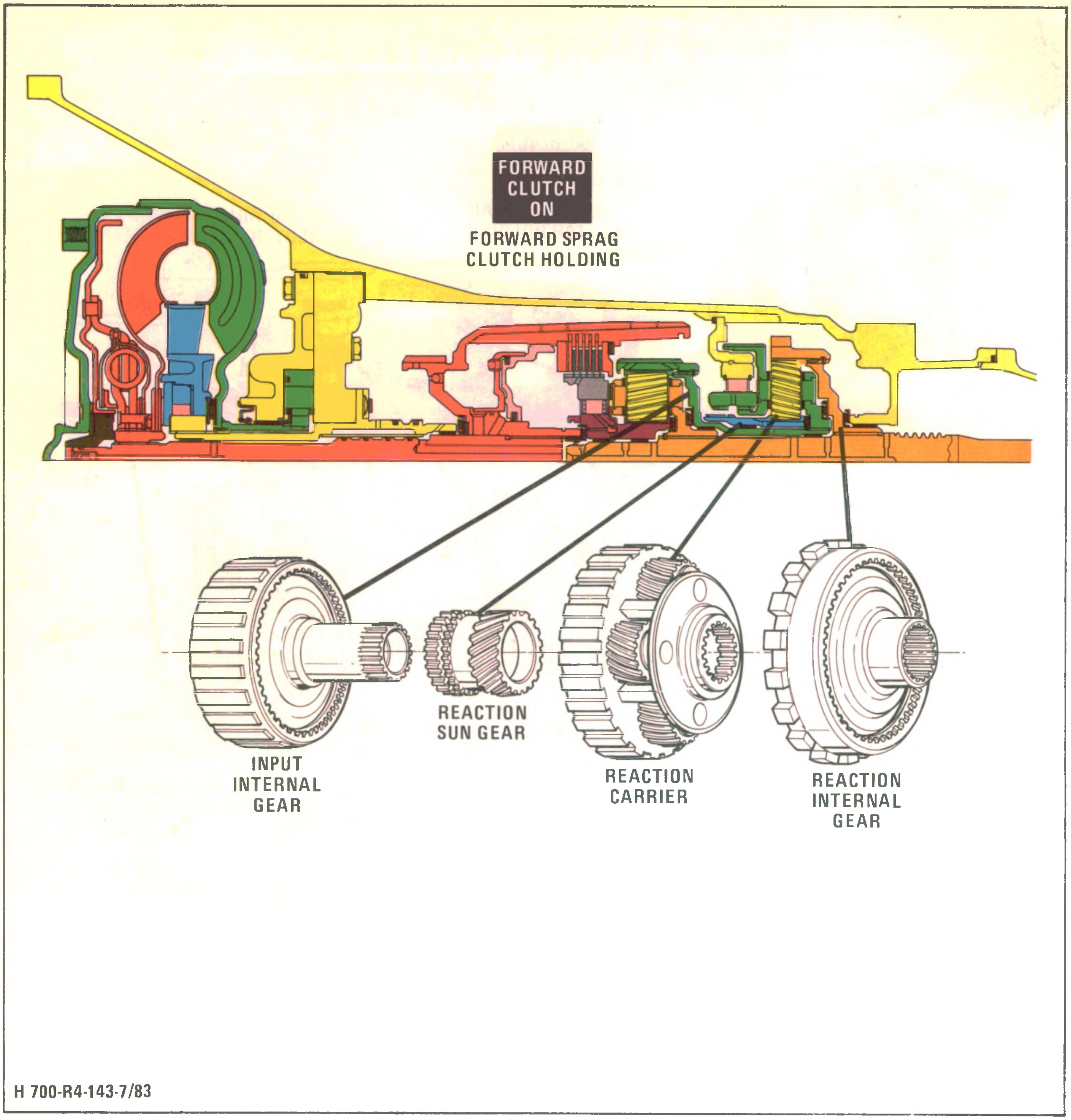


Figure 23 - Reaction Gear Set

REACTION GEAR SET

In first gear the input internal gear is prevented from turning counterclockwise giving the transmission full torque multiplication (3.06:1) through the input gear set. If we were to start rotating the input internal gear clockwise in reduction and still use the sun gear as input and the carrier as output the torque multiplication would change and the transmission would be in a different gear, second gear.

In first gear the reaction internal gear, splined to the output shaft is rotating clockwise in reduction (3.06:1). The reaction carrier is held stationary by the lo roller clutch. The reaction sun gear is driven counterclockwise by the reaction internal gear (Fig. 23). In second gear the reaction sun gear is held, forcing the reaction carrier and the input internal gear to rotate clockwise in reduction. To make the change then, from first gear to second gear the counterclockwise rotation of the reaction sun gear is stopped. This is accomplished by adding the reaction sun shell, the reverse input drum, and the 2-4 band (Fig. 24).

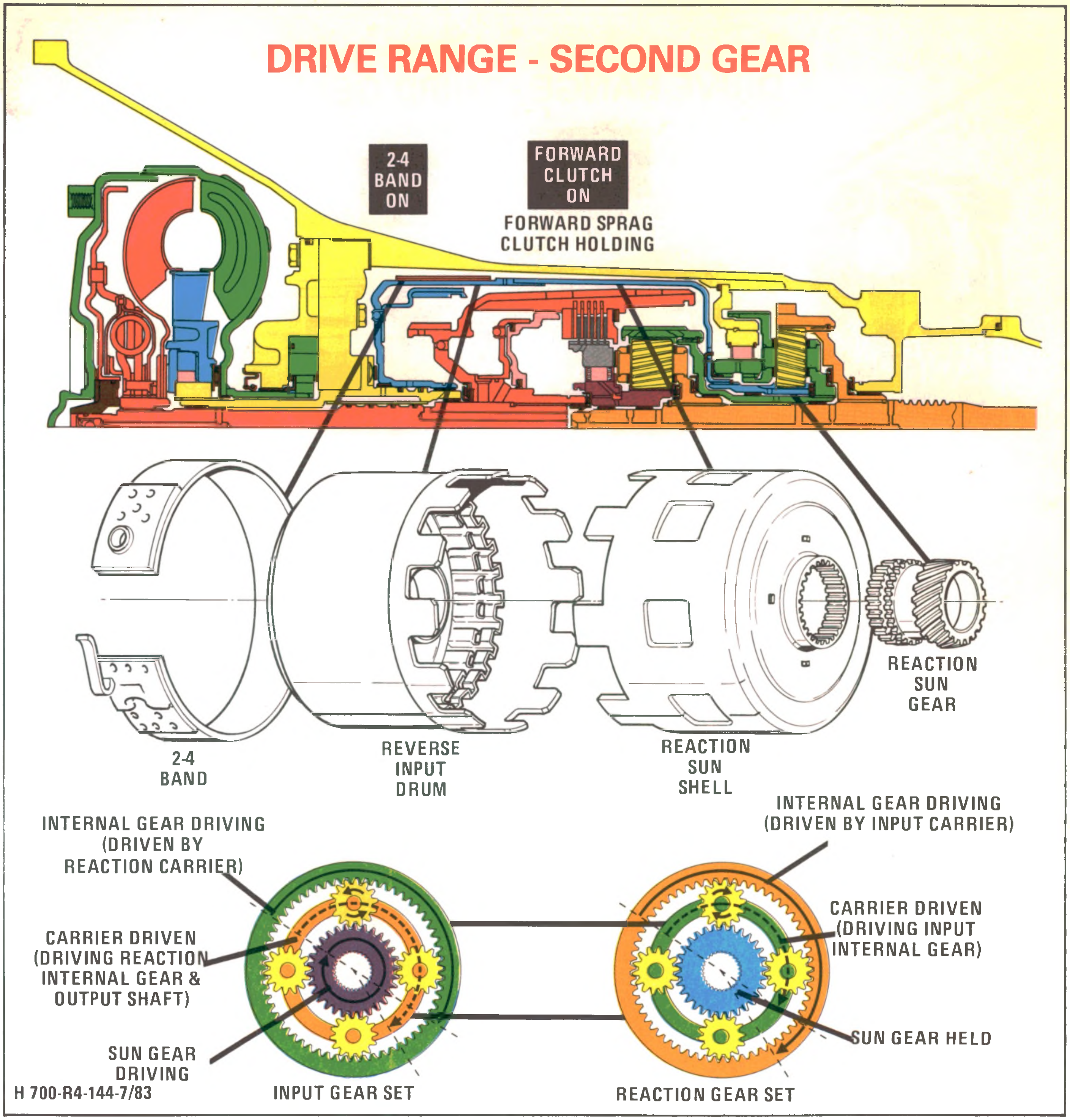


Figure 24 - 2-4 Band

2-4 BAND

The reaction sun shell is splined to the reaction sun gear and tanged to the reverse input drum. With the 2-4 band hydraulically applied, the reverse input drum, reaction sun shell, and reaction sun gear are held, preventing them from rotating (Fig. 24).

Power flow is now as follows:

Converter output is transmitted through the input housing, the forward clutch, and the forward clutch sprag assembly to the input sun gear. The input carrier, rotating in reduction, transmits power through the output shaft to the reaction internal gear. The reaction internal gear forces the reaction pinions to rotate clockwise on their pins and walk around the stationary reaction sun gear. This rotates the reaction carrier and input internal gear clockwise in a second reduction of 1.44:1.

Power input is through the input sun gear and output is through the input carrier as it was in 1st gear, but the input internal gear is rotated clockwise in reduction to change the overall gear ratio to approximately 1.63:1 (1.63 input to 1 output) or second gear.

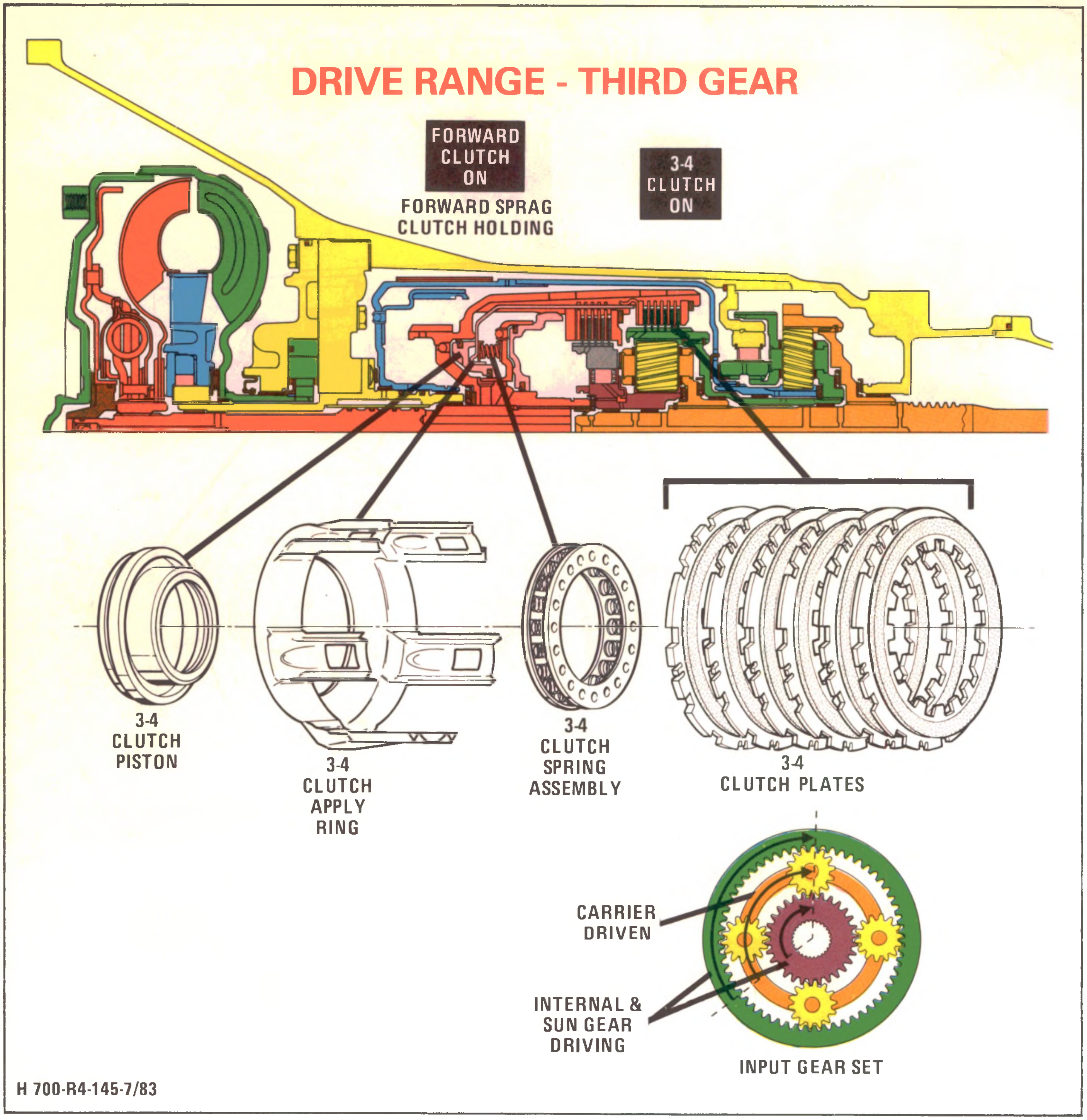


Figure 25 - 3-4 Clutch

3-4 CLUTCH

As the vehicle continues to accelerate and the engine's most efficient speed (R.P.M's) would again be exceeded, it becomes desirable to shift the transmission to a lower ratio a second time. This is accomplished by releasing the 2-4 band and adding the 3-4 clutch: piston, apply ring, and clutch plates (Fig. 25).

The 3-4 clutch steel plates are splined to the input housing which is welded to the turbine shaft. The 3-4 clutch fiber plates are splined to the input internal gear. The 3-4 clutch plates are hydraulically applied by the 3-4 piston located in the input housing. With the 3-4 clutch applied, power travels from the input housing to the input internal gear turning the front internal gear at turbine speed. The forward clutch is still applied providing power from the input housing, through the input roller clutch to the input sun gear, at turbine speed. The input sun and internal gears are now turning at the same speed, turbine speed. The input carrier pinions act as wedges forcing the input carrier and the output shaft to turn at the same speed, turbine speed. The transmission is now in direct drive.

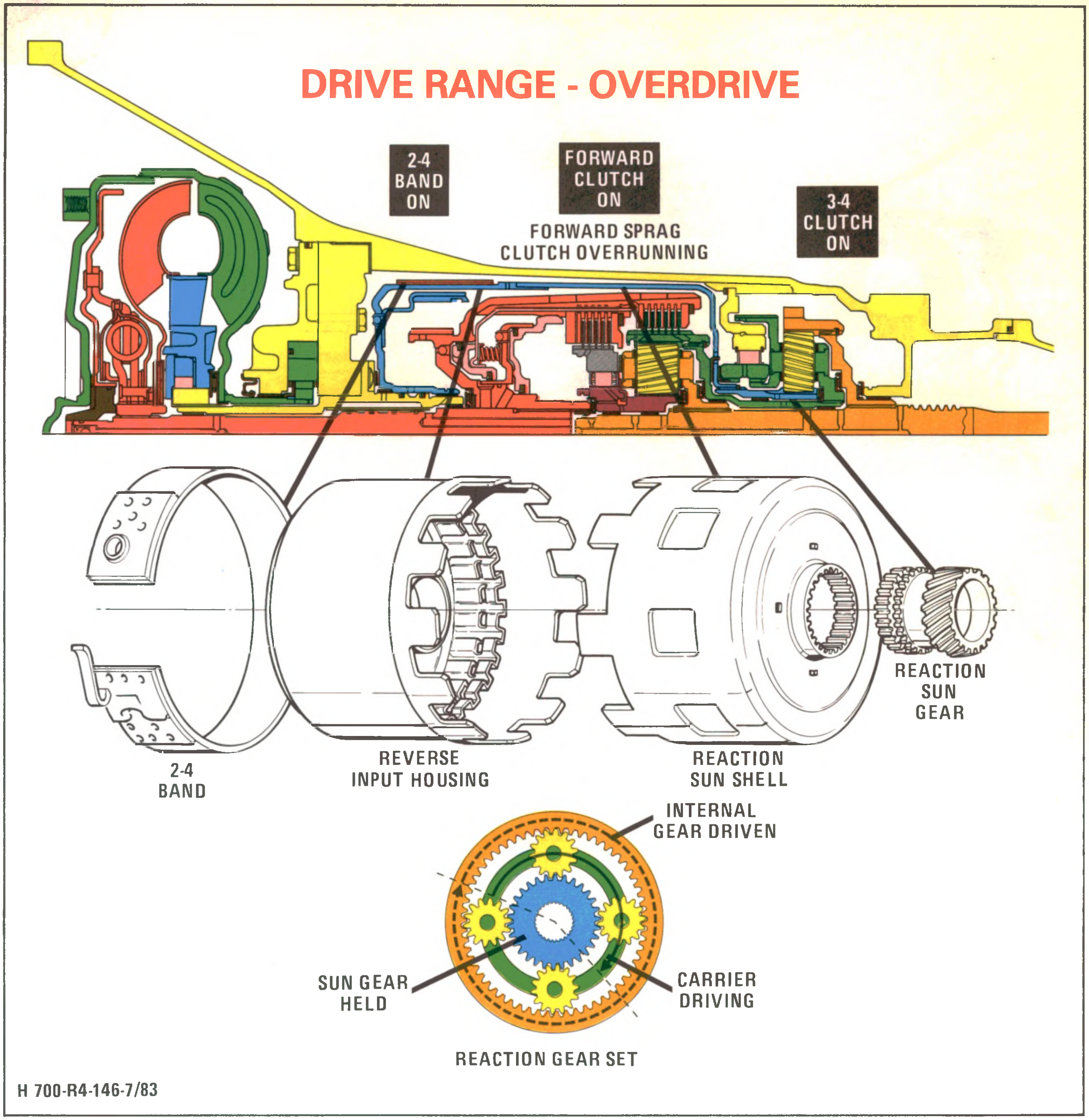


Figure 26 - Overdrive

DRIVE RANGE — OVERDRIVE

When the vehicle is at cruising speed, with the transmission in direct drive, the engine R.P.M's are greater than what is required to maintain vehicle speed. To increase fuel economy the transmission can shift into overdrive.

To shift the transmission into overdrive the 2-4 band is, again, applied and holds the reverse input housing, the reaction sun shell, and the reaction sun gear stationary. (Fig. 26). Power flow is now transferred, at turbine speed, from the input housing through the 3-4 clutch to the input internal gear and reaction carrier. The reaction pinions are forced to walk around the stationary reaction sun gear and drive the reaction internal gear clockwise, in overdrive, at approximately a .70:1 (.7 input to 1 output) ratio.

It should be noted that the forward clutch is still applied, but is ineffective due to the input sun gear being driven faster than the input housing by the input carrier. This causes the forward sprag clutch to overrun rendering the forward clutch ineffective.

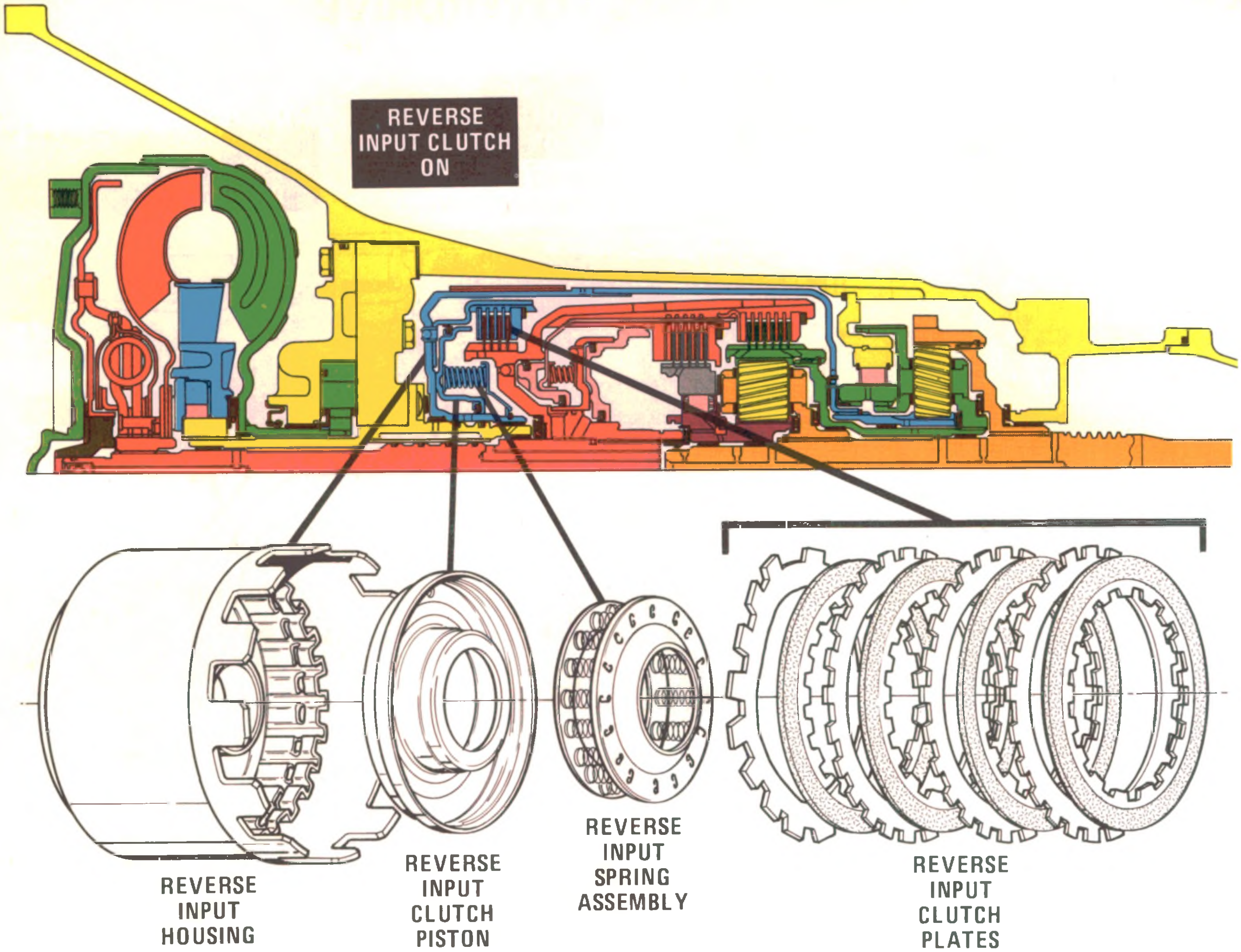


Figure 27 - Reverse Input Clutch

REVERSE INPUT CLUTCH

To provide a means of driving the vehicle in reverse the reverse input clutch assembly is used. (Fig. 27). The reverse input clutch assembly consists of a reverse input housing tanged to the reaction sun shell, steel clutch plates tanged to the reverse input housing, composition clutch plates tanged to the input housing, a clutch piston which hydraulically applies to hold the clutch plates together, and release springs that retract the piston to release the clutch when hydraulic pressure is exhausted. With the reverse input clutch applied, power from the converter travels, clockwise, through the input housing, to the reverse input housing, to the reaction sun shell, to the reaction sun gear. With the weight of the vehicle restraining the output shaft and reaction internal gear from turning, the reaction sun gear will try and turn the reaction carrier clockwise overrunning the lo roller clutch. To make the reaction gear set effective in driving the vehicle in reverse, the reaction carrier must be prevented from rotating clockwise.

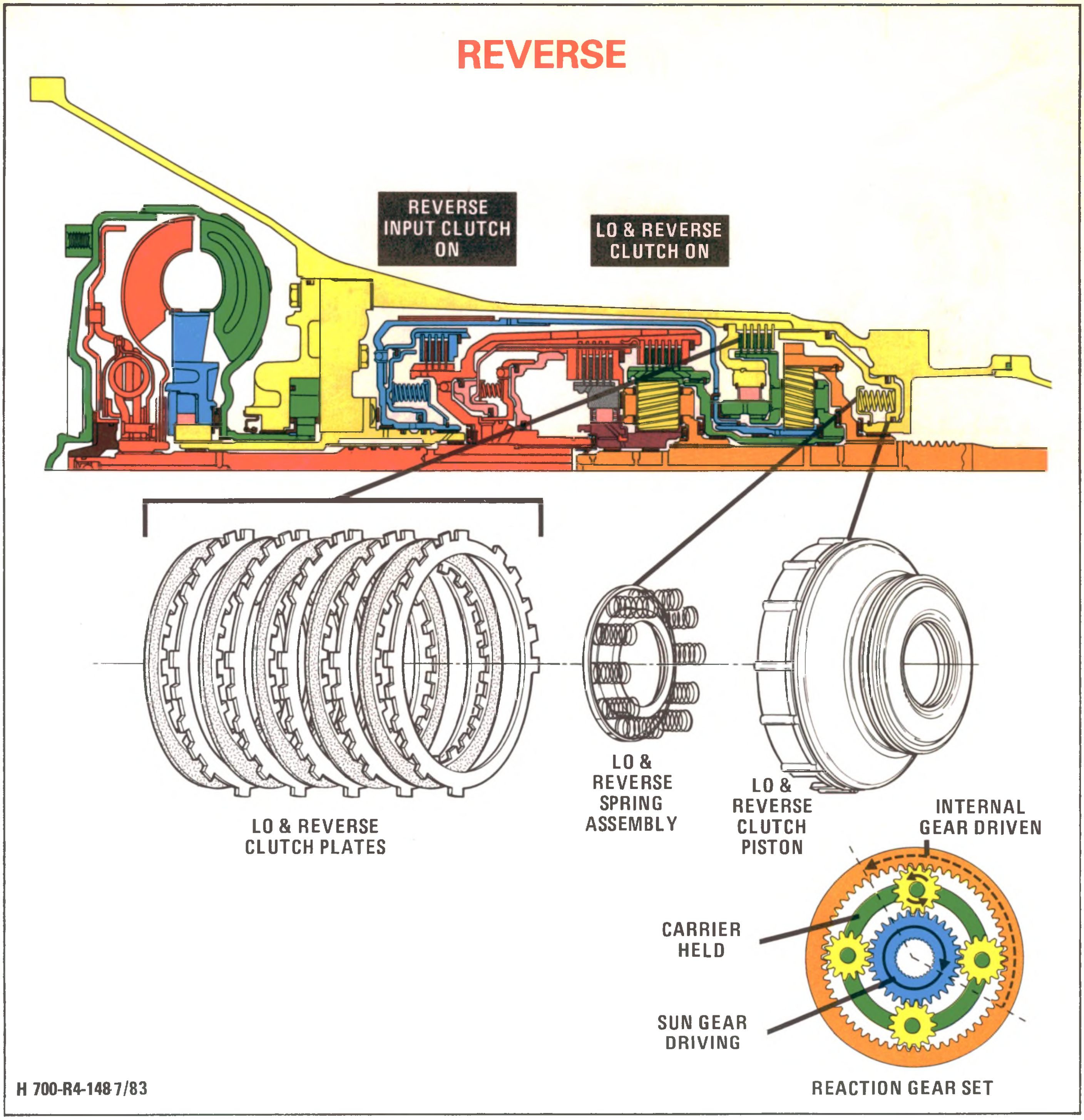


Figure 28 - Lo and Reverse Clutch

LO AND REVERSE CLUTCH

To drive the vehicle in reverse the reaction carrier must not be allowed to be driven clockwise by the reaction sun gear. The lo and reverse clutch is provided to hold the carrier stationary (Fig. 28).

The lo and reverse clutch consists of steel clutch plates splined to the case, composition clutch plates splined to the reaction carrier, a clutch piston which hydraulically applies to hold the clutch plates together, and release springs that retract the piston to release the clutch when hydraulic pressure is exhausted. With the reverse input and lo and reverse clutches applied power from the converter travels clockwise, through the input housing to the reverse input drum, to the reaction sun shell, to the reaction sun gear. With the carrier held, the sun gear will cause the pinions to rotate counterclockwise on their pins and drive the reaction internal gear counterclockwise in reduction at a ratio of approximately 2.30:1. The overall torque multiplication and gear reduction, is approximately 4.60:1 (4.60 input to 1 output).

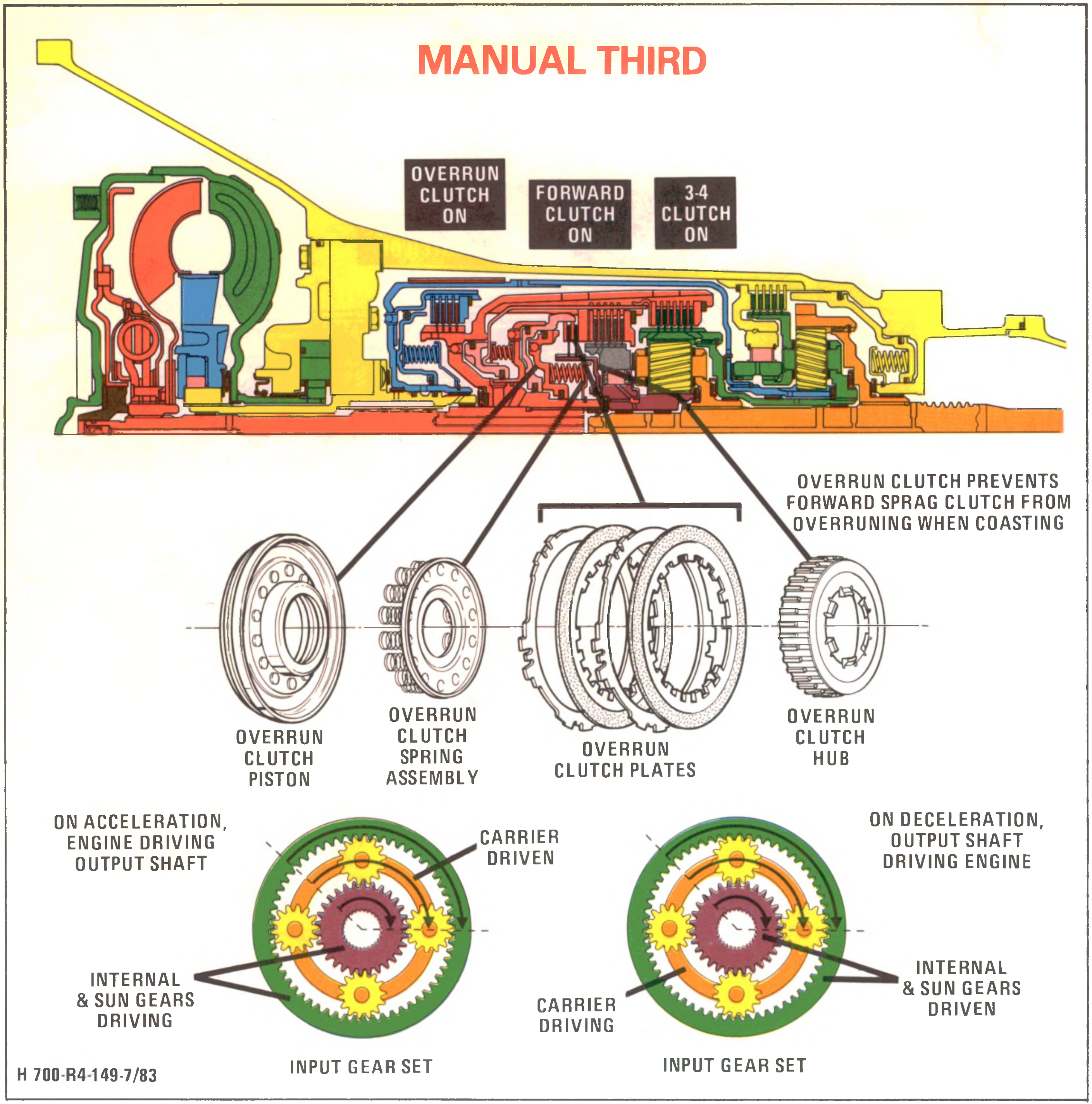


Figure 29 - Overrun Clutch

ENGINE BRAKING — MANUAL THIRD

In Manual Third the transmission performs first to second and second to third gear shifts as it did in Drive Range, but is prevented from making a third to fourth gear shift. If the transmission is in overdrive it will immediately downshift to third gear (Fig. 29). In Drive Range when the rear wheels are driving the output shaft and the input carrier faster than the engine is driving the turbine shaft, deceleration, the input carrier drives the input sun gear faster than the input housing, and the forward sprag clutch overruns. In Manual Third, Second, and Lo the overrun clutch prevents the forward sprag clutch from overrunning and provides engine braking.

The overrun clutch consists of steel clutch plates splined to the input housing, composition clutch plates splined to the overrun clutch hub, and an overrun clutch hub splined to the input roller clutch cam, which is splined to the input sun gear. Thus, the overrun clutch, when applied, forces the input sun gear to turn at the same speed as the input housing, preventing the forward sprag clutch from overruning, and provides engine braking.

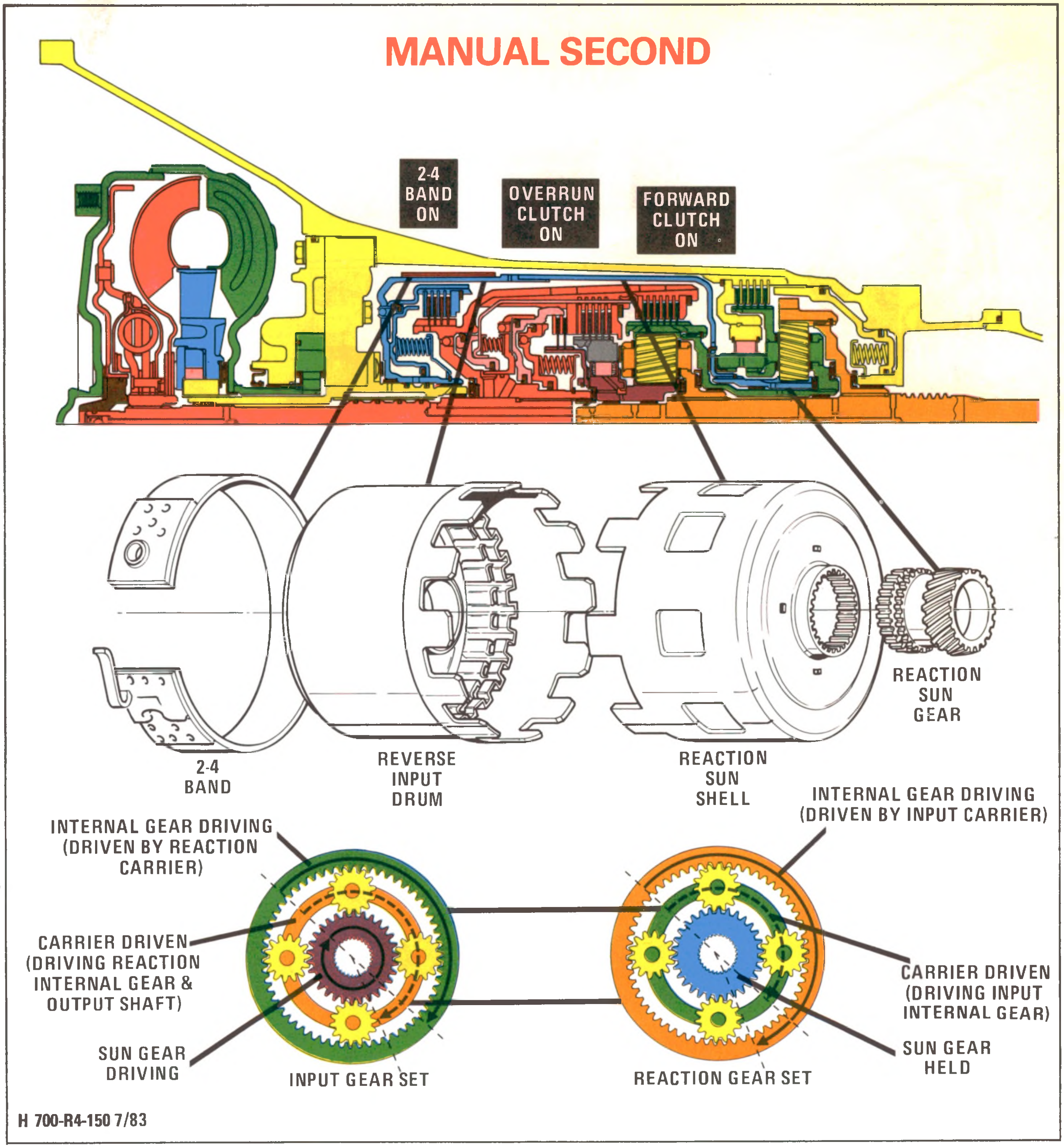


Figure 30 - 2-4 Band — Manual Second

ENGINE BRAKING — MANUAL SECOND

In Manual Second the 700-R4 transmission operates in the same manner as it did in Drive Range — Second Gear (Fig. 30), except the transmission performs a first to second gear shift as it did in Drive Range but is prevented from making a second to third gear shift. If the transmission is in third gear or overdrive it will immediately shift to second gear. The overrun clutch is applied as in Manual Third, to permit the use of engine compression as a braking force when the accelerator is released.

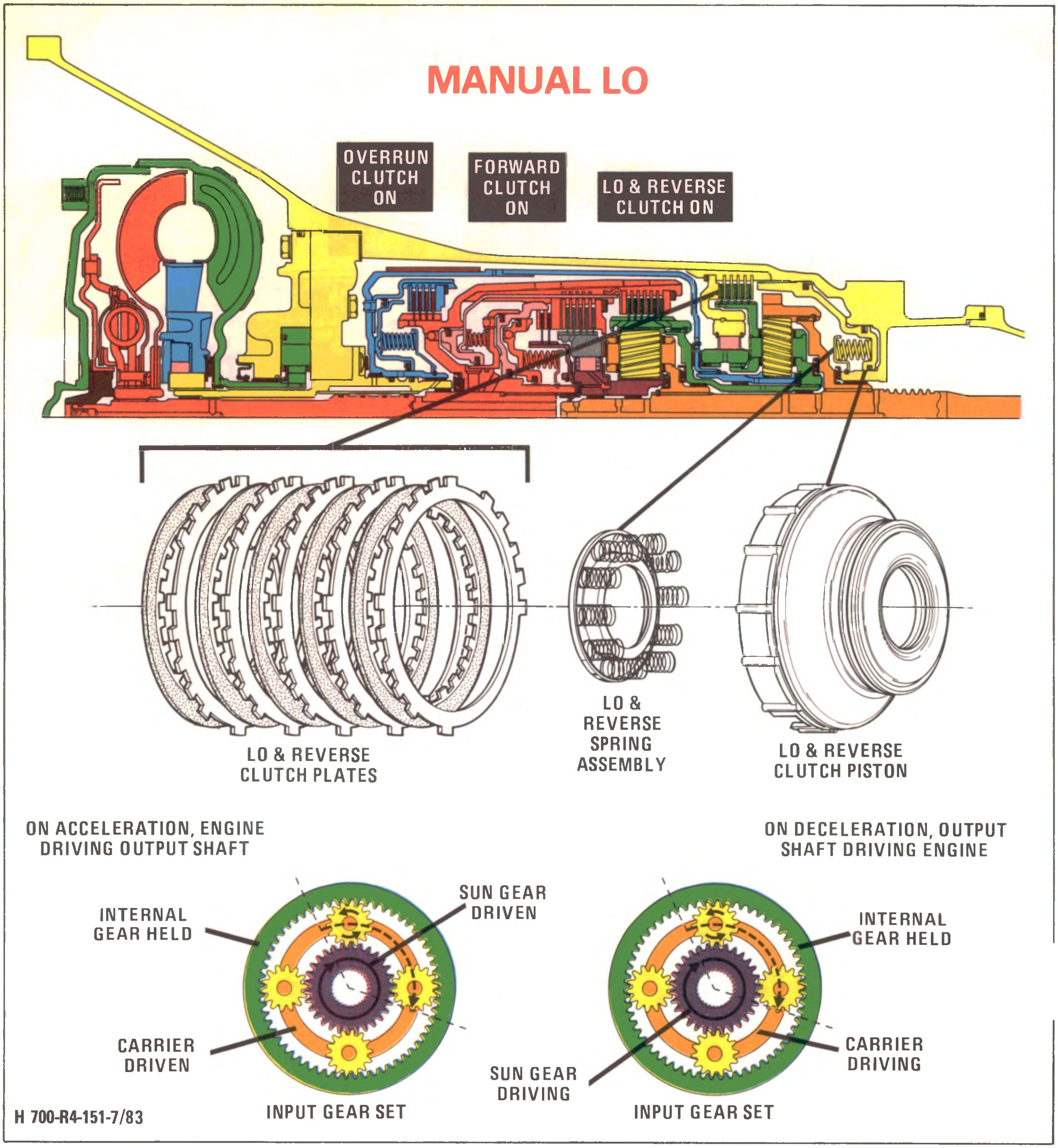


Figure 31 - Lo and Reverse Clutch — Manual Lo

ENGINE BRAKING — MANUAL LO

For maximum engine braking the selector lever can be placed in the Manual Lo position (Fig. 31). At speeds below approximately 30 m.p.h. (48 km/h), the transmission will shift to first gear. When the vehicle coasts in first gear, the rear wheels are driving the transmission through the output shaft. With the output shaft and reaction internal gear being driven faster by the rear wheels, than the engine is driving them through the input gear set, the reaction internal gear would drive the reaction carrier clockwise overrunning the lo roller clutch. To prevent the rear carrier from overrunning the roller clutch, the lo and reverse clutch is applied and keeps the transmission in first gear to provide effective braking using engine compression.

SUMMARY OF POWER FLOW

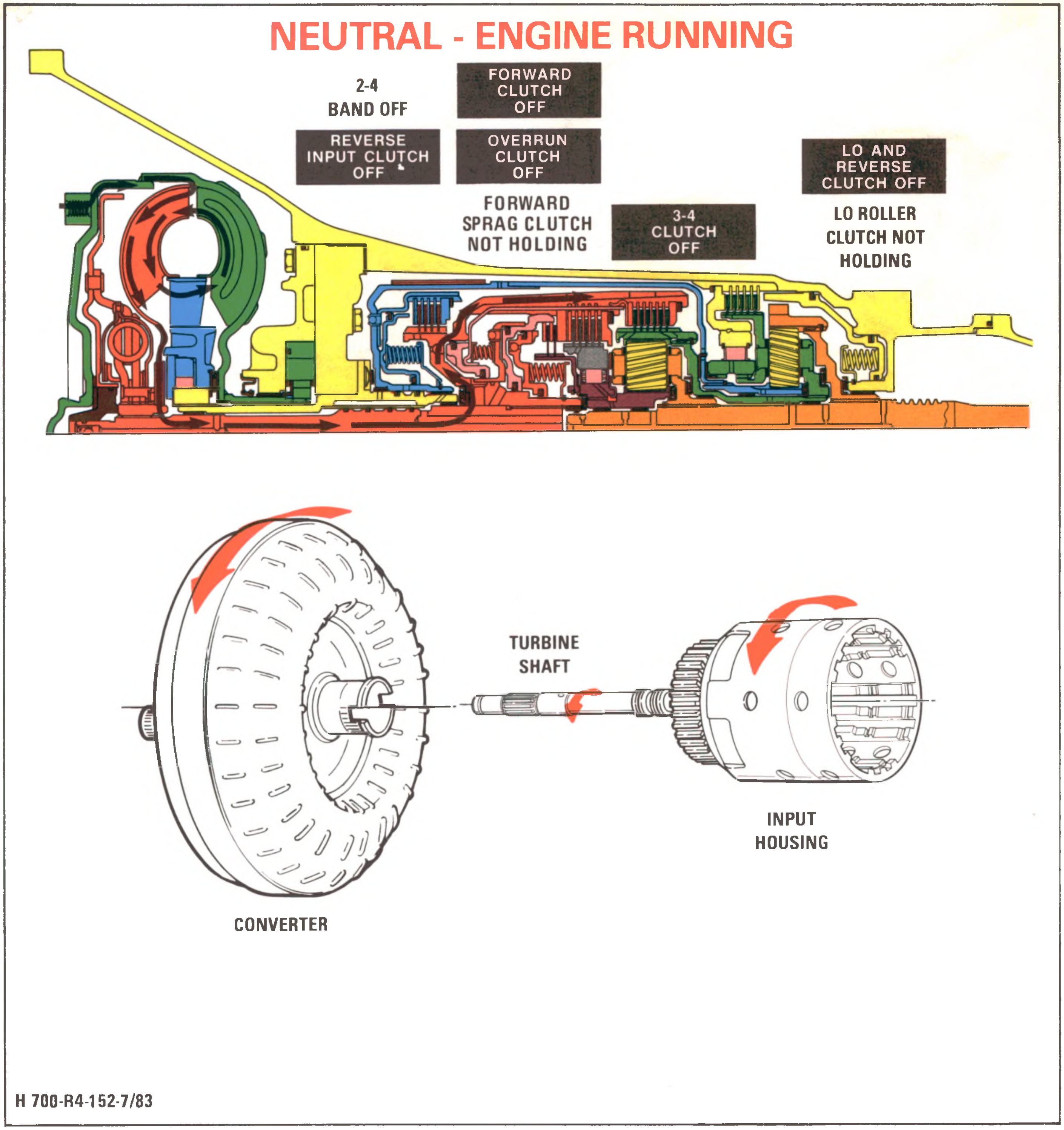


Figure 32 - Neutral — Engine Running

FORWARD CLUTCH-RELEASED

2-4 BAND-RELEASED

LO AND REVERSE CLUTCH-RELEASED

FORWARD SPRAG CLUTCH-NOT HOLDING

3-4 CLUTCH-RELEASED

REVERSE INPUT CLUTCH-RELEASED

LO ROLLER CLUTCH-NOT HOLDING

OVERRUN CLUTCH-RELEASED

With the selector lever in Neutral (N), the band and all clutches are released; therefore, no power is transmitted from the turbine shaft and input clutch housing to the planetary gear train and output shaft.

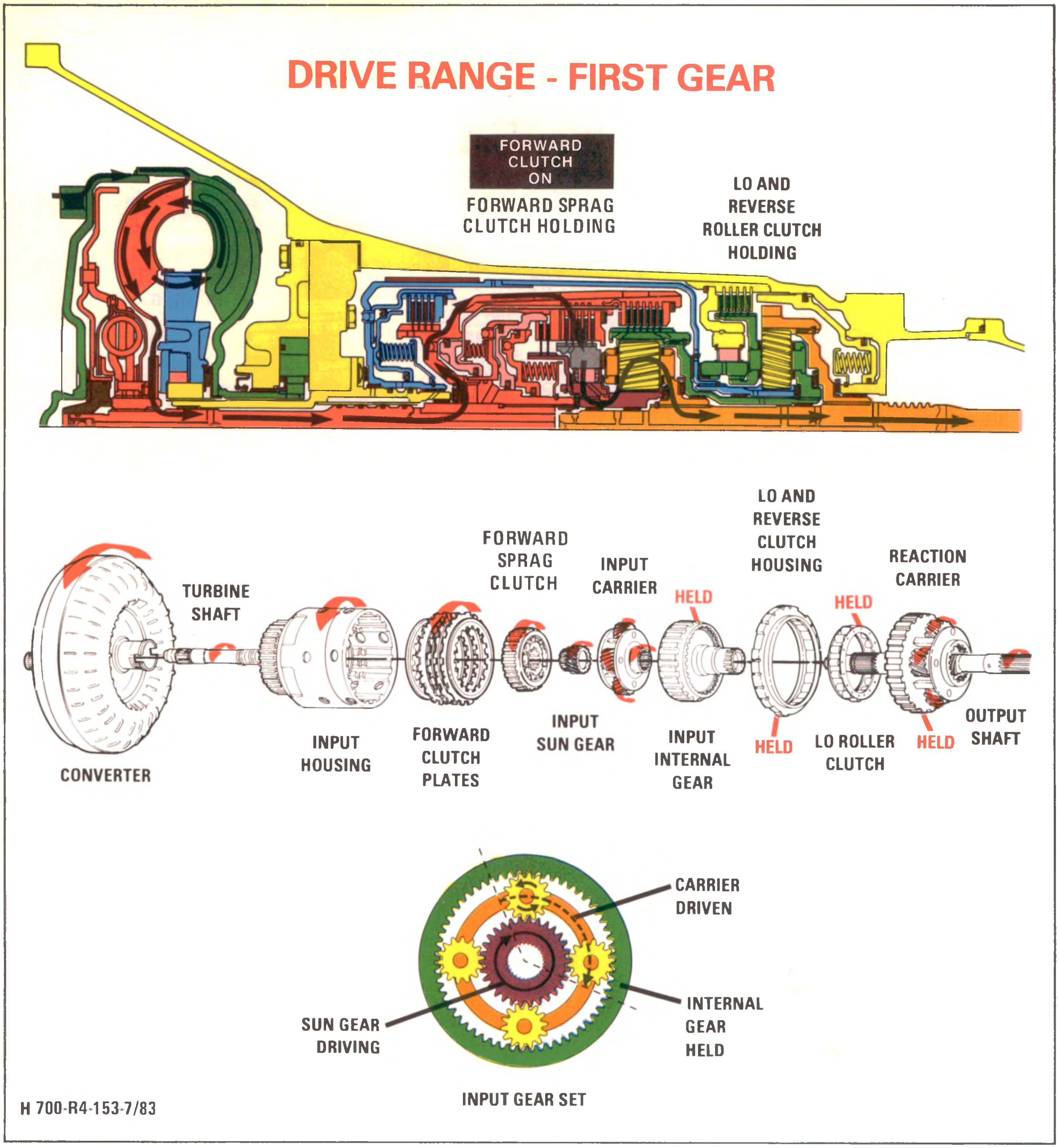


Figure 33 - Drive Range — First Gear

FORWARD CLUTCH — APPLIED | **FORWARD SPRAG CLUTCH – HOLDING** | **LO ROLLER CLUTCH — HOLDING**

With the selector lever in Drive Range (D), the forward clutch is applied. Converter torque is now applied through the input housing and forward clutch, to the forward sprag clutch. The forward sprag clutch holds, driving the input sun gear at least as fast as the input housing. With the input sun gear driving clockwise, at turbine speed, it will try and drive the input carrier, and output shaft clockwise or the input internal gear counterclockwise. The lo roller clutch prevents the reaction carrier and input internal gear from turning counterclockwise, forcing the input sun gear to drive the input carrier and output shaft clockwise in a reduction of approximately 3.06:1. Converter torque is approximately two times engine torque at stall to give an approximate overall stall ratio of 6.12:1 (6.12 input to 1 output) in first gear.

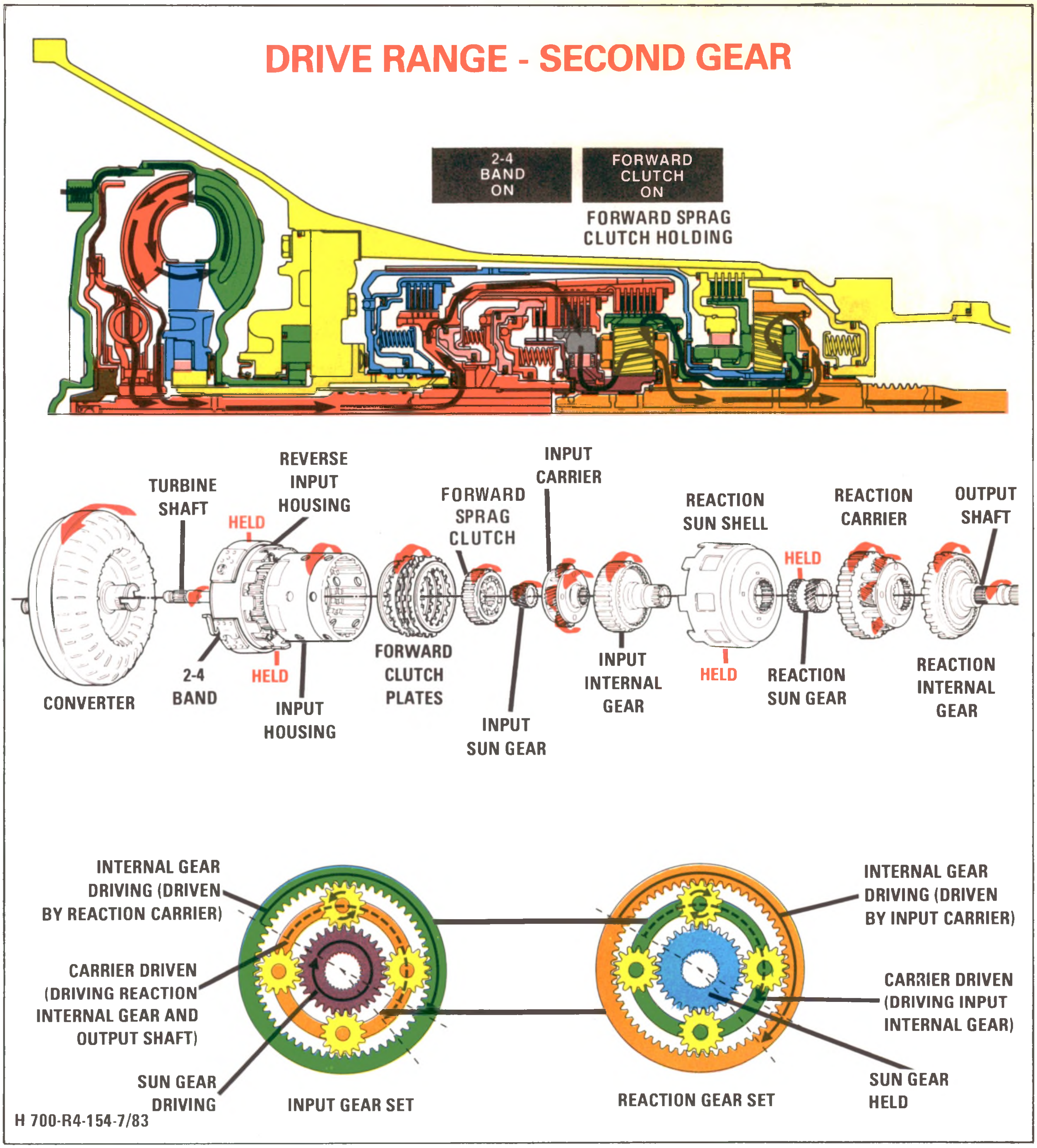


Figure 34 - Drive Range - Second Gear

FORWARD CLUTCH-APPLIED **FORWARD SPRAG CLUTCH – HOLDING** **2-4 BAND-APPLIED**

In Driving Range Second Gear, the 2-4 band is applied to hold the reverse input housing, reaction sun shell, and reaction sun gear stationary. Converter torque is now applied through the input housing, forward clutch, and forward sprag clutch to the input sun gear. The input sun gear drives the input carrier, output shaft and reaction internal gear clockwise in reduction. With the reaction sun gear held, the reaction internal gear drives the reaction carrier and input internal gear clockwise in a second reduction. With the input sun gear driving clockwise at turbine speed and the input internal gear driving clockwise in reduction, the input carrier and output shaft are driven clockwise in a reduction of approximately 1.63:1 (1.63 input to 1 output).

DRIVE RANGE - THIRD GEAR

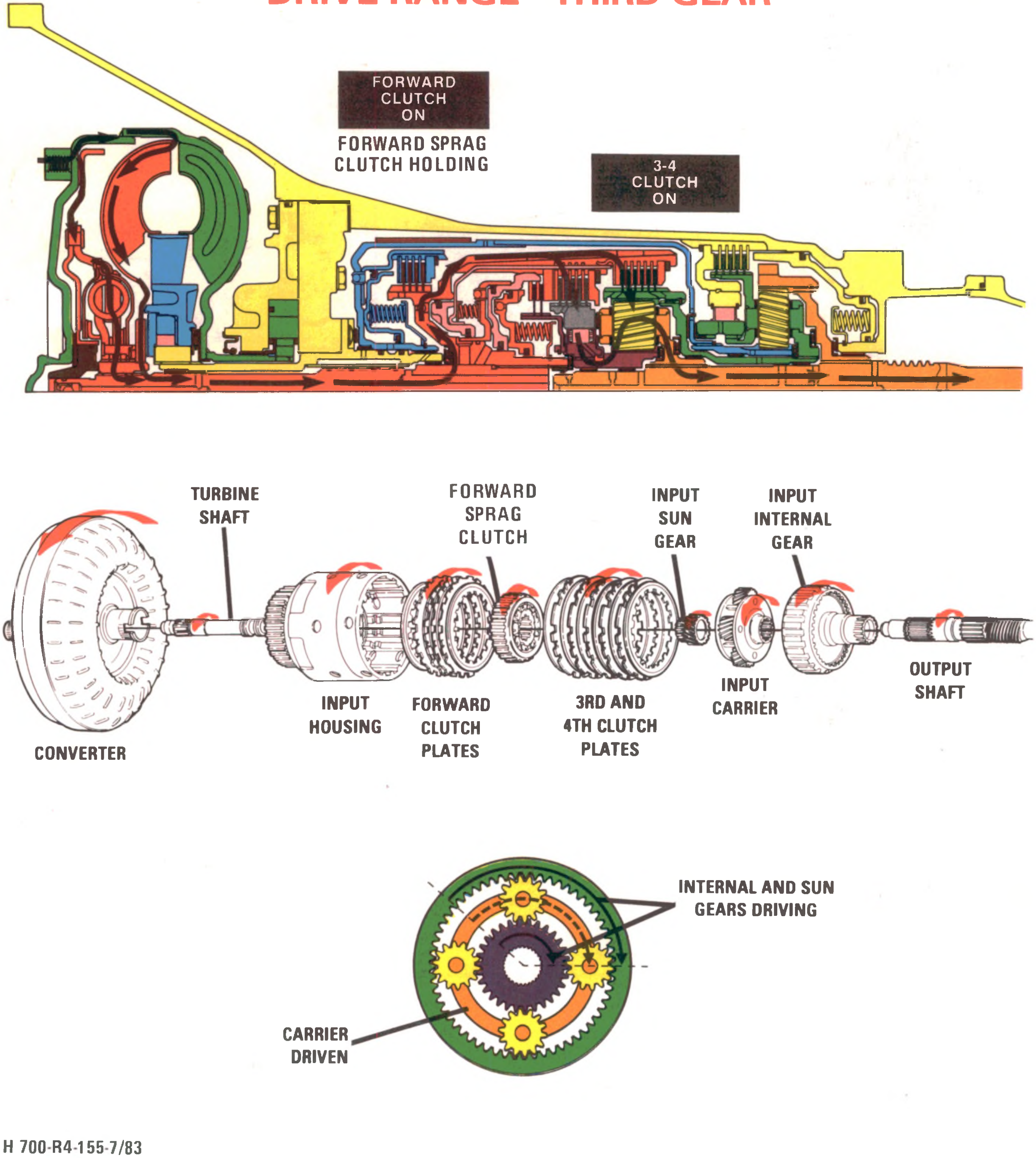


Figure 35 - Drive Range - Third Gear

FORWARD CLUTCH — APPLIED **FORWARD SPRAG CLUTCH – HOLDING** **3-4 CLUTCH — APPLIED**

In Drive Range Third Gear, the 2-4 band is released and the 3-4 clutch is applied. Converter torque is still applied through the input housing, forward clutch, and forward sprag clutch to the input sun gear. Converter torque is now applied through the input housing and the 3-4 clutch to the input internal gear. With both the input sun and internal gears turning at converter speed, the input planetary carrier is forced to turn at converter speed or at a ratio of 1:1.

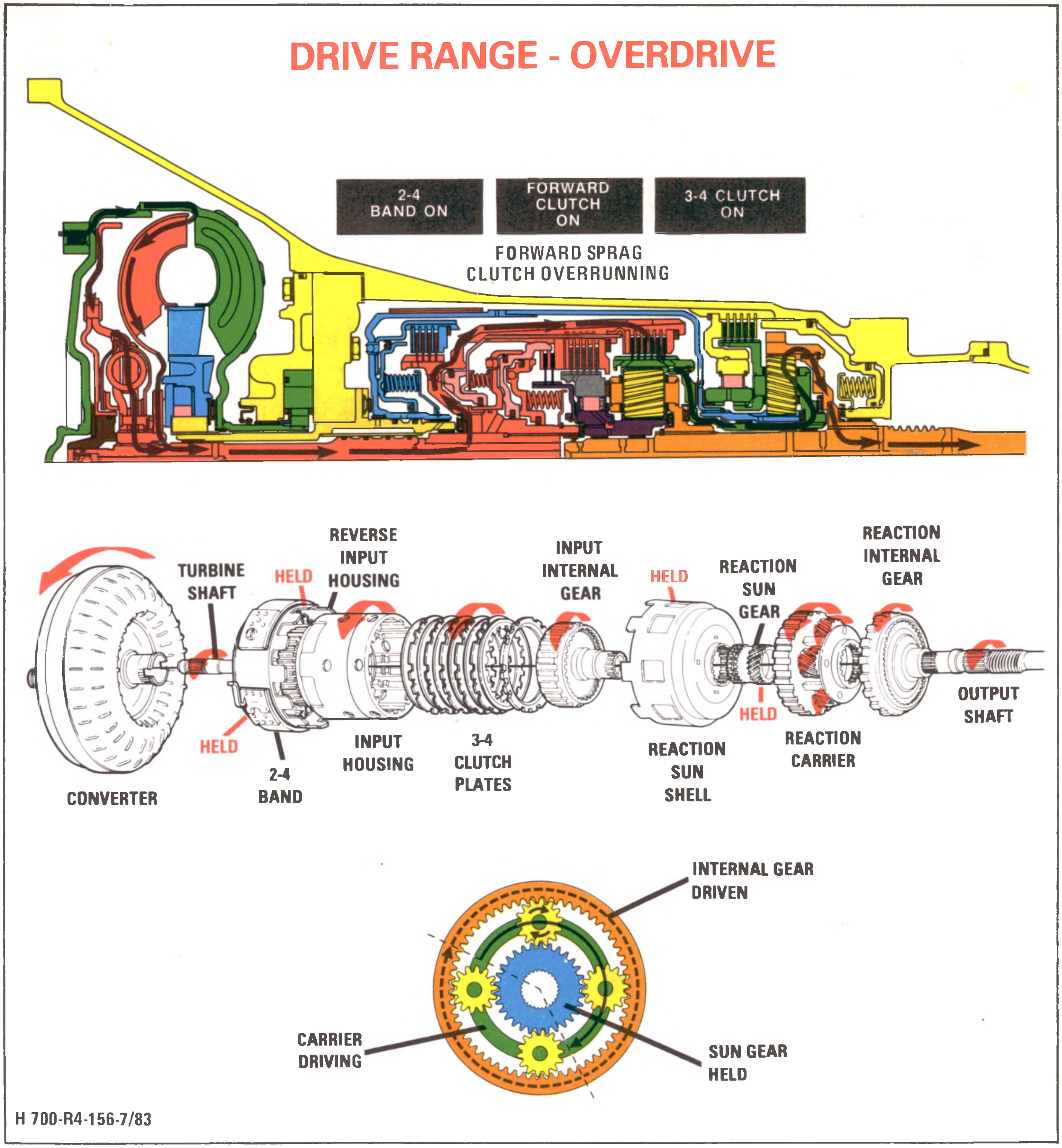


Figure 36 - Drive Range Overdrive

FORWARD CLUTCH-APPLIED **3-4 CLUTCH-APPLIED** **2-4 BAND-APPLIED**

In Drive Range Overdrive, the 2-4 band is again applied to hold the reverse input housing, reaction sun shell, and reaction sun gear stationary. Converter torque is now applied through the input housing, the 3-4 clutch, and the input internal gear to the reaction carrier. With the reaction sun gear held, the reaction carrier pinions will rotate in a clockwise direction on their pins and drive the reaction internal gear and output shaft in overdrive at an approximate ratio of .70:1. (.7 input to 1 output).

The forward clutch is still applied, but is ineffective due to the input carrier driving the input sun gear faster than the forward clutch and overruning the forward sprag clutch.

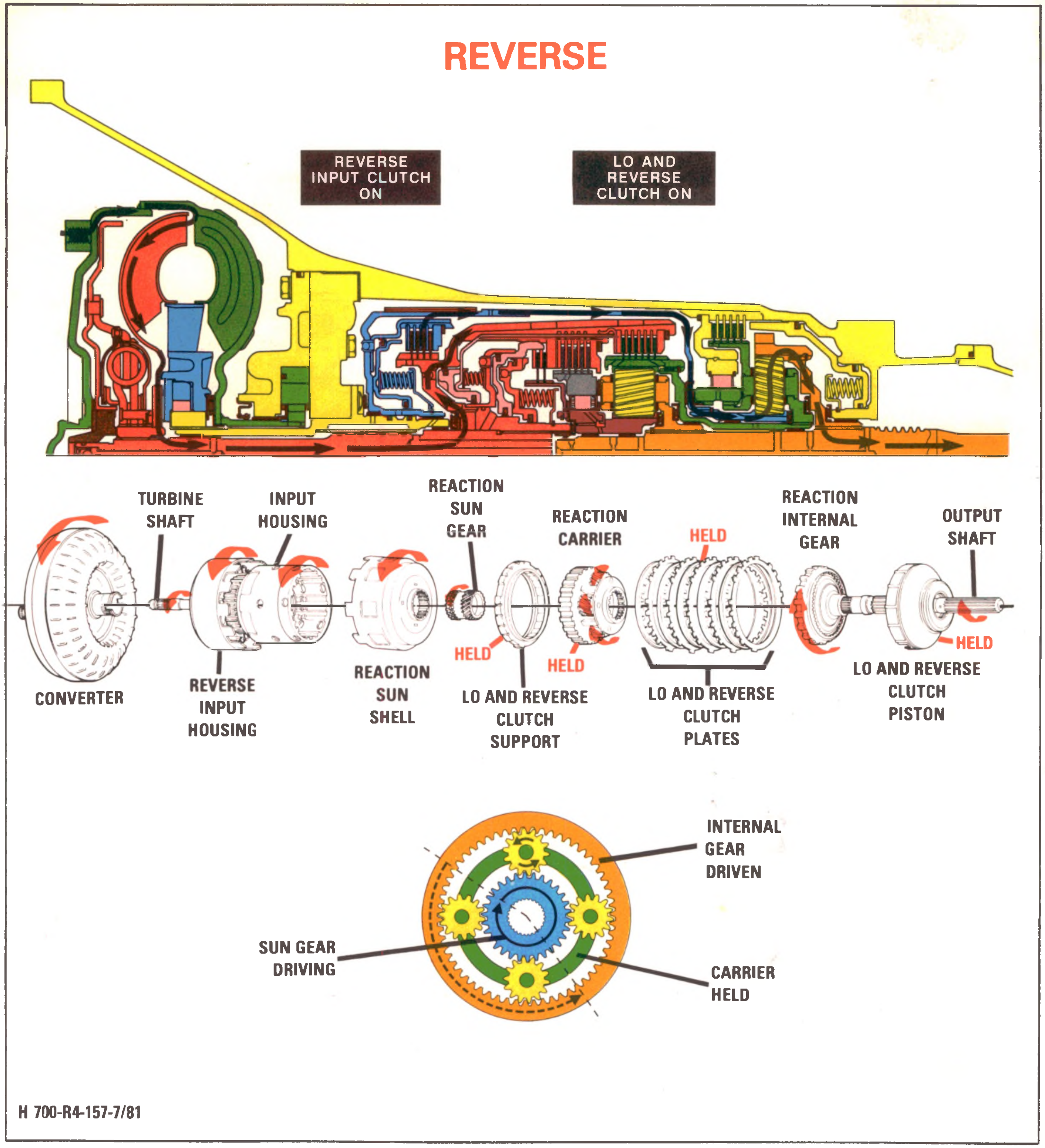


Figure 37 - Reverse

REVERSE INPUT CLUTCH — APPLIED

LO AND REVERSE CLUTCH — APPLIED

With the selector lever in Reverse (R), the reverse input clutch is applied to transmit converter torque from the input housing to the reaction sun shell and reaction sun gear. With the lo and reverse clutch applied and holding the reaction carrier stationary the reaction sun gear will drive the reaction carrier pinions counterclockwise on their pins. The pinions will then drive the reaction internal gear and output shaft counterclockwise in reduction at a ratio of approximately 2.30:1. Converter torque is approximately two times engine torque at stall to give an approximate overall stall ratio of 4.60:1 (4.60 input to 1 output) in reverse.

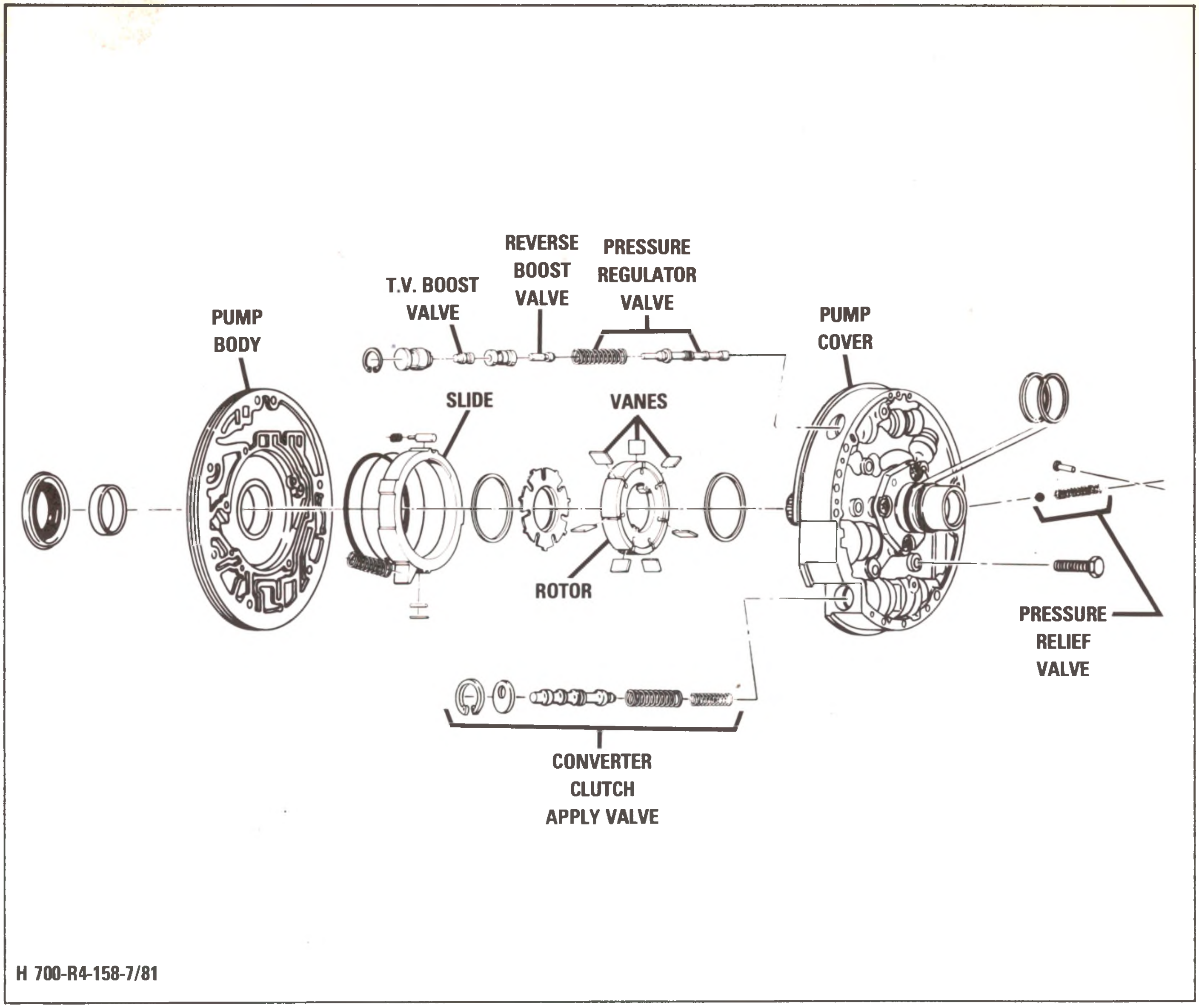


Figure 38 - Typical THM 700-R4 Pump Assembly

HYDRAULIC SYSTEM

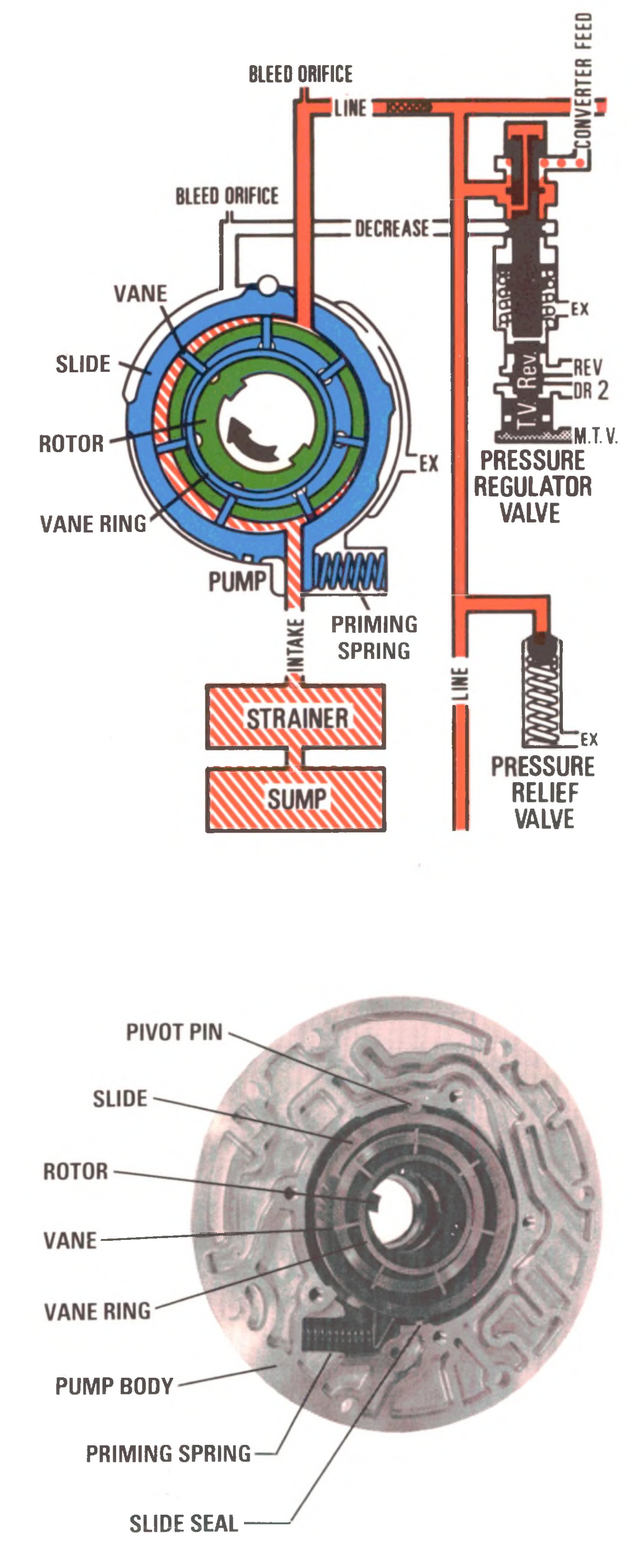
In previous sections, the mechanical phase of the transmission operation has been described involving references to the band and clutches being hydraulically applied. The next section describes in detail the hydraulic system that applies the band and clutches and controls automatic shifting.

PUMP ASSEMBLY

A hydraulic pressure system requires a source of clean hydraulic fluid and a pump to pressurize the fluid. The THM 700-R4 uses a variable capacity vane type pump. The pump rotor is keyed to the converter pump hub and therefore turns whenever the engine is operating. A slide is fitted around the rotor and vane which automatically regulates pump output, according to the needs of the transmission. Maximum pump output is obtained when the priming spring has been fully extended and has the slide held against the side of the body (Fig. 39, pg. 36). As the slide moves toward the center, the pump output is reduced until minimum output is reached.

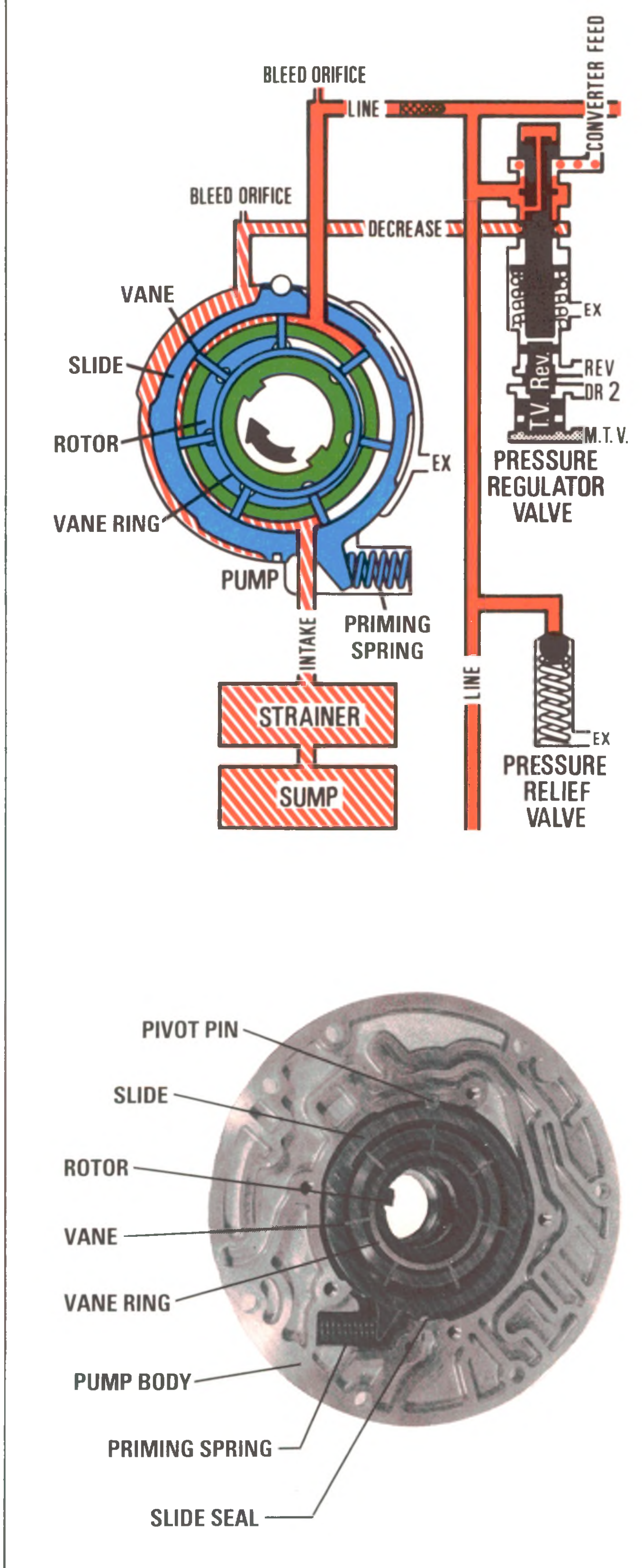
PRESSURE REGULATOR

As the pump rotor rotates, the pump output is directed to the pressure regulator valve (Fig. 40, pg. 36). The pressure regulator valve is held closed by the pressure regulator valve spring. As the pump pressure increases, the pressure regulator valve is opened, directing oil from the pressure regulator to a cavity on the side of the pump opposite the priming spring. This oil pressure acts against the priming spring and moves the slide, decreasing the pump output to a steady 445 kPa (65 psi). With the engine off, the slide is held in a maximum output position by the priming spring.



H 700-R4-159-7/81

Figure 39 - Maximum Pump Output



H 700-R4-160-7/81

Figure 40 - Minimum Pump Output

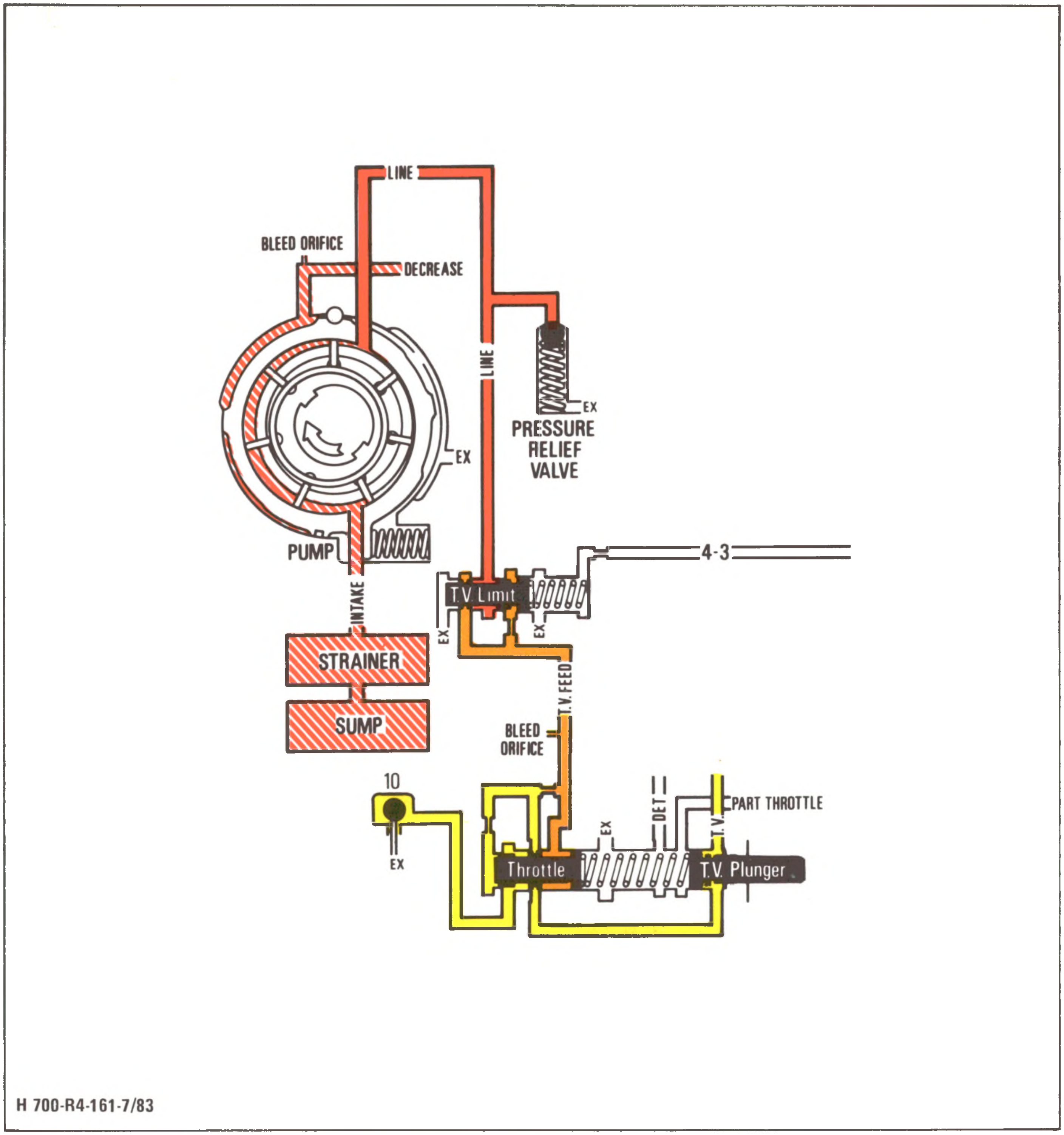


Figure 41 - T.V. Limit Valve

T.V. LIMIT VALVE

The pressure requirements of the transmission for apply of the band and clutches vary with engine torque and throttle opening. Under heavy throttle operation, the 445 kPa (65 psi) line pressure is not sufficient to hold the band and clutches on without slipping. To provide higher line pressure with greater throttle opening, a variable oil pressure related to throttle opening is desired. The throttle valve (T.V.) regulates line pressure in relation to carburetor opening. The T.V. limit valve limits this variable pressure to avoid excessive line pressure. The T.V. limit valve feeds the throttle valve (T.V.) and receives oil directly from the oil pump (Fig. 41). As the pressure in the line leading from the T.V. limit valve and feeding the T.V. valve exceeds 620 kPa (90 psi), the pressure will push against the T.V. limit valve spring, bleeding off excess pressure. This limits T.V. feed pressure to a maximum of approximately 620 kPa (90 psi).

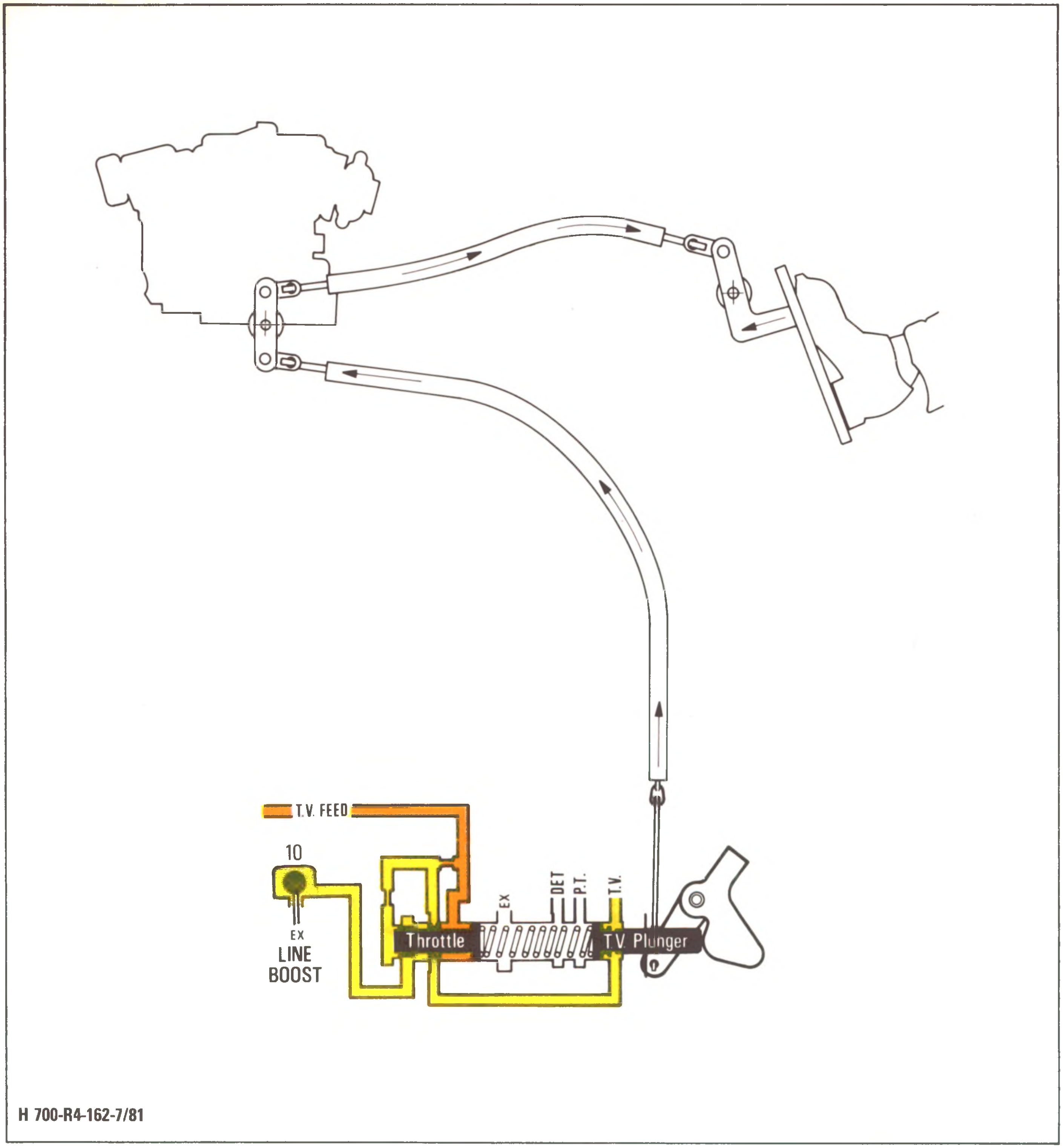


Figure 42 - Accelerator, Carburetor and T.V. Linkage

THROTTLE VALVE

Throttle valve (T.V.) pressure is related to carburetor opening which is related to engine torque. The system is a mechanical type with a direct, straight line relation between the carburetor throttle plate opening and the transmission throttle plunger movement.

As the accelerator pedal is depressed and the carburetor opened, the mechanical linkage (T.V. Cable) relays the movement to the throttle plunger and increases the force of the T.V. spring against the throttle valve, increasing T.V. pressure which can regulate from 0 to 620 kPa (90 psi), (Fig. 42). T.V. oil is directed through the T.V. plunger to provide a hydraulic assist reducing the pedal effort necessary to actuate the plunger.

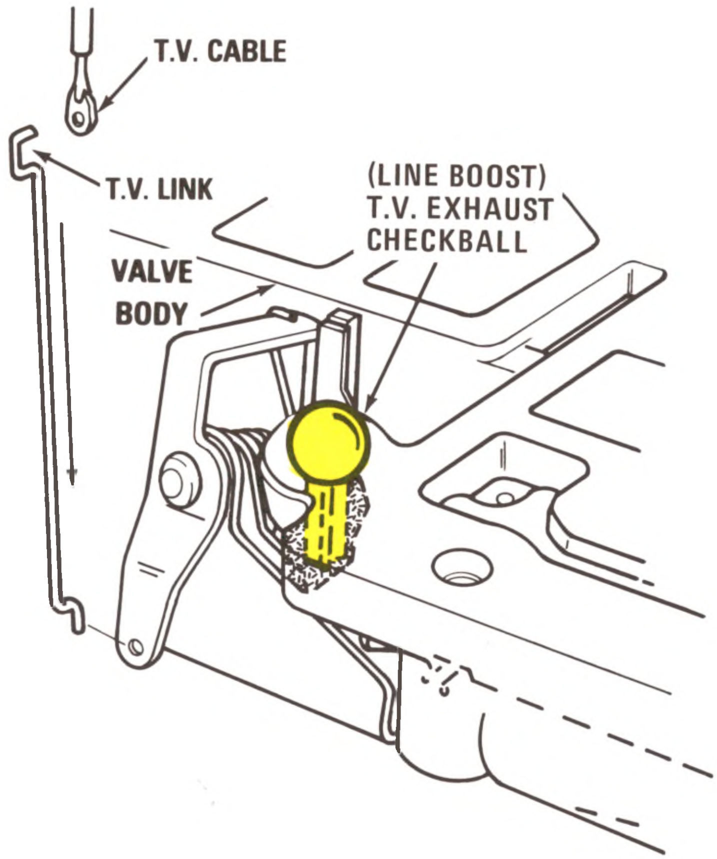


Figure 43 - T.V. Exhaust Check Ball and Linkage

T.V. EXHAUST CHECK BALL

A feature has been included in the T.V. system that will prevent the transmission from being operated with low or minimum line pressure in the event the T.V. cable is disconnected or broken. This feature is the (line boost) T.V. exhaust check ball, which is located in the control valve and pump assembly at the T.V. regulating exhaust port.

The T.V. exhaust check ball is held off its seat by the throttle lever and bracket assembly (this allows T.V. oil to regulate normally) when the T.V. cable is properly adjusted. If the T.V. cable becomes disconnected or is not adjusted properly, the T.V. exhaust check ball will close the T.V. exhaust port and keep T.V. and line pressure at full line pressure (Fig. 43).

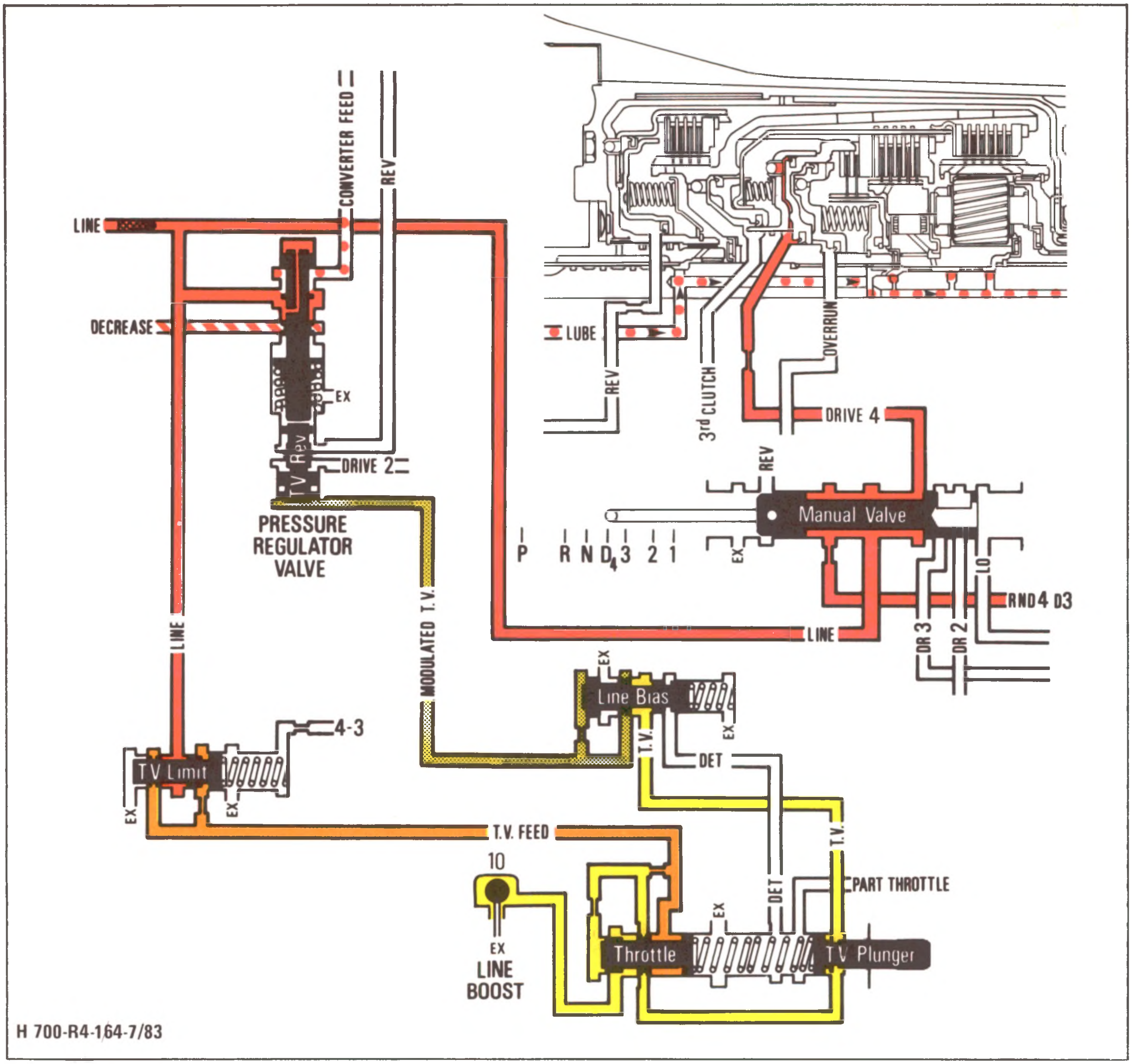


Figure 44 - Line Pressure Control

LINE BIAS VALVE

The capacity of a band or clutch to resist slipping is directly related to the pressure supplied to its apply piston. In order to prevent the band or clutches from slipping when an increase in engine torque is applied, oil pressure supplied to the apply piston must be increased. However, excessive pressure will cause a harsh shift. It is then desirable to vary the pressure supplied to each apply piston at the same rate at which engine torque is varied.

In the Throttle Valve section, T.V. pressure was discussed as having a straight line, direct relation with throttle opening. However, engine torque does not increase in a straight line as the throttle is opened. Instead, engine torque increases rapidly with early acceleration and increases slower as the throttle is opened fully. The line bias valve is fed by throttle valve (T.V.) oil and performs the function of regulating throttle valve (T.V.) pressure as engine torque varies. This oil pressure, called Modulated Throttle Valve oil (M.T.V.), is fed to the T.V. boost valve in the bottom of the pressure regulator valve (Fig. 44), to increase line pressure as throttle opening or engine torque increases.

In summary, the T.V. plunger controls T.V. pressure which becomes M.T.V. pressure at the line bias valve, and the line bias valve regulates line pressure at the pressure regulator valve. It is this line pressure the manual valve routes to the shift valves and to the

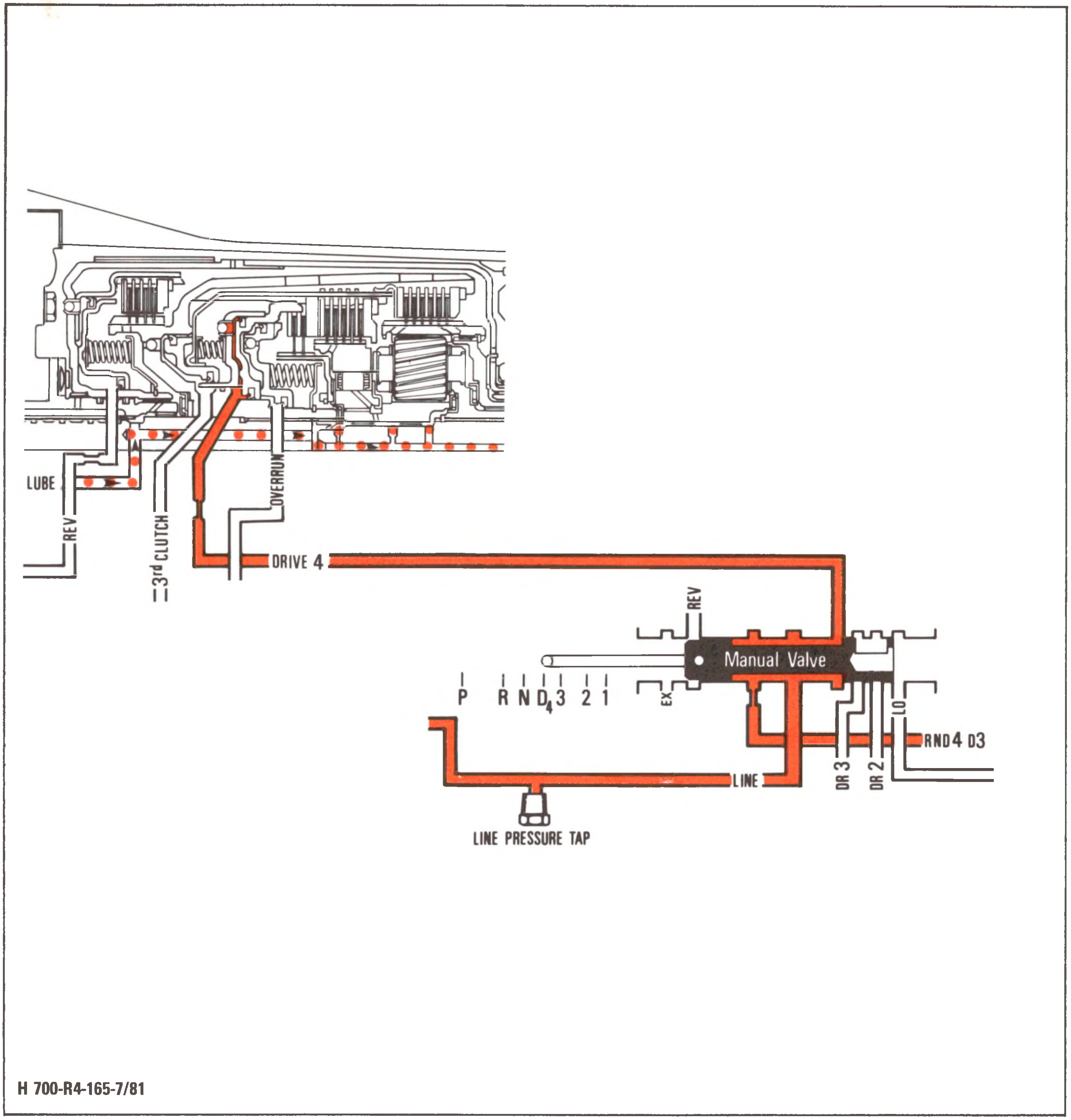


Figure 45 - Forward Clutch Applied

band and clutches. Line pressure is varied in relation to engine torque in such a manner as to apply the band or clutch with just enough pressure to hold against engine torque plus a safety factor, but not so much pressure that the shifts are harsh.

FORWARD CLUTCH

When the transmission selector lever is moved to the Drive (D) position, the manual valve moves to allow Drive 4 (D4) pressure to be delivered to the forward clutch (Fig. 45).

With the forward clutch applied, and the forward sprag clutch holding, a mechanical connection has been provided between the turbine shaft and the front internal gear. The lo roller clutch assembly becomes effective as a result of the power flow through the compound planetary gear set. Thus, the transmission is in first gear, ready for the vehicle to start moving.

As the vehicle begins to accelerate and first gear reduction is no longer required, the transmission will automatically shift to second gear.

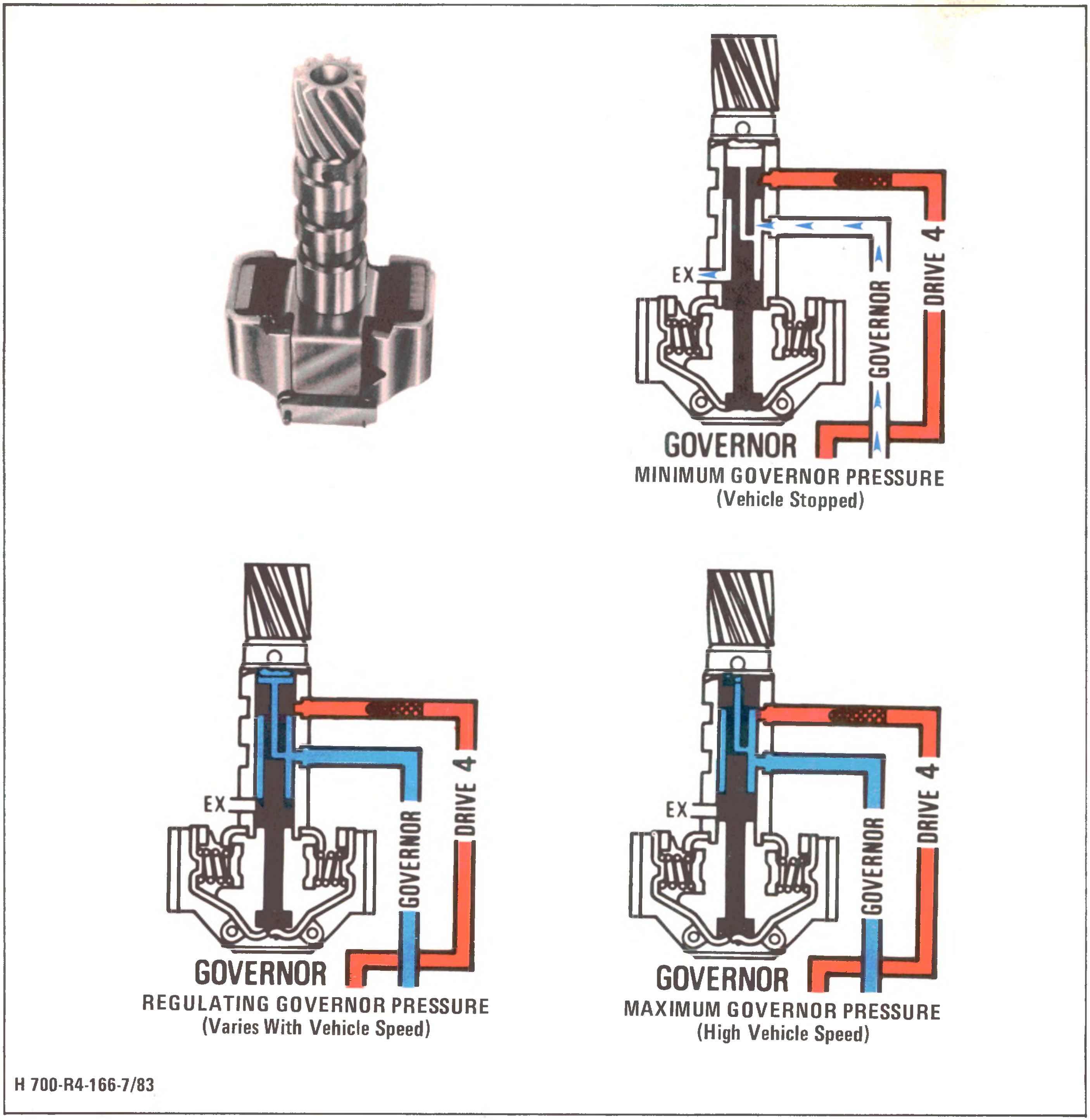


Figure 46 - Governor Assembly

GOVERNOR ASSEMBLY

The vehicle speed signal for the shift is supplied by the transmission governor which is driven by the output shaft. (Fig. 46). The governor assembly consists of a regulating valve, a pair of primary weights, a pair of secondary weights, a pair of secondary springs, the body, and the driven gear. The weights are arranged so that only the smaller, secondary weights act directly on the valve. Because centrifugal force acting on the governor weights varies with the size of the weight and speed squared, at low speeds, small changes in output shaft speed result in small changes in the centrifugal force exerted by the smaller secondary weights. To give greater changes in centrifugal force at low output shaft speeds the, larger, primary weight adds its heavy force to the secondary weights through the secondary springs. As the primary weights move out at greater output shaft speeds, they finally reach a stop and are no longer effective. From this point on, only the secondary weights and secondary springs are used to apply force to the governor valve.

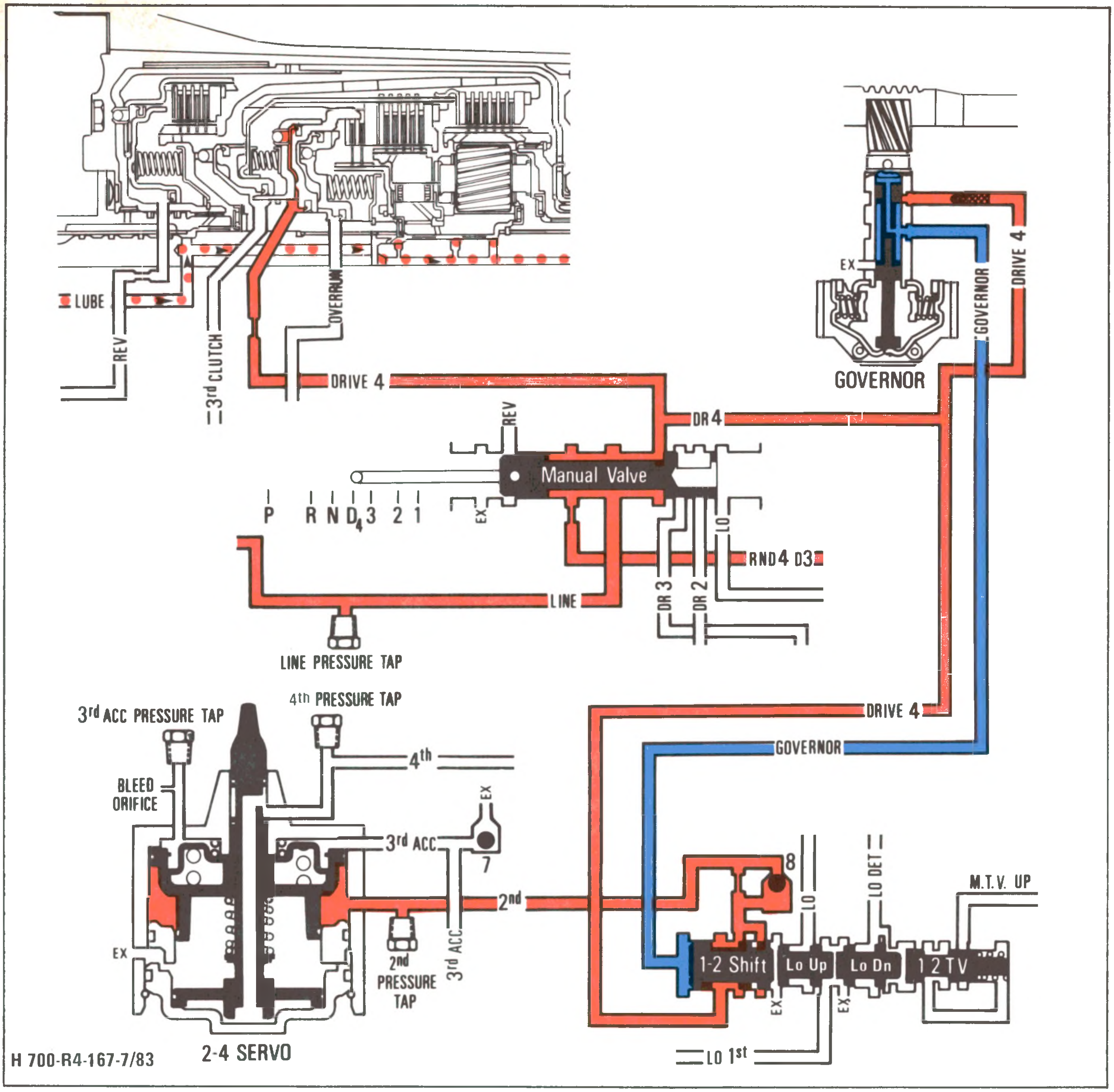


Figure 47 - 1-2 Shift

Drive 4 (D4) oil is fed to the governor valve. Governor oil feeding through a passage in the governor valve exerts pressure on the valve in a direction opposite to the governor weight force. When the vehicle is stationary there is no governor weight force so the governor oil pressure will move the valve, blocking off the Drive 4 (D4) oil passage and opening the exhaust, resulting in little or no governor oil pressure (Fig. 46). As the vehicle begins to move the governor weight force increases moving the valve against governor pressure, blocking off exhaust and opening the Drive 4 (D4) passage, resulting in governor pressure that is proportional to vehicle speed (Fig. 46). The governor valve will then balance governor oil pressure against governor weight force only moving slightly (Fig. 46) to increase or decrease governor pressure as vehicle speed increases or decreases.

1-2 SHIFT VALVE TRAIN

The 1-2 shift valve train is used to make the shift from first to second gear (Fig. 47). A spring acting on the 1-2 valve train tends to keep it in the closed position, blocking Drive 4 (D4) oil. Governor pressure is directed to the 1-2 shift valve against the spring force. As the vehicle speed is increased, governor pressure increases, overcoming the spring force. The 1-2 valve train opens, allowing D4 oil to flow to the 2-4 Servo and apply the 2-4 band; thus, the transmission has shifted to second gear.

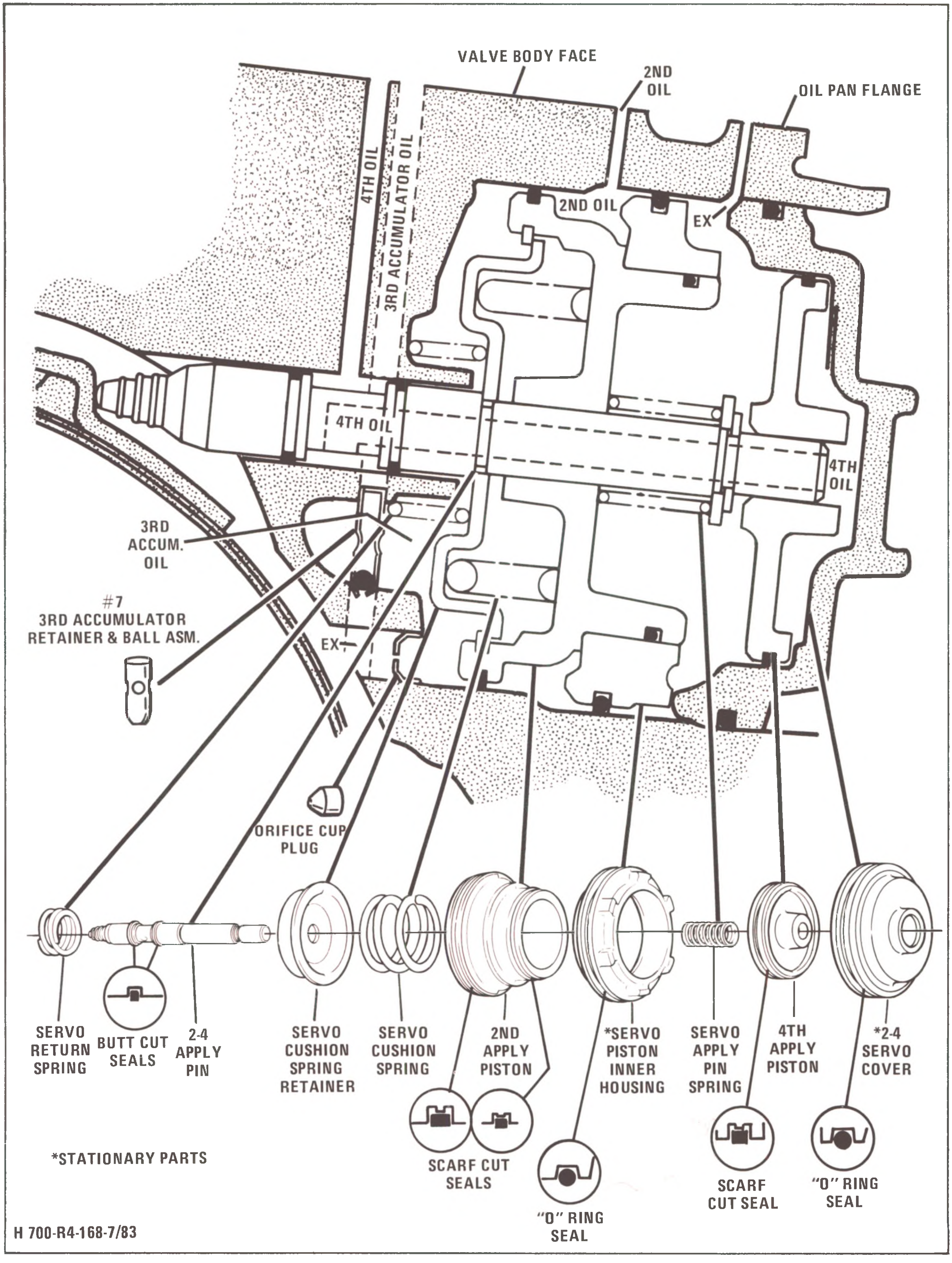


Figure 48 - Typical 2-4 Servo Assembly

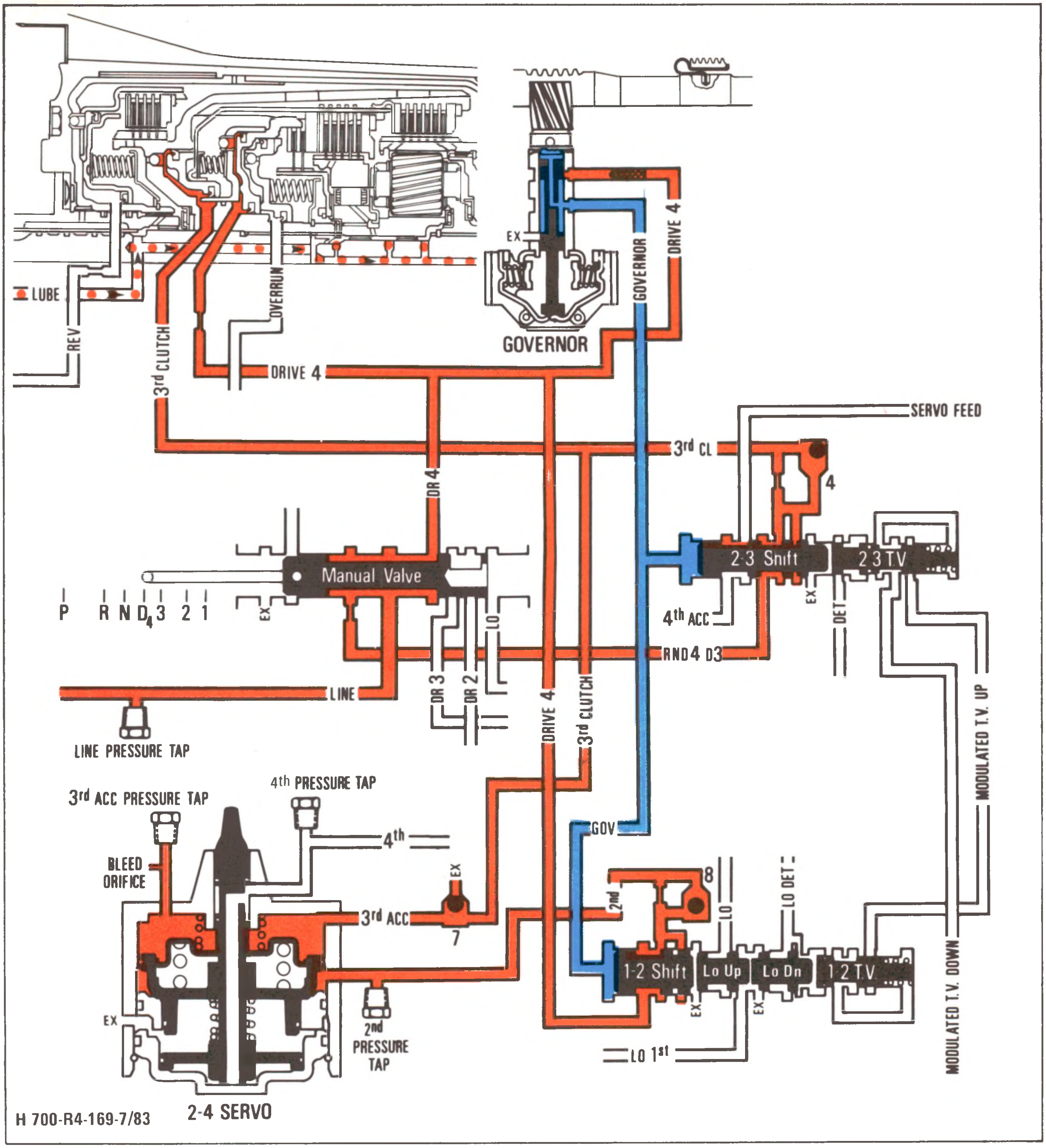


Figure 49 - 2-3 Shift

2-3 SHIFT VALVE TRAIN

Further increases in vehicle speed and governor pressure will cause the transmission to shift to third gear. The shift to third gear is initiated by the 2-3 shift valve train (Fig. 49). The operation of the 2-3 shift valve train is very similar to the 1-2 shift valve train. A spring acting on the shift valve train tends to keep the valve closed, blocking reverse, neutral and Drive 4 and Drive 3 (RND4D3) oil coming from the manual valve, while governor pressure attempts to open the valve. When vehicle speed increases enough to develop sufficient governor pressure to open the 2-3 shift valve train, RND4D3 oil passes through the shift valve and enters the third clutch passage. Third clutch oil is routed to apply the 3-4 clutch. It also flows to the release side of the 2-4 servo piston to release the band, thus shifting the transmission into third gear.

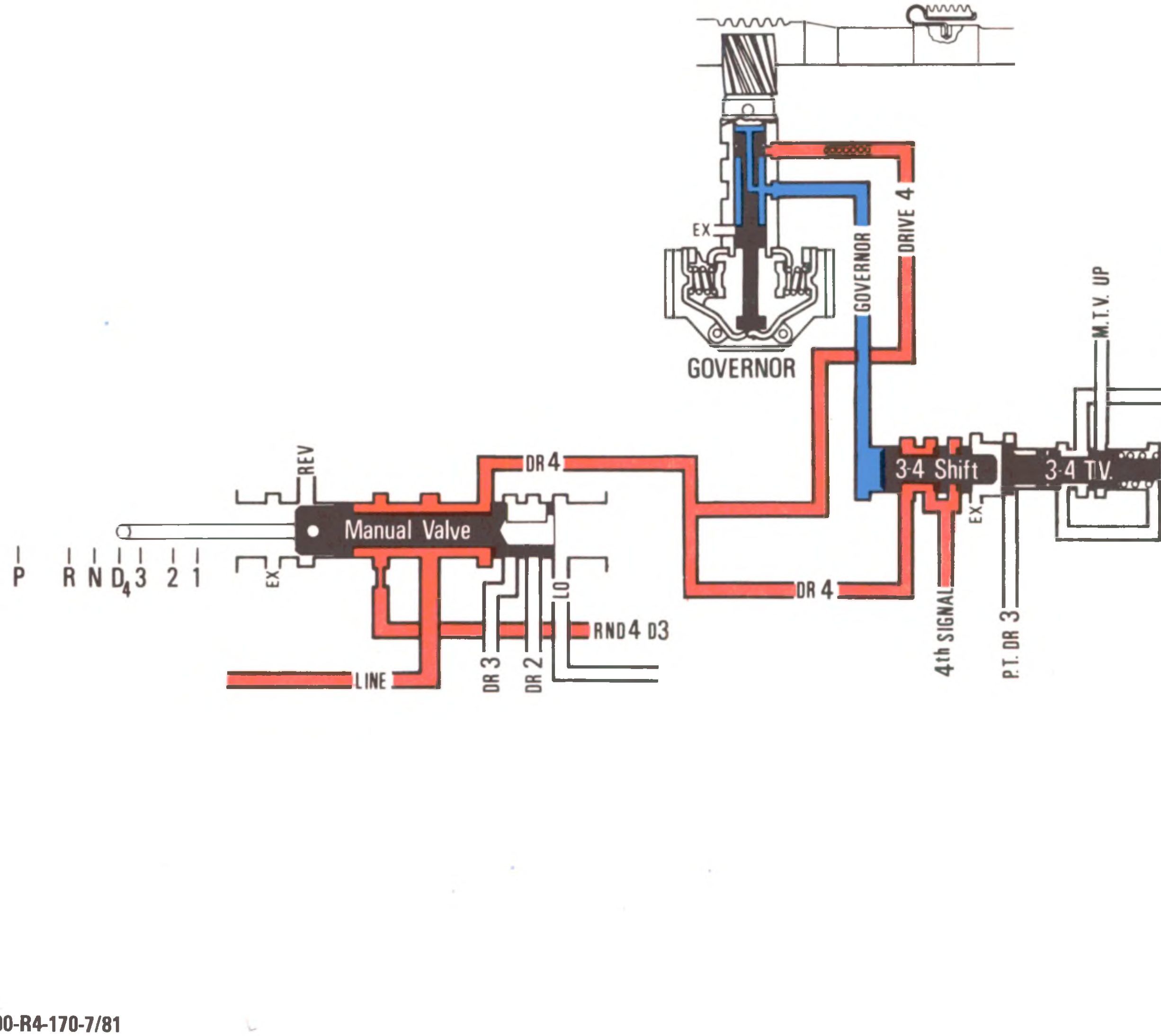


Figure 50 - 3-4 Shift Valve Train

3-4 SHIFT VALVE TRAIN

Further increase in vehicle speed and governor pressure will cause the transmission to shift to overdrive. The shift to overdrive is initiated by the 3-4 shift valve train (Fig. 50). The operation of the 3-4 shift valve train is very similar to the 1-2 shift valve train. A spring acting on the shift valve train tends to keep the valve closed, blocking Drive (D4) oil coming from the manual valve, while governor pressure attempts to open the valve. When vehicle speed increases enough to develop sufficient governor pressure to open the 3-4 shift valve train, D4 oil passes through the shift valve and enters the fourth signal passage.

3-4 RELAY VALVE AND 4-3 SEQUENCE VALVE

A spring acting on the 4-3 sequence valve tends to keep the 4-3 sequence and the 3-4 relay valve closed. Fourth signal oil from the 3-4 shift valve will open the valve allowing second clutch oil into the servo feed passage (Fig. 51). Servo feed oil will flow through the 4-3 sequence valve and into the fourth passage. The fourth passage will fill the area between the fourth apply piston and the 2-4 servo cover, and together with second oil, will overcome third accumulator oil and apply the band. The transmission is now in overdrive.

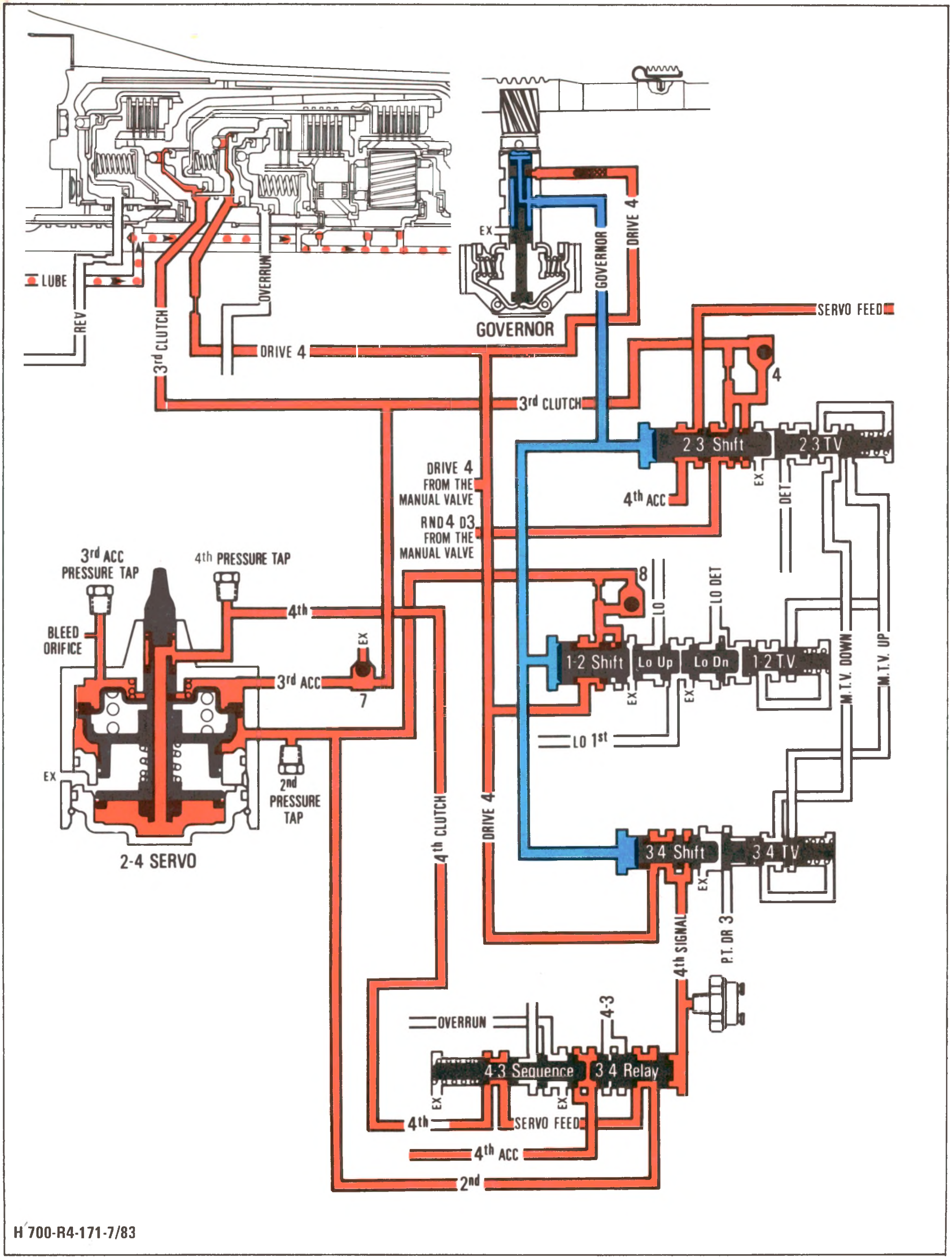


Figure 51 - 3-4 Shift

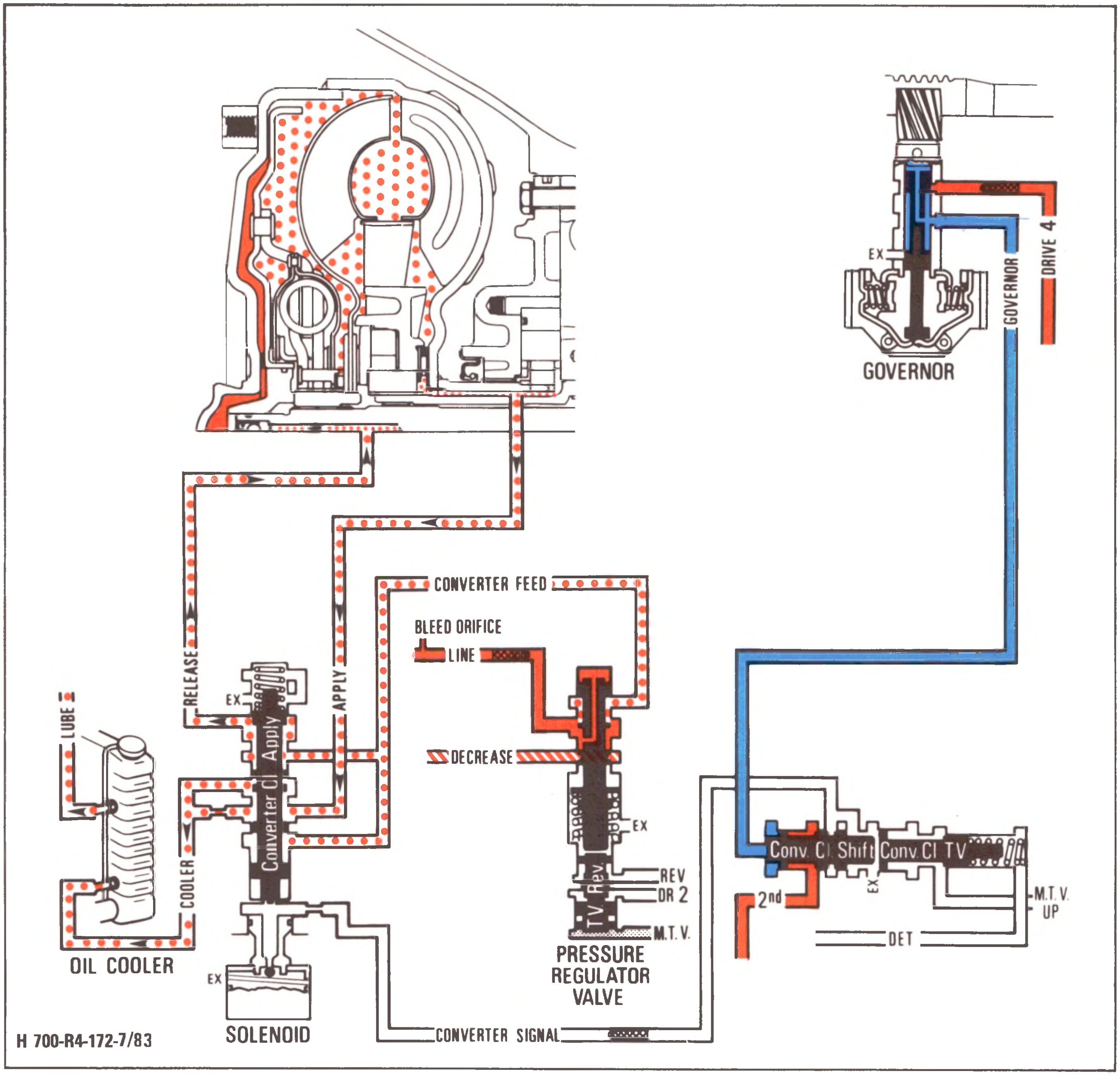


Figure 52 - Converter Clutch Apply Valve (Release Position)

CONVERTER CLUTCH APPLY VALVE (RELEASE POSITION)

In Park, Neutral, Reverse, and First gear, the converter clutch apply valve, located in the pump, is held in the release position by the converter clutch apply valve spring. That is, the apply valve in this position takes the converter feed oil, coming from the pressure regulator valve, and sends it into the release passage, through the turbine shaft, and into the cavity between the converter clutch pressure plate and the converter cover (Fig. 52). This moves the clutch pressure plate away from the converter cover, releasing the converter clutch.

After the oil releases the converter clutch, it flows from behind the pressure plate and through the converter. From the converter, the oil flows backwards through the apply passage to the apply valve. The apply valve then sends oil, returning from the converter, to the transmission cooler in the radiator. Oil, returning from the cooler, is then directed to the transmission lubrication system.

The apply valve is controlled by the converter clutch shift valve and will stay in the release position until it receives converter clutch signal oil from the converter clutch shift valve in the valve body.

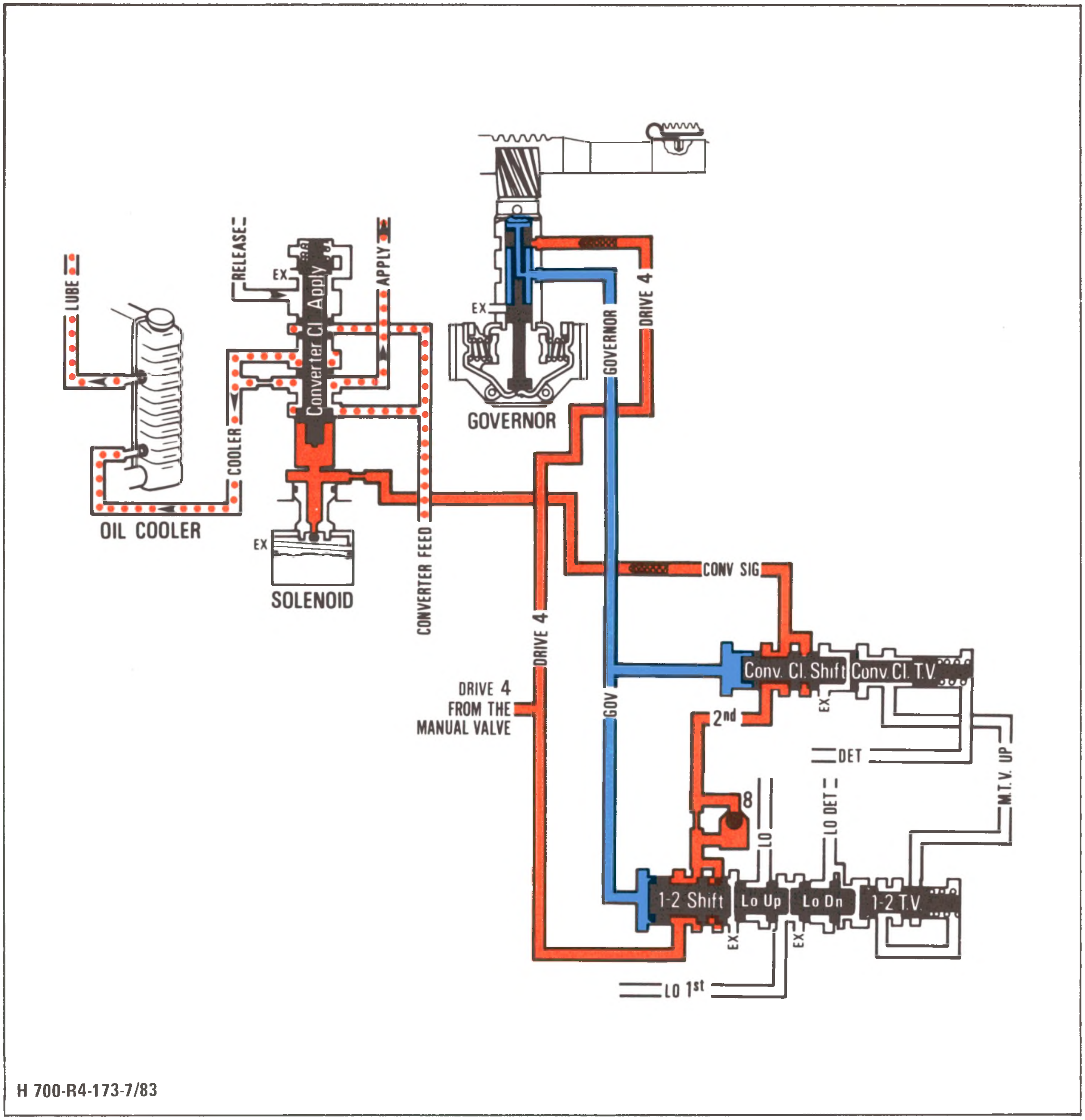


Figure 53 - Converter Clutch Shift Valve Train

CONVERTER CLUTCH SHIFT VALVE TRAIN

When the automobile has reached a sufficient speed where heavy acceleration is no longer needed, the torque multiplication of the converter is no longer needed. Because the converter is a fluid coupling, there is some slippage between the converter pump and the turbine. To eliminate this slippage and to improve fuel economy, the converter clutch can be applied in either Second (2nd), Third (3rd), or Fourth (4th) gear, depending on the model of transmission.

The converter clutch apply is initiated by the converter clutch shift valve, located in the valve body. A spring acting on the converter clutch shift valve train tends to keep the valve closed, blocking second oil coming from the 1-2 shift valve, while governor pressure attempts to open the valve (Fig. 53). When vehicle speed increases enough to develop sufficient governor pressure to open the converter clutch shift valve train, second oil enters the converter clutch signal passage. Converter clutch signal oil passes through an orifice to the converter clutch apply valve.

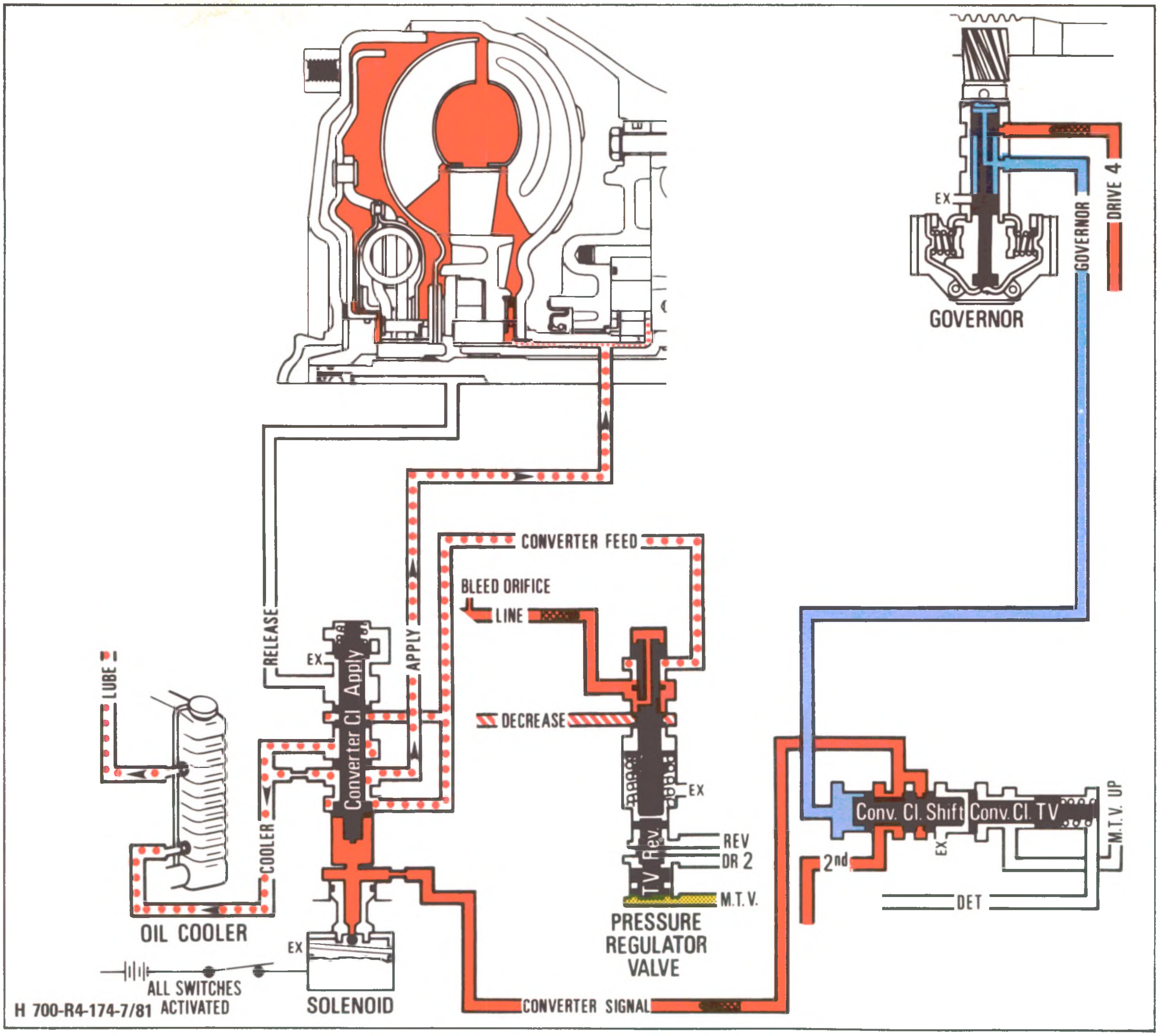


Figure 54 - Converter Clutch Apply Valve (Applied)

CONVERTER CLUTCH APPLY VALVE (APPLIED)

The converter clutch shift valve allows second oil to enter the converter clutch signal passage to the converter clutch apply valve. The converter clutch signal oil overcomes the converter clutch apply valve spring, shifting the valve and changing the direction of the converter feed oil (Fig. 54). The converter clutch apply valve will now send converter feed oil from the pressure regulator into the apply passage. The apply oil will flow between the stator shaft and the converter hub to charge the converter with oil and force the converter clutch pressure plate against the converter cover, causing a mechanical link between the engine and the turbine shaft. At the same time the converter clutch apply valve will direct some converter feed oil through an orifice to the transmission cooler in the radiator. Oil returning from the cooler, is then directed to the transmission lubrication system.

It should be noted that the converter clutch apply valve can shift to apply the converter only when the converter clutch solenoid is energized electrically. When the solenoid is not energized, the converter clutch signal oil is exhausted and the converter will stay in the release position. The converter clutch solenoid would be off under conditions such as: high engine vacuum (idle), low engine vacuum (full throttle), braking, or cold engine operation.

• • •

In the hydraulic system as described thus far, the 1-2, 2-3, 3-4, and converter clutch shifts will always take place at the same vehicle speeds; that is, whenever the governor pressure overcomes the force of the springs on the shift valves. When accelerating under a heavy load or for maximum performance, it is desirable to have the shifts occur at higher vehicle speeds.

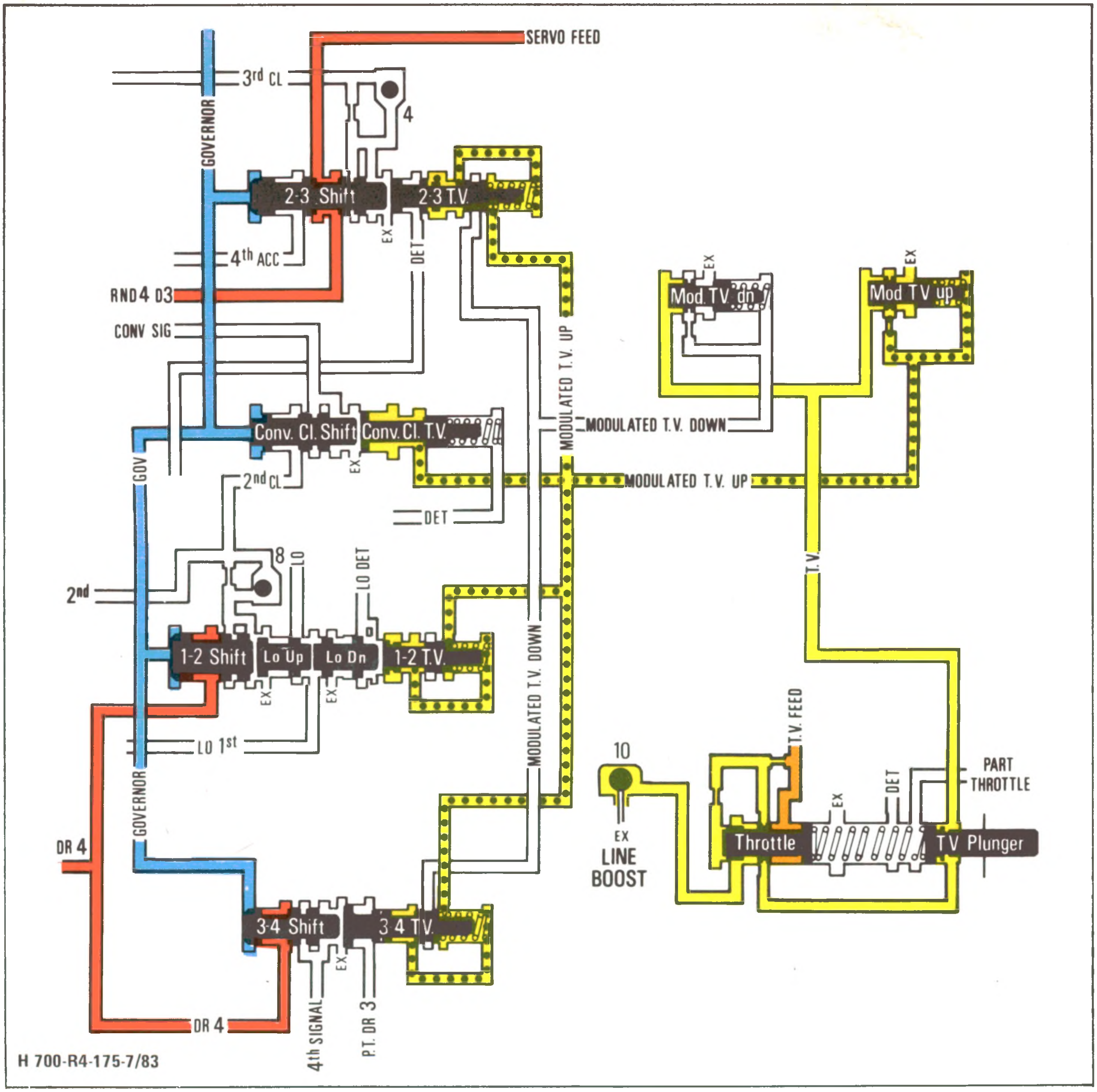


Figure 55 - T.V. Modulated Upshift Valve, Valves Shown in First Gear Position

T.V. MODULATOR UPSHIFT VALVE

In the section describing the throttle valve, T.V. oil increases with throttle opening and could be used to delay upshifts under heavy acceleration. However, some T.V. pressure is possible even at idle. To lower T.V. pressure at low throttle openings, the T.V. modulator upshift valve (M.T.V. up) is used. The M.T.V. up valve receives oil from the throttle valve and directs oil to the 1-2, 2-3, 3-4 and converter clutch throttle valves (Fig. 55). The M.T.V. up valve does not open until there is approximately 70 kPa (10 psi) of T.V. pressure (Graph 57, pg. 52). With the M.T.V. up valve in the closed position, governor pressure must overcome the valve spring force to open any of the shift valves. Above 70 kPa (10 psi) of T.V. pressure, the M.T.V. up valve opens and assists each of the valve springs in holding the shift valves closed. Governor pressure must now overcome the valve springs force, and M.T.V. up pressure to open any of the shift valves. The upshifts can now be delayed to take place at higher vehicle speeds when heavier throttle is applied.

The M.T.V. up valve is used only in delaying upshifts. To create a throttle downshift, a slightly different pressure is needed.

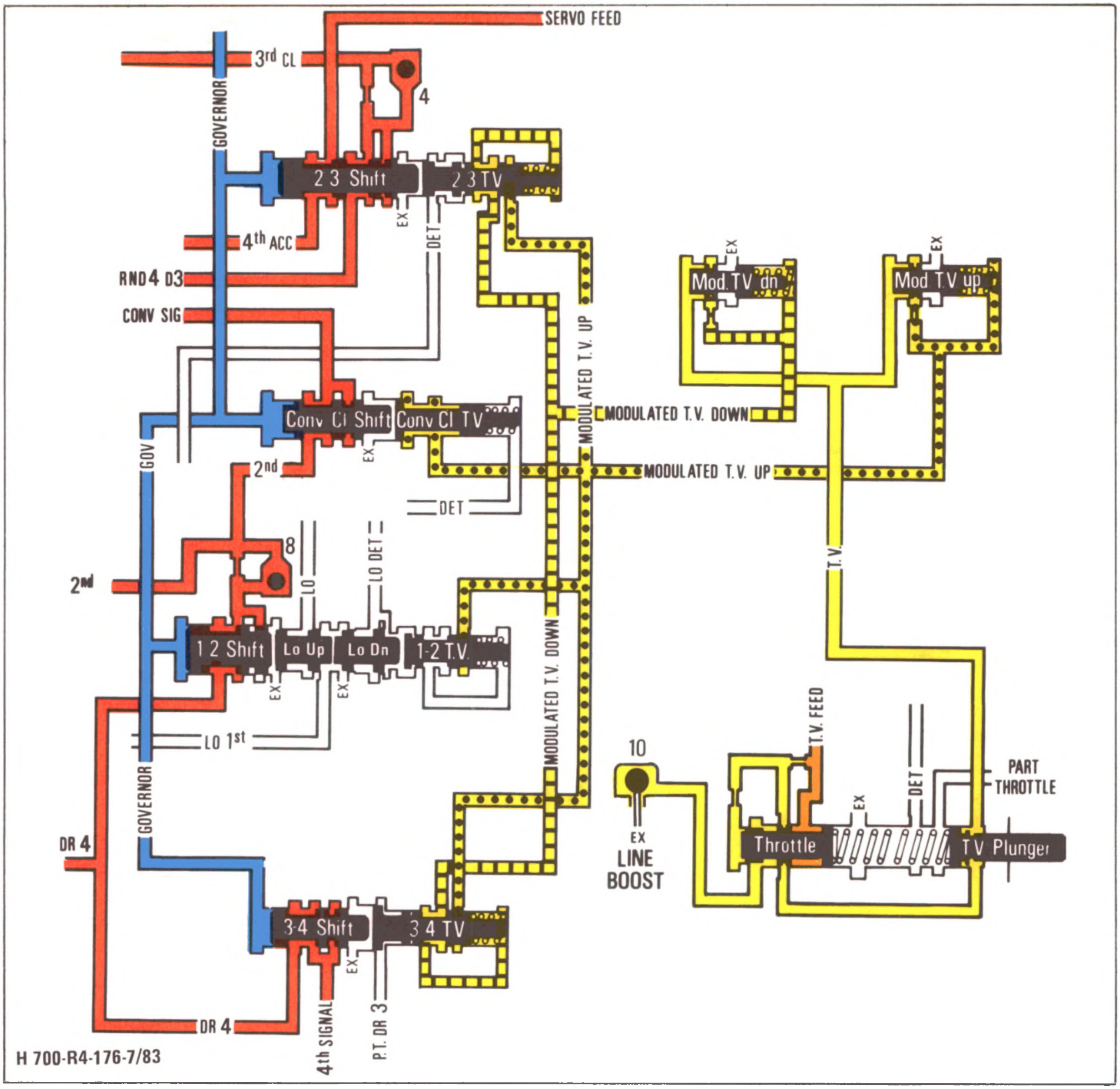
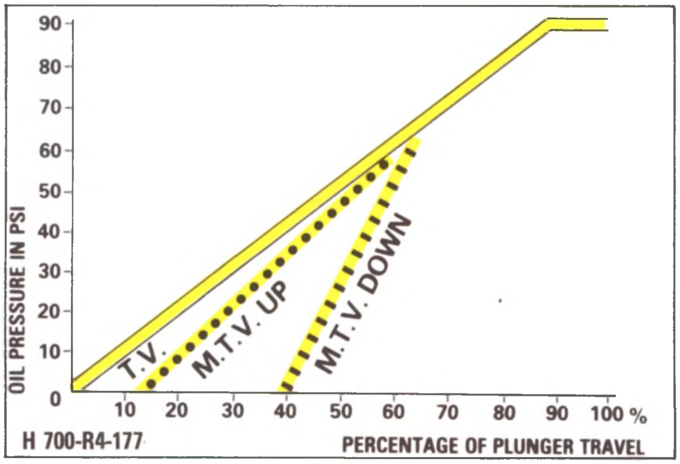


Figure 56 - T.V. Modulated Downshift, Valves Shown in Fourth Gear Position

T.V. MODULATOR DOWNSHIFT VALVE

The T.V. modulator downshift valve (M.T.V. down) operates the same way as the M.T.V. up, except it does not open until there is approximately 275 kPa (40 psi) of T.V. pressure (Graph 57) and only exerts pressure on the throttle valves when they are in the open position (Fig. 56). With the 2-3 and 3-4 shift valves in the open position, M.T.V. down pressure (after there is 275 kPa (40 psi) of T.V.) assists each of the valve springs in trying to close the shift valves. To keep the shift valves open, the governor pressure must be higher than the valve spring force and the M.T.V. down pressure. Downshifts can now be made at higher vehicle speeds by applying heavier throttle. When a downshift is made by M.T.V. down oil it is called a modulated downshift.



Graph 57 - M.T.V. Up and M.T.V. Down

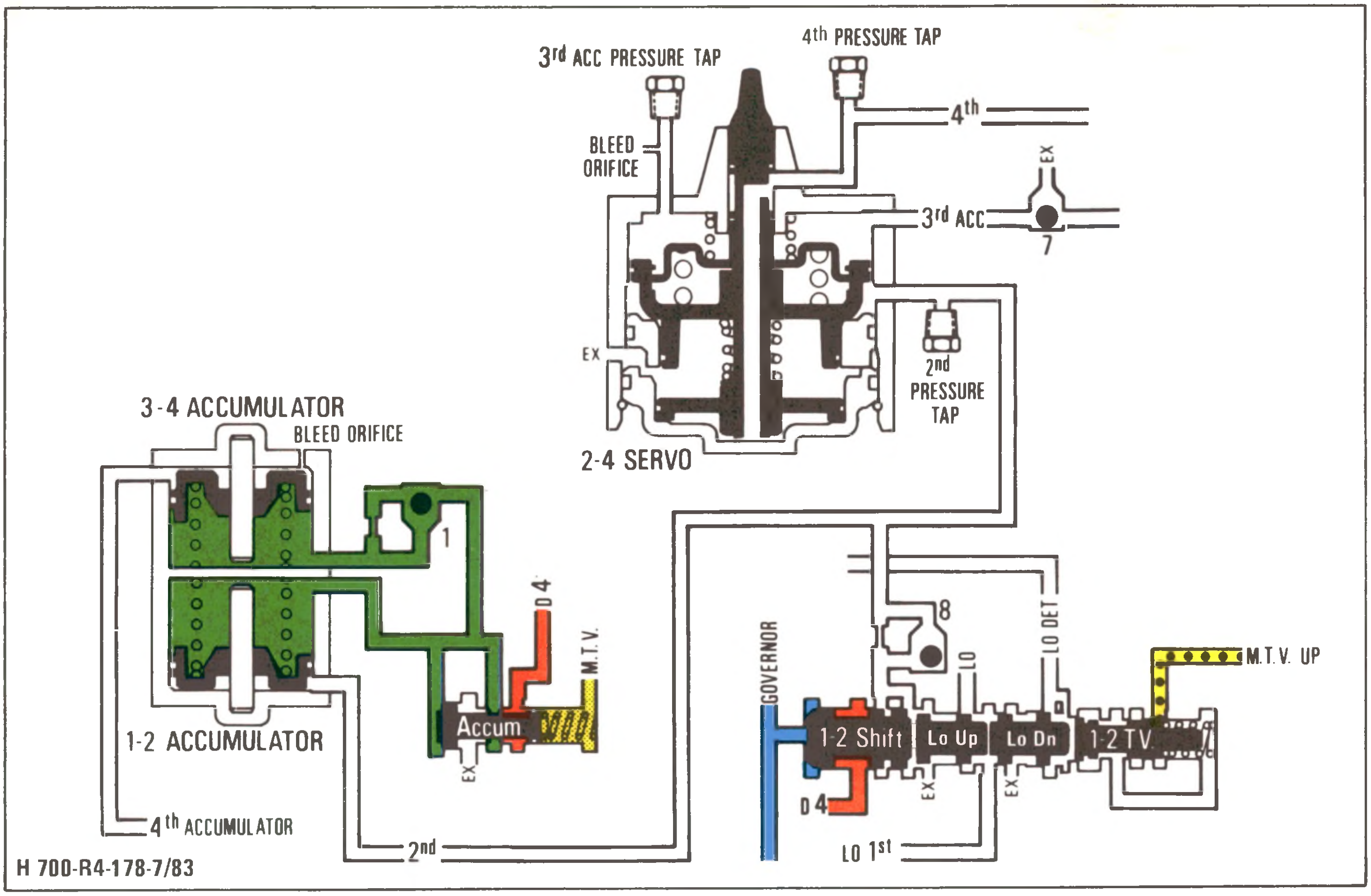


Figure 58 - 1-2 Accumulation - First Gear

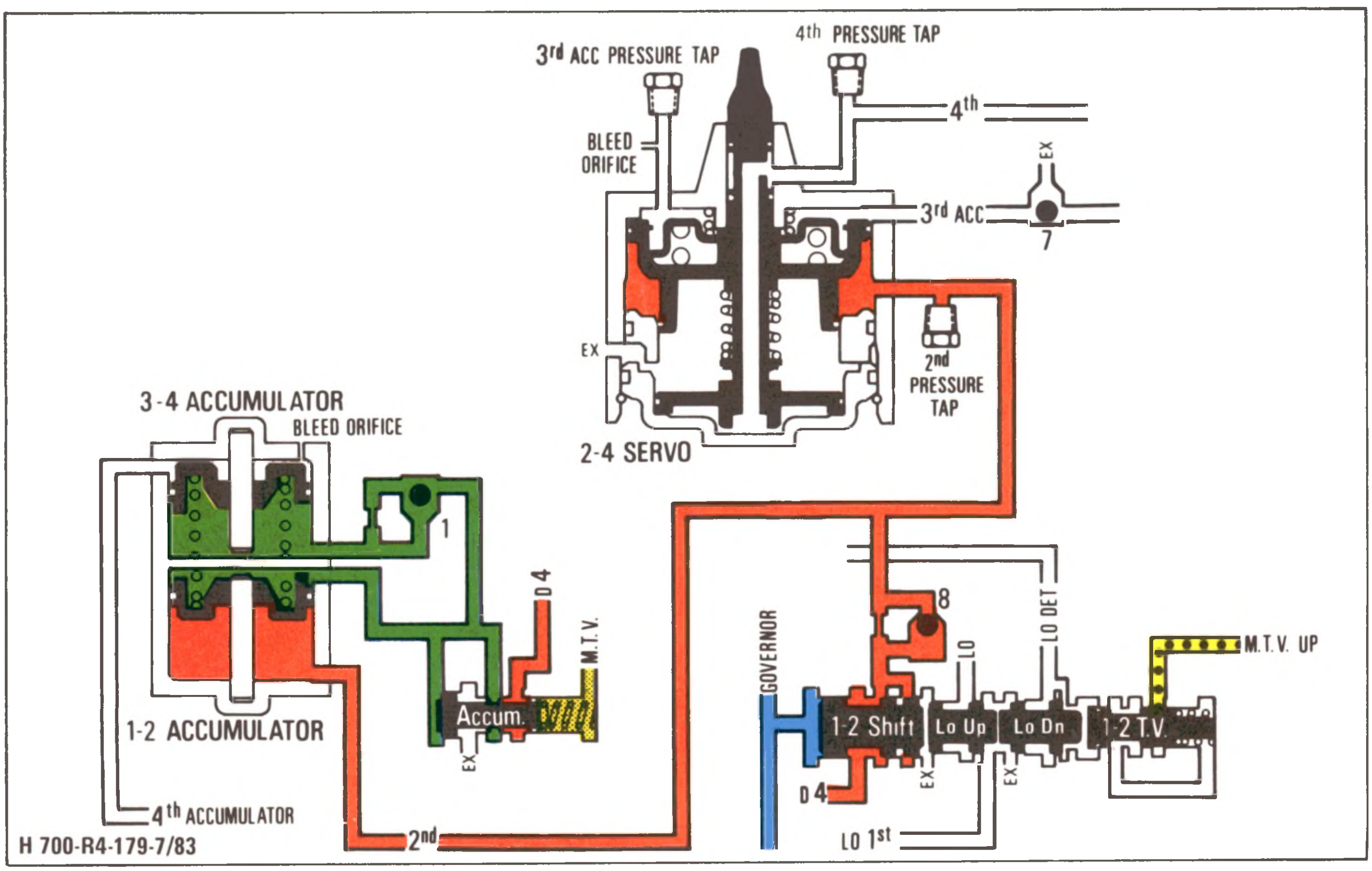


Figure 59 - 1-2 Accumulation - Second Gear

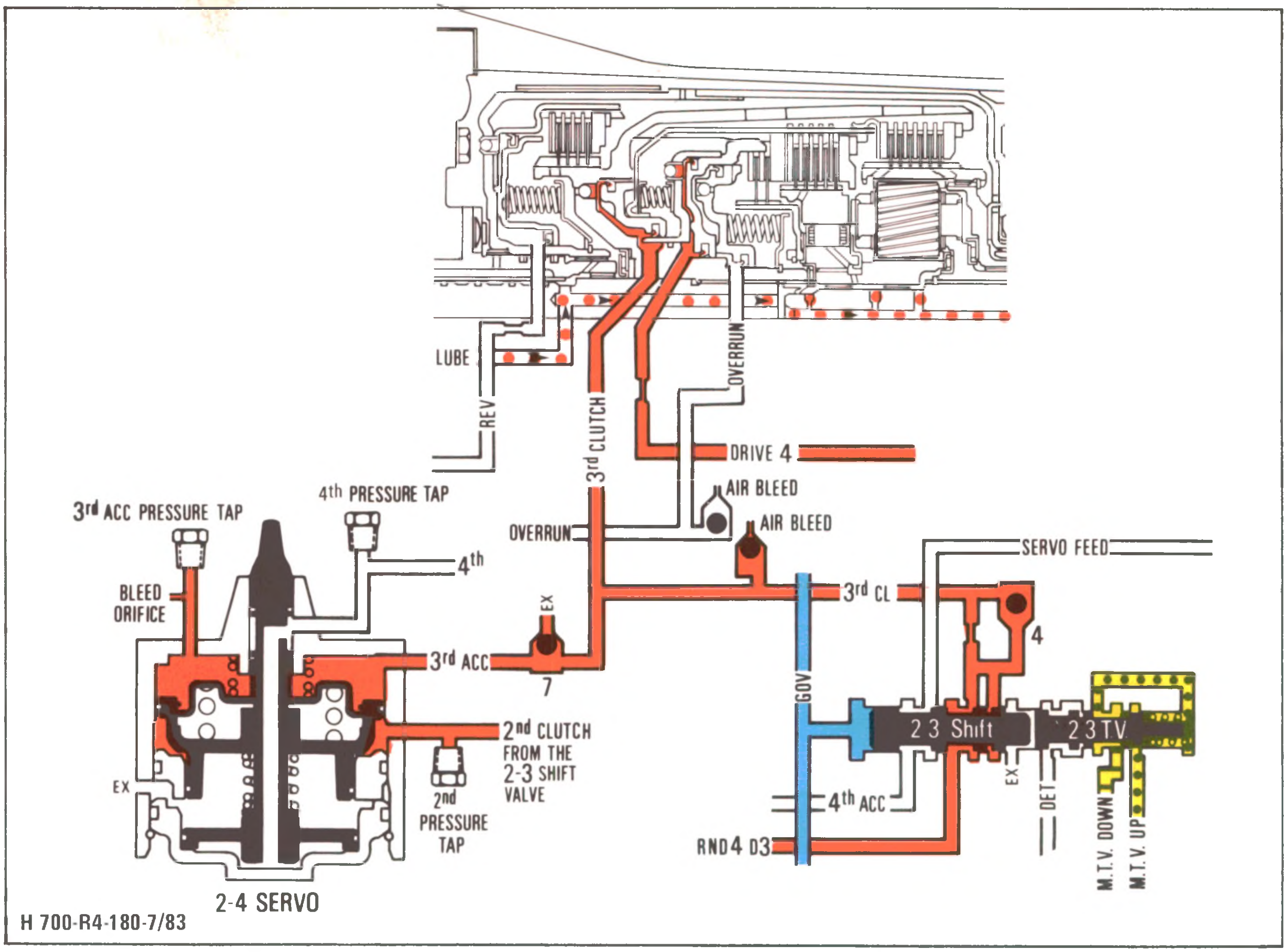


Figure 60 - 2-3 Shift Accumulation

ACCUMULATOR VALVE

The 1-2 shift feel and the durability of the 2-4 band are largely dependent on the pressure that applies the band. At minimum or light throttle operation, the engine develops a small amount of torque; and as a result, the band requires less apply force to hold the reverse clutch housing. At heavy throttle, the engine develops a large amount of torque which requires a greater apply pressure for the band to hold the reverse input clutch housing. If the band stops the housing too quickly, the shift will be too aggressive. If it applies too slowly, the band will slip excessively and burn, due to the heat created by the slippage.

Controlling of the 2-4 band apply pressure is accomplished by the accumulator valve which provides a variable accumulator pressure to cushion the band apply in relation to throttle opening (Fig. 59, pg. 53).

The accumulator valve system is supplied by Drive 4 (D4) oil pressure and is controlled by M.T.V. pressure. For light throttle operation, D4 oil is regulated to a lesser accumulator pressure. At heavy throttle, accumulator pressure is increased by M.T.V. pressure. Accumulator pressure is supplied to act on the spring side of the 1-2 accumulator piston located in the 1-2 accumulator housing, and the spring side of the 3-4 accumulator piston located in the case. In first gear, accumulator pressure is directed to the 1-2 and 3-4 accumulator piston to make it ready for the 1-2 and the 3-4 shift.

When the 1-2 shift valve opens, second oil strokes the second apply piston (Fig. 59, pg. 53), compressing the servo cushion spring and applying the 2-4 band. Second oil is also directed to the 1-2 accumulator piston and strokes the 1-2 accumulator piston against accumulator pressure and the 1-2 accumulator spring. This action absorbs some 2-4 band apply (second) oil and permits the band apply time and pressure to be controlled for proper shift feel.

2-3 SHIFT ACCUMULATION

The 3-4 clutch apply rate is controlled by the second apply piston (Fig. 60). In second gear, the servo piston is stroked by second oil, compressing the cushion spring and applying the 2-4 band. Second oil pressure varies with line pressure, thus the pressure on the second apply piston is varied according to throttle opening.

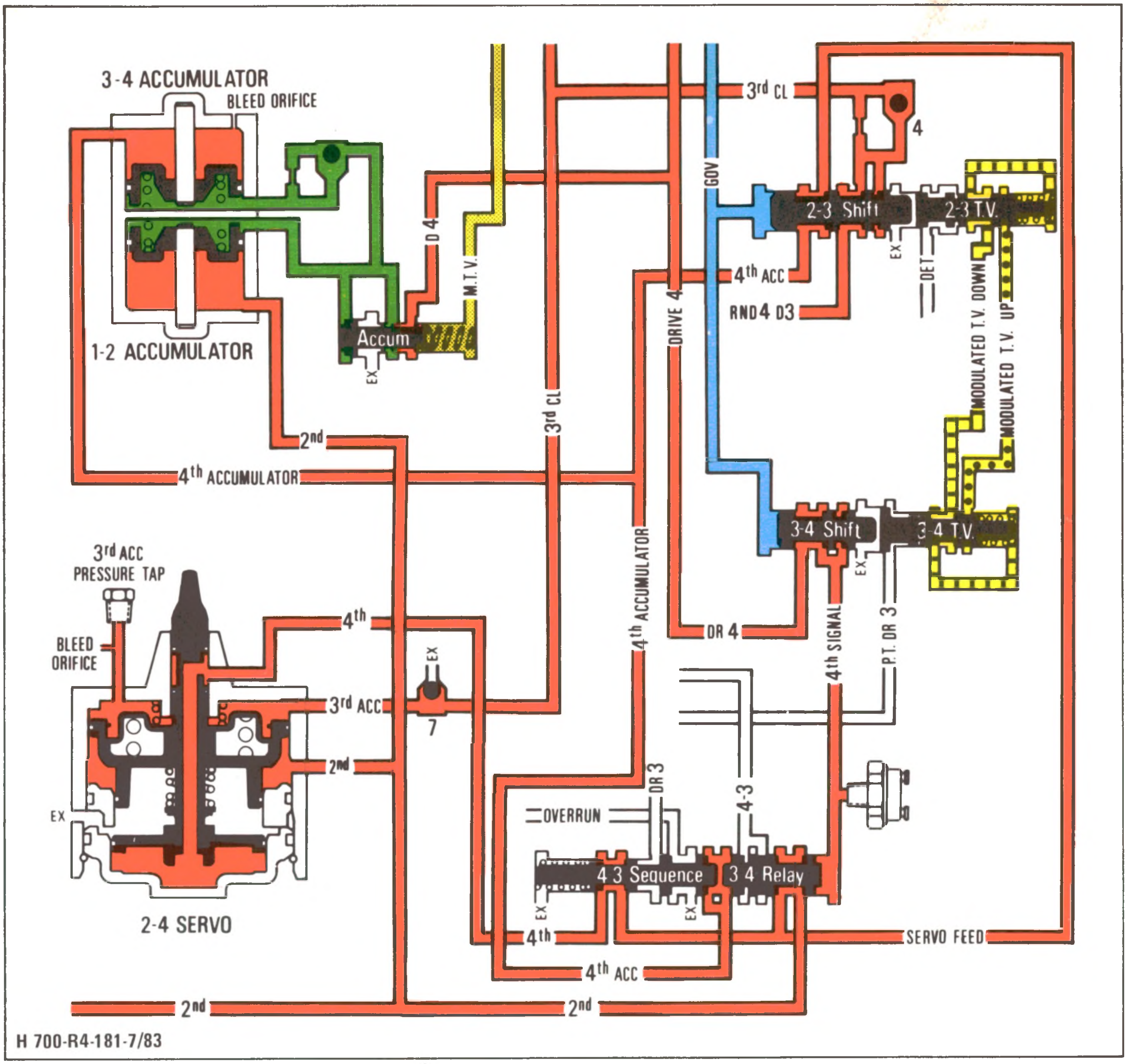


Figure 61 - 3-4 Shift Accumulation

When the 2-3 shift valve opens, third clutch oil flows to the 3-4 clutch. Third clutch oil also seats the accumulator exhaust check ball (7) and flows to the release side of the second apply piston. The servo cushion spring force and third accumulator oil pressure will overcome the pressure of the second apply oil and move the second piston to release the band. The stroking of the second apply piston to release the band acts as an accumulator and absorbs some third clutch oil. This permits the 3-4 clutch to apply at a controlled rate for a smooth 2-3 shift.

3-4 ACCUMULATOR PISTON

The 3-4 accumulator piston works in the same manner as the 1-2 accumulator piston. Pressure which varies in relation to throttle opening is supplied to the 1-2 and 3-4 accumulator pistons from the accumulator valve (Fig. 61).

When the 3-4 shift valve opens, fourth signal oil opens the 3-4 relay and 4-3 sequence valve. Second oil then can feed through the 3-4 relay valve, to the servo feed passage. Servo feed oil will then pass through the 4-3 sequence valve to the fourth passage and apply the 2-4 band. At the same time servo feed oil will pass through the 2-3 shift valve and into the fourth accumulator passage. Fourth accumulator oil will stroke the 3-4 accumulator piston against accumulator pressure and the 3-4 accumulator spring. This action absorbs some of the fourth oil and permits the 2-4 band apply, and pressure to be controlled for proper shift feel.

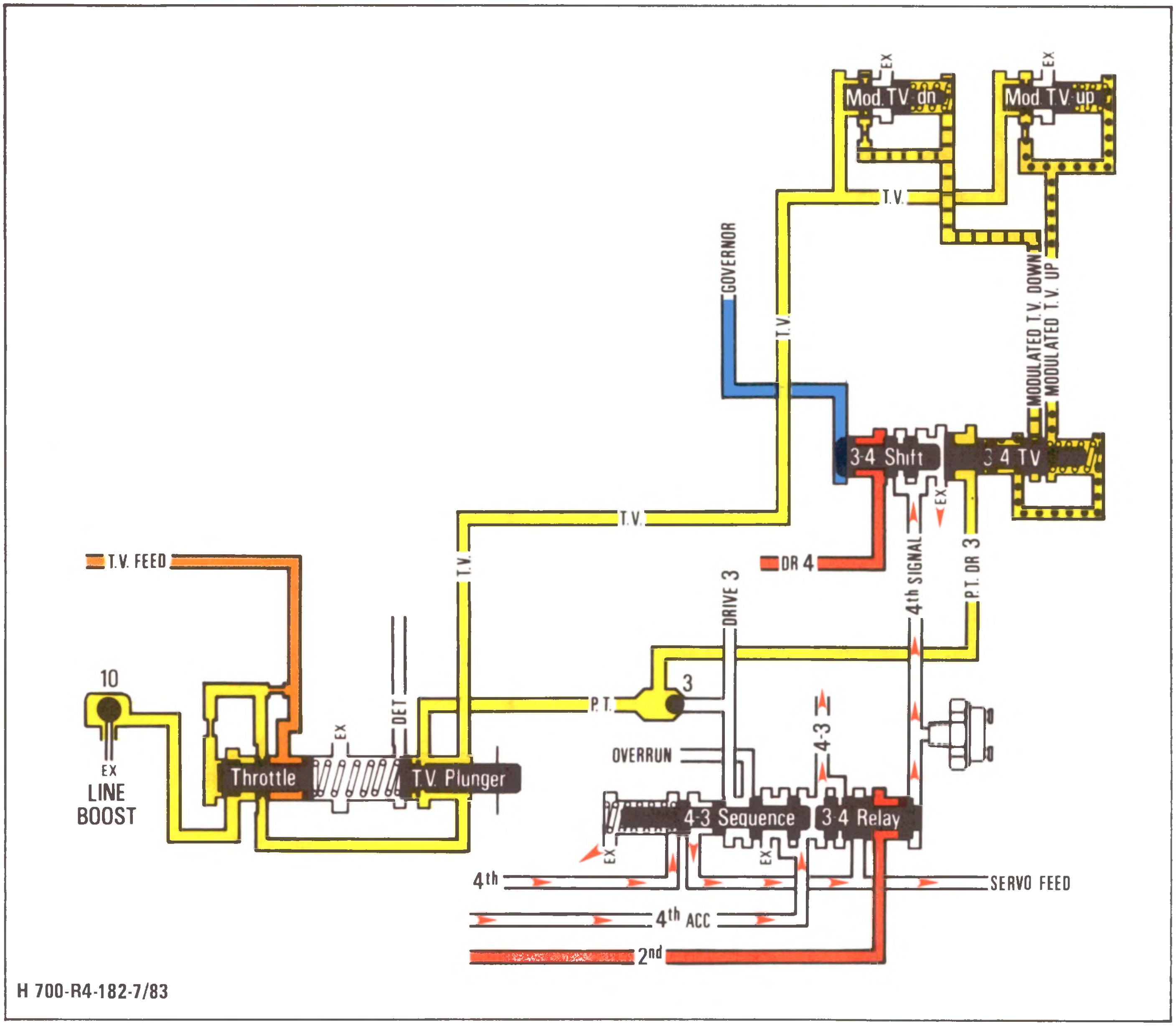


Figure 62 - Part Throttle 4-3 and Modulated Downshift Valves Shown in Third Gear Position

PART THROTTLE 4-3 AND MODULATED DOWNSHIFT

During moderate acceleration in overdrive, improved performance can be obtained with additional throttle opening, causing a 4-3 part throttle (P.T.) downshift (Fig. 62).

A part throttle 4-3 downshift can be accomplished by depressing the accelerator pedal far enough to move the T.V. plunger and open the part throttle (P.T.) passage. The travel of the T.V. plunger raises T.V. pressure and allows T.V. oil to enter into the P.T. passage. T.V. oil then acts on the 3-4 throttle valve train against governor pressure and closes the 3-4 shift valve. Fourth signal oil will then exhaust and allow the 4-3 sequence valve spring force and fourth accumulator pressure to close the 3-4 relay valve. With the 3-4 relay valve closed, fourth oil exhausts and the transmission shifts to third gear.

It should also be noted that M.T.V. down oil operating on the 2-3 shift valve trains, when they are in the open position, also acts as a type of part throttle downshift called a modulated downshift. With sufficient T.V. pressure, M.T.V. down, combined with the throttle valve spring pressure, can cause the shift valve to close against governor pressure.

DETENT (FULL THROTTLE) 4-2 DOWNSHIFT

If the vehicle is in fourth gear, a detent 4-2 downshift is possible. By depressing the accelerator fully the T.V. plunger opens the detent passage at speeds below approximately 60 mph (96 km/h). Part throttle oil acting on the 3-4 throttle valve and detent oil acting on the 2-3 throttle valve (Fig. 63), in addition to M.T.V. down oil and spring force, moves both valve trains against

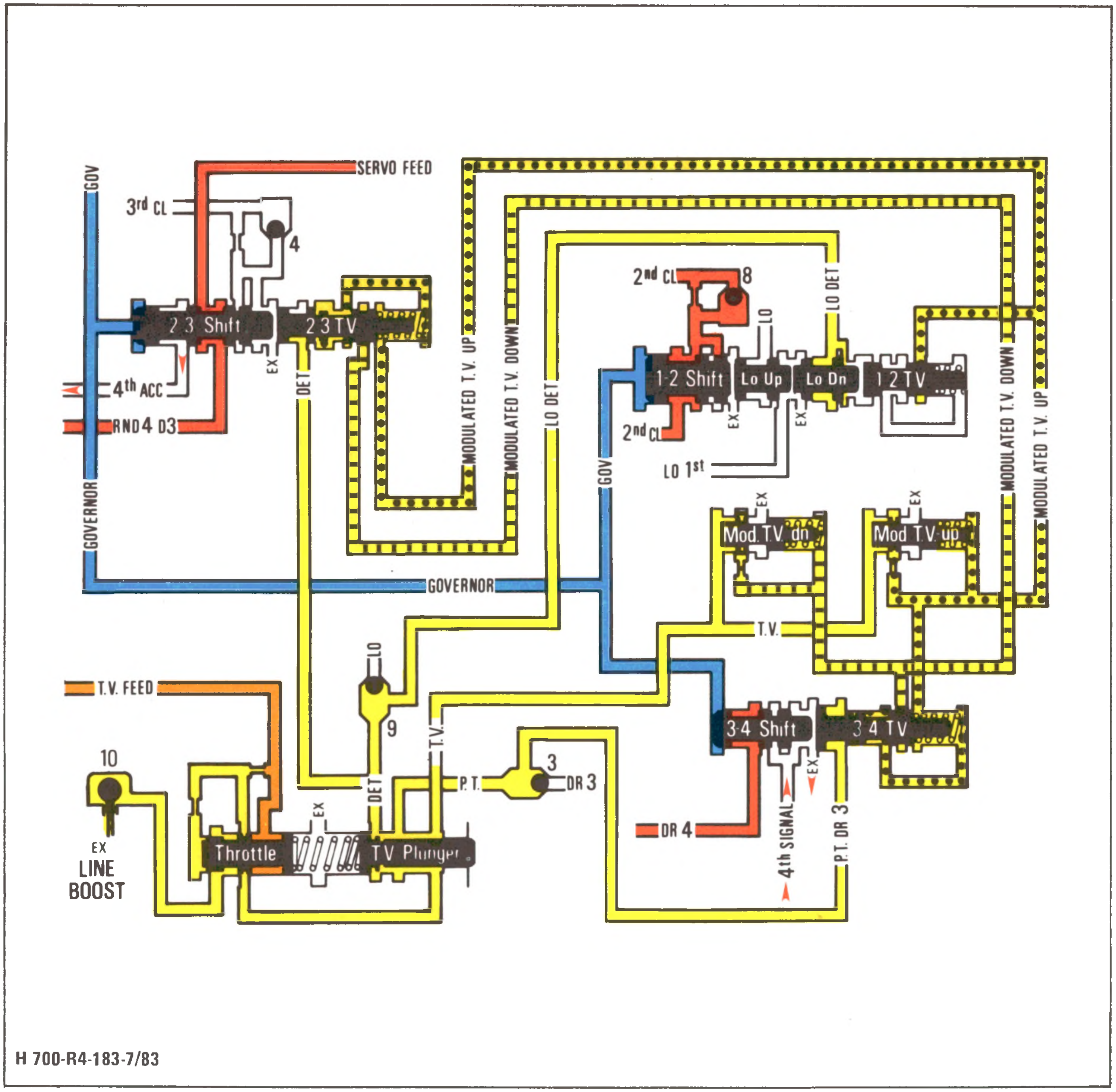


Figure 63 - Detent (Full Throttle) 4-2 or 3-2 Downshift, Valves Shown in Second Gear Position

governor pressure at approximately the same time, shifting the transmission from fourth to second gear.

DETENT (FULL THROTTLE) 3-2 DOWNSHIFT

If the vehicle is in third gear, a detent 3-2 downshift is possible at speeds below approximately 60 mph (96 km/h). Detent oil acting on the 2-3 throttle valve (Fig. 63), in addition to M.T.V. down oil and spring force, moves the valve train against governor pressure, shifting the transmission from third to second gear.

DETENT (FULL THROTTLE) 3-1 DOWNSHIFT

If the vehicle is in third gear, a detent 3-1 downshift is possible at speeds below approximately 30 mph (48 km/h). Detent oil acting on both the 1-2 and 2-3 throttle valves (Fig. 63), in addition to M.T.V. down oil and spring force, moves both valve trains against governor oil pressure at approximately the same time, shifting the transmission from third to first gear.

DETENT (FULL THROTTLE) 2-1 DOWNSHIFT

If the vehicle is in second gear, a detent 2-1 downshift can be accomplished at speeds below approximately 30 mph (48 km/h). Detent oil acting on the 1-2 throttle valve (Fig. 63), moves the 1-2 shift valve train against governor pressure, shifting the transmission to first gear.

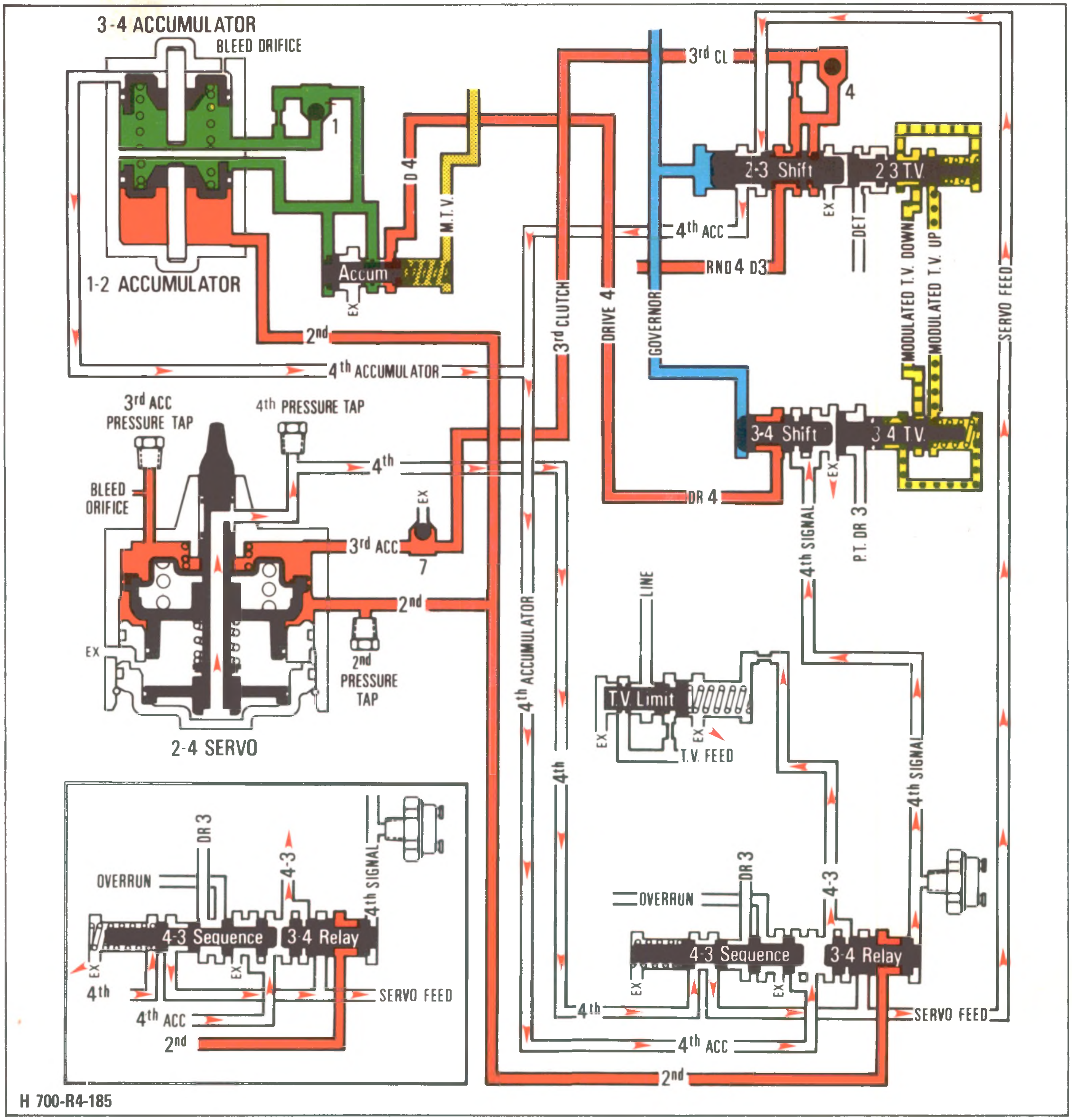


Figure 64 - Part Throttle or Modulated 4-3 Downshift Timing

PART THROTTLE OR MODULATED 4-3 DOWNSHIFT TIMING

The rate at which the fourth apply piston releases the 2-4 band during a 4-3 downshift will determine shift feel.

When part throttle or M.T.V. down oil closes the 3-4 shift valve, fourth accumulator pressure will close the 3-4 relay valve, but will hold the 4-3 sequence valve open (Fig. 64). This allows fourth oil to pass through the 4-3 sequence valve and into the servo feed passage. With the 2-3 shift valve open, servo feed oil will pass through the 2-3 shift valve to the fourth accumulator passage. Fourth accumulator oil from the 3-4 accumulator and the 2-4 servo will both work to hold the 4-3 sequence valve open and flow into the 4-3 passage where it will be exhausted through an orifice at the T.V. limit valve. When fourth accumulator pressure is low enough, the 4-3 sequence valve will close (Fig. 64 insert) and the remaining fourth and fourth accumulator oil will exhaust at the 4-3 sequence valve.

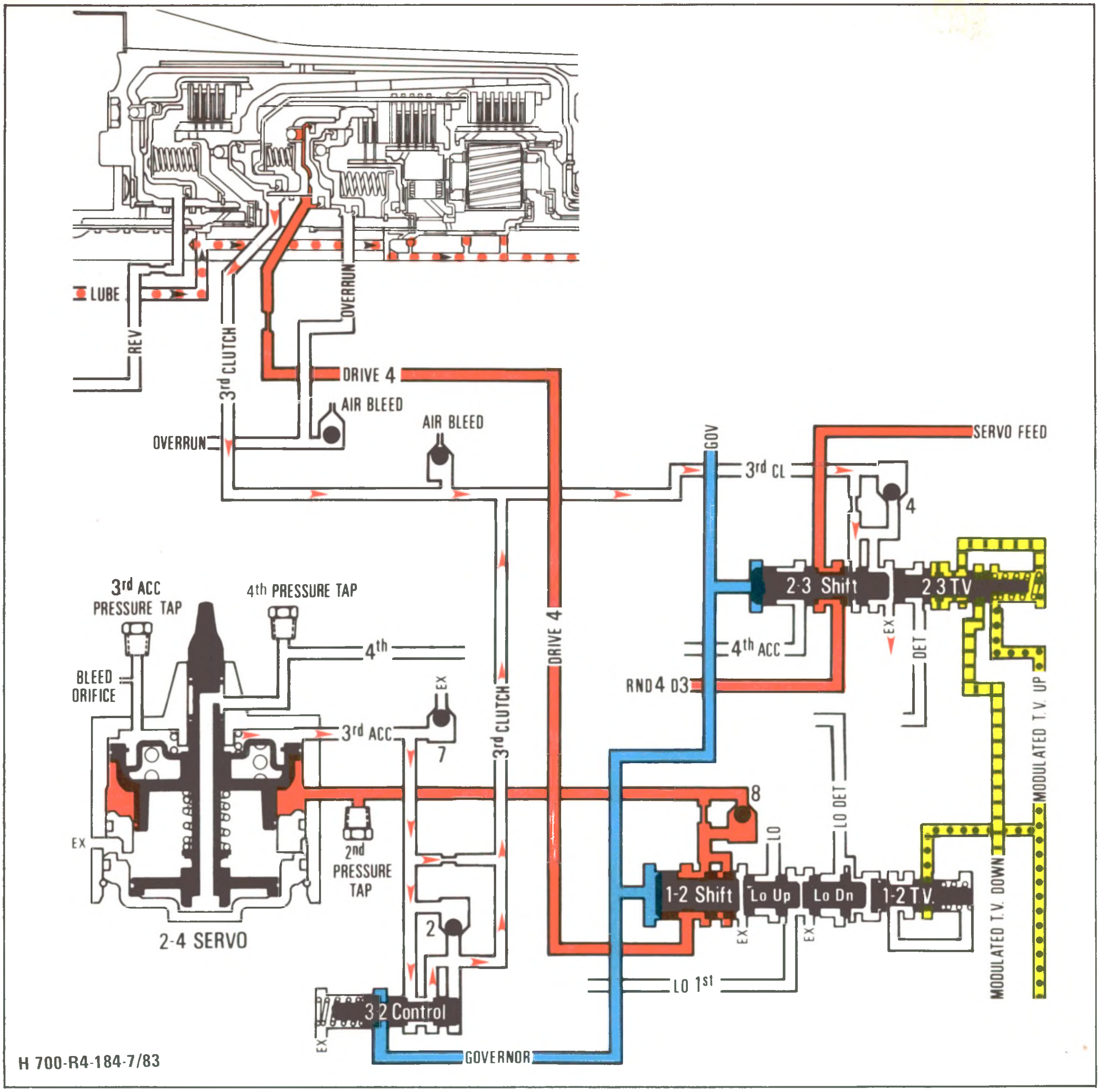


Figure 65 - Downshift Timing (Low Speed)

It is the 4-3 sequence valve that controls the 4-3 downshift. At first the valve forces exhausting fourth oil to be orificed, slowing the release of the 2-4 band for proper shift feel. Then the 4-3 sequence valve closes and allows the remaining fourth oil to quickly exhaust, preventing the band from dragging.

DETENT OR MODULATED 4-2 DOWNSHIFT TIMING

During a 4-3 downshift the 2-4 band is released. During a 3-2 downshift the 3-4 clutch is released and the 2-4 band is applied. To perform a 4-2 downshift then, it is necessary to keep the 2-4 band on and to release the 3-4 clutch. In a 4-3 downshift, fourth oil exhausts through the 4-3 sequence valve to the servo feed passage which passes through the 2-3 shift valve (Fig. 64). In a 4-2 downshift the 2-3 shift valve is closed. This will give second oil time to apply the 2-4 band. Then fourth accumulator oil, which has been orificing out the exhaust at the T.V. limit valve, will become a lower pressure than the 4-3 sequence valve spring force and the 4-3 sequence valve will close. This will then allow fourth oil to exhaust after second oil has the 2-4 band applied. Control of the 3-4 clutch release is discussed in the 3-2 downshift timing section.

RND4D3 oil feeds into the 1-2 servo passage. The servo feed oil keeps the band applied, until the 4-3 sequence valve downshifts and exhausts fourth oil.

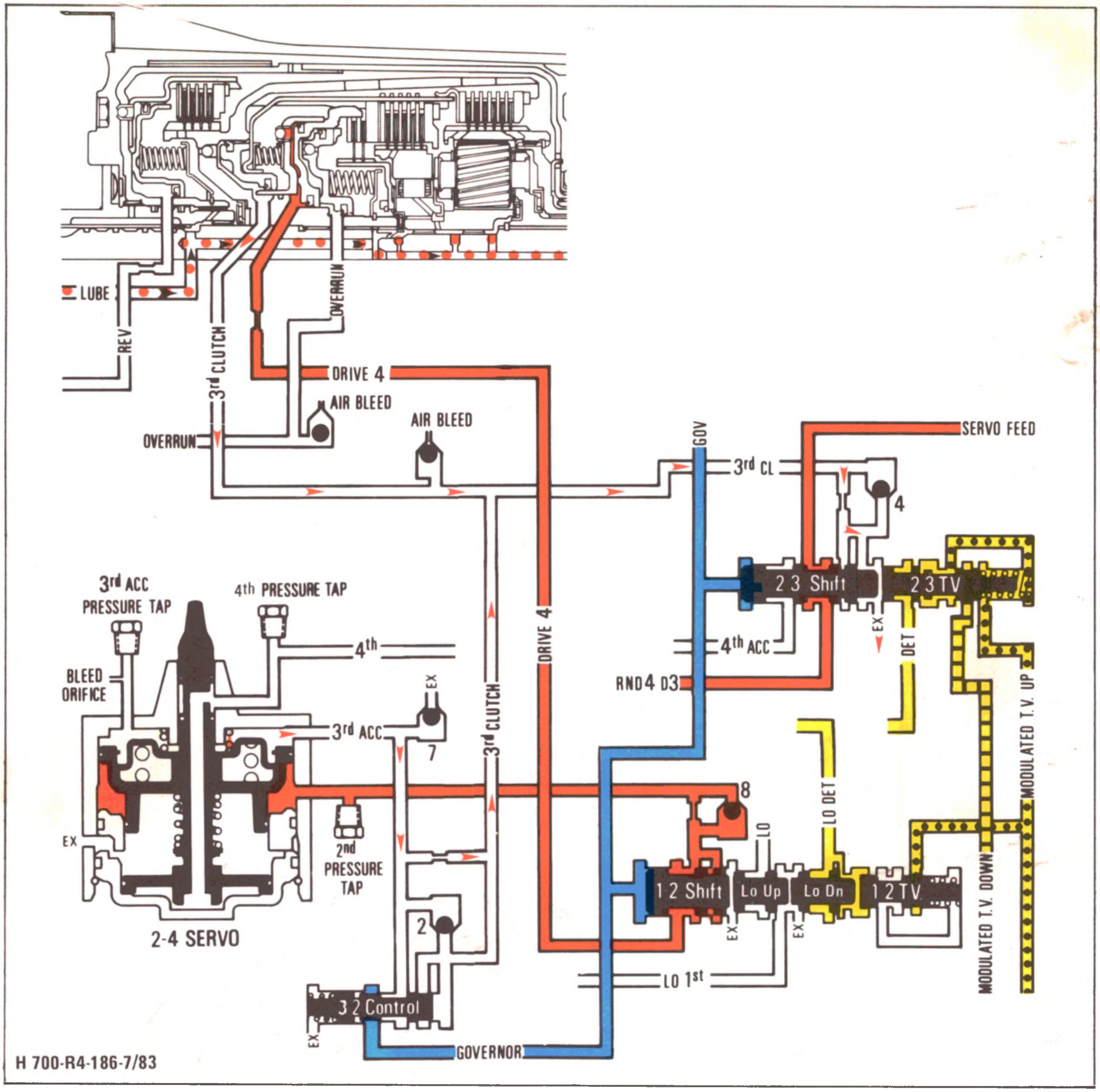


Figure 66 - Detent Downshift Timing (High Speed)

3-2 DOWNSHIFT TIMING (LOW SPEED)

The rate at which the 3-4 clutch releases and the 2-4 band applies during detent or modulated 3-2 downshifts is controlled by the 3-2 control valve.

During detent or modulated downshifts below approximately 50 mph (80 km/h), the exhausting third clutch apply oil and third clutch accumulator oil is regulated by the 3-2 control valve according to vehicle speed. This regulated exhaust oil seats the 3-2 exhaust check ball (4), flows through the orifice, and exhausts at the 2-3 shift valve, allowing the 3-4 clutch to release gradually.

With low vehicle speed downshifts, governor and third clutch pressure will not be sufficient to close the 3-2 control valve (Fig. 65, pg. 59). Third accumulator oil will pass through the 3-2 control valve instead of being orificed. This allows the 2-4 band to apply quickly for a smooth 3-2 shift. However, at high vehicle speed, the 2-4 band apply must be delayed in order to allow the engine RPM to increase at the proper rate for a smooth transfer of the driving load to the 2-4 band.

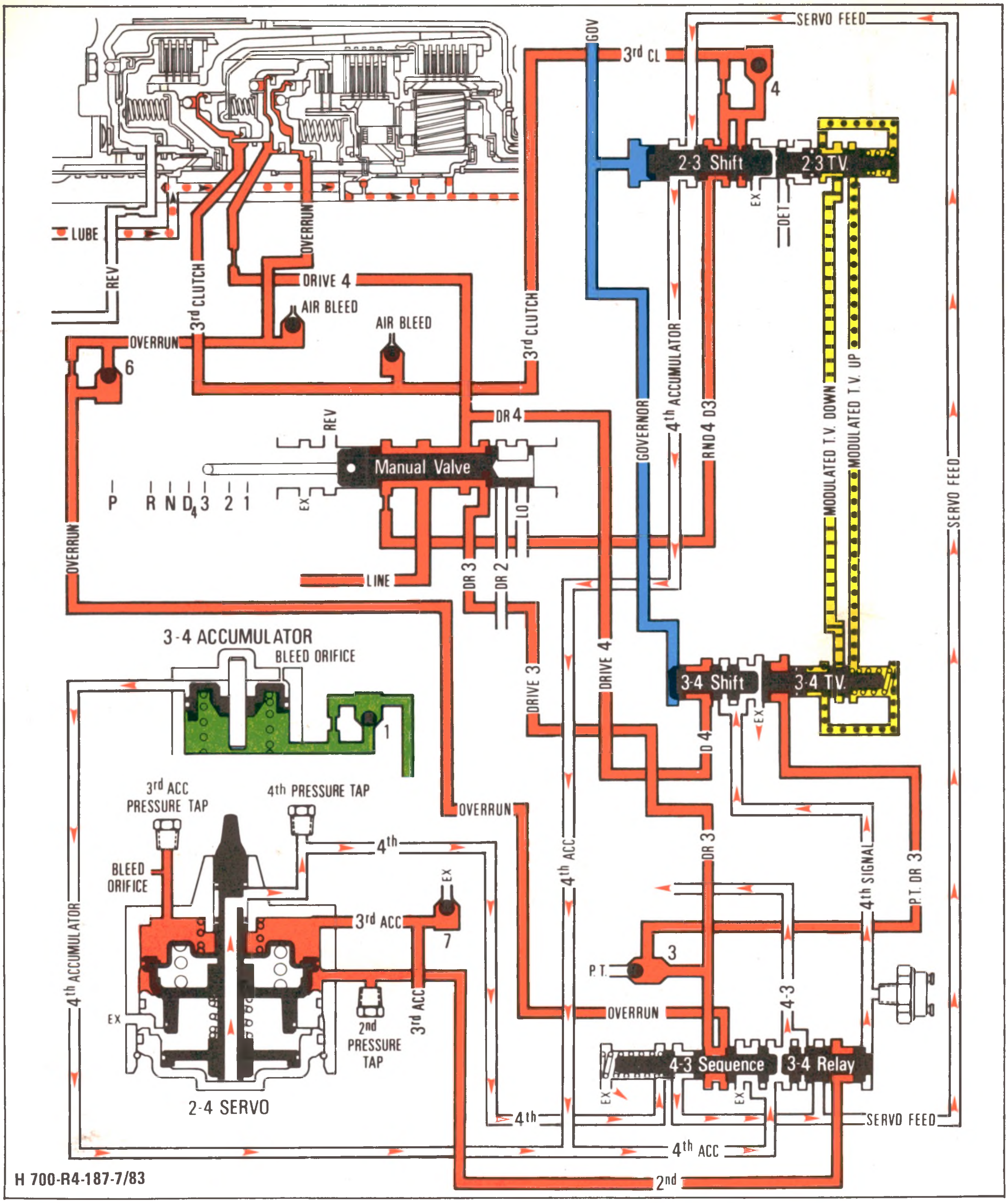


Figure 67 - Manual Third, Valves Shown in Third Gear Position

3-2 DOWNSHIFT TIMING (HIGH SPEED)

On detent 3-2 downshifts, above approximately 50 mph (80 km/h), governor and third accumulator pressure will close the 3-2 control valve and block third clutch accumulator oil from flowing through the valve. Exhausting third clutch oil still seats the 3-2 exhaust check ball (4), and flows through an orifice, exhausting at the 2-3 shift valve. The exhausting third clutch accumulator oil seats the third clutch ac-

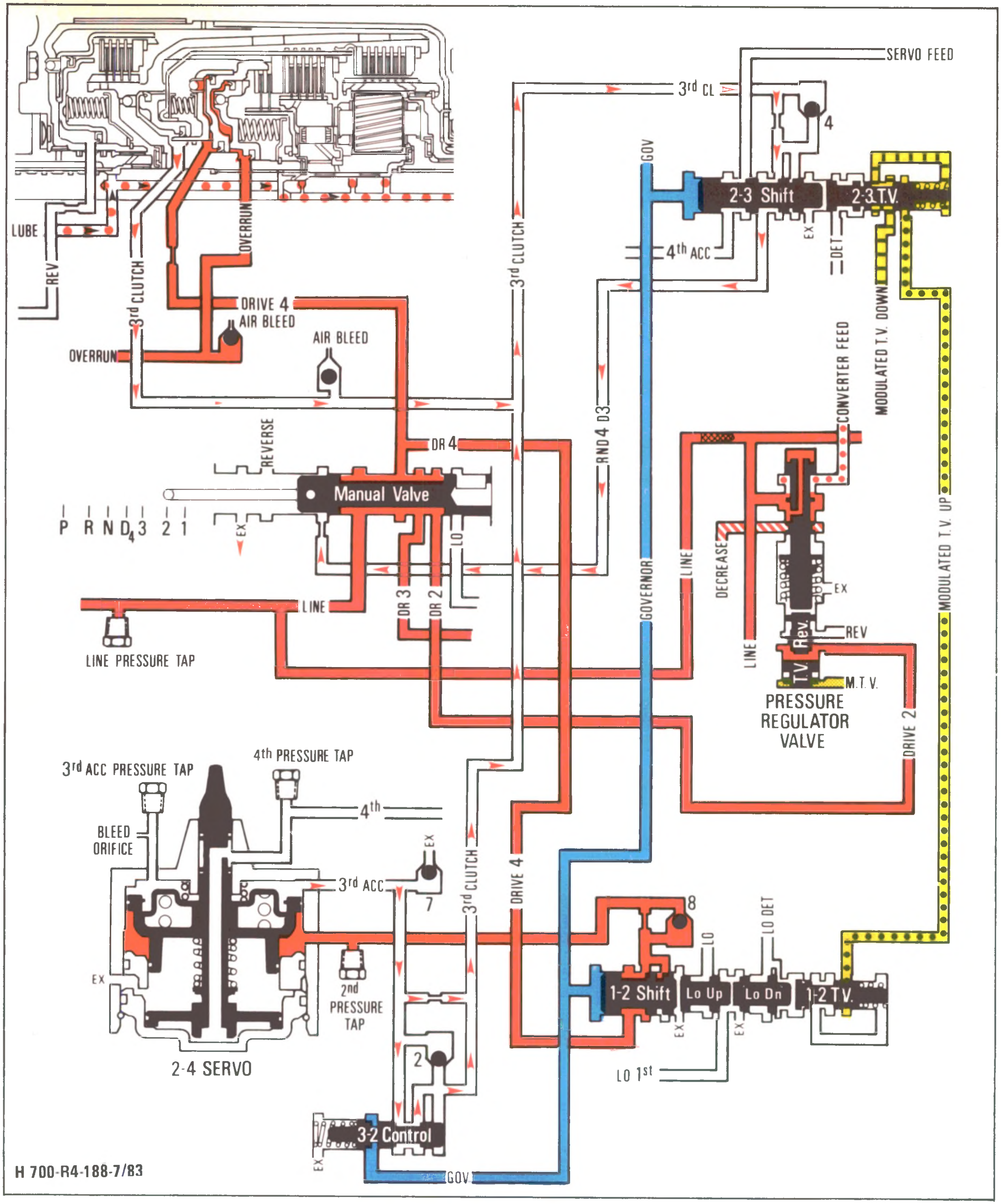


Figure 68 - Manual Second, Valves Shown in Second Gear Position

cumulator check ball (2) and flows through another orifice, controlling the apply of the 2-4 band (Fig. 66, pg. 60).

MANUAL THIRD

When the selector lever is moved to the third gear position, the manual valve is moved to open the Drive 3 (D3) passage (Fig. 67, pg. 61). D3 oil will seat the D3 part throttle and (3) check ball in the part throttle passage. D3 oil combined with M.T.V. down oil and 3-4 throttle valve spring pressure will close the

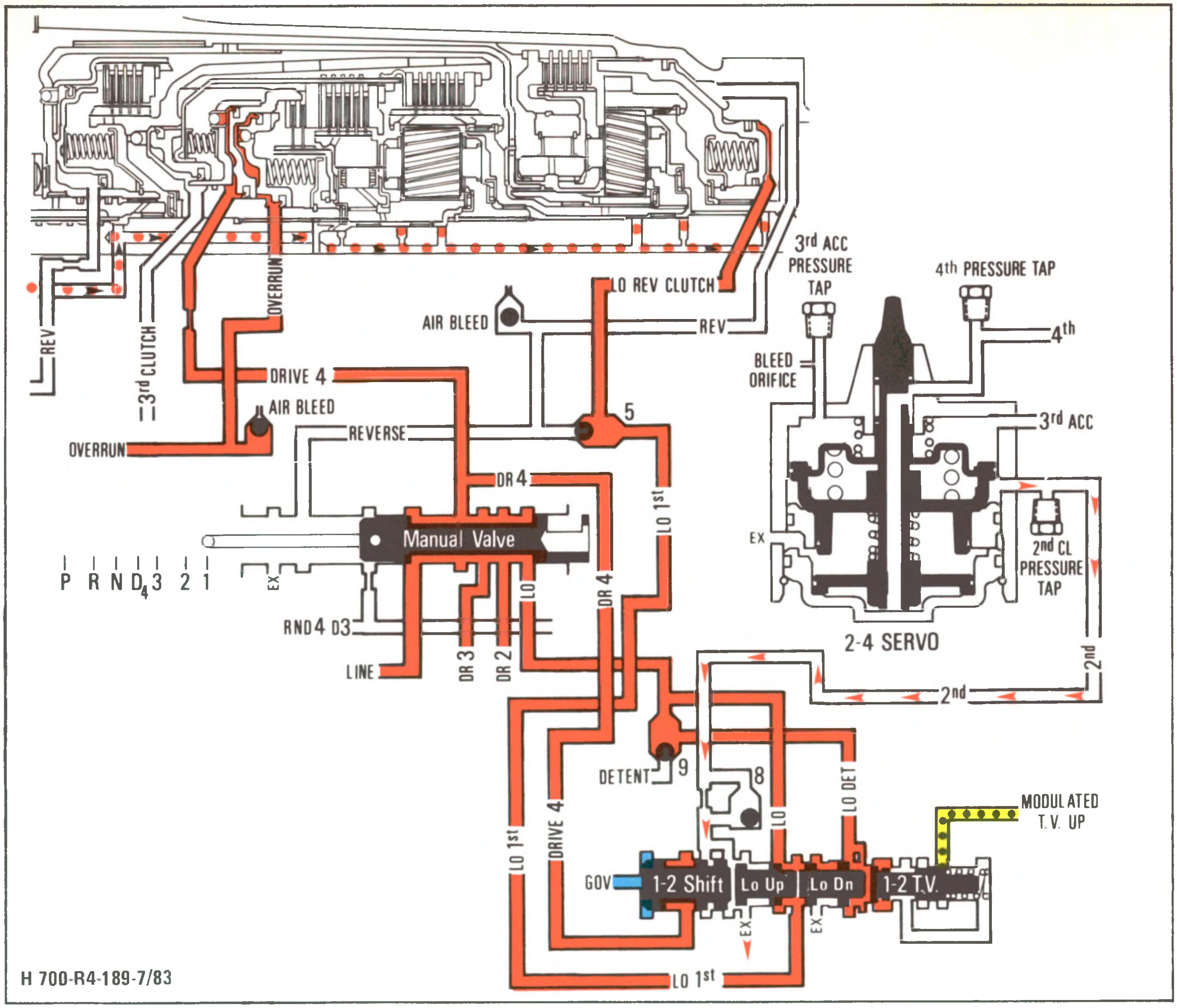


Figure 69 - Manual Lo, Valves Shown in First Gear Position

3-4 shift valve against governor pressure. D4 oil will then be blocked from entering the fourth signal passage. D3 oil at the 4-3 sequence valve combined with 4-3 sequence valve spring force will close the 4-3 sequence valve and the 3-4 relay valve. Fourth oil and fourth accumulator oil will exhaust at the 4-3 sequence valve, shifting the transmission to third gear. When the 4-3 sequence valve closes D3 oil can then pass through the valve to the overrun passage and apply the overrun clutch. With the overrun clutch applied, engine braking is available.

Figures 67, 68, and 69 for manual; third, second, and lo, show M.T.V. up and M.T.V. down pressure being present. When a manual range is used for engine braking and there is minimum throttle, as a result of low T.V. pressure, there would be no M.T.V. up or M.T.V. down pressure.

MANUAL SECOND

When the selector lever is moved to the second gear position, the manual valve is moved to block the supply of line pressure to the RND4D3 passage (Fig. 68). Also, the manual valve opens an exhaust port which allows the oil that was applying the 3-4 clutch (third clutch oil) and releasing the 2-4 band (third accumulator oil) to pass back through the 2-3 shift valve and exhaust at the manual valve. Second oil will then apply the 2-4 band, and with the 3-4 clutch released, the transmission has now shifted to second gear regardless of speed.

To provide sufficient holding force on the 2-4 band for closed throttle overrun engine braking, the manual valve will direct line pressure into the D2 passage which leads to the reverse boost valve. D2 oil acting on the reverse boost valve, combined with the pressure regulator valve spring force, will boost line pressure to 760 kPa (110 psi). To continue to allow engine braking, D3 oil is still directed by the manual valve to apply the overrun clutch.

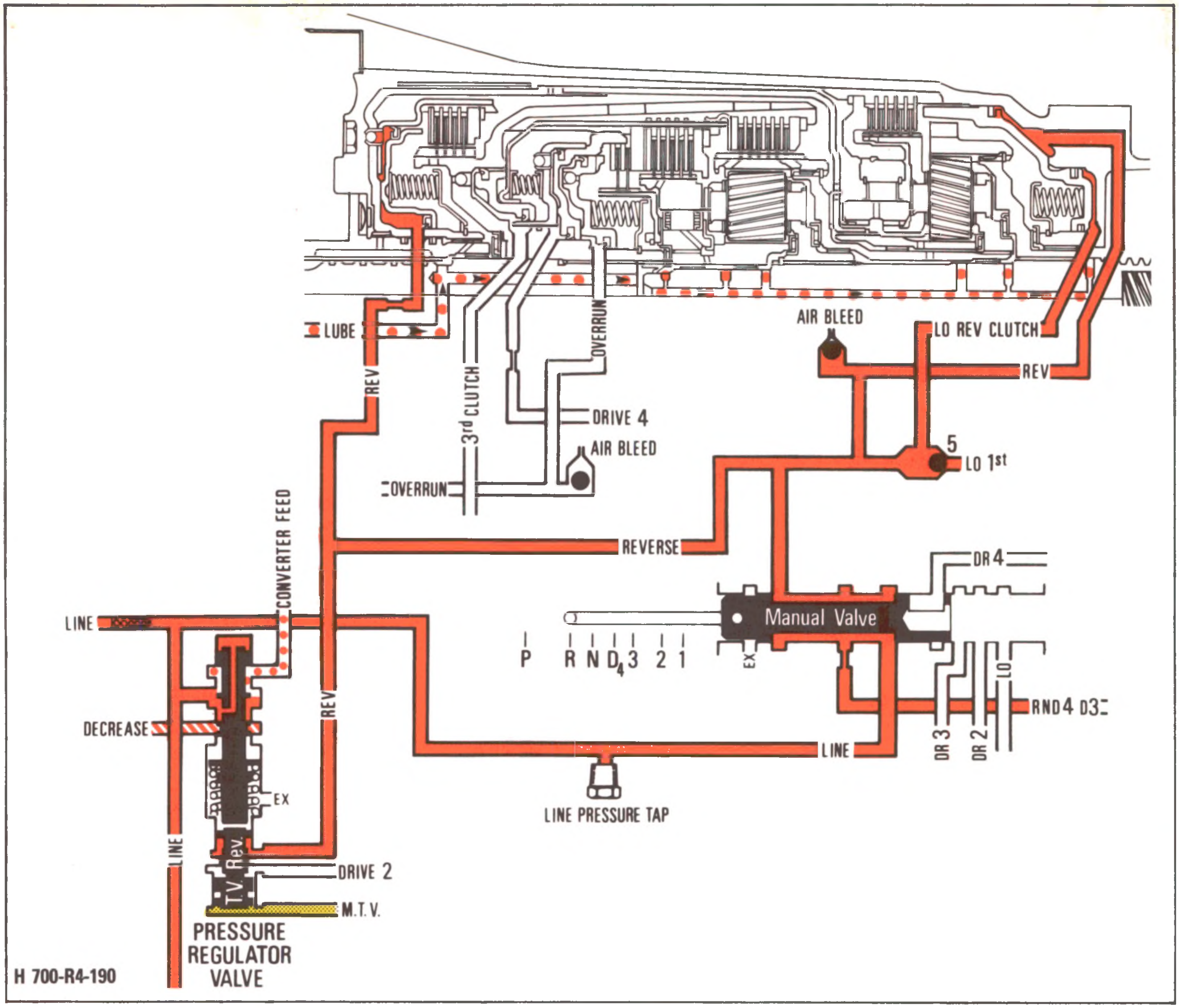


Figure 70 - Reverse

MANUAL LO

When the selector lever is moved to the lo gear position, the manual valve is moved to allow line pressure into the lo passage (Fig. 69, pg. 63). Lo oil will move the lo/detent check ball (9) over to block the detent passage. Lo oil will then flow into the 1-2 shift valve where at speeds below 30 mph (48 km/h), it will close the 1-2 shift valve allowing lo oil to enter the lo-1st passage. The lo-1st passage leads to the lo/reverse check ball (5), which seals off the reverse passage. Lo oil will then enter the inner area of the lo and reverse piston and apply it.

With D2 oil exerting pressure on the bottom of the pressure regulator, line pressure will remain the same 760 kPa (110 psi), as when the manual valve was in the D2 position. When the 1-2 shift valve is closed, line pressure is blocked from entering the second passage. This not only causes the transmission to shift to first but also releases the converter clutch if it has not already released.

To continue to allow engine braking, D3 oil is still directed by the manual valve to the overrun clutch.

REVERSE

Selecting the reverse position moves the manual valve to allow D4, D3, D2, and lo oil to be exhausted. Line oil then enters the reverse passage where it seats the lo and reverse check ball (5) in the lo/1st passage and applies the lo and reverse clutch (Fig. 70).

Reverse oil is also orificed into the reverse input clutch piston and applies the reverse input clutch.

To ensure adequate oil pressure for the torque requirements, reverse oil acts on the reverse boost valve, and will boost reverse line pressure to about 670 kPa (100 psi).

M.T.V. oil from the line bias valve acts on the T.V. boost valve and will boost reverse line pressure from 670 kPa (100 psi) at idle to 1,690 kPa (245 psi) at full throttle.

CLUTCH EXHAUST CHECK BALLS

To complete the exhaust of apply oil when the forward, 3-4 or overrun clutch is released, an exhaust check ball assembly is installed near the outer diameter of the clutch housings. Centrifugal force, resulting from the spinning clutch housings, working on the residual oil in the clutch piston cavity would give a partial apply of the clutch plates if it were not exhausted. The exhaust check ball assembly is designed to close the exhaust port by clutch apply pressure seating the check ball when the clutch is being applied (Fig. 71).

When the clutch is released and clutch apply oil is being exhausted, centrifugal force on the check ball unseats it and opens the port to exhaust the residual oil from the clutch piston cavity (Fig. 72).

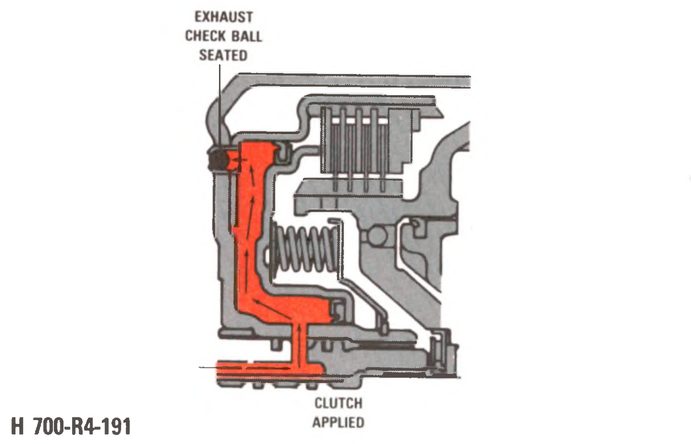


Figure 71 - Exhaust Check Ball Applied

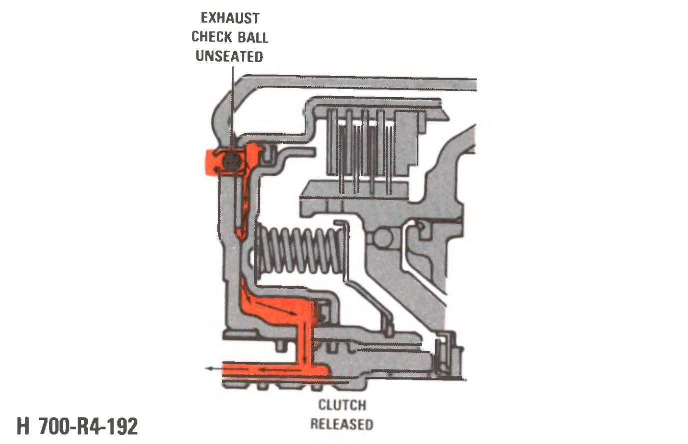


Figure 72 - Exhaust Check Ball Released

CHECK BALLS:

#1 Fourth Accumulator Check Ball:
Forces accumulator oil flowing to the 3-4 accumulator to pass through an orifice.

#2 Third Clutch Accumulator Check Ball:
Forces exhausting 3rd clutch accumulator oil to either flow through an orifice if the 3-2 control valve is closed, or through the open 3-2 control valve.

#3 Part Throttle and Drive 3 Check Ball:
Separates part throttle and D3 oil passages to the 3-4 shift valve.

#4 3-2 Exhaust Check Ball:
Forces exhausting 3rd clutch oil through an orifice before exhausting at the 2-3 shift valve during 3-2 downshifts.

#5 Lo/Reverse Check Ball:
Separates the lo and reverse passages to the lo/reverse clutch.

#6 Drive 3 (D3) Check Ball:
Forces Drive 3 (D3) oil flowing to the overrun clutch to flow through an orifice. When D3 oil exhausts, the check ball releases, allowing a clear flow of oil.

#7 Third Clutch Accumulator Exhaust Check Ball:
It closes the exhaust port in the 3rd clutch accumulator oil passage during 2-3 upshifts. Also, it allows 3rd clutch accumulator oil at a low pressure to exhaust which results in good 1-2 upshifts.

#8 1-2 Shift Check Ball:
Forces 2nd oil flowing to the intermediate servo to flow through an orifice. When second oil exhausts, the check ball releases, allowing a clear flow of oil.

#9 Lo/Detent Check Ball:
Separates the lo passage and the detent passage to the 1-2 shift valve train.

#10 (See Page 39)

COMPONENT DESCRIPTION

PRESSURE REGULATOR VALVE:
Controls line pressure by regulating pump output and is controlled by the pressure regulator spring, the T.V. boost valve and the reverse boost valve.

PRESSURE RELIEF VALVE:
Prevents line pressure from going above 2,240 to 2,520 kPa (320 to 360 psi) by exhausting oil.

REVERSE BOOST VALVE:
Acted on by Drive 2 (D2) and reverse oil, this valve moves against the pressure regulator spring, increasing line pressure.

T.V. BOOST VALVE:
Acted on by M.T.V. oil, from the line bias valve, this valve moves against the reverse boost valve and the pressure regulator spring force increasing line pressure.

1-2 ACCUMULATOR PISTON:
Absorbs 2nd oil to provide a cushion for the band apply. The firmness of the cushion is regulated by the accumulator valve.

3-4 ACCUMULATOR PISTON:
Absorbs 4th clutch oil to provide a cushion for the apply. The firmness of the cushion is regulated by the accumulator valve.

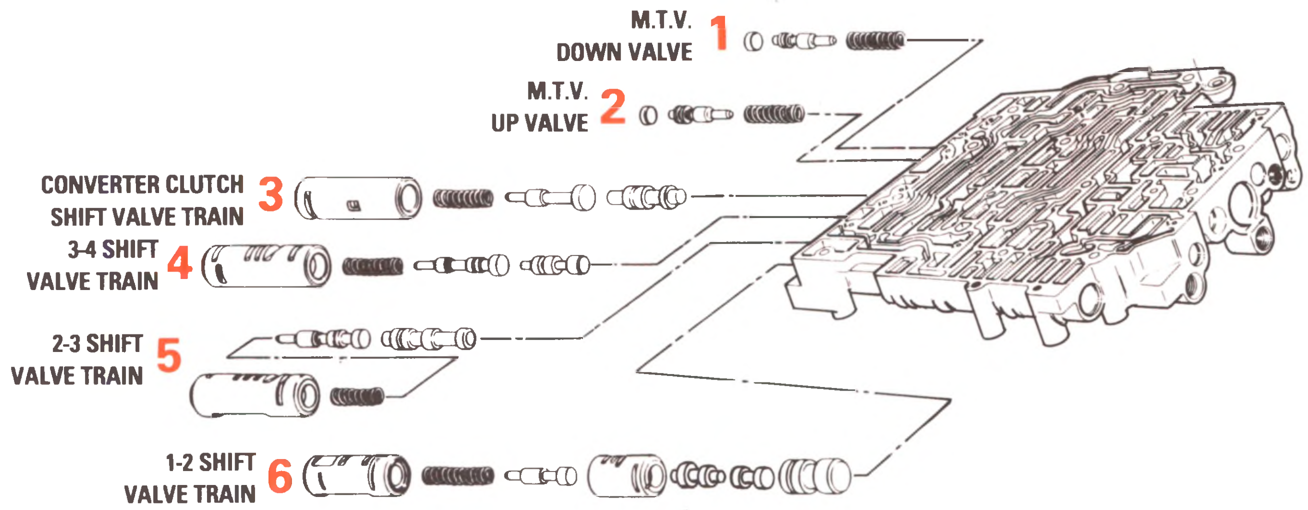


Figure 73 - Typical THM 700R4 Control Valve Assembly: 1-6

1 M.T.V. DOWN VALVE:
M.T.V. down oil operates on the 2-3 and 3-4 shift valves when they are in the open position. M.T.V. down oil causes early downshifts when there is heavy acceleration. The M.T.V. down valve receives T.V. oil and modulates it into M.T.V. down oil. Under light to medium acceleration M.T.V. down pressure is lower than T.V. pressure so there will be no early downshifts.

2 M.T.V. UP VALVE:
M.T.V. up oil operates on all the shift valves, when they are in the closed position, to delay upshifts during medium to heavy acceleration. The M.T.V. up valve receives T.V. oil and modulates it into M.T.V. up oil. Under light acceleration, M.T.V. up pressure is lower than T.V. pressure so the light throttle upshifts will not be delayed.

3 CONVERTER CLUTCH SHIFT VALVE TRAIN:
Located in the valve body, sends signal oil to the converter clutch apply valve helping to determine whether the converter clutch should be released or applied. It is affected by the governor, M.T.V. up and M.T.V. down oil.

4 3-4 SHIFT VALVE TRAIN:
Signals the transmission to shift from 3rd to 4th gear or 4th to 3rd gear, depending on governor, M.T.V. up, M.T.V. down, part throttle, detent, or Drive 3 oil.

5 2-3 SHIFT VALVE TRAIN:
Shifts the transmission from 2nd to 3rd gear or 3rd to 2nd gear depending on governor, M.T.V. up, M.T.V. down or detent oil.

6 1-2 SHIFT VALVE TRAIN:
Shifts the transmission from 1st to 2nd gear or 2nd to 1st gear, depending on governor, M.T.V. up, detent, or lo oil.

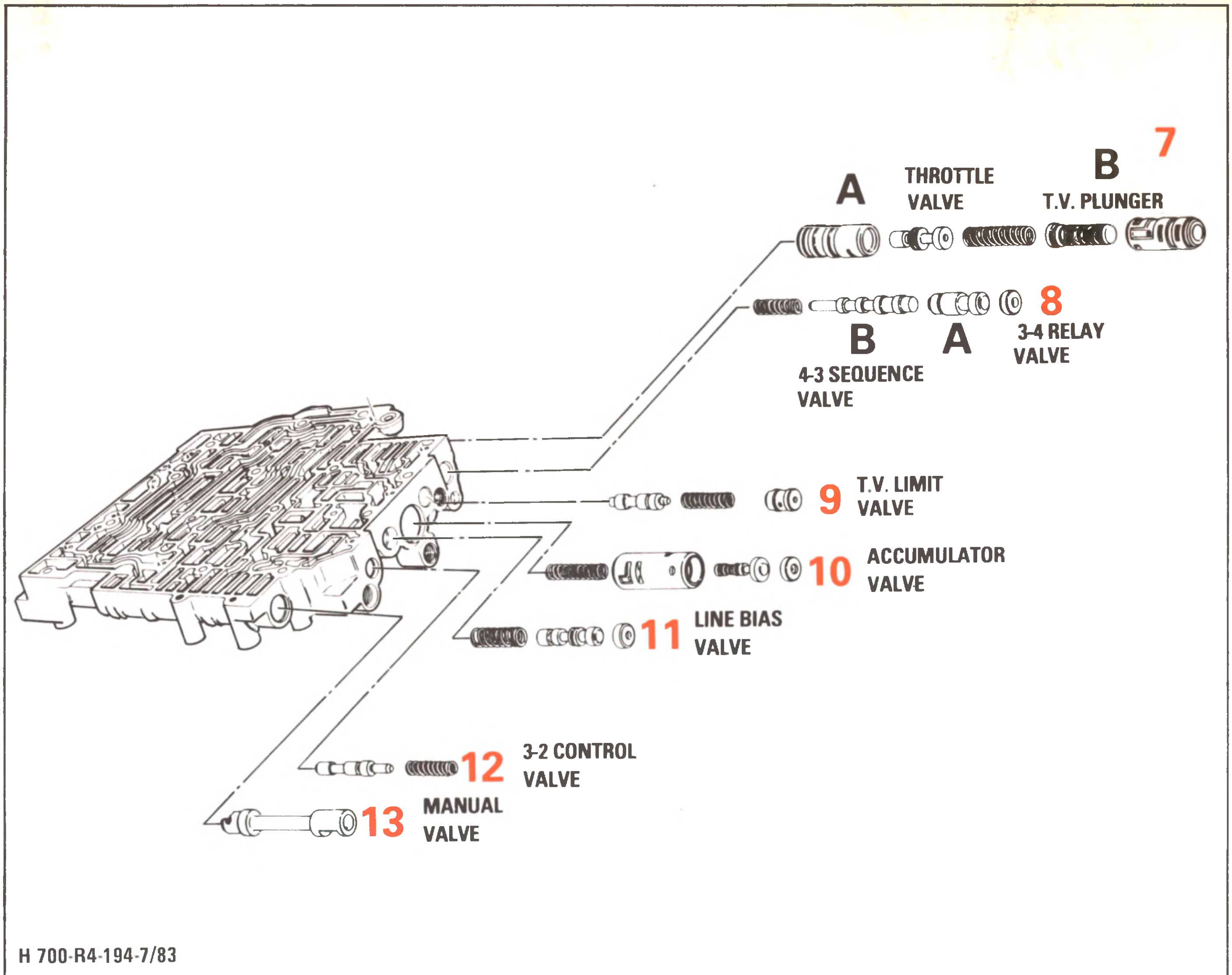


Figure 74 - Typical THM 700R4 Control Valve Assembly: 7-13

7A THROTTLE VALVE:

Regulates T.V. feed pressure to T.V. oil pressure. Valve is controlled by T.V. plunger movement, and T.V. spring force.

7B T. V. PLUNGER:

Controlled by the throttle lever and bracket assembly and linked to the carburetor. With acceleration, this valve moves against the throttle valve spring and throttle valve increasing T.V. pressure. It also controls the opening of the P.T. and detent ports.

8A 3-4 RELAY VALVE:

Shifts the transmission from 3rd to 4th gear and is controlled by 4th signal oil from the 3-4 shift valve.

8B 4-3 SEQUENCE VALVE:

Controls as well as times the 4th to 3rd gear downshift and 4th to 2nd gear downshift.

9 T.V. LIMIT VALVE:

Limits the line pressure fed to the throttle valve to 90 psi.

10 ACCUMULATOR VALVE:

Receives line pressure from the manual valve and is controlled by M.T.V. oil from the line bias valve. The accumulator valve regulates accumulator oil according to M.T.V. pressure.

11 LINE BIAS VALVE

Modulates T.V. pressure to closely follow engine torque instead of throttle opening. M.T.V. oil from the line bias valve acts on the pressure regulator valve to increase line pressure in relation to engine torque.

12 3-2 CONTROL VALVE:

Regulated by governor oil, it controls the rate at which the 3-4 clutch releases and 2-4 band applies.

13 MANUAL VALVE:

Mechanically connected to the shift selector. It is fed by line pressure from the pump and directs pressure according to which range the driver has selected.

COMPLETE HYDRAULIC OIL CIRCUITS

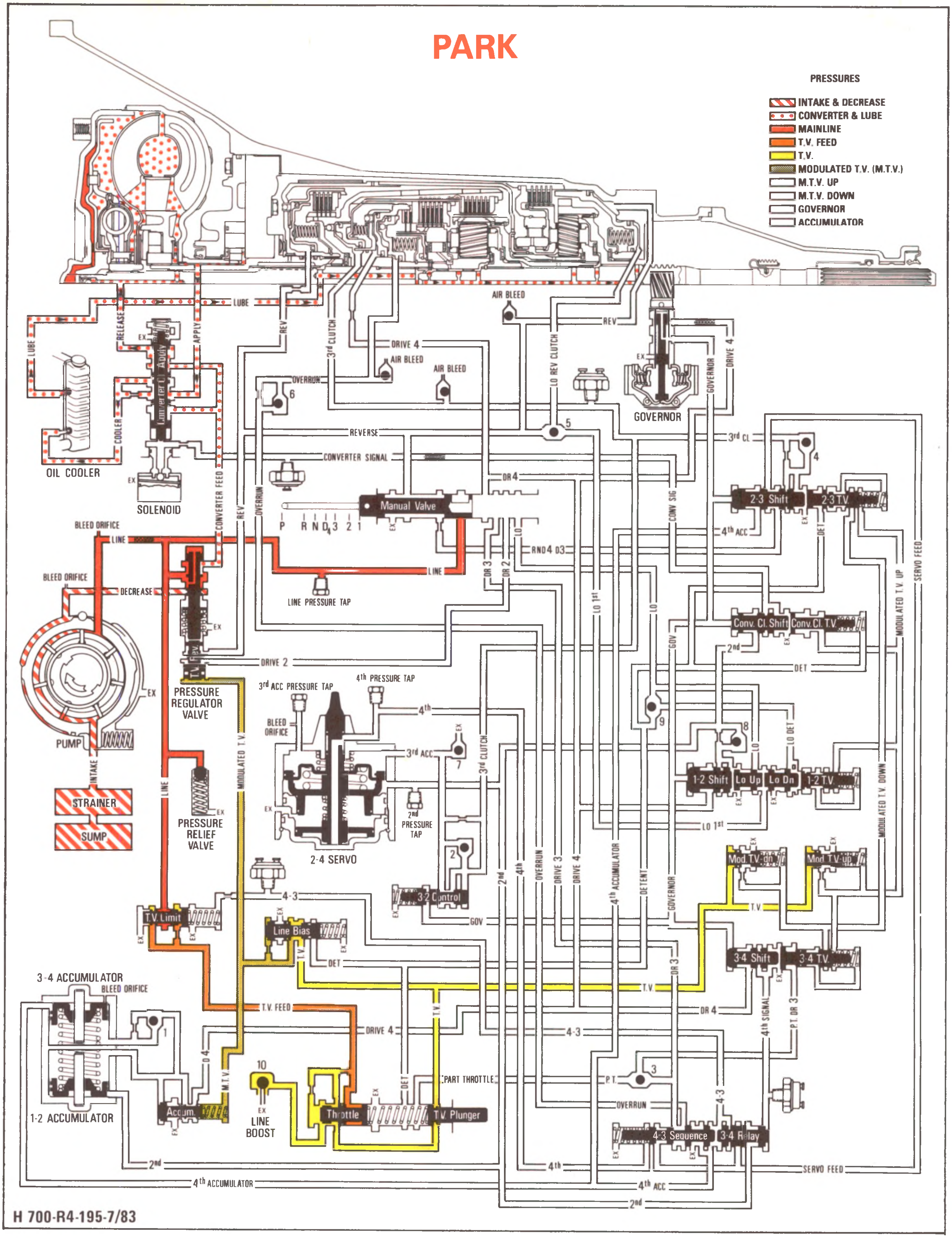


Figure 75 - Park — Engine Running

PARK-ENGINE RUNNING

CONVERTER CLUTCH — RELEASED
3-4 CLUTCH — RELEASED
2-4 BAND — RELEASED
REVERSE INPUT CLUTCH — RELEASED
LO AND REVERSE CLUTCH — RELEASED
OVERRUN CLUTCH — RELEASED
FORWARD CLUTCH — RELEASED
LO ROLLER CLUTCH — NOT HOLDING
FORWARD SPRAG CLUTCH – NOT HOLDING

With the selector lever in the Park (P) position, oil from the pump is directed to the following:

1. Pressure Regulator Valve
2. Release Side of the Converter and the Lubrication System
3. Decrease Side of the Pump Slide
4. Manual Valve
5. T.V. System (Limit Valve, Throttle Valve, Line Bias Valve, M.T.V. Up Valve and M.T.V. Down Valve)
6. Pressure Relief Valve
7. Line Pressure Tap

Oil flows from the pump to the pressure regulator valve which regulates the pump pressure. When the pump output exceeds the demand of line pressure, oil from the pressure regulator valve is directed to the converter clutch apply valve. The converter clutch apply valve directs oil to the release side of the converter clutch. Converter return oil is directed to the transmission cooler by the converter clutch apply valve. Oil from the cooler is directed to the transmission lubrication system.

Oil is also directed from the pressure regulator valve to the pump slide to decrease pump output in relation to the combined pressure of M.T.V. oil and regulator valve spring force. Line pressure acts on the pressure relief valve which will exhaust any oil above 2,240 to 2,520 kPa (320 to 360 psi).

Line pressure at the manual valve is available for use in other drive ranges.

Line pressure at the T.V. limit valve is limited to 620 kPa (90 psi). This limited pressure is directed to the throttle valve where it is regulated to a variable pressure called throttle valve (T.V.) pressure. T.V. pressure increases with carburetor opening and is directed to the line bias, M.T.V. up and M.T.V. down valves.

At the line bias valve, T.V. pressure is modulated to M.T.V. pressure. M.T.V. pressure helps to control line pressure at the pressure regulator valve and accumulator pressure at the accumulator valve.

T.V. pressure at the M.T.V. up valve and M.T.V. down valve is available for use when accelerating in other ranges.

SUMMARY

The converter is filled from the release side; all clutches and the band are released. The manual linkage has the parking pawl engaged in the reaction internal gear lugs. At idle, there is not sufficient T.V. pressure to open the M.T.V. up or M.T.V. down valves.

NEUTRAL — ENGINE RUNNING

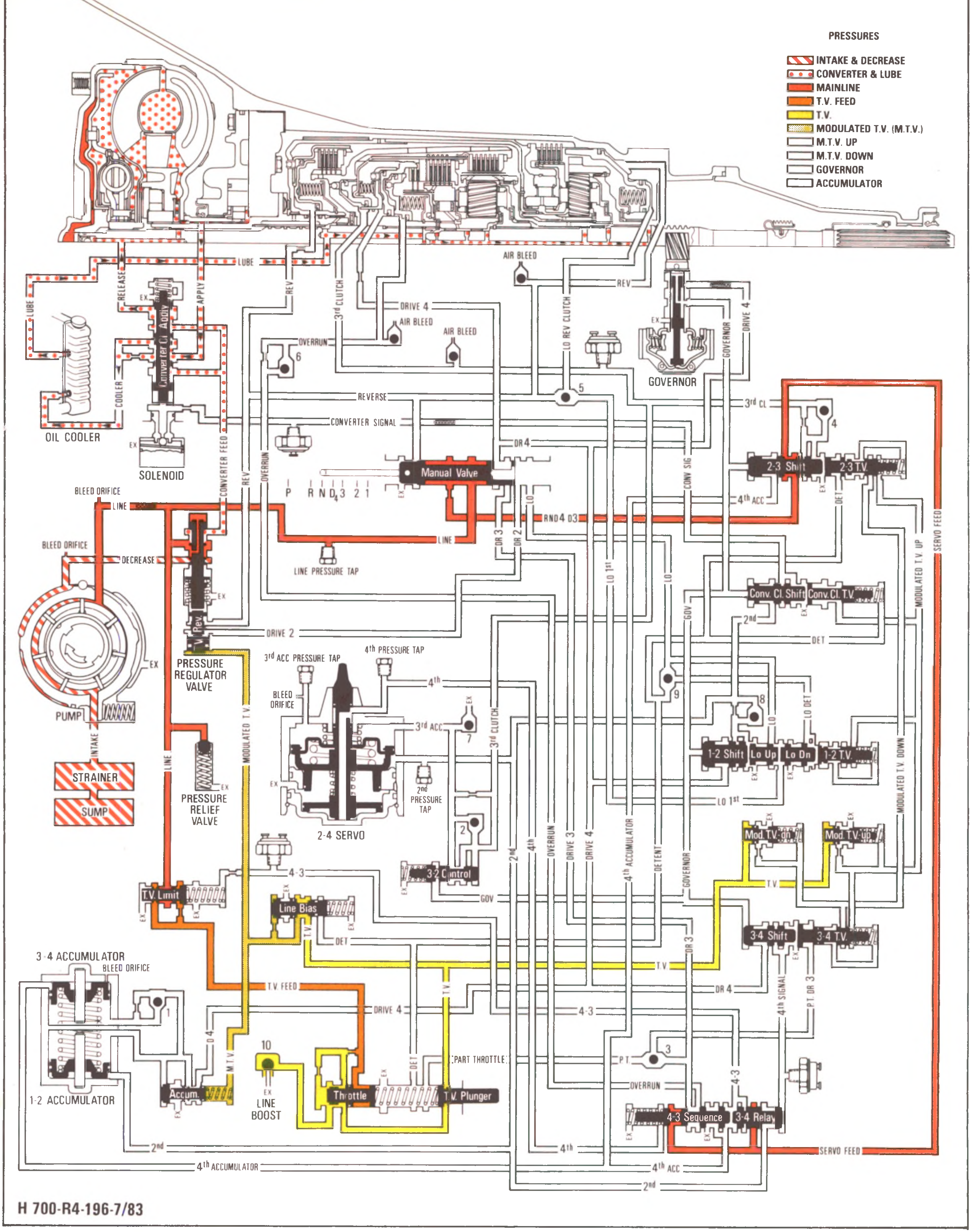


Figure 76 - Neutral - Engine Running

NEUTRAL-ENGINE RUNNING

CONVERTER CLUTCH — RELEASED
REVERSE INPUT CLUTCH — RELEASED
FORWARD CLUTCH — RELEASED

3-4 CLUTCH — RELEASED
LO AND REVERSE CLUTCH — RELEASED
LO ROLLER CLUTCH — NOT HOLDING

2-4 BAND — RELEASED
OVERRUN CLUTCH — RELEASED
FORWARD SPRAG CLUTCH – NOT HOLDING

When the selector lever is moved to the Neutral (N) position, the line pressure is directed to the same areas as in Park, except in Neutral (N) the manual valve directs oil into the Reverse, Neutral, Drive 4, Drive 3 (RND4D3) oil is directed to the 2-3 shift valve which directs RND4D3 oil to the 3-4 relay valve through the servo feed passage. Oil at these valves is available for use in other ranges.

SUMMARY

The converter is filled from the release side; all clutches and the band are released. At idle, there is not sufficient T.V. pressure to open the M.T.V. up or M.T.V. down valves.

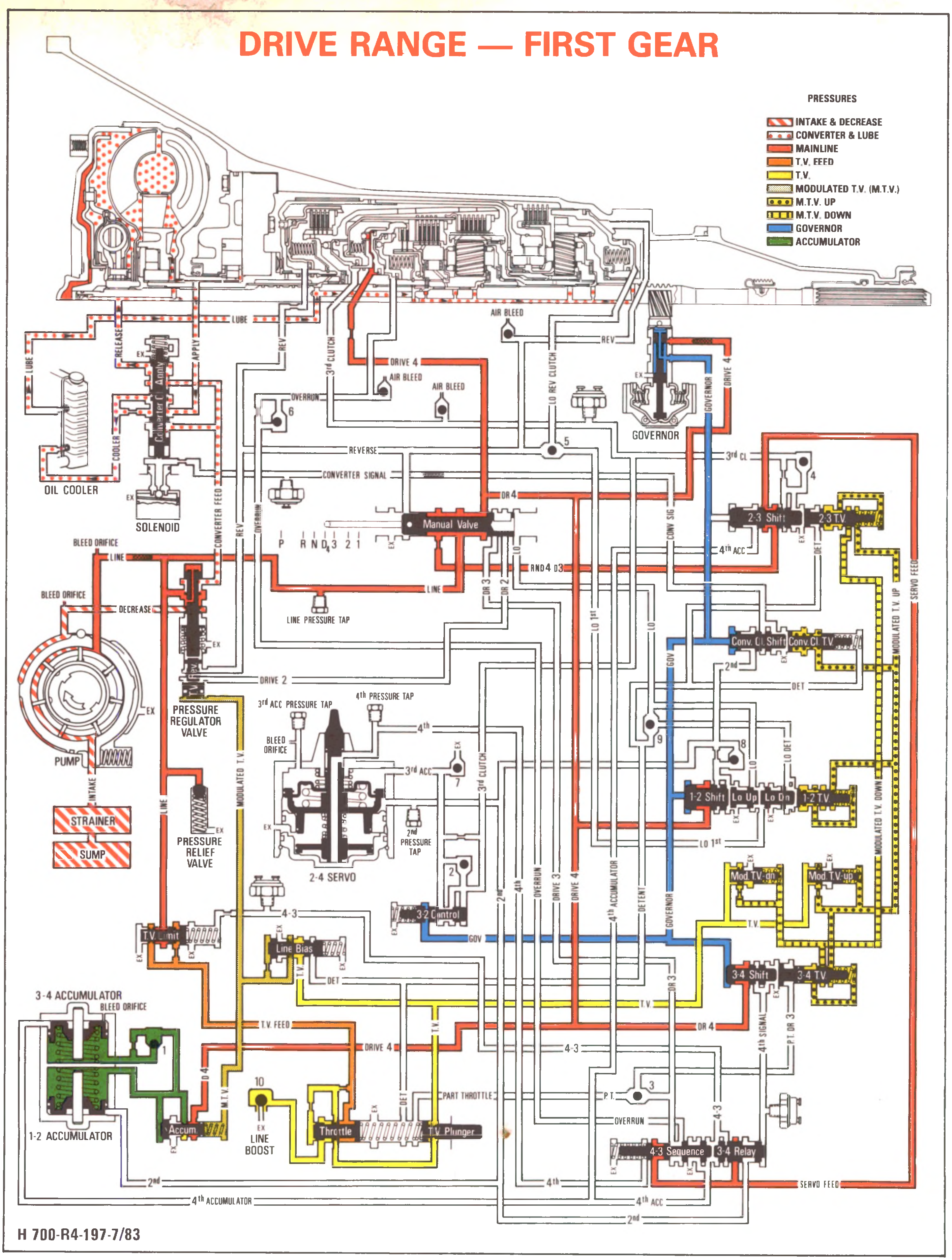


Figure 77 - Drive Range — First Gear

DRIVE RANGE-FIRST GEAR

FORWARD CLUTCH — APPLIED LO ROLLER CLUTCH — HOLDING FORWARD SPRAG CLUTCH – HOLDING

When the selector lever is moved to the Drive (D) position, the manual valve is repositioned to allow line pressure to enter the Drive 4 (D4) passage. Drive 4 oil then flows to the following:

1. Forward Clutch
2. Governor Valve
3. 1-2 Shift Valve
4. Accumulator Valve
5. 3-4 Shift Valve

BASIC CONTROL

Drive 4 oil is directed to the forward clutch where it acts on the clutch piston to apply the forward clutch.

Drive 4 oil is directed to the 1-2 and 3-4 shift valves. Drive 4 oil is directed to the accumulator valve and is regulated to a pressure called accumulator pressure; this pressure is directed to the 1-2 and 3-4 accumulator pistons to act as a cushion for the band apply in second gear and overdrive.

Drive 4 oil is orificed into the governor passage, and is regulated to a variable pressure called governor pressure. Governor pressure increases with vehicle speed and acts against the 1-2, 2-3, 3-4, converter clutch and the 3-2 control valve springs.

In first gear, there could be sufficient throttle valve plunger travel to increase T.V. pressure enough to open the M.T.V. up and the M.T.V. down valves. In first gear, M.T.V. up exerts pressure against governor pressure at the 1-2, 2-3, 3-4, and converter clutch throttle valves. M.T.V. down pressure is stopped by a land at the 2-3 and 3-4 throttle valves.

SUMMARY

The converter clutch is released, the forward sprag clutch is holding, the forward clutch is applied; the transmission is in Drive (D) Range — First Gear.

DRIVE RANGE — SECOND GEAR

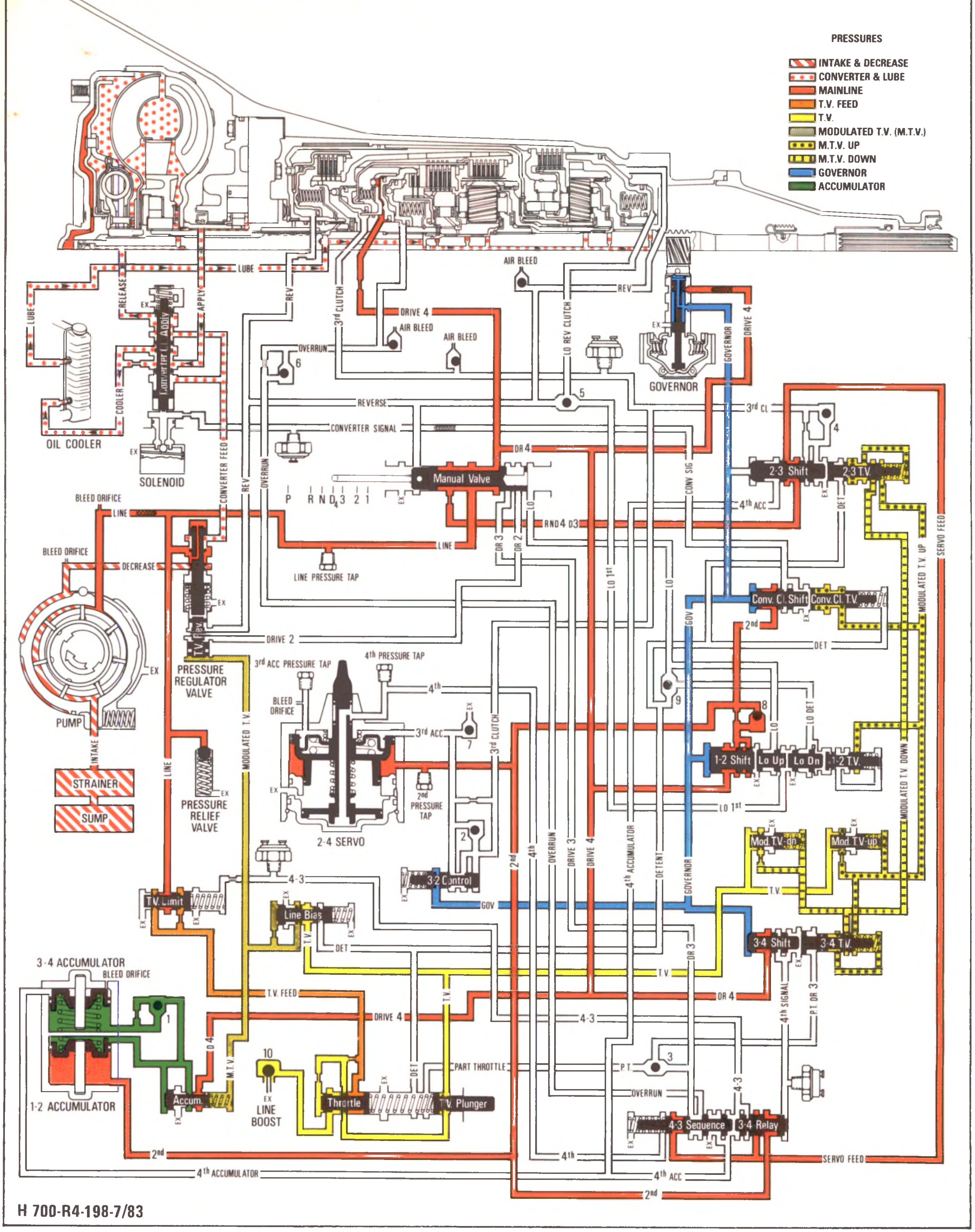


Figure 78 - Drive Range — Second Gear

DRIVE RANGE-SECOND GEAR

2-4 BAND — APPLIED | **FORWARD SPRAG CLUTCH – HOLDING** | **FORWARD CLUTCH — APPLIED**

As both vehicle speed and governor pressure increase, the force of the governor oil acting on the 1-2 shift valve overcomes the pressure of M.T.V. up oil and the force of the 1-2 throttle valve spring.This allows the 1-2 shift valve to open and Drive 4 (D4) oil to enter the second (2nd) oil passage. This oil is called second (2nd) oil. Second oil from the 1-2 shift valve is directed to the following:

1. 1-2 Shift Check Ball (8)
2. 2-4 Servo
3. 1-2 Accumulator Piston
4. Converter Clutch Shift Valve
5. 3-4 Relay Valve

BASIC CONTROL

Second oil from the 1-2 shift valve will seat the 1-2 shift check ball (8) forcing 2nd oil through an orifice. Second oil is then directed to the 2-4 servo to apply the 2-4 band. At the same time, 2nd oil moves the 1-2 accumulator piston against accumulator pressure and the accumulator spring to maintain a controlled build-up of pressure on the servo during the 1-2 shift for a smooth band apply. 2nd oil at the converter clutch shift valve and the 3-4 relay valve is available for use in other ranges.

SUMMARY

The converter clutch is released, the 2-4 band is applied, the forward clutch is applied, and the forward sprag clutch is holding; the transmission is in Drive (D) Range — Second Gear.

DRIVE RANGE — CONVERTER CLUTCH APPLIED

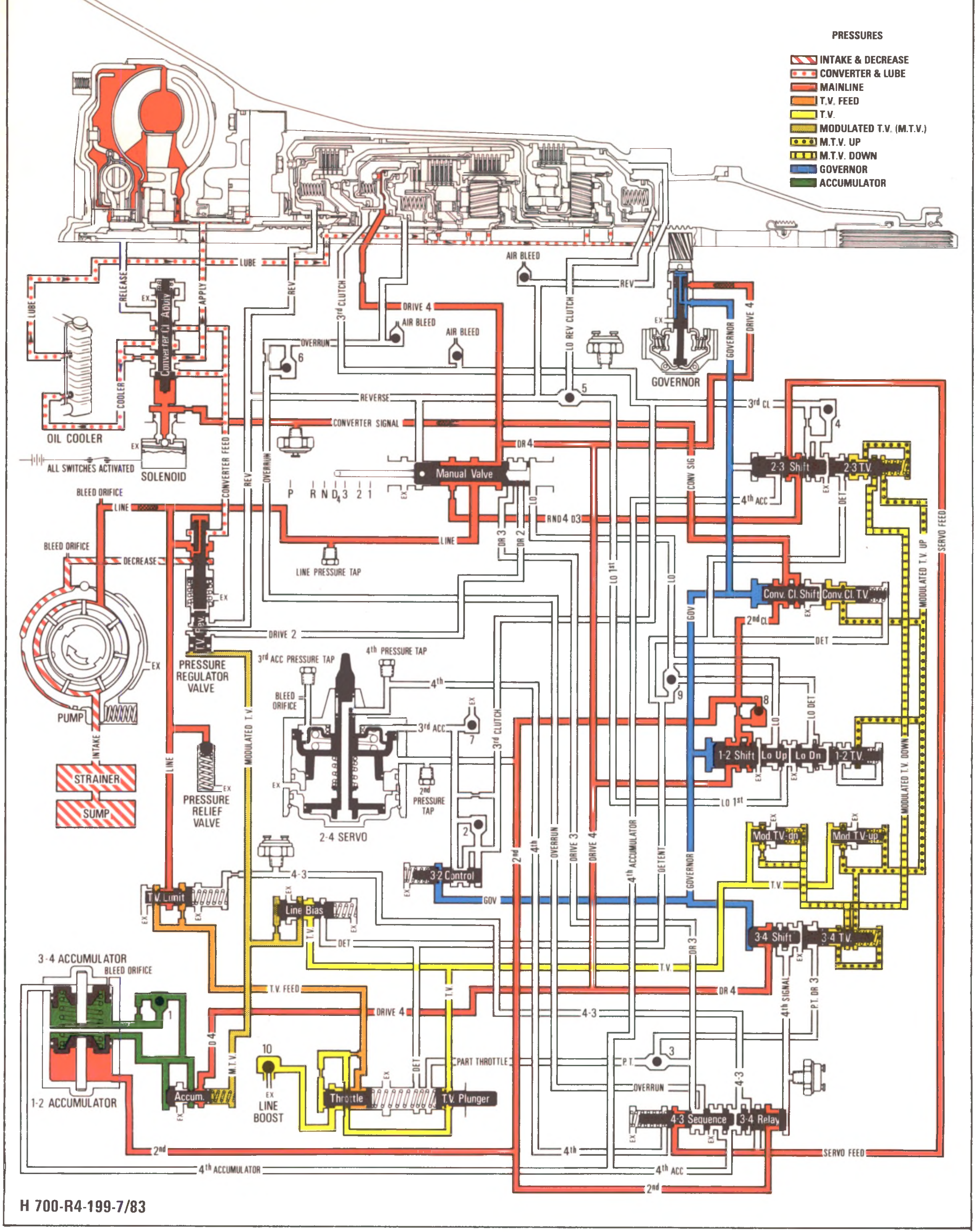


Figure 79 - Drive Range, Converter Clutch Applied, Second Gear

DRIVE RANGE-CONVERTER CLUTCH APPLIED

CONVERTER CLUTCH — APPLIED

FORWARD CLUTCH — APPLIED

2-4 BAND — APPLIED

FORWARD SPRAG CLUTCH – HOLDING

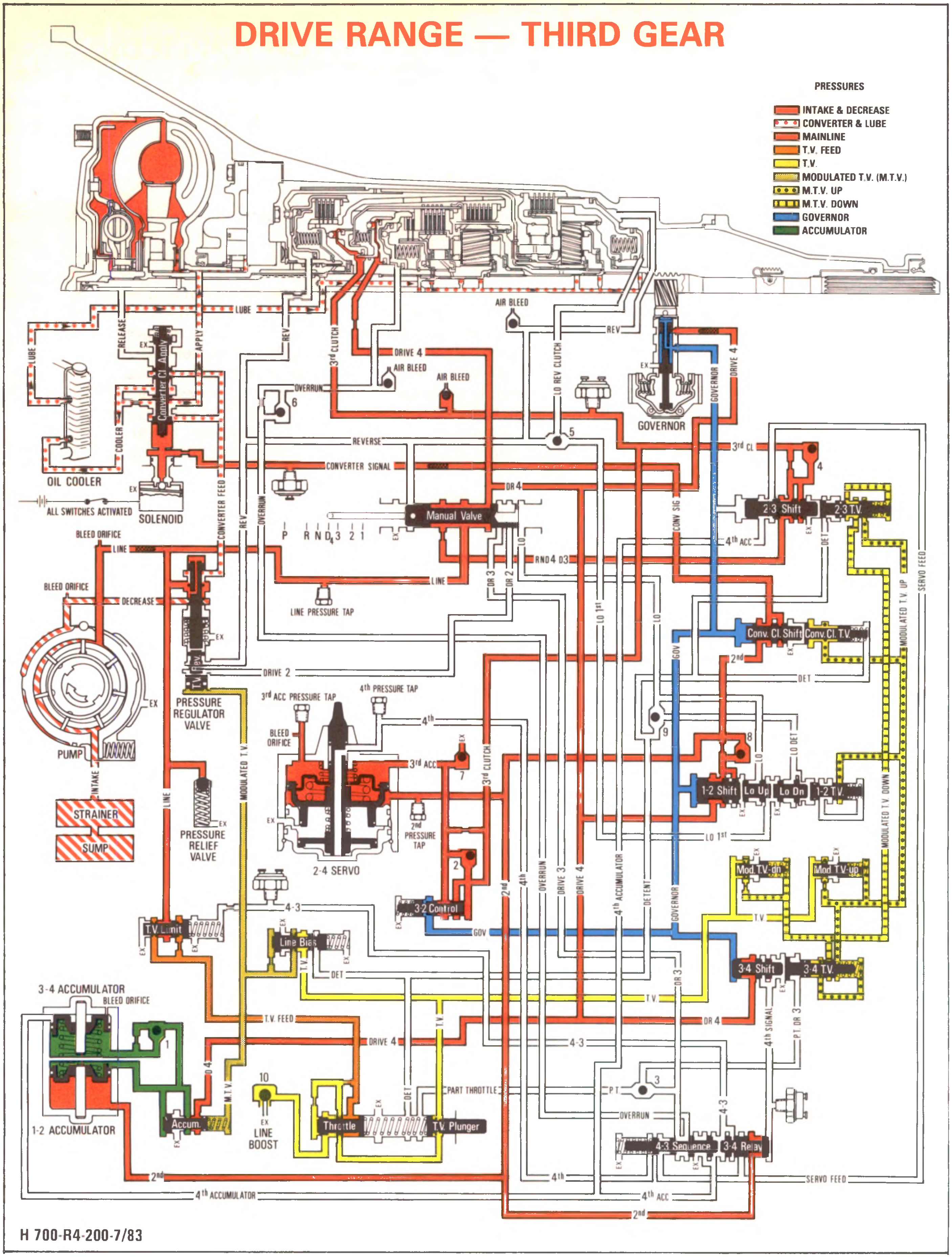
As vehicle speed and governor pressure increase, the force of governor oil acting on the converter clutch shift valve overcomes the pressure of M.T.V. up oil and the force of the converter clutch T.V. spring. This allows the converter clutch shift valve to open and 2nd oil to enter the converter clutch signal passage. Providing the converter clutch solenoid is on, converter clutch signal oil will shift the converter clutch apply valve, and redirect converter feed oil into the apply passage. The apply oil flows between the stator shaft and converter hub to charge the converter with oil and push the converter pressure plate against the converter cover, causing a mechanical link between the engine and the turbine shaft. The rate of apply is controlled by the orifice check ball capsule in the end of the turbine shaft.

At the same time the converter clutch apply valve will direct converter feed oil through an orifice to the transmission cooler. Cooler oil is directed to the transmission lubrication system.

SUMMARY

The converter clutch is applied, the 2-4 band is applied, the forward clutch is applied, and the forward sprag clutch is holding; the transmission is in Drive (D) Range — Second Gear. The converter clutch is shown applied in second gear. In some models, the converter clutch shift valve will not shift until the transmission is in third gear.

DRIVE RANGE — THIRD GEAR



H 700-R4-200-7/83

Figure 80 - Drive Range — Third Gear

DRIVE RANGE-THIRD GEAR

CONVERTER CLUTCH — APPLIED*

FORWARD SPRAG CLUTCH – HOLDING

FORWARD CLUTCH — APPLIED

3-4 CLUTCH — APPLIED

As both vehicle speed and governor pressure increase, the force of governor oil acting on the 2-3 shift valve overcomes the force of the 2-3 T.V. spring and M.T.V. up oil. This allows the 2-3 shift valve to open and allows RND4D3 oil to enter the 3rd clutch passage.

Third clutch oil from the 2-3 shift valve is directed to the following:

1. 3-2 Exhaust Check Ball (4)
2. 3-4 Clutch Piston
3. Third Clutch Accumulator Check Ball (2)
4. Third Accumulator Exhaust Check Ball (7)
5. 2-4 Servo (Release Side)
6. 3-2 Control Valve

BASIC CONTROL

Third clutch oil from the 2-3 shift valve flows past the 3-2 exhaust check ball (4), to the 3-4 clutch piston. At the same time, third clutch oil is directed past the third clutch accumulator check ball (2), seats the third accumulator exhaust check ball (7), and then into the release side of the 2-4 servo. This third clutch accumulator pressure combined with the servo cushion spring, moves the second apply piston, in the 2-4 servo, against second oil and acts as an accumulator for a smooth 2-4 band release and 3-4 clutch apply.

Third clutch oil is present at the 3-2 control valve in preparation of a third gear to second gear shift.

SUMMARY

The converter clutch is applied*, the forward clutch is applied, the forward sprag clutch is holding, the 3-4 clutch is applied and the 2-4 band is released; the transmission is in Drive (D) Range — Third Gear (direct drive).

*The converter clutch may or may not be applied, depending on shift calibration and solenoid operation.

DRIVE RANGE — OVERDRIVE

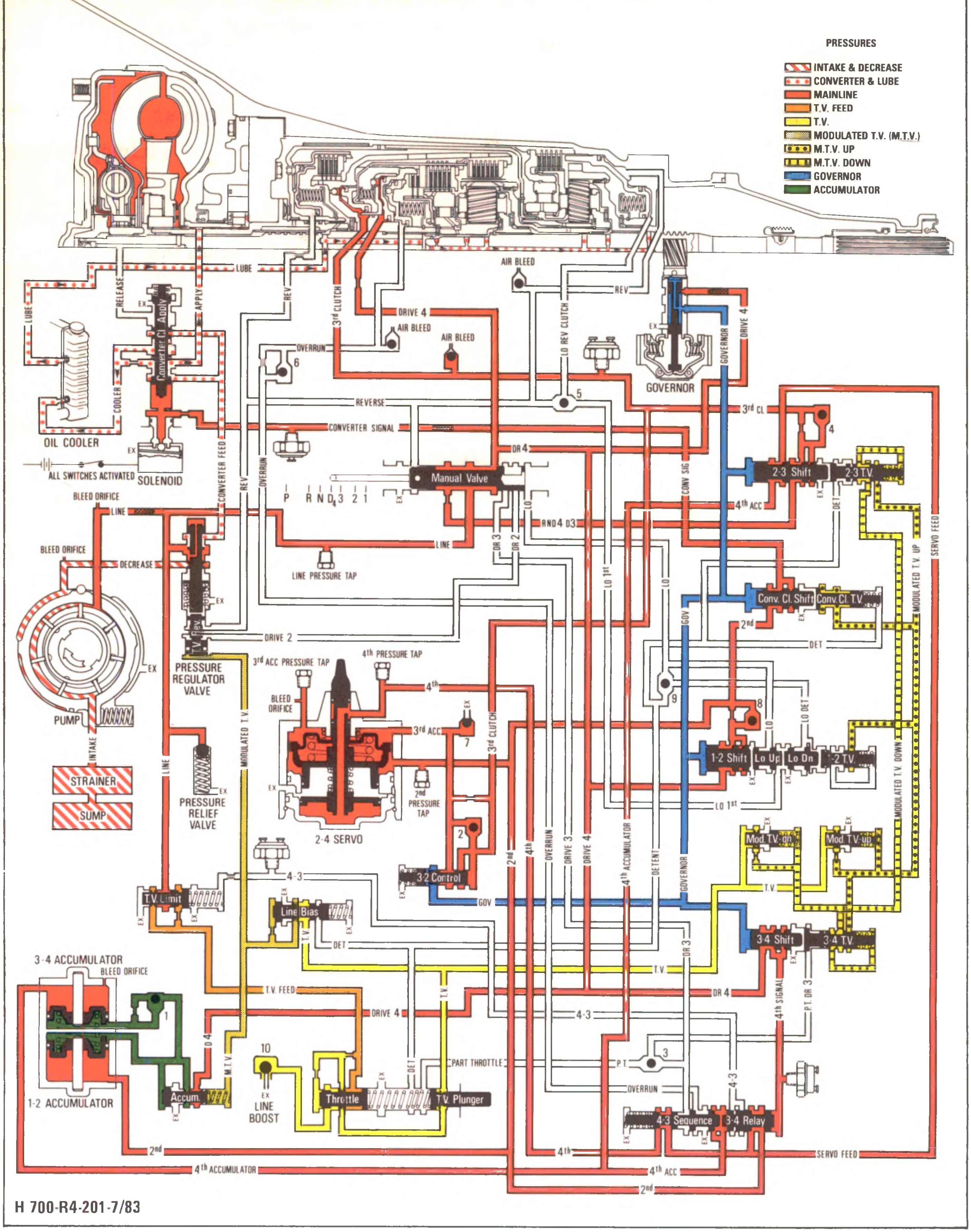


Figure 81 - Drive Range — Overdrive

DRIVE RANGE-OVERDRIVE

CONVERTER CLUTCH — APPLIED *

3-4 CLUTCH — APPLIED

2-4 BAND — APPLIED

FORWARD CLUTCH — APPLIED

FORWARD SPRAG CLUTCH – NOT HOLDING

As both vehicle speed and governor pressure increase, the force of governor oil acting on the 3-4 shift valve overcomes the force of the 3-4 T.V. spring and M.T.V. up oil. This opens the 3-4 shift valve sending Drive 4 (D4) into the fourth signal passage. Fourth signal oil will overcome the 4-3 sequence valve spring and open the 3-4 relay and the 4-3 sequence valves, allowing second oil to enter the servo feed passage.

Servo feed oil is directed to the following:

1. 2-3 Shift Valve
    a. Which directs oil to the:
        1) 3-4 Accumulator
        2) 4-3 Sequence Valve
2. 4-3 Sequence Valve
    a. Which directs oil to the:
        1) 4th Apply Piston (in the 2-4 servo)

BASIC CONTROL

Servo feed oil passes through the 4-3 sequence valve and becomes fourth oil. Fourth oil then enters the 2-4 servo, applies pressure on the fourth apply piston, and applies the 2-4 band.

SUMMARY

The converter clutch, 2-4 band, forward clutch, the 3-4 clutch are applied, and the forward sprag clutch is overrunning; the transmission is in Drive (D) Range — Overdrive.

*The converter clutch may or may not be applied depending on solenoid operation.

PART THROTTLE 4-3 AND MODULATED DOWNSHIFTS

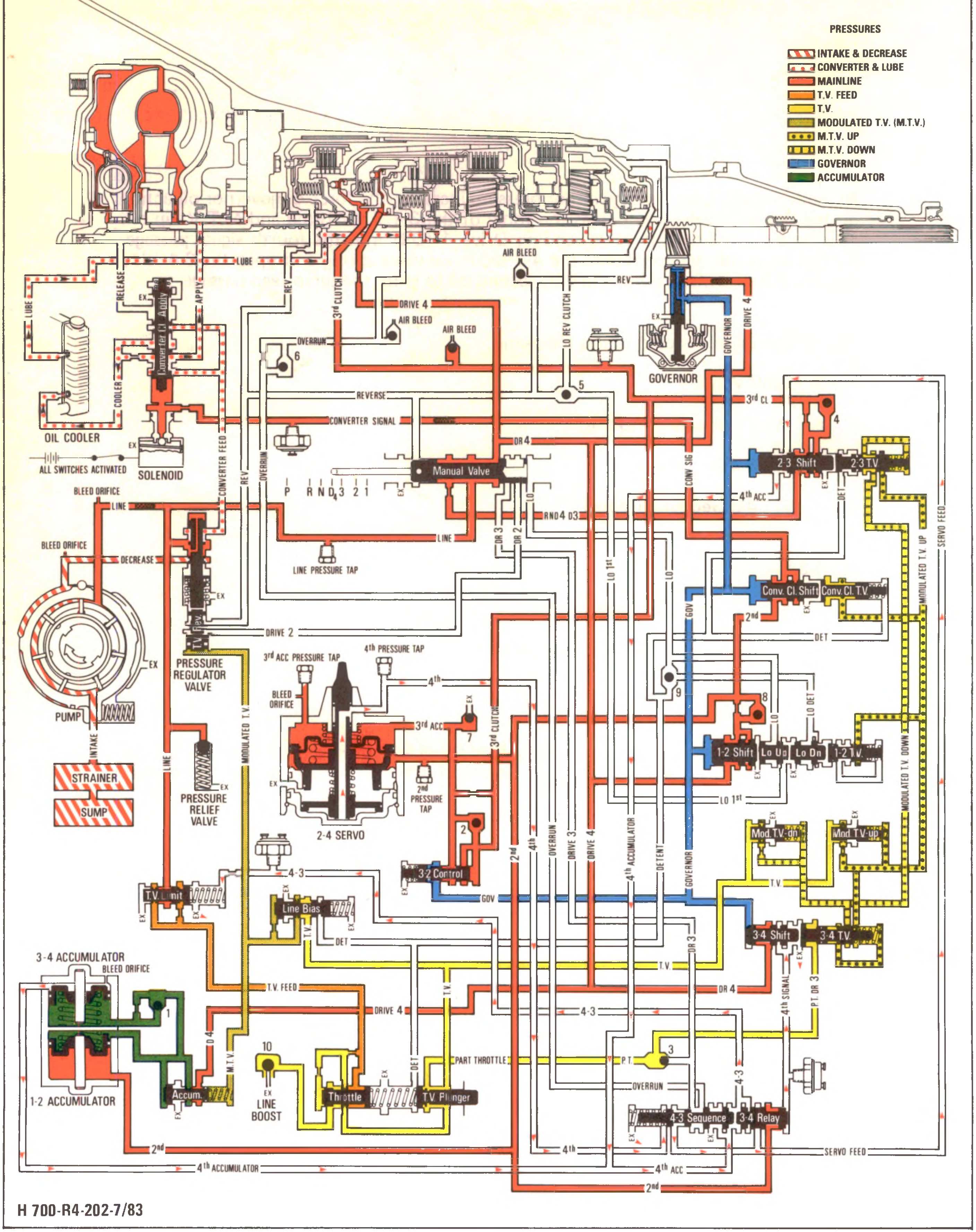


Figure 82 - Part Throttle 4-3 and Modulated Downshifts, Valves Shown in Third Gear Position.

PART THROTTLE 4-3 AND MODULATED DOWNSHIFTS

Valves In Third Gear Position

CONVERTER CLUTCH — APPLIED*

FORWARD SPRAG CLUTCH – HOLDING

FORWARD CLUTCH — APPLIED

3-4 CLUTCH — APPLIED

A part throttle 4-3 downshift can be accomplished by depressing the accelerator pedal far enough to move the throttle valve (T.V.) plunger to allow the T.V. oil to enter the part throttle (P.T.) passage. This oil, called part throttle (P.T.) oil, is then routed to the 3-4 throttle valve.

Part throttle oil and the 3-4 throttle valve spring force will close the 3-4 shift valve against governor pressure, shutting off D4 oil to the fourth signal passage. Fourth accumulator oil will push the 3-4 relay valve closed and hold the 4-3 sequence valve open while it exhausts at an orifice at the T.V. limit valve. Fourth oil will pass through the 4-3 sequence valve to the servo feed passage to the 2-3 shift valve to the fourth accumulator passage. When fourth accumulator pressure is low enough, the 4-3 sequence valve spring will close the 4-3 sequence valve and the remaining fourth and fourth accumulator oil will exhaust at the 4-3 sequence valve.

A type of part throttle downshift can be accomplished in some ranges (4-3, and 3-2, shifts) by depressing the accelerator pedal far enough to raise M.T.V. down pressure. This pressure when combined with the throttle valve spring pressure can overcome governor pressure and cause a modulated downshift.

*The converter clutch may or may not be applied depending on shift calibration and solenoid operation.

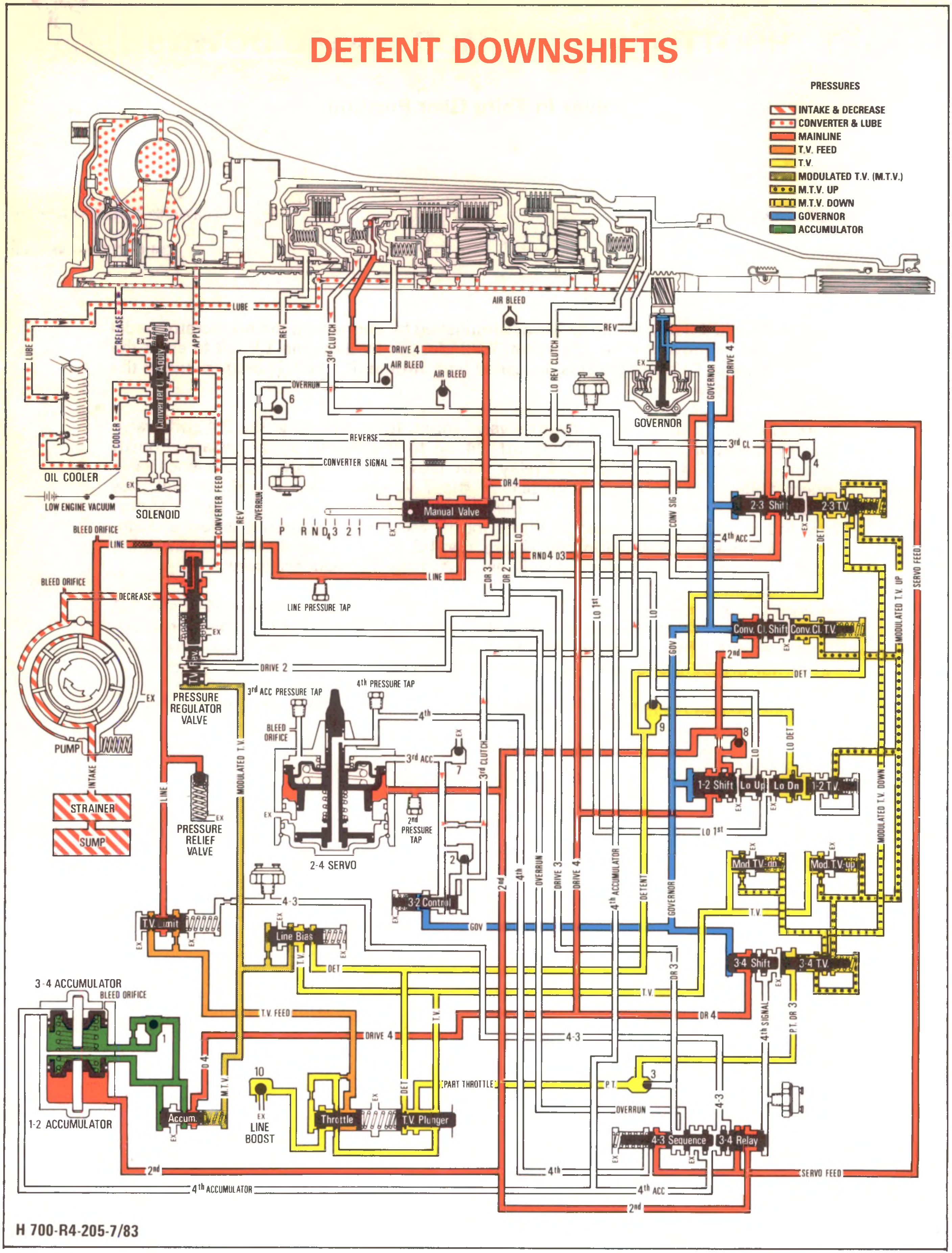


Figure 83 - Detent Downshifts, Valves Shown in Second Gear Position

DETENT DOWNSHIFTS

Valves In Second Gear Position

CONVERTER CLUTCH — RELEASED

FORWARD CLUTCH — APPLIED

2-4 BAND — APPLIED

FORWARD SPRAG CLUTCH – HOLDING

While operating at speeds below approximately 60 mph (96 km/h), a forced or detent 3-2 downshift is possible by depressing the accelerator pedal fully. This will position the throttle valve (T.V.) plunger to allow T.V. oil to enter the detent passage. This oil, called detent oil, is then routed to the following:

1. Line Bias Valve
2. 2-3 Throttle Valve
3. Lo and Detent Check Ball (9)
4. 1-2 Throttle Valve
5. Converter Clutch Throttle Valve

Detent oil from the T.V. plunger flows to the line bias valve to boost modulated T.V. (M.T.V.) pressure. M.T.V. oil acting on the T.V. boost valve will boost line pressure approximately 70 kPa (10 psi).

Detent oil from the T.V. plunger flows to the 2-3 throttle valve. Detent and M.T.V. down oil, acting on separate areas of the 2-3 throttle valve, will close the 2-3 shift valve against governor oil and allow 3rd clutch and 3rd accumulator oil to pass through an orifice and exhaust at the 2-3 shift valve.

At vehicle speeds above approximately 50 mph (80 km/h), governor oil acting on the 3-2 control valve will close it. Now the exhausting 3rd clutch accumulator oil from the intermediate servo will seat the 3rd clutch accumulator check ball (2) and flow through another orifice controlling the intermediate band apply for a smooth 3-2 shift at high speed.

A detent 2-1 downshift can be accomplished at speeds below approximately 30 mph (48 km/h), because detent oil pressure and the 1-2 spring force acting on the 1-2 throttle valve will close the 1-2 shift valve, shifting the transmission to first gear.

Detent oil at the converter clutch throttle valve will close the converter clutch shift valve train and release the converter clutch.

MANUAL THIRD

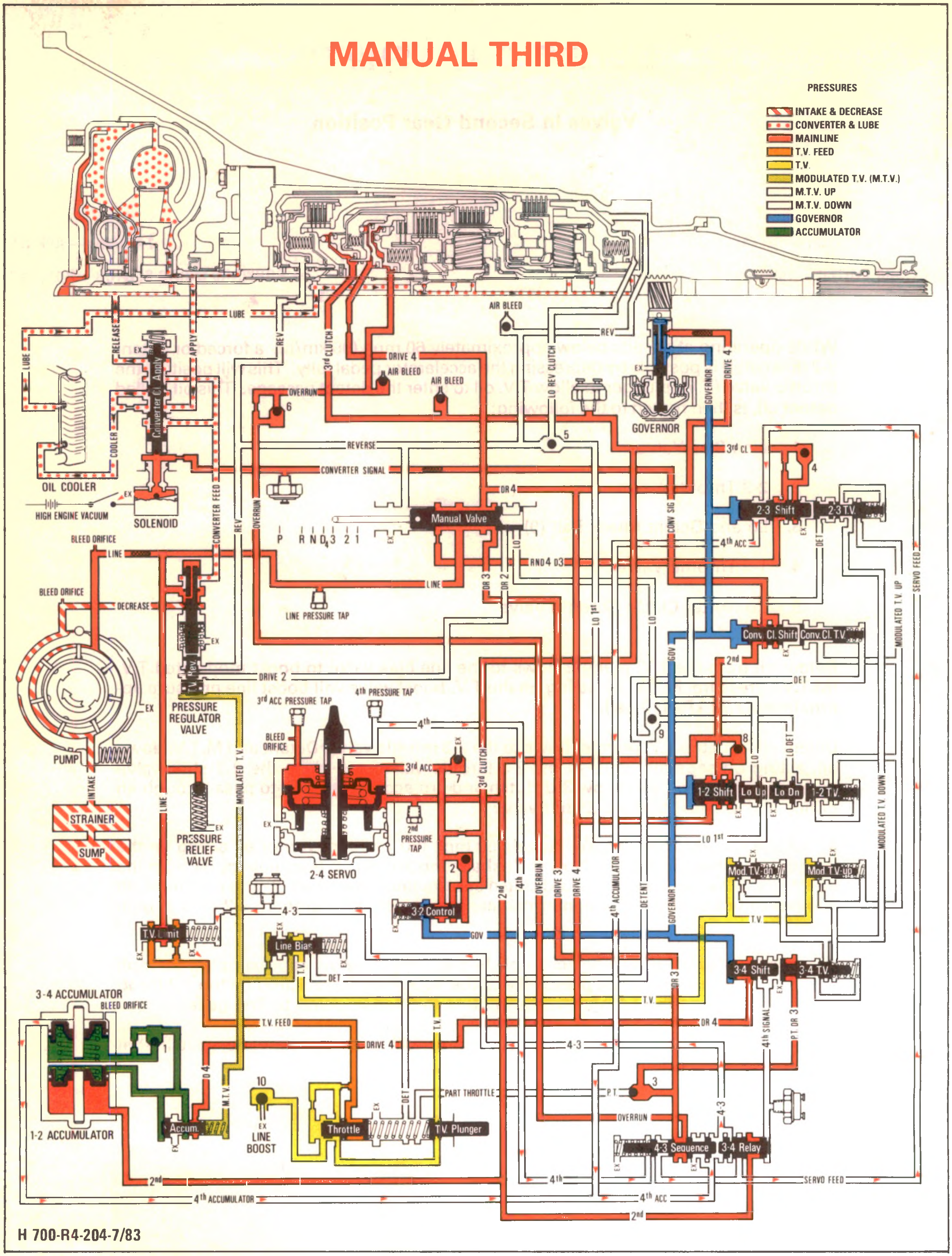


Figure 84 - Manual Third

MANUAL THIRD

CONVERTER CLUTCH — RELEASED*

FORWARD CLUTCH — APPLIED

OVERRUN CLUTCH — APPLIED

3-4 CLUTCH — APPLIED

A forced 4-3 downshift can be accomplished by moving the selector lever from Drive (D) Range to Third (3rd) Gear. When the selector lever is moved to the Third (3rd) Gear position, D3 oil from the manual valve is directed to the following:

1. 4-3 Sequence Valve
2. Part Throttle and Drive 3 (D3) Check Ball (3)
3. 3-4 Shift Valve

D3 oil will close the 3-4 shift valve and allow the 4th signal oil to exhaust.

D3 oil combined with the 4-3 sequence valve spring force will close the 4-3 sequence valve to allow the fourth and fourth accumulator oil to exhaust and release the band. D3 oil then flows into the overrun clutch passage where it applies the overrun clutch to keep the forward sprag clutch from overrunning when engine braking is needed.

The forward and 3-4 clutches are applied. The 2-4 band is released. The transmission is in Manual Third, direct drive. The overrun clutch is applied to allow engine braking.

*In manual 3rd, the converter is shown released by the engine vacuum switch and there is no M.T.V. up or M.T.V. down pressure. This is assuming the throttle is released. If the throttle is opened sufficiently, the converter clutch could engage and the M.T.V. up and M.T.V. down valves could open.

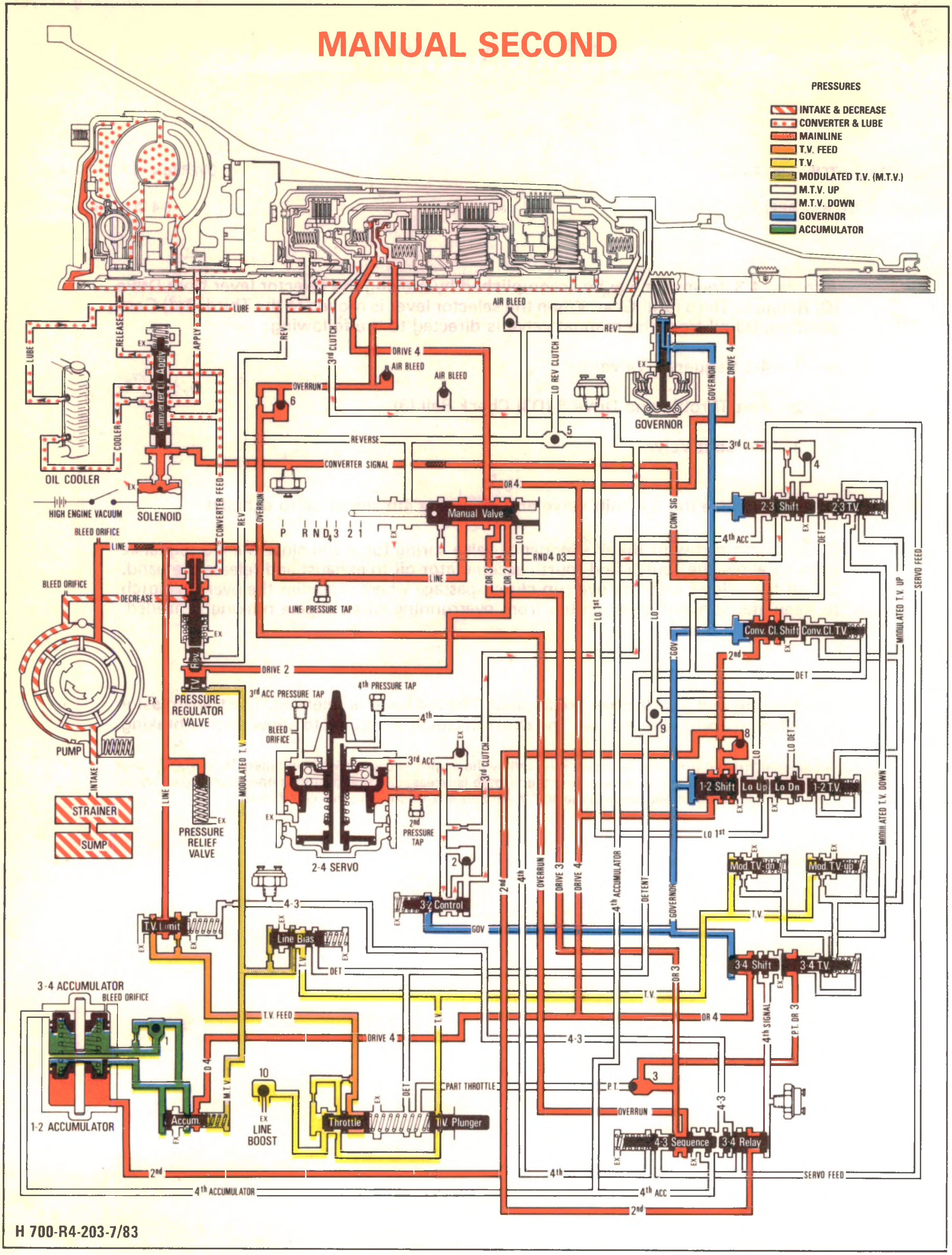


Figure 85 - Manual Second

MANUAL SECOND

CONVERTER CLUTCH — RELEASED*

OVERRUN CLUTCH — APPLIED

2-4 BAND — APPLIED

FORWARD CLUTCH — APPLIED

A forced 3-2 downshift can be accomplished by moving the selector lever from Third (3rd) Gear to the Second (2nd) Gear position.

When the selector lever is moved to the second (2nd) gear position, RND4D3, 3rd clutch, and 3rd accumulator oil will exhaust at the manual valve. With no pressure to apply the 3-4 clutch, or release the 2-4 band, the transmission will shift to second gear.

The manual valve will also direct line pressure into the D2 passage. Drive 2 (D2) oil will act on the reverse boost valve to boost line pressure to 760 kPa (110 psi) which is required to prevent the 2-4 band and forward clutch from slipping.

SUMMARY

The forward clutch and 2-4 band are applied. The transmission is in second gear. Also, the overrun clutch is still applied to allow engine braking when needed.

*In manual 2nd, the converter clutch is shown released by the engine vacuum switch and there is no M.T.V. up or M.T.V. down pressure. This is assuming the throttle is released. If the throttle is opened sufficiently, the converter clutch could engage and the M.T.V. up and M.T.V. down valves could open.

MANUAL LO

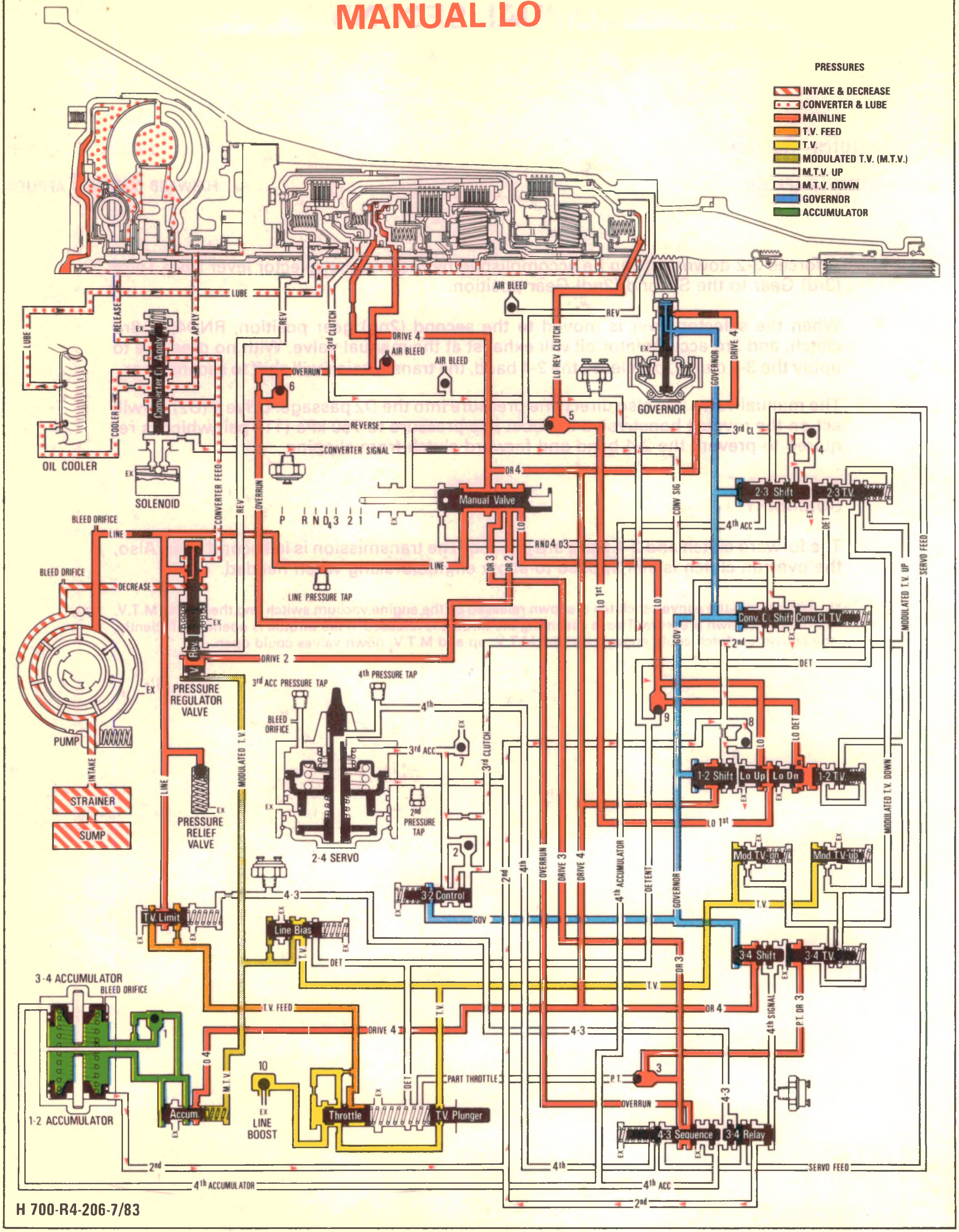


Figure 86 - Manual Lo

MANUAL LO

CONVERTER CLUTCH — RELEASED

FORWARD CLUTCH — APPLIED

OVERRUN CLUTCH — APPLIED

LO ROLLER CLUTCH — APPLIED

Maximum downhill braking can be obtained at speeds below 30 mph (48 km/h) with the selector in Lo (1st) range. Lo/1st oil pressure, which is 760 kPa (110 psi), is the same as second (2nd) oil pressure because second (D2) oil is still present.

Lo oil from the manual valve is directed to the following:

1. Lo and Detent Check Ball (9)
2. 1-2 Shift Valve Train (1-2 Lo Range Valve)
3. Lo and Reverse Check Ball (10)
4. Lo and Reverse Clutch

Lo oil at the Lo/1st detent valve combined with M.T.V. down and 1-2 throttle valve spring force will close the 1-2 shift valve at speeds below approximately 30 mph (48 km/h). This allows 2nd oil to exhaust, releasing the 2-4 band, and lo oil to travel to the lo and reverse clutch and applies it.

SUMMARY

The forward clutch is applied. The lo and reverse, and the overrun clutch are applied to allow engine braking. The 2-4 band is released, the transmission is in Lo Range — First Gear.

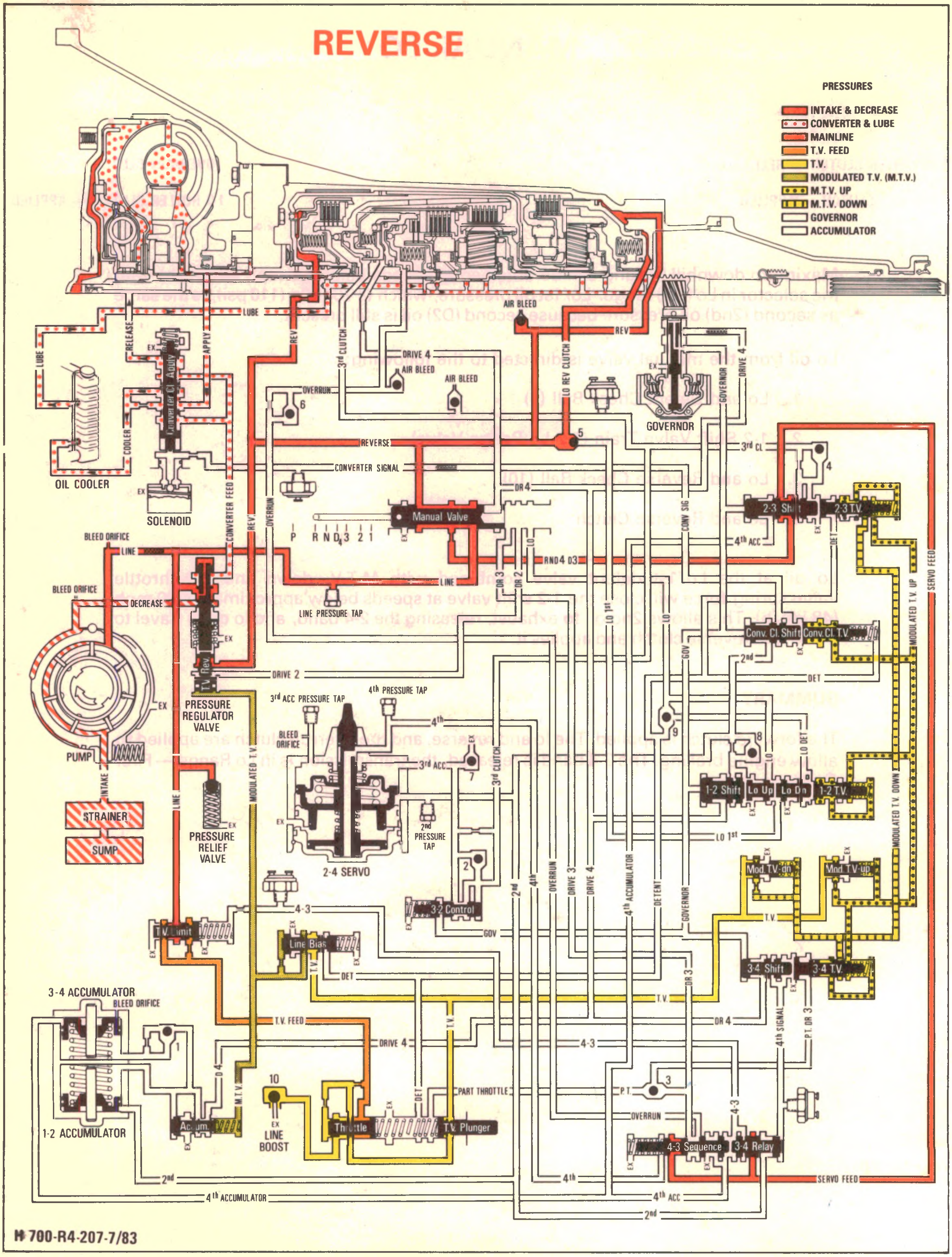


Figure 87 - Reverse

REVERSE

REVERSE INPUT CLUTCH — APPLIED

LO AND REVERSE CLUTCH — APPLIED

When the selector lever is moved to the Reverse (R) position, the manual valve is repositioned to allow line pressure to enter the reverse passage which directs oil to the following:

1. Lo and Reverse Check Ball (5)
2. Lo and Reverse Clutch
3. Reverse Input Clutch
4. Reverse Boost Valve

Reverse oil seats the lo and reverse check ball (5) in the lo/1st passage and flows to the lo and reverse clutch piston, applying the lo and reverse clutch.

Reverse oil is orificed into the reverse input clutch piston and applies the reverse input clutch.

Reverse oil acting on the reverse boost valve in the pressure regulator will boost line pressure to approximately 670 kPa (100 psi). M.T.V. oil from the line bias valve acting on the T.V. boost valve, in the pressure regulator, will further boost line pressure from 670 kPa (100 psi) at idle to 1690 kPa (245 psi) at full throttle.

SUMMARY

The reverse input clutch is applied. The lo and reverse clutch is applied. The transmission is in Reverse (R).

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