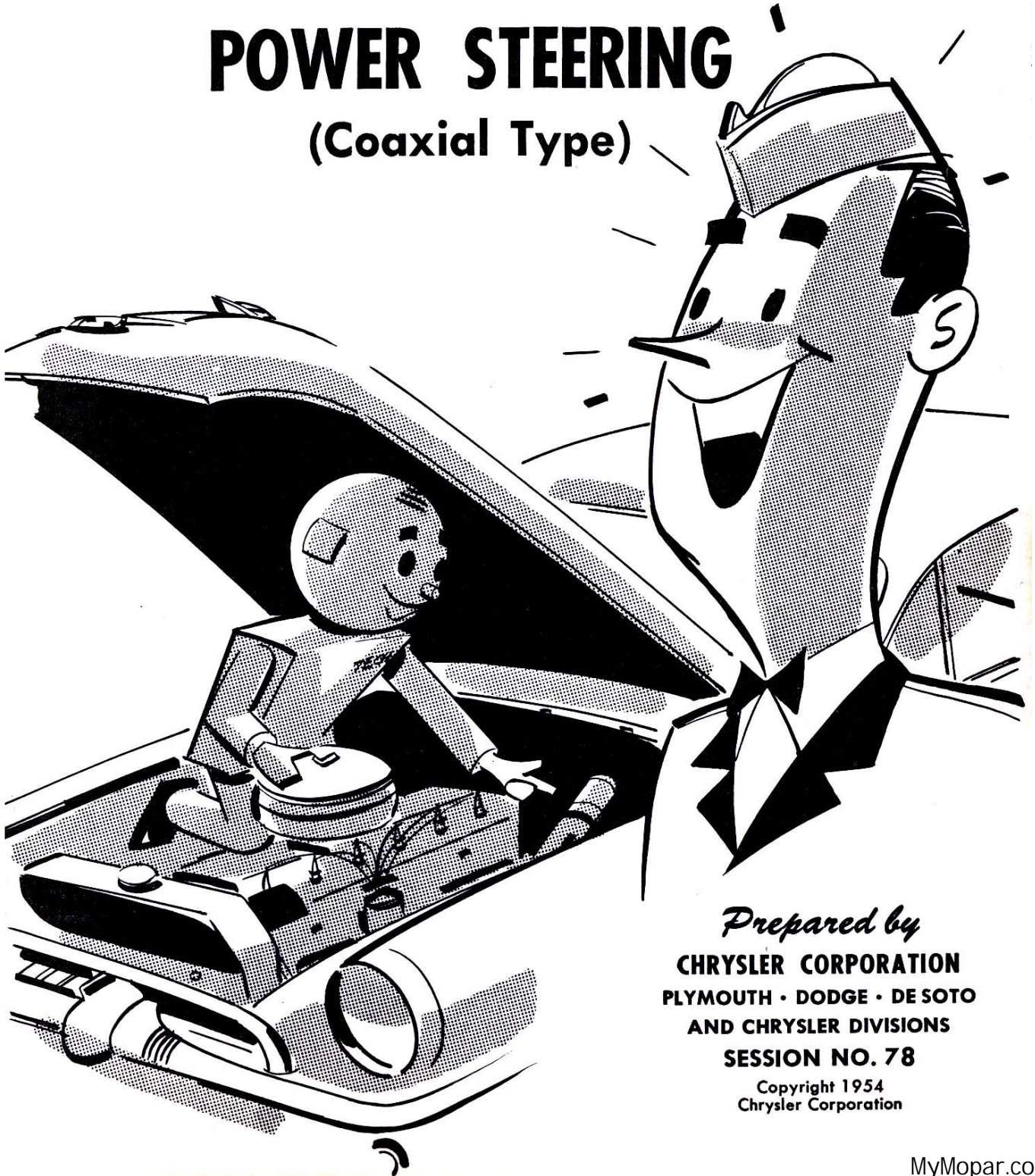


SERVICE REFERENCE BOOK

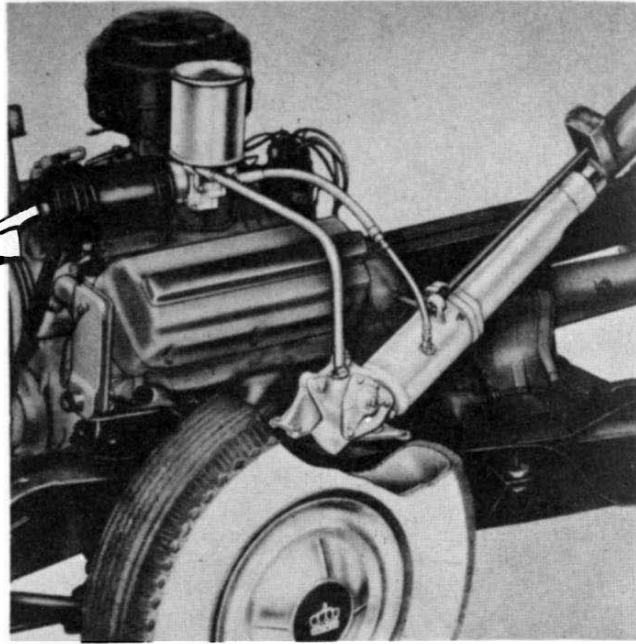
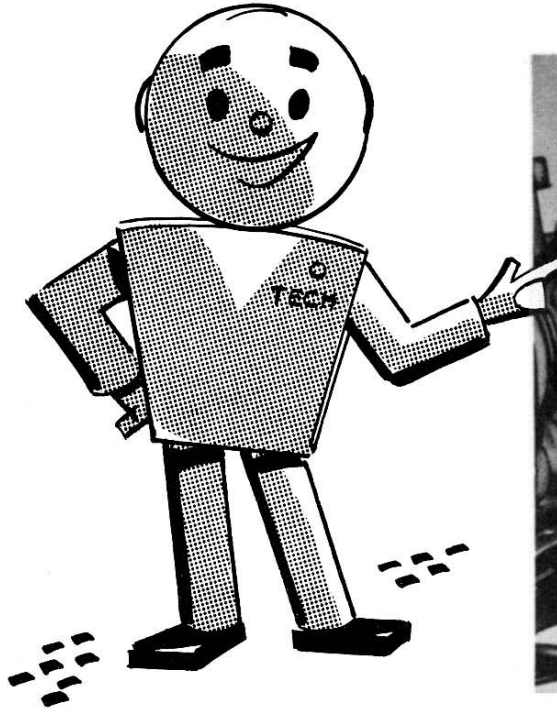
POWER STEERING
(Coaxial Type)



Prepared by

CHRYSLER CORPORATION
PLYMOUTH • DODGE • DE SOTO
AND CHRYSLER DIVISIONS
SESSION NO. 78

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Tech Sez:

BE IN "ON THE KNOW" WITH POWER STEERING (COAXIAL TYPE)!

It's gonna pay you to know all you can about the latest improvement in power steering. So, meet coaxial-type power steering, the finest steering unit ever designed.

One thing you'll notice right away is that this streamlined, compact unit gives you more room in which to work in the engine compartment, because it takes up less space than the former design.

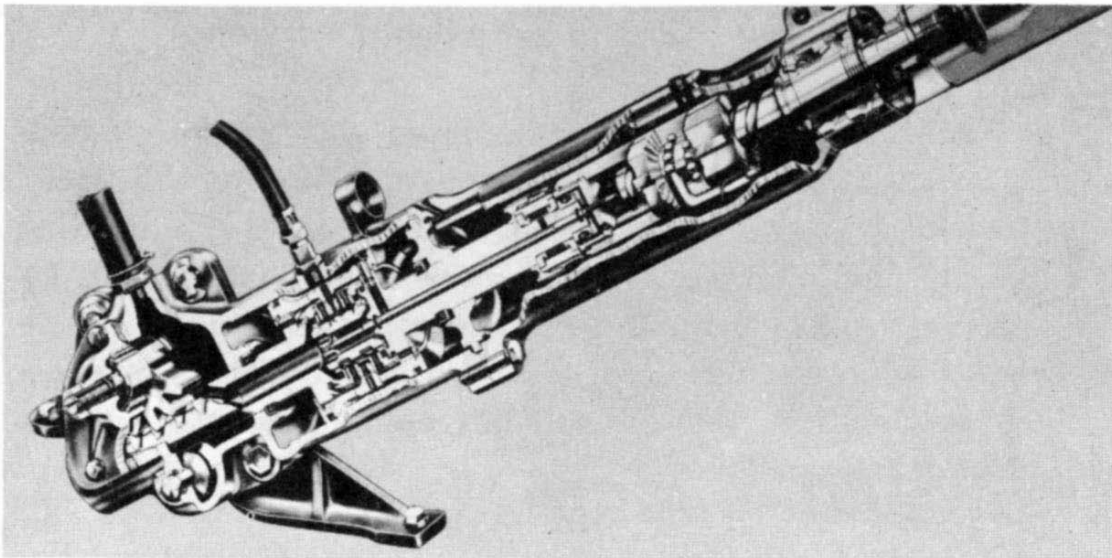
Besides that, there are fewer parts, it's several pounds lighter, and the over-all simplified design means less service attention on your part. Actually, this coaxial-type power steering is so great an advancement, it's the answer to a mechanic's dream.

When you're test-driving a car equipped with power steering and the owner is with you, don't miss the opportunity to "sell" power steering. Suggest to the owner that he will get a startling realization of the effectiveness of power steering if he will try steering his car with the ignition turned off when driving on an open stretch of road where there's little traffic. That will show him how much easier the car handles when power steering is doing most of the work.

This reference book explains what the coaxial-type power steering assembly is, how it works, and covers some of the minimum service features you should keep in mind. Here's how the information is arranged:

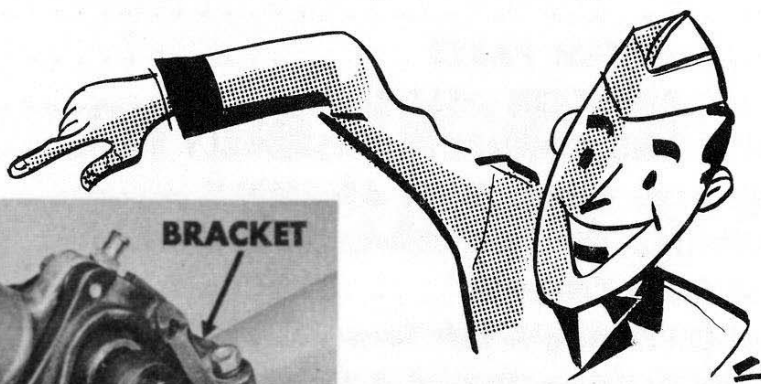
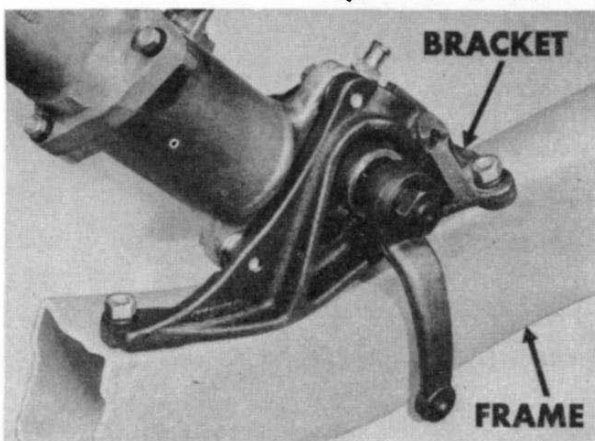
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GENERAL



Basically, the coaxial-type steering is a full-time power steering unit.

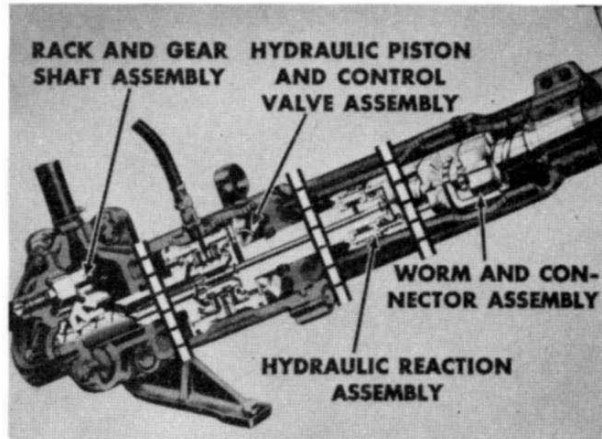
All parts are fitted into a slim, tubular housing, located centrally around the steering column axis. This grouping around a common axis is why the unit is called "coaxial" power steering.



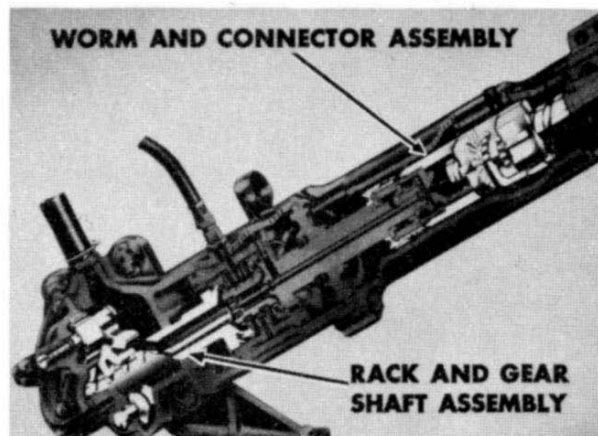
The lower end of the unit is mounted to a bracket bolted to the top of the frame side rail. You'll notice that mounting when you lift the hood.

Inside the unit's two-piece housing are *four main assemblies*:

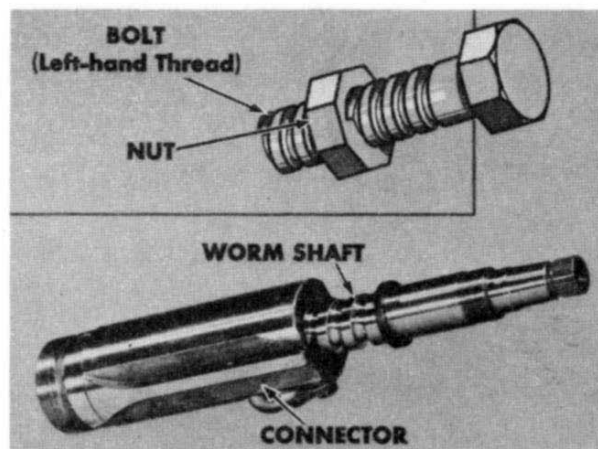
1. Rack and gear shaft assembly.
2. Hydraulic piston and control valve assembly.
3. Hydraulic reaction assembly.
4. Worm and connector assembly.

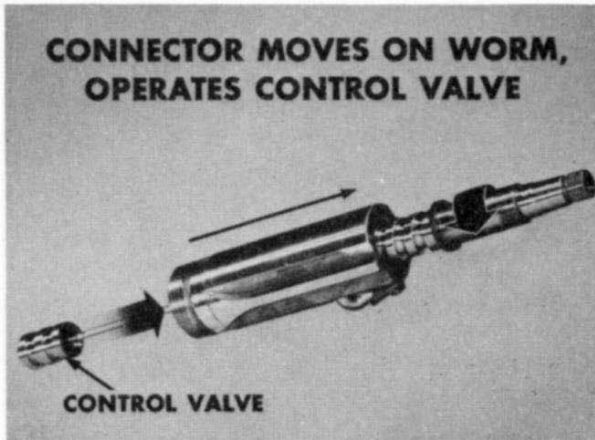


The rack and gear shaft, and the worm and connector assemblies are new in design, but easy to understand. The rack and gear shaft arrangement takes the place of the usual worm and roller tooth system.

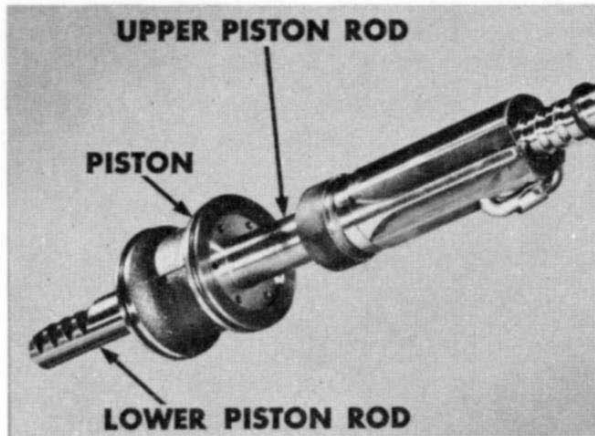


You can compare the action of the worm shaft and connector to that of a bolt with a left-hand thread, and a nut. The worm shaft is like the bolt. The connector acts like the nut.

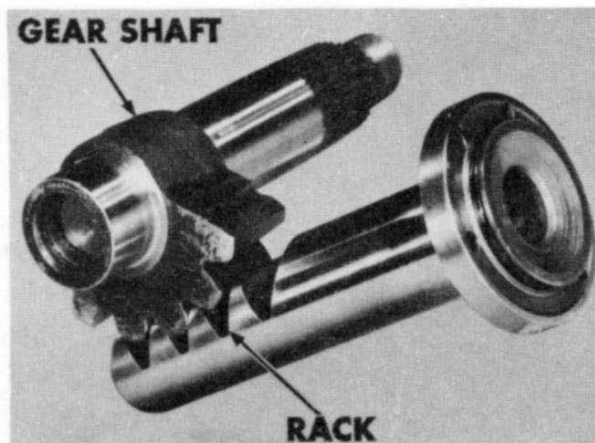




In short, when the worm shaft is turned, the connector moves on the worm and operates the control valve in the piston.



Fastened to the *lower* end of the connector are an upper piston rod, the hydraulic piston, and a lower piston rod.

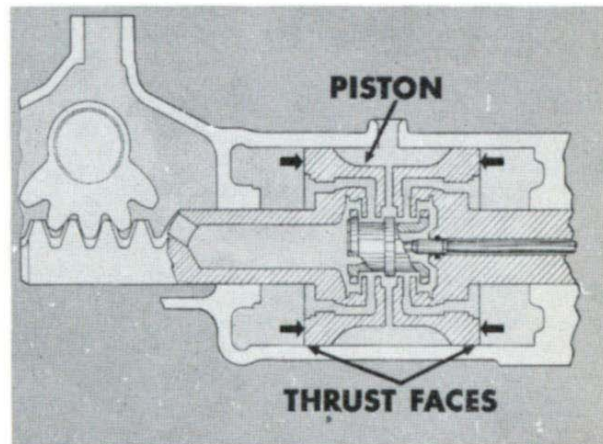


Machined into the bottom part of the lower piston rod is the rack which meshes with the gear shaft. That covers, in general, the mechanical make-up of this advanced coaxial-type power steering unit.

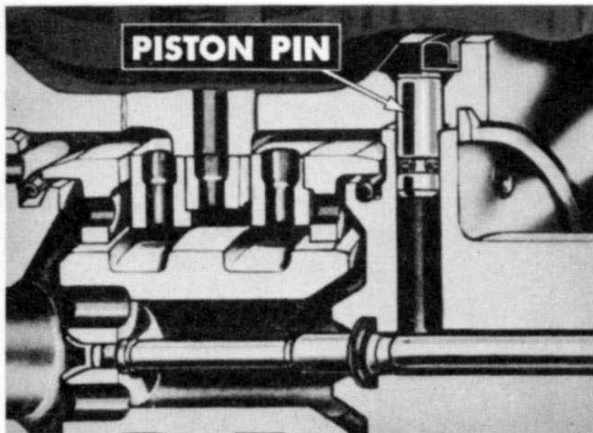


HYDRAULIC SYSTEM PARTS

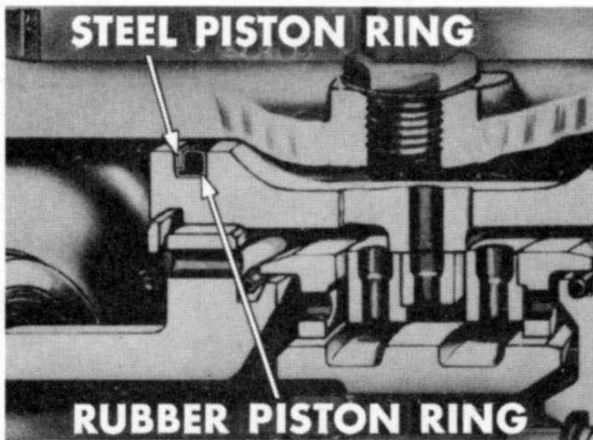
The basic power unit of the system is the piston and control valve assembly. This unit is enclosed in the upper end of the gear housing. Upper and lower ends of the piston serve as thrust faces against which the oil pressure exerts force to move the piston up or down.



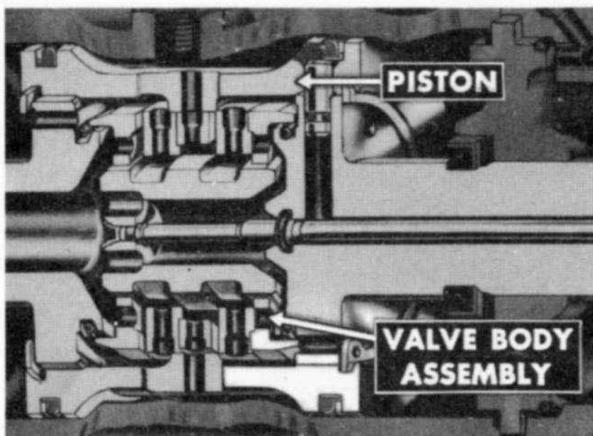
The central area of the piston's outside wall is of a smaller diameter to provide an oil chamber. Holes, drilled through this area, lead into the valve body and control valve.



A hollow steel plug, called a piston pin, is pressed into a reamed hole at the piston's upper end. This pin helps direct the flow of oil to the hydraulic reaction chamber.



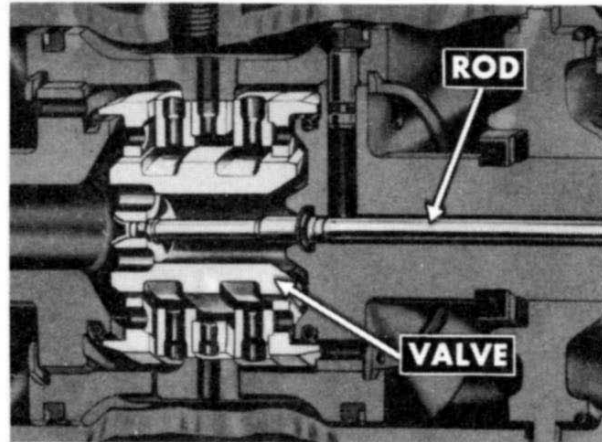
L-shaped, rubber piston rings, in single grooves at top and bottom of the piston, each have a steel piston ring. This steel ring keeps the rubber ring in place when oil pressure moves the piston.



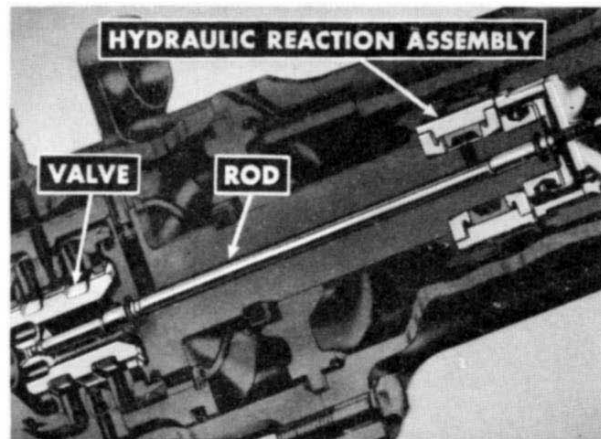
Inside the hydraulic piston is the control valve body assembly. This assembly consists of five steel discs with case-hardened inside diameters to preserve sharply ground edges so critical for proper valve action. These discs are sweated into position inside the piston

and are therefore not serviced separate from the piston. The valve body is also provided with a series of oil passages to direct oil through the control valve and to the pressure chambers above and below the piston.

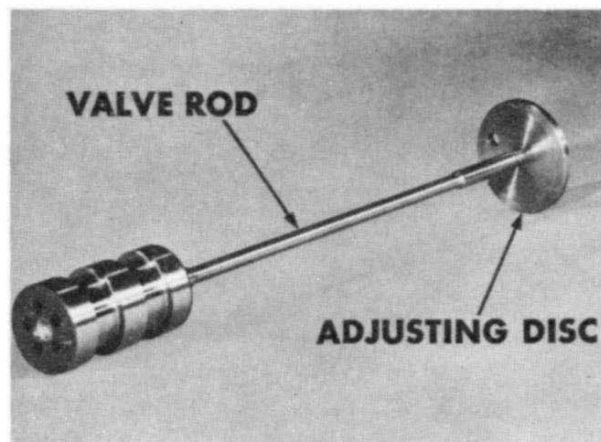
Inside the valve body is the control valve. This is a spool-type valve with oil passages through it. A steel rod, peened to this control valve — and threaded at the upper end — connects the valve to the hydraulic reaction assembly.

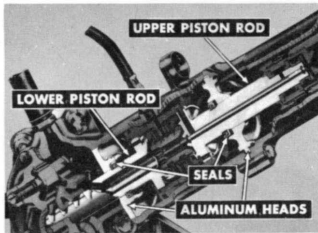
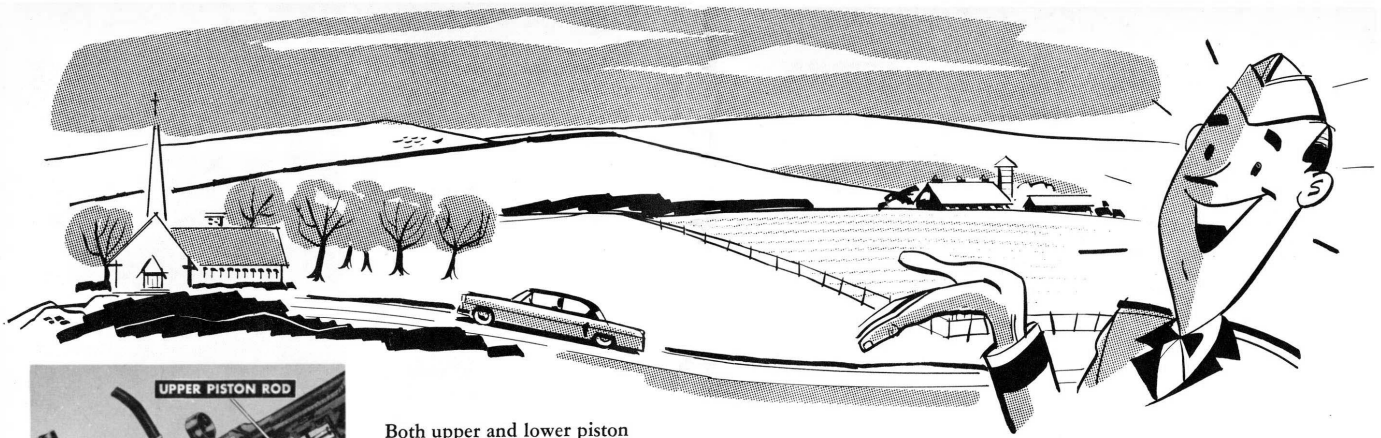


The hydraulic reaction assembly is located above the pressure area of the unit. The steel rod, just mentioned, is flexible enough to compensate for any slight misalignment which might take place during operation.

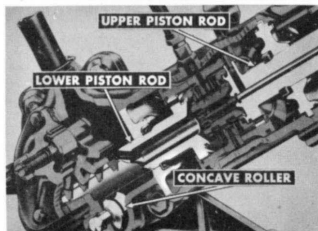


The control valve rod screws into an adjusting disc. This makes it possible to set the control valve exactly in "neutral" position in the valve body.





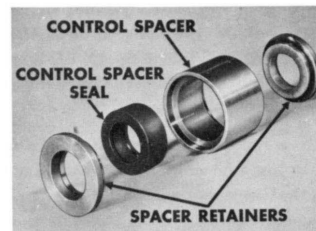
Both upper and lower piston rods pass through aluminum heads, which — like bulkheads — form the upper and lower retaining walls of the high-pressure cylinder. The heads are fitted with synthetic rubber, steel-backed, garter spring-type seals to prevent oil leakage.



The upper head also serves as a support bearing for the upper piston rod. The lower rod, which provides the rack for the gear shaft, is further supported by a concave roller operating on needle bearings.

Tapered snap rings fasten piston and rods together. The taper insures a positive connection with no free play.

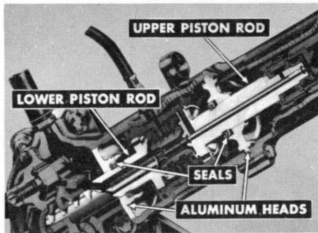
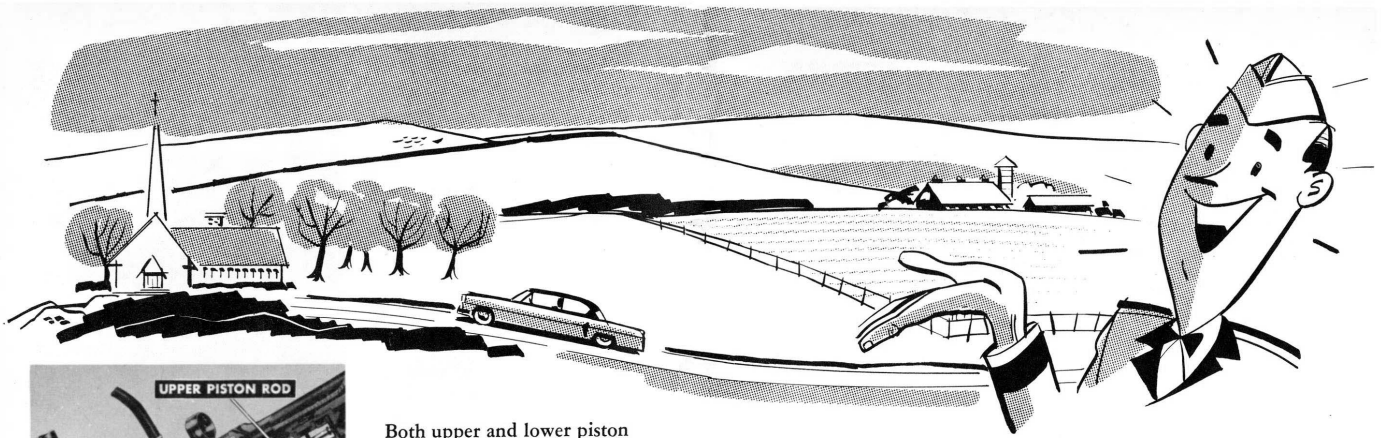
HYDRAULIC REACTION ASSEMBLY



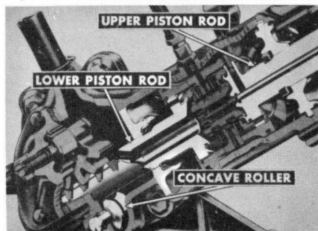
The hydraulic reaction assembly, located above the upper housing head, gives the driver the "feel" of the road. It does this hydraulically, by offering a slight resistance to the relative movement between control valve and the piston. Basically . . . the hydraulic reaction

assembly has four main parts: a control spacer, two spacer retainers, and a control spacer seal.

This hydraulic reaction group is mounted on the upper end of the upper piston rod, and enclosed in the lower end of the worm connector. A number of oil-resistant, synthetic rubber seals are used throughout the entire power steering assembly.



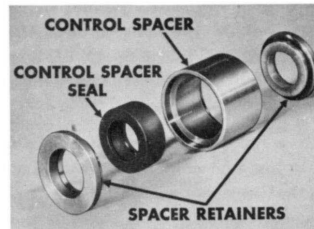
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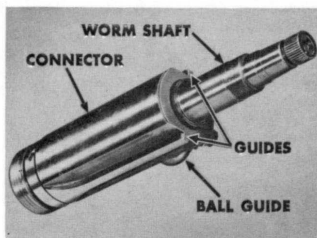


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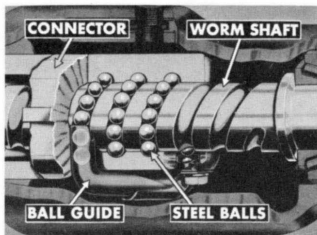
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THE WORM AND CONNECTOR ASSEMBLY

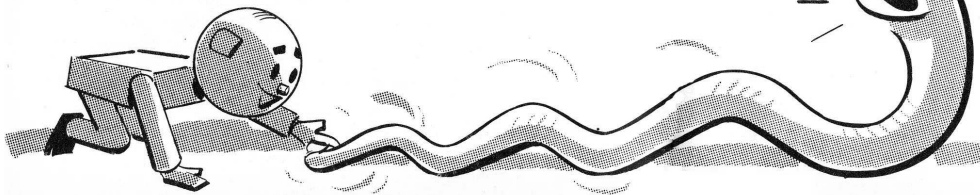


Principal parts of this assembly are the worm shaft, worm connector, ball guide, and forty small steel balls. The connector has two guides which slide in guide rails in the housing, preventing the connector from rotating. The lower end of the connector forms a housing for the hydraulic reaction assembly.



As the steering wheel is turned, the balls circulate through grooves machined in the connector and worm shaft. The balls are routed through the ball guide which returns them to starting point. This permits the balls to run free without jamming or sliding and keeps friction down to a bare minimum.

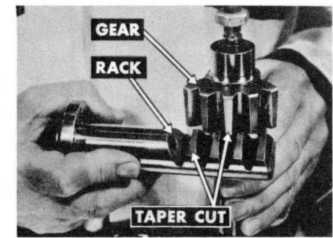
The diameters of the steel balls are maintained within one-half of one ten-thousandth of an inch in any one unit, which insures an even distribution of load. Commercial steel balls can't be used because they are not held to close enough tolerances.



12

THE RACK AND GEAR SHAFT ASSEMBLY

The rack and gear shaft assembly, in the gear housing, is a four-tooth rack and five-tooth gear set-up. Both rack and gear shaft teeth are cut across the face at a taper. That makes the tooth profile slightly wider at one side.



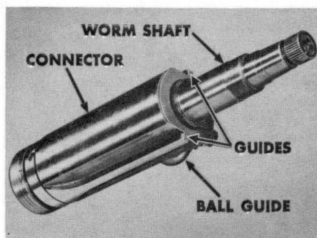
Because of that taper-tooth-cut design, free play and backlash are controlled by moving the gear shaft *laterally* . . . across the rack teeth. The center tooth is wider than the others because most normal driving is done in the center position.



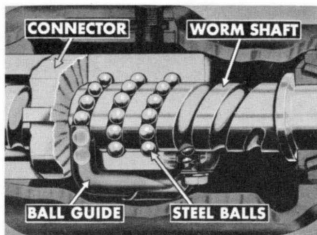
If the center tooth was not wider, a gear shaft adjustment would make the mesh too tight in the extreme right and left positions, where hardly any wear takes place. That adjustment, incidentally, doesn't have to be made very often. Once or twice during the life of the car is about all that is necessary.

13

THE WORM AND CONNECTOR ASSEMBLY

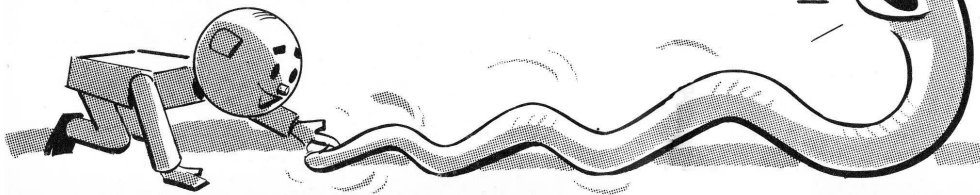


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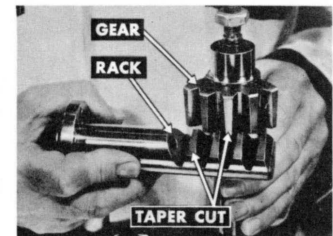
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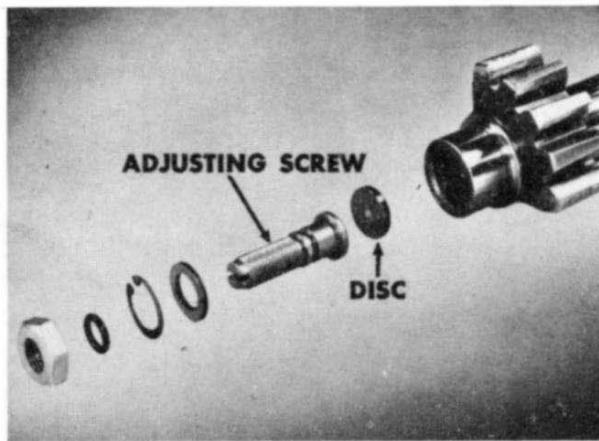
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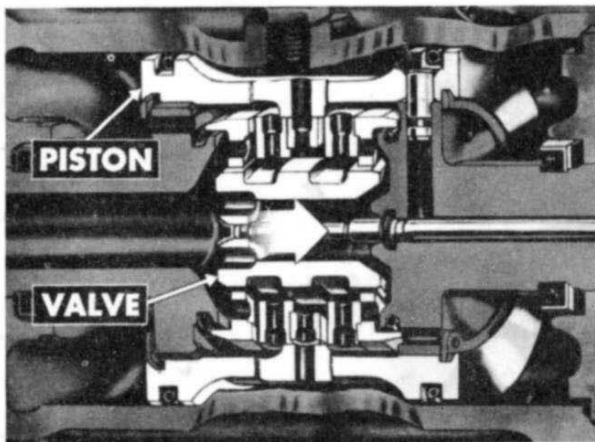
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The tooth mesh adjustment is made by a spherical head adjusting screw which pushes a hardened back-up disc against the gear end of the shaft. As the screw is turned, the tapered gear teeth move crosswise in the rack. A lock nut secures the adjustment.

You adjust to get no backlash for 150° either side of the center steering wheel position.

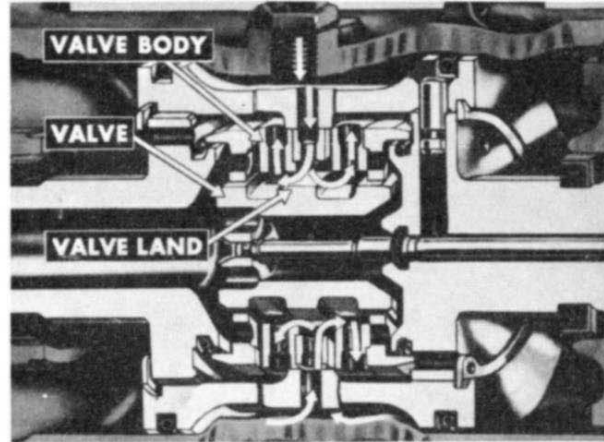
HOW COAXIAL-TYPE POWER STEERING WORKS



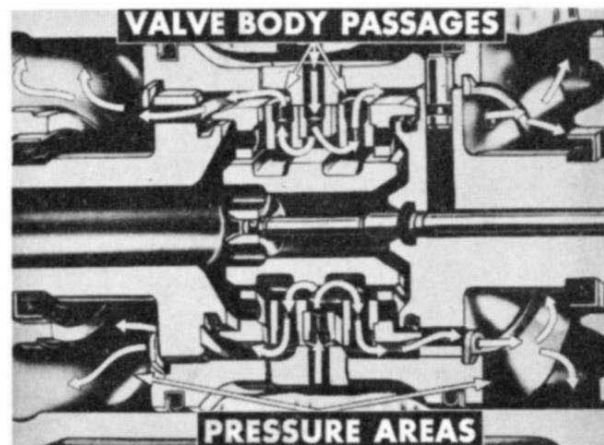
Operation center of the coaxial-type power steering unit is the control valve and hydraulic piston. Remember that the valve body is part of the piston. So, when a driver turns the steering wheel, he moves the control valve in relation to the piston to get quick power steering assistance. That relative movement is rarely more

than .0025", so, don't think of it as general movement of the whole steering system!

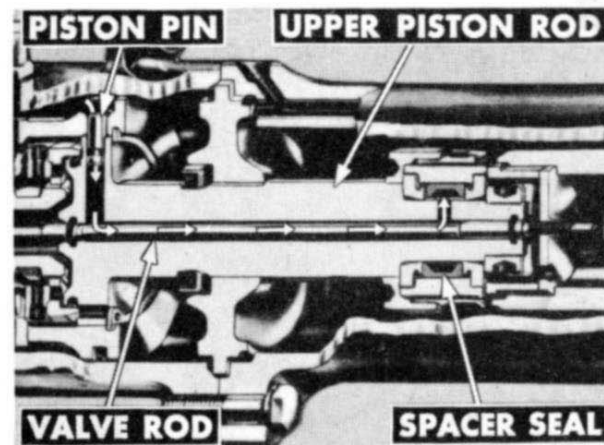
FLOW OF OIL IN "NEUTRAL"—To understand how oil flows through the unit, it will help to know what happens when the control valve is in neutral position in the piston. In other words, when the control valve is in neutral position in the valve body, that leaves clear passages for oil to flow through the unit. Oil from the pump enters the power unit and flows through holes in the piston and valve body into the valve. The flow divides at the center valve land into the grooves on both sides.

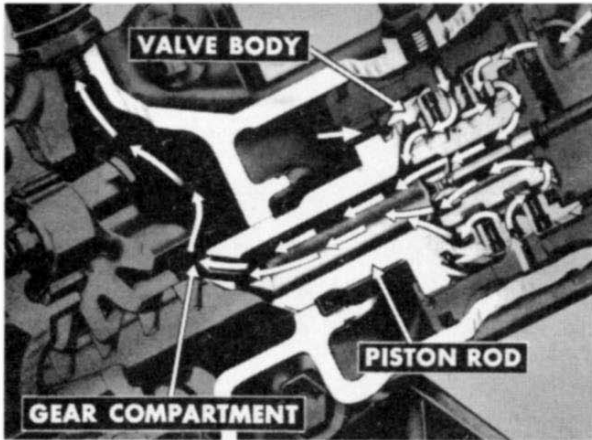


From those grooves, oil flows back through passages in the valve body leading to pressure areas on both sides of the piston.



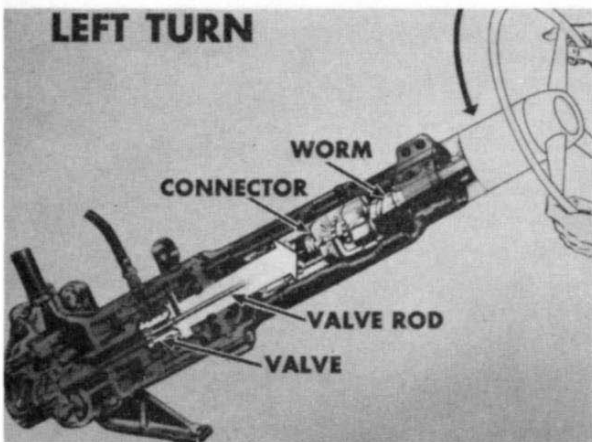
Some of the oil from the chamber around the piston passes through a hole in the piston pin near the top of the piston. From that piston pin, the oil goes through the center of the upper piston rod where the valve rod operates. This passage leads the oil into the center of the control spacer seal in the hydraulic reaction assembly.





Oil flowing from the lower end of the valve body passes through a drilled passage in the lower piston rod. Oil from the other side of the piston joins with it and goes into the gear compartment through a return hole above the rack.

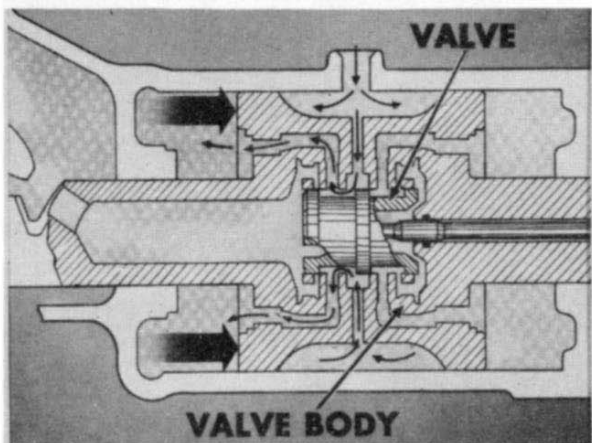
Finally, the oil returns to the reservoir for recirculation by the pump. Since oil pressure's relatively low and equal on both sides of the piston, no piston movement takes place.



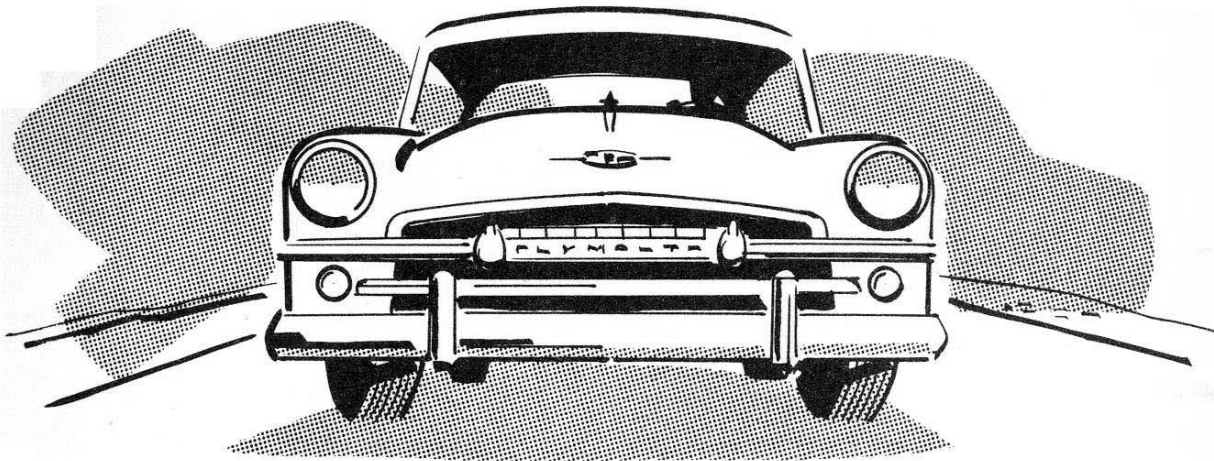
FLOW OF OIL

DURING A LEFT TURN

When the driver turns the steering wheel counterclockwise to make a *left* turn, the worm shaft turns *into* the connector. That causes the connector to move upward on the worm shaft and carries along with it the valve rod and valve.

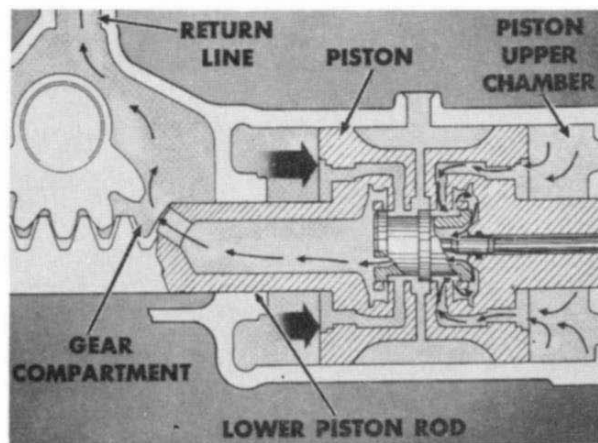
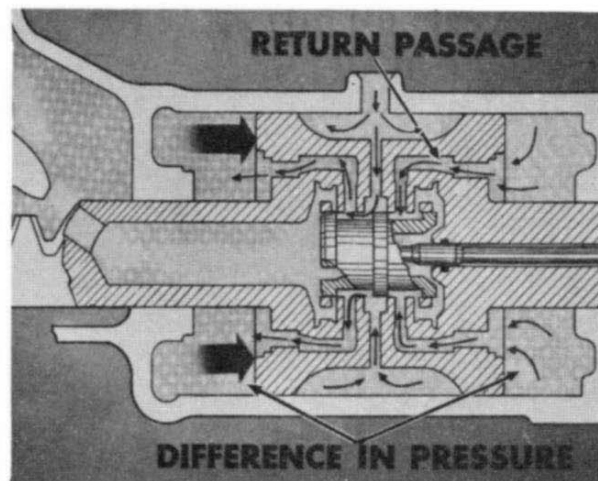


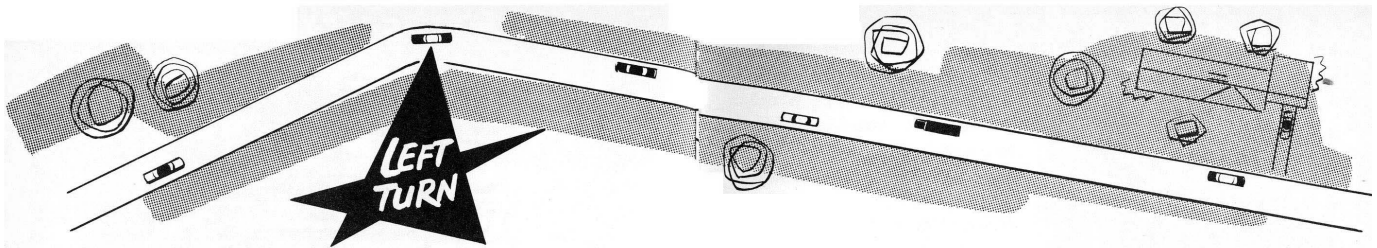
Naturally, that moves the control valve in relation to the valve body. Oil pressure is then directed through passages in the valve body to the lower face of the piston.



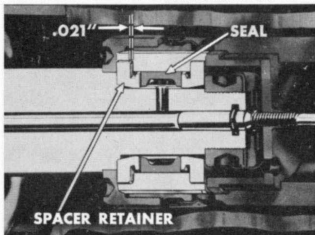
Now, since the opposite face of the piston is open to the return passage, there's a *difference in pressure* on both piston faces. The piston therefore moves, pulling the rack under the gear shaft, causing the gear shaft to move the steering arm, turning the road wheels to the left, the way the driver wants to go.

The oil in the piston upper chamber, displaced by the movement of the piston, is forced through piston and valve passages, through the lower piston rod, into the gear compartment, and out through the return line.

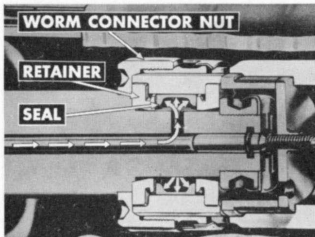




HYDRAULIC REACTION DURING A LEFT TURN—You may well ask, “What about the hydraulic reaction assembly during a left turn? Does it operate?” The answer is “yes”. It is in action on all turns. During a *left* turn, here’s what happens:



As the piston rod moves up, it forces the spacer retainer off its seat. That narrows the .021" operating clearance to about .019" and makes the retainer compress against the control spacer seal.



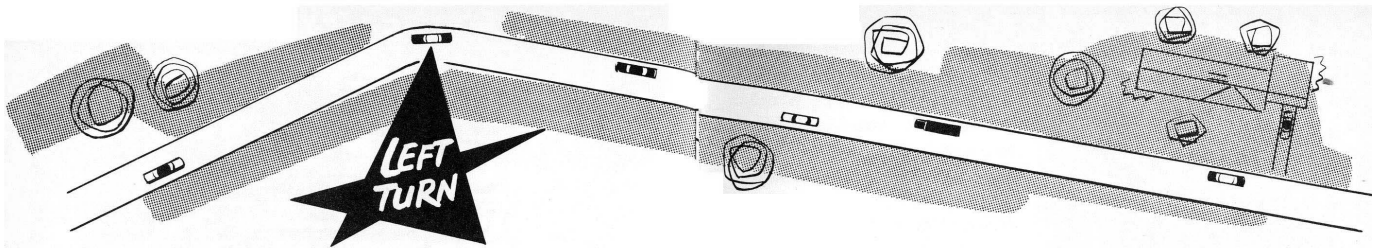
Actually, the retainer compresses *against oil pressure inside the seal*. This pressure resists being squeezed and produces a contact between the connector nut and the retainer which the driver can feel.

Now, suppose the front wheels offer slight resistance to turning as they usually will on a wide, sweeping curve. In this case, the driver won't turn the steering wheel very much. That means the valve won't be moved very much in relation to the piston. As a result, not much power assistance will be required and oil pressure inside the seal will be fairly low. The driver, in turn, will experience only a slight "feel" of the road.

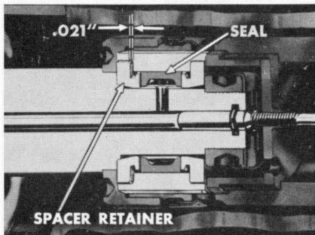


But when road wheels offer greater resistance to turning—as on a sharp corner—the steering wheel will be turned farther. That means the valve is moved more in relation to the piston and power assistance will be greater. Oil pressure inside the seal will be high also and the driver therefore will experience a greater "feel" of the road. You can see, then, that the hydraulic reaction assembly has a "feel of the road" job to do, in addition to providing a "hydraulic connection" in the unit.

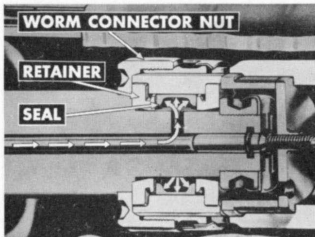




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Actually, the retainer compresses *against oil pressure inside the seal*. This pressure resists being squeezed and produces a contact between the connector nut and the retainer which the driver can feel.

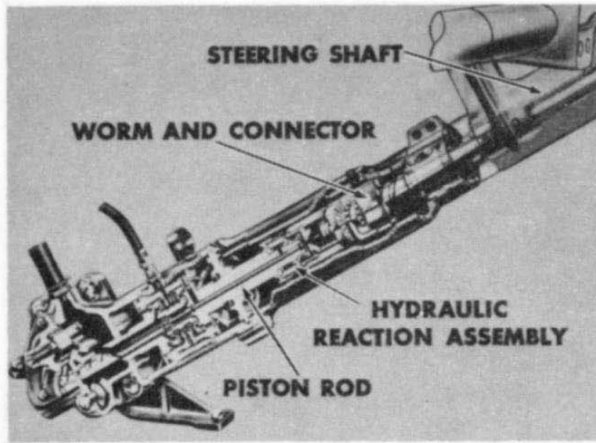
Now, suppose the front wheels offer slight resistance to turning as they usually will on a wide, sweeping curve. In this case, the driver won't turn the steering wheel very much. That means the valve won't be moved very much in relation to the piston. As a result, not much power assistance will be required and oil pressure inside the seal will be fairly low. The driver, in turn, will experience only a slight "feel" of the road.



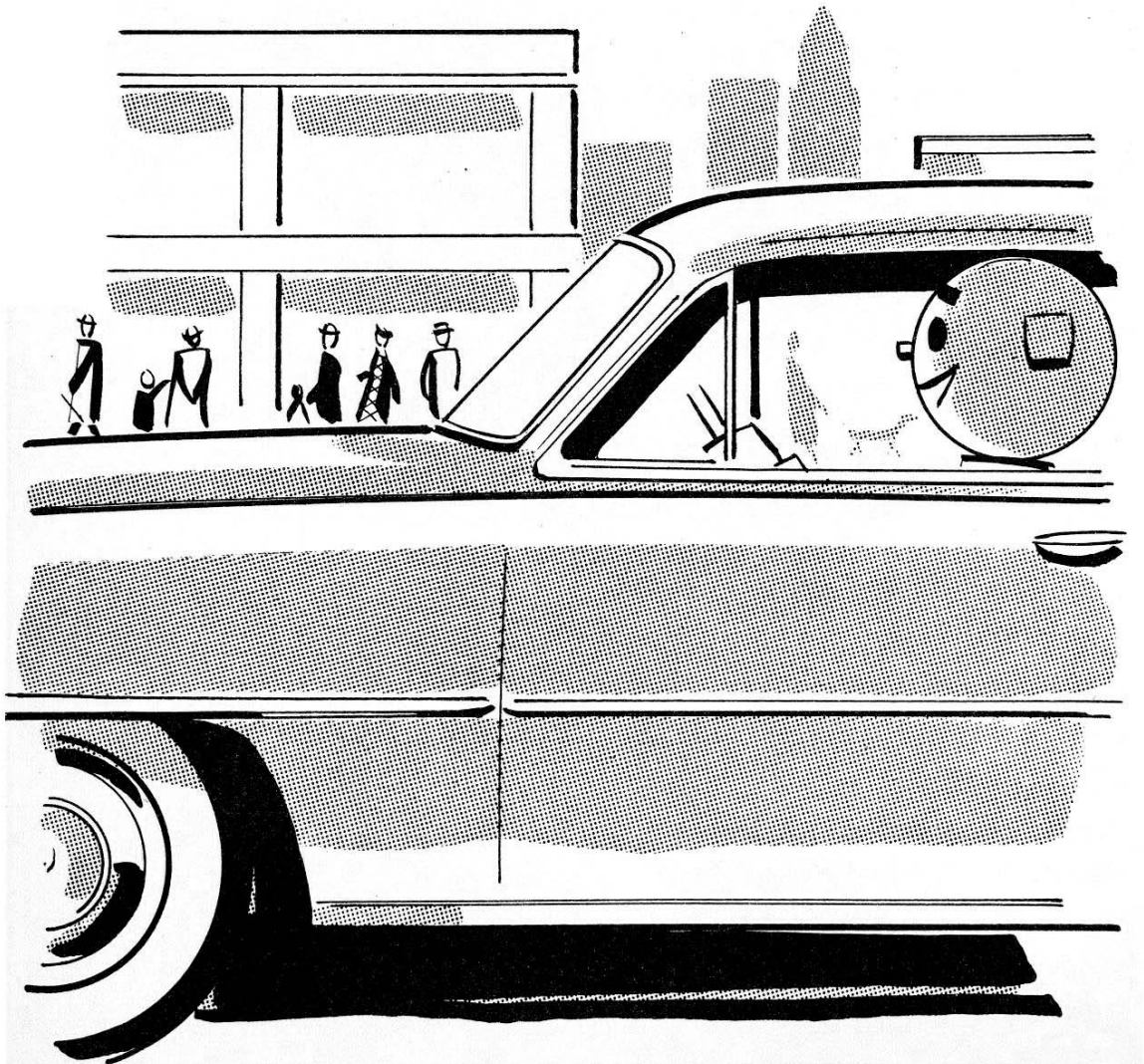
But when road wheels offer greater resistance to turning—as on a sharp corner—the steering wheel will be turned farther. That means the valve is moved more in relation to the piston and power assistance will be greater. Oil pressure inside the seal will be high also and the driver therefore will experience a greater "feel" of the road. You can see, then, that the hydraulic reaction assembly has a "feel of the road" job to do, in addition to providing a "hydraulic connection" in the unit.



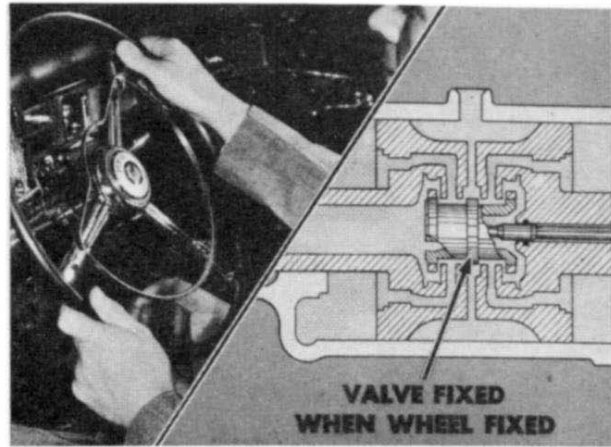
DIRECT MECHANICAL CONNECTION—A *mechanical* connection is



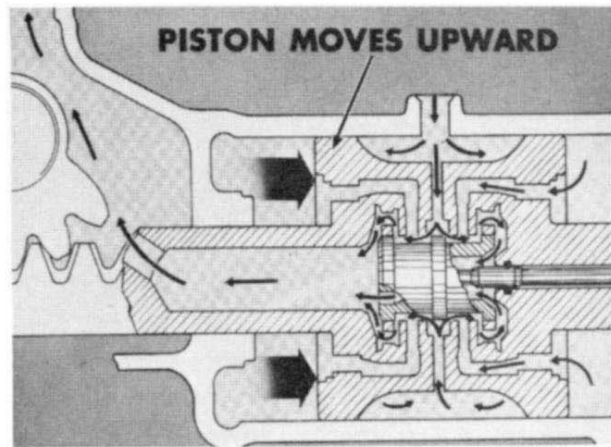
accomplished between the front wheels and steering wheel through the steering shaft, worm and connector, the hydraulic reaction assembly, and the piston rod. As a result, the driver of a car equipped with coaxial-type power steering never loses manual control of the front wheels.



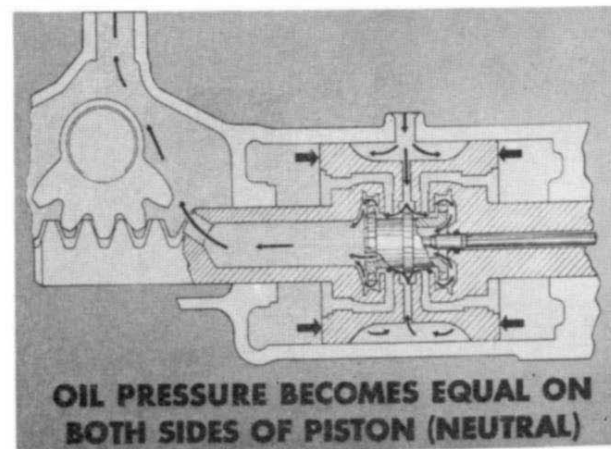
NEUTRALIZING POWER ASSIST. Suppose that a driver stops turning, and holds the steering wheel fixed, as he would when holding the front wheels in a wide, sweeping turn. In this case, here's what goes on hydraulically. With the wheel in a fixed position, the control valve also stays fixed because it's mechanically connected.

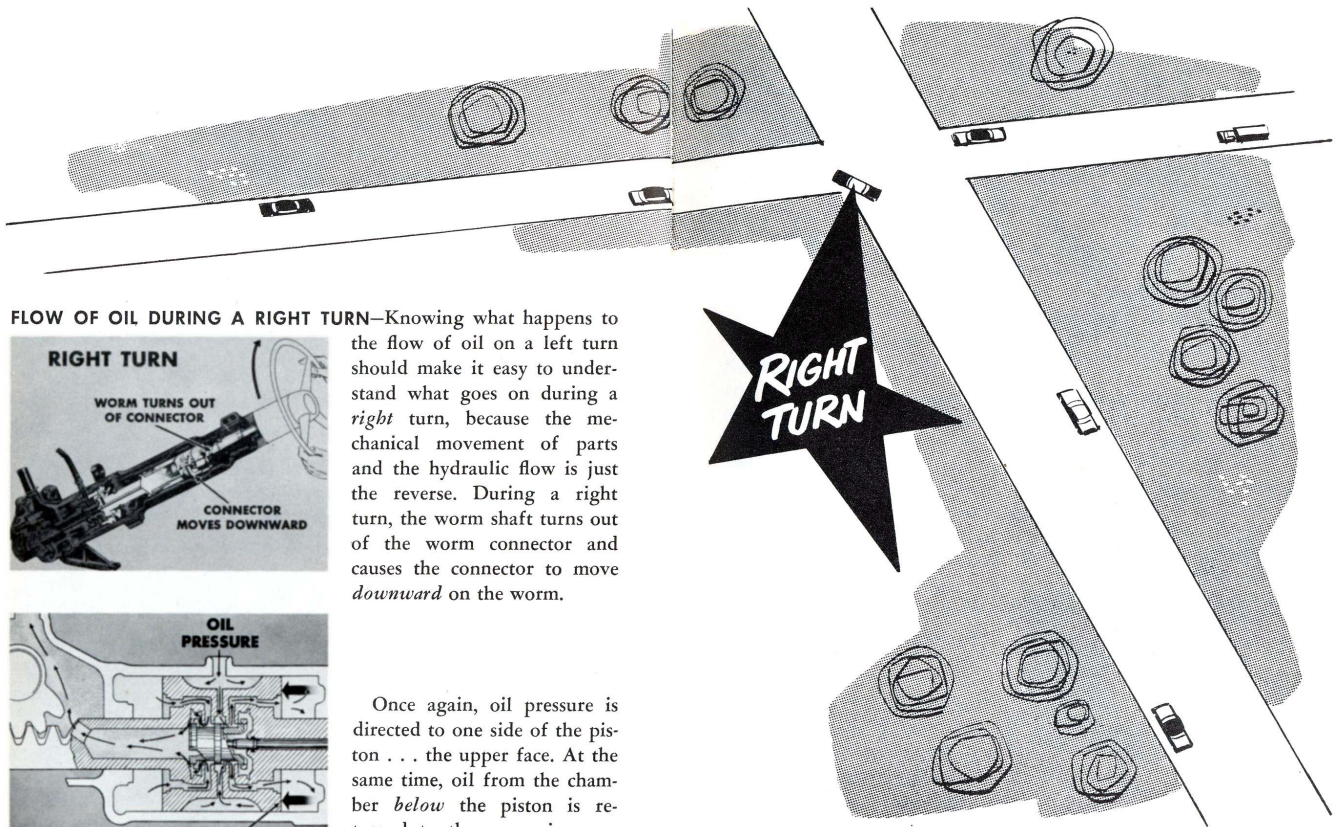


However, the piston is moving upward because of pressure on its lower face. The piston continues to move for a moment until it reaches a neutral position in relation to the valve.



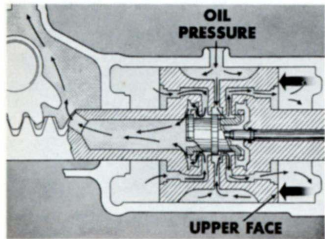
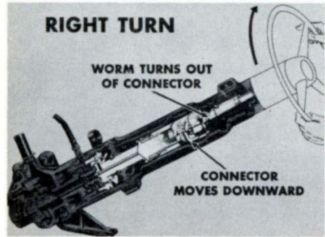
When that happens, oil pressure becomes equal on both sides of the piston, and the piston stops moving. Consequently, power assistance stops and the road wheels remain where the steering wheel holds them. That's split-second action, naturally, due to the very slight relative movement between control valve and valve body.



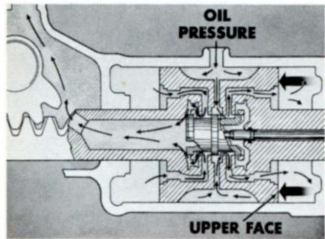
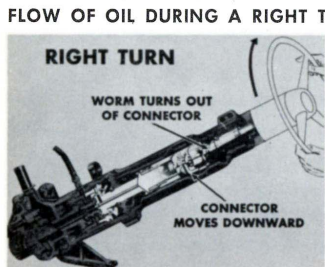
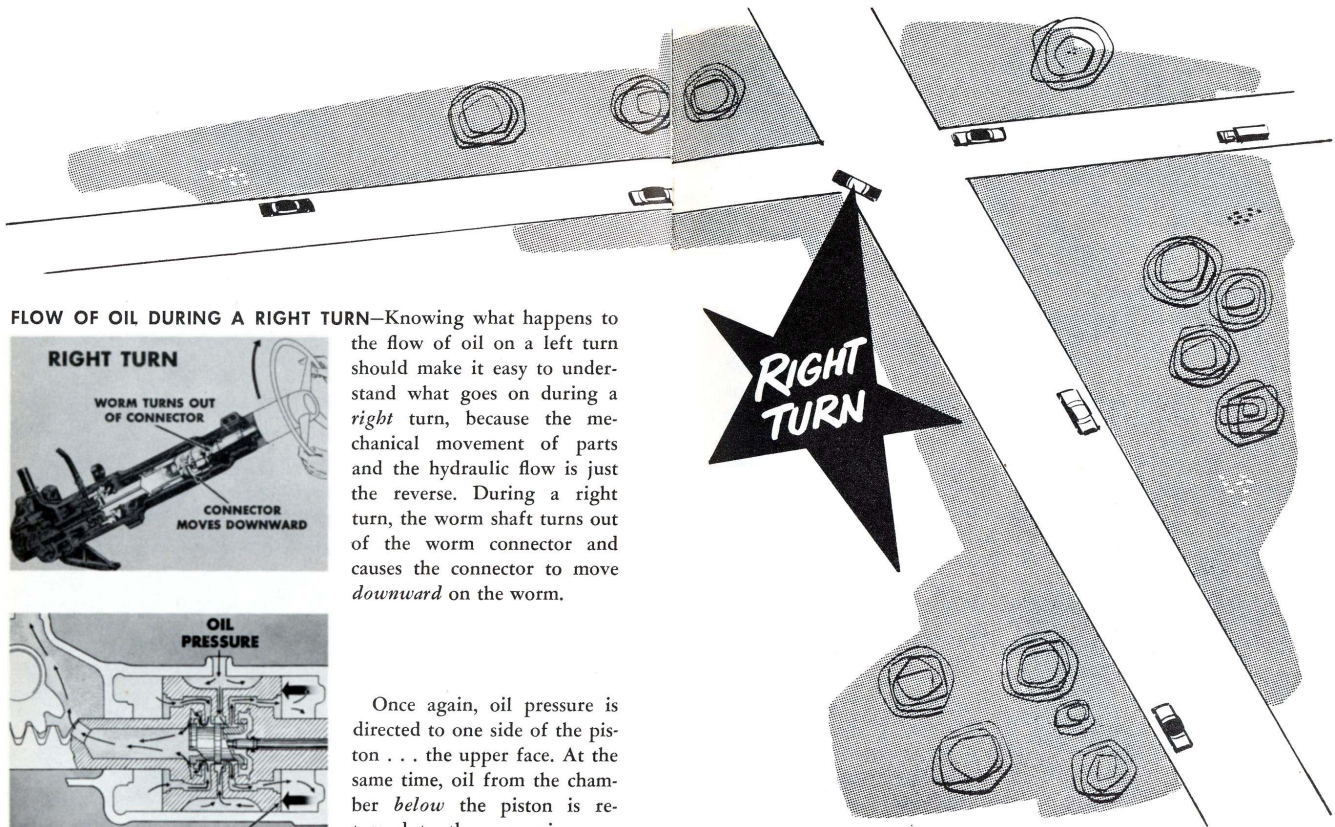


FLOW OF OIL DURING A RIGHT TURN—Knowing what happens to

the flow of oil on a left turn should make it easy to understand what goes on during a *right* turn, because the mechanical movement of parts and the hydraulic flow is just the reverse. During a right turn, the worm shaft turns out of the worm connector and causes the connector to move *downward* on the worm.



Once again, oil pressure is directed to one side of the piston . . . the upper face. At the same time, oil from the chamber *below* the piston is returned to the reservoir.



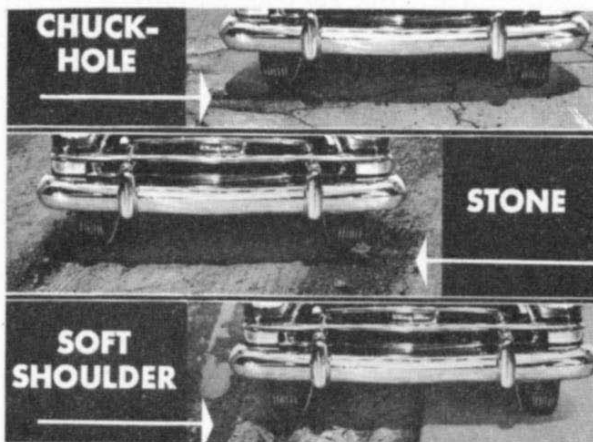
FLOW OF OIL DURING A RIGHT TURN—Knowing what happens to the flow of oil on a left turn should make it easy to understand what goes on during a *right* turn, because the mechanical movement of parts and the hydraulic flow is just the reverse. During a right turn, the worm shaft turns out of the worm connector and causes the connector to move *downward* on the worm.

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SAFETY FEATURES

Safety features have been designed into the coaxial-type power steering to give the driver added control and assurance. For example . . .

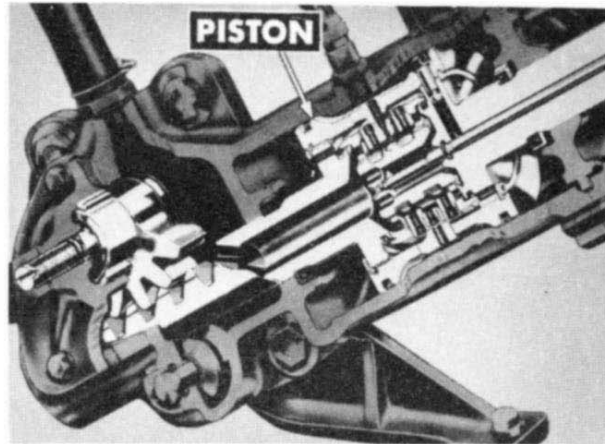


when a tire hits a road obstruction like a chuckhole, large stone, or soft shoulder . . . that would ordinarily tend to turn the front wheels off their course.

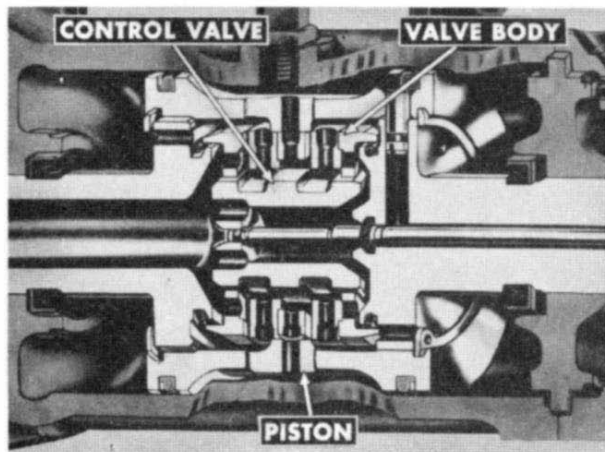
The driver, naturally, holds the steering wheel fixed, ordering the power system to hold the road wheels fixed in spite of the obstruction. But he

doesn't have to worry because the power system acts in *reverse* whenever road forces jar the wheels. Here's how that comes about:

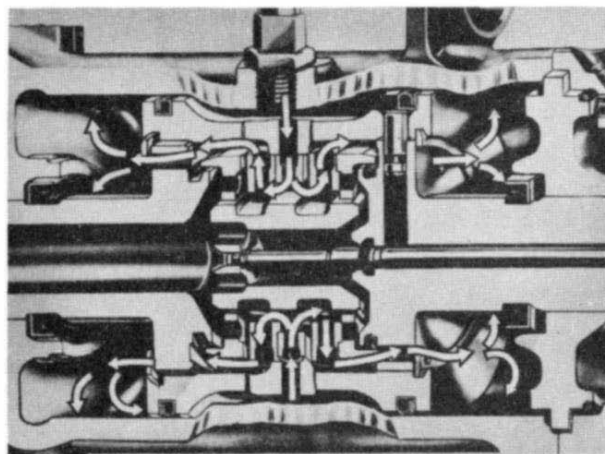
The first, slightest amount of off-course deflection is transmitted through the steering linkage to the piston. The piston moves a tiny fraction.



Now, since the driver holds the steering wheel steady, the control valve can't move. But there's relative motion between the valve body and valve as a result of the *piston* motion.

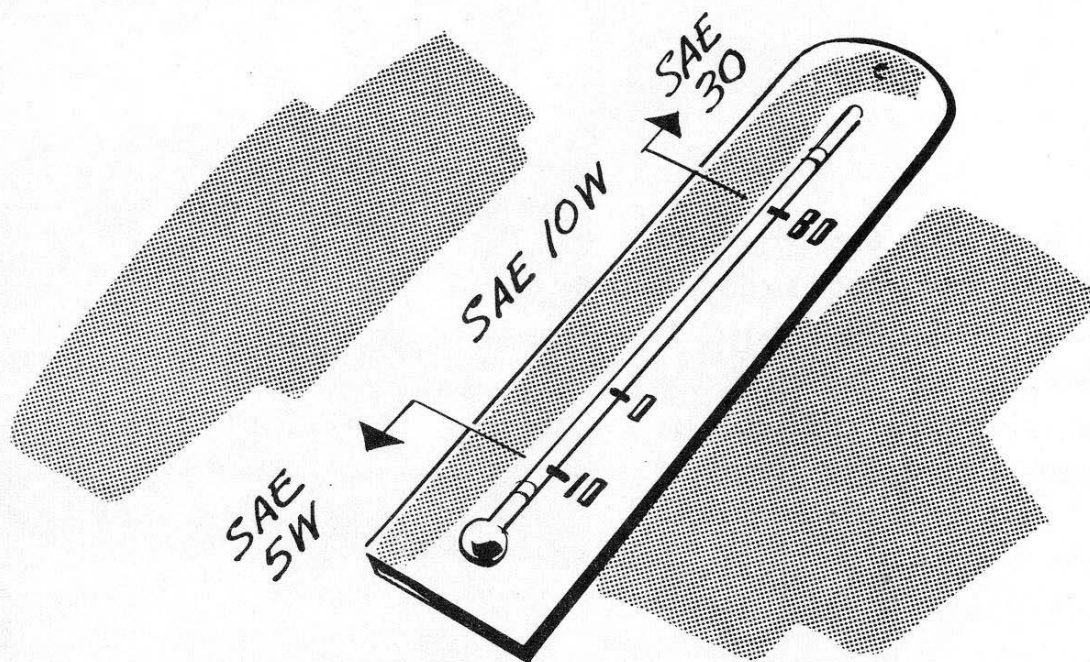


So pressure builds up on the one piston thrust face. That pushes the piston back toward the neutral position in direct opposition to the disturbing road forces. As a result, the wheels do not turn, and the driver maintains control on bad roads with a very minimum of effort.

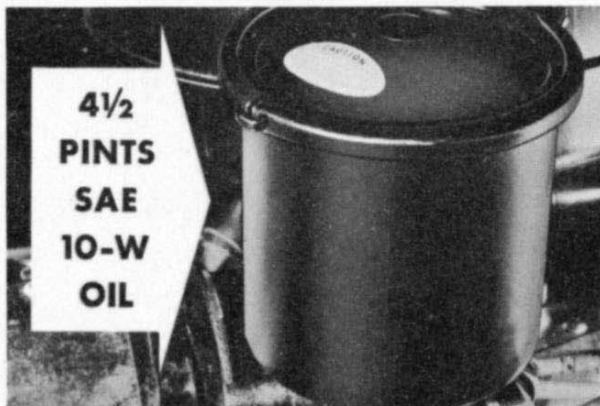


LUBRICATION AND THE OIL SYSTEM

Generally speaking, the oil pump is the same, single rotor type that's been used on power steering units with which you are probably acquainted. So, other than the thousand-mile oil level check, the hydraulic system needs no further attention. The worm housing is filled with oil (about 16 ounces) when the complete unit is assembled, and never requires changing. Oil in that upper housing lubricates the worm shaft and bearings.



The entire hydraulic system holds $4\frac{1}{2}$ pints of S.A.E. 10W engine oil. In extremely cold climates where temperatures are consistently lower than 10° below zero, drain the system and fill it with S.A.E. 5W oil. If a loss of power assistance is noticed where temperatures are consistently high, use S.A.E. 30 engine oil.



There are no periodic mechanical adjustments needed, except for a possible gear adjustment once or twice during the life of the car. This you can do right on the unit in the car.



The oil pump draws its oil from a large reservoir through an internal passage in the pump housing. It discharges oil to the power unit through a combination pressure relief and flow control valve similar to the one used on earlier models of power steering.

Oil returning to the reservoir passes through a full-flow filter located in the reservoir. Excessive build-up of pressure in the return line, when the oil is cold, is prevented by a spring-loaded relief valve in the top of the filter element. When pressure builds up to 5 to 7 pounds per square inch, the valve opens and allows oil to enter the reservoir chamber directly.

The top of the reservoir is closed to prevent the entrance of foreign matter that might contaminate the oil. A diaphragm valve in the cover opens if pressure exceeds 4 to 10 psi.

The oil pressure in the system is limited to 800 psi to prevent excessive stress developing in the steering linkage. In addition, the rate of oil flow is limited to 2 gallons per minute to keep the horsepower required to drive the pump at a low level. This is the capacity of the pump when the engine is idling. Both of these features are controlled by the combination pressure relief and flow control valve.

**USE THE NEW TECH QUESTIONNAIRE
FOR SESSION NO. 78
WHEN RECORDING YOUR ANSWERS
TO THESE TEN QUESTIONS**

The piston pin, pressed into a reamed hole at the piston's upper end, helps direct the flow of oil to the hydraulic reaction chamber. RIGHT **1** WRONG

The control valve body assembly, which is sweated into position inside the hydraulic piston, cannot be serviced as a separate part. RIGHT **2** WRONG

The control valve is set in its neutral position in the valve body by means of an adjusting disc threaded to the control valve rod. RIGHT **3** WRONG

The center tooth of the gear shaft is wider than the others because most normal driving is done in the center position. RIGHT **4** WRONG

You adjust to get no backlash for 150° either side of the center steering wheel position. RIGHT **5** WRONG

When the steering wheel turns, movement of the control valve in relation to the piston is rarely more than .0025"! RIGHT **6** WRONG

When the steering wheel is turned to the *left*, oil pressure is directed to the upper thrust face of the piston. RIGHT **7** WRONG

The driver retains manual control of steering at all times. RIGHT **8** WRONG

The hydraulic system holds 4½ pints of S.A.E. 10W engine oil. RIGHT **9** WRONG

If power assistance seems weak in extremely hot climates, drain and refill the hydraulic system with S.A.E. 30 oil. RIGHT **10** WRONG

LITHO IN U.S.A.