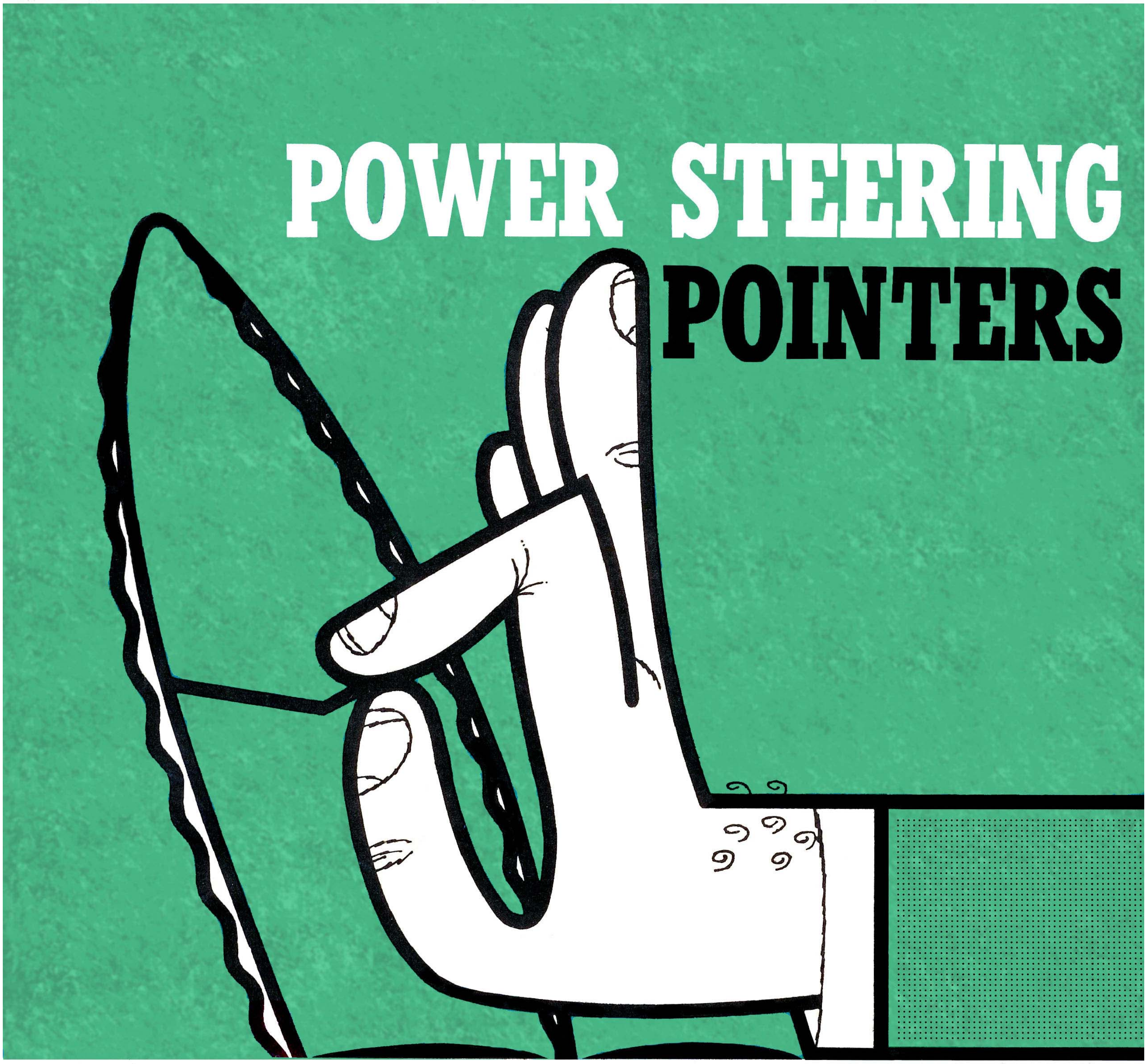
MASTER TECHNICIANS SERVICE CONFERENCE 66-8

REFERENCE BOOK

POWER STEERING POINTERS



CHRYSLER CORPORATION

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What You Don't Know CAN Hurt You!

The message in this headline is certainly no news to technicians like you, who regularly depend on their know-how to earn a living. But, things being what they are, we all tend to ignore the things that are the least troublesome.

A good example of this is power steering . . . one of the most trouble-free units on our cars today. Because power steering is remarkably trouble-free, many technicians probably haven't bothered to keep up to date, or to learn much about troubleshooting this equipment.

Unfortunately, a lack of understanding often results in "guesswork fixing" by changing parts instead of making a proper diagnosis to locate the trouble. Of course, indiscriminate parts changing may not correct the real cause of the trouble, invites "comebacks" and more often than not builds up a customer-jolting bill.

Tech had these problems in mind when this reference book was put together. So, if you're just starting in on power steering, or need a refresher, you'll find plenty of good information on the subject in this book. Read it through now and put it away for future reference.

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INTRODUCTION TO POWER STEERING

Chrysler Corporation's Constant-Control Power Steering supplies at least 80% of the effort needed to maintain positive car control. Yet, this full-time, hydraulically operated steering system requires just enough steering effort to provide the driver with a constant feeling of steering control. That's why it is called Constant-Control Power Steering.

A WORKING KNOWLEDGE WILL HELP

The mechanical operation of the power steering gear is very much like the operation of a mechanical gear and quite easy to understand. The application of hydraulic power to the power piston is also quite easily understood. The mechanical and hydraulic operation of the steering control system is a bit more complex. However, it isn't necessarily complicated or difficult to understand if you study control valve actuation and operation in easy steps.

A good working knowledge of the steering control valve, and all of the other valves in the power steering system, will enable you to do a much better job of diagnosing power steering problems. So let's go through the power steering gear and pump to make sure we all understand exactly what happens when the driver turns the steering wheel of a car equipped with power steering. For purposes of explanation we will use greatly simplified illustrations of the gear to begin with. We'll graduate to more detailed drawings after we've covered basic gear and control valve operation.

IT'S ALSO A MECHANICAL GEAR

Mechanically, there isn't anything very mysterious or complicated about a power steering gear. The power steering gear is designed to operate as a manual gear so that the car can be steered even if all power assist fails. So, for all practical purposes the power steering gear is a mechanical gear that has had a hydraulic power and control system added to it.

THE WORM SHAFT AND PISTON ASSEMBLY

In a power steering gear the worm shaft and piston assembly changes rotary steering wheel movement into up-and-down movement. For all practical purposes the worm shaft is free to rotate but cannot move up or down. The power piston is free to move up and down but cannot rotate. That's why turning the worm shaft moves the power piston up or down. This is exactly the same as the mechanical action in a manual steering gear. Of course in a manual gear, the part that moves up and down is called a ball nut instead of a power piston.

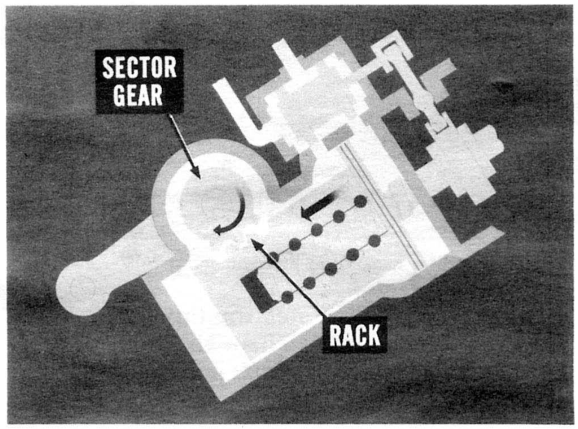


Fig. 1—Mechanically, a power gear is like a manual gear

THE SECTOR GEAR AND RACK

The up-and-down movement of the piston must be changed into rotary motion again to operate the steering linkage. This is accomplished by rack teeth machined into the power piston and the sector gear teeth on the cross shaft. This arrangement changes the up-and-down movement of the power piston into rotary cross shaft movement. It also provides the means of obtaining a gear ratio or mechanical advantage between the worm shaft and the cross shaft.

RIGHT-HAND GEARS AND LEFT-HAND GEARS

Some of our steering gears have a worm shaft with a right-hand thread and others have a worm shaft with a left-hand thread. A gear having a worm shaft with a right-hand thread is used on vehicles with a leading pitman arm.

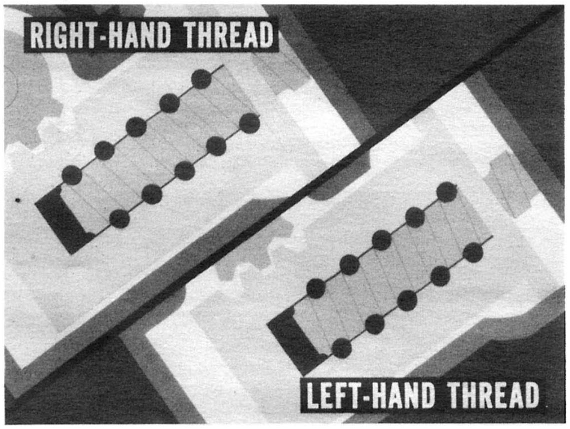


Fig. 2—Leading arm, right-hand; trailing arm, left-hand

In other words, if the steering linkage arrangement requires a pitman arm that extends forward from the sector shaft, a right-hand gear is used. A left-hand gear is used on vehicles with a trailing-type pitman arm. Both gears operate essentially the same, but the movement of the working parts is reversed.

A LEFT-HAND EXPLANATION

For purposes of explanation we will confine our discussion to the operation of a gear having a left-hand worm shaft. Rotating a worm shaft with a left-hand thread to the left causes the piston to move upward. This upward movement rotates the sector gear in a counterclockwise direction. The trailing-type pitman arm also turns counterclockwise, turning the front wheels to the left.

From the foregoing discussion it is obvious that there is no difference between the mechanical operation of power and manual steering gears. Next, let's look into the application of hydraulic power to a power steering gear.

HYDRAULIC PRESSURE DOES THE WORK

In a power steering gear, the steering gear housing is machined to form a cylinder. The flange and seal ring at the upper end of the power piston divides the cylinder into two separate chambers. When hydraulic pressure in the chamber above the piston flange is greater than pressure below the piston flange, the piston moves downward. Greater pressure below the piston flange helps move the piston upward. In other words, the difference in pressure between the two power chambers does most of the work.

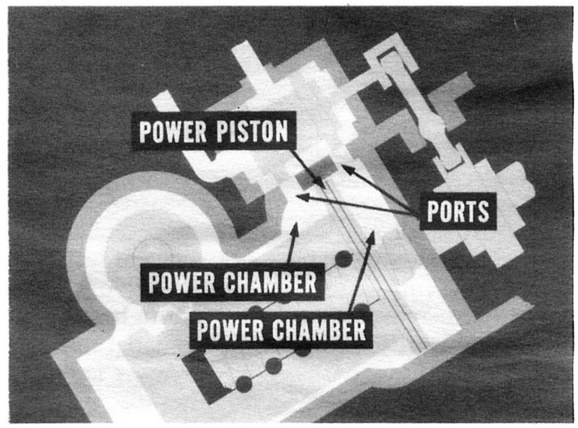


Fig. 3—The piston divides the cylinder into two chambers

HYDRAULIC PRESSURE SUPPLY AND CONTROL

A belt-driven pump provides the hydraulic pressure and flow needed to operate the power steering system. Flow between the pump and the power chambers in the gear is controlled by a steering control valve mounted on the gear.

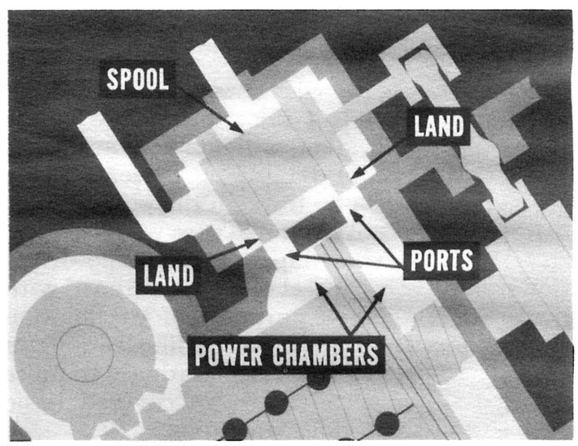


Fig. 4—Simplified steering control valve

A sliding spool valve in the steering control unit has lands which open or close ports connected to passages leading to the power chambers. The position of the spool valve lands determines which power chamber receives hydraulic assist pressure.

There is no pressure assist as long as the spool valve is centered. Because both ports are open an equal amount, hydraulic fluid circulates through the valve and pressure in the two power chambers is the same.

WHEN THE SPOOL VALVE MOVES

When the spool valve moves upward, its upper land uncovers more of the upper port to input flow. Full pump pressure acts on the upper power chamber. At the same time, the lower land closes the lower port to input flow and opens it to return flow from the lower power chamber. As a result, pressure in the upper chamber increases. At the same time, pressure in the lower chamber is reduced because its port is exposed to the pump return line.

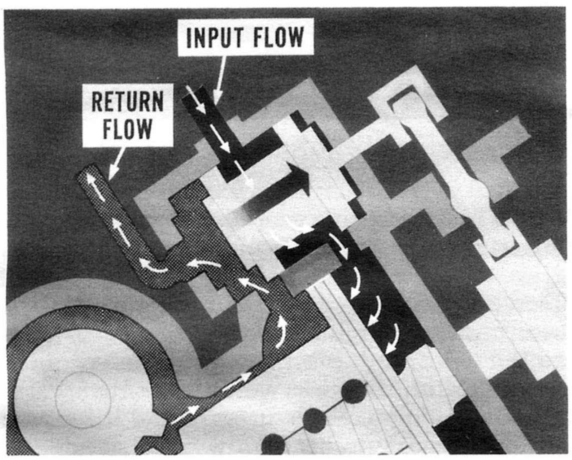


Fig. 5—Upper valve port open to input flow

PRESSURE DIFFERENCE PROVIDES POWER ASSIST

Power assist is provided whenever there is a difference in pressure between the upper and lower power chambers. In our example, greater pressure in the upper chamber and reduced pressure in the lower chamber helps move the piston downward. As the piston moves downward, it forces fluid out of the lower chamber and into the return side of the system. Power assist continues as long as the driver keeps the control valve spool off center by exerting turning force on the steering wheel. We will explain some of the fine points of steering control valve operation after we clear up a couple of facts about returnability.

WHEN THE SPOOL VALVE RE-CENTERS

Hydraulic power does not interfere with normal returnability coming out of a turn. When the driver relaxes the turning force on the steering wheel, the steering control valve is automatically centered by a combination of forces which will be explained a bit later.

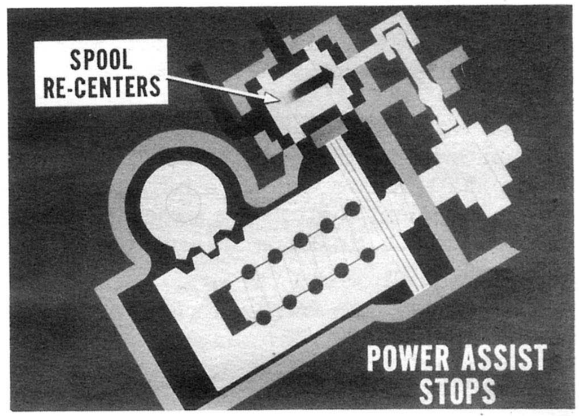


Fig. 6—Steering control valve centered

With the spool valve centered, piston movement can push the fluid out of the power chamber. Since there is no longer a difference in pressure between the two power chambers, the power piston is free to move back to its center position. This allows the front wheels to return to the straight-ahead position without power interference from the gear. Incidentally, you will probably remember that the front wheel geometry . . . positive caster, steering axis inclination, and camber provides the "returnability" force.

REVERSE POWER APPLICATION

Power steering is a safety as well as a convenience feature for several reasons. For one thing, power steering helps the driver maintain control easily when ruts, bumps or chuckholes try to deflect the front wheels. Let's see how this reverse power application works.

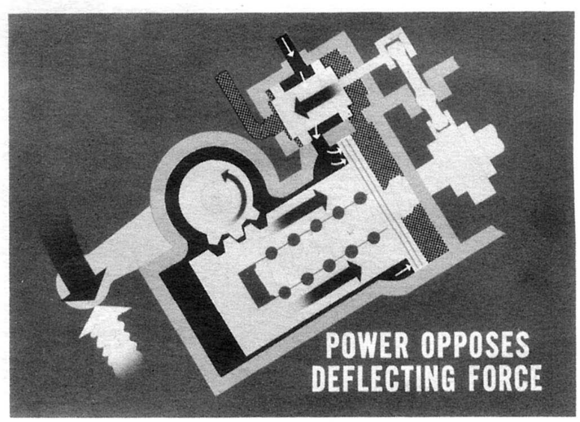


Fig. 7—Road shock reverses steering forces

When a car's front wheels hit a rut or chuckhole, the front wheels try to take over from the steering wheel. However, when road shock tries to deflect either front wheel, the steering linkage transmits this shock back through the pitman arm, sector gear, power piston and worm shaft. As we will see a bit later, worm shaft movement controls the steering valve so the road shock finally is transmitted all the way back to the spool valve.

Because road shock reverses normal forces transmitted to the spool valve, the spool valve causes the power boosting action to oppose the forces trying to deflect the front wheels. For example, if road shock tries to move the piston upward, the spool valve movement increases the pressure in the upper chamber and decreases the pressure in the lower chamber. The resulting difference in pressure counteracts the forces trying to deflect the front wheels.

STEERING CONTROL VALVE OPERATION

So far we have used a simplified version of the steering gear and the control valve to explain the basic operating principles of a power steering system. Now it's time to explain the fine points of control valve actuation and operation. In order to do this we'll have to use a reasonably accurate cross sectional view of a Constant-Control Power Steering gear.

An explanation of valve actuation and gear operation will be easier to follow if we stick to one gear and explain a turn in only one direction. So for a starter, let's consider a gear having a *left-hand worm shaft* and explain what happens when the *steering wheel is turned to the right*.

MECHANICAL FORCES COME FIRST

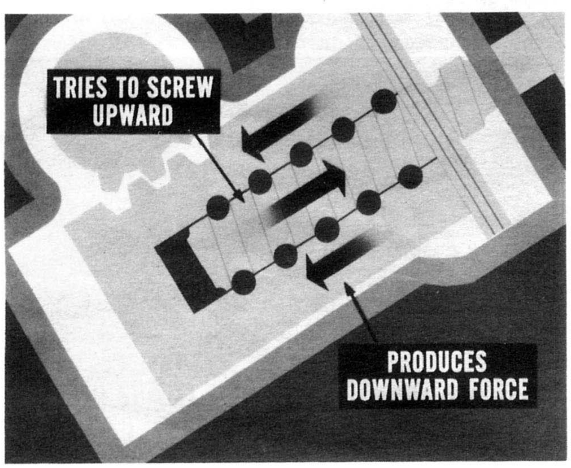


Fig. 8—Right turn, left-hand worm shaft

Control valve actuation starts with mechanical forces in the steering gear and steering linkage. In a right turn, the left-hand worm shaft thread tries to screw upward . . . out of the piston. However, since up-and-down movement of the worm shaft is limited, turning the worm shaft to the right produces a downward force on the power piston. In other words, the entire worm shaft is trying to move upward and the power piston is trying to move downward.

Now, the front wheels always offer some resistance to the turning force from the steering gear. This resistance is passed through the steering linkage to the pitman arm and sector gear. As a result, the sector gear tends to keep the piston from moving when the worm shaft is turned. Since something has to give, the worm shaft does move upward very slightly when the steering wheel is turned to the right. This slight lengthwise movement of the worm shaft is the key to the mechanical actuation of the control valve.

THE THRUST BEARING CAN MOVE UP OR DOWN

The worm shaft and thrust bearing assembly can move up or down because there is a small amount of clearance designed into the space between the cylinder head and the gear housing head. This clearance lets the worm shaft react to steering resistance and move the thrust bearing upward when the steering wheel is turned to the right. Obviously, on a left turn the thrust bearing would be moved downward. Next, let's see how thrust bearing movement is used to move the steering control valve.

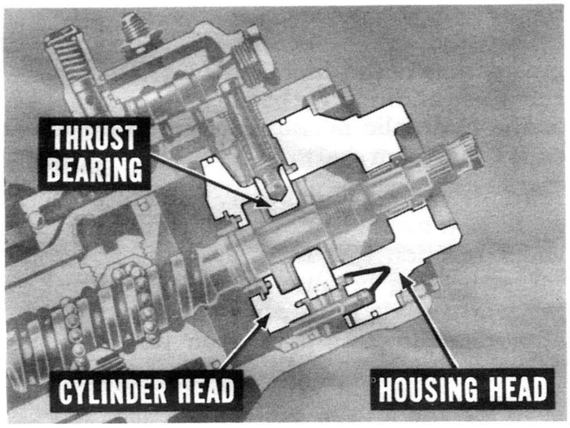


Fig. 9—The thrust bearing can move up or down

THE PIVOT LEVER MOVES THE STEERING VALVE

The center race of the assembled thrust bearing is actually sandwiched between two thrust bearings and outer bearing races. The center race is larger in diameter than the two bearings and outer races. The lower end of a control valve pivot lever fits into a pocket machined into the center race. The upper end of the pivot lever fits into a pocket machined into the control valve spool. All up-or-down movement of the thrust bearing assembly is translated into down-or-up movement of the spool valve. As a matter of fact, the pivot lever multiplies center race movement so that the valve moves about three times as far as the center race.

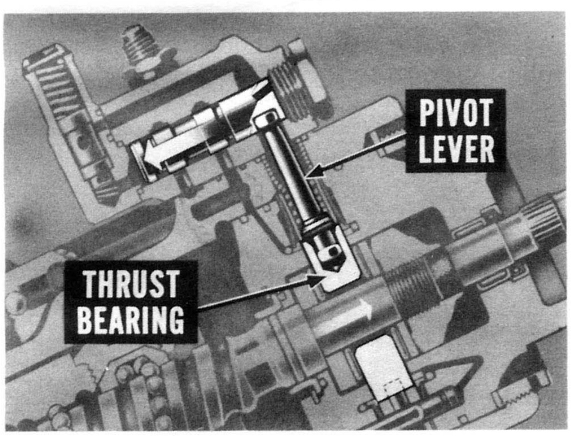


Fig. 10—The pivot lever moves the valve spool

THE REACTION SPRINGS AND RINGS

A power steering gear must have some built-in "feel" and resistance to turning. In Chrysler-built power steering gears a combination of spring-type reaction washers and reaction rings above and below the thrust bearing assembly provide steering resistance and feel of the road. Let's take a close look at these springs and reaction rings.

The spring-type washers provide the basic mechanical centering force acting on the thrust bearing center race. Whenever turning force on the steering wheel is relaxed, the spring washers center the bearing race and this in turn centers the steering control valve. Of course these springs also offer some resistance when the steering wheel is turned to either the left or the right. This resistance provides some of the very desirable "feel" built into the steering gear.

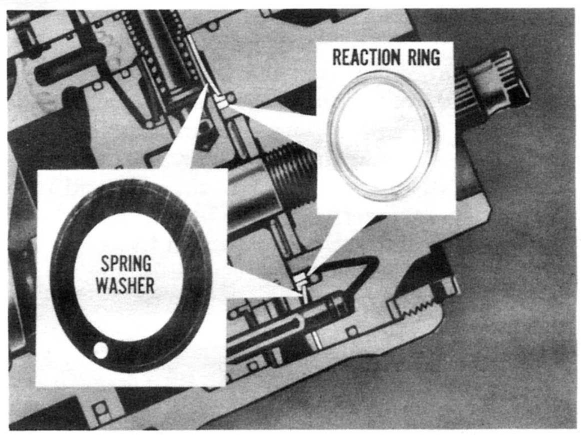


Fig. 11—Spring-type washers provide basic centering force

In the accompanying illustration you'll notice that the reaction springs don't bear directly against the center race of the bearing. Instead they bear against reaction rings which do bear against the center race. In this same illustration you'll also notice that the upper reaction ring is wider than the lower reaction ring. We will explain the reason for this difference in reaction ring size as soon as we trace out the hydraulic circuitry between reaction rings and power chambers.

REACTION RINGS AND PRESSURE CHAMBERS

The upper reaction ring is connected hydraulically to the upper power chamber. The lower reaction ring is connected to the lower power chamber. In other words, the hydraulic pressure against each reaction ring is the same as the hydraulic pressure in the power chamber to which the ring is hydraulically connected. When the steering control valve is centered, the hydraulic pressure pressing the two reaction rings against the center race is equal.

When the steering wheel is turned and the steering valve is moved off center, the hydraulic pressure against one reaction ring is greater than against the other. This difference in hydraulic pressure plus the mechanical pressure of the reaction springs provides the driver with steering resistance, or feel, that is proportional to steering effort required. Now let's see why the upper reaction ring must be wider than the lower reaction ring.

ACTION AND REACTION

We'll have to back-track a bit in order to explain why the reaction area of the upper ring is greater than the reaction area of the lower ring. When making a right turn with a gear having a left-hand worm shaft, hydraulic pressure is greater in the upper power chamber. Now, hydraulic pressure in the upper chamber is transmitted along the worm shaft threads and into the cavity *inside the piston* at the lower end of the worm shaft. So, pressure in this cavity is always the same as the pressure in the upper power chamber.

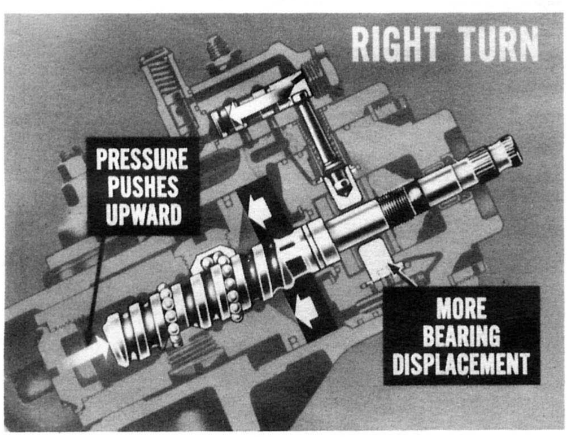


Fig. 12—Hydraulic pressure pushes worm shaft upward

Pressure in the cavity below the worm shaft pushes *downward* on the piston, compensating for the area taken up by worm shaft in the upper power chamber. However, pressure in the cavity is also pushing *upward* against the lower end of the worm shaft. This produces more upward thrust bearing displacement force on a right turn than downward displacement force acting on the thrust bearing in a left turn. The greater area of the upper reaction ring counteracts this condition by balancing out the effect of the hydraulic pressure acting on the lower end of the worm shaft.

Actually, it doesn't make any difference whether the gear has a right or a left worm shaft. The wider reaction ring is always used *above* the thrust bearing because the *upward* thrust on the worm shaft must always be balanced by additional downward reaction thrust on the bearing.

MOST OF THE POWER ALL OF THE TIME

The Chrysler-built power steering system is truly full-time power steering and provides power assist whenever the steering wheel is turned. Even more important from a standpoint of safety and driving pleasure, this design provides a realistic feel of the road. The amount of power assist is always proportional to steering wheel turning effort. Heavy pressure on the steering wheel gives more power assist . . . less effort on the steering wheel gives less assist.

THE BACK PRESSURE VALVE

So far we haven't mentioned the back pressure valve in the steering control valve body. This valve is designed to enable the pump to maintain a minimum pressure of about 50 p.s.i. in the gear. It simply remains closed until pump flow builds pressure in the gear up to about 50 p.s.i. When that pressure is reached, the back pressure valve lifts and allows power steering fluid to return to the pump reservoir.

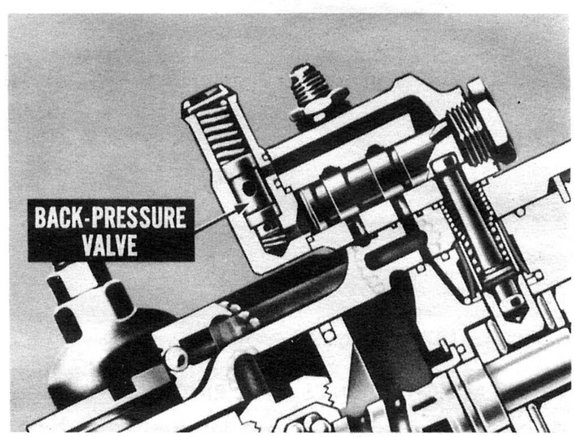


Fig. 13—Back-pressure valve maintains minimum pressure

Chrysler Constant-Control Power Steering uses a constant displacement, belt-driven pump. Three different pumps having different capacities and displacements are used on current model cars.

PUMPS ARE NOT INTERCHANGEABLE

Each pump is designed to meet the flow and pressure needs of a specific application. A smaller pump must not be used where a larger pump is specified. In current production models you'll find pumps having a 1.2-, a .96-, or a .94-cubic-inch displacement. In most cases, the differences in pump mounting dimensions help to prevent installation of the wrong pump.

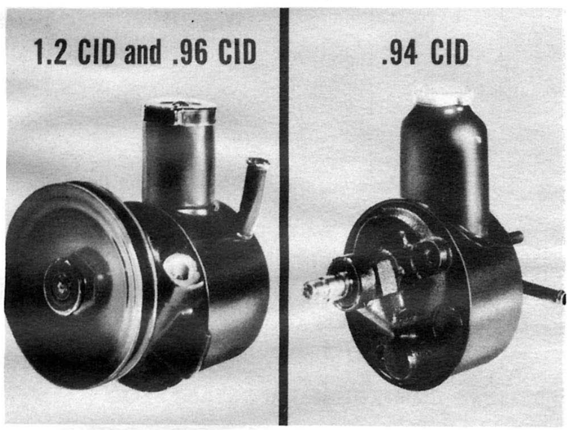


Fig. 14—Power steering pumps are not interchangeable

WHICH PUMP IS WHICH?

The parts book and service manuals tell you which pump goes on which model car. Of course, the parts book identification doesn't help you tell which pump is which. The 1.2- and the .96-cubic-inch displacement pumps appear to be almost identical. They both have pressed-on pulleys and the same shaped reservoirs and bodies. However, the reservoir of the 1.2-cubic-inch pump is $5\frac{1}{8}$ inches in diameter and the .96-cubic-inch pump reservoir diameter is $4\frac{5}{8}$ inches. The .94-cubic-inch pump is easily identified because it is entirely different. The pump shaft is threaded and the pulley is retained by a nut instead of being pressed on. Besides, this pump has a long, oval-shaped filler tube instead of the round filler tube used on the other two pumps.

All three pumps operate on the same basic eccentric cam principle. However, the two larger pumps are the spring-loaded slipper-type. The .94-cubic-inch pump is a vane-type pump. In this pump, hydraulic pressure and centrifugal force, rather than springs keep the vanes in contact with the pump body. Each pump has a flow valve and a pressure-relief valve.

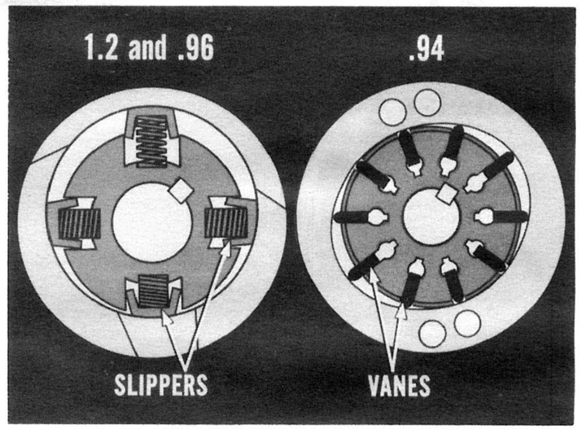


Fig. 15—Pumps are all eccentric cam type

WHY FLOW CONTROL IS NEEDED

Each pump must have sufficient capacity to

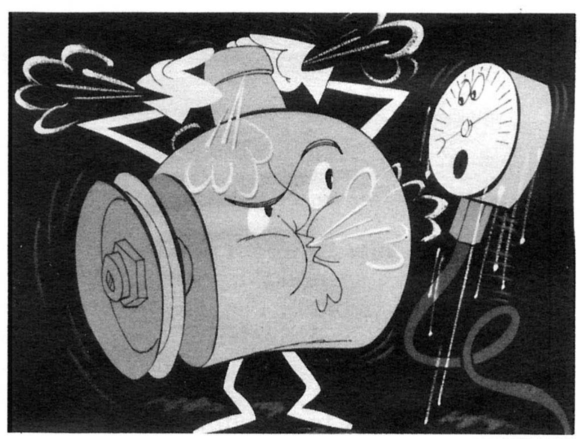


Fig. 16—Flow valve prevents overheating

provide full power assist for parking and at low engine speeds. Under most highway driving conditions, less assist and flow capacity is needed. However, pump output normally increases as engine speed increases. If it weren't for the flow control valve, pump output would become excessive at higher engine speeds. This would waste engine power and overheat power steering fluid and the entire power steering system.

THE FLOW CONTROL VALVES

The flow control valve design is different for each of the three current production pumps. However, each flow valve accomplishes the same thing and an understanding of the principle involved is more important than a study of the individual designs. For purposes of explanation we'll describe the operation of the metering rod-type flow valve used in the .96-cubic-inch pump.

IT WORKS LIKE A METERING ROD

The essential working parts of the flow control valve used in the .96-cubic-inch pump are the metering pin or rod and the valve. The metering pin position is fixed. The valve is movable and reacts to flow. The valve has an orifice in one end to accept the metering pin.

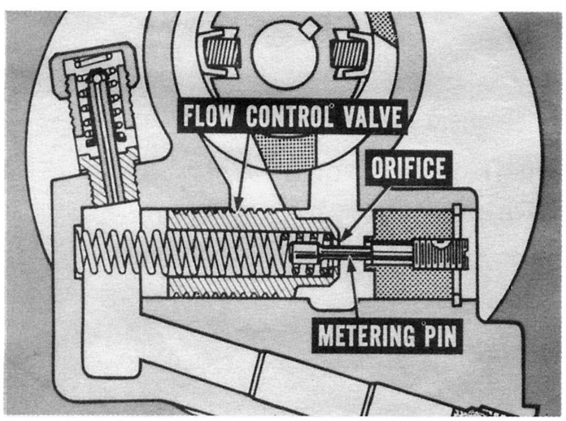


Fig. 17—The metering pin-type flow control valve

From engine idle to about 3,000 r.p.m., the valve doesn't move and the orifice of the valve is positioned at the small diameter of the metering pin. The small diameter of the pin offers minimum restriction to flow. This, of course, permits full output flow to provide ample power assist at low to medium engine speeds.

Above engine speeds of about 3,200 r.p.m., pump flow moves the valve inward until the metering pin's large diameter is in the valve orifice. This, of course, produces maximum restriction to flow through the orifice. At the same time, the valve also opens a passage to the input side of the pump. This allows some of the power steering fluid to bypass the flow valve and recirculate from the output to the input side of the pump. The metering pin restriction of the orifice and the bypass opening work together to limit flow to an acceptable rate at higher engine speeds.

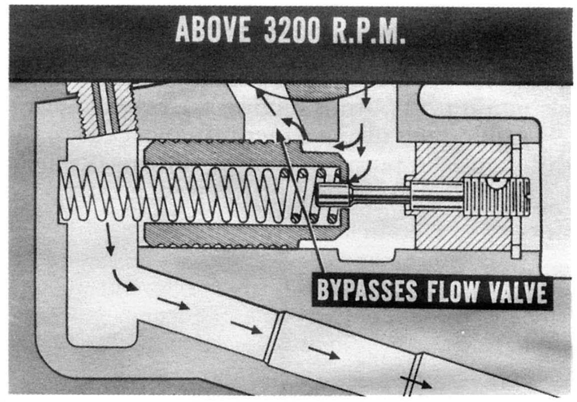


Fig. 18—Metering pin and bypass limit flow

CAUTION: The metering pin is carefully adjusted to provide correct flow control valve calibration when the pump is manufactured. DO NOT change this adjustment when you service a pump.

PRESSURE CONTROL IS IMPORTANT, TOO

A flow control valve limits the amount of flow from the pump but it doesn't control maximum pressure. When a pump tries to keep on pumping fluid into a sealed space, pressure keeps building up unless it is relieved. For example, let's suppose the front wheels are turned as far as they will go. The mechanical linkage between the front wheels and the power piston virtually locks the piston so that it can't move. Now, if the driver still tries to turn the steering wheel, the steering control valve will keep sending fluid into one of the power chambers. Since the piston can't move, pressure will build up in the power chamber. Pressure in the system will increase until it reaches the opening pressure of the relief valve. When the valve opens, it bypasses fluid from the pump outlet back into the pump reservoir.

The diagnosis and service instructions in your service manuals are very complete and quite easy to follow. If you use the special tools available for servicing the steering gear and pumps, there is no reason why any master technician can't do a top-notch job of servicing these units correctly. Besides, gear disassembly and assembly is not at all difficult or complicated. There is no need to repeat the information contained in your service manuals. However, the following diagnosis and service highlights will serve to remind you of things you should or should not do when servicing power steering units. These tips may help you avoid mistakes and costly comebacks.

FIRST THINGS FIRST

The power steering gear and pump are remarkably trouble-free. Probably the most common causes of trouble are slipping drive belts and low fluid level. It takes so little time to check out these two items that they should always be the first things you check on a power steering complaint. A slipping belt or low fluid level can cause lack of assist, off-and-on assist and noise problems.

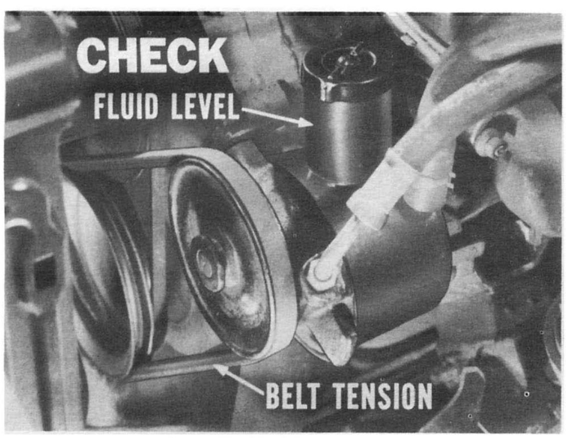


Fig. 19—Check the easy things first

PUMP AND DRIVE BELT NOISE

If the pump noise is caused by low fluid, the cure is obvious. However, if the fluid level is okay, don't jump to the conclusion that the pump is noisy . . . it may be a slipping drive belt or some other belt-driven unit.

Checking out suspected power steering pump noise is fast and simple. First, be sure and adjust drive belt tension. If a correct belt adjustment doesn't stop the noise, pour a little water on the belt or drive pulley. If the water eliminates the noise or changes the sound, you can be sure that you have belt or pulley noise rather than internal pump noise.

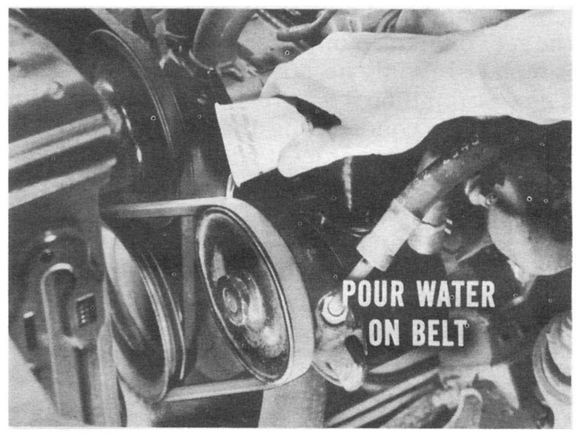


Fig. 20—Water helps diagnose belt noise

If the water treatment doesn't change or eliminate the noise, make sure the power steering pump is at fault before you remove or replace it. The easiest way to do this is to loosen the pump drive belt and run the engine. If this eliminates the noise, you've tracked the trouble down to the steering pump. Of course, if the noise continues when the power steering pump isn't being driven, you better take a close look at the alternator or water pump.

IT COULD BE THE FLOW VALVE

If a customer says his power steering seems okay at medium and high speeds but doesn't give full assist at low speeds, the trouble could be the pump flow control valve. Remember how that flow control valve reduces flow at higher speeds? If the flow valve sticks in the reduced-flow position, it could cause low-speed assist trouble.

Quite often you can free up a flow control valve without lifting the hood. Speed the engine up a couple of times to build up pressure and load the flow control valve. If this pressure treatment restores full power assist at low speeds, you'll know the flow valve was stuck. On a low-mileage car, it is quite possible that the sticking was caused by foreign material which will be trapped in the pump screen and taken out of circulation. On a higher mileage car or where dirty fluid is evident, a complete clean-up is called for.

IS IT THE PUMP OR IS IT THE GEAR?

When correcting the fluid level or adjusting the drive belt doesn't solve a power steering problem, try and find out whether the trouble is in the gear or in the pump. Far too often the pump is replaced simply because it's a lot easier to try a new pump than it is to remove and service the gear. That's condemning the pump without a fair hearing . . . or at least without logical diagnosis. Besides, if the trouble is actually in the gear, the pump substituting shot-in-the-dark is wasted effort and time. It's even worse if the new pump is left on the car when there was nothing wrong with the original pump.

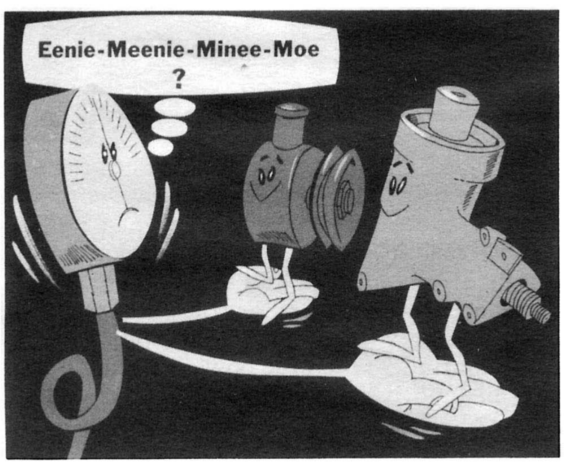


Fig. 21—Is it the pump or is it the gear?

In the long run, a little common sense and a test or two will tell you whether the trouble is in the gear or in the pump *before* you take anything off the car. Let's consider some of the test precaution possibilities.

THE PRESSURE TESTS

The pressure tests described in your service manual can usually tell you whether the trouble is in the gear or in the pump. There is no need to repeat this information, but a few comments and words of explanation may help you make better use of these tests.

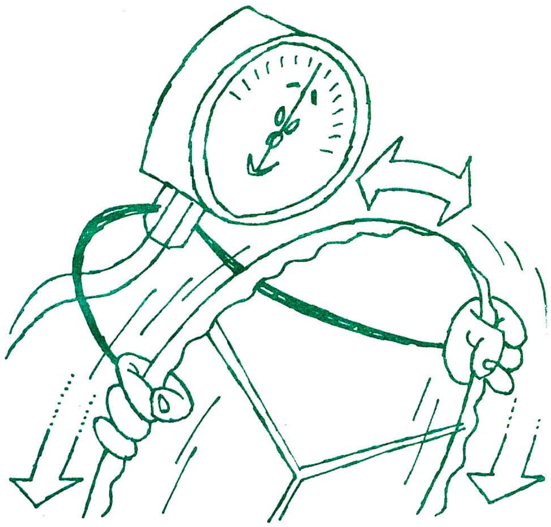
General Precautions: Test pressure specifications are based on steering fluid temperature of 150 to 170 degrees F. If fluid is cold, higher than normal pressures may be indicated and high fluid temperatures may give abnormally low pressure readings for a system that is okay. Don't guess at fluid temperature or engine speed. Use a reliable thermometer and tachometer. Do not close the test shut-off valve suddenly or leave the valve closed more than a few seconds when making pressure tests. When the shut-off valve is closed, temperatures increase very rapidly and this can cause damage.

Low-Speed Test: The purpose of this test is to make sure there are no abnormal restrictions anywhere in the hydraulic system. This checks out the possibility of internal as well as external restrictions to normal flow.

High-Speed Closed-Valve Test: The purpose of this test is to measure the pump's ability to develop specified pressure. If the pump passes this test, chances are the pump is okay and the trouble is in the gear. This can be checked out by using the "open-valve" test described below. If the pump does not develop specified pressure, the trouble is in the pump. However, it is more apt to be relief or flow valve trouble than actual pump wear . . . particularly on low-mileage cars. Tech has a few tips on diagnosing pump valve troubles as soon as we finish with pressure testing.

High-Speed Open-Valve Test: This test is made with the shut-off valve *fully open* and the engine operating at 1,000 r.p.m. Pressure readings are taken with the steering wheel held hard over against the left-turn stop and then hard over against the right-turn stop. In effect, you are using the steering control valve and gear as a shut-off valve. Pressure readings with wheels in extreme left and right position should be equal. If these pressure readings are not equal, internal gear leakage is indicated and the gear must be removed and repaired. Also, if left-turn and right-turn readings are equal but considerably lower than pressure registered in the

"Closed-Valve Test", internal gear leakage is indicated . . . probably past the piston ring, allowing flow between the two power chambers.



WHICH PUMP VALVE?

When there is less than the normal amount of power assist, the trouble may be caused by a sticking flow valve or a faulty or incorrect pump pressure relief valve. A sticking flow valve isn't apt to cause assist problems at higher engine speeds. It may cause low-speed assist problems if it is stuck in the minimum flow position. Besides, the flow valve isn't apt to cause low pressure when you run the high-speed, closed-valve test. If the pump doesn't develop specified pressure on this test, the most likely cause is a faulty or incorrect pressure relief valve.

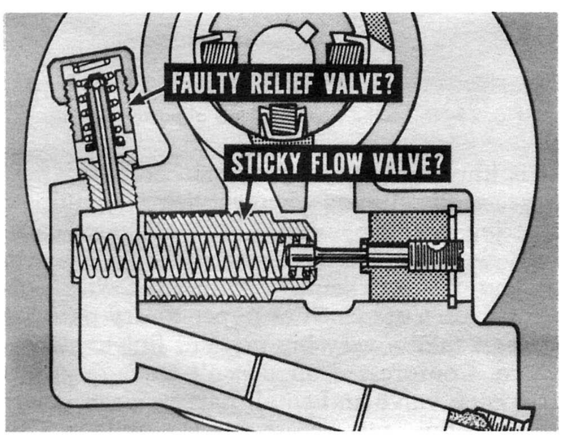


Fig. 22—Either valve could cause assist trouble

Probably the quickest way to check this out is to install a new pressure relief valve and repeat the high-speed pressure test. If pressure is now okay, leave the valve in and button up the job. If the new valve doesn't bring pressure up to specifications, you better disassemble the pump and look for trouble elsewhere.

STEERING VALVE ADJUSTMENT CAUTION

When adjusting the steering control valve, it's a lot easier to tap the back pressure valve body than it is to tap the back pressure valve attaching screws. DON'T DO IT! It doesn't take much of a tap to deform the back pressure valve body so that the back pressure valve sticks and becomes inoperative. If this valve sticks in the open position, it won't maintain the minimum back pressure in the gear, the pump will pump fluid out of the gear, air may circulate through the gear and steering assist will be erratic.

STEERING GEAR AND SHAFT ALIGNMENT

Correct steering gear and steering shaft alignment is particularly important on cars equipped with power steering. Any mechanical interference or misalignment will interfere with returnability and may cause lumpiness or a feeling of erratic assist. When these conditions pop up, don't blame the gear or control valve adjustment . . . check gear, steering shaft and coupling alignment and adjustment. After overhauling a gear assembly, be sure and check alignment of the gear and steering shaft when you reinstall the gear assembly. You'll find detailed instructions in your service manuals. You'll also find a good explanation of gear and steering shaft alignment in MTSC Session 65-5.

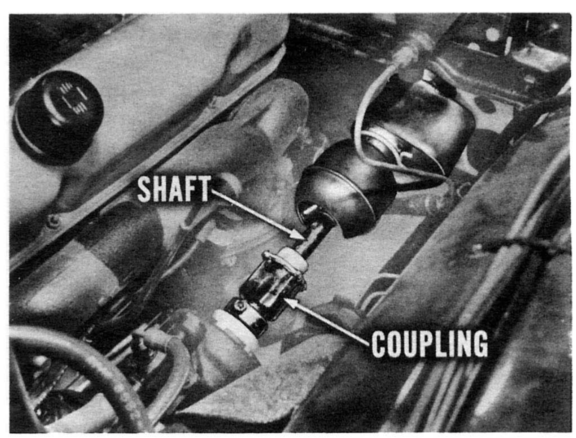


Fig. 23—Steering gear and shaft alignment is important

A WORD ABOUT VALVE SPOOLS

The pump flow control valve, back pressure valve and steering control valve are all spool-type valves. These valves are closely fitted in their respective bores and must be handled with care. It is most unlikely that the spools themselves will be damaged in operation. However, it is very easy to nick or damage these valves when they are removed for cleaning or service. Don't drop them or dump them into a cleaning basket or tank with other parts.

The sharp land edges of a spool valve wipe the valve bore and minimize valve sticking. Those sharp edges are also essential to precise valve action and flow control. If the sharp valve-land edges are rounded off, minute specks of dirt can wedge between the valve and valve body causing the valve to stick.

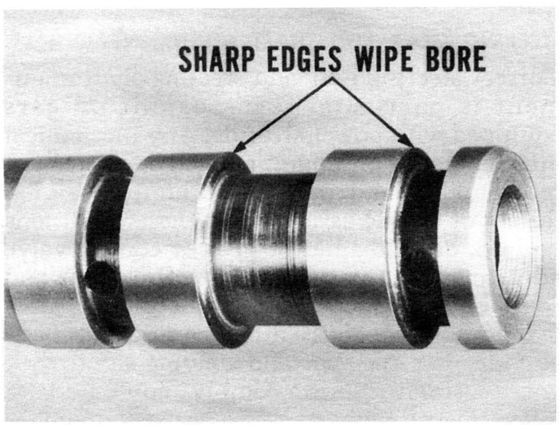


Fig. 24—Do not round off edges of lands

If a valve spool is nicked or scratched, the valve will score the valve bore, stick in the bore or both. These spools are quite hard and the best way to dress off a nick is with a fine stone. Don't pick up the spool in one hand and a piece of abrasive paper or cloth in the other and start working the valve over with a twisting motion. Chances are you'll round off the land edges long before you polish out the nick or scratch. If solvent doesn't clean up a spool to your satisfaction, you may want to polish it up with crocus cloth. If you do this, lay the crocus cloth on a flat surface and rotate the spool as you draw it across the crocus cloth. Keep the valve flat and you will be able to polish the valve surface without danger of rounding off the land edges.

NO ABRASIVE IN THE BORES PLEASE!

It's a sure short cut to trouble to use abrasive paper or cloth in a spool valve bore. In the first place, the valve bodies are much softer than the valve spools and vigorous scouring with abrasive may enlarge the bore, destroying the close fit between spool and valve bore. In the second place, abrasive is quite apt to become imbedded in the relatively soft valve body material. It takes very little abrasive in a valve bore to cause sticking and valve trouble.

KEEP IT CLEAN OR CLEAN IT UP!

Dirt is probably the greatest single enemy of any hydraulic system. The power steering system is certainly no exception. If you find dirt or chips in a pump, valve or reservoir, you can be sure that the entire system has been affected. The only sure cure is a complete disassembly and cleaning of the pump and the gear assembly.

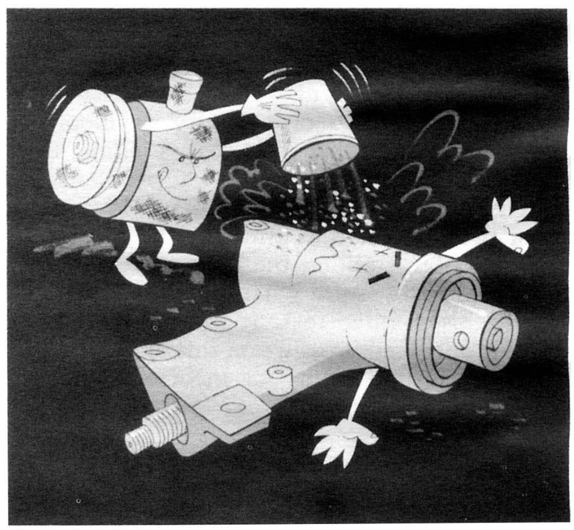


Fig. 25—Dirt is the deadly enemy of power steering

It is impossible to over-emphasize the importance of cleanliness when servicing a pump or steering gear assembly. Clean all parts carefully with solvent. When all parts are as clean as you can get them, rinse them in clean solvent. Don't use cloth or paper to dry parts. It doesn't take a very big piece of lint to stick a valve. Compressed air doesn't leave any lint! Dip each valve and small part in clean power steering fluid just before you assemble it. This provides initial lubrication.

A COUPLE OF PUMP SERVICE TIPS

When you reassemble a pump, make sure there is no dirt in the housing or between the front insert and the cam insert. Even a tiny speck of dirt between these mating surfaces will result in excessive rotor end clearance. This will cause internal leakage and reduced pump output.

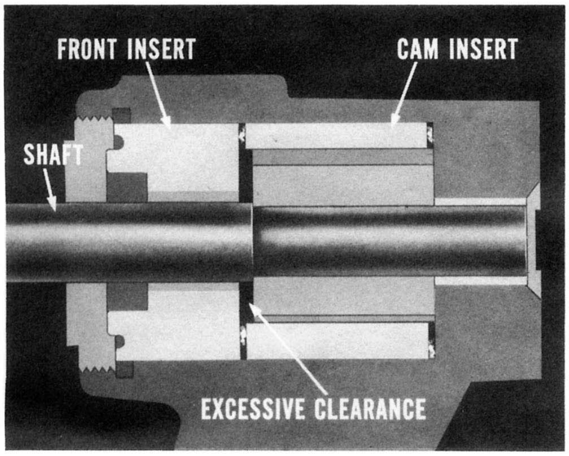


Fig. 26—Dirt can reduce pump output

Proper installation and seating of the pump rotor slipper springs is also very important. These springs must remain upright between the slippers and the rotor when you insert the slippers and rotor into the pump body. If a spring tips over sideways, it'll jam the slipper against the cam insert and cause pump failure. To avoid this possibility, follow the assembly procedure in your service manual. That tip about using the end of an ordinary lead pencil to help you seat the slipper springs in the spring pocket of the rotor is a particularly good one. The tapered end of the pencil holds the spring and a slight clockwise twist of the pencil "winds" the spring up so that it slips easily into its pocket.

CORRECT HOSES ARE IMPORTANT TOO

Always use the correct replacement pressure and return hoses. Each hose is designed to control hydraulic pressure noises, as well as flow and pressure, in each power steering application. Hose length, diameter and material are all important to safe, quiet operation. No substitutes, please!

Be especially careful to use the correct replacement hose on models which previously had a

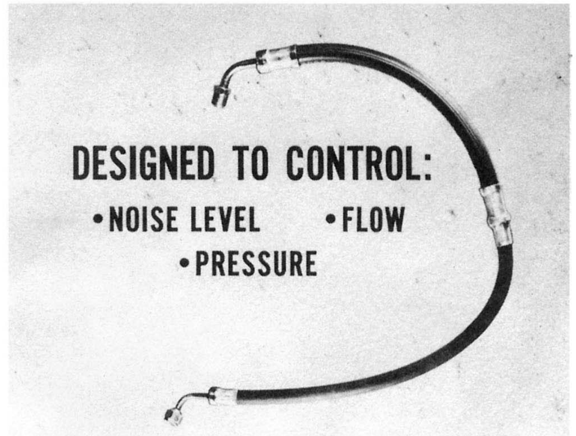


Fig. 27—Always use the correct power steering hoses

steering system oil cooler. These hoses are a special high-temperature type that must not be replaced with an ordinary power steering hose. Incidentally, if a specific early production model had a steering system oil cooler and an identical current production model doesn't have an oil cooler, the current model is equipped with one of the new hoses that is designed to tolerate higher fluid temperatures. Don't jump to the conclusion that one of these new hoses is a good substitute for all models. It isn't. It has different damping characteristics and could cause noise if used on models not designed for this type hose.

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