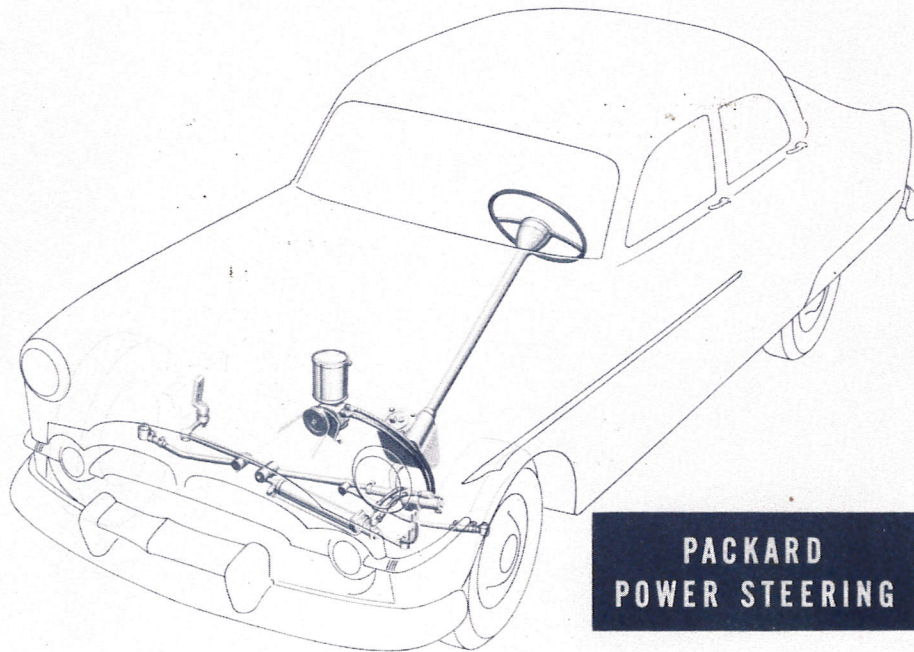




TRAINING PROGRAM

# *Serviceman's Training Book*

## **PACKARD POWER STEERING**



**FEBRUARY, 1953**

**PACKARD MOTOR CAR COMPANY**

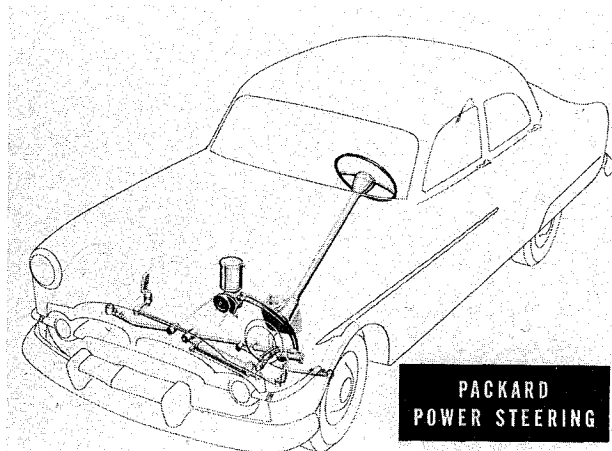
**DETROIT 32, MICHIGAN**



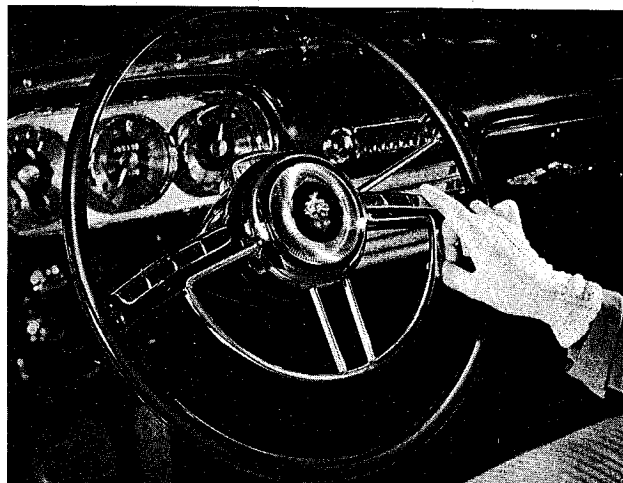
# PACKARD POWER STEERING

## Part I

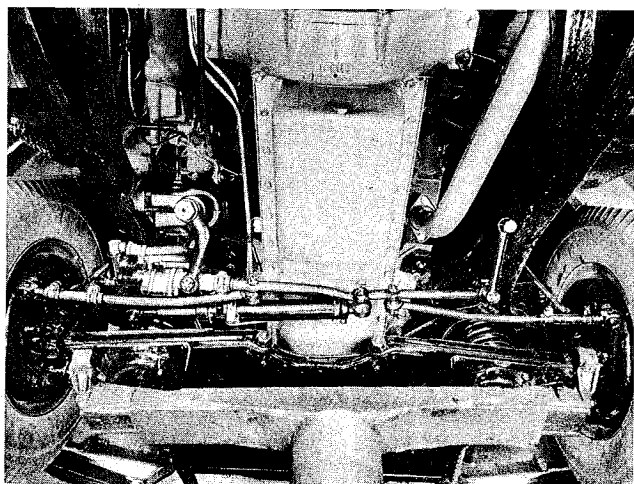
### INTRODUCTION



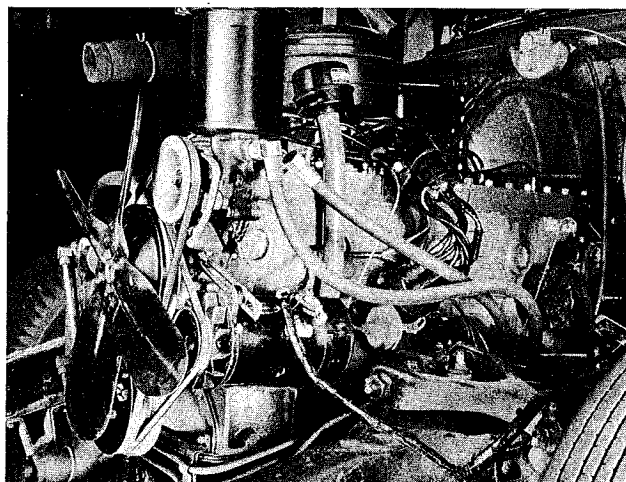
Packard Power Steering is now provided as special equipment when the car is ordered so equipped from the Factory.



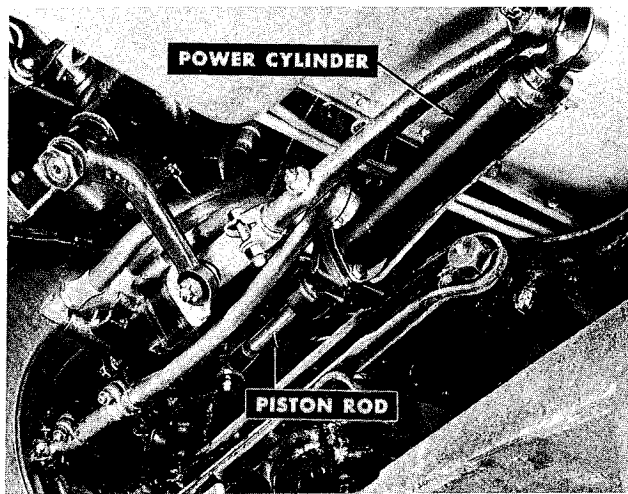
The manual effort that was previously required for guiding the car has been reduced 80% with power steering, and at the same time, the "feel" of full control has been retained for the driver.



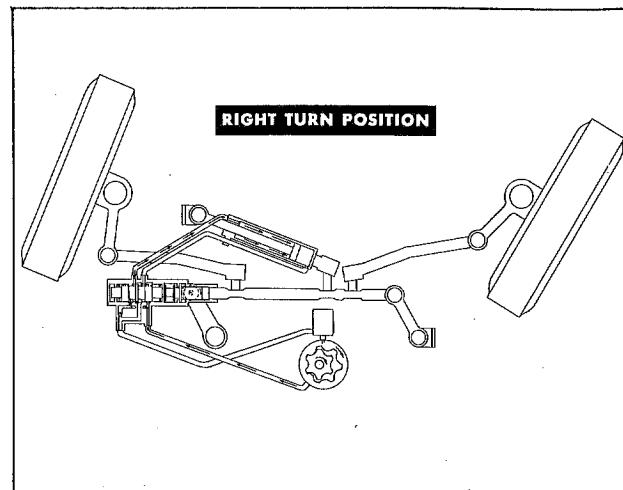
This new type steering is of a simplified design being of the linkage type and not integral with the steering gear.



Packard Power Steering is hydraulically operated and is in 100% operation the moment the engine is started. With a power steering equipped car, all normal steering is done with but very little physical effort required which is only in proportion to the force necessary to turn the front wheels. If the engine should stop or the hydraulic power system should become inoperative, a safety factor is provided in that the steering system returns to manual operation.



The steering power cylinder counteracts road shock which would otherwise be transmitted in full force to the steering gear. This hydraulic power cylinder does not assist in steering until a slight effort to turn the steering wheel is made by the driver.

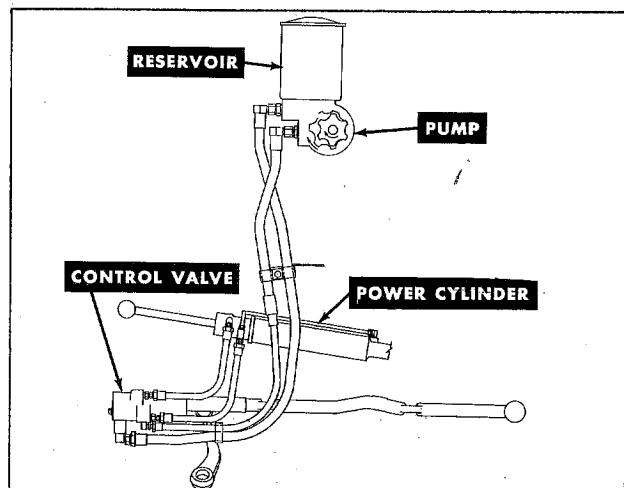


For example: if the driver is turning on a curve in the road, hydraulic pressure is supplied turning the wheels in the path directed as long as the steering wheel is being turned. When the driver stops turning the steering wheel, the hydraulic pressure is relieved, as it is no longer needed to assist in turning the wheels. Thus, power steering is always available when it is needed, but it does not take away the steering from the driver.



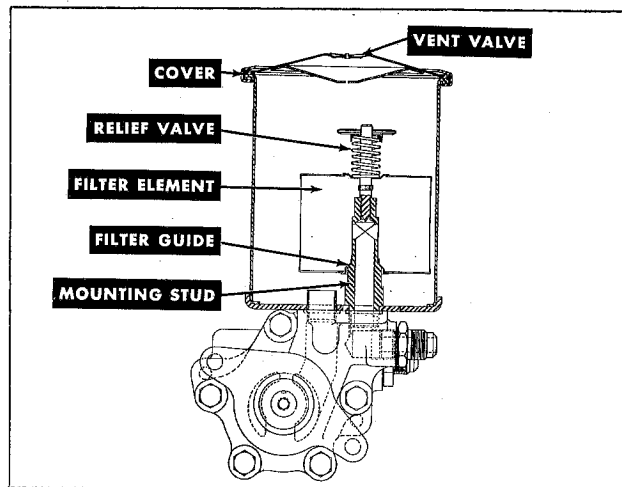
## Part II

# CONSTRUCTION AND OPERATION



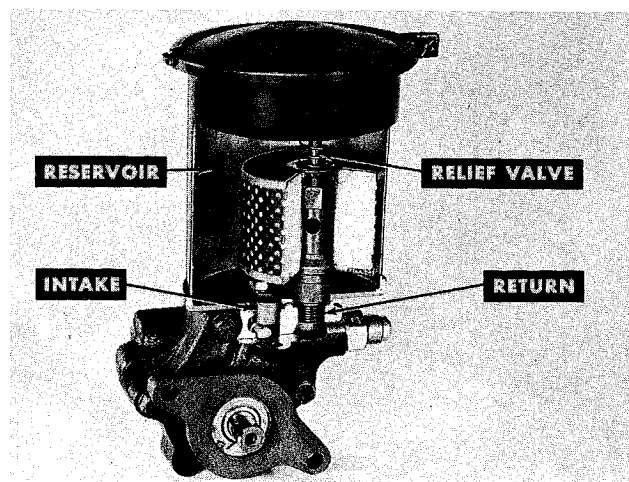
The Packard Power Steering consists of a hydraulic pressure system used in conjunction with the conventional steering gear. The basic units of the hydraulic pressure power system are:

- A fluid reservoir
- A pressure pump
- A control valve
- A power cylinder

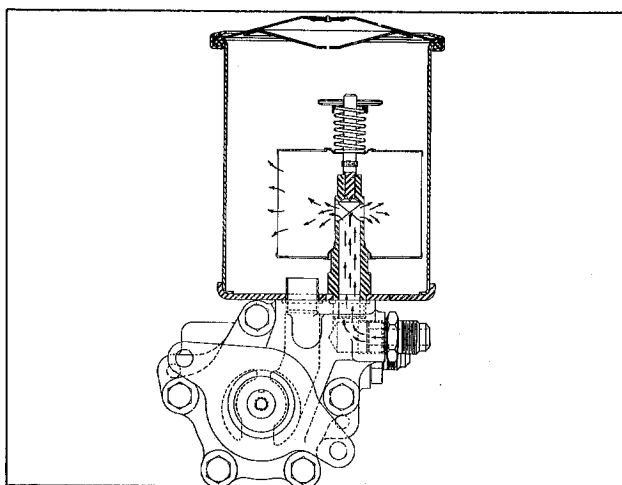


The reservoir assembly consists essentially of a reservoir chamber, mounting stud, filter guide, filter element, relief valve and a reservoir cover which incorporates a vent valve at the center.

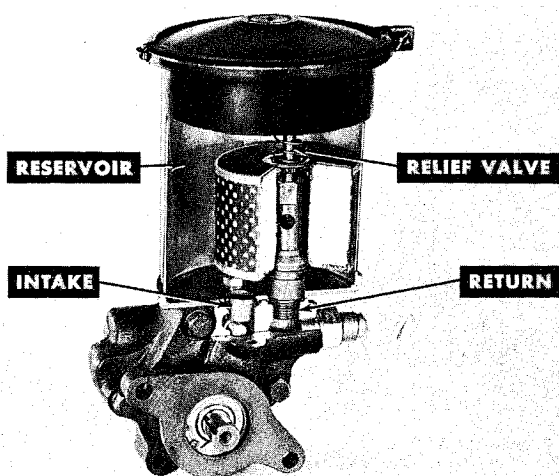
### Reservoir



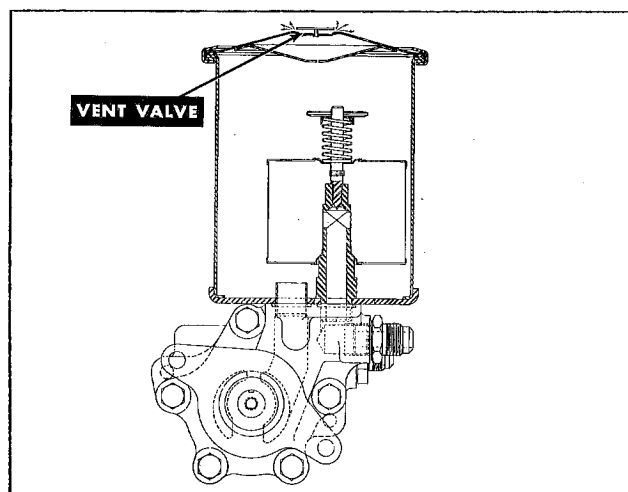
Fluid for operating the power system is held in reserve in the fluid reservoir which connects to the intake side of the pressure pump and to the return side of the pump.



The mounting stud is hollow to allow fluid to enter to the inner part of the filter element to be filtered to the reservoir chamber. The stud is threaded on one end for attaching to the reservoir. The filter element is slipped over the opposite end. A relief valve assembly holds the filter element to the mounting stud.

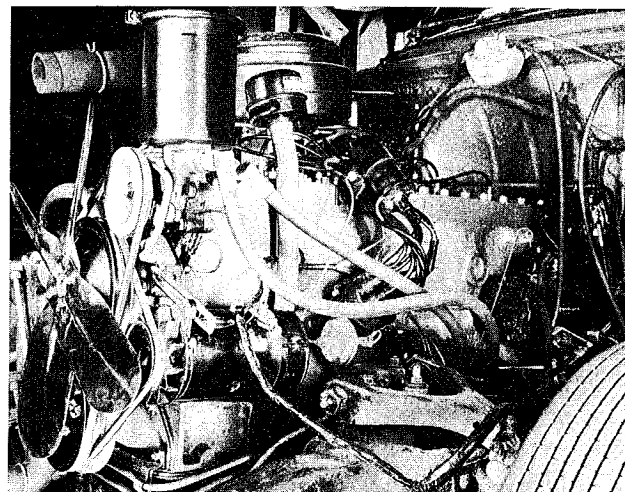


The spring-loaded relief valve raises to permit fluid to flow into the reservoir to the pump intake port if the fluid pressure builds up in the filter element due to the weather being extremely cold, or if the filter element becomes clogged. The relief valve opens up between 5-7 p.s.i.



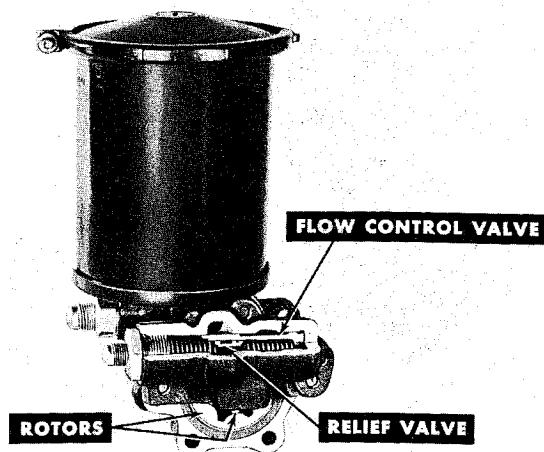
The reservoir cover, in addition to sealing the fluid in the reservoir, contains a vent valve at the center in the dimpled section. The valve consists of a cup-shaped washer which is riveted to the pump cover and protected by a baffle. It is designed to vent the excess air pressure when it reaches  $1\frac{1}{2}$ -8 p.s.i. in the reservoir. When external temperature changes cause an internal build up of pressure at the top of the fluid in the reservoir, the valve raises venting the pressure. The pump cover baffle prevents the fluid from escaping through this valve along with the air.

## Pump

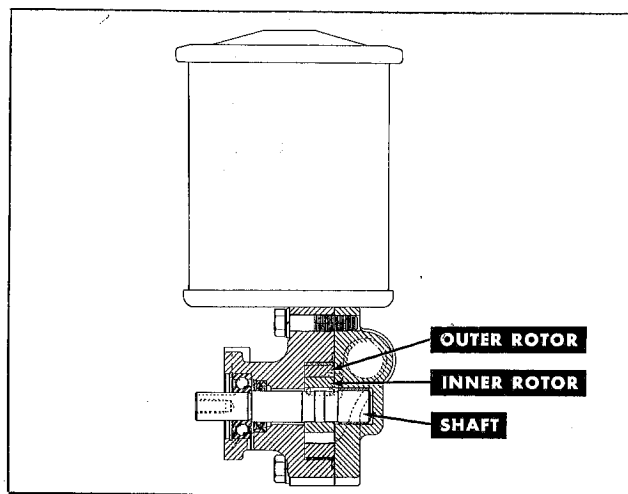


The belt driven rotor-type hydraulic pressure pump supplies hydraulic fluid to the power cylinder through the control valve in sufficient volume and pressure to meet any demands of the power system.

The Packard Power Steering Pump is located on a bracket at the left upper forward end of the engine. The pump is driven by a narrow "V" belt on a pulley at the forward end of the crankshaft. The combination fluid reservoir and filter is fastened by capscrews to the top of the pump body.

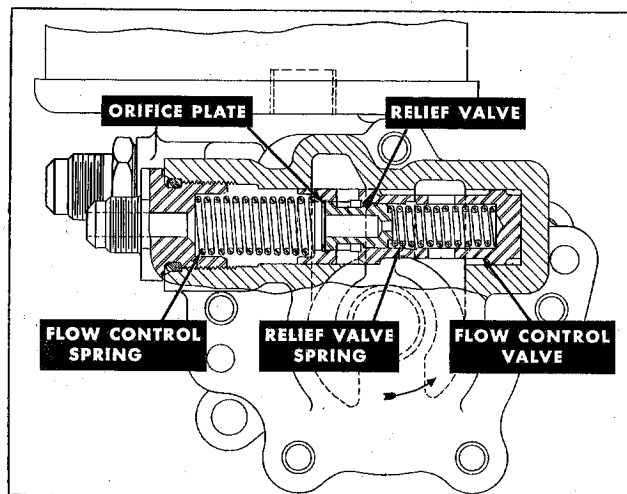


The power pump consists of a body, cover, a set of two rotors, a shaft, flow control valve, relief valve and the necessary bearings, packings, seals, etc.



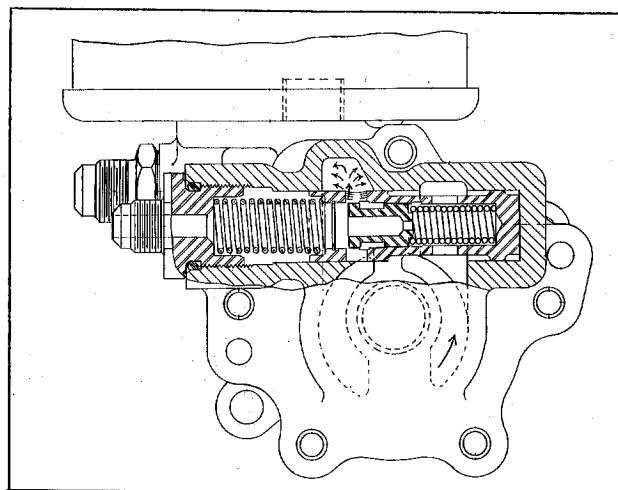
The pump is of the rotor-type, having a pumping element of a specially designed rotor set, in which the inner and outer members are mutually generated. The inner rotor is keyed to the shaft and drives the outer rotor which rotates in a bore offset from the shaft.

The generated tooth form of the rotors results in a rolling and sliding contact against each other which causes cavities to open and close. The opening of the cavities causes fluid to flow in to fill the cavities, while the closing of the cavities forces the fluid out under great pressure. This smooth and uniform action occurs through a great number of degrees of rotation. This gives quiet operation and long life because of the absence of shock loads.



The flow control valve of the pump contains a flow control spring, an orifice plate, and a piston type relief valve. When the fluid flow from the pump rises to 1.9 gallons per minute, the difference in pressure across the orifice of the flow control valve overcomes the spring load of the flow control valve moving the flow control valve forward to uncover an excess flow passage. The excess fluid is then returned to the intake side of the pump through this passage. By preventing excessive flow

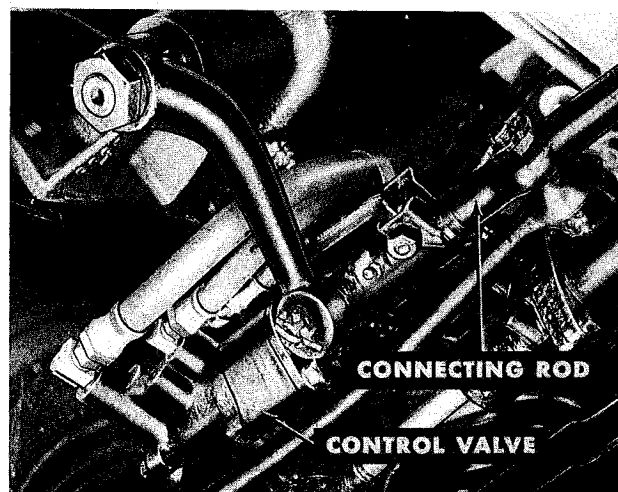
of fluid, the flow control valve thereby maintains a regulated pressure in the hydraulic system when the wheels are not being turned, thereby reducing the power needed to drive the pump. The pump fluid flow to the hydraulic system is approximately 1.4 gallons per minute when the engine is idling.



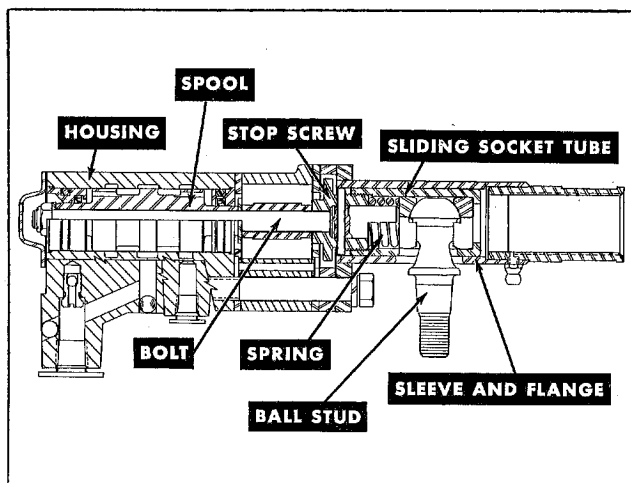
The pump relief valve operates only when the pressure rises above 650 p.s.i. due to the linkage control valve being actuated and the wheels being against the wheel stops or in deep ruts. Then the excess pressure of the fluid that has entered the area which contains the flow control valve spring, moves the piston type relief valve rearward, compressing the relief valve spring opening a bypass port to return this excess fluid to the inlet side of the pump.

The fluid pressure needed for the hydraulic system is determined by the resistance of the wheels to the power system. Excessive build up of fluid pressure tends to occur when the wheels are turned to the stops. Therefore, the wheels should not be held against the stops for any length of time to avoid this excessive pressure build up.

### Control Valve



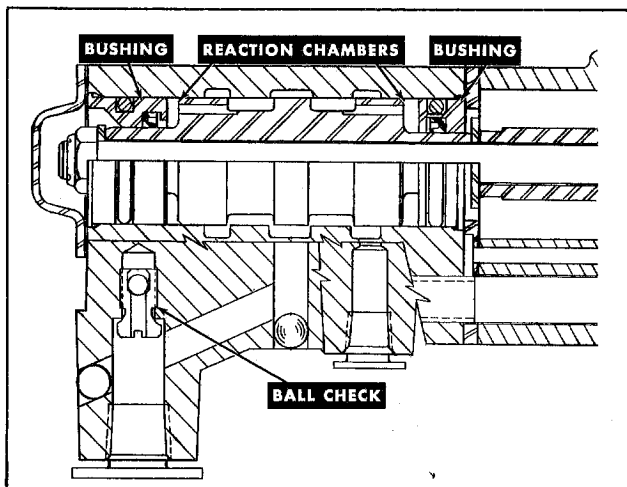
The control valve is threaded to the end of the steering linkage connecting rod and is attached to the pitman arm by means of a ball stud mounted inside of a sliding socket tube. The valve regulates the flow of fluid from the pressure pump to either end of the power cylinder.



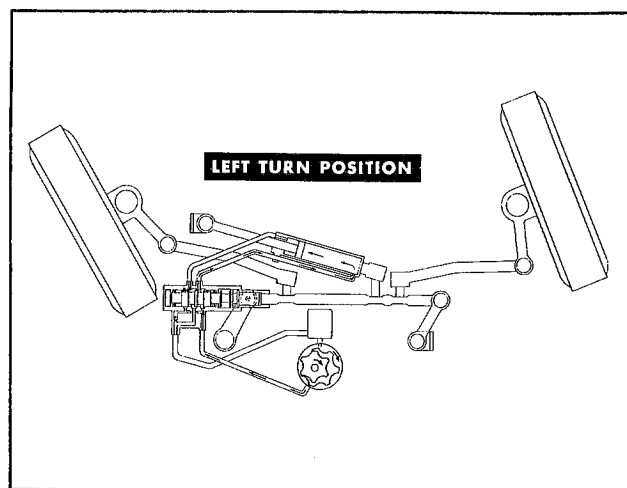
The control valve consists primarily of a housing, sleeve and flange, spool, bolt, spring, ball stud, stop screw, sliding socket tube, etc.

The housing contains three annular grooves with the two end grooves communicating with the pump pressure port and the center groove communicating with the fluid reservoir port.

The spool or movable part of the control valve has three lands with the outer lands having a drilled metering hole.



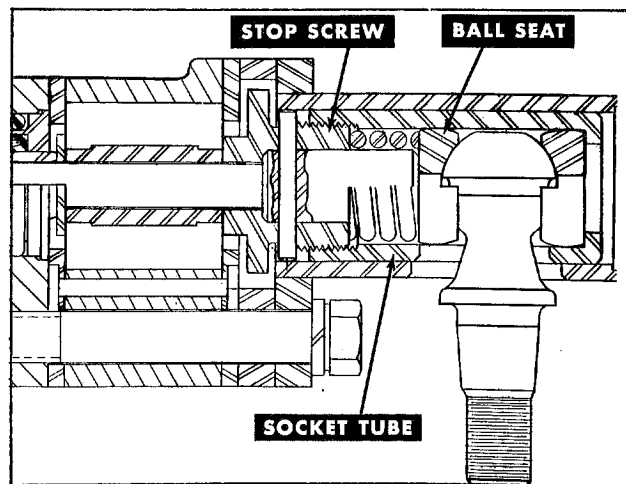
A reaction chamber is located at each end of the spool and is sealed fluid tight by a seal bushing. In the straight ahead position, the spool is balanced by the fluid pressure which has entered these chambers through the drilled metered holes in each end land of the spool. Therefore, the same pressure is maintained in the reaction chambers as at the spool valve.



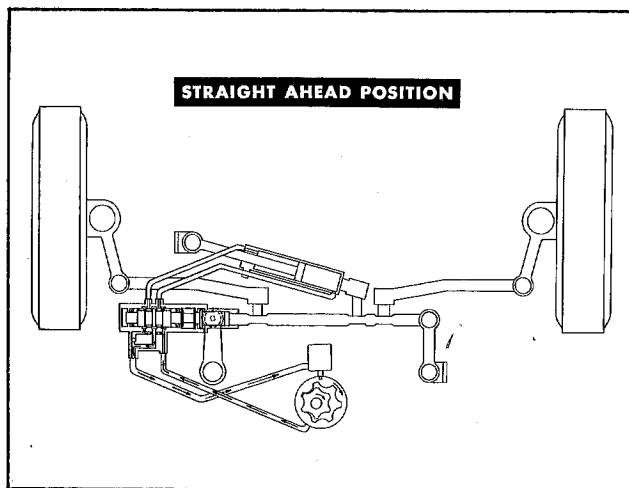
While the left turn is being made, the spool moves to the right, allowing fluid pressure to pass through the control valve to the power cylinder. At this time, the pressure is higher in the control valve than it is in the reaction chambers. The higher pressure is forced through the metering hole into the right reaction chamber, thus causing a reactionary pressure against the spool, trying to force the spool to the center or neutral position. Thus, the effort in turning the steering wheel against the reactionary chamber pressure provides the driver with that "feel" of steering at all times.

When making a right turn, the pressure is metered into the control valve left reaction chamber in the same manner as previously described for making the left turn.

After the wheels have been turned in either direction and the power demands satisfied, the fluid pressure in the reaction chambers returns the spool to the mid or neutral position.

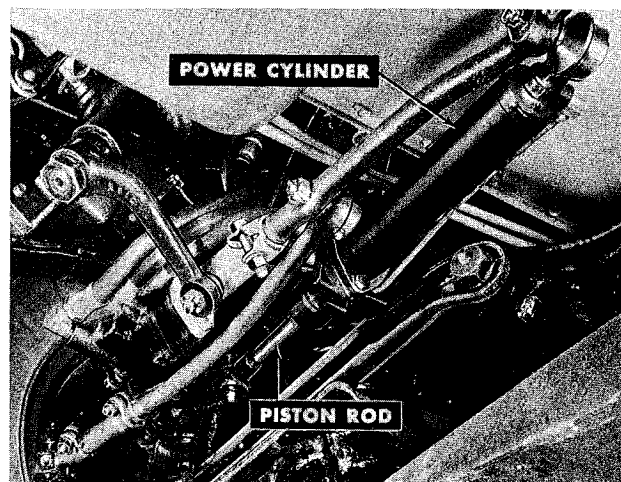


Movement of the sliding socket tube is limited between the ball seat and the stop screw. Since the valve spool is connected to the sliding socket tube, the spool has the same travel limits as the socket tube.

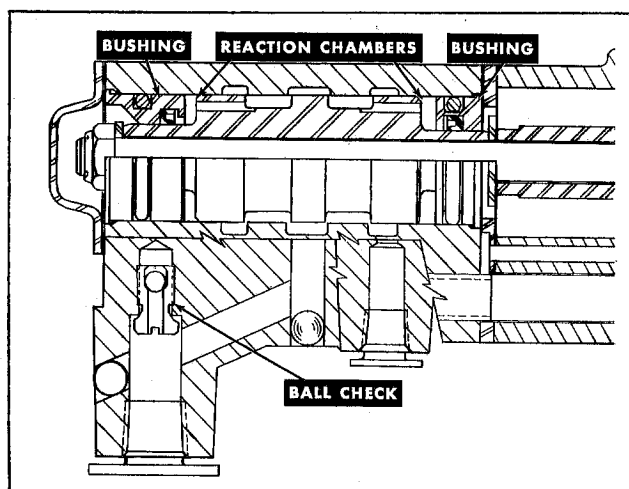


In the straight ahead position the fluid pressure is by-passed at the control valve spool center land, permitting the fluid to return to the reservoir. As the steering wheel is turned in either direction, the control valve meters fluid under pressure to either one end or the other of the power cylinder.

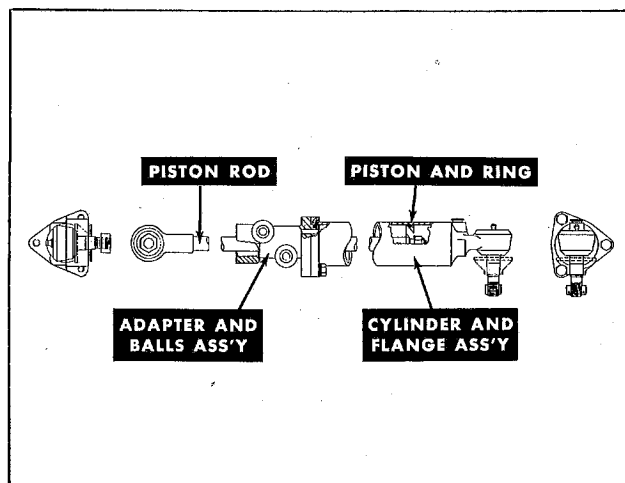
## Power Cylinder



The power cylinder is the double acting type with the cylinder housing attached directly through a ball socket to the steering linkage connecting rod, while the end of the piston rod is attached by means of a ball socket to the car frame.

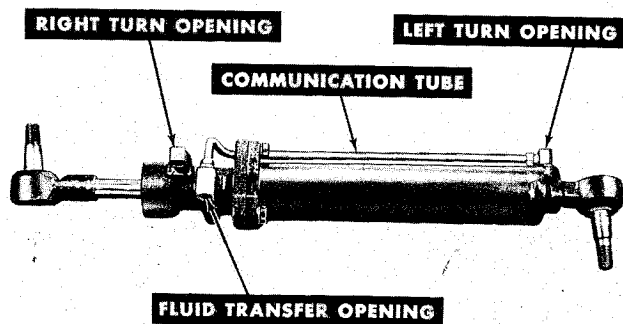


A ball check or by-pass valve is incorporated in the control valve which operates only if the hydraulic pump should fail and stop. In this event the by-pass valve will open to allow the fluid to by-pass the pump and permit normal manual operation of the steering gear.

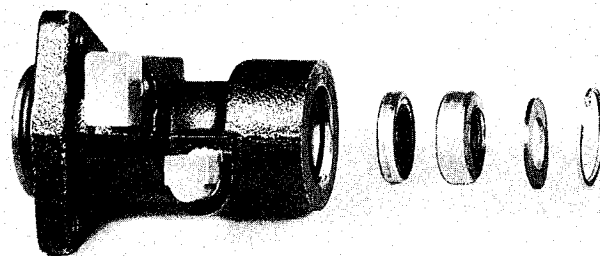


The power cylinder consists primarily of a cylinder and flange assembly, adapter and balls assembly, piston rod, piston and ring, communication tube and the necessary seals, packings and washers, etc.

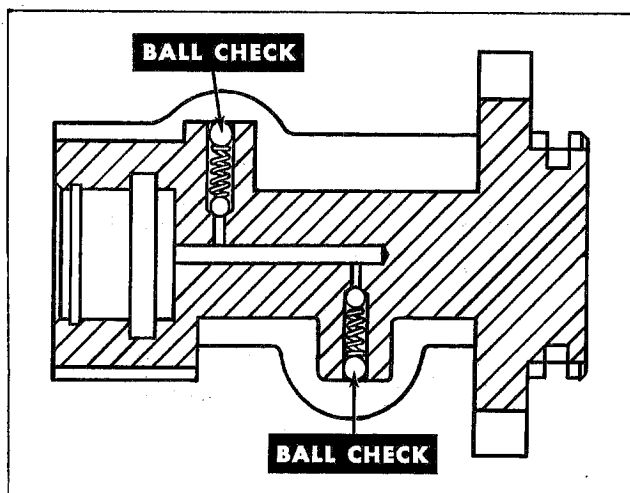




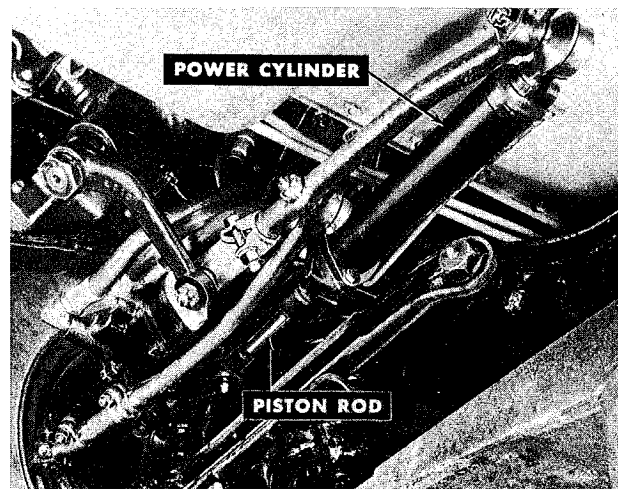
The adapter and balls assembly contains the right turn and fluid transfer openings. At the right turn opening, fluid pressure is admitted to the cylinder body at the left end for making a right turn. At the transfer opening a tee is installed. Fluid pressure is admitted here from the control valve and transferred through a communication tube to the right end of the cylinder body for making a left turn.



At the outer end of the adapter body two seals and a scraper washer are installed and held by a retaining ring. The inner seal wipes the piston rod during steering movement. The outer seal is a dust seal and prevents the entry of dust to the cylinder body.



Located internally in the adapter housing are two ball check assemblies. These ball check assemblies relieve the fluid pressure build-up at the seals, by venting the pressure to the return line of the reservoir to prevent leakage at the piston rod seals and excessive wear.

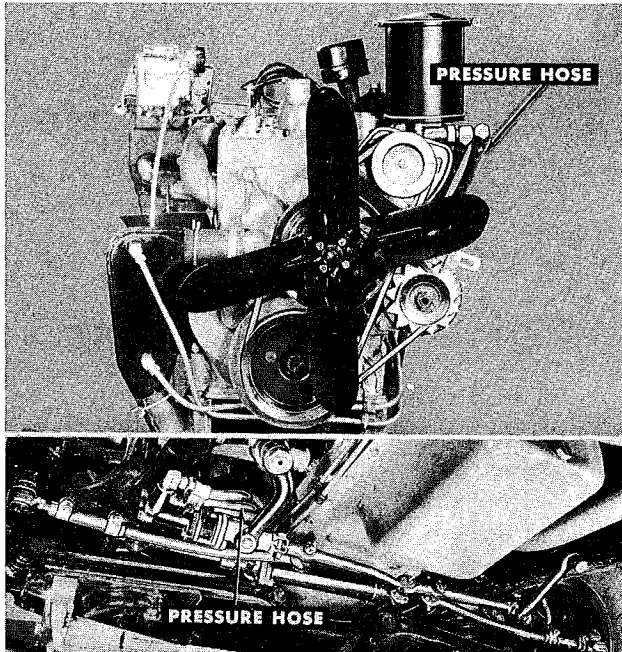


The scraper washer, which is installed at the end of the outer seal in the adapter bore, scrapes the piston rod during steering movement to prevent road dirt or ice formation from working its way along the piston rod and into the seals.

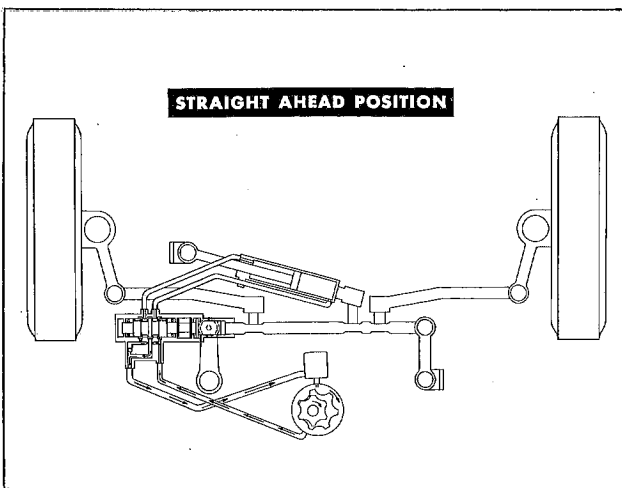
As pressure is admitted to either end of the power cylinder from the control valve, "power" for steering is transmitted to the wheels. The power cylinder then pushes or pulls the linkage in the direction selected by the driver.

Since the control valve and power cylinder are attached to the steering linkage, and not built integral with the steering gear housing, this form of power steering is referred to as "direct acting type power steering."

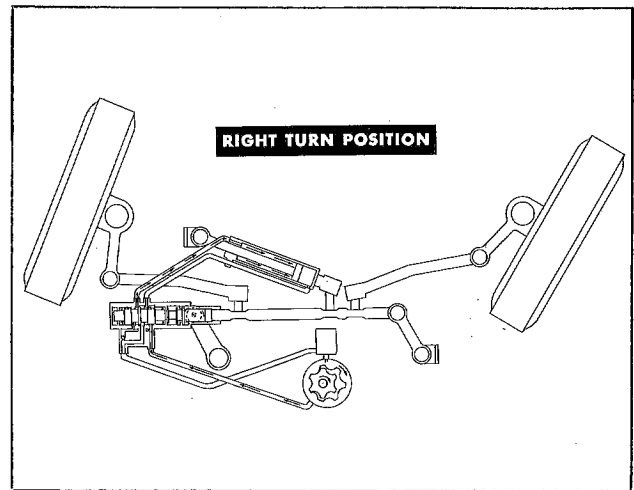
## OPERATION



As the engine starts, filtered fluid from the reservoir chamber is drawn in by the pump and forced under pressure down through a flexible hose to the control valve body on the steering linkage.



After oil reaches the control valve body and the control valve spool is in the mid position, the fluid entering the two end grooves of the spool is free to return through the center groove of the spool to the pump and reservoir return line since all three grooves are interconnected in the center position. In this position no "power" has been supplied to the power cylinder for turning the wheels.

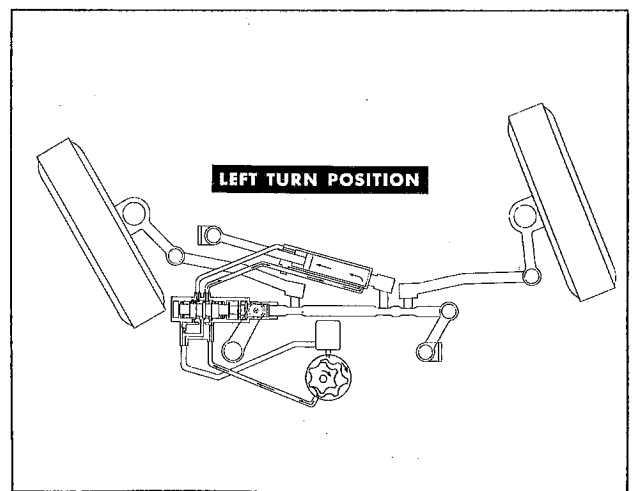


When making a right turn, the pitman arm moving to the left moves the sliding socket tube and spool to the left. In this position the center land of the spool blocks off the passage between the left end annular groove and the center annular groove in the valve spool body.

Fluid pressure is then transmitted through the left annular groove in the spool to the left side of the power cylinder piston.

With the spool in the left end position fluid is free to return from the right side of the power cylinder piston to the reservoir through the passage in the control valve formed by the center and right end land of the spool.

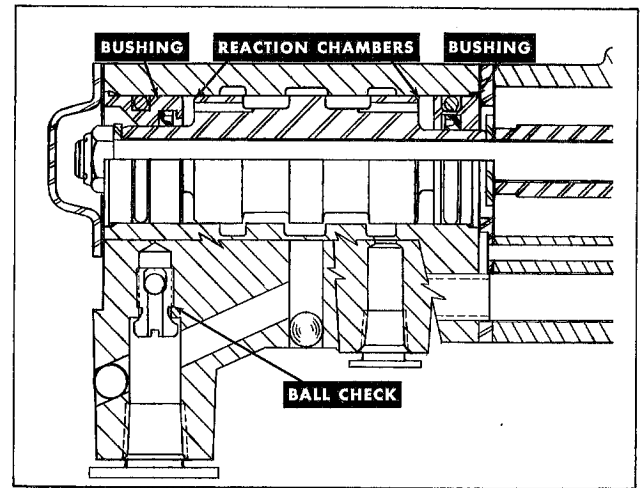
In this position the pressure output of the hydraulic pump is transmitted to the left end of the power cylinder piston. As the power cylinder piston rod is attached to a bracket on the frame left side, the power cylinder body which is attached to the steering cross tube moves under this pressure towards the left which turns the wheels to the right.



When making a left turn, the pitman arm, moving to the right moves the sliding socket tube and spool to the right.

In this position the center land of the spool blocks off the passage between the right end annular groove and the center annular groove in the valve housing. Fluid pressure is then transmitted through the right annular groove in the valve spool through the communication tube to the right end of the power cylinder position. With the spool now in the right end position, fluid is free to return from the left side of the power cylinder piston to the reservoir through the passage in the control valve formed by the center and left end land of the spool.

In this position the pressure output of the hydraulic pump is transmitted into the right end of the power cylinder piston. As the power cylinder piston rod is attached to a bracket on the frame left side, the power cylinder body which is attached to the steering cross tube moves under this pressure towards the right which turns the wheels to the left.



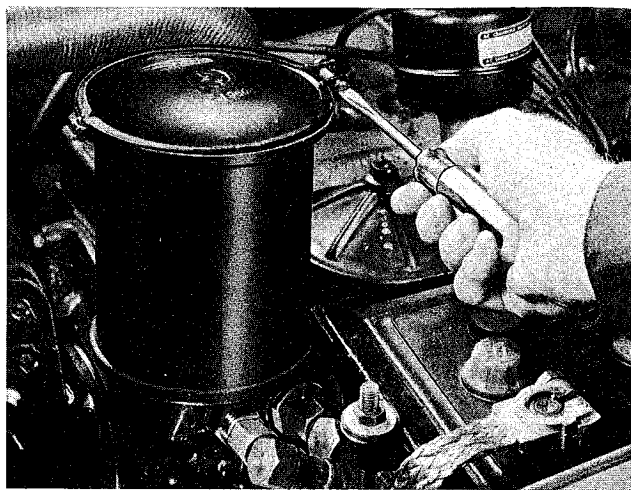
Whenever the need for power has been met to make either a right or left turn, the spool returns to its mid or neutral position to again balance the pressure on the two sides of the power cylinder piston. The outer annular grooves of the valve body are again interconnected with the center groove and return side of the reservoir to free the power system of pressure.

## Part III

# SERVICING POWER STEERING

The following conditions can affect the operation of the power steering unit. They are: Improper drive belt tension, incorrect fluid level, sludge dirt in the reservoir, leakage at the fitting or gaskets, and air in the power steering hydraulic system. These conditions, with their corrections, will be described in the following paragraphs and the Trouble Shooting and Corrections section of this book.

### Checking and Bleeding the Hydraulic System



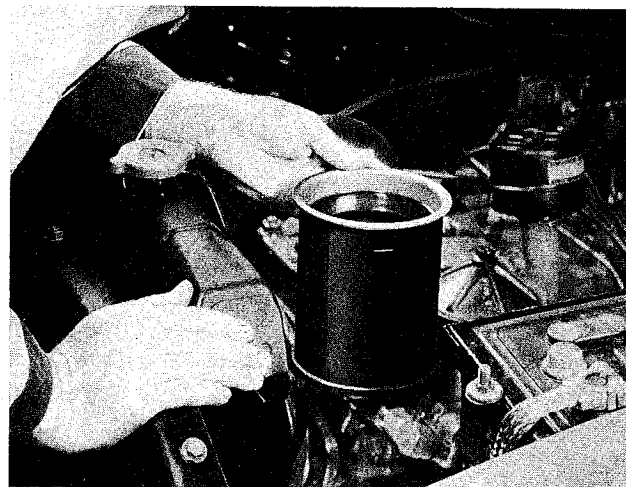
With the engine shut off, remove the reservoir cover hold-down clamp screw and remove the clamp, cover and gasket.

The fluid level should be 1" from the top of the reservoir. A line marking the correct height will be found on the exterior of the reservoir.

Fill the reservoir, if fluid is needed, to within one inch from the top of the reservoir with Ultramatic Drive fluid or a Type "A" automatic transmission fluid, which has an AQ-ATF number embossed on the can.

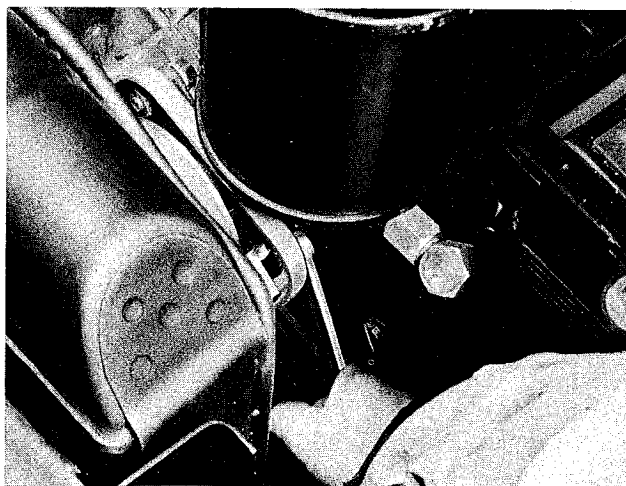
### Bleeding The System

If there is air in the hydraulic system, it may be removed in the following manner: Start the engine and fill the reservoir with fluid to its proper level. Turn the wheels to the full right position and then to the full left position several times. The wheels should *not* be held at the wheelstops or the pump pressure will build up and create an excessive strain on the system. Therefore, when bleeding the system of air, turn the wheels immediately away from the stops.

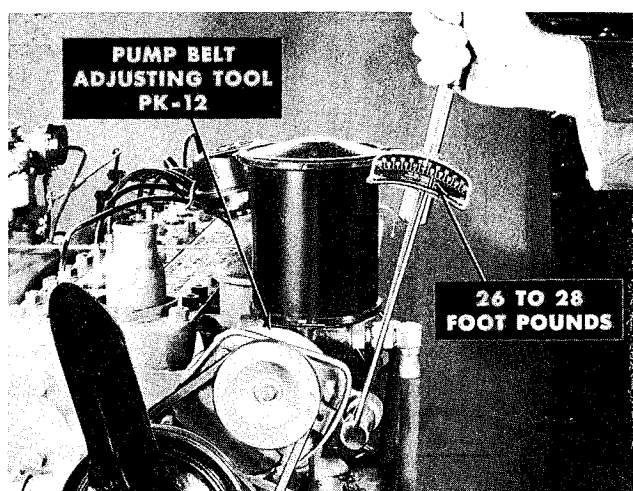


Run the engine at idle for about two minutes. When all bubbles cease to appear in the reservoir, the system has been purged of air. Add fluid if needed to bring it to the proper level. Check all hose connections for leaks. Install reservoir cover, gasket and hold down clamp and tighten screw.

### Pump Belt Tension Adjustment



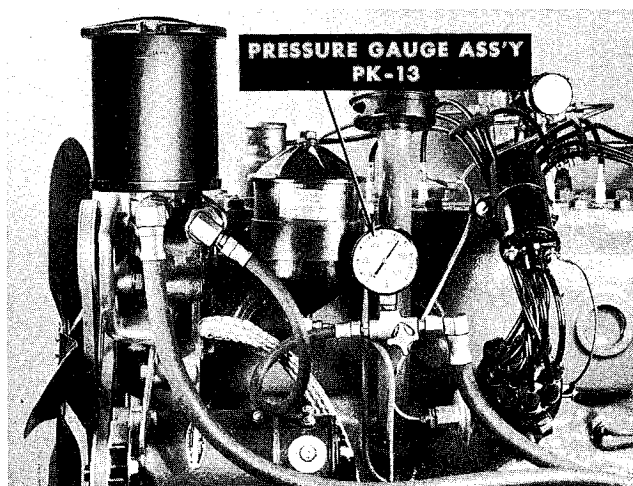
Loosen the pump pivoting bolt. Loosen the pump belt adjusting bolt in the slotted hole in the pump bracket.



Install Power Pump Belt Adjusting Tool No. PK-12 on the pump body flange. Using a torque wrench, install the torque wrench in the square hole on the side of the belt adjusting tool. Pull upward until a torque of 26 to 28 foot pounds is reached. While holding this torque, tighten the pump pivoting bolt and adjusting bolt.

### Checking Pump Pressure

Remove the reservoir, clamp, cover and gasket. Using a suction pump, remove the oil from the reservoir. If a suction pump is not available, disconnect the pump hose at the control valve and drain the oil from the pump. If the last method has been used, after the oil has been drained, reconnect and tighten the hose to the control valve.



Disconnect the pressure hose at the union on the right side of the pump. Install the pump pressure Gauge Hose and Valve PK-13 on the union at the pump with the hand valve open. Connect the pressure hose to the fitting on the hand valve side of the gauge. Refill the reservoir to the proper oil level. Run the engine until it is warmed up. Then turn the wheels from the full right to the full left position to bleed the system of air.

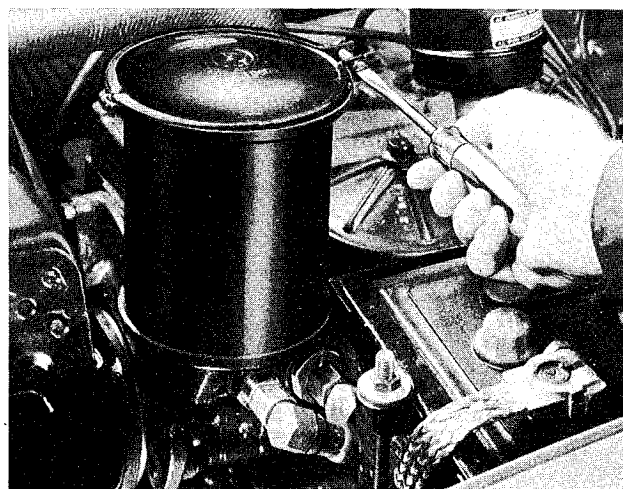
Add oil if necessary to reservoir to bring the fluid to the proper level. After the engine has been warmed up and idled to 375 r.p.m., wheels should be resting on the ground and in the straight-ahead position. Close the gauge hand valve and observe the gauge reading. The reading should be approximately 650 p.s.i. It will be noticed that the gauge needle will oscillate several hundred p.s.i. on the gauge dial. The center reading will be approximately 650 p.s.i. if the pump is at its maximum efficiency. If the average reading is below 550 p.s.i. it will indicate that the pump needs repair. **CAUTION:** Do not keep the gauge hand valve closed any longer than is necessary to read the gauge.

Then turn the steering wheel toward either of the wheel stops. As the wheel is turned from the straight-ahead position, the pressure will start increasing until it reaches the wheel stops where it should be 600 to 650 p.s.i. If the pressure is less than 600 p.s.i., it is an indication that the trouble lies in the control valve or power cylinder. After completing these tests, shut the engine off and drain the oil from the reservoir. Disconnect and remove the gauge hose and valve from the pump and pump pressure line. Reconnect the pump pressure line to the pump and tighten the hose to pump connector. Fill the reservoir to the level mark with Ultramatic Drive Fluid. Start the engine and turn the wheels from the full left to the full right position several times to bleed the system of air. Add oil if necessary to the reservoir to bring the fluid to the proper level. Check the pump pressure line at the pump for fluid leakage. Install the reservoir gasket, cover, clamp and clamp screw on the reservoir and tighten screw.

## PUMP AND RESERVOIR

### Removal From Vehicle

Before removing the reservoir cover, carefully clean the cover and adjacent surface, so dirt will not enter the assembly when cover is removed.

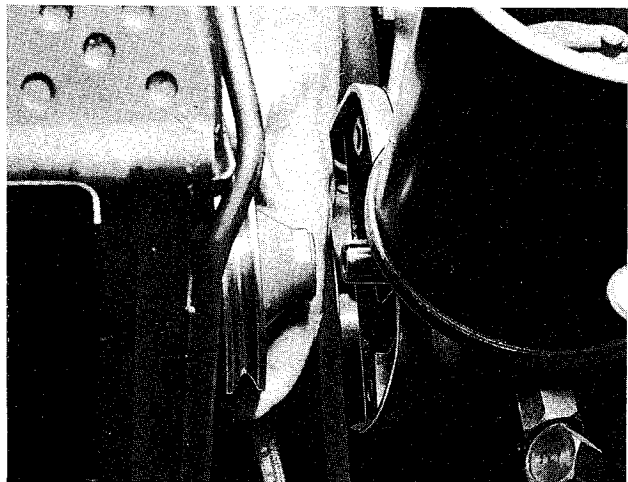




Remove the locking clamp screw, clamp, cover, and gasket from the top of the fluid reservoir. Disconnect either hose at the pump and permit the fluid to drain from the reservoir and pump into a two quart pan or receptacle. Secure and cap the disconnected hose in the upright position to prevent fluid from dripping on the engine or dirt entering the hose. Disconnect the remaining hose at the pump connection and secure it in the upright position. Install plugs or caps on the fittings of the pump where the hoses have been disconnected to prevent the fluid from dripping. Loosen the rear cap-screw at the pump mounting bracket which the pump pivots on.

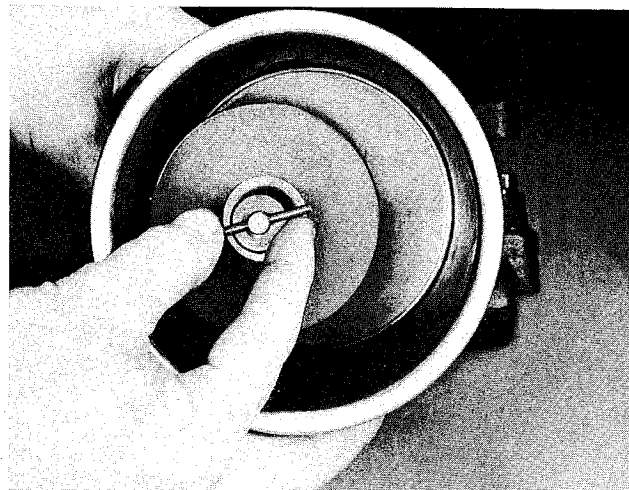


Loosen the pump belt tension adjustment screw which attaches the pump through a slotted hole to the mounting bracket to release the belt tension. Slip the belt off the pump pulley.

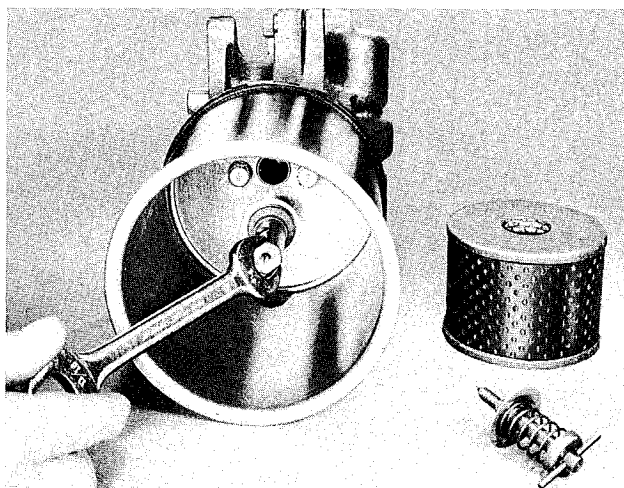


Remove the capscrew attaching the pump pulley to the pump hub and remove the pulley. Remove the two capscrews holding the pump to the pump mounting bracket. These are the capscrews that were previously loosened to release the tension on the pump belt. The power pump may then be removed from the pump mounting bracket.

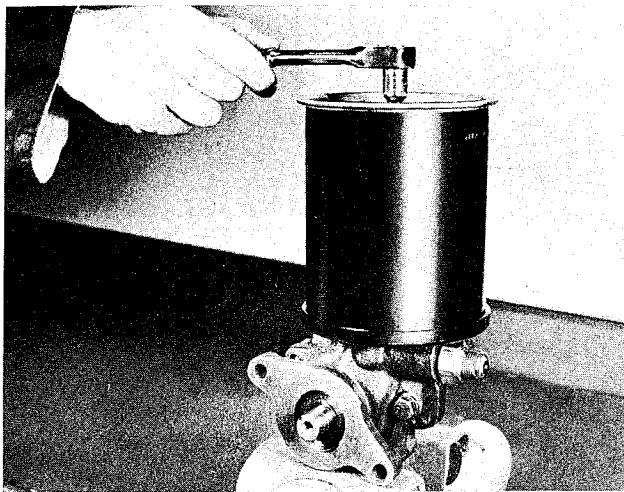
## Pump Disassembly at Bench



Remove the relief valve and handle from the filter mounting stud. Remove the filter element.



Unscrew and remove the filter mounting stud from the top of the pump.

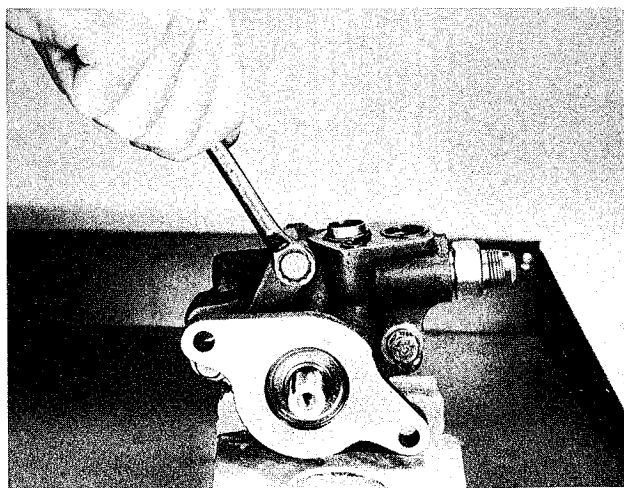


Remove the two capscrews mounting the reservoir to the top of the pump and remove reservoir from the pump.

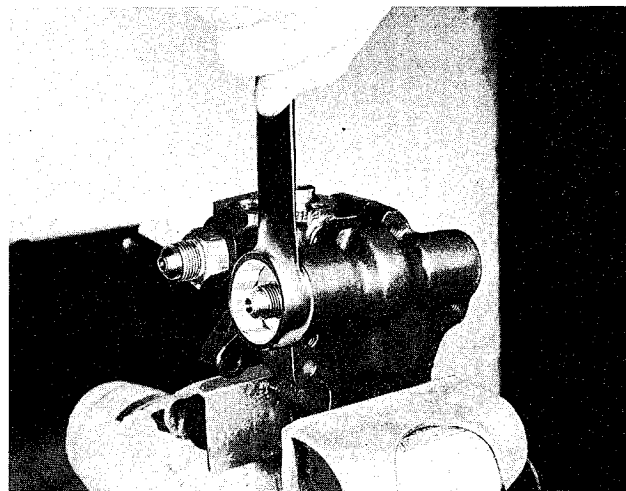


Remove the four "O" ring gaskets from the openings at the top of the pump.

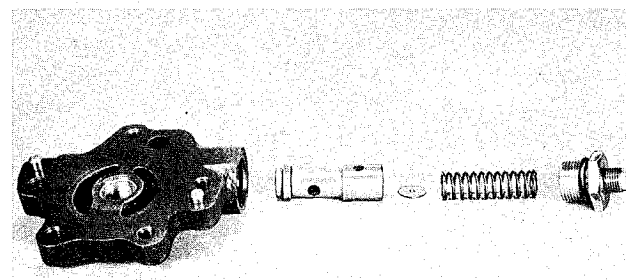
Clamp the pump in a vise at the two lower bolts. Loosen the hose adaptor valve cap.



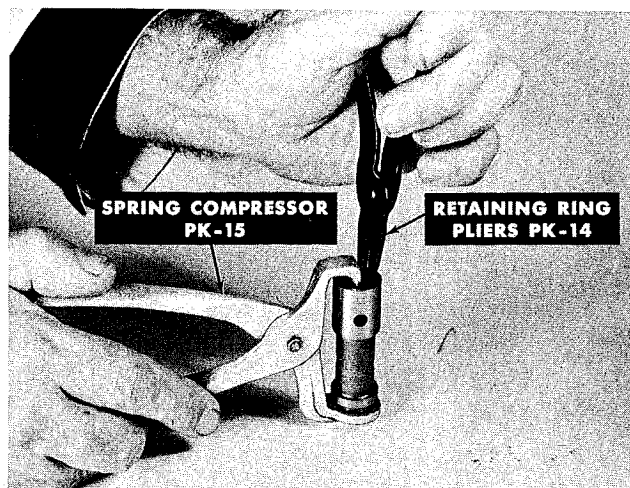
Remove the five bolts attaching the pump cover to the pump body. Tap the end of pump shaft with plastic hammer to separate the pump body from the cover. Remove the large body to cover gasket from the recess at the rotors and the "O" ring gasket.



Remove the hose adaptor valve cap and the "O" ring gasket.



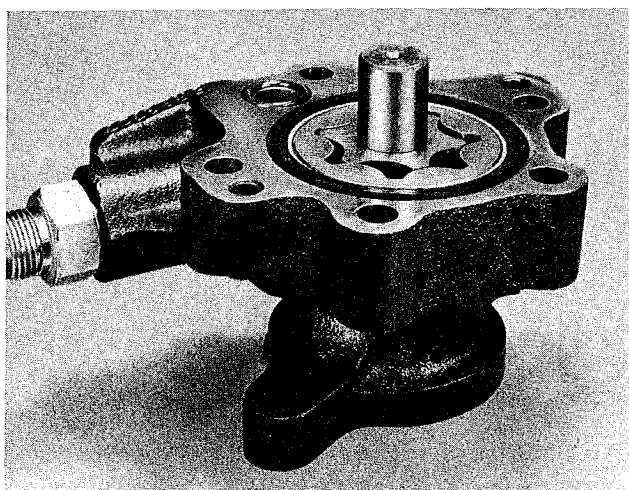
Remove the flow control valve spring, the orifice plate and the valve sub assembly from the pump body cover.



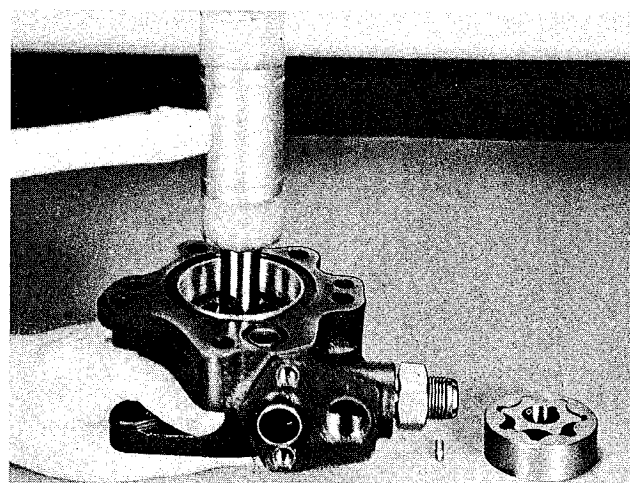
To disassemble the valve sub assembly, compress the relief valve spring in the valve sub assembly body with Power Pump Relief Valve Spring Compressor No. PK-15 and remove the retaining ring with Retaining Ring Pliers No. PK-14. After the retaining ring is removed, lift out the relief valve, and relief valve spring from the flow control valve body.



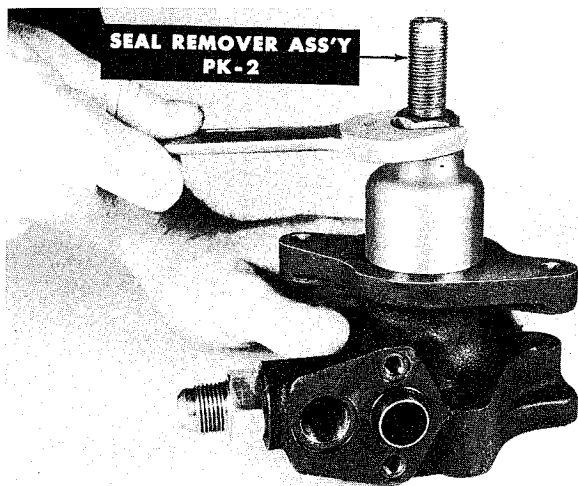
From the opposite end of the pump body remove the retaining ring holding the bearing assembly in the pump bore using Retaining Ring Pliers Tool No. PU-376.



Remove the rotors as an assembly from the pump body keeping them nested in the position from which they were removed. Remove the drive pin.

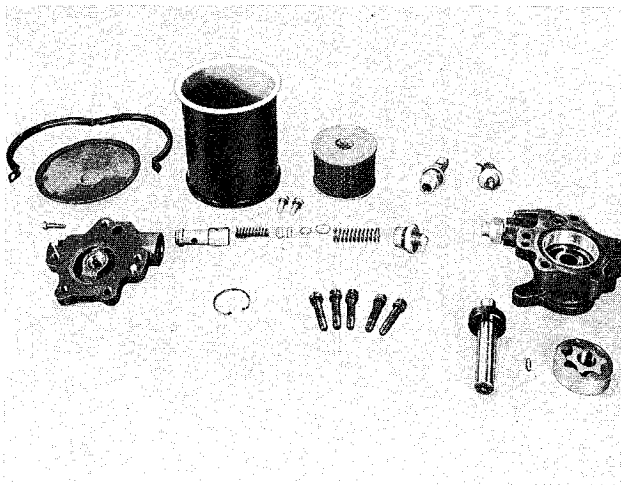


Remove the assembly of shaft and ball bearing retainer from the pump body as a unit by tapping the pump shaft on the end with a plastic hammer. The ball bearing assembly may be removed from the pump shaft if necessary by using an arbor press. The pump shaft oil seal may be removed, if necessary, from the body with the following tools.



Install Pump Drive Shaft Seal Remover No. PK-2-A into PK-2-C Cup. Position this assembly on the pump body bore. Screw PK-2-A into the inner bore of the seal until it is tight. Then install PK-2-D Nut on PK-2-A Remover and tighten nut until oil seal pulls free from the bore.

### Inspection

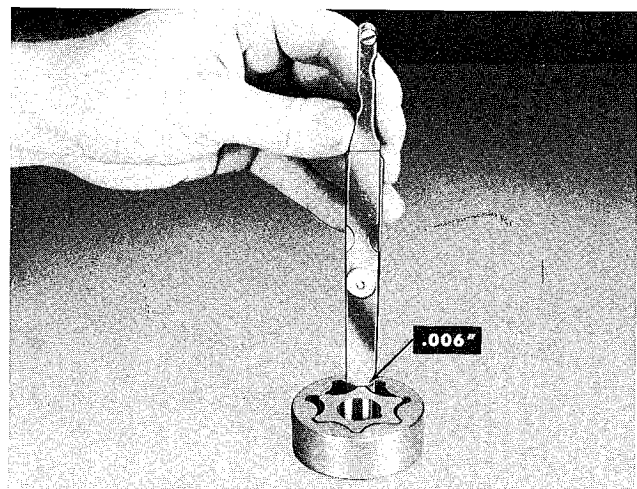


Wash all parts in carbon tetrachloride or a suitable cleaner and blow parts dry with compressed air. Do *not* use a cloth for drying the parts as lint left on the parts may effect the pump operation after assembly. Following is a list of the parts in the order in which they may receive the most wear:

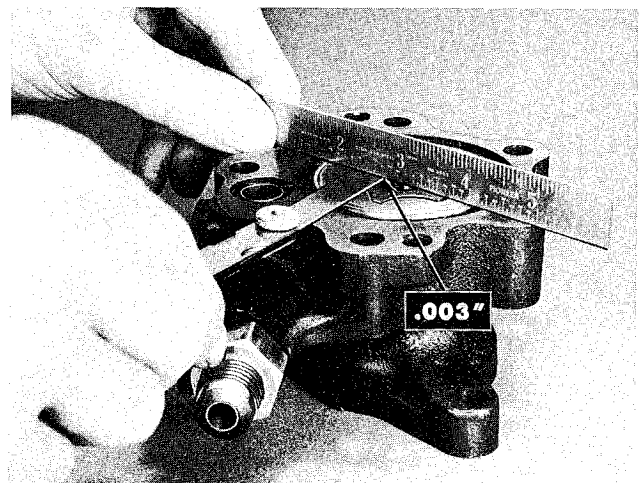
- A. Oil seal
- B. Rotors
- C. Cover shaft bushing
- D. Rotor pocket bushing
- E. Cover (face)
- F. Body face
- G. Key, rotor drive
- H. Ball bearing
- I. Valve and valve components

Inspect the pump body face for nicks and burrs. Inspect the pump body bores and remove burrs or nicks with crocus cloth if found in this condition. Inspect the pump body pocket bushing which houses the rotors. If badly scored or damaged, replace with new pump body.

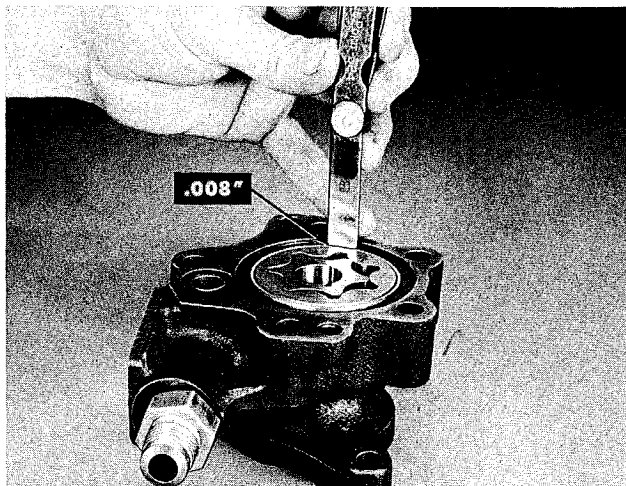
Inspect the pump cover face for nicks and burrs and the pump cover bushing for excessive wear.



Check the tooth nose clearance of the rotors with a feeler gauge. If the clearance exceeds .006" replace rotors with a new set.



Check the end clearance with a feeler gauge. If the clearance exceeds .003", replace the rotors with a new set. Check the rotor to body clearance with a feeler gauge.

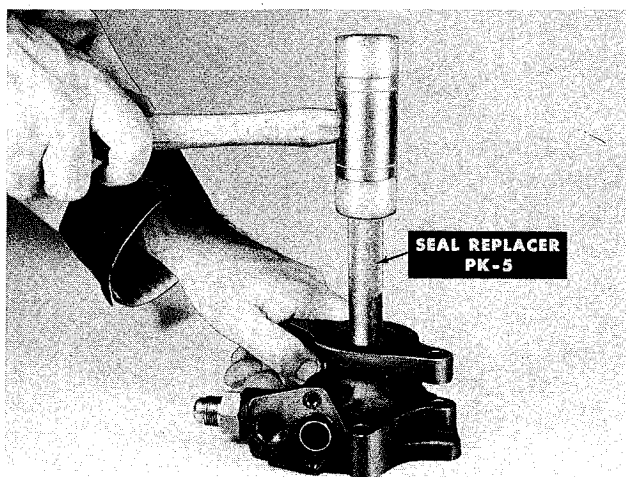


If clearance exceeds .008", replace pump body.

Check the relief valve spring and flow control valve spring for cracks. Install the relief valve in the flow control valve body moving it to see if it is sticking or has burrs. Clean up with crocus cloth or replace as required. Check the condition of the ball bearing. Check the condition of the reservoir filter mounting stud.

Always install new gaskets and "O" rings after dismantling pump to prevent possible leakage. Lubricate all parts that are to be assembled to provide easy installation and lubrication of parts.

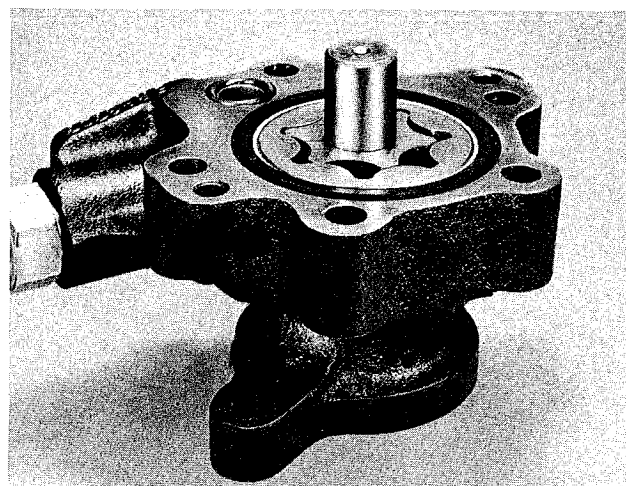
## Pump Assembly at Bench



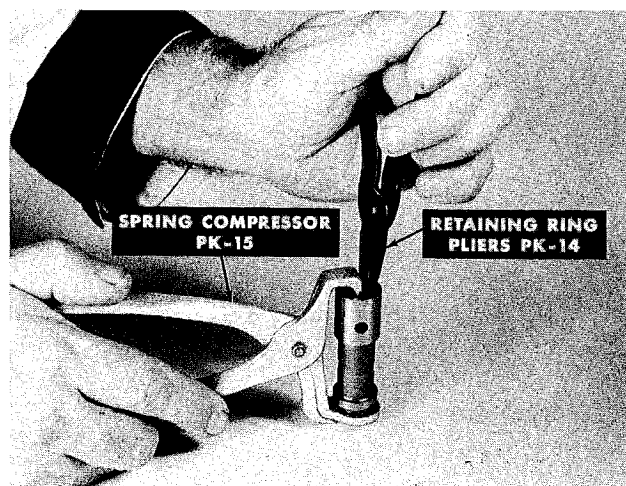
If oil seal has been removed from pump body bore, install new seal with the "lip" side down using Pump Drive Shaft Seal Replacer No. PK-5. If ball bearing has been removed from the pump shaft, the new bearing should be pressed on with an arbor press until it butts against the shoulder on the pump shaft.

Install the assembly of pump shaft and bearing in the pump body bore.

Install the ball bearing retainer using Retaining Ring Pliers Tool No. PU-376.



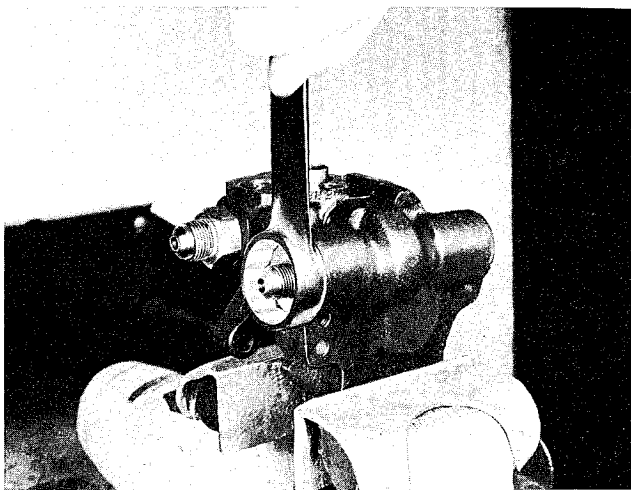
Position the pump shaft drive pin in the slot in the pump shaft and install the rotor assembly.



If the valve sub assembly has been disassembled, install the relief valve spring, relief valve, and retaining ring in the flow control valve body. Using Power Pump Relief Valve Spring Compressor No. PK-15, compress the assembly in the body until there is sufficient room for installing the retaining ring in the valve body groove. Using Power Pump Relief Valve Retaining Ring Pliers No. PK-14, install the retaining ring.

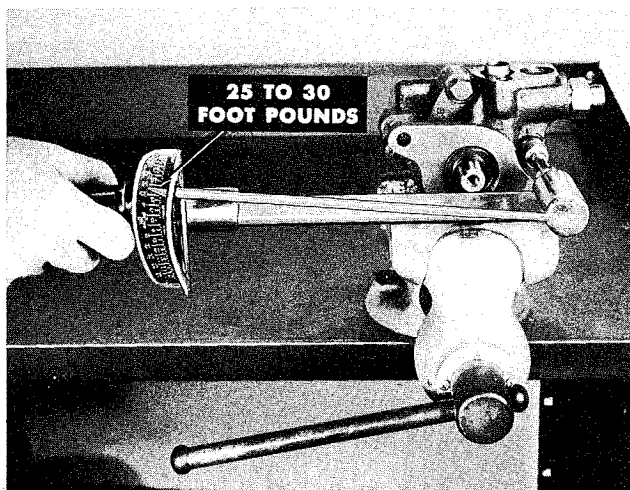
Install the orifice plate into the pump body bore.



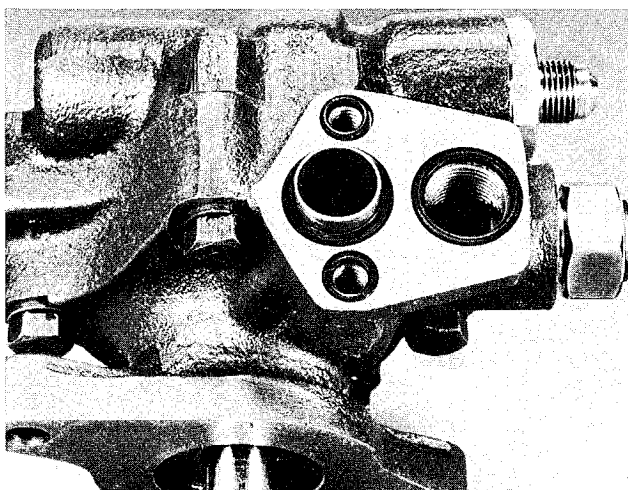


Install a new gasket on the hose adaptor valve cap and install and tighten cap. Install a new gasket at the pump body pressure port and a pump body to cover gasket.

Install pump cover on pump body.

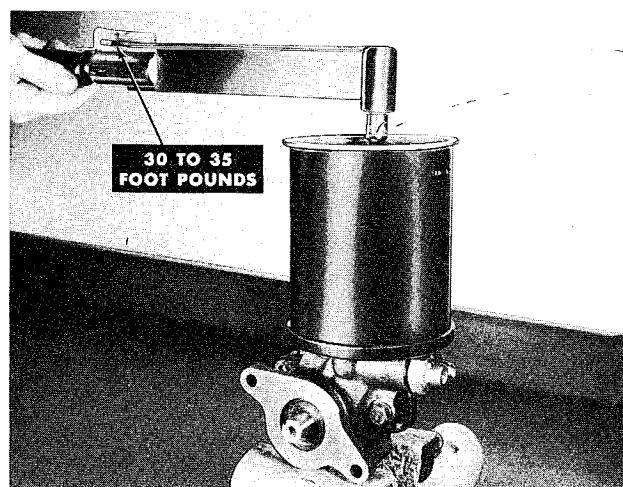


Install the capscrews and torque tighten to 25-30 foot pounds.

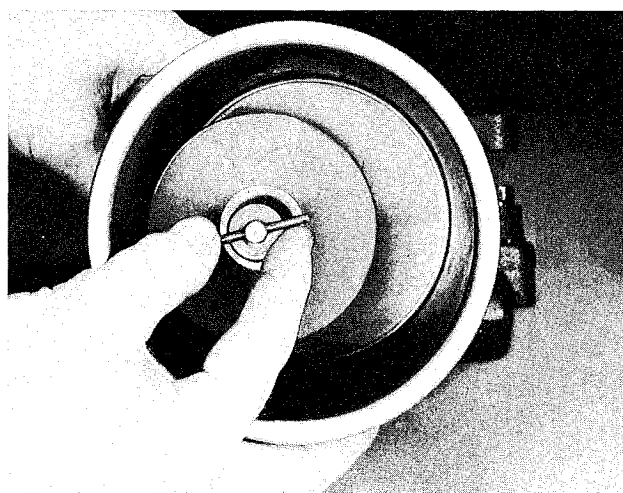


Install new "O" ring gaskets on the openings for the reservoir mounting capscrews. Install new intake and reservoir stud "O" ring gaskets. Install a new "O" ring gasket around the flange of the pump inlet tube on the top of the pump body. This tubing in the top of the pump body prevents fluid from being drawn off the bottom of the reservoir into the pump in which there might be dirt or foreign particles.

**NOTE:** First production 26th Series power steering equipped cars used a power pump reservoir, filter element and mounting stud that was longer than the parts now being used. The short 2 inch long filter element and mounting stud may be used when servicing is required on the "long" reservoir, but the *long* filter mounting stud and filter element cannot be used in the *shallow* reservoir.



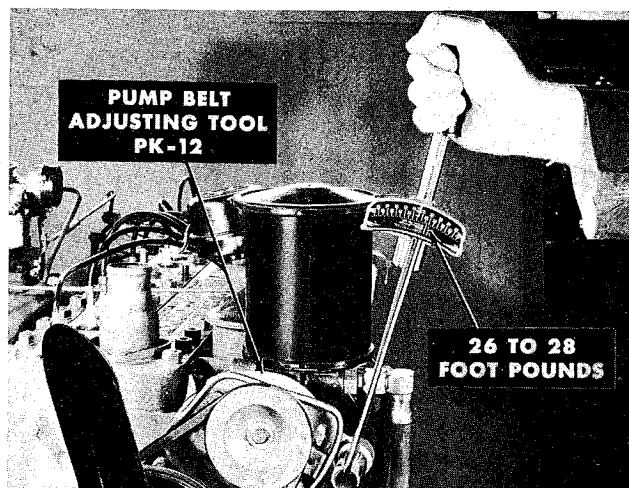
Install the reservoir filter mounting stud and tighten. Install the reservoir to pump capscrews and tighten to 30-35 foot pounds.



Install filter element on mounting stud. Install the relief valve and handle subassembly and tighten.

## Installation on Vehicle

Position the pump and reservoir in the pump mounting bracket. Install the bolt in the pump and mounting bracket on which the pump pivots. Install the pump belt adjustment bolt. Install the pump driving pulley on the key of the pump shaft. Install the pulley retaining bolt and torque tighten to 15-18 foot pounds. Install the pump driving belt on the pulley.

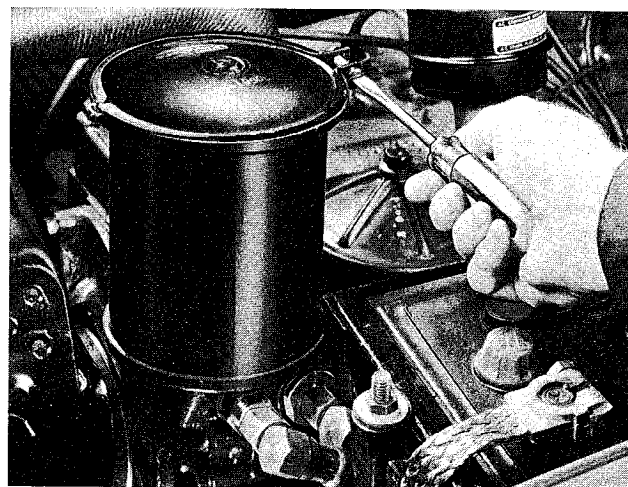


Position Pump Belt Adjusting Tool No. PK-12 on the pump body flange. Install a torque wrench in the square hole that is provided on the side of the tool. Pull upward on the wrench until a torque of 26 to 28 foot pounds is reached. While holding this torque, tighten the two bolts. Connect the two hoses to the pump fittings and tighten.

Fill the power pump reservoir with Ultramatic fluid until the level is within 1" from the top of the reservoir.



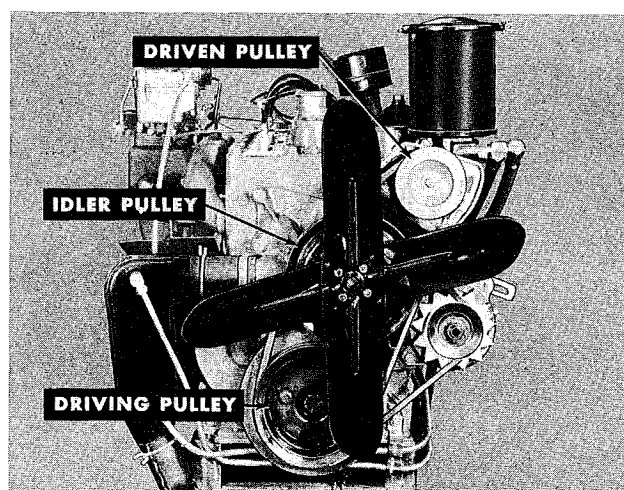
A mark indicating this level is on the outside of the reservoir. Start the engine and turn the wheels from right to left several times to bleed the hydraulic system of any air that may have entered. When the hydraulic system is free of air no more air bubbles will be noticed coming up through the fluid in the reservoir. Add fluid if needed to bring the "level" up to the 1" mark on the outside of the reservoir.



Install the pump reservoir gasket, cover and locking clamp. Install the reservoir cover screw and tighten.

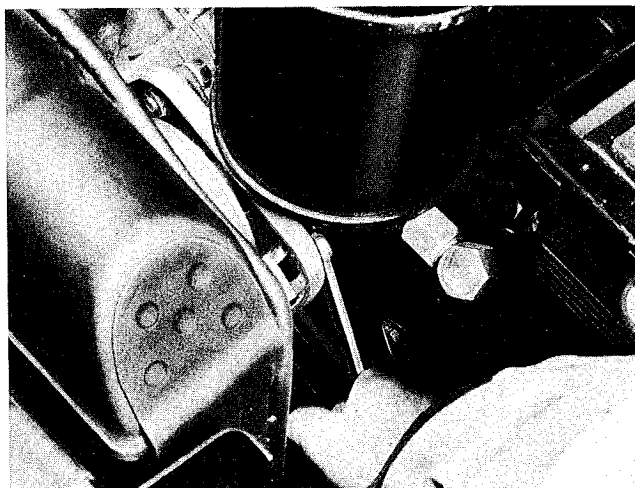
Check the hose connections for fluid leakage. If leakage is found, tighten the fittings only tight enough until the leakage stops.

## POWER STEERING PULLEYS



There are three pulleys used with power steering, the driving pulley which is attached to the engine vibration damper, the idler pulley attached to the engine fan pulley and the driven pulley that drives the power pump. When it is necessary to remove all three pulleys the fastest method of removal is to drain the cooling system and remove the radiator core to gain access to these parts.

## Driven Pulley Removal



Loosen the pump pivoting and the pump belt adjusting bolt. Slip the belt off the pulley. Remove the driven pump pulley attaching screw and remove the pulley from pump shaft.

## Driven Pulley Installation

Inspect the power pump belt to see if it is excessively worn, stretched or cracked. If it is found in this condition, it should be replaced.

When it is necessary to replace the power pump belt, the new belt used should be that which is Factory approved and carried by an Authorized Packard Dealer.

Inspect the flanges of the pulley for being cracked or bent, and inspect the keyway for excessive wear. Replace the pulley if necessary. Inspect the condition of the key and replace if necessary.

Align the keyway of the power pump driven pulley with the key in the pump shaft and install the pulley. Install the pulley to pump shaft attaching screw and torque tighten to 15 to 18 foot pounds.

Install the belt on the pulleys. Position the Pump Belt Adjusting Tool No. PK-12 on the pump body flange. Install a torque wrench into the square hole on the side of the tool. Pull upward on the wrench until a torque of 26 to 28 foot pounds is reached. While holding this torque, tighten the pump belt adjustment bolt and pump pivoting bolt.

## Idler Pulley Removal

Loosen the pump belt adjustment and pump pivoting bolts. Slip the pump belt off the idler pulley. Remove the capscrews attaching the fan and pulleys to the fan hub and remove these parts.

## Idler Pulley Installation

Inspect the idler pulley for being cracked or bent and replace if necessary. Inspect the pump drive belt as described under Power Pump Pulley Installation. It would, also, be well to inspect the condition of the engine fan for being bent, cracked or having loose rivets before reinstalling. Inspect the fan pulley.

Align the holes in the fan and idler pulley with the holes in the fan pulley and water pump hub. Install attaching screws and torque tighten to 8-10 foot pounds.

Install the pump drive belt over the pulleys and adjust belt tension as previously described.

## Driving Pulley Removal

Loosen the tension on the power pump belt and remove the belt. Remove the two capscrews attaching the power pump driving pulley to the engine vibration damper. Remove the large capscrew holding the pump driving pulley to the vibration damper and remove the pulley.

## Driving Pulley Installation

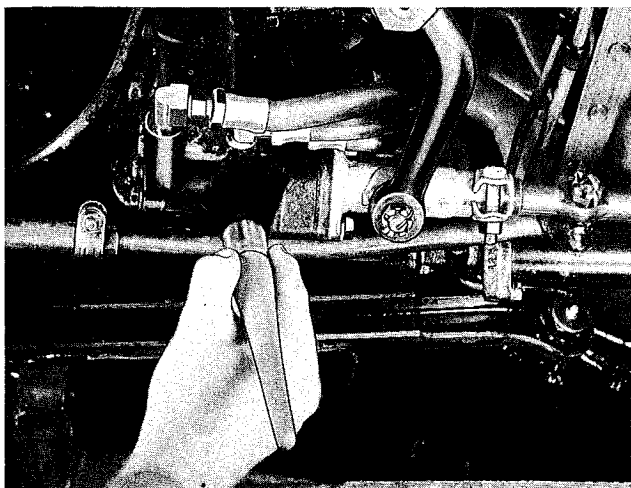
Inspect the condition of the driving pulley. If it is found cracked, bent or damaged, replace with new part before making installation.

Position the driving pulley with the holes of the driving pulley aligned with those in the vibration damper. Install the driving pulley to vibration damper capscrews and torque tighten to 55-60 foot pounds. Install the large capscrew which threads into the crankshaft and torque tighten to 130-150 foot pounds. Install the pump drive belt on the pulleys and torque tighten as previously described.

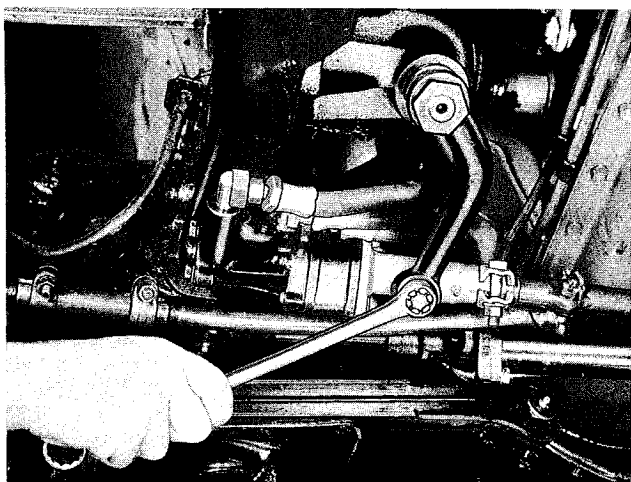
## CONTROL VALVE

### Removal from Vehicle

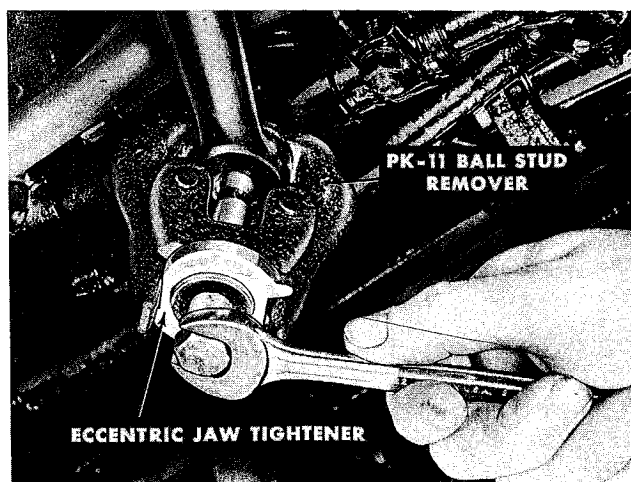
Before disassembling the control valve assembly from the steering connecting rod, it is important that the exterior of the valve and surrounding parts be thoroughly cleaned to prevent dirt from getting into the valve body.



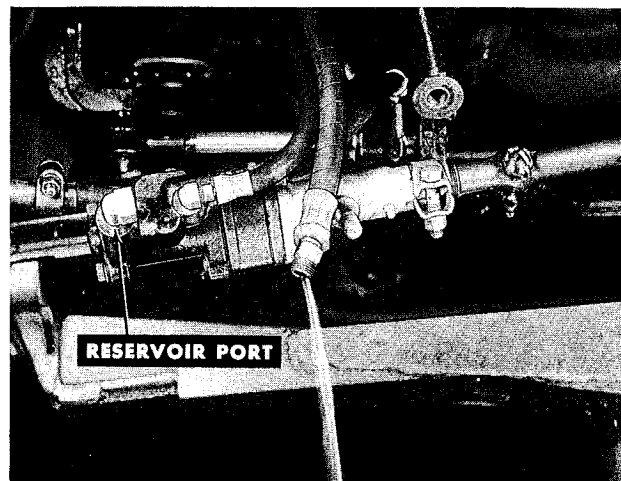
Using a stiff bristle brush and carbon tetrachloride or a suitable cleaner, clean the valve body and hose connections.



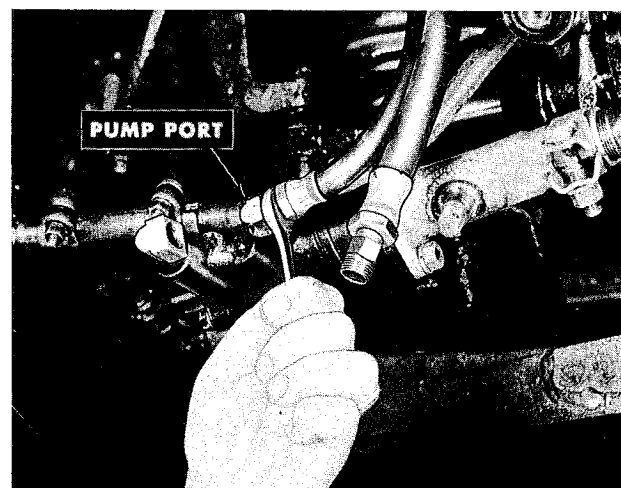
Remove the cotter pin and the ball stud nut, attaching the forward end of the pitman arm to the control valve.



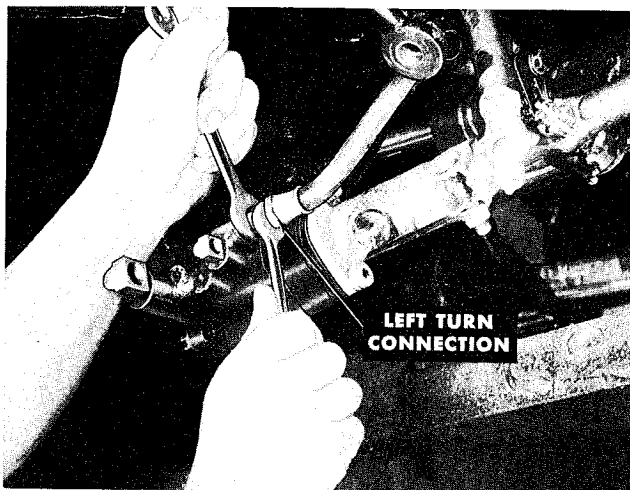
Using tool No. PK-11 the Ball Stud Remover, install the jaws of this tool between the pitman arm and ball stud in the control valve. If the dust cap spring is under the jaws of the tool, pry it up before inserting tool. After the ball stud has been loosened, push up on linkage to release the ball stud and control valve from the pitman arm.



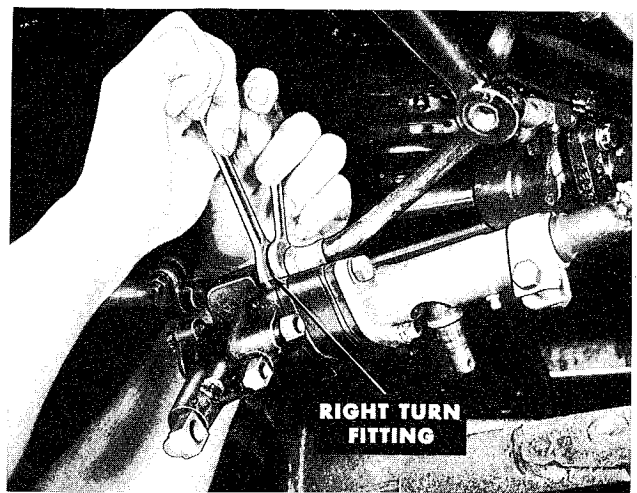
Disconnect the reservoir port hose at the left end fitting on the control valve. Allow the fluid to drain in a clean pan or receptacle. Cap or plug the hose fitting to prevent fluid from dripping and dirt getting into the hose line.



Disconnect the pump port hose at the connector on the valve. This is the second connection from the left end.

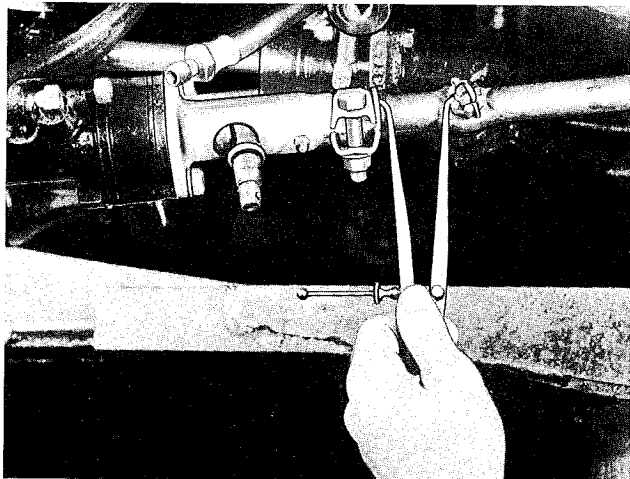


Disconnect the left turn hose at the connector on the valve. This is the connection farthest to the right.



Disconnect the right turn hose at the fitting. This is the connection at the center front of the valve body. If additional room is needed for removing the control valve, the wheels should be turned to the left turn position before capping or plugging the control valve hose connections.

Plug or cap the hoses to prevent the fluid from dripping. Unscrew the control valve from the end of the connecting rod.



Using calipers or a "rule" measure the distance between the end of the control valve and the center of the connecting rod ball stud.

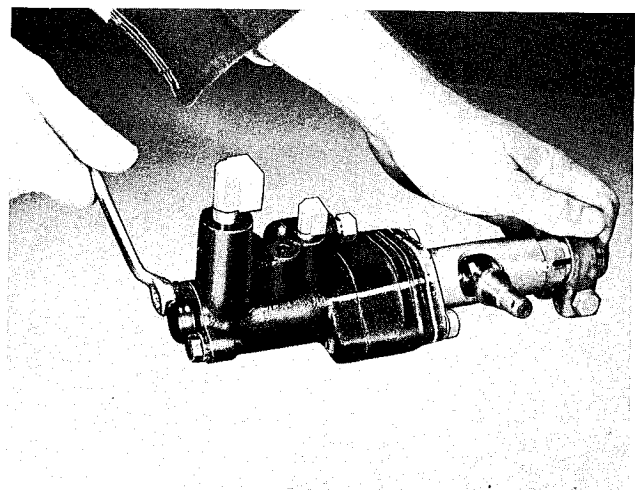
This measurement is taken so that on reinstallation of the control valve that it will be threaded on the end of the steering connecting rod to the exact position from which it was removed. If it were threaded on the connecting rod further or less than originally, the steering wheel spoke position would be changed.

Unscrew and remove the zerk grease fitting from the control valve.

Loosen the bolt in the clamp on the end of the control valve and turn the valve by hand to provide room for the tools that are to be used for disconnecting the hose.

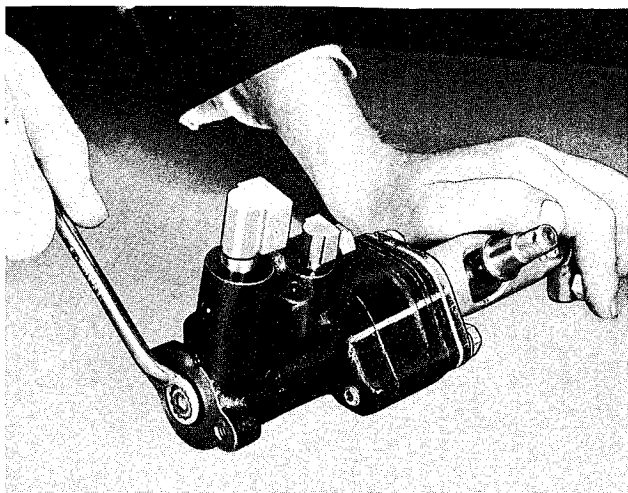
### Disassembly at Bench

Mark or scribe the control valve housing flange, and the sleeve and flange assembly with a punch or scratch awl to assure proper reassembly.

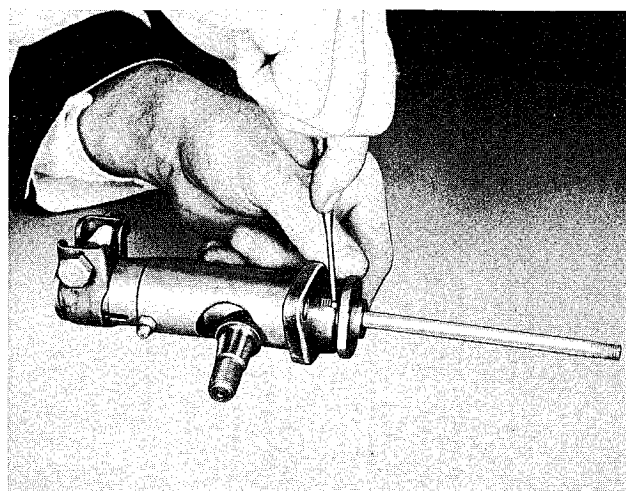


Remove the capscrews holding the control valve cap and gasket to the end of the control valve spool housing and remove these parts.



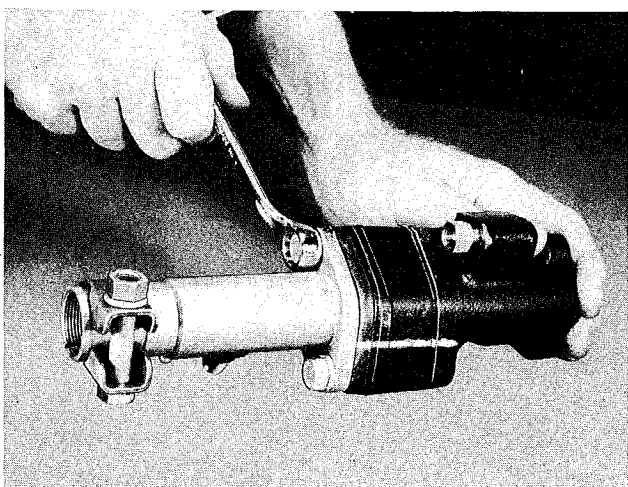


Remove the nut and washer from the valve spool bolt.

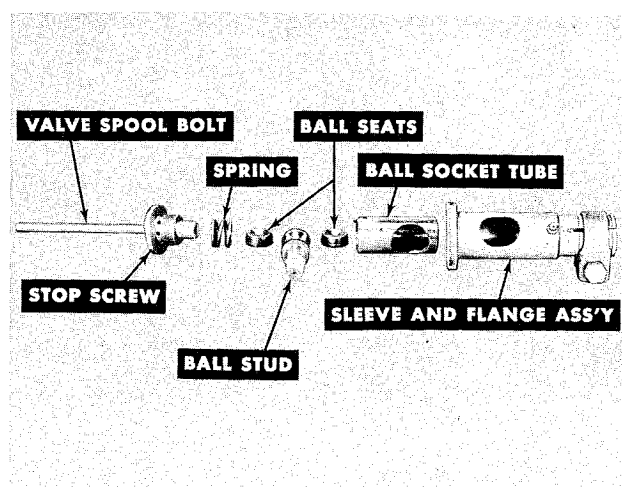


Using a small punch, push out the pin that locks the socket tube, stop screw and valve spool bolt together as a unit.

Unscrew the stop screw from the socket tube.

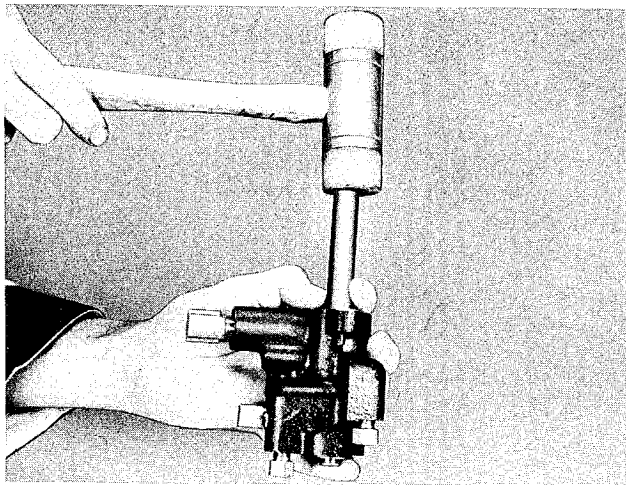


Remove the attaching capscrews holding the valve spool housing and adaptors to the flange end of the sleeve and flange assembly and separate the spool housing, adaptors, spool washer and spacer from the valve spool bolt.

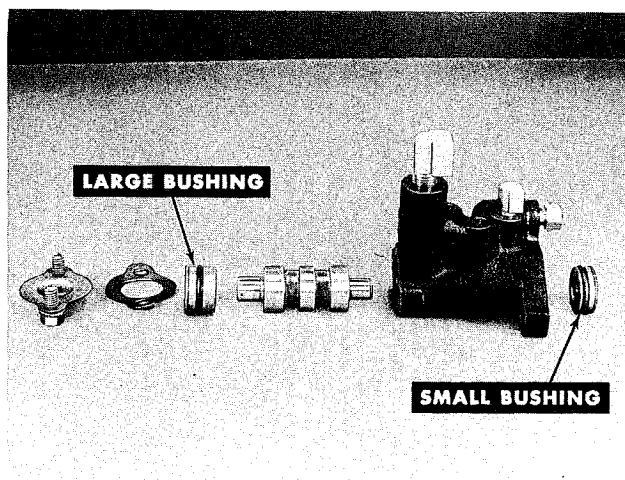


Remove the ball seat spring, ball seats and ball stud from the ball socket tube. Remove socket tube from bore of sleeve and flange assembly.

The bushings holding the control valve spool in the valve spool housing have a "push fit."



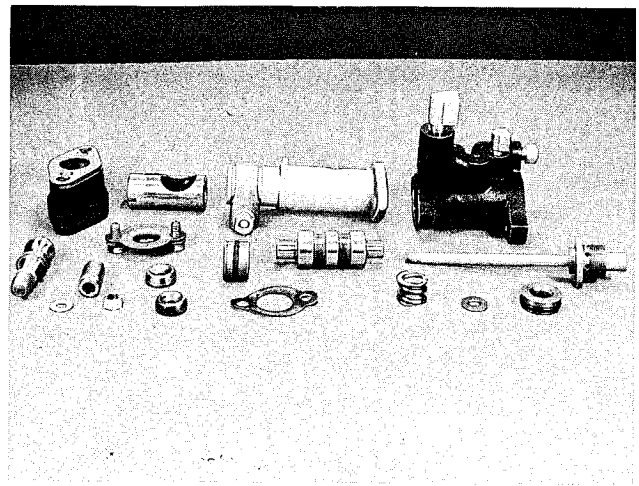
To remove the valve spool, use a round piece of brass rod slightly smaller in diameter than the spool stem and tap lightly inward until bushing is free from the spool housing bore. This method of removal may be used at either end of the spool housing. After removing the bushing and spool from one end, the bushing at the opposite end may be tapped out.



The stem of the valve spool has a large diameter at one end with a smaller diameter at the opposite end. Each end has a small drilled hole near the end. If the bushing seals are worn permitting fluid to by-pass the seals, the fluid is permitted to escape through these holes preventing a pressure build up outside the bushing seal.

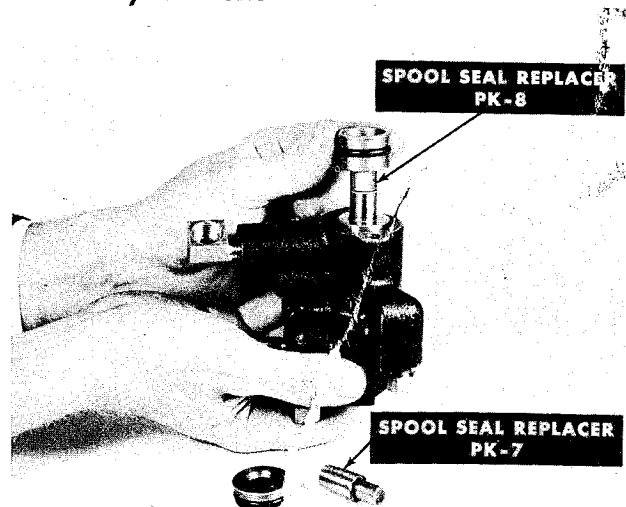
The end of the spool valve that has the largest end is always installed in the valve spool housing, toward the left end to which the spool housing end-cover is attached.

## Inspection

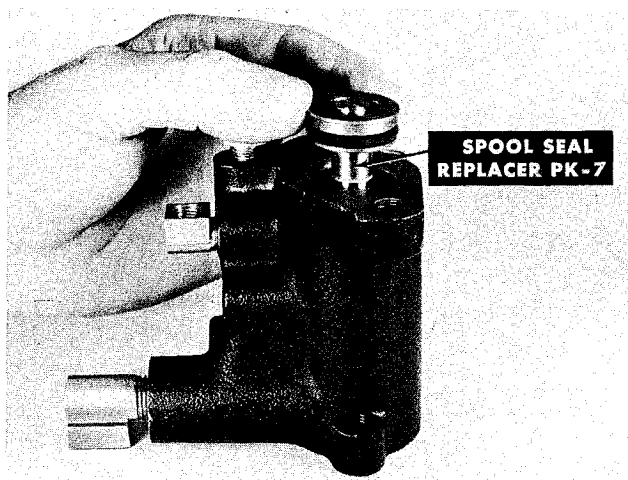


Inspect the packings on the inner and outer diameters of the valve spool bushings for being damaged or excessively worn. Inspect the lands of the valve spool for nicks and burrs. Clean up with crocus cloth if needed. Inspect the valve spool housing bore and adaptor for being excessively worn or scored or cracked. Examine the valve spool bolt to see if it is bent. Check the condition of the ball seat spring. Replace as required. Wash all parts with carbon tetrachloride or a suitable cleaner. Blow out all fluid passageways with compressed air to remove any dirt or foreign matter. Always use new packing rings on reassembly.

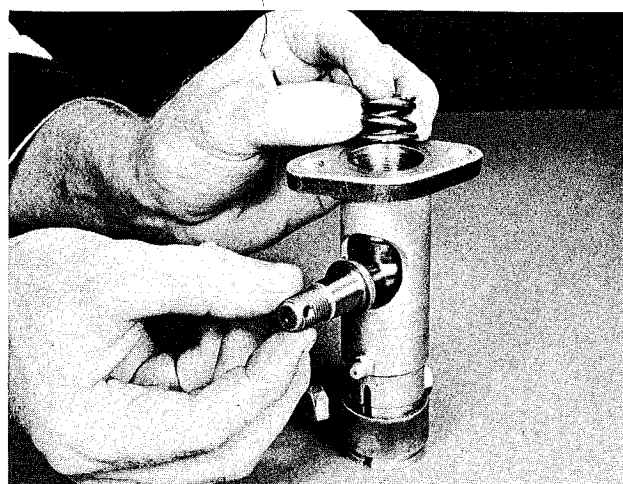
## Assembly at Bench



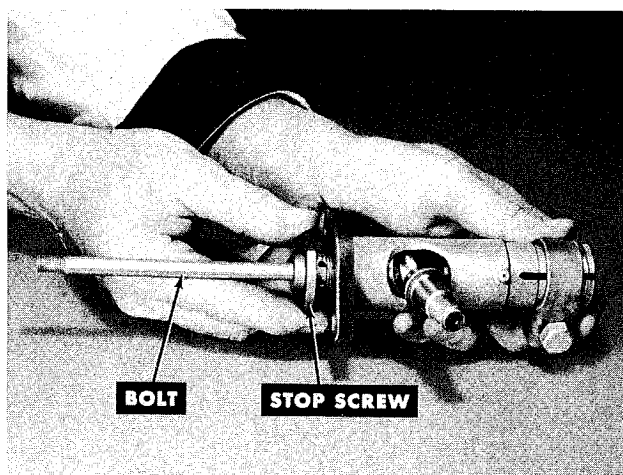
Using Control Valve Spool Seal Replacer PK-8, install the large bushing on the large stem end of the valve spool and install it in the valve housing bore.



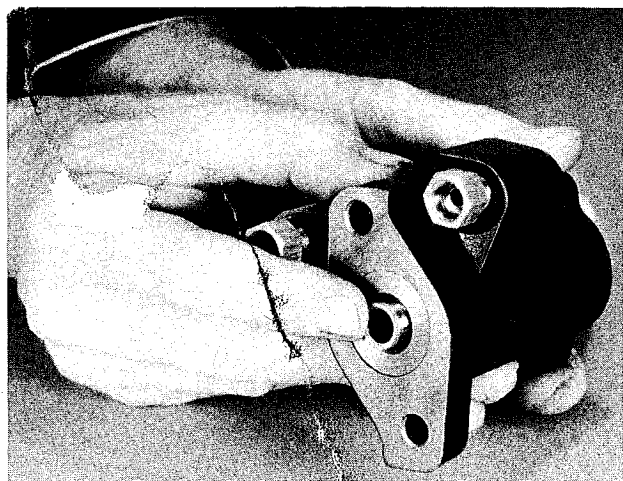
Using Control Valve Spool Seal Replacer PK-7, install the small bushing on the opposite end of the spool.



Install the ball stud and ball seat spring.

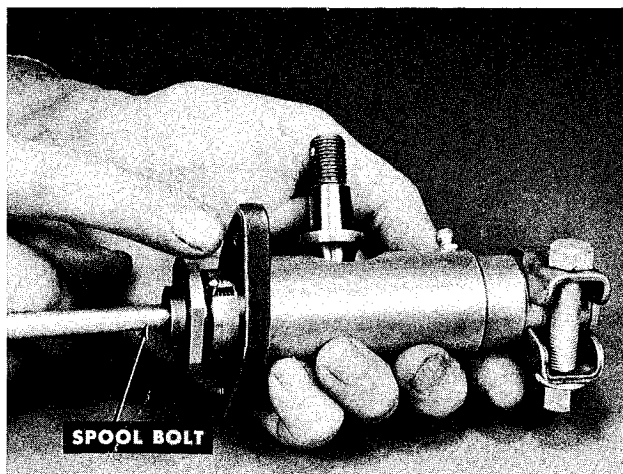


Slide the stop screw over the valve spool bolt and tighten the stop screw into the ball socket tube which has been assembled into the sleeve and flange assembly.

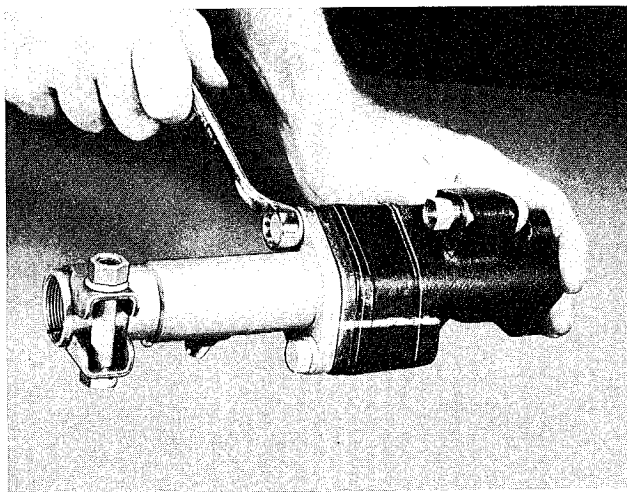


Check the movement of the spool in the spool housing bore to see if it operates freely.

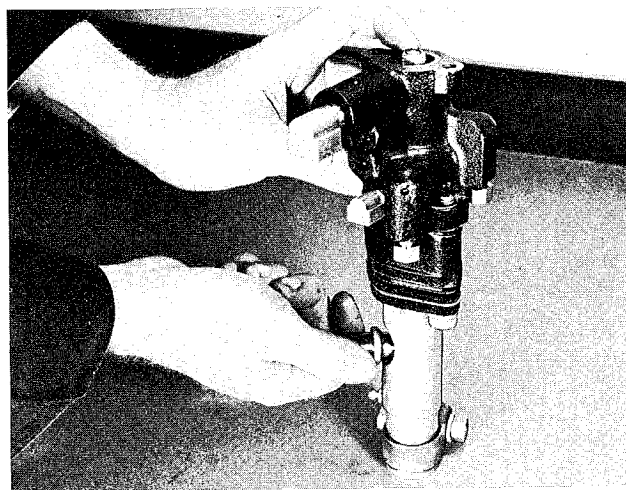
Install the ball seats in the ball socket tube and insert this assembly into the sleeve and flange assembly.



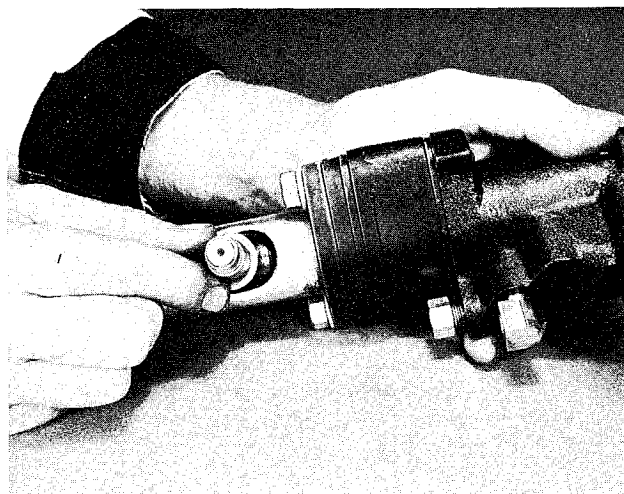
Back off the stop screw to the nearest hole and where the stop screw hole lines up with the hole in the spool bolt and socket tube. If spool bolt can then be rotated, install stop screw pin.



Install the adaptors, spool washer, spool spacer on the valve spool bolt. Assemble these parts with the cap-screws to the valve spool housing making certain the alignment marks put on at time of disassembly are lined up.

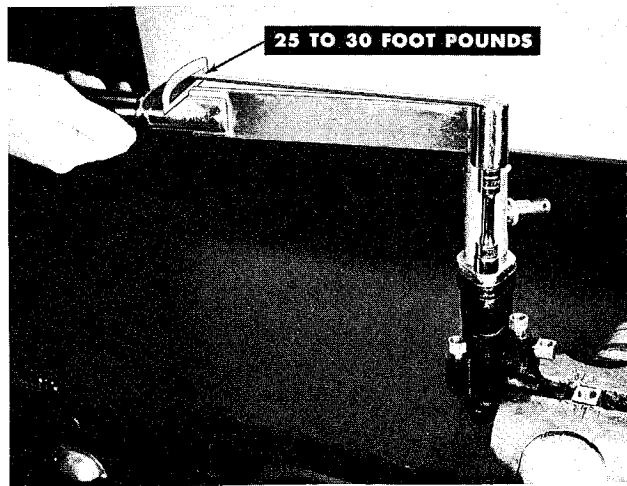


Nut should be tight enough to permit a slight side to side movement of the nut and spool bolt and yet not bind the spool.



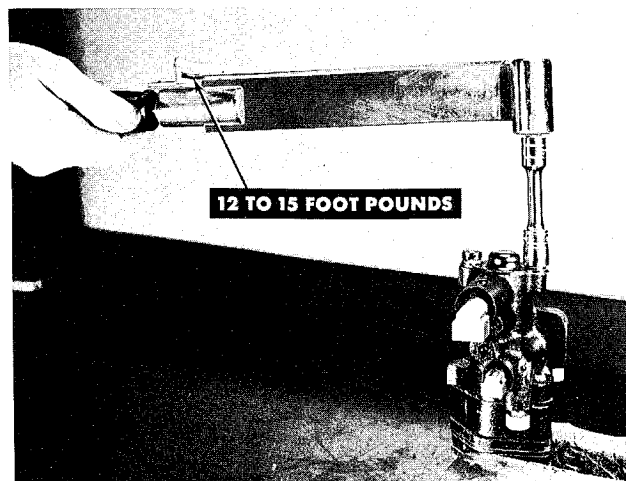
Center the ball stud in the socket tube.

Check operation of the control valve spool in the housing by moving the ball stud.



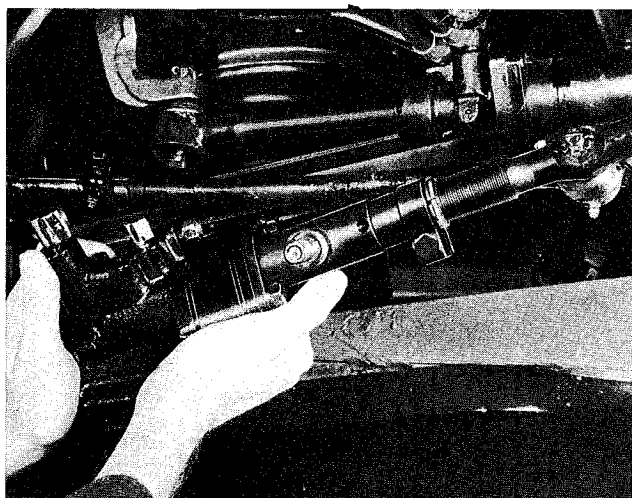
Tighten capscrows to 25-30 foot pounds.

Install the washer and nut to the valve spool bolt and tighten.

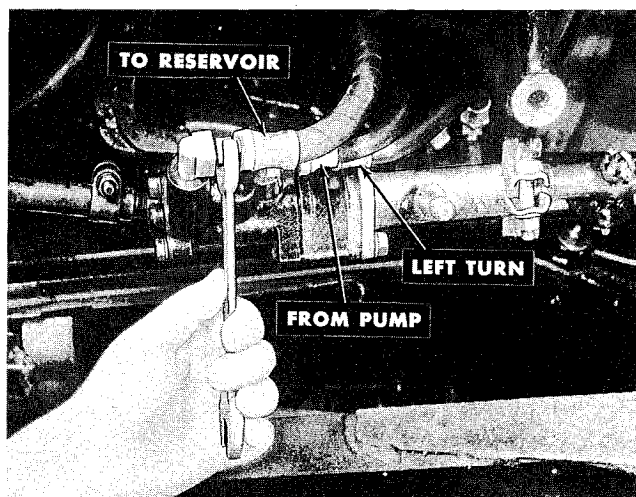


Install the valve spool body end gasket, end cover and capscrews and torque tighten to 12-15 foot pounds.

## Installation On Vehicle



Thread the control valve on the end of the steering connecting rod. Check the measurement with a rule or calipers to make certain the control valve is in the identical position from which it was originally removed. If the measurement is found correct, then tighten the locking clamp bolt on the control valve to 25-30 foot pounds. Install the zerk grease fitting. Position the control valve ball stud in the pitman arm, install the attaching nut, and tighten to 45-50 foot pounds. Install a new cotter pin.



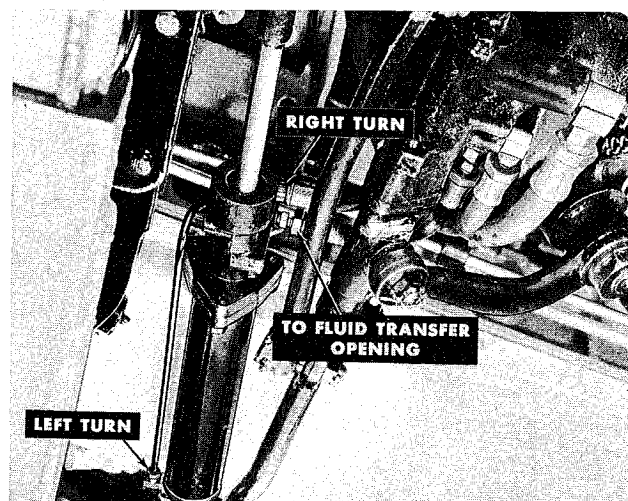
Install the hoses at their proper connectors on the control valve and tighten. See illustration.

Remove the reservoir cover and fill the reservoir to the level mark. Start the engine and turn the wheels from the full right to the full left position several times to bleed the hydraulic system of any air that has entered.

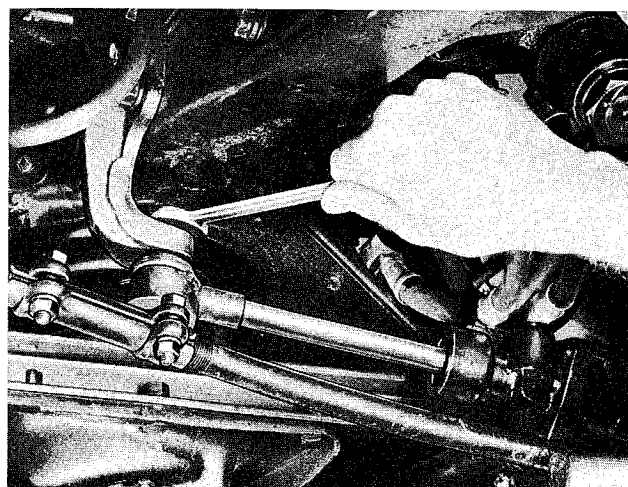
When the system has been purged of air, no more bubbles will be noticed coming up through the fluid in the reservoir. Add fluid if needed to bring it to the proper level. Reinstall the reservoir cover, gasket and clamp. Install attaching screw. Check hose fittings at control valve for leakage. If any leakage is found tighten fitting only enough to stop leakage.

## POWER CYLINDER

### Power Cylinder Removal From Vehicle



Disconnect the hoses at the power cylinder. Secure the hoses in an upright position and "cap" or plug the ends to prevent fluid from dripping and dirt entering the hoses.



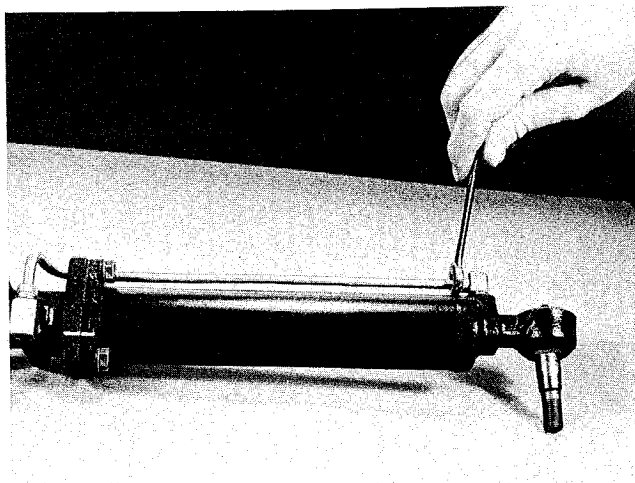
Remove the cotter pin and nut holding the power cylinder piston rod end to the bracket on the frame. Remove the power cylinder to frame mounting bracket bolts. Using Ball Stud Remover No. PK-11 free the piston rod ball stud from the frame bracket. Remove



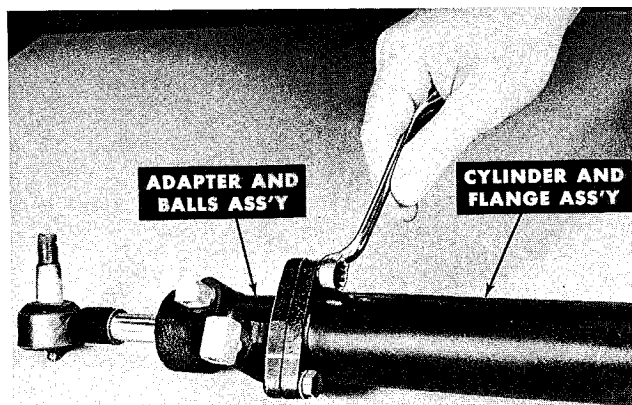
the cotter pin and nut attaching the cylinder end to the steering linkage connecting rod. Install the Ball Stud Remover PK-11 on the ball stud of the cylinder end of the power cylinder and steering connecting rod. Turn the eccentric cam on the tool to tighten the jaws. Tighten the screw of the ball stud remover. Then tap the screw with a hammer to release the tapered end of the ball stud from the hole in the connecting rod.

### Disassembly At Bench

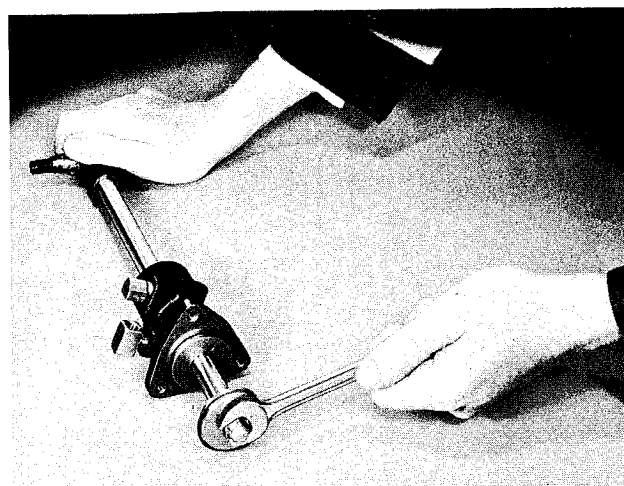
Mark or scribe the two flanges of the power cylinder so the connecting parts will be in their proper places on reinstallation.



Remove the fluid communication tube by disconnecting it at the connections on the cylinder.



Remove the capscrews holding the adapter and balls assembly housing to the cylinder end and separate these parts. Pour the fluid from the cylinder into a container.



Remove the nut holding the piston and ring on the power cylinder piston rod. Remove the piston and piston ring assembly from piston rod. Remove piston rod from the housing bore.

Remove the "O" ring packing from the adaptor and balls assembly.

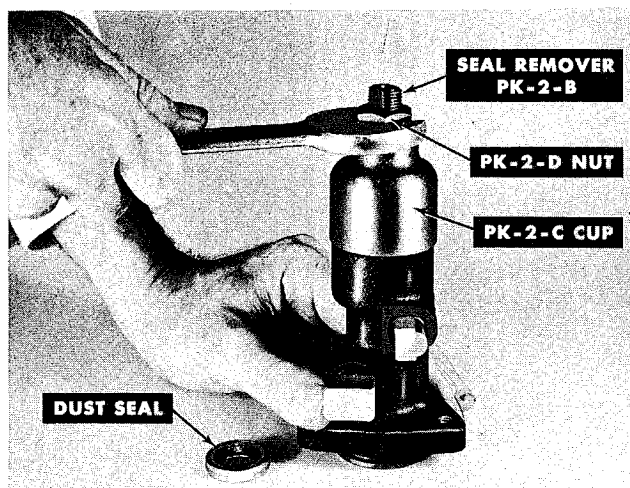


Using Special Pliers No. PU-376, remove the retaining ring from the adaptor and balls assembly housing.

Remove the scraper washer from the bore of the casting.

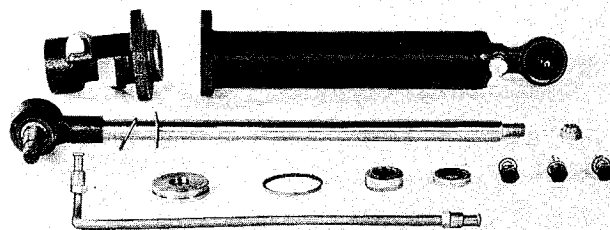
The next step is to remove the piston rod dust seal. This can be removed in the following manner.





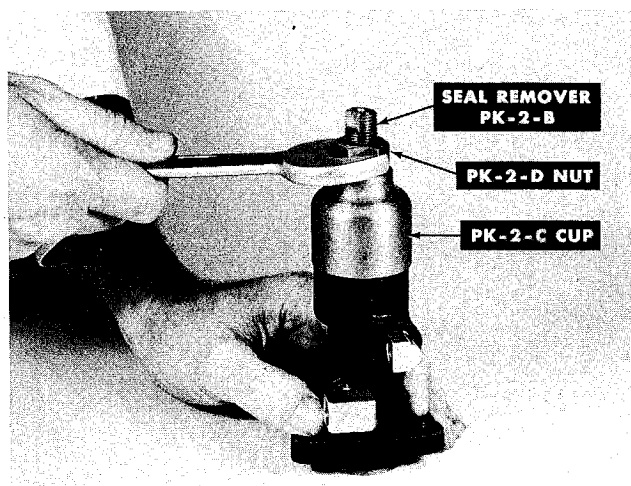
Install Piston Rod Oil and Dust Seal Remover PK-2-B in PK-2-C Cup. Position this assembly on the adapter housing bore and screw Seal Remover PK-2-B into the inner bore of the seal. Install PK-2-D Nut on PK-2-B Seal Remover and tighten nut until seal is removed from bore.

## Inspection

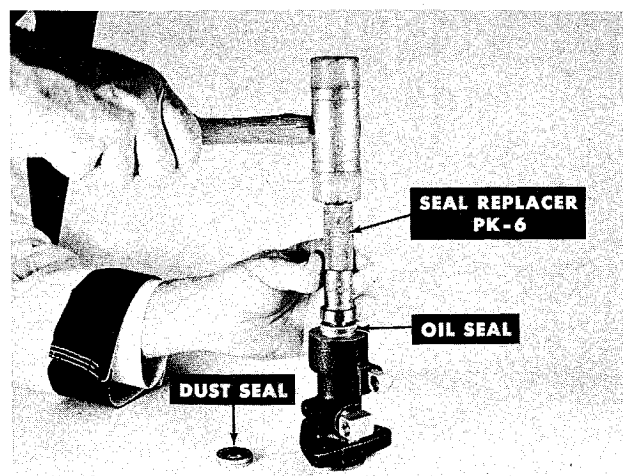


Wash all parts with carbon tetrachloride or a suitable cleaner and blow parts dry with compressed air. Inspect the cylinder rod end of the casting and the bore of cylinder body for cracks, dents, being excessively scratched, worn, or having broken welds. Inspect the threads of the fittings. Examine the piston rod to see if it is bent or the threads damaged. Examine the ball stud on the piston rod, for being excessively worn or threads damaged. Replace as required. The "O" ring packing, piston rod seal and dust seal should be replaced with new parts at time of reassembly.

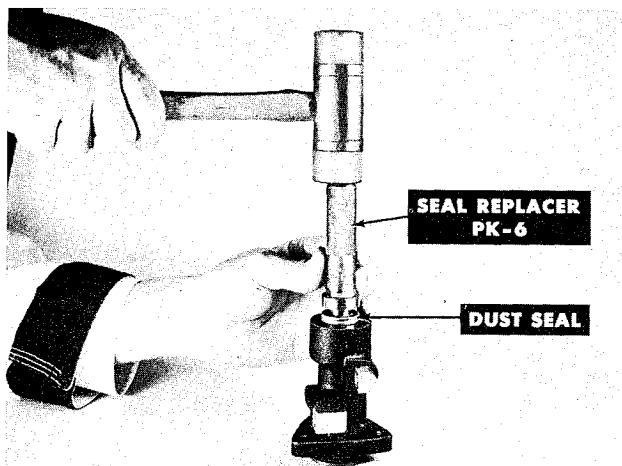
## Assembly at Bench



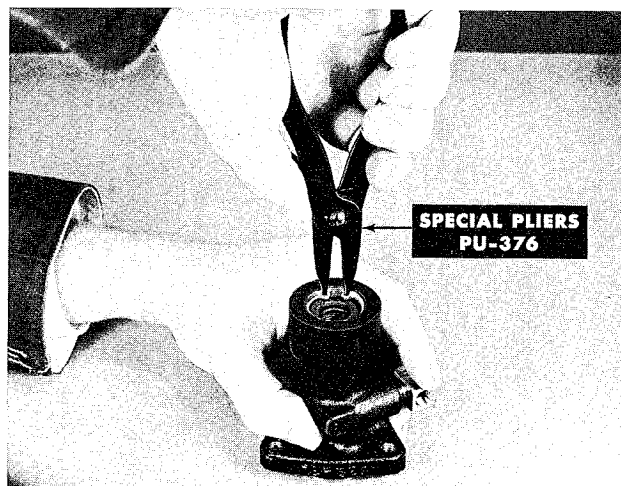
After removing the dust seal, remove the piston rod oil seal using the same tools.



Install the piston rod oil seal into the adapter and balls assembly housing using Piston Rod Oil and Dust Seal Replacer PK-6.



Then install the dust seal with the lip side down into the same bore using the same tool. Install the scraper washer and retaining ring on the piston rod.

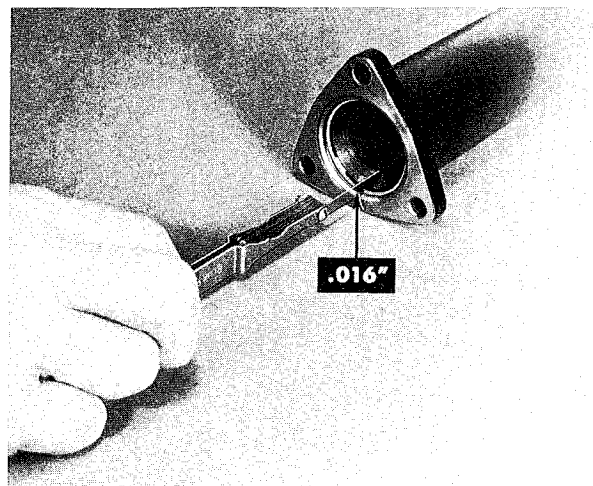


Install the retaining ring with Special Pliers Tool No. PU-376 in the groove near the end of the adapter and balls assembly.

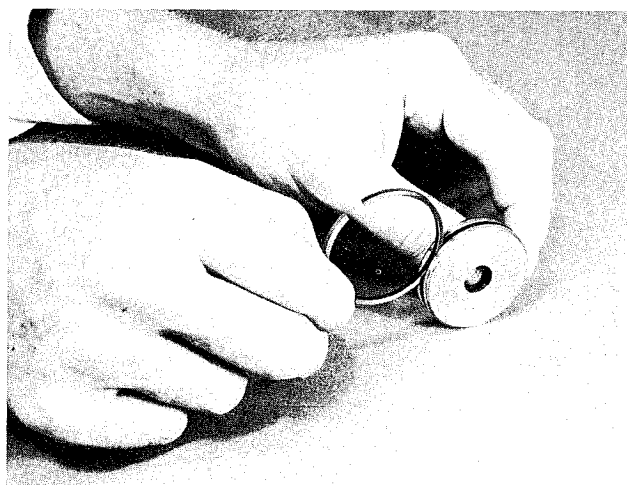
Lubricate piston rod with clean Ultramatic fluid.



Slip the Piston Rod Guide No. PK-16 over the threaded end of the piston rod and insert the piston rod through seal into adapter housing bore.

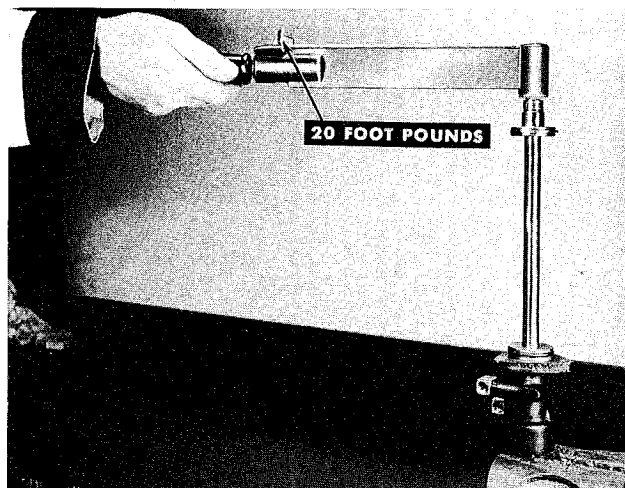


Install the piston ring in the bore of the cylinder and check the ring gap. The gap should not exceed .016\"/>



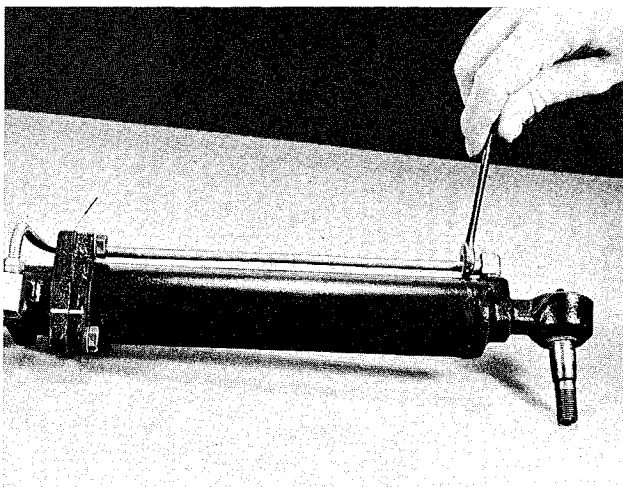
Check the fit of the ring in the piston groove. It should be "free" to rotate in the groove.

Install piston ring on piston. Position this assembly on the piston rod with the counterbored end facing the piston rod.



Install the attaching nut and torque tighten to 20 foot pounds. Lubricate the inner surface of the cylinder body.

Compress the piston ring and install this assembly into the cylinder bore. Align the marks on the two flanges and install the capscrews. Torque tighten to 12-15 foot pounds.

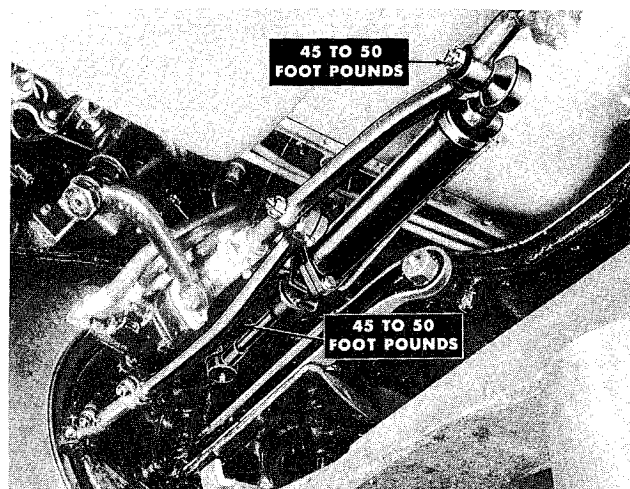


Install the oil communication tube on the connections and tighten. Install the hoses in the fittings of the power cylinder and tighten.

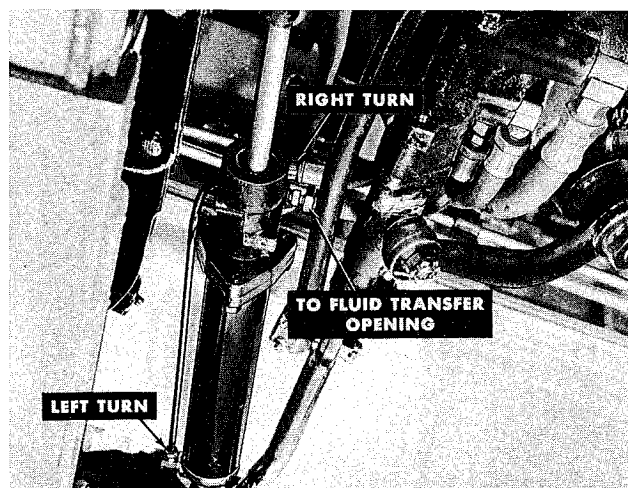
### Installation on Vehicle

Position the power cylinder to frame mounting bracket on the frame side and install and tighten the attaching bolts. Install the rubber grommet on the power cylinder piston rod in the hole in the frame mounting bracket. Install the attaching nut and torque tighten to 45-50 foot pounds. Install a new cotter pin.

Install the grommet on the ball stud of the cylinder end and install ball stud in connecting rod.

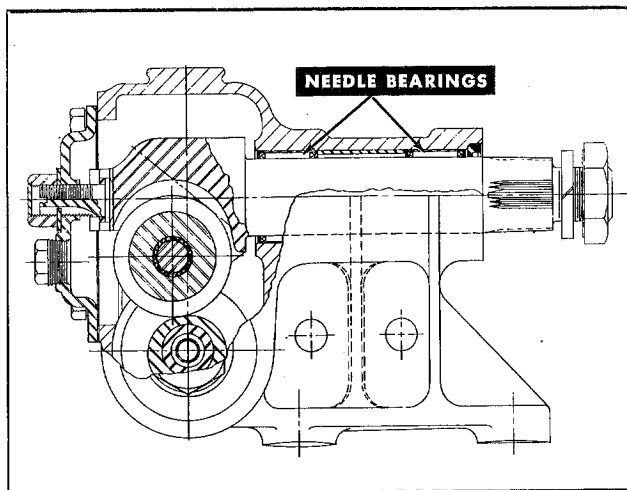


Install the attaching nut and torque tighten to 45-50 foot pounds. Install a new cotter pin.



Reconnect the hoses at the proper connections. Bleed hydraulic system as previously described under Pump Installation on Vehicle.

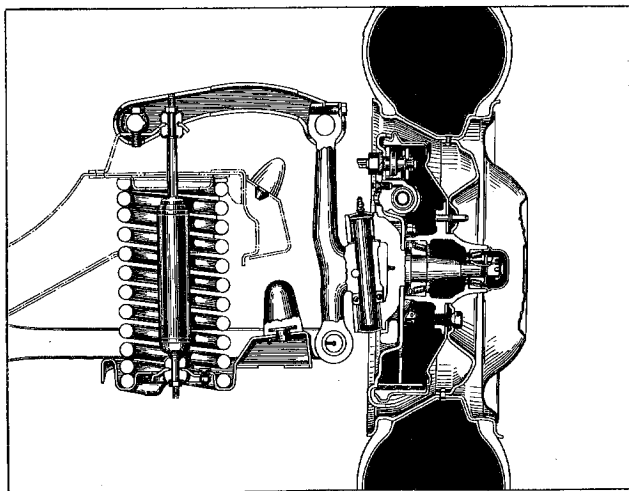
## SERVICING THE STEERING GEAR (Power Steering)



The steering gear used with Power Steering equipped cars has a new and faster steering ratio of 22.5 to 1 for quicker steering and faster control.

Needle roller bearings are used in the steering gear shaft and a threaded pivot bushing on the idler lever.

## PRELIMINARY OPERATIONS BEFORE STEERING GEAR ADJUSTMENTS

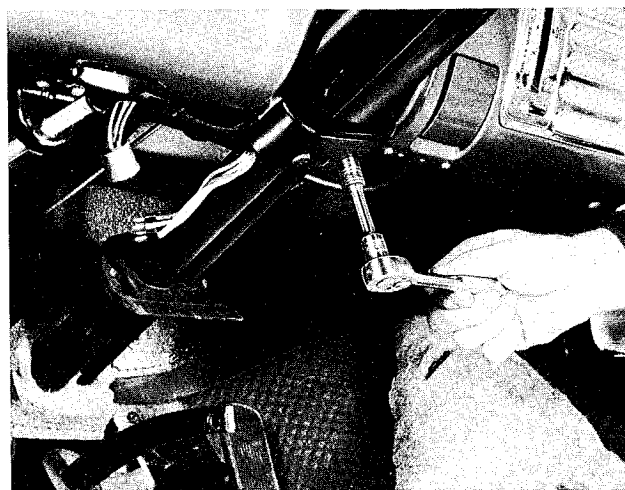


Sometimes there are conditions affecting the operation of the steering gear which are not the fault of the steering gear itself but to closely related factors—front end alignment, shock absorbers, tire pressures, wheel balance, etc. Therefore, before making any adjustments or disassembly of the steering gear, these items should be checked and adjusted, if necessary.

## Steering Gear Alignment

It is very important that the steering gear be properly aligned to the frame before proceeding with any adjustments to the steering gear. Misalignment places a stress on the steering worm shaft so that the shaft must alternately bend during each revolution.

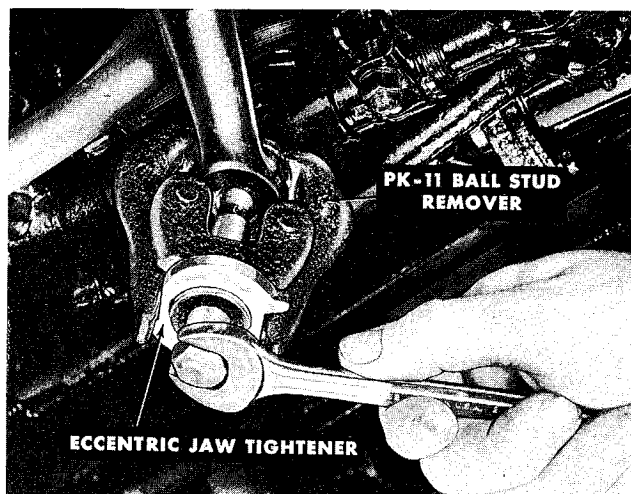
To align the steering gear, loosen the steering gear to frame bolts to permit the gear to align itself to the height determined by the column to instrument panel bracket. Check the seat of the steering gear mounting pad to the frame, and if there is a gap at either of the attaching bolts, proper alignment may be obtained by placing shims where excessive gap appears. This will bring the mounting pad in proper alignment with the frame. Torque tighten the steering gear case to frame bolts to 55 to 60 foot pounds.



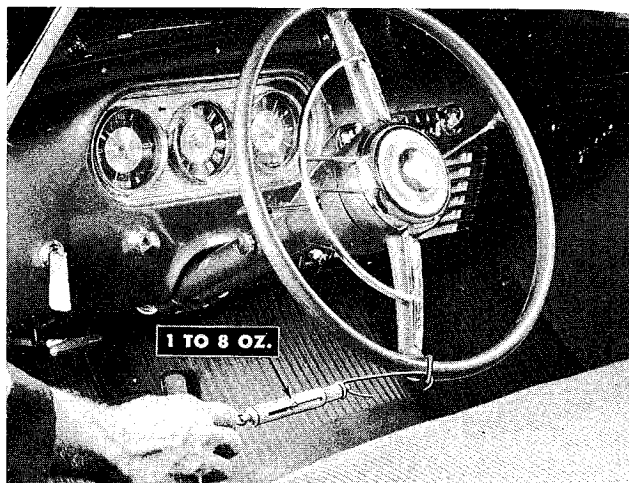
Loosen the column to instrument panel bracket, and if necessary shift the bracket on the instrument panel to align the steering column laterally. In some cases, it may be necessary to elongate the holes in the instrument panel to obtain proper alignment.

## Worm Bearing Inspection and Adjustment

Remove the pitman arm nut at the control valve ball stud.



Using Ball Stud Remover No. PK-11, "pull" the pitman arm loose from the ball stud and push linkage up out of the way. Turn the steering wheel to the extreme right or left stop and back up approximately  $\frac{1}{8}$  turn. This is necessary so that the worm and roller are not on the high spot when the worm bearing inspection is made.



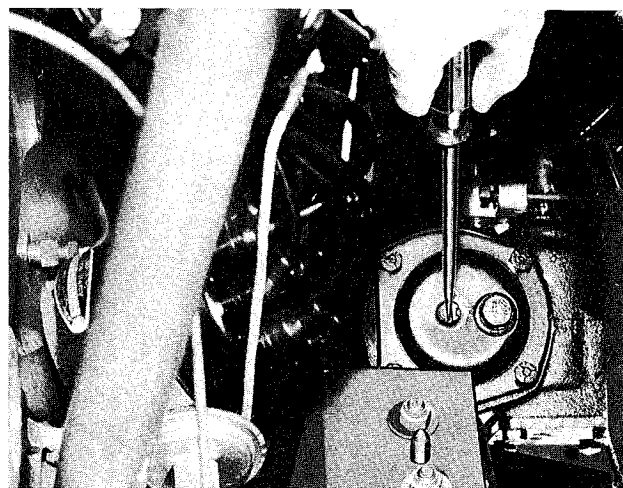
With a spring scale attached to the outside edge of the steering wheel rim, the pull required to turn the steering wheel should not be less than 1 oz. nor more than 8 oz., as indicated on the spring scale.

If the pull required to turn the steering wheel is less than 1 oz., loosen the four cover attaching screws and back them out approximately  $\frac{1}{8}$  inch. Move the cover away from the steering gear, separate the shims, and remove the thinnest shim, being careful not to damage the remaining shims. Tighten the worm cover attaching screws to a torque tightness of 15 to 18 foot pounds, and recheck the effort required to turn the steering wheel. If the reading on the scale still indicates less than 1 oz. pull, remove another shim. However, if the pull exceeds 8 oz., the worm cover should be removed and a .003 inch shim should be added and the pull rechecked after the worm cover is installed and tightened.

**NOTE:** These shims are available in three thicknesses: .003 inch, .005 inch, and .010 inch. Do not remove more than 1 thin shim without rechecking the steering wheel effort or pull. Be sure the worm cover plate is not distorted. If it is damaged or distorted, it should be replaced with a new cover. After the worm bearing adjustment is properly performed, proceed with the cross shaft inspection and adjustment.

### Cross Shaft Inspection and Adjustment

Locate the straight-ahead or high spot position of the steering gear by turning it to the stop at the extreme left or right and then turning back  $\frac{1}{2}$  of the number of revolutions required to turn the steering gear from the extreme left to right. Turn the steering wheel  $\frac{1}{4}$  turn to either side of the straight-ahead or high spot position. Pull the steering wheel through the high spot with a spring scale attached to the outside edge of the steering wheel rim. The pull should increase approximately to 12 oz. when passing through the high spot. The total effort or pull should not exceed 12 oz. If the pull or effort is outside these limits, the cross shaft should be adjusted.



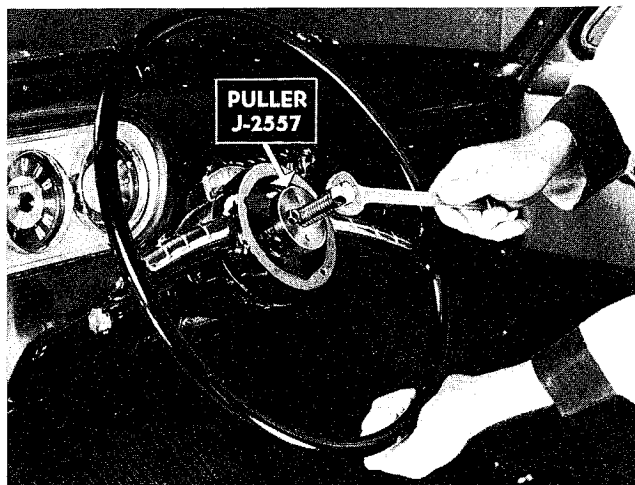
Turn the steering wheel to the straight-ahead or high spot position. Remove the cross shaft adjusting screw lock nut, and raise the lock plate enough to clear the jaws on the cross shaft cover.

Turn the adjusting screw until the effort required to pull the steering wheel through the high spot position is approximately 12 oz. Turning the screw clockwise brings the cross shaft roller in closer mesh with the worm and increases the effort, while turning the screw counter-clockwise moves the roller away from the worm and decreases the effort.

**NOTE:** Do not attempt to adjust the cross shaft until the steering gear alignment and worm bearing adjustment are known to be correct. Recheck the operation of the steering gear off the "spot." There should be no binding or drag in excess of 3 oz. when the gear is off the high spot.

### Steering Gear Removal

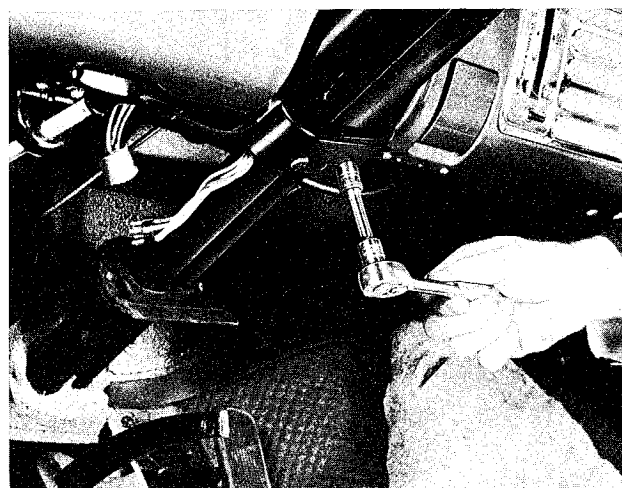
Disconnect the horn button cable at the bottom of the steering gear case. Remove the horn button by pressing down on the button and turning it counter-clockwise. Remove the horn blowing ring.



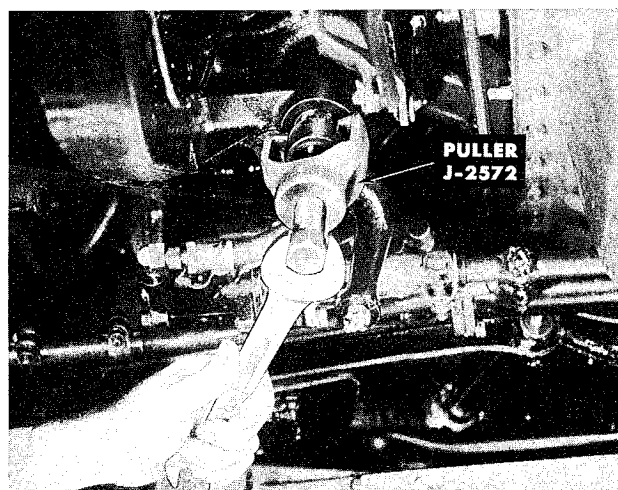
Remove the steering wheel attaching nut and remove the steering wheel, using Steering Wheel Puller J-2557 and Adapter J-2557-3.

Disconnect the directional switch cable connector. Disconnect the windshield wiper cable control at the motor. Remove the clutch and brake pedal pads. Remove steering column grommet to floor board screws. Raise the steering column grommets and the left front corner of the floor mat. Remove clutch and brake pedal cover plate.

If car is equipped with Easamatic brake, remove the clevis pin connecting brake pedal to Easamatic Valve rod. Remove the Easamatic unit and toe board plate screws and allow unit to slip down and rest on opening.



Remove steering column to bracket capscrews and remove bracket. Loosen the bottom steering gear shift shaft and housing u-bracket nuts. Disconnect the low, reverse, second, and high shifting rods from the levers at the lower end of the gear shift shaft, or the Ultra-matic Drive shift linkage. Loosen the steering gear case to frame bolts. Remove the steering column and shroud assembly through the opening in the floor board. If the car is equipped with Easamatic brakes, turn the column and shroud over from the right to the left position to allow sufficient room for the shift lever shafts to clear floor board opening while the column and shroud assembly is being pulled through.



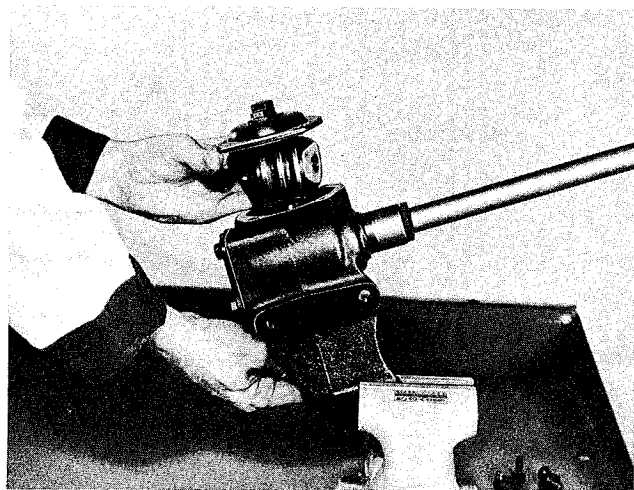
Remove the pitman arm nut and pull the pitman arm from the cross shaft using Pitman Arm Puller J-2572.

Remove the steering gear case to frame attaching screws and remove the steering gear from the car.

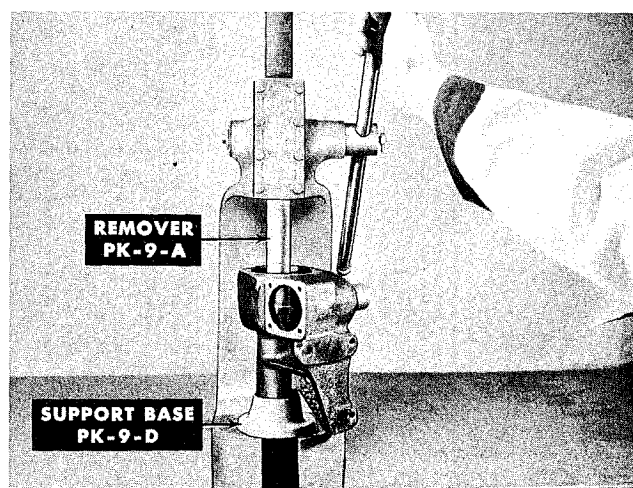
### Steering Gear Disassembly

Drain the lubricant from the steering gear. Support the steering gear in a vise by clamping the jaws of the vise over the mounting pad.





Remove the cross shaft cover and lift out the cross shaft. Remove the worm cover and tube assembly and shims. Remove the worm and shaft and the worm bearings and cups out of the lower end of the steering gear case. If the cross shaft bearings are in need of replacement, they may be pressed out in the following manner. Position the steering gear case in an arbor press with the cross shaft cover end of the case up and the bottom end supported in PK-9-D Support Base.



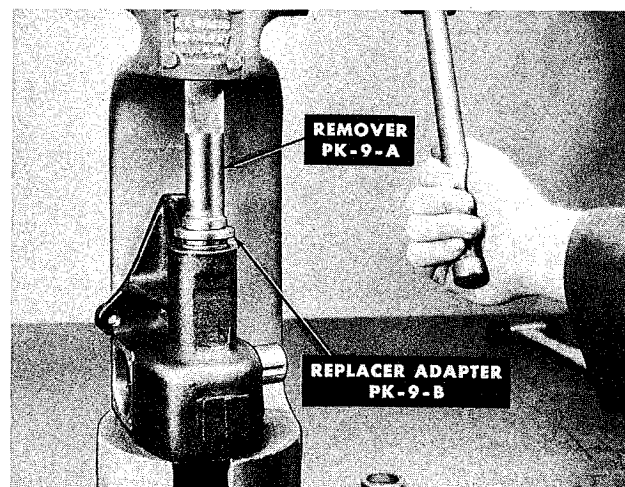
Using Cross Shaft Bearing and Sleeve Remover No. PK-9-A, install this tool in the inner bore of the needle bearing and press out the two needle bearings, sleeve and oil seal.

## Cleaning and Inspection

Clean all the steering gear parts with clean, unleaded gasoline, naphtha, kerosene, or carbon tetrachloride. Blow the parts dry with compressed air. Inspect the worm and cross roller for wear, roughness, or flat spots. Inspect the bearings and cups for wear, scores, chips, or pits. Inspect the cross shaft and bearings for excessive wear or damage. Inspect the cross shaft oil seal. Replace any parts that do not meet inspection standards with new parts.

## Steering Gear Assembly

If the needle bearings, sleeve, and oil seal for the steering gear cross shaft have been removed from the steering gear case bore, lubricate these parts with steering gear oil before reassembling in case. To reassemble, position the steering gear case in an arbor press with the oil seal end of the case into PK-9-D Support Base. Using Cross Shaft Bearing and Sleeve Remover No. PK-9-A, press the needle bearing with the lettered end up against the shoulder of the tool until it is below flush of the top end of the bore. Then install the split sleeve into the bore until it contacts the lower end of the bearing.



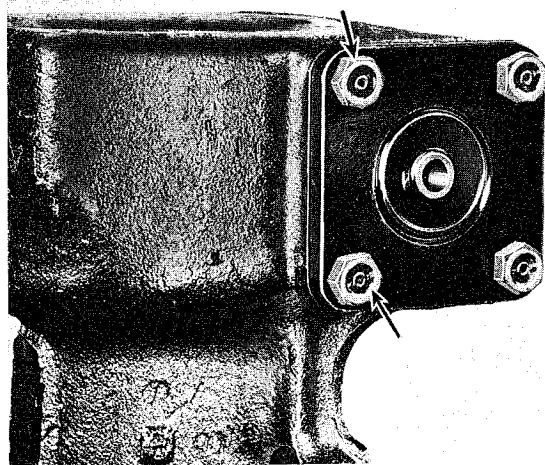
Install Cross Shaft Bearing Replacer Adapter No. PK-9-B on Cross Shaft Bearing and Sleeve Remover No. PK-9-A and press in the remaining needle bearing assembly until the tool bottoms against the outer end of the gear case. Remove Replacer Adapter PK-9-B and install Cross Shaft Oil Seal Replacer Adapter PK-9-C on PK-9-A with the tapered end facing this tool.



Lubricate the oil seal with steering gear oil and press it into the case until the seal bottoms.

When the gear case has not been removed from the car and the oil seal requires replacement, it may be tapped into position using the tools specified for that purpose.

Lubricate the worm bearing and cups with a heavy lubricating oil. The short bearing cup is used at the upper end. Install the upper bearing cup and felt seal in housing. Slide the bearing over the end of the worm and shaft assembly and install this assembly in the case. Install lower bearing and cup. Install the adjusting shims, and worm cover. Check the worm bearing adjustment as described under Worm Bearing Inspection and Adjustment. Temporarily install the steering wheel to make this check.



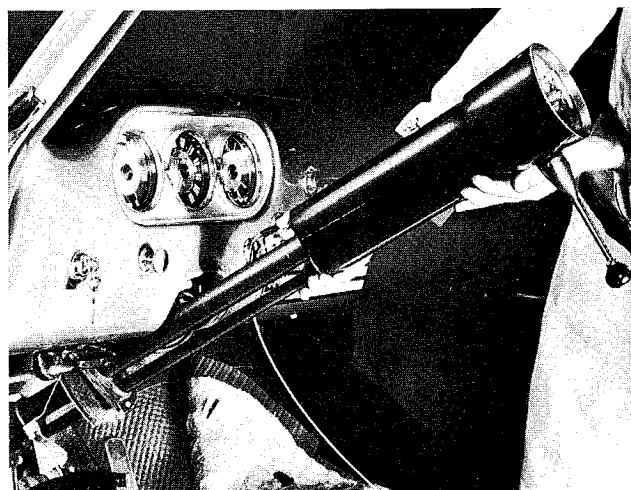
After the worm bearing adjustment is performed, remove the two cover attaching screws nearest to the cross shaft as indicated by arrows, and coat the threads of these screws with a suitable sealing compound: Reinstall and torque tighten these screws to 15-18 foot pounds. This is necessary since these holes are tapped directly into the steering gear case, and unless the threads were sealed would result in steering gear lubricant leakage.

After the worm bearings are properly adjusted, install the cross shaft and cross shaft cover, making sure that the cross shaft adjusting screw head and plate fit into the slotted, claw-like recess of the cross shaft. Be sure to use a new gasket when installing the cross shaft cover. Back off the cross shaft adjusting screw before tightening the cover plate attaching screws.

Adjust the cross shaft to obtain approximately 12 oz. pull at the steering wheel through the high spot. After the steering gear cross shaft is properly adjusted, install the lock plate and lock nut and remove the steering wheel.

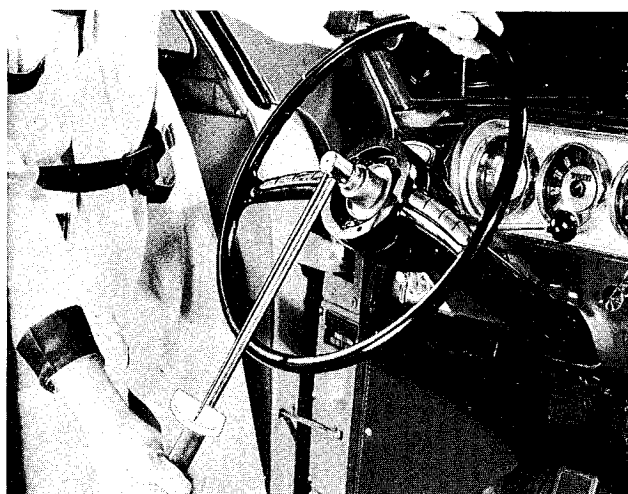
### Steering Gear Installation

Install the steering gear case on the frame side leaving the attaching capscrews finger tight at this time.



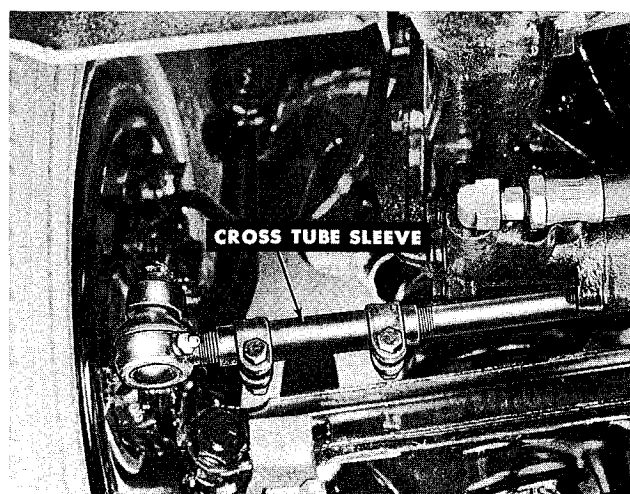
Install the column jacket and shroud assembly. Tighten the clamp around the lower end of the column jacket. Install the steering column to instrument panel bracket with the attaching capscrews and tighten securely. Connect the directional signal switch. Connect the windshield wiper cable at the motor. Connect the gear shift rods at the lower end of the steering gear.

Lubricate the steering column upper bearing and install bearing. Install the steering column upper bearing thrust spring. Install the steering wheel, making certain that it is in the straight-ahead position when the steering gear is in the center of the high spot. Install horn contact cup and steering wheel attaching nut.



Torque tighten steering wheel attaching nut to 50-55 foot pounds. Check clearance between the steering wheel and shroud. This clearance should be  $\frac{1}{16}$  inch, and may be adjusted by loosening the column to instrument panel bracket cap. The shroud may be shifted up or down to obtain this clearance.

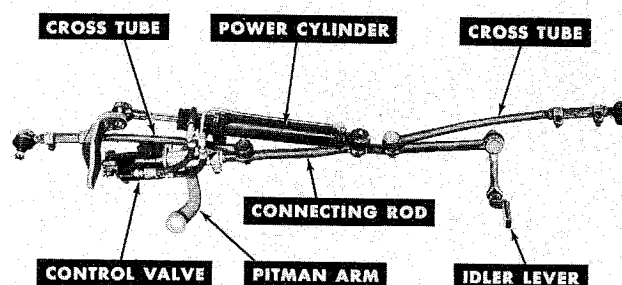
Tighten the lower U clamp attaching nuts to 15-18 foot pounds. Tighten the steering gear case to frame bolts. Install pitman arm, lockwasher, and nut. Torque tighten nut to 100-110 foot pounds. Install brake and clutch cover plate. Or if car is equipped with Easamatic Brake install Easamatic unit and the 4 attaching bolts. Install clutch and brake pedal plate. Install floor mat in place. Install clutch and brake pedal pads. If car is equipped with Easamatic Brake, connect brake pedal to valve rod. Install steering column grommet and insulating pad in place. Install the pad to floor attaching screws. Connect horn wire at lower end of steering gear. Fill steering gear case with S.A.E. 90 transmission lubricant to approximately 1 inch below the level of the plug. Install the plug.



With the steering wheel in the straight-ahead position and the steering gear in the center of the high spot, adjust the steering cross tube sleeves until the wheels are in the straight-ahead position and there is zero to  $\frac{1}{16}$  inch toe-in.

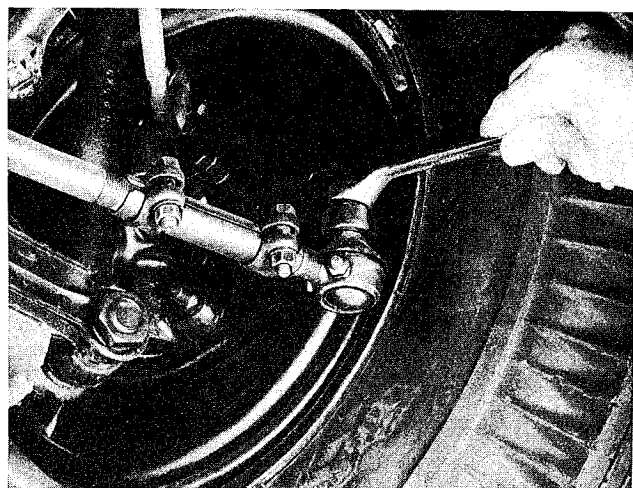
## SERVICING THE POWER STEERING LINKAGE

The steering linkage will seldom require any attention other than the proper lubrication at the specified 1000 mile intervals.



With power steering a new type of linkage is used. The steering connecting rod instead of being tubular is now a solid bar. The ball sockets for the pitman arm and idler lever are located in line with the connecting rod with the ball sockets of the cross tubes to the steering knuckle levers being located on the forward side of the steering connecting rod.

The connecting rod has the control valve threaded on the left end. At the opposite end it attaches to the steering idler lever. It no longer contains an adjustment for the spring load on the ball joints at the outer ends. When the right connecting rod ball socket is excessively worn, the entire rod must be replaced, as the ball joint retainer is "spun" into the right connecting rod. The ball joint on the end of the power cylinder piston rod is threaded on and then welded to the end of the rod while the cylinder end ball joint retainer is "spun" into the end of the cylinder. To replace these ball sockets, it is necessary to replace either the power cylinder piston rod assembly, or the power cylinder body. The right and left steering cross tubes remain unchanged at the outer end having the ends that are adjustable and replaceable if necessary. The ball joint retainers at the inner end of the cross tubes are also "spun" into the tube ends. When these tubes are bent or the ball joints worn at the inner ends, the tube and joint is replaced as an assembly.



When it is necessary to disconnect the ball joint studs from the connecting rods or cross tubes, this can be accomplished by removing the cotter pin and attaching nut. The ball stud end of the joint may then be pulled loose by using Ball Stud Remover Tool No. PK-11. After reassembling the ball joints, tighten the attaching nuts to 45-50 foot pounds and lock the nut with a new cotter pin.

### Steering Linkage Centering Adjustment

Set the steering wheel in the straight-ahead position and the steering gear in the center of the high spot. Adjust the cross tube adjusting sleeves until the wheels are in the straight-ahead position and there is zero to  $\frac{1}{16}$  inch toe-in. Torque tighten the adjusting sleeve clamp screws to 15-18 foot pounds.

### Steering Wheel Removal

Disconnect the horn button cable at the connector at the bottom of the steering gear case. Press down on the horn button and turn it counter-clockwise and remove it from the horn ring. Remove the button cushion. Remove the horn ring, button contact plate and spring retainer. Remove the spring. Remove the steering wheel attaching nut. The steering wheel may be pulled using Steering Wheel Puller J-2557 and Steering Wheel Puller Adapter J-2557-3.

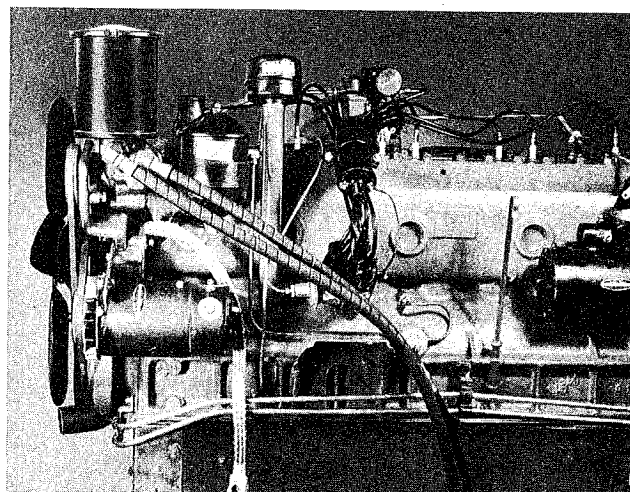
### Steering Wheel Installation

Align the wheels and install the steering wheel in the straight-ahead position.

Install the ring contact plate and nut. Tighten steering wheel attaching nut to 50-55 foot pounds.

Install the spring and spring retainer. Install the button contact plate and horn ring. Install the button cushion and button. Connect horn wire at the lower end of the steering gear case.

### POWER STEERING LUBRICATION



The Packard Power Steering hydraulic system is sealed requiring only a nominal amount of care. The hydraulic system, including the reservoir, holds approximately two quarts of fluid. This fluid should be checked at the first 1000 miles and every 5000 miles thereafter.

Ultramatic fluid should always be used, or if not available, use a Type "A" automatic transmission fluid which has an AQ-ATF number embossed on the can.

The fluid level should be maintained at 1" from the top of reservoir. This level is stamped on the outside of the reservoir. The minimum safe fluid level would be not lower than the top of the filter cartridge in the fluid reservoir. If loss of fluid is noted, the hose fittings should be checked for leakage.

**CAUTION:** In the event of damage to any of the power steering units such as the power pump, power cylinder, valve assembly, hoses or connections, and there is excessive leakage of fluid, it is recommended that the belt driving the power pump be removed. Running the power pump without sufficient fluid will severely damage the pump.

# Section IV

## TROUBLE SHOOTING AND CORRECTIVE MEASURES

CONDITION	POSSIBLE CAUSE	CORRECTION
<b>1. Hard steering.</b>	(a) Failure of pump.	Replace or recondition pump.
	(b) Loose or broken belt.	Tighten or replace.
	(c) Badly worn pump parts.	Recondition pump.
	(d) Broken or weak relief valve spring.	Replace spring.
	(e) Sticking relief valve.	Free up valve.
	(f) Low pump pressure.	Replace worn or faulty parts.
	(g) Line leakage.	Tighten connections.
	(h) Fluid in system low.	Fill to correct level.
	(i) Under-inflated tires.	Inflate to proper pressure.
	(j) Bent linkage.	Replace damaged parts.
	(k) Steering tube mis-alignment.	Check alignment and correct.
	(l) Steering adjustment tight.	Check adjustments at worm and roller.
	(m) Improper wheel alignment.	Align wheels.
	(n) Lack of lubrication.	Lubricate.
	(o) Leakage in power cylinder past piston ring.	Recondition power cylinder. Check cylinder for out of round.
	(p) Air in system—improperly bled.	Bleed the system.
	(q) Pump control valve sticking.	Free up the valve.
	(r) Control valve spool out of round, or damaged.	Replace the spool.
<b>2. Steering too sensitive.</b>	(a) Overinflated tires.	Check pressure of tires.
	(b) Pump pressure too high.	Check for sticky check valve.
	(c) Flow control valve stuck in closed position.	Free up control valve.
<b>3. Loose steering.</b>	(a) Wheels out of alignment.	Align wheels.
	(b) Loose ball joints.	Tighten joints or replace.
	(c) Loose steering knuckle pins.	Recondition.
	(d) Wheel bearings loose or worn.	Adjust the wheel bearings.
	(e) Lash in linkage.	Tighten ball joint or replace.
	(f) Air in system—improperly bled.	Bleed the system.
	(g) Shock absorbers not operating properly.	Replace if faulty.
	(h) Loose steering gear to frame bolts.	Tighten bolts.
	(i) Steering gear needs adjustment.	Adjust worm and roller.
	(j) Loose pitman arm.	Tighten pitman arm.

## TROUBLE SHOOTING AND CORRECTIVE MEASURES—Continued

CONDITION	POSSIBLE CAUSE	CORRECTION
<b>4. Poor centering.</b>	(a) One tire underinflated.	Check tire pressures.
	(b) Faulty or binding control valve spool.	Recondition valve. Be sure the pin is installed correctly.
	(c) Control valve spool nut too loose or too tight.	Adjust the nut properly.
	(d) Loose wheel bearings.	Adjust wheel bearings.
	(e) Steering misalignment.	Align steering.
	(f) Binding power cylinder.	Recondition power cylinder.
<b>5. Car will steer with ease in one direction but with effort in opposite direction.</b>	(a) Foreign matter in valve spool or incorrect assembly.	Clean and reassemble control valve.
	(b) Faulty power cylinder.	Recondition power cylinder.
	(c) Damaged fluid transfer tube on power cylinder.	Replace tube.
	(d) Ball checks sticking in the power cylinder body adaptor assembly.	Recondition power cylinder. Flush and blow out with air the passages in power cylinder. Sticking check valves will show up when making check with pressure gauge.
<b>6. Poor recovery.</b>	(a) Lack of lubrication of linkage.	Lubricate linkage.
	(b) Steering gear adjusted too tight.	Adjust according to specifications for power steering.
	(c) Improper caster adjustment.	Readjust caster and camber.
	(d) Low tire pressure.	Inflate to proper pressure.
	(e) Stop nut pin installed in wrong hole causing spool assembly to bind in bore.	Install the pin correctly.
<b>7. Pump noise.</b>	(a) Improper fluid level.	Fill to correct level.
	(b) Loose return hose connection.	Tighten or replace hose.
	(c) Pump belt squeal.	Adjust belt tension.
	(d) Hose rubbing against other parts.	Reroute hose.
	(e) Mechanical trouble in pump, worn parts, etc.	Replace or recondition.
	(f) Clogged intake line or filter.	Clean out line or replace filter.
	(g) Pump pulley loose.	Tighten pulley or install new pulley.
	(h) Relief valve chattering.	Check for sticky valve and free up.
	(i) Improper fluid used in power system.	Drain and fill with Ultramatic fluid.
	(j) Wheels held at stops too long. Overheating pump.	Do not hold at stops any longer than necessary.



## TROUBLE SHOOTING AND CORRECTIVE MEASURES—Continued

CONDITION	POSSIBLE CAUSE	CORRECTION
<b>8. Low oil pressure when tested with gauge.</b>	(a) Belt slips. (b) Low fluid level. (c) Pump mechanical trouble (worn parts, etc.). (d) Pump relief valve spring weak. (e) Pump relief valve stuck open. (f) Flow control valve stuck open. (g) External leakage. (h) Internal leakage.	Adjust belt tension. Fill reservoir to level with Ultramatic fluid. Overhaul or replace pump. Replace spring. Remove and free up valve. Free up flow control valve. Replace fittings, hoses, or seals. Replace control valve and/or overhaul cylinder assembly.
<b>9. No power action on steering gear when engine is running.</b>	(a) No pressure at pump. (b) Relief valve stuck in open position. All items 8(a) to (h) apply.	Check belt and pulley. Free up relief valve.
<b>10. Chuckle or rattle in steering.</b>	(a) Too much back lash in steering. Worn or loose parts. (b) Control valve improperly adjusted. (c) Ball socket or ball studs not tight.	Adjust steering gear or replace worn parts. Adjust the control valve. Tighten joints or replace.
<b>11. Shimmy.</b>	(a) Lash in linkage (worn or loose steering parts). (b) Wheels out of balance.	Replace worn parts. Balance wheels.
<b>12. Oil leaks (pump).</b>	(a) Loose or defective connections. (b) Hose leaks. (c) "O" ring seals between reservoir and pump. (d) "O" ring seals between connections. (e) Seal on pump shaft. (f) Seal between pump cover and body.	Tighten or replace. Replace hose. Replace seals. Replace seals. Recondition pump. Replace seal.
<b>13. Oil leaks (power cylinder).</b>	(a) Loose or defective connections. (b) Defective seals between cylinder flange and body. (c) Worn spring loaded metal encased seal on shaft. (d) Scored shaft.	Tighten or replace. Replace seals. Recondition cylinder. Recondition cylinder and replace shaft.
<b>14. Oil leaks (control valve).</b>	(a) Worn seals on ends of spool. (b) Dripping of fluid from the ball stud section indicates that the seals on the spool are passing fluid.	Recondition control valve. Recondition the valve assembly.

## **TROUBLE SHOOTING AND CORRECTIVE MEASURES—Continued**

<b>CONDITION</b>	<b>POSSIBLE CAUSE</b>	<b>CORRECTION</b>
<b>15. Control valve noise.</b>	(a) Spool bolt nut loose, causing spool flutter.	Remove the two cap screws and cover from end of control valve body and adjust nut.
<b>16. Steering wheel will not control operation of power steering. (after assembling the units to the car).</b>	(a) Hose connections not connected correctly.	Install hoses to the proper connections.

# NOTES



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