SECTION 8-B

POWER STEERING GEAR AND PUMP

CONTENTS OF SECTION 8-B

SERVICE BULLETIN REFERENCE

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8-8 POWER STEERING GEAR AND PUMP SPECIFICATIONS

a. Tightening Specifications

Use a reliable torque wrench to tighten the parts listed to insure proper tightness without straining or distorting parts. These specifications are for *clean and lightly lubricated threads only:* dry or dirty threads produce increased friction which prevents accurate measurement of tightness.

Part	Location	Thread Size	Torque-Ft. Lbs.
Bolt	Gear Housing Side and End Covers	3/8-16	30-35
Bolt	Power Rack Cover and Guide	3/8-16	30-35
Bolt	Power Cylinder	3/8-16	30-35
Nut	Power Cylinder Bolt	3/8-24	30-35
Bolt	Valve Cover	3/8-16	15-20
Bolt	Gear Housing to Frame Bracket	7/16-20	30-35
Nut	Steering Wheel to Steering Shaft	11/16-20	45-55
Nut	Pitman Arm	7/8-14	100-110
Bolt	Power Cyl. Line Universal Fitting	9/16-18	20-30

b. Steering Gear Specifications

Gear Type	Recirculating Ball Nut and Worm
Make	Saginaw
Ratio, actual	21.3 to 1
Steering Wheel Diameter	18″
Turns of Wheel, Lt. to Rt. (gear connected)	4.5
Lubrication, Gear Housing	Vented Plug
Gear Lubricant	M-P Gear Lubricant
Gear Housing, Oil Capacity (dry)	28 oz.
Lubrication, Hydraulic System	Reservoir
Lubricant, Hydraulic System	Oil for Dynaflow Transmission
Hydraulic System Capacity (dry)	1½ qts.
Number and Type of Steering Shaft Bearings	
Upper End	One Fabric Bushing
Worm End	Two Needle Bearings
Worm and Nut Balls—No. and Diameter	60, 9/32″
Number and Type of Pitman Shaft Bearings	3 Bronze Bushings
Pitman Shaft Diameter—Long End	1.1205″ to 1.1210″
Clearance in Bushings	.0035″ to .0045″
Pitman Shaft Diameter—Short End	1.2485″ to 1.2490″
Clearance in Bushing	.0005″ to .0015″

Adjusting Screw and Shim Clearance in Pitman Shaft	0 to .002″
Piston Clearance in Cylinder	.0065″-.0115″
Piston Ring Side Clearance in Piston	.001″-.003″
Piston Ring Gap, in Cylinder	.005″-.015″
Piston Rod Clearance in Adapter	.0002″ min.
Centering Plunger Clearance in Housing	.0003″-.001″

c. Pump Specifications

Pump Capacity, gal./min. @ 450 RPM (Engine) x 700 psi	1
Relief Valve Opening Pressure, p.s.i.	875-1025
Pump Test Pressure, min. p.s.i. @ 450 RPM (Engine) and 170°F oil temperature	700
Drive Belt Adjustment, Torque on Pulley Nut to Slip Belt	40-45 ft. lbs.

8-9 DESCRIPTION OF POWER STEERING GEAR AND PUMP

Buick Power Steering, standard equipment on Series 70 and Model 100 and available as optional equipment on all other models, consists of a conventional manually operated steering gear to which hydraulic power mechanism has been added. The hydraulic mechanism furnishes additional power to ASSIST the manual operation so that the turning effort required at steering wheel is greatly reduced.

The engine drives the oil pump which furnishes hydraulic pressure. When the engine is not running, or when any part of the power mechanism is inoperative, steering is entirely manual and requires approximately the same effort at the steering wheel as the manual gear used as standard equipment.

With the engine running, steering is entirely manual under conditions which requires an effort of less than four pounds at the steering wheel rim. When a greater effort is required, the power mechanism operates to ASSIST in turning the front wheels. The effort then required at steering wheel rim is thereby limited to a maximum of approximately nine pounds for normal steering and parking conditions, compared to possibly fifty pounds with the standard manual gear. If some abnormal condition requires more work than the power mechanism can do, the driver must assist with increased effort at the steering wheel.

The driver's effort on the steering wheel is always proportional to the force necessary to turn the front wheels. When the effort on the wheel drops to less than four pounds as the turn is completed, power assistance ceases. When the wheel is released to recover from the turn, the front wheels may return to the straight ahead position in the usual manner without assistance or interference from the power mechanism. Through this conventional steering action the driver always has the "feel" of steering which is essential to confidence in controlling the direction of the car.

It should be noted that power steering always follows the manual steering action. *No steering action is obtained except through the manual guidance of the driver.*

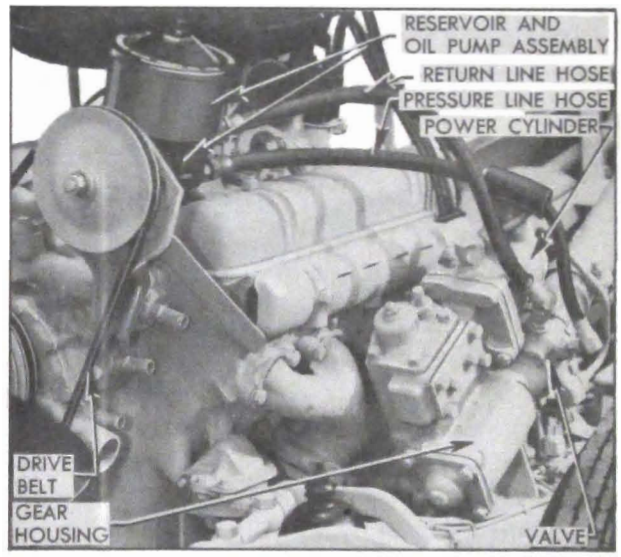

Figure 8-12—Power Steering Gear and Pump Installation

The hydraulic power mechanism added to the steering gear includes a power cylinder and rack connected to a separate gear sector on the steering gear pitman shaft, a hydraulic valve mounted concentric with the steering shaft and operated by the shaft, a high pressure oil pump driven by a belt from the engine, an oil reservoir integral with the pump, and connecting hoses. See figure 8-12.

The hydraulic units are filled with the same oil as specified for Dynaflow transmissions. The steering gear housing is filled with regular steering gear lubricant.

a. Power Steering Gear Assembly

The power steering gear assembly is the recirculating ball nut and worm type, having a ratio of 21.3 to 1.

As shown in figure 8-13, the upper end of the

pitman shaft is extended and provided with a separate gear sector which meshes with a power rack mounted in the gear housing. The power rack is pinned to the piston rod of the power cylinder, mounted on the rear side of gear housing, and is held in proper mesh with the pitman shaft sector by a guide attached to a shim adjusted housing cover (not shown).

with centering springs and plungers contained in the hydraulic valve. One thrust bearing butts against a shoulder and the other bearing is retained by a spring (washer) and a threaded nut on the worm section of steering shaft. The inner races of both bearings contact the valve centering plungers which are under pressure of the centering springs. See figure 8-13.

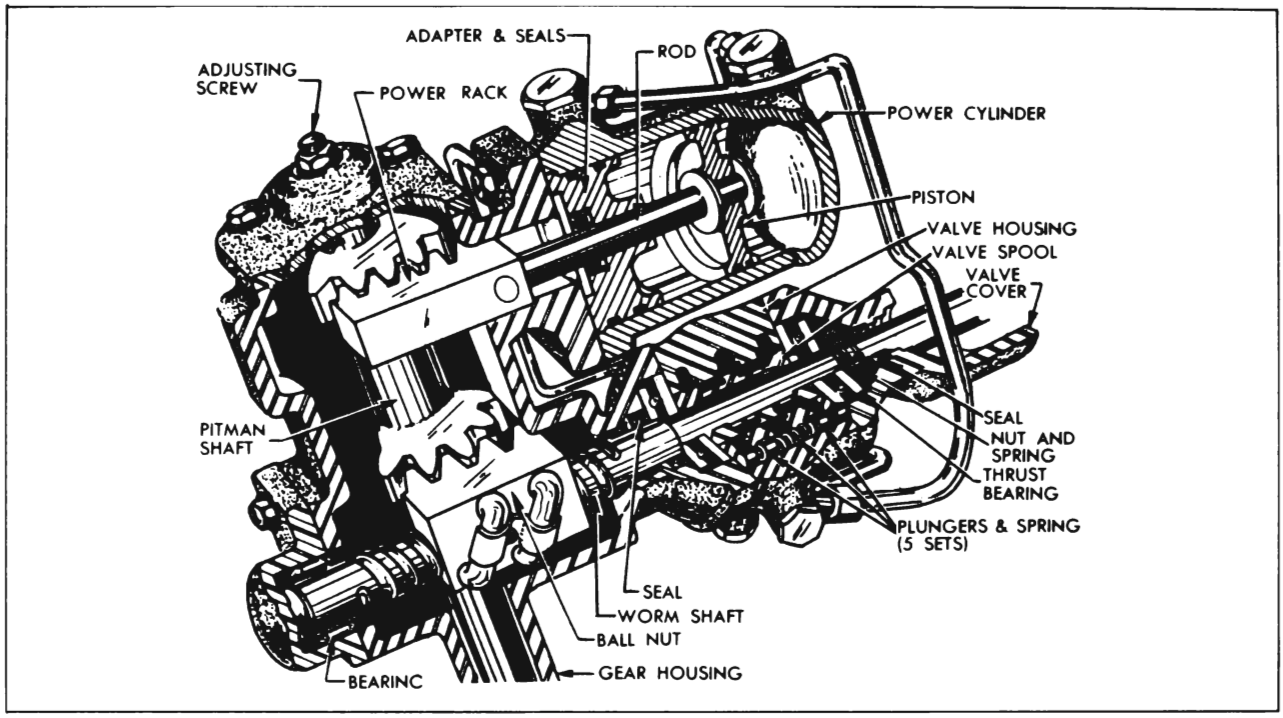

Figure 8-13—Power Steering Gear Assembly

The power cylinder is a double acting type since oil pressure may be applied to either side of the piston through external tubes connected to the hydraulic valve, described below (subpar. b). An adapter closes the inner end of the cylinder and provides a bearing for the piston rod. The two outer grooves in the circumference of the adapter contain "O" ring rubber seals, and the bore is fitted with a spring loaded rubber seal to prevent escape of oil at piston rod. See figure 8-13. Normal seepage of oil through the bearing is bled back to the hydraulic valve through passages in adapter and cylinder connected to an external tube.

The upper end of steering shaft is supported by a fabric bearing mounted in steering column jacket. The lower (worm) end of shaft is supported in gear housing by two needle bearings. These bearings permit axial (endwise) movement of the shaft.

Axial movement of the steering shaft is opposed by two flat thrust bearings in conjunction

Axial movement of the steering shaft under load is limited to approximately .030" either way from the neutral (no load) position by the clearance between the thrust bearings and the hydraulic valve housing. This axial movement is used to operate the hydraulic valve.

b. Hydraulic Valve

The hydraulic valve controls the flow of oil from the pump to the proper side of the power cylinder piston when power assistance is required and cuts off this flow when power assistance is not required. It also regulates the effort at steering wheel within the normal range of four to nine pounds so that this effort is proportional to the force necessary to turn the front wheels, thereby providing the "feel" of steering previously mentioned.

All parts are contained in the valve housing which is mounted on the steering gear housing and is concentric with the steering worm shaft. The housing has one central annular groove con-

nected to the oil pump and two outer annular grooves connected to the reservoir.

A valve spool, having a very close sliding fit in valve housing, is mounted concentric with the worm shaft and between the worm thrust bearings so that it moves with these parts. The spool contains two annular grooves which control the flow of oil between the grooves and oil passages in valve housing. See figure 8-13.

The housing contains five equally spaced *pairs* of centering plungers which are forced outward against the gear housing and the valve cover by a heavy coil spring located between the plungers. As previously explained, the worm thrust bearings contact the plungers so that axial movement of the worm shaft is opposed by the plungers and springs.

The worm shaft and thrust bearings will move the spool endwise in the valve housing, permitting oil flow to the power cylinder, whenever the thrust load on the worm shaft is sufficient to overcome the preload of the centering springs. The resulting control of the power mechanism will be fully explained in paragraph 8-10.

The check valve located in the hydraulic valve housing permits the oil displaced by the power cylinder piston to bypass the oil pump during manual operation whenever the oil pump is not operating. It also prevents oil from overflowing through the reservoir vent under the same conditions.

c. Oil Pump

The Vickers oil pump, which is mounted on the engine in position to be driven by a belt from the crankshaft balancer, converts some engine power into oil pressure which is used by the power cylinder and rack to rotate the pitman shaft.

The pump houses a slotted driving hub or rotor in which twelve vanes slide radially outward to contact the hardened and ground inside surface of a ring. As the shaft and rotor rotates, centrifugal force and fluid pressure against the inner ends cause the vanes to follow the cam contour of the ring, which is so shaped that two opposing pumping chambers are formed. See figure 8-37. In each pumping chamber, the increasing and decreasing pockets formed between the rotor, vanes, and ring propel the oil from the reservoir into a discharge cavity in the pump cover.

Oil flows from the discharge cavity into the exit port in pump cover through a restricted passage (.1015" dia.) therefore pressure in the discharge cavity is always greater than in the exit port. A control valve assembly regulates the opening of another passage through which oil may be bypassed back to the reservoir. See figure 8-14. The valve assembly includes a flow valve and a pressure relief valve.

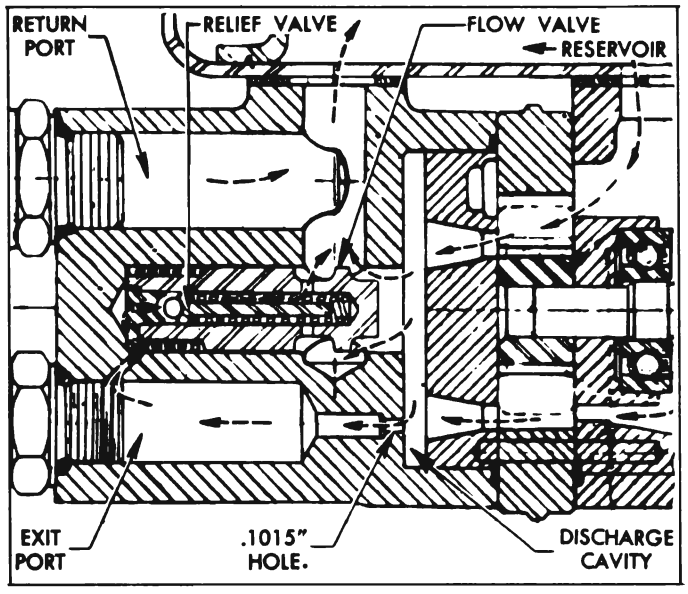

Figure 8-14—Flow and Pressure Relief Valve Operation

When pump is running without demand for steering pressure, pressure in the discharge cavity is high enough to push the flow control valve open against a spring load of approximately 6.5 pounds. A small orifice leads oil from the exit port into the spring chamber and this pressure tends to close the valve. Since pressure in the discharge cavity is always greater than in the exit port the valve is not closed, and the flow valve action depends on the spring load and the difference in pressure on the inner and outer ends of the valve.

When power steering is demanded and the steering gear hydraulic valve cuts off free circulation of oil as described later (par. 8-10), the pump pressure builds up rapidly. When pump output pressure reaches a predetermined maximum the increased pressure in the flow valve spring chamber forces the pressure relief valve open, and oil escapes from the spring chamber into the by-pass passage. As oil pressure is relieved in the spring chamber, the high pressure in the pump discharge cavity overcomes the spring load to completely open the flow valve. See figure 8-14. Oil is dumped into the by-pass passage until the line pressure opposing the pump drops below the relief valve setting, permitting this valve to close. The flow valve then resumes normal operation.

The flow valve starts to open at 300-400 RPM of pump and is functioning when pump idles at 465 RPM (450 RPM of engine). The minimum flow the pump must produce is 1 gal. per minute at 465 RPM against a pressure of 700 psi. The flow valve permits a maximum flow of 1.8 gal. per minute at 2000 RPM against a pressure of 50 psi. The pressure relief valve is set for 875-1025 psi.

d. Reservoir and Hoses

The reservoir is mounted on top of the oil pump and provides a reserve supply of oil to assure complete filling of the hydraulic system. The reservoir is vented at the cover bolt by bleed grooves in the washer which permits escape of any air that may be introduced into the system during assembly of the various units.

A pressure line hose and a return line hose connects the oil pump to the hydraulic valve in the steering gear. See figure 8-12. The pressure line hose is reduced in size at the valve end to provide a dampening effect on any turbulence in the oil stream.

8-10 OPERATION OF HYDRAULIC POWER MECHANISM

When the steering wheel is turned, the ball nut must move axially along the worm shaft in order to rotate the pitman shaft and thereby turn the front wheels through the connecting linkage. Movement of the ball nut is opposed by the force necessary to turn the front wheels, consequently the worm shaft tends to move endwise through the ball nut. The ball nut and worm shaft act like a screw jack to thrust a load against one worm thrust bearing, tending to move the bearing.

Movement of the thrust bearing (and worm shaft) is opposed by the centering plungers and springs in the hydraulic valve, therefore the thrust load must exceed the 290 pound total preload of the five centering springs before the worm shaft can actually move endwise. A pull of four pounds on the steering wheel rim produces a thrust load of 290 pounds, consequently the worm shaft will move endwise only when the force necessary to turn the front wheels requires an effort of more than four pounds at the steering wheel.

Since movement of the hydraulic valve spool is controlled by the worm shaft and thrust bearings it remains in the neutral or centered

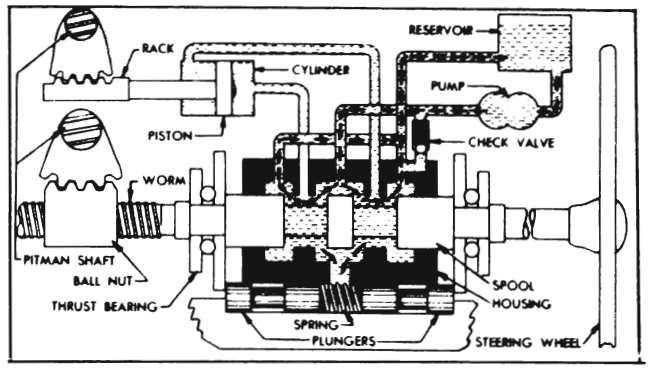

Figure 8-15—Oil Circulation Without Power Application

position in valve housing whenever the effort applied to steering wheel is less than four pounds. In this case the oil merely circulates from the pump through the valve and reservoir without having any effect on the steering operation. See figure 8-15. Although the power cylinder is filled with oil there is no interference with manual steering because the oil displaced by the piston can flow from one side of the piston to the other through the hydraulic valve.

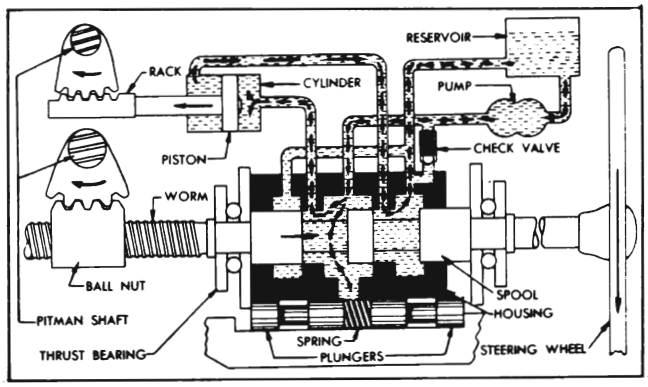

Figure 8-16—Oil Circulation During Power Application on a Left Turn

When the steering wheel is turned *left* with an effort greater than four pounds, the resulting thrust load compresses the centering springs and the worm shaft moves the spool *upward* in the valve housiing. The spool then routes the oil flow from the pump into the *upper end* of the power cylinder. The passage to the lower end of power cylinder is left open for return of oil to the reservoir. See figure 8-16.

Flow of oil into the power cylinder is resisted by the piston because of its connection to the pitman shaft. The oil pump then builds up just enough pressure to overcome this resistance so that just enough power is applied to rotate the pitman shaft.

Since the pitman shaft is also geared to the ball nut on the worm shaft it is obvious that the

pitman shaft cannot turn unless the steering wheel is also turned. Thus, *power steering cannot be applied without manual steering.*

As the pump pressure builds up, oil pressure is also directed against the inner ends of the centering plungers. This pressure, added to the centering spring preload, tends to force the spool back to the neutral position. Since the pump pressure builds up in proportion to the force necessary to turn the front wheels, the corresponding pressure on the plungers creates a reaction that must be overcome by effort on the steering wheel. In this way, the effort required at the steering wheel is regulated in proportion to the resistance of the front wheels, giving the "feel" of steering previously mentioned.

The effort on the steering wheel naturally drops to less than four pounds as the turn is completed; therefore the centering springs and plungers return the valve spool to the centered position, thereby cutting off application of oil pressure to the power cylinder. When the spool returns to the centered position, steering becomes entirely manual. The oil merely circulates through the hydraulic valve as shown in figure 8-15 and the oil pressure drops because there is virtually no resistance to oil flow.

Power steering on a *right turn* is accomplished in the manner described except that the worm thrust is in the opposite direction, therefore the valve spool moves *down* to route oil to the *lower end* of the power cylinder so that power will be applied to turn the pitman shaft in the opposite direction.

When the front wheels strike an obstruction which kicks them to the *left*, the force is transmitted through the steering linkage and pitman shaft to exert a *downward* thrust on the ball nut and worm shaft; this is opposite to the direction of thrust when the steering wheel is turned left. If the thrust load exceeds 290 pounds, the valve spool will move down to route oil flow to the *lower end* of power cylinder, thereby applying opposing power to counteract the leftward movement of the front wheels. The opposite action occurs when the wheels are kicked to the right. In this manner, the power mechanism counteracts road shock before it is transmitted to the steering wheel.

The check valve located in the hydraulic valve housing remains closed when the oil pump is operating. When the oil pump is not operating and the steering gear is operated manually, the oil displaced by the power cylinder piston flows through the check valve and back into the central groove of valve housing without passing through the reservoir and pump. The oil bypasses the pump which would obstruct its flow. This feature also prevents overflowing of oil through the reservoir vent.

8-11 TROUBLE DIAGNOSIS—POWER STEERING GEAR AND PUMP

This paragraph will cover only those causes of trouble which may be due to the hydraulic power mechanism. Causes which are due to the mechanical components of the steering gear, linkage, and front suspension are the same as described for the standard steering gear in paragraph 8-3.

Before assuming that the hydraulic power mechanism is at fault, make certain that the mechanical components are in proper condition. The mechanical items include: Front wheel alignment, tire condition and pressure, wheel bearing adjustment, lubrication and adjustment of steering linkage, and proper alignment of steering gear in mountings to eliminate binding.

a. Excessive Play or Looseness in Steering Mechanism

(1) Excessive lash between pitman shaft sectors and the ball nut or power rack (par. 8-12).

(2) Loose worm thrust bearing adjustment or sticking valve spool, requiring removal of gear assembly (par. 8-14).

b. Front Wheel Shimmy

(1) Air in hydraulic system, requiring bleeding by operating pump and steering gear until oil stops foaming in reservoir.

(2) Excessive lash between pitman shaft sectors and the ball nut or power rack (par. 8-12).

c. Failure to Recover from Turns

When the steering wheel is released at completion of a turn the front wheels should return to the straight ahead position in the same manner as permitted by the manual steering gear. In cases of failure to recover from turns check the following items.

(1) Tightness of king pins in bushings. Lubricate or otherwise free up.

(2) Heavy adjustment of steering gear or steering linkage (par. 8-12).

(3) Tight steering shaft upper bearing. Replace bearing.

(4) Loose worm thrust bearings; this may cause snapping noise in the gear. Remove gear assembly for proper adjustment (par. 8-14).

(5) Thrust bearings reversed at assembly. Remove gear assembly and install parts correctly (par. 8-14).

(6) Improper O-ring seals on each side of valve or improperly machined grooves in valve spool or valve housing. Install proper seals or replace valve assembly (par. 8-14).

(7) Tip interference between center tooth of pitman shaft sector and mating tooth of ball nuts. This will be evident when lashing the gear as the scale reading approximately 120 degrees off center, left or right, will be higher than on center. This condition requires replacement of pitman shaft.

d. Rattle or Chuckle in Steering Gear

(1) Excessive lash between pitman shaft sectors and ball nut or power rack (par. 8-12).

NOTE: *A very slight rattle may occur on turns because of the increased lash off the "high point." This is normal, and lash must not be reduced below specified limits to eliminate this slight rattle.*

(2) Excessive clearance at steering shaft upper bearing in column jacket.

e. Hard Steering When Parking

NOTE: *It is a normal condition to feel an increase in parking effort if the hydraulic oil temperature exceeds 170°F. The oil temperature may exceed 170°F after excessive turning or on very hot days.*

To determine whether hard steering actually exists, place car on clean dry floor, apply brakes, and with engine idling turn steering wheel from side to side to bring oil temperature to approximately 170°F. Apply Gauge J 5178 (15 lbs.) to a spoke at rim of steering and check the pull required to turn the wheel steadily, with gauge held at 90 degrees to the spoke.

If the pull required to turn the steering wheel exceeds 10 pounds, check the following possible causes:

(1) Pump drive belt loose. Adjust tension (par. 8-13).

(2) Low oil level in reservoir. Fill to proper level (par. 1-1). NOTE: *If oil level is excessively low, check all hydraulic system lines and joints for evidence of external leakage of oil.*

(3) Air in hydraulic system. Tighten valve cover bolts and all oil line connections on steering gear and pump, then bleed the hydraulic system by operating the pump and steering gear until oil stops foaming in reservoir.

(4) Insufficient oil pressure. If the preceding suggestions do not reveal the cause of hard steering it will be necessary to make the following tests of oil pressure (subpar. f).

f. Testing Hydraulic Oil Pressure

(1) Disconnect the pressure line hose at oil pump, attach Gauge J 5176 to pump and connect the hose to end of gauge where the valve is located. See figure 8-17.

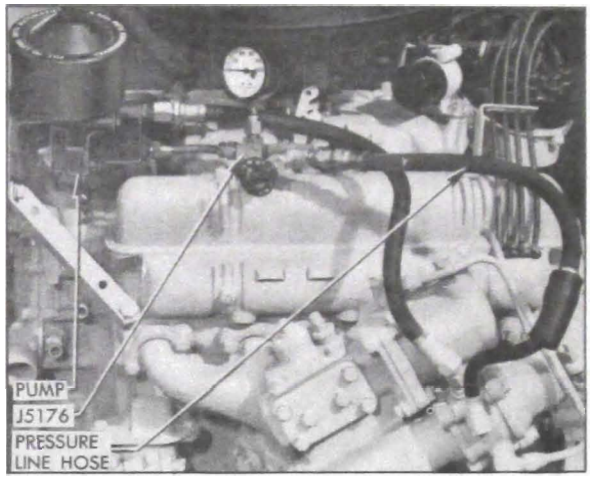

Figure 8-17—Pressure Gauge J 5176 Installed

(2) With engine idling at 450 RPM and gauge valve open, note the oil pressure on the gauge while turning steering wheel from one extreme position to the other. Especially note the maximum pressure which can be built up with the wheel held in either right or left extreme position. CAUTION: *Do not hold wheel in extreme position for an extended period because it will drastically increase the oil temperature and will cause undue wear on the oil pump relief valve.*

(3) With oil temperature between 150°F and 170°F, the maximum oil pressure should not be less than 700 p.s.i. for satisfactory power steering operation.

(4) If the maximum oil pressure is less than 700 p.s.i. it indicates trouble in the pump, or external oil lines, or steering gear, or a combination of these parts. To eliminate the lines and gear, close the gauge valve and quickly test pressure of the pump only, with engine idling

at 450 RPM, then open the valve to avoid increasing oil temperature.

(5) Comparing the maximum pressures obtained in these two tests will indicate the source of trouble as follows:

a. First test (step 2) pressure low, and second test (step 4) pressure normal — indicates faulty external oil lines or steering gear (subpar. g or h).

b. First test (step 2) and second test (step 4) pressures equally low—indicates faulty oil pump (subpar i).

c. First test (step 2) pressure low, and second test (step 4) pressure higher but below normal—indicates faulty pump and also faulty external oil lines or steering gear (subpar. g, h, i).

g. Low Oil Pressure Due to External Oil Lines

(1) Loose connections. Clean and tighten all connections and test for oil leakage.

(2) Leakage at hose unions or oil tube elbows. Remove leaking unions or elbows and install new "O" ring seals.

h. Low Oil Pressure Due to Steering Gear

(1) Leakage at worm shaft seal or cylinder piston rod seal, evidenced by an accumulation of hydraulic oil in gear housing. Leakage at valve cover seal, evidenced by oil dripping from top of valve cover. Remove gear assembly for replacement of seals (par. 8-14).

(2) Pressure loss in hydraulic valve or power cylinder. Remove gear assembly for disassembly and inspection (par. 8-14).

i. Low Oil Pressure Due to Pump

(1) Pump drive belt loose. Adjust tension (par. 8-13).

(2) Low oil level in reservoir. Fill to proper level (par. 1-1).

(3) Oil too light. Change to specified Dynaflow oil (par. 1-4).

(4) Loose pump assembly bolts. Tighten all pump bolts.

(5) Faulty internal pump condition such as—dirt or sludge, sticking or scored relief or flow control valve, worn rotor parts, shaft oil seal leakages. Remove pump and disassemble for inspection (par. 8-15).

j. Oil Pump Noisy

(1) Air in hydraulic system. Tighten all external line connections and bleed hydraulic system by operating the pump and steering gear until oil stops foaming in reservoir.

(2) Drive belt too tight. Adjust tension (par. 8-13).

(3) Oil too heavy. Change to specified Dynaflow oil (par. 1-4).

(4) Sludge and dirt in pump. Remove pump and clean out. (par. 8-15).

(5) Bearings, shaft or other rotating parts worn. Remove pump and disassemble for inspection (par. 8-15).

8-12 ADJUSTMENT OF POWER STEERING GEAR IN CAR

1. Disconnect pitman arm from intermediate tie rod and check tightness of pitman arm nut with an 18" wrench. NOTE: *Never attempt to adjust steering gear with pitman arm connected to intermediate rod.*

2. Turn steering wheel slowly through its full travel to check for binding, tight spots or uneven action.

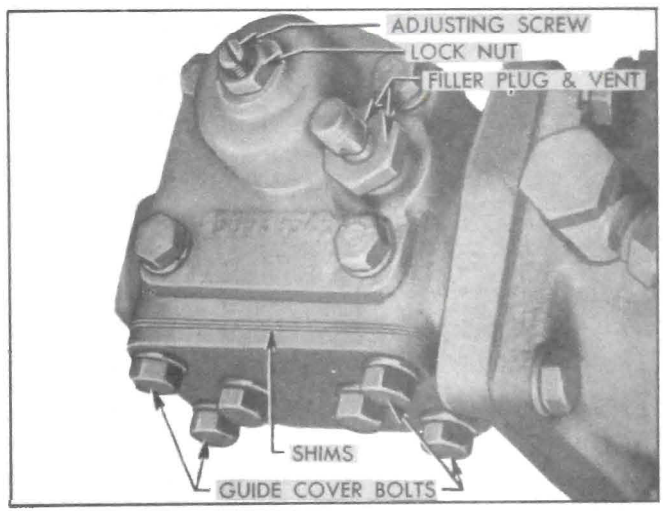

Figure 8-18—Steering Gear Adjustments

3. Loosen the four corner bolts of power rack guide cover about one half turn or just enough to assure lash between the power rack and pitman shaft sector. See figure 8-18. NOTE: *If bolts are loosened too much, the rack will bind on sector teeth.*

4. Turn steering wheel to extreme right or left position. Apply Scale J 544-A to a spoke at rim of wheel and, while pulling scale at 90 degrees to spoke, check the pull required to turn the wheel steadily in the range *where lash normally exists* between ball nut and pitman shaft sector. See figure 8-5. The lash range

exists for one eighth turn of steering wheel from either extreme position.

5. The reading on the scale should be between ½ and ⅞ pound, which would indicate normal loading or drag at the steering shaft upper bearing and at the thrust bearings. If within these limits proceed to step 9; otherwise continue with step 6.

6. Loosen the steering column bracket at instrument panel and recheck the scale pull on steering wheel *in lash range*. If scale reading is now within limits specified in step 5 it indicates misalignment of steering gear in its mountings at frame and instrument panel. Loosen mounting bolts at frame and shift gear assembly to provide proper alignment when all mountings are tightened.

7. If scale reading is still high after releasing steering column at instrument panel, remove steering wheel, direction signal switch housing and steering shaft upper bearing.

If upper bearing is too deep or too tight in column jacket to be removed easily, drill a hole in lower side of bearing shell and insert a self-tapping metal screw to provide a means of pulling bearing. *Be very careful to aviod marring steering shaft.*

8. Again check the scale pull on steering wheel *in lash range*. A scale reading of between ½ and ¾ pound indicates that the excessive loading was due to a faulty upper bearing or a bent steering shaft. If reading is not within these limits the worm thrust bearing adjustment is not correct; the steering gear must be removed from car to correct this adjustment.

9. If the scale reading is within limits in any preceding step, turn steering wheel 2¾ turns from either extreme position to center the ball nut on the central "high point" of pitman shaft sector. At this position the center spoke of wheel should be straight down.

10. Turn pitman shaft adjusting screw clockwise until lash between pitman shaft sector and ball nut is just removed, checking by working pitman arm, then tighten lock nut. See figure 8-18.

11. Turn steering wheel two turns either way from central position and check pull with scale. This should be between ½ and ⅞ pound. *Write down the actual scale reading.*

12. Turn steering wheel back to near central position and check the pull required to turn wheel through the "high point" or no-lash range. Turn pitman shaft adjusting screw clockwise as required to obtain a scale reading ½ to ¾ pound *higher* than was obtained in step 11, after lock nut is tightened. It is always advisable to adjust to near the high limit. *Write down the actual scale reading.*

13. Tighten the four power rack guide cover bolts and recheck the pull through the "high point." The scale reading should be ¼ to ½ pound *higher* than in step 12, or between 1⅛ and 2 pounds.

If reading is not within these limits, add or remove cover shims (fig. 8-18) as required to obtain the specified pull through the "high point" or *no lash range*. Guide cover shims are available in .003" and .005" thicknesses so that they may be combined to produce any required total thickness. NOTE: *To avoid spilling lubricant, it is advisable to remove filler plug with vent attached (fig. 8-18) and use a clean oil gun to draw out approximately ¾ pint of lubricant from the gear housing before removing the guide cover.*

14. Connect intermediate rod to pitman arm and adjust end plug as specified in figure 8-6.

15. Fill gear housing to proper level with specified lubricant (par. 1-1).

8-13 REMOVAL AND INSTALLATION OF STEERING GEAR AND PUMP

a. Removal and Installation of Steering Gear Assembly

1. Place car cover over left front fender then remove the battery and battery shield.

2. Disconnect the pressure and return line hoses from the hydraulic pump and immediately install shipping caps on pump fittings to retain oil in pump. Drain hoses and install shipping plugs to prevent dripping of oil.

3. Continue with removal, following the same procedure as given for the manual gear assembly in paragraph 8-6.

4. Install the gear assembly by reversing the procedure for removal, paying particular attention to the points given in paragraph 8-6 (subpar. b) where applicable. The following additional points must be observed with power steering gears.

5. When installing column jacket assembly over steering shaft place Bearing Protector J 5159 over serrated end of shaft to avoid damage to steering shaft upper bearing in jacket.

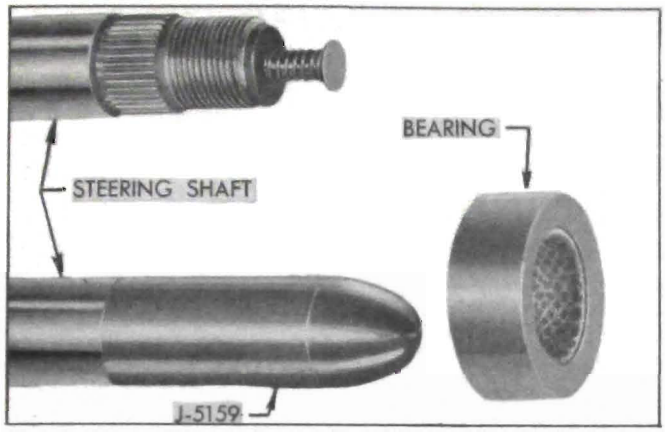

Figure 8-19—Steering Shaft, Bearing, and Bearing Protector

See figure 8-19. Slot in lower end of jacket must engage dowel pin in hydraulic valve cover.

6. When mounting the gear and jacket assembly in brackets, make certain that the column is properly positioned at instrument panel and tighten column bracket before tightening gear housing to frame, then check for bind as follows.

7. Temporarily install steering wheel and use Scale J 544-A to check the pull required to turn the wheel steadily through the high point or no lash range. The pull should not be more than ¼ pound more than before installation.

8. If pull is greater than specified, a damaged upper bearing or a bind in the mountings is indicated. Check and correct cause of excessive loading before continuing with installation.

9. Connect the pressure line hose to the *lower* union on the hydraulic pump, and connect the return line hose to the *upper* union on pump.

NOTE: *Tighten hose nuts firmly but avoid excessive tightening which may distort nuts and fittings.*

10. After gear installation is completed, fill the reservoir and gear housing to proper levels with specified lubricants (par. 1-1).

b. Removal and Installation of Oil Pump

1. When removing the pump, use shipping plugs and caps to cover the hose connectors and unions on pump and plug open ends of the pressure and return line hose to avoid entrance of dirt.

2. When pump is installed on mounting bracket, adjust drive belt tension by using a torque wrench applied to the pulley nut. With a *new* belt, the belt tension should be set so that the pulley will slip in belt when 40-45 ft. lbs. torque is applied to pulley nut. With a *used* belt the torque should be 30-35 ft. lbs.

3. Connect the pressure line hose to the *lower* union on pump cover and connect the return line hose to the *upper* union.

4. Fill the reservoir to proper level with specified Dynaflow oil (par. 1-1).

8-14 DISASSEMBLY, INSPECTION, ASSEMBLY OF POWER STEERING GEAR

a. Disassembly of Steering Gear

1. Thoroughly clean exterior of gear assembly with a suitable solvent.

2. Remove two hoses, two large valve-to-cylinder tubes, and the small bleed line tube, then allow oil to drain from hydraulic valve and power cylinder. Remove filler plug with vent and drain lubricant from gear housing. See figure 8-20.

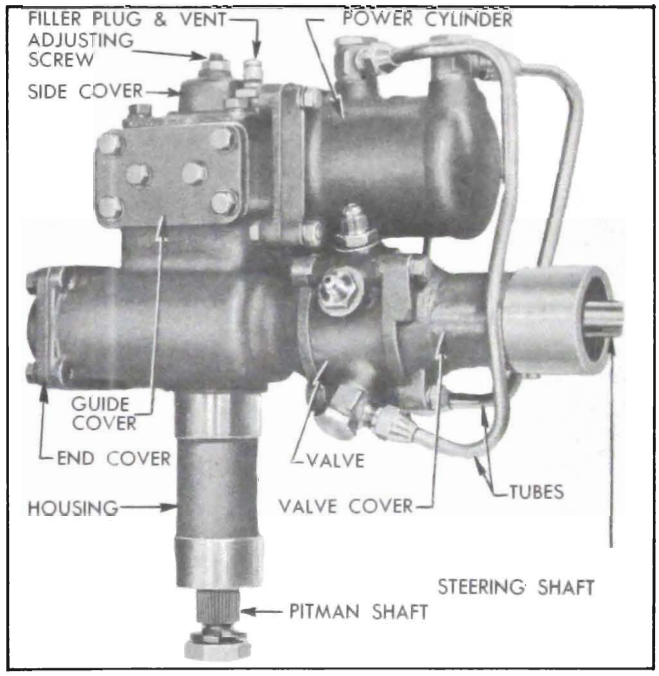

Figure 8-20—Left Side of Power Steering Gear Assembly

3. Turn steering shaft clockwise as far as possible, remove the four corner bolts only from the power rack guide cover, then remove the cover and guide assembly and all cover shims. See figure 8-20.

4. Remove bolts and elbows from power cylinder, then remove power cylinder and rack assembly, and cylinder gasket, from gear housing.

5. Push rack up to the cylinder adapter and then pull it sharply away to hammer the piston against the adapter. It may be necessary to repeat this several times to break the grip of rubber seals between adapter and cylinder so that

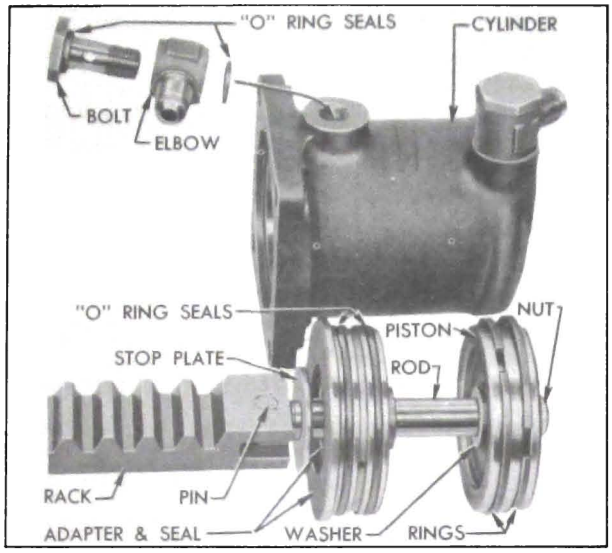

Figure 8-21—Power Cylinder and Rack Parts

the rack and piston can be removed. See figure 8-21.

6. Remove safety nut, piston, thrust washers, adapter, and stop plate from piston rod.

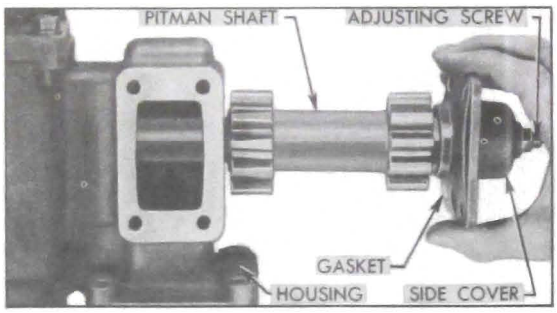

Figure 8-22—Removing Pitman Shaft and Side Cover

7. Turn steering shaft counterclockwise to move the ball nut to approximate center position, then remove the gear housing side cover and gasket with pitman shaft attached by the adjusting screw. See figure 8-22.

8. Unscrew the adjusting screw to separate the pitman shaft from the side cover and remove adjusting screw and shim from the shaft.

9. Measure from end of hydraulic valve cover to nearest edge of the horn cable contact on steering shaft and write down this dimension for use when reinstalling the contact.

10. Using hot soldering iron, disconnect the horn cable from the cable contact, then remove wire and contact from steering shaft.

11. Remove hydraulic valve cover. Drive up edge of worm bearing nut where staked into worm shaft keyway, using suitable chisel, then remove nut, spring (washer) and thrust bearing. See figure 8-23.

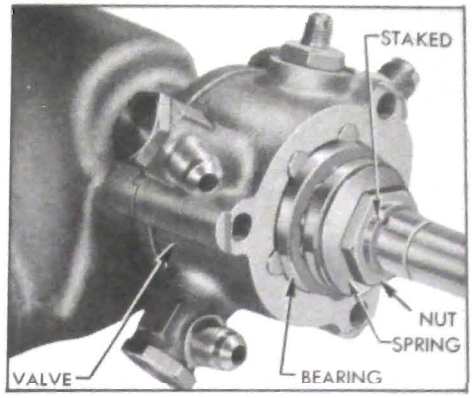

Figure 8-23—Thrust Bearing and Nut

12. With steering shaft horizontal, remove the hydraulic valve assembly, using care to keep the spool and plungers from falling out. Remove lower thrust bearing from gear housing.

13. Check the valve spool and centering plungers for possible sticking in valve housing, then carefully remove these parts and the centering springs. See figure 8-24. *Place spool and plungers where they will not be damaged by contact with other parts.*

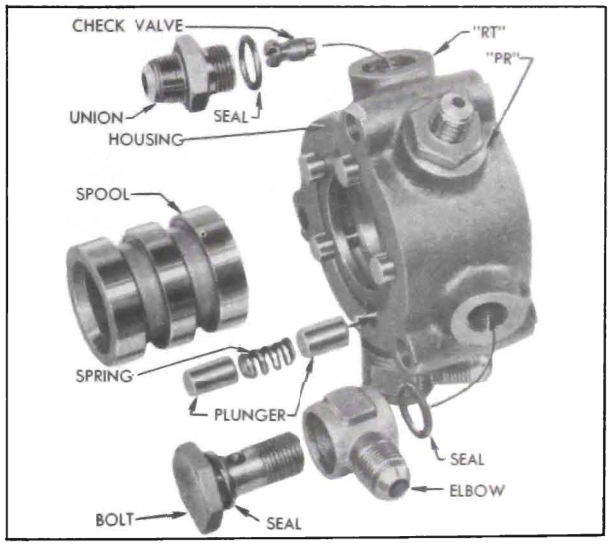

Figure 8-24—Hydraulic Valve Parts

14. Remove unions and elbows, then remove check valve from the return ("RT") port of valve housing. See figure 8-24.

15. Remove gear housing end cover and gasket, then remove steering shaft and ball nut from gear housing.

16. Remove clamps and ball return guides from ball nut, turn nut over to remove all balls (60), then remove ball nut from steering shaft worm.

b. Cleaning and Inspection of Power Steering Gear Parts

1. Thoroughly wash all parts in clean kerosene or solvent and wipe dry with clean, lint-free cloths.

2. Inspect steering shaft for wear or brinelling in ball and needle bearing races, which would require replacement of shaft.

3. Support steering shaft in V-blocks and check it for straightness. Run-out at center should not exceed .020".

4. Inspect teeth of ball nut and all sector teeth of pitman shaft. If teeth are excessively worn or scored replace the part. Replace pitman shaft if serrated end is twisted.

5. Check fit of pitman shaft adjusting screw and shim in the slot in end of pitman shaft. With shim in place, screw head must be free to turn in slot with no perceptible end play to .002" loose. If end play is excessive, selectively fit a new shim; these are furnished in four different thicknesses.

6. Inspect pitman shaft bushings in gear housing and side cover. Replace bushings in housing and replace cover assembly if bushings are worn excessively.

7. Remove worm seal from gear housing with a punch and use Installer J 5189 to install a new seal *with spring side outward.* See figure 8-25.

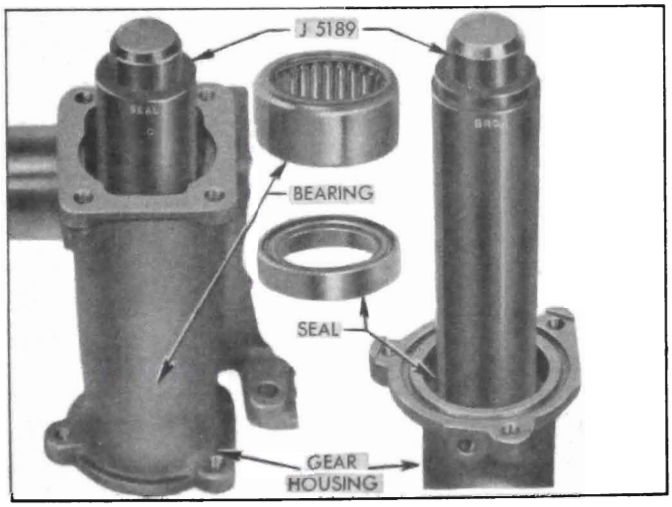

Figure 8-25—Installing Bearing and Seal in Gear Housing

8. If worm bearing in housing requires replacement, drive it out with a punch and use Installer J 5189 to install the new bearing. See figure 8-25.

9. If worm bearing in the housing end cover requires replacement, insert Remover J 5190 into bearing and turn the screw, which will expand two plates under the bearing and will then force the tool and bearing out. See figure 8-26.

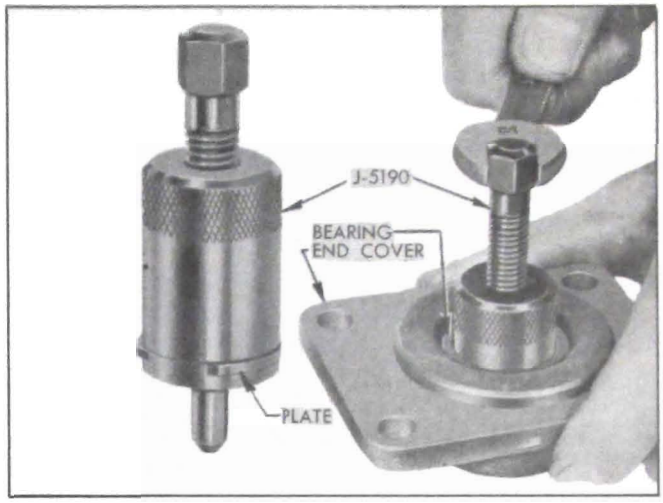

Figure 8-26—Removing Bearing from End Cover

Use Installer J 5191 to install the new bearing. This tool has a shoulder to locate the bearing at proper depth in cover. See figure 8-27.

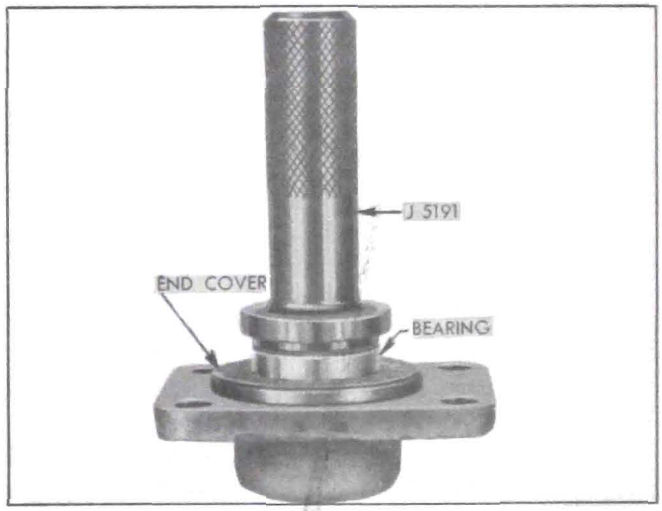

Figure 8-27—Installing Bearing in End Cover

10. Replace pitman shaft seal, installing new seal with feather edge toward inside of gear housing.

11. Inspect piston rod, teeth and guide bearing surface of power rack, and rack guide for excessive wear or scoring. If necessary to replace piston rod or rack, drive out the coupling pin and use new pin to connect new parts. Stake rack at three places on each side to retain the pin, and file down burrs raised by staking.

12. Inspect power cylinder bore for scores or other damage. Remove any burrs from the chamfered edge to prevent damage to seals on the adapter during assembly.

13. Inspect piston rings for scores or breaks.

14. Inspect piston rod seal in power cylinder adapter. If seal is damaged or of doubtful condition drive it out, and remove the O-ring seal from groove in adapter bore. Install new O-ring seal in groove, then press a new piston rod seal into adapter *with the spring side inward.*

15. Inspect hydraulic valve housing, spool, and centering plungers for scores, nicks or burred edges. Slight stickiness of spool or plungers in housing may be corrected by polishing with crocus cloth. *Do not use emery cloth.* Replace damaged parts and make sure that all parts slide freely in housing. Valve spool and housing are selectively fitted and must be replaced as an assembly.

16. Test the check valve by blowing through both ends. Ball should seat when blowing through small end, and allow passage of air when blowing through slotted end of valve body.

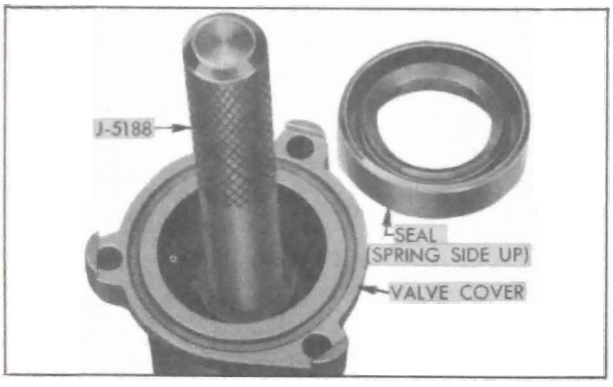

Figure 8-28—Installing Valve Cover Seal

17. Remove the seal and the control shaft lower bearing from hydraulic valve cover with a punch. Press a new bearing into cover. Use Installer J 5188 to press the new seal into cover, with spring side of seal outward toward shoulder of tool. See figure 8-28.

18. Inspect steering shaft upper bearing in the control lever housing support and replace it if worn or damaged.

c. Assembly of Power Steering Gear

NOTE: *Make sure that all parts are absolutely clean, and lubricate parts with clean engine oil during assembly.*

1. Place steering shaft on bench with upper end to your right, then install ball nut on worm so that when teeth are uppermost the *deeper side* of teeth are toward you. Install 30 balls in each circuit of the worm, nut, and return guides, and install guide clamp.

2. Run ball nut to the upper end of worm, then install steering shaft in gear housing, using care to avoid damaging worm seal in housing. Install end cover with new gasket.

3. Install lower thrust bearing over steering worm with the large race outward, and place a new O-ring seal in groove in face of gear housing.

4. Install check valve in "RT" port of the hydraulic valve housing and tighten securely. See figure 8-24.

5. Install hose unions with *new* O-ring seals, placing union with smaller outer threads in valve housing port marked "PR" and other union in port marked "RT". Install elbows and bolts at the other ports with *new* seals on both sides of each elbow. Do not tighten these parts.

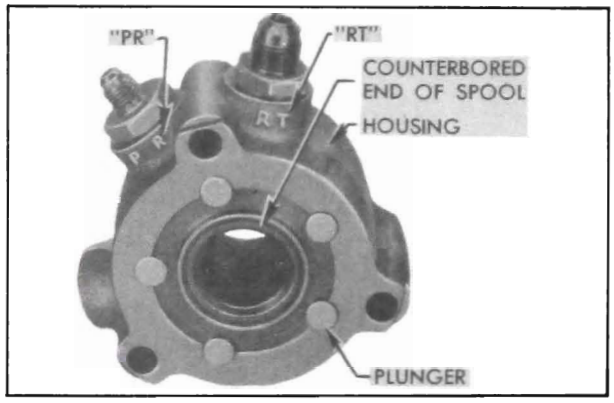

Figure 8-29—Spool Installed in Valve Housing

6. Place valve housing on bench with the return ("RT") port to the right of the pressure ("PR") port, then carefully install the valve spool *with the counterbored end upward* as shown in figure 8-29. NOTE: *The spool is a very close fit in housing and must be started carefully to avoid jamming. Do not force spool into place.*

7. Install five centering springs and ten plungers in valve housing, with drill spotted ends of plungers inward.

8. With steering shaft horizontal, install valve assembly *with the counterbored* end of valve spool outward toward the free end of steering shaft. Use care to keep spool and plungers from sliding out of housing.

9. Support steering gear in a vertical position to make sure that thrust bearing balls are seated in races, then align the large ("RT")

union with left edge of cylinder flange on gear housing. Install Valve Cover Adapter J 5182 (fig. 8-30) with valve cover bolts and tighten securely.

10. Install upper thrust bearing with large race toward hydraulic valve, make sure that balls are seated in races, and install a *new* spring (washer) and a *new* worm bearing nut.

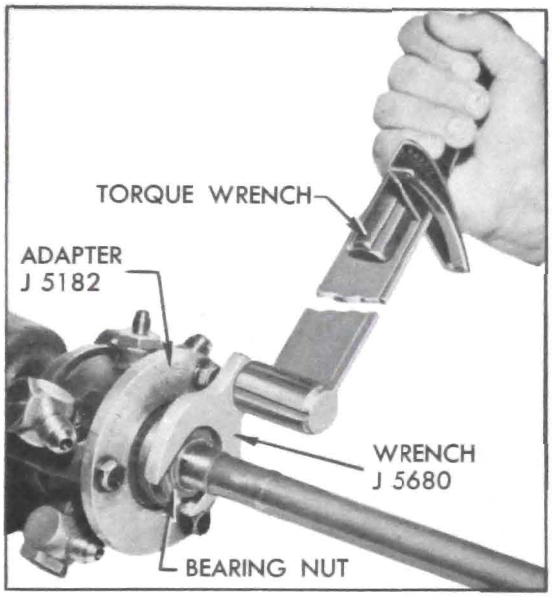

Figure 8-30—Tightening Worm Bearing Nut

11. Temporarily install steering wheel to hold steering shaft. Tighten worm bearing nut to 20-25 ft. lbs. torque, using Wrench J 5680 installed *in straight line* with torque wrench as shown in figure 8-30, then back off nut ¼ turn.

12. Apply Scale J 544-A to a spoke at rim of wheel and, while pulling scale at 90 degrees to spoke (fig. 8-5), check pull required to turn wheel steadily. Scale reading should be between ½ and ¾ pound.

13. Stake outer edge of worm bearing nut down into keyway of worm shaft (fig. 8-23), making sure that nut does not turn from its adjusted position.

NOTE: *Check for possible looseness of bearing adjustment by attempting to turn bearing outer race by hand; a very heavy drag should exist.*

14. Remove steering wheel and Adapter J 5182, place Protector J 5159 over threaded end of steering shaft (fig. 8-19) and install hydraulic valve cover with a new O-ring seal properly seated in its groove. With dowel pin in cover placed on opposite side from the "RT" port in valve housing install cover bolts with lockwashers and tighten securely.

15. Place adjusting screw and shim in slot of pitman shaft, install side cover with a *new* gasket, and install lock nut finger tight on screw.

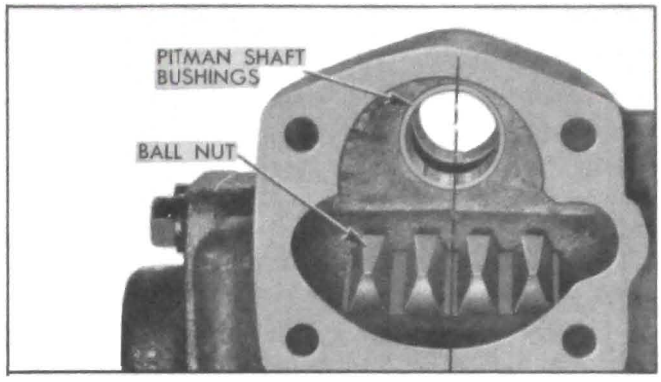

Figure 8-31—Position of Ball Nut for Installation of Pitman Shaft

16. Place gear assembly on left side, turn steering shaft until ball nut teeth are centered on pitman shaft bushings, and tilt nut slightly toward side cover opening. See figure 8-31. Hold pitman shaft with the gear sectors straight down as it is installed in gear housing; use care to avoid damaging pitman shaft seal in gear housing as shaft is pushed through it. Install side cover and tighten bolts securely.

17. Install steering wheel and turn slowly through full range (5½ turns) to check for free action, then turn wheel back to midway position (2¾ turns) to center the ball nut on the central "high point" of pitman shaft sector.

18. Turn pitman shaft adjusting screw clockwise until lash between ball nut and pitman shaft sector is just removed and tighten lock nut.

19. Turn steering wheel two turns right or left from center. Apply Scale J 544-A to a spoke at rim of wheel and, while pulling scale at 90 degrees to the spoke, check the pull required to turn the wheel steadily in the range *where lash normally exists.* See figure 8-5.

Write down the scale reading, which should be between ½ and ¾ pound.

20. Turn steering wheel back to near center and again use the scale to check the pull required to turn the wheel steadily through the "high point" or *no-lash range.*

21. The pull through the "high point" (step 20) should be ½ to ¾ pounds greater than the pull in the lash range (step 19). Turn adjusting screw as required to obtain this difference in pull after lock nut is securely tightened. *Write down the final scale reading for use later.*

22. Install new O-ring seals in both grooves of power cylinder adapter. Place stop plate on piston rod, then install Rod Inserter J 5193 to

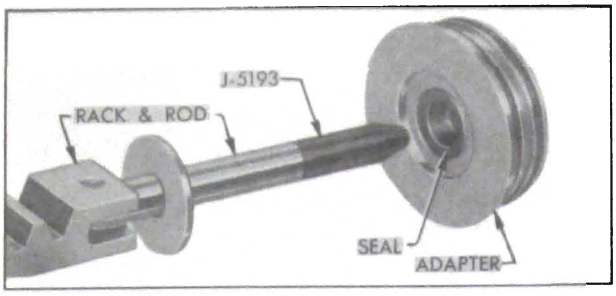

Figure 8-32—Application of Rod Inserter J 5193

protect the seal as rod is pushed through seal and adapter. See figure 8-32. Install thrust washer, piston with rings, thrust washer, and safety nut on piston rod and tighten securely.

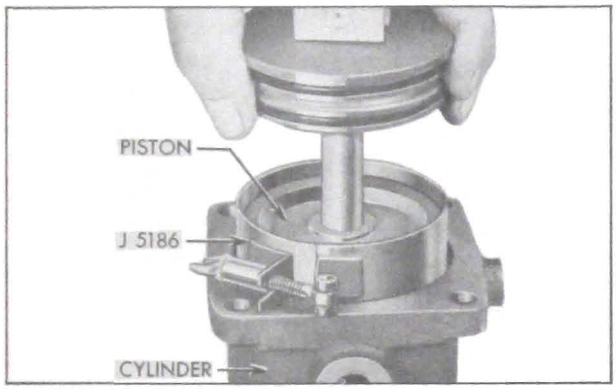

Figure 8-33—Installing Piston With Ring Compressor

23. Use Ring Compressor J 5186 to compress the piston rings, then install piston and adapter in power cylinder. See figure 8-33. It may be necessary to tap the end of power rack with a soft mallet to push rings through the compressor and into cylinder. Tap the adapter down flush with cylinder flange.

24. Install the two elbows and bolts on power cylinder, place *new* O-ring seals on each side of each elbow. Do not tighten bolts.

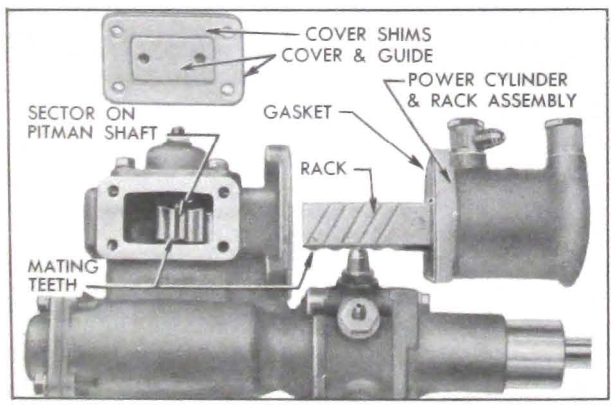

Figure 8-34—Position of Rack and Sector for Installation of Power Cylinder

25. Turn steering shaft clockwise to limit of travel. Push power rack in against stop plate in cylinder adapter. Install power cylinder and rack assembly on gear housing with a *new* gasket. The end tooth of rack must mesh between the two end teeth in pitman shaft sector. See figure 8-34.

26. Install power rack guide and cover assembly with all of the original shims and tighten cover bolts securely.

27. Use Scale J 544-A to check the pull required to turn steering wheel steadily through the "high-point" or no-lash range; this should be ¼ to ½ pound greater than the pull previously obtained in step 21. Change the total thickness of cover shims as required to obtain this difference, then finally tighten cover bolts securely.

28. Install the small bleed line tube and the two large valve-to-cylinder tubes. The longer tube goes on left side of gear assembly. See figure 8-20. Tighten the elbow bolts at hydraulic valve but leave elbow bolts loose at power cylinder.

29. Install the horn cable contact on steering shaft with notch for cable aligned with hole in shaft and inner edge of contact located the distance from end of valve cover measured in step 9.

30. Install horn cable and terminal assembly in steering shaft and solder the cable end into notch of cable contact, using soldering iron and *rosin flux*. Make sure that contact surface is free of flux and solder.

31. Remove unions from the hydraulic valve and fill valve as completely as possible with oil specified for Dynaflow transmissions (par. 1-4), then install and tighten unions. Attach the pressure and return line hoses, fill them with oil and install plugs in open ends.

32. Remove both elbow bolts from power cylinder and fill the cylinder and tubes with Dynaflow oil, then install and tighten the elbow bolts securely.

NOTE: *It is desirable to fill the valve, tubes and cylinder as completely as possible to exclude air. Rapping the valve and cylinder with a soft mallet during the filling operation will aid in eliminating air pockets.*

33. Fill the gear housing to filler opening with Multi-Purpose Gear Lubricant specified for synchromesh transmissions (par. 1-1) and install filler plug with vent.

8-15 DISASSEMBLY, INSPECTION, ASSEMBLY OF VICKERS OIL PUMP

a. Disassembly of Vickers Pump

1. Use shipping caps to cover the hose unions on pump to exclude dirt, then thoroughly clean exterior of pump.

2. Remove reservoir cover, drain out all oil, then remove reservoir which is attached with four bolts on the inside. Remove two cork gaskets, being careful not to lose the spacer located in each bolt hole. See figure 8-35.

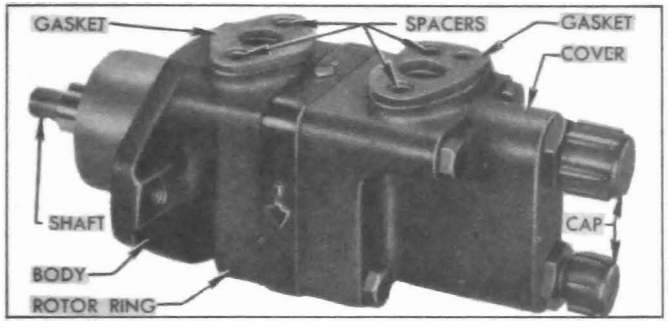

Figure 8-35—Pump with Reservoir Removed

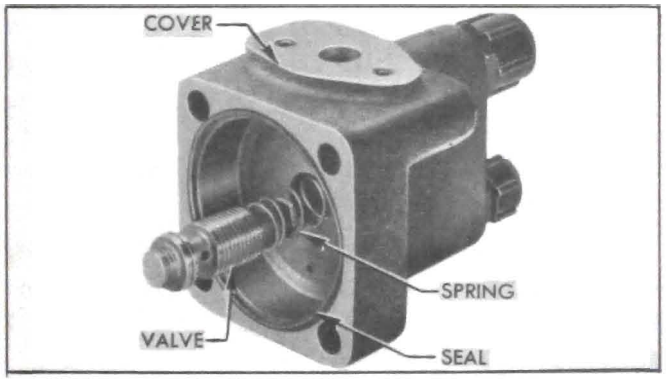

Figure 8-36—Pump Cover and Control Valve

3. Remove four bolts (no lockwashers) and separate the pump cover and O-ring seal from rotor ring and body, then remove the control valve assembly and spring from pump cover. See figure 8-36.

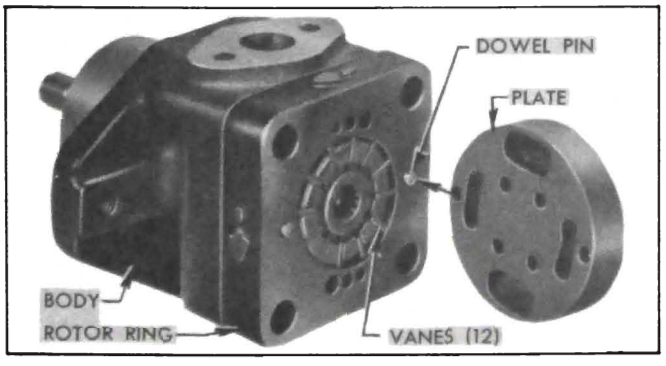

Figure 8-37—Pressure Plate, Ring, Rotor and Vanes

4. Remove the pressure plate which fits over two dowel pins extending through the rotor ring, then remove the ring, O-ring seal, and the rotor and vanes. See figure 8-37.

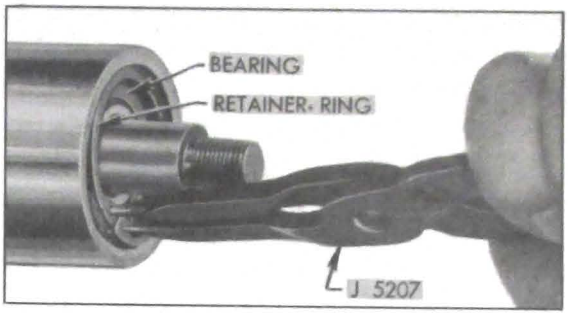

Figure 8-38—Removing Bearing Retaining Ring

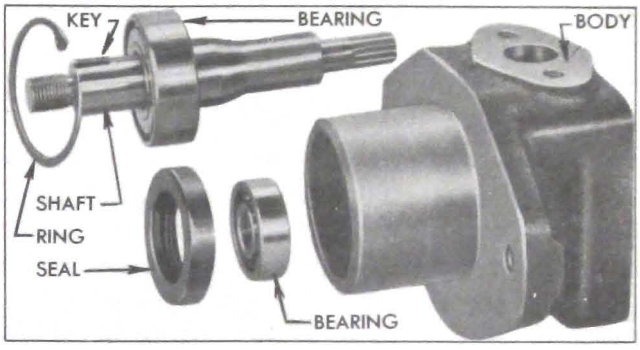

Figure 8-39—Drive Shaft, Bearings, and Seal

5. Remove bearing retaining ring, using Ring Compresser J 5207 (fig. 8-38), then press drive shaft and outer bearing out of pump body. Shaft must be pressed through the inner ball bearing which is located in body behind the shaft seal. See figure 8-39.

6. Drive the shaft seal from body with a punch and remove the inner ball bearing.

b. Cleaning and Inspection of Vickers Pump Parts

1. Wipe the bearing and shaft assembly with clean cloths; do not soak in cleaning solvent as the lubricant sealed into the bearing may be diluted by solvent and wipe dry with clean lint free cloths.

2. Inspect the drive shaft for wear and check both ball bearings for roughness or noisy operation. If the large bearing must be replaced, press the new bearing on shaft with a tool that applies pressure on the inner race only.

3. Check fit of vanes in slots of rotor; vanes must slide freely but snugly in slots. Tightness may be relieved by thorough cleaning or removal of irregularities. Replace rotor if excessive looseness exists between rotor and vanes,

and replace vanes if they are irregularly worn or scored.

4. Inspect all ground surfaces of the rotor ring for roughness or irregular wear. Slight irregularities may be removed with a hard Arkansas stone. Replace ring if inside cam surface is scored or worn.

5. Inspect the flat faces of the pressure plate and body for wear or scoring. These faces may be repaired by lapping until smooth and flat, after which all lapping compounds must be thoroughly washed away.

6. Inspect the control valve bore in pump cover for scores or other damage. Hair line scratches are normal but heavy scratches or scores should be cleaned up with a cylindrical hard Arkansas stone. If this cannot be done satisfactorily, replace the cover.

7. Inspect ground surfaces of the control valve for scores. Hair line scratches are normal but heavy scratches or scores should be cleaned up with a hard Arkansas stone. Replace the valve assembly if it is badly scored or if it is found to be the cause of low pump pressure. It is not practicable to disassemble, clean and assemble the valve parts and assure proper pressure control. Make certain that control valve slides freely in bore of pump cover.

c. Assembly of Vickers Pump

Assemble the pump by reversing procedure for disassembly, paying attention to the following items:

1. Make sure that all parts are absolutely clean, and lubricate all moving parts with clean engine oil during assembly.

2. Use *new* seals and gaskets.

3. Make certain that the bearings and shaft seal are firmly seated in their proper positions. After the inner ball bearing is installed, the shaft seal must be installed with the lip toward the inside. Use a tube *or shaft* 1⅝" in diameter to apply pressure against outer edge of seal during installation.

4. Install the outer bearing retaining ring with the *beveled side outward.*

5. The rotor ring must be installed over the dowel pins with the embossed arrows pointing in a *counterclockwise* direction as viewed from *rear end* of pump. See figure 8-37. *NOTE: When viewed from the front or shaft end of pump, the arrows on ring point in a clockwise direction, which is the direction of rotation of pump shaft.*

6. Install vanes in slots of rotor with the rounded edge outward toward the ring.

7. When pump cover is installed, turn cover bolts down snug only. Install the reservoir with *new* gaskets, being sure that a spacer is located in each bolt hole (fig. 8-35), then tighten reservoir and pump cover bolts securely. This is necessary to assure proper alignment of the cover, reservoir, and body.

8. When assembly is completed, rotate pump shaft to make sure of free movement, then install caps on hose unions to exclude dirt until pump is installed.