POWER STEERING GEAR

CONTENTS OF THIS SECTION

GENERAL DESCRIPTION

The Rotary Valve Safety power steering gear assembly operates entirely on displacing oil to provide hydraulic oil pressure assists only when turning. As the entire gear assembly is always full of oil, all internal components of the gear are immersed in oil making periodic lubrication unnecessary. In addition this oil acts as a cushion to absorb road shocks that may be transmitted to the driver.

The steering shaft, hydraulic valve, worm and the rack-piston nut are all in line making a compact and space-saving gear. All oil passages are internal except the pressure and return hoses between the gear and pump.

The rotary valve feature is a new concept in driver ease and control. It provides a smooth transmission through the driving range of steering wheel effort. A torsion bar transmits the "road feel" to the driver. Response of the steering gear to effort applied to the steering wheel has been greatly increased. This increased response gives the driver greater control and minimizes over-steering.

DESIGN

Design of the new gear with fewer parts reduces the over-all size and weight. In addition, this simple design requires fewer service tools. Being a self-bleeding unit the steering gear requires no external bleeding.

The mechanical element of this steering gear is a low-friction, high-efficiency recirculating ball system in which steel balls act as a rolling thread between the steering worm and rack-piston nut. The rack-piston nut is one piece and is geared to the sector of the pitman shaft. Lash between the pitman shaft and rack-piston nut is maintained by an adjusting screw which is retained in the end of the pitman shaft gear (Fig. 9A-1).

The rotary valve assembly is contained in the gear housing. It is shown schematically in Figs. 9A-2, 9A-3 and 9A-4, and is an open-center, rotary type valve. The valve spool is inside the valve body and is held in a neutral position by a torsion bar attached to one end of the valve body through the torsion bar cap and extends through this valve. The other end of the torsion bar is attached to a stub shaft assembly which in turn is splined to the gear flange that bolts to the steering shaft flange.

Twisting of the torsion bar allows the valve spool to displace or move its position in relation to the valve body, thereby directing oil to the proper area in the gear to provide a hydraulic assist on turns. During the turn the steering worm turns in the same direction as the turn. This causes the rack-piston nut to move which in turn applies a turning effort to the pitman shaft gear.

While the advantages of the rotary valve safety power steering gear design are many, the most important of these are light turning effort, increased response, smoothness of gear operation and a "fail-

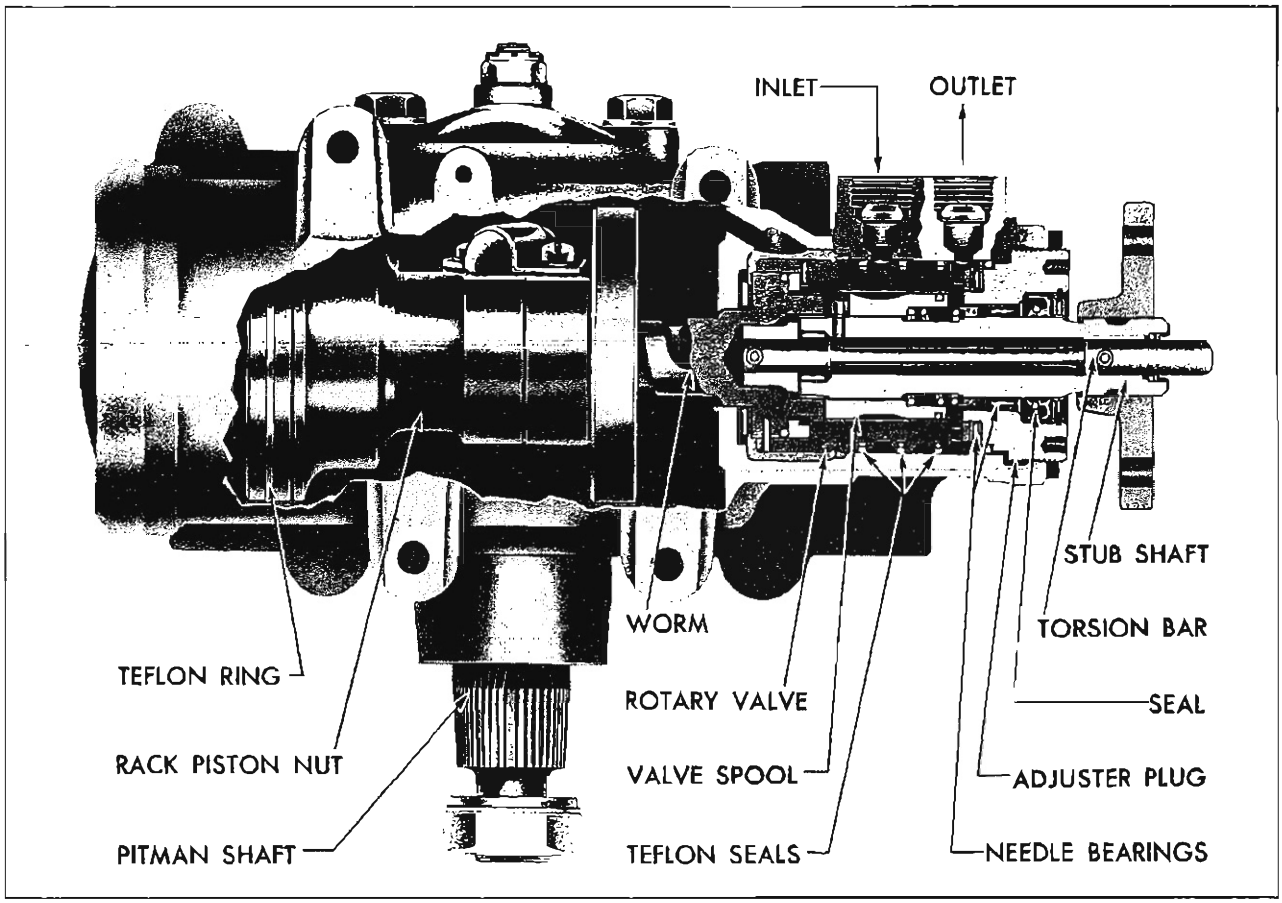


Fig. 9A-1 Power Steering Gear—Sectional View

safe" feature. This feature provides for manual operation if for any reason the power system should fail or become inoperative.

OPERATION

OPERATING PRESSURES

Under normal driving conditions, the hydraulic oil pressure in the power cylinder should not exceed 40-100 psi. Pressure for turning corners should be approximately 100-600 psi. Parking pressure, the most difficult of turning conditions, should range from 600 psi to 1300 psi depending upon roadbed conditions and the weight of the car. The steering gear ratio is 17.5 to 1. The over-all steering ratio of the power steered car is approximately 22 to 1. During normal driving, the steering wheel effort will range from 1 pound to 2 pounds. The parking effort will range from 2 pounds to 3-1/2 pounds, again depending upon roadbed conditions.

OIL FLOW—STRAIGHT-AHEAD POSITION

The rotary valve assembly contains a valve spool which is a selective slip fit inside the valve body and is positioned so the grooves and lands on the outside surface of the valve spool align with the lands and grooves on the inside surface of the valve body (Fig. 9A-2). Grooves are slightly wider than their mating land and clearance on both sides of the land provides the "open" position. A stub shaft assembly (stub shaft and a torsion bar pinned together at one end) extends through and is attached to one end of the rotary valve assembly; a pin locks the stub shaft and the valve spool together and a pin in the valve body retains the torsion bar assembly.

In the straight-ahead or neutral position, oil flows from the power steering pump through the "open" position of the rotary valve assembly (Fig. 9A-2), and back to the power steering pump reservoir without circulating in the power cylinder in which the rack-piston is located. Since all passages are open, flow resistance is low in the neutral position, and

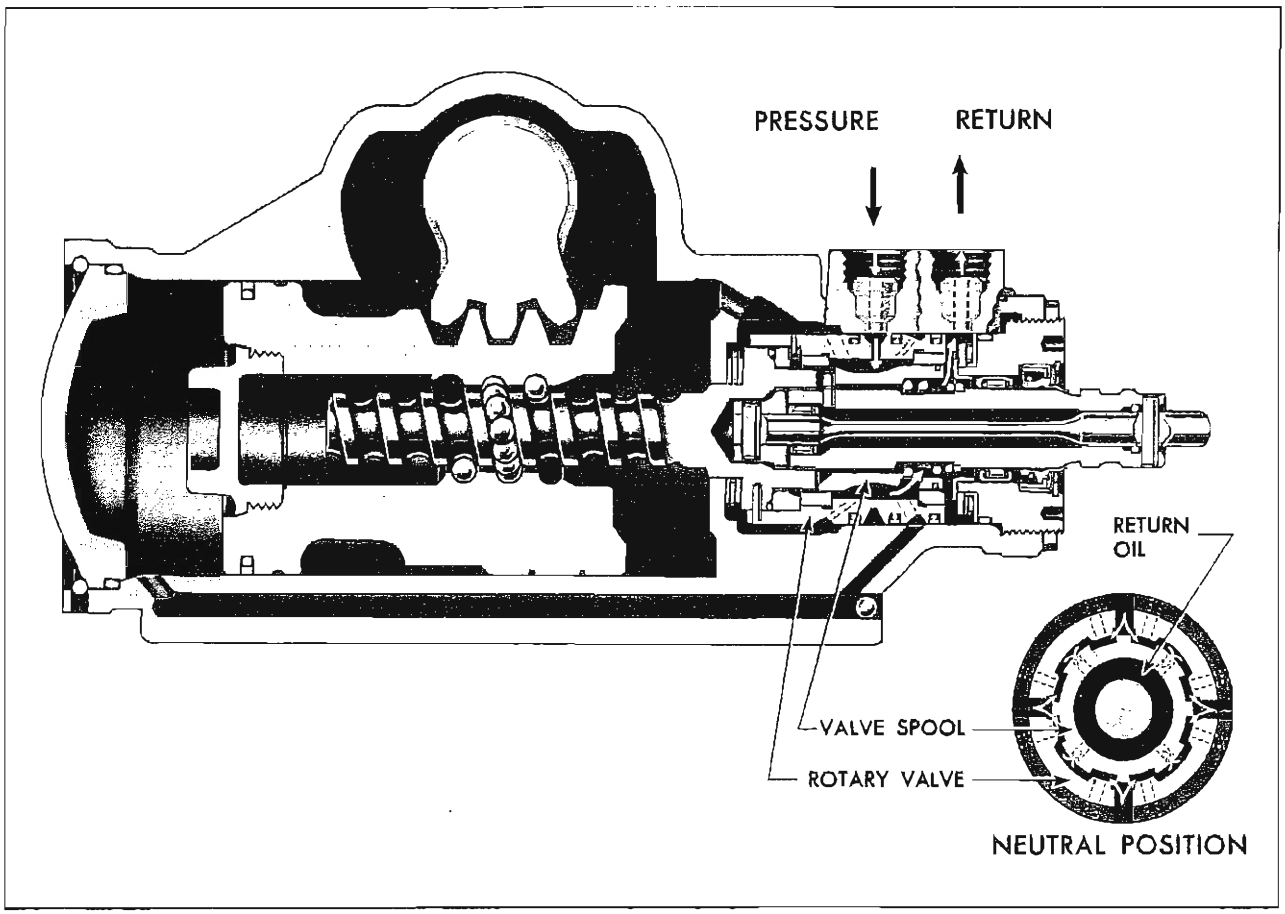


Fig. 9A-2 Oil Flow—Straight Ahead Position

since the valve remains in this position at all times except when steering in turns, the power required to operate the pump is at the minimum.

The power cylinder is full of oil at all times, although in the straight-ahead position the pressure on both sides of the rack-piston is equal and very low.

Oil from the steering gear pump flows through a passage in the gear housing to an annular groove around the valve body. Four holes evenly spaced around the valve are drilled from the bottom of this groove through the valve body wall to a groove on the inside surface of the valve body. Eight pressure holes evenly spaced around the valve body are also drilled through the valve body wall but these are through a land portion on the inside surface of the valve body with one hole on each side of the four inlet pressure holes.

When no twisting force is applied to the steering gear stub shaft assembly from the steering wheel there is sufficient clearance between the land groove alignment of the valves to permit oil to flow between the valves. Oil flows back to the pump via four drilled holes through the valve spool wall that align with a groove on the stub shaft assembly. From here oil flows around the stub shaft to an area between the rotary valve assembly and adjuster plug assembly, through the return port to the pump.

Oil in the power cylinder acts as a cushion that absorbs road shocks that may be transmitted to the steering wheel for increased safety and reduces driving fatigue. In addition, this oil lubricates all internal components of the gear, making it unnecessary to lubricate the gear at any time.

OIL FLOW—RIGHT TURN POSITION

When a right turn is executed, oil from the power steering pump flows through the rotary valve assembly, through the steering gear housing to an area between the housing end plug and the rack-piston

nut to assist in forcing the rack to turn the pitman shaft and steering linkage for assist in the turn.

When the steering wheel is turned to the right, resistance to turning is encountered between the front wheels and the roadbed tending to twist the stub shaft assembly. Since the stub shaft assembly is pin locked to the torsion bar at one end and the opposite end indexes the valve spool by a pin on the stub shaft, the twisting action moves the valve spool to the right in relation to the valve body. This slight movement causes the land in the valve spool to restrict the right side opening between the valve spool land and valve body lands and opens the clearance on the left side of the spool lands (Fig. 9A-3).

The right openings being restricted permits oil to flow through the unrestricted passages to the left (Fig. 9A-3) to an annular groove around the valve body which aligns with an oil passage in the gear housing.

Oil is then directed to flow between the housing end plug and the rack-piston nut to force the rack upward permitting the steering worm to screw into the rack-piston nut. This forces the pitman shaft to turn and reduces driver turning effort in executing the right turn. The oil in the upper end of the cylinder is simultaneously forced out through the rotary valve and back to the pump reservoir.

The higher the resistance to turning between the roadbed and the front wheels, the more the valve spool is displaced, and the higher the oil pressure on the lower end of the rack-piston nut. Since the amount of valve displacement and, consequently, the amount of hydraulic pressure built in the cylinder is dependent upon the resistance to turning, the driver is assured of the proper amount of smooth hydraulic assistance at all times.

As the driver stops applying steering effort to the steering wheel and then relaxes the wheel, the spool valve is forced back into its neutral position by the

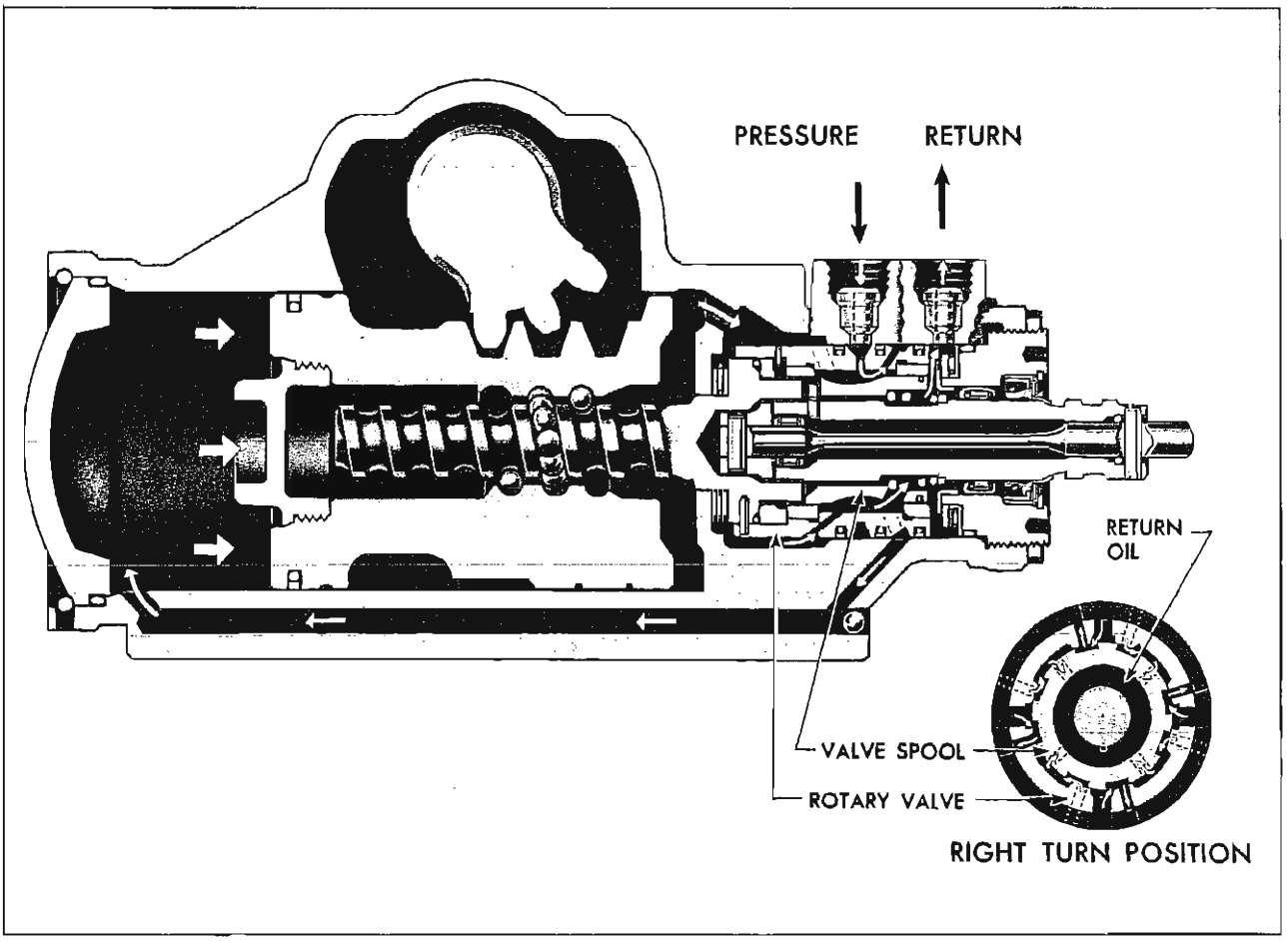


Fig. 9A-3 Oil Flow—Right Turn Position

"untwisting" of the torsion bar. The spool valve lands and grooves align themselves with the grooves and lands in the valve body providing a balanced clearance between the land-groove alignment. When this happens, the oil pressure is again equal on both sides of the rack-piston nut and the steering geometry of the car causes the wheels to return to the straight-ahead position.

OIL FLOW—LEFT TURN POSITION

Executing a left turn causes oil to flow from the power steering pump through the rotary valve assembly and to the area between the rotary valve assembly and the rack-piston nut rack via a drilled passage in the steering gear housing. This is to assist in forcing the rack to turn the pitman shaft and linkage for added assist in the turn.

When the steering wheel is turned to the left, resistance to turning is encountered between the front wheels and the roadbed tending to twist the stub shaft assembly. Since the stub shaft assembly is pinlocked to the torsion bar at one end and the opposite end indexes the valve spool by means of a pin in the stub shaft, the twisting action moves the valve spool to the left in relation to the valve body. This slight movement causes the land on the valve spool to restrict the left side opening between valve spool lands and the valve body lands and opens the clearance on the right side of spool lands (Fig. 9A-4).

The left openings being restricted permits oil to flow through the unrestricted passages to the right to an annular groove around the valve body which aligns with an oil passage in the gear housing.

Oil is then directed to flow between the rotary valve assembly and the rack-piston nut via a drilled passage in the steering gear housing to force the rack-piston nut downward. This forces the pitman shaft to turn and reduces driver turning effort in executing the left turn. The oil in the lower end of the housing is simultaneously forced out through the rotary valve from a drilled passage in the housing and back to the pump reservoir.

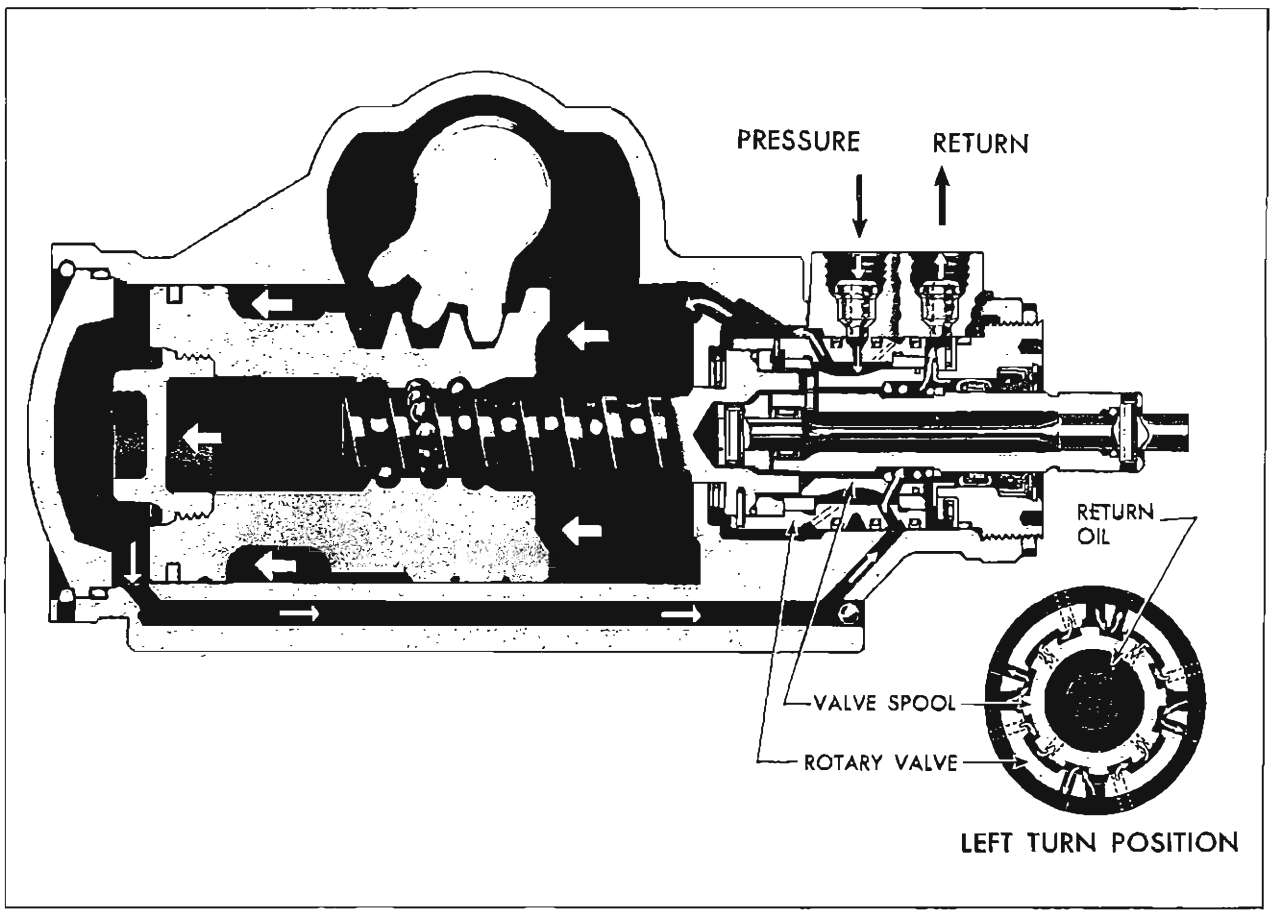


Fig. 9A-4 Oil Flow—Left Turn Position

The higher the resistance to turning between the roadbed and the front wheels, the more the valve spool is displaced, and the higher the oil pressure on the upper end of the rack-piston nut. Since the amount of valve displacement and, consequently, the amount of hydraulic pressure built in the cylinder is dependent upon the resistance to turning, the driver is assured of the proper amount of smooth hydraulic assistance at all times.

As the driver stops applying steering effort to the steering wheel and then relaxes the wheel, the spool valve is forced back into its neutral position by the "untwisting" of the torsion bar. The spool valve lands and grooves align themselves with the grooves and lands in the valve body providing a balanced clearance between the land-groove alignment. When this happens, the oil pressure is again equal on both sides of the rack-piston nut and the steering geometry of the car causes the wheels to return to the straight-ahead position.

PERIODIC SERVICE RECOMMENDATIONS

Since the steering gear is constantly lubricated, it is only necessary to periodically check the level in the pump reservoir. See Specifications on page 9A-25 for system capacity.

ADJUSTMENTS ON CAR

Before making adjustments to the power steering gear to correct conditions such as, shimmy, hard or loose steering, road shock, wander or weave, a check should be made of front end alignment, shock absorbers, wheel balance, or for tight front wheel bearings, loose steering rod ends or loose pitman arm.

CHECK STEERING GEAR ADJUSTMENTS

1. Disconnect steering gear connecting rod from pitman arm.

2. Remove horn button or horn ring from steering wheel.

3. With inch pound torque wrench attached to a 5/8"-12 point socket, measure and record readings taken from the following steering gear positions. See Fig. 9A-5.

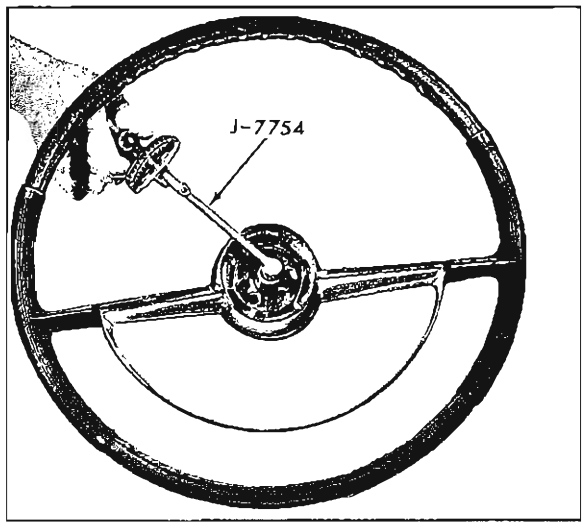


Fig. 9A-5 Checking Steering Gear Adjustment

NOTE: DO NOT use a torque wrench having maximum torque reading of more than 100 inch pounds. When taking following torque readings, take a reading pulling the torque wrench to the right and a reading pulling the torque wrench to the left. Total both readings and take one half of this total as the average torque.

a. One full turn off center high point. This reading represents adjuster plug preload plus resistance offered by seals and bearings and should not exceed 7 lb. in. torque. If the reading is below 3 lb. in. torque, it may indicate some lash in the thrust bearing.

NOTE: If the reading for "a" is not in specifications, correct adjuster plug bearing preload as follows: Loosen adjuster plug lock nut, using drift or similar tool, and move flexible coupling (by turning steering wheel) as necessary to permit installation of tool J-7624 on adjuster plug (Fig. 9A-10). Tighten plug as required to obtain proper reading (3-5 lb. in.) and tighten adjuster plug lock nut. If after obtaining proper adjuster plug bearing preload in "a" and the torque reading in "b" is not within specification, then DO NOT remove gear assembly to refit rack-piston balls unless a complaint of loose steering is received. Upon such a complaint, a thrust adjustment ("a") and over center adjustment ("c") should correct the problem if it lies in the steering gear.

b. One-half turn off center high point. This reading represents resistance offered in "a" above and also worm preload as determined by the size of the balls used in the rack-piston nut. This reading should be 0.5 to 5.0 lb. in. torque higher than the reading obtained in "a" above.

c. Through center high point. This reading represents resistance offered in "b" above and also pitman shaft lash. This reading should be 3 to 6 lb. in. torque higher than the reading obtained in "b" above, and should not exceed 14 lb. in.

4. If reading in step "3c" above is not within specifications, loosen pitman shaft gear lash adjuster nut and adjust to load specified in "c", using 7/32" allen wrench. Tighten lock nut to 20 to 30 lb. ft. torque.

NOTE: Final adjustment should always be made in a clockwise or downward direction.

5. Reassemble horn button or horn ring to steering wheel.

6. Reassemble connecting rod to pitman arm. Tighten nut to 40-50 lb. ft.

MINOR REPAIRS

The following operation may be performed with the steering gear in the car.

REMOVAL OF PITMAN SHAFT SEALS WITH GEAR IN CAR

NOTE: Removal of seals can be accomplished with the steering gear in the car, using hydraulic pressure from the gear assembly to force the seals out of pitman shaft bore.

1. Remove pitman arm retaining nut and lock washer.

2. Remove pitman arm using tool J-5504.

3. Remove pitman shaft outer dust seal retaining ring, using J-4245 pliers.

4. Remove outer dust seal using screwdriver or similar tool and place a cloth around housing and pitman shaft to absorb oil leakage from seal bore.

5. Hold a clean dry pan under the gear housing and with engine running, momentarily turn steering gear to extreme left position for not more than two seconds. This will build up pressure on upper side of piston and in pitman shaft chamber forcing seals and inner back-up washer out of bore.

NOTE: If pressure of oil does not remove seals, turn off engine, remove pitman shaft assembly and remove seals in normal manner being careful not to score the seal bore in housing

6. Turn off engine.

7. Remove steering gear assembly to replace seals.

STEERING GEAR—REMOVE

1. Disconnect pressure and return hose assemblies from housing.

2. Disconnect pitman arm from pitman shaft using J-5504.

3. Scribe mark on steering shaft worm shaft flange and disconnect gear lower flange from steering shaft.

4. Remove gear housing to frame bolts noting number and location of gear to frame shims (if any).

5. Remove steering gear assembly.

STEERING GEAR—DISASSEMBLE

Disassemble and reassemble steering gear and sub-assemblies on a clean work bench, preferably while the assembly is mounted on a holding fixture (J-5205 or J-6448-01) as shown in Fig. 9A-6.

CAUTION: DO NOT clamp housing in vise.

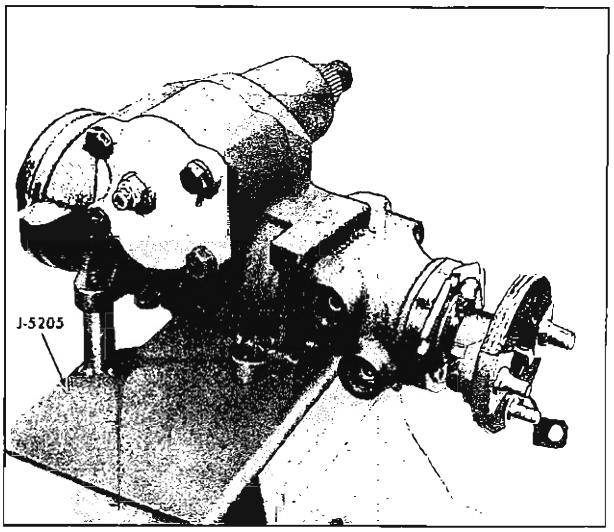


Fig. 9A-6 Steering Gear Mounted on Tool J-5205

Cleanliness is of utmost importance; therefore bench, tools, and parts must be kept clean at all times.

Before disassembling gear, thoroughly clean exterior with suitable solvent and drain as much fluid as possible. Assist draining by turning gear flange through its entire range two or three times.

REMOVE HOUSING LOWER END PLUG AND RACK-PISTON NUT END PLUG

1. Remove end plug retaining ring as shown in Fig. 9A-7.

2. Rotate gear (stub shaft) flange to the left and force end plug out of housing and discard end plug "O" ring seal.

CAUTION: DO NOT turn flange any farther than absolutely necessary or balls from ball nut and worm circuit may escape from this circuit and lay loose inside the rack-piston nut chamber.

3. Remove rack-piston nut end plug retaining ring, using 1/2" square drive (from socket set).

REMOVE PITMAN SHAFT GEAR AND SIDE COVER

1. Remove side cover retaining screws and washers.

2. Rotate cover as necessary to see when pitman shaft is centered in gear housing opening while rotating gear (stub shaft) flange. See Fig. 9A-8.

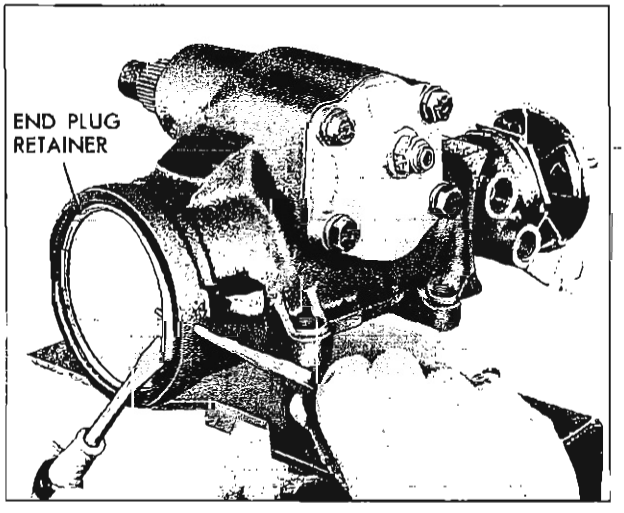


Fig. 9A-7 Removing End Plug Retaining Ring

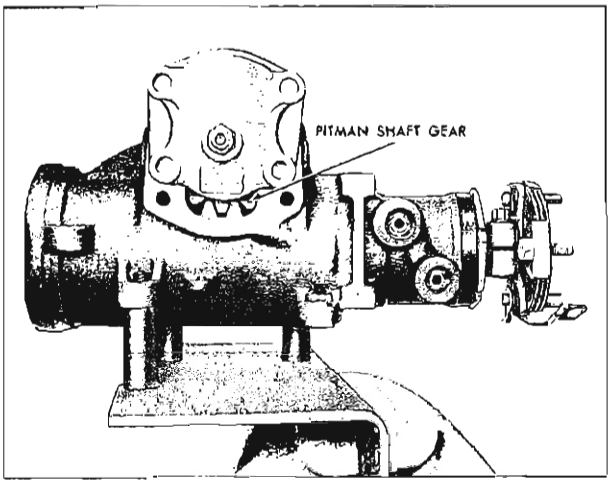


Fig. 9A-8 Position of Pitman Shaft Gear for Removal

3. Remove pitman shaft and cover assembly.

4. Remove side cover "O" ring seal and discard.

REMOVE RACK—PISTON NUT

1. Holding arbor tool J-7539 against the end of steering worm, rotate stub shaft flange to the left until rack-piston is free from worm. See Fig. 9A-9.

2. With arbor in rack-piston, remove rack-piston nut from housing bore.

NOTE: The arbor prevents balls from falling out of rack-piston nut.

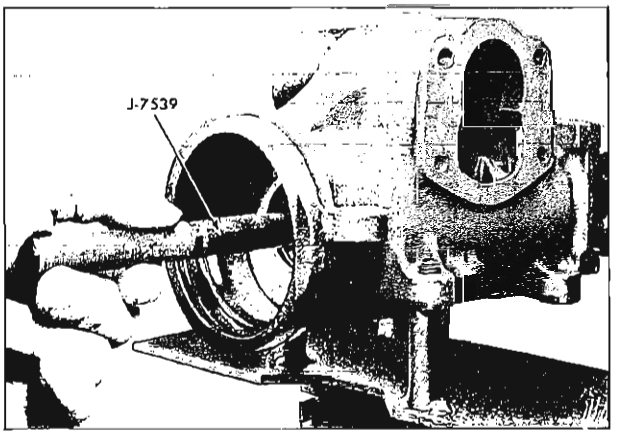


Fig. 9A-9 Arbor J-7539 Against End of Steering Worm

REMOVE ADJUSTER PLUG ASSEMBLY ROTARY VALVE WITH WORM SHAFT AND PIN ASSEMBLY AS AN INTEGRAL UNIT

1. Remove flange locking bolt and remove flange.

2. Remove adjuster plug lock nut, using punch or suitable spanner wrench such as J-972 or J-7624.

3. Remove adjuster plug assembly, using a spanner as shown in Fig. 9A-10.

4. Push on end of worm shaft with a hammer handle while pulling on stub shaft with slight rotary motion.

5. Remove adjuster plug, rotary valve and worm shaft assembly as an integral unit.

6. Remove adjuster plug from rotary valve and torsion bar by pulling straight out (Fig. 9-11).

7. Separate worm shaft and valve assembly by pulling apart.

8. Remove lower bearing and discard torsion bar cap to worm "O" ring seal (in the Rotary Valve). See Fig. 9A-12.

9. Remove lower bearing races and bearing (these parts may come out with worm shaft or remain in the housing).

10. Remove adjuster plug "O" ring seal and discard.

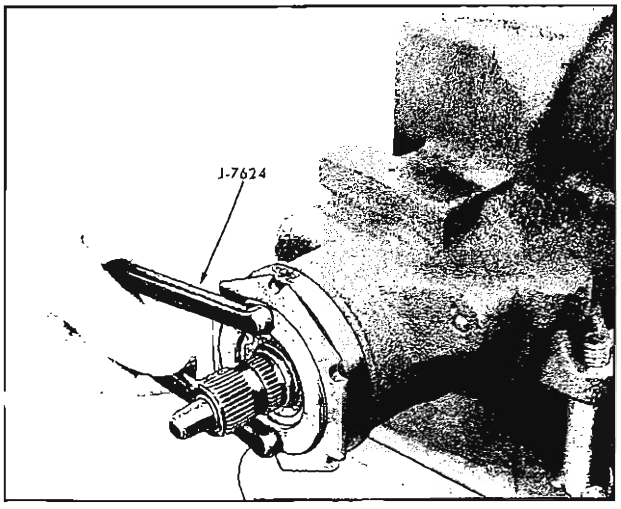


Fig. 9A-10 Removing Adjuster Plug Assembly

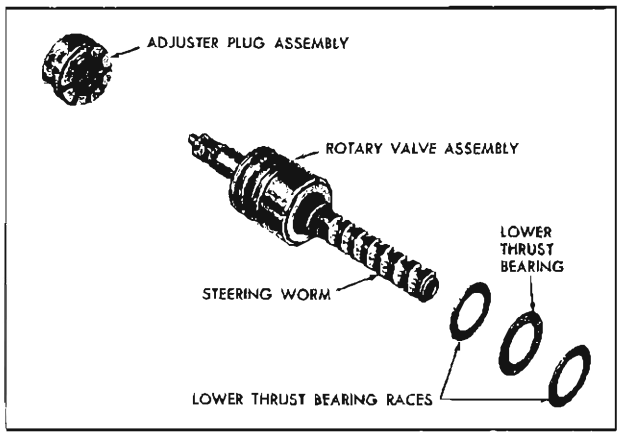


Fig. 9A-11 Adjuster Plug Removal

DISASSEMBLE PITMAN SHAFT GEAR AND SIDE COVER

1. Hold lash adjuster with 7/32" allen wrench and remove lash adjuster nut and discard.

2. Screw lash adjuster out of side cover.

NOTE: Do not disassemble pitman shaft and component parts as these are serviced as an assembly. See Fig. 9A-13.

DISASSEMBLE RACK—PISTON NUT

1. Place the rack-piston nut assembly on a clean cloth.

2. Remove arbor tool J-7539, ball return guide, and balls, making sure all of the balls are caught on the cloth (11 bright and 11 black).

3. Remove and discard Teflon ring and back-up seal from rack-piston nut.

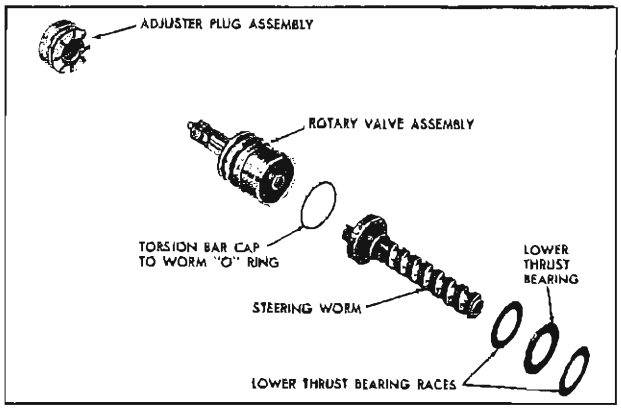


Fig. 9A-12 Location of Torsion Bar Cap to Worm "O" Ring

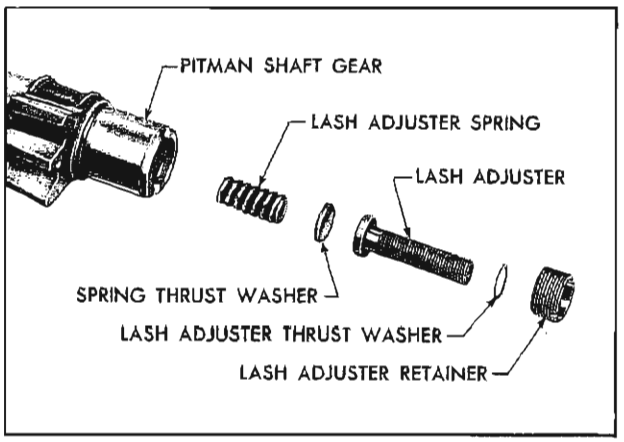


Fig. 9A-13 Parts in End of Pitman Shaft Gear
—DO NOT DISASSEMBLE—

VALVE SPOOL DAMPENER "O" RING—REPLACE (ONLY IF NECESSARY DUE TO "SQUAWK" IN GEAR)

The rotary valve assembly includes the valve body, valve spool and the stub shaft assembly. All these parts are precision units and are hydraulically balanced at the factory.

Under no conditions are parts in this unit to be replaced or interchanged with other parts or units. If unit parts are scored or damaged the entire rotary valve assembly is to be replaced.

NOTE: If the valve spool dampener "O" ring requires replacement perform the following operations.

1. Work spool spring onto bearing diameter of the stub shaft and remove spool spring.

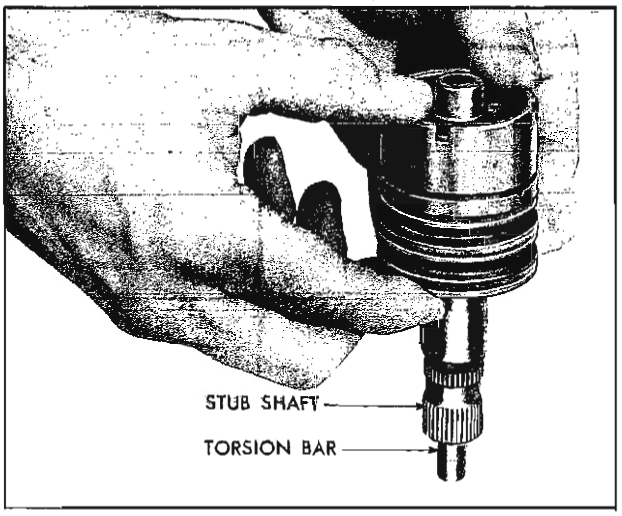


Fig. 9A-14 Tapping to Loosen Valve Spool

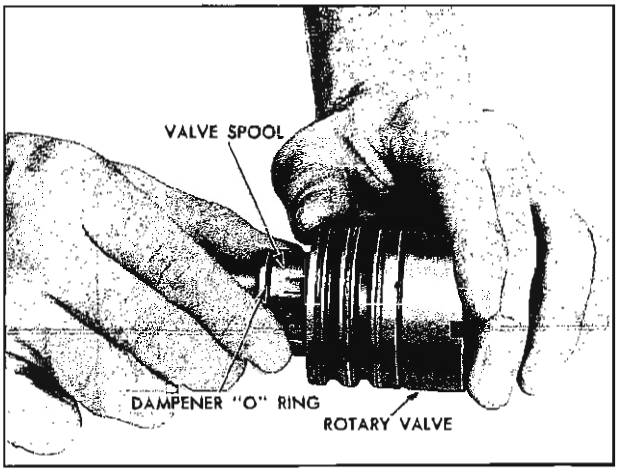


Fig. 9A-15 Removing Valve Spool from Rotary Valve

2. Tap end of stub shaft assembly gently against workbench to remove valve spool (Fig. 9A-14).

CAUTION: The diametrical clearance between the valve body and the spool may be as low as .0004". The slightest cocking of the spool may jam it in the valve body (Fig. 9A-15).

3. Remove and discard valve spool dampener "O" ring.

4. Install valve spool dampener "O" ring seal in valve spool groove, then lubricate seal in type A hydraulic fluid. Do not allow seal to twist in the groove.

5. With notch end of spool towards valve body, install spool, aligning spool notch with pin in stub shaft. See Fig. 9A-16.

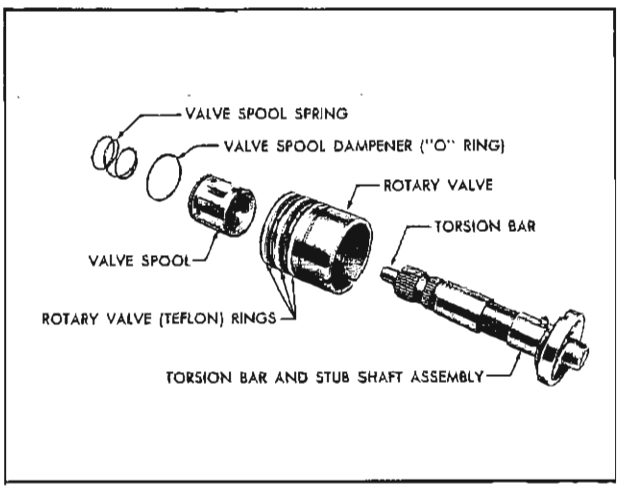


Fig. 9A-16 Rotary Valve—Exploded View

CAUTION: Because of the small clearance between the valve spool and valve body, extreme care must be taken when assembling these parts. Push the spool evenly and slowly with a slight oscillating motion until spool reaches drive pin. Before pushing spool completely in, make sure dampener "O" ring seal is evenly distributed in spool groove. Slowly push spool completely in, with extreme care taken not to cut or pinch the "O" ring seal.

6. Slide spool spring over stub shaft and work the spring in position.

DISASSEMBLE ROTARY VALVE (ONLY IF NECESSARY)

1. Work spool spring onto bearing diameter of the stub shaft and remove spool spring.

2. Tap end of stub shaft assembly gently against workbench to remove valve spool (Fig. 9A-14).

CAUTION: The diametrical clearance between the valve body and the spool may be as low as .0004". The slightest cocking of the spool may jam it in the valve body (Fig. 9A-15).

If slight sticking occurs, make a gentle attempt to reverse the removal procedure. If this does not free the spool, it has become cocked in the valve body bore and may be removed later.

3. Remove and discard valve spool dampener "O" ring.

4. Remove stub shaft, torsion bar (small diameter bar extending through stub shaft) and valve cap assembly by tapping end of torsion bar lightly with a plastic hammer. This will dislodge the cap from valve body cap pin. See Fig. 9A-16. Do not disassemble stub shaft assembly. The parts are pinned together and are serviced as an assembly.

5. If valve spool has become cocked as described in step 3, it can now be freed as follows:

a. Inspect parts to determine in which direction the spool is cocked.

b. A few very light taps with a soft plastic or rawhide hammer should align and free the spool in the bore.

c. Remove and discard "O" ring dampener seal from valve spool.

6. Carefully remove and discard valve body Teflon rings and ring back-up "O" ring seals.

DISASSEMBLE HOUSING

1. Remove pitman shaft outer dust seal back-up washer retaining ring, using pliers J-4245.

2. Remove outer dust seal back-up washer.

3. Remove seal (double lip) by inserting offset screwdriver between seal and back-up washer and prying out of housing.

CAUTION: Do not damage housing bore when removing seal.

4. Remove back-up washer.

5. Remove seal (single lip) by cutting and collapsing seal.

CAUTION: Do not damage housing bore when removing seal.

6. If pitman shaft needle bearings are to be replaced, remove bearing by driving out of housing using tool J-6278-1 with adapter J-6278-3. See Fig. 9A-17.

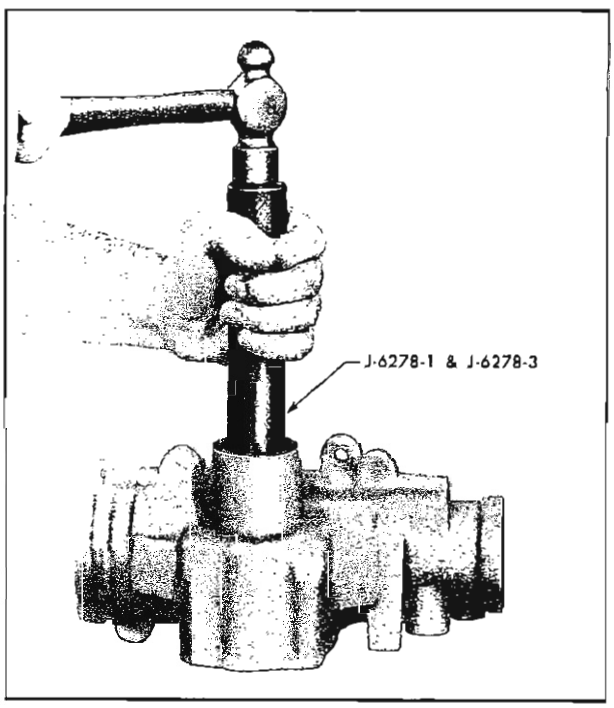


Fig. 9A-17 Removing Pitman Shaft Needle Bearing

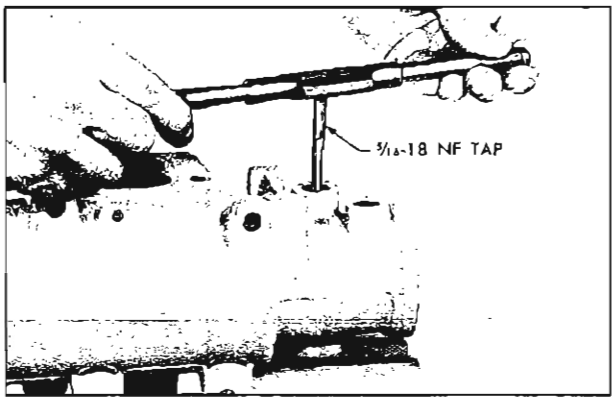


Fig. 9A-18 Tapping Connector Hole

7. If connectors are to be removed, tap threads in holes of connectors using 5/16-18 NF tap. See Fig. 9A-18.

8. Remove connectors by using threaded bolt into tapped holes with washer and nut as extractor (Fig. 9A-19).

CLEANING AND INSPECTION

Carefully wash all parts in a suitable cleaning solvent.

CAUTION: Do not use solvent on oil seals and "O" rings which are going to be replaced (Fig. 9A-20).

INSPECTION OF PITMAN SHAFT GEAR AND SIDE COVER

1. Inspect pitman shaft bearing surface in side cover for excessive wear or scoring. If badly worn or scored, replace side cover and bushing assembly.

2. Check pitman shaft sector teeth, bearing and seal surfaces and replace if badly worn, pitted or scored.

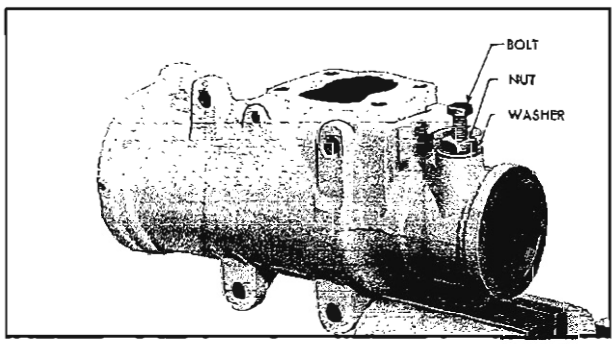


Fig. 9A-19 Removing Connector

3. Check lash screw for end play.

If end play is noticed in Step 3, replace pitman shaft gear assembly.

INSPECTION OF RACK–PISTON NUT AND WORM

1. Inspect worm and rack-piston nut grooves and all of the balls for excessive wear or scoring. If either the worm or rack-piston nut needs replacing, both must be replaced as a matched assembly.

2. Inspect ball return guides, making sure that ends where balls enter and leave guides are not damaged.

3. Inspect lower thrust bearing and races for excessive conditions of wear, pitting, scoring, or cracking. If any of these conditions are found, replace the thrust bearing and races.

4. Inspect rack-piston nut teeth for pitting, wear, and scoring.

5. Inspect outside surface of rack-piston nut for wear, scoring, or burrs.

6. Inspect thrust bearing rollers and races for excessive conditions of wear, pitting, scoring, cracking, or brinelling. If any of these conditions are found, replace the thrust bearing assembly.

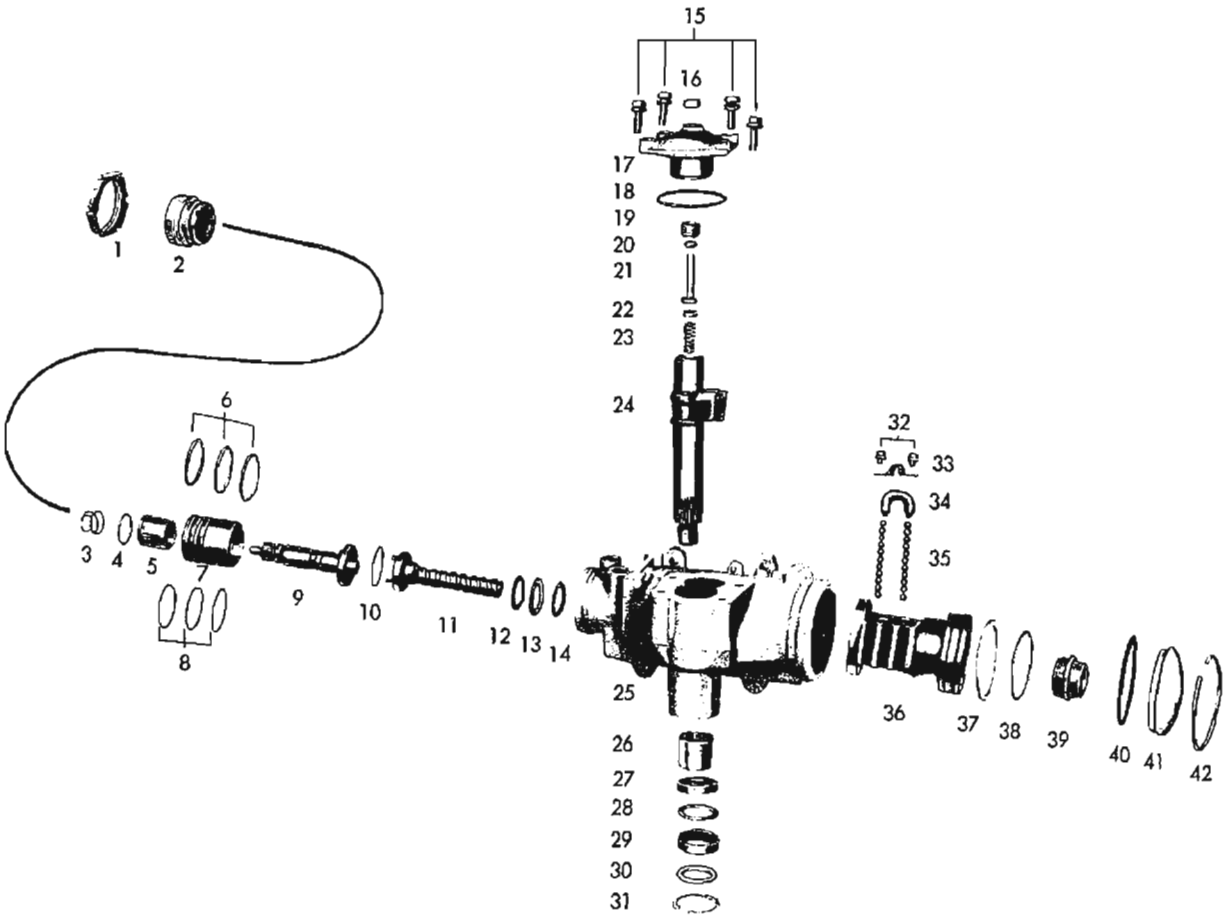
INSPECTION OF ROTARY VALVE

1. If there was evidence that the torsion bar to stub shaft "O" ring seal has been leaking (oil leak between the stub shaft and torsion bar at the stub shaft coupling flange), the entire rotary valve assembly should be replaced if it cannot be properly sealed.

NOTE: Since the seal between the stub shaft and the torus bar at the stub shaft coupling flange is a permanent static seal which should never be replaced, it is permissible to make a permanent mechanical seal installation instead of replacing the entire valve assembly.

Clean the area around the intersection of the torsion bar and stub shaft and around the balancing pin (both ends) with solvent and/or a wire brush. Dry thoroughly and apply a liquid sealant which would flow into the area between these pieces and then harden. Devcon "B" or equivalent (commercially available products) will work very well in this application.

2. If any part or parts of the rotary valve assembly (including stub shaft assembly) are badly worn,



1. Adjuster Plug Lock Nut
2. Adjuster Plug Assembly
3. Valve Sppol Spring
4. Valve Spool Dampener ("O" Ring)
5. Valve Spool ("O" Ring)
6. Rotary Valve Teflon Seals
7. Rotary Valve
8. Rotary Valve "O" Ring Seals
9. Torsion Bar and Stud Shaft Assembly
10. Torsion Bar Cap to Worm "O" Ring
11. Worm Shaft
12. Worm Thrust Bearing Inner Race
13. Worm Thrust Bearing
14. Worm Thrust Bearing Outer Race
15. Side Cover Screws
16. Lash Adjuster Lock Nut
17. Side Cover
18. Side Cover "O" Ring Seal
19. Lash Adjuster Retainer
20. Lash Adjuster Thrust Washer
21. Lash Adjuster
22. Spring Thrust Washer
23. Lash Adjuster Spring
24. Pitman Shaft
25. Steering Gear Housing
26. Pitman Shaft Needle Bearing
27. Single Lip Oil Seal
28. Inner Back-up Washer
29. Double Lip Oil Seal
30. Outer Back-Up Washer
31. Retaining Ring
32. Ball Return Guide Retainer Screws
33. Ball Return Guide Retainer
34. Rack - Piston Nut Balls
35. Rack - Piston Nut Balls
36. Rack - Piston Nut
37. Rack - Piston Nut Ring
38. Rack - Piston Nut Ring Back-Up Seal
39. Rack - Piston Nut End Plug
40. End Plug "O" Ring Seal
41. Housing Lower End Plug
42. Housing Lower End Plug Retainer

Fig. 9A-20 Power Steering Gear Assembly—Exploded View

cracked, pitted or broken, the entire rotary valve assembly should be replaced. A slight polishing on the valve surfaces is normal.

INSPECTION OF GEAR HOUSING

1. Inspect gear housing for any defects in the piston bore or the rotary valve bore. Inspect all retaining ring grooves and seal surfaces for scratches or nicks. If any major defects are found, the housing should be replaced.

NOTE: A slight polishing of the cylinder bore by the piston is not uncommon and does not affect the operation of the gear.

2. Inspect ball plug in the housing, if leaking or raised above the housing surface, drive in flush to 1/16" below the surface. The ball plug can be tightened by staking the housing. The housing should be replaced only if leaks in this area cannot be properly sealed.

Clean area of leak with solvent and/or a wire brush. Dry thoroughly and apply a liquid sealant which will flow into the area between the ball plug and the housing and then harden. Devcon "B" or equivalent (commercially available products) should seal such leaks.

3. Inspect the connectors. If badly brinelled or scored, replacement will be necessary.

4. Inspect pitman shaft gear needle bearing; if worn or pitted, replace.

SUB-ASSEMBLIES—ASSEMBLE

Lubricate all parts as they are assembled.

ASSEMBLE PITMAN SHAFT GEAR AND SIDE COVER

1. Screw lash adjuster through side cover until cover bottoms on pitman shaft gear.

2. Install lash adjuster lock nut while holding lash adjuster with 7/32" allen wrench.

ASSEMBLE ROTARY VALVE

1. Assemble one valve body Teflon ring back-up "O" ring seal in each groove on valve body. Do not allow seals to become twisted.

2. Assemble valve Teflon rings in ring grooves over the "O" ring seals by carefully slipping the rings over valve body. The rings may appear loose or twisted in the grooves, but the heat of the oil after assembly will cause them to straighten.

3. Install valve spool dampener "O" ring seal in valve spool groove, then lubricate seal in Type A hydraulic fluid. Do not allow seal to twist in the groove.

4. Assemble stub shaft assembly in valve body aligning the groove in the valve cap with pin in valve body (Fig. 9A-21). Press on cap until cap is against the shoulder in valve body with valve body pin in the cap groove. Hold these parts together during the rest of the assembly.

5. With notch end of spool towards valve body, install spool, aligning spool notch with pin in stub shaft.

CAUTION: Because of the small clearance between the valve spool and valve body, extreme care must be taken when assembling these parts. Push the spool evenly and slowly with a slight oscillating motion until spool reaches drive pin. Before pushing spool completely in, make sure dampener "O" ring seal is evenly distributed in spool groove. Slowly push spool completely in, with extreme care taken not to cut or pinch the "O" ring seal.

6. Slide spool spring over stub shaft and work the spring in position.

7. Lubricate cap to worm "O" ring seal and install in valve assembly.

NOTE: If during the assembly of the valve the stub shaft and cap assembly is allowed to slip out of engagement with the valve body pin, the spool

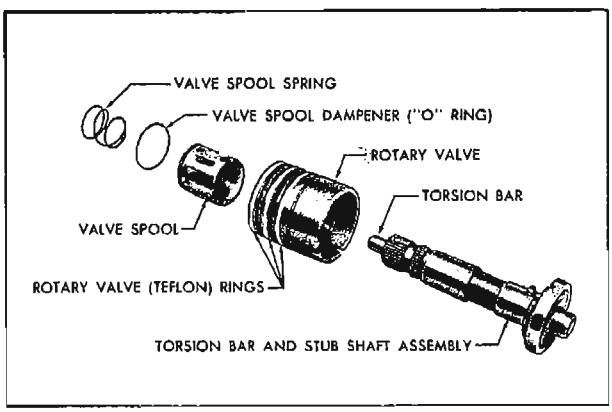


Fig. 9A-21 Rotary Valve—Exploded View

will be permitted to enter valve body too far. The dampener "O" ring seal may expand into valve body oil grooves preventing removal of spool.

a. Remove valve spool spring and disassemble rotary valve assembly.

b. Press on spool until the "O" ring seal is cut and spool can be removed.

c. Replace "O" ring seal and proceed with assembly as before.

ASSEMBLE HOUSING

1. With stamped end of needle bearing against shoulder of adapter J-6278-3, use Remover and Replacer J-6278-1 to drive pitman shaft needle bearing into bore from outside of housing until flush-to-1/32" below shoulder. Make sure needle bearings rotate freely (Fig. 9A-22).

2. Lubricate the cavity between lips of pitman shaft (double lip) seal with high melting point, water resistant wheel bearing lubricant.

3. Lubricate and install pitman shaft seals; single lip seal, inner back-up washer, double lip seal, outer dust seal and retaining ring in housing bore (Fig. 9A-23). Use tool J-6219 (Fig. 9A-24) for seals and J-4245 for retaining ring. Make sure seal lips are properly positioned, retaining ring is seated, and that approximately 1/16" clearance is maintained between the inner seal (single lip) and the bearing.

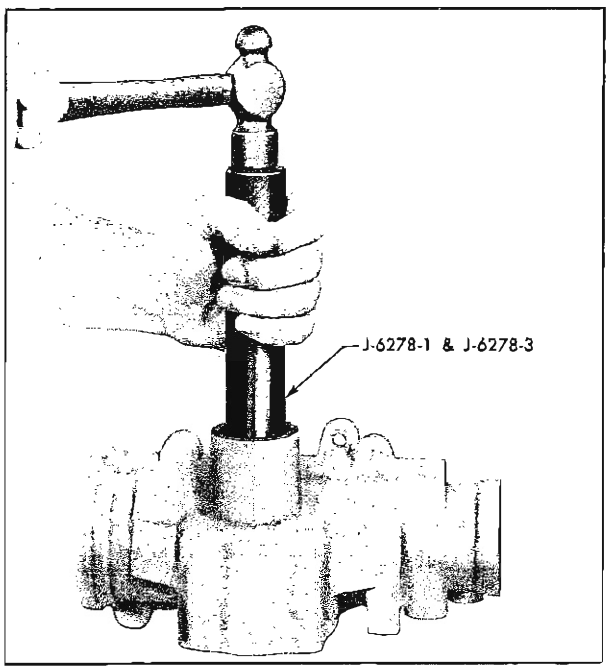


Fig. 9A-22 Installing Pitman Shaft Needle Bearing

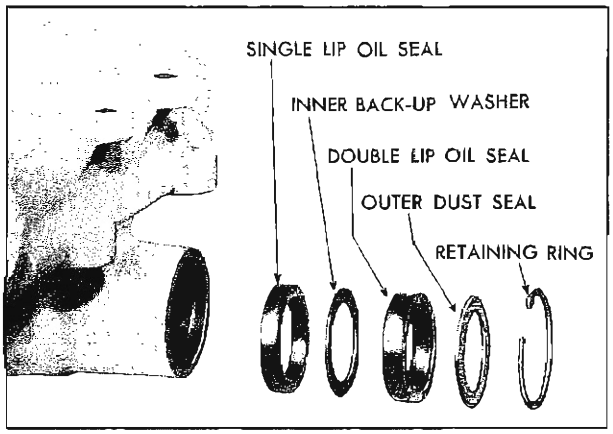


Fig. 9A-23 Pitman Shaft Seals and Washers

4. If connectors were removed, install new connectors by driving into place with tool J-6217 (Fig. 9A-25).

ASSEMBLE RACK—PISTON NUT AND WORM

1. Lubricate and install new ring back-up seal and Teflon piston ring on rack-piston nut being careful ring and seal do not twist during installation.

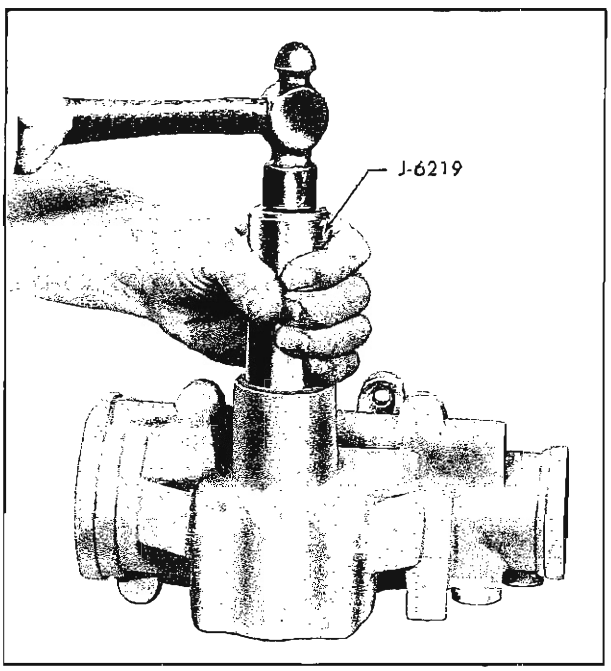


Fig. 9A-24 Installing Pitman Shaft Seals Using J-6219

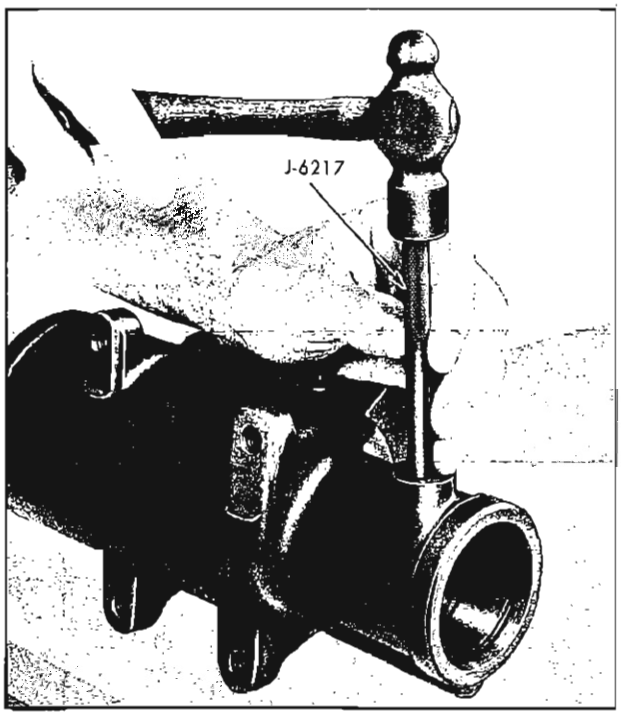


Fig. 9A-25 Installing Connector Using J-6217

2. Insert worm into rack-piston nut to bearing shoulder (Fig. 9A-26).

3. Align ball return guide holes with worm groove. Load 15 balls into the guide hole nearest the Teflon piston ring while slowly rotating worm to left feed balls through the circuit. Alternate black balls with the silver balls. If balls are installed properly the worm should turn out of rack-piston nut.

4. Fill one-half of ball return guide with the remaining 7 balls. Place the other guide over the balls and plug each end with heavy grease to prevent the balls from falling out when installing guides into rack-piston nut (Fig. 9A-27).

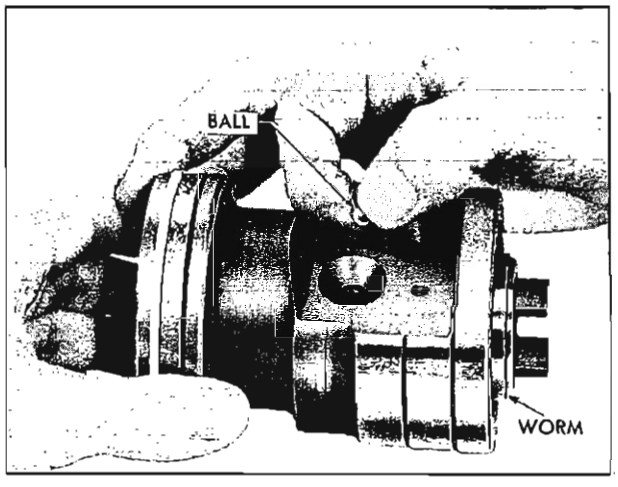


Fig. 9A-26 Loading Rack - Piston Nut

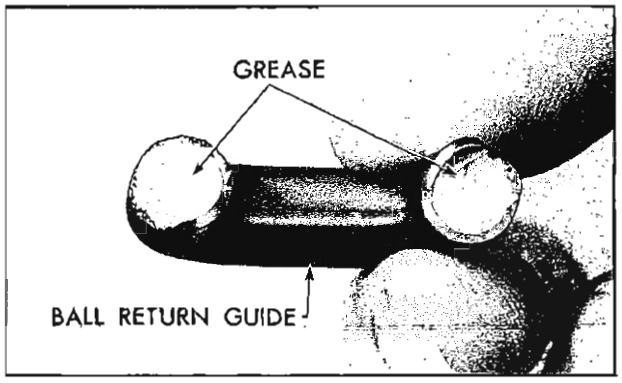


Fig. 9A-27 Ball Return Guide

5. Insert guides into guide holes of the rack-piston nut. Guides should fit loosely.

6. Place return guide clamp over guides and install two screw and lock washer assemblies and tighten to 8-12 lb. ft. torque.

CHECK WORM PRELOAD

The worm groove is ground with a high point in the center. When the rack-piston nut passes over this high point, a preload of 0.5-3.0 lb. in. torque should be obtained.

NOTE: DO NOT refit rack-piston balls unless a complaint of loose steering is received. Upon such a complaint, a thrust adjustment and over center adjustment should correct the problem if it lies in the steering gear.

1. With worm pointing up, lightly clamp rack-piston nut in a bench vise having brass jaws.

CAUTION: Do not hold rack-piston nut in area of Teflon ring.

2. Place valve assembly on worm, engaging worm drive pin.

3. Rotate worm until it extends 1-1/4 inches from rack-piston nut to thrust bearing face. This is the center position.

4. Attach an inch-pound torque wrench with 3/4 inch 12-point socket to stub shaft (Fig. 9A-28).

5. Oscillate wrench through a total arc of approximately 60 degrees in both directions several times and take a reading. The highest reading obtained with worm rotating should be between 0.5 to 3.0 lb. in. torque. Record torque when in specifications.

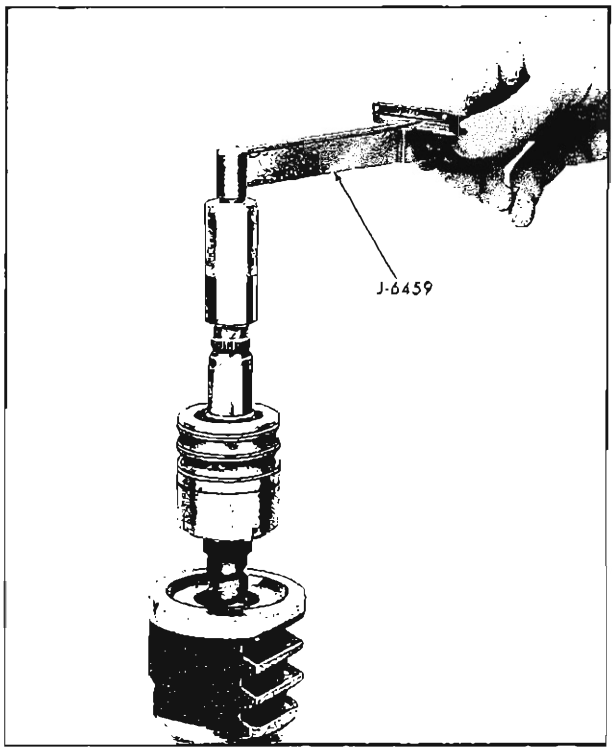


Fig. 9A-28 Checking Worm Preload

NOTE: DO NOT use a torque wrench having maximum torque reading of more than 100 lb. in. When taking following torque readings, take a reading pulling the torque wrench to the right and a reading pulling the torque wrench to the left. Total both readings and take one-half of this total as the average torque.

NOTE: DO NOT refit rack-piston balls unless a complaint of loose steering is received. Upon such a complaint, a thrust adjustment and over center adjustment should correct the problem if it lies in the steering gear. If balls were pitted or rough, then select the proper ball size for proper adjustment.

6. If the reading is too high or low (on new balls only), disassemble and reassemble using next size smaller (or larger) balls and recheck.

Table of Selective Sizes of Steering Nut Balls

6	.28117"
7	.28125"
8	.28133"
9	.28141"
10	.28149"
11	.28157"

A rack-piston nut with a ball size of 7 does not have a number stamped on the flat surface. For ball sizes other than No. 7 the ball size is stamped on the flat surface of the rack-piston nut. In order to obtain proper worm bearing preload install the proper new balls.

7. Remove rotary valve assembly from worm head.

8. Position arbor (tool J-7539) against worm end. Turn worm out of rack-piston assembly following worm end with arbor. Do not allow arbor to separate from worm until rack-piston nut is fully on the arbor. The arbor now keeps the balls from dropping out of the ball nut.

ASSEMBLE WORM SHAFT, ROTARY VALVE ASSEMBLY AND ADJUSTER PLUG AS AN ASSEMBLY

1. Assemble lower thrust bearing and races on worm (Fig. 9A-29).

2. Be sure "O" ring seal is between valve body and worm head and assemble valve assembly to worm by aligning slot in valve body with pin on worm head.

3. Install new "O" ring on adjuster plug.

4. Install adjuster plug assembly on stub shaft so bearing rests against upper bearing assembly.

STEERING GEAR ASSEMBLE

ADJUST THRUST BEARING PRELOAD

1. Install worm valve assembly and adjuster plug in housing as integral unit.

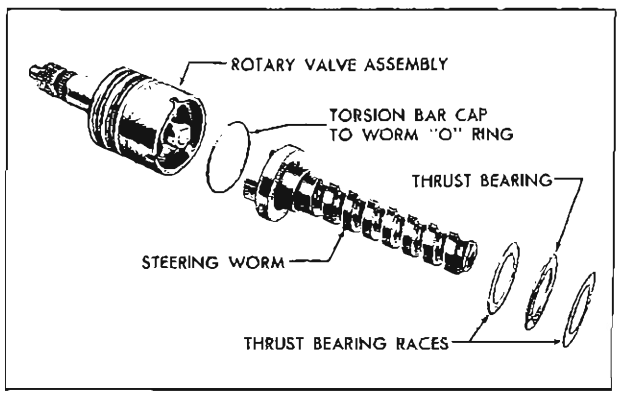


Fig. 9A-29 Worm Shaft and Rotary Valve — Exploded View

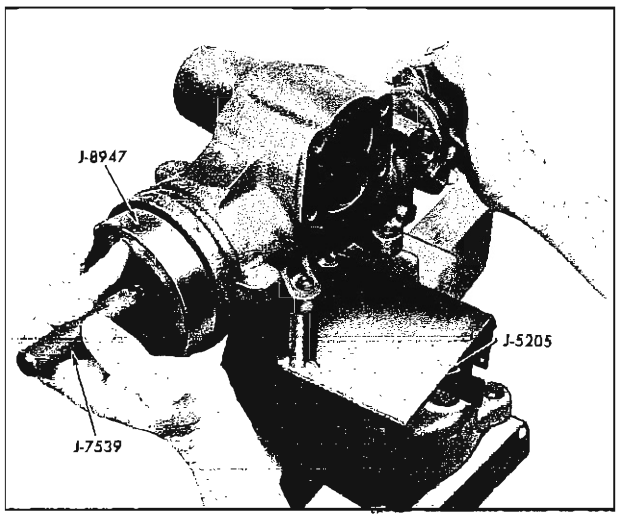


Fig. 9A-30 Installing Rack - Piston Nut

2. Tighten adjuster plug snug in gear housing and back off slightly (1/8 turn maximum.)

3. With torque wrench on stub shaft read torque required to rotate worm, valve assembly, and stub shaft in housing (drag).

4. Turn adjuster plug in until torque reading increased 0.5-3.0 lb. in. above drag reading obtained in (3) above.

NOTE: Do not use a torque wrench having maximum torque reading of more than 100 lb. in. When taking following torque readings, take a reading pulling the torque wrench to the right and a reading pulling the torque wrench to the left. Total both readings and take one-half of this total as the average torque.

5. Install adjuster plug lock nut and tighten to 50-110 lb. ft. torque.

6. Recheck thrust bearing preload. Total thrust bearing adjustment plus drag should not exceed 7 lb. in. torque.

REPLACE RACK—PISTON

1. Slip stub shaft flange onto end of stub shaft.

2. Holding Teflon ring compressor sleeve tool J-8947 tightly against the shoulder of gear housing, insert the rack-piston nut and arbor into housing, holding the arbor (tool J-7539) until arbor contacts worm end. See Fig. 9A-30.

3. Holding the arbor tight against the worm, turn stub shaft flange (and worm) to draw ball nut onto worm and into housing until the arbor is free.

CAUTION: Be certain that no balls drop out.

4. Remove arbor and sleeve.

REPLACE PITMAN SHAFT GEAR AND SIDE COVER

1. Turn steering worm until center groove of rack-piston is aligned with center of pitman shaft needle bearing.

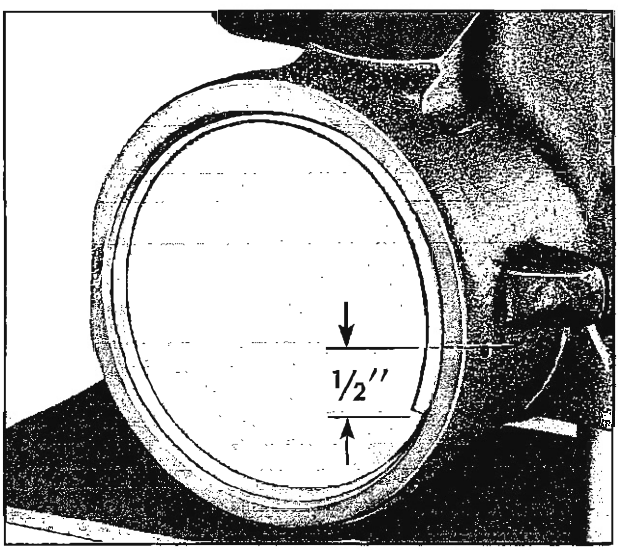


Fig. 9A-31 Installing End Plug Retainer Ring

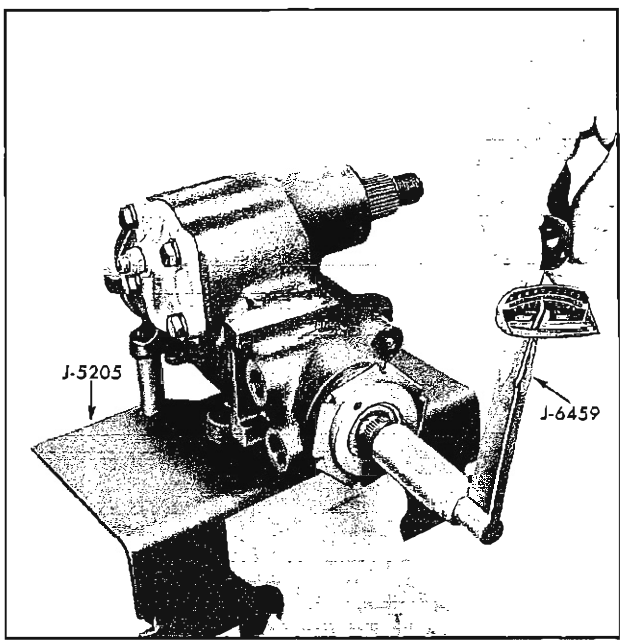


Fig. 9A-32 Adjusting Pitman Shaft Preload

2. Install new side cover "O" ring seal.

3. Install pitman shaft gear so that the center tooth of gear meshes with the center groove of rack-piston. Make sure that side cover "O" ring seal is in place before pushing cover against housing.

4. Install side cover screws and tighten to 25 to 35 lb. ft. torque.

5. Install end plug in rack-piston nut using 1/2" square drive and tighten to 50-100 lb. ft. torque.

REPLACE HOUSING LOWER END PLUG

1. Install new housing end plug "O" ring seal.

2. Insert end plug into gear housing and seat against "O" ring seal. Slight pressure may be necessary to seat end plug properly.

3. Install end plug retainer ring so end of ring extends over and at least 1/2" beyond the ring removal assist hole (Fig. 9A-31).

ADJUST PITMAN SHAFT PRELOAD THROUGH CENTER HIGH POINT

NOTE: DO NOT use a torque wrench having maximum torque reading of more than 100 lb. in. When taking following torque readings, take a reading pulling the torque wrench to the right and a reading pulling the torque wrench to the left. Total both readings and take one-half of this total as the average torque.

Using a 3/4"-12 point deep socket and inch-pound torque wrench (Fig. 9A-32), take a reading through the center position to determine total drag, thrust bearing adjustment, and rack and worm preload. Adjust lash adjuster so torque is between 3 and 6 lb. in. in excess of the total reading found above.

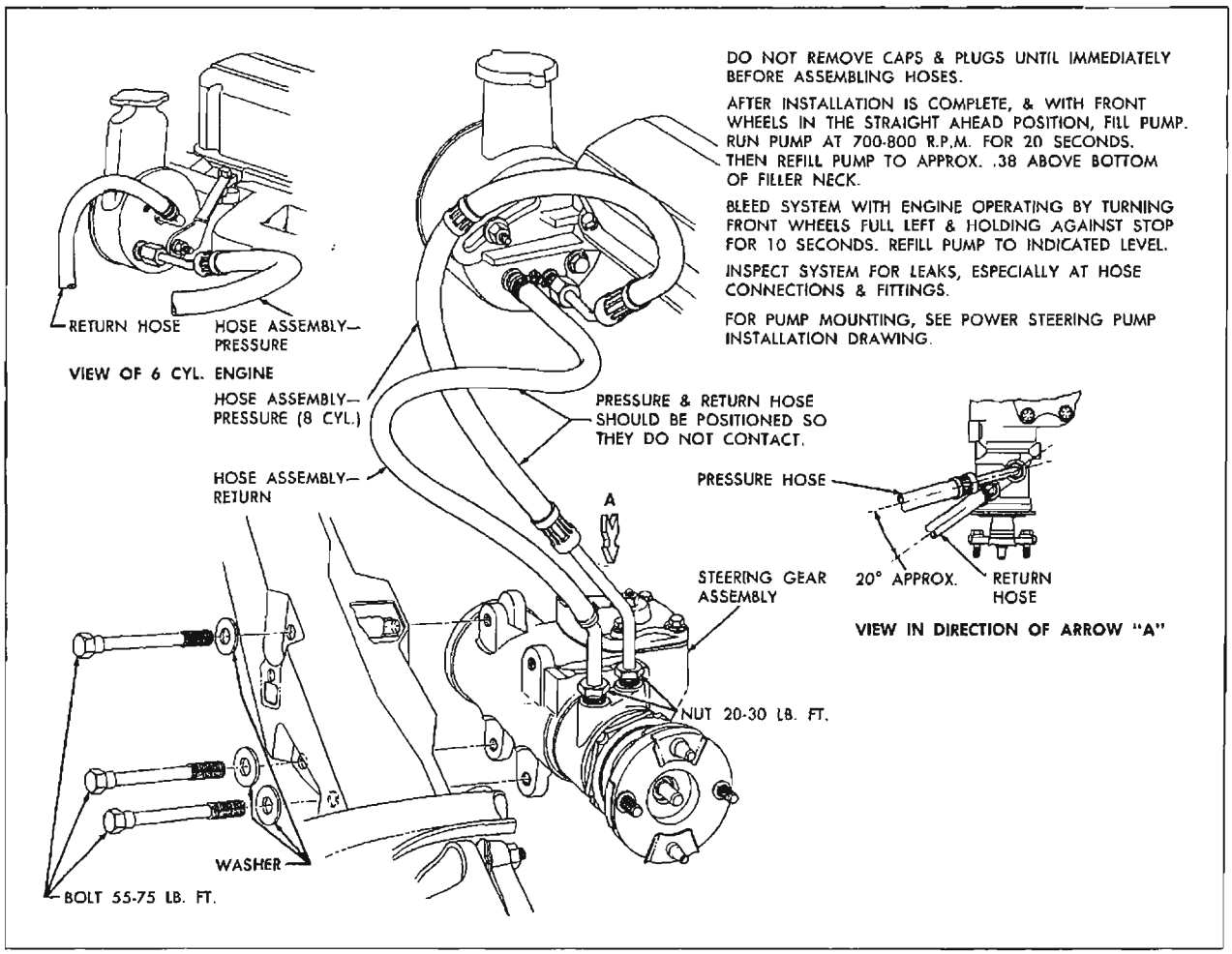


Fig. 9A-33 Installation of Power Steering Gear Assembly

Total over center preload must not exceed 14 lb. in. through center high point when rotating worm shaft through an arc of approximately 20°. Tighten lash adjuster nut to 20-30 lb. ft. torque. Recheck preload after nut has been tightened.

REPLACE STUB SHAFT FLANGE

1. Replace stub shaft flange, aligning the flat surface on the stub shaft serrations with the flat section in the flange hole.

2. Install flange clamping bolt and tighten to 25 to 35 lb. ft. Be sure to position flange so that it clears the end of the adjuster plug by approximately 1/16 inch and rotates without interference with the adjuster plug.

STEERING GEAR—INSTALL

1. Position steering gear assembly in car aligning large head rivet in widest upper flange opening.

NOTE: If same gear housing is replaced, locate any 1/8" standard washer shims that were removed in their original position between housing and frame. If steering gear has new housing or requires any alignment, flatwashers of appropriate thickness and diameter should be selected for proper alignment of steering gear and steering column assembly. Metal to metal contact between flanges on stub shaft assembly and steering shaft assembly will transmit and amplify gear noise to the driver.

2. Install steering housing to frame bolts finger tight. Shift gear assembly to obtain best alignment with flange on steering shaft. Tighten housing to frame bolts to 55-75 lb. ft. torque.

3. Install pitman arm and secure with lock washer and nut. Tighten nut to 110-140 lb. ft. torque.

4. Connect pressure and return hose assemblies to gear assembly and tighten to 20-30 lb. ft. torque.

5. Install two flange flexible coupling attaching nuts and lock washers and tighten to 15-20 lb. ft. torque.

6. Check fluid level in pump reservoir. Fluid should be up to oil level mark in reservoir. Add Automatic Transmission Fluid Type A identified by an AQ-ATF qualification number as necessary. With front wheels off floor, start engine and bleed hydraulic system by manually steering through cycle several times until there is no evidence of air bubbles in reservoir. Recheck fluid level and lower car.

POWER STEERING GEAR TROUBLE DIAGNOSIS

CONDITION	CAUSE	REMEDY
1. Hard steering while driving	Frozen steering shaft bearings	Replace bearings
	Lower coupling flange rubbing against adjuster	Loosen bolt and assemble properly
	Steering wheel rubbing against gearshift bowl	Adjust jacket endwise
	Steering adjustment tight	Check adjustment by dropping pitman arm from gear or disconnecting linkage from pitman arm ball. Readjust if necessary
2. Poor return of steering	Frozen steering shaft bearings	Replace bearings
	Lower coupling flange rubbing against adjuster	Loosen bolt and assemble properly
	Steering wheel rubbing against gearshift bowl	Adjust jacket endwise

CONDITION	CAUSE	REMEDY
2. Poor return of steering (cont'd.)	Tires not properly inflated	Inflate to specification
	Incorrect caster or toe-in front wheels	Adjust to specification
	Tight steering linkage	Lubricate-check end plugs
	Steering gear misalignment	Re-shim at frame
	Tightness of suspension ball joints	Lubricate or otherwise free up
	Steering adjustment tight	Check adjustment by dropping pitman arm from gear or disconnecting linkage from pitman arm ball. Readjust if necessary
	Tight sector to rack-piston adjustment	Adjust in car to specification
	Thrust bearing adjustment too tight	Remove gear and adjust to specification
	Rack-piston-nut and worm preload too tight	Remove gear and replace balls as required
	Sticky valve spool	Remove and clean valve or replace valve
3. Car leads to one side or the other	Due to front end misalignment	Adjust to specification
	Unbalanced or badly worn valve *NOTE: If this is cause, steering effort will be very light in direction of lead and heavy in opposite direction.*	Replace valve
4. Momentary increase in effort when turning wheel fast to the right	Low oil level in pump	Check oil level in pump reservoir
	Pump belt slipping	Tighten or replace belt
	High internal leakage	Replace rack-piston nut piston ring, ring back-up seal and/or replace valve
5. Momentary increase in effort when turning wheel fast to the left	Low oil level in pump	Check oil level in pump reservoir
	Pump belt slipping	Tighten or replace belt
	High internal leakage	Replace rack-piston nut piston ring, ring back-up seal, valve body to worm seal and/or replace valve

CONDITION	CAUSE	REMEDY
6. External oil leaks (wipe gear thoroughly and make sure source of leakage is determined)	Loose hose connections	Tighten
	Damaged hose	Replace
	Side cover "O"-ring seal	Replace seal
	Pitman shaft seals	Replace seals
	Housing end plug seal	Replace seal
	Adjuster plug seals	Replace seals
	Torsion bar seals	Replace rotary valve assembly
7. Gear noise (rattle or chuckle)	Loose over-center adjustment *NOTE: A slight rattle may occur on turns because of the increased lash off the "high point". This is normal and the lash must not be reduced below the specified limits to eliminate this slight rattle.*	Adjust to specification
8. Gear noise ("hissing" sound)	Gear loose on frame	Check gear-to-frame mounting bolts. Tighten bolts to specifications
	There is some noise in all power steering systems. One of the most common is a "hissing" sound most evident at standstill parking. There is no relationship between this noise and performance of the steering. Hiss may be expected when steering wheel is at end of travel or when slowly turning at standstill.	Do not replace valve unless "hiss" is extremely objectionable. Slight hiss is satisfactory and in no way affects steering. A replacement valve may also exhibit slight noise and is not always a cure for the objection. Be sure steering shaft and gear are aligned so the flexible coupling rotates in a flat plane and is not distorted as shaft rotates. Any metal - to - metal contact through the flexible coupling will transmit the valve hiss into the car
9. Excessive wheel kickback or loose steering.	Lash in steering linkage	Adjust parts affected
	Air in system	Add oil to pump reservoir and bleed system of air
	Excessive lash between pitman shaft sector and rack-piston	Adjust to specification
	Loose thrust bearing adjustment	Remove gear and adjust to specification

CONDITION	CAUSE	REMEDY
9. Excessive wheel kickback or loose steering (cont'd.)	Ball nut and worm preload	Check thrust bearing adjustment and over center adjustment. Check for looseness in steering linkage. If complaint still exists, remove rack-piston and worm, and change balls to obtain specified preload
	Ball joints loose	See Ball Joints under FRONT SUSPENSION
	Front wheel bearings incorrectly adjusted or worn	Adjust or replace front wheel bearings
10. Steering wheel surges or jerks when turning with engine running, especially during parking	Loose pump belt	Adjust to specification
11. Hard steering when parking	Loose pump belt	Adjust to specification
	Low oil level in reservoir	Fill to proper level. If excessively low, check all lines and joints for evidence of external leakage
	Lack of lubrication in linkage or front suspension	Add lubricant where needed
	Tires not properly inflated	Inflate to recommended pressure
	Insufficient oil pressure	If all of the above checks do not reveal the cause of hard steering, make the following tests of oil pressure: 1. Disconnect the pressure line at oil pump. Attach gauge to pump. Connect the hose to end of gauge where the valve is located. 2. With engine at warm idle 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

CONDITION	CAUSE	REMEDY
11. Hard Steering when parking (cont'd.)	Insufficient oil pressure (contd.)	*CAUTION: Do not hold wheel in extreme position for an extended period of time because it will drastically increase the oil temperature and will cause undue wear on the oil pump.* 3. With oil temperature between 150°F and 170°F, as measured with a thermometer in the reservoir, the maximum oil pressure should not be less than 925 psi for satisfactory power steering operation 4. If the maximum oil pressure is less than 925 psi, it indicates trouble in the pump, oil hoses, steering gear, or a combination of these parts. To eliminate the hoses and gear, close the gauge valve and quickly test pressure of the pump only with the engine at warm idle, then open the valve to avoid increasing oil temperature 5. Comparing the maximum pressures obtained in these two tests will indicate 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. b. First test (Step 2) and second test (step 4) pressures equally low - indicates faulty oil pump If above test shows trouble to be in pump, see pump section If trouble is shown to be in steering gear or hoses, examine for external oil leaks as under Condition No. 6

CONDITION	CAUSE	REMEDY
11. Hard Steering when parking (cont'd.)	Low oil pressure due to restriction in hoses:	
	a. Check for kinks in hoses	Remove kink
	b. Foreign object stuck in hose	Remove hoses and remove restricting object or replace hose
	Low oil pressure due to steering gear:	
	a. Pressure loss in cylinder due to worn piston ring, damaged ring back-up seal or scored housing bore	Remove gear from car for disassembly and inspection of ring, back-up seal and housing bore
	b. Leakage at valve rings and/or valve body to worm seal	Remove gear from car for disassembly and replace ring or seal
	c. Loose fit of spool in valve body or leaky valve body	Replace rotary valve assembly
	Loss of assist coming out of left turn:	Check oil level in pump reservoir
		Tighten or replace belt
		Replace rack-piston nut, piston ring and ring back-up seal. When the rack-piston nut is out, make sure there is a chamfer on both sides of the ring groove, otherwise replace nut with one having a chamfer on both sides of the ring groove
12. Valve squawk when turning or when recovering from a turn	Cut or worn dampener ring on valve spool	Replace dampener ring, being careful not to cut the new ring at installation
	Loose or worn rotary valve parts	Replace rotary valve assembly
13. No effort required to turn	Broken torsion bar	Replace rotary valve assembly

POWER STEERING GEAR SPECIFICATIONS

Over-all Steering Ratio . . . . . approx. 20.65 to 1

Steering Gear Ratio . . . . . 17.5 to 1

Steering Wheel Effort

- Normal Driving. . . . . 1 to 2 lbs.
- Parking. . . . . 2 to 3.5 lbs.

Torque

- Adjuster Plug Lock Nut . . . . . 50-110 lb. ft.
- Lower Flange Attaching Bolt . . . . . 25-35 lb. ft.
- Pitman Arm Lock Nut . . . . . 110-140 lb. ft.
- Pitman Shaft Preload Lash Adjuster Lock Nut . . . . . 20-30 lb. ft.
- Pressure Hose Connector at Gear . . . 20-30 lb. ft.
- Rack-piston Nut End Plug. . . . . 50-100 lb. ft.
- Return Hose Connector at Gear . . . . 20-30 lb. ft.
- Side Cover Screws . . . . . 25-35 lb. ft.
- Steering Gear Housing to Frame Bolts . . . . . 55-75 lb. ft.

Power Steering System Fluid Capacity . . . . . 2.5 Pints