

# STEERING

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## STEERING COLUMNS

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### GENERAL

A noncompressible steering column is used in CJ Models. The solid shafts are connected by a yoke U-joint assembly. Cherokee, Wagoneer, and Truck Models are equipped with the anti-theft energy-absorbing steering column. The Adjust-O-Tilt adjustable steering steering column is optional on vehicles with automatic transmission. Like the non-tilt model, the Adjust-O-Tilt column is an energy-absorbing unit, and has an anti-theft locking feature.

### Anti-Theft Energy-Absorbing Column

The anti-theft energy-absorbing steering column serves three functions:

- The column is energy-absorbing, designed to compress up to 8.25 inches in a front-end collision to minimize the possibility of injury to the driver.
- The ignition switch and lock are mounted conveniently on the column.
- With the column-mounted lock, the ignition, steering, and gear shifting operation can be locked to inhibit theft of the automobile.

**WARNING:** Use only specified screws, bolts, and nuts during reassembly, and tighten to the specified torque to ensure the energy-absorbing action of the assembly. Overlength bolts must not be used as they may prevent a portion of the assembly from compressing under impact. The bolts or nuts securing the column mounting bracket to the instrument panel must be tightened to the proper torque so that the bracket will break away under impact.

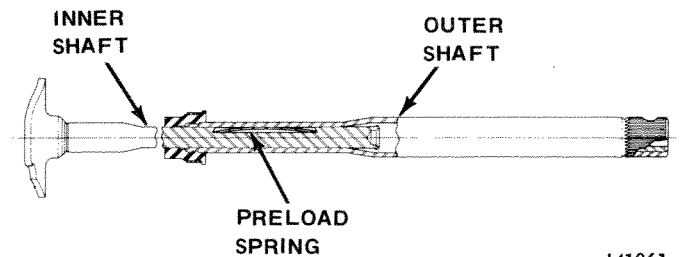
**CAUTION:** When removed from the vehicle, special care must be taken in handling the column. Such actions as a sharp blow on the end of the steering shaft or shift levers, leaning on the column assembly, or

dropping of the assembly, could shear or loosen the plastic fasteners that maintain column rigidity.

### Intermediate Steering Shaft

Cherokee, Wagoneer, and Truck models have a telescoping (center-slip) intermediate steering shaft (fig. 11-1). It is attached at the steering gear by a flexible coupling, and at the steering column with a non-slip cardan joint. The shaft is used for both manual and power steering applications.

The telescoping design allows the shaft to be shortened or lengthened for a total adjustment travel of 1.5 inches. When fully extended the shaft measures 22.18 inches, and 20.68 inches fully compressed. If damage to the shaft occurs it should be serviced as an assembly.



J41061

Fig. 11-1 Intermediate Steering Shaft

### STEERING WHEEL

#### CJ Models

##### Removal

- (1) Disconnect battery negative cable.
- (2) Place front wheels in straight-ahead position.
- (3) Pull horn button from steering wheel.
- (4) Remove steering wheel nut and horn button contact cup.
- (5) Scribe a mark on steering wheel and steering shaft to facilitate installation.
- (6) Release turn signal assembly from steering post and install Puller J-25163.
- (7) Remove steering wheel and spring.

### Installation

(1) Align scribe marks on steering shaft with steering wheel and secure steering wheel spring, steering wheel, and horn button contact cup with steering wheel nut. Tighten nut to 35 foot-pounds torque.

(2) Install horn button.

(3) Connect battery cable and test horn.

### Cherokee-Wagoneer-Truck

#### Removal

(1) Disconnect battery negative cable.

(2) Place front wheels in straight-ahead position.

(3) Remove steering wheel spoke horn cover attaching screws from underside of steering wheel spoke and remove horn cover.

(4) Disconnect horn wire from switch in steering wheel cavity by gently pulling and wiggling quick-disconnect connector.

(5) Remove steering wheel nut and connector.

(6) Scribe a mark on steering wheel and steering shaft to facilitate installation.

(7) Install Puller J-25115 (fig. 11-2).

(8) Remove steering wheel.

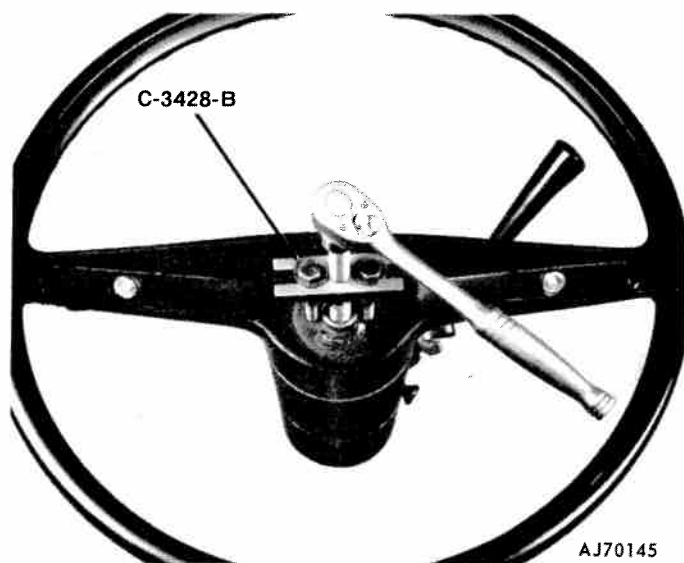


Fig. 11-2 Steering Wheel Removal

#### Installation

(1) Align scribe marks on steering shaft with steering wheel and secure wheel using washer and nut. Tighten nut to 20 foot-pounds torque.

(2) Connect horn wire to switch in steering wheel cavity.

(3) Install spoke horn cover.

(4) Connect battery cable and test horn.

### INTERMEDIATE STEERING SHAFT

#### Removal

(1) Remove attaching parts at flexible coupling. Index coupling before removal to facilitate correct installation.

(2) Remove clamp bolt that secures splined end of shaft to cardan joint. Index shaft and cardan joint prior to removal of clamp.

(3) Lift flanged end of shaft and pull splined end out of cardan joint.

**NOTE:** If necessary, shaft may be compressed to facilitate removal and installation.

#### Installation

(1) Insert splined end of shaft into cardan joint. Use index marks to guide alignment. Do not tighten clamp bolt.

(2) Secure shaft flange to flexible coupling with attaching parts. Use index marks to guide alignment.

(3) Tighten clamp bolt at cardan joint.

**NOTE:** Shaft should be neither fully extended nor fully compressed when installed.

### STEERING COLUMN SERVICE—CJ MODELS

#### Removal

(1) Disconnect battery negative cable.

(2) Disconnect steering column wiring connector from wiring harness located under instrument panel.

**NOTE:** The steering wheel does not have to be removed to remove the steering column.

(3) Scribe a line mark on steering shaft and upper steering shaft to lower shaft U-joint.

(4) Remove U-joint pinch bolt.

(5) Disconnect steering column toeboard to tube plate and clamp.

(6) Remove rubber grommet attaching screws.

(7) Disconnect steering column at instrument panel and remove column.

#### Steering U-Joint Coupling

CJ Models are equipped with a Saginaw steering gear and use a two-piece steering shaft with the sections connected by U-joint couplings. The upper U-joint connecting the intermediate and steering column shafts, is non-repairable and must be replaced with a new U-joint assembly when faulty. The lower U-joint coupling has a single spring which is placed between two bearing blocks, tending to spread them

apart and automatically take up the wear. When servicing the lower U-joint coupling, the following procedure should be followed.

### Disassembly

- (1) Disconnect lower U-joint coupling at steering gear output shaft by removing pinch bolt and clamp.
- (2) Loosen clamp holding U-joint coupling cover to lower shaft and remove U-joint coupling cover.
- (3) Remove spring clip from cover and carefully remove cover from steering shaft. Use caution to avoid loss of small parts inside cover.

**CAUTION:** Use care to prevent damage to bearing surfaces of the pin.

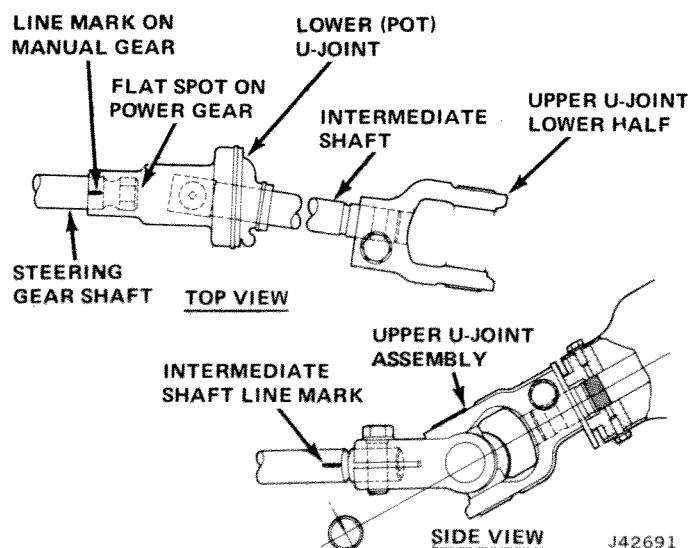
- (4) Remove steering shaft pivot pin bearing blocks and wave washers.

### Inspection

Carefully inspect all parts for signs of wear. If pivot pin in steering shaft is not serviceable, steering shaft must be removed and replaced with a new steering shaft-pin assembly.

### Assembly

- (1) Install coupling cover on lower shaft, aligning slot in clamp with mark on shaft (fig. 11-3).
- (2) Install clamp bolt and tighten to 40 foot-pounds torque.
- (3) With steering shaft installed, place bearing blocks with wave washers in place over each end of pivot pin after first lubricating pin with chassis grease.
- (4) Place retainer over end of shaft.
- (5) Lubricate inside of housing with chassis grease and carefully position over pivot pin.



**Fig. 11-3 Steering Gear-to-Steering Wheel Alignment**

- (6) Position retainer and boot in housing and install spring clip.

- (7) Connect lower U-joint and shaft to steering gear output shaft. Install clamp pinch bolt and tighten.

### Steering Column Disassembly

- (1) Remove steering wheel.
- (2) Remove upper steering shaft from steering column and horn wire and contact ring from shaft (fig. 11-4).
- (3) Remove horn contact brush from column.
- (4) Remove bearing assembly and bushing assembly from steering column ends.
- (5) Inspect all parts for damage and wear. Replace worn or damaged parts.

### Steering Column Assembly

- (1) Install bushing assembly and bearing assembly to steering column ends.
- (2) Install horn contact brush.
- (3) Install steering shaft with horn wire and contact ring.
- (4) Install steering wheel.

### Steering Column Installation

- (1) Insert steering column assembly downward, through firewall of vehicle.
- (2) Position steering column assembly and install attaching bolts, nuts, and screws at instrument panel.
- (3) Install and secure toeboard to tube plate clamp.
- (4) Install U-joint pinch bolt.
- (5) Install horn contact brush on column.
- (6) Install turn signal assembly and connect turn signal and horn connectors underneath instrument panel.

## STEERING COLUMN SERVICE—CHEROKEE-WAGONEER-TRUCK

### Directional Signal Switch

#### Removal (Column in Vehicle)

- (1) Disconnect battery negative cable.
- (2) Release horn contact trim cover by loosening attaching screws at underside of steering wheel and remove horn button by lifting up.
- (3) Remove steering wheel nut. Note alignment of steering wheel-to-steering shaft index marks for later installation.
- (4) Remove steering wheel with Steering Wheel Puller C-3428-B.
- (5) Loosen anti-theft cover retaining screws, lift

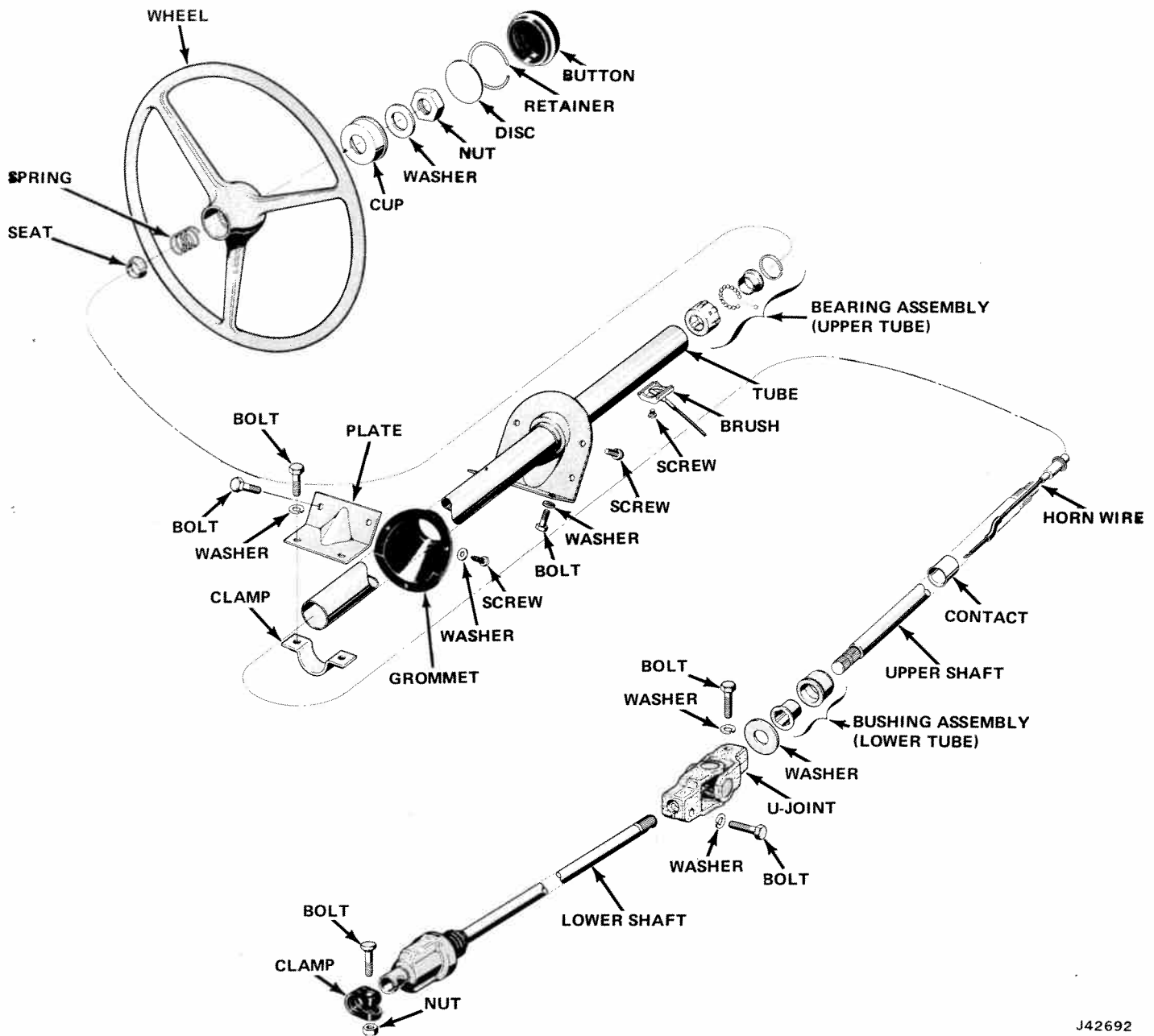


Fig. 11-4 Steering Column—CJ Models

cover from column, and remove signal switch wire protector.

(6) Use Lock Plate Compressor Tool J-23653 to depress lock plate (fig. 11-5).

**WARNING:** Exercise care when removing snap ring as lock plate is under considerable spring tension.

Once lock plate is depressed, pry the round wire snap ring from steering shaft groove. Remove Lock Plate Compressor Tool, snap ring, lock plate, directional signal canceling cam, upper bearing preload spring, and thrust washer from the steering shaft.

(7) Place directional signal actuating lever in the right turn position and remove lever.

(8) Depress hazard warning light switch, located on right side of column adjacent to key lock, and remove button by turning counterclockwise.

(9) Remove directional signal wire harness connector block from its mounting bracket on right side of lower column. On vehicles equipped with automatic transmission, use a stiff wire such as a paper clip to depress the lock tab which retains the shift quadrant light wire in the connector block. Disconnect the wire.

(10) Remove directional signal switch retaining screws and pull directional signal switch and wire harness from the column (fig. 11-6).

## Installation

(1) Guide wiring harness into position and carefully align switch assembly. Be sure that actuating

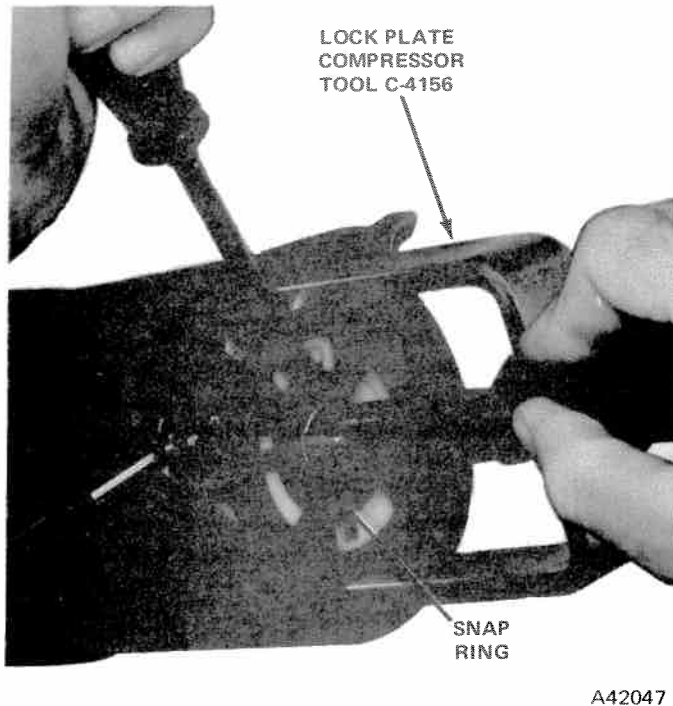


Fig. 11-5 Lock Plate Snap Ring Removal

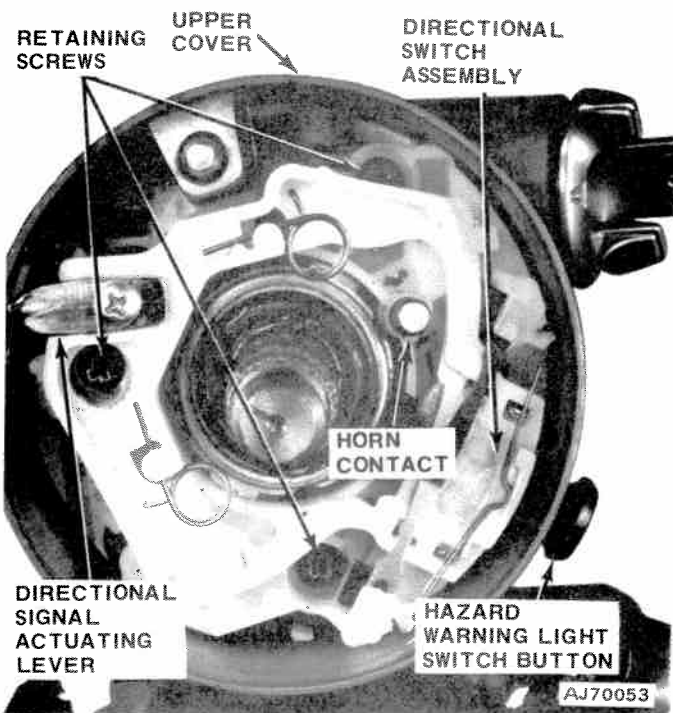


Fig. 11-6 Directional Switch

lever pivot is correctly aligned and seated in upper housing pivot boss prior to installing retaining screws.

(2) Install directional signal lever and actuate directional signal switch to assure correct operation.

(3) Place thrust washer, spring, and directional signal canceling cam on upper end of steering shaft.

(4) Align lock plate splines with the steering shaft splines and place lock plate in position, with the di-

rectional signal canceling cam shaft protruding through the dog-leg opening in the lock plate.

(5) Place steering shaft snap ring on steering shaft and use Snap Ring Installer Tool J-23653 to push the snap ring into place.

(6) Install anti-theft cover.

(7) Align directional signal cancelling cam, index marks on steering shaft and steering wheel, and install steering wheel.

(8) Tighten steering wheel nut to 20 foot-pounds torque.

(9) Install hazard warning light switch button and steering wheel trim cover.

(10) On center horn button type installations, index projection on rubber retainer ring with notch in cup. With wheel centered, cup notch is up. Tighten screws to 25 inch-pounds torque.

(11) On vehicles equipped with automatic transmission, connect the shift quadrant light wire into the connector block.

(12) Position the connector block in its mounting bracket and connect wiring harness.

### Steering Column Alignment

(1) Loosen toeboard two-piece seal cover and remove lower clamp bracket.

(2) Remove instrument panel trim plate below jacket tube.

(3) Loosen mounting bracket attaching bolts which will allow column to assume an aligned position with steering gear.

(4) Pull steering column upward. Maintain upward pressure while tightening mounting bracket to column bolts 15 to 25 foot-pounds torque.

(5) Install lower clamp bracket and tighten bolts 12 to 17 foot-pounds torque.

(6) Install two-piece seal retainer.

(7) Install instrument panel trim plate below jacket tube.

**NOTE:** Upon completion of steering column alignment, column shift linkage adjustment must be checked to ensure proper operation.

### Steering Column Removal

**CAUTION:** Once the steering column is removed from the vehicle, the column is extremely susceptible to damage. Dropping the column assembly on its end could collapse the steering shaft or loosen the plastic components which maintain column rigidity. Leaning on the mast jacket could cause the column to bend or deform. Any of the above damages could impair the collapsibility function of the column. If it is necessary to remove the steering wheel, use standard wheel puller. Do not hammer on end of shaft, as hammering could fracture plastic retainers which maintain column rigidity.

- (1) Disconnect battery negative cable.
- (2) Disconnect steering column wiring connectors from wiring harness located underneath instrument (dash) panel.

**NOTE:** *Steering wheel does not have to be removed to remove steering column.*

- (3) On vehicles without power steering, scribe a line mark on steering shaft and upper steering shaft to lower shaft U-joint.
- (4) Remove U-joint pinch bolt.
- (5) On vehicles with power steering, remove two flexible coupling-to-flange bolt nuts. Note difference in size of bolt shanks and nuts to ensure correct assembly.
- (6) Disconnect shift linkage from shift lever on column shift models.
- (7) Remove column to toe board parts.
- (8) Remove lower instrument panel crash pad trim plate, bracket capsule stud nuts (or bolt) at instrument panel.
- (9) Remove bracket-to-column bolts and remove bracket.

**CAUTION:** *Set bracket aside to protect breakway capsules.*

**NOTE:** *Bracket capsules are slotted to permit column movement for adjustment.*

- (10) Remove column from vehicle.

## Upper Section Disassembly (Except Adjust-O-Tilt)

Column removal is not necessary if only upper section is to be repaired. However, if complete column or lower section is to be disassembled, remove column and use Steering Column Support Fixture J-23074 to mount column assembly in a vise. The following disassembly procedure applies to column shift and floor shift steering columns (except Adjust-O-Tilt columns), with minor differences noted where applicable.

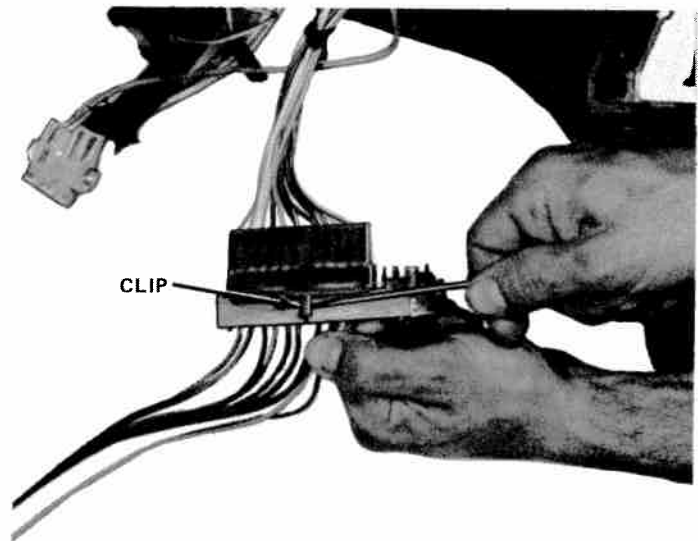
- (1) Disconnect battery negative cable.
- (2) Cover painted areas of column.
- (3) Remove instrument panel lower finish panel.
- (4) Remove steering wheel.
- (5) Loosen anti-theft cover retaining screws and lift cover from column. It is not necessary to completely remove these screws as they are held on cover by plastic retainers.
- (6) Use Lock Plate Compressor Tool J-23653 to depress lock plate. Once lock plate is depressed, remove round wire snap ring from steering shaft groove (fig. 11-5).

**WARNING:** *Lock plate is under strong spring pressure.*

- (7) Remove Lock Plate Compressor Tool.
- (8) Remove snap ring, lock plate, directional signal canceling cam, upper bearing preload spring, and thrust washer from steering shaft.

**NOTE:** *Steering shaft is now free in column. During bench overhaul, steering shaft should be removed at this time by pulling out from lower end of column.*

- (9) Place directional signal actuating lever in right turn position then remove lever.
- (10) Depress hazard warning light switch, located on right side of column adjacent to key lock, then remove button by turning it in a counterclockwise direction.
- (11) With shift lever in Park, remove shift lever pivot pin with a punch, and remove lever.
- (12) Unhook directional signal wire harness connector from mounting bracket on lower right side of column, below instrument panel.
- (13) Unhook plastic locking tab and disconnect turn signal harness from instrument panel harness (fig. 11-7).
- (14) Use a stiff wire (paper clip) to depress lock tab retaining shift quadrant light wire in connector block.
- (15) Remove plastic harness protector from column jacket.
- (16) Wrap a piece of tape around upper harness connector to prevent snapping and remove harness (fig. 11-8).



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**Fig. 11-7 Steering Column Harness Connector**

- (17) With key in on position, remove key warning buzzer contacts using a wire hook (a paper clip with a right angle bend) or needlenose pliers (fig. 11-9).

**CAUTION:** *Do not attempt to remove switch separately, as a clip can fall down into column assembly.*

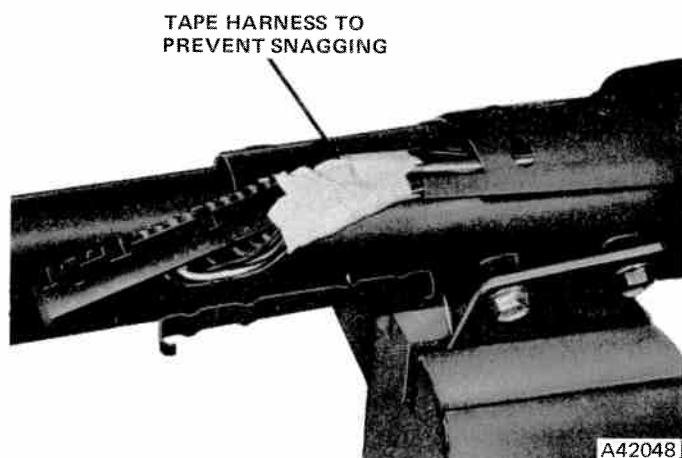


Fig. 11-8 Steering Column Harness Removal

(18) Place lock in LOCK position, depress lock cylinder retaining tab, and remove lock cylinder (fig. 11-10).

**NOTE:** If tab is not visible through hole, scrape flashing from hole.

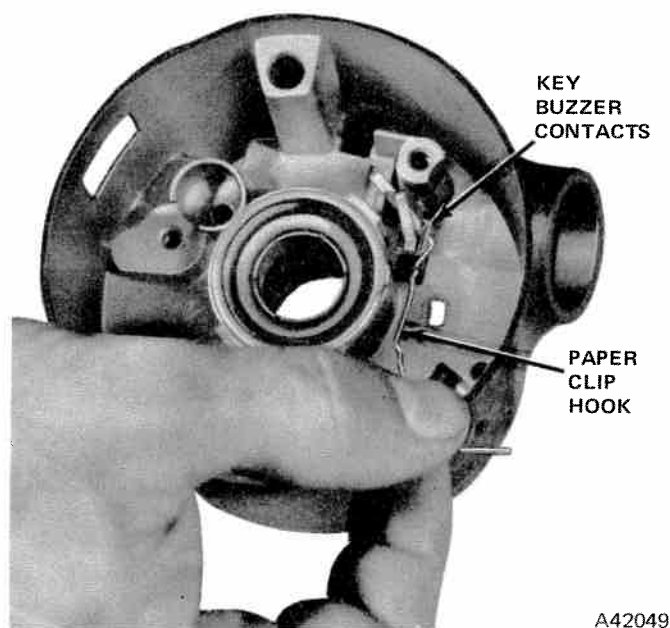


Fig. 11-9 Removal of Key Warning Buzzer Contacts

(19) Remove ignition switch from lower column.

(20) Remove four hex head screws retaining upper housing, then remove upper housing. Remote lock rod and automatic column shift quadrant light wire, if equipped, will be removed with upper housing.

**NOTE:** Proceed with steps (21) through (28) for complete disassembly of column shift steering columns. To complete the disassembly of floor shift columns, skip to step (29).

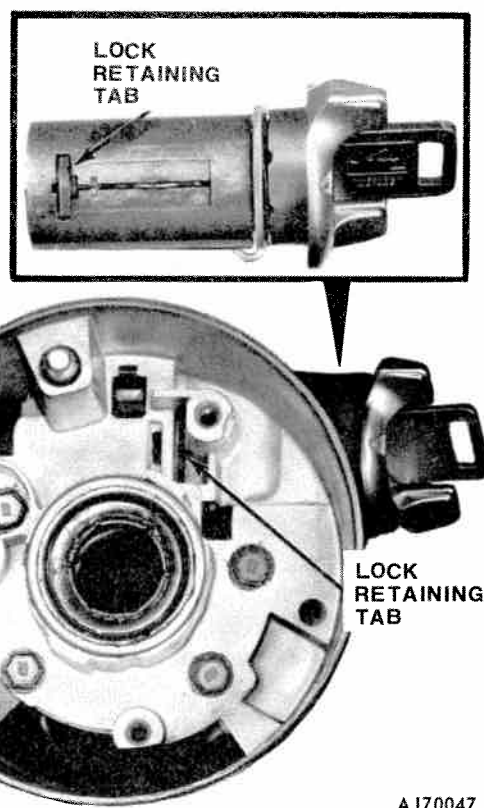


Fig. 11-10 Lock Cylinder Retainer Tab Location

(21) Remove thrust cup from upper housing (fig. 11-11).

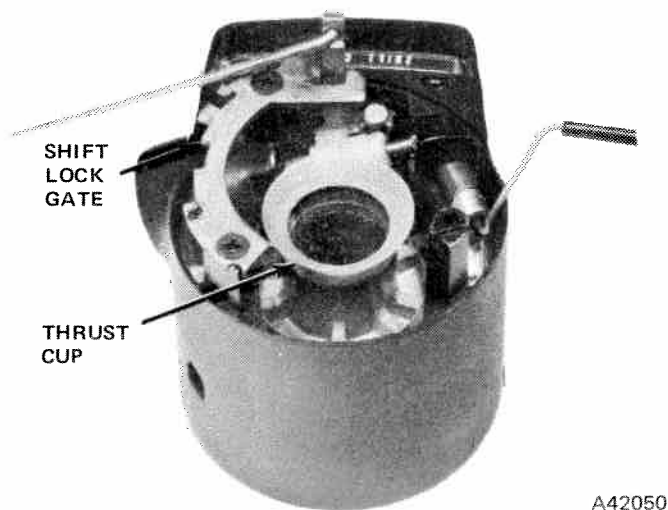
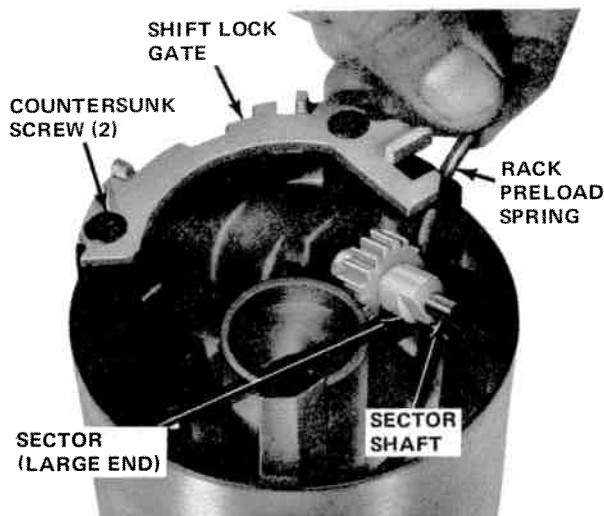


Fig. 11-11 Thrust Cup Position

(22) Remove lock bolt and rack. If rack preload spring requires service, remove at this point (fig. 11-12).

(23) If sector gear requires service, note position of sector on shaft for aid in assembly, and remove by driving it from its shaft with a suitable punch (fig. 11-12).





**Fig. 11-12 Rack Preload Spring Removal**

(24) Remove shift lock gate from upper housing. Examine shift lock gate detents for wear; replace if excessively worn.

(25) Remove shift quadrant which is retained by two retaining clips.

**NOTE:** Clips must be pried out with a small punch (fig. 11-13).



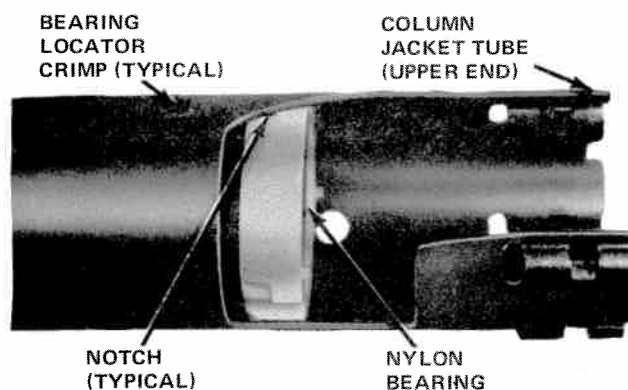
**Fig. 11-13 Retainer Clip Removal**

(26) Remove shift quadrant light cover then remove screw which retains socket assembly, and remove assembly.

(27) Remove shift bowl from column.

(28) Remove nylon bearing from upper end of jacket tube (fig. 11-14).

**NOTE:** If lower section is also being disassembled, it is easier to remove nylon bearing after shift tube is removed.



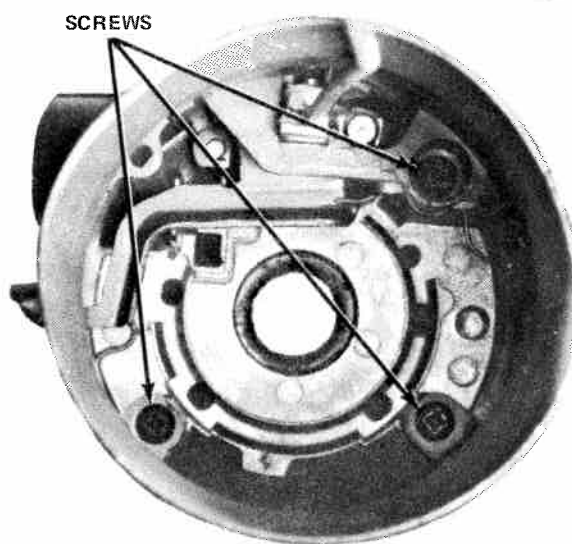
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**Fig. 11-14 Nylon Bearing**

**NOTE:** The following procedural steps are for complete disassembly of floor shift steering columns.

(29) Remove three screws attaching shroud to signal housing.

(30) Remove shroud (fig. 11-15).



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**Fig. 11-15 Shroud Removal**

(31) Place a rag over inhibitor lever pivot (to prevent lever spring from flying into face) and carefully remove inhibitor lever (fig. 11-16).

(32) Remove spring.

(33) Lift remote lock rod and rack assembly, and lock bolt and spring assembly out of housing. If rack preload spring requires service, remove at this time (fig. 11-12).

(34) If sector gear requires service, note position of sector on shaft for aid in assembly, and remove by driving it from its shaft with a suitable punch.



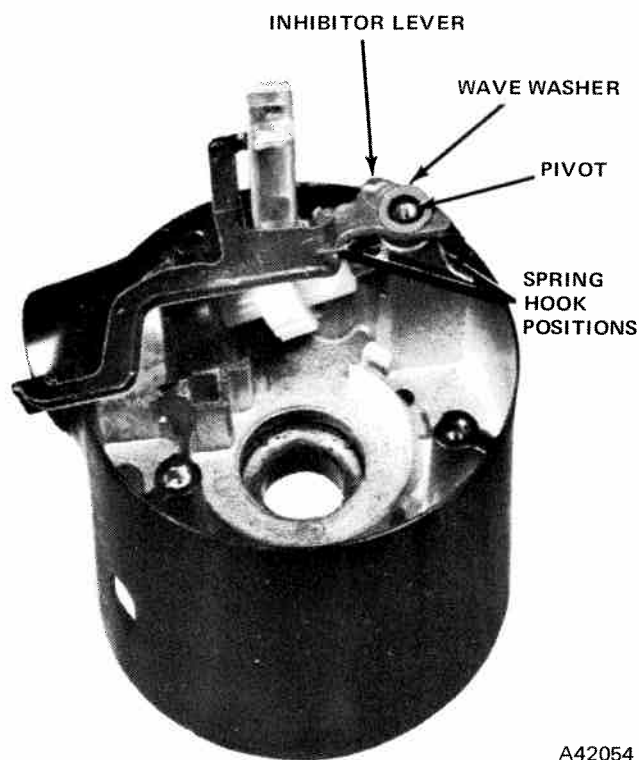


Fig. 11-16 Inhibitor Lever Arrangement

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### Lower Section Disassembly

#### Column Shift Steering Columns

**NOTE:** The following steps require steering column removal.

(1) If lower section only is to be serviced, remove upper steering shaft snap ring, lock plate, directional signal canceling cam, upper bearing preload spring, and thrust washer as outlined in Upper Section Disassembly. Further disassembly of upper section is not necessary.

(2) Remove steering shaft by pulling out from lower end of column.

(3) On automatic column shift, remove lower bearing retainer ring, lower bearing, preload spring, and nylon washer (fig. 11-17).

(4) Remove neutral safety and back-up lamp switch.

(5) Remove low-reverse shift lever and spacer, if equipped.

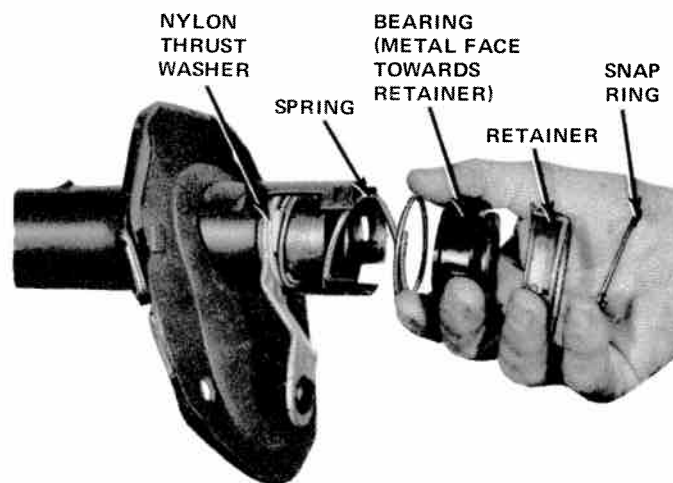
(6) Remove shift tube bearing retaining screws.

(7) Remove shift tube.

**NOTE:** If nylon shift tube bearing was not removed during upper section disassembly, remove it at this time.

#### Floor Shift Steering Columns

**NOTE:** The following steps require column removal.



**NOTE:** FLOOR SHIFT STEERING COLUMNS HAVE NO THRUST WASHER OR SPRING

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Fig. 11-17 Lower Bearing Assembly

(1) If lower section only is to be serviced, remove upper steering shaft, snap ring, lock plate, directional signal canceling cam, upper bearing preload spring and thrust washer as outlined in Upper Section Disassembly. Further disassembly of the upper section is not necessary.

(2) Remove steering shaft by pulling out from lower end of column.

(3) Remove lower bearing retaining ring and lower bearing (fig. 11-17).

**NOTE:** Refer to figure 11-18 for Standard Column Assembly Sequence.

### Lower Section Assembly

**NOTE:** Apply multipurpose lubricant to all friction-bearing surfaces before assembly.

#### Floor Shift Steering Columns

Install lower bearing (with metal face toward retainer), bearing retainer, and lock ring.

**NOTE:** If complete column overhaul is being performed, continue with Upper Section Assembly. Otherwise, install steering shaft, upper bearing thrust washer and preload spring, upper bearing, directional signal canceling cam, lock plate, and snap ring as outlined in Upper Section Assembly.

#### Column Shift Steering Columns

(1) Install shift tube.

(2) Install nylon thrust bearing on lower end of automatic column shift tube with flat side of bearing toward top end of tube (fig. 11-17).

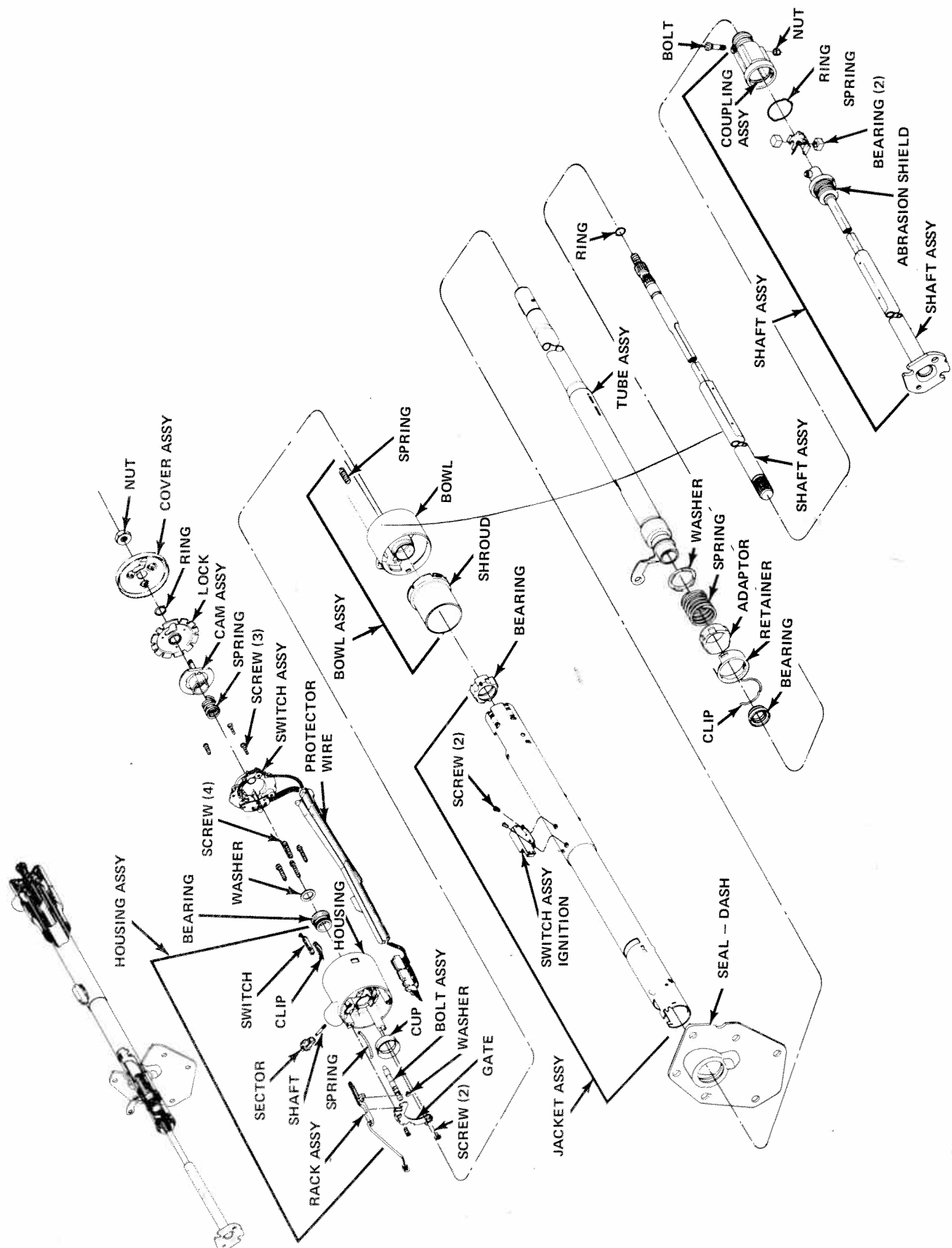


Fig. 11-18 Standard Column Assembly Sequence—Typical

(3) Install preload spring, lower bearing (with metal face toward retainer), bearing retainer, and lock ring.

(4) Install neutral safety and back up lamp switch.

**NOTE:** If complete column overhaul is being performed, continue with Upper Section Assembly. Otherwise install steering shaft, upper bearing thrust washer and preload spring, upper bearing, directional signal canceling cam, lock plate, and snap ring (outlined in Upper Section Assembly).

## Upper Section Assembly

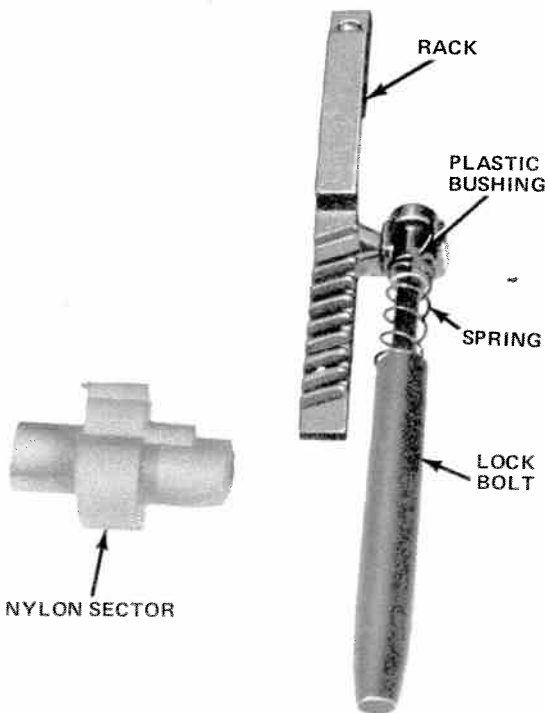
### Floor Shift Steering Columns

Apply a thin coat of Jeep All Purpose Lubricant, part number 8991230, to all friction-bearing surfaces.

(1) Install sector into upper housing. Place large end of sector through lock cylinder hole and onto sector shaft (fig. 11-12). Press sector onto shaft with a blunt tool.

(2) If removed, insert rack preload spring into housing from lower end. Hook both ends of spring onto housing.

(3) Assemble lock bolt, rack, and remote rod (fig. 11-19). Install into housing.



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Fig. 11-19 Lock Bolt, Rack, and Sector

**NOTE:** First tooth of rack must engage between first and second teeth of sector.

(4) Place inhibitor lever spring over lever pivot on housing. Position lever on pivot with spring hooked on lever.

(5) While holding down on lever pivot, place other spring in slot in housing.

(6) Place wave washer in position on the pivot.

(7) Place shroud over remote rod and onto housing.

(8) Install three attaching screws.

## Column Shift Steering Columns

(1) Insert lower bowl nylon bearing in upper end of jacket tube.

**NOTE:** Bearing must be installed with smaller inside diameter toward lower end of jacket tube, and the bearing notches must engage three locator crimps in column (fig. 11-14).

(2) Align shift bowl with shift tube spline and install bowl.

(3) Install rack preload spring into upper housing (fig. 11-12).

(4) Place large end of sector on sector shaft and press into position (fig. 11-12).

(5) Install shift lock gate using two countersunk screws (fig. 11-12).

(6) Install shift quadrant light and place light cover in position.

(7) Place shift quadrant indicator into position and press retainer clips into place with flat side towards bowl.

(8) Place lock bolt on rack (fig. 11-19) and install assembly into bowl.

**NOTE:** First tooth of rack must engage between first and second teeth of sector.

(9) Install nylon thrust cup in upper housing with flared end facing out (fig. 11-11).

## Upper Section Assembly—All Series

(1) On column shift steering columns, rotate shift bowl counterclockwise to stop, and install upper housing on column. On 01-40-70 Series with automatic transmission column shift, guide shift quadrant light wire and remote lock rod into position between shift bowl and mast jacket.

(2) Install key warning buzzer switch with brass tabs pointing upwards toward shift indicator (fig. 11-9).

(3) Install directional signal switch assembly. Guide wire harness into position and carefully align switch assembly.

(4) Untape connector, assemble wires into protector and protector-to-column jacket, and install switch retaining screws.

## ADJUST-O-TILT COLUMN STEERING DIAGNOSIS

Condition	Possible Cause	Correction
BEARING HOUSING SCRAPES ON BOWL	(1) End of jacket not square with center line (2) Shroud portion of bowl is not concentric with hub (3) Lock plate tab holes in jacket are improper width	(1) Replace jacket (2) Replace bowl (3) Replace lock plate
STEERING WHEEL LOOSE	(1) Excessive clearance between holes in support and pivot pin diameter	(1) Replace support and pivot pin
STEERING WHEEL LOOSE IN EVERY OTHER TILT POSITION	(1) Loose fit between shoe and pivot pin	(1) Replace both shoes and pivot pin
STEERING COLUMN NOT LOCKING IN ANY TILT POSITION	(1) Shoe seized on pivot pin (2) Shoe grooves burred or dirty (3) Shoe lock spring weak or broken	(1) Replace shoe and pin (2) Clean dirt/burrs from shoe groove (3) Replace shoe lock spring
STEERING WHEEL FAILS TO RETURN TO TOP TILT POSITION	(1) Pivot pins are bound up (2) Defective wheel tilt spring	(1) Remove pin, check holes for burrs Install new pins (2) Replace tilt spring
NOISE WHEN STEERING WHEEL RETURNS TO TOP TILT POSITION	(1) Tilt wheel upper tilt bumpers have failed	(1) Replace upper tilt bumpers
NOISE WHEN TILTING COLUMN	(1) Tilt spring rubbing in bearing housing	(1) Grease all points of contact for tilt spring

**NOTE:** Ensure that actuating lever pivot is correctly aligned and seated in upper housing pivot boss prior to installing retaining screws.

(5) Install turn signal lever and actuate directional signal switch to ensure correct operation.

(6) Install steering shaft.

(7) Place thrust washer, spring, and directional signal canceling cam on upper end of steering shaft.

(8) Align lock plate splines with steering shaft splines and place lock plate in position with directional signal canceling cam shaft protruding through dogleg opening in lock plate (fig. 11-20).

(9) Place steering shaft snap ring onto Lock Plate Compressor Tool J-23653.

(10) Install tool on steering shaft and compress lock plate and push snap ring into place.

(11) Remove tools.

(12) Install anti-theft cover.

(13) Align directional signal canceling cam, index marks on steering shaft and steering wheel and install steering wheel. Tighten steering wheel nut to 20 foot-pounds torque.

(14) Install hazard warning light switch button and steering wheel trim cover.

(15) Install shift lever, if equipped.

(16) Install key lock cylinder.

(17) Install and adjust ignition switch.

(18) Adjust neutral safety and backup lamp switch.

(19) Install lower finish panel.

(20) Remove protection from column painted areas.

(21) Reconnect battery negative cable.

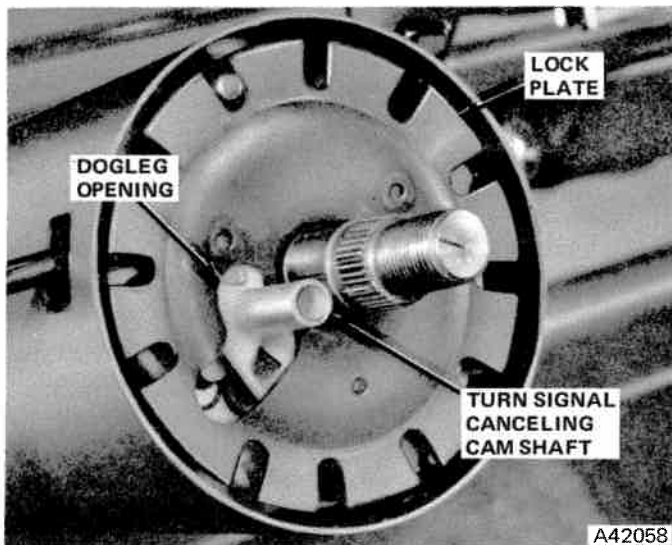


Fig. 11-20 Lock Plate

## Adjust-O-Tilt Steering Column

### Upper Section Disassembly

**NOTE:** Although it is possible to disassemble column down to the upper bearing housing without column removal, if disassembly is to be extensive, it is suggested column be removed from the vehicle. Use Steering Column Support Fixture J-23074 to mount column assembly in a vise.

- (1) Disconnect battery negative cable.
- (2) Cover painted areas of column.
- (3) Remove steering wheel.
- (4) Remove gearshift lever retaining pin and shift lever, if equipped.

(5) Loosen anti-theft cover screws and lift cover from column. It is not necessary to completely remove these screws as they are held on cover by plastic retainers.

(6) Use Lock Plate Compressor Tool J-23653 to depress lock plate, and remove round wire snap ring from steering shaft groove (fig. 11-5).

**WARNING:** Lock plate is under strong spring pressure.

(7) Remove lock plate compressor tool, snap ring, lock plate, directional signal canceling cam, upper bearing preload spring, bearing race seat, and bearing race.

(8) Place directional signal switch in right turn position then remove lever.

(9) Depress hazard warning light switch then remove button by turning it counterclockwise.

(10) Remove directional signal wire harness connector from mounting bracket on lower right side of column.

(11) Remove directional signal harness plastic protector from jacket.

(12) Wrap a piece of tape around harness connector to prevent snagging, and remove harness (fig. 11-8).

(13) Remove directional signal switch retaining screws and pull directional signal switch and wire harness from column.

(14) With key in on position, remove key warning buzzer contacts using a wire hook (a paper clip with a right angle bend), or needlenosed pliers (fig. 11-9).

**NOTE:** Do not attempt to remove switch separately, as clip can fall down into column.

(15) Place key lock in LOCK position.

(16) Depress lock cylinder retaining tab and remove lock cylinder (fig. 11-10).

**NOTE:** If tab is not visible through hole, remove flashing from hole.

(17) Remove shift quadrant.

**NOTE:** Quadrant is retained by a spring clip which may be removed with long-nosed pliers (fig. 11-13).

(18) Remove shift quadrant mounting bracket and light socket, if equipped.

(19) Unscrew tilt release handle.

(20) Remove three upper cover retaining screws.

(21) Gently tap upper cover from column.

(22) Remove lock sector tension spring retaining screw and remove spring.

**NOTE:** Spring must be unhooked from the lock bolt.

(23) Remove Tru-Arc snap ring from lock sector shaft then remove sector, shaft, and lock pin.

(24) Install tilt release handle and place upper housing in full up position.

(25) Insert screwdriver into slot in tilt spring retainer.

(26) Depress retainer approximately 3/16 inch, rotate 1/8-turn counterclockwise and remove retainer and spring.

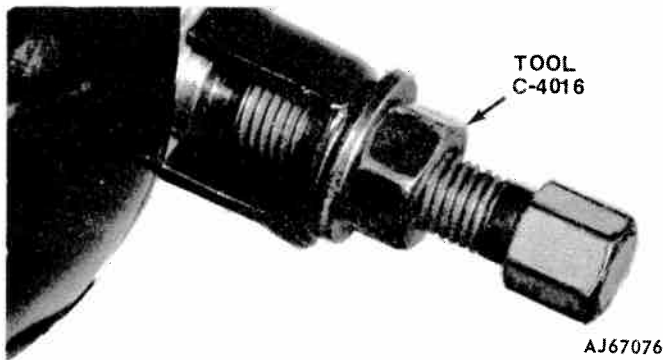
**WARNING:** Care should be taken when releasing tilt spring due to high compression rate of spring.

(27) Place upper housing in straight position.

(28) Remove two pivot pins using Pivot Pin Remover Tool J-21854-1 (fig. 11-21).

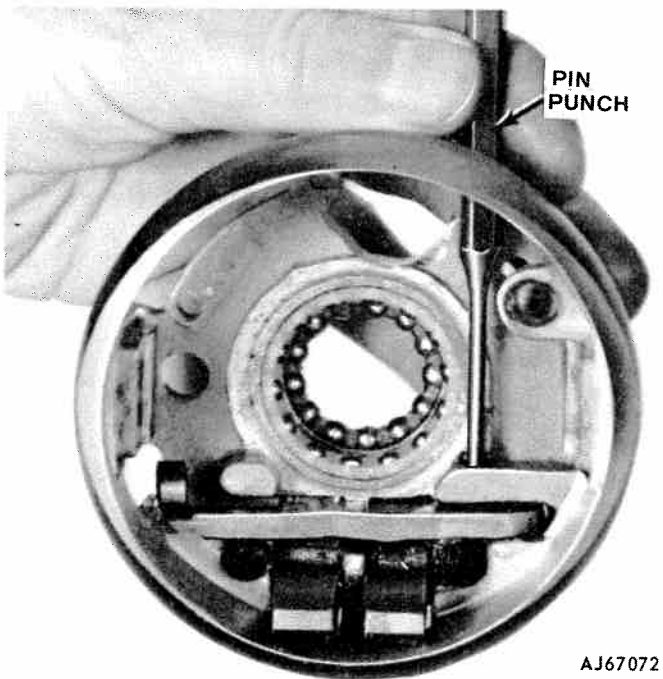
(29) Lift tilt release handle to disengage lock shoes and remove bearing housing assembly.

(30) Remove tilt release lever.



**Fig. 11-21 Pivot Pin Removal**

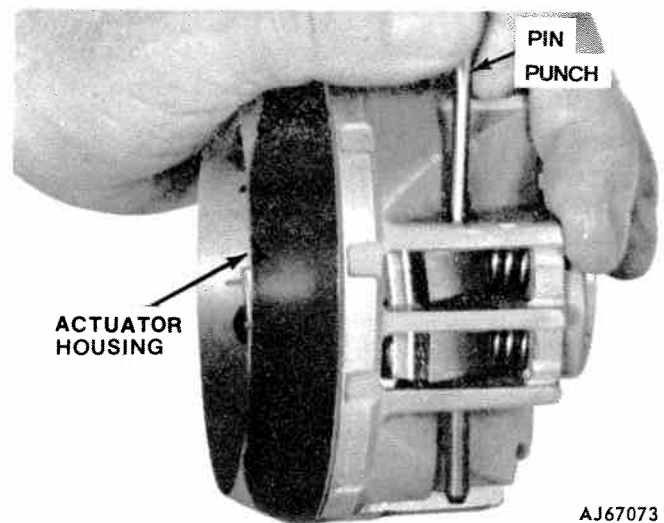
(31) If lock shoes, release lever, or springs are to be serviced, remove release lever pin and lock shoe pin with a punch or Pin Remover and Installer Tool J-22635. Hold lock shoe springs in compression to relieve load on pins (fig. 11-22, -23).



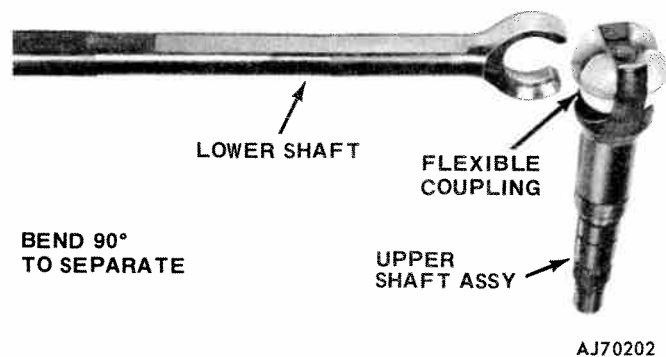
**Fig. 11-22 Release Lever Pin Removal**

(32) Remove steering shaft from top of column. Flexible joint may be disassembled by folding the shaft 90° (fig. 11-24).

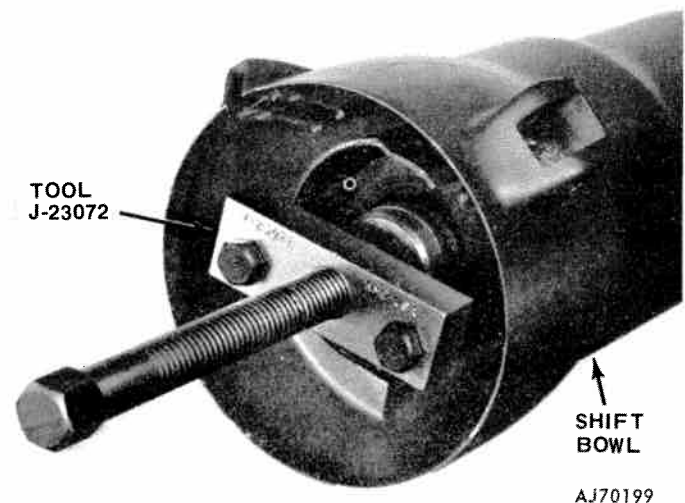
- (33) Remove ignition switch.
- (34) Remove neutral safety and back up switch.
- (35) Remove lock rack and rod.
- (36) Remove lower bearing retainer snap ring, retainer, bearing and adapter.
- (37) Remove upper support attaching screws and upper support. Remove shift gate pin and shift gate.
- (38) Remove shift tube retainer ring and thrust washer.
- (39) Remove shift tube using Shift Tube Remover Tool J-23072 (fig. 11-25).



**Fig. 11-23 Lock Shoe Pin Removal**



**Fig. 11-24 Flexible Joint**



**Fig. 11-25 Shift Tube Removal**

(40) Remove retainer plate by rotating shift bowl clockwise, sliding plate out of jacket notches, tipping it down toward shift bowl hub at the 12 o'clock position and removing bottom side of plate first (fig. 11-26).



(41) Remove wave washer, tube spring, and shift bowl from column.

(42) If column is in car, remove instrument panel lower finish panel.

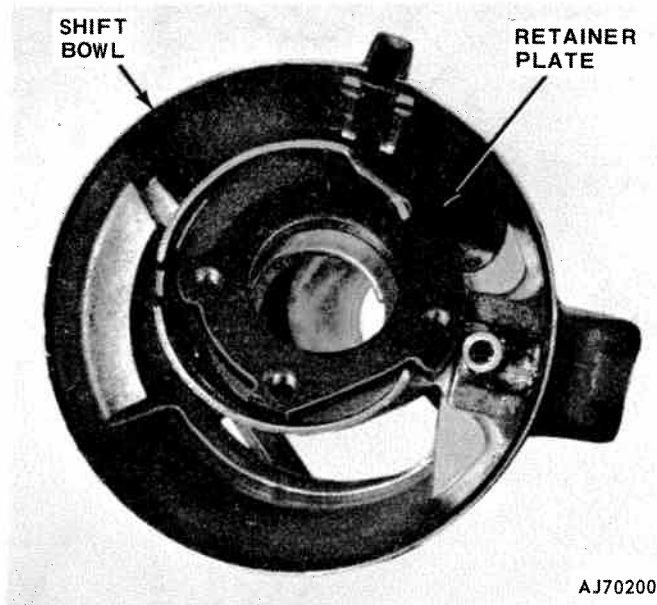


Fig. 11-26 Retainer Plate Removal

### Lower Section Disassembly and Assembly

For assembly and disassembly of lower section of Adjust-O-Tilt Column, refer to procedures outlined in Steering Column Lower Section Disassembly and Assembly (except Adjust-O-Tilt).

#### Upper Section Assembly

(1) Apply a thin coat of lithium grease to all friction surfaces.

(2) Place shift bowl onto column.

(3) Install wave washer and retainer plate into column.

(4) Carefully install shift tube into lower end of mast jacket. Align spline on tube with keyway in shift bowl.

(5) Insert Shift Tube Installer Tool J-23073-2 and -4 into shift tube (fig. 11-28). Spring-loaded lower foot must engage tube inner shoulder and guide should seat in tube. Tighten spring tension nut to snug fit.

(6) Place Receiver Tool J-23073-3 and -4 over puller stud and tighten puller nut to pull tube into bowl (fig. 11-29).

(7) Install shift tube thrust washer and shift tube retainer snap ring.

(8) Install lower bearing (with metal face toward retainer), retainer, and snap ring.

(9) Install pin and shift gate on upper support and install upper support aligning V-notch in support with notch in column (located at 9 o'clock position).

(10) Install four retaining screws.

(11) Assemble steering shaft and slide into column.

(12) Place bearings (14 balls each) in upper housing (if removed).

(13) Install tilt handle.

(14) Insert ignition switch remote rod between shift bowl and mast jacket and into guide channel in left side of upper support.

(15) Place lock rack on rod (fig. 11-30).

(16) Carefully guide upper housing over steering shaft and lock rack, aligning lock shoes with teeth in upper support. Lift tilt lever to allow engagement of lock shoes into upper support.

(17) Align upper housing and upper support pivot pin holes and drive pivot pins into position using a fiber mallet or brass drift.

(18) Install lock shoes, lock shoe springs, tilt bumpers, and lockpin in upper housing.

(19) Install lock sector and sector shaft. Large tooth on sector must engage large slot in lock rack. Install sector shaft retaining snap ring.

(20) Hook lock sector tension spring on lockpin, engage sector, and install spring retaining screw (fig. 11-31).

(21) Place upper housing in full up position and install tilt spring and seat. Depress spring retainer approximately 3/16 inch into housing. Rotate retainer approximately 1/8 turn clockwise to secure spring.

(22) Place upper housing cover into position and install three retaining screws.

(23) Install key warning buzzer switch and tension spring. Buzzer switch brass contact should point upwards, toward shift indicator.

(24) Guide shift quadrant light wire up through upper housing and then down between shift bowl and mast jacket.

(25) Install shift quadrant mounting bracket and attach light socket.

(26) Install tilt release handle.

(27) Hook base of shift quadrant over tabs on left side of retainer and place in position.

(28) Install shift pointer into bowl and engage with quadrant.

(29) Install quadrant retainer clip with flat side of clip facing down.

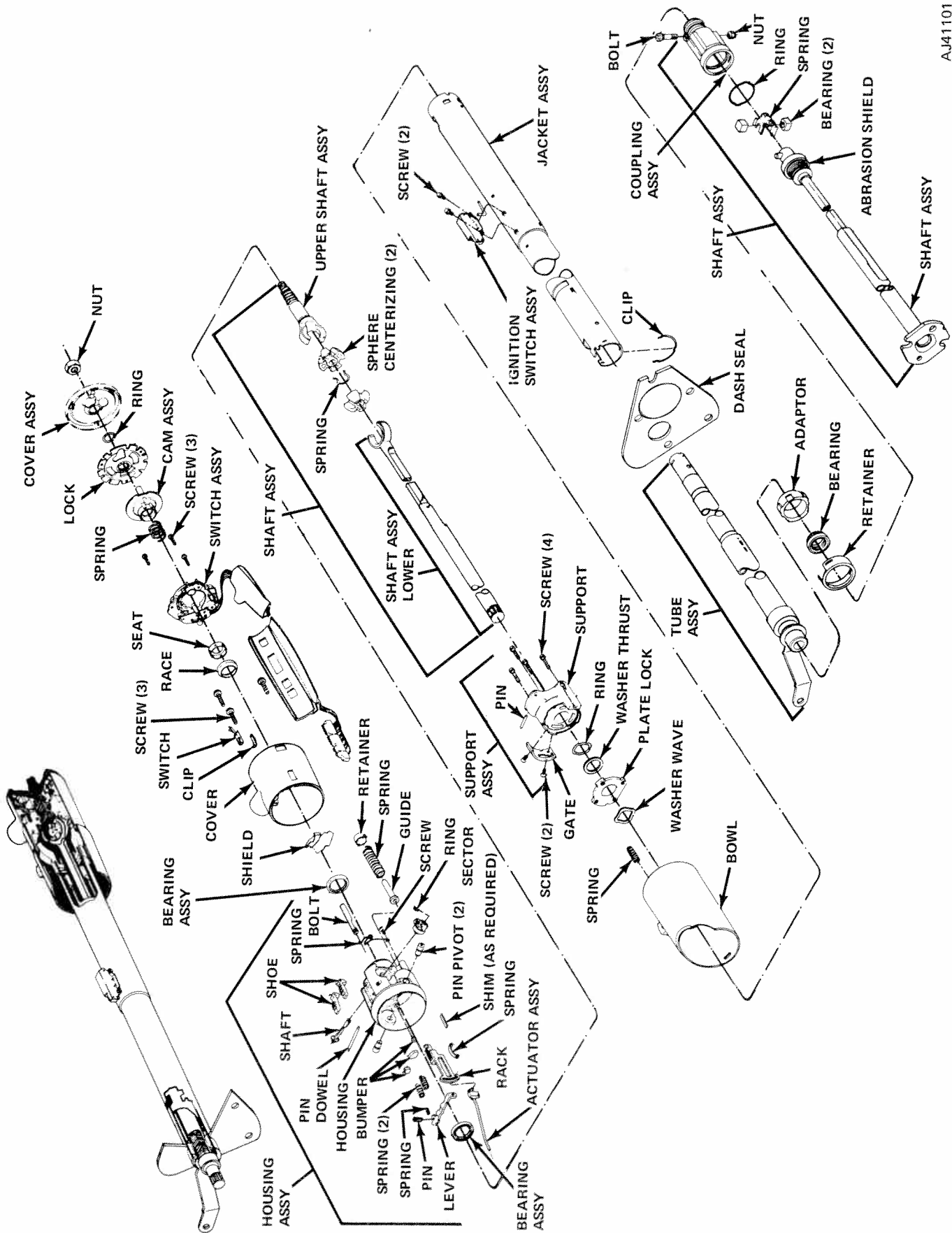
(30) Install directional signal switch assembly. Guide wire harness between cover and mast jacket and carefully align switch assembly.

(31) Untape connector, assemble wires into protector and protector-to-column jacket, and install switch retaining screws. Assure that actuating lever pivot is correctly aligned and seated in upper housing pivot boss prior to installing retaining screws.

(32) Install directional switch lever and actuate switch to assure correct operation.

(33) Place upper bearing race, bearing race seat, preload spring, and directional signal canceling cam onto steering shaft.

(34) Align lock plate splines with steering shaft



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Fig. 11-27 Adjust-O-Tilt Column Exploded View



splines and place lock plate in position with directional signal canceling cam shaft protruding through dogleg opening in lock plate (fig. 11-20).

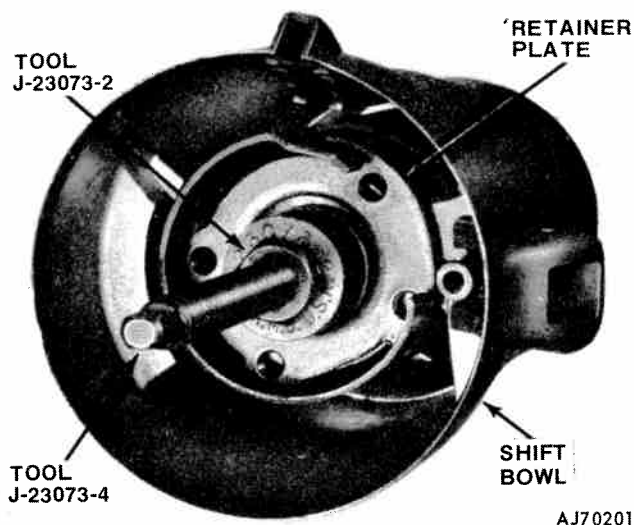


Fig. 11-28 Shift Tube Installer Seated in Tube

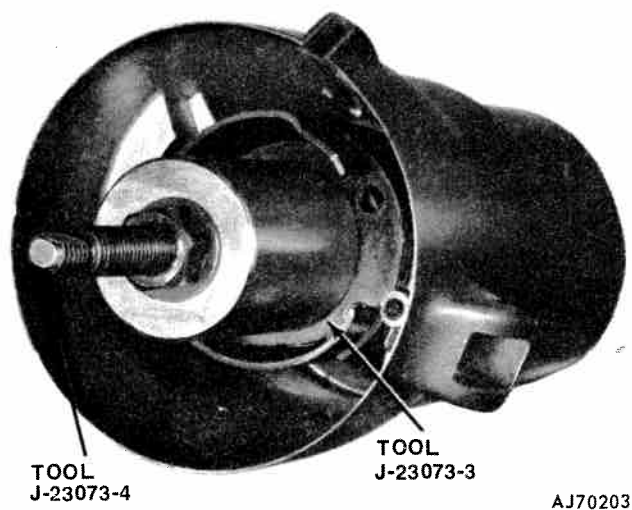


Fig. 11-29 Pulling Shift Tube Into Bowl

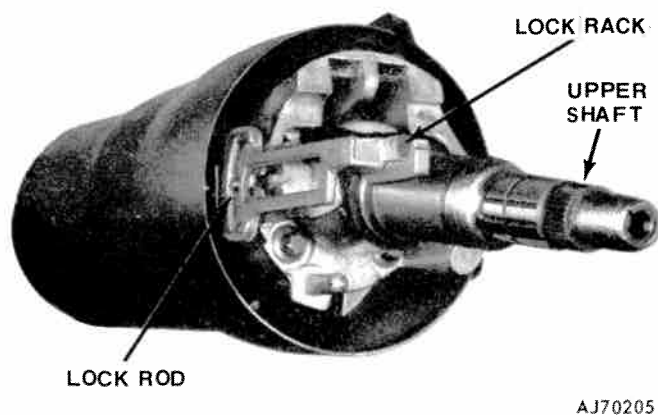


Fig. 11-30 Lock Rack and Remote Rod Position

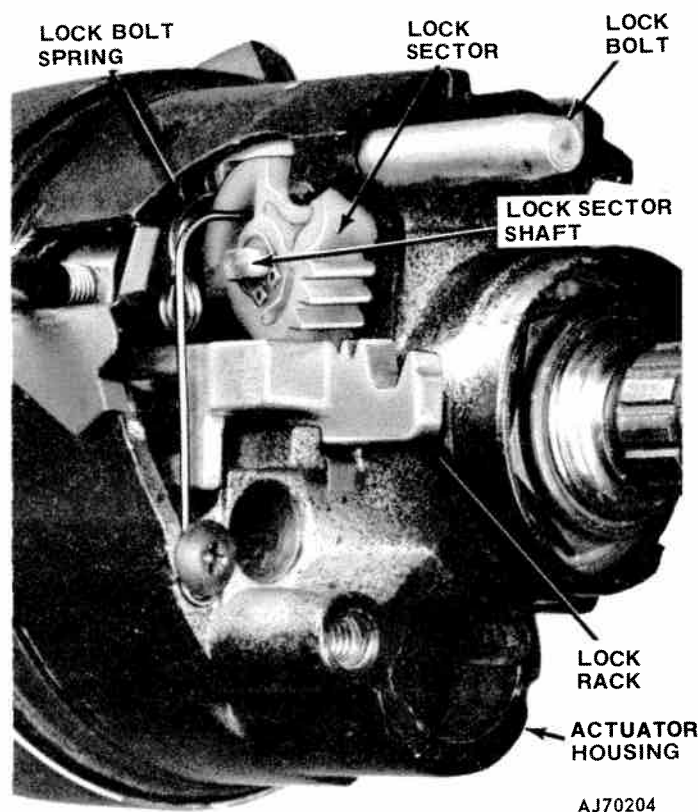


Fig. 11-31 Position of Lock Sector Tension Spring

(35) Place steering shaft snap ring onto Lock Plate Compressor Tool J-23653. Install tool onto steering shaft. Compress lock plate and push snap ring into place (Fig. 11-32).

(36) Install anti-theft cover.

(37) Carefully guide gear shift lever over tension spring and into shift bowl, aligning pivot pin holes with a suitable size punch. Drive pivot pin through lever with a fiber mallet or brass drift.

(38) Install key lock cylinder.

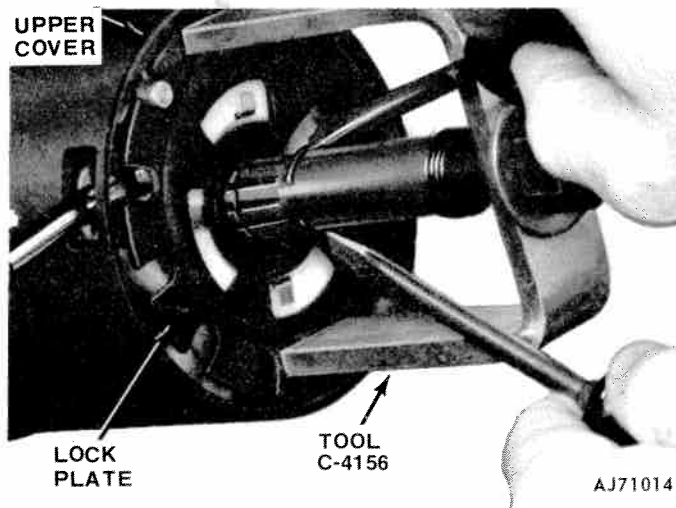


Fig. 11-32 Lock Plate Snap Ring Installation

- (39) Hold lock cylinder sleeve and rotate cylinder clockwise against stop. Insert cylinder into housing with key on cylinder sleeve aligned with housing keyway. Lightly push cylinder against sector and rotate cylinder counterclockwise until cylinder mates with sector. Push in until cylinder retainer tab snaps into place and cylinder is secured.
- (40) Adjust neutral safety and backup lamp switch.
  - (41) Install lower finish panel, if equipped.
  - (42) Remove protection from column painted areas.
  - (43) Reconnect battery negative cable.

Installation

**NOTE:** Correct steering column alignment can be obtained during installation by following, in exact sequence, procedure outlined below:

- (1) Attach lower clamp bracket to column. Tighten bolts 12 to 17 foot-pounds torque.

**CAUTION:** Do not use substitute bolts. Install column into place and loosely attach column to instrument panel at mounting bracket rear attaching studs.

**WARNING:** Make certain that column instrument panel mounting is never unsupported when either

dash mounting or gear mounting is connected.

- (2) On vehicles without power steering, align scribe marks on steering shaft with upper steering shaft to lower shaft U-joint. Install U-joint pinch bolt.
- (3) On vehicles with power steering, position and secure flexible coupling with attaching bolts and nuts.
- (4) Pull steering column upward. Maintain upward pressure while tightening the mounting bracket attaching nuts 15 to 25 foot-pounds torque.

**CAUTION:** Do not overtighten fastenings. Correct torque on bolts and nuts is necessary to ensure breakaway action of bracket and capsules in the event of a collision.

- (5) Install toe board parts.
- (6) Connect all electrical components and check for proper operation.
- (7) Install instrument panel trim plate below jacket tube.
- (8) Upon completion of steering column installation and alignment, shift linkage adjustment must be checked to ensure proper operation. For correct shift linkage adjustment refer to the respective transmission section.
- (9) Reconnect battery cable.

MANUAL STEERING GEAR

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SERVICE DIAGNOSIS

Condition	Possible Cause	Correction
HARD STEERING	<div><div>(1) Lack of lubrication</div><div>(2) Tie rods ends worn</div><div>(3) Drag link ball joints tight</div><div>(4) Cross-shaft improperly adjusted</div><div>(5) Steering gear parts worn</div><div>(6) Frozen steering shaft bearings</div><div>(7) Lower coupling flange rubbing against steering shaft</div><div>(8) Steering wheel rubbing against directional switch housing</div><div>(9) Steering gear adjusted too tight</div></div>	<div><div>(1) Lubricate all connections</div><div>(2) Replace</div><div>(3) Adjust</div><div>(4) Adjust</div><div>(5) Replace</div><div>(6) Replace bearings</div><div>(7) Loosen bolt and assemble properly</div><div>(8) Adjust jacket endwise</div><div>(9) Check adjustment by dropping pitman arm from gear or disconnect linkage from pitman arm ball</div><div>Readjust if necessary</div></div>

## SERVICE DIAGNOSIS (Continued)

Condition	Possible Cause	Correction
HARD STEERING (Continued)	(10) Front spring sagged  (11) Frame bent or broken (12) Steering knuckle bent (13) Ball joint galled or too tight (14) Low or uneven tire pressure  (15) Steering gear or connections binding	(10) Check front end jounce height. It should be approximately the same at both wheels. Replace front springs if sagged.  (11) Repair frame as necessary. (12) Install new knuckle. (13) Replace ball joint. (14) Inflate tires to recommended pressure. (15) Test steering system with wheels off floor. Adjust and lubricate.
LOOSE STEERING	(1) Tie rod ends worn (2) Drag link ball sockets worn (3) Steering gear parts worn (4) Steering gear improperly adjusted	(1) Replace (2) Replace (3) Replace (4) Adjust
ROAD SHOCKS	(1) Steering drag link too tight (2) Axle clip loose (3) Wheel bearings loose (4) Shock absorbers worn	(1) Repair as necessary (2) Repair as necessary (3) Repair as necessary (4) Replace
TURNING RADIUS SHORT ONE SIDE	(1) Center bolt in spring sheared off (2) Axle shifted (3) Steering arm bent (4) Steering arm not properly located on steering side	(1) Repair as necessary (2) Repair as necessary (3) Replace (4) Repair as necessary

## LEFT-HAND DRIVE VEHICLES

- (1) Disconnect steering gear from lower steering shaft by removing bolt and nut attaching coupling to worm shaft.
- (2) Disconnect steering arm from connecting rod.
- (3) Remove upper steering gear-to-frame bracket bolt.
- (4) Remove two lower steering gear-to-frame bracket bolts and remove steering gear.

## Disassembly

- (1) Rotate wormshaft until it is in center of travel. Mark along shaft, just beneath double spline, shall be centered between top and bottom of shaft when looking at shaft from side cover side (fig. 11-33).
- (2) Remove adjuster locknut.
- (3) Remove side cover bolts and lockwashers and turn lash adjuster screw clockwise to force side cover from housing. Remove side cover and gasket (fig. 11-34).
- (4) Remove adjuster screw and shim from T-slot in

pitman shaft. Keep shim with screw.

- (5) Remove pitman shaft from housing, taking care not to damage seal in housing with pitman shaft splines or threads. Tap lightly on spline end if necessary.

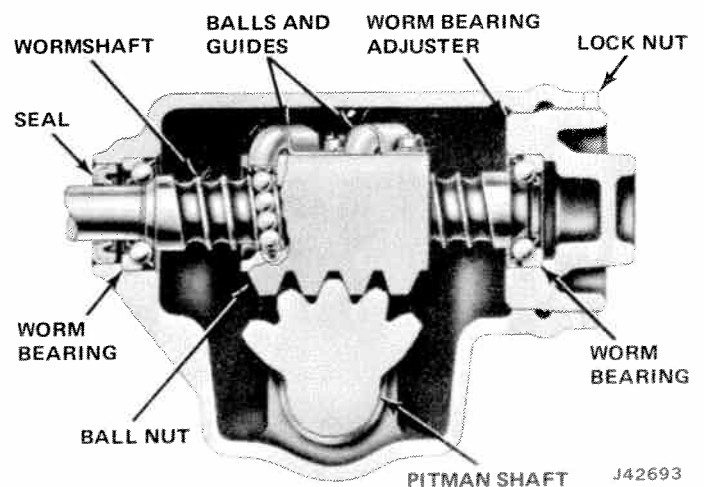


Fig. 11-33 Cross-Section of Steering Gear

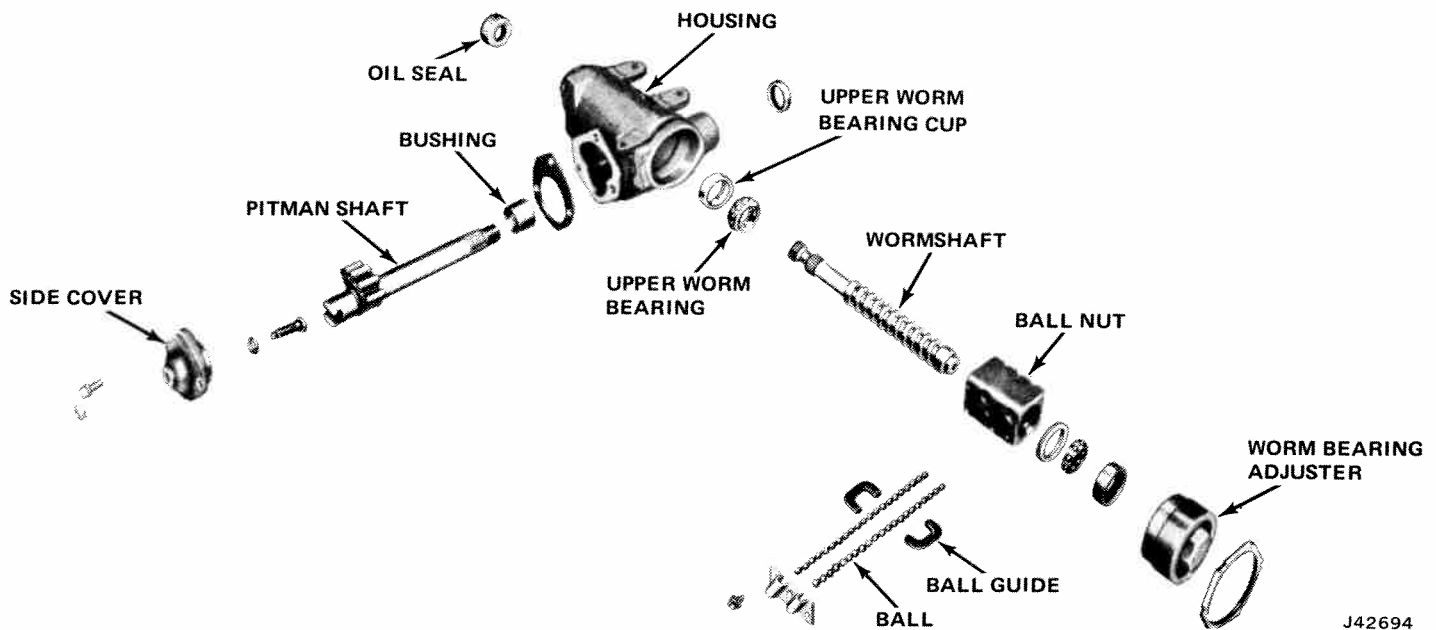


Fig. 11-34 Left-Hand Drive Manual Steering Gear

(6) Remove worm adjuster nut; remove worm adjuster and lower worm bearing.

(7) If bearing is damaged, pry retainer out with screwdriver. Remove bearing from worm adjuster.

(8) Remove assembled wormshaft, ball nut, and upper worm bearing from the housing (fig. 11-35). Do not allow ball nut to rotate freely to end of worm travel; this could damage ball return guides. Take care not to damage oil seal with worm shaft splines.

(9) Remove upper bearing from shaft.

(10) If oil seals are damaged, pry them out of housing.

(11) Remove three screws securing clamp to ball nut; remove ball guides from nut.

(12) Turn ball nut over and rotate wormshaft back and forth until all balls drop out on a clean cloth (50 balls).

(13) Remove ball nut from shaft.

### Inspection

Wash all parts in clean solvent and wipe dry with a clean cloth.

Inspect bearing cups in worm adjuster and in housing. If they are damaged remove them using worm shaft bearing cups remover tool C-3780 (fig. 11-36).

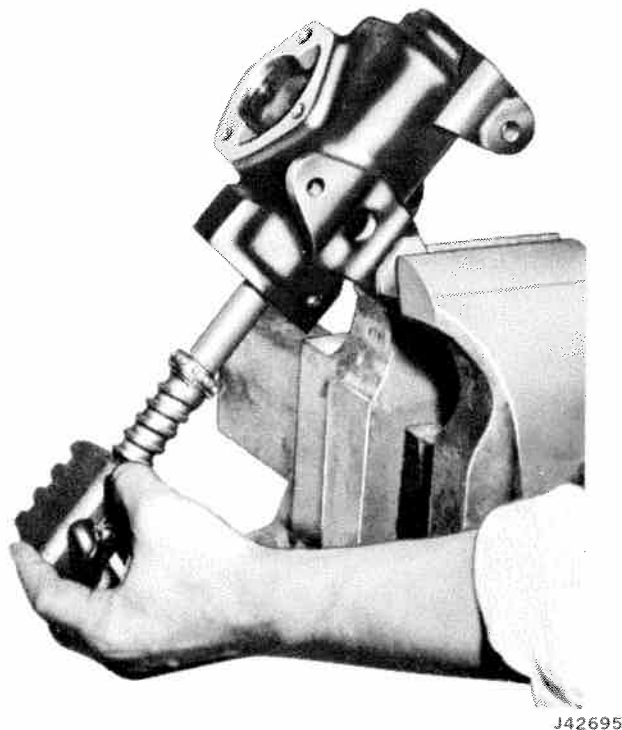


Fig. 11-35 Wormshaft and Ball Nut Removal

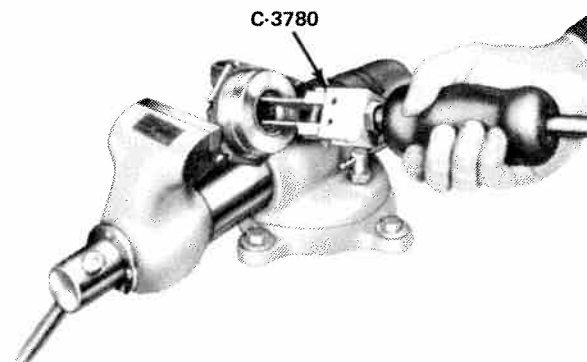


Fig. 11-36 Wormshaft Bearing Cup Removal

Inspect wormshaft, particularly in area near worm for pitting, grooving, or other damage; replace if damaged.

Inspect bushings for pitman shaft in housing and in side cover. If bushing in housing is damaged, drive



bushing into housing with Remover and Installer Tool J-1614. If bushing in side cover is damaged, replace side cover and bushing assembly (fig. 11-37).

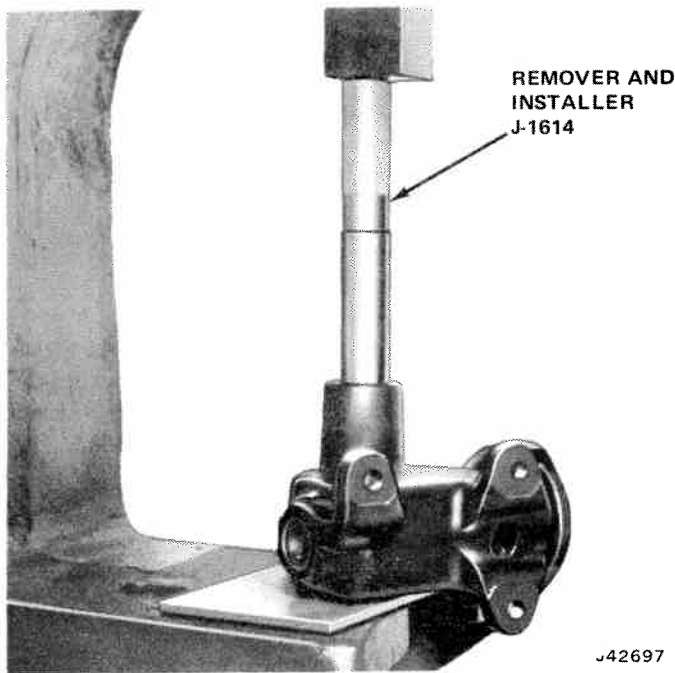


Fig. 11-37 Pitman Shaft Bushing Removal

Inspect teeth of ball nut and pitman shaft for pitting or heavy scoring, which would require replacement of ball nut or pitman shaft.

Inspect ball guides, balls, and clamp for damage; if damaged, replace with new ball kit parts.

Check fit of lash adjuster screw and shim in T-slot of pitman arm (fig. 11-38).

Lash adjuster screw must be free to turn, and end play should not exceed 0.002 inch. If end play exceeds this limit, change shim thickness to obtain correct end play. A lash adjuster shim kit is available.

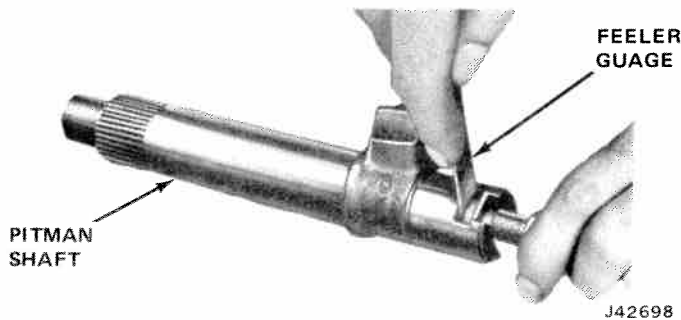


Fig. 11-38 Checking Lash Adjuster End Play

## Assembly

**NOTE:** Lubricate all parts before assembly. Use special lubricant, Jeep Part No. 940657.

(1) Position ball nut on worm shaft so deep side of teeth will be toward side cover when shaft is installed in housing.

(2) Install 20 balls in each circuit. Rock worm shaft back and forth to aid in installation. Use a punch to install the balls (fig. 11-39).

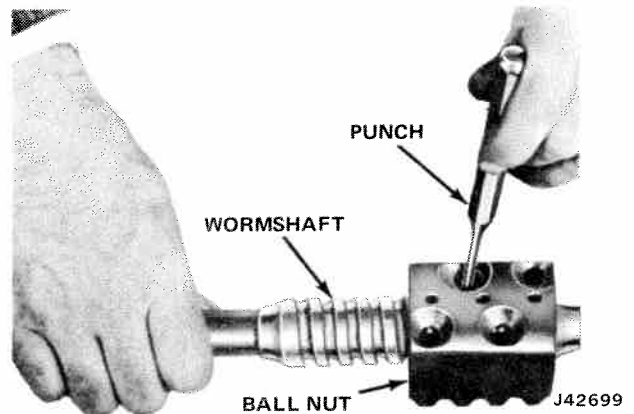


Fig. 11-39 Filling Ball Circuits

(3) Install ball guides in ball nut (fig. 11-40). Hold them in place with fingers and install 5 more balls in each circuit through window in top of ball guide.

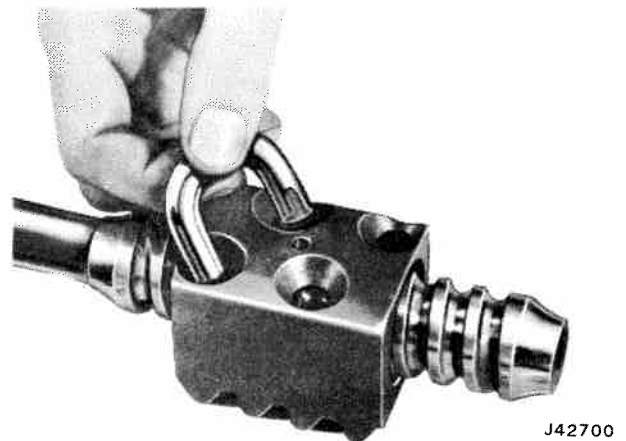


Fig. 11-40 Installing Ball Guides

(4) Position clamp over two ball guides and secure with three bolt and washer assemblies.

(5) Rotate worm through its complete travel several times to ensure that balls are installed correctly and rotate freely. Do not allow ball nut to hit end of worm travel; this could damage ball return guides.

(6) If bearing cups were removed from worm adjuster or housing, press in a new bearing cup, using Worm Shaft Bearing Cup Installer J-5755 (fig. 11-41).

(7) Install upper worm bearing on upper part of wormshaft and center ball nut on worm.

(8) Install assembly in housing with bearing seated in bearing cup.

(9) If bearing was removed from worm adjuster, install a new bearing and retainer in worm adjuster.

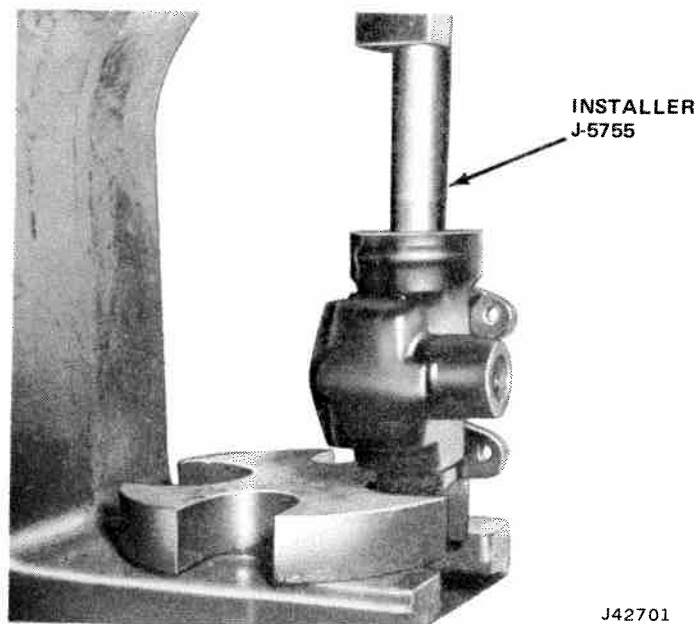


Fig. 11-41 Pressing in Bearing Cup

(10) Install adjuster in bottom of housing, seating wormshaft in lower bearing in adjuster.

(11) Install bearing adjuster locknut, but do not tighten.

Turn wormshaft until center tooth space of ball nut is centered in opening for side cover. Install correct shim, and lash adjuster screw in T-slot of pitman shaft.

(12) Install pitman shaft in housing, meshing center tooth of sector gear on shaft with center tooth space of ball nut.

(13) Position a gasket and side cover on housing; turn lash adjuster screw in threaded opening of side cover but do not tighten.

(14) Secure side cover with three lockwashers and bolts. Tighten bolts 25 to 35 foot-pounds. Install nut loosely on lash adjuster screw.

(15) If pitman shaft oil seal was removed, use Pitman Shaft Oil Seal Protector J-5787 and Pitman Shaft Oil Seal Installer J-7171 to install a new oil seal in housing over pitman shaft threads and splines.

(16) If wormshaft oil seal was removed, use Wormshaft Upper Oil Seal Installer J-7017 to install a new oil seal in housing.

(17) Fill steering gear with 11 ounces of lubricant, Jeep Part No. 940657, and adjust final torque steering gear.

### Adjustments

**NOTE:** Worm bearing adjustment should always precede each adjustment of steering gear.

#### Worm Bearing Preload Adjustment

- (1) Attach Torque Wrench N-7754 to splined end

of worm shaft and turn shaft to either extreme left or right position. Do not hit travel stops.

- (2) Tighten worm bearing adjuster until torque wrench registers 8 inch-pounds. Make sure adjustment is made within 1/2-turn of either extreme position of shaft.

- (3) Tighten adjuster locknut to 70 to 110 foot-pounds. Recheck torque of wormshaft.

### Overcenter Adjustment

- (1) Turn steering gear from one extreme position to opposite position, counting number of turns.

- (2) Turn back one-half total number of turns. This places steering gear on high point or straight-ahead position (total number of turns should be 6.14).

- (3) With Torque Wrench J-7754 on the pitman shaft, tighten lash adjuster screw until torque registered is less than 18 inch-pounds. Make sure torque does not exceed this value over center range.

- (4) Tighten nut on adjuster screw to 18 to 27 foot-pounds. Recheck torque.

### Installation

- (1) Install coupling on splines of wormshaft, and secure coupling to shaft by installing attaching bolt and nut.

- (2) Position steering gear against side frame rail; secure with three bolts.

- (3) Check steering column alignment and adjust if necessary.

- (4) Install pitman steering arm on pitman shaft; secure with lockwasher and nut. Tighten nut to 160 to 210 foot-pounds.

- (5) Attach steering arm to connecting rod.

**NOTE:** After gear is installed in vehicle, it may have a slight roughness. Run through 10 to 15 complete turn cycles to eliminate any roughness.

## RIGHT-HAND DRIVE VEHICLES

### Removal

- (1) Disconnect steering gear from steering column by removing flexible coupling-to-gear Allen-head clamping screw.

- (2) Disconnect connecting rod from steering arm.

- (3) Remove three bolts attaching steering gear to frame.

- (4) Remove steering gear by sliding it slightly forward and to right and lifting it out of engine compartment.

### Disassembly

Refer to figures 11-42 and 11-43.



Fig. 11-42 Right-Hand Drive Steering Gear

- (1) Clean exterior of steering gear.
- (2) Remove filler plug from steering gear housing and drain lubricant from gear.
- (3) Make index marks on roller gear and shaft assembly and on steering arm to assure correct alignment during assembly.
- (4) Remove nut and lockwasher from shaft.
- (5) Remove arm from shaft with a steering arm puller or gear puller.

**CAUTION:** Do not use a hammer or wedge to remove steering arm from roller gear and shaft assembly. This will damage gear and shaft assembly.

(6) With a fine file or piece of emery cloth, remove any nicks or burrs from exposed portions of roller gear and shaft assembly and from worm gear and shaft assembly.

(7) Remove four attaching capscrews, side cover, and gasket from steering gear housing. When cover is removed, attached roller gear and shaft assembly will also be withdrawn from housing.

(8) Remove locknut from adjustment screw.

(9) Turn screw clockwise until it is completely unthreaded from side cover; then remove roller gear and shaft assembly from cover.

(10) Remove four attaching capscrews and end cover from steering gear housing.

(11) Withdraw worm gear and shaft assembly from housing.

(12) Remove lower and upper bearing cups and ball bearings from shaft.

(13) Remove worm gear shaft oil seal and roller gear shaft oil seal from housing. Discard both seals.

### Inspection

Clean all parts with suitable cleaning solvent and wipe dry.

Inspect the steering gear housing for cracks, breaks, leaks, or other damage. Replace if damaged.

Inspect the roller gear and shaft assembly visually for wear, scoring, or pitting. If necessary, polish lightly with a fine abrasive cloth. Inspect the roller gear to assure that it has proper freedom of movement and lacks excessive lash or roughness. Replace gear and shaft assembly if visibly worn or damaged.

Check adjustment screw of roller gear and shaft assembly for excessive end play. If end play exceeds 0.015 inch remove the retaining ring, thrust washer, and screw from the gear and shaft assembly. Replace the retaining ring if unserviceable. Secure a new adjustment screw and thrust washer in the gear and shaft assembly with a retaining ring.

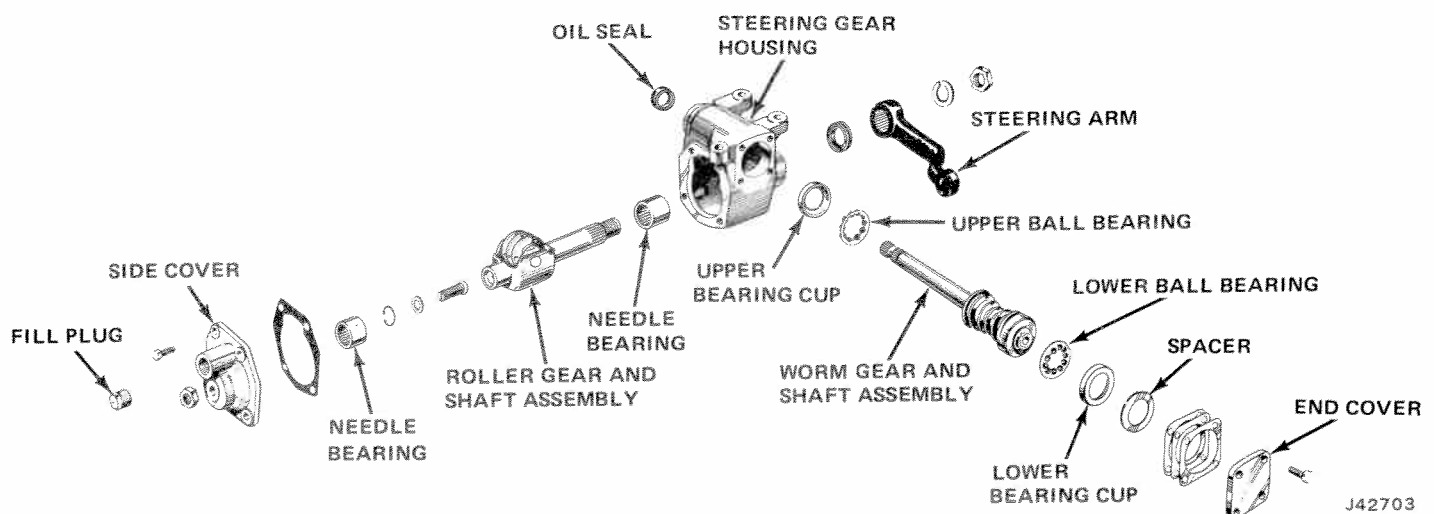


Fig. 11-43 Steering Gear Exploded View

Inspect needle bearings, which carry roller gear and shaft assembly, in the side cover and the steering gear housing. Replace if visibly worn or damaged. Insert a shaft through each bearing and check for clearance. If clearance exceeds 0.010 inch, replace bearings.

To remove either needle bearing, press out with a piloted mandrel. To install a new needle bearing, press the bearing into the side cover or steering gear housing with a piloted mandrel so that the face of the bearing is flush with the bearing boss of the cover or housing.

Inspect the worm gear and shaft assembly visually for wear, scoring, or pitting. If necessary, polish lightly with a fine abrasive cloth. Replace assembly if it is visibly worn or damaged.

Inspect upper and lower ball bearings and cups of the worm gear and shaft assembly for wear and damage. Replace if visibly worn or damaged.

**NOTE:** *Bearing balls must be replaced as a full set in each bearing.*

### Assembly

(1) Position new oil seals at worm gear shaft and roller gear shaft oil seal bores of steering gear housing with longer lip of each seal facing into housing.

(2) Press each seal into housing with a mandrel of suitable diameter to touch seal bore of the housing around its entire perimeter.

(3) Lubricate worm gear and shaft assembly and upper ball bearing and cup with Gear Lubricant MIL-L-2105B, Grade SAE 80.

(4) Install bearing and cup on shaft.

(5) Install shaft assembly in steering gear housing. Be certain that splined end of shaft does not damage oil seal.

(6) Lubricate lower end of worm gear and shaft assembly and lower ball bearing and cup with Gear Lubricant MIL-L-2105B, Grade SAE 80.

(7) Install bearing, cup, and spacer on shaft.

(8) Position shims and end cover to steering gear housing; attach loosely with four capscrews.

(9) Adjust bearing preload.

(10) Position tapped hole of side cover to adjustment screw of roller gear and shaft assembly.

(11) Thread screw counterclockwise into the cover until end of shaft just touches inner face of the cover.

(12) Install a locknut loosely on adjustment screw.

(13) Install a new gasket on side cover.

(14) Lubricate gear of roller gear and shaft assembly with Gear Lubricant MIL-L-2105B, Grade SAE 80.

(15) Insert gear and shaft assembly into steering gear housing. Be certain that end of shaft does not damage oil seal in housing.

(16) Roller gear and worm gear must mesh to seat side cover to housing.

(17) Secure cover to housing with four capscrews. Tighten capscrews 18 to 22 foot-pounds.

(18) Adjust gear clearance.

(19) Clamp exposed section of roller gear and shaft assembly firmly in soft jaw vise.

(20) Observe index marks made during disassembly and position steering arm to splined end of shaft.

(21) Install lockwasher and nut on shaft threads; tighten nut to draw arm into position on spline.

(22) Fill steering gear housing to required level with Gear Lubricant MIL-L-2105B, Grade SAE 80.

### Adjustments

#### Bearing Preload Adjustment

This steering gear adjustment determines preload applied to upper and lower ball bearings which support the worm gear and shaft assembly. It is made by adding to or subtracting from the number of shims between the steering gear housing and end cover.

If necessary, loosen four capscrews which fasten the end cover to the steering gear housing (fig. 11-43).

Alternately tighten capscrews evenly, but only slightly at a time, and rotate the worm gear shaft. Tighten screws 18 to 22 foot-pounds.

Check rolling torque required to rotate the worm gear shaft. When bearing preload is correct, this torque will be 2 to 5 inch-pounds. If necessary, remove capscrews and end cover. Either add to or subtract from the number of shims, and repeat the above procedure to obtain correct bearing preload.

#### Steering Gear Clearance Adjustment

This steering gear adjustment sets proper backlash between the worm gear and the roller gear of the steering gear assembly. It prevents gear wear resulting from insufficient backlash, and steering play which would result from excessive backlash. Gear backlash is adjusted by an adjustment screw which determines the longitudinal position of the roller gear and shaft assembly.

(1) If necessary, loosen locknut and turn adjustment screw at the side cover counterclockwise until worm gear shaft turns freely through its entire range of travel (fig. 11-43).

(2) Count number of turns necessary to rotate worm gear shaft through its entire range of travel.

(3) Turn shaft to center of its travel.

(4) Rotate shaft back and forth through its center of travel, and tighten adjustment screw until shaft shows slight bind at center of its travel.

(5) Adjust screw to obtain a rolling torque requirement of 7 to 12 inch-pounds to rotate shaft through center of travel.

(6) Hold adjustment screw in position and torque locknut 16 to 20 foot-pounds.

(7) Recheck rolling torque necessary to rotate worm gear shaft through center of its travel. If necessary, repeat above procedure until rolling torque is correct.

## STEERING LINKAGE

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### GENERAL

The steering linkage consists of a pitman arm attached to the steering gear assembly, a connecting rod, a tie rod, a steering damper, and steering knuckle arm (integral with the steering knuckle). End assemblies (ball-studs) are used on the tie rod and connecting rod to maintain toe-in and good steering control (fig. 11-44).

On the steering linkage, the connecting rod attaches to the pitman arm at one end and to the tie rod at the other end. The tie-rod ends are connected to the steering knuckle arms at the wheels. The steering damper is attached to the tie rod on one end and to a bracket on the left spring tie-plate at the other end.

### Tie Rod

The tie rod (fig. 11-45) consists of a solid rod threaded on one end with an integral ball-stud end assembly at the other end. A turnbuckle and a removable ball-stud end complete the tie rod assembly. The threaded end of the tie rod has right-hand threads which accept the turnbuckle. The ball-stud tie-rod end

screws into the turnbuckle. A large boss is located on the tie rod about eight inches from the unthreaded right end. A tapered hole machined into the boss accepts the steering connecting-rod end. The steering damper is connected to a stud which is mounted on a bracket that is either welded or clamped at the center of the tie rod.

### Connecting Rod

The connecting rod (fig. 11-46) consists of a rod threaded at the left end, with an integral ball-stud end assembly at the right end. A turnbuckle and a removable ball-stud end complete the connecting rod assembly. The end having the integral ball-stud end assembly attaches to the tie rod. The threaded end, with the turnbuckle and removable ball-stud end assembly, is attached to the pitman arm.

On Cherokee and Wagoneer models the connecting rod is 26.38 inches long, and on Truck models 28.38 inches long. The difference in length is due to the wider track of Truck models.

If damaged or worn, the connecting rod must be serviced as an assembly. However, the ball-stud end assembly can be replaced separately.

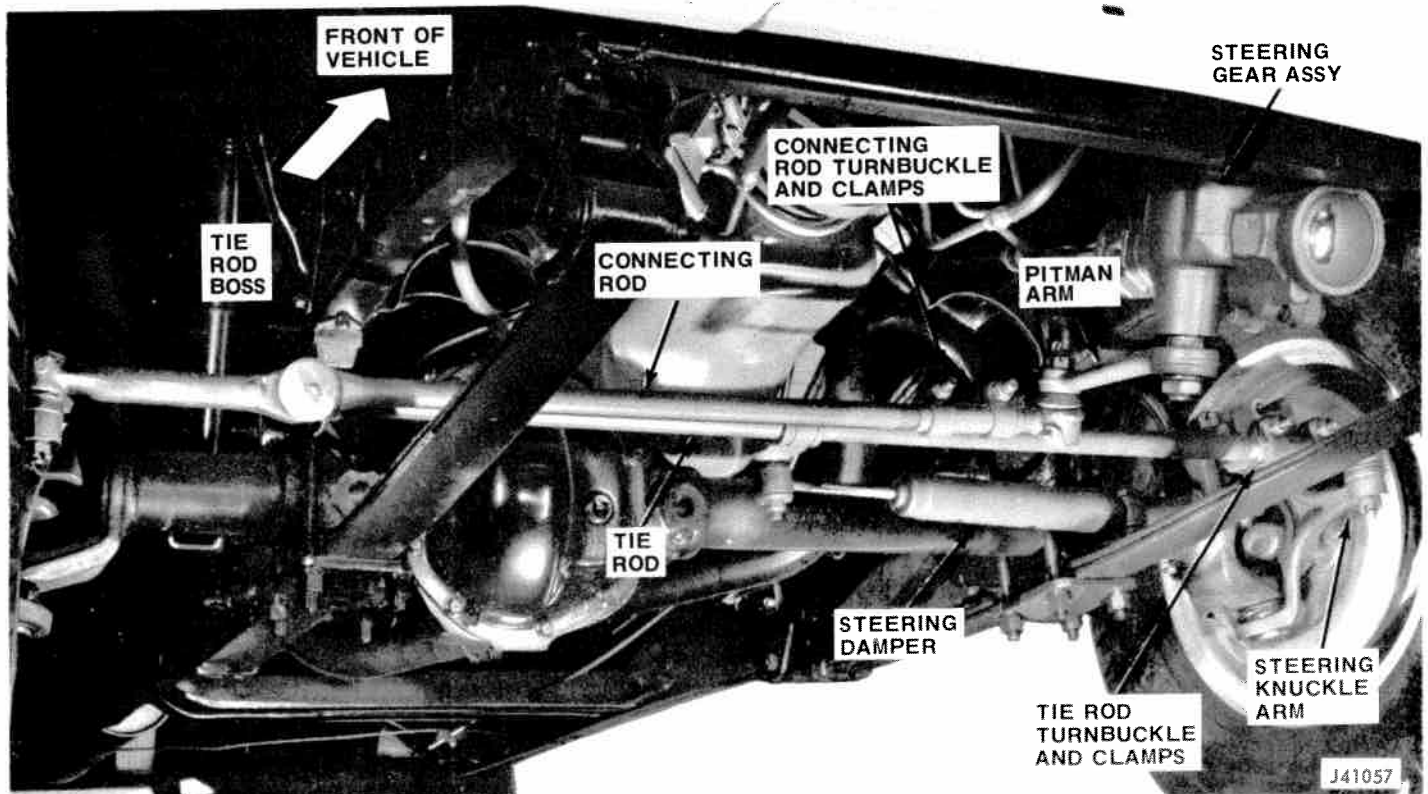
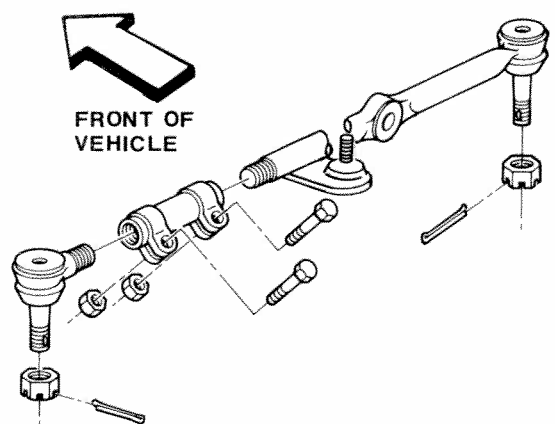
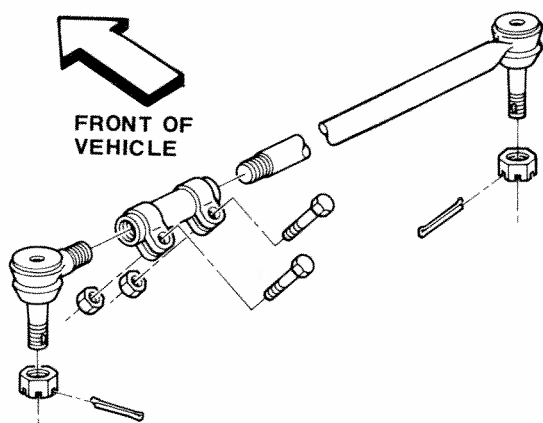


Fig. 11-44 Steering Linkage—Cherokee, Wagoneer, Truck



J41059

Fig. 11-45 Tie Rod Exploded View



J41058

Fig. 11-46 Connecting Rod Exploded View

## Steering Damper

Steering damper (fig. 11-47) mounting has been revised. The damper now has eyelets at each end for mounting on studs. Formerly, the push rod end was threaded and was attached to a bracket which was attached to the tie rod with U-bolts. The bracket is either welded or clamped to the tie rod and incorporates a stud for push rod attachment. The body end of the damper attaches to a stud on a bracket mounted between the left axle spring and the axle spring pad.

The steering damper is serviced as an assembly. If damaged or leaking, replace with a new assembly. The rubber bushings used in the damper eyelets can be replaced individually, if required.

## TIE ROD

### Removal

(1) Remove cotter pins and retaining nuts at both ends of tie rod, and from end of connecting rod where it attaches to tie rod.

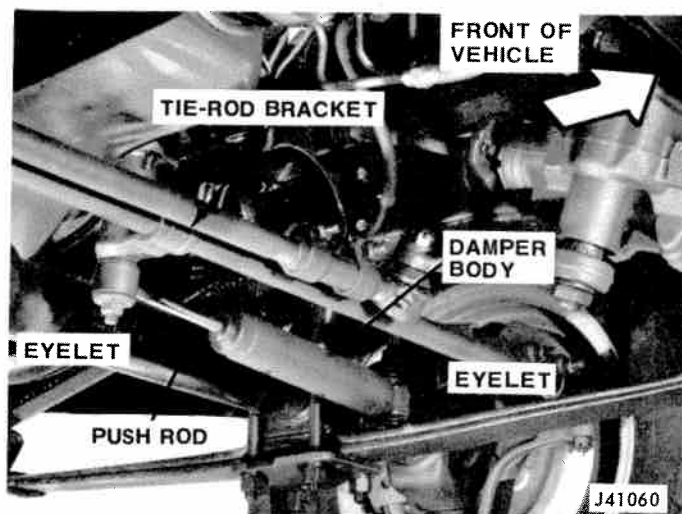


Fig. 11-47 Steering Damper Assembly

(2) Remove nut attaching steering damper push rod to tie-rod bracket and move damper aside.

(3) Remove tie-rod ends from steering arms and connecting rod using puller or expansion fork.

**NOTE:** After removal, the tie-rod ends can be removed from the tie rod by loosening the turnbuckle clamp bolts and unscrewing ends.

## Installation

(1) Attach tie-rod ends to steering arms. Tighten nuts to 50 foot-pounds torque and use new cotter pins to secure nuts.

(2) Attach connecting rod to tie rod. Tighten nut to 50 foot-pounds torque and use new cotter pin to secure nut.

(3) Attach steering damper to tie-rod bracket.

(4) Adjust toe-in as necessary.

## CONNECTING ROD

The steering connecting rod can be removed by removing the cotter pins and nuts from both ends, and then removing the rod. The steering connecting rod ball joints cannot be disassembled for service.

When installing the steering connecting rod, place the wheels in the straight-ahead position and place the steering arm parallel to the centerline of the vehicle. Have the steering gear steering arm properly indexed, with line marks on the steering arm and gear shaft and the steering gear on center of high point. With the steering arm so positioned, install the connecting rod.

### Removal

(1) Place front wheels in a straight-ahead position.

(2) Remove locknut securing damper to bracket on tie plate and lift damper off stud (fig. 11-48).



(3) Remove locknut securing push rod to tie rod bracket and remove damper assembly.

### Installation

- (1) Insert rubber bushings in damper eyelets.
- (2) Secure eyelet at push rod end to stud on tie rod bracket with attaching parts.
- (3) Extend push rod by pulling back on damper body until eyelet can be located on, and secured to stud on damper bracket at spring pad.
- (4) Tighten all locknuts securely.

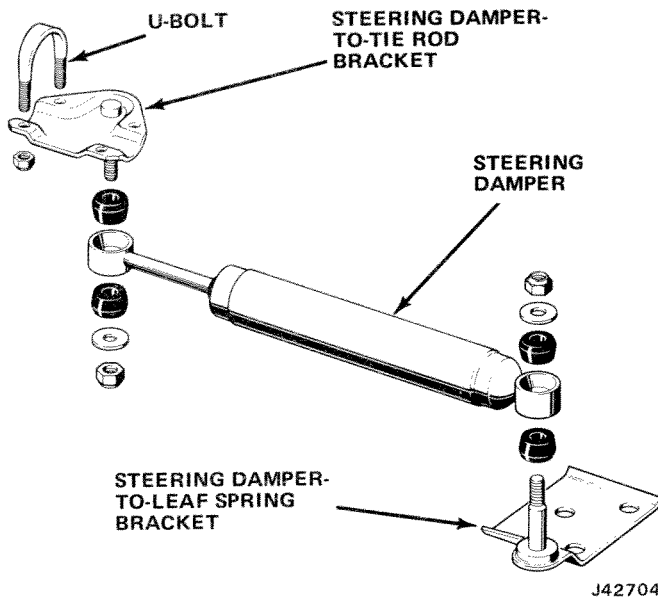


Fig. 11-48 Steering Damper

### FRONT WHEEL ALIGNMENT ADJUSTMENTS

To assure correct alignment, a definite procedure for inspection of the steering system is recommended. It is suggested that the following sequence be used.

- (1) Equalize tire pressures and level vehicle.
- (2) Check steering-gear-to-steering column alignment.
- (3) Inspect steering knuckle pivots, spindle and wheel bearing looseness.
- (4) Check wheel runout.
- (5) Test wheel balance and bearing adjustment.
- (6) Check for spring sag.
- (7) Inspect brakes and shock absorbers.
- (8) Check steering gear assembly adjustment and steering connecting rod.
- (9) Check caster.
- (10) Check toe-in.
- (11) Check toe-out on turns.
- (12) Check camber.
- (13) Check tracking of front and rear wheels.
- (14) Check frame alignment.

The factors of alignment, caster, camber, and toe-in, are all interrelated. After an alignment job is com-

pleted, make a complete recheck of all the adjustments to be sure the settings are within the limit. Be sure all front suspension and steering system nuts and bolts are all properly torqued before taking wheel alignment readings.

### Toe-In

Refer to figure 11-49.

To adjust the wheel toe-in, first raise the front of the vehicle to free the front wheels. Turn the wheels to the straight ahead position. Use a steady-rest to scribe a pencil line in the center of each tire tread as the wheel is turned by hand. A good way to do this is to first coat a strip with chalk around the circumference of the tread at the center to form a base for a fine pencil line.

Measure the distance between the scribed lines at the front and rear of the wheels using care that both measurements are made at an equal distance from the floor. The distance between the lines should be greater at the rear than the front by  $3/64$  inch to  $3/32$  inch. To make adjustment to obtain this distance, loosen the clamp bolts and turn the tie rod with a small pipe wrench. The tie rod is threaded with right and left hand threads to provide equal adjustment at both wheels. Do not overlook retightening the clamp bolts to specified torque.

It is common practice to measure between the wheel rims. This is satisfactory providing the wheels run true. By scribing a line on the tire tread, measurement is taken between the road contact points which will reduce error of wheel runout.

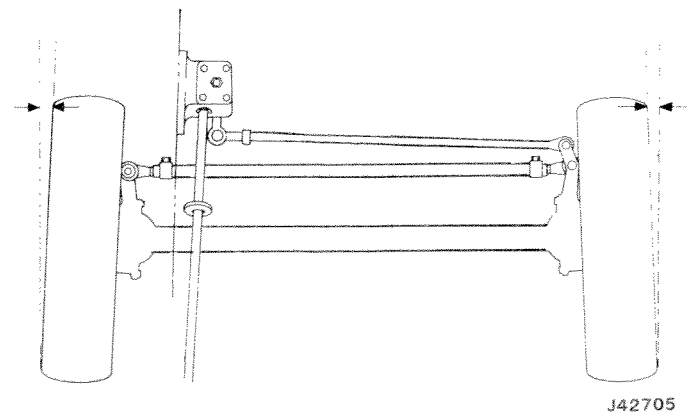


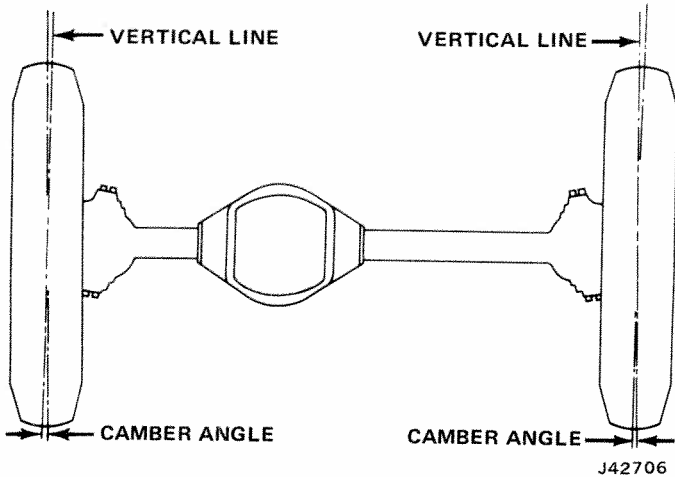
Fig. 11-49 Front Wheel Toe-In (Top View)—Typical

### Camber

Refer to figure 11-50.

Correct wheel camber of  $1-1/2^\circ$  is set in the solid front axle at the time of manufacture and cannot be altered by any adjustment. It is important that the camber is the same on both front wheels. Caster angle should be checked using wheel aligning fixture. Heating any of these parts to facilitate straightening

usually destroys the heat treatment given them at the factory. Cold bending may cause a fracture of the steel and is unsafe. Replacement with new parts is recommended rather than any straightening of damaged parts.



**Fig. 11-50 Front Wheel Camber (Front View)**

## Caster

Refer to figure 11-51.

Axle caster is preset at 3°. It should be checked on a wheel alignment fixture. If found to be incorrect, correction may be made by either installing new parts or installing caster shims between the axle pad and the springs.

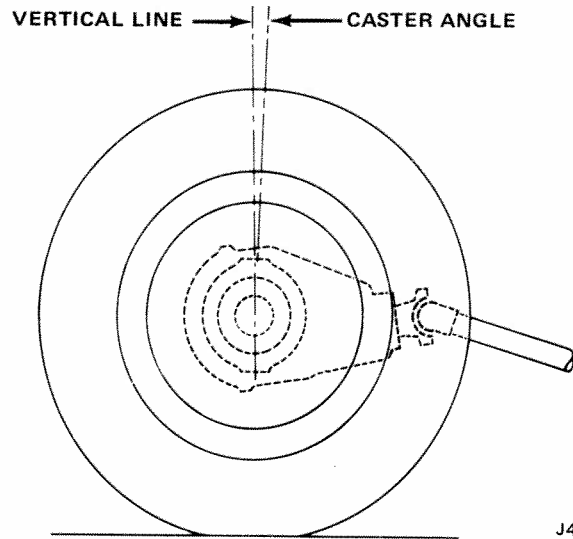
If the camber and toe-in are correct and it is known that the axle is not twisted, a satisfactory check may be made by testing the vehicle on the road. Before road testing, make sure all tires are properly inflated, being particularly careful that both front tires are inflated to exactly the same pressure.

If vehicle turns easily to either side but returns hard to straight-ahead position, incorrect caster is indicated. If correction is necessary, it can usually be accomplished by installing shims between the springs and axle pads to secure the desired result.

## Front Wheel Shimmy

Wheel shimmy may be caused by various conditions in the wheels, axle, or steering system, or a combination of these conditions. Outlined below will be found the usual corrections of this fault:

- (1) Equalize the tire pressures.
- (2) Check the wheel bearings for looseness. Be sure that the inner wheel bearing race is not too loose on the spindle.
- (3) Remove both steering knuckles and carefully inspect the upper and lower pivot pin bearings. Inspect the bearing cups for evidence of brinelling, pitting, or fretting. Any bearings that show the slightest imperfection must be replaced. Adjust the pivot pin



**Fig. 11-51 Axle Caster (Side View)**

bearings. Assemble and lubricate the front axle and steering linkage, installing new steering knuckle oil seals if present seals show any wear.

(4) Check wheel runout. This check should include radial runout and wheel looseness on the hub.

(5) Check wheel balance. Check for blowout patches, uniform tire tread, vulcanized tires, mud on inside of wheels, and tires creeping on the rims.

(6) Check for front spring sag. Also check for broken spring leaves, broken center spring bolt, loose spring clips (or tight clips), overlubrication of spring leaves, spring shackle bracket loose on frame, and loose rear spring shackle. Be sure that the shock absorbers are operating properly to eliminate bobbing of the front end.

(7) Check brakes to make sure that one does not drag.

(8) Check the steering assembly and steering connecting rod. This includes the up and down play of the steering worm shaft, end play of the lever shaft, tightness of the steering gear to the frame, tightness of steering arm, adjustment of the steering connecting rod, and condition of the steering tie rod ball joint ends.

(9) Check front axle caster. This should be the same on both sides, otherwise a locking brake may be indicated causing a twisting action of the axle.

(10) Check the front wheel toe-in.

(11) Check wheel toe-out on turns. This gives an indication of the proper angularity of the steering knuckle arms and tells whether or not they have been bent and require replacing. These may be checked by comparing them with new parts. If an arm is bent, check for a bent tie rod.

(12) Check wheel camber.

(13) Check the steering axis inclination.

(14) Check the tracking of the front axle and frame alignment, either of which may be out of alignment.

## POWER STEERING

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### GENERAL

Vehicles equipped with optional power steering employ a power steering system which consists of a mechanical steering gear with an integral steering valve and power cylinder, and a hydraulic pump. The engine-driven hydraulic pump circulates the oil from its integral reservoir through the pressure and return hoses, which run between the valve and the pump. The valve, in response to right or left turn, directs the oil to the integral power cylinder which operates the pitman arm shaft to cause steering. This oil under pressure is directed to either end of the power cylinder, where it builds up force to reduce the effort required at the steering wheel. The rotary valve gives a smooth transition through the range of wheel effort and allows the driver to retain the road feel necessary for effortless driving.

Under normal driving conditions, the steering wheel effort will range from one pound to two pounds. The hydraulic oil pressure in the power cylinder should not exceed 100 psi and the pressure for turning corners will not exceed 400 psi. Pressure during parking ranges from 900 psi to 1050 psi, depending upon the roadbed conditions.

If for any reason the power system should fail, the steering gear will operate manually, giving the driver full control of the vehicle. The steering gear, in this condition, operates as a typical ball-nut type manual steering gear. Hydraulic fluid is bypassed through the valve so that it does not restrict the manual operation.

### DESCRIPTION AND OPERATION

#### Power Steering Gear

The 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. As the steering shaft and worm are rotated, the rack-piston nut raises and lowers, imparting this movement to the pinion of the pitman shaft. The pitman shaft mounts the pitman arm which transfers the movement to the steering linkage. The steering shaft is connected to the steering gear through a flexible coupling attached to the steering shaft flanges. The flexible coupling minimizes shocks, vibrations, and hydraulic noises, and lessens the possibility of road noise coming up through the steering column. The steering valve, power piston, and cylinder are subassemblies of the power steering gear.

#### Steering Valve

The steering valve is contained in the gear housing and is a four-way, three-position, open-center, rotary type valve. The movement of the spool opens the valve ports, and the fluid coming through the pressure hose from the pump is directed through the valve. It is then regulated throughout the gear housing, depending on the direction of the turn. The spool is held in neutral position by means of a torsion bar. Turning of the torsion bar allows the spool to displace in relation to the valve body, operating the valve.

#### Neutral Position Operation

Refer to figure 11-52.

Oil pressure from the pump passes through the open-center valve and back to the pump reservoir without traveling through the power cylinder. This open-center position of the valve reduces pump losses to a minimum. The valve is in the open-center position at all times except when steering. The power cylinder is always full of oil, which acts as a cushion to absorb road shocks so that they are not transferred to the driver. In addition, this oil lubricates all the internal components of the gear making it unnecessary to lubricate at any time.

#### Right-Turn Operation

Refer to figure 11-53.

Due to the resistance to turning between the front wheels and the roadbed, the torsion bar is deflected, changing the relationship between the spool grooves and the valve body grooves with each other. The right turn grooves of the spool are closed off from the return grooves and opened more to the pressure grooves. The left turn grooves of the spool are closed off from the pressure grooves and opened more to the return grooves. This causes the oil to flow into the lower half of the pressure cylinder and force the rack-piston nut upward. As the rack-piston nut moves upward, it applies turning effort to the pitman shaft. The oil in the upper end of the cylinder is simultaneously forced out through the 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 as-

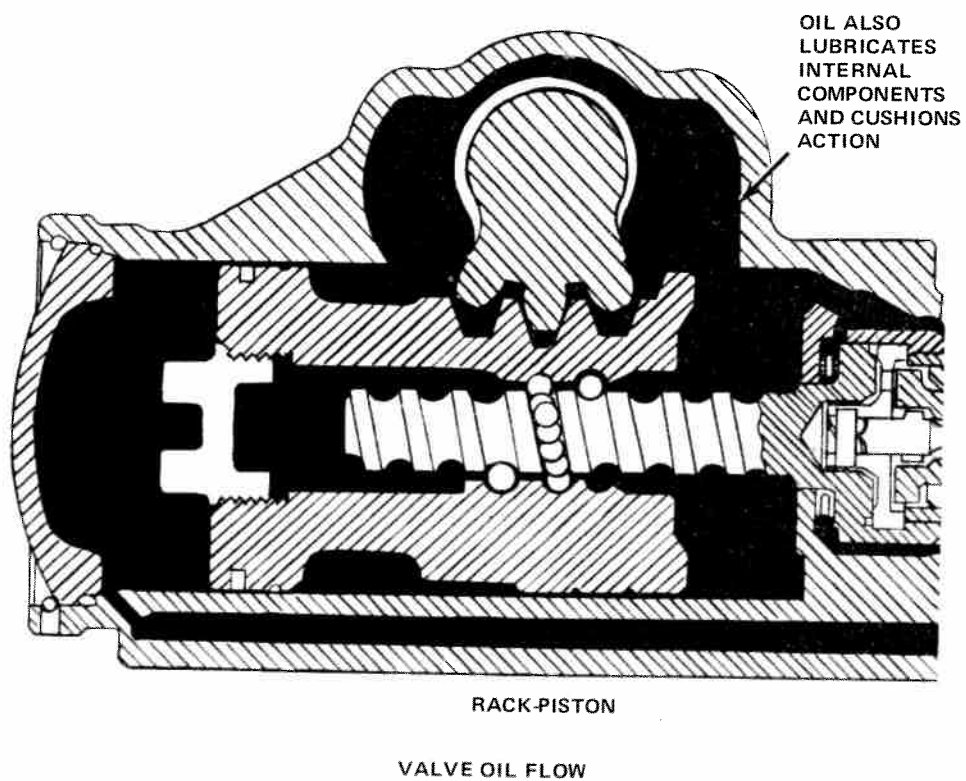
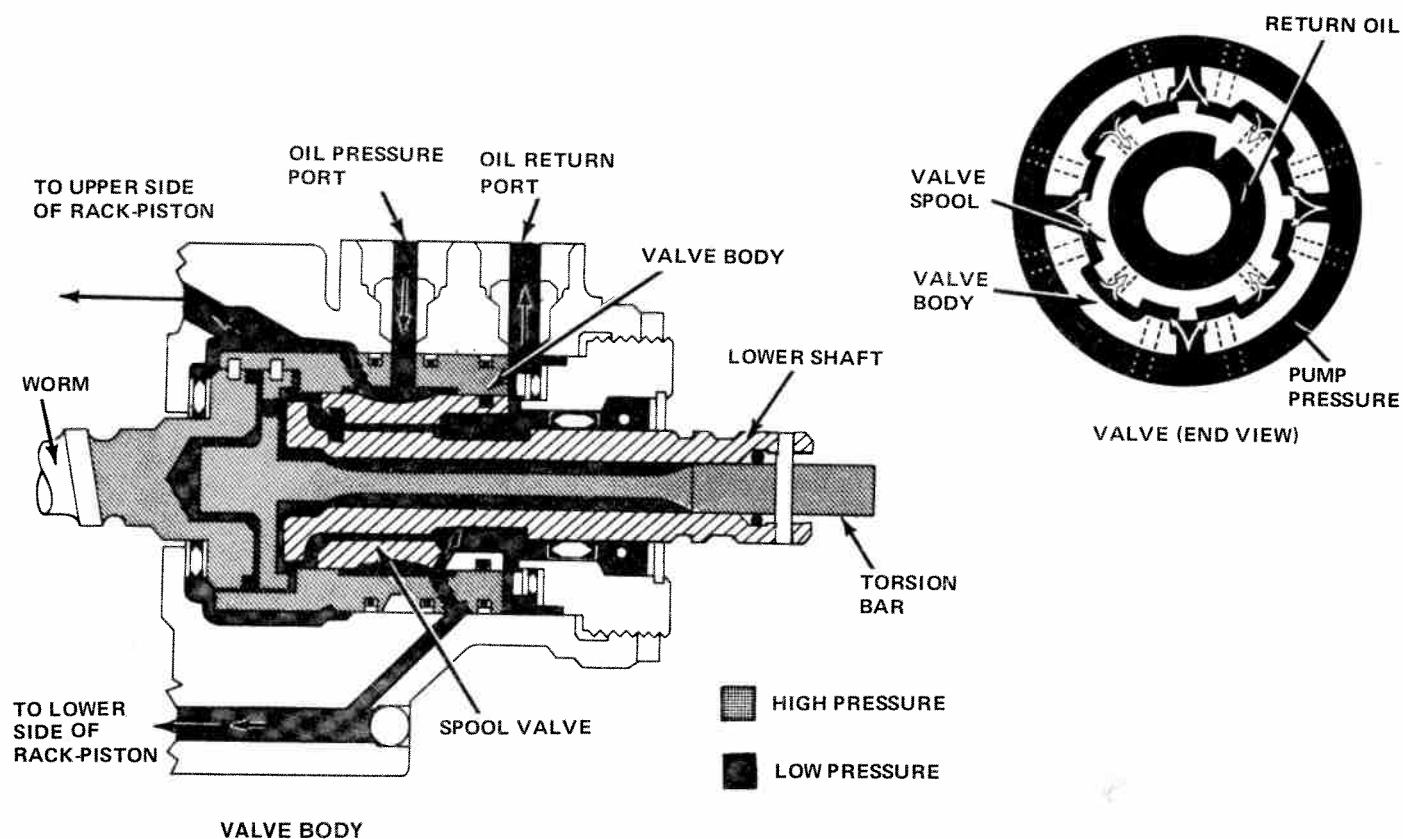


Fig. 11-52 Steering Valve Oil Flow—Neutral (Straight-Ahead) Position

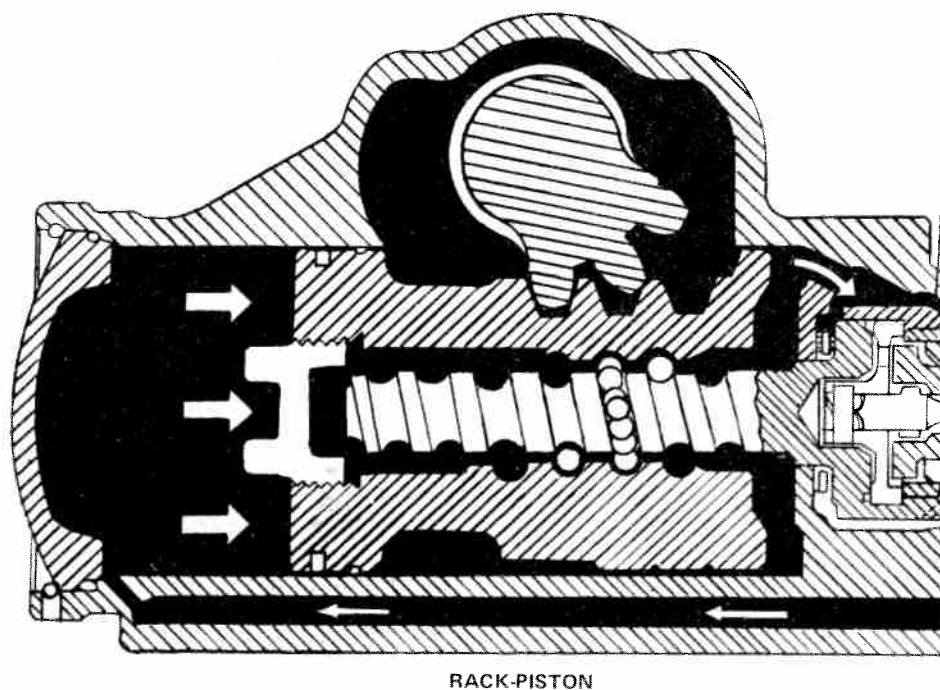
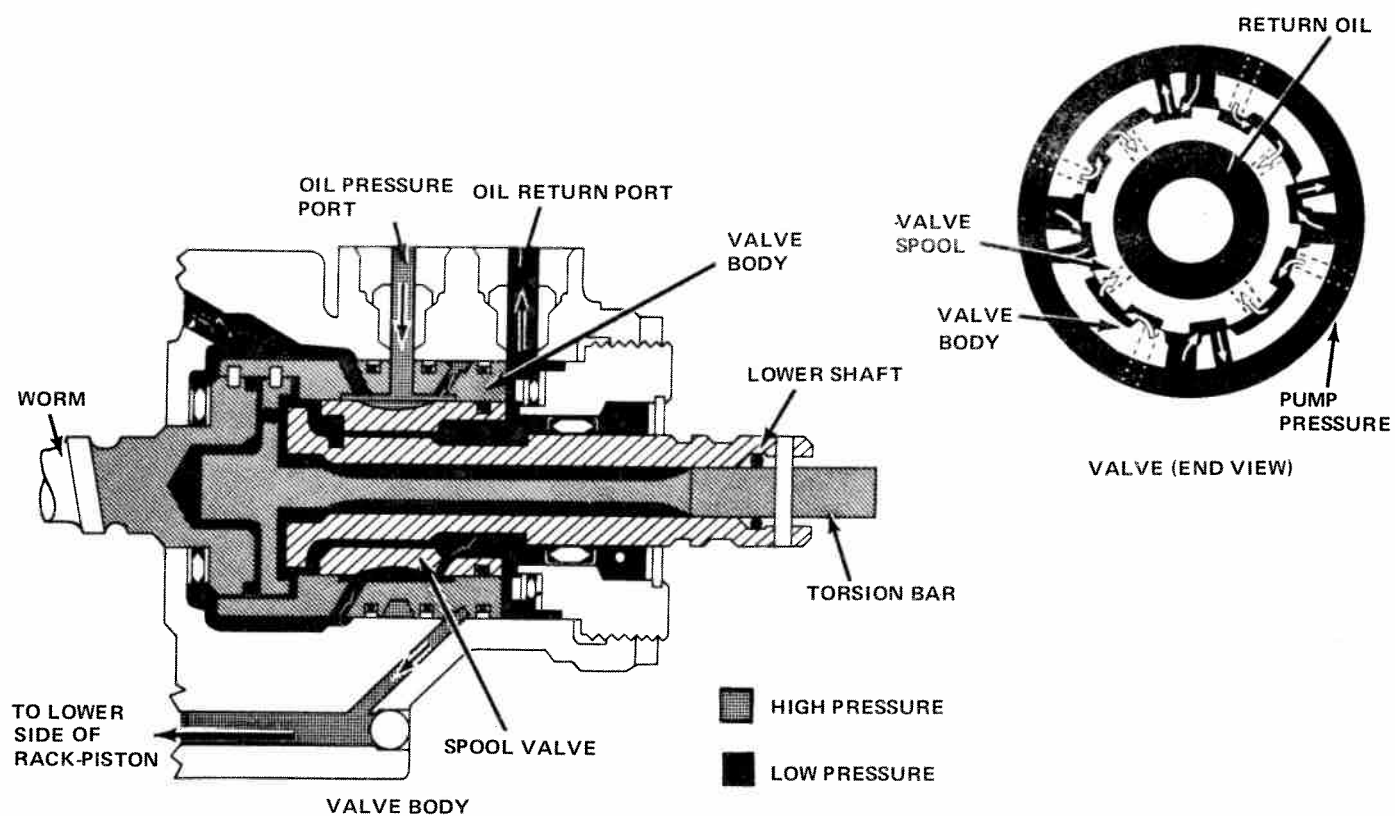


Fig. 11-53 Valve Oil Flow—Right Turn Position

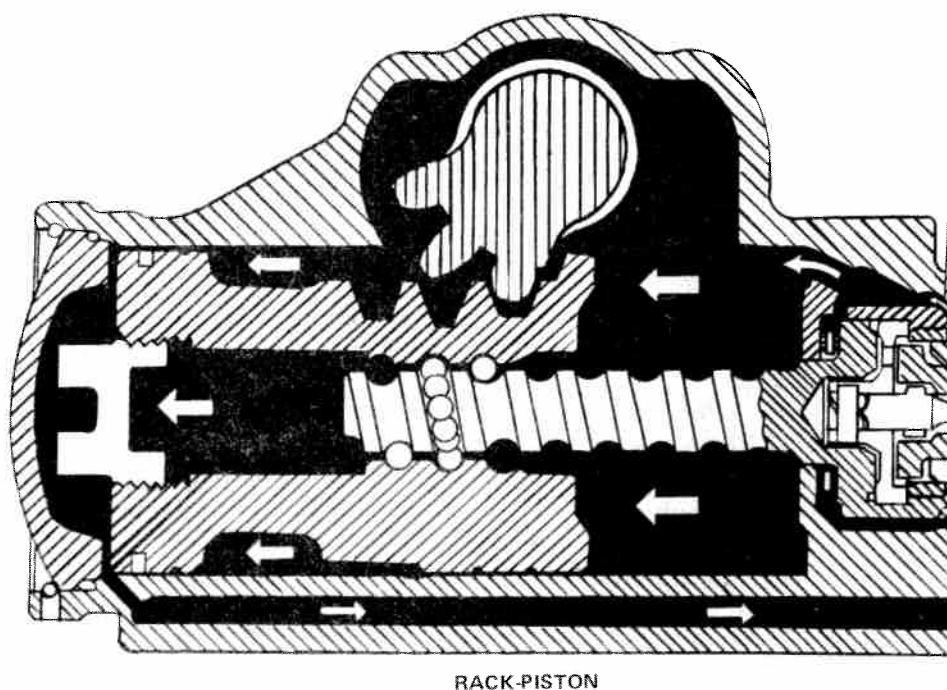
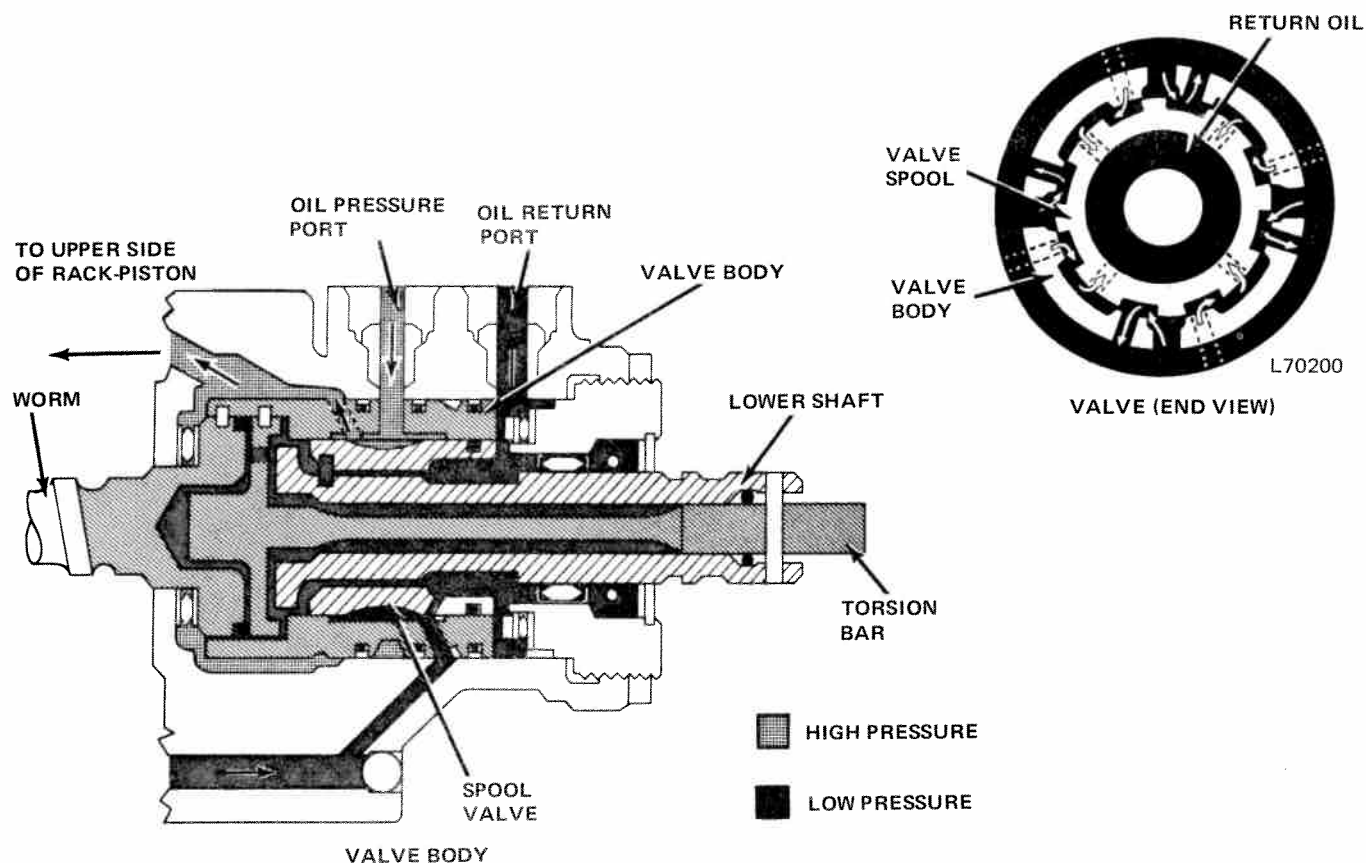


Fig. 11-54 Valve Oil Flow—Left Turn Position



sured of the proper amount of smooth hydraulic assistance at all times.

The instant the driver stops applying steering effort to the steering wheel, the valve is forced back into its neutral position by the torsion bar. 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.

#### Left-Turn Operation

Refer to figure 11-54.

The resistance to turning of the front wheels causes the torsion bar to deflect, changing the relationship between the spool grooves and the valve body grooves with each other. The grooves are reversed from the right turn position and change the flow of oil into the upper end of the pressure cylinder forcing the rack-piston nut downward and applying turning effort to the pitman shaft. The oil in the lower end of the cylinder is now forced through the valve and back to the pump reservoir. When the driver stops applying steering effort to the steering wheel, the valve returns to its neutral position and the steering geometry causes the wheels to return to the straight-ahead position.

#### Power Steering Pump

The oil pump converts engine power into oil pressure which is used against the rack-piston nut to rotate the pitman shaft.

The pump reservoir encloses the pump housing and provides a reserve supply of oil to assure complete filling of the hydraulic system (fig. 11-55).

The reservoir cap is vented to permit escape of any air that may be introduced into the system during assembly of the various units, and maintains atmospheric pressure in the reservoir.

The pump housing encloses the flow control valve and the rotor assembly. The flow control valve and spring are retained in the pump housing by the pressure union (fig. 11-56). This allows servicing the flow control valve without removing the pump from the engine. Inside the flow control valve is the pressure relief valve. Also in the end of the flow control valve is a filter screen which filters the oil that enters this valve. The pressure union which is the pump outlet, contains the pump oil exit hole and an orifice.

The rotor assembly consists of a drive shaft, thrust plate, rotor with ten vanes, pump ring and pressure plate.

Oil enters the rotor section of the housing through a hole which is open to the surrounding reservoir.

The rotor, which is loosely splined to the end of the drive shaft, is located adjacent to the face of the thrust plate and is enclosed by the pump ring. The rotor vanes slide radially outward to contact the hardened and ground inside cam surface of the ring (fig. 11-57).

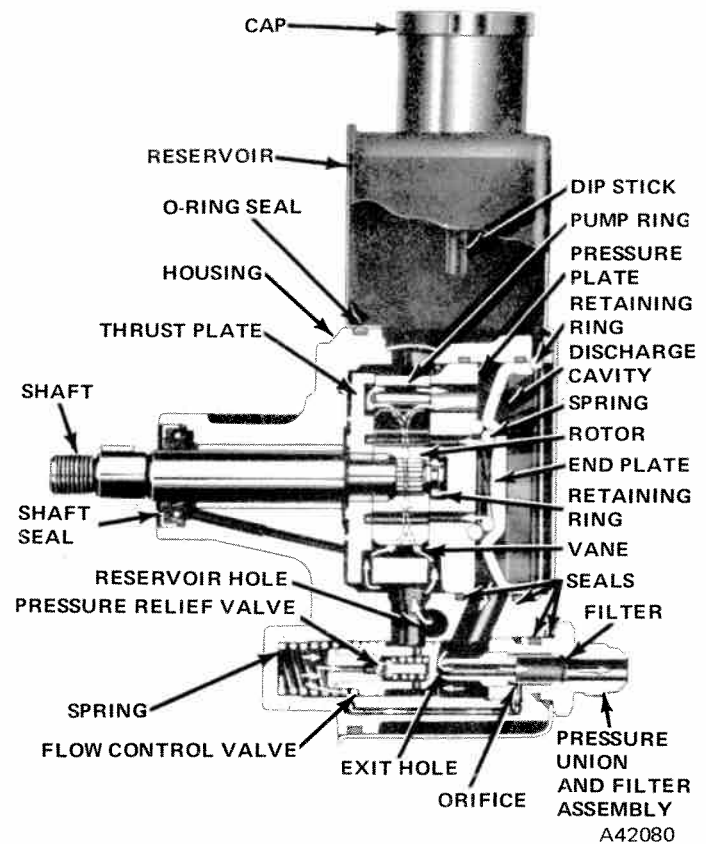


Fig. 11-55 Power Steering Pump—Cross Section

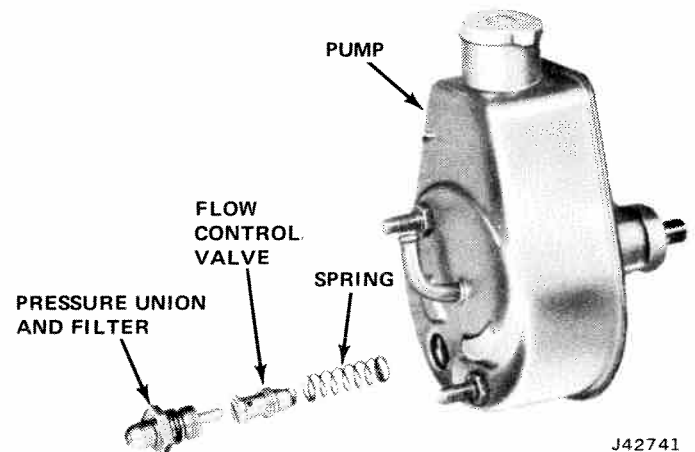


Fig. 11-56 Flow Control Valve Installation

As the shaft and rotor rotate, centrifugal force and fluid pressure against the inner ends cause the vanes to follow the cam contour of the ring. The cam surface is so shaped that two opposite pumping chambers are formed which cause a complete pumping cycle to occur every 180 degrees of rotation of the rotor. The pump ring has two crossover passages drilled in it, which transfer oil from the thrust plate into a discharge cavity located at the rear of the pressure plate.

When the engine is started, each pumping chamber picks up oil from two openings, one between the pressure plate and ring, and the other between the thrust

plate and ring (fig. 11-58). The oil is then propelled by the decreasing pockets in each pumping chamber into the discharge cavity through an opening in the pressure plate and an opening in the thrust plate which is connected to the crossover passage in the ring. The oil flows from the discharge cavity into a passage which is open to the rear of the flow control valve and to the exit hole in one end of the pressure union. Oil flows through the outlet end of the pressure union to the steering gear assembly. Some oil flows through the orifice in the pressure union and into a passage in the pump housing which directs oil into the spring chamber located in front of the flow control valve.

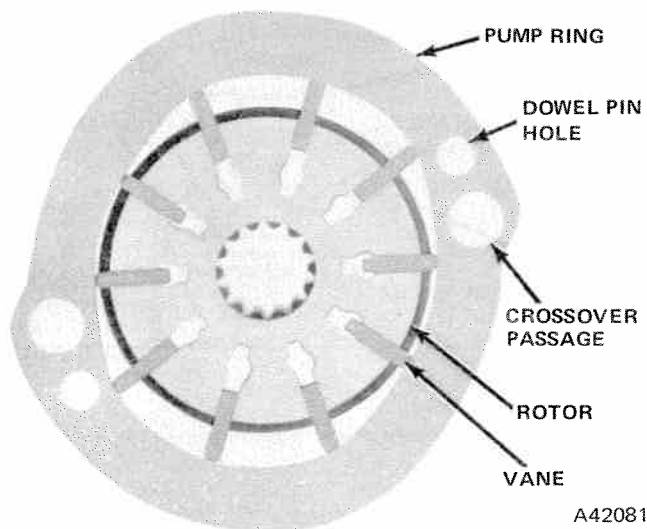


Fig. 11-57 Pump Ring and Rotor

Pressure in the discharge cavity is always greater than the pressure of the oil that has passed through the exit hole in the pressure union.

The flow control valve regulates the opening of a bypass passage through which oil may be returned to the suction and reservoir section of the pump.

When the pump is running without demand for steering pressure, pressure in the discharge cavity is great enough to push the flow control valve open against a spring load of approximately ten pounds.

The pressure in the spring chamber tends to close the valve, but since pressure in the discharge cavity is always greater than in the spring chamber, the valve is not closed. The movement of the valve is controlled by the spring tension and the difference in pressure on the front and rear side of the valve.

When power assistance is required, the steering gear rotary valve restricts free circulation of oil, and the pump pressure builds up rapidly. As the pressure increases in the discharge cavity it also increases in the spring chamber and, in turn, additional pressure is required to move the flow control valve to open the bypass passage. The maximum amount of build-up of pressure by the pump depends on the amount of restriction, controlled by the rotary valve. When power

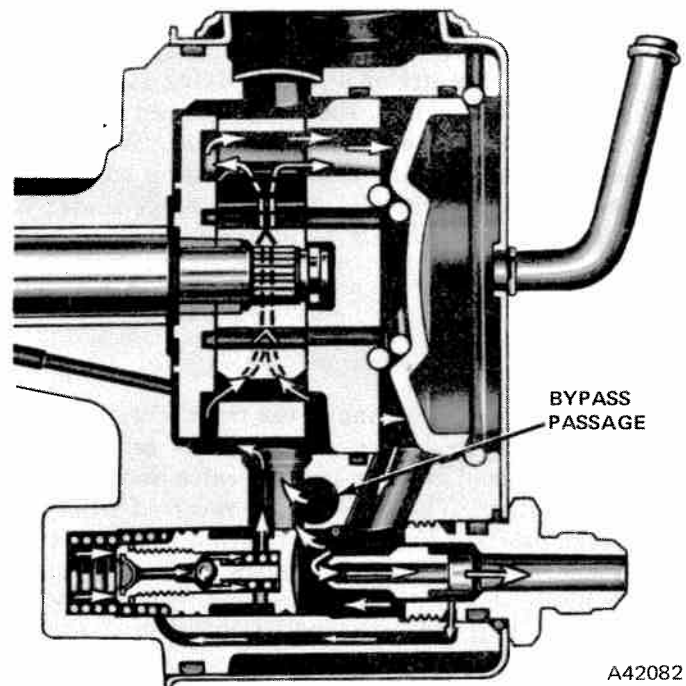


Fig. 11-58 Flow Control Valve Operation

assistance is no longer required, the restriction is reduced to a predetermined minimum. With a small amount of restriction, the pressure in the spring chamber drops to a minimum. Thus, the pressure in the discharge cavity also is reduced as this pressure is governed by the spring tension and the oil pressure present in the spring chamber of the pump.

If pump output pressure reaches 1100 to 1200 psi, the increased pressure in the spring chamber forces a pressure relief valve open and oil escapes from the spring chamber into the bypass hole around the pressure relief valve ball (fig. 11-58).

As oil pressure is relieved in the spring chamber, the high pressure in the pump discharge cavity overcomes the spring load to open the flow control valve. Because outlet pressure has to pass through an orifice to get into the spring chamber, the pressure in the spring chamber drops below outlet pressure for a fraction of a second. This allows the flow control valve to be open enough to lower line pressure to a safe level immediately. Oil is then pumped into the bypass passage until the line pressure opposing the pump drops below the relief valve setting, permitting this valve to close. The flow control valve then resumes normal operation. The flow control valve starts to open at 300-400 rpm of pump and is functioning when the pump is running 465 rpm (400 rpm of engine).

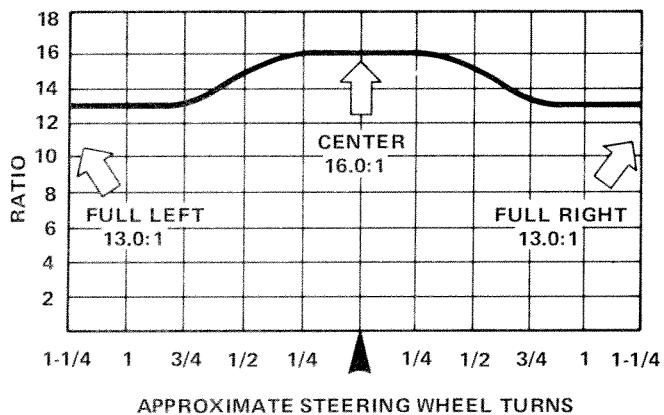
## VARIABLE RATIO POWER STEERING

A variable ratio power steering gear is included in the optional power steering package offered on Cherokee, Wagoneer, and Truck models. CJ-5 and CJ-6 models are equipped with the constant ratio gear unit.

The ratio of a steering system is the relationship of steering wheel movement to that of the front wheels, in terms of the number of degrees that the steering wheel must be moved to turn the front wheels one degree. To illustrate, the constant ratio power steering gear has a steering ratio of 17.5 to 1, which means that it is necessary to move the steering wheel 17.5 degrees in order to turn the road wheels one degree.

Variable ratio steering is more responsive, requiring fewer turns of the steering wheel to move the front wheels from stop to stop. Steering ratio varies from 16 to 1, to 13 to 1, and is dependent on the degree of steering wheel movement. In the straight-ahead position, the steering ratio remains constant at 16 to 1 for the first 40 degrees of steering wheel movement in either direction. When steering wheel movement exceeds 40 degrees of travel, the steering ratio gradually decreases with continued wheel movement, until maximum ratio variance of 13 to 1 is reached (fig. 11-59).

The low end of the ratio is achieved only near the extremes of steering wheel travel or at approximately one full turn of the wheel. Since the steering wheel is turned to its limit only when parking or backing. The lower ratio provides added maneuverability in these situations.



J41063

Fig. 11-59 Variable Ratio Steering

Variable ratio steering is accomplished by a pitman shaft sector incorporating a short tooth on either side of a long center tooth, rather than a sector with three teeth of equal length, as in the constant ratio gear. Companion changes are also made in the rack piston teeth (fig. 11-60).

Since the sector is basically a series of levers, any movement of the rack will cause the sector to swing the pitman arm in the same ratio; that is, it will turn the pitman arm the same number of degrees with each tooth in the sector.

To increase or decrease the ratio, it is only necessary to change the length of the sector teeth. Therefore, a low ratio, or smaller radius sector with shorter

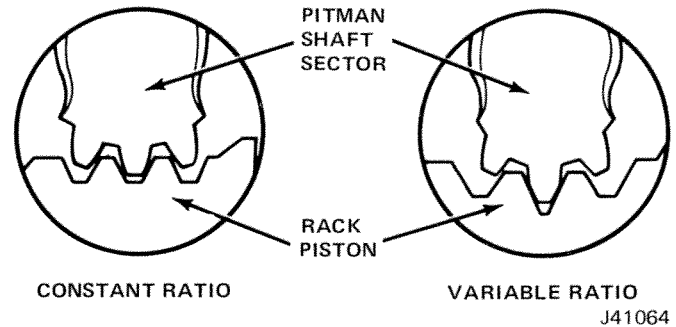


Fig. 11-60 Rack and Sector Comparison

teeth, produces greater pitman arm movement than the high ratio sector with its longer teeth and greater leverage.

On this basis, the variable ratio sector is in reality one long, high-ratio lever at the center, flanked by two lower-ratio levers for left and right turns.

Since only the tip of the long center tooth is in contact with the rack when the front wheels are straight, initial movement of the rack in either direction causes a relatively small response of the sector and pitman arm because of the high ratio that results from this long lever relationship.

As a result, the steering ratio remains a nearly constant 16.0:1 for the first forty degrees of steering wheel movement in either direction from center.

Turning the steering wheel further reduces the length of the lever. The point of contact now rolls down the side of the center tooth, to act as a shorter radius.

As a result, the steering ratio is reduced causing the pitman arm to move noticeably further for a given steering wheel movement. With the wheel turned one-half turn, the steering ratio is reduced to approximately 14.2:1.

With a three-quarter turn of the steering wheel, the leverage is further reduced to approximately 13.3:1.

This smooth reduction in steering ratio is produced by the rolling action between the rack and center tooth which constantly shortens the effective leverage by moving the contact point down the side to the root of the long, center tooth. At this time, the tip of the short tooth begins contact with the rack at the same radius and soon takes over the load.

From three-quarters to one full turn of the steering wheel, the ratio continues to diminish as the same rolling action moves the point of contact from the tip to the root of the short tooth.

This action completes the ratio reduction from 13.3 to 13.1:1. For the last quarter turn of the steering wheel, the ratio remains constant at 13.1:1 to provide greatest maneuverability for backing and parking.

**NOTE:** Service procedures for constant and variable ratio steering are the same.



## SERVICE DIAGNOSIS

Condition	Possible Cause	Correction
HARD STEERING	(1) Lower coupling flange rubbing against adjuster plug (2) Steering adjustment tight (3) Insufficient pressure in gear power cylinder due to leak or faulty valve (4) Gear check valve poppet incorrectly installed	(1) Loosen pinch bolt and assemble properly. Correct clearance between plug and flange is 1/16 inch. (2) Check adjustment by disconnecting pitman arm from gear. (3) Replace defective parts. (4) Check valve for proper operation.
POOR RETURN OF STEERING GEAR TO CENTER	(1) Lower coupling flange rubbing against adjuster plug (2) Pitman sector-to rack-piston nut adjusted to tight (3) Rack-piston nut to worm preload too tight (4) Thrust bearing adjustment incorrect (5) Sticky valve spool (6) Steering column misalignment	(1) Loosen pinch bolt and assemble properly. Correct clearance between plug and flange is 1/16 inch. (2) Adjust to specification. (3) Remove gear and replace balls as required. (4) Adjust to specification. (5) Remove and clean valve. (6) Realign.
LACK OF PUMP ASSIST	(1) Loose drive belt (2) Low oil level (3) Air in the oil (4) Defective hoses (5) Flow control valve stuck open (6) Loose screw in end flow control valve (7) Pressure plate not flat against ring (8) Extreme wear of pump ring (9) Scored pressure plate, thrust and/or rotor (10) Vanes not installed properly (11) Vanes sticking in rotor slots (12) Faulty flow control valve assembly (13) O-ring improperly installed on pressure union (14) End plate improperly installed or seal damaged	(1) Tighten belt. (2) Fill reservoir. (3) Locate source of air leak and correct. (4) Replace hose. (5) Remove burrs or dirt. (6) Tighten. (7) Properly seat pressure plate against ring. (8) Replace part. (9) Lap off light scoring. Replace heavily scored parts. (10) Install properly. (11) Free up by removing burrs or dirt. (12) Replace assembly. (13) O-ring must be in groove nearest outlet of union. (14) Install properly. Replace seal.
INCREASED EFFORT REQUIRED TO TURN WHEEL FAST	(1) Air in system (2) Low oil level in pump (3) High internal leakage	(1) Bleed gear. (2) Check oil level in pump reservoir. (3) Replace rack-piston ring and back-up O-ring, rack-piston nut end plug seal, and/or replace valve.

NOTE: With engine idling, very fast movements of steering wheel may give higher effort or feel. This is a normal result and will last momentarily until the system "catches up" with position of the valve.



## SERVICE DIAGNOSIS (Continued)

Condition	Possible Cause	Correction
STEERING GEAR OIL LEAKS	(1) Loose hose connections (2) Damaged hose (3) Side cover O-ring seal (4) Pitman shaft seal (5) Housing end plug O-ring seal (6) Adjuster plug O-ring seal (7) Torsion bar O-ring seal (8) Pitman shaft lash adjuster nut (9) Stub shaft seal	(1) Tighten (2) Replace (3) Replace seal (4) Replace seal (5) Replace seal (6) Replace seal (7) Replace valve (8) Replace nut (9) Replace seal
PUMP OIL LEAKS	(1) Reservoir too full (2) Oil leaking at top of reservoir caused by air bubbles in oil (3) Reservoir O-ring seal damaged or improperly installed (4) Pressure union or reservoir to housing bolt and stud not tightened sufficiently (5) Pressure union or reservoir to housing bolt and stud cross threaded or damaged (6) Defective pressure fitting seat on hose end (7) Damaged reservoir to housing or pressure union O-ring seals (8) Leaks in metal parts (9) Defective shaft seal (10) Damaged shaft at seal area	(1) Remove oil to proper level (2) Locate source of air leak and correct (3) Replace O-ring (4) Tighten union and stud and bolt to 35 foot-pounds torque (5) Replace damaged parts (6) Replace hose (7) Replace seals (8) Replace defective part (9) Replace seal (10) Replace shaft
STEERING GEAR RATTLE OR CLUCK	(1) Loose overcenter adjustment	(1) Adjust to specification

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

STEERING GEAR HISS	(2) Gear loose on frame  (1) Normal when steering wheel is at end of travel or when parking  (2) Gear loose on frame	(2) Tighten mounting bolts  (1) Replace valve only if noise is extremely objectionable. Investigate clearance around safety drive rivet pins. Be sure there is no metal-to-metal contact around flexible coupling, as hiss will be transmitted through vehicle. Re-align steering column if necessary. (2) Tighten mounting bolts
STEERING GEAR SQUAWK WHEN TURNING OR RECOVERING FROM A TURN	(1) Cut or worn damper O-ring on valve spool	(1) Replace O-ring



## SERVICE DIAGNOSIS (Continued)

Condition	Possible Cause	Correction
PUMP NOISE	(1) Loose belt (2) Hose touching other parts of vehicle (3) Low oil level (4) Air in the oil  (5) Excessive back pressure caused by hoses or steering gear  (6) Scored pressure plate (7) Vanes not installed properly (8) Vanes sticking in rotor slots (9) Extreme wear of pump ring (10) Face of thrust plate scored (11) Scored rotor (12) Defective flow control valve	(1) Tighten belt (2) Adjust hose positions (3) Fill reservoir (4) Locate source of air leak and correct  (5) Locate restriction and correct With pressure gauge installed in pressure hose between pump and gear and engine running at 1500 rpm oil warm, and no effort on the steering wheel. Pressure should not exceed specification. Check operation of check valve poppet (6) Lap out light scoring. Replace heavily scored part (7) Install properly (8) Free up by removing burrs and dirt (9) Replace part (10) Lap out light scoring Replace heavily scored part (11) Lap out light scoring Replace heavily scored part (12) Replace
EXCESSIVE WHEEL KICKBACK OR LOOSE STEERING	(1) Air in system (2) Excessive lash between pitman shaft sector and rack-piston (3) Loose thrust bearing adjustment (4) Rack-piston nut to worm preload too low (5) Incorrect installation or operation of the gear check valve poppet	(1) Add oil to pump reservoir and bleed (2) Adjust to specification (3) Remove gear and adjust to specification (4) Remove rack-piston nut and worm, and change balls (5) Check operation of valve
STEERING WHEEL SURGES OR JERKS WHEN TURNING	(1) Loose pump belt	(1) Adjust to specification
HARD STEERING WHEN PARKING	(1) Loose pump belt (2) Reservoir low  (3) Steering gear adjustments tight (4) Insufficient oil pressure	(1) Adjust to specification (2) Fill to proper level If excessively low, check all lines for leaks (3) Adjust to specification (4) Refer to Pump Pressure Check Procedure
LOW OIL PRESSURE	(1) Kink, restriction, or foreign object in hose(s) (2) Leakage at steering gear side cover O-ring, housing end plug O-ring, or pitman shaft seal shaft seal	(1) Remove hose(s) and remove restricting object (2) Replace defective seals



## SERVICE DIAGNOSIS (Continued)

Condition	Possible Cause	Correction
LOW OIL PRESSURE (Continued)	<p>(3) Steering gear piston ring worn, back-up O-ring damaged, or housing bore scored</p> <p>(4) Leakage at steering gear valve rings, valve body-to-worm seal, rack-piston end plug seal</p> <p>(5) Incorrect installation or operation of steering gear check valve poppet</p>	<p>(3) Remove and inspect steering gear</p> <p>(4) Remove and inspect steering gear</p> <p>(5) To determine if the poppet valve is installed and operating correctly, disconnect the pressure hose and install a pressure gauge between the hose and the pump. With the engine at warm idle (525 rpm) and no effort on the steering wheel oil pressure should not exceed 60 psi with warm oil. If gauge indicates more than 60 psi, the poppet valve should be checked for correct installation</p>

## PERIODIC MAINTENANCE—POWER STEERING

## Pump Reservoir

Oil must be maintained at a level one inch from top of reservoir. If necessary, add automatic transmission fluid to bring reservoir to correct level.

Start the engine and run it for ten minutes. Do not turn the steering wheel during this time. Raise the front wheels from the floor and perform several complete power-operated turns. Do not hold the steering wheel at maximum turn position or overheating of the pump will occur.

Recheck and, if necessary, refill reservoir to the required level. Inspect the system for external leaks. Check the fluid in the system for foam. A properly bled system will not foam.

**NOTE:** Air bubbles circulating through the pump will result in noise. Prevent this condition by carefully bleeding the system at time of assembly. Refer to Fluid Level and Initial Operation at the end of this section.

## Pump Drive Belt Tension

Adjust the belt tightness so that the tension is as specified when measured with belt tension gauge J-23600. When using a belt tension gauge, make sure gauge is placed in the center of the longest belt span. When checking notched belts, make sure the middle finger of the gauge is in the notched cavity of the belt.

## POWER STEERING GEAR SERVICE

## Removal

(1) Disconnect hoses from return port and pressure port. Raise hoses above pump to prevent oil from draining.

(2) Remove pinch bolt from lower flange.

(3) Remove pitman arm nut, lockwasher, and pitman arm.

(4) Remove mounting bolts attaching steering gear assembly to frame, and remove steering gear assembly.

## Disassembly

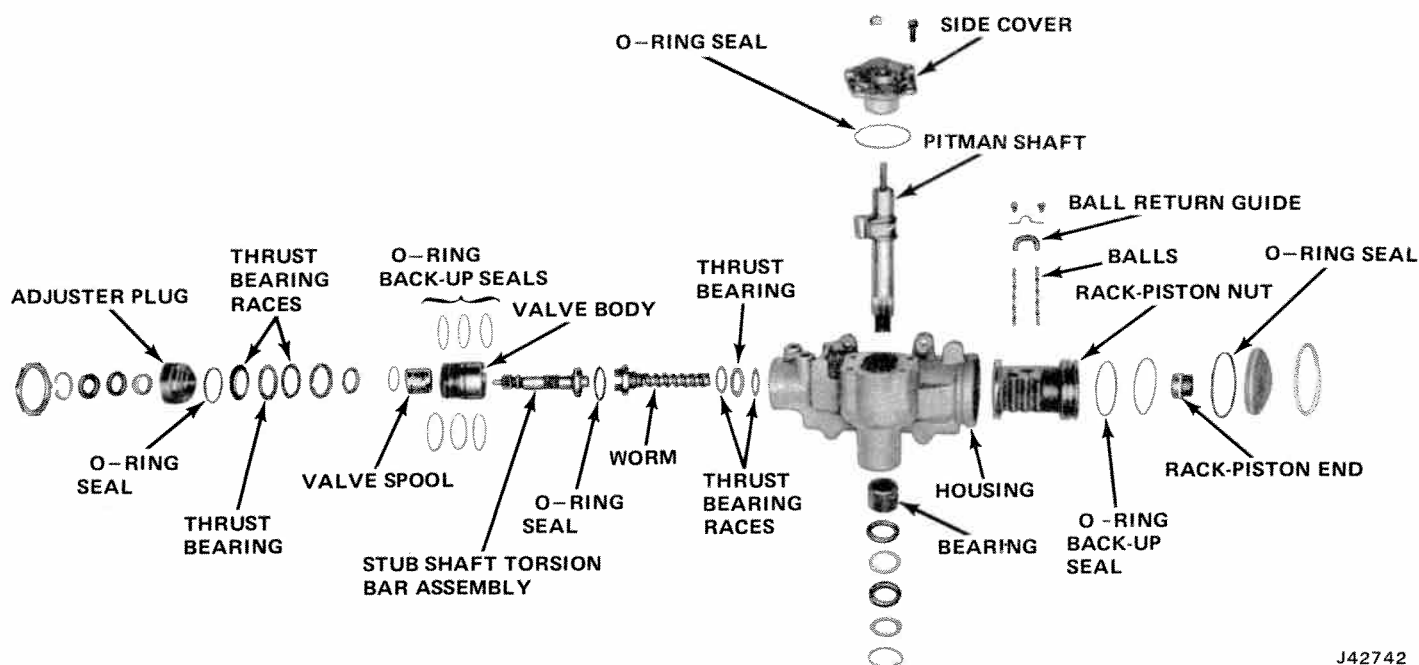
## Pitman Gear Assembly and Side Cover

Refer to figure 11-61.

(1) Place housing assembly on a holding fixture or clamp rear portion of housing in a vise. Do not overtighten the vise. This will distort housing assembly.

(2) Place pitman shaft on center or high spot.

**NOTE:** In most cases, complete disassembly of the power steering unit will not be necessary. It is suggested that only those assemblies that are faulty be disassembled. Disassembly and reassembly of the unit and the sub-assemblies must be made on a clean work bench. As in repairing any hydraulically oper-



J42742

Fig. 11-61 Power Steering Gear

ated unit, cleanliness is of utmost importance. Therefore, the bench, tools, and parts must be kept clean at all times. Thoroughly clean the exterior of the unit with a suitable solvent.

(3) Drain out as much of remaining oil as possible.

(4) Rotate stub shaft torsion bar until pitman shaft gear is in center position and remove side cover retaining screws and lockwashers.

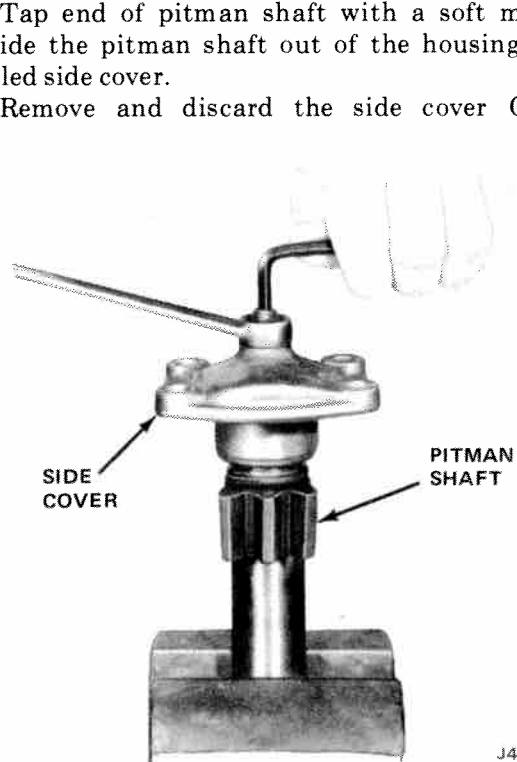
(5) Tap end of pitman shaft with a soft mallet, then slide the pitman shaft out of the housing with assembled side cover.

(6) Remove and discard the side cover O-ring seals.

(7) Hold lash adjuster with an Allen wrench and remove lash adjuster nut (fig. 11-62). Discard the nut.

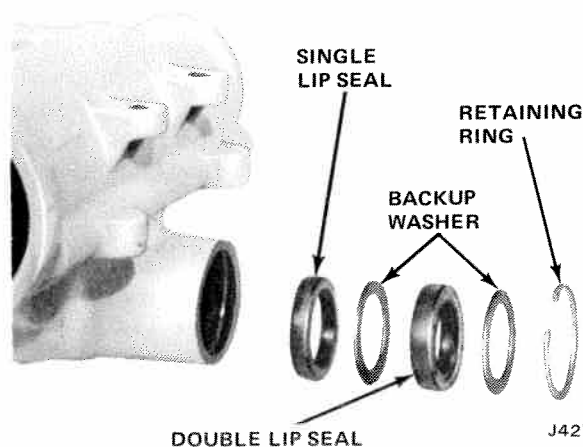
(8) Screw the lash adjuster out of the side cover by screwing adjuster clockwise into pitman shaft. **Do not remove** adjuster from pitman shaft.

(9) Remove pitman shaft seal retaining ring, using internal snap ring pliers C-3915.



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Fig. 11-62 Removing Lash Adjuster Locknut



J42744

Fig. 11-63 Pitman Shaft Seal

(10) Remove the outer back-up washer. Tap screwdriver between outer seal and inner back-up washer and pry out seal (fig. 11-63).

(11) Tap screwdriver between inner seal and shoulder in gear housing and pry out second seal. Be careful not to damage the seal bore. Discard seals.

(12) Remove needle bearing from gear housing with Tool J-6657. Drive the bearing out of the housing, **not** into the housing. Discard bearing.

### Adjuster Plug Assembly

(1) Loosen adjuster plug locknut with Wrench J-25194.

(2) Loosen adjuster plug assembly with Tool J-7624 (fig. 11-64). Hold stub shaft to keep it from turning and screw out adjuster plug assembly.

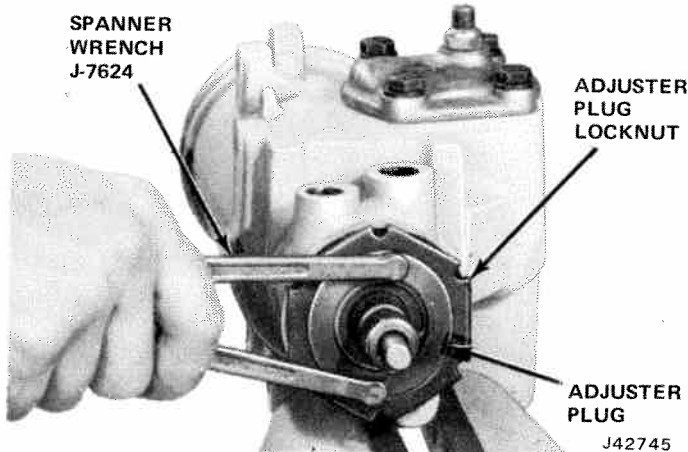


Fig. 11-64 Adjuster Plug Removal or Installation

(3) Remove thrust bearing retainer with a screwdriver (fig. 11-65) being careful not to score needle bearing bore. Discard retainer.



Fig. 11-65 Removal of Thrust Bearing Retainer

(4) Remove thrust bearing spacer, thrust bearing, and thrust bearing races (fig. 11-61).

(5) Remove adjuster plug O-ring seal and discard.

(6) Remove stub shaft seal retainer ring and stub shaft dust seal from adjuster plug.

(7) Remove stub shaft seal by prying out with screwdriver. Discard seal.

(8) If adjuster plug needle bearing rollers are broken or pitted, drive bearing from plug, using Adjuster Plug Bearing Removal and Installer Tool J-6221. Discard bearing.

### Valve Assembly

Refer to figure 11-61.

The complete valve assembly in each rotary valve safety power steering gear is a precision unit with

selective fitted parts and is hydraulically balanced at assembly. Only those parts which are marked as service items are replaceable and interchangeable. No other valve parts are individually interchangeable. If replacement of any nonserviceable valve part is necessary, the rotary valve assembly should be replaced completely.

**NOTE:** It is very uncommon to make any service repairs of the valve assembly with the possible exception of the valve spool damper O-ring. Do not disassemble the valve unless absolutely necessary since this may result in damaging the assembly. If the valve spool damper O-ring requires replacement, remove the valve spool only, replace the O-ring, and reinstall the spool immediately. Do not disassemble farther unless it is absolutely necessary. If disassembly is required, proceed as follows:

(1) Remove valve and stub shaft torsion bar, as an assembly, from gear by grasping stub shaft torsion bar and pulling out.

(2) Remove cap to worn O-ring seal and discard.

(3) Hold valve assembly in both hands with stub shaft pointing down. Lightly tap stub shaft against bench until shaft cap is free from valve body (fig. 11-66).



Fig. 11-66 Tapping Torsion Bar to Remove Valve Cap

(4) Pull the shaft assembly until the shaft cap clears the valve body approximately 1/4 inch.

**CAUTION:** Do not pull shaft assembly out too far or spool valve may become cocked in valve body.

(5) Carefully disengage shaft pin from valve spool and remove shaft assembly.

(6) Push spool valve out of flush end of valve body while rotating the valve. If valve becomes cocked, carefully realign valve, then remove.

(7) Remove dampener O-ring from the spool valve and discard.

(8) Carefully cut valve rings and ring backup seals. Remove and discard, providing rings show evidence of excessive wear.

**NOTE:** Valve rings are made of filled teflon, and it is very unusual that replacement is required.

## Rack-Piston and Worm Shaft

(1) Rotate end plug retainer ring so that one end of the ring is over hole in housing. Spring end of ring with a punch inserted through hole to allow screwdriver to be inserted to lift ring (fig. 11-67).

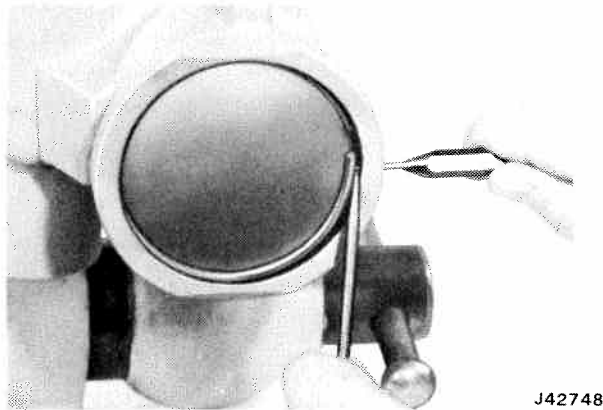


Fig. 11-67 End Plug Retaining Ring Removal

(2) Rotate stub shaft torsion bar with 3/4 inch box end of socket wrench to extreme left-turn position to force end out of housing.

**CAUTION:** Do not rotate farther than necessary or the balls from rack and worm assembly will fall off end of worm.

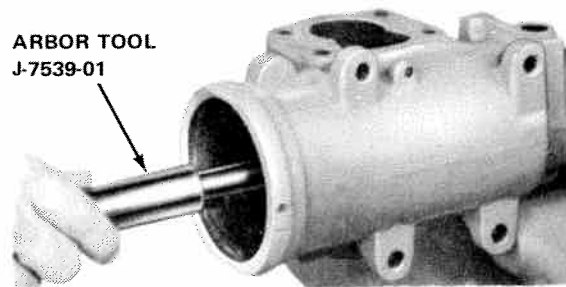
(3) Remove and discard housing end plug O-ring seal.

(4) Remove rack-piston end plug by inserting a 1/2 inch drive socket extension into the square hole in the plug and turning counterclockwise.

**NOTE:** This can be done only with the pitman shaft in place.

(5) Using the pitman arm shaft Rack-Piston Ball Retainer Arbor Tool J-7539-01, remove rack-piston nut (fig. 11-68). Rotate stub shaft torsion bar to left to force rack-piston nut onto the arbor. Remove rack-piston nut from gear housing.

**NOTE:** The arbor prevents balls from falling out of the rack-piston nut. After removing the rack-piston nut, place it on the workbench with the ring end toward the bench. Keep the arbor tool inserted in the rack-piston nut.



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Fig. 11-68 Using Arbor Tool to Remove Rack-Piston Nut

(6) Remove valve assembly (See Valve Assembly removal in preceding paragraph).

(7) Remove worm, lower thrust bearing, and races.

(8) Cut piston ring and O-ring backup seal. Remove from rack-piston nut and discard.

(9) Remove screw and lockwasher assemblies from rack-piston nut with screwdriver.

(10) Remove return guide clamp.

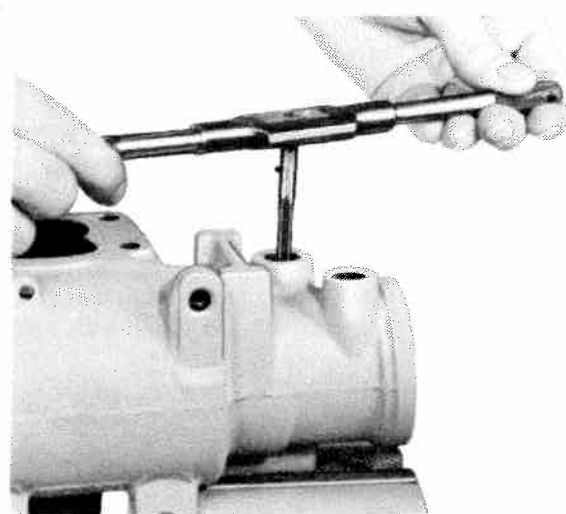
(11) Place assembly on a clean cloth, and remove ball return guides and arbor to release the balls. Make sure all of the balls are caught on the cloth.

## Inspection and Repair

### Housing

(1) Inspect the housing bore. If it is badly scored or worn, the housing must be replaced.

(2) Check the hose connectors. If they are damaged, scored, or brinelled, remove them by tapping with a 5/16-18 thread tap as shown in figure 11-69.



J42750

Fig. 11-69 Threading Connector with Thread Tap

(3) Thread a bolt with a nut and flat washer attached, into the threaded connectors. Hold the bolt and rotate the nut from the bolt to pull the connectors as shown in figure 11-70.



Fig. 11-70 Using Puller Screw to Remove Connector

(4) If it is necessary to remove the poppet valve from the pressure port, use a No. 5 screw extractor. Drive a new connector into the connector port with Connector Installation Tool J-6217 as shown in figure 11-71.

**NOTE:** After installing the connector, depress the poppet valve with a pencil point. The poppet valve must spring back when the pencil is removed.

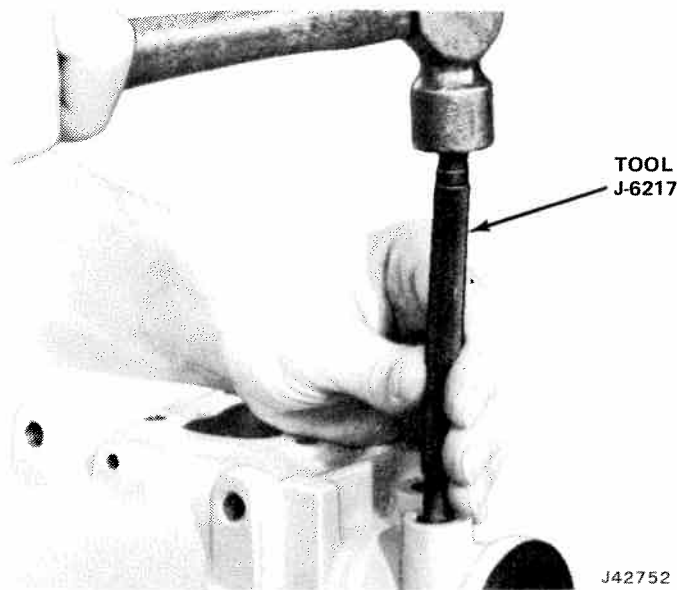


Fig. 11-71 Driving in Connector

(5) Inspect all seal surfaces and retaining ring grooves for defects. Replace housing if defective.

(6) Inspect the ball plug in the housing. If it is leaking or if the ball is raised above the housing surface, drive it in so that it is flush with or to 1/16 inch below the surface. Tighten the ball by staking the housing. If this does not stop leakage, replace the housing.

#### Rack-Piston Nut, Worm, and Balls

(1) Inspect worm shaft for wear, scoring, pitting, distortion, nicked threads, or other damage.

(2) Inspect rack-piston nut for scored, pitted, or nicked ball races.

(3) Inspect the exterior diameter of the nut for wear or scoring. Make sure the seal seats are clean and free from burrs or damage.

(4) Inspect the rack teeth for chips, cracks, dents, or other damage. If either the worm shaft or the rack-piston are damaged, both must be replaced as a matched set.

(5) Carefully inspect each of the balls for dents, nicks, out-of-roundness, flaking, or other damage. Replace as necessary.

(6) Inspect ball return guides, making sure that the ends, where the balls enter and leave the guides, are not damaged.

(7) Inspect lower thrust bearing and races for wear or scoring. Replace if damaged.

#### Valve Assembly Components

(1) If the valve assembly leaks externally between the torsion bar and stub shaft, the entire assembly must be replaced.

(2) Check the pin in the valve body which engages the cap. If it is badly damaged, the entire valve assembly must be replaced.

(3) Check the worm pin groove in the valve body. If the smaller groove is damaged, the entire valve assembly must be replaced.

(4) Check the spool drive pin in the stub shaft. If it is worn badly, cracked, or broken, the entire valve assembly must be replaced.

(5) Examine the spool OD for nicks and burrs. If any are found, they may be removed with a very fine hone. A slight polishing is normal on the valving surfaces.

(6) Examine the valve body ID for nicks or burrs. If any are found, they can be removed with light crocus cloth until the spool turns freely in the body. Be careful not to remove any stock from the surface of the body. As on the spool, a slight polishing is normal on the valving surfaces.

#### Pitman Shaft, End Cover and Bearings

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

(2) Check the pitman shaft sector teeth and the bearing and seal surfaces. If badly worn, pitted, or scored, replace the pitman shaft gear assembly.

(3) Inspect needle bearings for rough or catching operation, scored or worn rollers, distorted cases, or other damage. Replace faulty needle bearing.

## Assembly

### Rack-Piston and Wormshaft

**NOTE:** Thoroughly lubricate all internal parts with automatic transmission fluid during reassembly. Prevent entry of dirt into the assembly.

(1) Lubricate a new back-up O-ring seal with automatic transmission fluid. Assemble the seal in the piston ring groove on rack-piston nut (fig. 11-72).

(2) Install new piston ring in the ring groove over the O-ring seal by carefully slipping the ring over the rack-piston.

**NOTE:** The ring may be slightly loose after assembly. This is normal and it will tighten when subjected to the hot oil in the system.

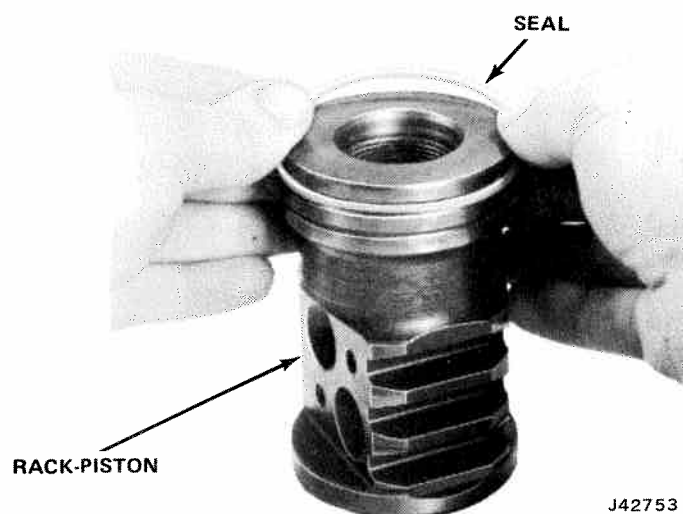


Fig. 11-72 Assembling Seal on Rack-Piston Nut

(3) Insert the worm shaft into rack-piston nut-to-bearing shoulder as shown in figure 11-73.

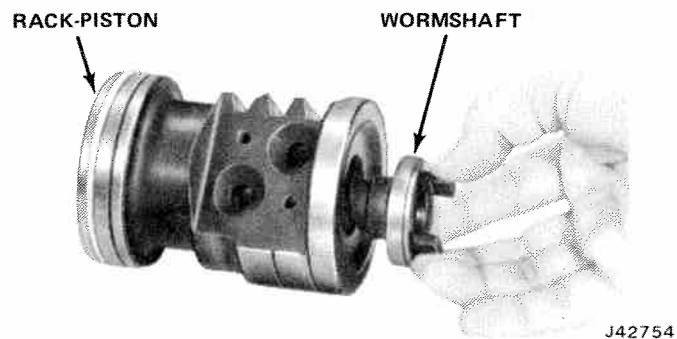
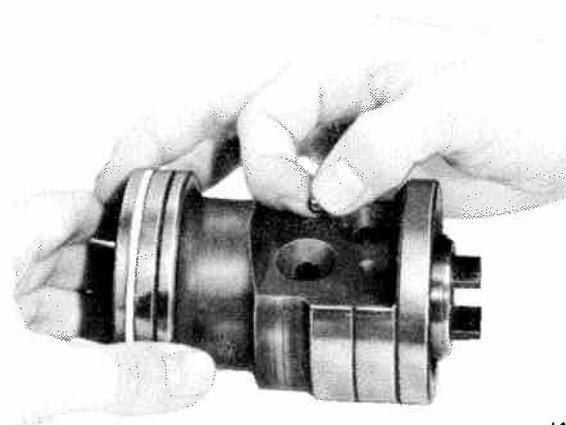


Fig. 11-73 Inserting Worm Shaft In Rack-Piston Nut

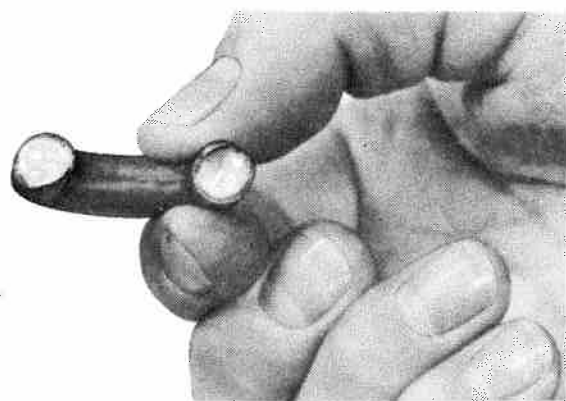
(4) Align the ball return guide holes with worm groove. Load 16 balls into guide hole nearest piston ring, while slowly rotating worm counterclockwise to feed balls through the circuit (fig. 11-74). Alternate black balls with standard balls.



J42755

Fig. 11-74 Inserting Balls in Rack-Piston Nut

(5) Fill one of the ball return guides with the remaining balls. Place the other guide over the balls and plug ends with petrolatum (fig. 11-75) to prevent balls from falling out when installing guide into the rack piston nut.



J42756

Fig. 11-75 Ball Return Guides Plugged With Grease

(6) Insert guides into guide holes of rack-piston nut as shown in figure 11-76. Guides should fit loosely.



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Fig. 11-76 Installing Ball Return Guides in Rack-Piston Nut



(7) Place return guide clamp over the guides and install two screw and lockwasher assemblies and tighten to 8 to 12 foot-pounds.

Do not allow the arbor to separate from the worm until the rack-piston nut is fully on the arbor.

#### Valve Assembly

(1) Lubricate three valve ring backup O-ring seals in automatic transmission fluid (Dexron or equivalent). Assemble in three ring grooves on the valve body.

(2) Assemble the valve rings in the ring grooves over the O-ring seals by carefully slipping the rings over the valve body. Refer to figure 11-77. The rings may appear loose or twisted in the grooves, but the heat of the oil after assembly will cause them to tighten.



J42758

Fig. 11-77 Installing Valve Rings on Valve Body

(3) Install new valve spool damper O-ring seal in valve spool groove.

(4) Lubricate spool valve and valve body with automatic transmission fluid (Dexron or equivalent), and slide spool valve into valve body. Push spool valve on through valve body until shaft pin hole is visible from other end (spool valve flush with shaft cap end of valve body).

(5) Carefully install shaft assembly into spool valve until shaft pin can be placed into spool valve.

(6) Align notch in the shaft cap with the pin in the valve body and press the spool valve and shaft assembly into the valve body.

**CAUTION:** Make sure that shaft cap notch is mated with valve body pin before installing valve body into gear assembly.

(7) Lubricate a new cap-to-worm O-ring seal in automatic transmission fluid (Dexron or equivalent) and install it in valve assembly.

If, during the assembly of valve, the stub shaft and cap assembly are allowed to slip out of engagement with the valve body pin, the spool will be permitted to

enter the valve body too far. The damper O-ring seal will expand into the valve body oil grooves, preventing withdrawal of the spool. Attempt to withdraw the spool with slight pull and much rotary motion. If this does not free the spool after several tries, make sure spool is free to rotate; place valve body on a flat surface with notched end up, and tap spool with wooden or plastic rod until the O-ring seal is cut and the spool can be removed. Replace damper O-ring seal and proceed with assembly as before. Make sure any cut pieces of rubber are removed.

#### Power Steering Gear Subassemblies

(1) Use Pitman Shaft Needle Bearing Tool J-6657 to install the needle bearing in the housing. Install the bearing from the inside of the housing toward the outside. Make sure the identification end is toward the inside of the gear and that the tool is placed against the identification end during installation. Press the bearing into the housing until it clears the shoulder in the gear housing by 0.030 inch.

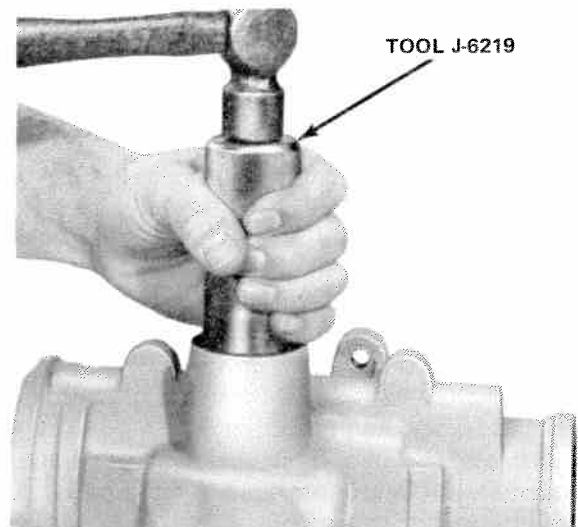
(2) Lubricate new pitman shaft seals with automatic transmission fluid (Dexron or equivalent). Install the single lip seal first, then the backup washer. Refer to figure 11-63.

(3) Use Seal Seating Tool J-6219, as shown in figure 11-78 to seat the seal and washer far enough to provide clearance for the second seal and backup washer. Make sure the seal does not bottom in the counterbore.

(4) Install the double lip seal and second backup washer. Again use Seal Seating Tool J-6219. Make sure both seals are installed with the lips toward the steering gear.

(5) Install the retaining ring.

(6) Assemble the thrust bearings and races on the worm of the assembled worm and valve.



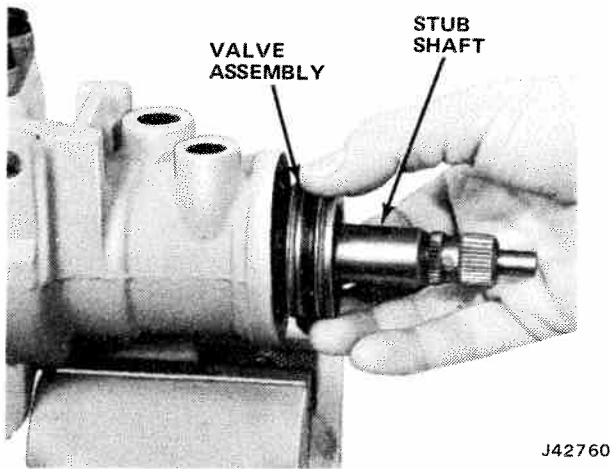
J42759

Fig. 11-78 Seating Pitman Shaft Seal in Housing

**NOTE:** Two types of thrust bearing races may be used. Both conical races must be installed so top of cone is toward bottom of gear. Flat races can be installed in any manner as long as one is above bearing and one below.

(7) Install the assembled valve and worm in the housing as an integral unit. Align the valve body drive pin in the worm with the narrow pin slot on the valve body. Insert the valve assembly into the gear housing as shown in figure 11-79.

**NOTE:** Push only on valve body — NOT on stub shaft.



**Fig. 11-79 Installing Valve Assembly in Housing**

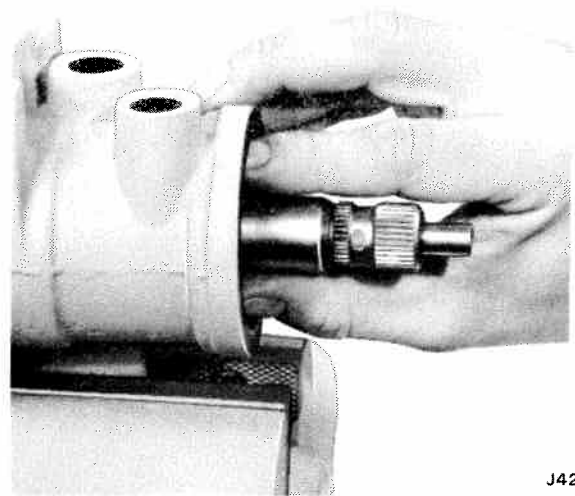
**CAUTION:** Do not push against the stub shaft as this may cause the stub shaft and cap to pull out of the valve body, allowing the spool seal to slip into the valve body oil grooves. The valve assembly should be pushed in by pressing against the valve body with the fingertips (fig. 11-80). Before assembling the adjuster plug assembly, be sure the valve is properly seated. Most of the return hole in the gear housing should be fully visible at this time.

(8) Install needle bearing in adjuster plug by pressing from thrust bearing end of adjuster plug against identification end of bearing, using Tool J-6621 (fig. 11-81). The end of the bearing must be flush with bottom surface of stub shaft seal bore.

(9) Lubricate new stub shaft seal with automatic transmission fluid (Dexron or equivalent), and using Tool J-5188 (fig. 11-82) install far enough to provide clearance for dust seal and retaining ring.

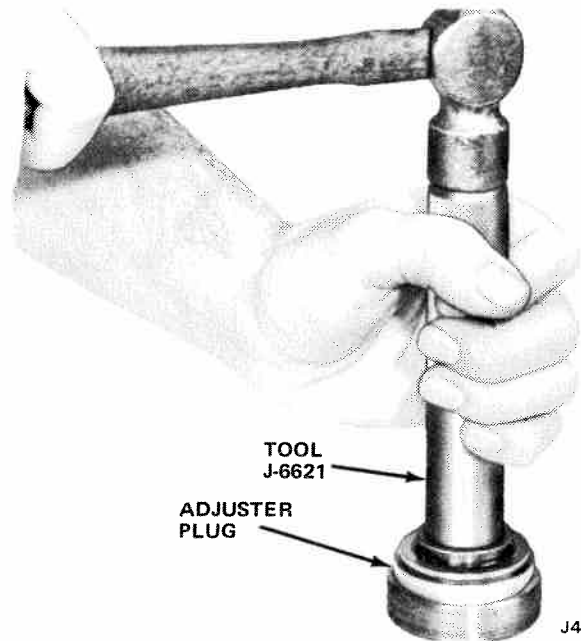
(10) Lubricate the new dust seal with automatic transmission fluid (Dexron or equivalent) and install with the rubber surface outward.

(11) Install the retaining ring, making sure that the ring is properly seated.



J42761

**Fig. 11-80 Installing Valve Assembly Fully into Housing**



J42762

**Fig. 11-81 Installing Needle Bearing in Adjuster Plug**

(12) Lubricate the O-ring seal with Vaseline and install on the adjuster plug.

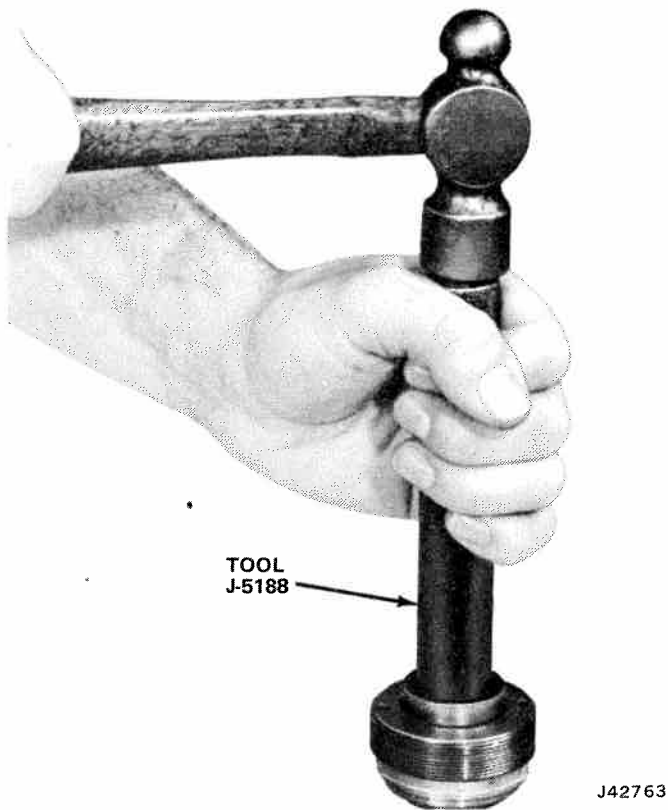
(13) Assemble large OD thrust bearing race, thrust bearing, small thrust bearing race, and thrust bearing spacer on adjuster plug. Do not flatten the dimples. The spacer should rotate freely after assembly. The radial location of dimples is not important.

(14) Install lash adjuster nut on lash adjuster without tightening.

(15) Place Tool J-6222 seal protector over the end of stub shaft.

(16) Install adjuster plug assembly in gear housing. Before adjusting preload, tighten the adjuster plug to 20 foot-pounds torque.

(17) Adjust thrust bearing preload as follows:



**Fig. 11-82** Installing Stub Shaft Seal in Adjuster Plug

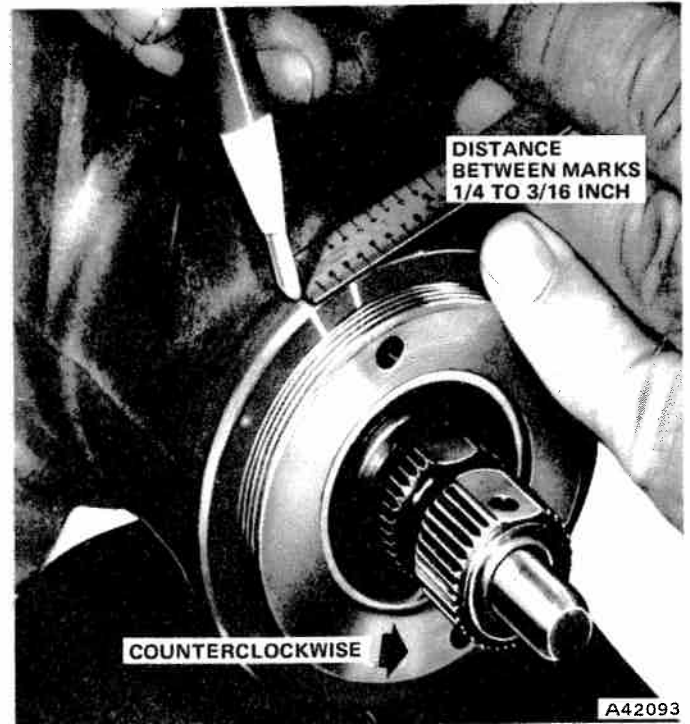
#### With Conical Races

(a) Mark housing opposite one of the holes in adjuster plug (fig. 11-83).

(b) Measure counterclockwise  $\frac{3}{16}$  to  $\frac{1}{4}$  inch and remark housing (fig. 11-84).



**Fig. 11-83** Marking Housing



**Fig. 11-84** Position of Second Mark

(c) Rotate adjuster plug counterclockwise until hole in plug is in line with second mark.

(d) Install and tighten adjuster plug locknut (80 foot-pounds torque) while holding adjuster plug in position.

(e) With an inch-pound torque wrench and a  $\frac{3}{4}$ -inch deep socket, measure drag torque required to turn stub shaft, and record reading (fig. 11-85).

#### With Flat Races

(a) Turn adjuster plug  $\frac{1}{4}$ -turn counterclockwise.

(b) With inch-pound torque wrench and a  $\frac{3}{4}$ -inch deep socket, turn stub shaft and measure valve body drag torque. Record reading (fig. 11-85).

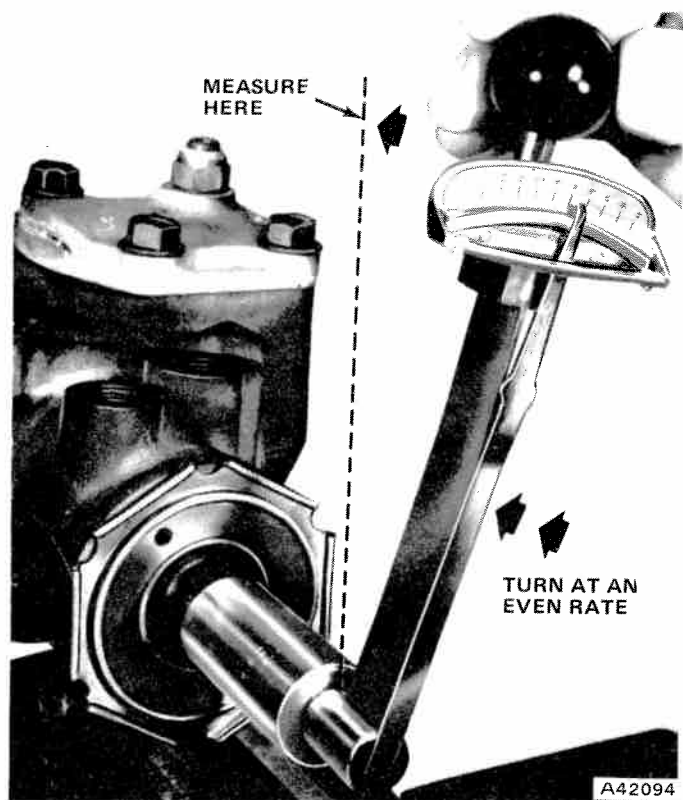
(c) Tighten adjuster plug to obtain 3 to 4 inch-pounds in addition to drag torque noted above.

(d) Tighten adjuster plug locknut securely (80 foot-pounds torque), while holding adjuster plug in position.

(e) Recheck torque and record reading.

**NOTE:** Preload tends to drop when locknut is tightened.

(18) Install Ring Compression Tool J-8947 into gear housing. Hold it tightly against shoulder in housing. Insert rack-piston nut into housing until arbor engages worm. Turn stub shaft clockwise, drawing rack-piston nut into housing. When piston ring is in housing bore, arbor may be withdrawn from rack-piston nut. Remove ring compressor tool. Move rack-piston to center position.



**Fig. 11-85 Drag Torque Measurement**

(19) Install a new rack-piston end plug by inserting a 1/2 inch drive socket extension in square hole of plug. Temporarily install pitman shaft to prevent rack-piston nut from turning. Tighten the plug to 50 to 100 foot-pounds torque.

(20) Lubricate new housing end plug O-ring with automatic transmission fluid Dexron or equivalent and install in gear housing.

(21) Insert end plug into gear housing and seat against O-ring seal. Install end plug retainer ring into place with fingers. It is necessary to install one end of the ring and work the ring into the groove until seated.

**NOTE:** Slight tapping may be required to securely bottom retainer ring in gear housing. When installed, one end of retaining ring must be 1/2 inch from the hole in the body.

(22) Assemble side cover and bushing assembly on pitman shaft gear assembly. Screw lash adjuster through side cover until side cover bottoms on pitman shaft, then back off 1/2 turn. Lubricate new side cover O-ring seal and install in groove in face of side cover. Hold O-ring in place with grease.

(23) Turn stub shaft as necessary until middle rack groove is aligned with center of pitman shaft needle bearing. Install the pitman shaft gear so that center tooth in sector meshes with center groove of rack-piston. Make sure that side cover O-ring is in place before pushing side cover down on gear housing.

(24) Install the side cover screws and lockwashers and tighten to 30 to 45 foot-pounds. Install lash adjuster nut on lash adjuster without tightening.

(25) With gear on center and pitman shaft backed off, measure total drag. With gear on center, adjust pitman shaft thrust screw so that preload is 4 to 8 inch-pounds in excess of total preload and drag (not to exceed 18 inch-pounds). Readings are to be made through an arc not exceeding 20 degrees with gear on center. Tighten locknut 20 to 30 foot-pounds torque.

## POWER STEERING PUMP

### Removal

**NOTE:** It is not necessary to remove the oil pump to service the flow control valve. The flow control valve is retained in the pump housing by a pressure union and filter assembly.

(1) Remove pump drive belt tension adjusting bolt and disconnect belt from pump.

(2) Disconnect return and pressure hoses from pump. Cover the hose connector and union on pump and open ends of the hoses to avoid entrance of dirt.

(3) On V-8, remove front bracket from engine.

(4) Remove two nuts securing rear of pump to bracket, and two bolts securing front of pump to bracket and remove pump.

### Pump Shaft Seal Replacement (Pump Assembled)

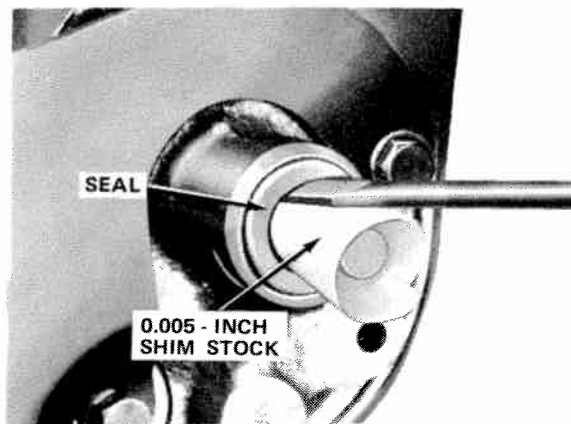
(1) Remove pump pulley nut.

(2) Remove pump drive belt from pulley.

(3) Remove pulley from pump using a suitable puller. **Do not hammer pulley off shaft.**

(4) Remove pulley drive key from shaft.

(5) Insert a piece of 0.005-inch shim stock (approximately 2-1/2 inches long) around shaft and push it past seal until it bottoms in pump housing (fig. 11-86).



J42764

**Fig. 11-86 Removing Oil Seal**

(6) Remove seal by cutting metal body of seal with a sharp tool and prying out. **Extreme care must be used to prevent damage to shaft and pump housing.**

(7) Place seal protector J-7586-01 over shaft.

(8) Lubricate new seal with power steering oil and drive in pump housing, spring side first, with installer J-7728 (fig. 11-87). Adjust bottom seal in housing. Excessive force must not be used when driving seal in place.

(9) Install pulley drive key in shaft.

(10) Install pulley and drive belt.

(11) Adjust belt tension to proper specification.

(12) Fill pump reservoir to proper level with power steering oil and bleed pump.



J42765

Fig. 11-87 Installing Oil Pump Shaft Seal

### Pump Disassembly

(1) Using masking tape, cover the hose union and pipe on pump and then thoroughly clean exterior of pump.

(2) Remove pump pulley key from pump shaft.

(3) Remove reservoir cap and drain out oil in pump reservoir.

(4) Install pump in a soft jaw vise with pump shaft pointing down.

**CAUTION:** Do not clamp pump too tightly in vise as this may distort bushing.

(5) Remove two reservoir to pump housing studs and O-rings. Discard the O-rings.

(6) Remove pressure union. Remove O-ring from union and discard O-ring.

(7) Remove flow control valve and spring.

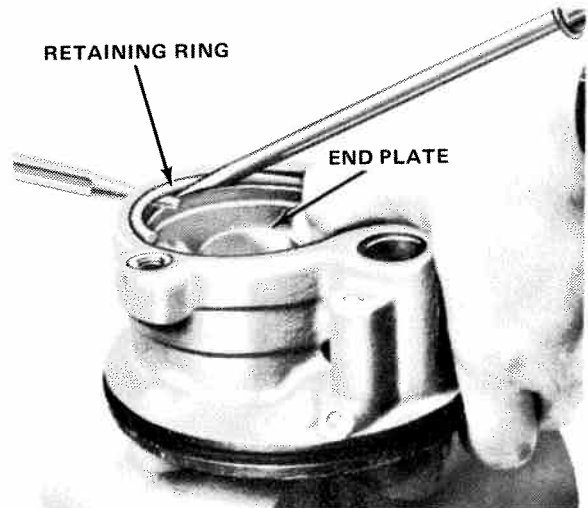
(8) Remove reservoir from housing by rocking housing back and forth while pulling upward.

(9) Remove reservoir O-ring seal on housing and discard.

(10) Remove small reservoir to housing O-ring seal from counterbore in housing and discard.

(11) Rotate end plate retaining ring until one end of ring is over hole in housing. Spring inward on one end of ring with 1/8-inch punch to allow screwdriver to be inserted and lift ring out (fig. 11-88).

(12) Remove pump from vise and remove end plate, pressure plate spring, flow control valve and spring by turning pump over. If end plate should stick in housing, lightly tap it to align and free it.



J42766

Fig. 11-88 End Plate Retaining Ring Removal

**NOTE:** Do not disassemble control valve.

(13) Remove and discard end plate O-ring seal.

(14) Place shaft end on bench and press down on housing until shaft is free.

(15) Turn housing over and remove shaft and rotor assembly, being careful not to drop parts. If the two dowel pins did not come out with assembly, remove dowel pins from housing.

(16) If it is desired to disassemble the shaft and rotor assembly use a screwdriver to remove retainer ring (fig. 11-89).

(17) Remove and discard pressure plate O-ring seal.

(18) Remove shaft seal, if defective, by prying out with small screwdriver.



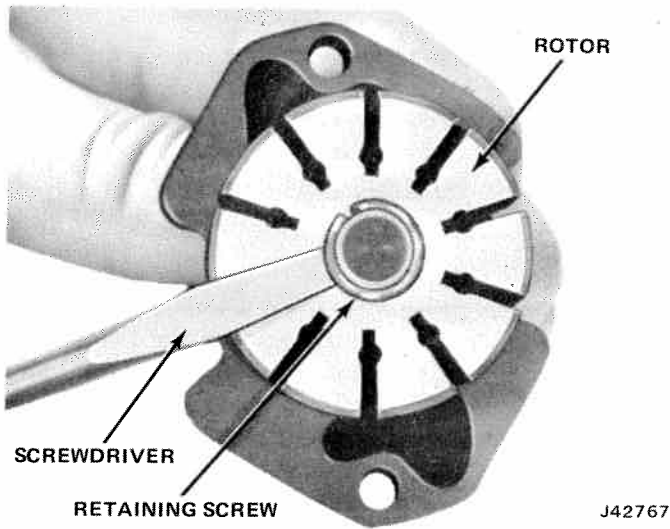


Fig. 11-89 Rotor Retaining Ring Removal

### Power Steering Pump Inspection

Clean all parts thoroughly with solvent and wipe with clean, lint-free cloth before inspecting.

Inspect shaft for wear.

Check fit of the ten vanes in slots of rotor; vanes must slide freely but fit snugly in slots. Tightness may be removed by thorough cleaning or removal of irregularities using a hard Arkansas stone. Replace rotor if excessive looseness exists between rotor and vanes and replace vanes if they are irregularly worn or scored. Light scoring on the rotor can be repaired by carefully lapping surface of rotor.

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 badly scored or worn and inspect outside radius of vanes very closely for damage.

Inspect the surfaces of the pressure plate and thrust plate for wear or scoring. Light scoring can be repaired by carefully lapping until surface is smooth and flat,

after which all lapping compound must be thoroughly washed away.

Inspect the flow control valve bore in the housing for scoring, burrs or other damage. Hair-line scratches are normal. Inspect bushing in housing, if worn or scored, replace housing.

Inspect the surfaces of the flow control valve for cores and burrs. Hair-line scratches are normal. Replace valve if badly scored or if it is the cause of low pump pressure. Check the screw in the end of the valve; if loose, tighten being careful not to damage machined surfaces. Filter in end of screw must be clean.

Check orifice in pressure union to be sure it is not plugged.

### Power Steering Pump Assembly

Refer to figure 11-90.

(1) Make sure all parts are absolutely clean. Lubricate seals and moving parts with power steering oil during assembly.

(2) If shaft seal was removed, use installer J-7017 to drive new seal into housing with spring side of seal toward housing (fig. 11-91). Adjust bottom seal in housing.

(3) Mount housing in vise with shaft end down. Install new pressure plate O-ring seal in groove in housing bore.

(4) Insert shaft into housing and press down with thumb on splined end to properly seat shaft. Be careful not to damage shaft seal in housing.

(5) Install the two dowel pins in housing and install thrust plate on the pins with ported face of plate to rear of housing.

(6) Install pump ring with small holes in ring on dowel pins and with arrow on outer edge to rear of housing.

(7) Install rotor on pump shaft with spline side of rotor to rear of housing. Rotor must be free on shaft splines.

(8) Install shaft retaining ring on pump shaft.

(9) Install ten vanes in rotor slots with radius edge toward outside and flat edge toward center of rotor.

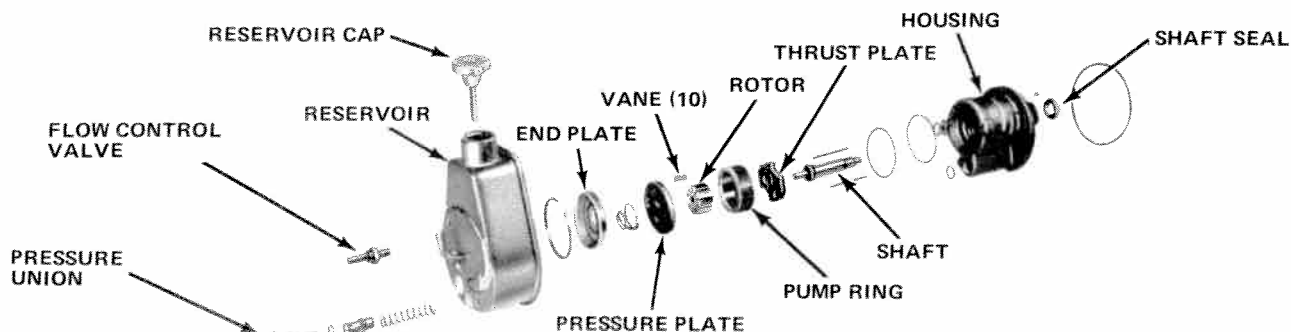
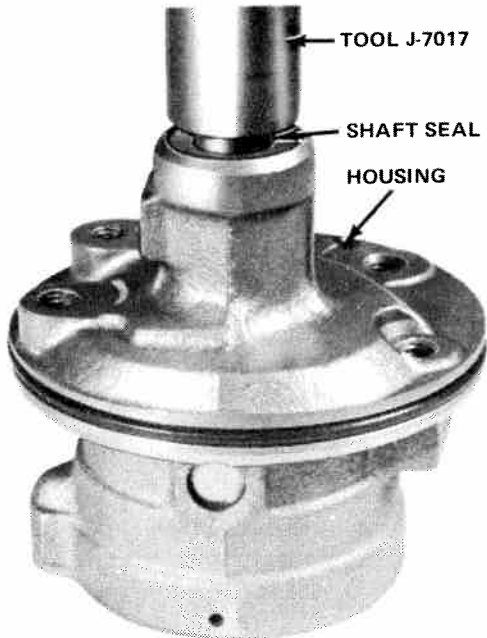


Fig. 11-90 Power Steering Oil Pump



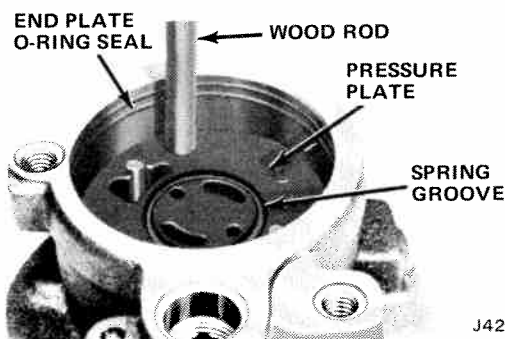
(10) Lubricate the outside diameter and chamfer of pressure plate with petrolatum and install on dowel pins with ported face toward rotor. Dowel pins fit into slots in plate that are nearest outside diameter of plate. Use a soft plastic or wood rod and lightly tap around outside diameter of pressure plate to seat it.

Pressure plate will travel about 1/16 inch to seat.



J42769

Fig. 11-91 Installing Pump Shaft Seal



J42770

Fig. 11-92 Seating Pressure Plate in Housing

**CAUTION:** Never press or hammer on the center of pressure plate as this will cause permanent distortion and result in pump failure.

(11) Install new end plate O-ring seal in groove in bore of housing. Be sure not to install it in end plate retaining ring groove which is first groove from rear of housing (fig. 11-92).

(12) Install the pressure plate spring.

(13) Lubricate outside diameter and chamfer of end plate with petrolatum and insert in housing.

(14) Place end plate retaining ring on top of end plate. Use an arbor press to lower end plate into housing until ring groove in housing is evenly exposed. Be sure ring is completely seated in housing groove and end plate is aligned properly.

**CAUTION:** Press end plate into housing only far enough to install retaining ring in groove.

(15) Install new reservoir O-ring seal on housing.

(16) Place pressure union seal and two stud seals in proper counterbores on rear of housing.

(17) Install reservoir on housing and line up holes for studs. Tap reservoir with a soft mallet to seat it on housing and install reservoir to housing studs with short end of stud in housing. Tighten studs to 35 foot-pounds torque.

(18) Install flow control valve spring in housing, then install flow control valve with hex head of valve going in housing first. Check movement of valve.

(19) Assemble new O-ring in groove nearest outlet end of pressure union. Install union in pump and torque 35 foot-pounds.

**CAUTION:** If O-ring is installed in groove on pressure union that contains the flow orifice, pump will not build up pressure.

(20) Remove pump from vise and install shaft key on shaft. Support shaft on opposite side while installing key.

(21) Check for bind in pump by rotating drive shaft. Shaft must rotate freely by hand.

### Power Steering Pump Installation

(1) Position pump in bracket and install rear attaching screws.

(2) On V-8, install front bracket.

(3) Connect hydraulic hoses.

(4) Fill reservoir with automatic transmission fluid (Dexron or equivalent).

(5) Bleed air from pump by turning pulley counterclockwise (viewed from front) until bubbles cease to appear.

(6) Install new pulley nut.

(7) Install drive belt on pulley.

(8) Using a 1-5/8-inch open-end wrench on pump housing boss, pull outward on pump to adjust belt tension, and snug pump attaching nuts.

(9) Check belt tension with Gauge J-23600. Refer to Specifications for desired belt tension.

(10) Tighten pump nuts to 30 foot-pounds torque and pulley nut to 60 foot-pounds torque.

(11) Tighten pump bracket nuts.

(12) Install and adjust air pump belt.

**NOTE:** If pump or gear has been disassembled, refer to Fluid Level and Initial Operation.



## Fluid Level and Initial Operation

- (1) Replenish reservoir.
- (2) Run engine until power steering fluid reaches normal operating temperature, approximately 170°F, then shut engine off. Remove reservoir filler cap and check oil level on dipstick.
- (3) If oil level is low, add power steering fluid to proper level on dipstick and replace filler cap. When checking fluid level after the steering system has been serviced, air must be bled from system. Proceed as follows:
  - (a) With wheels turned full left, add power steering fluid to Cold mark on dipstick.
  - (b) Start engine, and running at fast idle, recheck fluid level. Add fluid if necessary to Cold mark on dipstick.
  - (c) Bleed system by turning wheels from side to side without hitting stops. Maintain fluid level just above pump housing. Fluid with air in it will have a light tan or red appearance. Air must be eliminated from fluid before normal steering action can be obtained.
  - (d) Return wheels to center position and continue to run engine for two or three minutes, then shut engine off.
  - (e) Road-test car to make sure steering functions normally and is free from noise.
  - (f) Recheck fluid level as described in steps (2) and (3) making sure fluid level is at Hot mark on dipstick after system has stabilized at its normal operating temperature.

## Oil Pump Pressure Check

- (1) Disconnect the pressure line at oil pump. Attach pressure gauge to pump. Connect the hose to end of gauge where the valve is located.

- (2) With engine at hot 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.

**CAUTION:** *Holding wheel in extreme position for more than five seconds 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 1000 psi for satisfactory power steering operation.

- (4) If the maximum oil pressure is less than 1000 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 only with the engine at warm idle, then open the valve to avoid increasing oil temperature. A minimum pressure of 1000 psi should be present with valve closed.

- (5) Compare the maximum pressure obtained in these two tests to determine source of trouble as follows: Step (2) pressure low and Step (4) pressure normal indicates faulty external oil lines or steering gear. Step (2) and Step (4) pressures equally low indicate faulty oil pump.

## SPECIFICATIONS

### POWER STEERING GEAR SPECIFICATIONS

Type .....	Recirculating Ball, Worm and Nut
Ratio .....	CJ - 17.5:1 Constant Ratio-All Others 13/16:1 Variable Ratio
Bearings:	
Worm - Upper .....	Ball
Lower .....	Ball
Pitman Shaft .....	Bushing

#### Torque:

Pitman Arm to Pitman Shaft .....	160 to 210 foot-pounds
Adjuster Plug Locknut .....	50 to 110 foot-pounds
Pitman Shaft Lash-Adjuster Locknut .....	27 to 37 foot-pounds
Pressure and Return Hose Fittings .....	25 to 35 foot-pounds
Rack-Piston Plug .....	50 to 100 foot-pounds
Return Guide Clamp Screws .....	3 to 6 foot-pounds
Side Cover Bolts .....	30 to 45 foot-pounds
Steering System Oil Capacity (Dry) .....	1¼ quarts

### POWER STEERING PUMP SPECIFICATIONS

Capacity at 465 rpm .....	1.25 gpm
Flow Control Range .....	1.25 to 2.15 gpm
Relief Valve Setting - (V8) .....	1100 to 1200 psi
(Six-Cylinder) .....	1000 to 1100 psi

## SPECIFICATIONS (Continued)

### ENGINE DRIVE BELT TENSION

	Initial Pounds New Belt	Reset Pounds Used Belt
Air Conditioner, Six-Cylinder .....	125 to 155	90 to 115
Air Conditioner, V-8 .....	125 to 155	105 to 130
Air Pump (All except Six-Cylinder w/AC) .....	125 to 155	90 to 115
Air Pump Six-Cylinder w/AC (1/4 inch belt) .....	40 to 50	35 to 45
Fan .....	125 to 155	90 to 115
Idler Pulley .....	125 to 155	90 to 115
Power Steering Pump .....	125 to 155	90 to 115

### MANUAL STEERING GEAR SPECIFICATIONS

#### Left-Hand Drive Vehicles:

Type .....	Recirculating Ball
Ratio .....	24:1
Bearings - Upper .....	Ball
Lower .....	Ball
Pitman Shaft .....	Bushing

#### Torque:

Worm Bearing Adjuster Nut .....	8 inch-pounds
Pitman Shaft Adjuster Screw .....	18 inch-pounds
Cover Bolts .....	25-35 foot-pounds
Pitman Shaft Lash-Adjustment Locknut .....	18-27 foot-pounds
Worm Thrust-Adjustment Locknut .....	70-110 foot-pounds

#### Right-Hand Drive Vehicles:

Type .....	Cam and Lever
Ratio .....	24:1
Bearings - Upper .....	Ball
Lower .....	Ball
Lever Shaft .....	Roller and Bushing

#### Torque:

Cam Bearing Preload .....	2 to 5 inch-pounds
Input Torque Over Center (Maximum) .....	7 to 12 inch-pounds
Cover to Housing Cap Screws .....	18 to 20 foot-pounds
Flexible Coupling to Flange .....	15 to 20 foot-pounds
Worm Gear Shaft Locknut .....	16 to 20 foot-pounds

## SPECIFICATIONS (Continued)

## WHEEL ALIGNMENT SPECIFICATIONS

Steering Axis Inclination .....	8 1/2°
Caster	
CJ .....	+3° ± 1°
Cherokee, Wagoneer, and Truck .....	+4° ± 1°
Camber .....	+1-1/2° ± 1/2°
Toe-In .....	3/64 to 3/32 inch
Turning Angle	
CJ	
With Standard Tires .....	31°
With F78 x 15 Tires .....	34°
Cherokee, Wagoneer, and Truck .....	37 to 38°

## TORQUE SPECIFICATIONS

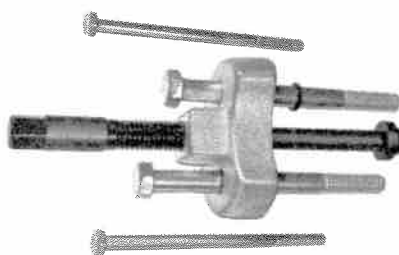
Part Name	Foot-Pounds
Clamp bolt, flexible coupling, intermediate shaft to power steering gear 3/8-24 .....	25-35
Clamp, intermediate shaft to steering gear .....	40-50
Clamp, shaft U-joint, upper shaft assembly to lower shaft assembly .....	45-55
Column capsule bracket to column bolt .....	12-17
Column capsule bracket to instrument panel nut to support rod .....	15-25
Connecting rod 5/8-18 (to castellated nut slot) .....	70 min.
Connecting rod clamp bolts (Cherokee-Wagoneer-Truck) .....	25-35
Connecting rod stud nuts 9/16-18 (Cherokee-Wagoneer-Truck) (to castellated nut slot) .....	60 min.
Intermediate shaft to steering gear coupling (power steering) 3/8-24, 5/16-24 .....	15-25
Pitman arm to pitman shaft .....	160-210
Steering bracket to frame 3/8-16 bolt (CJ) .....	35-45
Steering bracket to frame bolt and nut 7/16-20 (CJ) .....	60-70
Steering bracket to frame 7/16-20 (Cherokee-Wagoneer-Truck) .....	60-80
Steering gear to bracket - all models .....	60-80
Steering wheel nut (CJ) .....	32-38
Steering wheel nut (Cherokee-Wagoneer-Truck) .....	15-25
Tie-rod clamp bolt 5/16-24 (CJ) .....	10-15
Tie-rod clamp bolt 3/8-24 (CJ) .....	20-30
Tie-rod clamp bolt 7/16-14 (Cherokee-Wagoneer-Truck) .....	25-35
Tie-rod stud nuts 1/2-20 (CJ) (to castellated nut slot) .....	40 min.
Tie-rod stud nuts (to castellated nut slot) .....	60 min.
Wheel to hub nuts (CJ) .....	90-115
Wheel to hub nuts (Cherokee-Wagoneer-Truck Models 25 and 45) .....	65-80
Wheel to hub nuts (Model 46 Truck) .....	100-150



J-25194 THRUST BEARING  
ADJUSTER WRENCH  
(2 - 3/4" X 3 - 1/4")



J-23074 STEERING  
COLUMN HOLDING  
FIXTURE



J-25115 STEERING WHEEL PULLER



J-25163 STEERING  
WHEEL PULLER



J-8947 PISTON INSTALLER  
(POWER STEERING)



C-3780 WORM SHAFT BEARING  
CUP REMOVER (MANUAL STEERING)



J-7624 ADJUSTER  
PLUG ADJUSTABLE  
SPANNER WRENCH



J-6217 OIL LINE CONNECTOR  
(POWER STEERING)



J-7754 TORQUE WRENCH  
(0 - 25 INCH POUNDS)



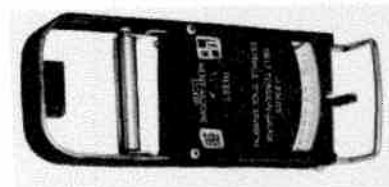
C-3777 WORM SHAFT BEARING CUP  
INSTALLER (MANUAL STEERING)



J-7539-01 RACK PISTON BALLS  
RETAINING ARBOR  
(POWER STEERING)



J-1614 PITMAN SHAFT BUSHING  
REMOVER AND INSTALLER



J-23600 BELT TENSION GAUGE



J-7171 PITMAN  
SHAFT OIL SEAL  
INSTALLER



J-5787 PITMAN  
SHAFT OIL SEAL  
PROTECTOR



C-3915 SNAP RING  
PLIERS (INTERNAL)



J-7017 WORM SHAFT UPPER  
OIL SEAL INSTALLER



J-5188  
ADJUSTER PLUG  
OIL SEAL INSTALLER



J-23653 LOCK PLATE  
COMPRESSOR AND  
SNAP RING INSTALLER



J-6657 PITMAN SHAFT  
NEEDLE BEARING REMOVER  
AND INSTALLER



J-6219 PITMAN  
SHAFT OIL SEAL  
INSTALLER



J-6222 ADJUSTER  
PLUG OIL SEAL  
PROTECTOR



J-1586-01 PUMP  
SHAFT OIL SEAL  
PROTECTOR



J-23073 SHIFT  
TUBE INSTALLER



J-23072 SHIFT  
TUBE REMOVER



J-21854-1 PIVOT  
PIN PULLER

J42771

Fig. 11-93 Steering Tools

# TECHNICAL SERVICE LETTER REFERENCE

[illegible]