# MANUAL STEERING GEAR

## CONTENTS



## DESCRIPTION AND OPERATION

### DESCRIPTION OF MANUAL STEERING GEAR

The steering gear is of the recirculating ball worm and nut type. The worm is located on the lower end of the steering shaft. The ball nut is mounted on the worm and has mating spiral grooves in which steel balls circulate to provide a low-friction drive between worm and nut (See Figure 3E-1).

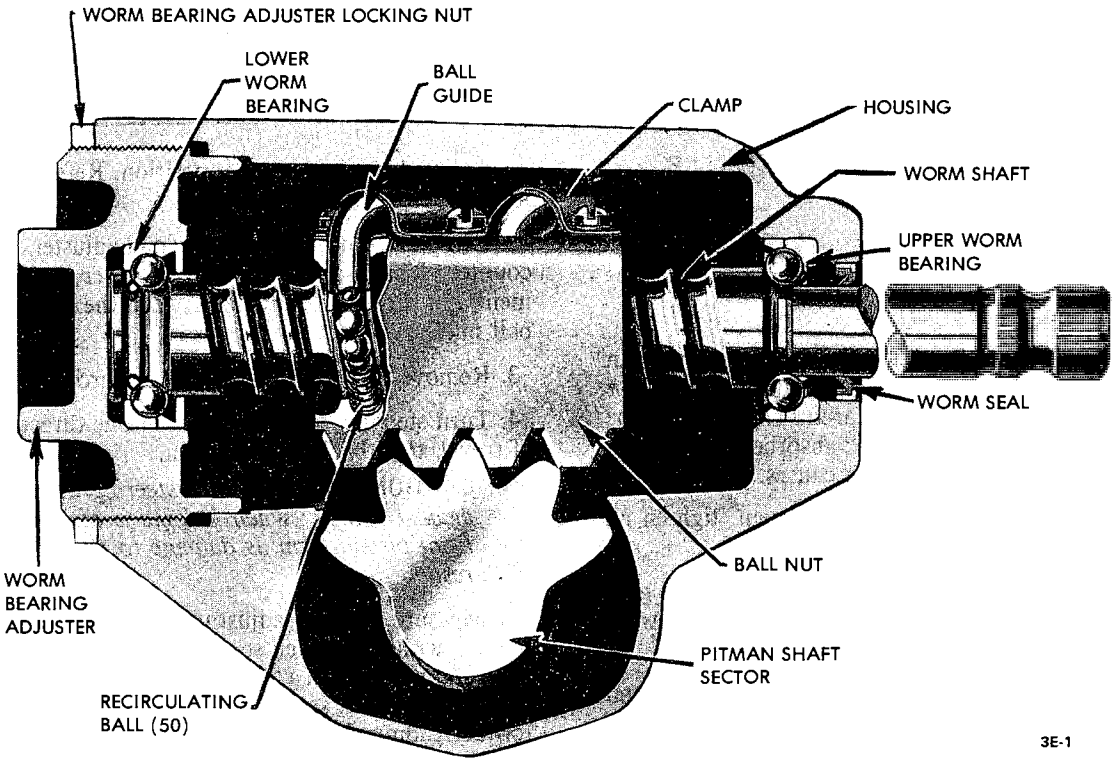


Figure 3E-1 - Steering Gear Worm and Ball Nut

Teeth on the ball nut engage teeth on the pitman shaft sector. The teeth on the ball nut are made so that a "high point" or tighter fit exists between the ball nut and pitman shaft sector teeth when front wheels are in the straight-ahead position. The sector teeth are slightly tapered so that a proper lash may be obtained by moving the pitman shaft endways by means of a lash adjuster screw which extends through the gear housing side cover. The head of the lash adjuster and a selectively fitted shim fit snugly into a T-slot in the end of the pitman shaft, so that the screw also controls end play of shaft. See Figure 3E-2.

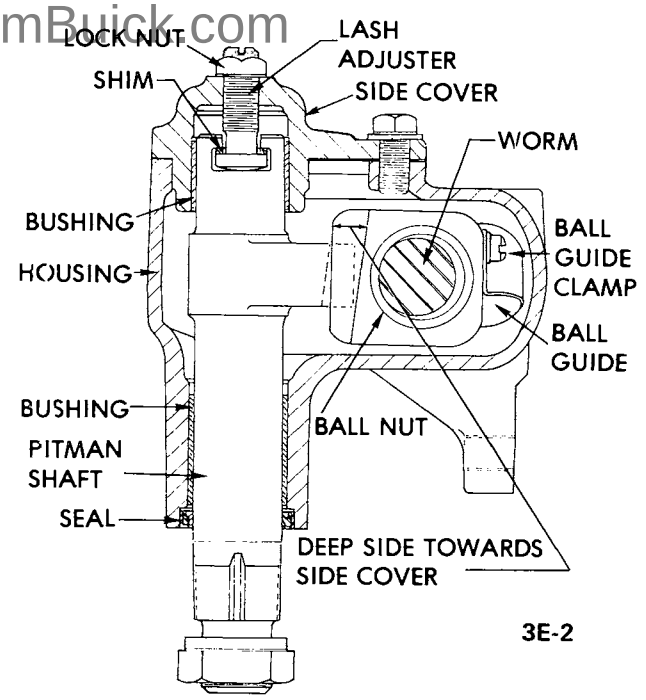


Figure 3E-2 Steering Gear - Sectional View

## DIAGNOSIS

### MANUAL STEERING GEAR DIAGNOSIS

| Condition | Test or Inspection Procedure |
|---|---|
| Steering gear loose on frame. | Visually obsere the gear while shaking it or while operating the steering wheel. If the gear is loose, properly attach the gear to the frame and torque to specifications. |
| Incorrect steering gear adjustment. | Both adjustments are checked with the gear in or out of the car as outlined in the Maintenance and Adjustments or Major Repair Sections. |

## MAINTENANCE AND ADJUSTMENTS

### IN CAR GEAR ADJUSTMENT

The steering gear assembly is designed to provide adjustment to compensate for normal wear at worm bearings, pitman shaft, and mating parts.

Before adjustments are made to the steering gear in an attempt to correct such conditions as shimmy, loose or hard steering and road shocks, a careful check should be made of front end alignment, shock absorbers, wheel balance, and tire pressure for possible causes.

Before making any steering gear adjustment, tighten all mounting bolts to torque specifications.

Procedures for checking and adjusting the steering gear must be performed in sequence given in the following paragraphs:

Always check worm bearing preload adjustment first, and adjust if necessary, before making pitman shaft preload adjustment.

#### Checking Worm Bearing Adjustment

1. Disconnect pitman arm from steering gear. Note relative position of linkage and pitman arm so parts may be reassembled in same relative position. Refer to "Steering Linkage" for correct procedures.

2. Loosen lock nut and turn preload adjuster a few turns counter clockwise to relieve over center preload adjustment and provide clearance between the sector gear and ball nut.

3. Remove the horn button cap or shroud.

4. Turn steering wheel **GENTLY** in one direction to end of travel, then back one full turn.

**CAUTION:** *DO NOT turn steering wheel hard against "stops" when linkage is disconnected from pitman arm as damage to the gear may result.*

5. Measure bearing adjustment by applying a torque wrench with a 3/4 inch socket on the steering wheel nut and rotating through a 90° arc. If worm bearings are properly adjusted and steering column bearings are free, the torque reading should be between 5 and 8 inch-lbs.

Do not use a torque wrench having a maximum torque reading of more than 50 inch pounds. If torque reading is not within above specification, worm bearings require adjustment. If "rough" or "lumpy" action is noted during

check, worm bearings are probably damaged. Steering gear should then be removed from vehicle, disassembled and bearings examined. If bearings do not require adjustment, proceed to adjust pitman shaft preload as described. If bearings need adjustment, proceed in the following manner.

### Worm Bearing Adjustment

1. Loosen adjuster lock nut and turn worm bearing adjuster plug clockwise until there is no perceptible end play in the worm.

2. Using torque wrench check the steering wheel torque as outlined previously. Turn adjuster plug until a torque of 5-8 inch pounds is obtained.

3. Tighten adjuster plug lock nut to specified torque.

4. Recheck worm bearing preload adjustment to make sure that it remains within specification after lock nut is tightened.

5. Readjust if necessary.

### Pitman Shaft Preload Adjustment

**CAUTION:** *DO NOT turn steering wheel hard against "stops" when linkage is disconnected from pitman arm as damage to the gear may result.*

1. Center steering gear by turning steering wheel from extreme right to extreme left positions, counting the exact number of turns. Turn wheel back exactly half-way, to center position. Mark wheel at top or bottom center with a piece of tape.

2. Loosen preload adjuster lock nut and turn adjuster clockwise to remove all lash between gear teeth. Tighten lock nut to 25-35 foot-pounds torque, then check steering wheel torque as outlined previously. Measure greatest torque as wheel is pulled through center position.

Torque should be 12 to 16 inch-pounds after lock nut is tightened.

3. If torque is not within specified limits, loosen lock nut and turn adjuster to obtain proper adjustment.

4. After all adjustments have been completed, reconnect pitman arm to steering gear.

## MAJOR REPAIR

### REMOVAL AND INSTALLATION OF MANUAL GEAR ASSEMBLY

#### Removal

1. Remove the flex coupling shield.

2. Remove the pinch bolt securing flexible coupling flange to steering gear stub shaft.

3. Remove pitman arm retaining nut and remove pitman arm from gear using Puller J-5504. When removing pitman arm from pitman shaft, do not hammer on end of puller as damage will result to gear. If necessary, tapping on side of pitman arm may help in removing arm.

4. Remove the steering gear to frame bolts and remove gear asssembly.

#### Installation

**CAUTION:** *Fasteners in steps 1, 2, and 3 are important attaching parts in that they could affect the performance of vital components and systems, and/or could result in major repair expense. They must be replaced with one of the same part number or with an equivalent part if replacement becomes necessary. Do not use a replacement part of lesser quality or substitute design. Torque values must be used as specified during reassembly to assure proper retention of these parts.*

Be sure to reinstall coupling flange so that tab on coupling flange is aligned with mark on gear stub shaft. See Figure 3E-3.

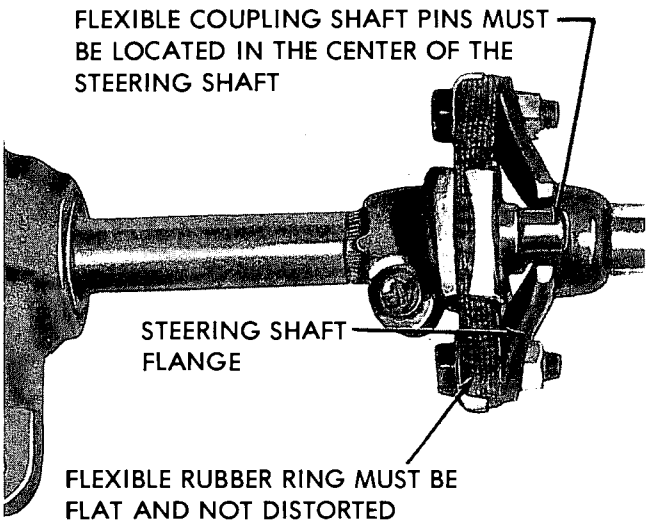


Figure 3E-3 Steering Gear Flexible Coupling Installation

1. Align flexible coupling flange to steering gear stub shaft and install gear assembly to frame. Tighten gear to frame bolts to specifications.

2. Install pinch bolt in flange and tighten to specifications. Install flex coupling shield if equipped.

3. Reconnect pitman arm to pitman shaft and torque pitman arm retaining nut to specifications.

### DISASSEMBLY OF GEAR

As with any ball bearing unit the steering gear parts must be kept free of dirt. Clean paper or rags should be spread on the workbench before starting disassembly of the steering gear.

1. Place the steering gear in a vise, clamping onto one of the mounting tabs. The wormshaft should be in a horizontal position.

2. Rotate the wormshaft from stop to stop, counting the total number of turns. Then turn back exactly half way, placing the gear on center.

3. Remove the three self locking bolts attaching the side cover to the housing.

4. Tap lightly on the end of the pitman shaft with a plastic hammer and lift the side cover and pitman shaft assembly from the gear housing (figure 3E-4).

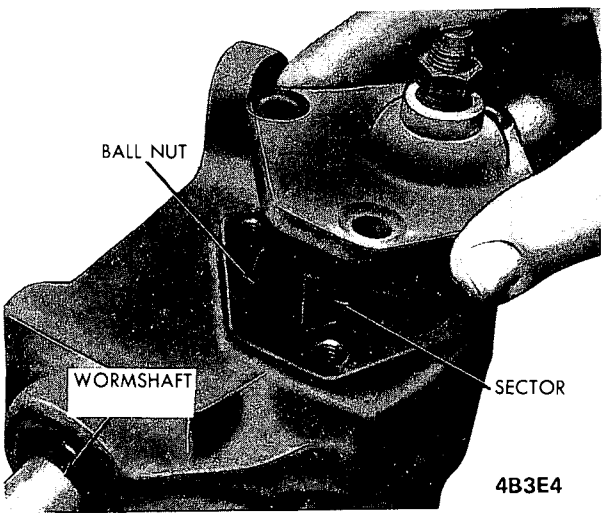


Figure 3E-4 Removing Pitman Shaft Assembly

If the pitman shaft sector does not clear the opening in the housing easily, *turn* the wormshaft by hand until the sector will pass through the opening in the housing.

5. Loosen and remove the adjuster plug lock nut. Remove plug assembly taking care not to drop the worm thrust bearing if it comes out with the assembly.

6. Draw the wormshaft and ball nut assembly from housing (figure 3E-5).

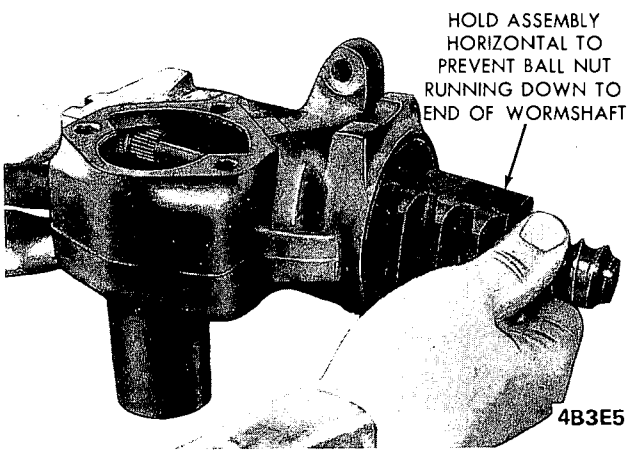


Figure 3E-5 Removing the Wormshaft and Ball Nut

Use care that the ball nut does not run down to either end of the worm. Damage may be done to the ends of the ball guides if the ball nut is allowed to rotate until stopped at the end of the worm.

7. Remove the remaining worm thrust bearing from either the wormshaft or from inside the gear housing.

8. Where applicable use a suitable size screw driver to pry the lower bearing retainer from the adjuster plug housing and remove the bearing (figure 3E-6).

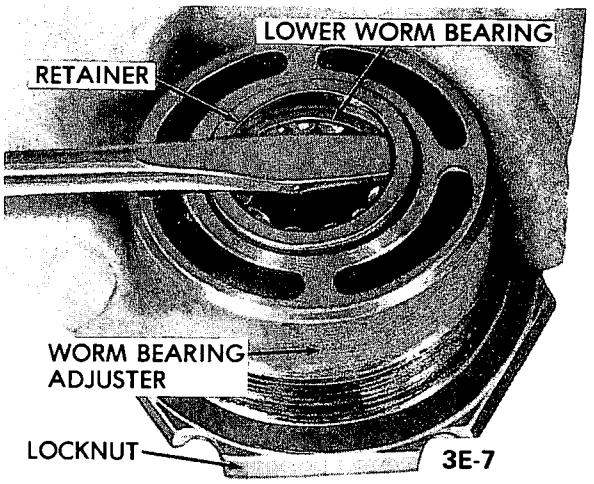


Figure 3E-6 Removing Lower Worm Bearing Retainer

9. Remove the lock nut from the preload adjuster screw in the side cover. Remove the preload adjuster screw from the side cover by turning the screw clockwise. Slide the adjuster screw and shim out of the slot in the end of the pitman shaft.

10. Pry out and discard both the pitman shaft and wormshaft seals.

### Inspection

With the steering gear completely disassembled, wash all parts in cleaning solvent. Dry them thoroughly with air. With a magnifying glass inspect the bearings and bearing races for signs of indentation. Also check for any signs of chipping or breakdown of the surface. Any parts that show signs of damage should be replaced.

Inspect all seals. Any seal that is worn or has been removed should be replaced.

Inspect fit of pitman shaft in bushings in side cover and housing. If these bushings are worn, a new side cover and bushing assembly or housing bushing should be installed.

Check steering gear wormshaft assembly for being bent or damaged in any way. NEVER ATTEMPT TO SALVAGE STEERING PARTS BY WELDING OR STRAIGHTENING!

### Repairs

The double lipped pitman shaft and wormshaft seals should be replaced each time a bad seal is indicated or the steering gear is disassembled.

1. Pry out the old seal using a suitable size screw driver.

Before installing a new seal, check the condition of the pitman shaft bushing(s) and the wormshaft bearing race installed in the gear housing. Also check seal rides of the pitman shaft and wormshaft for pitting and/or corrosion. If required, smooth with crocus cloth.

2. A suitable size socket, pressing on the outer diameter of the seal, may be used to install a new seal(s). Make sure that socket is large enough to avoid injuring the external lip of the seal.

Care should be taken to insure that the new seal is not assembled in a cocked position.

### PITMAN SHAFT BUSHING REPLACEMENT

1. Support the steering gear housing in an arbor press and press the pitman shaft bushing(s) from the housing using Tool J-1614, inserted from the lower end of the housing (figure 3E-7).

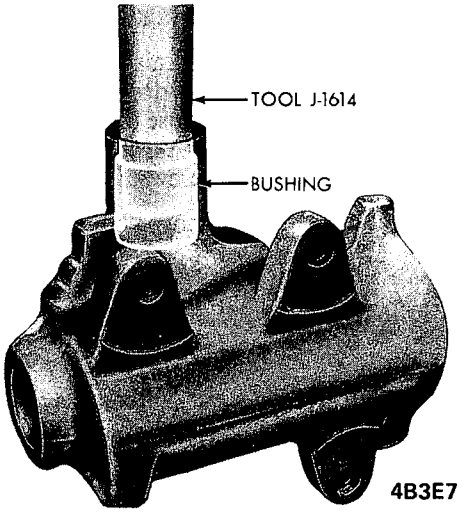


Figure 3E-7 Removing Pitman Shaft Bushing

2. Press the new bushing(s) into position using Tool J-1614. Position the bushings as shown in Figure 3E-2.

Service bushings are diamond bored to size and require no further reaming.

### SIDE COVER BUSHING REPLACEMENT

The entire side cover assembly, including bushing, is serviced as a unit.

### WORMSHAFT BEARING RACE REPLACEMENT ADJUSTER PLUG RACES

1. Remove the wormshaft bearing race using Tool J-5822 and Slide Hammer J-2619.

2. Press the new bearing race into position using Tool J-5755 (Figure 3E-8).

### HOUSING RACES

1. Using a drift or punch, drive the bearing race out of the housing.

2. Press the new bearing race into position using Tool J-5755 (figure 3E-8).

### BALL NUT SERVICING

As a rule, disassembly of the ball nut will not be necessary if it is perfectly free with no indication of binding or

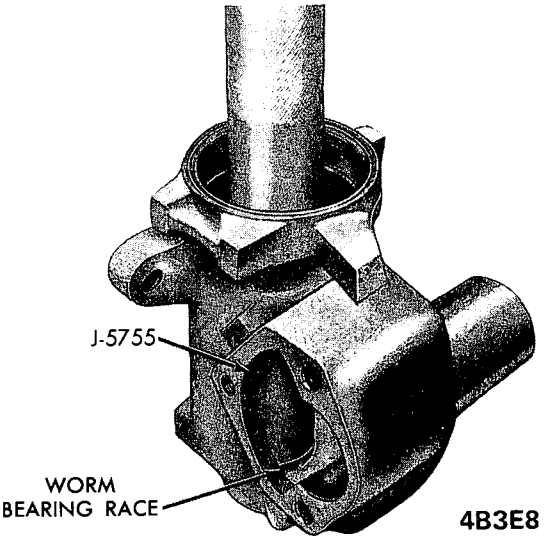


Figure 3E-8 Installing Wormshaft Bearing Race in Housing

tightness when rotated on the worm. However, if there is any indication of binding or tightness, the unit should be disassembled, cleaned and inspected as follows:

#### Disassembly

1. Remove screws and clamp retaining the ball guides in ball nut. Draw guides out of ball nut.

2. Turn the ball nut upside down and rotate the wormshaft back and forth until all the balls have dropped out of the ball nut into a clean pan. With the balls removed, the ball nut can be pulled endwise off the worm.

3. Wash all parts in cleaning solvent and dry them thoroughly with air. Using a magnifying glass inspect the worm and nut grooves and the surface of all balls for signs of indentation. Check all ball guides for damage at ends where they deflect or pick up the balls from the helical path. Any parts that show signs of damage should be replaced.

#### Assembly Figure 3E-9

1. Slip the ball nut over the worm with the ball guide holes

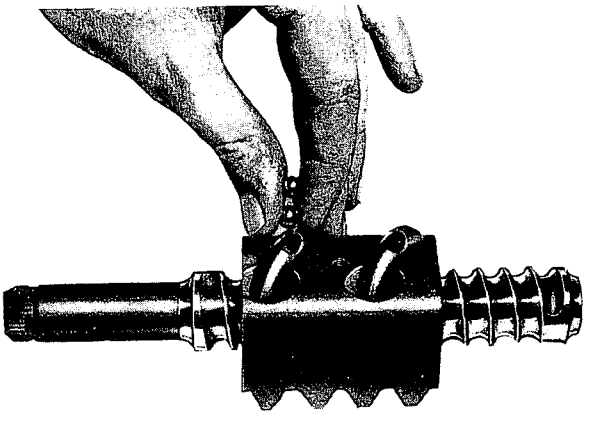


Figure 3E-9 Filling Ball Circuits

up and the shallow end of the ball nut teeth to the left from the steering wheel opsition. Align the grooves in the worm and ball nut by sighting through the ball guide holes.

2. Place two ball guide halves together and insert them into the upper circuit in the ball nut. Place the remaining two guides together and insert them in the lower circuit.

3. Count 25 balls into a suitable container. This is the proper number of balls for one circuit.

4. Load the balls into one of the guide holes while turning the wormshaft gradually away from that hole. When all of the balls have been installed, the circuit is complete.

5. Fill the remaining ball circuit in the same manner as described for the first circuit in Steps 3 and 4 above.

Assemble the ball guide clamp to the ball nut and tighten the screws to specified torque.

Check the assembly by rotating the ball nut on the worm to see that it moves freely. Do not rotate the ball nut to the end of the worm threads as this may damage the ball guides. If there is any "stickiness" in the motion of the ball nut, some slight damage to the ends of the ball guides or to other gear components may have been overlooked.

### Reassembly of Gear

After a major service overhaul apply steering gear lubricant meeting GM standard GM 4673M (or equivalent) to the wormshaft bearings, pitman shaft bushings, and side cover bushing.

1. Place the steering gear housing in a vise with the wormshaft bore horizontal and the side cover opening up.

2. Install the pitman shaft and worm shaft seals, pitman shaft bushings and wormshaft bearing races, and install the ball nut on the wormshaft.

3. Slip the upper ball bearing over the wormshaft and insert the wormshaft and ball nut assembly into the housing, feeding the end of the shaft through the upper ball bearing race and seal.

4. Pace the thrust bearing in the adjuster plug bearing cup and press the stamped retainer into place with a suitable socket. Make sure it is free to rotate after assembling retainer.

5. Install the adjuster plug and locknut into the lower end of the housing (being careful to guide the end of the wormshaft into the bearing) until nearly all end play has been removed from the wormshaft.

6. Position the lash adjuster (with shim) in the slotted end of the pitman shaft. Check the end clearance, which should not be greater than .002". The adjuster must be free to turn. If clearance is greater than .002", or adjuster is not free to turn, a steering gear lash adjuster shim unit is available. It contains four shims– .063", .065", .067" and .069" thick.

7. Lubricate the steering gear with 11 oz. of lubricant meeting GM Specification GM 4673M (or equivalent). Rotate the wormshaft until the ball nut is at the end of its travel and then pack as much new lubricant into the housing as possible without losing it out the pitman shaft opening. Rotate the wormshaft until the ball nut is at the other end of its travel and pack as much lubricant into the opposite end as possible.

8. Rotate the wormshaft until the ball nut is in the center of travel. This is to make sure that the pitman shaft sector and ball nut will engage properly, with the center tooth of the sector entering the center tooth space in the ball nut.

9. Tape the serations of pitman shaft and then insert the pitman shaft assembly (with lash adjuster screw and shim but without side cover) into the housing so that the center tooth of the sector enters the center tooth space in the ball nut.

10. Pack the remaining portion of lubricant into the housing, and place a quantity in the side cover bushing hole.

11. Place the side cover gasket on the housing.

12. Install the side cover onto the pitman shaft by reaching through the side cover with a screw driver and turning the lash adjuster screw counter-clockwise until the screw bottoms; back the screw off one-half turn. Loosely install a new locknut onto the adjuster screw.

13. Install and tighten the side cover bolts to specifications.

### On Bench Adjustment of Manusl Steering Gear Figure 3E-10

1. Tighten the adjuster plug until all end play has been removed and then loosen one-quarter turn.

2. Using an 11/16" 12-point socket and an in. lb. torque wrench, carefully turn the wormshaft all the way to the right corner and then turn back about one-half turn.

3. Tighten the adjuster plug until the proper thrust bearing preload is obtained (See Specifications). Tighten the adjuster plug locknut to Specifications.

4. Turn the wormshaft from one stop all the way to the other, counting the number of turns. Then turn the shaft back exactly half the number of turns to the center position.

5. Turn the lash adjuster screw clockwise to remove all lash between the ball nut and sector teeth. Tighten the locknut.

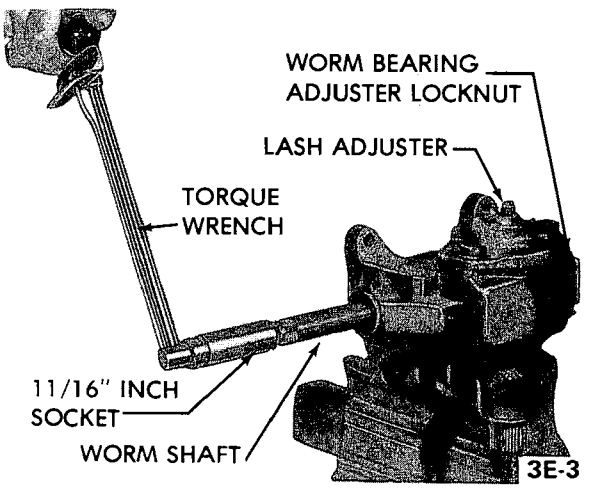


Figure 3E-10 Adjusting the Gear

6. Again using the 11/16" 12-point socket and an in. lb. torque wrench, observe the highest reading while the gear is turned through center position. See the Specifications Section for proper over-center adjustment.

7. If necessary, readjust lash adjuster screw to obtain proper torque. Tighten the locknut to specified torque and again check torque reading through center of travel.

## SPECIFICATIONS

### MANUAL STEERING GEAR SPECIFICATIONS

#### Tightening Specifications

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

| Part | Location | Thread Size | Torque Lb.Ft. |
|---|---|---|---|
| Bolt | Gear Housing to Frame | 7/16-14 | 70 |
| Bolt | Lower Coupling Flange to Worm Shaft | 3/8-24 | 30 |
| Bolt | Gear Side Cover to Housing | 3/8-16 | 30 |
| Nut | Pitman Arm to Pinion Shaft | | |
| | H Series | Special | 90 |
| | X-A Series | Special | 180 |
| Nut | Pitman Shaft Lash Adjuster Locking | 7/16-20 | 25 |
| Nut | Worm Bearing Adjuster Locking | Special | 85 |
| Screw | Ball Return Guide Retainer | 1/4-28 | 10 |

#### Manual Steering Gear Specifications

| Item | Specification |
|---|---|
| Gear Type | Recirculating Ball, Worm and Nut |
| Make | Saginaw |
| Ratio, Gear Only | |
| H Series | 20.9:1 |
| X Series | 24.0:1 |
| A Series | 28.0:1 |
| Ratio, Overall (Including Linkage) | |
| H Series | 22.5:1 |
| X Series | 26.16:1 |
| A Series | 33.06:1 |
| Lubricant Capacity | 11 Oz. |
| Lubricant Type | GM4673M (or equivalent) |
| Number and Type of Worm Shaft Bearings | 2 Ball Bearings |
| Number and Size of Worm and Rack-Piston Nut Balls | 50-0.2812" |
| Pitman Shaft Lash Adjusting Screw | |
| Clearance in Pitman Shaft | 0 to .002" |

| Adjustment | Manual Steering Gear Torque To Turn Worm Shaft |
|---|---|
| Worm Bearing Preload | 5-8 Lb. In. |
| Sector Lash Adjustment | 4-10 Lb. In. in Excess of Worm Bearing Preload |
| Total Steering Gear Preload | 16 Lb. In. Maximum |

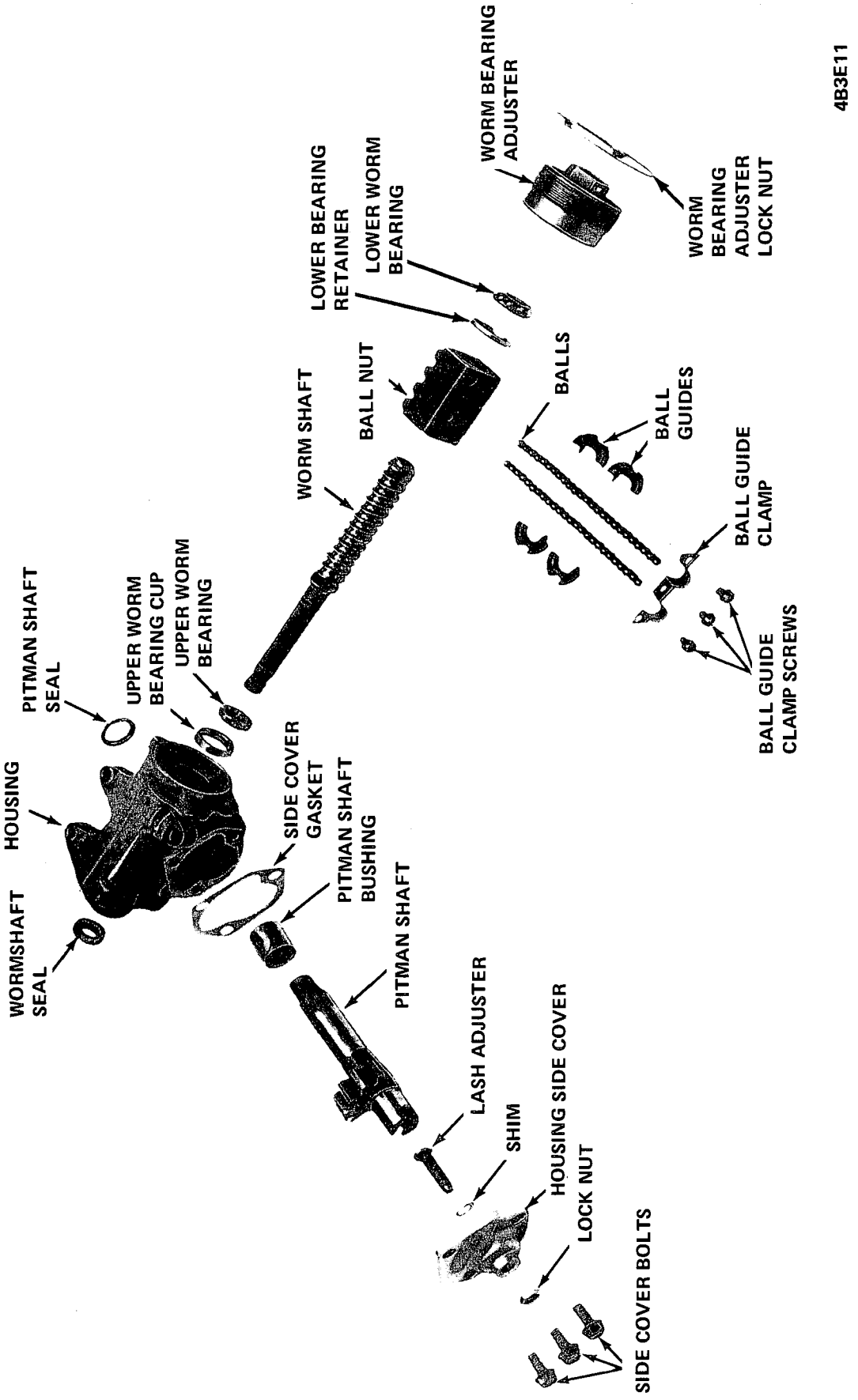


Figure 3E-11 Exploded View-Manual Steering Gear

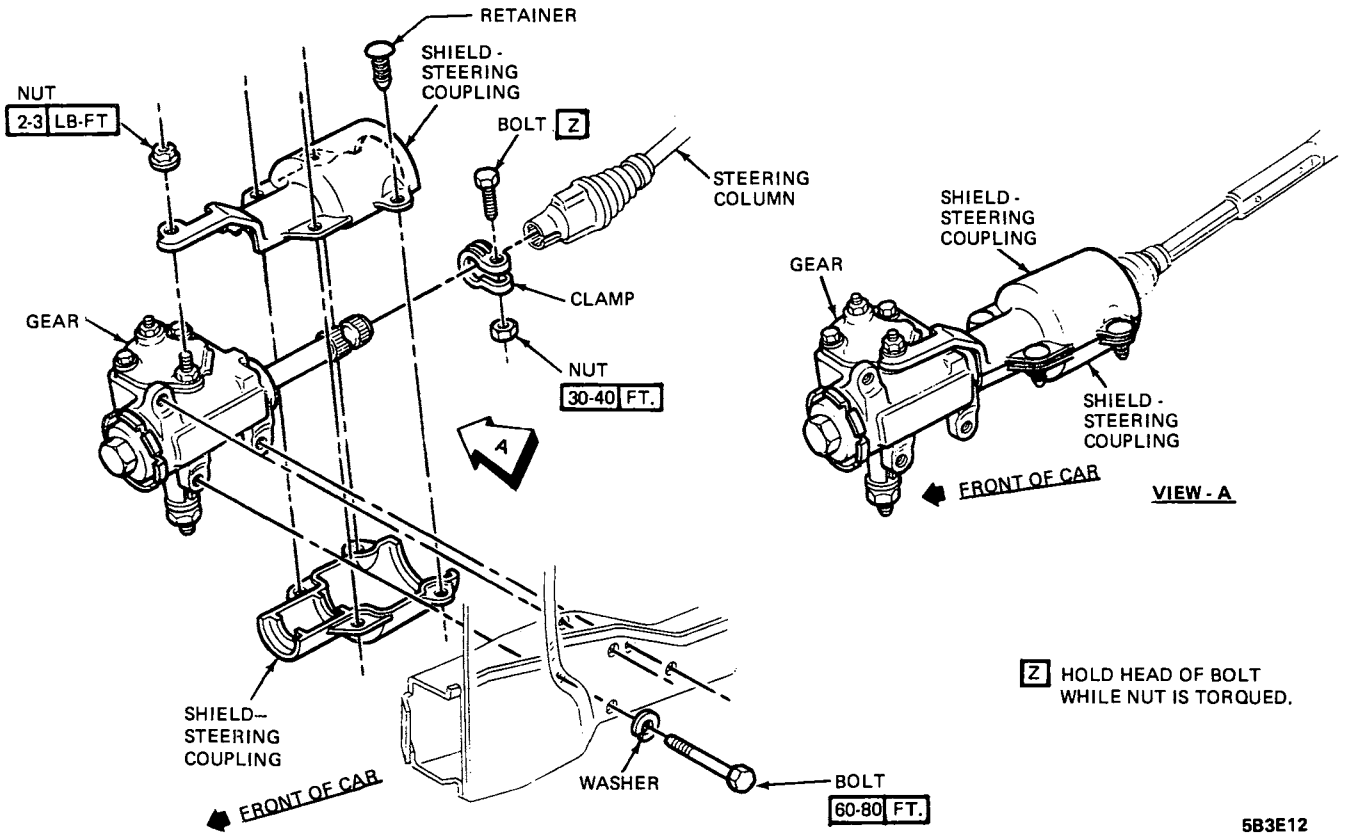


Figure 3E-12 - H Series Manual Steering Gear Installation

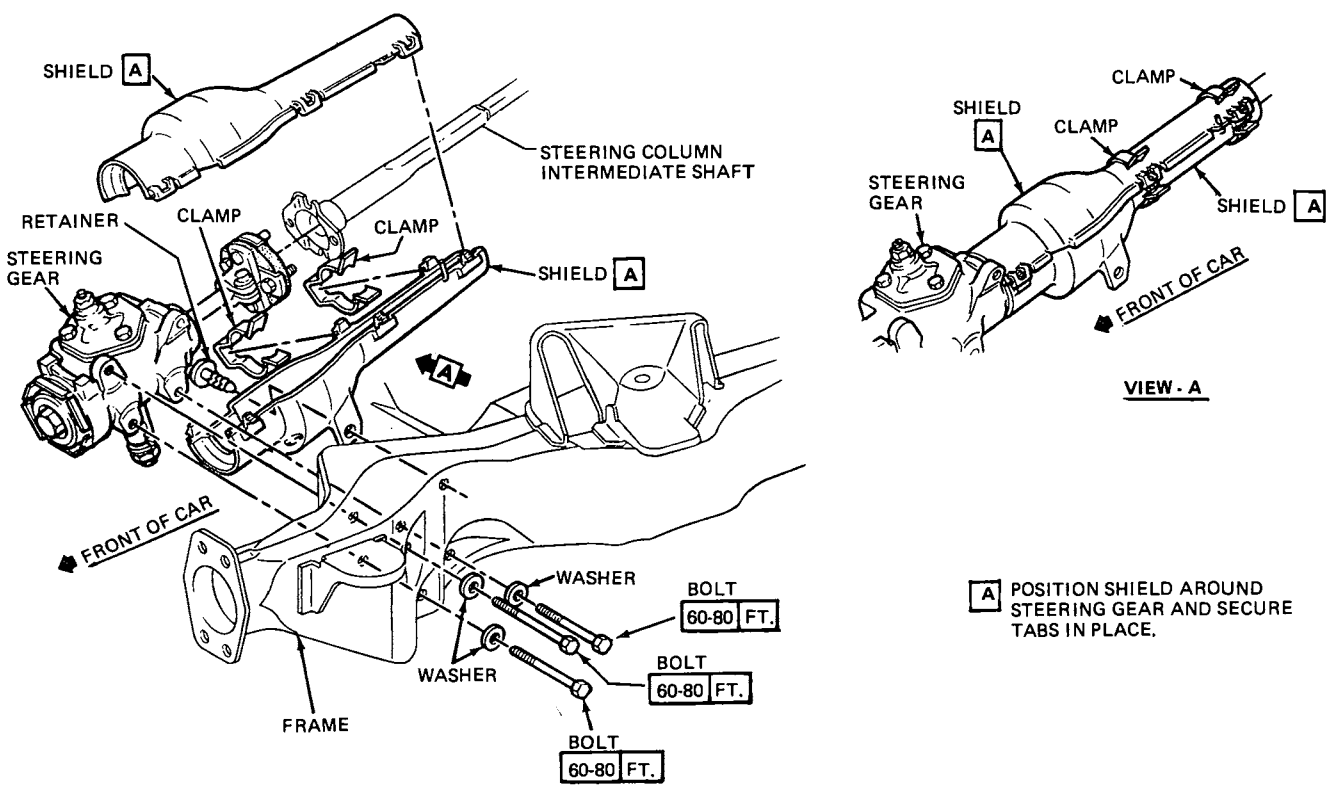


Figure 3E-13 - X Series Manual Steering Gear Installation

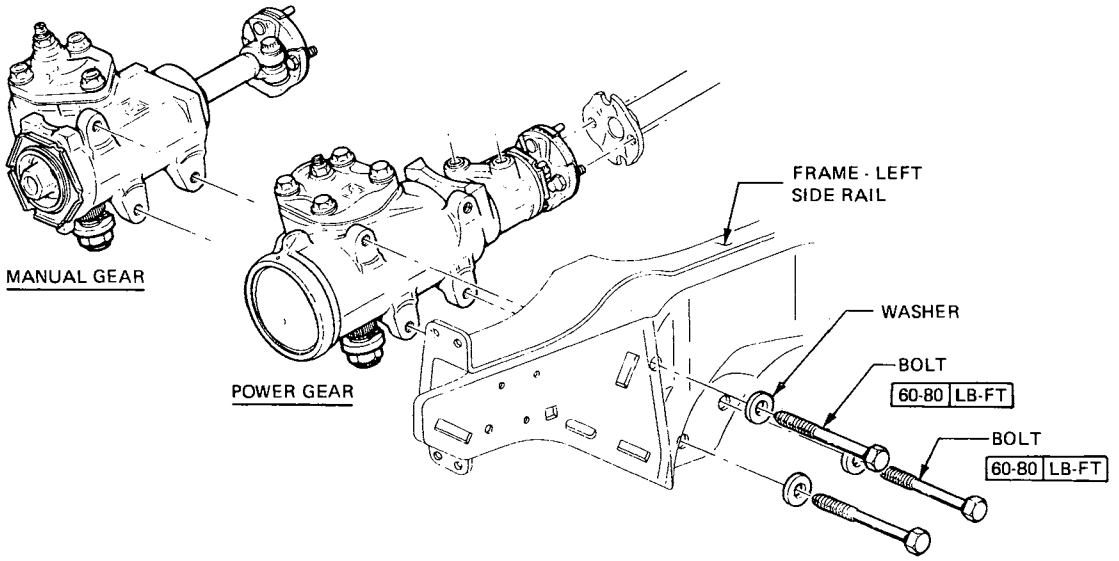


Figure 3E-14 - A Series Manual Steering Gear Installation