

GROUP 8

STEERING GEAR AND LINKAGE

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SECTION 8-A

MANUAL STEERING GEAR AND LINKAGE

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8-1 MANUAL STEERING GEAR SPECIFICATIONS

a. Tightening Specifications

Use a reliable torque wrench to tighten the parts listed to insure proper tightness without

straining or distorting parts. These specifications are for *clean and lightly lubricated threads only*; dry or dirty threads produce increased friction which prevents accurate measurement of tightness.

| Part | Location | Thread Size | Torque-Ft. Lbs. |
|------------|---|---------------------|-----------------|
| Bolt | Gear Side Cover to Housing | $\frac{3}{8}$ -16 | 25-35 |
| Bolt | Idler Arm Support to Frame | $\frac{3}{8}$ -16 | 20-30 |
| Bolt & Nut | Tie Rod Clamp | $\frac{3}{8}$ -16 | 20-30 |
| Bolt | Gear Housing to Frame | $\frac{7}{16}$ -14 | 50-60 |
| Nut | Tie Rod Ball Stud to Steering Arm | $\frac{1}{2}$ -20 | 50-60 |
| Nut | Steering Wheel to Steering Shaft | $\frac{11}{16}$ -20 | 30-35 |
| Nut | Pitman Arm to Pitman Shaft | $\frac{7}{8}$ -14 | 90-110 |
| Bushing | Idler Arm | $\frac{7}{8}$ -11 | 100-115 |

b. Steering Gear Specifications

| Items | |
|--|-------------------------------------|
| Gear Type | Recirculating Ball Worm and Nut |
| Make | Saginaw |
| Ratio, Gear Only | 23.6 to 1 |
| Ratio, Overall (Including Linkage) | 28.8 to 1 |
| Turns of Wheel, Lt. to Rt. (Gear connected) | 5 |
| Turning Circle Diameter (Curb to Curb) | |
| Series 4400-4600 | 44.0 ft. |
| Series 4700-4800 | 45.7 ft. |
| Lubrication | Plug in Housing |
| Oil Capacity | 13 oz. |
| Steering Wheel Diameter | 17" |
| Number and Type of Pitman Shaft Bearings | 2 Needle Bearings |
| Number and Type of Steering Shaft Bearings | 2 Ball Bearings |
| Worm and Nut Balls—No. and Diameter | 60, $\frac{9}{32}$ " |
| Adjusting Screw and Shim Clearance in Pitman Shaft | 0 to .002" |
| Worm Thrust Bearing Preload—Lbs. Pull at Wheel Rim | $\frac{3}{8}$ to $\frac{7}{8}$ lbs. |
| Pitman Shaft Overcenter (Including Worm Bearings)—Lbs. Pull at Wheel Rim | 1 $\frac{1}{4}$ to 2 lbs. |
| Intermediate Rod Plug Adjustments | See fig. 8-5 |
| Toe-in, Caster, Camber, etc. | See fig. 7-19 |

8-2 DESCRIPTION OF MANUAL STEERING GEAR AND LINKAGE

a. Steering Gear Assembly

The steering gear is the recirculating ball worm and nut type. The worm on lower end of the steering shaft and the ball nut which is mounted on the worm have mating spiral grooves in which steel balls circulate to provide a low-friction drive between worm and nut. See figure 8-1.

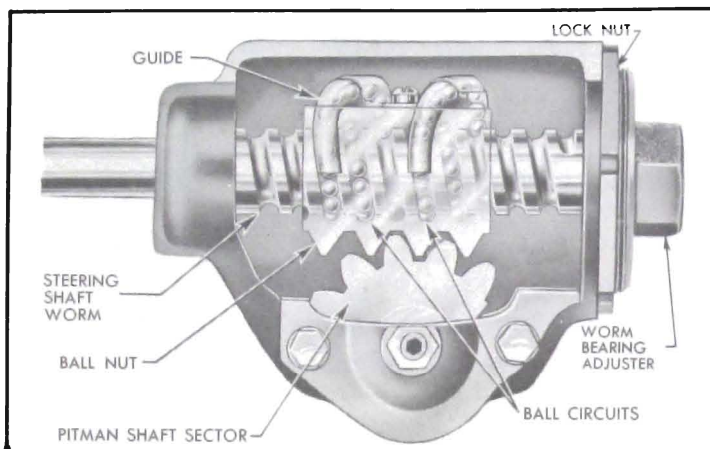


Figure 8-1—Steering Gear Worm and Nut, Showing Ball Circuits

Two sets of 30 balls are used, with each set operating independently of the other. The circuit through which each set of balls circulates includes the grooves in worm and ball nut and a ball return guide attached to outer surface of nut.

When the wheel and steering shaft turn to the left the ball nut is moved downward by the balls which roll between the worm and nut. As the balls reach the outer surface of nut they enter the return guides which direct them across and down into the ball nut, where they enter the circuit again. When a right turn is made, the ball nut moves upward and the balls circulate in the reverse direction. See figure 8-1.

Teeth on the ball nut engage teeth on a sector forged integral with the pitman shaft. 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 teeth of sector are slightly tapered so that a proper lash may be obtained by moving the pitman shaft endways by means of an adjusting screw which extends through the gear housing side cover. The head of adjusting screw 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. The screw is locked by an external lock nut. See figure 8-2.

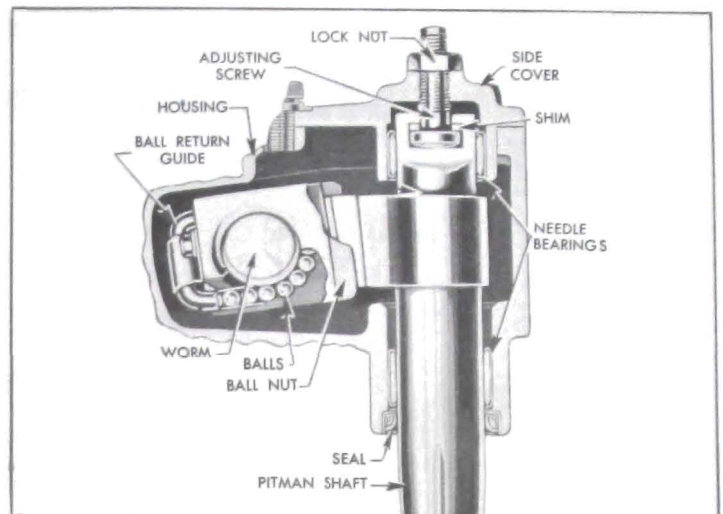


Figure 8-2—End Sectional View of Steering Gear

The pitman shaft is carried by a needle bearing in the steering gear housing and a needle bearing in housing side cover. A spring-loaded seal in housing prevents leakage of lubricant at outer end of the shaft. See figure 8-2.

The steering worm shaft is carried by two ball thrust bearings which bear against seats on the ends of the shaft worm. The outer race of the upper thrust bearing is pressed into the gear housing.

The outer race of the lower thrust bearing is pressed into the bearing adjuster which screws into the housing and is locked by a nut. The steering gear housing is attached to the frame by three bolts.

The upper steering shaft is a separate shaft supported in the steering column jacket. Its upper end is supported by a ball bearing; its lower end by an adapter and ball bearing assembly. A nylon pin in the instrument panel support bracket fits in a slot in the mast jacket and locates it radially.

The upper steering shaft is connected to the steering worm shaft through a flexible coupling. This flexible coupling helps absorb minor shocks and vibrations, and gear rattle, and also allows slight variations in alignment between the steering gear assembly and the steering column jacket assembly.

b. Steering Linkage

The Parallelogram type steering linkage is used to connect both front wheels to the steering gear pitman arm. As shown in figure 8-5, the right and left tie rods are connected to a tubular intermediate rod. The left end of the intermediate rod is supported by the pitman

arm and the right end is supported by an idler arm which pivots on a support attached to the frame. The pitman and idler arms are always parallel with each other and move through symmetrical arcs.

Four ball studs are held between pairs of ball socket type bearings contained in the intermediate rod. The bearings are held in firm contact with the ball studs through pressure applied by heavy coil springs located at the pitman and idler arm stud bearings. Steel spacers transmit this spring pressure to the tie rod ball stud bearings. See figure 8-5.

The linkages used for manual steering and power steering are the same except for ratio and that the anti-wheel kick springs at the pitman arm ball have been eliminated on the power steering linkage, and the internal spline on the pitman arm is $\frac{1}{8}$ " larger.

Flanged steel bumpers extending through the springs act as spring guides, permit a restricted movement of ball studs and bearings as the springs absorb road shock, and prevent the bearings from spreading and releasing the ball studs in the event of spring breakage. The spring tension and clearances at ends of bumpers are adjusted by the threaded end plugs. See figure 8-5.

The openings through which the ball studs enter the intermediate rod are protected by pressed steel dust covers to keep lubricant in and dirt and water out. Bearings and ball studs receive lubrication from inside the intermediate rod which is provided with two grease fittings.

The tie rod end, which connects each tie rod to a steering arm, is a spring-loaded ball stud and socket unit assembly. A rubber dust seal fits over the stud where it emerges from the socket, to provide protection against entrance of dirt and water. The tie rods are connected to the tie rod ends by internally threaded sleeves which provide for toe-in adjustment. The sleeves are slotted and provided with clamps at each end to lock them in place. See figure 8-5.

8-3 TROUBLE DIAGNOSIS—MANUAL STEERING GEAR AND LINKAGE

This paragraph covers improper steering actions which are most likely to be caused by the steering gear assembly or tie rods. Improper steering actions which are most likely to be caused by chassis suspension members are covered in paragraph 7-6.

a. Excessive Play or Looseness in Steering System

- (1) Front wheel bearings incorrectly adjusted (par. 7-10).
- (2) Worn upper ball joints (par. 7-11).
- (3) Steering wheel loose on shaft, loose pitman arm, tie rods, or steering arms.
- (4) Excessive pitman shaft sector to ball nut lash (par. 8-4).

b. Hard Steering—Excessive Effort Required at Steering Wheel

- (1) Low or uneven tire pressure (par. 1-1).
- (2) Insufficient or improper lubricant in steering gear or front suspension (par. 1-1).
- (3) Excessive steering shaft coupling misalignment.
- (4) Steering gear or tie rods adjusted too tight, or idler arm binding on support (par. 8-4).
- (5) Front wheel alignment incorrect (par. 7-17).
- (6) Frame bent or broken (par. 12-1).

c. Rattle or Chuckle in Steering Gear

- (1) Insufficient or improper lubricant in steering gear (par. 1-1).
- (2) Excessive back lash between ball nut and pitman shaft sector in straight ahead position or worm thrust bearings adjusted too loose (par. 8-4). *NOTE: On turns a slight rattle may occur, due to the increased lash between ball nut and sector as gear moves off the center or "high point" position. This is normal and lash must not be reduced to eliminate this slight rattle.*
- (3) Pitman arm loose on shaft, tie rod connections loose, or steering gear loose at mounting brackets.
- (4) Loose fit at steering shaft upper bearing.

8-4 ADJUSTMENT OF MANUAL STEERING GEAR AND LINKAGE

IMPORTANT: *Never attempt to adjust steering gear while it is connected to intermediate rod. Steering gear must be free of all outside load in order to properly adjust worm thrust bearings and the lash between ball nut and pitman shaft teeth.*

a. Adjustment of Steering Gear in Car

1. Disconnect intermediate rod from pitman arm by unscrewing end plug until bearings will release the ball stud. See Figure 8-5. Torque pitman arm nut to 100 ft. lbs.

2. Turn steering wheel gently in one direction until it stops, then turn it back one revolution. **CAUTION:** *Never turn wheel hard against stopping point as damage to ball nut assembly may result.*

3. Check for lash between ball nut and pitman shaft by working the pitman arm. If a perceptible lash does not exist, loosen lock nut and turn pitman shaft adjusting screw counterclockwise, until lash can be felt when working pitman arm. This separates the worm thrust bearing load from the "high point" load caused by close meshing of ball nut and pitman shaft teeth.

4. Turn steering wheel slowly from one extreme position to the other. Wheel should turn freely and smoothly through entire range. Roughness indicates faulty worm thrust bearings or brinelled races. Hard pull or binding indicates excessive misalignment of steering shaft coupling, or an excessively tight adjustment of worm thrust bearings. Any misalignment must be corrected before steering gear can be properly adjusted.

NOTE: *If steering shaft coupling is out of alignment, check body mounting bolts which may have loosened and allowed body to shift.*

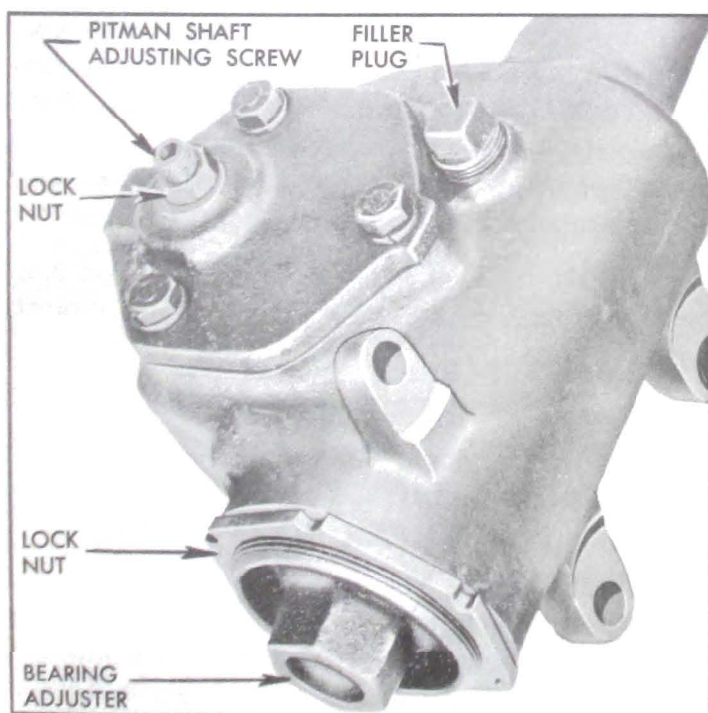


Figure 8-3—Steering Gear Adjustments

5. If binding exists readjust the steering gear upper shaft assembly in its upper and lower mounting as described in paragraph 8-5.

6. Loosen worm thrust bearing adjuster lock nut. Turn thrust bearing adjuster until a slight load is felt when turning steering wheel near extreme positions, then tighten lock nut. See figure 8-3.

CAUTION: *Do not back out adjuster far enough to permit thrust bearings to get out of line with ends of worm.*

7. After locking the bearing adjuster, check the load on thrust bearings with steering wheel turned to near one extreme position. Apply Scale J 544 to a spoke at rim of wheel and exert a steady pull while keeping the scale at 90 degrees to spoke. The pull required to keep wheel turning slowly should be between $\frac{3}{8}$ and $\frac{7}{8}$ pounds. Readjust to obtain this bearing load if necessary.

8. Turn steering wheel from one extreme position to the other while counting the turns, then turn wheel back one-half the total number of turns and have the lower spoke pointing straight down. This places steering gear on the "high point" at which no lash should exist between ball nut and pitman shaft teeth.

9. Tighten housing side cover bolts. Loosen lock nut and turn pitman shaft adjusting screw clockwise until lash between ball nut and pitman shaft teeth is just removed. Work pitman arm back and forth to feel for lash. After tightening adjusting screw lock nut, rotate steering wheel back and forth through the "high point" range and check for tight spots. Check pull at wheel with Scale J 544 as described above.

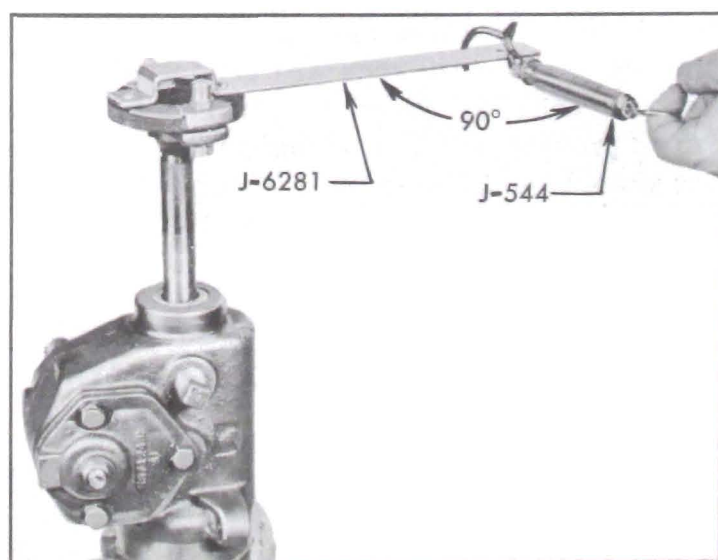


Figure 8-4—Checking Thrust Bearing or Lash Adjustment with Scale

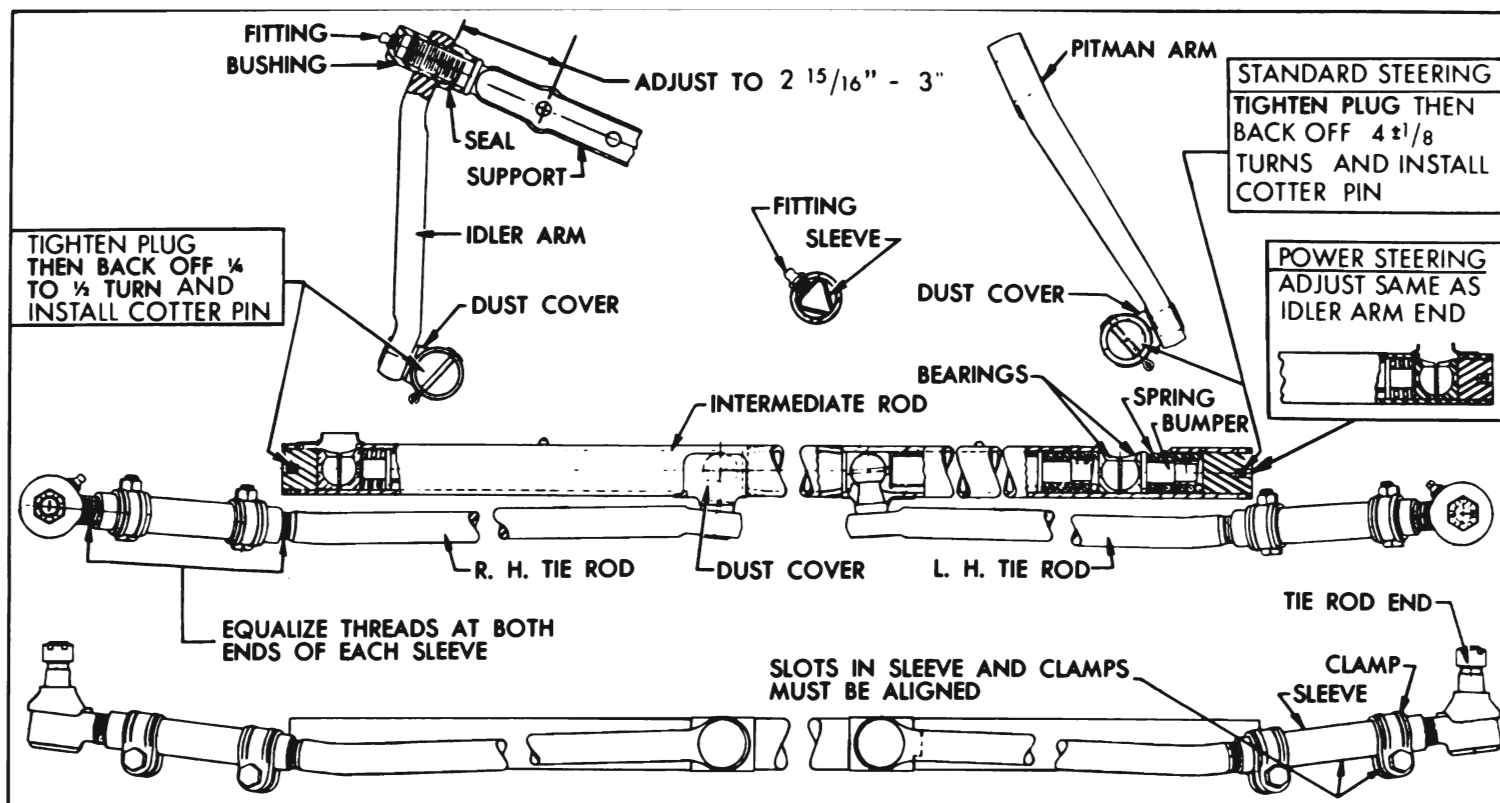


Figure 8-5—Steering Linkage (Manual and Power)

10. The pull required to keep wheel moving through "high point" should be between $1\frac{1}{4}$ and 2 pounds. Readjust if necessary to remove tight spots and obtain specified load at wheel rim. NOTE: *If lash cannot be removed at "high point," or if gear load varies greatly and feels rough, the gear assembly should be removed for inspection of internal parts.*

b. Adjustment of Steering Gear on Bench

1. Place manual steering gear in vise with worm shaft up. Then install Over-Center Adjuster J-6281 on flexible coupling. See figure 8-4.

2. Turn worm shaft to extreme right or left position. Apply scale 7-544 to Over-Center Adjuster Tool and while pulling scale at 90 degrees to tool, turn the thrust bearing adjuster to obtain a reading of $\frac{3}{8}$ to $\frac{7}{8}$ lbs. when pulling through the lash range (one-eighth turn of wormshaft from either extreme position).

3. Tighten lock nut and recheck reading.

4. Turn worm shaft from one extreme to the other while counting the turns, then turn wheel back one-half the total number of turns. This places the steering gear on the high point.

5. Turn pitman shaft adjusting screw clockwise until a reading of $1\frac{1}{4}$ to 2 lbs. is obtained while turning the Over-Center Adjuster tool

through the high point or no lash range. Tighten lock nut and recheck the adjustment.

c. Adjustment of Steering Linkage

The intermediate rod must be maintained in a level position to insure good steering action. This requires proper location of the idler arm on its support so that the idler arm ball stud will be level with the pitman arm ball stud. The support must be threaded into the idler arm bushing until the distance from the center of support lower bolt hole to the nearest face of idler arm is $2\frac{15}{16}$ " to 3", as shown in Figure 8-5. After any adjustment of idler arm on its support the front wheels should be checked to insure proper toe-in.

IMPORTANT: If the idler arm support is dismantled from the frame for other work, such as removal of the lower crankcase, wire the support to the idler arm so that it cannot turn from its existing position and possibly change the toe-in of the front wheels.

Whenever the intermediate rod is being connected to the idler arm or pitman arm, be careful to properly seat the bearings around the ball stud and make sure that the pressed steel dust cover properly protects the opening around ball stud. On *idler arm* end of rod, turn the end plug up tight then back off $\frac{1}{4}$ to $\frac{1}{2}$ turn ($\frac{1}{2}$ turn preferred) and install cotter pin. On *pitman arm*

8-6 MANUAL STEERING**STEERING GEAR AND LINKAGE**

end of rod, on manual steering linkage, tighten end plug, then back off $4 \pm \frac{1}{8}$ turns and install cotter pin.

On the power steering linkage, the pitman arm end plug adjustment is made in the same manner as idler arm end.

See paragraph 7-17 (subpar. e) for adjustment of tie rods to obtain proper toe-in of front wheels.

d. Road Test after Adjustment

Road test car for ease of steering. If steering gear was adjusted to specified load limits and hard steering exists, the front suspension members should be checked for lubrication and alignment and tire inflation pressures should be checked. When car is moving straight ahead, the lower spoke of steering wheel should be straight down, or not over $\frac{5}{8}$ " to either side of straight down position. If lower spoke is too far to either side, check steering wheel for proper position on steering shaft (par. 8-5) and check tie rods for equal adjustment and toe-in (par. 7-17). It is important to have the steering gear in the no-lash range when car is moving straight forward.

8-5 STEERING WHEEL REMOVAL, AND INSTALLATION**a. Removal of Steering Wheel**

1. Disconnect wire at horn cable connector on steering column to prevent horn from blowing.

2. Remove horn button or operating ring (par. 10-52) then reinstall steering wheel nut, leaving it backed off several turns.

3. Apply Puller J-3274 and pull wheel back to nut. See figure 8-6. NOTE: *If wheel hub is*

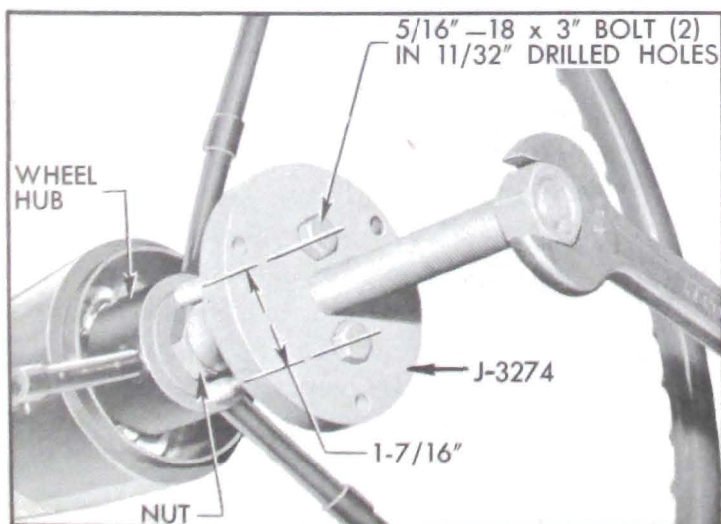


Figure 8-6—Removing Steering Wheel with Puller J 3274

very tight on shaft, apply a moderate strain with puller then tap end of puller screw to break hub loose from shaft without distorting wheel hub. Remove puller, nut, and steering wheel.

b. Installation of Steering Wheel

1. Install steering wheel with location marks on shaft and hub of wheel in line.

NOTE: *Location marks for proper installation of steering wheel on steering shaft are provided to insure a vertical position of the steering wheel lower spoke when front wheels are in straight-ahead position.*

2. With wheel properly located on shaft, install self-locking nut and tighten securely.

3. Install horn button or operating ring (par. 10-52) and connect wire to horn cable connector on steering column.

8-6 REMOVAL AND INSTALLATION OF MANUAL STEERING GEAR**a. Removal of Steering Gear Assembly**

1. Mark upper and lower steering shaft flanges for correct assembly. Then disconnect the flexible coupling.

2. Jack up car and remove the pitman shaft nut and lock washer, then remove the pitman arm.

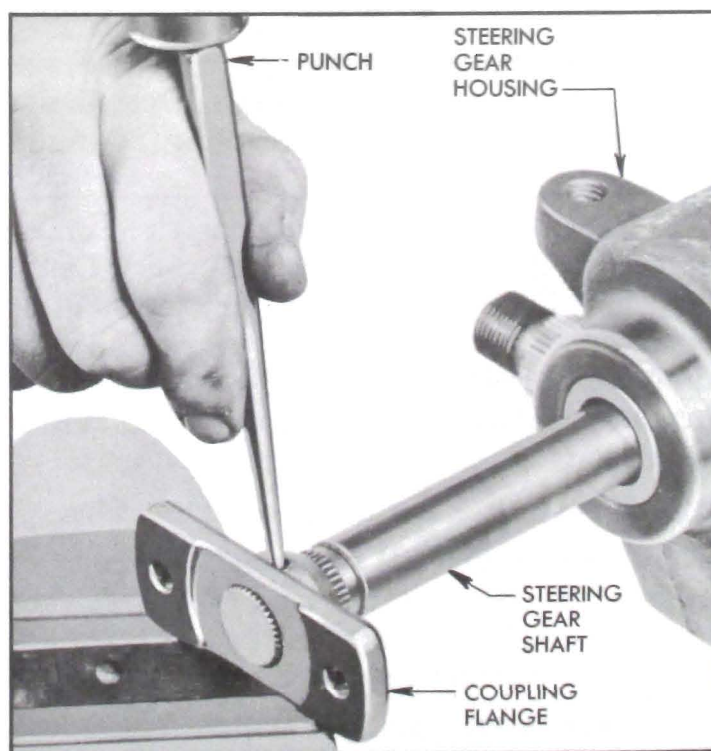


Figure 8-7—Removal of Coupling Flange

3. Remove the three steering gear to frame bolts at outside of left frame rail.

4. Remove steering gear from under car.

b. Installation of Steering Gear Assembly

1. Install the gear assembly by reversing the procedure for removal.

2. Torque the pitman arm nut to 100 ft. lbs.

3. Check toe-in after installation is completed.

8-7 DISASSEMBLY, INSPECTION, ASSEMBLY OF MANUAL STEERING GEAR

a. Disassembly of Steering Gear

1. Remove flexible coupling and mark coupling flange and steering worm shaft before disassembly.

2. Support coupling flange and remove from worm shaft by driving pin out with punch. See figure 8-7.

3. Loosen adjusting screw lock nut and remove side cover bolts. Turn worm shaft until nut is in center of travel, then remove side

cover and pitman shaft from steering gear housing.

4. Remove side cover from pitman shaft and slip the adjusting screw and shim out of slot in the pitman shaft.

5. Using a punch loosen the adjuster lock nut and remove worm thrust bearing adjuster.

6. Remove worm shaft assembly together with ball nut assembly from housing. Remove ball return guide clamps and guides from ball nut. Then turn worm shaft back and forth until all the balls have dropped out of the nut, catching the balls in a clean pan or cloth.

7. Remove ball nut from steering worm shaft.

b. Cleaning and Inspection of Steering Gear Parts

1. Wash all parts in clean solvent and wipe dry with clean cloths.

2. Inspect the worm, ball nut grooves and all balls for wear or scoring. Also inspect the thrust bearing races on worm shaft for brinelling or scoring. Replace parts as necessary.

3. Inspect thrust bearings and races for wear or scoring. Pry bearing retainer in adjuster out with screw driver if the race requires

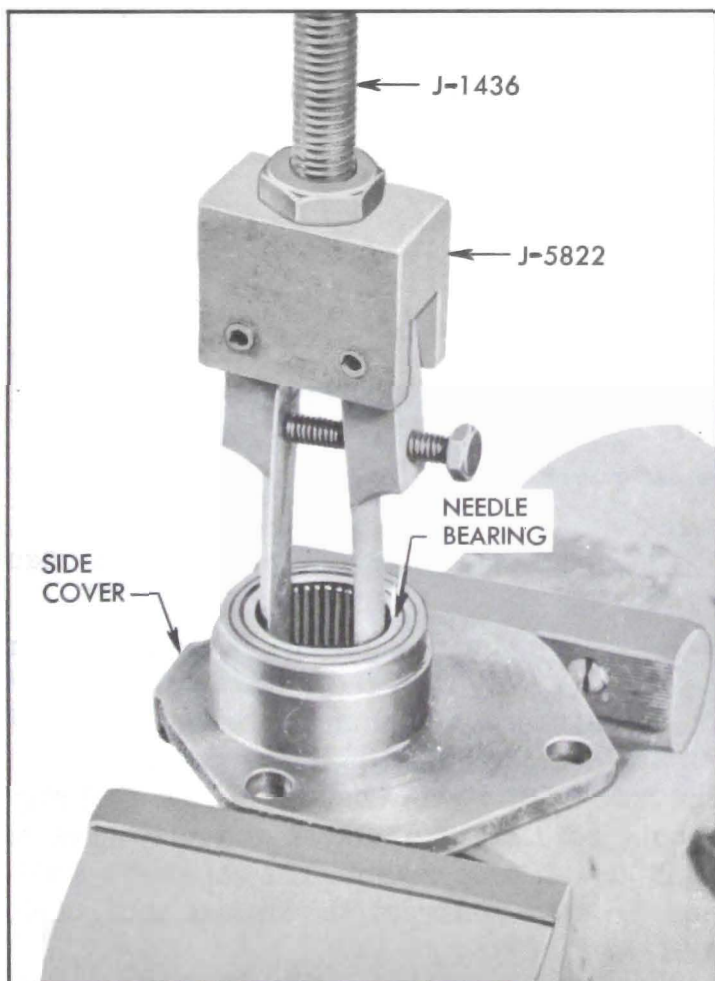


Figure 8-8—Removal of Needle Bearing

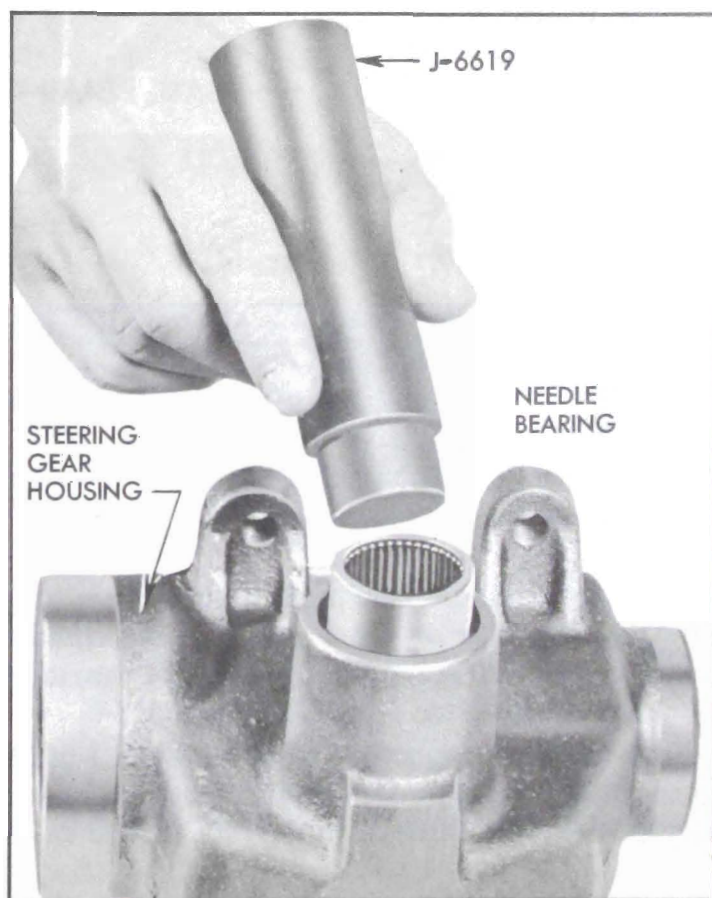


Figure 8-9—Installing Needle Bearing

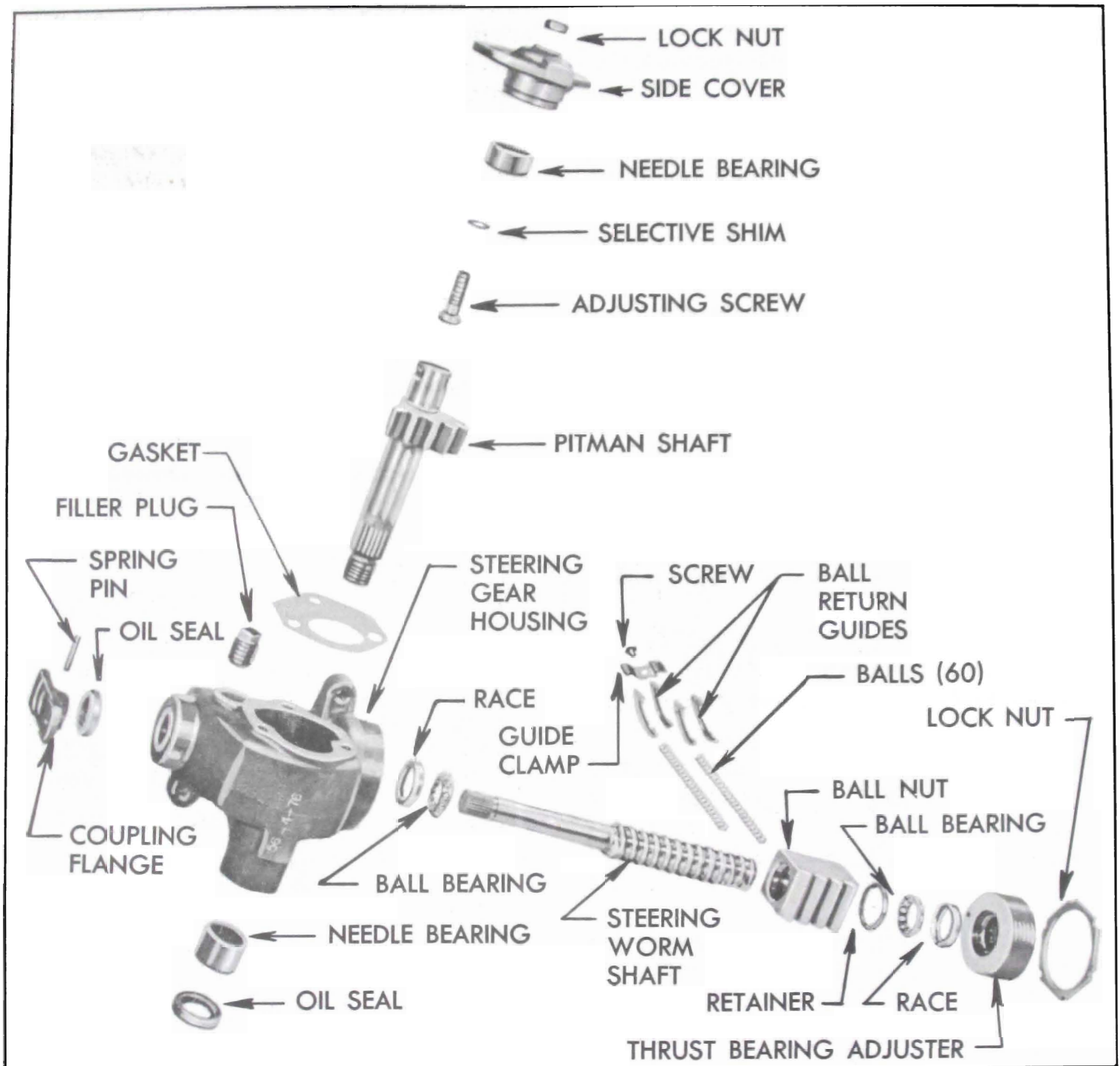


Figure 8-10—Steering Gear—Disassembled

closer inspection. Replace as necessary using a tool of suitable diameter to drive new races in place.

4. Inspect needle bearings in side cover and housing for wear or other damage. If replacement is necessary remove the needle bearings using bearing puller J-5822. See figure 8-8.

5. Install new bearings using installer J-6619 with stamped end of bearings against tool. Install bearings flush with surface of the casting bore. See figure 8-9.

6. Inspect teeth of ball nut and sector of pitman shaft for pitting or scoring which

would require replacement of nut or pitman shaft.

7. Check pitman shaft bearing surfaces for wear or scoring, then check fit of pitman shaft adjusting screw and shim in the slot in end of pitman shaft by inserting feeler gauge between the head of screw and bottom of slot. End play should not exceed .002". If end play exceeds .002" install proper shim. The shims are available in four different thicknesses .063, .065, .067, and .069".

8. It is advisable to replace the pitman shaft and steering worm shaft grease seals to avoid

possible leakage of lubricant. Install seals with lips inward using a block of wood to drive seals in place.

c. Assembly of Steering Gear

1. Lubricate bearings and gears with specified steering gear lubricant.

2. Assemble ball nut on worm, making sure that there are 22 balls in each circuit and 8 balls in each return guide, making a total of 60 balls. Then install return guides and clamp. See figure 8-10.

3. Install upper thrust bearing on steering worm shaft and install worm shaft assembly in housing, then install thrust bearing adjuster and lock nut. *NOTE: The thrust bearing adjuster should be adjusted just tight enough at this time to hold the bearings in place. Final adjustment will be made later.*

4. Install side cover on pitman shaft. Screw

the new adjusting screw through side cover until the side cover bottoms on the pitman shaft.

5. Turn worm shaft as necessary until under groove in nut is aligned with the center of pitman shaft bore. Install pitman shaft so that the center tooth in the sector meshes with the center groove of ball nut. Make sure that the new gasket is in place. Then push the side cover down on gear housing.

NOTE: When installing pitman shaft avoid damaging or turning the feather edge of the leather grease seal in gear housing.

6. Install and tighten side cover bolts to 30 ft. lbs. Then install adjusting screw lock nut and flexible coupling.

7. Fill steering gear with specified lubricant and adjust gear on bench as outlined in Par. 8-4b.

