MANUAL STEERING
DATA AND SPECIFICATIONS

MODELS	C-67, C-68, C-69, C-70
King Pin Diameter	.7953 in.
King Pin Bushings (Manual Steering) Type	
Upper	Needle Type Bearing
Lower	Bushing
King Pin Bushings (Power Steering) Type	
Upper	Floating Bushing
Lower	Floating Bushing
Dimensions of Lower Bushings	
Inside Diameter	.787 to .789 in.
Outside Diameter	.823 to .825 in.
Length	1.195 to 1.205 in.
Ream After Installation	.7960 to .7975 in.

COAXIAL POWER STEERING

MODELS	C-67, C-68, C-69, C-70
Fluid Capacity of Hydraulic System	2 qts.
Fluid Capacity of Worm Housing	1 pt.
Type of Fluid	Automatic Transmission Fluid, Type A
Maximum Pump Pressure	750 to 800 psi.
Maximum Fluid Flow at 3,000 R.P.M.	2 gal. (Minimum)
Maximum Pump Rotor Clearances:	
Between Rotor Lobes	.008 in.
Between Outer Rotor and Bushing	.006 in.

COAXIAL POWER STEERING (Cont'd)

End Clearance (Between Rotors and Face of Body)	.001 to .002 in.
Flow Control Valve Spring	
Free Length	2.13 in.
Working Length	1.20 in.
Force at Working Length	14 lbs. ± 1½ lbs.
Pressure Relief Valve Spring	
Free Length	1.51 in.
Working Length	1.18 in.
Force at Working Length	30 to 33 lbs.
Front End Alignment	
Steering Gear Ratio	16.2:1
Piston Rod Snap Ring Gap (Upper and Lower)	25/64 in.

SPECIAL TOOLS

MANUAL STEERING GEAR

Tool Number	Tool Name
C-143	Puller—Steering Arm
C-328	Bushing—King Pin Remover
C-611	Bushing—Eccentric Adjusting
C-3428	Puller—Steering Wheel
C-619	Bushing—Eccentric Adjusting
C-630	Reamer—Pilot Bushing

COAXIAL POWER STEERING GEAR

Tool Number	Tool Name
C-760	Pliers—Gear Snap Ring—Straight Type
C-3102	Gauge—Hydraulic Pump and Gear Checking
C-3106	Pliers—Gear Snap Ring—Right Angle
C-3107	Wrench—Adjustable Spanner
C-3108	Studs—(Pr.) Power Cylinder
C- 3109	Spacer—Aligning Unit In Chassis
C-3112	Puller—Steering Gear Tube Coupling Adapters for C-293 Puller (C-3145 Covers C-3112 Parts and C-293 Parts Required To Pull Coupling)
C-3113	Driver—Steering Gear Shaft Outer Bearing
C-3114	Driver—Steering Gear Shaft Inner Bearing
C-3116	Pilots—(Pr.) Reservoir Installing
C-3117	Plug—Oil Pump Return Hole (Tapered) (Small)
C-3128	Pliers—Pump Shaft Rear Bearing Ring
C-3129	Driver—Pump Oil Seal and Bearing
C-3130	Thimble—Protector—Pump Oil Seal
C-3136	Sleeve—Shaft Oil Seal Installing
C-3137	Remover—Shaft Oil Seal
C-3141	Driver—Valve Block Adjusting Pin Roller
C-3142	Driver—Steering Gear Shaft Inner Seal
C-3143	Driver—Steering Tube Oil Seal In Valve Body Cap
C-3189	Plug—Oil Pump Return Hole (Tapered) (Large)
C-485, C-524 or C-3005	Wrench—Foot-Pound Torque
C-612	Puller—Steering Wheel
C-685 or C-3380	Wrench—Inch-Pound Torque
SP-2623	Puller Screw—For Use With C-143 Puller (Previously Released)
C-3185	Remover—Pump Shaft Bushings and Seal
C-3211	Hose—High Pressure P/S Test
C-3214	Puller—Main Bearing

COAXIAL POWER STEERING GEAR (Cont'd)

Tool Number	Tool Name
C-3227	Wrench—Flange Holding
C-3228	Thimble—Shaft Oil Seal Protecting
C-3229	Pliers
C-3230	Driver—Shaft Oil Seal Installing
C-3233	Driver—Shaft Bushing Installing
C-3234	Adapter—For using C-3214 Puller
C-3250	Pliers—Hose Clamp
C-3251	Driver—Main Bearing Installing
C-3309	Gauge—Oil Pump, pressure checking
C-3317	Driver—Worm Housing Oil Seal
C-3318	Hose—Low Pressure P/S Test W/adapters
C-3319	Nut—Worm Shaft Holding
C-3320	Wrench—Worm Shaft Bearing Adjusting Nut
C-3321	Wrench—Worm Connector Holding
C-3322	Remover and Installer Worm Housing Bearing Cups
C-3323	Fixture—Gear Assembly Holding
C-3328	Spanner—Upper Piston Rod Nut
C-3329	Thimble—Valve Control Spacer Seal Installing
C-3331	Driver—Housing Head and Gear Housing Seal
C-3333	Driver—Remove and Install Gear Shaft Bearing
C-3344—SP-2604	Installer—Piston and Ring Assembly
C-3350	Remover and Installer—Gear Shaft Oil Seal
C-3437	Protector—Lower Piston Rod Seal
C-3392	Wedge—Coupling Removing—(Not Required If C-3112 Is Available)
C-3398	Remover and Installer—Gear Shift Rod Bushings
C-3399	Tool—Shifter Dial Bulb Removing and Installing
C-3401	Thimble—Gearshift Adjusting Screw "O" Ring Installing
C-3469	Flange—Upper Housing—Used For Pretesting for Hydraulic Leaks

TIGHTENING REFERENCE

MANUAL STEERING

	Foot-Pounds
Steering Gear to Frame Bolt	50
Steering Gear Arm (Pitman) Lock Bolt Nut	80
Steering Knuckle Tie Rod Clamp Bolt	15
Steering Gear Mounting Bracket Bolts	50
Steering Wheel Nut	40
Steering Knuckle Tie Rod End Ball Nut	75
Intermediate Steering Arm Pin Nut	50

POWER STEERING GEAR ASSEMBLY

	Foot-Pounds
Pump Body to Cover Bolts	30-35
Pump Reservoir to Pump Body Bolts	12-17
Pump Mounting Bolts	18-23
Pump Reservoir Mounting Stud	30-35
Steering Knuckle Arm Nuts (Brake Anchor Nuts)	55-75
Steering Gear Arm to Shaft Nut	100-125
Steering Arm to Transverse Link Nut	50-55
Steering Gear Assembly Mounting to Frame	65-70
Steering Wheel to Steering Shaft Nut	35-40
Jacket to Instrument Panel Screws	15-20
Tie Rod Clamp Bolts	10-15

POWER STEERING GEAR ASSEMBLY (Cont'd)

	Foot-Pounds
Tie Rod to Steering Knuckle Arm Nuts	45-75
Pump Coupling Attaching Screw	15-20
Pump Flow Control and Relief Valve Adapter (Retaining)	45-50
Pump Coupling Flange Attaching Screw	10-12
Upper Piston Rod Nut	25-30
Ball Guide Clamp Screws	10-12
Worm Housing to Gear Housing Screws	25-30
Gear Shaft Adjusting Screw Lock Nut	35-40

RESERVOIR

	Thread Size	Foot-Pounds
Reservoir Cover Bolt	5/16 x 24	8
Relief Valve Assembly Cap	1 x 8	8
Hose Connector Inlet	5/8 x 18	30

PUMP

	Thread Size	Foot-Pounds
Pump Assembly Bolt	5/16 x 18	20
Hose Connector Outlet	5/8 x 18	30
By-Pass Plug	3/4 x 16	50
Relief Valve Plug	1 x 14	50
Flow Divider Valve Plug	1 1/4 x 12	50
3/16 Drain Tube Nut	3/8 x 24	*1/2 to 3/4 Turn or 6 to 10

* The number of turns specified is after initial finger tightening.

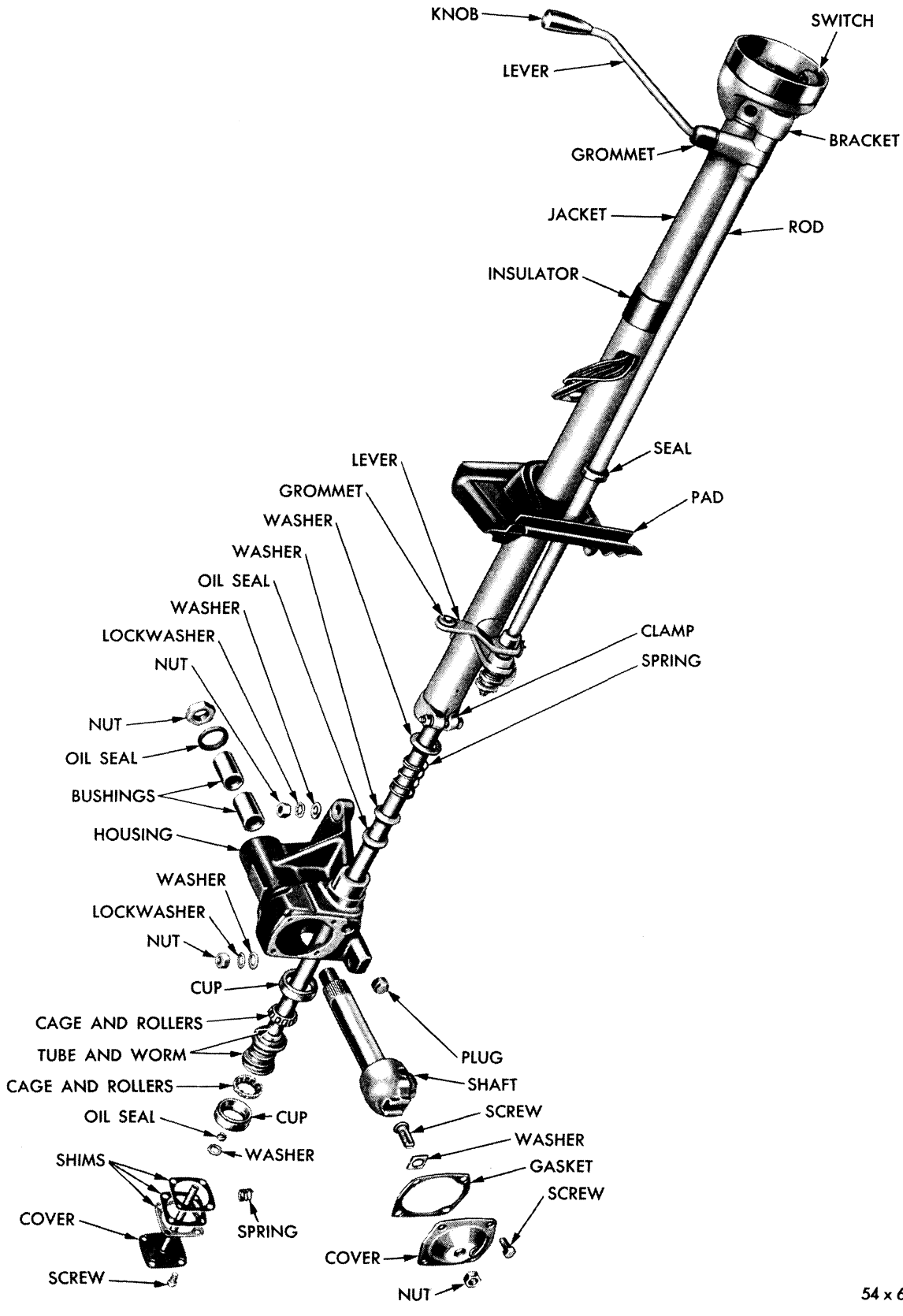

Fig. 1—Typical Steering Gear (Exploded View)

Section X

STEERING

(SEE FIG. 1)

1. LINKAGE

The symmetrical idler arm type of steering, as shown in Figure 2, is used on all models. A center link relays the motion from the Pitman arm to an idler arm at its opposite end. The idler arm is mounted on a bracket attached to the frame. Two equal length tie rods connect from the center relay link to the steering knuckle arms. Both tie rods are threaded for proper toe aligning adjustment.

2. STEERING GEAR (THREE-TOOTH ROLLER AND WORM) (Mechanical)

A three-tooth roller is mounted on needle roller bearings on a steel cross-shaft inserted through the steering gear shaft.

The worm is integral with the steering tube and is supported at each end by tapered roller bearings. The worm bearing pre-load is adjusted by means of shims placed between the housing and housing end cover. The steering gear shaft rotates in two bronze bushings pressed into the steering gear housing. The three-tooth roller on the shaft is meshed with the worm. When the steering wheel is turned, the worm rotates the steering gear shaft and roller, moving the Pitman arm, which is splined to the end of the shaft and held in place with a nut.

Backlash between the steering gear shaft roller tooth and the worm is controlled by an adjusting screw that is threaded through the shaft and roller cover. The base end of the adjusting screw is engaged in a slot in the end of the steering gear shaft. Correct backlash can be

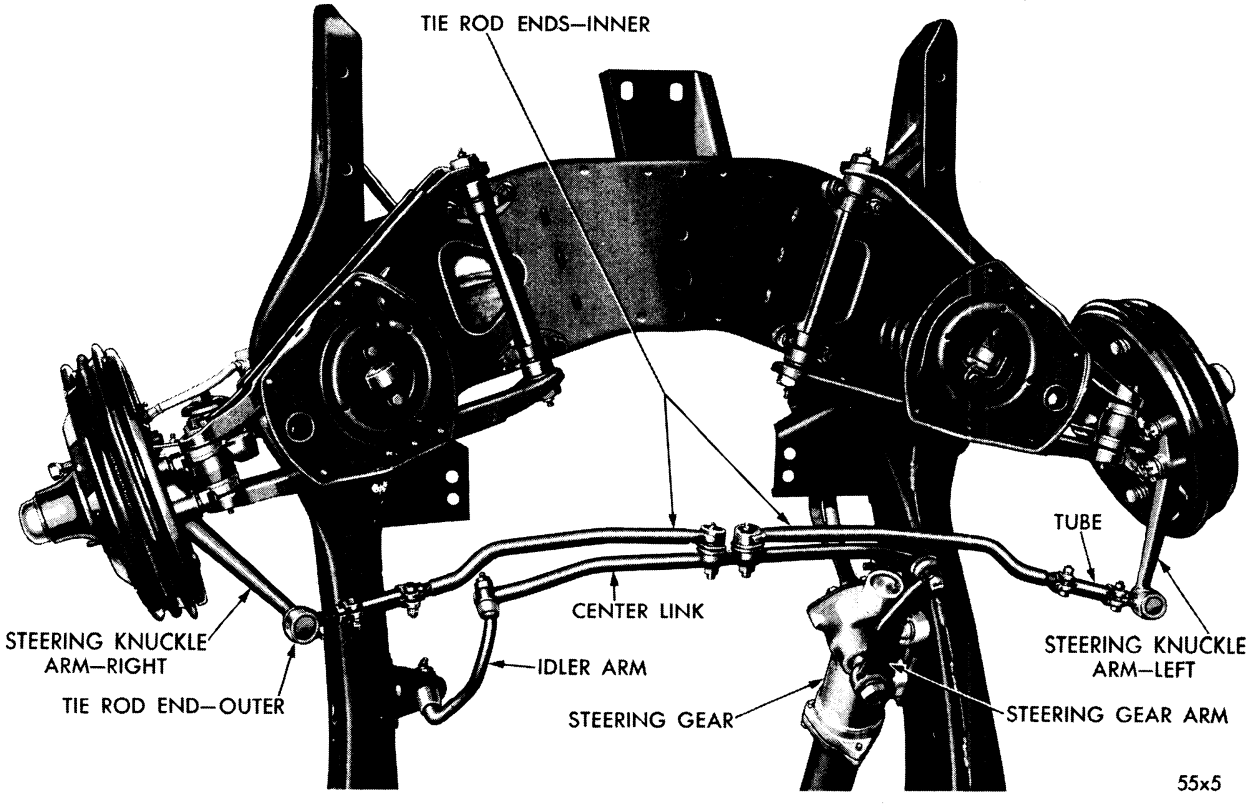

Fig. 2—Idler Arm Type Steering Linkage

obtained by turning the adjusting screw in or out, as required.

The steering wheel and Pitman arm are splined to the steering tube and steering gear shaft, respectively. Both the steering wheel and the Pitman arm have master serrations to insure correct installation.

The high point is the point of least clearance between the worm and roller and is at the mid-point of the worm and roller travel.

An oil seal is installed in the bore of the steering gear housing at the outer end of the shaft to prevent oil leakage and to keep foreign material from entering the steering unit.

3. REMOVAL OF STEERING WHEEL ASSEMBLY

Disconnect battery and center the steering wheel in the straight-ahead position. Press down on the horn blowing ring ornament and turn counter-clockwise. Lift out ornament retaining spring and pad. Disconnect horn wire from terminal on travel plate and insulator assembly. Remove bushing, travel plate, horn blowing contact ring spring, and triangular ground plate. Curl and push horn wire into the steering gear tube to make room for steering wheel puller pilot. Remove the steering wheel nut. Attach puller and remove steering wheel.

4. REMOVAL OF STEERING GEAR ASSEMBLY

It is not necessary to remove the complete steering column and mast assembly from the car for servicing the gear chuck and worm shaft. To remove the gear chuck and worm shaft assembly proceed as follows. Disconnect the battery, press down on the horn ring ornament while rotating it, and remove ornament. Remove steering column worm shaft nut. Pull steering wheel with puller. Loosen jacket bracket bolts at instrument panel. Remove dust pad retaining screws. Raise front of car and remove steering gear (Pitman) arm from gear shaft. Loosen jacket to gear chuck clamp bolt. Remove gear chuck to frame attaching bolts and work gear chuck and shaft assembly out of jacket. Remove assembly from lower side of car.

5. DISASSEMBLY OF STEERING GEAR (Unit Removed From Car)

To disassemble the Manual Steering Gear Assembly, proceed as follows:

Drain lubricant from the steering gear housing. Mount the gear assembly in a suitable bench vise, holding the assembly by the housing to chassis mounting flange, with the steering column in the horizontal position. Remove the shaft cover attaching cap screws, cover, gasket and steering gear shaft, and roller tooth assembly.

Loosen the column jacket clamp bolt, pry open clamp and remove column jacket from steering housing. Remove steering worm, lower oil seal housing cover bolts, cover and shims. Pull steering tube and worm assembly bearing cups and bearing cages out of the lower end of steering housing.

Clean the steering gear housing shaft, bearings and other parts thoroughly with a suitable cleaning solvent. Inspect roller tooth shaft, shaft serrations, bearings, bearing cups, oil seals, worm and tube for wear, nicks and flat spots. Replace with new parts as necessary.

Remove roller tooth assembly shaft cover adjusting screw nut and locking plate. Check adjusting screw threads in cover and on the adjusting screw. Replace if necessary.

6. ASSEMBLY OF STEERING GEAR (Unit Removed From Car)

NOTE

When the steering gear assembly is disassembled, it is always advisable to install new seals and gaskets to insure against oil leaks.

If either of the worm thrust tapered roller bearings have become damaged, it is advisable to replace both bearings. After thoroughly cleaning all parts, assemble the parts without any lubrication. Lubrication should be done after the adjustments have been completed. If bushings or needle bearings have been removed, press new bushings or needle bearings into place. Use new oil seals.

Insert the worm and tube into the housing with bearings and cups in the proper order, as shown in Figure 2. Install the shims and lower housing cover, making sure that bearings are seated in cups before tightening screws. Tighten the cover screws evenly, turning the worm tube at intervals to be sure no bind occurs. Final

tightening of the screws should cause the end play to just disappear with the torque required to rotate the wheel from 3/8 to 3/4 of a pound, when measured with the pull applied at rim of wheel. If a bind in the rotation of the tube occurs when the cover screws are fully tightened, it will be necessary to add shim thickness until bind just disappears. If end play is present after final tightening, less shim thickness is required. Shims are available in .003, .006, .011 and .025 inch. By using a micrometer to measure shims, the proper combination can be chosen.

Refer to Figure 2 and 3. Install the roller shaft bearing in the housing. Before installing the cover, turn the adjusting screw all the way out (counter-clockwise). When the roller shaft assembly is completely installed, with the exception of the Pitman arm, adjust as follows:

Place the steering wheel on the tube and rotate the wheel in either direction to the end of its travel. Then, rotate in the opposite direction to the end of travel while counting the turns. Rotate the wheel back 1/2 the full number of turns. This is the center of travel (mid-travel or high point). Turn the adjusting screw in (clockwise) until all end play in the roller shaft disappears. Roll the wheel back and forth several times. There should be no bind. Rotate the wheel to one of the ends of travel and apply a spring scale or torque wrench. With the pull applied at the rim of the wheel, the tension should measure from 1 to 2 pounds. Rotate the wheel back to the center and on past the center position. The greatest tension should be felt as the wheel is rotated through the center position. Adjust the bearing load by turning adjusting screw in or out of the cover, as required. Install lock plate, nut, and Pitman arm. Fill the gear housing with SAE 90 Fluid Gear Lubricant. Rotate the wheel back and forth through its full travel several times to be sure all parts are fully lubricated and check for leaks.

7. ADJUSTING WORM BEARINGS (In Car)

Rotate steering wheel to extreme right or left and turn back 1/4 turn. Press a finger at joint between bottom of steering wheel hub and shell. Have another mechanic shake the front wheels hard sideways, but not enough to turn steering wheel. Any end play in worm bearings can be felt at steering wheel hub. There should be no end play at the hub. End play should not be confused with clearance between the roller and worm. If any excessive end play exists, remove the steering gear arm, drain the housing, and disconnect the horn wire at connector between steering gear and horn.

Remove cap screws which hold grease retainer cover at bottom of steering gear housing. Remove shims of sufficient thickness between this cover and housing to eliminate the end play in worm, but not enough to cause binding when cover is bolted tightly in place. Turn steering wheel from extreme right to left. If any stiffness exists, too many shims have been removed, or the steering gear assembly is misaligned on car.

8. INSTALLATION AND ALIGNMENT OF STEERING GEAR ASSEMBLY

a. Installation

Where gear chuck and worm shaft assembly has been removed for service, install as follows. Raise front of car, insert worm shaft into jacket and move gear chuck assembly up into position.

It may be necessary for an assistant to guide the top of the worm shaft through the upper jacket alignment bearing. Install gear chuck to bracket attaching bolts and tighten forward bolt to a snug fit. Lower car to floor. Center the jacket in the instrument panel and tighten bracket bolts. Install and tighten dust pad retaining screws. Install steering wheel horn ring and ornament. Raise front of car. Tighten attaching bolts. Install steering (Pitman) arm and tighten nut.

b. Alignment (All Models)

A slight bind of the steering gear is sometimes caused by shifting of body due to loosened bolts. If this condition occurs, body bolts should first be tightened. Then, the steering gear should be loosened at frame, frame bracket and dash bracket, and allowed to seek its natural position. Position the center of steering column in center of instrument cluster. If this cannot be accomplished by the shifting of the frame bracket, as provided for by the oversize and elongated mounting screw holes, it will be necessary to add metal washer shims between the frame and frame bracket. Tighten dash bracket and tighten steering gear to frame.

NOTE

Be sure the body to frame bolts are tight and the spacers are in place. With the body bolts tight, loosen the gear housing mounting bolts to allow the steering gear to move in relation to the frame. Tighten the mounting bolts to 50 foot-pounds torque. Loosen the steering column bolts that hold column to instrument panel to determine if the column shifts its position in relation to the support.

9. ADJUSTMENT OF ROLLER TOOTH AND WORM (In Car)

End play of steering arm shaft and mesh of roller tooth with steering worm may be adjusted as follows:

Remove steering gear (Pitman) arm from shaft and install another arm for making adjustments. Turn steering wheel to mid-position. This is obtained by turning wheel to extreme right or left, and then turning it to opposite extreme, counting number of turns required. Turn steering wheel back ½ the number of turns required for turning it from one extreme to the other. With steering wheel in mid-position, attempt to move steering gear arm back and forth to determine whether or not there is any backlash. There should be **no** backlash. But if backlash exists, the roller tooth and worm should be adjusted.

Remove roller tooth shaft adjustment screw lock nut. Slide off lock plate far enough to clear lock boss on roller tooth shaft cover. Tighten roller tooth shaft adjusting screw (Fig. 3) enough to eliminate free play between roller tooth shaft and worm; **but, it must not bind.** Slide lock plate in position against roller tooth shaft cover and lock it. Install and tighten roller tooth shaft adjustment screw lock nut. Check steering gear operation again for binding and backlash. Correct any inaccuracies in adjustments. Install steering gear arm with tie rods.

10. SERVICING IDLER ARM

Service of the idler arm is restricted to replacement and adjustment. When replacing the idler arm, disconnect the relay rod (center link) from the idler arm. Remove the bracket attaching screws from the bracket and frame and remove

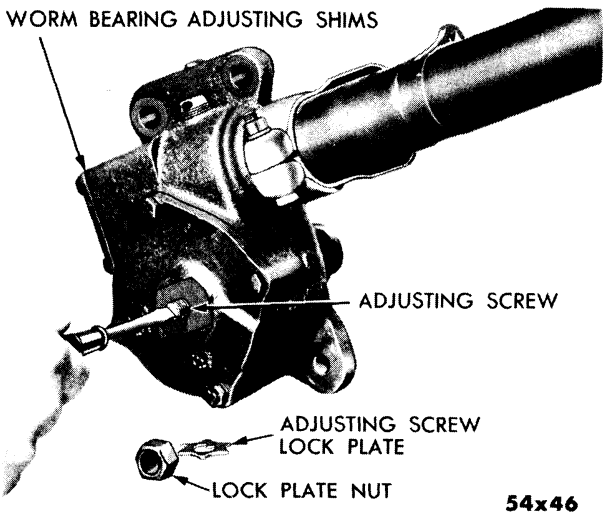

Fig. 3—Steering Gear Adjustments

the idler assembly. Screw the new idler arm into the bracket until the shoulder on the arm contacts the face of the bracket. Turn arm out of bracket one complete turn. **It may be necessary to rotate the arm slightly to line up the bracket for installing attaching bolts.**

11. REMOVAL AND INSTALLATION OF STEERING KNUCKLE TIE RODS

Remove cotter pin and loosen nut on upper end of the rod ball. With Tool C-3394, remove tie rod from steering arm (Fig. 4). **Tie rod balls are not removable from tie rod ends. If replacement of either is necessary, the complete tie rod end and ball assembly should be replaced.** Loosen clamping bolt nut on the tie rod end. Unscrew tie rod end assembly from tie rod.

When assembling tie rod ends to tube body, be sure to thread the ends evenly on tube body to the nominal length listed in Data and Specifications. This is necessary to obtain proper positioning of the steering wheel with respect to the straight-ahead position of the front wheels. Care must be taken to make certain the clamping bolts are beneath the tie rods to prevent interference on turns.

12. ADJUSTMENT OF FRONT WHEEL BEARINGS

After removing the hub cap and the grease cap, remove the cotter pin in the bearing adjusting nut at the outer end of the steering knuckle

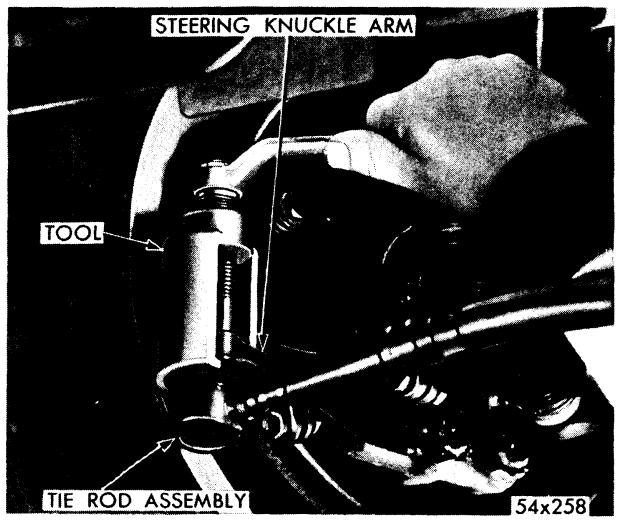

Fig. 4—Removing Tie Rod From Steering Knuckle Arm (Tool C-3394)

(wheel spindle). Turn bearing adjusting nut (Fig. 5) hand tight. Turn adjusting nut back one slot. Turn the nut back until slot nearest cotter pin hole centers over hole and install a new cotter pin. **The bearing nut threads must be in good condition and the cotter pin properly installed and spread. Always use new cotter pins.**

13. RECONDITIONING FRONT WHEEL HUB AND DRUM ASSEMBLY

Raise front end of car until wheel is off floor. Remove hub cap. Remove wheel hub bolts. Bolts on left wheels have left-hand threads and those on right wheels have right-hand threads. Remove wheel hub grease cup (snap type) with special Tool C-438, or by prying with a screw driver and tapping with a light hammer. Remove threaded type by unscrewing cap from hub. Remove cotter pin and unscrew front wheel bearing adjusting nut. Remove outer bearing and pull hub off steering knuckle. **It is not necessary to remove wheel from hub if hub is to be removed from steering knuckle spindle. Wheel and hub may be removed as a complete unit.** Inspect oil seal and replace if necessary.

Before installing front wheel hub and bearing assembly, remove lubricant from the hub and bearings and make sure parts are in good condition. Install inner and outer bearing cups so there is no clearance between the hub shoulders. Pack bearings with Short Fiber Wheel Bearing Lubricant (Medium). **When installing the oil seals, make certain that the seal flange bottoms on the bearing cup.**

14. REMOVAL AND INSTALLATION OF STEERING KNUCKLE KING PINS AND BUSHINGS

NOTE

Should servicing of the steering knuckle be nec-

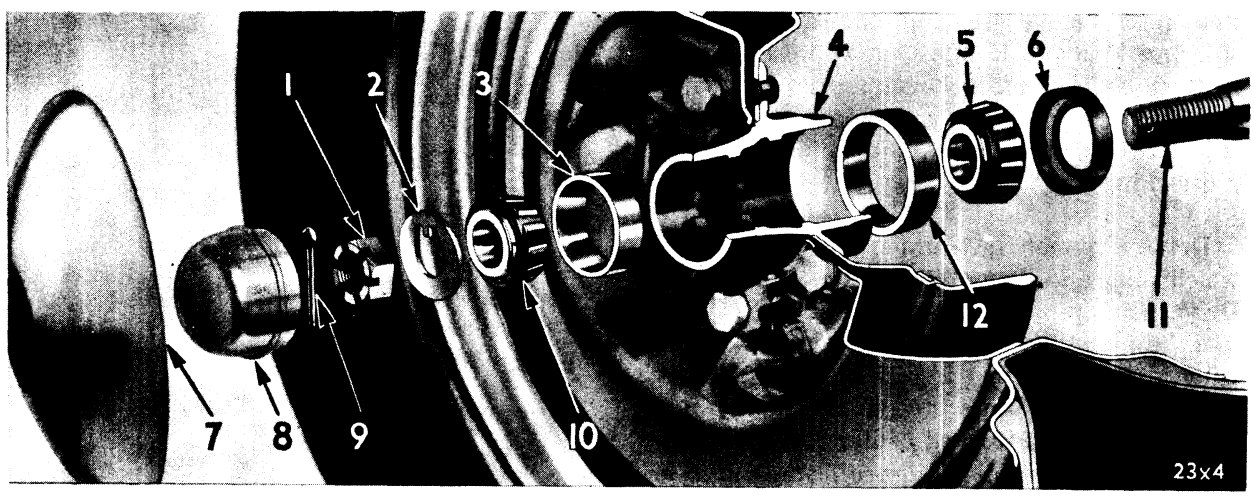

Fig. 5—Front Wheel Bearings

1—Bearing nut
2—Bearing thrust washer
3—Outer bearing cup
4—Hub
5—Inner bearing cone and rollers
6—Hub dust seal
7—Hub cap
8—Grease cap
9—Bearing nut cotter pin
10—Outer bearing cone and rollers
11—Steering knuckle
12—Inner bearing cup

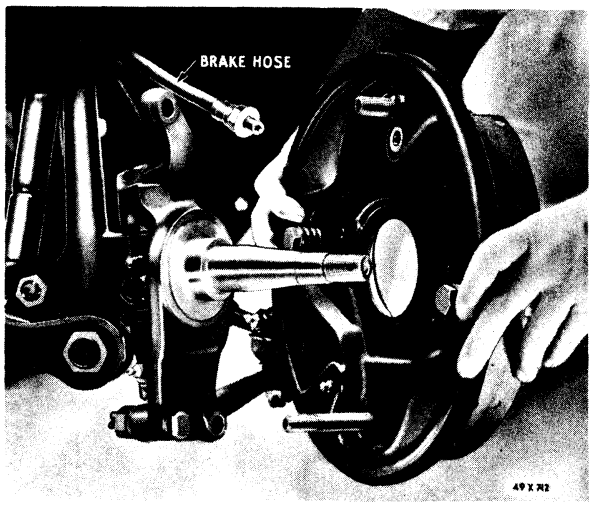

Fig. 6—Removing Brake Support

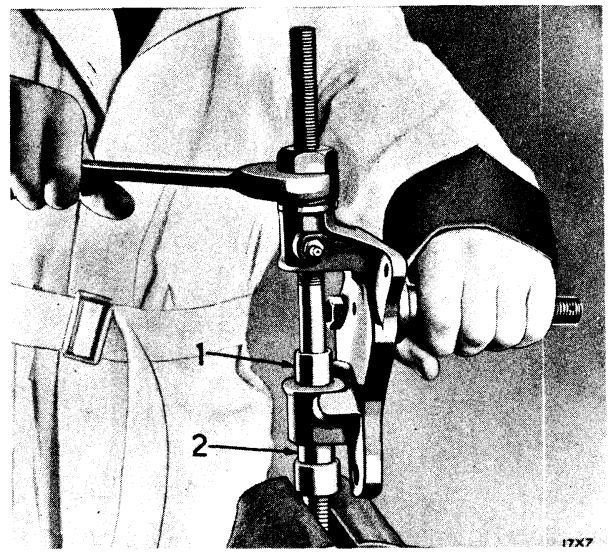

Fig. 7—Removing King Pin Bushing or Bearing

1—King pin bushing or bearing 2—Tool C-328

essary, time can be saved by removing the steering knuckle arm from the steering knuckle. Remove steering knuckle and brake support as an assembly. Make necessary repairs on a bench. If it is done in this manner, eliminate removing support. Remove brake hose connections, but leave brake support on steering knuckle. Remove unit as an assembly with steering knuckle after king pin is removed. Always use new bushings, seals, and pins when servicing the steering knuckle and support assembly.

Remove wheel and hub assembly. Block brake pedal so it cannot be depressed. Remove nuts and bolts that fasten brake support to steering knuckle. Remove steering knuckle arm from steering knuckle. Remove brake hose and connections and lift off brake support (Fig. 6). **Do not allow brake support and shoe assembly to be supported by flexible brake hose.** Remove king pin locking pin.

Drive a punch into upper steering knuckle welch plug and pry it out of steering knuckle. Drive king pin downward, forcing out lower welch plug. A soft brass drift should be used when driving against top of king pin. Remove steering knuckle upper needle bearing or bushing by pulling it toward center knuckle, using special tool, as shown in Figure 7. Remove steering knuckle lower bushing. If bushing is of the stationary type, use special tool to remove it.

The upper needle bearing must be installed from top of steering knuckle, with trade mark at top and oil hole in bearing lined up with oil hole in steering knuckle. Stationary type bushings (Fig. 8) should be line-reamed. First remove the upper needle bearing. Install reamer pilot bushing Tool C-631 and reamer Tool C-379. When installing lower and upper floating type bushing (Fig. 9), place open end of oil groove to the top. Both types of lower bushings should

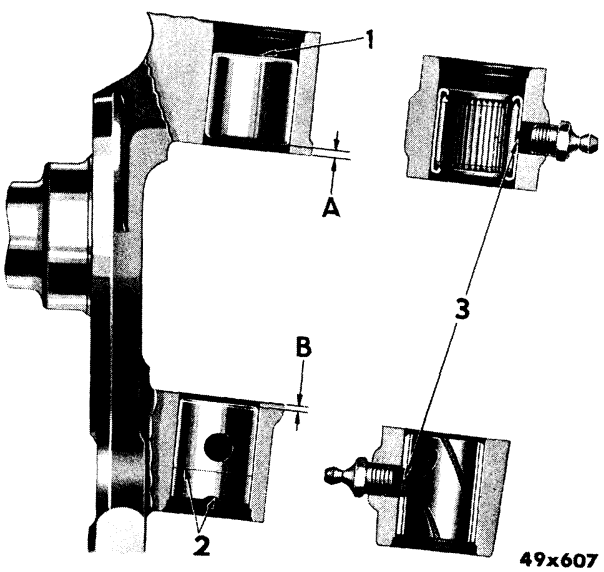

Fig. 8—Bearing and Stationary Type Bushing Installed

1—Bearing identification mark
2—Bushing identification line or notch
3—Lubricant holes
A—3/32 inch
B—1/16 inch

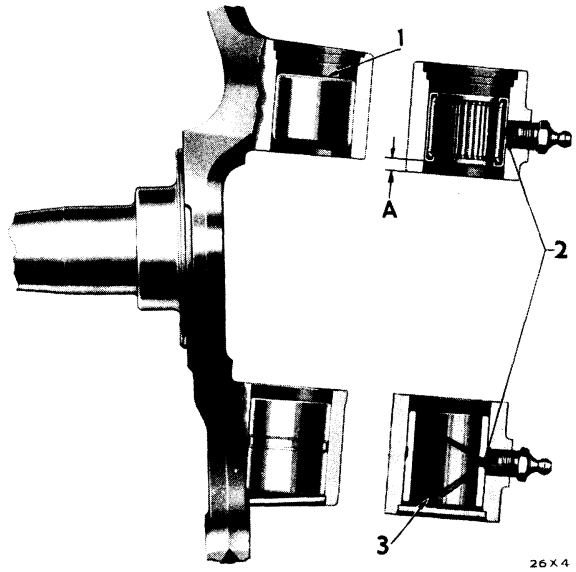

Fig. 9—Bearing and Floating Type Bushing Installed

1—Bearing identification mark
2—Lubricant holes
3—Floating type bushing
A—3/16 inch

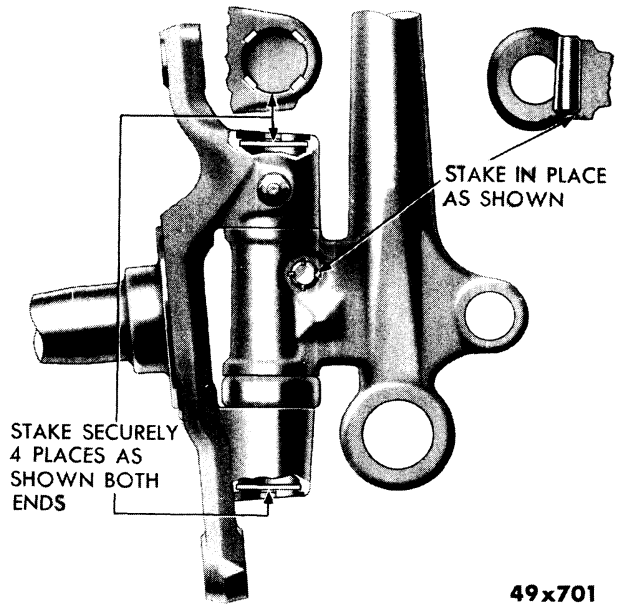

Fig. 10—Welch Plug and King Pin Lock Pin Installed

be installed with oil hole in bearing lined up with oil hole in steering knuckle. On cars equipped with Power Steering, the king pin bushings should be installed with the open end of the oil groove leading towards the "O" seal rings.

After installing the steering knuckle, make sure it is free in the support. Binding at this point may cause sensitive steering and car wander. There should be .006 to .008 inch clearance between the steering knuckle and the knuckle support. This clearance can be adjusted by the use of shims between the steering knuckle and the thrust bearings.

When installing a welch plug, it is necessary to stake it after it is properly in place, as shown in Figure 10.

Before installing hub and drum assembly, perform Major Brake Adjustment, described in Section III, Brakes, as applied to cars equipped with Manual Steering. After installing hub, drum and wheel assembly, check king pin inclination, caster, camber, and toe-in or toe-out, as outlined in Front Wheel Alignment in this Section. Adjust brakes.

COAXIAL POWER STEERING

15. DESCRIPTION (Fig. 11)

The Coaxial Power Steering Unit incorporates two basic gear mechanisms, a worm and worm connector and a rack and sector gear.

The worm and worm connector act in a manner similar to a bolt and nut assembly, rotation of the worm causes linear (axial) motion of the worm connector. Fastened to the worm connector, in succession, are an upper piston rod, a piston, and a lower piston rod, all concentric to the steering column axis. (This arrangement provides a means for adding power assistance to the system.)

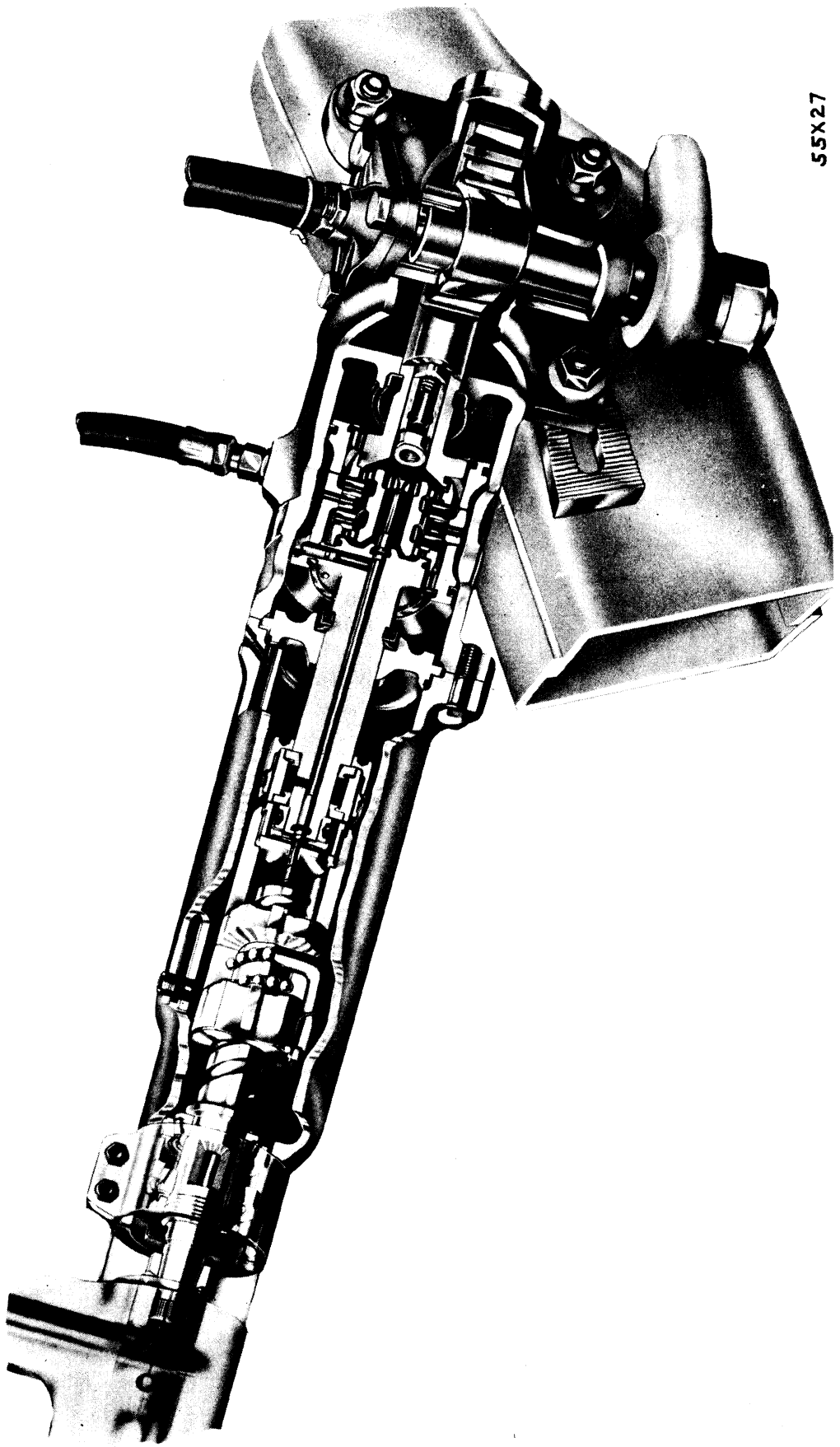

Fig. 11—Coaxial Full Time Power Steering

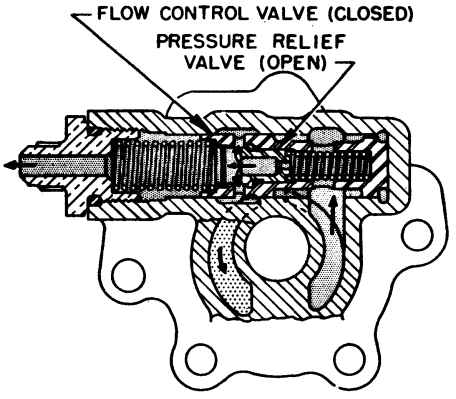

Fig. 12—Pump Pressure and Flow

A rack, machined in the lower portion of the lower piston rod, meshes with a sector gear. This combination produces rotation of the steering gear arm and thereby actuates the steering linkage.

The hydraulic system of the Coaxial gear consists of a double-acting piston, a valve (which fits inside the piston), and a hydraulic reaction chamber (which gives the driver the "feel" of the road). Axial positioning of the valve directs high pressure oil to one side or the other of the double-acting piston. At the same time, valve movement opens an oil return line which carries oil from the low pressure side of the piston to the oil reservoir. The direction of oil flow (which depends upon the direction of steering wheel rotation) is such that hydraulic force is added to the driver's effort and is transmitted through the rack and sector gear to the steering gear arm.

Other components of the hydraulic system are, a generator-driven oil pump with pressure relief valve and flow control valve, and a filter with the oil reservoir. The flow control valve limits the oil flow to a predetermined maximum (1½ gallons per minute) and thus holds the horsepower required to drive the oil pump to a minimum.

a. Power Steering Oil Pump, Reservoir and Assembly

The oil pump and reservoir assembly is mounted at the rear end of the generator. A cartridge-type filter element is located in the reservoir. Oil from the steering gear assembly flows through an internal passage in the pump body, through the full-flow oil filter, and into the reservoir chamber. From the reservoir, oil enters the oil pump intake (Fig. 12). The position of the oil pump is adjustable to help maintain level fluid in reservoir when drive belt is adjusted.

A small diaphragm vent valve in the reservoir cover is forced open to provide a passage to the atmosphere, if excessive pressure occurs in the reservoir.

With cold oil, insufficient oil would pass through the filter to the reservoir, and the oil pressure would build-up in the line from the steering gear assembly. Therefore, a spring-

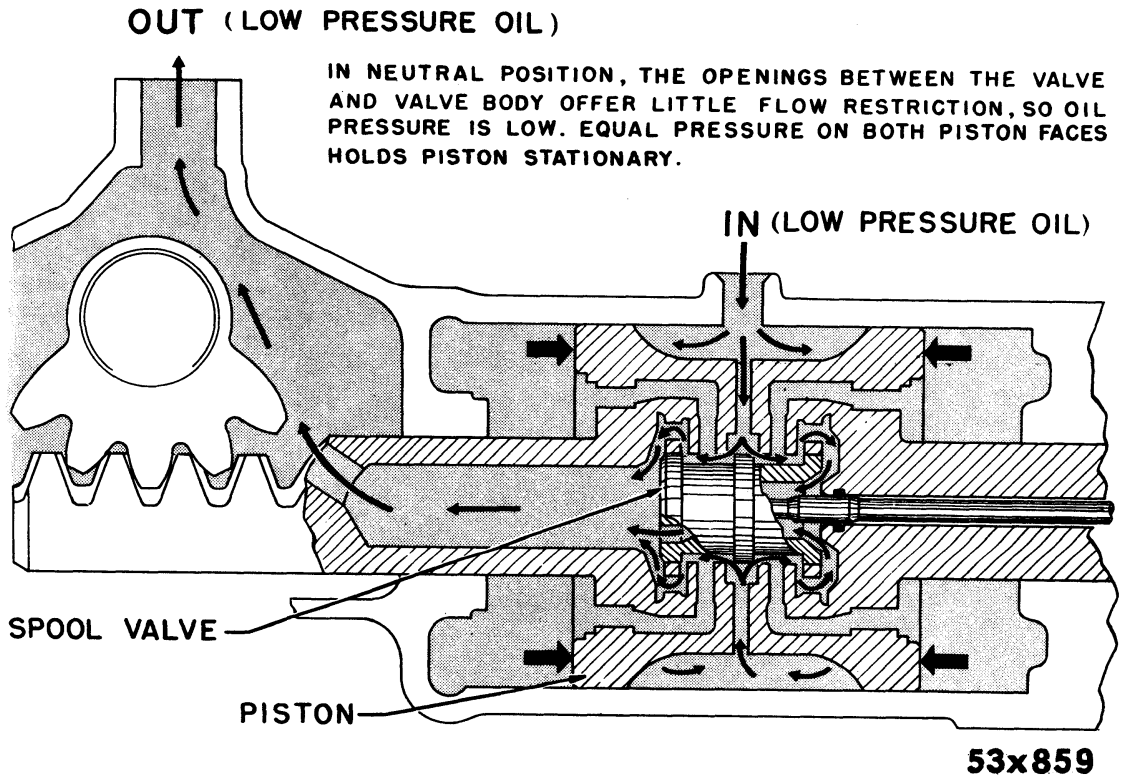

Fig. 13—Oil Flow—Neutral Valve Position

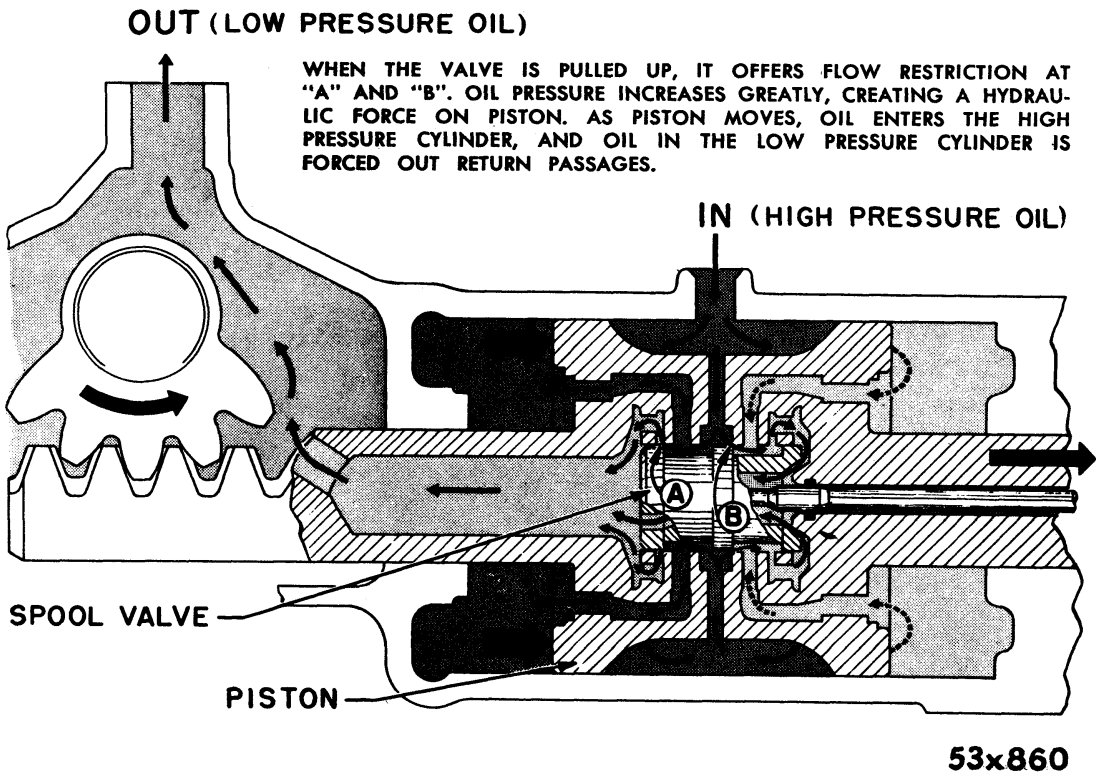

Fig. 14—Oil Flow—Right Turn—Valve Pulled Up

loaded relief valve is provided at the top of the filter element. When oil pressure in the filter builds up to about 5 to 7 psi., this valve opens and permits oil to pass directly into the reservoir chamber.

The rotary oil pump is driven from the rear end of the generator armature shaft through a flexible coupling. The single rotor in the pump draws oil from the reservoir, and discharges it through the built-in combination flow control valve and pressure relief valve to the valve in the power unit assembly.

In the power steering pump, the flow control valve and pressure relief valve are combined in a single assembly, as shown in Figure 12. The spring-loaded pressure relief valve is concentric with and fits inside the spring-loaded flow control valve. When the pressure relief valve is closed, it seats against a snap ring in the flow control valve. An orifice in the pressure relief valve provides the oil pressure drop that controls the operation of the flow control valve. When the oil flow from the pump tends to rise above 1½ gallons per minute, the difference in pressure across the orifice overcomes the spring load, and the flow control valve moves to uncover a passage to the intake side of the pump. By preventing excessive oil flow, the flow control valve limits the pressure drop through the hydraulic system and thus limits the horsepower required to drive the pump. Oil flow of the pump when the engine is idling is about 1½ gallons per minute.

Oil pressure in the hydraulic system builds up to that required to overcome the resistance to turning of the road wheels. In other words, straight-ahead highway steering requires a relatively low oil pressure, while a higher oil pressure is required when turning a corner. A rapid build-up of oil pressure tends to occur when the road wheels are turned against a curb or when the steering wheel is turned all the way in one direction so that the piston reaches the end of the stroke. To prevent excessive oil pressure, the pressure relief valve in the pump limits the oil pressure from 750 to 800 psi.

The entire hydraulic oil system for power steering has a capacity of 2 quarts of SAE 10 W engine, or type "A" oil. The worm housing capacity is one pint which is separate from the pressure system.

b. How the Coaxial Power Steering Operates

The heart of the Coaxial Power Steering Unit has two parts; the valve and the valve body (actually a part of the hydraulic piston, as shown in Figure 13). Together, these two pieces control the operation of the entire power system. When the driver turns the steering wheel, the valve moves with respect to the hydraulic piston, and power asistance instantly responds. The **relative** movement between the valve and piston is very slight (it seldom exceeds .0025 inch) and must not be confused with the general movement of the whole steering system as the front wheels turn. The driver controls the power steering unit by governing the relative movement between the valve and hydraulic piston. Control movements are based on feel of the road that comes through the steering wheel from a hydraulic reaction chamber inside the power unit. Relative movement of the valve and piston affects hydraulic action as follows:

As the valve moves relative to the piston, it regulates oil pressure and directs oil flow through the hydraulic circuit. Consider the case where the steering wheel is not turned and the valve is in neutral position, as shown in Figure 13. In this position, the valve leaves openings between it and the valve body so oil flows through the unit quite easily with very little flow restriction. Therefore, the oil pump has only a slight resistance to overcome, and the oil entering the power steering unit is under low pressure.

Inside the unit, the oil reaches the valve through holes drilled in the piston. At the valve the flow divides, and oil travels toward both ends of the valve. It flows through succeeding openings between the valve and adjacent valve body until it reaches the main return passage drilled through the lower piston rod. It then returns to the reservoir and filter. In the neutral position, oil pressure on both sides of the power piston is the same. Consequently, the piston remains stationary.

When the driver turns the steering wheel, the valve moves either up or down, depending on which direction he turns. Suppose that he moves the valve **up** slightly, relative to the piston. By moving the valve this small amount, the driver

puts the power system into operation, as shown in Figure 14.

The instant the valve is moved, two important things happen: (1) the inlet oil pressure increases because of restricted openings between the valve and valve body, and (2) the increased pressure is directed to **one side** of the power piston. The restrictions causing the pressure rise are marked "**A** and **B**" in Figure 14. These narrow spaces "dam up" the oil that is being forced through the system by the oil pump. Because the pump is a positive-displacement type, the oil must keep moving. As the oil "piles-up" behind the restrictions, its pressure increases tremendously, squeezing oil through the narrow spaces at a very fast rate. Often the restrictions may close completely, giving operating pressure at the fastest possible rate. The maximum pressure build-up is limited to 800 psi by a pressure relief valve in the pump assembly.

The high oil pressure is directed to the lower end of the cylinder (for this case through the passages indicated in Figure 14). However, the opposite end of the cylinder is open to the return line. Therefore, a difference in pressure exists in each end of the cylinder and the piston moves. Oil trapped in the lower pressure cylinder is forced through the return passages as the piston moves up.

By careful design, all of these elements have been combined into two compact units which are connected by a pair of flexible hoses. The power unit contains the power piston, spool valve, and hydraulic reaction chamber. The supply unit incorporates the reservoir and the oil pump with its valves.

If the driver stops turning the steering wheel and holds it in a fixed position, the front wheels immediately stop turning. This is how it happens: with the steering wheel held, the valve remains in its pulled up position because the valve is mechanically connected to the steering wheel. The piston, on the other hand, is moving up under the action of the pressure in the lower end of the cylinder, and continues to move up for the briefest instant until the relative motion between piston and valve has returned them to the neutral position. In neutral position, there is very little flow restriction, as explained before,

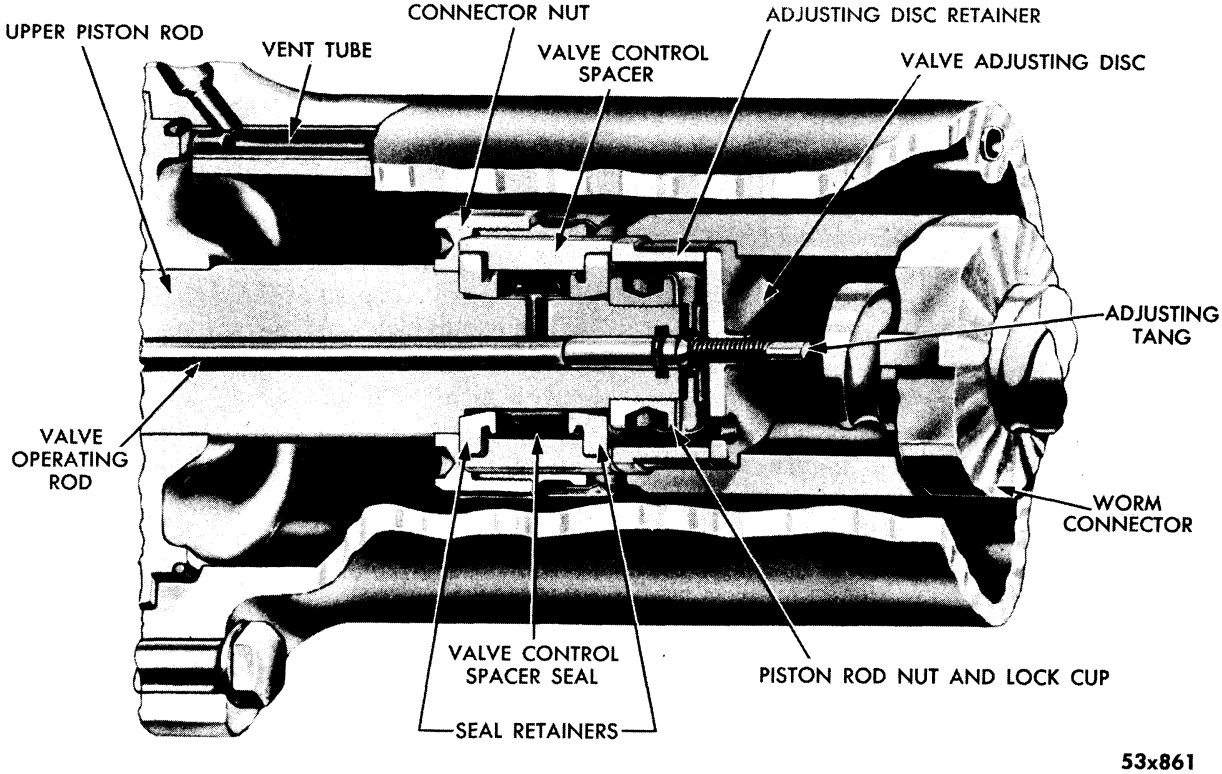

Fig. 15—Hydraulic Reaction Assembly

OIL IS SUPPLIED FROM MAIN LINE AT OPERATING PRESSURE. DRIVER'S STEERING FORCE PASSES FROM WORM CONNECTOR TO REACTION RING TO THE OIL-FILLED SEAL WHICH RESISTS BEING SQUEEZED BECAUSE OF THE PRESSURE WITHIN IT. THIS RESISTANCE GIVES DRIVER THE "FEEL" OF STEERING BECAUSE OPERATING PRESSURE IS PROPORTIONAL TO TURNING LOAD.

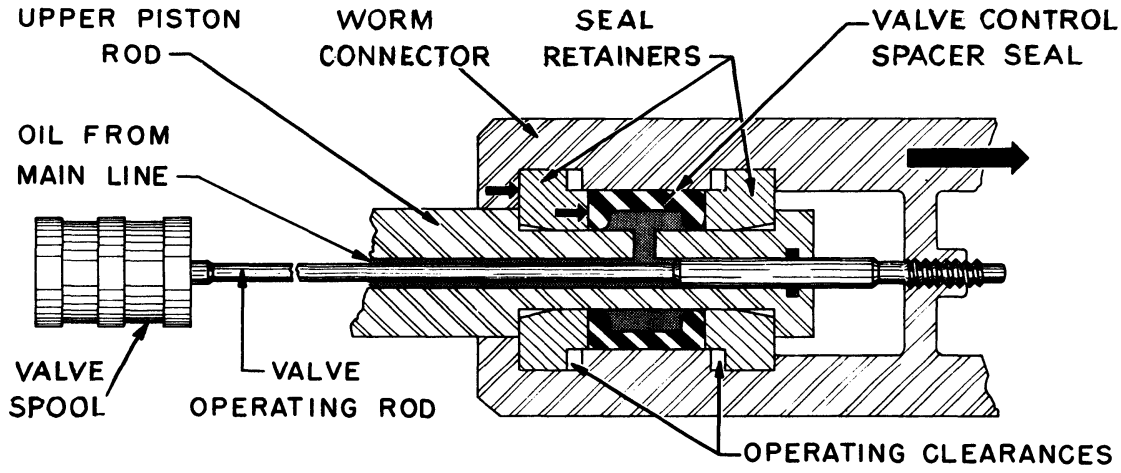

Fig. 16—Hydraulic Reaction Chamber

so oil pressure drops to its lowest point. Power assistance ceases and the front wheels remain where the steering wheel indicates. The entire action is instantaneous because the relative movement between valve and piston is so slight.

What causes the relative movement between these parts and how does the driver get his "feel" of the road?

The first important fact to remember is that the valve is mechanically connected to the steering wheel, as shown in Figure 15. The valve solidly connects to the worm connector through the valve-operating rod. The worm connector is attached to the steering wheel through a worm shaft, as shown in Figure 11. Hence, the slightest steering wheel movement is transferred through the worm connector to the valve.

Another important fact, is that the upper piston rod is **hydraulically** attached to the worm connector through two seal retainers and a rubber reaction seal whenever the power system is operating (Fig. 16). The connection is called hydraulic because the rubber seal, one of the connecting links between the worm connector and piston rod, is filled with oil. Oil from the main oil line is supplied to the seal through a hole drilled in the piston and another drilled down the long axis of the upper piston rod. The oil in the reaction seal is, therefore, at full operating pressure.

Suppose the steering wheel is turned in such a direction so that the worm connector (and valve) tries to move up (right turn). In trying to move up, the worm connector pushes on the lower seal retainers and squeezes the oil-filled seal. Because the valve has been in neutral position until this instant, the pressure inside the reaction seal is low and the seal compresses, allowing the worm connector — and valve — to move **without moving the piston rod.** In other words, there is relative motion between the valve and piston which is fastened to the piston rod. Therefore, oil pressure rises in the system because of the restrictions between the valve and valve body, and the piston begins to move the steering parts that connect to the front wheels. At the same time, the higher oil pressure is felt inside the oil-filled reaction seal. The greater pressure inside the reaction seal attempts to force the seal and the worm connector back to their original (neutral) positions. Therefore, the driver feels a resistance to turning the steering wheel (a resistance proportional

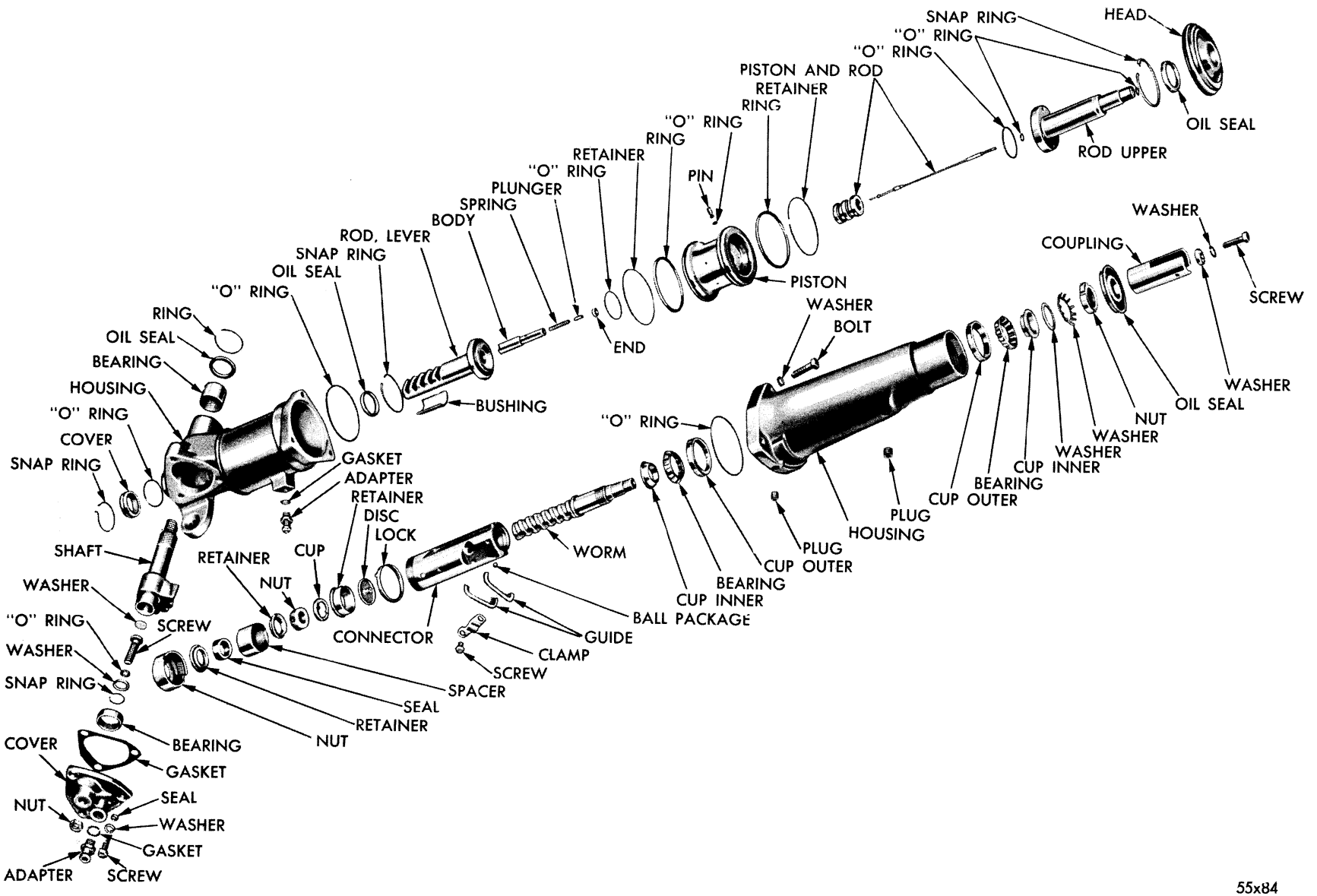

Fig. 17—Coaxial Power Steering (Exploded View)

to the steering resistance at the road). This permits a desirable "feel" of the road with a minimum of driving effort.

It should be remembered that the process just described is instantaneous as far as the driver is concerned; it has been broken into steps simply for explanation.

The driver controls the front wheels surely and accurately with his steering wheel. If he stops turning, piston movement will return the system to neutral, as already explained. If he keeps turning, he maintains the relative movement between valves and piston, and the power system keeps operating. During operation, the driver always "feels" the road through the steering wheel.

The driver is helped by power assistance, if road disturbances try to turn the front wheels off course. When a driver holds the steering wheel fixed, he actually is commanding the power system to hold the front wheels fixed, regardless of the forces that try to turn them. The power system complies by acting "in reverse" whenever road obstructions jar the wheels. For example, suppose the front wheel strikes a rut or chuck hole. The wheel begins to deflect from its course. The first slightest amount of off-course deflection is transmitted through the steering linkage to the hydraulic piston. The piston moves a fraction. However, because the driver is holding the steering wheel, the valve cannot move. There is relative motion between the valve and piston (this time caused by piston motion rather than the valve motion). Therefore, oil pressure builds up in the one end of the cylinder, creating a hydraulic force that pushes the piston back toward the neutral position in direct opposition to the disturbing obstruction. Hence, the front wheels do not turn. The driver maintains control on bad roads with a minimum of steering effort.

If oil pressure is somehow interrupted (such as the fan belt breaking), the small operating clearances in the hydraulic reaction chamber close up as the driver turns the wheel one way or the other, giving solid metal connections (Fig. 16). Therefore, the system steers mechanically; that is, steering wheel movements travel through the worm connector, through one seal retainer, through the piston rod and piston, and through the rack and sector gear to the linkage that connects to the front wheels. If this condition is allowed to continue, steering wheel play will greatly increase and oil will be pumped out of the system through the reservoir vent.

MAINTENANCE AND ADJUSTMENT OF COAXIAL POWER STEERING

16. REMOVAL OF COAXIAL POWER STEERING UNIT FROM CAR

Remove horn ring ornament from steering wheel. Disconnect horn wire and remove horn ring. Remove steering wheel with puller and remove turn signal lever and plate. Loosen the steering column to instrument panel bracket.

Loosen steering column jacket clamp screws and raise front of car. Disengage drag link from Pitman arm and pull Pitman arm with Tool C-3402. Loosen three gear housing to frame attaching bolts. Remove floor mat retaining plate and rubber dust pad. Disconnect pressure and return hoses and drain gear assembly by slowly rotating steering wheel until all oil is expelled from unit. Fasten disconnected ends of hoses above oil level in reservoir to prevent further loss of oil and cap the ends to prevent any foreign matter from entering. Remove gear housing to frame attaching bolts and alignment wedge. Remove gear assembly from lower side of car.

17. DISASSEMBLING THE COAXIAL POWER STEERING UNIT (Fig. 17)

a. Precautions to Follow During Disassembly and Assembly

Cleanliness throughout the entire disassembly and assembly operations is absolutely essential. The unit should be thoroughly cleaned in a suitable solvent when removed from vehicle. When disassembling, each part should be placed in the solvent, washed, and dried by compressed air. Careful handling of parts must be exercised to avoid nicks and burrs. Crocus cloth may be used to remove small nicks or burrs, provided it is used carefully. When used on valve

spool, use extreme care not to round off the sharp edge portion. The sharp edge portion is vitally important to this type of valve since it helps to prevent dirt and foreign matter from getting between the valve and bore, thus reduc ing the possibilities of sticking.

Remove and discard all "O" seal rings, and seals. Use new ones lubricated with Lubriplate when reassembling. To disassemble the Power Steering Unit for repair or overhaul, refer to Figure 17, and proceed as follows:

b. Removal of Worm Housing from Gear Housing

Drain lower portion of steering gear through pressure and return connections by turning steering tube coupling from one extreme of travel to the other. Using a 3/16 inch Allen wrench, remove worm housing filler plug and drain the worm (upper) housing. Attach holding fixture to unit and place in a vise. Use concave type washers when mounting steering housing on tool. Remove tube coupling screw, lockwasher and washer from center of coupling. Remove coupling from worm shaft, as shown in Figure 18. Remove the worm housing oil seal with a screwdriver from the housing. **Use extreme care to avoid damaging housing when removing seal.** Unlock bearing adjusting nut by bending tang of lockwasher. (Only one tang locks nut in position.) Place tools over worm shaft, as shown in Figure 19. Holding the worm stationary, remove worm bearing adjusting nut, lockwasher and thrust washer. The worm bearing adjusting nut is tapered on the bearing side. Remove the worm outer bearing race and bearing roller from worm. Remove the three worm to gear housing screws and concave washers and remove worm housing. It may be necessary to tap housing lightly due to interference fit with "O" ring seal between housing head and housing. The concave side of the washers fit against housing. **Use care to avoid dropping the inner bearing during this operation.** Remove lower bearing roller from housing. Inspect bearing roller and the upper and lower bearing cups in housing. **Do not remove bearing cups unless inspection reveals it is necessary.** To remove upper and lower bearing cups, use Tool C-3322, as shown in Figure 20.

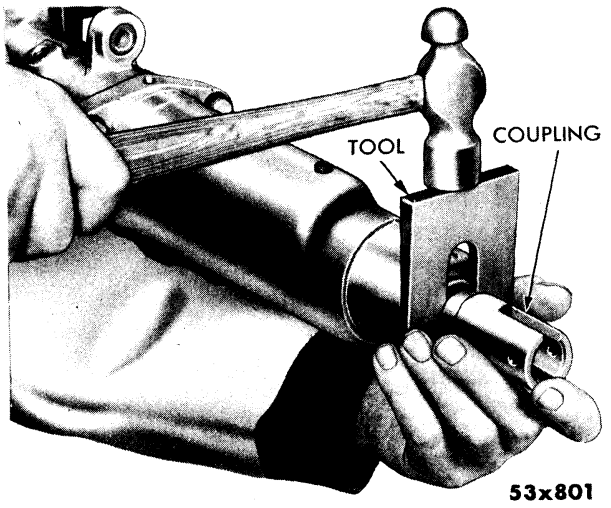

Fig. 18—Removing Tube Coupling (Tool C-3392)

c. Removal of Worm Connector

Remove housing head "O" ring. Unlock worm connector nut lock and slide lock back sufficiently to loosen worm connector nut. With Tool C-3321 attach to worm connector, remove connector nut, as shown in Figure 21. It may be necessary to rotate steering gear shaft (by installing Pitman arm), to raise worm connector in order to permit installation of Tool C-3326. Slide worm connector assembly from valve control spacer.

d. Disassembly of Worm Connector Assembly

Disassembly of the worm connector and worm shaft assembly is not recommended unless damaged or worn.

CAUTION

Caution should be exercised not to bottom the worm shaft in the outward direction upon disassembly or assembly. Bottoming the worm shaft may damage the ball guides and cause a tight and rough operating worm.

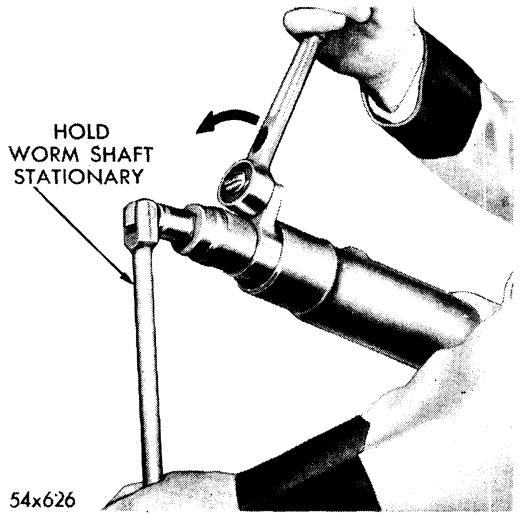

Fig. 19—Removing or Installing Bearing Adjusting Nut

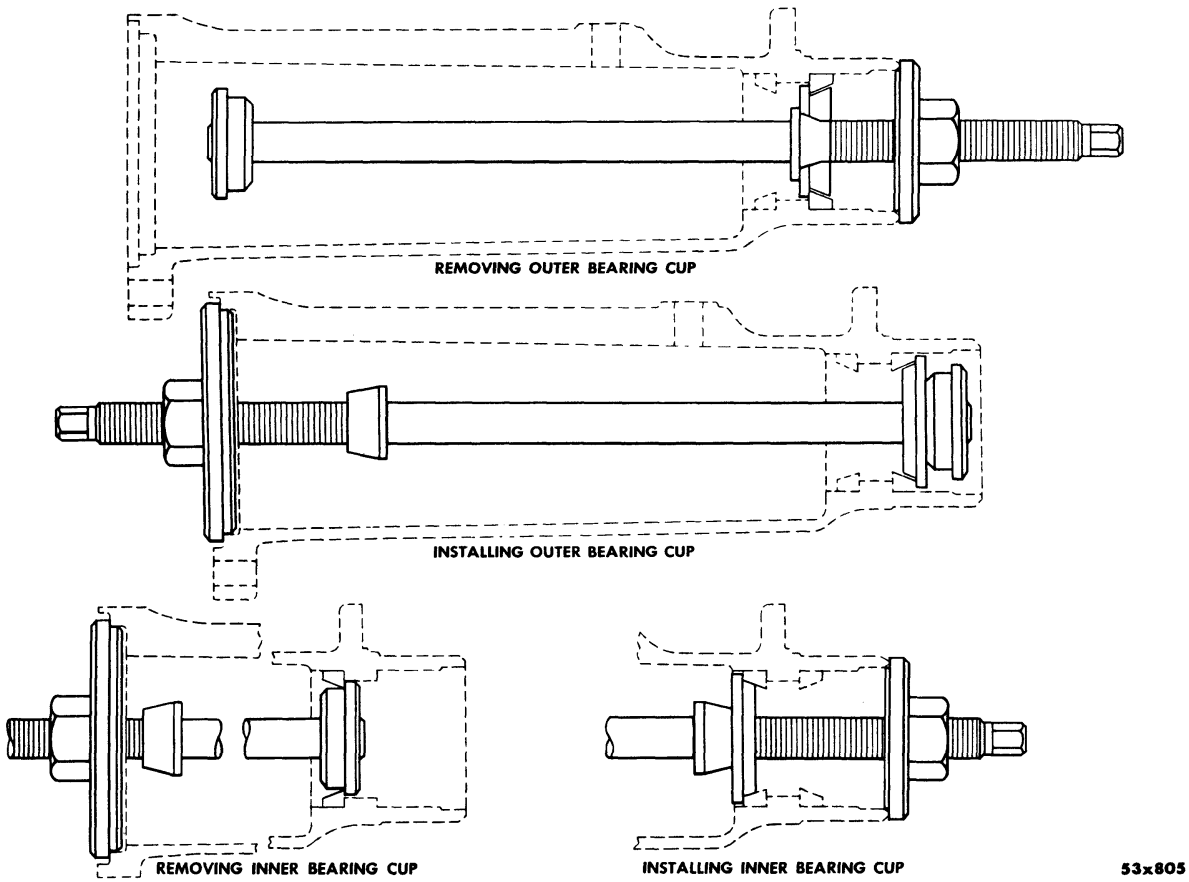

Fig. 20—Removing or Installing Upper and Lower Bearing Cups (Tool C-3322)

Remove the worm connector ball guide clamp screws and lockwashers. Remove guide clamp, as shown in Figure 22. Using care to avoid losing any of the worm balls, carefully remove the ball guide from the worm connector. Worm balls are a select fit with each other. If any of them are damaged and require replacing, it is recommended that a complete set (40) be installed.

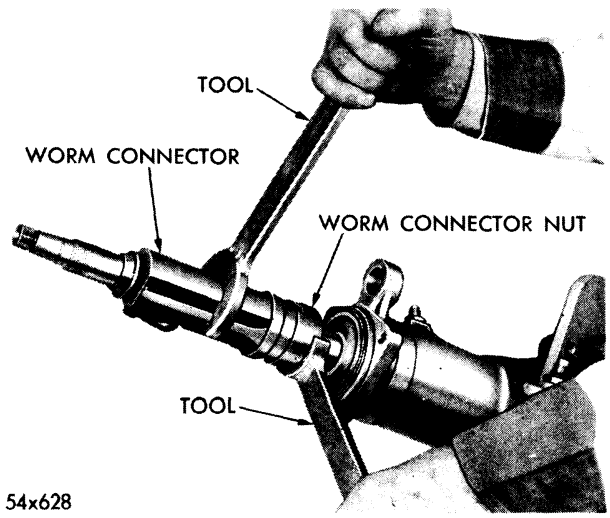

Fig. 21—Removing or Installing Worm Connector Nut

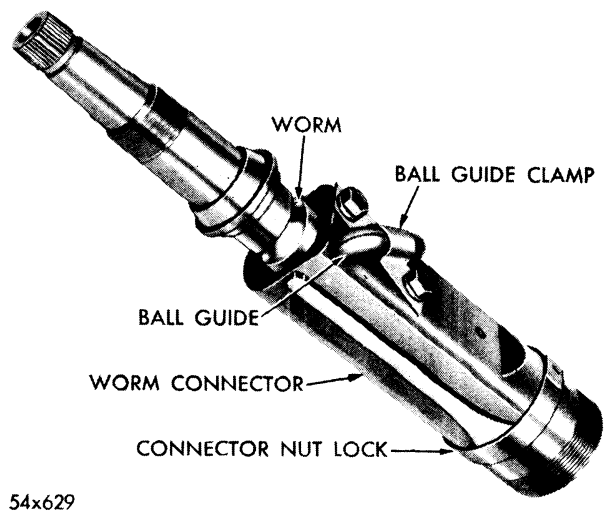

Fig. 22—Ball Guide and Guide Clamp

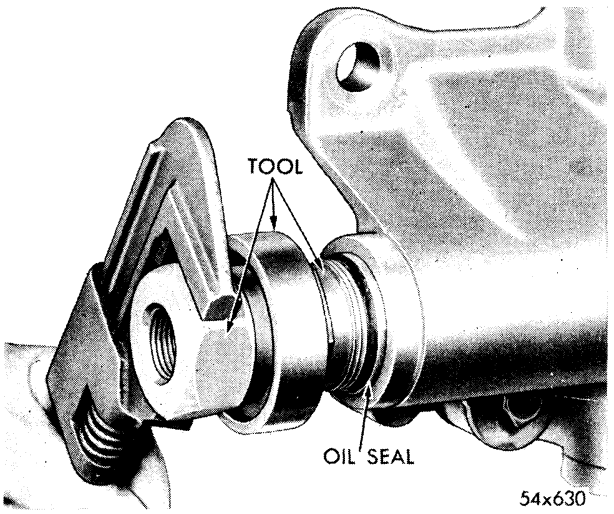

Fig. 23—Removing Gear Shaft Oil Seal (Tool C-3350)

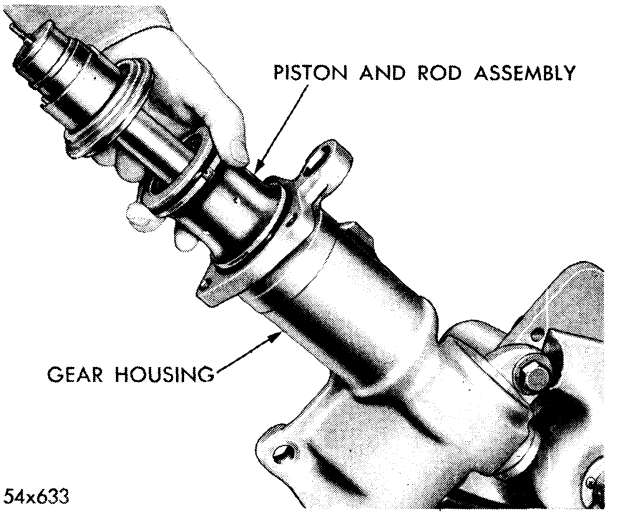

Fig. 25—Removing Piston and Rod Assembly

Turn worm connector assembly over and carefully thread the remaining worm balls out of the worm connector by turning the worm in and out. Count the worm balls which were removed. There should be a total of 40 balls. Remove worm from connector. Slide connector nut lock from connector. Inspect guide rails on connector for nicks and burrs.

e. Removal of Piston and Rods from Gear Housing

To remove the steering gear shaft oil seal, remove lock ring, and proceed as follows. Slide threaded portion of tool over steering shaft, and screw tightly into seal. To do this, install tool nut on steering gear shaft and force the threaded portion of tool into seal. Install the two half collars to lock the tool together, and install the half collar retaining ring. Turn nut and pull seal out of housing, as shown in Figure 23. Remove the tool.

Remove the lock nut from shaft adjusting screw. Remove the three screws from cover. Remove the steering gear shaft cover from housing by turning adjusting screw in.

Remove steering gear shaft assembly from gear housing by using a fiber hammer and tapping lightly. **Align gear on gearshaft to clear opening in lower housing before attempting removal. Removal of adjusting screw is not necessary unless screw is damaged.**

Using Tool C-3229, remove adjusting screw retainer snap ring. Remove adjusting screw, thrust washer, and washer from steering gear shaft, as shown in Figure 24. Remove adjusting

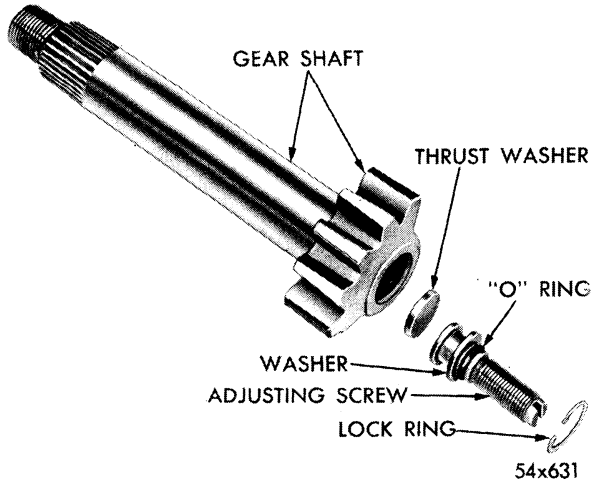

Fig. 24—Gear Shaft Adjusting Screw Assembly

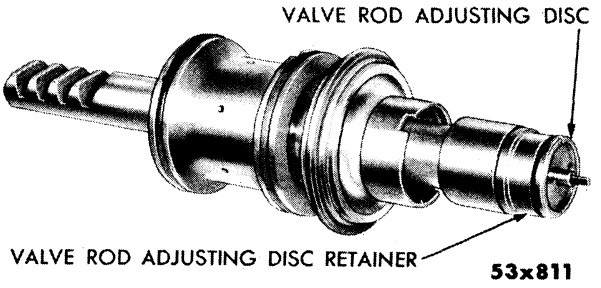

Fig. 26—Removing Valve Rod Adjusting Disc

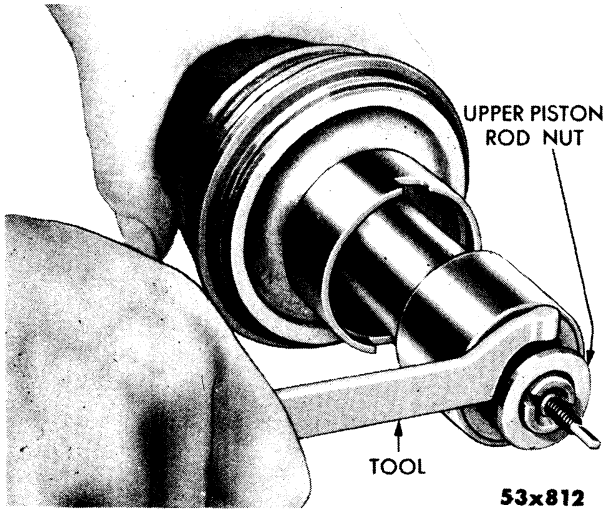

Fig. 27—Removing Upper Piston Rod Nut (Tool C-3328)

screw "O" ring. Inspect bearing surface on shaft for being pitted or scored. Inspect condition of teeth on shaft. Place a suitable container under the assembly to catch trapped oil and slide piston assembly and rods from gear housing, as shown in Figure 25.

CAUTION

Use extreme care in handling to avoid damaging the sealing surfaces on housing head.

f. Disassembly of Piston and Rods

Remove valve rod adjusting disc from valve

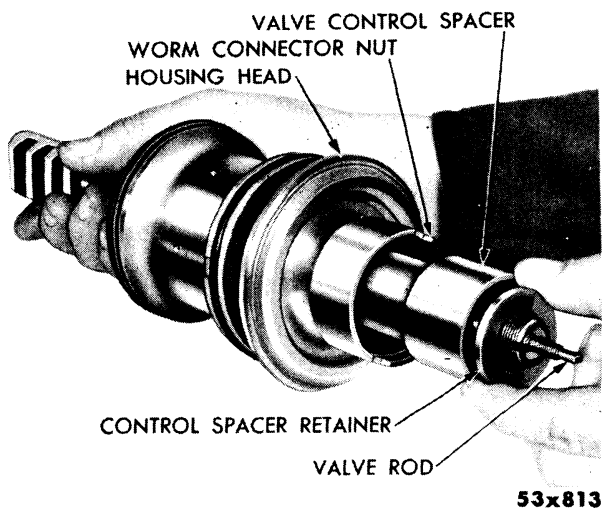

Fig. 28—Removing Valve Control Spacer Seal and Seal Assembly

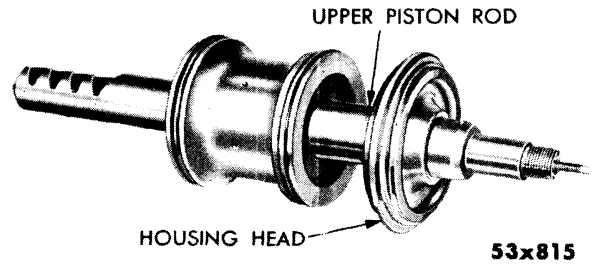

Fig. 29—Removing or Installing Housing Head

rod, as shown in Figure 26. To remove a tight fitting adjusting disc, wrap tape around the edge (this will prevent damaging disc), and grip it with multi-grip pliers. Tool C-3445 may be used to easily turn the valve rod from the disc.

Slide valve rod adjusting disc retainer from upper piston rod, as shown in Figure 26. Remove upper piston rod nut lock cap. Remove upper piston rod nut, as shown in Figure 27.

If the piston and upper piston rod turn when removing the upper piston rod nut, wrap several layers of masking tape around center piston, and clamp in a vise with protective jaws. The piston nut can then be removed. Support upper piston rod on a block of wood to help prevent damaging the housing head when removing nut. Slide valve control spacer assembly from upper piston rod, as shown in Figure 28. Remove spacer seal retainers from spacer and slide seal assembly from valve control spacer.

Remove worm connector nut from upper piston rod. Slide housing head off upper piston rod, as shown in Figure 29. Remove housing head "O" ring. Using a suitable drift, remove upper piston rod seal (lip type) from housing head.

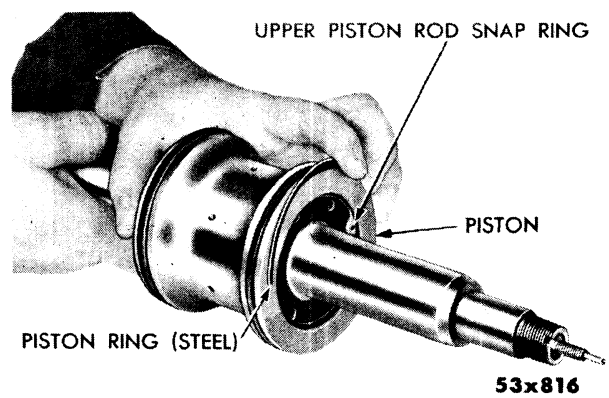

Fig. 30—Removing Piston Rings

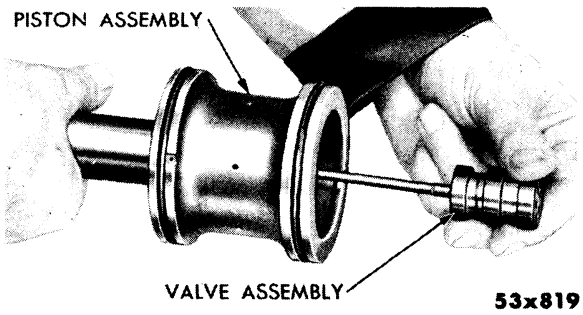

Fig. 31—Removing Valve Assembly from Piston

Remove the two backup (steel) and "D" type (neoprene) piston rings from piston, as shown in Figure 30. **Part of the 1955 production does not use steel rings. A new and wider type rubber ring is used instead.**

Using snap ring pliers, remove lower piston rod snap ring and slide lower piston rod from piston.

Using care not to bend the valve piston rod, slide valve assembly from piston assembly, as shown in Figure 31. Using a ¼ inch punch, drive piston pin into upper piston rod, as shown in Figure 32. Using snap ring pliers, remove upper piston rod snap ring. Note the position and construction of snap ring.

Remove upper piston rod from piston, as shown in Figure 33. Using a wire hook, remove piston pin and "O" ring from piston rod, as shown in Figure 34. Make sure the oil passage is open. Inspect the sealing surface on piston rod for being scored. Remove the two small valve rod "O" rings from the bore of the upper piston rod (one in each end). Remove the large upper piston rod "O" ring.

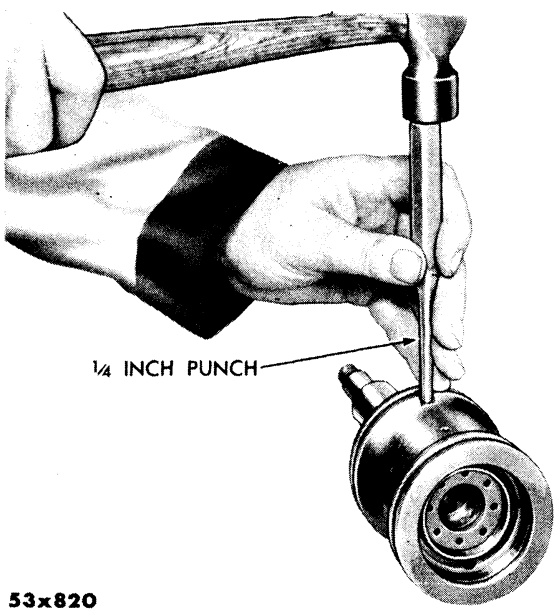

Fig. 32—Removing Upper Piston Rod Pin

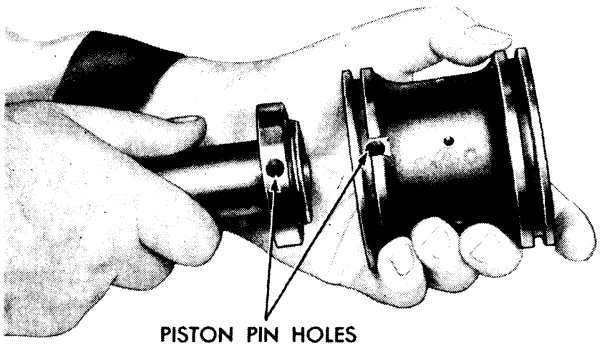

Fig. 33—Removing Upper Piston Rod

Remove lower piston rod "O" ring. Inspect rack teeth and sealing surfaces on lower piston rod.

g. Removal of Relief Valve Assembly

Thread a ¼ inch 28NF bolt into threads provided in plug (Fig. 35). Clamp bolt head in a vise and, by pulling on lower piston rod, plug can be removed. **Should end plug be seized in rod, a fiber hammer may be used to tap on retaining flange of lower piston rod.** Inspect piston for nicks and burrs. Make sure all oil passages are open and free from dirt.

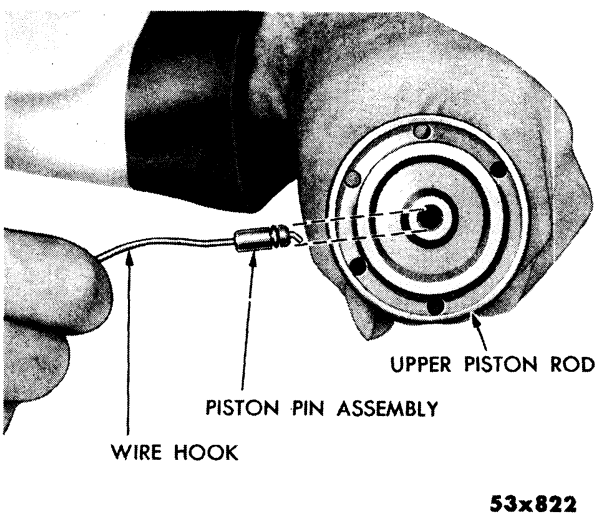

Fig. 34—Removing Piston Pin from Upper Piston Rod

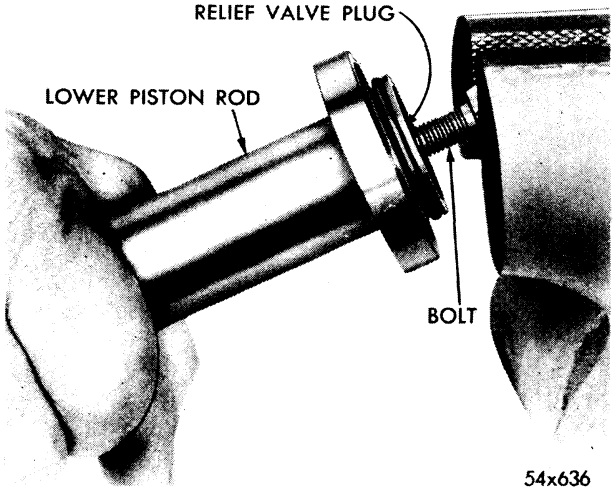

Fig. 35—Removing Lower Piston Rod Relief Valve Plug

h. Disassembly of Steering Gear Housing

Inspect steering gear shaft needle bearing in gear housing for broken or rough needles. **Do not remove bearing unless inspection reveals it is necessary to do so.** If it is necessary to remove needle bearings, use puller Tool C-3333 to pull steering gear housing shaft needle bearings from inside gear housing as shown in Figure 36.

Using snap ring pliers, remove gear housing cover snap ring (tapered) at bottom of housing.

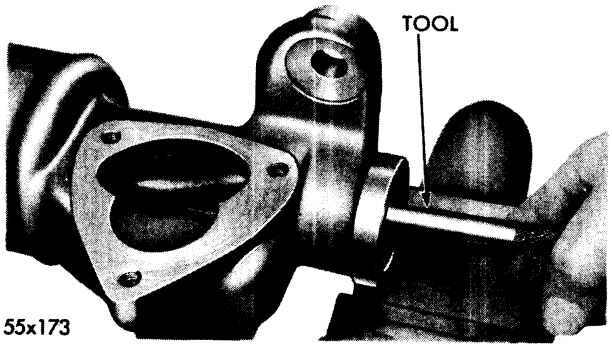

Fig. 37—Removing Lower Piston Rod Seal (Tool C-3331)

Remove housing cover and remove "O" ring from housing. **Use extreme care when removing the lower plug to prevent cocking. A cocked plug is apt to result in a broken gear housing.**

Remove lower piston rod seal (lip type) from housing, as shown in Figure 37. The lower rod is supported by a half bushing. The bushing is a friction fit over a dowel pin. If it is necessary to replace the support bushing it may be pried from the dowel pin with a screwdriver.

18. ASSEMBLY OF COAXIAL POWER STEERING GEAR

a. Assembly of Steering Gear Housing

Place a new piston rod seal over driver so the lip will be facing up or to the inside of the cylin-

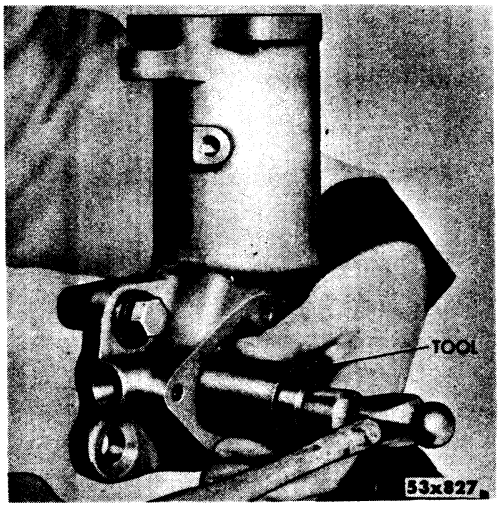

Fig. 36—Removing Steering Gear Housing Shaft Needle Bearing (Tool C-3333)

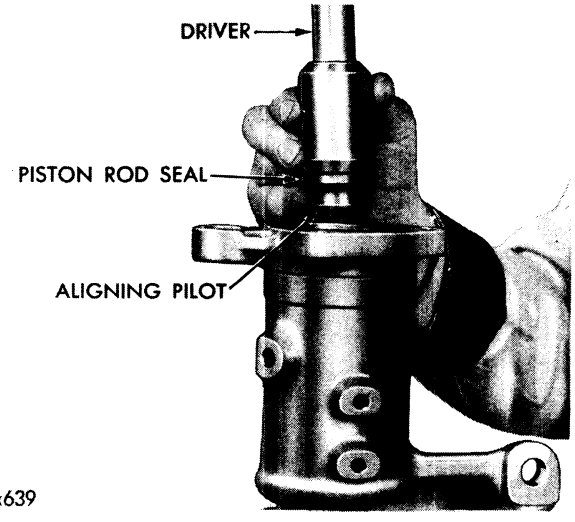

Fig. 38—Installing Lower Piston Rod Seal (Tool C-3395)

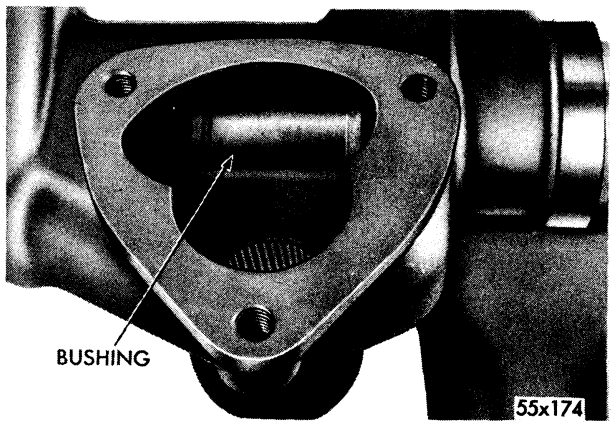

Fig. 39—Support Bushing Installed

der when installed. Insert seal aligning pilot of tool in end of driver and drive lower piston rod seal into position in gear housing, as shown in Figure 38.

Using driver Tool C-3333, install housing shaft needle bearing assemblies in gear housing until bearings bottom in the bores (if removed). **Always drive on letter side of bearing. Otherwise, damage to bearing may result.** Install piston rod support bushing in housing, making sure bushing is properly seated over dowel, as shown in Figure 39 (if previously removed).

b. Assembly of Piston and Rods

Insert relief valve spring followed by plunger into valve body and insert assembly (milled end first) into lower piston rod. Press end plug into lower piston rod sufficiently to seat against the relief valve body.

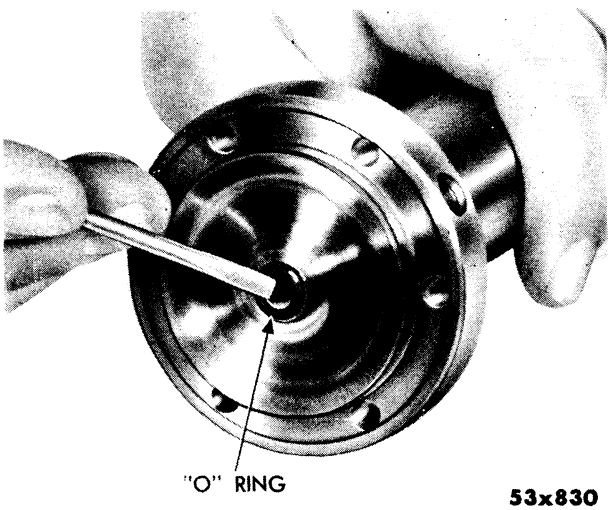

Fig. 40—Installing Valve Rod "O" Ring

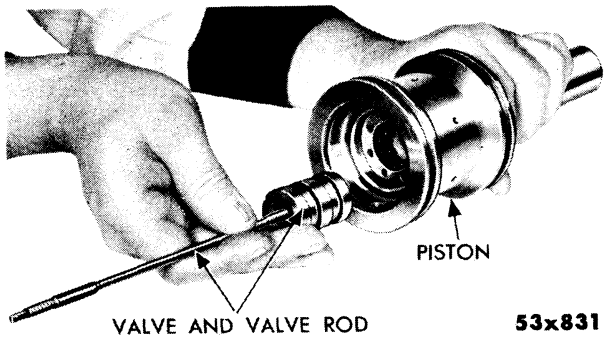

Fig. 41—Installing Valve Assembly

NOTE

A suitable adaptor will be required to press end plug into place. Otherwise, damage to rod will result. If plug is not pressed in far enough to properly seat against the valve body, it will produce a rattling or clattering sound when hydraulic pressure is applied. If the plug is pressed in too tightly, it will cause the relief ports in the valve body to collapse, restricting the plunger and creating high back pressure, resulting in lack of steering assistance and a hissing noise.

Remove all burrs from around the end plug. Lubricate the two valve rod "O" rings with Lubriplate and install one in each end of upper piston rod, as shown in Figure 40. **Make sure rings are seated properly.** Lubricate the two large "O" rings with Lubriplate and install one on each upper and lower piston rod. Make sure they seat properly in the ring grooves. Install lower piston rod (with rack) into end of piston assembly opposite pin hole. Using snap ring pliers, install snap ring.

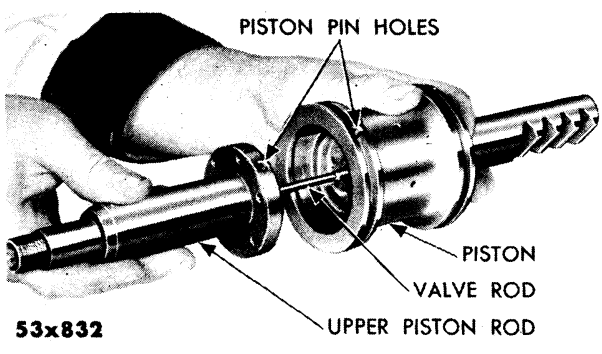

Fig. 42—Installing Upper Piston Rod

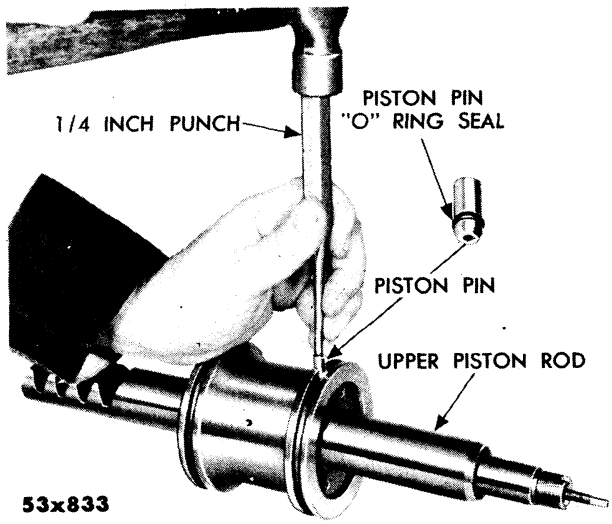

Fig. 43—Installing Piston Pin

NOTE

When installing the snap ring, it must be installed with the tapered side away from the piston so that the taper is visible after installation. The gap between the ends of the installed snap ring should be measured to be sure the ring is seated. The minimum permissible gap is $^{25}/_{64}$ inch. Be sure the snap ring does not restrict any part of the ports in the end of the piston rod.

Lubricate valve assembly with Lubriplate and slide into position in assembly, as shown in Figure 41. Using care not to damage the "O" rings, slide upper piston rod over the valve rod, aligning the piston pin hole in the piston assembly with the hole in the upper piston rod, as shown in Figure 42. Lubricate a new piston pin "O" ring with Lubriplate and install on piston pin, as shown in Figure 43. With the piston pin holes aligned in both the piston and upper piston rod, position piston pin (tapered end first) in position. Use a ¼ inch punch and hammer, tap lightly until piston pin is flush or slightly below bottom of piston ring groove (Figure 43). **If piston pin is too high in groove, piston ring will not properly seal. This will cause unequal pressure when valve is centered in piston.**

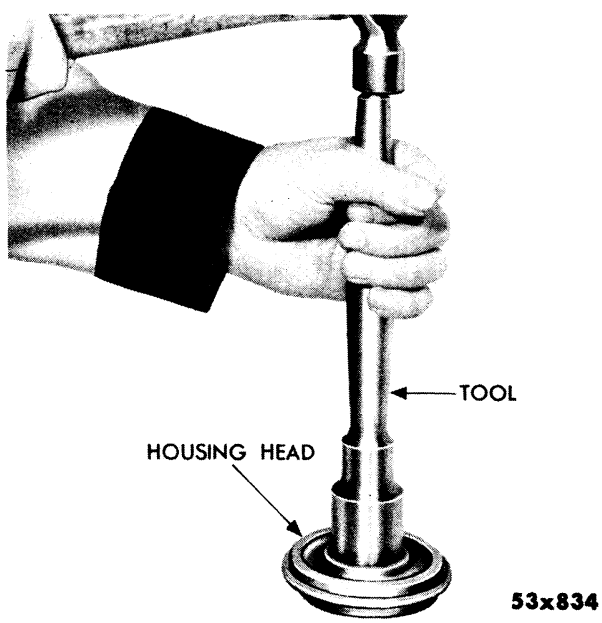

Fig. 44—Installing Upper Piston Rod Seal (Tool C-3395)

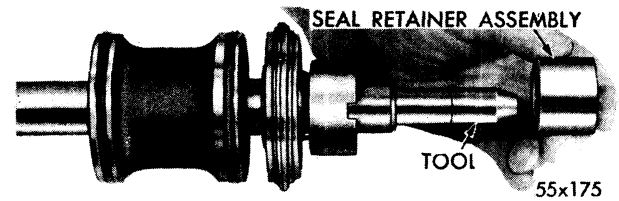

Fig. 45—Installing Valve Control Spacer (Tool C-3393)

Using snap ring pliers, install the upper piston rod snap ring. **Use the same precautions and specifications as previously used in positioning the lower piston rod snap ring.** Select snap ring of sufficient thickness to prevent turning of snap ring after it is installed. If it is too loose, the piston will move with relation to the piston

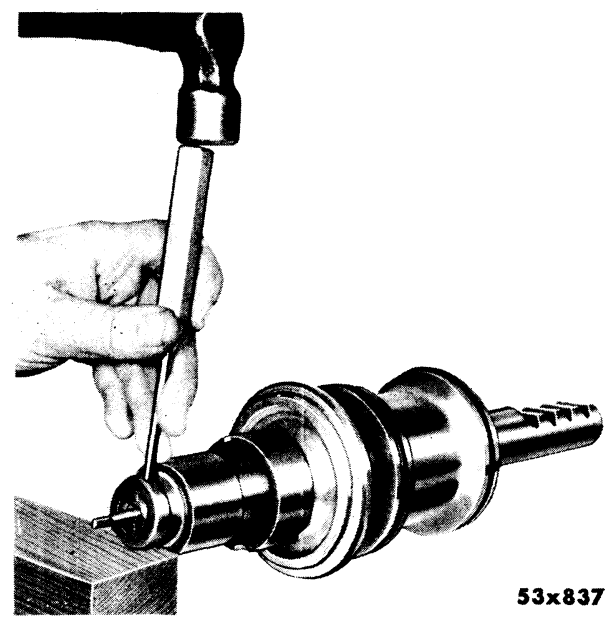

Fig. 46—Locking Upper Piston Rod Nut Lock Cap

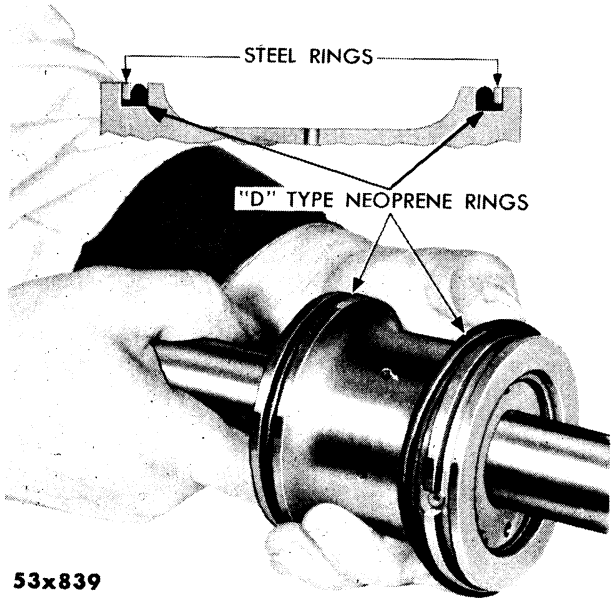

Fig. 47—Installing Piston Rings

rod and prevent consistent adjustment of control valve. Place a new upper piston rod seal on driver (lip of seal facing tool). Insert seal in end of driver and drive upper piston rod seal (lip of seal out) into position in housing head, as shown in Figure 44. Lubricate seal with Lubriplate.

Install housing head assembly (sealing lip first) onto upper piston rod. **Use same precautions to protect sealing surfaces on housing head as used when disassembling.** Slide connector nut onto the upper piston rod with open threaded end away from piston. Lubricate the valve control spacer seal with Lubriplate and

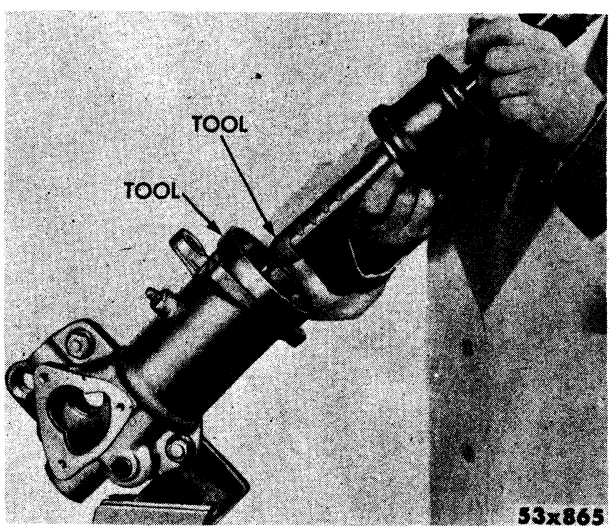

Fig. 48—Installing Piston and Rod Assembly

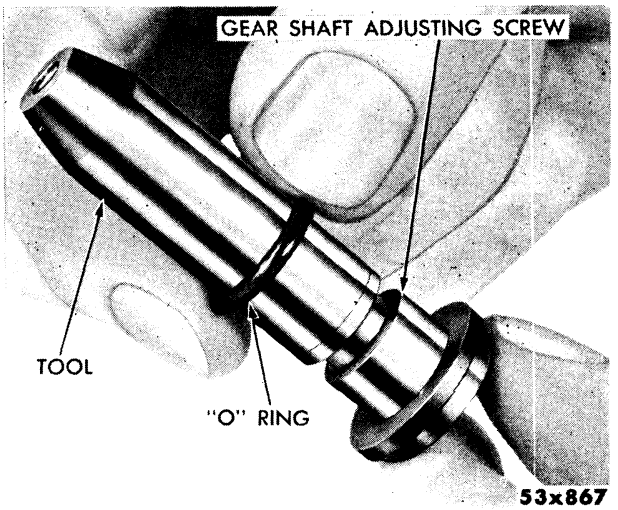

Fig. 49—Installing Gear Shaft Adjusting Screw "O" Ring (Tool C-3401)

install in center of valve control spacer. **Should it be necessary to replace the valve control spacer or upper piston rod for any reason, always select a spacer to match. The length of the valve control spacer selected must be identical to the distance between the seat of the valve control spacer seal retainer and seated upper piston rod nut.** Place tool over threaded end of upper piston rod.

Lubricate the valve control spacer retainers with Lubriplate and place into position (small diameter first) so they nest in valve control spacer. Slide spacer, seal and retainer assembly over tool and into position on piston rod, as shown in Figure 45, and remove tool.

Install upper piston rod nut and, using Tool C-3328, tighten from 25 to 30 foot-pounds torque. Lock in place using piston rod nut lock by tapping outer diameter of lock into nut recess, as shown in Figure 46.

Slide valve rod adjusting disc retainer (largest diameter first) over end of upper piston rod. Thread valve rod disc (extended lock thread section outward) onto valve rod until approximately three threads show for aid in later adjustment. **When installing disc on rod, considerable resistance should be noticed. If not, crimp end of disc slightly to cause the threads of the disc to bind on rod.** The maximum torque required to turn disc on rod should not exceed 20 inch-pounds, maximum. Place lock sleeve on worm connector (tang of sleeve) toward threaded end.

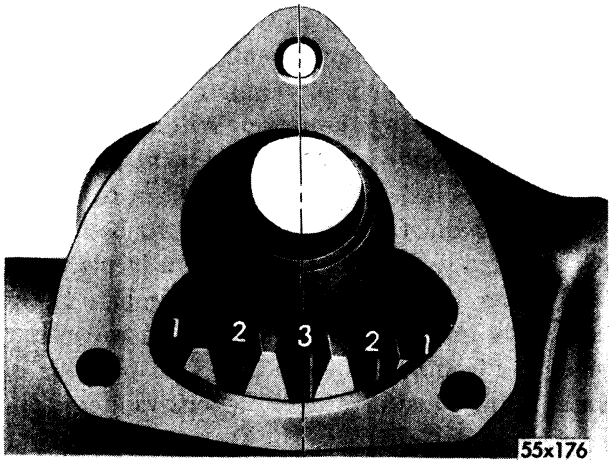

Fig. 50—Positioning Rack For Timing

Lubricate the two "D" type (neoprene) piston rings with Lubriplate and install on piston. To aid in installation of rings, first slide rings over ring lands and to center of piston, with lips facing away from each other. Slide rings into position in ring lands, as shown in Figure 47. Install back-up (steel) rings, one on each end of the piston. **Part of production does not use steel rings. Wider rubber rings are used instead.**

c. Installation of Piston and Rod Assembly in Gear Housing

Lubricate lower piston rod, teeth of rack and tool with Lubriplate, and position tool in teeth of rack. Lubricate large "O" rings with Lubriplate and install on the side of housing head that faces piston assembly.

Place ring compressing tool on gear housing. Position piston and rod assembly so the teeth on rack are 180 degrees from bushing support and install into gear housing, as shown in Figure 48. **Use extreme care when performing this operation so as not to damage gear housing oil seal or piston rings. Do not use a screwdriver to compress piston rings. To further aid in installation, piston and cylinder may be lubricated with Lubriplate. If the rack is not positioned properly when it is installed, it may be corrected by rotating the lower piston rod with a screwdriver through opening in end of gear housing.** Remove ring compressing tool and other tool from teeth of rack through opening in gear housing.

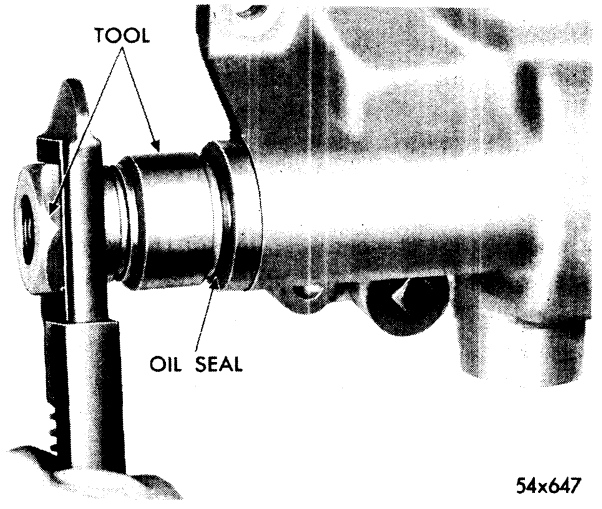

Fig. 51—Installing Gear Shaft Oil Seal (Tool C-3350)

d. Installing Gear Shaft

Install thrust button on gear shaft adjusting screw and position tool over thread of screw. Lubricate gear shaft adjusting screw "O" ring with Lubriplate and slide over tool and into position on adjusting screw, as shown in Figure 49. Remove tool and insert adjusting screw thrust button into gear end of steering gear shaft. Insert adjusting screw assembly into gear shaft and lock in position by installing internal snap ring. Use pliers, Tool C-3229, and make sure snap ring is properly seated. Screw the shaft adjusting screw with gear attached into the gear shaft cover assembly as far as possible. Position center groove (third from

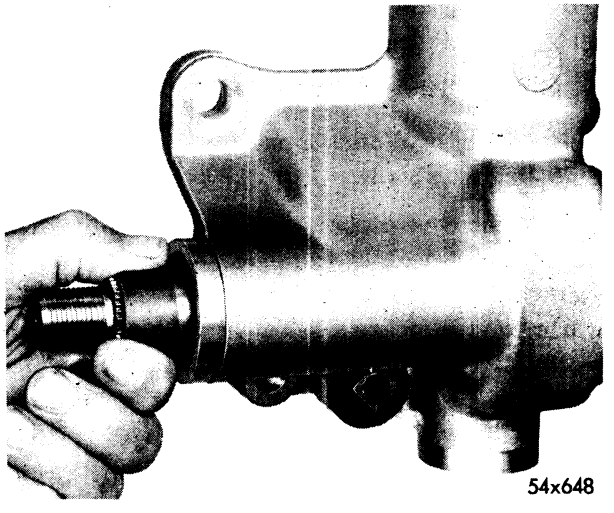

Fig. 52—Removing Sleeve (Part of Tool C-3350) with Friction Tape

either end) of the rack over center line of the gear shaft cover opening in gear housing. Position the middle tooth of the gear shaft with the third tooth groove from (either) end of rack. Insert gear shaft assembly with cover attached into gear housing, and tap lightly into position, as shown in Figure 50. **It is of the utmost importance that the center tooth of the gear shaft lines up with the center slot in the lower piston rod rack. Failure to observe this precaution will result in a broken gear housing.** Install gasket and cover and tighten the cover screws evenly.

e. Seal

Before attempting to install a new gear shaft seal, thoroughly clean the sealing surfaces on the gear shaft and counterbore of steering gear shaft oil seal with Lubriplate and place (lip of seal down) on a piece of clean paper. **Carefully** install tapered end of sleeve (part of Tool C-3350) in seal and slide seal back approximately ¼ inch on sleeve. Install this assembly (lip of seal toward housing) over steering gear shaft until seal contacts counterbore in housing. Push seal into position by installing adaptor over sleeve, and installing coupling nut on shaft threads until shoulder of adaptor contacts housing, as shown in Figure 51. Remove nut and adaptor. Wrap a new piece of friction tape around sleeve to provide a firm grip and, with a turning motion, remove sleeve from seal and gear shaft, as shown in Figure 52. Seal is then positioned properly. Install oil seal lock ring (circular section) and make sure it is properly seated. Install gear shaft adjusting screw lock nut, but do not tighten.

f. Assembly of Worm Connector (If Disassembled)

Insert worm into connector and visually align the upper portion of the passages with the ball guide holes. **The balls which are used in the worm connector are a select fit with each other. If any of them become lost or damaged, a complete set (40) must be installed. Balls which fit tight will result in increased and erratic steering effort and also lack of returnability. Balls which fit too loose will result in free play of the steering wheel before valve actuation or steering is accomplished.**

Insert 30 worm balls **(no more)** into lower hole by tapping them in gently (use the rubber end of lead pencil or similar object) while slightly oscillating the worm. When the 30 balls have been inserted, they should be visible in the other hole. Place the remaining worm balls (10) in either half of the worm connector ball guide. Grease end balls to help hold them in place and add other half of ball guide assembly. Insert assembly into holes until it seats on worm connector. Place ball guide clamp into position on ball guide, install the two lockwashers and screws and tighten to 12 foot-pounds torque. Check the operation of worm, making sure it is free to turn the maximum travel of the worm shaft. Caution should be exercised not to bottom worm in the outward direction. Otherwise, damage to the ball return guide may result and cause a rough or tight operating worm.

Slide the worm connector and worm shaft assembly over control spacer and screw worm connector nut onto connector. Pull worm shaft up about one inch and wrap several layers of masking tape around worm. Hold worm connector with Tool C-3321. Using Tool C-3326, tighten the nut. Stake ring with punch and remove masking tape.

g. Assembly of Worm Housing

If bearing cups were removed from worm housing during disassembly, refer to Figure 20 and proceed as follows. Install worm housing upper bearing cup (wide section of cup first) into worm housing. Make sure cup seats properly in housing. Install worm housing lower bearing cup (wide section of cup first) into worm housing. Make sure cup seats properly in housing.

h. Installation of Worm Housing

Lubricate worm housing inner bearing race with Lubriplate, and slide (wide section of cone first) over threaded end of worm until it seats. Lubricate worm connector guide rail with Lubriplate. Lubriplate upper housing head "O" ring with Lubriplate and install on housing head pilot opposite piston side. Install "O" ring on inner land of housing head. If it is installed

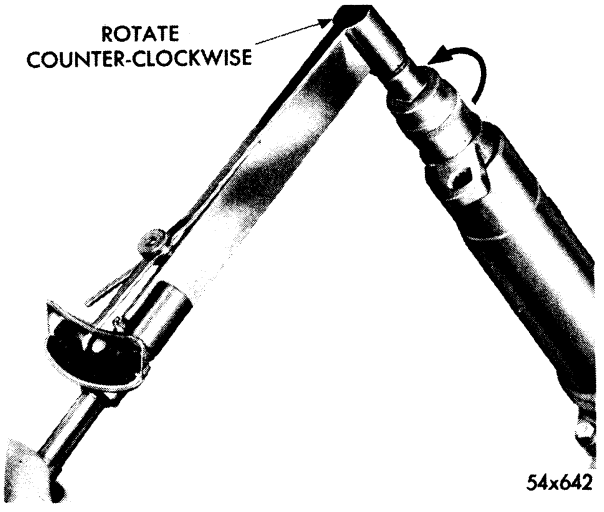

Fig. 53—Adjusting Worm Housing Bearings (Inner)

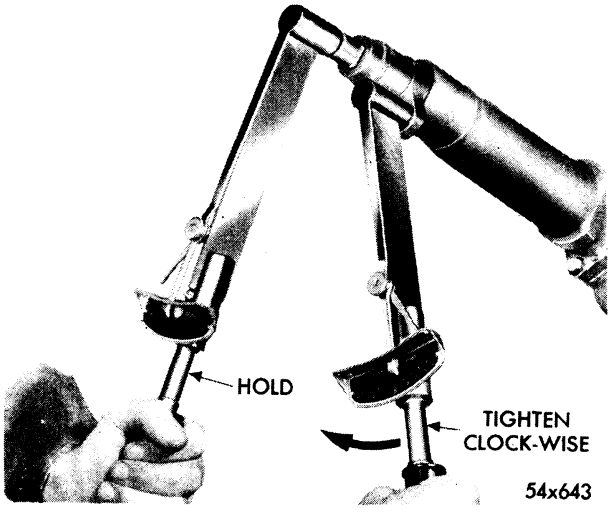

Fig. 54—Adjusting Worm Housing Bearings (Outer)

on outer land, damage to housing will result when they are attached to each other.

Drop inner bearing into housing and hold in place. Guide worm housing over rails on worm connector (ball guide down) until it is flush with gear housing. **If flanges cannot be installed flush, the housing head "O" ring is installed on the outer rather than the inner land and will have to be changed. Worm housing cannot be installed if bearing is installed on worm shaft prior to installing housing.**

Install the three screws and concave washers, draw down evenly and tighten from 25 to 30 foot-pounds torque. Lubricate worm outer bearing roller with Lubriplate and install in bearing cup. Position race in bearing. Slide thrust washer over worm and against outer bearing race, and follow with worm bearing nut lockwasher. Turn worm shaft out until lower race seats in bearing. Install worm housing bearing adjusting nut over shaft (tapered end first). Slide Tool C-3320 over worm shaft, followed by Tool C-3310. Using Tool C-3319 and a torque wrench, turn the worm shaft counter-clockwise to 20 foot-pounds against the inner bearing (Fig. 53).

While holding worm shaft against bearing at 20 foot-pounds torque, tighten the adjusting nut clockwise to 15 foot-pounds, as shown in Figure 54, using Tool C-3320 and another torque wrench.

Rotate the worm shaft several times in order to properly seat bearings. Loosen adjusting nut and hold worm shaft at 5 foot-pounds counter-clockwise against inner bearing, using Tool C-3319 and a torque wrench.

Retighten adjusting nut clockwise to 5 inch-pounds, as shown in Figure 55. Lock adjusting nut in position by bending tang of lockwasher to index with slot in the nut. **Only one tang is necessary to lock nut. A loose adjustment will result in free play. Too tight an adjustment will result in erratic valve action and lack of returnability.** Install worm housing oil seal by lightly tapping with plastic or rubber hammer until

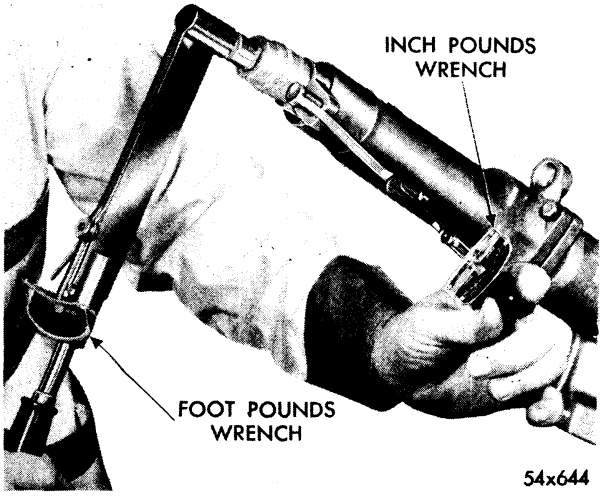

Fig. 55—Final Worm Housing Bearing Adjustment

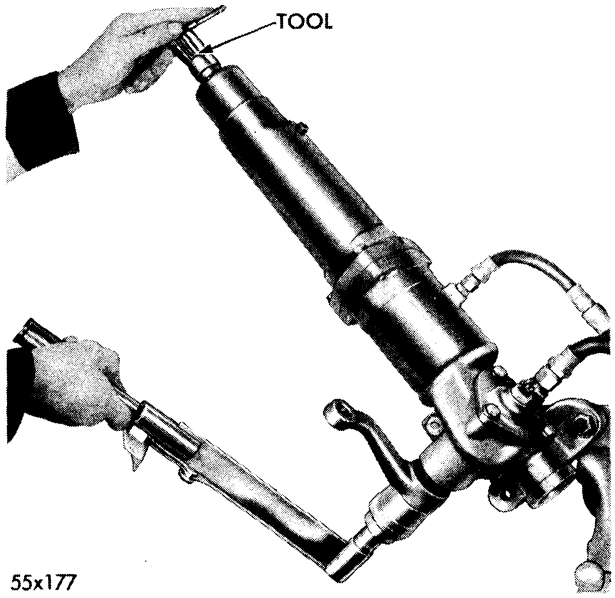

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Fig. 56—Adjusting Manual Control Valve to Neutral (Tool C-3445)

forcing the piston to its full length of travel. Adjust gear into a backlash condition, and tighten lock nut. **This adjustment is necessary before adjusting manual control valve to neutral position and is not to be considered a final adjustment.**

Filling worm housing is very important since there is no hydraulic connection between the worm and gear housing. Add type "A" oil to the worm housing through the worm housing filler hole. Keep gear assembly in a level position to facilitate filling. Install worm housing oil filter plug and tighten to equivalent of 50 inch-pounds torque.

19. ADJUSTING COAXIAL GEAR ASSEMBLIES (Removed)

a. Valve Neutral Position

Connect test hoses to hydraulic pump on car and to steering assembly. Remove oil reservoir cover. Start engine and operate at idle. Fill reservoir to level mark and allow system to warm up. **Oil level must be maintained above filter while hydraulically centering valve.**

Insert manual control valve centering tool (slotted end first) into worm shaft and engage slot in tool with tang on control valve operating rod. (Tool C-3445 can be rotated by using a tap wrench.) **If Pitman arm moves to one extreme or the other and stays there, rotate tool in either direction until arm starts to move. Slightly rotate tool in opposite direction until arm stops moving.** Install a $1\frac{7}{16}$ inch socket on a torque wrench and place on Pitman arm retaining nut. Rotate gear shaft in both directions from one extreme of travel to the other. The torque required to move the shaft should be the same in both directions.

Where torque is higher in one direction than in the opposite, rotate the valve adjusting tool, as shown in Figure 56, slightly in the opposite direction to the direction in which the Pitman arm has the highest torque reading. **Change valve position in slight variations, at a time, to prevent over adjusting. When torque is the same in both directions, remove the tool.**

b. Installing Coupling at Center of No Backlash Position and Gear Shaft Adjustment

The gear shaft teeth before production coaxial gears have unequal widths. This design allows for a period of travel through a center arc with no backlash. But, beyond 150 to 170 degrees on each side of the center of this arc, backlash is apparent. Later models have gear shafts with equal width teeth and, when adjusted properly, have no backlash for the full travel of the gear. Each type of gear requires a different procedure for determining the correct position for the coupling.

The steering tube coupling must be installed with the slot in the coupling in the vertical

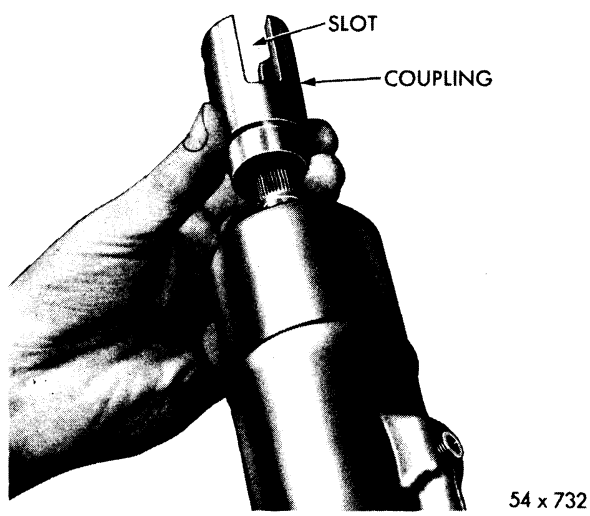

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Fig. 57—Installing Coupling

plane, as shown in Figure 57. There are no master serrations on either the worm shaft or the coupling. A mark is scribed on the coupling. This mark should be set at 12 o'clock when the steering worm shaft is at center so that the steering tube master serration will be in position to allow for proper installation of steering wheel.

c. Unequal Width Teeth Gear Shaft (Before Type Gear Shaft)

Check the steering for being properly centered by turning the coupling in each direction from the center. Pitman arm backlash should become evident at equal distances in both directions when turning from center. It may be necessary to reposition the coupling to obtain equal travel in both directions in which case it will be necessary to readjust Pitman arm backlash.

d. Equal Width Teeth Gear Shafts (After Type Gear Shaft)

A new gear shaft entered production in the Power Steering Units. This new shaft has an equal width center tooth and requires a different adjustment procedure than the adjustment used on gears built with the unequal center tooth. The letter "O" is stenciled on the steering arm end of the new shaft for positive identification.

Center the steering tube coupling or steering wheel to the overall travel of the steering gear. With gear in center position, loosen adjustment until there is some backlash. Slowly turn the adjusting screw in until the backlash disappears. Turn the adjusting screw in three-fourths of a turn and lock in position.

NOTE

Use a very light feather touch on the steering arm when checking for backlash.

The new equal tooth gear shaft may be installed in previously built gears without changing the lower piston rod. However, if a new shaft is used, this adjustment must be followed.

If difficulty is experienced in adjusting the gear shaft in previously built gears, the following check can be made to determine if the new equal tooth gear shaft may have been installed. With the steering gear centered, turn the adjusting screw until a small amount of backlash can be felt. Turn the coupling or steering wheel slowly to either extreme limit of travel. If the amount of backlash increases as it is turned, it is an indication that the unit has the original unequal tooth gear shaft. If the amount of backlash does not increase, then the new equal tooth gear shaft has been installed. Identification of the new gear shaft can also be made upon inspection of the shaft by the absence of the chamfer on the center tooth.

20. INSTALLATION OF COAXIAL POWER STEERING GEAR (In Car)

Install the Coaxial Power Steering Gear assembly from under the car, and up through the dash panel into the jacket. Install housing to frame attaching bolts, flat washers, swivel washers and nuts, but do not tighten. **Swivel washers permit alignment of housing to dash.**

Slide steering column jacket down over worm housing. Install turn signal lever, being sure column jacket does not restrict lever. Tighten jacket to Coaxial housing clamp. Connect turn signal wires. Install steering column to instrument panel bracket and install steering wheel. If clearance between steering column jacket and steering wheel is less than $\frac{1}{8}$ inch, adjust steering column jacket to provide proper clearance. Install dust pads and retaining plates.

Tighten front upper and lower gear housing to frame attaching bolts to 20 foot-pounds torque. Install wedge over rear bolt between housing and frame, so that tapered surfaces match, tapping it lightly in place. Tighten three attaching bolts to 70 foot-pounds torque. Install horn ring and horn wire in steering wheel and install horn ring ornament.

Connect hoses from steering gear to hydraulic pump.

21. ADJUSTMENTS OF COAXIAL GEAR (Installed)

Adjusting Manual Control Valve (Centering Hydraulically.) (In Car.) Where it is difficult to rotate the steering wheel in one direction but not in the other direction, or where the wheels turn

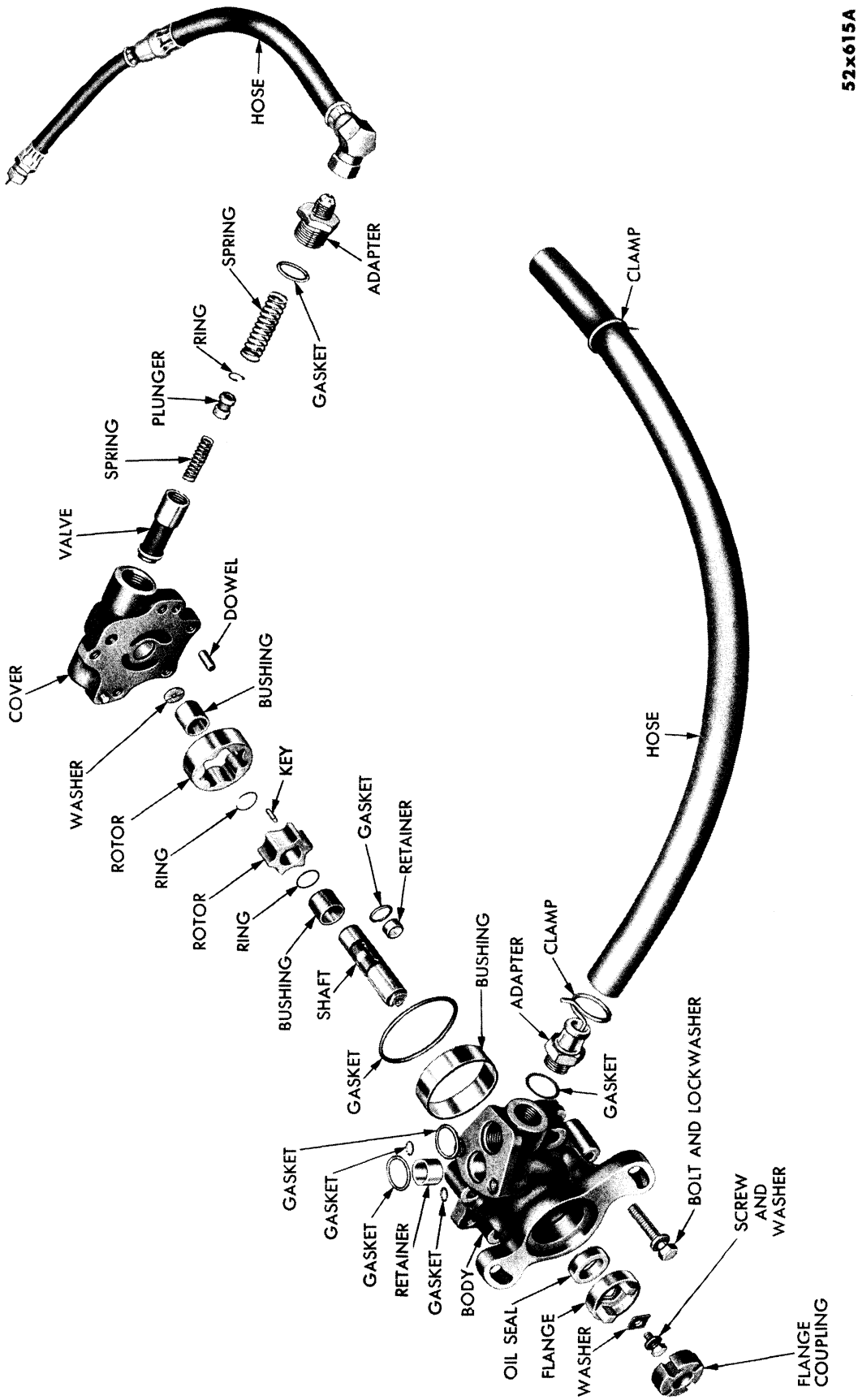

Fig. 58—Hydraulic Oil Pump (Exploded View)

of their own accord, equalize tire pressure and check front wheel alignment. If conditions still exist, it is an indication that the control valve is out of adjustment.

Remove parts, as necessary, to gain access to steering tube coupling. Remove coupling retaining screw, lockwasher, and plain washer from worm shaft. Insert manual control valve centering tool (slotted end first) into worm shaft and engage tool with tang on control valve operating rod. **Two men are required to center the valve.**

One man moves the valve as directed, while another man checks the torque required to move the Pitman arm through its travel in both directions. Move Pitman arm through travel from one extreme to the other with torque wrench, Tool C-3005 and $1\frac{7}{16}$ inch socket, observing the torque reading. The torque should be the same in both directions. Turn adjusting rod as required until an equal torque reading is obtained. **The Pitman arm retaining nuts should be tightened to 120 foot-pounds torque.**

NOTE

Where the gear shaft requires more than 40 foot-pounds torque to rotate it, and (or) where torque is uneven at any point through the full travel of shaft, it probably has a cocked gear shaft cover, dirt has entered the interior, or the circulating balls are defective or improperly installed.

22. REPLACING STEERING GEAR SHAFT OIL SEAL (Unit Mounted in Car)

The steering gear shaft oil seal may be replaced (with the unit in car) similarly to the method outlined in Paragraph 18.

23. HYDRAULIC STEERING PUMP PRESSURE CHECK

Should the lack of steering assistance (in both directions) be encountered and other checks have failed to reveal the cause, a pressure check should be made to determine if pump is operating properly, as follows:

Connect tachometer leads to coil and ground. Install gauge Tool C-3309 in pressure line between pump and hose. Refill reservoir to proper level. Open valve on gauge, start engine, and run until power steering oil pump reaches operating temperature. With engine idling (475-500 r.p.m.), turn the shut-off valve on gauge to its closed position.

CAUTION

Do not keep valve closed more than a few seconds or accelerate engine with valve closed. Otherwise, damage to the pump and (or) belt may result.

If the pressure does not gradually increase to at least 700 psi as the valve is closed, it is possibly due to the following conditions:

a. Fan belt slipping. Adjust the belts. Where two belts are used, make definitely sure both belts are adjusted or the condition will still exist.

b. Flow control valve stuck in open position. Remove the high pressure hose at the pump fitting and insert a $\frac{1}{4}$ inch **clean** blunt rod against the valve plunger. If the plunger moves inward $\frac{3}{16}$ to $\frac{1}{4}$ inch, the plunger was stuck. To correct, remove the flow control and relief valve assembly and inspect for nicks, burrs, or foreign matter. Small nicks or burrs may be removed by using **crocus cloth.** When reinstalling valve assembly, make sure it fits freely in the bore of pump cover. Recheck pump pressure after installation. If the pump pressure does not increase to at least 700 psi as the valve is closed, proceed as follows:

c. With cover removed from reservoir, start the engine and observe whether oil is flowing through the filter. If it does not, remove the pump from generator (it is not necessary to disconnect hose) and inspect for broken coupling flange. If either coupling flange is broken, disconnect hose, and remove pump and reservoir assembly from vehicle. Disassemble pump and determine cause of coupling flange breaking.

24. REMOVAL AND INSTALLATION OF HYDRAULIC STEERING PUMP ASSEMBLY

a. Removal

Disconnect the pressure and return hoses from pump assembly. **Loss of oil will be noted when hoses are removed. Keep both hose ends up to prevent excessive loss of oil. Ends of hose should be covered or capped to prevent the entrance of foreign matter.**

Remove the pump to generator mounting screws and lockwashers. Remove pump and reservoir assembly from generator. Remove the rubber coupling.

b. Installation

Place the rubber coupling in position in pump assembly. Place pump and reservoir assembly in level position on back of generator, using care to index coupling. Pump mounting brackets have slotted holes to allow level positioning of pump reservoir (Figure 59). Install the pump to generator mounting bolts, lockwashers, and washer. Draw down evenly and tighten to 17 foot-pounds torque. Connect the pressure and return hoses to pump and tighten. Refill the reservoir.

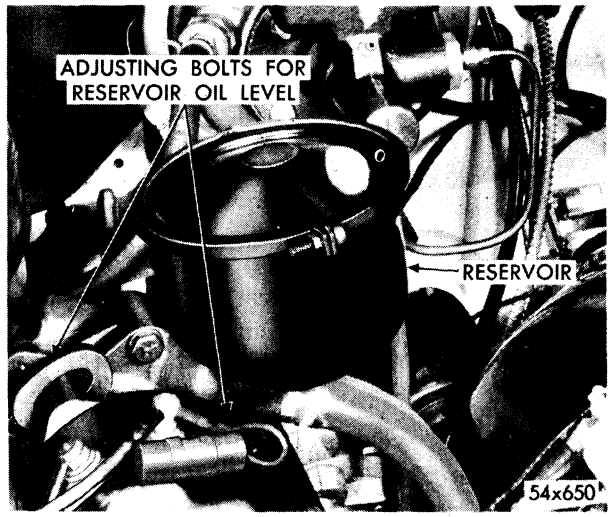

Fig. 59—Adjusting Oil Pump to Level Oil in Reservoir

25. SERVICING THE HYDRAULIC STEERING PUMP (Fig. 58)

a. Disassembly

Do not disassemble the hydraulic pump in dirty surroundings or on a dirty work bench. Use clean paper on bench. After the pump has been disassembled, place the parts in a suitable cleaning solvent and protect them from dirt and chips. Remove cover on reservoir and remove filter.

Remove the two reservoir to pump attaching bolts and lockwashers, unscrew the filter element standpipe, and separate reservoir from pump. **There are four rubber "O" seal rings between the reservoir and pump body.** Using holding Tool C-3227, remove coupling locking screw, lockwashers and coupling. **The locking screw is of a special type for torquing purposes and should not be replaced with any other type.** Place pump body in a vise equipped with protective jaws and remove the five body to cover attaching bolts. Remove cover and "O" seal ring. Remove outer pump rotor by inverting and tapping pump body on wooden block. Remove pump shaft and inner rotor from pump body. Remove inner pump rotor from pump shaft by removing the rear circular section snap ring and sliding rotor and drive key off shaft.

To remove the combination control and relief valve in pump cover, remove the 1¼ inch hexagon spring retainer cap fitting and circular section rubber "O" ring. Lift out flow control valve spring. Tap cover on wooden block to remove the flow control and relief valve combination. To remove pressure relief valve and spring from flow control valve body, remove the internal snap ring, as shown in Figure 60.

b. Inspection

Clean all parts in a suitable solvent and blow dry with compressed air. Inspect the babbitt pump rotor bushing in pump body for wear or scoring. Inspect bronze pump shaft bearings in

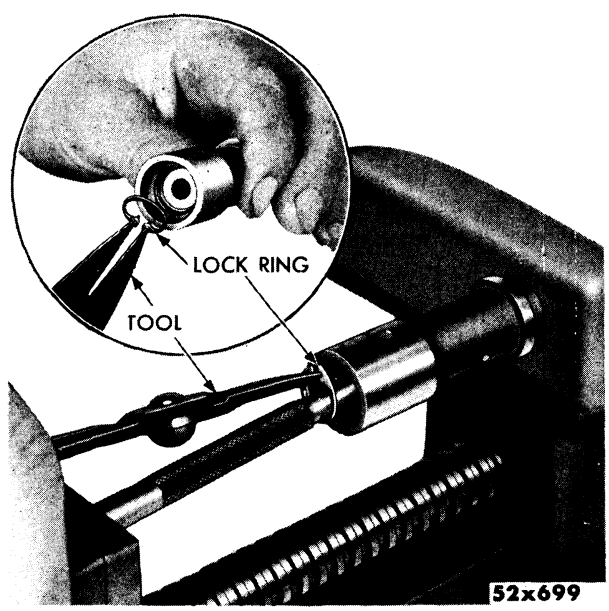

Fig. 60—Disassembly or Assembly of Pressure Relief and Flow Control Valve (Tool C-3229)

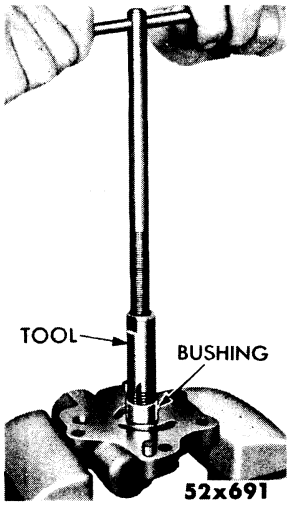

Fig. 61—Removing Pump Cover Bushing

cover and pump body. Inspect pump rotors and shaft for scoring and wear.

Position rotor and shaft in pump body. Using a straightedge and feeler gauge, check the end clearance. The specified limits are .001 inch to .002 inch. Inspect the pressure relief and flow control valves for scoring, replace if necessary.

c. Replacement of Pump Cover Bushing

Place pump cover in a vise equipped with protective jaws, install tool, and tap threads into bushing with outer section of tool, as shown in Figure 61. When tool has been threaded into bushing sufficiently, screw "T"-handle section of tool into cover until it bottoms, and continue

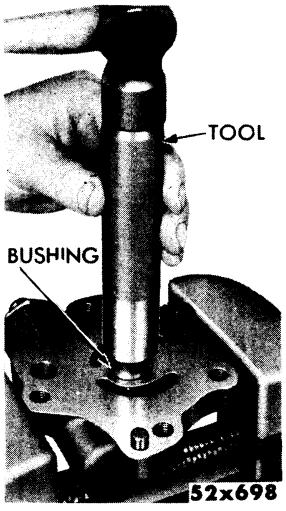

Fig. 62—Installing Pump Cover Bushing

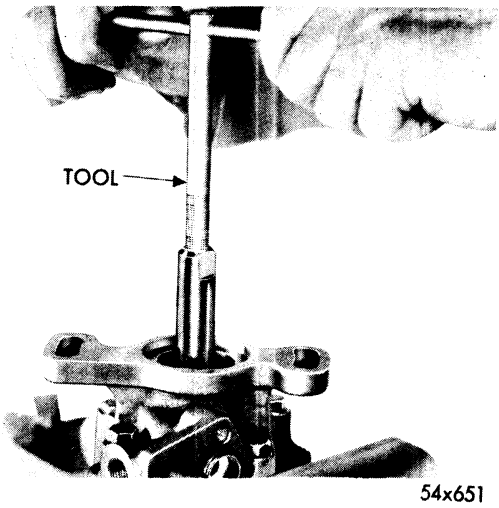

Fig. 63—Removing Pump Body Shaft Bushing (Tool C-3185)

turning to remove bushing. Install bushing with tool, as shown in Figure 62.

d. Replacement of Pump Body Bushings

Place pump body in vise equipped with protective jaws. Place pump cover on pump body and install attaching bolts. Install tool in cover bushing hole and thread tool into housing bush ing, as shown in Figure 63. Remove bushing and seal. (Always use a new seal when bushing is replaced.) Place bushing on tool, as shown in Figure 64, start bushing squarely and drive into place.

e. Replacement of Outer Rotor Bushing (Babbitt)

Thread tool into pump body (cover removed).

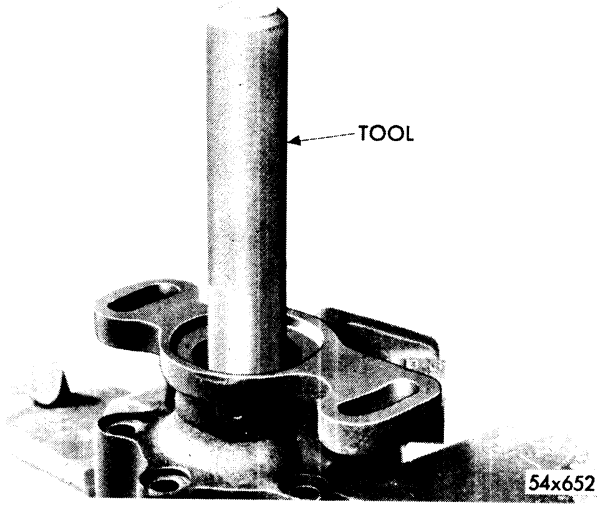

Fig. 64—Installing Shaft Bushing in Body (Tool C-3233)

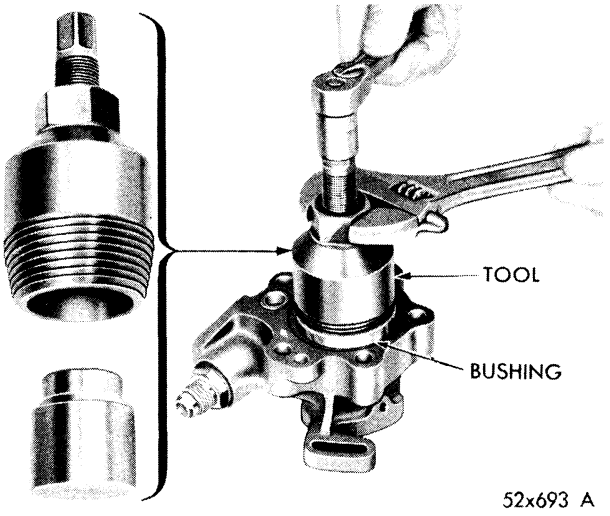

Fig. 65—Removing Babbitt Bushing from Body (Tools C-3214 and C-3234)

Using adaptor, remove the bushing (Fig. 65). Clean all parts thoroughly in a suitable solvent and blow dry with compressed air.

f. Installation of Pump Body Outer Bushing (Babbitt)

Start bushing squarely and, using tool, drift into place, as shown in Figure 66.

g. Installation of Pump Shaft Oil Seal

Reposition pump body in vise. Place seal on tool, as shown in Figure 67. Drive seal into position in pump body. To assemble pump, refer to Figure 58, and proceed as follows:

Lubricate all moving parts with clean SAE 10 W engine oil or Automatic Transmission Fluid, Type "A". Coat "O" seal rings with Lubriplate.

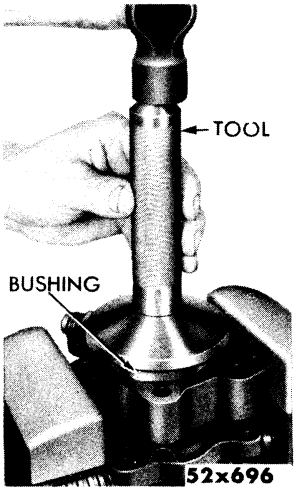

Fig. 66—Installing Babbitt Bushing in Body

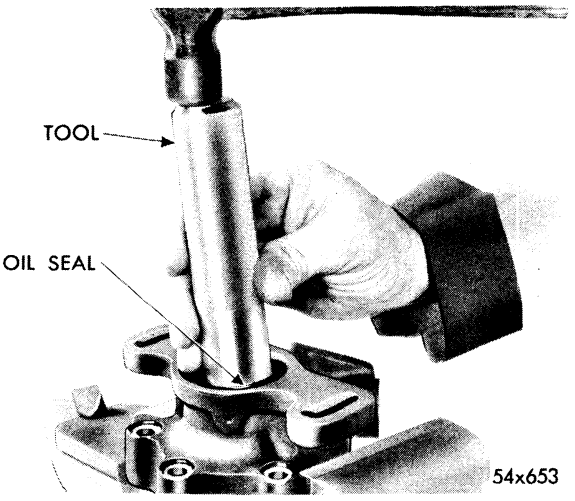

Fig. 67—Installing Pump Shaft Oil Seal (Tool C-3230)

Reassemble combination flow control and relief valve by inserting spring and relief valve, with small end first. Compress valve and spring and install snap ring. Make sure snap ring seats properly. Install the combination flow control and relief valve assembly into pump body, with the narrower land first. Insert spring, gasket, and adaptor. Tighten adaptor to 50 foot-pounds torque.

Install inner pump rotor and drive key on shaft and install snap ring. Install shaft protector thimble in pump body until it bottoms as shown in Figure 68. Using care not to dam-

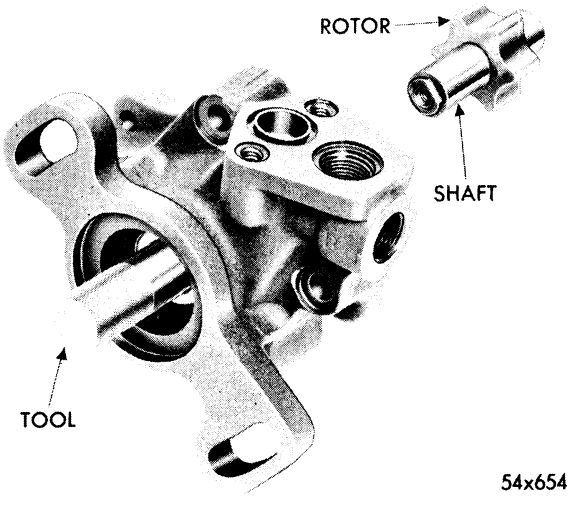

Fig. 68—Installing Pump Rotor Shaft with Thimble (Tool C-3350)

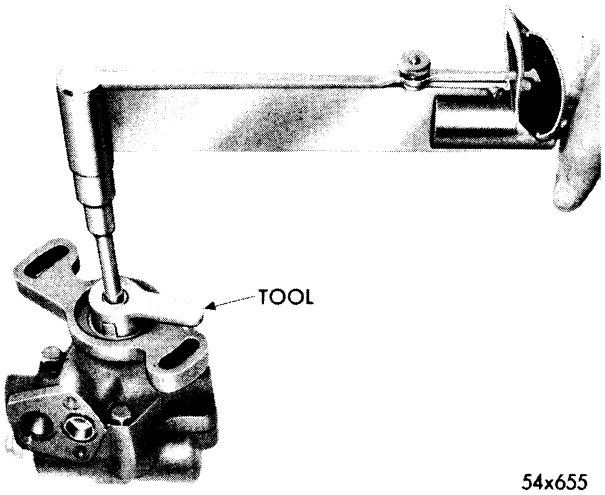

Fig. 69—Tightening Coupling Screw

age the babbitt bushings when installing rotor, insert rotor and shaft assembly, with coupling end first, into pump body. Insert outer rotor into pump body. Coat the "O" seal ring with Lubriplate and position on pump body. Place cover in position on pump body and install the five attaching bolts and lockwashers. Tighten to 35 foot-pounds torque.

Tap coupling flange on pump shaft until it bottoms and install special square washer, screw, and lockwasher. Using tool to hold coupling, as shown in Figure 69, tighten screw to 12 foot-pounds torque. To attach reservoir to pump, coat the "O" seal rings with Lubriplate. Install the two large and two small "O" rings on the reservoir mounting surface of pump. Place reservoir on pump, install filter standpipe stud and two reservoir to pump attaching screws. Tighten screws to 17 foot-pounds torque. Install filter element and tighten filter retaining screw assembly until it seats on the screw shoulder. **Install cover to keep dirt out of pump until after it has been installed on generator.**

26. FRONT WHEEL ALIGNMENT

Refer to Front Wheel Alignment procedures in this section.

SERVICE DIAGNOSIS

27. LEAKAGE THROUGH VENT IN UPPER HOUSING

Signs of oil at the upper housing vent hole does not necessarily indicate that an internal seal is causing the leaking. Make the following checks before disassembly of the unit:

Overfilling of the upper housing. If an upper housing has recently been refilled, oil may seep out the vent hole due to expansion after the gear has been operated.

If a unit has recently been installed, it is possible that in handling some oil may have become trapped in the vent passage and may drain as the gear is operated.

If doubt exists as to whether internal seal leakage is causing a leak at the vent, or whether it is caused by one of the above conditions, make the following check: Insert a pipe cleaner, or a similar absorbent object, into the vent to absorb any oil that may have been trapped in the vent passage. Start the engine and rotate the steering wheel from right to left, holding it against the wheel stop for a short time. **Do not exceed 1400 engine r.p.m. or hold the wheels against the stops longer than 15 seconds.**

If the oil does not come out the vent during this test, there is no need for further corrective work. There is, however, a rare possibility that the neoprene plug could have been lost from the vent package inside the housing and caused the loss of all the oil in the upper housing.

NOTE

If it is not necessary to add oil to the reservoir between checking periods of 1,000 miles, it is a good indication that there is not seal leakage, but a normal amount of seepage brought about by expansion of the oil during gear operation.

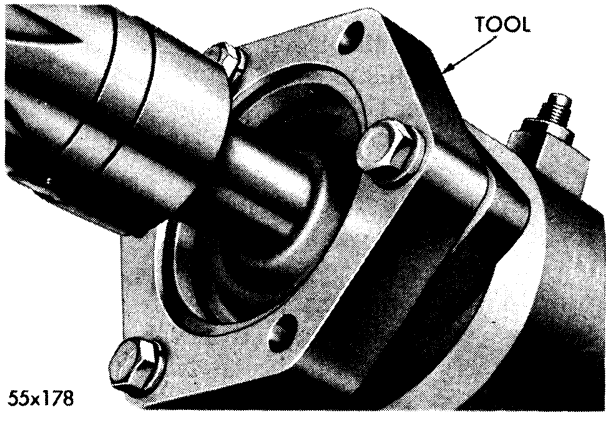

Fig. 70—Tool C-3469 Installed

If the oil is coming from the vent while making the test, remove the unit, place it in the holding fixture Tool C-3323, and connect test hoses so that the gear can be operated under pressure.

Remove the upper housing. To test the gear for leaks with the housing removed, install Tool C-3469, Flange-Housing Head Retaining, as shown in Figure 70.

With the use of this tool, the gear may be operated under normal pressure and the exact point of leakage can be determined.

From our experience, we strongly recommend the use of this flange Tool C-3469 since it pinpoints the exact nature of the leak and eliminates the possibility of disassembling the gear more than once for repairs.

When the flange tool is used, proceed with test as follows:

Remove all traces of oil around the housing head, upper piston rod and connector assembly. Start engine and check for source of oil leaks. Move the control valve off center in each direction with adjusting tool to build up pressure in the unit for testing leaks.

Leaks out through the vent hole may be coming from one or more of the following seals:

Reaction Seal—If leaking, oil can be detected to be coming from the connector assembly. Inspect seal for signs of shrinkage or being damaged. Use a new seal marked with a silver "M" as a replacement. Check new seal for snug fit in the valve control spacer. Also, inspect upper rod for being scratched at the sealing surface.

Upper Valve Rod "O" Ring—This leak can also be determined by observing oil coming from the connector assembly. Inspect for damaged "O" ring or not seating properly due to foreign material or roughness in the ring groove. Inspect ring groove location in upper piston rod to determine if "O" ring can possibly come out of the groove when pressure is applied. Install new "O" ring, making sure it is seated in the upper piston rod. Inspect sealing surface on the valve rod for roughness or scratches which would damage the "O" ring.

Upper Piston Rod Seal—Leaks from this seal will appear around the upper piston rod at the housing head. Inspect for damaged seal or improper seating in the housing head. Examine seal seating surface in the housing head for nicks, burrs, etc., and the sealing surface travel on upper piston rod for scratches. Make sure new seal is seated in the housing head.

Porous Housing Head—Inspect for oil seeping through pores in housing head. Replace housing head, if leaking.

Mating Surface Between the Upper and Lower Housings—Leakage at the mating surface may be caused by looseness of the three attaching screws which secure the two housings together. Tighten to 30 foot-pounds torque.

Leakage at this point may be caused by continuing to exert turning force on the steering wheel after the front wheels have reached their limit of travel, and by accelerating the engine excessively. It is possible to build up pump pressure in excess of 1,000 psi which will cause the Power Steering Unit to flex at the point where the two housings are bolted together. Constant flexing at this point will eventually cause seepage at the "O" ring. This is an abnormal operating condition and should not be practiced.

If leakage is not caused by looseness of attaching bolts or abnormal operation, remove the upper housing and inspect for improperly seated or damaged "O" rings on the housing head, especially the one located on the pressure side. Also, inspect "O" ring seating surface on hous-

ing head and gear housing for nicks or foreign material. Install new "O" rings. **Make sure the upper "O" ring is installed properly on the housing head or damage to housings will result when bolts are tightened.**

Lower Housing Cover—Leakage at this point is usually caused by a damaged "O" ring. Replace "O" ring. If leak continues, it is possible that the cover is porous. **Be sure that the cover is installed correctly (cupped portion of cover in) or damage to the lower gear housing will result when the unit is operated.**

Gear Shaft Oil Seal—Inspect for damaged seal. Make sure seal and snap ring are seated properly.

Gear Shaft Cover—The following points of leakage may be encountered at the gear shaft cover. All of these may be corrected without removing the unit from the car.

Leaks Between The Gear Shaft Cover and Housing—This condition may be caused by looseness of attaching screws. After tightening these screws if leak continues, inspect for damaged gasket, nicks or burrs on the gear housing and cover. Replace gasket.

Leaks Around Gear Shaft Cover Attaching Screws—Two of these screws have neoprene seals on them, while the one adjacent to the engine is used in a blind hole and does not require a seal. Be sure the seals are installed on the proper screws. Replace seals as required.

Leaks Around Threads Of Gear Shaft Adjusting Screw—This is usually caused by a damaged "O" ring. Remove cover and replace adjusting screw "O" ring.

28. NOISE ORIGINATING IN POWER STEERING UNIT

a. Squealing Noise (High Pitched)

This type of noise may, in some instances, be caused by slippage of the upper generator drive belt or the lower fan belt. If so, it will be noticeable while turning the steering wheel.

Should this noise occur while releasing the steering wheel from a high load to a low load, particularly on right turns, it may be vibration set up by the control valve rod.

To correct this condition, install a new type valve rod adjusting disc. The new adjusting disc is counterbored on the lower surface. If the noise still exists after installing a new disc, it may be caused by air in the hydraulic system. Operate the steering gear sufficiently to be sure that all of the air is bled out.

It may be necessary, in rare instances, to replace the piston and valve assemblies if the above does not eliminate the noise.

b. Hissing Noise (No Load)

This may be caused by low oil level in the reservoir. Add oil sufficient to cover the top of the filter element.

Hissing noise may also be an indication that the pressure control valve in the lower piston rod is not operating properly. To check operation of this valve, make the following test:

Connect pressure gauge C-3102 between the pump and pressure hose. Open valve on gauge and idle engine at 475 to 500 r.p.m. With engine idling at operating temperature and no turning effort on the steering wheel, the pressure should read between 70 to 100 psi.

If the pressure is not within these limits, disassemble and inspect the pressure control valve for: proper sequence of parts installed, refer to Service Bulletin No. 621; crushed valve body causing excessive leakage or plunger sticking, and end plug not seated against the valve body, allowing leakage or chatter.

During assembly, be sure that the end plug is seated firmly against the valve body. Check seating of plug by attempting to turn the valve body with a small screwdriver inserted in the oil outlet hole in the lower piston rod.

c. Hissing Noise (Right Turn Only)

This may be caused by oil leakage by the lower piston rod gear housing oil seal.

Disassemble and inspect for: damaged lower piston rod gear housing oil seal; seal not seating properly in the gear housing; lower piston rod for scratches which could permit leakage by the seal, and seal seat in the gear housing for nicks, burrs, etc., which would keep the seal from seating properly. Install new seal.

d. Hissing Noise Accompanied by Loss of Oil Through Vent in the Upper Housing (Left Turn Only)

This may be caused by oil leakage by the upper piston rod housing head oil seal. Disassemble and inspect for: damaged housing head (upper piston rod) oil seal; seal not seating properly in the housing head; upper piston rod for scratches which could permit leakage by the seal, and seat seal in the housing head for nicks, burrs, etc., which would prevent the seal from seating properly. Replace seal.

e. Creaking Noise (On Turns)

This noise may be detected while turning in either direction and can be caused by loose gear to frame mounting bolts. Tighten bolts and recheck for noise. If the noise continues, install the latest type of new gear shaft. Shaft can be installed without removal of the unit.

f. Snapping Noise

This noise is usually intermittent and can be produced when the direction of the steering wheel is suddenly reversed. Inspect for loose steering gear to frame bolts. Tighten and recheck for noise. If the noise still exists, check front suspension for springs not being properly seated; camber adjusting bushing set screw being loose; center link and tie rod joints for alignment; brake supports, and spacer washer on brake shoe anchor biting into support, etc.

In some rare instances, the noise may be caused by one of the following items: lower piston rod bushing dowel pin being too high; foreign material preventing bushing from seating, and bearing surface of bushing rough. Install a new bushing, if necessary, making sure it is seated in the gear housing and that the head of the dowel pin is slightly below the bearing surface of the bushing. Inspect for the lower piston rod being loose in the piston. Replace parts, as necessary, to assure a tight fit.

g. Chuckle Noise

This noise is most noticeable when the car is driven over rough or choppy roads and is usually accompanied by road wander. The condition may be caused by one or more of the following. Check in the following order:

Steering gear arm nut loose on the gear shaft, Tighten to 100-120 foot-pounds torque.

Loose front wheel bearings. Adjust bearings.

Gear shaft adjustment too loose.

Excessive king pin end play. There should be .006 to .008 inch clearance between the steering knuckle and the knuckle support. Adjust clearance through the use of shims as needed.

Steering tube coupling screw loose.

Worm bearing pre-load adjustment too loose. Adjust pre-load.

Excessive worm shaft end play in connector assembly. Replace worm and connector as an assembly.

h. Looseness, Shake or Roughness at Upper End of Steering Column or Steering Wheel

This noise condition may be caused by improper assembly of the upper column jacket bearing. The prongs of the jacket should be staked over the outer bearing race so that the distance from the end of the jacket to the upper or outer surface of the staked prong is .08 inch, or approximately $\frac{5}{64}$ inch. If the bearing is not assembled properly, the column bearing spring is not loaded sufficiently and causes one of the above conditions.

29. IMPROPER STEERING

a. Wander (Steering Wheel Free Play)

To determine whether or not this condition is caused by the Power Steering unit, proceed as follows: With front wheels in the straight-ahead position and resting on the floor, start engine and, with a very light touch, move the steering wheel to check free play. Free play should not exceed $\frac{5}{8}$ inch. It requires careful checking to determine the exact amount of steering unit free play without any movement of the steering linkage. If it has been accurately established that the free play exceeds $\frac{5}{8}$ inch, the cause may be one of the following:

Gear shaft adjustment too loose.

Steering tube coupling screw loose.

Worm bearing pre-load adjustment too loose.

Excessive worm shaft end play in the con-

nector assembly. Replace worm and connector as an assembly, if any end play is detected.

If steering wheel free play does not exceed 5/8 inch, it is an indication that the condition is caused by one of the following:

Steering gear arm nut loose on gear shaft. Tighten to 120 foot-pounds torque.

Loose front wheel bearings.

Steering linkage — check for worn or loose tie rod ends. Loose steering knuckle arms.

Front wheel alignment.

Binding at king pins and bushings or at other pivot points in front suspension.

b. Poor Recovery of Wheels to Straight-Ahead Position (Both Directions)

This condition may be caused by low tire pressure, binding in front suspension parts, front end alignment, etc. If the condition still exists after checking and eliminating these possible causes, make the following checks to determine exactly what is causing the difficulty:

Disconnect linkage from the steering gear and start engine. With engine idling, use a torque wrench on the steering gear arm nut and check the torque required to turn the gear shaft from one extreme to the other. The readings should be approximately equal and not exceed 40 foot-pounds in either direction. If reading does not exceed 40 foot-pounds, it is an indication that the difficulty is caused by one of the following: binding — tie rods ends, steering knuckles, king pins and bushings, and front wheel alignment.

If the reading does exceed 40 foot-pounds, it is an indication that the difficulty is caused by the Power Steering Unit. To determine the exact source of the difficulty, start engine and recheck the torque required to turn the gear shaft each time one of the following possible causes is checked:

Steering wheel to column jacket interference.

Steering column jacket bearing. Remove steering wheel, jacket, shroud assembly and steering tube. Recheck torque and, if reading is 40 foot-pounds or below, replace the bearing and position, as outlined in preceding item. If reading is not below 40 foot-pounds, proceed with next item.

Gear shaft adjustment too tight. Adjust gear shaft. If condition still exists and the torque reading increases considerably when passing through the center of gear travel, it is possibly due to excessive chamfer on the center tooth of the gear shaft. **This condition does not apply to units incorporating the equal tooth gear shaft (identified by absence of chamfer). Units built with the equal tooth can be identified by an "O" stenciled on the end of the steering gear shaft or cross shaft.**

Remove gear shaft from unit and check for excessive chamfer on the center tooth of gear shaft. (It is not necessary to remove unit from car.) The width of the chamfer flat on the center tooth should not exceed 1/16 inch. If it does, replace shaft.

If torque reading still remains above 40 foot-pounds, remove the unit and proceed with checking.

Worm bearing pre-load too tight. Place unit in holding fixture, connect test hoses and refill reservoir. Remove worm shaft oil seal. Start engine and check torque after readjusting worm bearing pre-load. If torque is still too high, it may be caused by worm shaft binding in the connector or connector guide rails binding in housing. Replace parts as necessary.

c. Poor Recovery of Wheels to Straight-Ahead Position (One Direction Only)

Make checks, as outlined in previous item, to eliminate the possibility of the difficulty being caused by the front suspension or steering linkage parts. After these possibilities have been eliminated and the condition still exists, center the control valve until equal torque readings are obtained in each direction.

d. Unequal Steering Effort

Unequal steering effort may be mistaken for "lack of assist in one direction." To establish if such a condition exists, check steering wheel turning effort as follows: With engine idling and front wheels on floor, turn steering wheel at a normal rate of r.p.m. from one extreme to the other, and note the amount of turning force required. After this check, turn the wheel in the

same manner except at a higher rate of r.p.m. Do not exceed approximately 60 steering wheel r.p.m. when making this check. If the turning force did increase considerably while turning the wheel at high rate of speed, then the condition is "Lack of Assist in One Direction." If the amount of turning force did not increase, then it is "Unequal Steering Effort." Proceed as follows to determine cause:

e. Control Valve Adjustment

Disconnect linkage and center control valve so that an equal amount of torque is required to turn the gear shaft from one extreme to the other. (If proper adjustment cannot be maintained, refer to "Inability to Maintain Control Valve Adjustment.")

f. Upper Piston Rod Movement in Piston

Check fit of snap ring which retains upper piston rod in the piston by attempting to rotate the snap ring. If the snap ring can be rotated, it will allow the upper piston rod to move axially with respect to the piston and displace the control valve relationship to the valve body. This can cause self steering in either direction, however, it is usually noted to be to the left. Replace piston, making sure the snap ring seats tightly.

g. Connector Nut

Any condition which will cause the valve rod adjusting disc to become loose in the connector will result in self steering. Check for connector nut not tightening sufficiently to lock the valve rod adjusting disc and reaction assembly in the connector. Remove the worm connector and reaction assemblies from the upper piston rod. Reassemble by placing the adjusting disc, adjusting disc retainer and valve control spacer in their respective positions in the worm connector. Install worm connector nut and tighten securely. Insert a small punch or screwdriver through the bottom of the connector and attempt to rotate the adjusting disc. If it cannot be rotated, it is properly locked. If it can be rotated, check threads on connector nut, connector, etc., and replace parts as necessary.

h. Control Valve Loose on Rod

The control valve rod is connected to the control valve by peening. Check for any movement between the two. If movement does exist, replace the control valve and rod assembly. Do not attempt to tighten.

i. Upper Piston Rod Nut Loose

Tighten securely.

j. Upper Piston Rod

Inspect rod for being scored at reaction seal retainer bearing surfaces and replace if necessary.

k. Reaction Assembly

If the above items have failed to correct unequal steering effort, replace all reaction parts. Make sure the valve control spacer is matched to the upper piston rod. The length of the valve control spacer must be identical to the distance between the seat of the lower valve control spacer retainer and the upper piston rod nut.

30. INABILITY TO MAINTAIN CONTROL VALVE ADJUSTMENT

This condition may be caused by the following conditions:

Valve control rod loose in disc. The locking effort of the adjusting disc can be increased by slightly compressing the locking portion in a vise. Turning effort of rod in disc should be 10 to 20 inch-pounds. Do not exceed 20 inch-pounds or the valve rod and (or) adjusting tool may be damaged.

Upper piston rod nut loose. Tighten securely.

Control valve loose on rod. Replace assembly if any looseness is found.

Reaction spacer too long or too short, or burrs or out-of-squareness of any of the reaction area parts which are held inside the connector by the connector nut (including the nut not being tightened) can cause this condition.

31. LACK OF ASSISTANCE

a. One Direction

Lack of assistance in one direction is usually found to be caused by one of the following conditions:

Damaged neoprene piston ring.

Housing head oil seal (upper piston rod).

Damaged or improperly seated housing head oil seal will cause lack of assistance when turning to the left, and will also be accompanied by loss of oil out of the vent in the upper housing. Inspect sealing surface on upper piston rod for being scratched. Replace, if necessary. Install new housing head oil seal and make sure that it is seated in the housing head.

Valve rod lower "O" ring. Inspect for damaged lower valve rod "O" ring in upper piston rod.

Piston rod "O" rings. Inspect for damaged "O" rings on both upper and lower piston rods which may be causing leakage between piston and rods. Install new "O" rings and make sure they fit in the grooves.

b. Both Directions

Tire pressure too low. Upper and lower fan and generator belts slipping. Low fluid level in reservoir. Fill so that fluid covers top of filter. Lack of pump pressure. Make pressure checks.

FRONT WHEEL ALIGNMENT

(All Models)

32. DESCRIPTION

Correct front wheel alignment produces easy, positive steering with a minimum of scuffing action between tire and road.

All factors of front wheel alignment are interrelated but each angle has a specific purpose. Four different angles are used in positioning front wheels for proper steering under varying conditions of weight and speed.

Should one of the four angles get out of position, the harmonious relationship of all of them is destroyed. Each angle depends upon the proper setting of the others if front wheels are to lead properly.

In making corrections to front wheel alignment, or installing new front wheel suspension parts, all four angles in both front wheels should be checked in the following order.

33. KING PIN INCLINATION

King pin inclination is the amount the top of the king pin inclines away from the vertical toward the center of the car, as viewed from the front of the car (Fig. 71). Inclined king pins are closer together at the top than at the bottom.

When the king pin inclination is incorrect, it is an indication of a bent frame or bent control arms. Correction should be made by

straightening the frame as required, or by replacing the damaged parts.

34. CAMBER

Camber is the amount the wheel inclines away from the vertical at the top, as viewed from the front of the car (Fig. 71).

With positive camber, the wheels are farther apart at the top than at the bottom. Negative or reverse camber is the opposite—the wheels are closer together at the top than at the bottom.

Unequal camber in the front wheels may cause the car to lead to the right or left.

35. CASTER

Caster is the amount the top of the king pin is inclined toward the front or rear of the car, as viewed from the side of the car (Fig. 72).

Positive caster is the tilt of the top of the king pin toward the rear of the car. Negative or reverse caster is the tilt of the top of the king pin toward the front of the car.

Positive caster imparts a trailing action to the front wheels, while negative or reverse caster causes a leading action. The correct amount of caster helps to keep the front wheels in the straight-ahead position. When turning a curve caster and king pin inclination act as a lever, assisting the driver to return the front wheels to the straight-ahead position.

36. TOE-IN AND TOE-OUT

Toe-in is the amount the front wheels are closer together at the front than they are at the rear, when viewed from the top of the car.

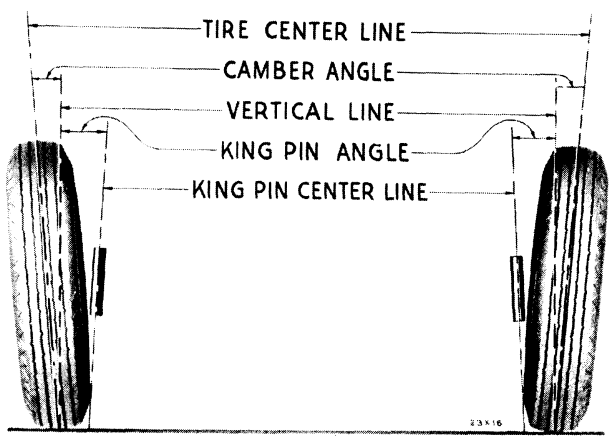

Fig. 71—Camber Angle and King Pin Inclination

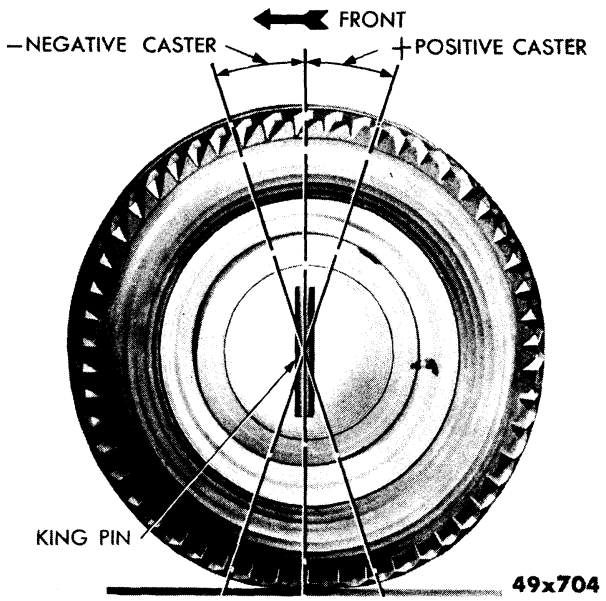

Fig. 72—Caster Angle

Excessive or insufficient toe-in causes lateral slipping or scuffing between the tire and the road, resulting in abnormal tire wear.

When the wheels are turned to the right or left, they actually toe out (are farther apart at the front than at the rear).

The design of the steering knuckle arm regulates the amount of toe-out, depending on the wheelbase of the car and the distance between the steering knuckles. To be in correct relative alignment when negotiating a turn, both front and rear wheels must travel in circles having a common center. The inside front wheel travels in a circle having a smaller arc than the circle traveling by the outside front wheel. Therefore, the wheels will be farther apart at the front than at the back when turned off the straight-ahead position. The amount the front wheels toe-out on turns depends on how far the front wheels are turned.

A bent steering knuckle arm will cause excessive tire wear, even though the amount of toe-in is correct for the straight ahead position of the front wheels, because when the front wheels are turned to the right or left, the error in toe-out, due to the bent steering knuckle arm, would cause excessive scuffing between the tire and the road.

The instructions in this manual for checking front wheel alignment are based on use of Tool C-3409 gauge and DD-435 turntables. There are many other types of checking equipment in use that accomplish the same purpose. However, the method of using the equipment may differ from the instructions in this manual.

Regardless of make or type of equipment used, checking and adjusting should be done in proper sequence as outlined herein.

CHECKING FRONT WHEEL ALIGNMENT

Normally, when checking front wheel alignment, the car should be empty (all luggage or load should be removed). If a constant load is carried, such as when a car is used by a salesman for carrying samples, etc., the car should be loaded with its normal amount of weight before checking front wheel alignment.

IMPORTANT

The front springs and shock absorbers should be placed in "normal" position by grasping front bumper at its center and moving the front end of the car up and down several times.

The car must remain in this "normal" position while front wheel alignment is being checked. If one side of car is lower than other, due to someone getting into or out of car, gauge readings will be incorrect, unless the foregoing operation is repeated.

37. CHECKING KING PIN INCLINATION

(1) Inflate all tires to recommended pressures.

IMPORTANT

Set foot brakes so that front wheels will not turn while king pin inclination is being checked.

(2) Place front wheels on locked turntables, as shown in Figure 73, with front wheels in straight-ahead position.

NOTE

The center of the tire contact area should be approximately two inches inside the center of the turntable pad.

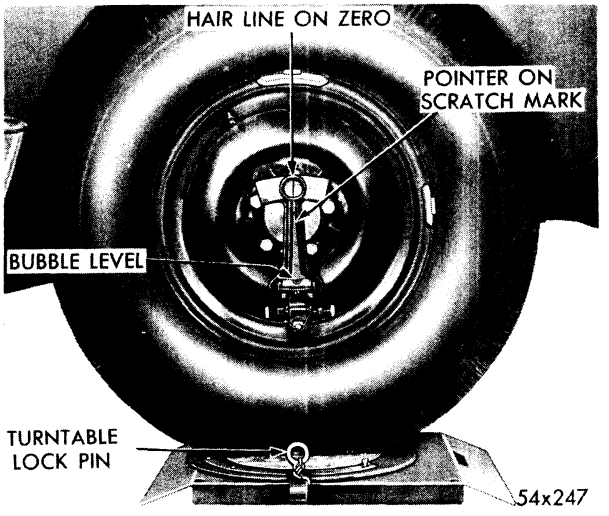

Fig. 73—Gauge C-3409 and Turntable DD-435 on Right Wheel

(3) Remove Wheel Cover Assembly.

(4) Assemble gauge to right front wheel hub as shown in Figure 73, with quadrant parallel with wheel and pull out turntable lock pins.

(5) Grasp the front bumper at the center and move, or bounce, the front end of car up and down three or four times to allow the car to rest at "normal," unloaded position.

(6) With gauge on the right wheel, turn front wheels to left until right wheel has turned more than 20 degrees, as indicated on turntable scale. Allow wheel to back off to exactly 20 degrees.

(7) Adjust secondary screw which controls short pointer (Fig. 74), until bubble is centered between the two lines on the spirit level. Do not disturb gauge setting or release brakes.

IMPORTANT

To relieve bind and friction, or looseness in steering mechanism, and for accurate gauge reading, it is advisable to turn wheels slightly beyond 20 degrees, and then back to exactly 20 degrees.

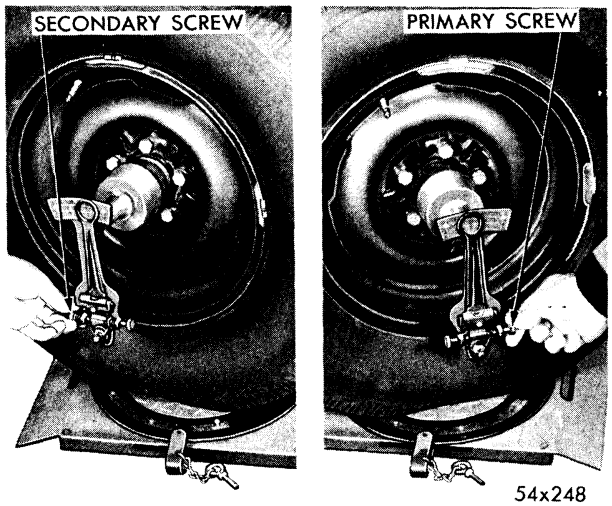

Fig. 74—Checking King Pin Inclination—Right Wheel Tool C-3409 Gauge

(8) With foot brakes still applied, turn front wheels to the right until right wheel has been turned to an angle of more than 20 degrees past straight-ahead position.

(9) Adjust primary screw (Fig. 74) which controls hair line, until bubble centers in spirit level. The reading on the 40 degree scale on gauge will be the king pin angle for the right wheel.

(10) **To check king pin angle on left wheel,** place wheels in straight-ahead position and attach gauge to left wheel as explained in Step (4). Turn wheels to right, repeating Steps (6), (7), (8) and (9), as outlined above.

NOTE

When the king pin inclination is found to be other than shown on the special chart, it is an indication of bent frame, steering knuckle support or control arm. Correction should be made by straightening the frame, as required, or by replacing the damaged parts.

38. CHECKING CAMBER

(1) Be sure king pin inclination (6½ to 8 degrees on Model C-70 and 5 to 6½ degrees on all other models) is correct. Refer to Paragraph 36, King Pin Inclination. Place front wheels in straight-ahead position with weight of car on wheels and front end of car level.

(2) With gauge assembled on wheel, as shown in Figure 75, adjust secondary screw on quadrant assembly so that pointer, which is just above the spirit level, is on scratch mark.

(3) Adjust primary screw so that spirit level bubble is centered.

(4) Take camber reading in degrees on scale. Use 60 degree section of scale on quadrant assembly of gauge for checking camber. If wheel is not true, turn it 180 degrees and take another reading. Average the two readings to obtain camber angle.

(5) Readings from zero toward wheel indicate positive camber. Readings from zero away from wheel indicate negative or (reverse) camber.

(6) Check camber of opposite wheel in the same manner.

39. CHECKING CASTER

(1) Be sure king pin inclination and camber angle are correct. Refer to Paragraphs 21 through 23, King Pin Inclination and Camber.

(2) With gauge on right wheel, as shown in Figure 76, turn front wheels to left until right wheel has turned beyond 20 degrees, as indicated on turntable scale. Allow wheels to back off to exactly 20 degrees for

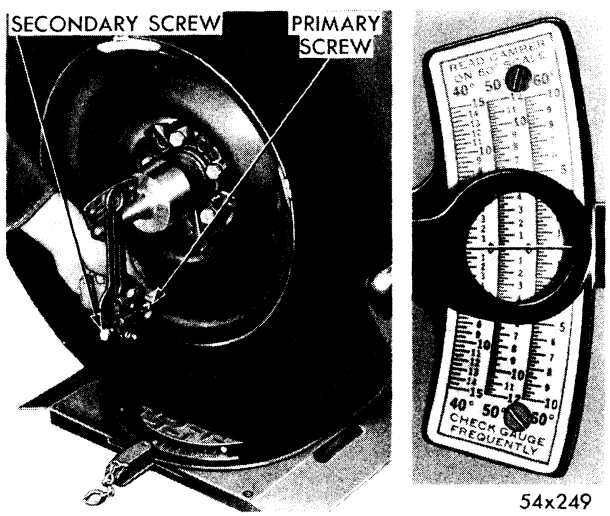

Fig. 75—Checking Camber (Tool C-3409)

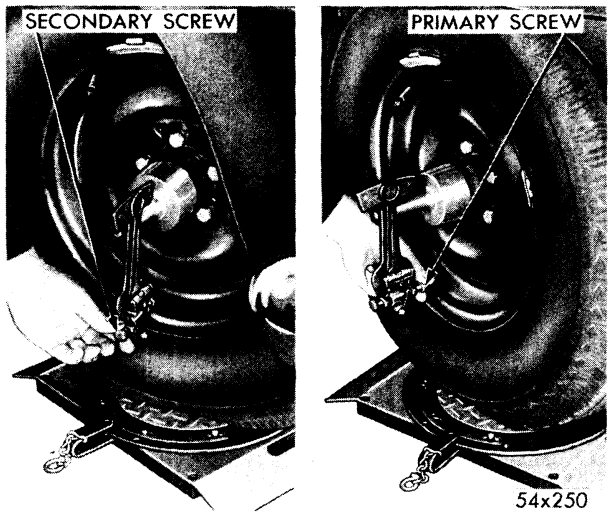

Fig. 76—Checking Caster (Tool 3409)

accuracy and to relieve possible bind in steering mechanism.

(3) Adjust secondary screw until bubble is centered between two lines on spirit level. Do not disturb this gauge setting.

(4) Turn front wheels to right until right wheel has turned to an angle of more than 20 degrees past straight-ahead position. Allow wheels to back off to exactly 20 degrees.

(5) Adjust primary screw until bubble centers in spirit level. The reading on 40 degree scale will be the caster. Reading from zero away from wheel indicates negative (reverse) caster. Readings from zero toward the wheel indicate positive caster.

(6) To check amount of caster in left wheel, place wheels in straight-ahead position and attach gauge to left wheel. Then, turn wheel to right until left wheel has turned beyond 20 degrees, as indicated on turntable scale. Back off to exactly 20 degrees.

(7) Adjust secondary screw until bubble is centered between two lines on spirit level. Do not disturb this gauge setting.

(8) Turn front wheels to left until left wheel has turned more than 20 degrees past straight-ahead position. Back off to exactly 20 degrees.

(9) Adjust primary screw until bubble centers in spirit level. The reading on 40 degree scale on gauge will be caster angle. Readings from zero toward wheel indicate positive casters. Readings from zero away from wheel indicate negative (reverse) caster.

40. MEASURING TOE

Front wheel toe should be checked with a suitable gauge, such as Tool C-695.

(1) Raise front end of car until front wheels clear the turntables.

(2) Spin front wheels and scribe broad chalk lines on center tread all around tire.

(3) Use a pointed tool to scribe a fine hairline within the broad scribed chalk line.

(4) With front wheels straight-ahead, lower car until full weight rests on the turntables. This allows free movement of wheels to settle into the normal position they would assume when car is in motion.

(5) After car has come to rest on turntables, use Tool C-695 to measure at hub height the distance between points (A) and between points (B) of front and rear of front wheels (Fig. 77). Distance between points (A) should not exceed that of points (B) by more than $\frac{1}{16}$ inch. Equal distances between points (A) and points (B) are preferable.

41. MEASURING TOE-OUT ON TURNS

Before checking toe-out, wheel alignment on turns (Fig. 79), all other factors of front wheel alignment should be checked in their proper sequence, namely: king pin inclination, caster, camber and toe-in. Check amount of toe-out on turns as follows:

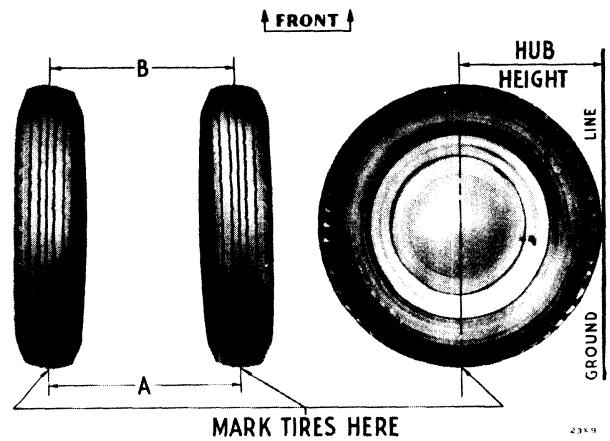

Fig. 77—Front Wheel Toe-In

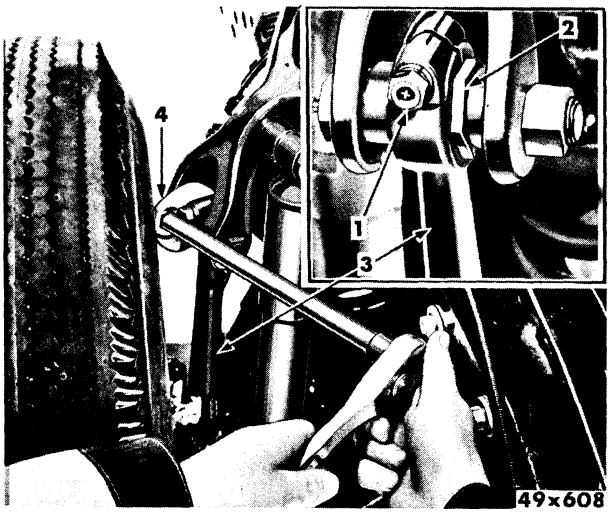

Fig. 78—Camber Angle Adjustment

1—Lock screw
2—Upper control arm pin (eccentric bushing)
3—Steering knuckle support
4—Tool C-611 (Tool C-619 for 8-Pass. Sedan)

(1) Turn front wheels to left until turntable under right wheel registers 20 degrees.

(2) Take reading of turntable under left wheel. With right wheel set at 20 degrees angle, the angle of left wheel should be 21½ degrees plus or minus 1 degree.

(3) Repeat foregoing operations, but turn the wheels to right until turntable under left wheel registers 20 degrees. Under this condition the angle of right wheel should be 21½ degrees plus or minus 1 degree.

ADJUSTING FRONT WHEEL ALIGNMENT

42. ADJUSTING CASTER AND CAMBER

Correct caster angle is obtained by proper adjustments of the upper control arm eccentric bushing. To adjust the camber, loosen the lock screw, as shown in Figure 78. Turn the bushing to obtain the correct setting, within ½ revolution from the point where correct caster setting is obtained. Do not turn the eccentric bushing until it binds against either side of the upper control arm. Keep the steering knuckle support as nearly centered between the ends of the upper control arm as possible. Adjust to specifications in Data and Specifications and tighten the lock screw.

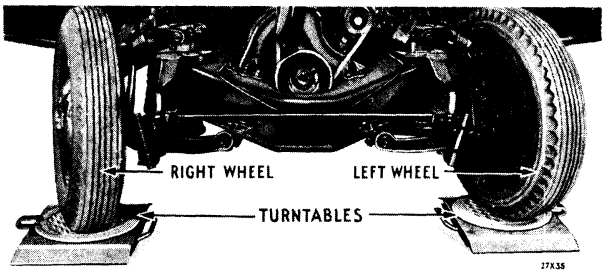

Fig. 79—Checking Toe-Out on Turns (Tool DD-435)

NOTE

If correct wheel camber cannot be adjusted within specified limits, the use of spacer shims at the top of spring will correct this condition. Each spacer shim represents an increase of approximately ½ degree with the maximum of 2 spacer shims to be used.

43. ADJUSTING TOE

With the steering wheel in its center position, lengthen or shorten tie rods an equal amount until toe of 0 to 1/16 inch (0 inch preferred) is obtained.

CAUTION

The steering wheel hub, the steering gear arm, the steering tube and the steering gear roller shaft are machined with master serrations to place the wheels straight-ahead when the steering wheel is in its center position. No attempt should be made to change the relative position of these parts by altering the master serrations. Improper positioning of the steering wheel should be corrected only by adjusting the tie rods.

44. TOE-OUT ON TURNS

Assuming that camber, caster, king pin inclination and toe-in are correct and that the steering arms are not bent, toe-out on turns will be within the specified tolerance. There is no adjustment to be made (Fig. 79).

SERVICE DIAGNOSIS
(Manual Steering)

45. EXCESSIVE PLAY OR LOOSENESS IN THE STEERING WHEEL

Possible Causes:

a. Steering gear adjusted too loosely or badly worn.

b. Steering linkage loose or worn.

c. King pins and bushings loose and worn.

d. Front wheel bearings improperly adjusted.

e. Pitman arm loose on steering gear shaft.

f. Steering gear housing attaching bolts loose.

g. Steering arms loose at anchor bolts.

Remedies:

a. If excessive play exists in the steering wheel without moving the Pitman arm, refer to Steering Gear Adjustments, Paragraph 8. Correct as necessary.

b. Check the steering linkage ends for wear. If any appreciable amount is evident, replace with new end assemblies.

c. Refer to Paragraph 14 for procedure checking and replacing king pins and bushings.

d. Refer to Paragraph 12 for procedure checking and adjusting wheel bearings.

e. Check for looseness between the Pitman arm and steering gear shaft, while turning the steering wheel back and forth. If looseness is evident, inspect the serrations and correct as necessary.

f. Rotate steering wheel and check the steering gear housing. If movement is noted, align the assembly and tighten attaching bolts securely.

g. Check steering gear arms for looseness and tighten to the specified torque.

46. HARD STEERING

Possible Causes:

a. Low or uneven tire pressure.

b. Insufficient lubricant in the steering gear housing.

c. Steering gear adjusted too tightly, steering gear and jacket assembly misaligned, or binding in the linkage.

d. Front wheels out of line.

e. Steering column out of line.

Remedies:

a. Check and correct tire pressure, as required. Refer to Wheels and Tires Section XIII for correct tire pressure.

b. Check level of lubricant, and if found to be low, add correct amount. Refer to Lubrication Section XV.

c. Disconnect the Pitman arm at the steering gear shaft. Turn the steering wheel to both extremes. If binding is evident near the ends of travel, the cause can usually be traced to either a misaligned steering gear assembly, improperly adjusted gears, or worn bearings. If binding is evident in center position only, the gear mesh adjustment is too tight.

The steering gear assembly can be correctly aligned as follows: loosen the housing to frame bracket, the frame bracket to frame bolts and the instrument panel bolts and realign assembly to frame and instrument panel. There must be no misalignment at either the frame or instrument panel. If the gears are improperly adjusted, refer to Paragraph 8.

If binding was evident before the Pitman arm was disconnected, but disappeared after being disconnected, check the steering linkage for dry or binding tie rod ends. Lubricate or replace tie rod ends as necessary. Also check for .005 to .010 inch clearance around king pin, between knuckle and support.

For other possible conditions that may be encountered pertaining to steering, refer to Front Wheel Alignment in this Section.

d. Refer to Front Wheel Alignment. Correct condition as required.

e. Refer to Paragraph 6 in this section. Correct condition as required.

Section XI

TRANSMISSION

SERVICE BULLETIN REFERENCE

NUMBER	DATE	SUBJECT	CHANGES