

Power Steering

1971-73 SAGINAW ROTARY VALVE

American Motors, All Models
 Ford Mustang, Mercury Cougar
 General Motors, All Models
 Jeep

DESCRIPTION

Saginaw Rotary Valve power steering gear operates entirely on displacing fluid to provide hydraulic fluid pressure assists road only when turning. As the entire gear assembly is always full of fluid, all internal components are immersed in fluid making periodic lubrication unnecessary. Fluid acts as a cushion to absorb road shocks that may be transmitted to the driver. All fluid passages are internal except pressure and return hoses between gear and pump. Rotary valve provides a smooth transmission through driving range of steering wheel effort. A torsion bar transmits road feel to driver. Rack-piston nut is one piece and is geared to sector shaft. Lash between sector shaft and rack-piston nut is maintained by an adjusting screw which is retained in the end of the shaft gear.

LUBRICATION

Check fluid level in pump reservoir every 6000 miles. Steering gear and fluid must be at normal operating temperature. If necessary, add fluid to bring level to proper mark on dipstick. If steering gear and fluid are cold, bring fluid level to lower end of filler neck.

ADJUSTMENT

American Motors

Pitman Shaft Overcenter Adjustment (On Car) - Mark pitman arm and shaft, remove pitman arm. Remove horn contact assembly. Place steering wheel at center of its travel. Factory mark on upper end of steering shaft should be up. Turn gear 1/2 a turn off center (either direction). Using an Inch Lb. torque wrench and socket on steering wheel nut determine torque required to rotate shaft slowly thru a 20° arc. Now turn

gear back to center and repeat method of reading torque. If torque reading is equal to 6 Inch Lbs. of first reading, no adjustment is required. To adjust, loosen adjuster nut and turn screw until reading is equal to 6 Inch Lbs. in excess of first reading.

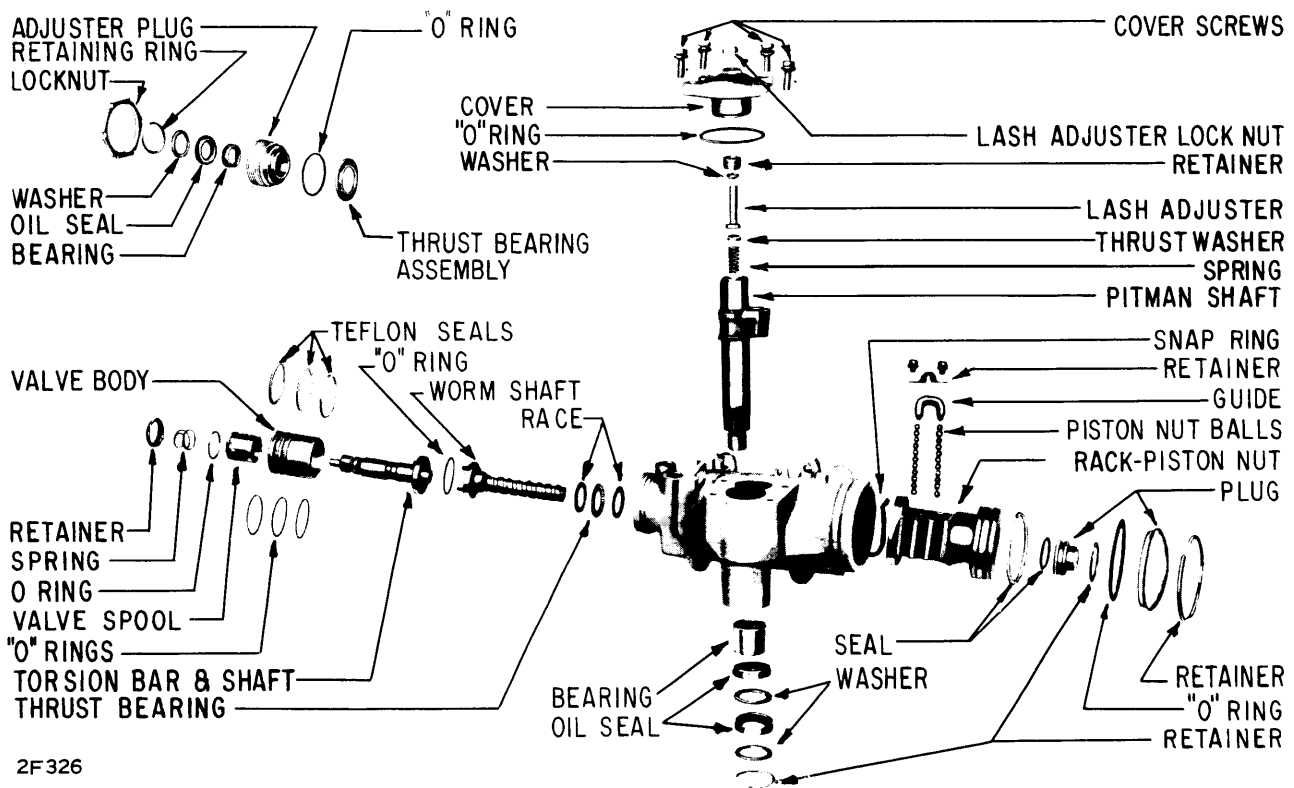
Worm Thrust Bearing Preload (Off Car) - Loosen pitman shaft adjuster lock nut, and back off lash adjusting screw. This must be done to obtain an accurate worm bearing adjustment. Loosen adjuster plug lock nut. Adjust thrust bearing preload using an adjustable spanner wrench (J-7624). Tighten adjuster plug up snug, back off slightly, and with an Inch Lb. torque wrench on stub shaft, measure torque required to turn shaft. Adjust so that preload is 5 1/2 to 7 1/2 Inch Lbs.

Pitman Shaft Endplay Overcenter Adjustment (Off Car)

With gear on center and pitman shaft adjusting screw backed off, measure total drag. With gear on center, adjust pitman shaft Allen screw so preload is 4-8 Inch Lbs. in excess of total preload and drag. Readings are measured thru an arc not to exceed 20°.

Buick

Worm Thrust Bearing Preload (Off Car) - Loosen pitman shaft adjuster screw lock nut. Back off pitman shaft lash adjuster screw. Loosen thrust bearing adjuster plug lock nut. Back off adjuster plug. Using an Inch Lb. torque wrench on gear stub measure drag torque. Tighten adjuster plug until torque required to turn shaft is 3-4 Inch Lbs. greater than drag torque. Total reading should not exceed 7 Inch Lbs. *NOTE - Preload torque tends to drop off when lock nut is tightened, therefore torque reading must be taken with lock nut tight.*



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SAGINAW ROTARY VALVE POWER STEERING GEAR ASSEMBLY

1971-73 SAGINAW ROTARY VALVE (Cont.)

Pitman Shaft Endplay Overcenter Adjustment (Off Car)

With gear on center, loosen pitman shaft adjuster lock nut, and tighten pitman shaft lash screw, retighten lock nut. Measure gear overcenter torque using an Inch Lb. torque wrench. When measuring, torque wrench should be rotated thru a 180° arc. Continue adjusting lash adjuster screw and checking over center torque. Torque should be 4-8 Inch Lbs. additional to thrust bearing preload on new gear, and 4-5 Inch Lbs. on used gear. Not to exceed 18 Inch Lbs. on new gear, and 14 Inch Lbs. on used gear.

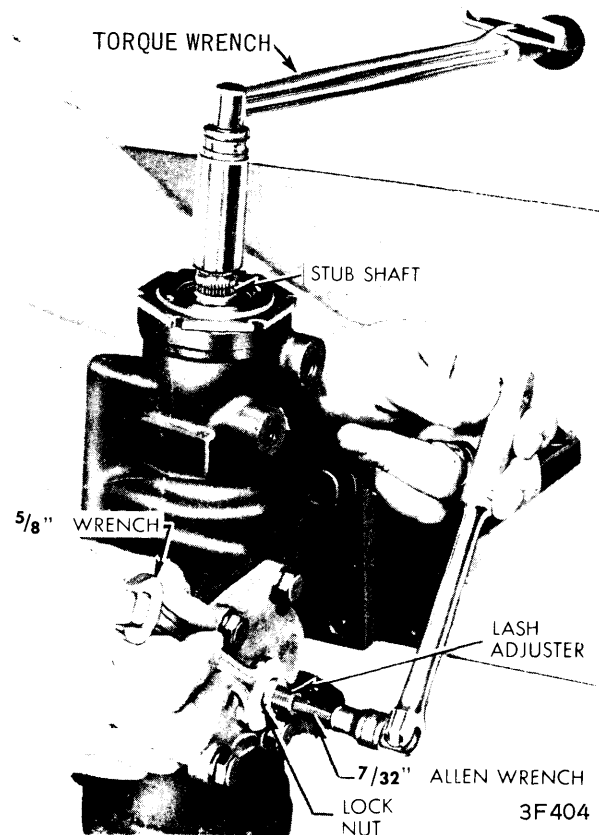
Cadillac

Thrust Bearing Preload – Disconnect pitman arm from drag link using suitable puller, check flexible coupling and make certain it is not distorted or binding. Turn steering wheel to either end position just off the stop, attach spring tension scale to steering wheel rim. Pull required to turn wheel through an arc not greater than one inch should be 4-12 ounces (thrust bearing and friction drag). If pull not within these limits, loosen adjuster plug locknut and back off adjuster plug 1/8 turn. Recheck steering wheel pull, adjust preload by tightening adjuster plug until turning pull at wheel rim is 2-6 ounces in excess of drag measured with adjuster plug backed off. Tighten adjuster plug locknut and recheck turning pull to make certain it has not changed.

Worm & Ball Preload (Off-Center) – Locate steering wheel center position (straight-ahead), then turn wheel 1/2 turn off-center. With spring scale attached to steering wheel rim, measure pull required to turn wheel through an arc not greater than one inch (**CAUTION** – Turning pull must be tangent to wheel rim). This pull should be 2-8 ounces greater than “adjusted” thrust bearing preload pull previously recorded. If turning pull less than 1 ounce or greater than 9 ounces in excess of this thrust bearing preload pull, steering gear must be removed from car and disassembled for replacement of worm-and-rack piston balls. Also check for roughness in worm-and-rack piston by turning wheel between 1/4 and 1 turn from center on each side. Noticeable roughness requires worm replacement.

Pitman Shaft Endplay (On-Center) – Locate steering wheel center position (straight-ahead) and position wheel in this center position. With spring scale attached to steering wheel rim, measure pull required to turn wheel through an arc not greater than three inches (**CAUTION** – Wheel center “tight spot” may extend for 1/4 turn either side of center but pull must be measured within this 3” arc and spring scale must be tangent to wheel rim). Scale reading should be 8-20 ounces more than recorded in “Off-Center” measurement (preceding) but should not be more than 36 ounces (see Note below). If this pull not within limits, adjust by loosening locknut and turning pitman shaft endplay adjusting screw on steering gear side cover as required, then tighten locknut and recheck setting. Adjust endplay for “On-Center” preload of 16-18 ounces more than the “Off-Center” preload (preceding) but not more than 36 ounces. After adjustments completed, connect pitman arm to drag link and tighten drag link nut to 40 ft. lbs. torque (except Eldorado), 60 ft. lbs. torque (Eldorado).

CADILLAC NOTE – On new steering gears, total drag may be as high as 40 ounces. Within 100 miles of service, seals will seat and balls will polish grooves sufficiently to reduce drag to 36 ounce service limit.



PITMAN SHAFT ENDPLAY ADJUSTMENT

Worm Thrust Bearing Preload (Off Car) – Loosen pitman shaft adjuster lock nut, and back off lash adjusting screw. This must be done to obtain an accurate worm bearing adjustment. Loosen adjuster plug lock nut. Adjust preload using an adjustable spanner wrench (J-7624). Tighten adjuster plug up snug. Then back off plug 1/4 of a turn, and with an Inch Lb. torque wrench measure torque required to turn shaft. Adjust preload so that it exceeds measured drag by 3-4 Inch Lbs.

Pitman Shaft Endplay Overcenter Adjustment (Off Car)

Rotate shaft stub from one end of its travel to the other and find center. With gear on center, adjust preload so that it exceeds thrust bearing preload by 8-10 Inch Lbs. Total preload should not exceed 20 Inch Lbs.

Chevrolet (All Models including Vega)

Chevrolet, Over Center Adjustment – **NOTE** – If equipped with tilt column, steering coupling must be disconnected to obtain torque reading of the column. This torque should then be subtracted from any reading taken on the gear. Disconnect pitman arm. Loosen pitman shaft adjusting screw lock nut and thread adjusting screw out to its limit of travel. Disconnect battery cable, remove horn button or shroud. With steering wheel centered in its travel, check combined ball and thrust bearing preload with an inch pound torque wrench on steering shaft nut. Note highest reading by rotating through center of travel (approximately 1/4 turn in each direction). Tighten pitman shaft adjusting screw, check torque at steering shaft nut until over center preload and total steering gear preload falls within specifications.

1971-73 SAGINAW ROTARY VALVE (Cont.)

Worm Thrust Bearing Preload (Off Car) – Back off pitman shaft lash adjuster screw. This must be done to obtain an accurate worm bearing adjustment. Using an adjustable spanner wrench (J 7624) tighten adjuster plug up snug, then back off 1/4 of a turn. With an Inch Lb. torque wrench on shaft stub measure valve drag. Adjust thrust bearing preload to obtain 3-4 Inch Lbs. in excess of seal drag. Tighten adjuster plug lock nut.

Pitman Shaft Endplay Overcenter Adjustment (Off Car) – Back out Allen head lash adjuster screw all the way and then turn back 1/2 turn. Rotate stub shaft from one stop to the other, count number of turns, and locate center. With an Inch Lb. torque wrench on stub shaft, measure drag thru center of travel and note reading. Tighten lash adjuster screw until torque reading is 3-6 Inch Lbs. higher than original reading. The total reading should not exceed 14 Inch Lbs.

Chevrolet Adjustment Specifications

Item	Torque (Inch Lbs.)
Ball Drag	3 (Max.)
Thrust Bearing Preload	① 1/2-2
Over-Center Preload	② 3-6
Total Preload	14 (Max.)

① – In excess of valve assembly drag.

② – In excess of ball drag and thrust bearing preload.

Ford Mustang & Cougar

Mesh Load Adjustment – *NOTE* – This is the only adjustment which should be performed on the car and will eliminate excessive lash between sector shaft and rack teeth. Disconnect pitman arm from sector shaft and remove steering wheel hub. Disconnect fluid return line at steering pump reservoir, cap reservoir fitting and place end of return line in a container. Cycle steering gear in both directions to discharge fluid from the gear, discard old fluid. Place steering gear 1/2 turn off-center in either direction, use a 24 In. Lb. torque wrench on steering wheel nut to rotate shaft slowly through a 20° arc and note pull required as indicated on torque wrench. Place steering gear in centered (straight ahead) position and again note torque wrench reading while turning shaft through 20° arc. This reading should be 6 In. Lbs. in excess of torque reading measured 1/2 turn off-center. Loosen locknut and turn sector shaft endplay adjustment screw on side cover inward (use 7/32" allen wrench), then tighten locknut and recheck over-center turning torque. Repeat adjustment, as required, until correct turning torque is secured (6 In. Lbs. in excess of 1/2 turn off-center torque). Replace steering wheel hub, connect pitman arm and pump fluid return line, fill pump reservoir to correct level with specified fluid.

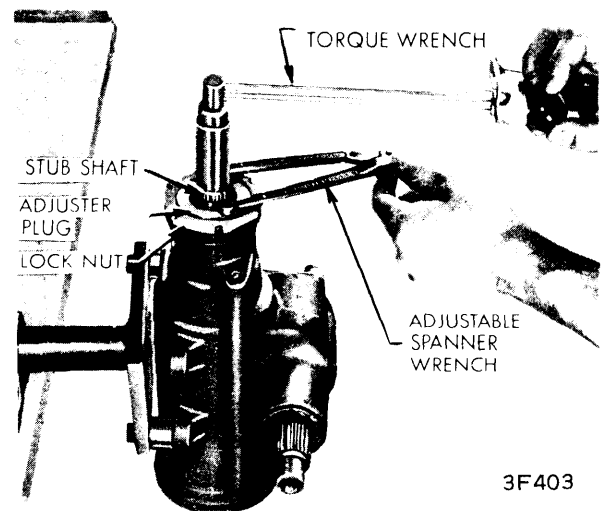
Worm Thrust Bearing Preload (Off Car) – Remove pitman shaft from gear. Loosen adjuster plug lock nut, and loosen adjuster plug. Tighten adjuster plug while rotating input shaft, as soon as additional drag is noted, back off adjuster plug 1/8 turn. Measure drag with an Inch Lb. torque wrench on stub shaft. Now tighten adjuster plug to obtain a 1-3 Lb. preload in excess or original drag measured. Total preload should not exceed 8 Inch Lbs.

Pitman Shaft Endplay Overcenter Adjustment (Off Car) – Turn input shaft to full left or full right, then turn it back 1 3/4 turns to center. Place an Inch Lb. torque wrench on stub shaft. With gear on center and lash adjuster screw backed off, measure total drag. Adjust lash adjuster screw so preload is 4-8 Inch Lbs. higher than original reading.

Jeep

NOTE – Steering gear does not ordinarily require adjustment in service (after correct adjustment during assembly or overhaul); however, if excessive lash develops in service, adjust lash as follows:

Pitman Shaft Lash – Disconnect pitman arm from pitman shaft (use suitable puller), remove ornamental cover from center of steering wheel, place steering wheel 1/2 turn off-center position (either right or left). Using an In. Lb. torque wrench on steering wheel nut, note and record turning torque required to turn wheel slowly through 20° arc. Place steering gear in centered (straight-ahead) position and repeat turning torque measurement. This torque should be 6 In. Lbs. greater than turning torque at 1/2 turn off-center. To adjust, loosen locknut and turn sector shaft endplay adjustment screw on side cover inward, tighten locknut and recheck turning torque. Repeat adjustment as required to secure this 6 In. Lb. torque difference between center and off-center rotation. Reinstall pitman arm and steering wheel ornament.



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THRUST BEARING PRELOAD ADJUSTMENT

Worm Thrust Bearing Preload (Off Car) – Back off pitman shaft lash adjuster screw. This must be done to obtain an accurate worm bearing adjustment. Loosen adjuster plug lock nut, tighten adjuster plug up snug, then back off 1/8 turn. With an Inch Lb. torque wrench on stub shaft, measure valve assembly drag. Adjust thrust bearing preload to 1-3 Inch Lbs. more than original measurement. Tighten adjuster plug lock nut.

Pitman Shaft Endplay Overcenter Adjustment (Off Car)

– Back off Allen head adjuster screw. Turn gear from one stop to the other, count number of turns and locate center. With an Inch Lb. torque wrench on stub shaft, measure total drag. With gear on center adjust lash adjuster screw to obtain 4-8 Inch Lbs. over original measurement. Readings should be made thru an arc not exceeding 20°.

Oldsmobile

Thrust Bearing Preload – With locknut loose and worm bearing adjuster backed off, tighten adjuster plug until it is just snug, then back off 1/4 turn. Using an In. Lb. torque wrench on stub shaft, measure torque required to rotate shaft. This is valve drag. Then tighten adjuster plug until bearing preload requires approximately 3-4 In. Lbs. additional turning torque to rotate wheel. Hold adjuster plug and tighten locknut securely, then recheck turning torque.

1971-73 SAGINAW ROTARY VALVE (Cont.)

Over-Center Preload – With locknut loosened and pitman shaft adjusting screw on side cover backed all the way out, turn the adjusting screw inward ½ turn. Place the gear in center straight-ahead position by rotating the stub shaft from one end stop to the other while counting turns, then rotate shaft back exactly ½ this number of turns. With In. Lb. torque wrench on stub wrench, note and record torque required to rotate shaft through this center position (this is combined ball and thrust bearing preload). Tighten adjusting screw until the turning torque as indicated on the torque wrench is 3-6 In. Lbs. greater than original torque reading; however, this torque reading must not exceed 16 In. Lbs. Tighten adjusting screw locknut to 35 ft. lbs. torque, recheck setting.

Pontiac

NOTE – Adjustments should be made only with steering gear removed from car and fluid drained.

Worm Thrust Bearing – Loosen pitman shaft (lash) adjuster screw locknut. Back off pitman shaft adjuster screw 1½ turns and retighten locknut. Loosen thrust bearing adjuster plug locknut, and back off adjuster plug ½ turn and retighten locknut. Turn gear shaft stub to right stop and then back ½ turn. Using an In. Lb. torque wrench on gear shaft, measure drag torque. Tighten adjuster plug until torque to turn stub shaft is 3-4 In. Lbs. greater than the drag torque.

Pitman Shaft Overcenter Adjustment – Overcenter turning torque should be 4-8 In. Lbs. (new gear), 4-5 In. Lbs. (used gear) more than the total worm thrust bearing torque. The total overcenter torque (drag, thrust bearing, and pitman shaft overcenter torque) must not exceed 18 In. Lbs. (new gear), 14 In. Lbs. (used gear).

TESTING

Pump Pressure

Install a suitable pressure gauge between pump and pressure line at pump, then with gauge valve open and engine at idle speed, turn wheels against stops to bring fluid to operating temperature. With wheels against stops, pressure should not be less than specified in table below. **CAUTION** – Do not hold wheels against stops for more than 5 seconds. If pressure is below specifications, slowly close valve and check for pressure increase. Pressure will increase if pump is in good condition. If pressure does not increase with valve closed, pump is faulty. **CAUTION** – Do not hold gauge valve closed for more than 5 seconds. After removing gauge, bleed hydraulic system.

1970-71 Pump Pressure Specifications

Car Model	Minimum Pressure
American Motors	
Roller Type Pump	1000 lbs.
Vane Type Pump	665 lbs.
Buick	1000 lbs.
Cadillac	1350 lbs.
Chevrolet Div.	
Constant Ratio (Station Wagon)	900 lbs.
(Corvette)	870 lbs.
Variable Ratio (L6)	1200 lbs.
(V8)	1350 lbs.
Ford Motor Co.	1175 lbs.
Jeep	1100 lbs.
Oldsmobile	900 lbs.
Pontiac	900 lbs.

1972 Pump Pressure Specifications

Car Model	Minimum Pressure
American Motors	1100 psi
Buick	1000 psi
Cadillac	1350 psi
Chevrolet Div.	
Constant Ratio (Station Wagon)	900 psi
(Corvette)	870 psi
Variable Ratio (All)	1350 psi
Ford Motor Co.	1175 psi
Jeep	665 psi
Oldsmobile	900 psi
Pontiac	900 psi

1973 Pump Pressure Specifications

Car Model	Minimum Pressure
American Motors	1000 psi
Buick	1000 psi
Cadillac	1350 psi
Chevrolet Div.	
Corvette	870 psi
Vega	750-850 psi
All Others	1350 psi
Ford Motor Co.	1175 psi
Jeep	1000 psi
Oldsmobile	1350 psi
Pontiac	1300 psi

REMOVAL & INSTALLATION

Steering Gear

American Motors – Disconnect hoses and raise them above pump level. Remove flexible coupling bolt nuts, and note difference in size as an aid to reassembly. Remove pitman arm. Remove steering gear mounting screws and lower steering gear. To install, center steering gear, approximately two turns from right or left travel limit, with flat on shaft facing up. Flat on shaft and index on flange are to be aligned at assembly. Clearance between coupling hub and housing should be a minimum of 1/16". Index flex coupling bolts to shaft, torque nuts to 20 Ft. Lbs. and pinch bolt to 30 Ft. Lbs. Torque gear mounting screws to 45 Ft. Lbs. and pitman arm nut to 115 Ft. Lbs. **NOTE** – After tightening pitman nut, center punch thread at nut for retention. Connect pressure and return line hoses and tighten hose fittings to 25 Ft. Lbs.

Ford Motor Co. – Disconnect hydraulic lines from steering gear and cap openings. Remove flexible coupling bolts and pitman arm. On standard transmission cars, remove clutch release lever retracting spring for clearance. Remove steering gear attaching bolts and remove steering gear. To install, reverse removal procedure.

Buick – Disconnect hoses and raise them above pump level. Remove pinch bolt securing lower steering column flexible coupling flange to steering gear stub shaft. Remove pitman arm nut, then remove arm. Loosen three frame to steering gear bolts at outside of frame and remove steering gear. To install, reverse removal procedure, torque pitman nut to 180 Ft. Lbs. and flex coupling pinch bolt to 30 Ft. Lbs. Clearance between adjuster plug and gear coupling flange should be 3/64".

Power Steering

1971-73 SAGINAW ROTARY VALVE (Cont.)

Cadillac - Disconnect pressure and return lines at steering gear, and position them out of the way. Remove two nuts and lockwashers that secure upper half of flexible coupling to lower shaft. Raise car. Remove pitman arm using a suitable puller (J-9172). Remove screws securing gear to frame rail and lower gear from vehicle. To install, reverse removal procedure. Tighten pitman arm nut to 185 Ft. Lbs., gear to frame to 55 Ft. Lbs., and fittings to 30 Ft. Lbs.

Chevrolet - Disconnect hydraulic lines at steering gear and cap all openings. Remove retaining nuts, lockwashers, and bolts at steering coupling to steering shaft flange. Remove pitman arm nut and washer from pitman shaft and mark relation of arm position to shaft. Remove pitman arm with Tool (J-6632 or equivalent). Remove screws securing steering gear to frame and remove gear from vehicle. To install, reverse removal procedure.

Oldsmobile - Remove coupling flange hub bolt, then disconnect hoses from pump and cap all openings. On Toronado equipped with a cooler assembly, disconnect the return hose at inlet pipe of cooler assembly. Remove pitman shaft nut and disconnect pitman arm from shaft using Puller J-5504 or equivalent. On Toronado, remove pitman arm from relay rod using Puller J-22292 or equivalent. On all models, remove three bolts, securing gear to frame side rail, allow lower shaft to slide free of coupling flange, then remove gear with hoses attached. Before installing, lubricate gear mounting pads with sodium soap fine fiber grease. Make certain there is a minimum of .040" clearance between coupling hub and steering gear upper seal. Install coupling flange hub bolt and torque to 18 Ft. Lbs. (25 Ft. Lbs. on Toronado). Before tightening steering gear to frame bolts, shift gear to place it in the same plane as steering shaft so flex coupling is not distorted. Torque steering gear to frame bolts to 70 Ft. Lbs. (all models). Torque pitman shaft nut (except Toronado) to 200 Ft. Lbs. On Toronado, install pitman arm to relay rod and torque nut to 45 Ft. Lbs.

Pontiac - Disconnect hydraulic hoses, then disconnect pitman arm from pitman shaft using Puller J-5504 or equivalent. Remove flex coupling flange attaching nuts and lockwashers, then remove gear housing to frame bolts. On Pontiac models, remove a brake hose bracket before removing frame bolts. Remove steering gear assembly. To install, reverse removal procedure, torque housing to frame bolts to 70 Ft. Lbs., torque pitman arm nut to 185 Ft. Lbs., pressure fittings to 25 Ft. Lbs. and flex coupling flange attaching nuts to 20 Ft. Lbs.

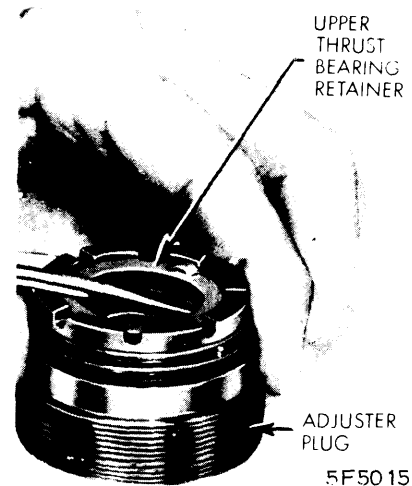
Jeep - Disconnect hydraulic hoses and raise them above pump level. Remove pinch bolt from lower flange, then remove pitman arm nut, lockwasher and arm. Remove gear assembly. To install, reverse removal procedure and torque pitman arm to pitman shaft to 140 Ft. Lbs.

OVERHAUL

Adjuster Plug

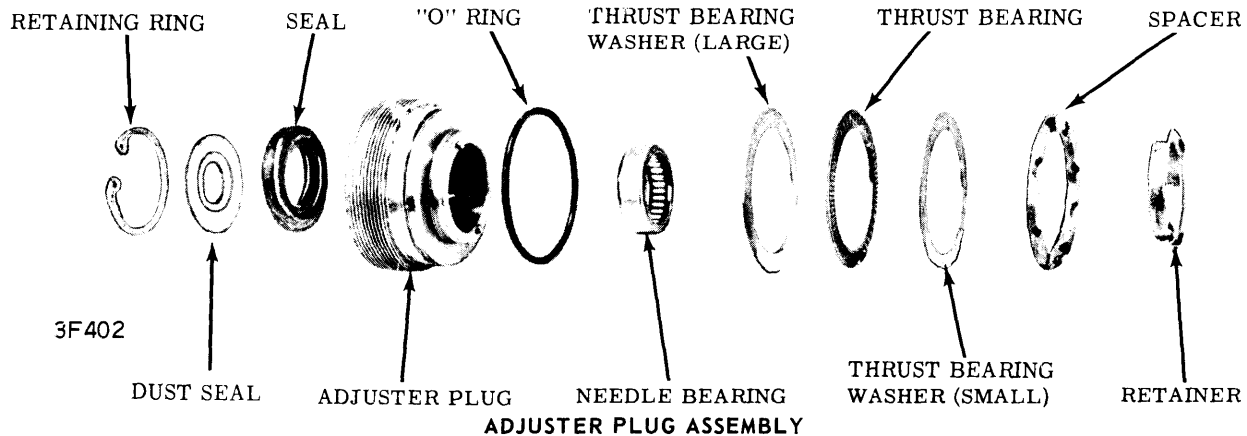
Removal - Loosen and remove adjuster plug locknut, then remove adjuster plug with a suitable spanner wrench (J-7624).

Disassembly - Remove thrust bearing retainer with screwdriver, being careful not to score needle bearing bore, and discard retainer. Remove thrust bearing spacer, thrust bearing, and thrust bearing races. Remove adjuster plug "O" ring and discard, then remove stub shaft seal retaining snap ring. Remove and discard dust seal. Remove stub shaft seal by prying out. Discard seal. Inspect needle bearing in adjuster plug, and if rollers are broken or pitted, remove needle bearing from adjuster plug by pressing from thrust bearing end. Discard the bearing.



REMOVING UPPER THRUST BEARING RETAINER

Inspection - Inspect thrust bearing spacer for cracks, then inspect thrust bearing rollers for water, pitting, scoring or cracking. If any of these conditions are found,



1971-73 SAGINAW ROTARY VALVE (Cont.)

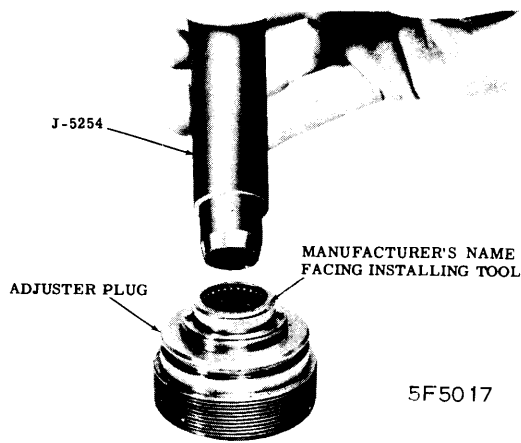
replace both thrust bearing races and check thrust bearing spacer. Inspect thrust bearing races for wear, pitting, scoring, cracking, or brinelling. Replace if necessary.

Reassembly - Install needle bearing by pressing from thrust end of adjuster plug against identification end of bearing. **NOTE** - End of bearing must be flush with bottom surface of stub shaft seal bore. Lubricate stub shaft seal with automatic transmission fluid, then install seal with spring in seal toward adjuster plug. **NOTE** - Install seal far enough in plug to provide clearance for dust seal and retaining ring. Install dust seal with lip upward in plug, then install retaining ring. Lubricate "O" ring seal with petroleum jelly and install on adjuster plug. Assemble large diameter thrust bearing race, thrust bearing, small thrust race, and thrust bearing spacer on adjuster plug. Press bearing retainer into needle bearing bore with a brass or wooden dowel (radial position of dimples on retainer is not important). **NOTE** - Thrust bearing assembly and spacer must be free to rotate, and retainer must be completely below surface of spacer.

Installation - Install adjuster plug in end of housing just far enough to make sure all parts are properly seated in gear housing, then back out adjuster plug 1/8 of a turn, measure valve assembly drag, and adjust thrust bearing preload as outlined in adjustment section.

Rotary Valve

ROTARY VALVE OVERHAUL NOTE - The complete valve assembly is hydraulically balanced during manufacture. If replacement of any part other than rings, seals, or valve spool centering spring is necessary, replace complete rotary valve assembly. **DO NOT disassemble valve unless absolutely necessary.** If valve spool dampener "O" ring requires replacement, remove valve spool, replace "O" ring, and replace spool immediately.

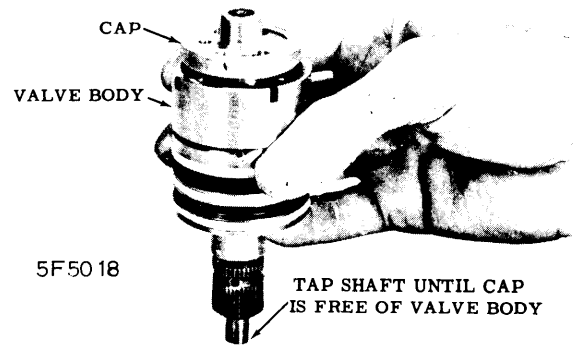


INSTALLING BEARING

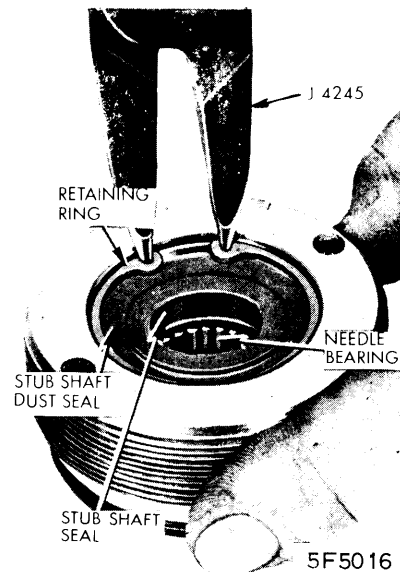
Removal - Remove adjuster plug assembly (see above), then remove valve assembly by grasping stub shaft and pulling rotary valve, stub shaft, and steering worm assembly out of housing.

Disassembly - Remove cap-to-worm "O" ring seal and discard, then remove snap ring from top of spool spring. Remove spring by prying small coil with a small screwdriver. Work spring onto bearing diameter of stub shaft and slide spring off shaft. Remove valve spool. **CAUTION** - Clearance between valve body and spool may be

as low as .0004" and the slightest cocking of spool may jam it in valve body. To remove valve spool, hold valve assembly in both hands with stub shaft pointing down. Place fingers under valve body and thumbs on valve body cap, holding it against valve body squarely. End of torsion bar should be rapped lightly against bench. This will expose spool far enough so that it may be withdrawn from valve body. Withdraw spool with a steady oscillating pull to prevent jamming. If slight sticking occurs, make a gentle attempt to reverse withdrawal procedure. If this does not free the spool, it has become cocked in valve body bore. Do not attempt to force spool in or out if it becomes cocked. Continue to disassemble valve assembly and return to spool as described later. Remove stub shaft, torsion bar and valve cap assembly by holding valve assembly in both hands as before, only with thumbs on valve body. Rap torsion bar lightly against bench. This will dislodge cap from valve body-to-cap pin. The stub shaft, torsion bar, and valve cap assembly can now be removed from valve body. If valve spool has become cocked (see above), it can now be freed. By visual inspection on a flat surface, it can be determined in which direction spool is cocked. A few very light taps with a soft plastic or rawhide mallet should align spool in bore and free it. **CAUTION** - Do not tap with anything metallic. If spool can be rotated, it can be removed. Remove "O" ring dampener seal from spool and discard. Carefully cut valve rings and ring back-up seals. Remove and discard.



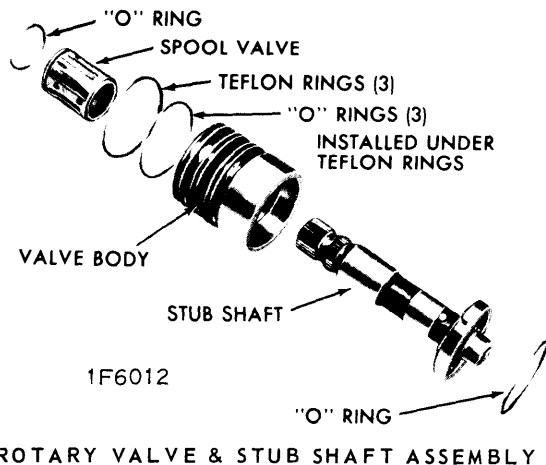
FREEING SHAFT CAP



REMOVING STUB SHAFT SEAL RETAINING RING

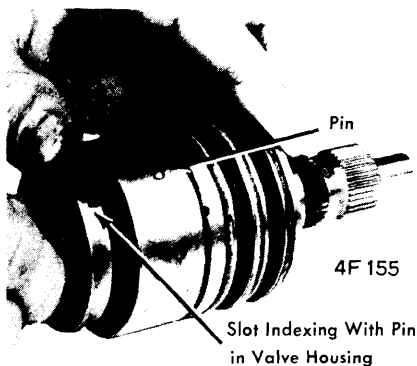
1971-73 SAGINAW ROTARY VALVE (Cont.)

Inspection – If it is evident that torsion bar “O” ring seal in stub shaft has been leaking, the entire assembly should be replaced. Check pin valve body that engages the cap. If it is severely worn, cracked, or broken, then entire valve assembly should be replaced. Check smaller of the two worm pin grooves in valve body. If it is severely worn, replace entire valve assembly. Check spool drive pin on stub shaft. If it is severely worn, cracked, or broken, replace entire valve assembly. Check spool outer diameter and valve body inner diameter for nicks, burrs, or bad wear spots. If any are found, replace entire valve assembly. **NOTE** – A slight polishing is normal on valve surfaces. Check fit of spool in valve body before installing valve spool dampener “O” ring seal. When lubricated with transmission oil, the spool should rotate smoothly without binding or catching. If either occurs, the entire valve assembly should be replaced. Examine needle bearing diameter of stub shaft. If it is badly worn, brinelled, or scored, replace entire valve assembly. Measure free length and inner diameter of top loop of valve spool spring. If not within specifications listed in table below, replace spring.



ROTARY VALVE & STUB SHAFT ASSEMBLY

Reassembly – Lubricate three valve ring back-up “O” ring seals with transmission oil and assemble in three grooves in valve body. Do not allow seals to become twisted. Assemble valve rings in ring grooves over the “O” ring seals by carefully slipping rings over valve body. **NOTE** – Rings may appear to be twisted in grooves, but heat of oil after assembly will cause them to straighten. Install new valve spool dampener “O” ring seal in valve spool groove, then lubricate seals with transmission oil. Do not allow seals to twist in groove. Assemble stub shaft in valve body, aligning groove in valve cap with pin in valve body. Tap lightly on cap with a plastic hammer until cap is seated against shoulder in valve body with valve body pin in cap groove. Hold these parts together



STUB SHAFT INSTALLATION

during rest of assembly. Lubricate valve spool with transmission oil and slide spool over stub shaft with notch toward valve body. Align notch with spool drive pin in stub shaft and carefully engage spool in valve body bore.

CAUTION – The same care taken in removing the valve spool must be taken when installing it. Push spool evenly and slowly with a slight oscillating motion until spool reaches drive pin. Rotate spool slowly with pressure until notch engages the pin. Before pushing spool completely in, make sure the dampener “O” ring seal is evenly distributed in spool groove. Slowly push spool completely in, with extreme care taken not to cut or punch the “O” ring seal by inserting the spool beyond normal position. Slide spool spring snap ring over stub shaft and work spool spring and snap ring down with a screwdriver until snap ring is seated in stub shaft groove. Lubricate new cap-to-worm “O” ring seal with transmission oil and install in valve assembly. **CAUTION** – If during assembly, the stub shaft cap assembly is allowed to slip out of engagement with valve body pin, the spool will enter too far into valve body, and dampener “O” ring seal will expand into valve body oil grooves, preventing withdrawal of spool. Attempt to withdraw the spool with a slight pull while rotating. If this does not free the spool after several tries, make sure spool is free to rotate. Place valve body on a flat surface with notched end up, and tap spool with wooden or plastic rod until the “O” ring seal is cut and spool can be removed. Replace dampener “O” ring seal and proceed with assembly as before. Make sure that all “O” ring chips are removed before assembling the valve.

Installation – Align valve body drive pin on worm with narrow pin slot on valve body. Insert valve assembly into gear housing. **CAUTION** – Do not push against stub shaft, as this might cause stub shaft and cap to pull out of valve body allowing the spool seal to slip into valve body oil grooves. The valve assembly can be pushed in with one hand by pressing against valve body with finger tips, while pulling out on stub shaft with the palm. Be sure valve is properly seated before assembling adjuster plug assembly. The return hole in gear housing should be fully visible at this time. Install adjuster plug assembly (see above).

Pitman Gear Shaft & Side Cover

Removal & Checking – With stub shaft rotated until pitman shaft gear is in center position, remove locknut and side cover, and tap pitman shaft out of housing. Discard locknut, then remove side cover “O” ring. **NOTE** – Production pitman shafts have wear washer and heavy spring in shaft assembly to provide automatic over-center adjustment up to 10,000 miles of operation. If gear chattering or clunk cannot be corrected by over-center adjustment, there may be excessive wear or broken spring in pitman shaft. Check for wear or broken spring as follows: With pitman shaft in a vise, lock two nuts on adjusting screw and note torque required to turn adjusting screw. If not within 1-15 inch pounds, replace pitman shaft assembly. **CAUTION** – Do not disassemble shaft. **NOTE** – Replacement shafts do not have spring and wear washer and no torque should be required to turn adjusting screw.

Inspection – Clean and dry all parts. If shaft bearing surface in side cover badly worn or scored, replace side cover. Make sure sealing and bearing surfaces of pitman shaft are not rough, nicked, or badly scored. If shaft teeth damaged, replace shaft.

Installation – Lubricate and install “O” ring into side cover groove. Make sure center groove of rack-piston is aligned with center of pitman shaft hole, put masking

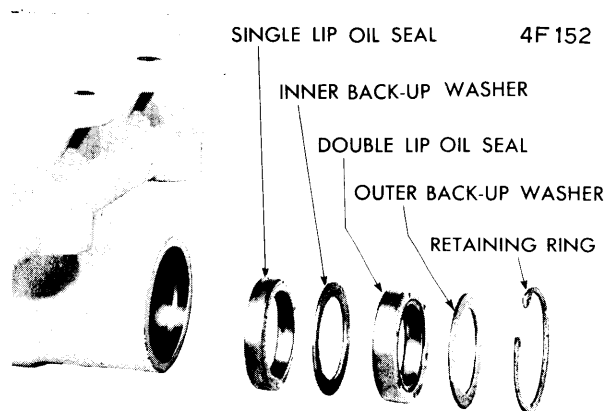
1971-73 SAGINAW ROTARY VALVE (Cont.)

tape over end of pitman shaft to protect seal, then install pitman shaft so center tooth in sector meshes with center groove of rack-piston nut. Install side cover and tighten bolts to 30 ft. lbs. Install new lash adjuster nut on adjusting screw and make over-center adjustment (see above).

Pitman Shaft Seals & Bearing Replacement

NOTE – Seal may be replaced with unit installed on car by first removing pitman arm.

Removal – Remove seal retaining ring, then remove outer steel washer, outer seal, inner steel washer, and inner seal. Drive out needle bearing with suitable tool.



PITMAN SHAFT SEALS & WASHERS

Installation – Install bearing in housing with manufacturer's name on bearing facing inside of housing, and so bearing is flush with outer face of housing. Install seals with lips of seals facing inside of housing. Install seal retaining ring.

Housing Hose Connector Seats & Check Valve Replacement

To remove connectors, tap threads using a 5/16"-18 tap. Tap only 2 or 3 threads to avoid damaging check valve. Thread a bolt with a nut and flat washer into tapped hole, pull connector out by holding bolt from rotating while turning nut off bolt. Remove poppet valve and spring from pressure port. Install new check valve spring in pressure port with large end down, being sure spring is seated in counterbore. Place new check valve over spring, tangs down, being sure valve is centered on small end of spring. Drive new connector seats in ports, using a suitable Valve Connector Seat Installer Tool (J-6217 or equivalent), check for free operation of check valve and connect hoses.

Rack-Piston Nut & Worm

Removal – Remove pitman shaft (see above). Rotate end plug retainer ring so one end of ring is over hole in housing. Spring one end of ring with a punch so a screwdriver can be inserted to lift ring out. Rotate stub shaft to left turn position and force end plug out of housing. **CAUTION** – Do not rotate more than necessary or balls from rack

and worm assembly will fall out. Remove and discard housing end plug "O" ring, then remove end plug with a 1/2" square drive. Insert Ball Retainer Tool J-7539 into end of worm, turn stub shaft so rack-piston will go onto tool, and remove rack-piston nut from housing. Keep ball retainer tool completely through rack-piston to prevent

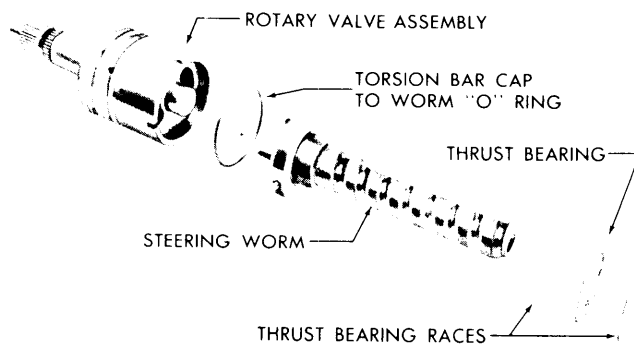
balls from falling out. **NOTE** – Do not remove snap ring in upper end of piston bore in housing. Remove adjuster plug, rotary valve, worm and lower thrust bearing.

Disassembly – Remove piston ring and back-up "O" ring from rack-piston nut. Remove ball return guide clamp, return guide, ball retaining tool, and all balls.

Inspection – 1) If gear housing bore badly worn or scored, replace housing. If ball plug in housing leaking or raised above housing surface, drive ball in flush to 1/16" below housing, and tighten by staking housing. If leak cannot be stopped, replace housing. See above for pitman shaft bearing and seal replacement, and for hose connector seat and check valve replacement.

2) Inspect worm and rack-piston nut grooves and all balls for excessive wear or scoring. Inspect rack-piston nut teeth for pitting, wear, or scoring, and make sure there are no burrs, wear, or scoring on O.D. of rack-piston nut. If either worm or rack-piston nut must be replaced, replace both parts as a matched assembly. Make sure ends of ball return guides where balls enter and leave the guides are not damaged. Replace lower thrust bearing and races if worn, pitted, scored or cracked.

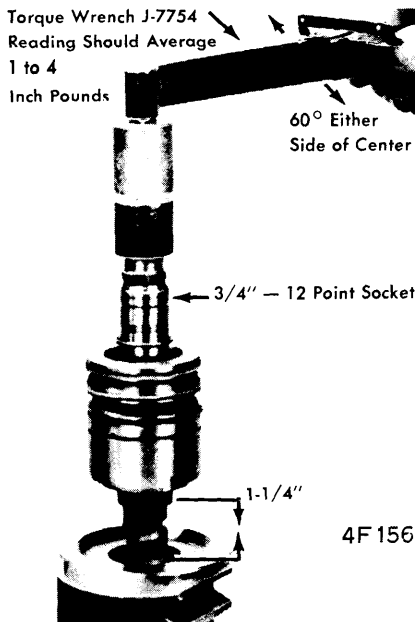
Reassembly – 1) Install "O" ring and piston ring on rack-piston (do not twist "O" ring). Install worm into rack-piston until worm is against piston shoulder. Install all balls (except for 6, three plain and three black) into rack-piston while slowly rotating worm counterclockwise. **NOTE** – Install plain and black balls alternately. Install the 6 remaining balls into ball return guide, making sure balls in guide alternate in color with the last balls installed in rack-piston. Install guide into rack-piston, install guide clamp, and tighten clamp attaching screws.



TORSION (WORM) BAR ASSEMBLY

2) Clamp rack-piston in a vise with worm shaft up and install rotary valve assembly on worm so it engages worm drive pin. Rotate worm so it is 1/4" from rack-piston to thrust bearing face (center position), install an inch

1971-73 SAGINAW ROTARY VALVE (Cont.)



WORM & RACK PISTON BALL PRELOAD CHECK

pound torque wrench on stub shaft and note torque required to turn shaft through a 60° arm in both directions several times. Torque with worm rotating should be as indicated in table below. If not within specifications, replace silver balls only with balls 1 size larger or smaller as required. *NOTE - Ball size stamped on rack-piston (no number indicates No. 7 balls). A change of 1 ball size will change reload 1 inch pound. Balls furnished in 6 sizes from .28117" diameter (No. 6), to .28157" (No. 11) in .0008" increments.*

3) Remove rotary valve and stub shaft from worm. Thread Ball Retainer Tool J-7539 into worm and turn worm out of rack-piston nut (do not let tool separate from worm until worm is fully removed).

Installation - Install thrust bearing and races on worm, then assemble valve to worm by aligning small slot in valve body with pin on worm (be sure to install "O" ring seal between body and worm head). Install valve assembly and worm in housing as an integral unit and install valve (see "Rotary Valve" above). Install Rack-Piston Seal Compressor, J-7576, in gear housing, holding it tightly against shoulder in housing. Insert rack-piston nut into housing until arbor engages the worm, then turn stub shaft clockwise, drawing rack-piston into housing. When piston ring is into housing piston bore, remove Tool J-7539 and J-7576. Lubricate new "O" ring seal with transmission oil and install on rack-piston end plug (do not allow "O" ring seal to twist in groove). Install rack-piston end plug, tapping it into place with a mallet. Install retaining ring with snap ring pliers and make sure it is bottomed in groove. Lubricate new housing end plug "O" ring seal with transmission oil and install in gear housing. Insert end plug into housing and seat it against "O" ring seal, tapping it into place if necessary. Snap end plug retainer ring into place with fingers and bottom it securely in gear housing. Install pitman shaft assembly (see above).

NOTE - Ball size stamped on rack piston. If no mark a number 7 (standard) ball is used. Balls furnished in 6 sizes.

Ball Size	Range
6	.28112-.28122"
7	.28120-.28130"
8	.28128-.28138"
9	.28136-.28146"
10	.28144-.28154"
11	.28152-.28162"

Worm & Rack-Piston Ball Preload

Car Model	Preload (Inch Lbs.)
American Motors	1-4½
Buick	1-5
Cadillac	1-4
Chevrolet	3
Ford	1-4
Jeep	1-4
Oldsmobile	1-4
Pontiac	1-4