SAGINAW ROTARY VALVE

American Motors
Ford Torino (With 302")
General Motors
Jeep
Mercury Montego (With 302")

DESCRIPTION

Gear is variable ratio recirculating ball type. Steel balls work as a rolling thread between steering gear worm shaft and rack-piston nut. Wormshaft thrust is supported by a thrust bearing and two conical thrust races at lower end, and a bearing assembly in adjuster plug at upper end. This design provides continual spring loaded pressure on wormshaft to prevent loss of thrust bearing preload for life of gear. Adjuster plug provides initial preload adjustment and service adjustment when servicing gear. As wormshaft is turned right, rack-piston moves upward in gear; turning wormshaft left moves rack-piston downward in gear. Rack-piston teeth mesh with sector which is forged as part of pitman shaft. Turning wormshaft turns pitman shaft which turns wheels through mechanical linkage.

LUBRICATION

Check fluid level in pump reservoir every 6,000 miles. Steering gear and fluid must be at normal operating temperature. If necessary, add fluid to bring level to proper mark on dipstick.

ADJUSTMENT

AMERICAN MOTORS

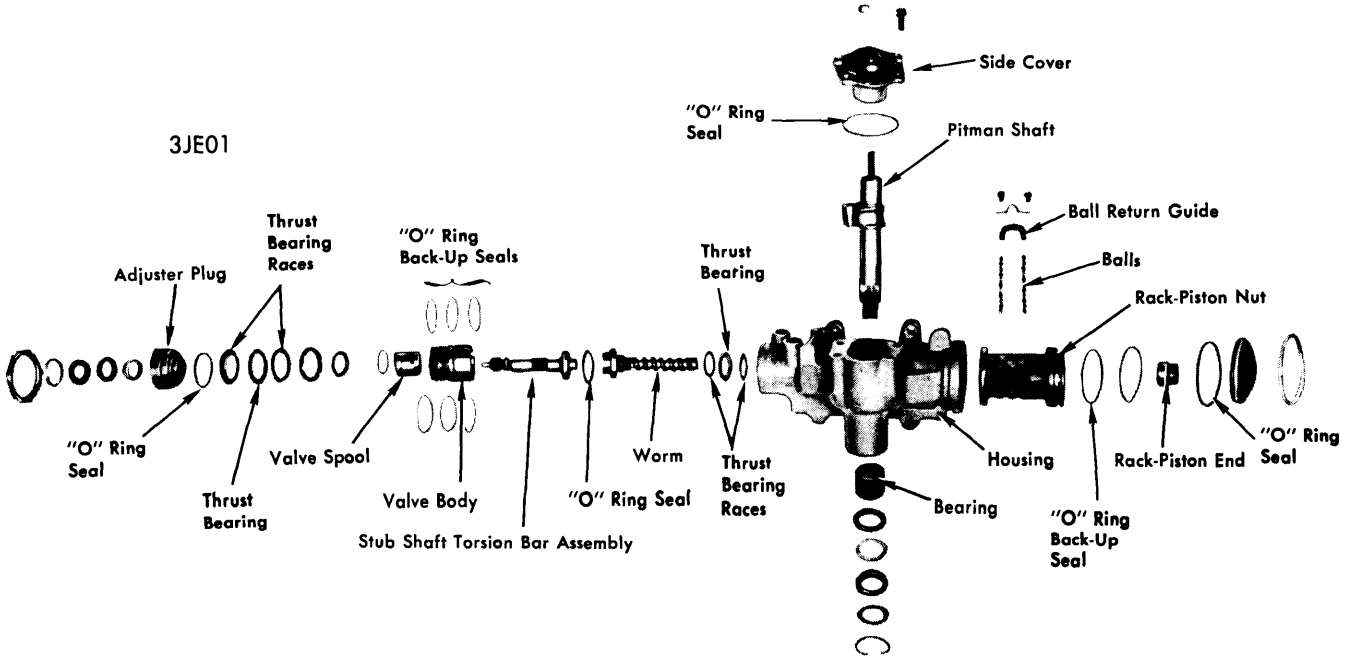
NOTE — Two thrust bearing preload adjustment procedures follow: one is for gears with conical thrust races, and the other is for gears with flat thrust races.

Thrust Bearing Preload (Conical Thrust Races) — Drain fluid from gear by rotating stub shaft from stop to stop several times. Mount gear in a vise, then loosen and remove adjuster plug lock nut. Using a spanner wrench, turn adjuster plug clockwise until plug and thrust bearing are firmly bottomed. Place an index mark on housing opposite hole in adjuster plug. Measure counterclockwise 3/16-1/4" and remark housing. Rotate adjuster plug counterclockwise until hole in plug is in line with second mark. Tighten lock nut while holding adjuster plug to maintain position.

NOTE — Above procedure provides proper preload for gears with conical races. Since gear is assembled and it cannot be known for sure if it has conical races, drag torque must be checked as follows:

Turn stub shaft to right stop, then back 1/4 turn. Using an INCH lb. torque wrench and a 3/4" deep socket, measure drag torque required to turn stub shaft. Reading should be taken with beam of torque wrench near vertical while turning counterclockwise at an even rate. If reading is less then 4 INCH lbs. or more than 10 INCH lbs., use alternate adjustment procedure for flat thrust races. If reading is within 4-10 INCH lbs., record reading.

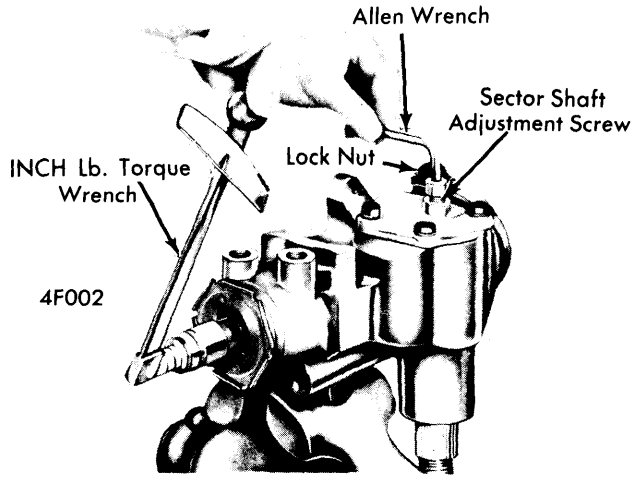
Thrust Bearing Preload (Flat Thrust Races) — Drain gear by rotating stub shaft from stop to stop several times, then mount gear in a vise. Loosen pitman shaft adjusting screw lock nut, then turn adjusting screw 1 1/2 turns counterclockwise. Retighten lock nut. *NOTE — If screw bottoms when turning it counterclockwise, turn back clockwise* 1/2 turn. Loosen adjuster plug lock nut. Using a spanner wrench, loosen adjuster plug one turn counterclockwise. Turn stub shaft to right turn stop, then back 1/4 turn. Using an INCH lb. torque wrench and a 3/4" deep socket, measure drag torque required to turn stub shaft. Turn adjuster plug clockwise until it bottoms, then back off until torque reading is 3-4 INCH lbs. in excess of drag torque noted previously. Tighten adjuster plug lock nut, then recheck preload torque. *CAUTION — It is not possible to properly adjust thrust bearing preload unless adjuster plug is firmly bottomed and torque set while adjuster plug is being loosened. Never attempt to adjust thrust preload while tightening or advancing adjuster plug into gear assembly.*



SAGINAW ROTARY VALVE POWER STEERING GEAR ASSEMBLY

SAGINAW ROTARY VALVE (Cont.)

Pitman Shaft Overcenter Sector Adjustment – Rotate stub shaft from stop to stop, then turn back ½ total number of turns. Rotate torque wrench approximately 45° each side of center and read highest reading on or near center. Loosen lock nut and turn preload adjusting screw clockwise until correct overcenter torque, in addition to reading just taken is obtained. Correct overcenter torque for a new gear (less than 400 miles) should be 4-8 INCH lbs. additional torque, but not to exceed 18 INCH lbs. total. For a used gear (over 400 miles), overcenter torque should be 4-5 INCH lbs. additional torque, but not to exceed 14 INCH lbs. total. After adjustment, tighten lock nut while holding preload adjusting screw, then recheck adjustment.



PITMAN SHAFT ENDPLAY ADJUSTMENT

FORD TORINO, MERCURY MONTEGO

Mesh Load Adjustment – 1) *NOTE – This is only adjustment to be performed on vehicle. Adjustment will eliminate excessive lash between sector shaft and rack teeth.* Disconnect pitman arm from sector shaft, then remove steering wheel hub. Disconnect fluid return line at pump reservoir, cap fitting, then place end of return line in a container. Cycle steering wheel in both directions to discharge fluid from gear.

2) Turn gear ½ turn off center in either direction. Using a 24 INCH lb. torque wrench on steering wheel nut, note torque required to rotate shaft slowly through a 20° arc. Turn gear back to center and repeat procedure. Loosen adjuster lock nut and turn screw inward until reading is 6 INCH lbs. greater than first reading. Tighten lock nut while holding adjusting screw in place. Recheck readings then replace pitman arm and steering wheel hub. Connect fluid line and replace fluid.

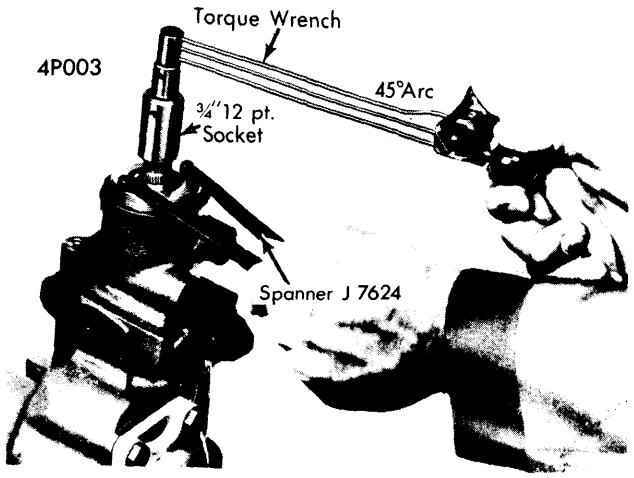
Thrust Bearing Preload – Loosen adjuster plug lock nut. While rotating input shaft, tighten adjuster plug until a slight drag is evident. Loosen adjuster plug ⅛ turn. Measure input shaft drag with an INCH lb. torque wrench. Tighten adjuster plug until preload is 1-3 INCH lbs. greater than last reading taken. Tighten adjuster plug lock nut and recheck preload. Total preload must not exceed 8 INCH lbs.

Overcenter Adjustment – Turn input shaft to full left or full right, then turn back approximately 1¾ turns to center. With gear on center and sector shaft adjuster loose, rotate input shaft with an INCH lb. torque wrench and note torque required to rotate input shaft. Center gear and adjust sector shaft thrust screw so preload is 4-8 INCH lbs. greater than total preload and drag. *NOTE – Do not rotate shaft more than 20° with gear on center.* Tighten lock nut and recheck preload.

GENERAL MOTORS

NOTE – Adjustments should be made with gear off vehicle and fluid drained.

Thrust Bearing Preload – 1) Loosen pitman shaft preload adjuster screw lock nut, then turn adjuster screw 1½ turns counterclockwise. *NOTE – If screw bottoms, turn back ½ turn.* Loosen adjuster plug lock nut, then loosen adjuster plug one turn counterclockwise. Turn stub shaft to right stop, then back ¼ - ½ turn. Using an INCH lb. torque wrench on stub shaft, measure drag torque.



THRUST BEARING PRELOAD ADJUSTMENT

2) Bottom adjuster plug firmly by turning clockwise, then back off until torque reading is 3-4 INCH lbs. in excess of drag torque. Tighten adjuster plug lock nut. *NOTE – It is impossible to properly adjust thrust bearing preload unless adjuster plug is firmly bottomed out and torque set while plug is being loosened. DO NOT adjust preload while tightening or advancing adjuster plug into gear assembly.*

Pitman Shaft Overcenter Adjustment – Rotate stub shaft from stop to stop counting total number of turns, then turn shaft back exactly half the amount. Using an INCH lb. torque wrench, rotate stub shaft approximately 45° each side of center and note torque reading. Loosen lock nut and turn preload adjuster screw clockwise until correct overcenter torque is obtained. Overcenter torque should be 4-5 INCH lbs. over original reading (but not more than 14 INCH lbs.) for a used gear, or 4-8 INCH lbs. over original reading (not to exceed 18 INCH lbs.) for a new gear.

TESTING

PUMP PRESSURE

Install a suitable pressure gauge between pump and pressure line at pump. With gauge valve open at 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. *CAUTION – Do not hold wheels against stops for more than five seconds.* If pressure is below specifications, slowly close valve and check for pressure

SAGINAW ROTARY VALVE (Cont.)

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 valve closed for more than five seconds.* After removing gauge, bleed hydraulic system.

Pump Pressure Specifications

Model	Minimum Pressure (Psi)
American Motors	1000
Buick	1000
Cadillac	1425
Chevrolet	
Corvette	870
Vega	750
All Others	1350
Ford Motor Co.	1175
Jeep	1000
Oldsmobile	1350
Pontiac	1300

REMOVAL & INSTALLATION

STEERING GEAR

American Motors — Disconnect hose from gear then raise above pump level. Remove flexible coupling nuts, noting difference in size to aid in reassembly. Using a suitable puller, remove pitman arm. Remove steering gear mounting screws and lower steering gear. To install, center steering gear with flat on shaft facing up. Install coupling bolts to shaft, then tighten nuts to 20 ft. lbs., and pinch bolt to 30 ft. lbs. Tighten gear mounting bolts to 45 ft. lbs. and pitman arm nut to 115 ft. lbs. *NOTE — After tightening nut, center punch thread at nut for retention.* Connect pressure and return lines, then 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 models with standard transmission, remove clutch release lever retracting spring for clearance. Remove steering gear attaching bolts and remove gear from vehicle. To install, reverse removal procedure.

Buick — Disconnect hoses from gear, then raise above pump level. Remove steering gear coupling shield, then remove pinch bolt securing lower steering column flexible coupling flange to steering gear stub shaft. Remove pitman arm nut, then remove pitman arm using a suitable puller. Remove steering gear attaching bolts, then remove gear from vehicle. To install, reverse removal procedure. Tighten pitman arm nut to 140 ft. lbs. on Apollo, 180 ft. lbs. on all others. Tighten flex coupling pinch bolt to 30 ft. lbs.

Cadillac — Disconnect hoses from gear then position out of way. On Eldorado, remove pitman arm from drag link. On all others, remove pitman arm from gear. Remove flexible coupling shield (if equipped), then remove flexible coupling nuts. Remove steering gear attaching bolts, then remove gear from vehicle. To install, reverse removal procedure. Tighten attaching bolts to 55 ft. lbs. (70 ft. lbs. on Eldorado), pitman arm nut to 185 ft. lbs., and flexible coupling nuts to 20 ft. lbs.

Chevrolet — Disconnect hoses at steering gear and cap all openings. Remove flexible coupling nuts, then remove pitman arm from gear. Remove gear to frame bolts, then remove gear from vehicle. To install, reverse removal procedure. Tighten gear mounting bolts to 70 ft. lbs., pitman shaft nut to 140 ft. lbs. on Nova and Vega, 180 ft. lbs. on all others.

Oldsmobile — 1) Remove flexible coupling shield (if equipped), then remove coupling flange hub bolt. Disconnect hoses from gear and cap all openings. On Toronado with cooler assembly, disconnect hose at inlet pipe of cooler assembly. Using suitable tools, disconnect pitman arm from intermediate rod (Toronado), or from pitman shaft (all others). Remove gear attaching bolts, then remove gear from vehicle.

2) To install, reverse removal procedure and note following: Lubricate gear mounting pads with sodium soap fine fibre grease. Make certain there is at least .040" clearance between coupling hub and gear upper seal. Tighten gear to frame bolts to 70 ft. lbs., pitman shaft nut to 180 ft. lbs., pitman arm to intermediate rod (Toronado) to 45 ft. lbs., and coupling flange hub bolt to 30 ft. lbs.

Pontiac — Disconnect hoses from gear and cap all openings. Disconnect pitman arm from gear using suitable puller. Remove flexible coupling nuts, then remove gear attaching bolts. On Pontiac models, remove brake hose bracket before removing gear attaching bolts. Remove gear from vehicle. To install, reverse removal procedure. Tighten gear mounting bolts to 70 ft. lbs., pitman arm to 185 ft. lbs., and flexible coupling nuts to 20 ft. lbs.

OVERHAUL

STEERING GEAR

NOTE — If complete assembly is not to be overhauled, remove unit to be serviced and proceed to disassembly and reassembly of that unit.

Disassembly — Rotate end plug retainer ring so one end of ring is over hole in housing. Force end of ring from its groove and remove ring. Rotate stub shaft counterclockwise to force end plug from housing. *CAUTION — Do not rotate more than necessary or balls from rack and worm assembly will fall out.* Remove cover and discard "O" ring, then remove end plug. Loosen pitman shaft adjusting screw lock nut and remove side cover attaching bolts. Rotate side cover until rack and piston and pitman shaft teeth are visible, then turn stub shaft until shaft teeth are centered in housing opening. Tap pitman shaft with soft hammer, then remove shaft and side cover from housing. Remove and discard side cover "O" ring. Insert ball retainer tool (J 7539) into rack-piston bore with pilot of tool seated in end of worm. Turn stub shaft counterclockwise while holding tool tightly against worm. Rack-piston will be forced onto tool. Remove rack-piston and tool from housing. Remove adjuster plug lock nut and using suitable spanner wrench, remove adjuster plug assembly and "O" ring. Grasp stub shaft and pull assembly from housing bore. Separate worm and shaft, and remove stub shaft cap "O" ring. If worm or lower thrust bearing and race remained in gear housing, remove at this time.

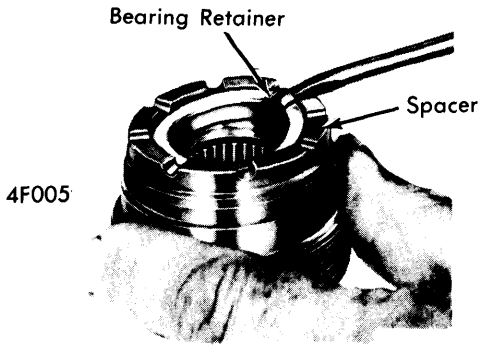
Reassembly — Lubricate all parts with suitable power steering fluid. Install one thrust washer, bearing, and other thrust washer over end of worm. Install lower shaft cap "O" ring in valve body so it is seated against lower shaft cap. Align narrow notch in valve body with pin in worm, then install valve and shaft assembly in gear housing. *NOTE — Valve body is properly seated when oil return hole in housing is entirely uncovered.* Install new "O" ring in groove on adjuster plug. Place suitable seal protector (J 6222) over stub shaft then install adjuster plug assembly in housing until it seats against valve body. Remove seal protector. Position suitable seal compressor against shoulder of housing. With ball retainer (J 7539) in place in rack-piston, push rack-piston into housing until tool

SAGINAW ROTARY VALVE (Cont.)

contacts center of worm. Turn lower shaft clockwise to thread rack-piston onto worm, then remove tool. Install new "O" ring in pitman shaft side cover. Turn lower shaft until rack-piston teeth are centered in pitman shaft opening, then install shaft and cover so that center tooth of pitman shaft engages center groove of rack-piston. Install side cover bolts and tighten to 30 ft. lbs. Install rack-piston plug and tighten to 75 ft. lbs. Install new housing cover "O" ring, end cover, and retainer ring. Adjust steering gear. Install flexible coupling on shaft and tighten clamping bolt or nut to 35 ft. lbs.

ADJUSTER PLUG

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.



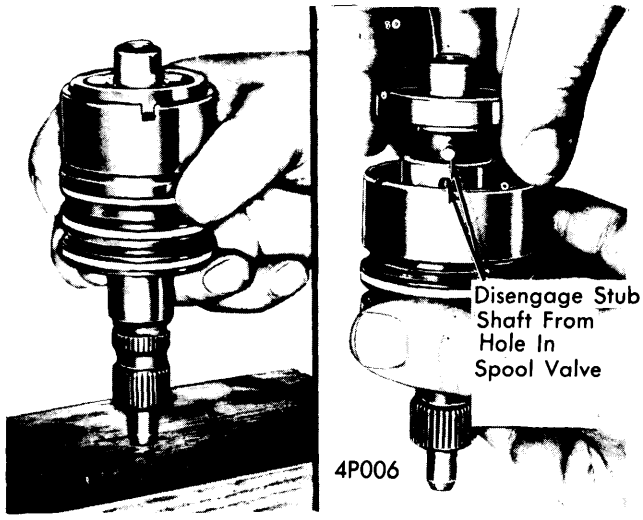
REMOVING UPPER THRUST BEARING RETAINER

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, 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.*

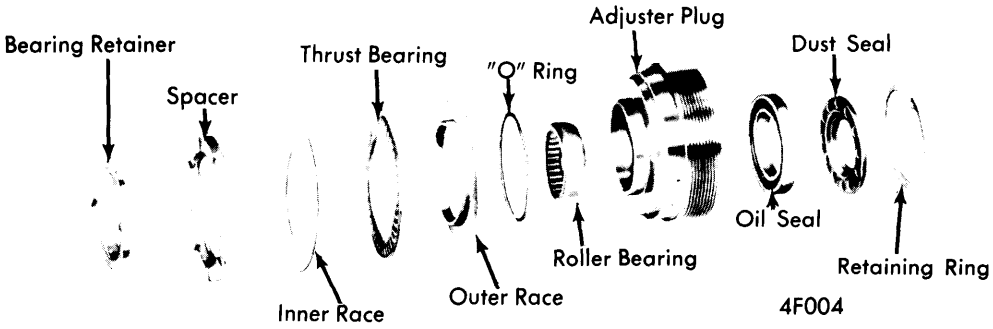
ROTARY VALVE

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.



REMOVING STUB SHAFT ASSEMBLY

Disassembly – Remove and discard "O" ring seal in shaft cap end of valve assembly. While holding assembly (lower shaft down), lightly tap stub shaft against bench until shaft cap is free from valve body. Pull shaft assembly until shaft cap clears valve body approximately ¼". *CAUTION – Do not pull shaft assembly too far or spool valve may become cocked in valve body.* Disengage shaft pin from valve spool and remove shaft assembly. Push spool valve out flush end of valve body until dampener "O" ring is exposed, then pull spool from body, while rotating valve. If spool valve becomes cocked, realign valve, then remove. Remove dampener "O" ring from

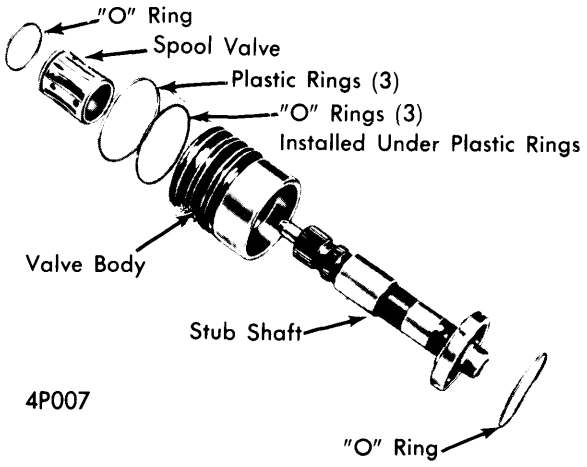


ADJUSTER PLUG ASSEMBLY

SAGINAW ROTARY VALVE (Cont.)

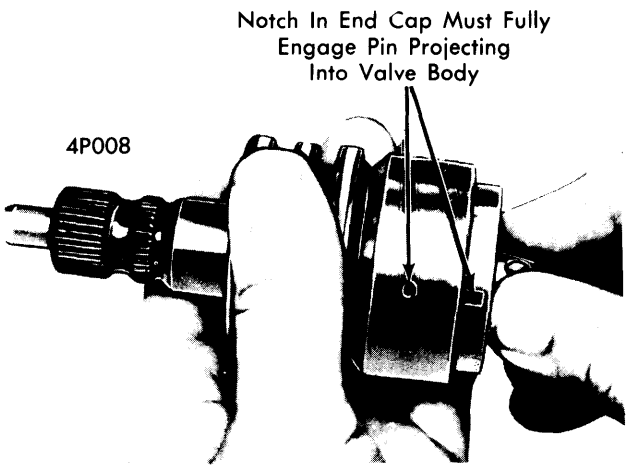
spool valve and discard. Cut plastic oil rings and "O" rings from valve body and discard.

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 AND 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 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.



STUB SHAFT INSTALLATION

CAUTION – Make sure that notch in shaft cap is mated with valve body pin before installing valve body into gear assembly. Lubricate new cap-to-worm "O" ring seal with power steering fluid and install in shaft cap end of valve body assembly.

PITMAN SHAFT & SIDE COVER

Disassembly – Remove pitman shaft adjuster screw lock nut and unscrew side cover from adjusting screw. Discard lock nut. *CAUTION – Do not disassemble pitman shaft.*

Inspection – Clean and dry all parts. If shaft bearing surface in side cover is badly worn or scored, replace side cover. Make sure sealing and bearing surfaces of pitman shaft are not rough, cracked, nicked, or badly scored. If shaft teeth are damaged, replace shaft. Check pitman shaft lash adjusting screw for ease in turning with no end play. If adjusting screw is loose, replace pitman shaft assembly.

Reassembly – Thread side cover onto pitman shaft adjusting screw until it bottoms, then turn in ½ turn. Install new adjusting screw lock nut and make over-center adjustment. See *Steering Gear Adjustment.*

RACK-PISTON AND WORM

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.

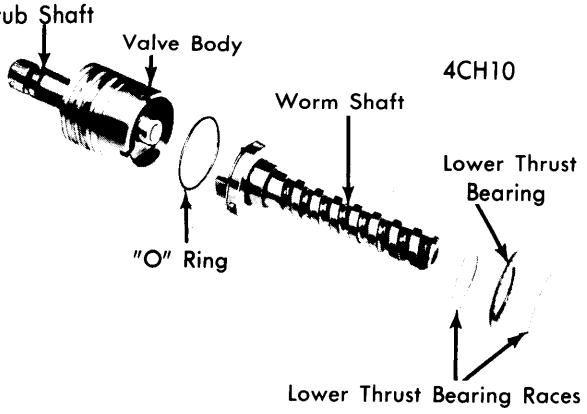
Inspection – Clean and dry all parts. Inspect worm and rack-piston grooves and all balls for scoring. *NOTE – If either worm or rack-piston are damaged, both must be replaced as a matched assembly.* Make sure ends of ball return guides, where balls enter and leave guides, are not damaged. Replace lower 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 17 balls into rack-piston while slowly rotating worm counterclockwise. *NOTE – Install plain and black balls alternately.* Install 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.

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 1¼" from rack-piston to thrust bearing face (center position), install an inch 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*

SAGINAW ROTARY VALVE (Cont.)

(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.



WORM AND VALVE BODY ASSEMBLY

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

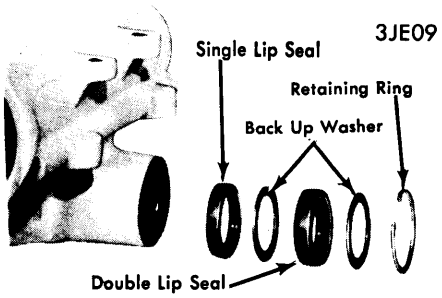
Ball Size	Range
6	.28112-.28122"
7	.28120-.28130"
8	.28128-.28138"
9	.28136-.28146"
10	.28144-.28154"
11	.28152-.28162"

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).

PITMAN SHAFT SEALS & BEARING REPLACEMENT

NOTE – Seals may be replaced with steering gear on or off vehicle.

Removal – Remove seal retaining ring, then remove outer steel washer, outer seal, inner steel washer, and inner seal. Remove pitman shaft needle bearing using suitable tool (J6217). *NOTE – Bearing is flanged and must be removed from pitman arm end of housing.*



PITMAN SHAFT SEALS AND WASHERS

Installation – Using suitable tool (J22407), press bearing into housing, until tool bottoms against housing. *CAUTION – Do not drive bearing further into housing after removing tool, as damage to bearing may result.* Using suitable tool (J 6278) and adapter (J 6278-2) install seals with lips of seals facing inside of housing. Install seal retaining ring.

STEERING GEAR HOSE CONNECTOR SEATS & CHECK VALVE

NOTE – Following procedure may be performed with steering gear on or off vehicle.

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.