# TABLE OF CONTENTS

1. **GENERAL DESIGN AND OPERATION**
   - 1.1 Integral Power Steering ................................................................. 2
   - 1.2 Rotary Control Valve .................................................................. 2
   - 1.3 Pressure Means Work, Flow Means Speed ........................................ 2

2. **GENERAL OPERATION** ....................................................................... 2
   - 2.1 What Happens During a Steering Maneuver ................................. 2
   - 2.2 Shock Loads to the Gear ............................................................... 2
   - 2.3 Unloading (Poppet) Valves ............................................................ 5
   - 2.4 Relief Valves ............................................................................ 5
   - 2.5 Bleed Systems ........................................................................... 5

3. **TROUBLESHOOTING** ....................................................................... 5

4. **ON-VEHICLE SERVICE** ................................................................. 6
   - 4.1 Filling and Air Bleeding the System .............................................. 6
   - 4.2 Input Shaft Seal Replacement ...................................................... 6
   - 4.3 Sector Shaft Adjustment ............................................................... 10
   - 4.4 Poppet Readjustment .................................................................. 12

5. **DISASSEMBLY PROCEDURES** .......................................................... 15
   - 5.1 Removal from Vehicle ................................................................. 15
   - 5.2 Disassembly ............................................................................ 15

6. **INSPECTION** ................................................................................. 23
   - 6.1 Rack Piston ............................................................................. 23
   - 6.2 Input Shaft ............................................................................. 23
   - 6.3 Housing Cylinder ..................................................................... 24
   - 6.4 Side Cover ............................................................................. 24
   - 6.5 Sector Shaft Assembly ............................................................... 24

7. **COMPONENT REPAIRS** ................................................................. 25
   - 7.1 Poppet Component Replacement ............................................... 25
   - 7.2 Valve Housing / Worm Screw Service ........................................ 27
   - 7.3 Roller Bearing and Retainer Ring Replacement ............................ 34
   - 7.4 Replace Housing Ports, Plugs, Screws and Fittings ................. 35

8. **ASSEMBLY PROCEDURES** .............................................................. 36
   - 8.1 Preparation for Assembly ......................................................... 36
   - 8.2 Assembly .............................................................................. 37
   - 8.3 Final Adjustments .................................................................... 44

9. **ALIGNMENT PROCEDURE** .............................................................. 45

10. **TRW SERVICE BULLETINS** ............................................................ 46
1 GENERAL DESIGN

1.1 Integral Power Steering. TAS power steering gears are the latest design in the TRW Commercial Steering Division family of integral hydraulic power steering gears. Integral hydraulic power steering means that the gear contains a manual steering mechanism, a hydraulic control valve, and a hydraulic power cylinder, all in a single, compact package.

1.2 Rotary Control Valve. The rotary control valve combines simplicity of construction with desirable performance characteristics. The speed at which the driver can turn the steering wheel with power assist is dependent upon the pump flow (measured in gallons per minute or liters per minute) directed to a cylinder cavity. The control valve controls flow through the steering gear.

The pressure (measured in pounds per square inch, or bar) required for the gear to steer the vehicle is created by the power steering pump to overcome resistance at the steered wheels. The control valve senses these requirements and directs fluid to the appropriate cylinder cavity in the steering gear and in the auxiliary cylinder at the proper flow rate and pressure.

1.3 Pressure Means Work, Flow Means Speed. The higher pressure a steering gear can withstand, the more work it can perform. The maximum operating pressure for the TAS85 gear is 2,175 psi (150 bar), maximum flow rate for all TAS gears is 8 gal/min (30.3 L/min).

The TAS series gears can steer a vehicle within its front-end weight rating through a turn at low speed and engine idle. As the driver turns the steering wheel faster or slower, more or less fluid will be required by the gear. The front axle rating for the TAS85 is 18,000 pounds (8,200 kg). The recommended minimum flow at 1 1/2 steering wheel turns per second is 3.6 gal/min (13.6 L/min).

With the auxiliary cylinder, the minimum flow is required (generally at least 75%) based on the size of the auxiliary cylinder and the vehicle’s steering geometry.

2 GENERAL OPERATION

2.1 What Happens During a Steering Maneuver. When the driver turns the steering wheel, he transmits force from the steering wheel to the steering gear input shaft. A torsion bar, pinned at its one end to the input shaft and at its other end to the worm shaft, turns with the input shaft and exerts a rotational force on the worm shaft. In response to this rotational force, the worm shaft, acting through the recirculating ball mechanism, tries to move the race piston axially through the gear housing cylinder bore.

The rack piston’s axial movement is resisted by its engagement to the sector shaft, which is connected by linkage to the steered wheels. Because of this resistance, the torsion bar is twisted by the input shaft, thereby actuating the control valve. Pressurized fluid, directed by the control valve, assists in moving the rack piston axially through the cylinder bore. The rack piston then turns the sector shaft to steer the vehicle.

2.2 Shock Loads to the Gear. If the steered wheels receive a shock load, the shock forces are transmitted through the sector shaft to the rack piston, and on to the worm shaft. The internal geometry of the steering gear causes the control valve to send high-pressure fluid to the correct cylinder cavity to resist the shock forces. By absorbing the shock forces hydraulically, the steering gear prevents objectionable kickback at the steering wheel.
Steering Wheel Input:

- Right Hand Lead
- Right Hand Turn: Steering Wheel Input: Clockwise Rotation
- Straightline Running: No Steering Action
- Left Hand Turn: Steering Wheel Input: Counter-Clockwise Rotation

Figure 2. Oil Flow Illustration.

[Diagram showing the steering gear system with labels for supply and return pressures.]
These items are included in seal kits. Kits also include 406015 lubricant and a service bulletin.

Item Description
1. Bolts (4-Valve Housing)
2. Dirt and Water Seal
3. Retaining Ring
4. Seal (Input Shaft)
5. Valve Housing
6. Seal Ring (Valve Housing)
7. Seal Ring (Valve Housing)
8. Seal Ring (2)
9. O-ring (2)
10. Seal Ring
11. O-ring (Valve Housing)
12. Thrust Washer (Thick)
13A. Input Sh., Valve, Worm Assy. (Alt)
14. Spacer Sleeve (Alt.)

15. Thrust Bearing (1 or 2)
16. Thrust Washer (Thin)
17. Bearing Adjuster
18. Adjuster Locknut
19. Rack Piston
20. Teflon Seal Ring
21. O-ring (Back up, Rack Piston)
22. Poppet Seat and Sleeve Assy. (2)
23. Poppet (2)
24. Poppet Spring
25. Spacer Rod
26. Push Tube
27. Balls
28. Ball Return Guide Halves (2)
29. Seal (Cap)
30. Ball Return Guide Cap
31. Torx Screws (2 Cap)
32. Ball Return Guide Clip
33. Hex Screws (2 Clip)
34. Housing
35. Grease Fitting
36. Retaining Ring (2)
37. Roller Bearing
38. Dirt Seal
39. Dirt and Water Seal (Trunnion)
40. Washer (Spacer)
41. Seal (2-Output)
42. Sector Shaft
43. Adjusting Screw (Sector Shaft)
44. Retainer (Adjusting Screw)
45. Gasket (Side Cover)
46. Side Cover Assembly
47. Jam Nut
48. Special Bolts (6 or 8-Side Cover)
49. Vent Plug (Side Cover)
50. Bleed Screw (Manual)
51. Plug (Auto Bleed)
52. Fixed Stop Screw (Poppet)
52A. Fixed Stop Screw (Poppet-Alt)
53. Washer (Stop Screw)
54. Auxiliary Port Plug (2)
55. O-ring (2-Aux, Port Plug)
56. Relief Valve Cap
57. O-ring (Relief Valve)
58. Relief Valve (2 piece)
59. Service Poppet Adjusting Screw
60. Service Sealing Jam Nut

Figure 3. TAS85 Exploded View.
2.3 Unloading (Poppet) Valves. The TAS85 gear is equipped with two unloading valves, one at each end of the rack piston. One valve or the other, depending on the direction of turn, will trip as the steered wheels approach the axle stops (which must be set according to manufacturer’s specification). The tripped valve reduces pressure in the gear and helps to reduce heat generated by the pump. At the same time, the valves also reduce forces on the steering linkage. These valves are automatically set to axle stops after installation in vehicle at first full right and left turn.

2.4 Relief Valve. The TAS85 is supplied with a relief valve. The relief valve limits maximum supply pressure to protect the power steering gear, but it does not reduce pressure as the steered wheels approach the axle stops.

2.5 Bleed Systems. Some TAS gears which are mounted with the output shaft above the rack piston bore are equipped with either an automatic bleed system or a manual bleed screw.

The procedure for air bleeding the system is described in section 4.1 of this group. Replacement of damaged automatic bleed plugs, and manual bleed screws is described in section 7.4 of this group.

3 TROUBLESHOOTING

Use the “Chart Your Way to Easy Steering” Troubleshooting Guide in group 360 in this manual with the chart below for troubleshooting problems with your vehicle’s steering.

<table>
<thead>
<tr>
<th>Failed Test</th>
<th>Problem</th>
<th>Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test 8</td>
<td>Excessive internal leakage.</td>
<td>Replace damaged parts / reseal.</td>
</tr>
<tr>
<td>Test 9</td>
<td>Excessive internal leakage.</td>
<td>Replace damaged parts / reseal.</td>
</tr>
<tr>
<td>Test 11</td>
<td>Intermittent loss of power assist.</td>
<td>Reseal.</td>
</tr>
<tr>
<td>Test 12</td>
<td>Air in hydraulic system.</td>
<td>Bleed system.</td>
</tr>
<tr>
<td>Test 17</td>
<td>Poppets improperly set.</td>
<td>Reset poppets.</td>
</tr>
<tr>
<td>Test 18</td>
<td>Input shaft – Output shaft lash.</td>
<td>Adjust sector shaft.</td>
</tr>
<tr>
<td>Test 19</td>
<td>Steering gear misadjusted.</td>
<td>Adjust sector shaft first; if required, replace worm assembly.</td>
</tr>
<tr>
<td>Test 28</td>
<td>Gear control valve imbalanced.</td>
<td>Replace worm-valve assy / reseal.</td>
</tr>
<tr>
<td>External Leakage</td>
<td>Porosity in housing, side cover, or valve assy.</td>
<td>Replace porous parts / reseal.</td>
</tr>
<tr>
<td></td>
<td>Input shaft seal.</td>
<td>Replace seal.</td>
</tr>
<tr>
<td></td>
<td>Output shaft seal.</td>
<td>Reseal.</td>
</tr>
<tr>
<td></td>
<td>Side cover seal, vent plug, bolts, gaskets.</td>
<td>Replace parts / reseal.</td>
</tr>
<tr>
<td></td>
<td>Valve housing sealing area.</td>
<td>Remove nicks or replace / reseal.</td>
</tr>
<tr>
<td></td>
<td>Poppet screw or sealing nut.</td>
<td>Replace with poppet adjusting screw kit / reset poppets.</td>
</tr>
</tbody>
</table>
4 ON-VEHICLE SERVICE

4.1 Filling and Air Bleeding the System.

⚠️ CAUTION
Be sure poppets are set correctly before beginning this procedure.

(1) Fill the reservoir nearly full. Do not steer. Start and run the engine for 10 minutes, then shut it off. Check and refill the reservoir. Repeat at least three times, checking the reservoir each time.

⚠️ CAUTION
Do not allow the fluid level to drop significantly or run out of the reservoir. This may induce air into the system and cause damage.

(2) Start the engine and let it idle for 2 minutes. Do not steer. Shut off the engine and check the fluid level in the reservoir. Refill as required.

(3) Start the engine again. Steer the vehicle from full left to full right several times. Add fluid, as necessary, to the full line on the dipstick. Automatic bleed systems should now be free from trapped air. Manual bleed systems continue with step 4.

⚠️ CAUTION
Do not turn steering wheel with bleed screw loosened.

(4) With engine idling, steer from full left turn to full right turn several times. Stop steering and loosen the manual bleed screw about one turn. Allow air and aerated fluid to “bleed out” until only clear fluid is seen. Close the bleed screw, refill the reservoir if required.

4.2 Input Shaft Seal Replacement.

NOTE
This procedure uses the vehicle’s power steering pump to force out the input shaft seal. To use this procedure, the power steering pump should have a minimum of 1500 psi available.

(1) Disconnect return line from steering gear and plug the line. Also cap the return port of the gear with a high pressure fitting.

(2) Remove the steering column from the gear input shaft.
(3) Remove the dirt and water seal from the steering gear.

(4) Wipe out the grease and then remove the spiral retaining ring. Use a screwdriver inserted into the notch formed in the end of the ring. Be careful not to scratch the bore with the screwdriver.

(5) Slip the steering column back onto the input shaft with the pinch bolt installed, but not tightened.

(6) Tie or wrap a shop towel around the input shaft area and place a drip pan under the vehicle to catch the oil.
CAUTION

Any mixture of fluid types or use of any unapproved fluid could lead to seal deterioration and leaks. A leak could ultimately cause the loss of fluid, which could result in a loss of power steering assist.

(7) Add fluid as necessary to the full line on the dipstick. Do not mix fluid types.

(8) Momentarily press the ignition switch and release (quickly turn off the engine if it starts). This will force the seal out.

(9) Remove the shop towel. Disconnect the steering column, and remove the input shaft seal.

(10) Check the seal area of the valve housing for any seal fragments. Remove any that are found.

(11) Check the seal for heat damage. If the seal is stiff and brittle, and not pliable like the new seal, it is probably heat damaged. Determine and fix the cause of excessive heat in the vehicle.
CAUTION

Do not use a socket to install new seal because you will not be able to control seal installation depth, possibly resulting in a leak. Use tool J37073.

(12) Put clean grease on the inside diameter of the new input shaft seal and place it over the input shaft. With the small diameter of tool J37073 against the seal, tap the tool until the tool shoulder is square against the valve housing. Remove any seal material that may have sheared off in the seal bore or retaining ring groove.

(13) Insert new retaining ring into the groove.

(14) Pack the end of the valve housing bore around the input shaft with clean, high temperature industrial grease. Apply more of the grease to a new dirt & water seal and install it over the input shaft. Seat it in the groove behind the serrations and against the valve housing.

(15) Reconnect the steering column to the input shaft and tighten the pinch bolt to torque level specified.
(16) Reconnect the return line to the steering gear return port.

(17) Air bleed the system. Refer to Section 4.1 in this manual for instructions.

4.3 Sector Shaft Adjustment.

NOTE
This adjustment can only be completed on the vehicle if the adjusting screw jam nut is accessible. This nut is located on the side cover.

(1) With the engine off, rotate the steering wheel (input shaft) until the timing mark on the sector shaft lines up with the mark on the hous-

ing. The line on the sector shaft should be at a 90° angle from the input shaft. The sector shaft is now on its "center of travel".

CAUTION
To avoid resetting the poppets, do not rotate the input shaft more than 1-1/2 turns from the "center of travel" position while the drag link is disconnected.

(2) Remove the drag link from the pitman arm.

(3) From the "center of travel" position, grasp the pitman arm and gently try to rotate it. If looseness or lash is felt at this point, the sector shaft is out of adjustment.
(4) Loosen the jam nut.

(5) If no lash was detected in Step 3, turn the shaft adjusting screw counterclockwise until you feel lash at the output shaft.

(6) Slowly turn the shaft adjusting screw clockwise until you feel no lash at the output shaft without using more than 10 lb-ft of torque. From this position, turn the screw clockwise 1/8 to 3/16 of a turn more. Hold the adjusting screw in place and tighten the jam nut. Torque to 43 lb-ft (58 N-m).

(7) Turn the steering wheel 1/4-turn each side of center, then back to center and recheck the pitman arm for lash. You should feel no lash. If there is lash, repeat Steps 4, 6, and 7.
CAUTION

Maintain grease in the sector shaft bearing through the grease fitting in the housing using only a hand operated grease gun. Add grease until it begins to extrude past the dirt and water seal. Do not use a power grease gun because it will supply grease too fast, affecting the high pressure seal and contaminating the hydraulic system.

4.4 Poppet Readjustment.

(1) Set the axle stops to vehicle manufacturer's wheelcut or clearance specifications (Refer to section 9 of this group). Then, start the engine and allow the vehicle to idle for 5-10 minutes to warm the hydraulic fluid. Shut off the engine.

(2) If a new poppet adjusting screw and nut are being used, turn the screw into the non-sealing end of the jam nut until the drive end of the screw is flush with the nut.

(3) Make sure the engine is off and the road wheels are in the straight-ahead position. Remove and discard the poppet fixed stop bolt (if equipped) and washer from the lower end of the housing.

Figure 27. Recheck for Lash.

Figure 28. Connect Drag Link.

Figure 29. Set Axle Stops.

Figure 30. Assemble Adjusting Screw Into Nut.
Figure 31. Remove Poppet Stop Bolt.

NOTE
If the unit has a poppet adjusting screw and sealing nut that need to be replaced, remove and discard them.

(4) Without rotating the nut on the screw, turn the adjusting screw and sealing nut assembly, into the housing until it is firmly against the housing using a 7/32 inch Allen wrench. Tighten the sealing nut against the housing.

CAUTION
If the drive end of the screw is below the face of the nut, the poppet seat flange will break during Step 7d.

Figure 32. Turn Adjusting Screw.

Figure 33. Refill Reservoir.
(5) Refill the system reservoir with approved hydraulic fluid.

CAUTION
Do not mix fluid types. Mixing of transmission fluid, motor oil, or other hydraulic fluids will cause seals to deteriorate faster.

(6) Place a jack under the center of the front axle and jack up the front end of the vehicle so the steer axle tires are off the ground.

Figure 34. Jack Up Vehicle.
(7) Start the engine and let it run at idle speed. Note which output shaft timing mark is nearest to housing piston bore.
(8) Turn the steering wheel in the direction that makes this timing mark move toward the adjusting screw just installed. Turn in this direction until axle stop contact is made.
(9) Pull hard on steering wheel (40 lb rim pull on a 20" steering wheel) after the axle stop is contacted.
(10) Set upper poppet:
(a) Turn the steering wheel in the opposite direction (end of timing mark away from adjusting screw) until the other axle stop is contacted.
(b) Pull hard on steering wheel (40 lb rim pull on a 20" diameter steering wheel).
(c) Release steering wheel and shut off the engine.

Figure 35. Set Upper Poppet.

(11) Loosen the sealing nut and back out the adjusting screw until 1" is past the nut. Tighten the sealing nut against the housing.

Figure 36. Adjusting Screw.

(12) Set lower poppet:
(a) Start the engine and let it idle.
(b) Turn the steering wheel in the original direction (end of timing mark toward adjusting screw) until axle stop contact is made.

CAUTION
Do not hold the steering wheel for any more than 10 seconds at a time. Heat build-up at pump relief pressure may damage components.
(c) Hold the steering wheel in this position (with up to 40 lb rim pull) for 10 seconds, then release. Repeat this hold and release process as many times as necessary while completing Step 13.

Figure 37. Hold Steering Wheel Tightly.

(13) With the steering wheel held tightly at full turn, loosen the jam nut and hold it in place with a wrench.
(14) Turn adjusting screw clockwise (using finger pressure only) until the Allen wrench stops. DO NOT use a ratchet. Pause the turning-in process each time the driver releases the steering wheel. Then continue turning only while the wheel is held at full turn.

Figure 38. Positioning Adjusting Screw.
CAUTION
The length of the adjusting screw beyond the nut must be no more than 1-1/16" for proper thread engagement.

(15) Back off the adjusting screw 3-1/4 turns and tighten the sealing nut. Torque sealing nut to 35 lb-ft.

(16) Lower the vehicle and check the fluid level in the reservoir. Fill if required.

5 DISASSEMBLY PROCEDURE

5.1 Removal from Vehicle.

(1) Stop the vehicle with the wheels in the straight-ahead position.

(2) Clean off all outside dirt from around fittings and hose connections before you remove the gear.

CAUTION
Do not use a hammer on the pitman arm to remove it from sector shaft as internal damage to steering gear could result.

CAUTION
On steering gear with the automatic poppet adjustment feature, do not allow input shaft to rotate more than 1.5 revolutions. Poppet setting will be disrupted.

(3) Remove the input and output shaft connections.

(4) Remove supply and return lines from the gear. Immediately plug all port holes and fluid lines.

(5) Using a proper lifting device, remove steering gear from the vehicle frame and take it to a clean work surface.

CAUTION
Never steam clean or high-pressure wash hydraulic steering components.

(6) As gear is disassembled, clean all parts with a cleaning solvent and air blow-dry them. Keep each part separate to avoid nicks and burrs.

(7) Discard all seals, o-rings, and gaskets removed from the gear. Replace them with new parts only.

5.2 Disassembly.

CAUTION
Do not clamp against body of housing. If mounting boss or flange is not accessible, fabricate and attach a mounting plate to the housing mounting bosses.

(1) Put steering gear in a vise, clamping firmly against the housing mounting flange or boss. The input shaft should be horizontal. The side cover and valve housing are now accessible for disassembly.

(2) Prepare for fluid drainage and unplug hydraulic ports.

(3) Rotate the input shaft until the timing mark on the end of the sector shaft is in line with the timing mark on the end of the housing. This will position the sector shaft for removal.
(4) Remove and discard dirt and water seal from the housing trunnion using a small screwdriver.

(5) Using a fine grade emery cloth, remove any paint or corrosion from the exposed area of the sector shaft.

(6) Tape the serrations and bolt groove of the sector shaft with one layer of masking tape. The tape should not extend onto the sector shaft bearing diameter.

(7) Remove the sector shaft adjusting screw jam nut using a 3/4” socket wrench.
NOTE

Upon removal of the side cover, more fluid will drain from the gear housing. Use a container to collect the fluid for proper disposal.

(8) Remove the eight (8) bolts from the side cover.

(9) Remove the side cover and sector shaft assembly from the gear. You may start the shaft and cover assembly removal by tapping the end of the shaft lightly with a soft mallet or wooden hammer.
(12) Screw sector shaft adjusting screw clockwise through the side cover and pull the sector shaft out of the side cover.

![Figure 50. Remove Sector Shaft.]

**CAUTION**

Do not damage the bore when removing seal.

(13) Clamp the side cover in a vise. Place a standard 5/8" or 11/16" – 3/8 drive socket in the center of the side cover. Pry the seal out with a rolling head pry bar, using the socket for support. Discard the seal and remove the socket.

![Figure 51. Remove Side Cover Seal.]

(14) Inspect the sector shaft assembly for damaged adjusting screw threads. The retainer must be securely staked in place. The adjusting screw must rotate by hand with no perceptible end play (lash).

(15) If equipped, remove relief valve cap, o-ring, and two-piece relief valve from the valve housing. Discard the o-ring.

![Figure 52. Inspect Adjusting Screw and Retainer.]

(16) Remove and discard the dirt and water seal from the input shaft.

![Figure 53. Remove Relief Valve.]

![Figure 54. Remove Dirt and Water Seal.]

(16) Remove and discard the dirt and water seal from the input shaft.
(17) Clean any paint or corrosion from the exposed area of the input shaft using a fine grade emery cloth.

Figure 55. Clean Input Shaft.

(18) Remove the four torx head valve housing bolts.

Figure 56. Remove Valve Housing Bolts.

**CAUTION**
The set position of poppet seat and sleeve assemblies must not be disturbed if the poppets are not going to be replaced or reset during disassembly.

**NOTE**
Upon removal of the rack piston subassembly, more fluid will drain from the gear housing. Use a container to collect the fluid for proper disposal.

(19) Be prepared for more fluid drainage and remove the rack piston subassembly. It may help to rotate the input shaft to move the rack piston toward the lower end of the housing. Place the assembly on a clean cloth.

Figure 57. Remove Valve Housing, Worm, and Rack Assembly.

**NOTE**
If your gear is short “V” construction, the rack piston seal is on the end of the rack piston farthest from the input shaft. Remove the seal before removing the valve housing assembly to prevent the Teflon rack piston seal ring from “hanging up” when it exits the housing. Expose the seal through the sector shaft cavity, then cut and remove the seal ring from the rack piston.

(20) Remove and discard the valve housing seal rings.
CAUTION

Do not remove the input shaft, valve worm assembly or balls from the rack piston until the ball return guides are removed as damage to the ball guides will occur.

(21) Remove and discard the two special sealing screws. Remove the ball return cap and cap seal. Discard seal.

OR: Bend down the two tabs (tangs) that are against the hex head bolts. Remove two bolts and the clip. Discard the clip.

NOTE

The left hand ball return guide halves are copper plated for identification and the right hand guides are not plated.

(22) Place a cloth under the rack piston to prevent balls from rolling as they fall out. Remove ball return guide halves by carefully inserting a screwdriver between the rack piston and guides.

CAUTION

The steel balls are a matched set. If any are lost, the set must be replaced by service balls. The TAS 85 contains 34 balls.

(23) Remove the steel balls from the rack piston by rotating the input shaft valve worm as-
assembly until the balls fall out. Place the balls and return in a cup or other container. Count balls and make sure all 34 have been removed.

Figure 62. Remove Steel Balls.

(24) Remove the input shaft, valve/worm, and valve housing subassembly from the rack piston.

Figure 63. Separate Rack Piston From Worm Subassembly.

(25) Using a pocket knife, cut and remove the Teflon seal ring and o-ring from the rack piston if not removed in previous steps.

Figure 64. Remove Seal Ring and O-Ring.

(26) Push poppet stems. They should spring back. Push poppet seat. It should not move by hand. If components are bent or broken, poppet stems don’t spring back, or poppet seat moves by hand, replace poppets.

NOTE

TRW recommends the poppet adjuster seat and sleeve assemblies not be removed unless replacement of poppet components is required.

Figure 65. Inspect Poppet Assemblies.

(27) Inspect valve housing/worm screw subassembly for heat damage or bearing roughness. If these conditions are present, or if
there was excessive internal leakage, or if preload adjustment is required, go to section 7.2 in this group.

(28) Using a screwdriver, remove the retaining ring that is closest to the output end of the housing trunnion.

(29) Using a screwdriver, remove and discard dirt seal.

(30) Insert a screwdriver into housing bearing bore from the trunnion end and carefully push seal and spacer washer out of the other end of bearing bore. Do not damage the sealing area of the bore or the spacer washer. Discard the seal.

(31) Inspect roller bearing in the housing for brinelling or spalling. Inspect retaining ring for damage. If replacement of either part is required, go to section 7.3 in this group for instructions.
6 INSPECTION.

Inspect all parts for brinelling, cracks or breaks, or twisted serrations. Make sure all sealing surfaces and seal cavities are free from nicks and corrosion. Replace all damaged parts.

**WARNING**

Failure to replace all damaged components could result in a serious vehicle accident.

6.1 Rack Piston. Inspect the rack piston teeth for cracks or obvious damage. If teeth are damaged, replace the rack piston, sector shaft, and set of balls.

Figure 72. Rack Piston Teeth.

Inspect the rack piston ball track grooves for brinelling or spalling. If either condition exists, replace the input shaft, valve/worm assembly, valve housing, rack piston subassembly and balls.

6.2 Input Shaft. Inspect the sealing area of input shaft and valve for nicks and damage. Inspect for discoloration from excess heat. Inspect input shaft ball-track grooves for brinelling or spalling. If any of these conditions exist, replace the input shaft, valve worm assembly, valve housing and balls. Also replace rack piston if brinelling or spalling is found.
6.3 **Housing Cylinder.** Inspect the housing cylinder bore. Some scoring marks are normal. If there was internal leakage greater than 1 gal/min, make sure there are no damaged seals before replacing the housing.

Figure 75. Housing Cylinder Bore.

Inspect the housing faces for nicks that would prevent proper sealing. Replace the gear housing if these nicks are present and cannot be easily removed with a fin-tooth flat file without changing the dimensional characteristics.

6.4 **Side Cover.** Inspect roller bearing in the side cover assembly for brinelling or spalling. If either condition exists, replace the side cover and bearing assembly.

Figure 77. Side Cover Bearing.

6.5 **Sector Shaft Assembly.** Inspect the sector shaft bearing and sealing areas and sector teeth contact surfaces for brinelling, spalling, or cracks. Run your fingernail edge across these areas to detect steps. Remove masking tape from the shaft and inspect for twisted or otherwise damaged serrations. If any of these conditions exist, replace the sector shaft.

NOTE

A new service sector shaft will come assembled with the adjusting screw and retainer.
7 COMPONENT REPAIRS

7.1 Poppet Component Replacement.

(1) If the poppet assemblies are to be removed for replacement, place rack piston in a soft-jawed vise.

NOTE

Poppet adjuster seat and sleeve assemblies are retained by Loctite applied to the threads which makes the assemblies difficult to remove.

(2) Slide special tool J36452-A over the seat of poppet adjuster seat and sleeve assembly and engage tool in the slots in the threaded sleeve. Hit the end of the tool firmly four or five times with a 2 lb sledge hammer to loosen Loctite.

(3) With a ratchet applied to the tool, turn one adjuster seat and sleeve assembly out of the rack piston. If the ratchet does not turn easily, strike the adjuster removal tool again with a hammer. If the engaging tangs won’t stay in place while torquing, it might be necessary to hold in place with an arbor press while applying loosening torque. Discard poppet seat and sleeve assembly.

(4) Remove the two poppets, spring, spacer rod, and push tube.
NOTE

It is possible to reset one poppet adjuster seat and sleeve assembly for automatic adjustment while it is in the rack piston if one adjuster seat and sleeve assembly and the poppets, spring, spacer rod, and push tube are removed.

(5) Remove and discard remaining poppet seat and sleeve assembly only if required.

(6) If one poppet seat and sleeve assembly was left in rack piston, it can be reset for automatic poppet adjustment by inserting a 3/8” (9.52 mm) diameter X 6” (152.4 mm) drill rod down through the poppet seat hole at the opposite end of the rack piston and against the adjuster seat to press the seat in until it bottoms against the adjuster sleeve.
(9) From the other end of the poppet hole in the rack piston, install one poppet, poppet spring, nylon spacer rod, push tube, other poppet, and the other new poppet adjuster seat and sleeve assembly. Torque both poppet seat and sleeve assemblies to 18 lb-ft (25 N-m).

7.2 Valve Housing / Worm Screw Service.
(1) With worm vertical, place the valve housing, input shaft, valve/worm assembly in vise.
(2) Using a roll pin punch and hammer, unstake the valve housing where it was upset into the adjuster locknut slot. Also unstake adjuster nut from adjuster.
(3) Turn bearing adjuster locknut out of the valve housing using special tool J37464.
(4) Turn bearing adjuster out of the valve housing using tool J37070.

(5) Remove and discard seal ring and o-ring from bearing adjuster.

(6) Remove the input shaft, valve/worm assembly from the valve housing.

(7) Remove thin thrust washer and thrust bearing from input shaft.
Figure 94. Remove Thin Washer and Bearing.

(8) Remove thick thrust washer and thrust bearing from valve housing.

Figure 95. Remove Thick Washer and Bearing.

⚠️ CAUTION

Input shaft valve worm assembly must not be disassembled further. The components were a select fit at assembly and are available only as part of this subassembly. If disassembled further, the entire subassembly must be replaced.

(9) Remove and discard seal rings and o-rings from valve housing.

Figure 96. Remove Seal Rings and O-Rings.

(10) Turn over valve housing and remove retaining ring.

Figure 97. Remove Retaining Ring.

⚠️ CAUTION

Exercise special care when removing seal to prevent damaging the valve housing seal bore.

### NOTE

Valve housing utilizes a ball plug for manufacturing purposes and must not be removed.

(11) Using a 1 1/8" socket and hammer, tap input shaft seal out of valve housing. Discard seal.
(12) Inspect the sealing areas of input shaft and valve for nicks and run your fingernail edge across the sealing surfaces to detect steps. Inspect for discoloration from excess heat. Inspect input shaft ball-track grooves for brinelling or spalling. If any of these conditions exist, you must replace the input shaft, valve/worm assembly, valve housing and balls. Also replace rack piston if brinelling or spalling is found.

CAUTION
Do not clamp housing against threaded port hole or relief valve hole sealing faces when placing in vise.

(14) Place valve housing firmly in a vise so the input shaft valve/worm assembly can be assembled vertically with the worm end up.

(13) Inspect the thrust bearing rollers for any deterioration. Inspect thrust washers for brinelling, spalling, or cracks. Replace any part with these conditions.

(15) Oil and assemble a new o-ring into its counterbore in valve housing.
Figure 102. Assemble O-Ring.

(16) Lightly oil and assemble new o-ring and new seal ring into the large diameter seal ring groove in valve housing, bending and working them in and smoothing them out as necessary.

Figure 103. Assemble Other O-Ring and Seal Ring.

(17) Install roller thrust bearing and then the thick washer (square side out) onto input shaft end of input shaft valve worm subassembly, seating them against the input shaft thrust face.

Figure 104. Install Roller Thrust Bearing and Washer.

(18) Lightly oil and assemble new seal ring onto input shaft and against the thick thrust washer to hold the bearing components in place.

Figure 105. Install Seal Ring.

(19) Dip the input end of the input shaft valve worm assembly into oil up to the worm lead. Assemble the input shaft end of the assembly into the valve housing until it is firmly seated.
(20) Apply oil and assemble the other thrust bearing and thin thrust washer over the ball groove end of worm. Seat them against the shoulder of input shaft valve worm assembly.

(21) Lightly oil a new o-ring and assemble into the seal groove in bearing adjuster. Oil and work a new seal ring into the same groove and smooth it out.

(22) Lightly oil and assemble bearing adjuster over worm and into valve housing. Torque adjuster to 13 lb-ft (18 N-m) indicated torque using a torque wrench inserted in adjuster tool J37070. This will seat the components. Back off adjuster 1/4 to 1/2 of a turn.

(23) Lightly oil and assemble new locknut onto bearing adjuster with radius (slightly rounded) side down. Tighten slightly to keep the bearing adjuster in place using tool J37464.
(24) Reverse assembly in vise so the worm end is down. With an inch pound torque wrench on the input shaft, note torque required to rotate the input shaft 360° in each direction. Tighten the bearing adjuster to increase the maximum torque at the input shaft 5 - 10 lb-in. (0.5 - 1.0 N-m) over that which was previously noted.

Figure 110. Assemble New Locknut.

Figure 111. Adjust to Required Input Torque.

NOTE
The bearing adjuster, locknut and valve housing flange should be flush. If not, the seal ring or o-ring may be out of position. This will result in axial lash.

Figure 112. Torque Locknut.

(25) Again reverse the assembly in vise. Torque locknut while holding bearing adjuster in position established in Step 24 with appropriate adjuster tool. When using a torque wrench in locknut tool J37464, the torque wrench reading should be 112 lb-ft (152 N-m).

Figure 113. Check Input Shaft Torque.

(26) Recheck input shaft torque. It should match torque measured in step 24. Repeat Steps 24 and 25 if necessary.

(27) Stake valve housing into the clockwise most corner of two opposing slots in locknut. Stake the locknut into the adjuster in two places (180° apart) at threaded area. Choose areas that have not been previously staked.
After staking, torque required to rotate input shaft must be between 5 - 10 lb-in. (0.5 - 1.0 N-m) greater than the torque noted in step 24. Torque value must not exceed 22 lb-in. (2.5 N-m). Unstake and readjust if necessary.

(28) Reposition worm screw/valve housing sub-assembly in soft-jawed vise, clamping tightly against valve housing so the worm screw is pointing down.

(29) Apply clean grease to the outside and inside diameters (fill cavity between the lips) of the new input shaft seal and assemble it, garter spring side first over the input shaft. Align seal in the valve housing seal bore.

**CAUTION**

The input shaft seal must be square in the seal bore and installed to the correct depth.

Assemble seal installer tool J37073, small diameter end first, over the input shaft and against the seal. Tap the seal installer tool until the tool shoulder is squarely against the valve housing. This will correctly position the seal in the housing bore just beyond the retaining ring groove.

(30) Insert new retaining ring into its groove in valve housing.

**CAUTION**

The bearing must be pressed out from the side cover side to protect the seal counter bore. Be sure to use a bearing removal tool that will clear the retaining ring.
(1) If roller bearing in housing needs to be replaced, place the bearing removal end of the bearing and seal tool J38779 against the side cover end of the bearing and press it out of trunnion end of the bearing bore. Discard bearing.

Figure 118. Remove Roller Bearing.

(2) If the retaining ring that is still in the housing bearing bore needs to be replaced, remove it through the trunnion end of the bearing bore to protect the pressure seal bore area from being damaged.

Figure 119. Remove Retaining Ring.

(3) Insert retaining ring (if it was removed) into the housing bore from the trunnion end to protect sealing area. Make sure it is seated in the retaining ring groove closest to the side cover end of the bearing bore. Lubricate the bearing bore.

Figure 120. Install Retaining Ring.

**CAUTION**

Use the bearing installation end of the tool to press roller bearing into housing. If the bearing removal end of the bearing & seal tool is used to press in bearing, the cage on the new bearing may be damaged.

(4) Using tool J38779, press the roller bearing into the housing from the trunnion end of bearing bore until it is seated against the retaining ring. Be sure the housing is square with the press base and the bearing is not cocked.

Figure 121. Press In Housing Roller Bearing.

7.4 Replace Housing Ports, Plugs, Screws, and Fittings.

(1) If damaged, remove and replace the poppet fixed stop screw and washer if equipped. Replace with poppet fixed stop screw, discard washer. Torque to 48 lb-ft (65 N-m).
**Figure 122. Replace Poppet Fixed Stop Screw.**

(2) If damaged, remove poppet adjusting screw and sealing nut without allowing the nut to change its position on the screw.

Assemble the new nut onto the new adjusting screw, matching its position to the nut and screw removed. Torque sealing nut to 35 lb-ft (47 N-m).

**Figure 123. Replace Poppet Adjusting Screw.**

(3) If damaged, remove and replace automatic bleed plug. Torque to 48 lb-ft (65 N-m).

If damaged, remove and replace permanent auxiliary port plugs and o-rings. Assemble new o-rings on port plugs and torque to their respective ports in the housing or valve housing to 30 lb-ft (41 N-m).

**Figure 124. Replace Automatic Bleed Screw and Auxiliary Port Plugs.**

(4) If damaged, remove and replace manual bleed screw. Torque to 30 lb-in. (3.4 N-m).

**Figure 125. Replace Manual Bleed Screw.**

8 ASSEMBLY PROCEDURES

8.1 Preparation for Assembly.

(1) Wash all parts in clean, OSHA approved solvent. Air blow-dry them only.

**WARNING**

Because they are flammable, be extremely careful when using any solvents. Even a small explosion or fire could cause injury or death.

**CAUTION**

Wear eye protection and be sure to comply with OSHA or other maximum air pressure requirements.

(2) Replace all seals, seal rings, and gaskets with new ones each time you disassemble the gear.
(3) TRW Commercial Steering Division does provide individual seals, seal rings, and gaskets, as well as complete seal kits. These parts should be available through most OEM parts distributors.

8.2 Assembly.

(1) Install new dirt seal into the trunnion end of housing sector shaft bore and against bearing with the seal lip out.

![Figure 126. Install Dirt Seal.](image1)

(2) Install the second retaining ring, seating it firmly in the housing retaining ring groove.

![Figure 127. Install Retaining Ring.](image2)

(3) Install washer into the side cover side of housing seal bore with small diameter piloted into retaining ring.

![Figure 128. Install Washer.](image3)

(4) Assemble new seal onto bearing and seal tool J38779 so the lip with the garter spring is toward the shoulder of the tool.

Working from the side cover side of the housing, pilot the seal tool into the washer and bearing and press with a force of 100 - 800 lb (445 - 3,560 N) until the seal is seated against the washer.

![Figure 129. Press Seal Into Housing.](image4)

(5) Liberally pack the area between dirt seal and pressure seal, including roller bearing, with clean, high temperature industrial grease.
(6) Lightly oil new seal ring and assemble in valve housing mounting face. Oil new seal ring and assemble in valve housing pilot groove.

(7) Install a new backup o-ring and then a new Teflon seal ring on rack piston. Do not over-stretch these rings as you install them. Do not allow the Teflon seal ring to be twisted.

(8) Apply clean oil to housing cylinder bore. Place the rack piston in the housing piston bore with ball return guide holes up.

(9) Insert the worm screw into the rack piston close to maximum depth, without the valve housing making contact with the poppet stem. Insert two 7/16"-14 All threads through valve housing bolt holes and tighten into housing to support the worm screw. Line up rack piston ball guide holes with the worm ball track grooves by rotating the input shaft.
WARNING
Do not seat guides with a hammer. Damage to guides can result in subsequent lockup or loss of steering.

(10) Compare the new guides with the guides removed from the gear, use the ones that look the same. Left hand guides are copper plated, right hand guides are unplated. Assemble the new ball return guide halves into the rack piston until seated, rotate the input shaft slightly if necessary.

CAUTION
If a new rack piston or a new input shaft, valve, worm subassembly is being assembled, the balls removed from the unit must be discarded and a service ball kit utilized. The balls in a service ball kit are sized to function in the ball track guide path as altered by component replacement.

NOTE
When using the service ball kit, use the correct quantity of service balls. The TAS 85 uses 34 balls.

(11) Hold the ball return guides firmly through Step 12. Insert as many of the steel balls as you can through the hole in the top of the ball return guides. Rotate the input shaft to pull the balls down and around the ball track guide path. Continue until the correct number of balls are in the ball track guide path. Continue holding ball return guides.

CAUTION
Continue to hold down the ball return guides until cap or clip is reinstalled. Failure to hold the guides will result in a trapped ball or balls, which could cause a vehicle accident. If the ball guides become unseated at any time, repeat the procedure starting at Step 9.

(12) If your gear is equipped with the ball return guide cap, grease a new ball return cap seal and place it in the seal groove of the cap. Assemble the cap so the seal makes full contact.
with the rack piston surface. Install two new Allen or Torx head screws and torque each screw alternately until a final torque of 18 lb-ft (24.5 N-m) is achieved.

**OR** If your gear is equipped with a ball return guide slip instead of a cap, install a new clip so both bolt hole faces are in full contact with the rack piston surface. Install the two hex head bolts. Torque the bolts to 18 lb-ft (24.5 N-m). Finish by bending the guide clip locking tabs up against the bolt head flats.

**CAUTION**

If you install a gear on a vehicle with the worm shaft unable to rotate, the gear will not function correctly. Steering and gear failure may result.

(13) Rotate the input shaft from one end of travel to the other without contacting the poppet stem to the valve housing and without moving the valve housing face more than 2-1/2″ (69.1 mm) from input end (upper end) or rack piston. If you cannot rotate the input shaft, remove the balls and reassemble them.

**CAUTION**

Do not damage the seal ring while installing the rack piston into housing. If the seal ring end of rack piston enters the housing first, the seal ring will be destroyed when the rack is removed.

**CAUTION**

The poppet seat and sleeve assemblies must not bottom against the internal poppet stops in the steering gear until the gear is installed on the vehicle and the poppet adjustment procedures are performed.

(14) Apply clean oil to Teflon seal ring on rack piston. Make sure there is a space of 3/8 – 1/2″ (10.0 – 13.0 mm) between valve housing and poppet stem to prevent poppet contact at either end. Remove the all threads and push the rack piston assembly into the housing with the rack piston teeth toward the sector shaft cavity. Line up the valve housing cylinder feed hole with the gear housing feed hole.

---

Figure 137. Ball Return Guide Cap.

Figure 138. Ball Return Guide Clip.

Figure 139. Rotate Input Shaft.
Make sure both o-rings in the valve housing remain in position.

Figure 140. Install Rack Piston, Worm, Valve Assembly.

(15) Lubricate and install the four valve housing bolts into the housing. Torque to 118 lb-ft (160 N-m).

Figure 141. Install Valve Housing Bolts.

(16) If the gear is equipped with a relief valve, assemble a new o-ring on relief valve cap. Assemble the small end of tapered spring onto the pin on the relief valve cartridge and insert the assembly (large end of tapered spring end first) into the relief valve cap cavity. Turn the relief valve cap as assembled into the valve housing and torque to 30 lb-ft (41 N-m).

Figure 142. Install Relief Valve Parts.

CAUTION

The bearing assembly inside the side cover is sealed and will not receive lubrication from the hydraulic fluid in the gear. Failure to grease properly could result in premature bearing wear.

(17) Apply a generous amount of Mobil Temp 1 or 2 grease to the caged bearing assembly inside the side cover.

Figure 143. Lubricate Side Cover Bearing.

(18) Grease and install new seal onto installation tool J38779 so the side with the garter spring is against the shoulder of the tool. Pilot the tool into the side cover with a force of 100 - 800 lb (445 - 3560 N) until it is seated against the bearing or bushing.
Figure 144. Press Seal In Side Cover.

(19) Apply a generous amount of grease to the short bearing area of the sector shaft.

Figure 145. Lubricate Sector Shaft.

(20) Insert the sector shaft into the side cover subassembly and screw the sector shaft adjusting screw counterclockwise to the side cover until the screw reaches solid height.

Rotate the adjusting screw clockwise one half turn so the side cover will rotate freely on the sector shaft.

Figure 146. Install Sector Shaft Into Cover.

(21) Install the sector shaft adjusting screw jam nut onto the sector shaft adjusting screw a few threads. Final adjustment will be made later.

Figure 147. Install Jam Nut.

**CAUTION**

Do not weld or otherwise plug the vent plug hole in any permanent manner. This is a safety vent which functions only if the side cover seal fails. If the seal fails and the plug cannot vent, the steering gear may lock-up or otherwise malfunction.

(22) Press the new vent plug into the hold provided in the side cover until the plug is bottomed.
Figure 148. Assemble Vent Plug.

(23) Apply clean grease to the new side cover gasket to hold it in place and assemble it onto the side cover.

Figure 149. Install Side Cover Gasket.

⚠️ CAUTION

If the rack piston is not centered when the sector shaft is installed, gear travel will be severely limited in one direction. This could result in an accident.

(24) There are four teeth on the rack piston. Rotate input shaft to position the rack piston so the space between the second and third tooth is in the center of the sector shaft opening. This will center the rack piston for assembly of sector shaft.

Figure 150. Center Rack Piston.

⚠️ CAUTION

If the serrations on the sector shaft are not properly taped, they will damage the output seal in housing, causing the seal to leak.

(25) Clean off any old tape on the serrations. Reapply one layer of masking tape. Install the sector shaft assembly into the housing. The center tooth of the sector shaft must engage the center space (between the second and third tooth) of the rack piston, with side cover gasket in place.

Figure 151. Install Sector Shaft and Side Cover Into Housing.

(26) Install the special side cover bolts into the side cover and torque them in the sequence shown. If bolts must be replaced, use bolts of the same design, type, and length as those you removed. Do not use a substitute.
Lubricate side cover bolts and torque to 170 lb-ft (230 N-m).

Figure 152. Side Cover Bolt Torque Order.

(27) Remove tape from sector shaft and pack the end of housing trunnion area at the sector shaft with clean, high temperature industrial grease. Apply more of the grease to inside of the new trunnion dirt seal and assemble it over the sector shaft and into the trunnion bore.

Figure 153. Assemble Trunnion Dirt Seal.

(28) Pack the end of the valve housing bore around the input shaft with clean, high temperature industrial grease. Apply more of the grease to the inside of a new dirt and water seal and install it over the input shaft and seat it in the groove behind the serrations and against the valve housing.

Figure 154. Install Dirt and Water Seal.

8.3 Final Adjustments.

**CAUTION**

Do not rotate the input shaft more than 1.5 revolutions from center position until the steering gear is installed during poppet setting procedure. Doing so could make the automatic poppets inoperative, which would require disassembly of steering gear to reposition poppet seat and sleeve assemblies.

**NOTE**

Initial poppet contact will occur at less than one input shaft rotation if new or reset poppet adjuster seat and sleeve assemblies are assembled in the unit.

**NOTE**

Worm preload adjustment was set when input shaft, valve and worm were assembled into valve housing.

(1) To center the steering gear, rotate input shaft valve worm assembly, until the timing mark on the end of the sector shaft is in line with the timing mark on the end of the housing trunnion.
NOTE

The following procedure will properly mesh and seat the rack piston and sector shaft teeth for final adjustments.

(2) With adjusting screw jam nut loose, turn sector shaft adjusting screw clockwise to provide 45 – 50 lb-in. (5 – 5.5 N-m) of torque required to rotate the input shaft, valve/worm assembly through one half turn (180°) each side of center.

(3) Turn sector shaft adjusting screw counterclockwise one half turn and note maximum torque required to rotate the input shaft valve/worm assembly through one half turn (180°) each side of center.

(4) Adjust sector shaft adjusting screw clockwise to increase maximum torque noted in step 3 by 7 lb-in. (0.8 N-m). Tighten jam nut firmly against side cover while holding the adjusting screw in position. Final torque the jam nut to 43 lb-ft (58 N-m) and check input shaft valve/worm assembly torque again. Readjust if input shaft torque exceeds 40 lb-in. (4.5 N-m).
Service Bulletin #TAS-100

On-Vehicle Input Shaft Seal Replacement for TAS Gears

Revised February, 1993

NOTE
Use this procedure for removing the input shaft seal if you have determined that an external leak is caused by this seal.

1. Disconnect return line from the steering gear and plug the line. Also cap the return port of the gear with a high pressure fitting.

2. Remove the steering column from the gear input shaft.

3. Remove the dirt & water seal from the steering gear.

This TRW Commercial Steering Division service bulletin has been written to help you repair commercial vehicles more efficiently. This bulletin should not replace your manuals; you should use them together. These materials are intended for use by properly trained, professional mechanics, NOT "Do-it-yourselfers". You should not try to diagnose or repair steering problems unless you have been trained, and have the right equipment, tools and know-how to perform the work correctly and safely.
Remove retaining ring
4. Wipe out the grease and then remove the spiral retaining ring. Use a screwdriver inserted into the notch formed in the end of the ring.

Replace column
5. Slip the steering column back onto the input shaft with the pinch bolt installed, but not tightened.

Wrap exposed area
6. Tie or wrap a shop towel around the input shaft area and place a drip pan under the vehicle to catch the oil.

Fill reservoir
7. Add fluid as necessary to the fill line on the dipstick.

⚠️ WARNING
DO NOT MIX FLUID TYPES.
See service manual for recommended fluids.

Force out the seal
8. With the vehicle in neutral, momentarily turn the starter (quickly turn off the engine if it starts).
9. Remove input shaft seal.

10. Inspect seal area. Check the seal area of the valve housing for any seal fragments. Remove any that are found.

11. Inspect old seal. Check the seal for heat damage. If the seal is stiff and brittle, and not pliable like the new seal, it is probably heat damaged. You need to determine and fix the cause of excessive heat in the vehicle.

12. Install new seal. Put clean grease on the new input shaft seal and place it over the input shaft, garter spring side first. Place seal installer tool #J3073 over the input shaft and against the seal, small diameter end first. Tap the seal installer tool until the tool shoulder is square against the valve housing. Remove any seal material that may have sheared off in the seal bore or retaining ring groove.

13. Install retaining ring. Insert new retaining ring into the groove.
14. Pack the end of the valve housing bore around the input shaft with clean high temperature industrial grease (Mobil Temp® 1 or 2 or equivalent). Apply more of the grease to a new dirt & water seal and install it over the input shaft. Seat it in the groove behind the serrations and against the valve housing.

15. Reconnect the steering column to the input shaft and tighten the pinch bolt to torque level specified.

16. Reconnect the return line to the steering gear return port.

Continue by bleeding air from the system using the procedure on page 5 for automatic bleed gears, and the procedure on page 6 for manual bleed gears.
Remove Air From Automatic Bleed System

1. Fill Reservoir
   - Fill the reservoir nearly full.

2. Idle engine for 10 seconds, repeat 3 times
   - Start and run the engine for 10 seconds, then shut it off. Check and refill the reservoir. Repeat at least three times, each time checking and refilling the reservoir.

3. Idle engine for 2 minutes
   - Start the engine and let it idle for 2 minutes. Shut the engine off and check the fluid level in the reservoir.

4. Complete several turns, engine on
   - Start the engine again. Steer the vehicle from full left to full right several times. Add fluid, as necessary, to the full line on the dipstick.
Remove Air From Manual Bleed System

Complete the procedure on page 5

1. Remove the air from a gear mounted in an inverted position and equipped with a manual bleed screw by first following the air bleeding procedure for automatic bleed gears, on page 5.

Loosen bleed screw, remove air, repeat

2. With the engine idling and no steering action, loosen the manual bleed screw about one turn, allowing air and aerated fluid to "bleed out" around the bleed screw until only clear (non aerated) fluid is observed. Then close the bleed screw and check and refill the reservoir.

   Repeat this procedure 3 or 4 times until only clear (non aerated) fluid is discharged when the bleed screw is loosened.

Torque bleed screw

3. Torque the manual bleed screw to **27-33 lbf•in.** (3.1-3.7 N•m). Check and refill the reservoir.

   **NOTE** Do not steer the vehicle while the bleed screw is loose.
Service Bulletin #TAS-101

On-Vehicle Poppet Readjustment for TAS Gears

Revised January, 1993

What are poppets?

Poppets are pressure unloading valves set to trip just before full turn is reached in each direction. When this procedure is completed correctly, system pressure will be reduced before the axle stop screw contacts the axle stop in both directions.

To determine if the poppets require readjustment or if they are performing properly, install a Power Steering System Analyzer (PSSA) between the power steering pump and the steering gear. If poppet readjustment is necessary, you can leave the PSSA in the system to verify that the following procedure is completed properly.

Why might poppets need to be readjusted?

- Changing to larger tires
- Reduced vehicle wheelcut
- Pitman arm mistimed; condition corrected
- Steering gear being installed on a different truck
- Steer axle stop bolt(s) were bent or broken
- Steer axle u-bolt(s) were bent or broken

NOTE

This resetting procedure will work in most cases with at least 1¾ hand-wheel-turns from each side of center. If you're making a large reduction in wheelcut and this procedure does not work, you may have to internally reset the poppets using the procedure described in the TAS Service Manual.
1. Set the axle stops to vehicle manufacturer’s wheelcut or clearance specifications.

Start the engine, and allow the vehicle to idle for 5-10 minutes to warm the hydraulic fluid. Shut off the engine.

2. If a new poppet adjusting screw and nut are being used, turn the screw into the non-sealing end of the jam nut until the drive end of screw is flush with the nut.

Your steering gear will have either a fixed stop bolt or an adjusting screw. If the adjusting screw is already part of the steering gear, back the nut off of the adjusting screw until it is flush with the end of the adjusting screw.

3. Make sure the engine is off and the road wheels are in straight ahead position. Remove and discard the poppet fixed stop bolt (if equipped) and washer (if equipped) from the lower end of housing.

If the unit has a poppet adjusting screw and sealing nut that need to be replaced, remove and discard them.

4. Turn the adjusting screw and sealing nut assembly, without rotating the nut on the screw, into the housing until the nut is firmly against the housing using a 3/8” Allen wrench. Tighten the sealing nut against the housing.

5. Refill system reservoir with approved hydraulic fluid.

⚠️ CAUTION Do not mix fluid types. Mixing of transmission fluid, motor oil, or other hydraulic fluids will cause seals to deteriorate faster.
Jack up vehicle 6. Place a jack under the center of the front axle and jack up the front end of the vehicle so the steering axle tires are off the ground.

Push upper poppet out to prepare it for setting 7.  
   a) Start the engine and let it run at idle speed.  
   b) Note which output shaft timing mark is nearest the housing piston bore.  
   c) Turn the steering wheel in the direction that makes this timing mark move toward the adjusting screw just installed. Turn in this direction until axle stop contact is made.  
   d) Pull hard on the steering wheel (put 30 lbs. rim pull on a 20" dia. steering wheel) after the axle stop is contacted.

Set upper poppet 8.  
   a) Turn the steering wheel in the opposite direction (end of timing mark away from adjusting screw) until the other axle stop is contacted.  
   b) Pull hard on the steering wheel (put 30 lbs. rim pull on a 20" dia. steering wheel).  
   c) Release the steering wheel and shut off the engine.

Back out adjusting screw 9. Loosen the sealing nut and back out the adjusting screw until 1" is past the nut. Tighten the sealing nut against the housing.

Set lower poppet 10.  
   a) Start the engine and let it idle.  
   b) Turn the steering wheel in the original direction (end of timing mark toward adjusting screw), until axle stop contact is made.  
   c) Hold the steering wheel in this position (with 30 lbs. rim pull) for 10 seconds, then release. Repeat this hold and release process as many times as necessary while completing step 11.

⚠️ CAUTION ⚠️ Do not hold the steering wheel at full turn for more than 10 seconds at a time; the heat build-up at pump relief pressure may damage components.
11. a) With steering wheel held at full turn, loosen the jam nut and hold it in place with a wrench.
b) Turn the adjusting screw in (clockwise) using finger pressure only (don't use a ratchet), until the Allen wrench comes to a stop. Do not attempt to turn it in farther. Pause the turning-in process each time the driver releases the steering wheel; Continue turning only while the wheel is held at full turn.
c) Back off the adjusting screw 3½ turns and tighten the sealing nut. Torque the sealing nut to 33-37 lb-ft.

12. The poppets have now been completely reset. Lower the vehicle. Check the reservoir and fill if required.

**WARNING** The length of the adjusting screw beyond the nut must be no more than 1⅜" for proper thread engagement.

**NOTE** The length of adjusting screw beyond the sealing nut may be different for each vehicle.
TRW Automotive
Steering & Suspension Systems

Service Bulletin #TAS-103

Lubrication of TAS Gears

Revised February, 1993

This TRW Commercial Steering Division service bulletin has been written to help you repair commercial vehicles more efficiently. This bulletin should not replace your manuals; you should use them together. These materials are intended for use by properly trained, professional mechanics, NOT "Do-it-yourselfers". You should not try to diagnose or repair steering problems unless you have been trained, and have the right equipment, tools and know-how to perform the work correctly and safely.

Lubricate trunnion bearing
At chassis lube intervals or once per month

1. Locate the grease fitting on the trunnion side of the steering gear near the output shaft. Use a hand-type grease gun to force grease (NLGI grade 2 or 3 multipurpose EP chassis lube) through the fitting until you can see it past the external dirt and water seal.

CAUTION Do not use an automatic or power grease gun on this fitting. The high rate of flow from such devices could force grease inside the high pressure seal. This could contaminate the hydraulic system and also promote seal leakage.

Maintain input shaft dirt & water seal grease pack
Twice per year

2. Clean old grease from the dirt & water seal near the input shaft, and the cavity behind the seal with a lint-free cloth. Repack the area using clean, high temperature industrial grease (Mobil Temp* 1 or 2 or equivalent). Re seat the dirt & water seal in its groove behind the serrations and against the valve housing.

*Mobil Temp is a registered trademark of Mobil Oil Corp.

TRW Commercial Steering Division
P.O. Box 60
Lafayette, IN 47902
Phone: 317.423.5377
Fax: 317.429.1868

370-30A, Page 56
Service Bulletin #LNK-100

Boot Seal Replacement Procedure
(replace when seal is damaged or otherwise not sealing correctly)

Revised July, 1992

1. Disconnect drag link from axle arm.

2. If the socket assembly is threaded onto the drag link, unscrew it and remove it from the drag link assembly. If the socket assembly is staked to the drag link, remove the entire drag link assembly.

3. Press or tap on the flanged foot portion of the seal to remove it from the socket assembly. If you use a screwdriver to loosen the seal, be careful not to damage the sealing face of the socket forging.

4. Wipe off all grease and foreign material from around the ball stud and socket throat. Do not use any type of cleanser to remove the grease.

5. Using No. 5 calcium soap base grease, grease the socket throat and stud ball. Then fill the new boot seal ¾ full with the same grease.

6. Position the socket assembly in a large vise, or on a press so that the ball stud is perpendicular to the socket stem.

7. Press on the new boot seal using the tool described below. The seal is in place when the flanged portion is seated on the machined section (sealing face) of the socket forging.

TOOL: A section of tubing with the inside diameter as close to the outside diameter of the boot seal (middle section) as possible.

The inside corner of the tube should be radiused (rounded) or chamfered (angled) so it will not cut the rubber during the press-on operation.

CAUTION: DO NOT over-press the seal; over-pressing could cause it to deform and seal improperly. DO NOT use a screwdriver, chisel, punch, etc. on the flanged foot of the seal for installation.

8. Reconnect the socket assembly to the drag link, if removed. Reconnect the drag link to the axle arm and tighten to specifications.

TRW Commercial Steering Division
P.O. Box 60
Lafayette, IN 47902
Phone: 317.423.5377
Fax: 317.429.1868
TRW Automotive
Steering & Suspension Systems

Service Bulletin #LNK-103

Sliding Seal Replacement Procedure
(replace when seal is damaged or otherwise not sealing correctly)

Released July, 1993

1. Remove the old seal by sliding it off the ball stud.

2. Wipe off all grease and foreign material from around the ball stud and socket throat with a clean cloth. Don't use any type of chemical cleanser to remove the grease.

3. Slide the new seal over the ball stud until it seats on the shell.

4. Wipe off all foreign material from around the grease fitting. Apply #2 NLGI extreme pressure, lithium-based, moly-filled heavy duty grease through the fitting until it can be seen extruding past the seal.

This TRW Commercial Steering Division service bulletin has been written to help you repair commercial vehicles more efficiently. This bulletin should not replace your manuals; you should use them together. These materials are intended for use by properly trained, professional mechanics, NOT "Do-it-yourselfers". You should not try to diagnose or repair steering problems unless you have been trained, and have the right equipment, tools and know-how to perform the work correctly and safely.

TRW Commercial Steering Division
P.O. Box 60
Lafayette, IN 47902
Phone: 317.423.5377
Fax: 317.429.1868
Service Bulletin #LNK-104

8000 Series Ball Socket Maintenance and Repair Procedures

Released July, 1993

TRW Ball sockets should be lubricated with #2 NLGI extreme pressure, lithium-based, moly-filled, heavy duty grease, at regular intervals recommended by the vehicle manufacturer. General guidelines for lubrication are listed below, but each owner has the ultimate responsibility for making sure the sockets are lubricated appropriately for the vocation of the vehicle.

Lubrication Guidelines (on-highway vehicles only)

**With Boot Seal**
Severe Service - Lubricate socket every oil change or 10,000 miles, whichever comes first.

Normal Service - Lubricate socket every other oil change or 20,000 miles, whichever comes first.

**With Sliding Seal**
Normal Service - Lubricate socket every oil change or more frequently when the vehicle is subjected to harsh environments.

Damage Inspection at Lubrication Intervals

Any form of tear or improper sealing requires seal replacement.

Steering arm to ball stud mating condition - Any rocking motion between the two mating parts requires replacement of one or both.

Seal replacement instructions are included with replacement parts. (Boot seal replacement bulletin #LNK-100, Sliding seal replacement bulletin #LNK-103.) The procedure for assembling the socket to the mating arm is as follows:

**Assembly of Socket to Mating Arm**

1. Clean and dry the tapered opening of the mating arm and the tapered section of the ball stud.
2. Insert the tapered section of the ball stud through the larger opening of the mating arm.
3. With hand pressure, attach the ball stud to the arm until it locks into position. No rocking motion is allowed between the stud and arm at this position.
4. Attach the slotted hex nut into the threaded portion of the ball stud. Torque the nut to the minimum value recommended by the vehicle manufacturer. If the cotter pin cannot be installed, tighten the nut to the next slot. Do not back off the nut when minimum torque is reached.
WARNING

Do not use a wrench or other object to apply leverage when inspecting sockets. Applying leverage can give skewed results, and damage components. Component damage may ultimately result in loss of steering control.

TRW Commercial Steering Division
P.O. Box 60
Lafayette, IN 47902
Phone: 317.423.5377
Fax: 317.429.1868

Service Bulletin #LNK-105

Inspection Procedure for TRW Ball Socket Wear

Released March, 1994

Truck Shop Inspection Procedure:

1. Make sure the stud is seated tightly in the steering arm taper, and the nut is tight.

2. With vehicle engine on, lightly rock the steering wheel while checking for looseness in any threaded joint, or any movement of the stud nut. Any looseness requires repair.

3. With the engine off and wheels straight ahead, push and pull the socket in and out by hand in the direction of the ball stud. If no movement is detected, the socket is operable. Any movement detected by hand requires replacement of the socket.

Inspection Station Criteria:

Follow preceding procedures for inspecting ball sockets. Measure any movement detected by hand with a scale for in and out motion on the ball stud axis.

Any motion, other than rotational, between any linkage member and its attachment point of 1/8" (3 mm) or more, measured with hand pressure only, is cause to remove the vehicle from service for immediate socket replacement.

If movement is less than 1/8" (3 mm) the socket should be replaced at the next practical servicing stop.

If no movement is detected by hand the socket is operable.