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## 1. STEERING SYSTEM DESCRIPTION

The steering system consists of the steering wheel and column assembly, a vane-type hydraulic pump, reservoir, filter, interconnecting system lines and hoses, integral power steering gear, linkage and steering damper (Figure 1). The steering linkage includes the pitman arm, drag link, steering arm, tie rod arms and tie rod.

Hydraulic components are added to transmit, increase and regulate steering control forces. These elements are:

1. Steering stabilizer (damper);
2. A vane type hydraulic pump; and
3. Hydraulic reservoir and hoses.

The steering stabilizer reduces road shocks and vibrations in the system. The steering gearbox is self powered and provides movement with power assistance to the left wheel.

Steering stability and tire wear are influenced by wheels, hubs, tires, air suspension, brakes, front suspension and front end alignment which are all covered in their respective sections in this manual.

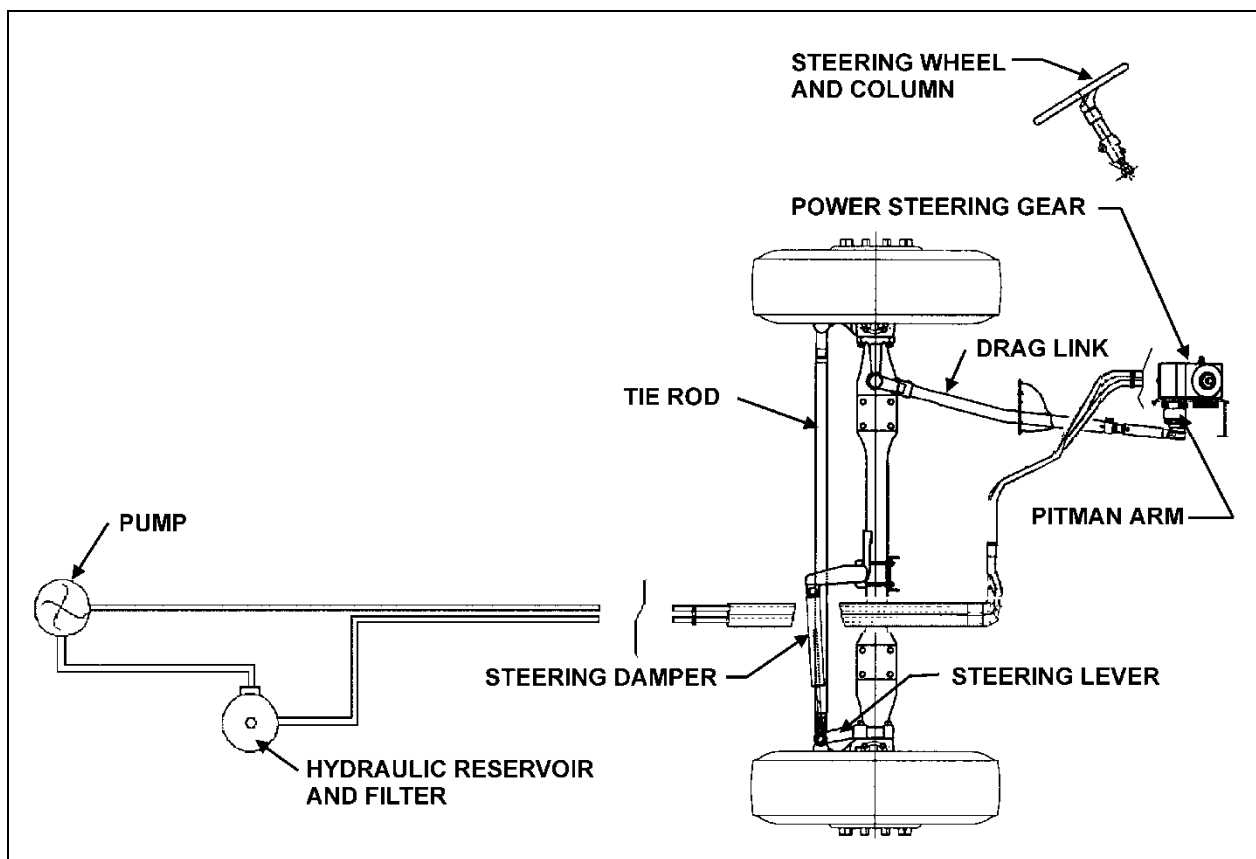


FIGURE 1: I-BEAM AXLE STEERING SYSTEM SETUP 14041

## 2. POWER STEERING GEAR

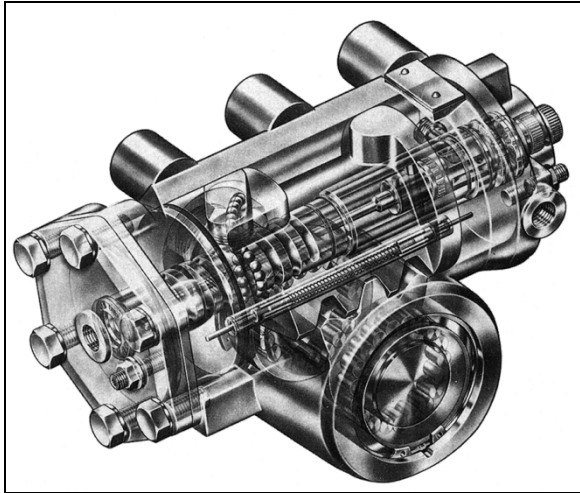


FIGURE 2: POWER STEERING GEAR

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### 2.1 DESCRIPTION

The power steering gear is located in the lower part of front service compartment (Figs. 2 & 3). The housing of the ZF-Servocom contains a control valve, working cylinder and a complete mechanical steering gear. The pressure oil for the steering is delivered by a motor-driven oil pump which is supplied with oil from an oil tank.

The housing is designed as a cylinder for the piston, which converts the rotation of the steering shaft and the worm into an axial movement and transfers this to the steering worm sector shaft. The serration of the sector shaft is straight-cut with a high surface quality in such a way that it is only possible to set a unique setting without play on installation in the straight-ahead driving area by means of the two eccentrically designed lateral housing covers.

The piston and worm are connected via a ball chain. When the worm is turned, the balls are collected by a circulating pipe at one end of the chain and fed in again at the other end, thus producing an endless ball chain.

The control valve consists of the valve slide in a needle bearing in the worm, with six control grooves on the circumference and the control sleeve on the worm, which also has six control grooves. The valve slide, designed with steering shaft connection, turns together with the worm as the steering wheel is turned.

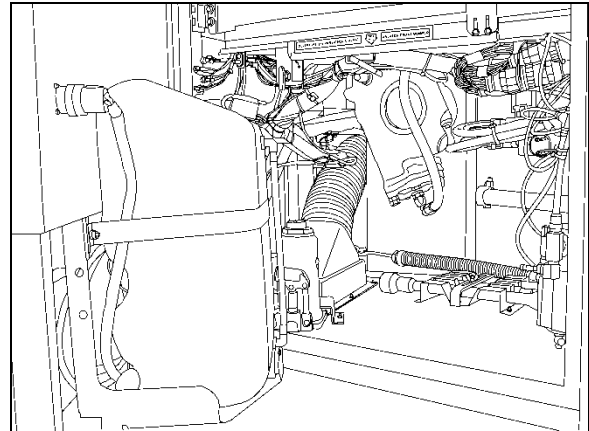


FIGURE 3: FRONT SERVICE COMPARTMENT

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A torsion bar, which is pinned with the valve slide and the worm, keeps the control valve in the neutral position as long as no opposing force is applied to the steering wheel. The steering housing contains a pressure relief valve, which limits the discharge pressure of the oil pump to the maximum value required. A replenishing valve can also be used, through which oil is sucked from the return if steering is not hydraulically boosted.

Compared with constant ratio, steering versions with variable ratio are more directly designed in the center area than outside the center area. The resulting smaller steering corrections benefit steering behavior in straight-ahead driving. At the same time, the indirect transmission means that there is a higher hydraulic torque available at the steering arm in parking movement. If the hydraulic assistance fails, the operating forces on the steering wheel are correspondingly lower in this area. This is achieved through a piston/steering worm sector shaft serration with differing modulus and angle of pressure.

Upon transfer of a torque from the steering shaft to the worm, or vice versa, the torsion bar is deformed in the elastic area so that there is torsion between the valve slide and the control sleeve. When the steering wheel is released, the torsion bar ensures that the valve is returned to the neutral position.

Refer to the *"ZF-SERVOCOM Repair Manual"* and *"ZF-SERVOCOM Operating, Servicing /Maintenance and Inspection Instructions"* for the functional aspects and maintenance procedure of the steering gear.

## 2.2 POWER STEERING GEAR REMOVAL



### WARNING

The steering gearbox weighs approximately 100 lbs (45 kg) dry. Exercise caution when handling.

1. Put a container into place, then disconnect both the inlet and outlet hoses from the power steering gear. Cover fittings to prevent fluid contamination.
2. Mark both the pitman arm and sector shaft with a line, then remove pitman arm. Refer to "11.1 Pitman Arm Removal" procedure.
3. Mark both the steering shaft universal joint yoke and steering gear input shaft with a line, then disconnect universal joint.
4. Unscrew and remove the power steering gear.

## 2.3 POWER STEERING GEAR INSTALLATION

Reverse "Power Steering Gear Removal" procedure paying particular attention to the following:

1. Tighten fasteners as recommended under paragraph 14: "Torque Specifications".
2. Bleed air from the system as per step 3, next.

## 2.4 TROUBLESHOOTING

Perform troubleshooting of the steering gear as outlined in the "ZF-SERVOCOM Repair Manual", the "ZF-SERVOCOM Operating, Servicing /Maintenance and Inspection Instructions".

## 3. BLEEDING POWER STEERING HYDRAULIC SYSTEM

To bleed the power steering hydraulic system, refer to the "ZF-SERVOCOM Repair Manual", under heading "Setting And Functional Test".

## 4. HYDRAULIC PRESSURE TEST

Perform a pressure test as outlined in the "ZF-SERVOCOM Repair Manual" under heading "Setting And Functional Test".

## 5. POWER STEERING HYDRAULIC PUMP

The power steering pump is a gear driven hydraulic unit which supplies hydraulic pressure for the operation of the steering gear. The pump is mounted on the engine, at the flywheel end and is also used for driving the fuel pump.

### 5.1 REMOVAL AND INSTALLATION

The pump is accessible through the engine compartment R.H. access door.

To remove the pump, proceed as follows:

- You must first remove the fuel feed pump.
- Clean around the fuel pump and fuel lines. Position a container to catch any fuel that might drain from the pump or lines.
- Remove the fuel pump.

#### NOTE

Only unfasten the bolts marked with arrows.

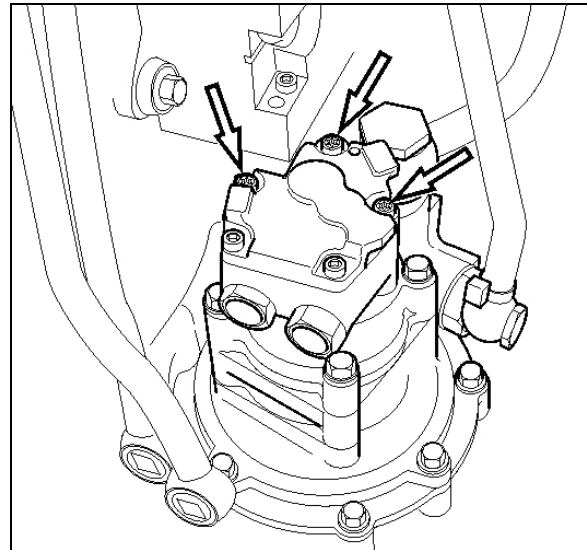


FIGURE 4: FUEL PUMP REMOVAL



### CAUTION

Ensure to clean around the head of the bolts. Debris will prevent the tool from fitting properly and cause damage to the fasteners.

- Check that the adapter and fuel pump drive axle are not damaged.

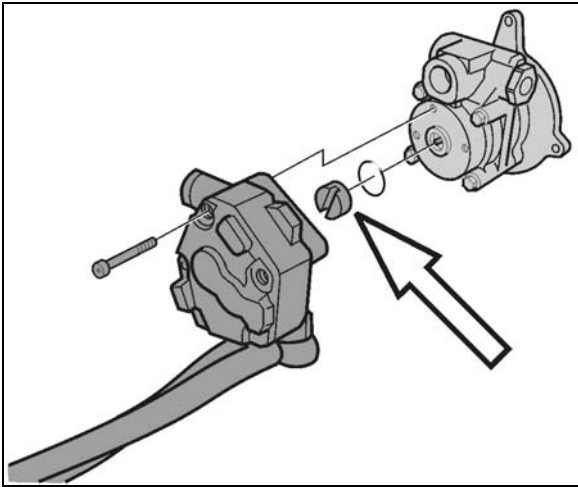


FIGURE 5: FUEL PUMP DRIVE AXLE

- Set the fuel pump aside.
- Clean around the power steering pump and loosen the steering lines. Position a container to catch any hydraulic fluid that might drain from the pump or lines.
- Unfasten the power steering pump bolts.

**NOTE**

Only unfasten the bolts marked with arrows.

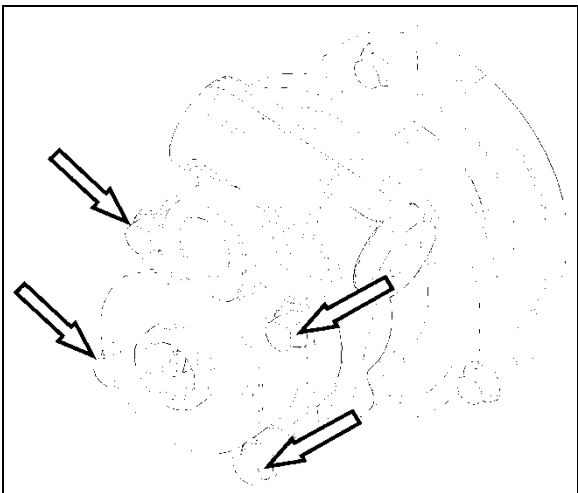


FIGURE 6: POWER STEERING PUMP REMOVAL

- Install the new power steering pump. Torque-tighten bolts to specification.

**NOTE**

Use a new gasket.

- Connect the hydraulic lines to the power steering pump.
- Install the fuel pump. Torque-tighten bolts to specification.

**NOTE**

Use a new sealing ring. Check that the fuel pump drive axle sits correctly in the power steering pump.

- Start the engine and let run for 5 minutes. Make sure that there are no leaks.

**6. STEERING COLUMN REMOVAL**

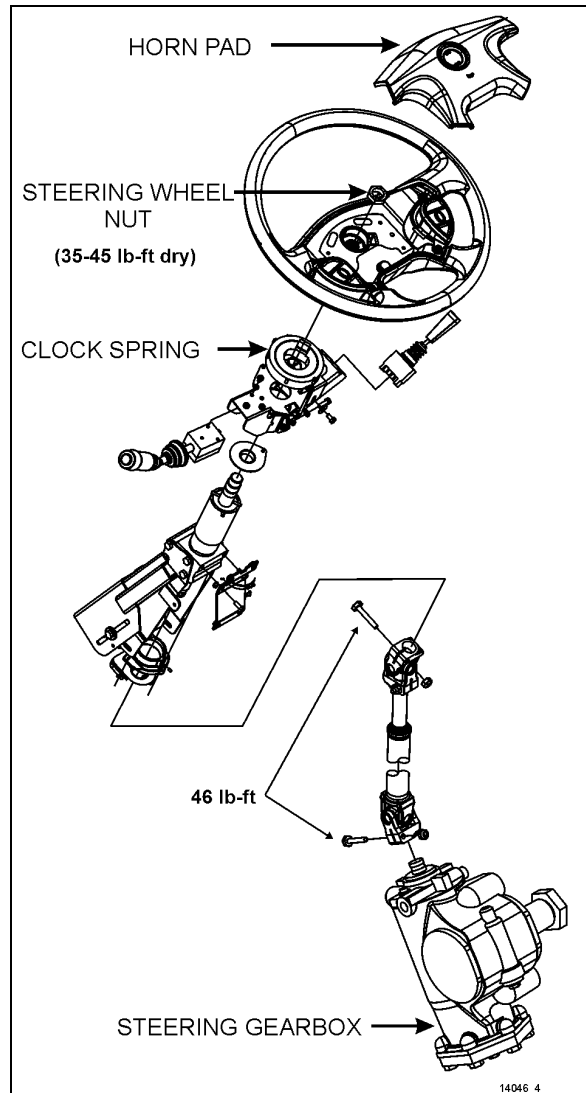


FIGURE 7: STEERING COLUMN

To disassemble the steering column from system, refer to figure 7 & 8. The steering column has no lubrication points. The lower steering column U-joint is easily accessible through the front service compartment. The upper steering column U-joint and the steering slip joint are accessible from the front driver's area. To access these joints, proceed as follows:



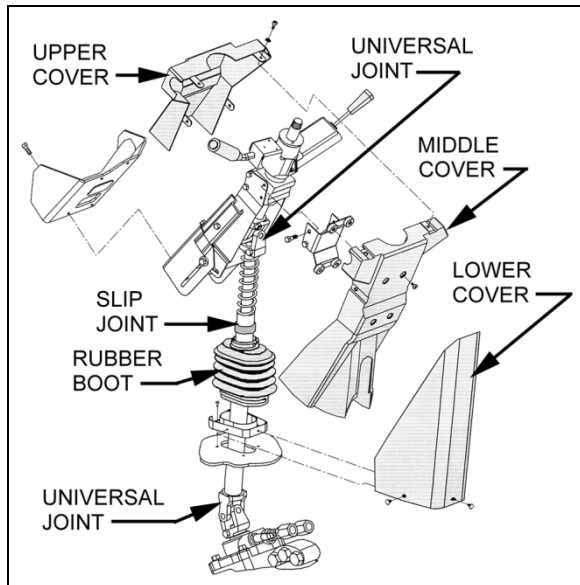


FIGURE 8: STEERING COLUMN COVERS

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1. From the front driver's compartment area, remove the three plastic fasteners on steering column lower cover. Remove the lower cover (Figure 8).
2. Unscrew the four retaining screws on steering column middle cover.
3. Unscrew the four retaining screws fixing steering column upper cover to middle cover. Remove the steering column middle and upper covers.
4. Position the steering wheel in order to gain access to the joints.

## 7. STEERING WHEEL

### 7.1 REMOVAL

#### **NOTE**

*Before undertaking the steering wheel removal, assure that the front wheels are pointing straight ahead, aligned with the vehicle.*

1. Set the battery master switch located on the rear electrical panel to the "OFF" position.
2. Pull the horn pad straight up gently to detach it from the steering wheel (Figure 9).
3. Disconnect the horn wire (white) connected to the horn pad and the steering wheel harness 4-pin connector.

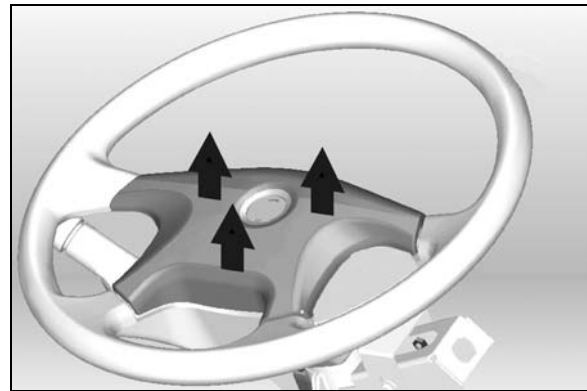


FIGURE 9: REMOVING THE HORN PAD

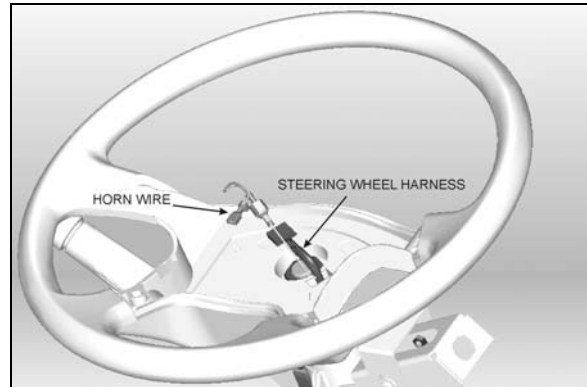


FIGURE 10: STEERING HARNESS &amp; HORN WIRE

4. Unscrew the steering wheel nut. To simplify installation and ensure steering wheel alignment, mark the relationship of the spline shaft to the steering wheel hub (if marks don't already exist or don't line up).
5. Using an appropriate puller, separate the steering wheel from the spline shaft.
6. From behind the steering wheel, pull gently on the electrical wires passing through the rectangular opening in the steering wheel to finish removal of the steering wheel.
7. Once the steering wheel is removed, it is important to block any rotating movement of the clockspring in order to prevent it from losing its neutral position. Use two pieces of masking tape to lock it in place (Figure 11).

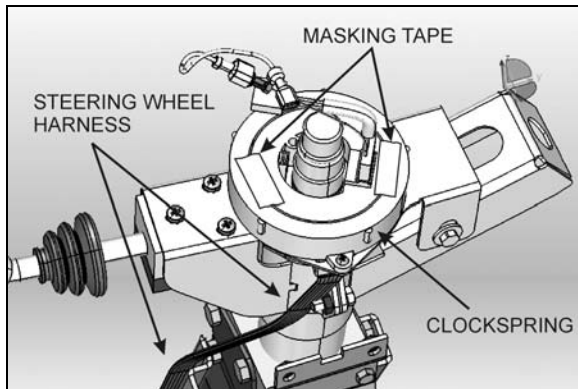


FIGURE 11: LOCKING THE CLOCKSPRING IN PLACE

**NOTE**

*The clockspring mechanism permits a certain number of turns in each direction. At the moment of reinstalling the steering wheel, if the clockspring is not at its neutral position, the number of available turns will be reduced. That may damage the clockspring if the steering wheel is turned to its maximum amplitude.*

**7.2 INSTALLATION**

1. Route the white horn wire and the 4-pin connector through the opening on the steering wheel.
2. Align the mark on the steering wheel hub with the mark on the spline shaft and slide the wheel onto the shaft.
3. Tighten wheel retaining nut to a torque of 35-45 lbf-ft.
4. Plug the 4-pin connector and connect the white horn wire to the center pad.
5. Reinstall the center pad and test for proper horn functioning.

**7.3 CLOCKSPRING REPLACEMENT**

1. Remove the steering wheel.
2. Remove the 2 clockspring mounting screws and then remove the clockspring. You will have to disconnect the clockspring harness connector located lower along the steering wheel column. If necessary, remove the steering column covers (Figure 8).
3. Route the new clockspring harness through the opening in the clockspring support

(Figure 12). Plug the connector at the base of the steering wheel column and fix harness along the steering wheel column.

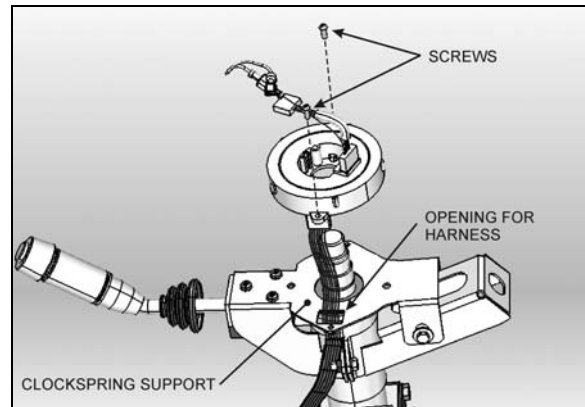


FIGURE 12: CLOCKSPRING INSTALLATION

4. Mount the clockspring in place with 2 screws.
5. Break the paper seal and rotate the center part of the clockspring about 50° clockwise (Figure 13). This step is necessary for the installation of the steering wheel.

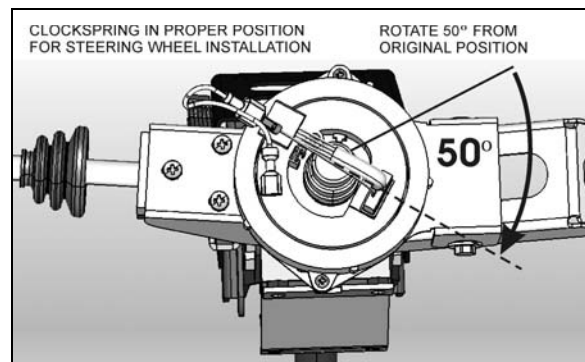


FIGURE 13: PROPER CLOCKSPRING POSITION

6. Reinstall the steering wheel.

**8. TURNING ANGLE ADJUSTMENT**

The maximum turning angle is set through two (2) steering stop screws installed on the axle center. Steering stop screws are factory adjusted to accommodate the chassis design, and therefore, do not require adjustment on new vehicles. However, these should be checked and adjusted if necessary, any time a steering system component is repaired, disassembled or adjusted. Refer to section 10 "Front Axle" under heading "6.4 "Turning Angle Adjustment".



**CAUTION**

To prevent the steering damper from interfering with the adjustment of turning angles, make sure its fixing bracket is at correct location on the axle (refer to "12.2 Steering Stabilizer Cylinder (Damper)").

**Hydraulic Stop****CAUTION**

Reduce or shut off the power steering hydraulic pressure before the boss on the axle touches the stop screw. If not, the components of the front axle will be damaged (refer to "ZF-SERVOCOM Repair Manual" and "ZF-SERVOCOM Operating, Servicing /Maintenance and Inspection Instructions", under heading "Setting The Steering Limiter").

**CAUTION**

Never maintain the relief pressure for more than 5 seconds, since damage to the power steering pump may occur.

**9. STEERING LINKAGE ADJUSTMENT**

The steering linkage includes the pitman arm, drag link, steering arm, tie rod arms and tie rod. Perform lubrication according to "DANA SPICER Service Manual NDS Axle Range" found in the OEM manuals folder.

Steering linkage pivot points should be checked each time they are lubricated. Looseness can be visually detected while rotating the steering wheel in both directions. Replace defective parts.

**CAUTION**

Front wheel alignment should be checked and adjusted if necessary, any time a component of the steering system is repaired, disassembled or adjusted. Refer to section 10 "Front Axle" under heading 6. "Front Wheel Alignment".

**10. PITMAN ARM****10.1 REMOVAL**

1. Remove cotter pin, nut and washers from drag link ball stud at pitman arm.
2. Disconnect drag link from pitman arm, using jaw style pullers (pressure screw type).

**WARNING**

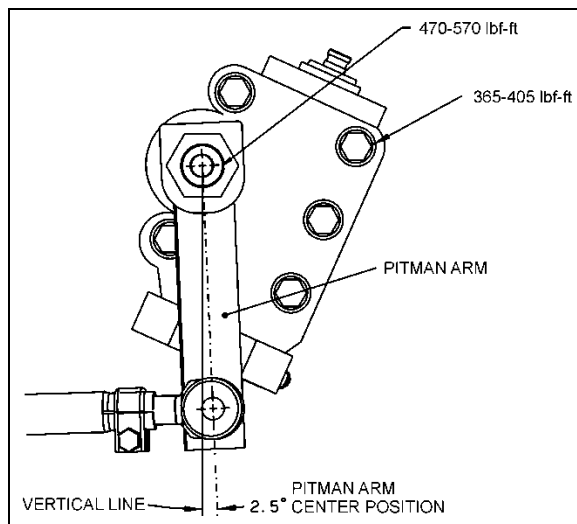
Always wear approved eye protection when operating pullers.

**CAUTION**

Do not drive (hammer in) pitman arm on or off pitman shaft as this can damage the steering gear.

**CAUTION**

Heating of components to aid in disassembly is not allowed because it has a detrimental effect on axle components and steering linkages.

**FIGURE 14: PITMAN ARM ADJUSTMENT**

3. Using a cold chisel, undo punch mark that locks fixing nut to the pitman arm.
4. Remove pitman arm fixing nut.
5. Check the radial position of the pitman arm in relation to the sector shaft prior to removal of pitman arm.

8. Add reference marks to the arm and shaft if necessary to ensure correct alignment at reassembly.
7. You must use a puller to remove pitman arm.

10.2 INSTALLATION

1. Position pitman arm on sector gear shaft with reference marks aligned.
2. Install fixing nut (Prevost #661050). Tighten nut to 470-570 lbf-ft (637-773 Nm).

**NOTE**

Use a new nut if the previously removed nut was punched.

1. Lock nut with sector shaft using a punch mark into the groove (Refer to figure 15).

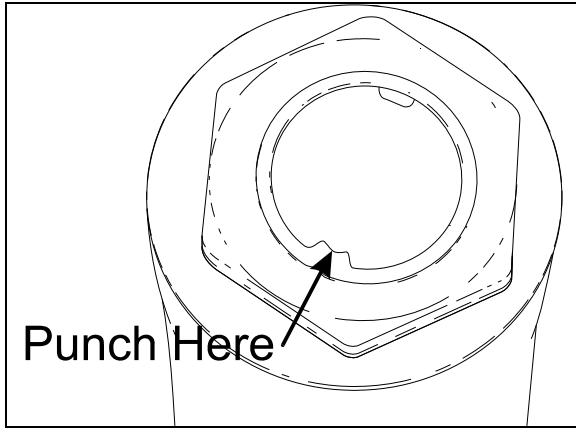


FIGURE 15: FIXING NUT PUNCH MARK 16098

2. Connect drag link to pitman arm while ensuring that rubber stabilizer is in place on the rod end. Install washers. Tighten nut to 150-200 lbf-ft (203-271 Nm). Afterwards, install a new cotter pin.

**CAUTION**

Input shaft marks must be aligned before adjusting pitman arm.

10.3 ADJUSTMENT

1. Disconnect the drag link from pitman arm. Center steering wheel by dividing the total number of steering wheel turns in two. Scribe a reference mark on steering gearbox at the center previously determined.

2. Using a protractor, check the angle of the pitman arm (refer to Figure 14 for details).
3. The pitman arm should be adjusted to an angle of 2.5° in relation with the vertical axis (towards front of vehicle). If not, unscrew and remove fixing nut. Remove the pitman arm according to the procedure outlined under previous heading "Pitman arm removal". Adjust to the proper angle.
4. When adjustment is achieved, replace fixing nut and torque to 470-570 lbf-ft (637-773Nm).

10.4 TAG AXLE UNLOADING SWITCH ADJUSTMENT

1. Make sure vehicle wheels are straight and facing forward.
2. Line up switch lever with reference to the bracket center (Refer to figure 16).

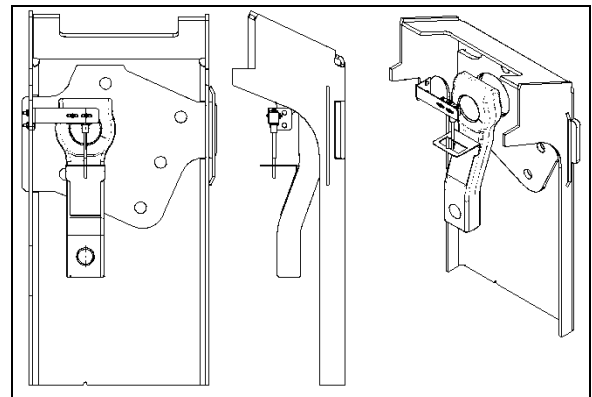


FIGURE 16: TAG AXLE UNLOADING SWITCH ADJUSTMENT 14061

**11. DRAG LINK**

The drag link on your vehicle connects the steering gear pitman arm to the front axle's steering arm.

For additional details please refer to ZF assembly instructions LMN404-3 and Lemförder service information leaflet for the fine adjustment system.

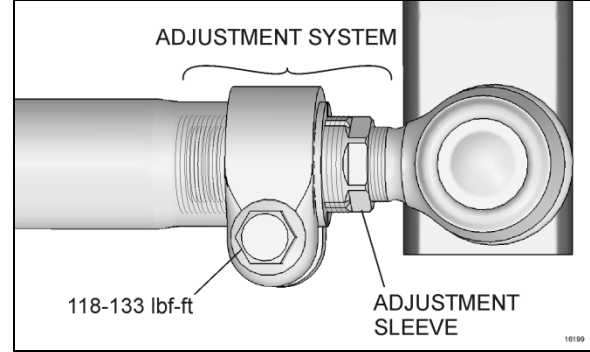
**PINCH HAZARD**

Keep hands and fingers clear of pinch zones around pitman arm.

Pinch zones are between pitman arm and clamp, and between front of pitman arm and vehicle structure.

PINCH ZONES

Apply a small amount anti-seize compound on the threads for corrosion protection. Be sure to avoid smearing the ball joint boot.



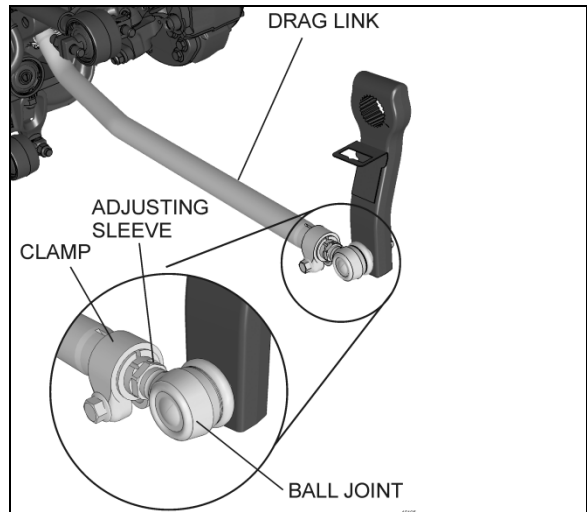
**FIGURE 18: DRAG LINK ADJUSTMENT**

**12. STEERING SYSTEM MAINTENANCE**

The power steering system requires little maintenance. However, the system should be kept clean to ensure maximum operating performance and trouble-free service. Periodic inspections should also be made to check for leakage and all parts for damage or distortion. Insure all fasteners are tight (see "14. Specifications" for recommended tightening torques.

When the slightest evidence of dirt, sludge or water is discovered in the system, disconnect fluid lines at the power steering gear to drain the system. Drain and refill the system.

Air in the hydraulic system will cause spongy action and noisy operation. When a hose has been disconnected or when fluid has been lost for any reason, the system must be bled. Bleed system as outlined under heading 3: "Bleeding Power Steering Hydraulic System".



**FIGURE 17: DRAG LINK**

**11.1 FINE ADJUSTMENT**

The drag link fore end is provided with an adjusting sleeve which has internal and external left and right threads. Turning this sleeve allows fine adjustments to the length of the drag link.

**CAUTION**

Do not operate the pump without fluid in the power steering fluid reservoir.

If the steering linkage between the steering gear and the two front wheels is not properly adjusted, or if it is bent, twisted or worn, the steering of the vehicle will be seriously impaired. Whenever a steering linkage part is repaired, replaced or adjusted, steering geometry and front wheel alignment must be checked and necessary corrections made. Refer to section 10 "Front Axle" under heading 6: "Front Wheel Alignment".

At regular lubrication intervals, the steering linkage should be thoroughly inspected for worn or loose components.

After the vehicle has been operated continually and high mileage figures have been reached, overhaul of the various steering units will be required. General overhaul procedure normally requires removal of the entire assembly, cleaning and inspection of all parts and final assembly. Careful inspection of all parts during overhaul is very important and must not be neglected.

Lubrication fittings must all be cleaned before applying lubricant. Moreover, always be sure the equipment used in applying lubricant is clean. Every precaution should be taken to prevent entry of dirt, grit, lint or other foreign matter into lubricant containers. Replace fittings that have become broken or damaged. Lubrication intervals, as well as the recommended lubricants for the steering components, are given in the "Lubrication And Servicing Schedule" in Section 24 of this manual. The intervals given in the schedule are recommended for normal service. More frequent intervals may be required under severe operating conditions.

**12.1 STEERING SYSTEM PLAY INSPECTION**

Basically, the steering system play is checked with the engine running and the front wheels in the straight ahead driving position. The steering wheel is slowly turned in one direction until there is a perceptible movement of a front wheel. If a point on the steering wheel rim moves more than the value indicated below before perceptible return movement of the wheel under observation, there is excessive free play in the steering system.

Steering wheel travel covered

**Maximum value:** 1.732 inch (44mm) with  
Prevost 18-inch steering  
wheel

**NOTE**

*The full procedure is described under paragraph 1.6.7 **Checking the Steering Gear Play** in ZF SERVOCOM DESIGN, OPERATION, MAINTENANCE, INSPECTION (8090) manual.*

**Take note that the maximum travel covered value specified in ZF's manual doesn't apply to the Prevost design which uses a**

**18-inch steering wheel.**

If the maximum value is exceeded, the steering system should be thoroughly inspected for worn or loose components, beginning with the steering linkage. If the steering linkage is in good condition, then the steering column and the steering gear should be inspected.



**MAINTENANCE**

Perform the steering system play inspection every 100 000 miles.

**12.2 POWER STEERING RESERVOIR AND FILTER**

The power steering reservoir is located on R.H. side of engine compartment and accessible through the engine compartment doors. (Figure 19).

**12.2.1 Oil Level Check Procedure**

1. Stop engine. Open engine compartment doors.
2. Unscrew and remove the dipstick located on top of reservoir and wipe with a clean rag.
3. Insert dipstick in reservoir. Remove it again to check fluid level (Figure 19).
4. Adjust level to "**FULL**" mark using proper dipstick side depending on fluid temperature, use 80W140 full synthetic gear oil.
5. Reinsert and tighten the dipstick.
6. At regular intervals, fluid level should be checked in the reservoir and filter assembly.

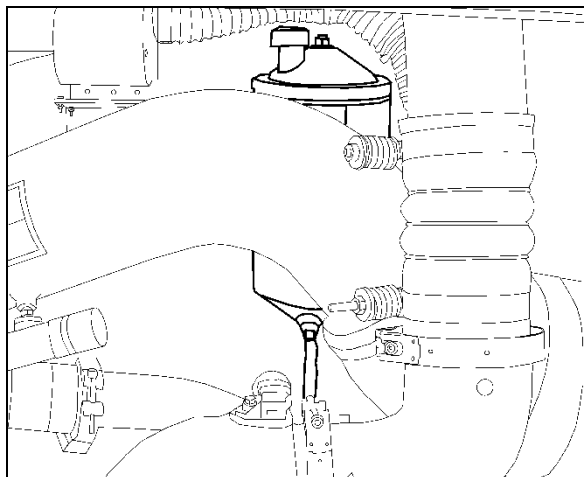


FIGURE 19: HYDRAULIC FLUID RESERVOIR LOCATION  
14059



## MAINTENANCE

Replace the oil filter element in the power steering reservoir every 50,000 miles.

Drain system and refill with fresh power steering fluid every 150,000 miles. Use Mobil DEXRON-VI ATF (Automatic Transmission Fluid)

### 12.2.2 Filter Element Replacement

Before removing the cover, clean the upper part of the steering fluid reservoir to prevent dirt and other contaminant from falling inside the reservoir.

Unscrew the cover nut and keep the gasket located found on top of the reservoir cover.

Remove the reservoir cover and the gasket.

Remove the retaining spring, the element retainer and finally the filter element.

The power steering fluid reservoir is equipped with a magnetic drain plug. When element replacement coincide with the power steering fluid replacement, check for trapped metal particle before installation of the new filter cartridge element.

Pass the reservoir threaded rod through the element and install the element with the element's writing "THIS END UP" on top.

Pass the reservoir threaded rod through the retainer and rest the retainer on top of the element, followed by the compression spring.

Clean the large gasket and the mating surfaces on the cover and reservoir.

Properly place the large gasket in the cover. Install the cover, making sure the gasket is properly placed.

Clean the small gasket and install with the rubber side against the cover. Screw and tighten the nut as necessary to prevent leaks.

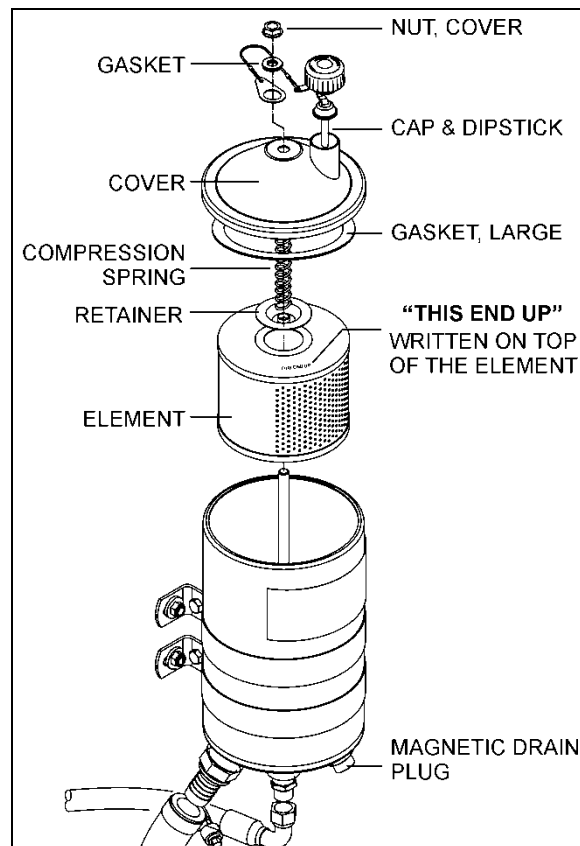


FIGURE 20: POWER STEERING FLUID RESERVOIR 14018

### 12.2 STEERING STABILIZER CYLINDER (DAMPER)

The steering damper is located on R.H. side, aft of front axle (Figure 21).

The cylinder is non-adjustable and non-repairable. Check for oil leaks or lack of resistance. Disconnect the cylinder from axle, then carefully attempt to extend and collapse it manually.



## MAINTENANCE

Steering damper ball joint (rod end) is provided with a grease fitting for pressure lubrication. This grease fitting should be serviced every 6,000 miles.

Check the ball joint for wear, and replace if necessary.

Good quality lithium-base mineral grease NLGI No. 1 and 2 like Shell Retinax LX are recommended.

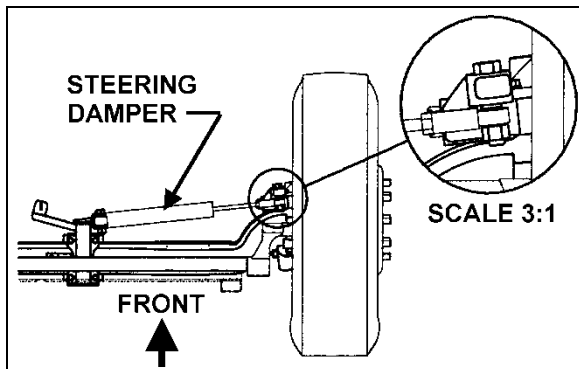


FIGURE 21: STEERING STABILIZER (DAMPER) 14042

### 12.3 DRAG LINK

Visually inspect drag link components for broken, corroded or deformed clamps, loose, bent or corroded nuts and gauges on tube from rubbing parts.

#### 12.3.1 Front I-beam Axle

On vehicles equipped with I-beam front axle, the drag link features “lubricated for life” ball joints and a compact fine adjustment system.

#### Visual inspection

Inspect the adjustment system to ensure the threads are firmly seated. Also, a visual inspection should be carried-out looking for damage or corrosion to the adjustment system components. Replace any part showing corrosion or damage.

#### Functional inspection

**Clean the adjustment system with a brush and compressed air prior to inspection, if required.**

With the engine running and the vehicle on the ground (with a load on the axle) turn the steering wheel left and right.

To verify that the threads are tight and do not present any play, use one of the following methods:

- Visual inspection
- Place a finger on the separation line from the adjuster sleeve to the threaded ball joint shaft.  
**Keep fingers clear of pinch zones.**
- Use a dial gage clamped to the tube and feelers aligned on the ball joint to indicate any play

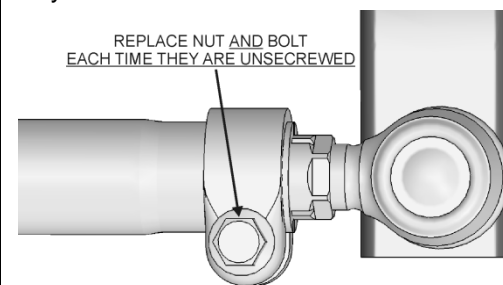
*When play is discovered in the adjusting system, replace the complete drag link.*



## CAUTION

**Do not re-use clamp hardware.**

Bolt and nut should be replaced every time they are unsecured.



While assembling the clamp, make sure the bolt does not touch the drag link tube.

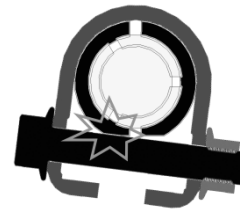


FIGURE 22: I-BEAM FRONT AXLE DRAG LINK



12.4 TIE ROD

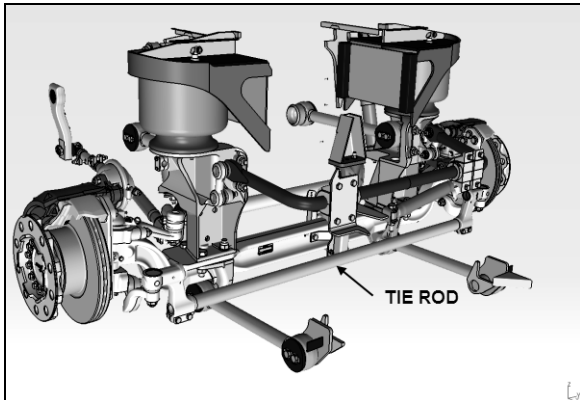


FIGURE 23: TIE ROD

**MAINTENANCE**

Tie rod ends (ball joint) are provided with grease fittings for pressure lubrication. These grease fittings should be serviced every 6,000 miles.

To prevent corrosion from forming around the ball pin, remove the old grease bead and assure sufficient grease is applied to purge the old grease and fill the joint and dust seal.

Good quality lithium-base mineral grease NLGI No. 2 like Shell Retinax LX are recommended.

12.5 DRAG LINK AND TIE ROD BALL JOINTS INSPECTION FOR CORROSION

Inspection of ball joints is important. Damaged sealing boots, salt and climatic conditions can cause loss of the corrosion protection coating applied at time of manufacturing.

**MAINTENANCE**

Inspect tie rod end ball joints for corrosion once a year.

1. Carefully clean the sealing boot or dirt seal contact area to ensure that no contaminants can get under the sealing boot or dirt seal during the following inspection procedure.
2. Use an appropriate inspection tool (e.g. spatula with cut out) to push up (sealing boot) or down (dirt seal) the seal (without damaging it) until ball pin surface is visible.

Degrease the ball pin surface and inspect carefully.

3. If there is corrosion of the ball pin or the sealing boot has deteriorated through ageing or is damaged, replace the ball joint.
4. If there is corrosion of the steering arm or tie rod arm area which is in contact with the sealing boot or dirt seal, clean and eliminate all surface irregularities.
5. If there is no corrosion or damage to the sealing boot or dirt seal, smear the steering arm and tie rod arm with Lithium grease and push seal back into its properly seated position.

When dismantling tie rod, ensure that no damage is caused to the sealing boots, dirt seals or ball joint housings.

12.6 DROP TYPE BALL JOINT (SOCKET)

Refer to "*Dana Instructions for Maintenance and overhaul of Straight and Drop Ball Sockets iss A*", found on Prevost Technical Publications web site for detailed instructions on disassembly, strip down and rebuilding of a drop type ball joint.

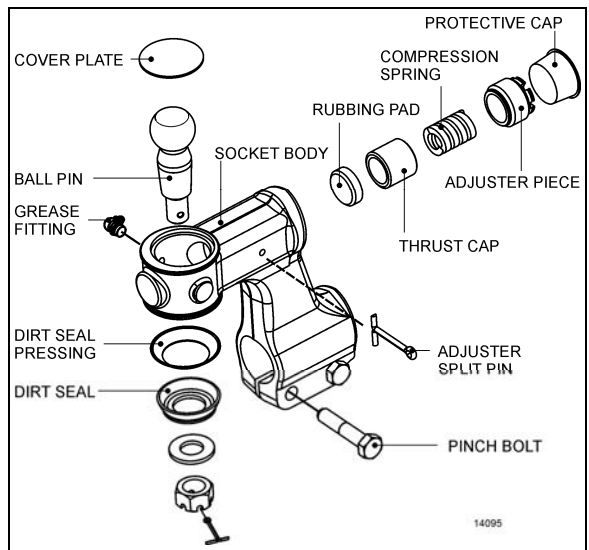


FIGURE 24: DROP TYPE BALL JOINT FOUND ON TIE ROD (2X)

12.6.1 Drop Type Ball Joint End Play Adjustment

If end play exceeds 0.047" (1.2 mm), readjustment is necessary.

1. Remove protective cap, using a suitable tool i.e.: a 1" x 1/8" x 9" long flat bar, tighten

adjuster piece fully home (SOLID) locating thrust cup onto ball pin.

2. Still with tool located on adjuster piece, back off carefully (LEAST AMOUNT) until adjuster piece cotter pin is allowed to pass through body, then remove tool.
3. Reinstall protective cap.

#### 12.6.2 End Play Adjustment Limitation

If ball pin does not rotate when re-adjusted in line with above instructions, this suggests that ball pin has local worn flats as shown in FIGURE 25 (a). In this instance ball pin, thrust cup and rubbing pad MUST be replaced, if not FAILURE could occur in service, i.e. ball pin not being able to move in assembly when turning from lock to lock as shown in FIGURE 25 (b).

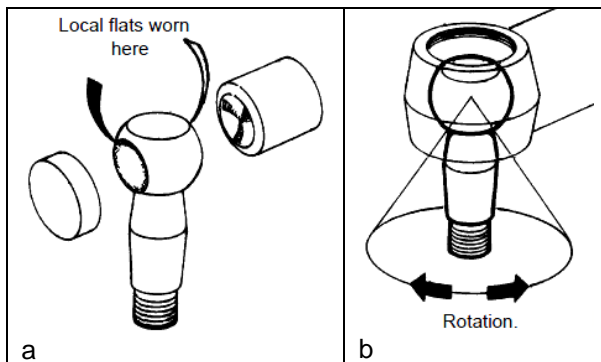


FIGURE 25: BALL PIN HAS LOCAL WORN FLATS

#### 12.6.3 Dismantling Drop Type Ball Joint

1. Remove dirt seal and dirt seal pressing from ball pin.
2. Slacken pinch bolt nut then unscrew and remove ball socket assembly from tie rod having first marked ball socket body and tie rod to enable tracking on re-assembly.
3. Remove adjuster split pin from ball socket body.
4. Remove cap then using a suitable tool i.e.: a piece or 1"x1/8"x 9" flat bar, unscrew and remove adjuster piece. Waggle ball pin to free thrust cap.
5. Remove compression spring and thrust cap from ball socket body.
6. Relieve peening on socket body top then using a hide faced mallet, tap ball pin out of body. This operation will also remove cover plate from body.

7. The rubbing pad can now be removed from body.

**Thoroughly clean all parts and check for wear, renewing where necessary.**

#### 12.6.4 Assembling Drop Type Ball Joint

1. Apply a bead of Loctite 638 sealant to mating corner of rubbing pad in socket body then knock rubbing pad into its recess in ball socket body.
2. Thoroughly grease rubbing pad and ball pin with Shell Retinax LX or equivalent.
3. Insert ball pin into body.
4. Insert thrust cap, compression spring and adjuster piece into body.
5. Tighten adjuster piece fully home (SOLID) locating thrust cup onto ball pin.
6. Still with tool located on adjuster piece, back off carefully (LEAST AMOUNT) until adjuster piece split pin is allowed to pass through body, and that ball pin shank can be moved by force of hand, then remove tool.

**NOTE: If ball pin does not rotate when re-adjusted in line with above instructions, this suggests that ball pin has local worn flats. In this instance ball pin, thrust cup and rubbing pad MUST be replaced, if not FAILURE could occur in service, i.e. ball pin not being able to move in assembly when turning from lock to lock (see FIGURE 25).**

7. Fit cover plate into top of ball socket body, re-peen using a cold chisel to secure.
8. Screw assembled ball socket onto tie rod. Lining up marks on both body and tie rod previously made, or retracking using manual instructions.
9. Fit pinch bolts and nuts then tighten nuts alternately and progressively to 65- 75 lbf-ft (88-102 Nm.) thus securing ball joint to tie rod.
10. Fit dirt seal (pressing) and dirt seal (rubber) onto ball pin.
11. Locate ball socket and tie rod assembly with lever, carefully align and fit ball pin into hole in tie rod arm.

**NOTE: Ball pin and ball pin tapers in bottom tie rod arms must be clean, dry and free from oil prior to assembly.**

12. Fit pin washer onto ball pin.
13. Screw pin nut onto ball pin then tighten to 175 lbf-ft (237 Nm) torque.
14. Using a 2lb hammer, tap tie rod arm to "shock" ball pin into taper hole.
15. Re-torque pin nut to 175 lbf-ft (23 7Nm).
16. Fit split pin, if slot/hole are not in line, adjust up to next slot.

**Pin nut torque 175 lbf-ft, max pin nut torque 200 lbf-ft.**

17. Re-charge ball socket with Shell "Retinax LX" or equivalent grease through grease fitting.

12.7 STRAIGHT BODY TYPE BALL JOINT

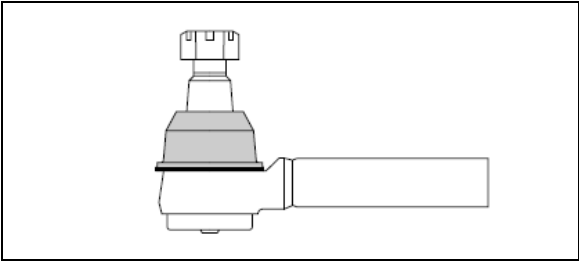


FIGURE 26: STRAIGHT BODY TYPE BALL JOINT

12.7.1 Visual Inspection

- Visually inspect for missing or damages grease fittings and replace if required.
- Damaged sealing boot or improper sealing requires seal replacement.
- Check ball joint connection for missing cotter pins.
- Check for looseness in the ball/socket assembly.

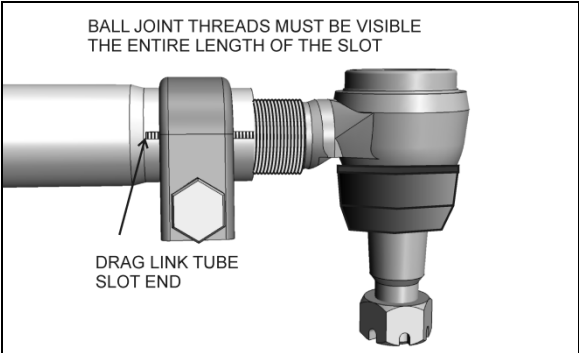


FIGURE 27: ADEQUATE CLAMPING CONDITION

For adequate clamping, the ball joint threads must be visible the entire length of the tube slot. If not, the drag link must be adjusted or replaced. It is either the wrong size, or improper adjustment was used to compensate for another problem (e.g. bent steering arm).

12.7.2 Straight Body Type Ball Joint End Play And Looseness

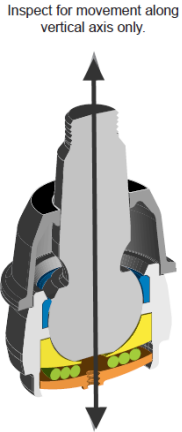
**What creates movement in sockets?**

In each straight body type ball joints, the compressive force of the spring creates resistive torque by applying a constant load on the bearing and stud.

As wear occurs on the components, the spring creates less resistive torque. With less torque, you no longer have the precise joint needed for optimum steering, but you do still have a safe linkage. **When all compression is lost, it's time to replace the linkage.** This wear can be caused by impact, lack of lubrication and normal wear.

1. With vehicle engine on, lightly rock the steering wheel while checking for looseness in any threaded joint. Observe any looseness in the two mating tapers or any movement of the ball pin nut. Any looseness requires further inspection. If either of the mating tapered parts shows distortion or wear, both parts must be replaced.

2. With the engine off and wheels straight ahead and no force is being exerted on the linkage by the steering gear, push and pull the ball joint in and out by hand (approximately 100 lbs. force) in the direction of the ball pin. If no movement is detected, the ball joint is safe. **Any movement detected by hand requires replacement of the ball joint.**





**CAUTION**

Do not use a wrench or other object to apply leverage when inspecting ball joint. Applying leverage can give distorted results and damage components.

**13. DRIVING TIPS**

In order to maximize power steering pump service life, do not attempt to turn the steering wheel when the vehicle is stationary, and especially when service brakes are applied (wheel locking will oppose the effect of steering geometry which tends to make the front wheels rotate in opposite directions).

Persisting in turning, or maintaining the steering wheel with an extra effort, could make the hydraulic system work at the relief pressure, and consequently, cause the hydraulic fluid to become overheated.



**CAUTION**

Never maintain the hydraulic system at the relief pressure for longer than 5/10 seconds to avoid damaging the power steering pump.

***NOTE***

*Unequal or low tire pressure, oversize tires, and vehicle overloading are some of the causes that may increase steering effort.*

## 14. TROUBLESHOOTING

CONDITION	CAUSE	CORRECTION
Tires wear out quickly or have uneven tire tread wear.	<ol style="list-style-type: none"> <li>1. Tires have incorrect air pressure.</li> <li>2. Tires out-of-balance.</li> <li>3. Incorrect tag axle alignment.</li> <li>4. Incorrect toe-in setting.</li> <li>5. Incorrect steering arm geometry.</li> </ol>	<ol style="list-style-type: none"> <li>1. Put specified air pressure in tires.</li> <li>2. Balance or replace tires.</li> <li>3. Align tag axle.</li> <li>4. Adjust toe-in specified setting.</li> <li>5. Service steering system as necessary.</li> </ol>
Vehicle is hard to steer.	<ol style="list-style-type: none"> <li>1. Low pressure in the power steering system.</li> <li>2. Steering gear not assembled correctly.</li> <li>3. Steering linkage needs lubrication.</li> <li>4. Kingpins binding.</li> <li>5. Incorrect steering arm geometry.</li> <li>6. Caster improperly adjusted.</li> <li>7. Tie rod ends hard to move.</li> <li>8. Worn thrust bearing.</li> </ol>	<ol style="list-style-type: none"> <li>1. Repair power steering system.</li> <li>2. Assemble steering gear correctly.</li> <li>3. Lubricate steering linkage.</li> <li>4. Replace kingpins.</li> <li>5. Service steering system as necessary.</li> <li>6. Adjust caster as necessary.</li> <li>7. Replace tie rod ends.</li> <li>8. Replace thrust bearing.</li> </ol>
Bent or broken steering arm, steering top lever or tie rod assembly.	<ol style="list-style-type: none"> <li>1. Too much pressure in the power steering system.</li> <li>2. Cut-off pressure of the power steering system improperly adjusted.</li> <li>3. Vehicle not powered on correctly.</li> <li>4. Power steering system not installed correctly.</li> </ol>	<ol style="list-style-type: none"> <li>1. Replace damaged part(s), adjust power steering system to specified pressure.</li> <li>2. Make sure vehicle is powered on correctly.</li> <li>3. Correctly install the power steering system.</li> <li>4. Correctly install the power steering system.</li> </ol>
Worn or broken steering ball pin.	<ol style="list-style-type: none"> <li>1. Drag link fasteners tightened past specified torque.</li> <li>2. Lack of lubrication or incorrect lubricant.</li> <li>3. Power steering stops improperly adjusted.</li> </ol>	<ol style="list-style-type: none"> <li>1. Replace damaged part(s), tighten drag link fasteners to specified torque.</li> <li>2. Lubricate linkage with specified lubricant.</li> <li>3. Adjust stops to specified dimension.</li> </ol>
Worn kingpins and knuckle bushings.	<ol style="list-style-type: none"> <li>1. Worn or missing seals and gaskets.</li> <li>2. Incorrect lubricant.</li> <li>3. Axle not lubricated at scheduled frequency.</li> <li>4. Incorrect lubrication procedures.</li> <li>5. Lubrication schedule does not match operating conditions.</li> </ol>	<ol style="list-style-type: none"> <li>1. Replace damaged part(s), replace seals and gaskets.</li> <li>2. Lubricate axle with specified lubricant.</li> <li>3. Lubricate axle at scheduled frequency.</li> <li>4. Use correct lubrication schedule to match operating conditions.</li> <li>5. Change lubrication schedule to match operating conditions.</li> </ol>
Vibration or shimmy of front axle during operation.	<ol style="list-style-type: none"> <li>1. Caster not adjusted properly.</li> <li>2. Wheels and/or tires out-of balance.</li> <li>3. Worn steering stabilizer cylinder.</li> </ol>	<ol style="list-style-type: none"> <li>1. Adjust caster.</li> <li>2. Balance or replace wheels and/or tires.</li> <li>3. Replace steering stabilizer cylinder.</li> </ol>

**15. TORQUE SPECIFICATIONS**

The torque specifications applicable to the front axle steering are grouped with information regarding the front suspension. Please refer to Section 16: SUSPENSION of this manual.

**16. SPECIFICATIONS**

**Power Steering Gear**

Make ..... ZF-SERVOCOM  
 Model ..... 8098  
 F.E.W. .... 16,600 lbs (7 545 kg)  
 Pressure rating .....2,175 psi (150 Bar)  
 Gear ratio (center) .....22.2 : 1  
 Gear ratio (extremities) .....26.2 : 1  
 Minimum pump flow for 1.5 hwt/sec ..... 4.22 gpm (16 lpm)

**Power Steering Reservoir**

Make ..... Nelson Muffler  
 Oil capacity ..... 4 US qts (3.7 liters)  
 Make ..... Nelson Muffler

**Steering Stabilizer Cylinder (Damper)**

Make .....Arvin  
 Extended length ..... 32.73±0.12"  
 Collapsed length..... 20.26±0.12"  
 Stroke..... 12.47±0.12"

**17. SECTION CHANGE LOG**

DESCRIPTION		DATE
1	Addition of section 12.1 STEERING SYSTEM PLAY INSPECTION	08/16/2016
2	Addition of section 12.6.2 END PLAY ADJUSTMENT LIMITATION	04/30/2018
3		
4		
5		
6		