Steering movement is transferred from the pitman arm that is splined to the sector shaft opposite each front wheel, through the center link and tie rods, to the steering knuckle at each front wheel. The idler arm supports the passenger side of the center link and keeps the steering linkage level with the road. This type of linkage is called a parallelogram type design.

**FREQUENTLY ASKED QUESTION**

*Why is a Grease Fitting Sometimes Called a Zerk Fitting?*

In 1922 the zerk fitting was developed by Oscar U. Zerk, an employee of the Alemite Corporation, a manufacturer of pressure lubrication equipment. A zerk or grease fitting is also known as an Alemite fitting.
The most common type of steering is the parallelogram. The cross-ear and Haltenberger linkage designs are used on some trucks and vans.

Typical steering damper used on a Hummer H2.

(a) A dual bearing design with a preload spring. The use of two bearing surfaces allows for one surface for rotation (for steering) and another surface for pivoting (to allow for suspension up-and-down movement). (b) The nylon wedge bearing type allows for extended lube intervals. Wear is automatically compensated for by the tapered design and spring-loaded bearing.
Figure 117-5  A rubber bonded socket is constructed of a rubber casing surrounding the ball stud which is then inserted into the socket of the tie rod end. The hole in the socket allows air to escape as the ball stud is installed and there is not a place for a grease fitting. (b) The socket is crimped over the ball so that part of the socket lip retains the stud.

Figure 117-6  Rack-and-pinion steering systems use a ball-and-socket-type inner tie rod end.

Figure 117-7  A variety of methods are used to secure the inner tie rod end socket assembly to the end of the rack.
Figure 117-8
Exploded view of a center-take-off-style rack-and-pinion steering gear assembly.

Figure 117-9
In a rear-steer vehicle, the steering linkage is behind the centerline of the front wheels, whereas the linkage is in front on a front-steer vehicle.

Figure 117-10
Opposite-phase four-wheel steering is usually used only at low vehicle speed to help in parking maneuvers. Same-phase steering helps at higher speeds and may not be noticeable by the average driver.
Figure 117-11 Being equipped with four-wheel steer allows a truck to make shorter turns than would otherwise be possible.

Figure 117-12 The Quadrasteer system includes many components that all work together.

Figure 117-13 Rear steer select switch schematic.
Figure 117-14 The dash-mounted select switch showing the three positions for the four-wheel steer system.

Figure 117-15 The output of the handwheel sensor digital signal.

Figure 117-16 Handwheel analog signal.
Figure 117-17  Handwheel position sensor analog signal to control module.

Figure 117-18  Handwheel position sensor digital signal to control module.

Figure 117-19  A Quadrasteer system showing all of the components. The motor used to power the rear steering rack can draw close to 60 amperes during a hard turn and can be monitored using a Tech 2.
Figure 117-20  Greasing a tie rod end. Some joints do not have a hole for excessive grease to escape, and excessive grease can destroy the seal.

Figure 117-21  Part of steering linkage lubrication is applying grease to the steering stops. If these stops are not lubricated, a grinding sound may be heard when the vehicle hits a bump when the wheels are turned all the way one direction or the other. This often occurs when driving into or out of a driveway that has a curb.

FREQUENTLY ASKED QUESTION: What Is "Goofy Mode"?

Trucks that are equipped with the Quadrasteer system have a three-position switch on the dash:
1. 2WS
2. 4WS
3. Tow

The Quadrasteer module then determines the right amount of rear steer and rear-axle action based on vehicle speed and steering wheel angle. If trailer towing mode is selected and the truck is not towing a trailer, the Quadrasteer module will slightly delay the rear steering action when changing lanes and other maneuvers. As a result, when the steering wheel is turned, the front wheels will of course turn in direct proportion to the input from the steering wheel, however, the rear wheels will be delayed in their action to allow the trailer to track properly. If, however, a trailer is being towed, this delay feels "goofy" and could result in customer concerns about the proper operation of the Quadrasteer system. Be sure that the control switch is placed in the off or normal modes unless a trailer is in fact being towed.
Figure 117-22 Checking for freeplay in the steering.

Figure 117-23 All joints should be felt during a dry park test. Even inner tie rod ends (ball socket assemblies) can be felt through the rubber bellows on many rack-and-pinion steering units.

FREQUENTLY ASKED QUESTION

Why Do Only a Few Vehicles Use Grease Fittings? Many years ago, all vehicles were equipped with grease fittings, while today very few vehicles are so equipped. The reasons for this, as given by engineers, include the following:

- It has been determined that the use of the wrong type of grease can cause more harm than good.
- If a grease fitting is used to allow grease to enter the suspension or steering joint, then water can also get inside the joint.
- Grease fittings are often ignored or the greasing of the joint is not performed by the service technician.
- Low-friction joints do not require routine service like the older metal-to-metal joints required.
The steering and suspension control arms must remain parallel to prevent the up-and-down motion of the suspension from causing the front wheels to turn inward or outward.

**TECH TIP: Jounce/Rebound Test**

All steering linkage should be level and "work" at the same angle as the suspension arms, as shown in FIGURE 117–24. A simple test to check these items is performed as follows:

1. Park on a hard, level surface with the wheels straight ahead and the steering wheel in the unlocked position.
2. Bounce (jounce) the vehicle up and down at the front bumper while watching the steering wheel. The steering wheel should not move during this test. If the steering wheel moves while the vehicle is being bounced, look for a possible bent steering linkage, suspension arm, or steering rack. SEE FIGURE 117–25.

The center link should be parallel to the ground.
TECH TIP: Wear and Nonwear Center Links

Some center links are equipped with ball-and-socket joints, which can wear. Other center links are manufactured with holes for ball joint studs only. See Figure 117-27. Generally, the center links that do not use joints are unlikely to need replacement unless a joint becomes loose and wears the tapered stud hole. Knowing which style of center link is used will help determine the most likely location to check for excessive steering linkage play.

Figure 117-26 Typical parallelogram steering linkage. The center link can also be named the relay rod, drag link, or connecting link.

Figure 117-27 Some center links have ball joints while others have tapered socket holes to accept ball joints on the pitman arm, idler arm, and inner tie rod ends.
Figure 117-28: To check an idler arm, most vehicle manufacturers specify that 25 pounds of force be applied by hand up and down to the idler arm. The idler arm should be replaced if the total movement (up and down) exceeds 1/4 in. (6 mm).

Figure 117-29: Steering system component(s) should be replaced if any noticeable looseness is detected when moved by hand.

Figure 117-30: All joints should be checked by hand for any lateral or vertical play.
REAL WORLD FIX

Bump Steer

Bump steer, or orbital steer, is used to describe what happens when the steering linkage is not level. The front tires turn inward or outward as the wheels and suspension move up and down. (A common condition improves as the vehicle slows.) The sudden direction is changed without moving the steering wheel whenever the front tires and/or lower control arms are not parallel or level. This affliction is known as “bump steer” and will never forget the vertigo feeling of not having control of the vehicle. After noting the deflection and applying the brake, everything was OK and about 10 mph, then the vehicle started sagging forward and making a loud noise. The condition was called “bump steer” as it is not considered as a normal occurrence. Even while holding the steering wheel perfectly still and straight ahead, the vehicle would go left, then right. Did a tie rod break? It certainly felt exactly like that happened. I slowed down to below 30 mph and returned to the shop.

REAL WORLD FIX (cont.)

After several hours of checking everything, including the alignment, I discovered that the idler arm was not level with the pitman arm. This caused a pull on the steering linkage whenever the suspension moved up and down. As the suspension compressed, the steering linkage pulled inward on the tie rod on that side of the vehicle. As the wheel moved inward (toed in), it created a pull as if the wheel were turned by the driver. This is why all steering linkages must be parallel with the lower control. The reason for the bump steer was that the idler arm was bolted to the frame, which was slotted vertically. I did not pay any attention to the location of the original idler arm and simply bolted the replacement to the frame. After raising the idler arm back up where it belonged (about 1/2 in. [13 mm]), the steering problem was corrected.

Other common causes of bump steer are worn or deteriorated rack mounting bushings, a noncentered steering linkage, or a bent steering linkage. If the steering components are bent, any amount of repair work may not correct the problem. 

TECH TIP: The Killer Bs

The “three Bs” that can cause steering and suspension problems are bent, broken, or binding components. Always inspect each part under the vehicle for each of the killer Bs.
If a rack-and-pinion or any other steering linkage system is not level, the front tires will be moved inward and/or outward whenever the wheels of the vehicle move up or down.

The preferred method for separating the tie rod end from the steering knuckle is to use a puller such as the one shown. A pickle-fork-type tool should only be used if the tie rod end is going to be replaced. A pickle-fork-type tool can damage or tear the rubber grease boot.

Two hammers being used to disconnect a tie rod end from the steering knuckle. One hammer is used as a backing for the second hammer. Notice that the attaching nut has been loosened, but not removed. This prevents the tie rod end from falling when the tapered connection is knocked loose.
Figure 117-34  A pitman arm puller is used to remove the pitman arm from the pitman shaft.

Figure 117-35  Pitman arm and pitman shaft indexing splines.

Figure 117-36  Align the hole in the tie rod end with the slot in the retaining nut. If the holes do not line up, always tighten the nut farther (never loosen) until the hole lines up.
Replacement tie rods should be of the same overall length as the originals. Measure from the edge of the tie rod sleeve to the center of the grease fitting. When the new tie rod is threaded to this dimension, the toe setting will be close to the original.

All tie rod ends should be installed so that the stud is in the center of its operating range, as shown.

(a) Tie rod adjusting sleeve. (b) Be sure to position the clamp correctly on the sleeve.
Figure 117-40 An articulation test uses a spring scale to measure the amount of force needed to move the tie rod in the ball socket assembly. Most manufacturers specify a minimum of 1 lb (4.4 N) of force and a maximum of 6 lb (26 N).

Figure 117-41 Removing a staked inner tie rod assembly requires two wrenches—one to hold the rack and the other to unscrew the joint from the end of the steering rack.

Figure 117-42 When the inner tie rod end is reassembled, both sides of the housing must be staked down onto the flat shoulder of the rack.
After replacing an inner tie rod end, the socket assembly should be secured with a rivet or set screw, depending on the style of the replacement part.

DRY PARK TEST 1
Drive the vehicle onto a drive-on-type hoist and have an assistant gently rotate the steering wheel back and forth about 2 inches (50 mm).

DRY PARK TEST 2
Perform a visual inspection of the steering and suspension system, looking for damage from road debris or other factors.
DRY PARK TEST 3
As the assistant wiggles the steering wheel, grasp the joint at the outer tie rod end and on the other side to check for any movement.

DRY PARK TEST 4
Next, check for any freeplay at the pitman arm.

DRY PARK TEST 5
Check the joint between the left inner tie rod end and the center link for play.
DRY PARK TEST 6: Move to the passenger side and check for any looseness at the joint between the center link and the right side inner tie rod end.

DRY PARK TEST 7: Check for looseness at the idler arm connector to the center link and the idler arm at the frame bracket.

DRY PARK TEST 8: Check for looseness at the passenger-side outer tie rod end. After the inspection, record the results on the work order.