INTRODUCTION - Front Suspensions

Most vehicles today use a separate control-arm-type of suspension for each front wheel, which allows for movement of one front wheel without affecting the other front wheel. This type of front suspension is called independent suspension. Regardless of the design type of suspension, all suspensions use springs in one form or another.

The short-/long-arm suspension uses a short upper control arm and a longer lower control arm and is usually referred to as the SLA-type suspension. Figure 1.

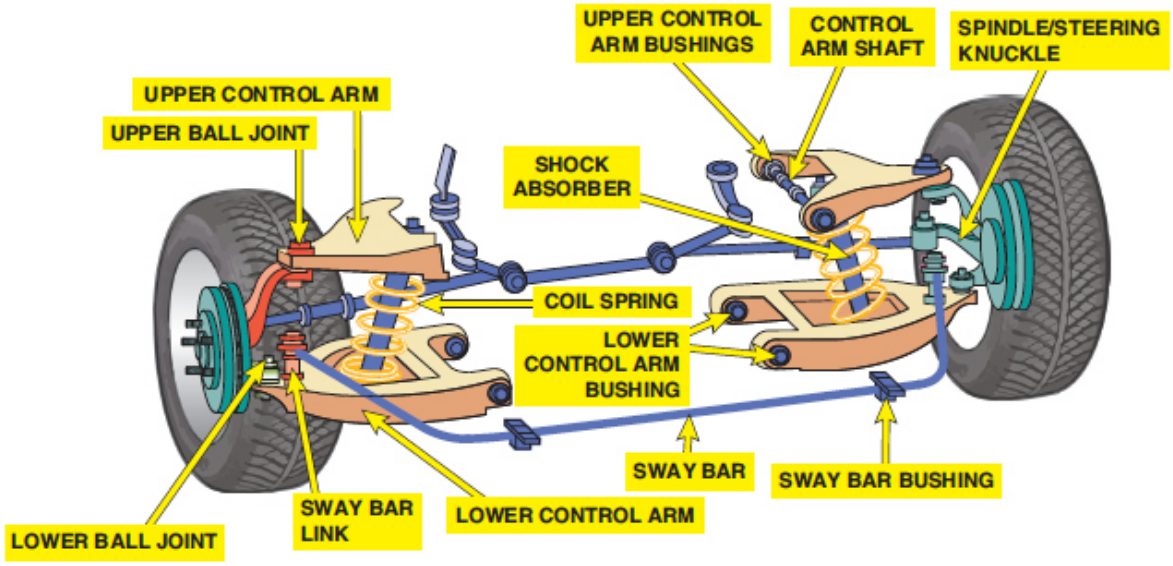

Figure 1. SLA-type front suspension.

Some short-/long-arm (SLA) suspensions use longitudinal torsion bars for springs, especially in trucks. Figure 2.

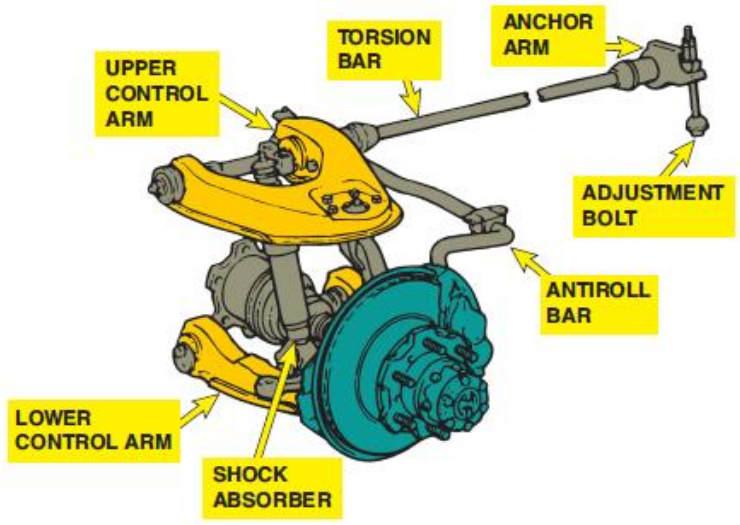

Figure 2. SLA front suspension using a torsion bar spring. This allows space for the front drive axles on four-wheel-drive vehicles.

A MacPherson strut front suspension includes the suspension spring that transfers the weight of the body to the wheel. The strut assembly typically incorporates an upper and a lower spring seat, a shock absorber mount and dust cap, a dust cover for the piston rod, and a bump stop. The upper mount secures the upper spring seat to the strut tower. A rubber bushing at the top of the strut absorbs vibrations. In most applications, a bearing on the top of a front-wheel strut allows it to rotate on the vertical steering axis. Figure 3.

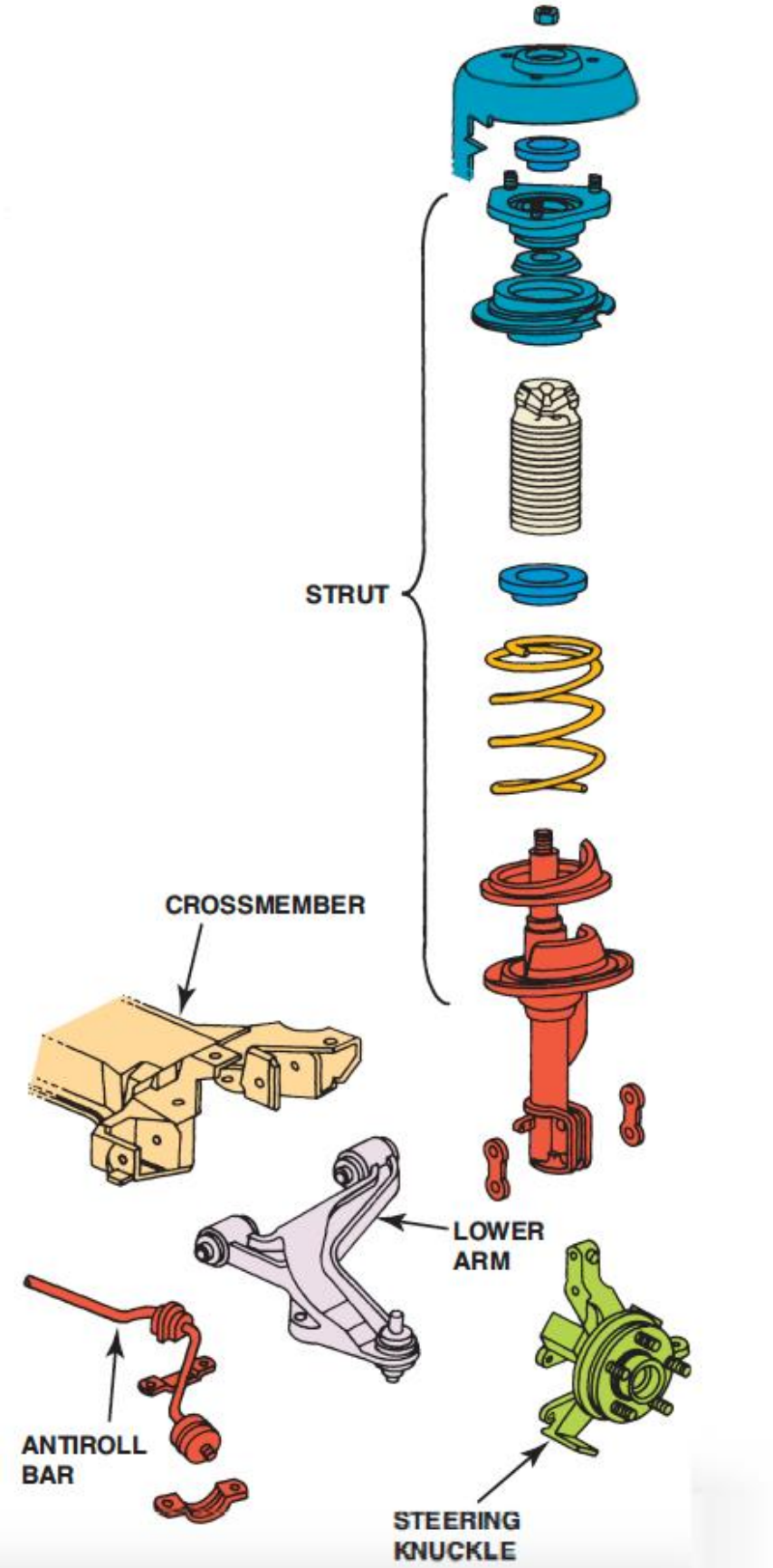
STRUT
CROSSMEMBER
LOWER ARM
ANTIROLL BAR
STEERING KNUCKLE

Figure 3. MacPherson strut front suspension components.

ASE TEST TOPICS

1. Diagnose front suspension system noises, handling, ride height and ride quality concerns; determine needed action.

The purpose of any diagnosis is to eliminate known good components. If possible, perform a road test of the vehicle with the owner of the vehicle.

- Drive beside parked vehicles. Any noise generated by the vehicle suspension or tires is reflected off solid objects.
- Drive into driveways. Suspension problems often occur when turning at the same time the suspension hits a bump.
- Drive over a bumpy road. Worn or defective suspension (and steering) components can cause the vehicle to bounce or dart side to side while traveling over bumps and dips in the road.

Some symptoms and possible causes are shown in figure 4.

SUSPENSION PROBLEM SYMPTOMS CHART

Item or System to Check	CONCERN/PROBLEM: Noise	Instability/ Wander	Pull to One Side	Excessive Steering Play	Hard Steering	Shimmy
Tires/Wheels	Road/tire noise	Low/uneven air pressure	Low/uneven air pressure, mismatched tire sizes	Low/uneven air pressure	Low/uneven air pressure	Wheel out of balance/uneven tire wear/ overworn tires
Shock Absorbers (Struts)	Loose/worn mounts/ bushings	Loose/worn mounts/bushings, worn/ damaged struts/shock absorbers	Loose/worn mounts/ bushings		Loose/worn mounts/bushings on strut assemblies	Worn/damaged struts/shock absorbers
Strut Rods (If Equipped)	Loose/worn mounts/ bushings	Loose/worn mounts/ bushings	Loose/worn mounts/ bushings			Loose/worn mounts/ bushings
Springs	Brakes damaged	Brakes damaged	Brakes damaged, especially rear			
Control Arms	Steering knuckle contacting control arm stop, worn/damaged mounts/bushings	Worn/damaged mounts/ bushings	Worn/damaged mounts/ bushings		Worn/damaged mounts/ bushings	Worn/damaged mounts/ bushings
Steering System	Component wear/ damage	Component wear/ damage	Component wear/ damage	Component wear/damage	Component wear/damage	Component wear/damage
Wheel Alignment		Front and rear, especially caster	Front, camber and caster	Front alignment	Front, especially caster	Front, especially caster
Wheel Bearings	Front-wheel bearings	Loose/worn (front and rear)	Loose/worn (front and rear)	Loose/worn (front and rear)		Loose/worn (front and rear)
Brake System			Stuck caliper/slide			
Other					Ball joint lubrication	Loose/worn friction ball joints

Figure 4. Front suspension diagnosis.

2. Inspect and replace upper and lower control arms, bushings, hardware, and shafts.

Defective control arm bushings are a common source of vehicle handling and suspension noise problems. To remove an old bushing from a control arm, the control arm must first be separated from the suspension and/or frame of the vehicle.

A puller tool is most often recommended. The puller can be used to remove the old bushing and install the replacement bushing without harming the control arm or the new bushing. Figure 5.

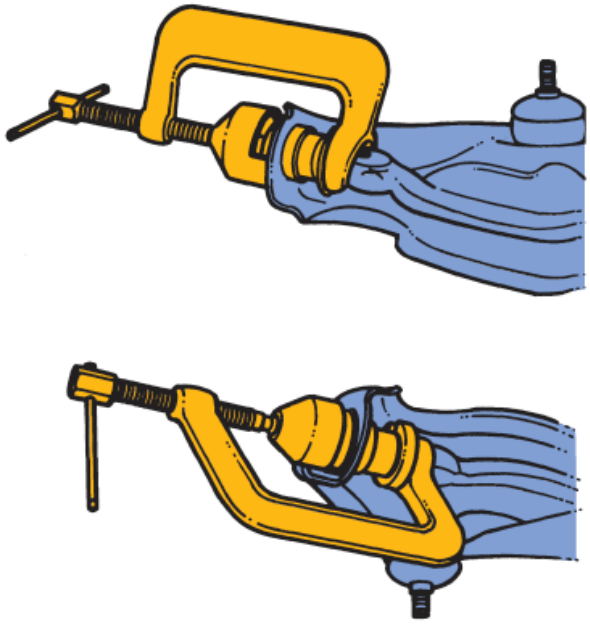

Figure 5. Removing and installing the bushing using a special tool.

All bushings should be tightened with the vehicle on the ground and the wheels in a straight-ahead position. An alignment should always be performed after making any suspension-related repairs.

3. Inspect and replace rebound and jounce bumpers/bump stops.

If a bump is large enough, the suspension is compressed to its mechanical limit. Instead of allowing the metal components of the suspension to hit the frame or body of the vehicle, a rubber or foam bumper is used to absorb and isolate the suspension from the frame or body. These bumpers are called bump stops, suspension bumpers, strike-out bumpers, or jounce bumpers. Figure 6.

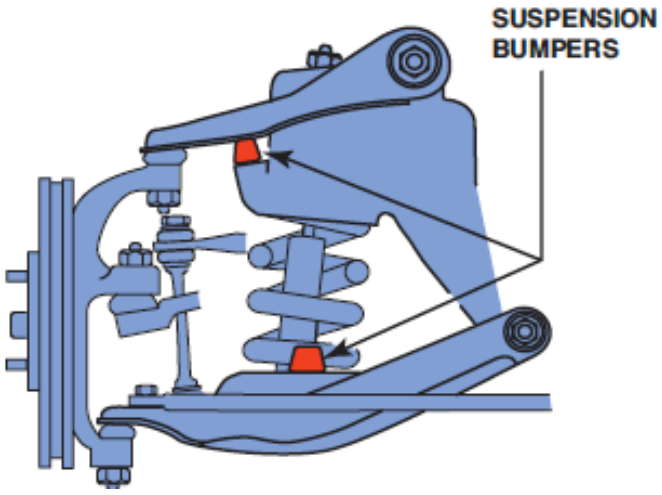

Figure 6. Bump stops are used to prevent the control arms from contacting the frame.

Damaged suspension-limiting bump stops can be caused by the following, figure 7.

- Sagging springs that result in lower-than-normal ride (trim) height
- Worn or defective shock absorbers

Figure 7. Bump stop damaged by a worn out shock absorber.

4. Inspect, adjust, and replace track bar, strut rods/radius arms, and related mounts/bushings.

Strut rods prevent lower control arm movement back and forth during braking. If the bushings are worn out or missing there will be noise heard when applying and releasing the brakes, usually a loud clunk sound.

The bushings are replaceable by removing a nut on the frame end of the strut rod. If a strut rod has a nut on both sides of the bushings, then the strut rod is also used to adjust caster. Figure 8.

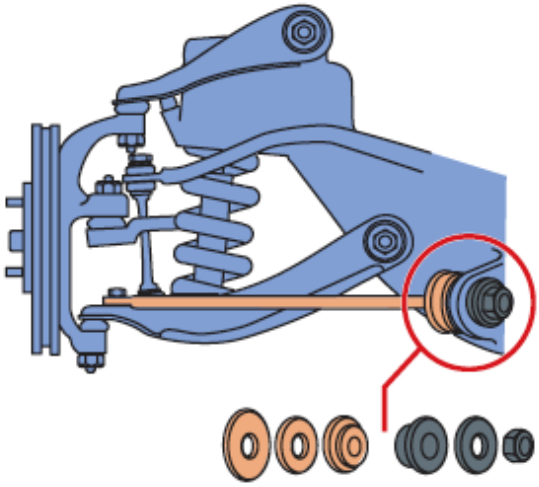

Figure 8. Strut rod and bushings.

5. Inspect and replace upper and lower ball joints.

Ball joints allow the front wheels to move up and down, as well as side to side (for steering). If the coil spring is attached to the lower control arm, then the lower ball joint is the load-carrying ball joint and the upper joint is the follower ball joint. Figure 9.

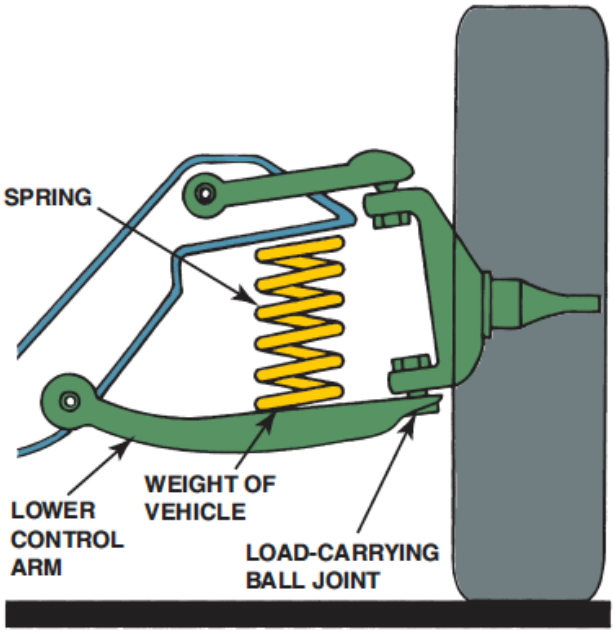

Figure 9. The lower ball joint is load carrying in this type of suspension because the weight of the vehicle is applied through the spring, lower control arm, and ball joint to the wheel.

Defective or worn ball joints can cause looseness in the suspension and the following common driver complaints:

- Loud popping or squeaking whenever driving over curbs, such as into a driveway

- Shimmy-type vibration felt in the steering wheel
- Vehicle wander or a tendency not to track straight
- Excessive freeplay in the steering wheel

Many load-carrying ball joints have wear indicators with a raised area around the grease fitting, called indicator ball joints. Check wear-indicator-type ball joints with the wheels of the vehicle on the ground. If the raised area around the grease fitting is flush or recessed with the surrounding area, the ball joint is worn more than 0.050 inch and must be replaced. Figure 10.

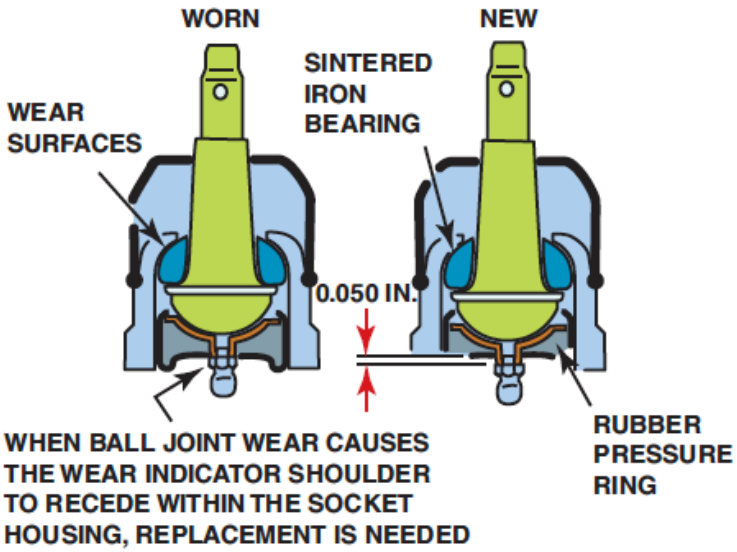

Figure 10. Worn ball joint (left) compared to a new ball joint (right).

A jack should be placed under the lower control arm as shown. A dial indicator is used to measure the amount of freeplay in the ball joints. Most manufacturers specify a maximum vertical play of approximately 0.050 inch (1.3 mm), or the thickness of a nickel. Figure 11.

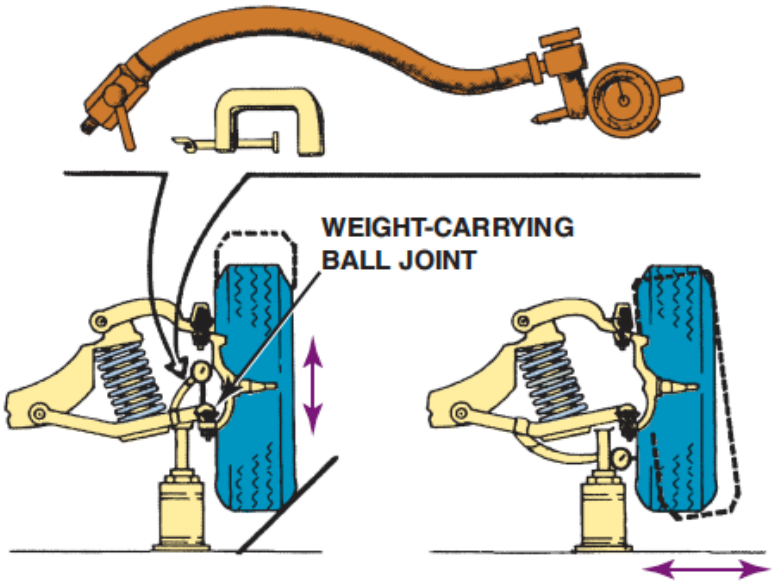

Figure 11. Checking a ball joint using a dial indicator.

When replacing ball joints, the lower control arm is supported with a jack and the wheel, brakes, and steering knuckle must be removed. To remove rivets from ball joints, center punch and drill out the center of the rivet then use a drill or an air-powered chisel to remove the rivet heads. Press-in-type ball joints are removed and installed using a special C-clamp-type tool. Figures 12 and 13.

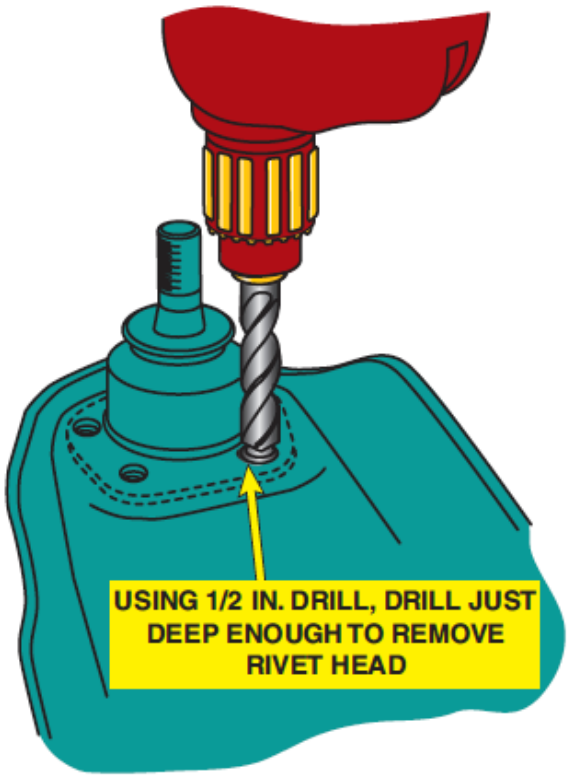

Figure 12. Removing a riveted-type ball joint.

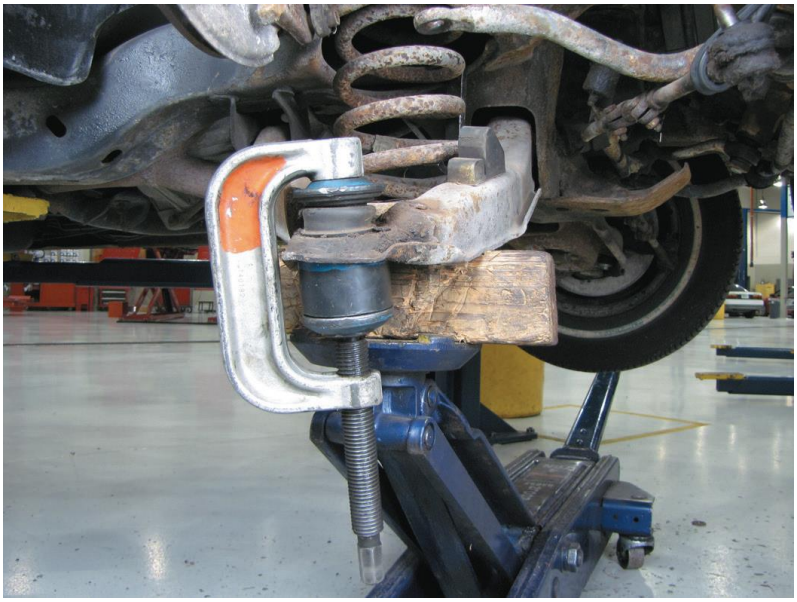

Figure 13. Removing a press-in-type ball joint.

6. Inspect solid front axle assembly for damage and misalignment.

A solid-axle front suspension is very strong and is still being used in the manufacture of medium and heavy trucks. At the end of many solid I-beam or tube axles are kingpins that allow the front wheels to rotate for steering. Figures 14. And 15.

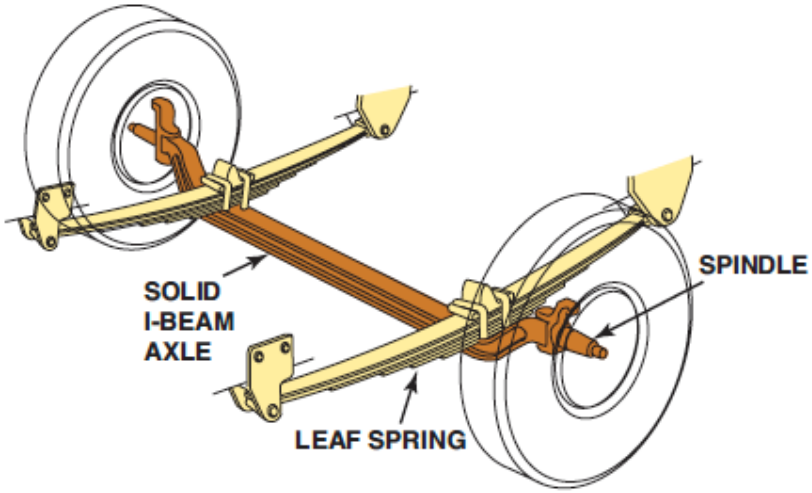

Figure 14. A solid axle is checked for misalignment with the vehicle on an alignment rack.

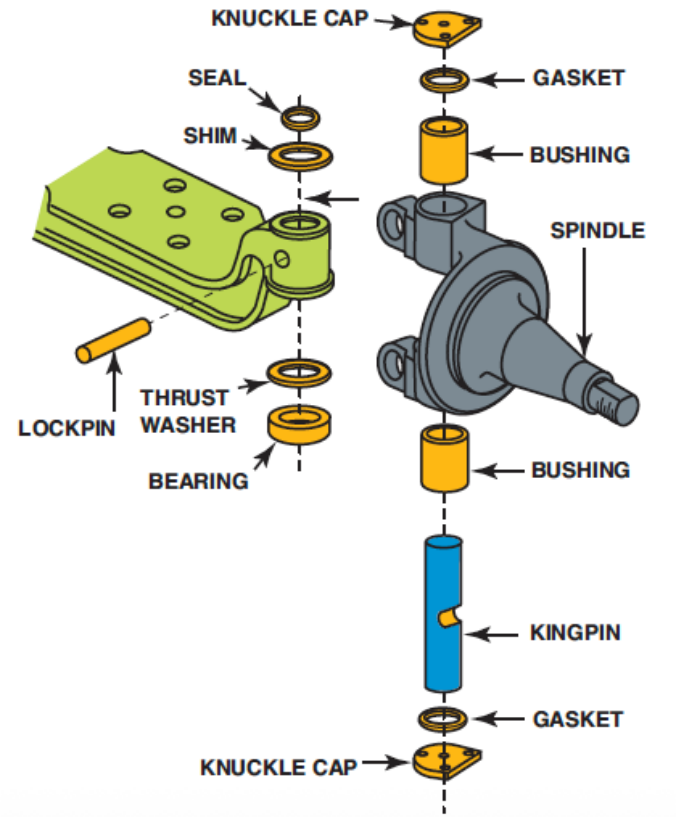

Figure 15. Worn thrust washers or kingpin bushings allow excess play at the front wheels.

7. Inspect and replace front steering knuckle/spindle assemblies and steering arms.

The steering knuckle/steering arm can become bent if the vehicle is in an accident or hits a curb sideways. Often this type of damage is not apparent until vehicle handling or excessive tire wear is noticed. Unless a thorough inspection is performed during a wheel alignment, a bent steering knuckle is often overlooked.

To replace the steering knuckle, both ball joints must be disconnected from the knuckle and the brake components removed. Be sure to support the control arm and spring properly during the procedure. Figure 16.

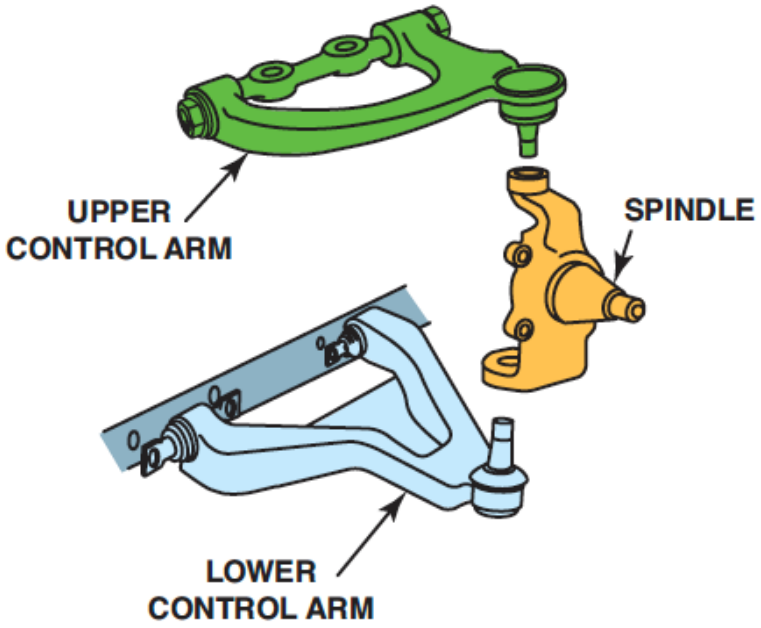

Figure 16. Typical steering knuckle (spindle).

8. Inspect and replace front suspension system coil springs and spring insulators (silencers).

Coil springs should be replaced in pairs if the vehicle ride height is lower than specifications. If a vehicle is overloaded, the springs of the vehicle can take a set and not recover to the proper ride height. Figure 17.

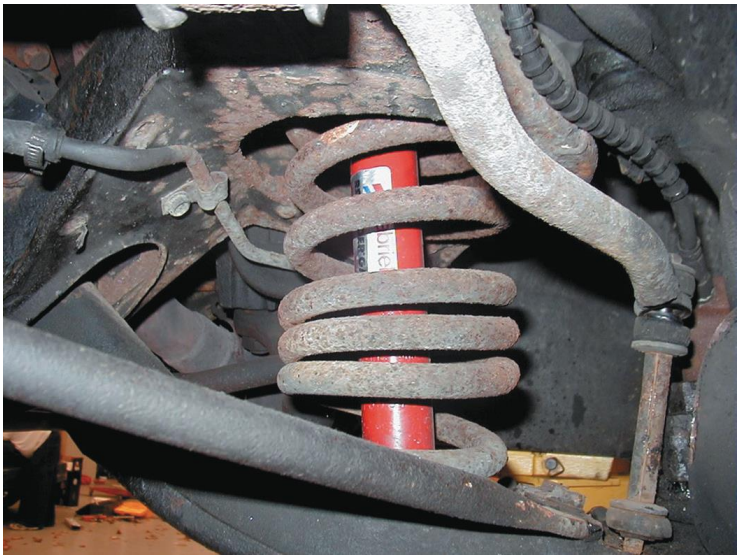

Figure 17. A collapsed front coil spring.

After removing the shock absorber, use a coil spring compressor and install it through the center of the coil spring. After the coil spring is retained, the control arm can be separated from the steering knuckle, and the coil spring can be removed. Replacement springs should be compressed and installed using the reverse procedure. Figure 18.

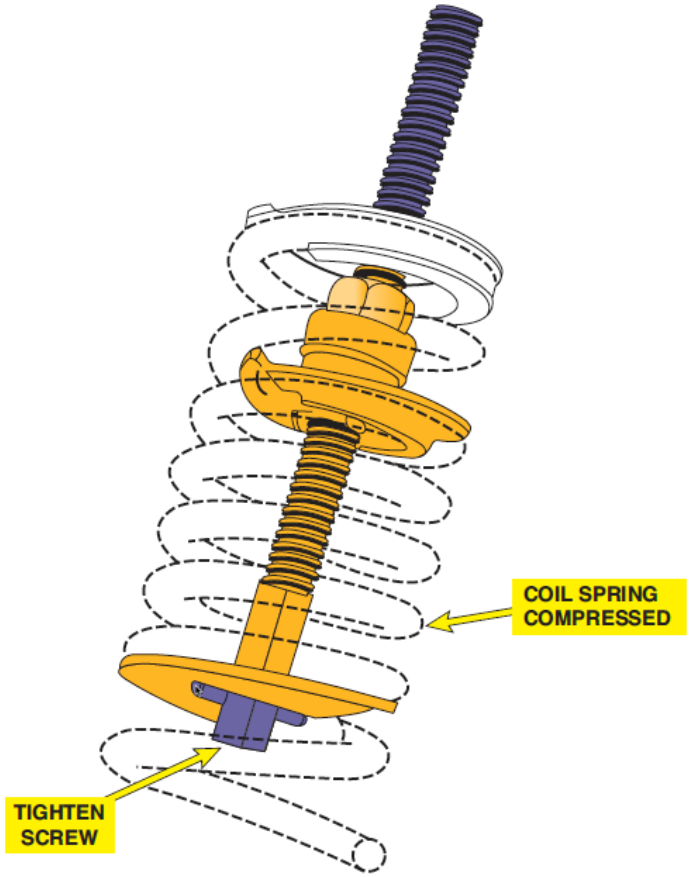

Figure 18. Coil spring compressor.

Make sure that the spring is positioned correctly in the control arm and that the spring insulators are installed correctly. Figure 19.

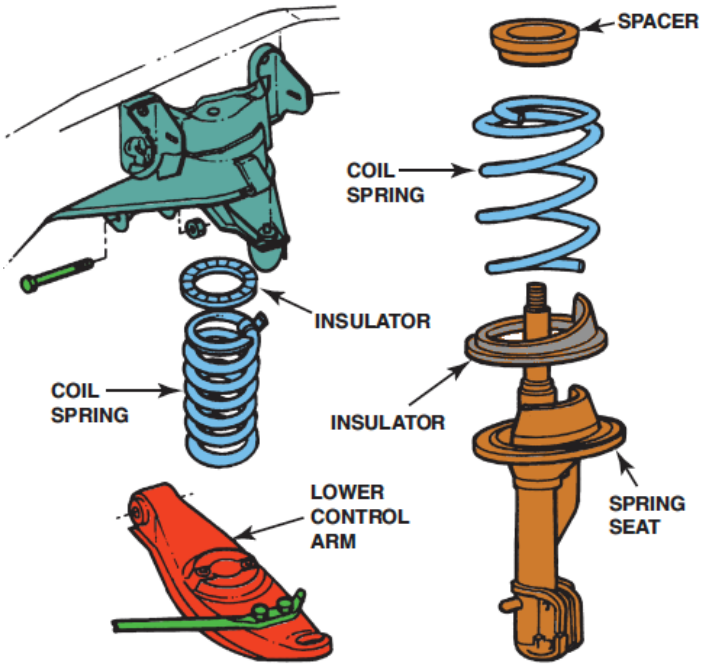

Figure 19. Spring and insulators.

9. Inspect and replace front strut(s), strut bearing(s) and strut mount(s).

Most strut faults will require the replacement of the entire strut. Front strut faults can include:

- Worn or seized upper bearing causing binding when steering.
- Loss of damping ability resulting in a excessive body movement after a bump.
- Leaks from the shaft seal. Figure 20.

Figure 20. A leaking strut shaft seal.

On most vehicles equipped with MacPherson strut suspensions, strut replacement involves the following steps:

1. Remove the upper strut mounting bolts except for one to hold the strut until ready to remove the strut assembly.

2. Remove the brake caliper or brake hose from the strut housing.

3. After removing all lower attaching bolts, remove the final upper strut bolt and remove the strut assembly from the vehicle. Figure 21.

4. Place the strut assembly into a strut spring compressor. Compress the coil spring enough to relieve the tension on the strut rod nut then remove the strut rod nut. Figure 22.

5. After removing the strut rod nut, remove the upper strut bearing assembly and the spring. Figure 23.

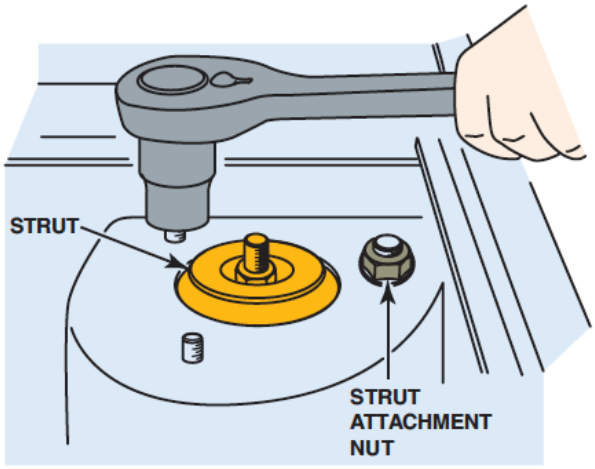

Figure 21. Removing the strut upper mounting nuts.

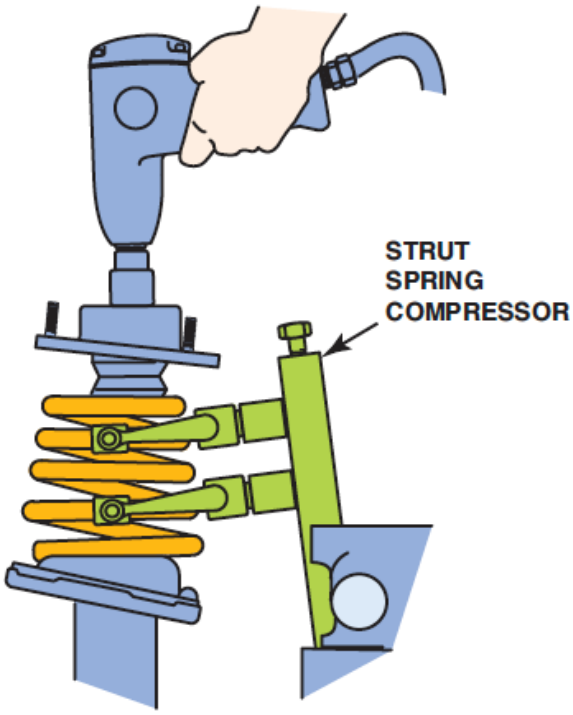

Figure 22. After compressing the spring remove the center nut.

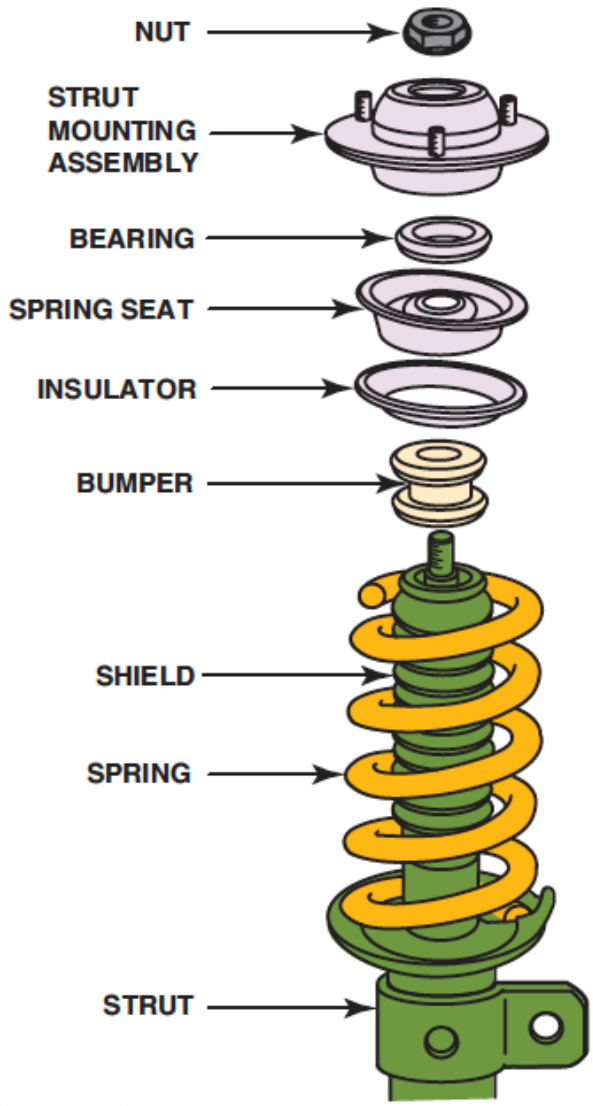

Figure 23. MacPherson strut components.

Reverse this procedure to reinstall the strut in the vehicle. The bearing assembly should be carefully inspected and replaced if necessary. Some automotive experts recommend replacing the bearing assembly whenever the strut is replaced.

10. Inspect, replace, and adjust front suspension system torsion bars and mounts.

Most torsion bar suspensions are designed with an adjustable bolt to permit the tension on the torsion bar to be increased or decreased to change the ride height. Unequal side-to-side ride height can be corrected by adjusting (turning) the torsion bar adjusting bolt. Figure 24.

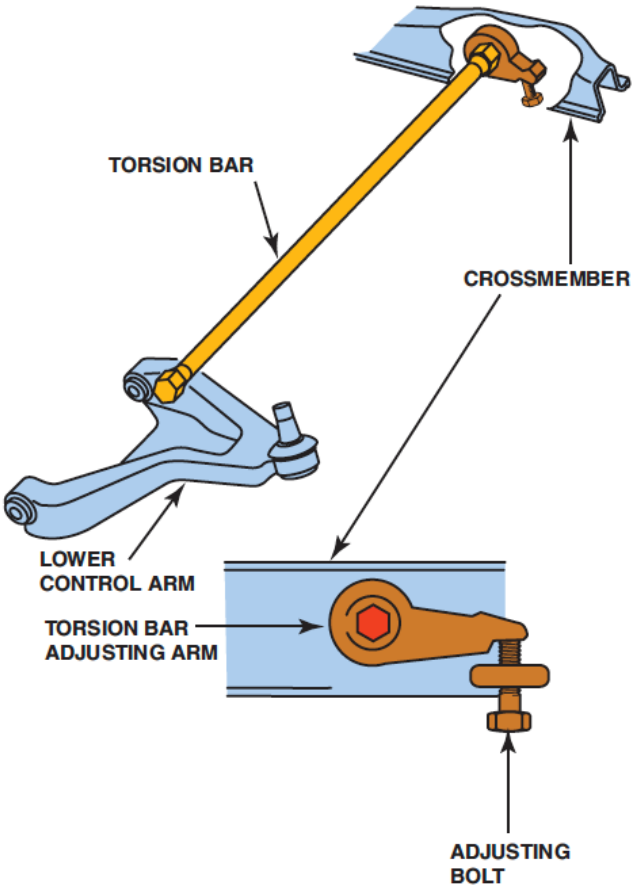

Figure 24. Torsion bar and adjusting bolt.

Torsion bar removal requires that the load on the bar be removed. On most vehicles an unloading tool is required.

11. Inspect and replace front stabilizer bar (sway bar), bushings, brackets, and links.

If the stabilizer bar mounting bushings (also called isolator bushings) on the body or frame are worn or defective, a loud squeaking or knocking sound is usually heard. The most common symptom of defective stabilizer bar links or bushings is noise while turning, especially over curbs. Figure 25.

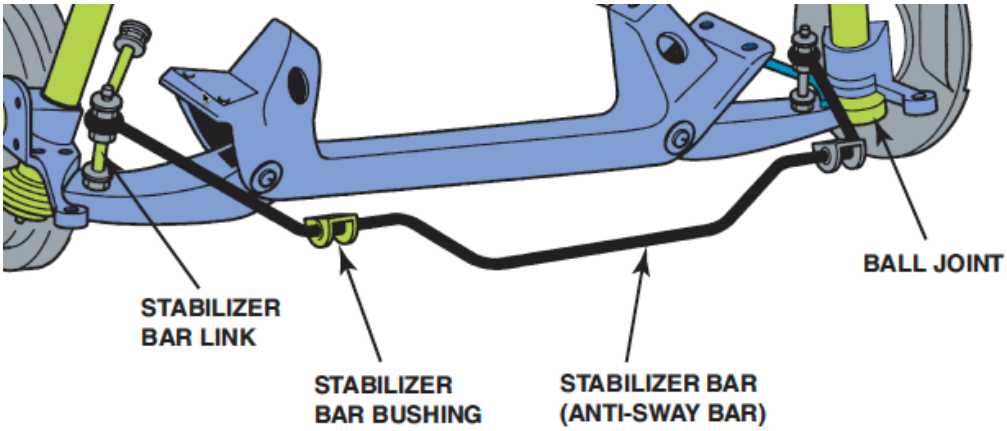

Figure 25. Stabilizer bar, bushings, and links.

Stabilizer bar bushing replacement involves the removal (unbolting) of the bushing retainers that surround the bushing and attach to the vehicle body or frame. The bushings are usually split so that they can be easily removed and replaced on the stabilizer bar.

Stabilizer bar links should be replaced as a pair. Stabilizer links are replaced by unbolting the old parts and installing replacement parts. Figure 26.

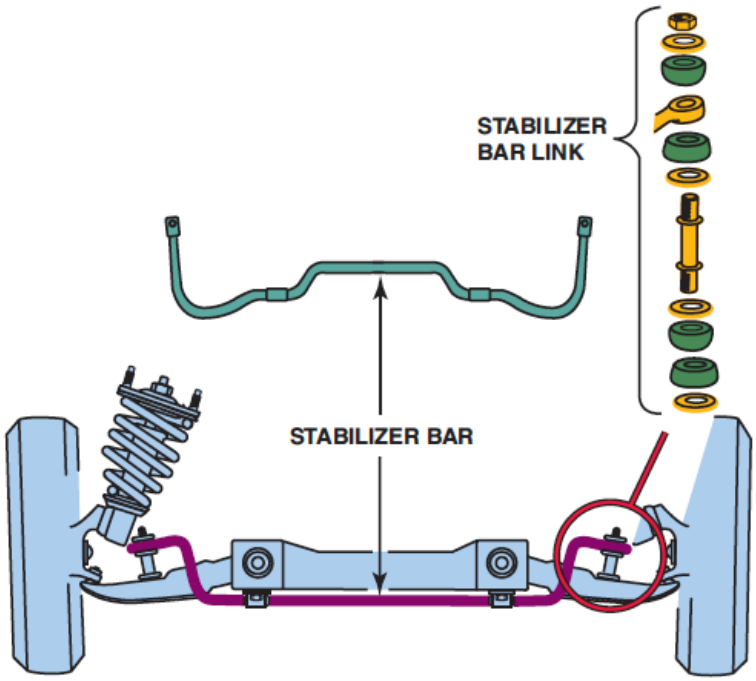

Figure 26. Stabilizer links are usually purchased as a kit that contains all needed parts.

12. Inspect and replace shock absorbers, mounts, and bushings.

Replacement of shock absorbers may be required when any or all of the following symptoms appear:

- Ride harshness.
- Frequent bottoming out on rough roads.
- Extended vehicle movement after driving on dips or a rise in the road.
- Cuppy-type tire wear.
- Leaking hydraulic oil.

The front suspension of most vehicles allows the removal of the shocks without the need to support the downward travel of the lower control arm. Figure 27.

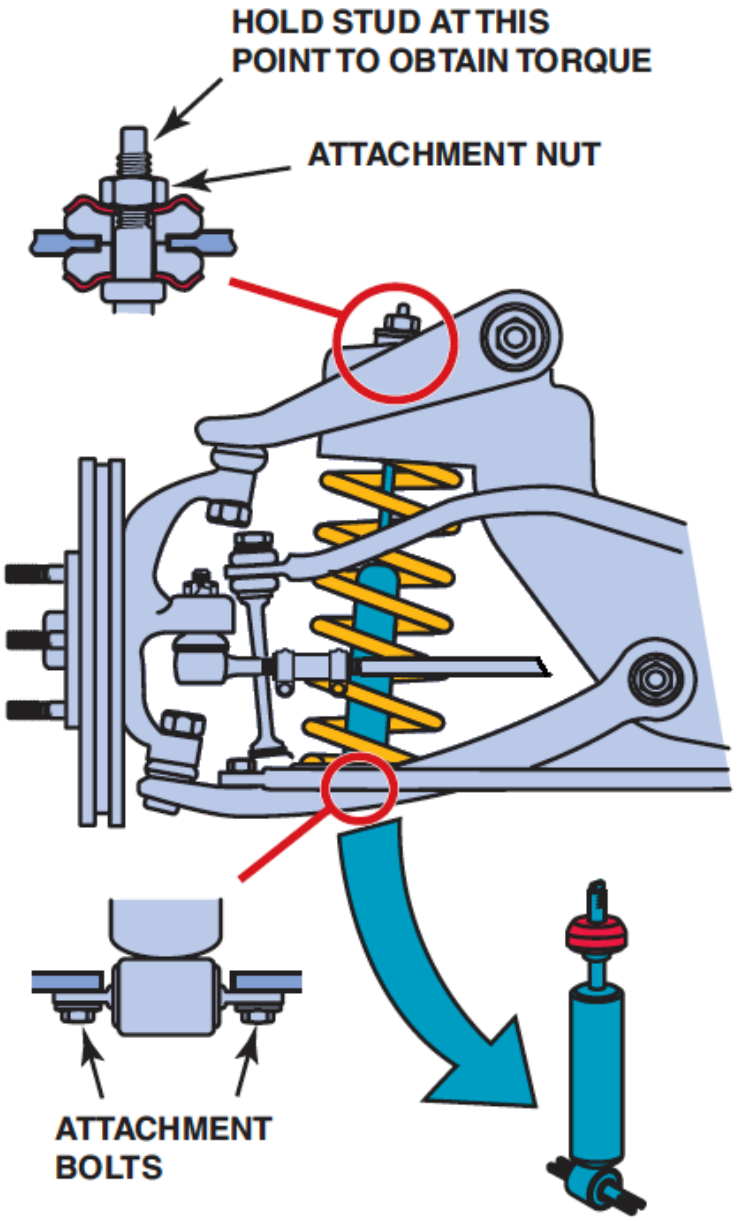

Figure 27. Most shock absorbers used on the front suspension can be removed from underneath the vehicle after removing the attaching bolts or nuts.

13. Diagnose, service and/or replace front wheel bearings and/or hub assemblies.

Many rear-wheel- drive vehicles use an inner and an outer wheel bearing on the front wheels. The inner wheel bearing is always the larger bearing because it is designed to carry most of the vehicle weight and transmit the weight to the suspension through to the spindle. Between the inner wheel bearing and the spindle, there is a grease seal, which prevents grease from getting onto the braking surface and prevents dirt and moisture from entering the bearing. Figure 28.

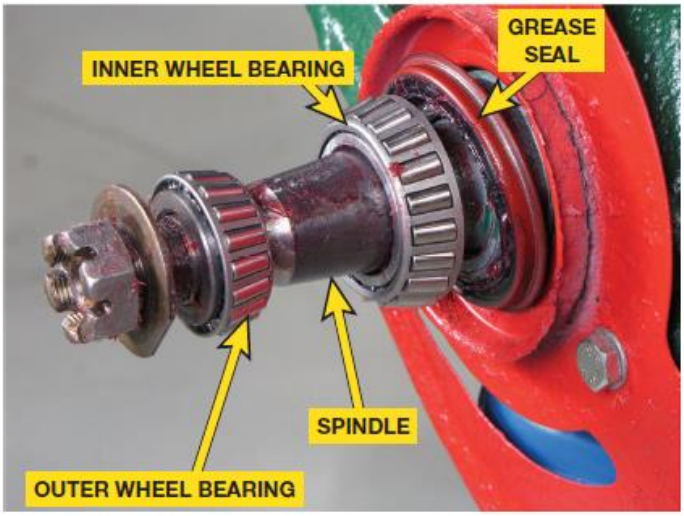

Figure 28. Two-piece wheel bearing requires adjustment when being installed.

Most front-wheel-drive vehicles use a sealed nonadjustable front wheel bearing. This type of bearing can include either two preloaded tapered roller bearings or a double-row ball bearing. This type of sealed bearing is also used on the rear of many front-wheel-drive vehicles. Figure 29.

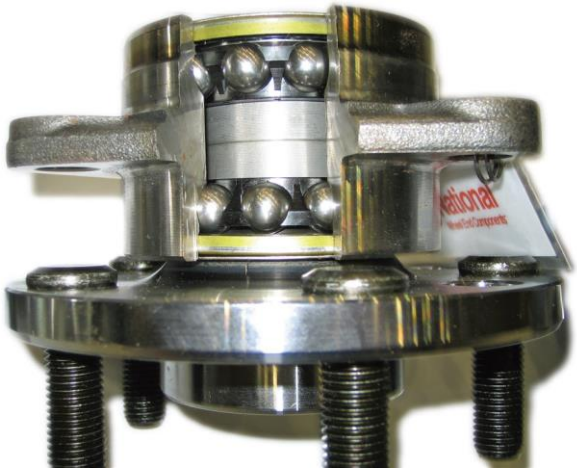

Figure 29. A sealed wheel bearing is replaced as a complete assembly.

Symptoms of defective wheel bearings include the following:

- A hum, rumbling, or growling noise that increases with vehicle speed
- Roughness felt in the steering wheel that changes with the vehicle speed or cornering
- Looseness or excessive play in the steering wheel, especially while driving over rough road surfaces
- A loud grinding noise in severe cases, indicating a defective front wheel bearing

A two-piece wheel bearing (inner and outer) is serviced by removing the bearings, washing out the old grease, cleaning the bearings, and then repacking with new grease. Figure 30.

Figure 30. Cleaning the wheel bearing.

During installation, the bearings require careful adjustment. When the wheel bearing is properly adjusted, the wheel will have about 0.001 to 0.005 inch (0.03 to 0.13 mm) end play. Figure 31.

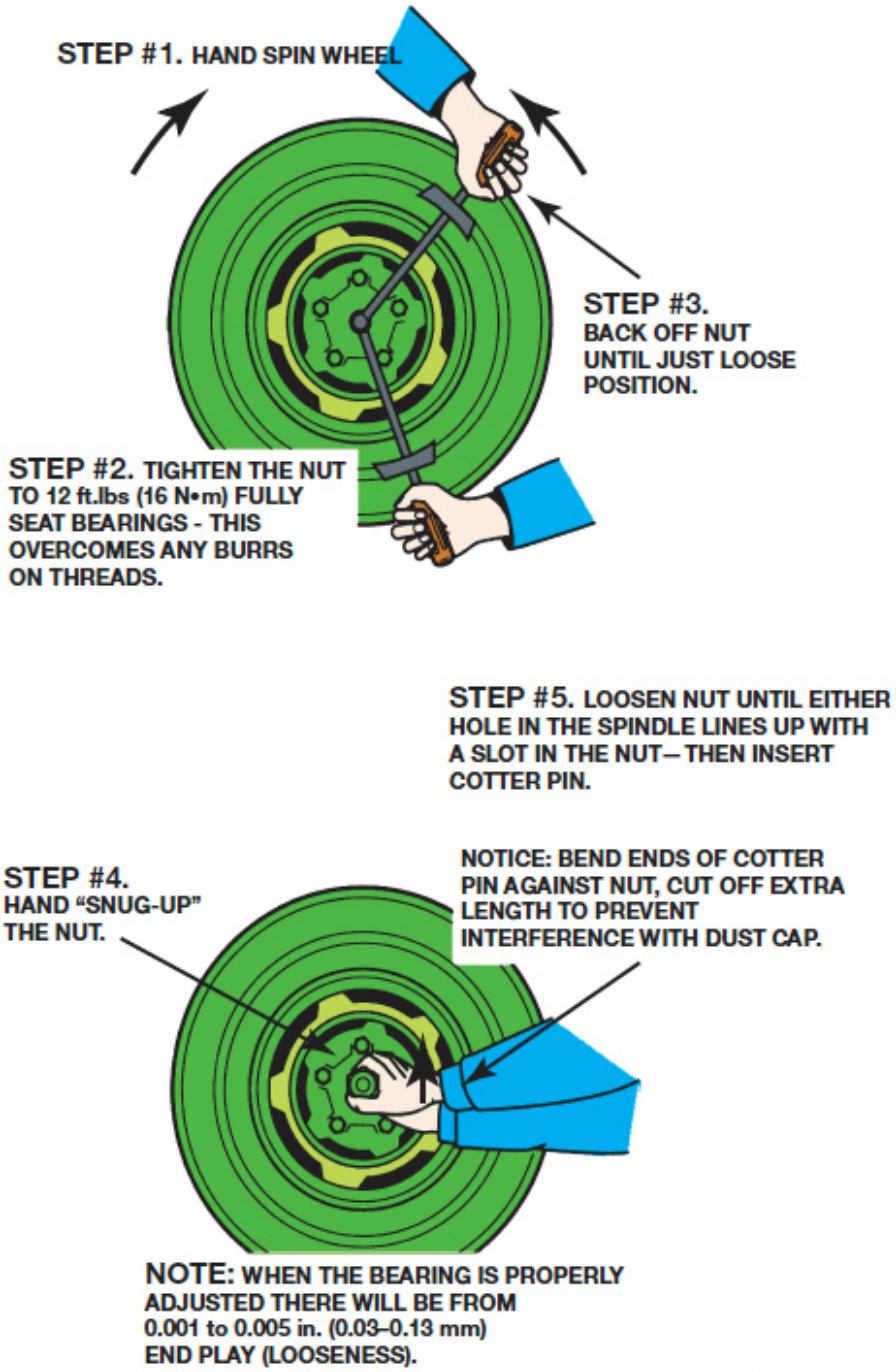

Figure 31. Wheel bearing adjustment.

Most front-wheel-drive vehicles use a sealed bearing assembly that is bolted to the steering knuckle. A sealed bearing/hub assembly may also be used on the rear wheels or a FWD vehicle. The bearing/hub assembly is replaced as a unit after removing the caliper, rotor, and mounting bolts.

14. Diagnose, inspect, adjust, repair or replace components (including sensors, switches, actuators, harnesses, and control units) of electrically/hydraulically/pneumatically controlled

suspension systems (including primary and supplemental suspension and ride control systems); initialize as needed.

Many vehicle manufacturers have been introducing models with electronic suspension controls that provide a variable shock stiffness or spring rate. The main advantage of electronic controls is that the suspension can react to different conditions. The system provides a firm suspension feel for fast cornering and quick acceleration and braking, with a soft ride for cruising.

Sensors and switches provide input to the electronic control module (ECM), or system computer. The ECM is a small computer that receives input in the form of electrical signals from the sensors and switches and provides output electrical signals to the system actuators. Figure 32.

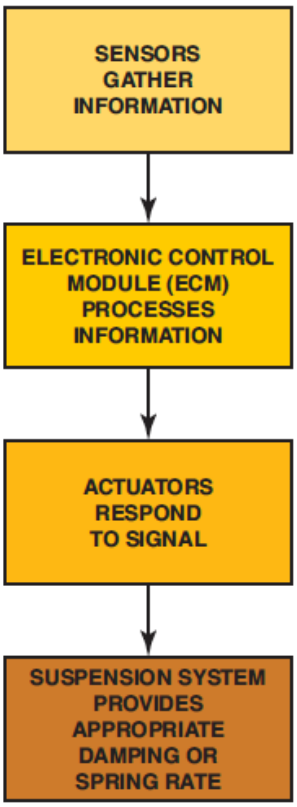

Figure 32. Block diagram of an electronic suspension system.

Sensors and switches include:

- Height sensors, Figure 33
- Steering wheel position sensor
- Vehicle speed sensor
- Lateral accelerometer sensor
- Yaw rate sensor
- Driver selector switch

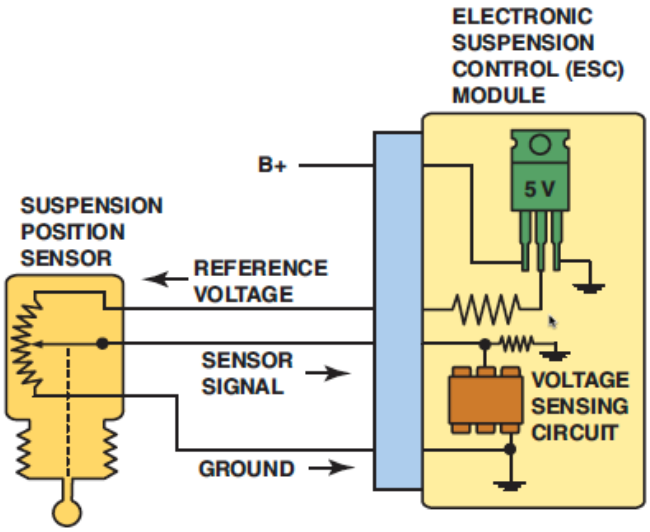

Figure 33. Typical suspension height sensor schematic.

Each actuator in an electronically controlled suspension system receives output signals from the ECM and responds to these signals, or commands, by performing a mechanical action. Common actuators are solenoids and motors. Figure 34.

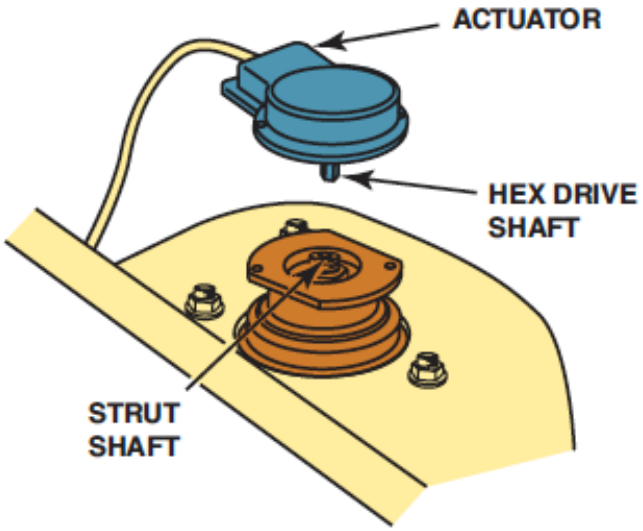

Figure 34. An actuator motor.

A factory-level scan tool is used when diagnosing these systems. Most systems may require sensor learning or reprogramming after replacement. Always check service information for the details and procedures to follow when replacing components on electronic suspension systems.

15. Inspect and repair front subframe/cradle/crossmember mountings, bushings, brackets, and bolts.

Many front-wheel-drive vehicles mount the drive train and lower suspension arms to a subframe or cradle. If the frame is shifted either left or right, it can cause differences side-to-side in alignment angles. Figure 35.

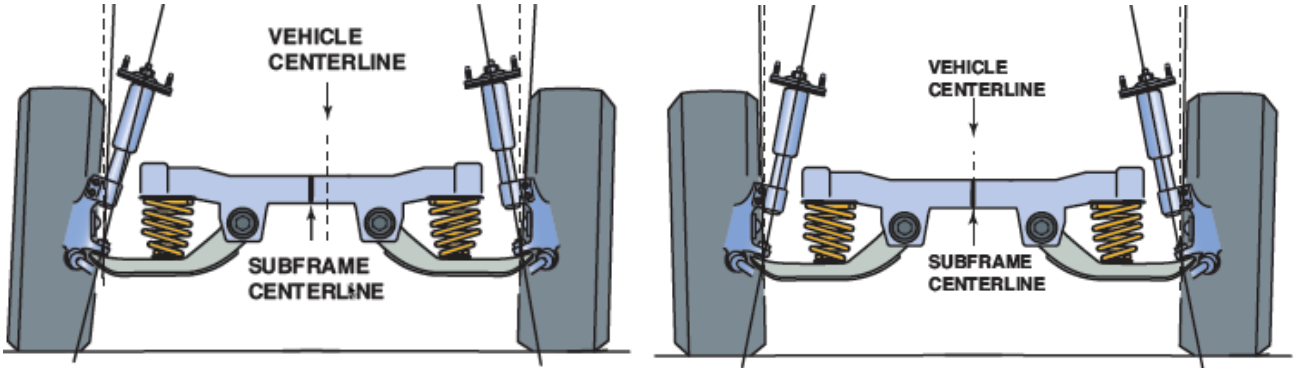

Figure 35. Left, cradle shifted out of position. Right, cradle adjusted to the correct position.

INTRODUCTION - Rear Suspensions

A solid axle can be used at the rear of either a rear-wheel-drive or front-wheel-drive vehicle. On a rear-wheel-drive vehicle, a solid rear axle consists of the differential gears and axle shafts inside a solid housing. On a front-wheel-drive vehicle, a solid axle is usually a simple U-shaped or tubular beam that may contain a torsion bar, rod, or tube to allow some twisting action. Figure 36.

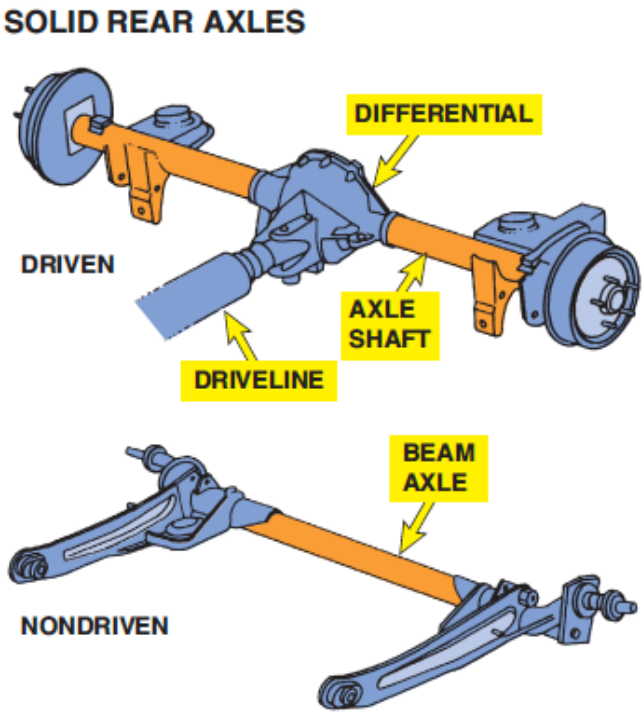

Figure 36. Solid axles are used on rear-wheel-drive vehicles as well as on front-wheel-drive vehicles.

A leaf spring suspension is a simple system because it does not require control arms to brace and position the axle. Most rear-wheel-drive trucks use a solid rear axle with leaf springs. Figure 37.

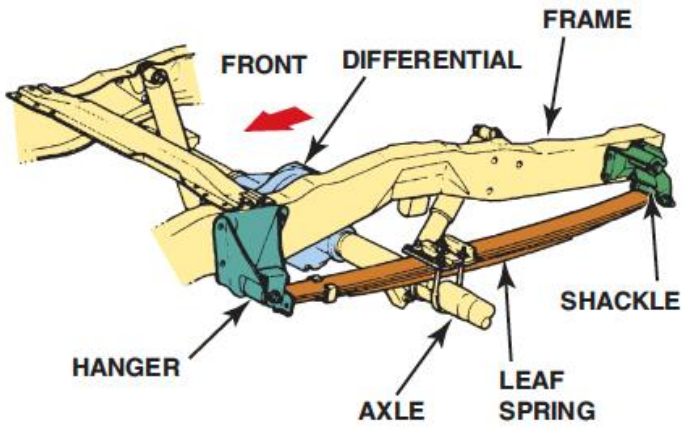

Figure 37. Leaf spring rear suspension.

Rear suspensions that use either coil springs or struts use trailing arms and track rods to control the position of the rear axle. Trailing arms are used to brace either a driven or non-driven solid rear axle against front-to-rear forces.

A trailing arm rear suspension solid axle usually includes a track rod, also called a Panhard rod. The purpose of the track rod is to keep the rear axle centered under the vehicle. Figure 38.

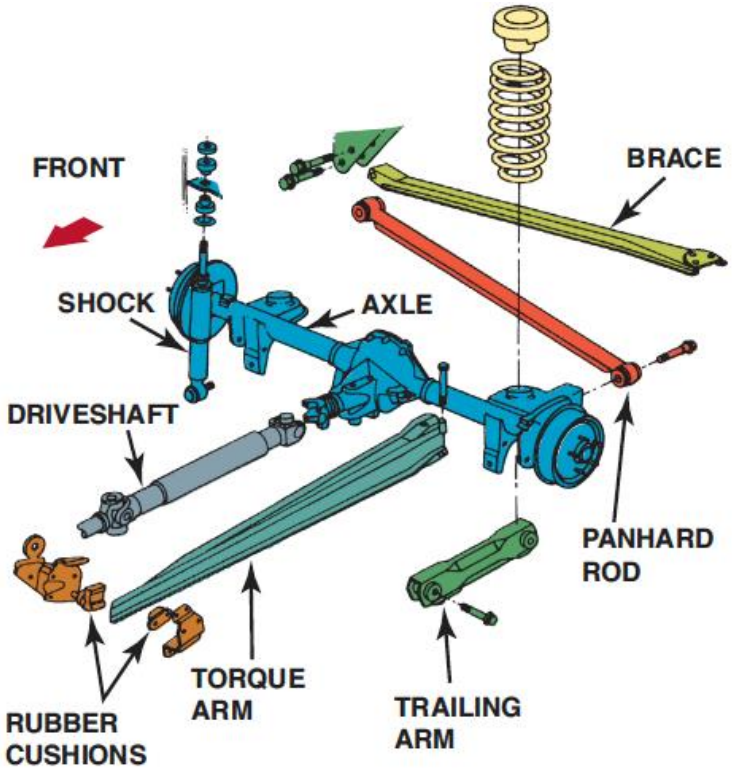

Figure 38. Rear suspension using a solid axle and coil springs.

A number of rear-wheel-drive vehicles feature an independent rear suspension. A vehicle with independent rear suspension rides and handles better than a similar vehicle equipped with a solid rear axle. An SLA-type of independent suspension may be used at the rear of a rear-wheel-drive vehicle. Figure 39.

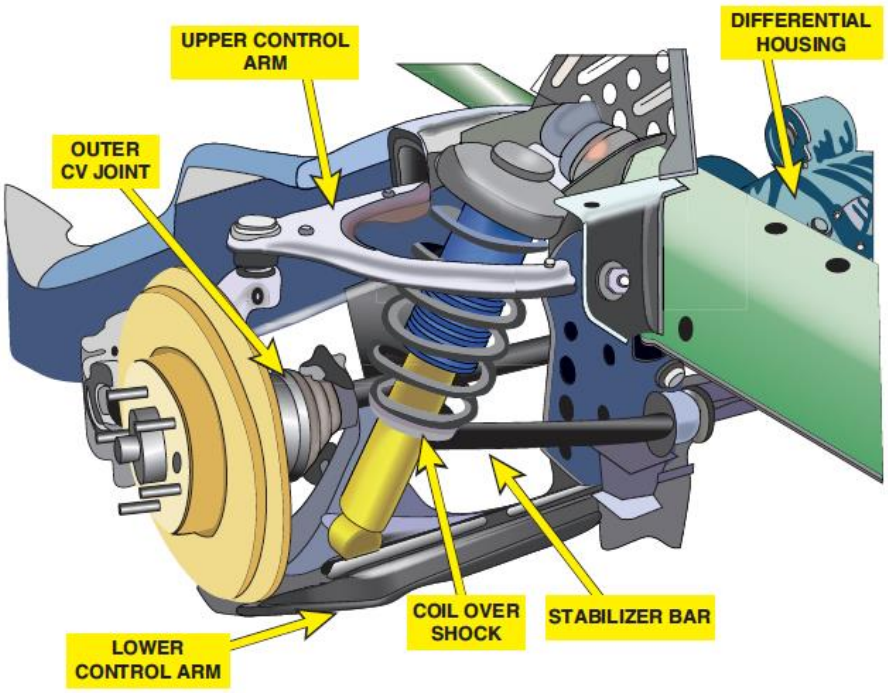

Figure 39. Independent rear suspension. The differential housing is bolted to the vehicle frame.

ASE TEST TOPICS

16. Diagnose rear suspension system noises, handling, ride height and ride quality concerns; determine needed action.

Rear suspension service starts with a thorough test-drive, to observe any unusual noises or vibrations that may be caused by a fault with a rear suspension component.

After a test-drive, safely hoist the vehicle and perform a thorough visual inspection. Use an appropriate prybar and move all of the bushings and joints, checking for deterioration or freeplay. Figure 40.

Figure 40 Check rubber bushings.

Inspect the shock absorber or struts for leakage or damage. Inspect the bump stops for damage. If the bump stops are damaged, this may indicate that the springs are fatigued and the vehicle is at lower-than-normal ride height, or that the shocks or struts are unable to control the springs. Figure 41.

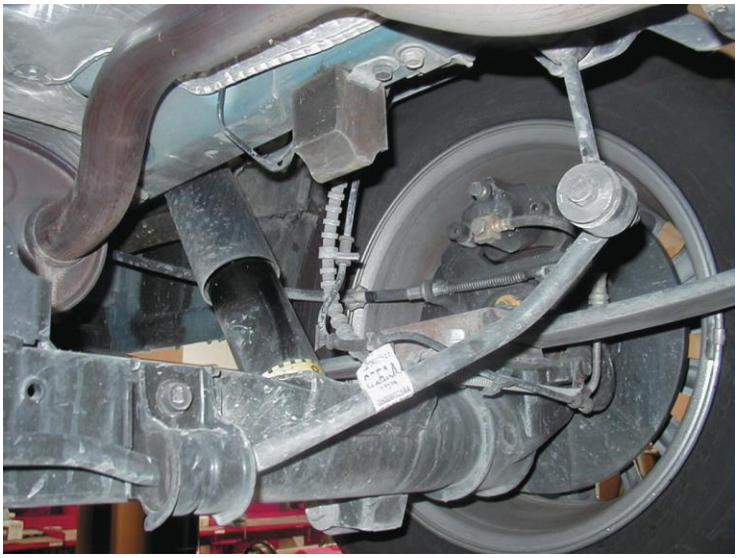

Figure 41. Check bump stops.

17. Inspect and replace rear suspension system coil springs and spring insulators (silencers).

To remove a rear axle coil spring follow these steps.

- Raise the vehicle safely on a hoist and remove both rear wheels.
- Support the rear axle assembly with a floor jack.

- Remove the lower shock absorber mounting bolts/nuts and disconnect the shock absorber from the rear axle assembly.
- Slowly lower the rear axle assembly just enough to remove the coil springs. Figure 42.

Figure 42. The shock absorber needs to be disconnected before removing the coil spring. Installation is the reverse of the removal procedure.

18. Inspect and replace rear suspension system lateral links/arms (track bars), control (trailing) arms, stabilizer bars (sway bars), bushings, and mounts.

Inspect the following links and arms for broken or worn rubber bushings, Figures 43 and 44.

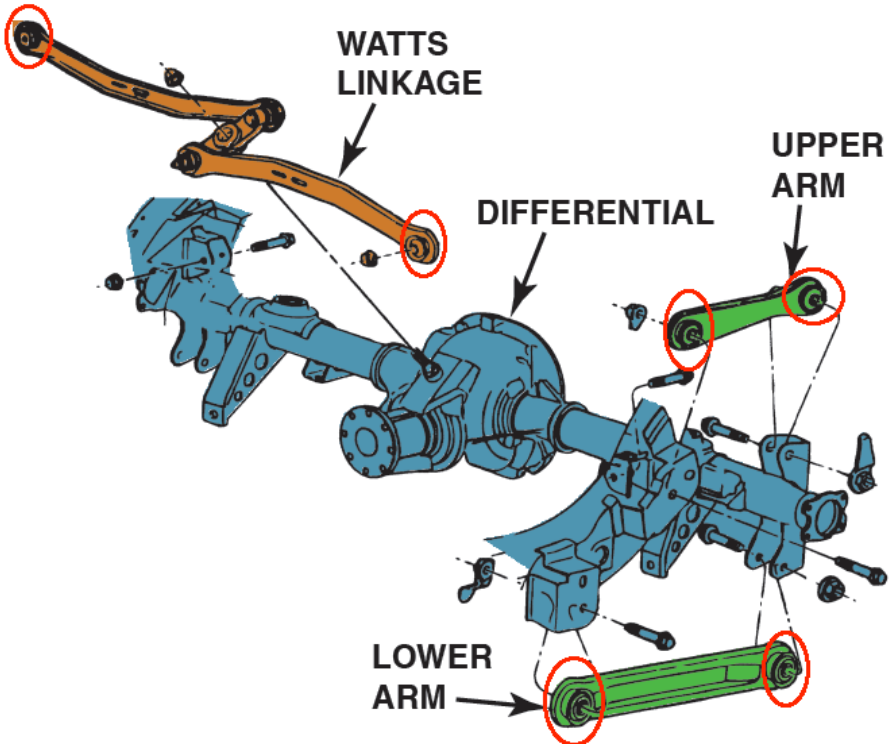

Figure 43. Rear suspension inspection points.

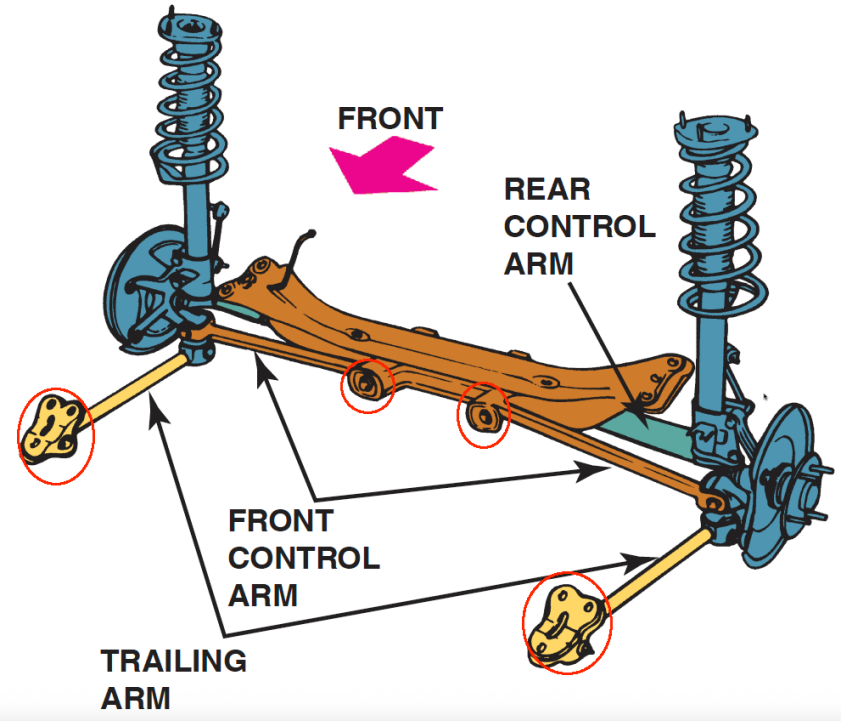

Figure 44. Rear suspension inspection points.

19. Inspect and replace rear suspension system leaf spring(s), leaf spring insulators (silencers), shackles, brackets, bushings, center pins/bolts, U-bolts, and mounts.

Rear leaf springs often need replacement due to one of the following common causes:

1. Individual leaves of a leaf spring often crack, then break. When a leaf spring breaks, the load-carrying capacity of the vehicle decreases, and it often sags on the side with the broken spring. Figure 45.

Figure 45. The crack shown is what a technician discovered when the leaf spring was removed during the diagnosis of a sagging rear suspension.

2. If the center bolt breaks, the individual leaves can move, and the rear axle is no longer held in the correct location. When one side of the rear axle is behind the other side, the vehicle will dog track. Dog tracking refers to the sideways angle of the vehicle while traveling straight. Figure 46.

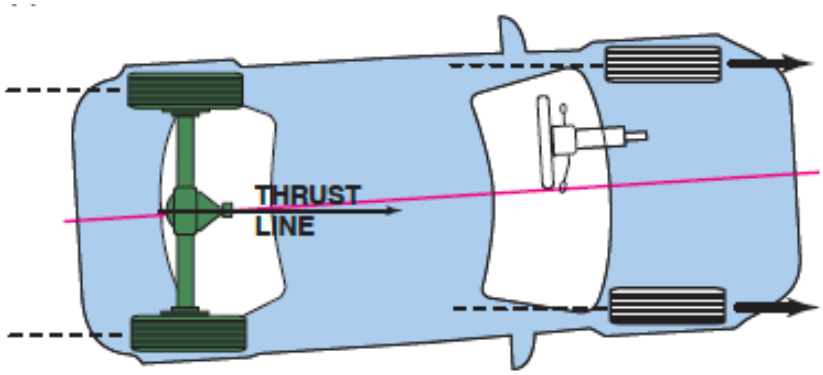

Figure 46. Dog tracking.

Leaf springs should be replaced in pairs. To replace leaf springs in the rear of a rear-wheel-drive vehicle, follow these steps:

1. Raise the vehicle safely on a hoist.
2. Support the rear axle with safety stands.
3. Remove the rear shackle bolts and forward mounting bolt or mounting bracket.
4. Remove the U-bolts.
5. Being careful of any nearby brake line, remove the spring.
6. Install the new spring, being careful to position the center bolt correctly into the hole on the axle pedestal.

20. Inspect and replace rear rebound and jounce bumpers/bump stops.

Bump stops are attached using snap-in rubber points or mounting bolts. Figure 47.

Figure 47. Remove the bolts to replace the bump stop.

21. Inspect and replace rear strut and/or upper strut mount.

Before removing the rear struts, the rear axle must be supported to prevent stretching of the rear brake flexible hose. Struts are attached to the frame or body of the vehicle at the top and to a bracket on the rear axle housing at the bottom. Often, the top of the strut is fastened inside the vehicle. Figure 48.

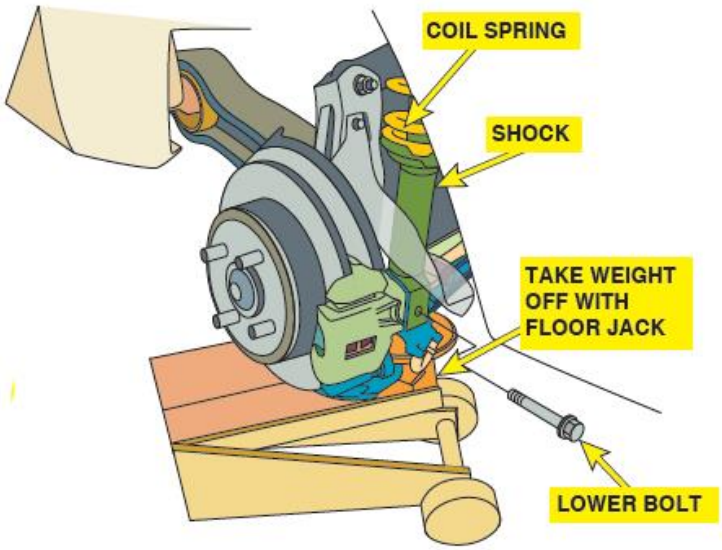

Figure 48. Before removing a rear strut assembly, the rear axle has to be supported.

22. Inspect non-independent rear axle assembly for damage and misalignment.

Rear axle damage or misalignment is usually indicated by abnormal tire wear or incorrect toe measurements during a four-wheel alignment. Figure 49.

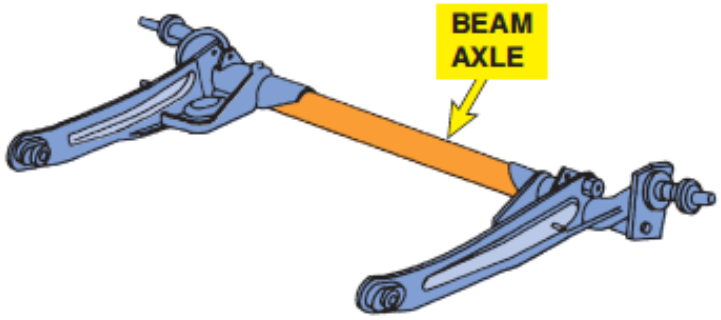

Figure 49. A solid rear axle can be damaged by improper lifting or towing.

23. Inspect and replace rear ball joints and tie rod/toe link assemblies.

Independent rear suspensions may use ball joints at the outer ends, and they are checked in a manner similar to front ball joints. On many vehicles the ball joint is not replaceable; the complete control arm must be replaced. Figure 50.

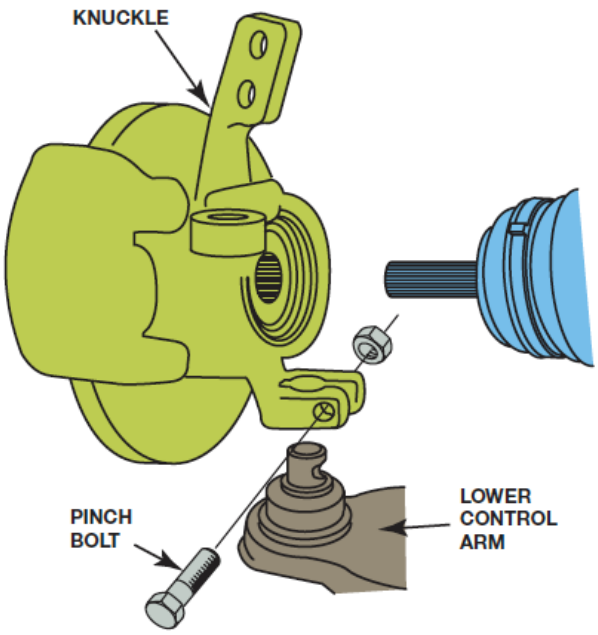

Figure 50. Rear knuckle and ball joint.

Rear toe may use a rod or link for adjustment; these are easily bent by improper lifting or towing. Figure 51.

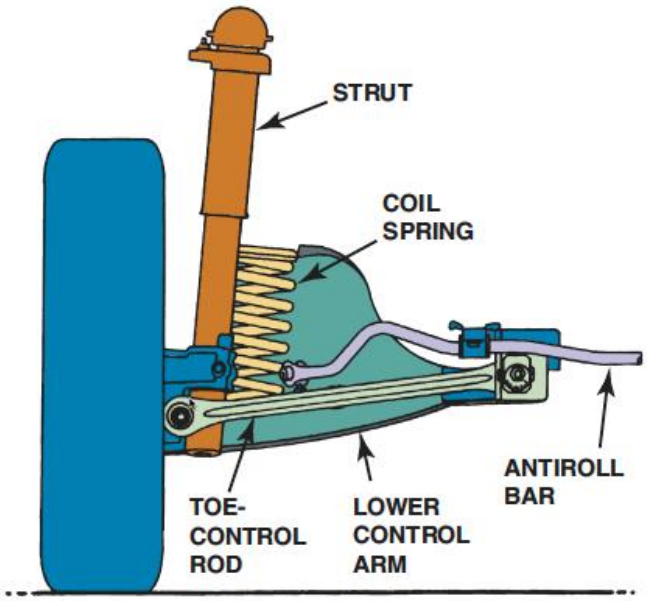

Figure 51. Toe is adjusted at the inner end by an eccentric bolt.

24. Inspect and replace rear knuckle/spindle assembly.

A rear knuckle on a strut-type suspension is removed by unbolting the knuckle from the lower ball joint and removing the strut attachment bolts. Figure 52.

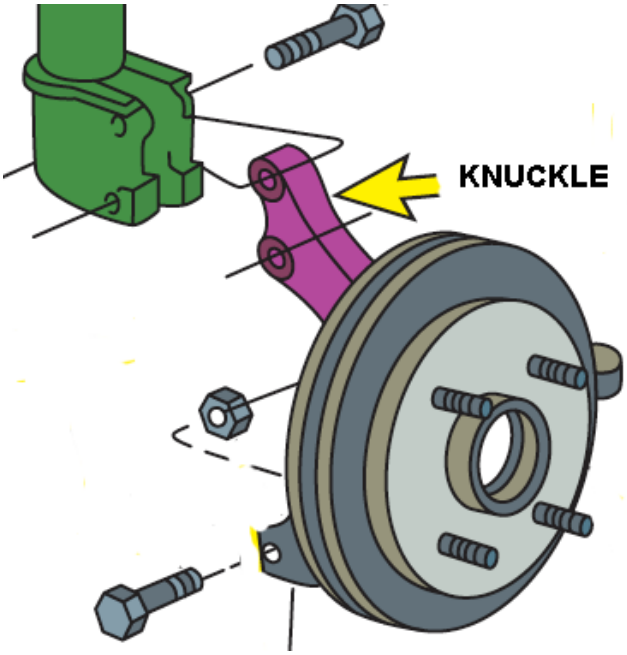

Figure 52. Rear knuckle removal.

25. Inspect and replace shock absorbers, mounts, and bushings.

Before removing the rear shock absorbers, the rear axle must be supported. Often, the top of the rear shock absorber is fastened inside the vehicle. Consult the vehicle manufacturer's service information for exact procedures and fastener torque values. Shock absorbers and/or struts should always be replaced as a pair. Figure 53.

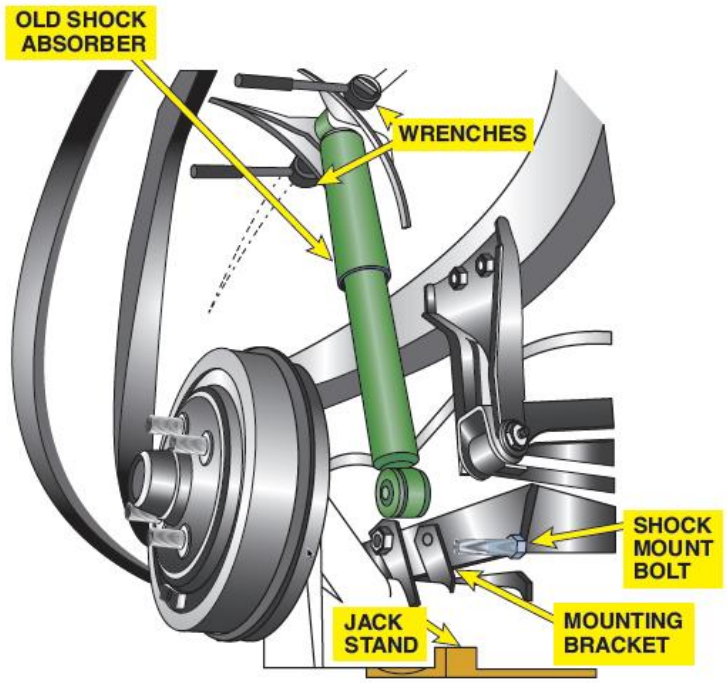

Figure 53. The lower control arm is supported by a hoist or floor jack before removing the shock absorber.

26. Diagnose, service, and/or replace rear wheel bearings and/or hub assemblies.

Bearing and seal replacement C-lock type. After removing the axle, the bearing and the seal are removed from the housing using a slide hammer and special adapter. The new bearing is driven straight into the housing to the end of its recess. The same installation procedure and tool is used to install the new seal. Figure 54.

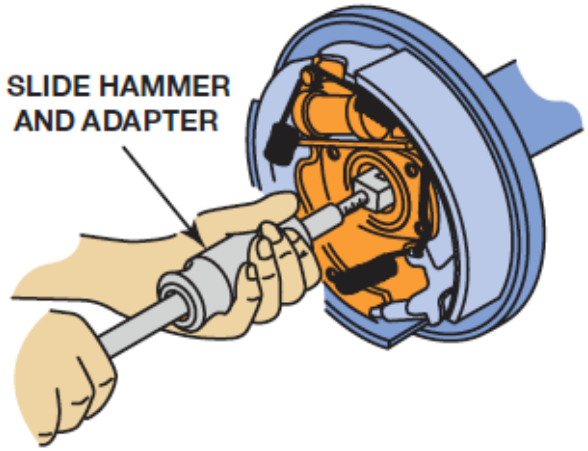

Figure 54. Removing the bearing and seal.

Bearing replacement retainer plate-type. The retainer bearing type axle bearing is press fit on the axle and requires a hydraulic press and special adapters to remove and install. The axle bearing retainer ring should be cut or stretched using a drill and a chisel before trying to press the bearing off the axle. Figure 55.

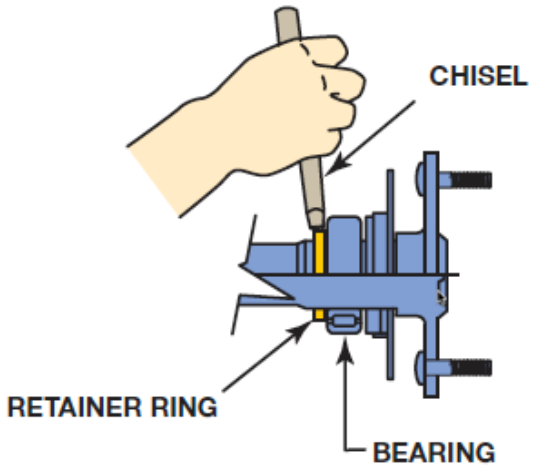

Figure 55. Cutting the retainer ring.

The new bearing is pressed on and then the retainer is pressed on, not both at the same time. Figure 56.

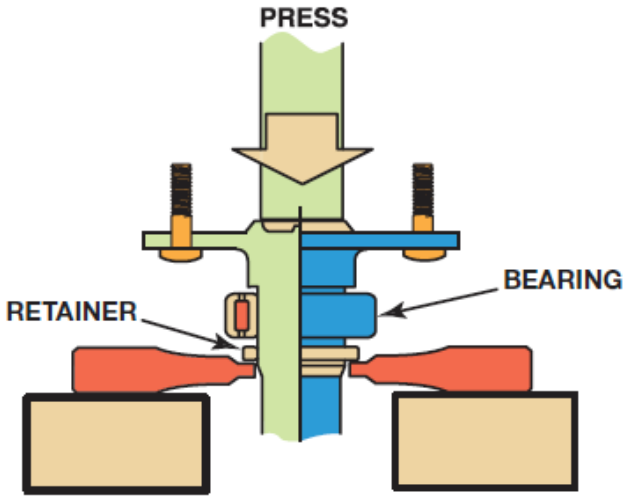

Figure 56. Pressing on the bearing retainer ring.

Sealed bearing and hub assemblies are used on the front and rear wheels of many vehicles. Figure 57.

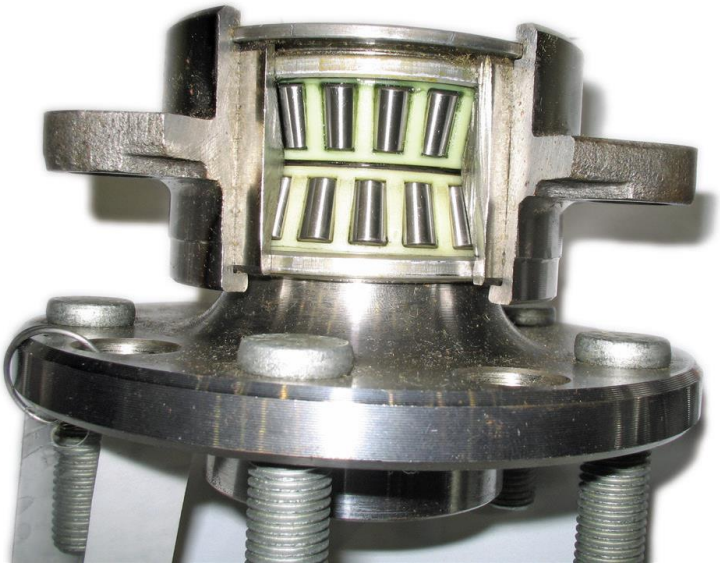

Figure 57. A hub and bearing assembly is replaced as a unit.

27. Diagnose, inspect, adjust, repair or replace components (including sensors, switches, actuators, harnesses, and control units) of electrically/hydraulically/pneumatically controlled suspension systems (including primary and supplemental suspension and ride control systems).

Many vehicle manufacturers have been introducing models with electronic suspension controls that provide a variable shock stiffness or spring rate. The main advantage of electronic controls is that the suspension can react to different conditions. The system provides a firm suspension feel for fast cornering and quick acceleration and braking, with a soft ride for cruising.

In addition to electronic systems discussed in ASE topic # 14 (above), some vehicles use an automatic level control (ALC) system that automatically adjusts the rear height of the vehicle in response to changes in vehicle loading and unloading. ALC controls rear leveling by monitoring the rear suspension position sensor and energizing the compressor to raise the vehicle or energizing the exhaust valve to lower the vehicle. Figure 58.

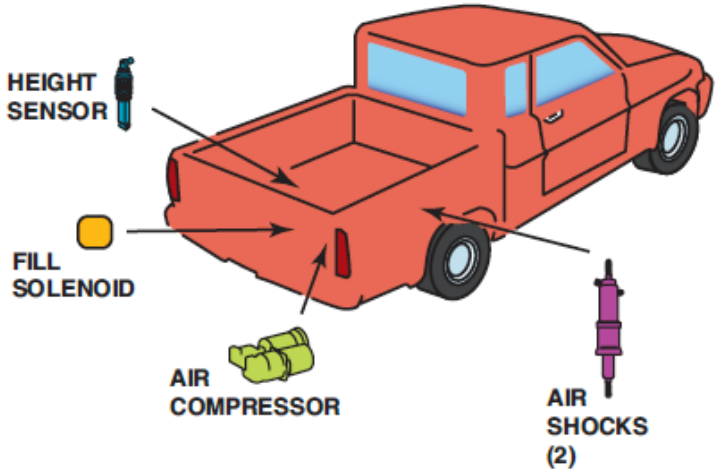

Figure 58. Automatic level control.

The suspension control module energizes the compressor relay to activate the compressor motor. This adjusts the rear trim height as needed. On some vehicle applications, the scan tool will display data relating to relay operation and can be used to command the compressor relay to verify proper operation. The special functions on many scan tools can be used to command the exhaust solenoid on and off, to verify its operation. Figure 59.

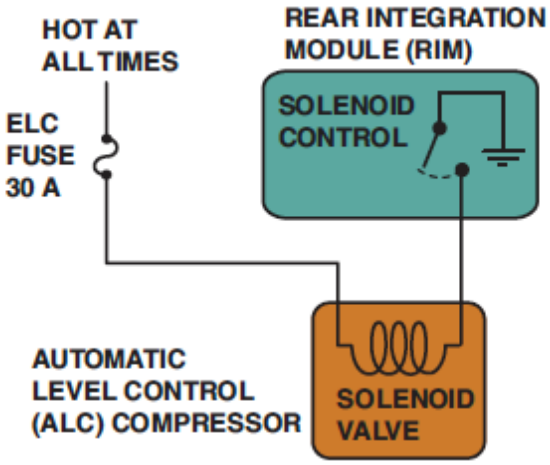

Figure 59. The exhaust solenoid is commanded ON to lower the rear of the vehicle.

28. Inspect and repair rear subframe/cradle/crossmember mountings, bushings, brackets, and bolts.

The rear subframe should be inspected for any damage caused by improper lifting or towing. Mounting bolts and washers can be checked for proper tightness with a torque wrench. Figure 60.

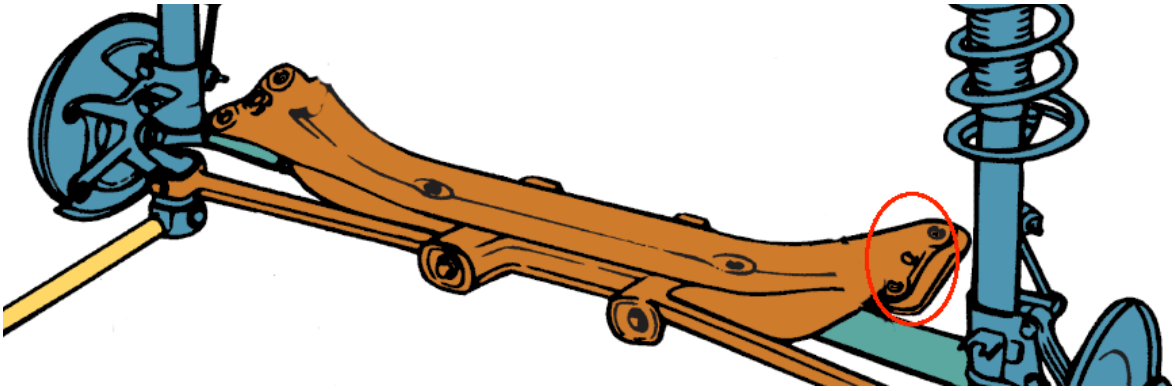

Figure 60. Check rear subframe mounting bolts, washers, and bolt holes.