CHAPTER EIGHT

Four-Wheel-Drive Systems

Classroom and Shop Manual

Objectives

- Explain the advantages and disadvantages of four-wheel drive.
- Use the correct terminology when discussing four-wheel-drive systems.
- Describe the different designs of four-wheel-drive systems and their applications.

Objectives *(cont'd)*

- Compare and contrast the components of part-and full-time four-wheel-drive systems.
- Describe the operation of various transfer case designs and their controls.
- Identify the differences in operation between manual and automatic locking front-wheel hubs.

Objectives *(cont'd)*

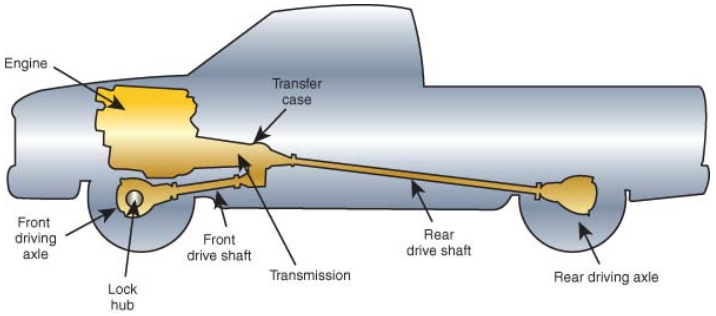
- Identify the suspension requirements of vehicles equipped with four-wheel drive.

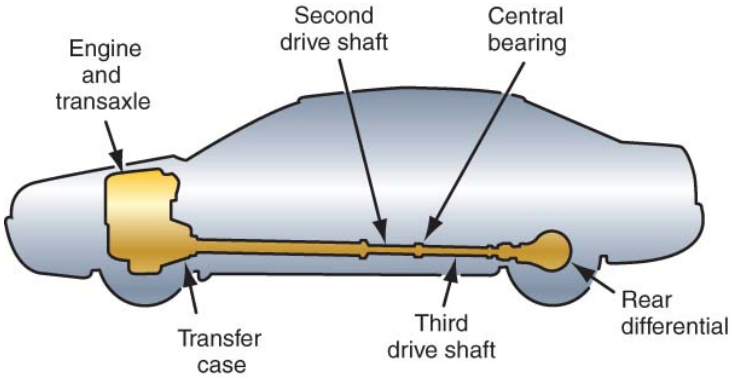
Why Four-Wheel-Drive?

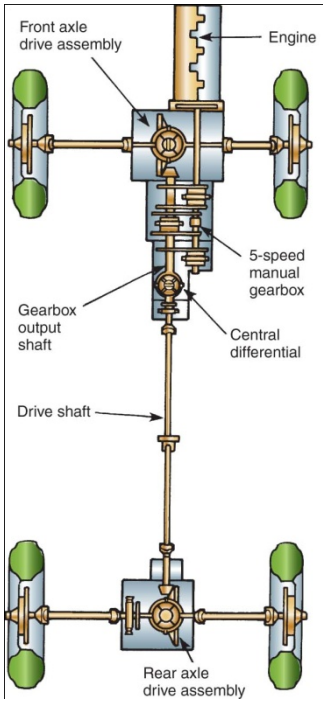
- Advantages
  - Improved traction and handling
  - Able to transmit more power to the wheels
- Disadvantages
  - Higher initial cost and weight
  - Requires special service and maintenance

4WD Designs

- RWD vehicles equipped with an added transfer case, a front drive shaft, a front differential, and front drive axles
- FWD vehicles with an added transfer case, a rear drive shaft, and a rear axle
  - Some use a center differential instead of a transfer case





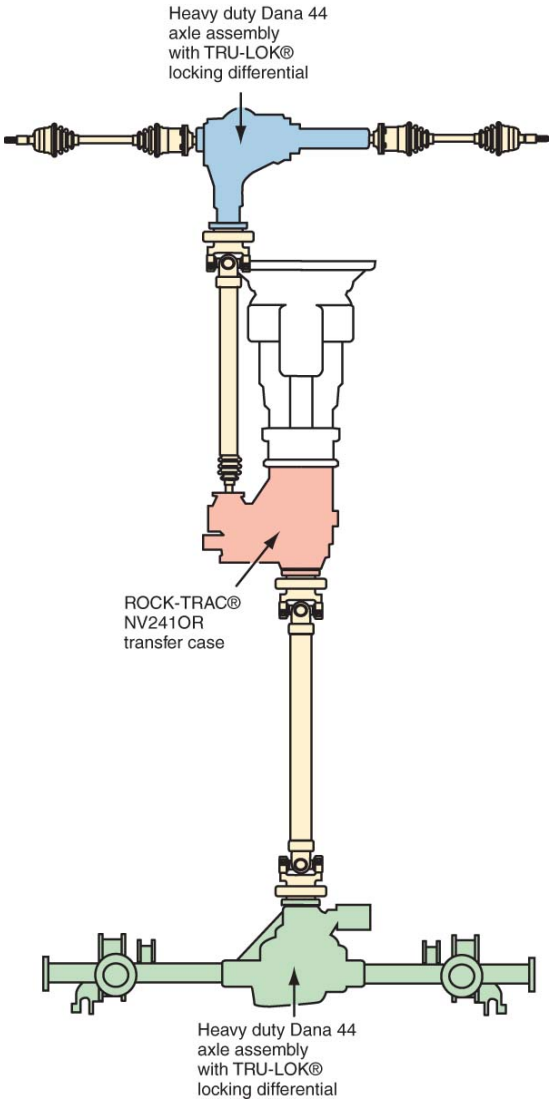


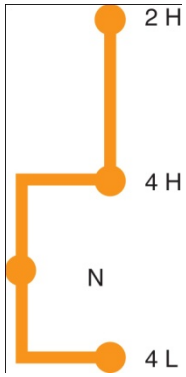
4WD Components

- Transfer case
  - Transmits power from the transmission to the front and rear drive shafts
- Drive shafts
  - Connect to the front and rear differentials
- Universal joints or CV-joints
  - Are used to connect front axles to the wheel hubs

4WD Systems

- Part-time systems
  - Can be operated in either two-wheel-drive or four-wheel-drive
  - Selection of two- or four-wheel-drive is done by a shifter, electric switch, or locking hubs
- Full-time systems
  - Cannot be selected out of four-wheel-drive





4WD Systems *(cont'd)*

- On-demand systems
  - Automatically controlled
  - Typically drives one axle until some wheel slip is detected
  - Some systems send torque to opposite axle when slip is anticipated

All Wheel Drive Systems

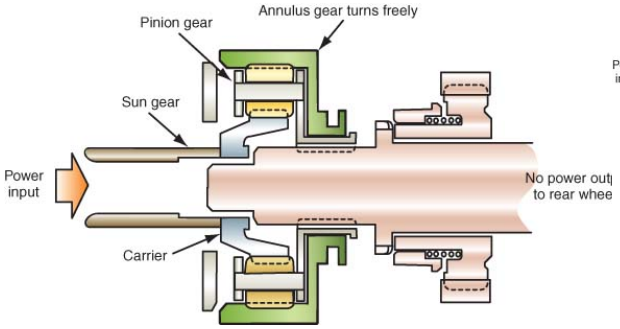
- Difficult to clearly define the difference between 4WD
- Primary difference is the transfer case
  - 4WD offers two speed ratios: high and low
  - AWD does not have a "low"
- Constantly provides power to all four wheels
- Does not give the driver the option of 2WD or 4WD

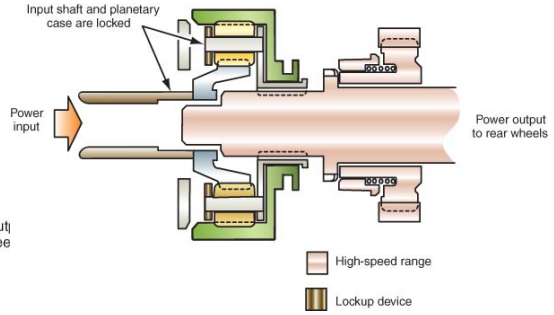
4WD Shift Controls

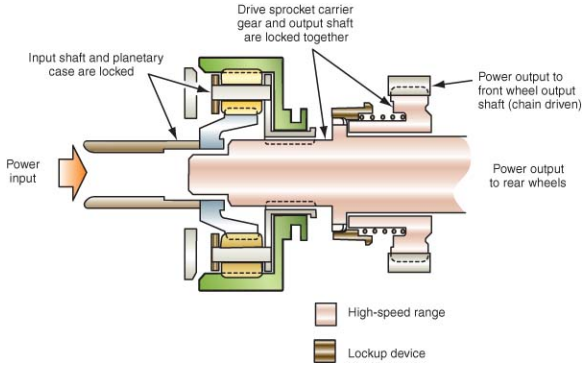
- Electric switch or shift lever
  - Allows the driver to select which axles receive power
  - Power can be directed to:
    - all four wheels
    - two wheels
    - none (neutral)
  - Some vehicles have a low-speed range that can be selected

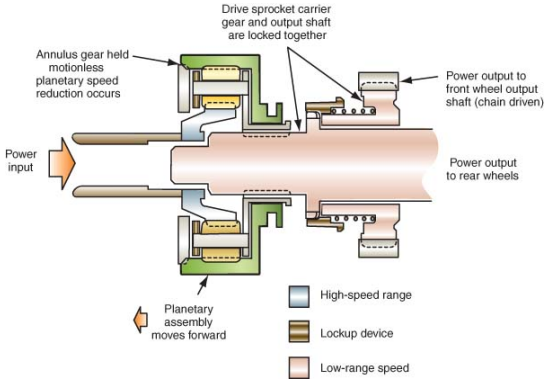
Transfer Case Modes of Operation

- Ranges available with a part-time transfer case:
  - Neutral
  - Two-wheel-drive—high
  - Four-wheel-drive—high
  - Four-wheel-drive—low









Transfer Case Modes of Operation *(cont'd)*

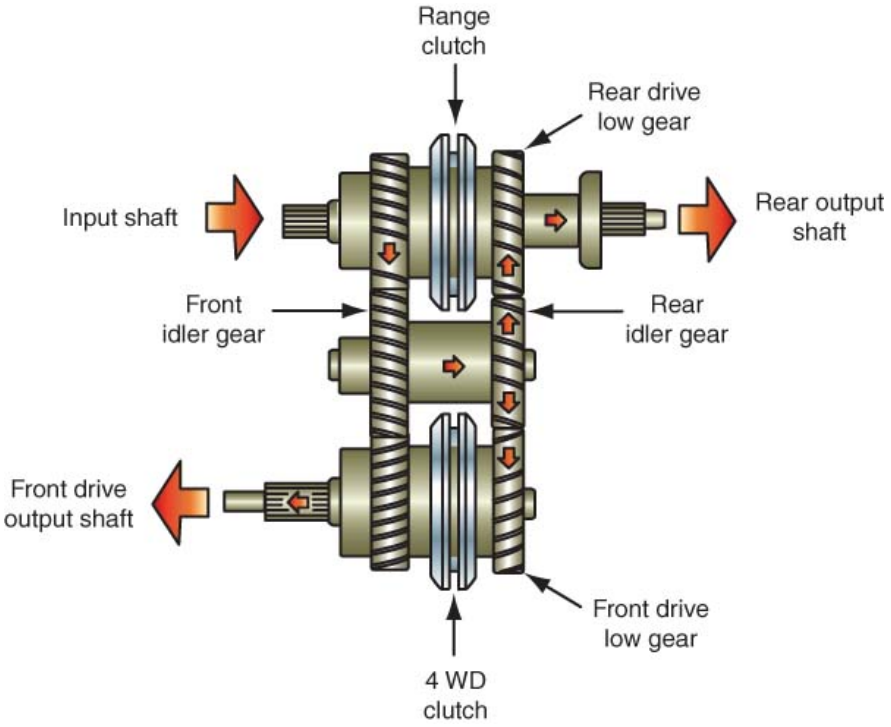
- Ranges available with a full-time transfer case:
  - Two-wheel-drive—high
  - Four-wheel-drive—high
  - Four-wheel-drive—low

Transfer Case Modes of Operation *(cont'd)*

- Ranges available with a part-time/full-time transfer case:
  - Two-wheel-drive—high
  - Full-time four-wheel-drive—high
  - Part-time four-wheel-drive—low

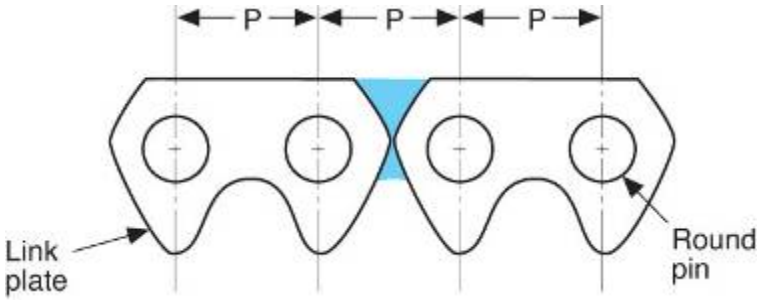
Types of Transfer Cases

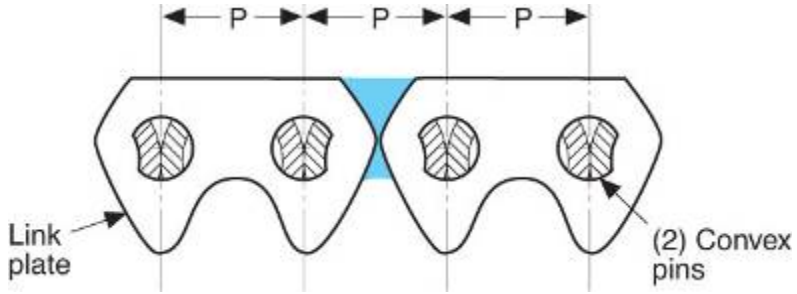
- Drive chain design
  - Has less weight to improve fuel economy
  - Is usually used with planetary gearsets
  - Is the most common design
- Gear-type
  - Uses only gearsets to transfer power



Drive Chain Variations

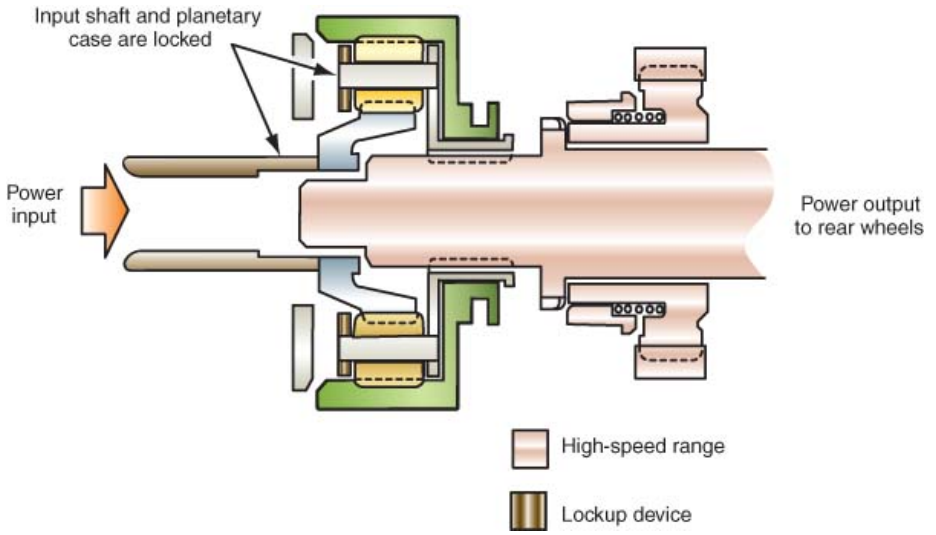
- Round-pin style
  - Is commonly used in transfer cases on part-time 4WD vehicles
  - Can handle higher loads
- Pin-and-rocker joint design
  - Is used on full-time 4WD systems
  - Is very efficient at continuous high speeds





Planetary Gear Drive Operation

- Neutral
  - The ring gear and pinion gears rotate freely and no power is transmitted
- Gear reduction
  - With the ring gear held, the sun gear drives the planetary gears and carrier at a reduction in speed

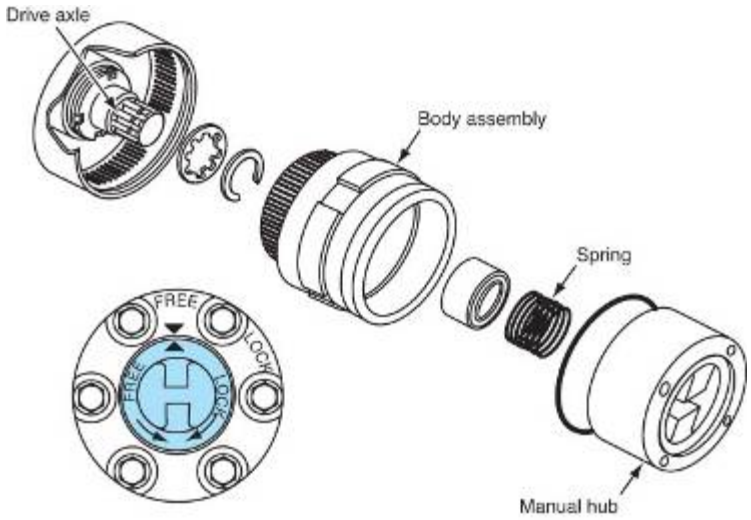


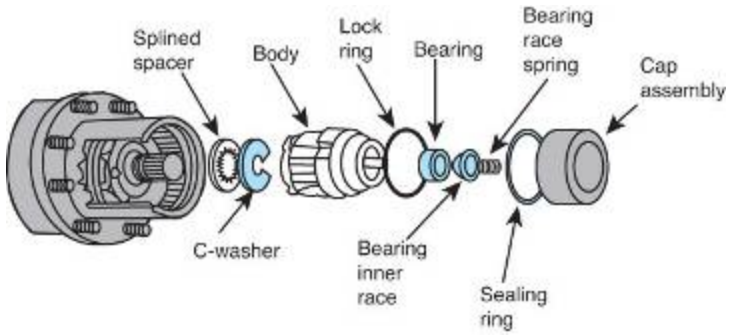
Planetary Gear Drive Operation *(cont'd)*

- High gear (direct)
  - The ring gear and planetary gears are locked together and the entire assembly turns as a unit, providing for direct drive

Locking Hub Operation

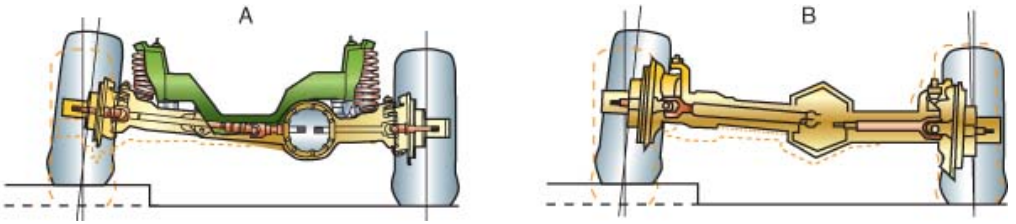
- *Manual hubs*
  - The hubs are at the wheel and must be turned by hand
  - The hubs are unlocked in 2WD
- *Automatic hubs*
  - The hubs are self-locking
  - Some hubs unlock when vehicle is driven in reverse
  - Some unlock when 4WD is disengaged

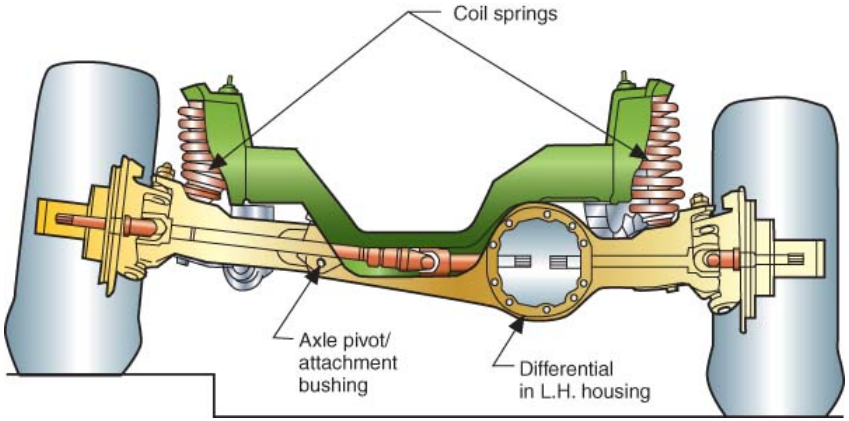




4WD Suspension Types

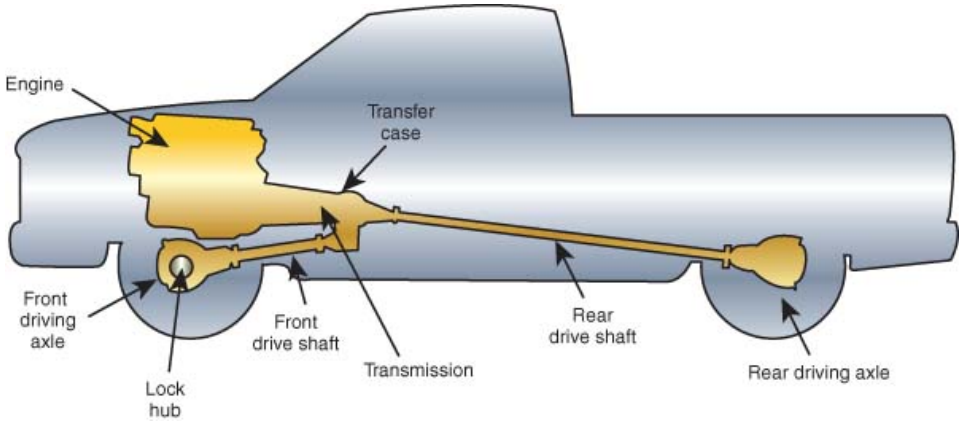
- *Solid axle*
  - Uses a rear axle design
  - The ends of the axle have steering knuckles for steering
- *Independent*
  - The differential is mounted to the frame
  - Most use two half-shafts with CV-joints
  - Some use one half-shaft and one solid axle





Steps in Diagnosis

- Talk to the customer
  - Find out under what condition the problem occurs
- Road test
  - Most problems show up as vibrations or noises
  - Try to verify that the 4WD system is causing the problem
- Perform a detailed inspection



4WD Noise and Vibration Diagnosis

- Noise or vibration is most noticeable at *high speed*
  - Usually caused by a transfer case problem, bent drive shaft, or bad wheel bearings
- Noise or vibration is most noticeable at *low speed*
  - Usually caused by bad U-joints
- Noise or vibration is most noticeable *while turning*
  - Usually caused by worn outboard axle joints

4WD Noise and Vibration Diagnosis *(cont'd)*

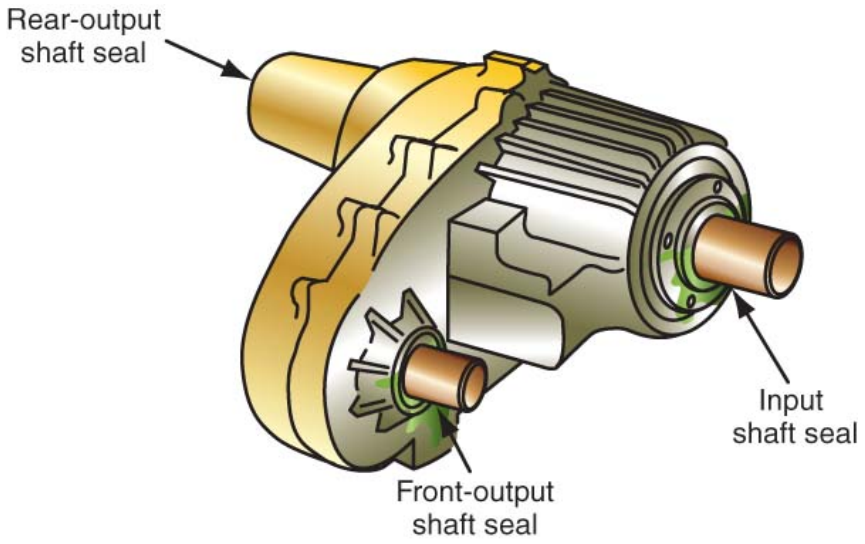
- Noise or vibration is most noticeable *when traveling over bumps*
  - Usually caused by suspension components
- Noise or vibration is most noticeable *with changes in throttle position*
  - Usually caused by U-joints or worn driveshaft splines

Shifting Problems

- Common complaint on all transfer cases is the inability to go from 4WD to 3WD
- It is common for these units to get spline-locked
- If transfer case jumps out of gear, suspect improperly adjusted shift linkage, loose mounting bolts or brackets, worn front/rear drive-shaft slip yokes, or a damaged sliding clutch hub

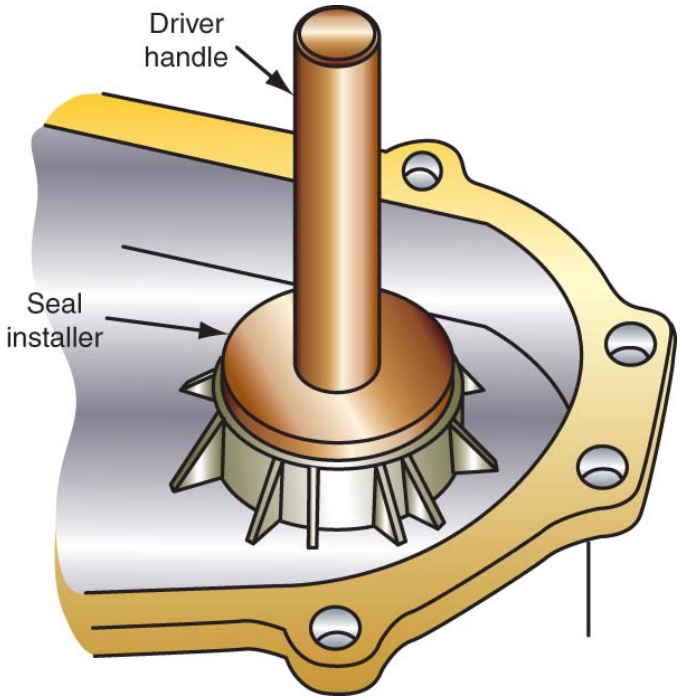
Common Sources of Leaks

- Driveshaft seals at the transfer case
- Driveshaft seals at the differentials
- Front or rear axle seals
- Threads at the transfer case fill plug



Fluid Leak Service Procedures

- Use only gaskets and seals recommended by the manufacturer
- Never use sealant in place of a gasket
- Always use the proper tools to install a seal
- Make sure the surface that the seal rides on is smooth

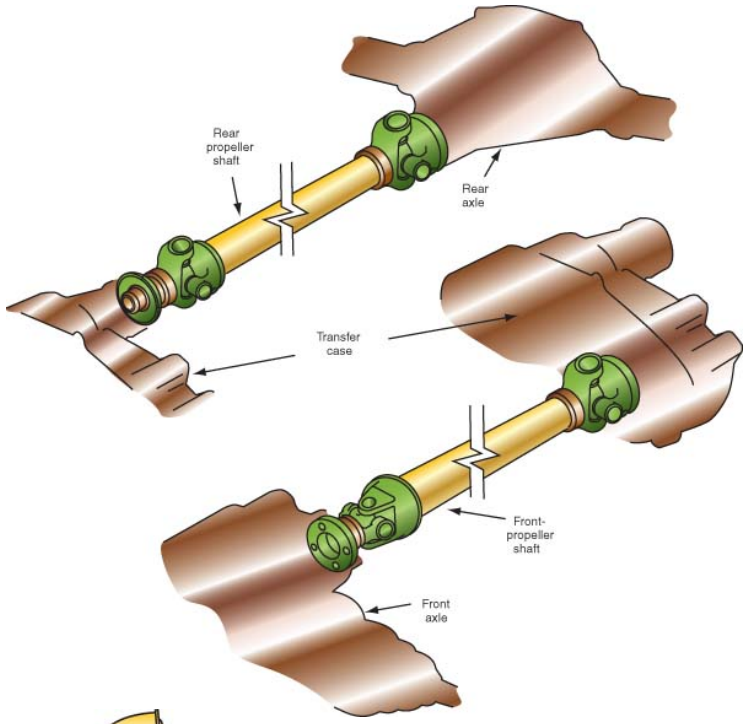


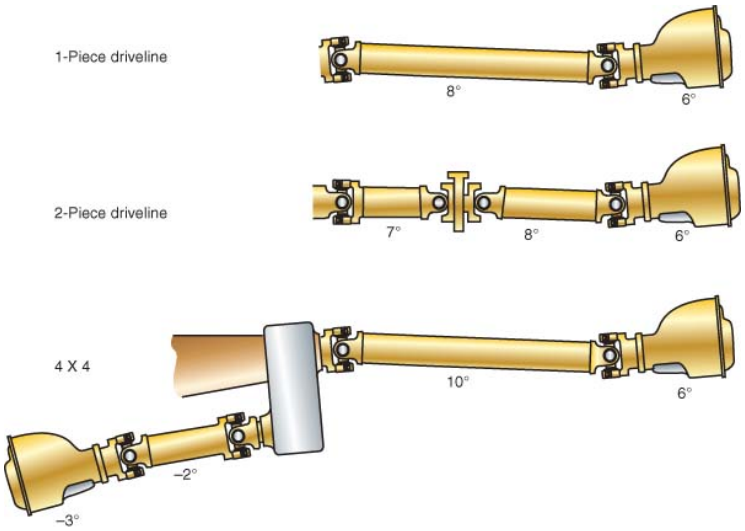
Transfer Case Inspection

- Vacuum-controlled transfer case
  - Verify that the engine is producing at least 15 inches of vacuum
- Mechanically-controlled transfer case
  - Make sure the shift linkage is tight and lubricated

Drive Shaft Inspection

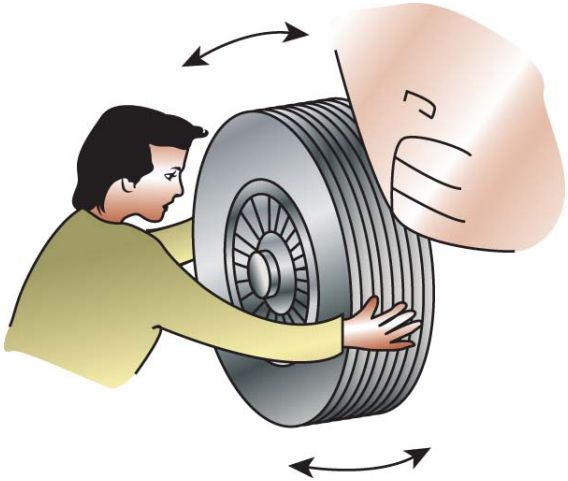
- Check the U-joints for looseness by twisting and shaking them
- Check the slip joints for looseness by moving them up and down
- Check the splines for wear by rotating the drive shaft

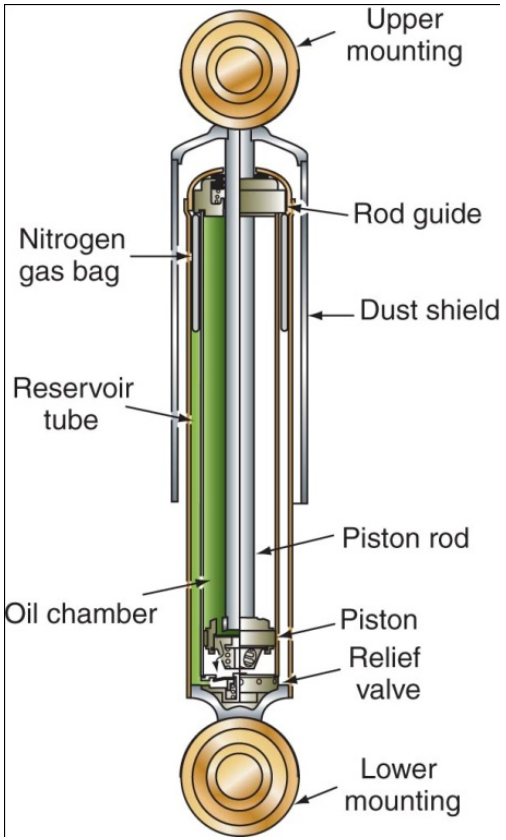




Suspension System Inspection

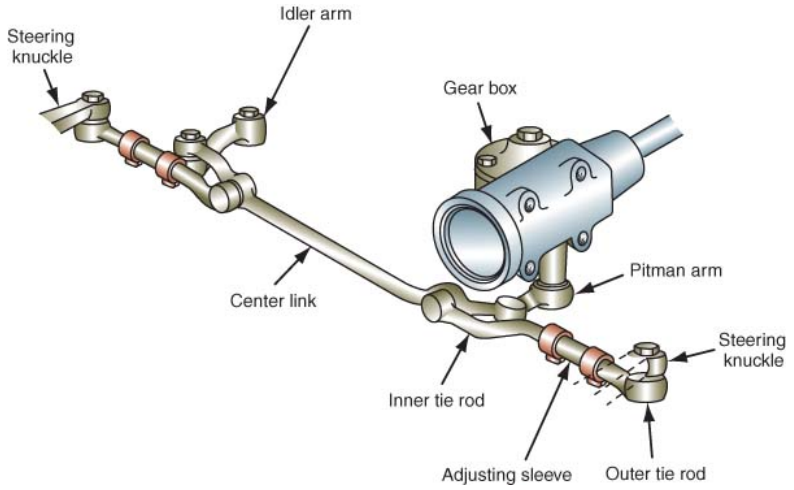
- Check the standing height of the vehicle and compare it to the factory specifications
- Check the spring pads for damage
- Check ball joints or king pins for looseness
- Check the shocks and sway bars for looseness or damage

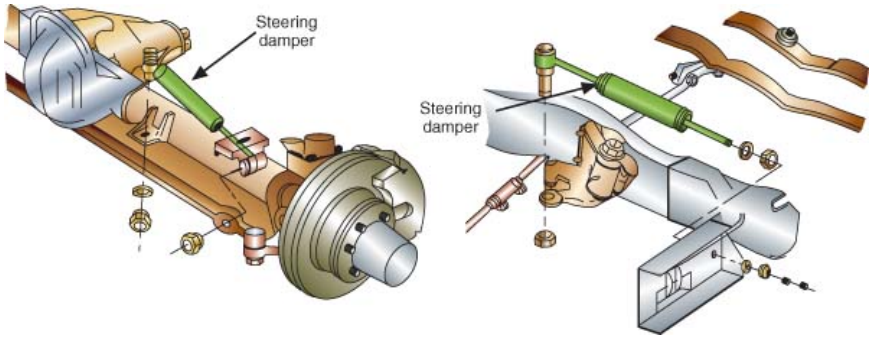




Steering System Inspection

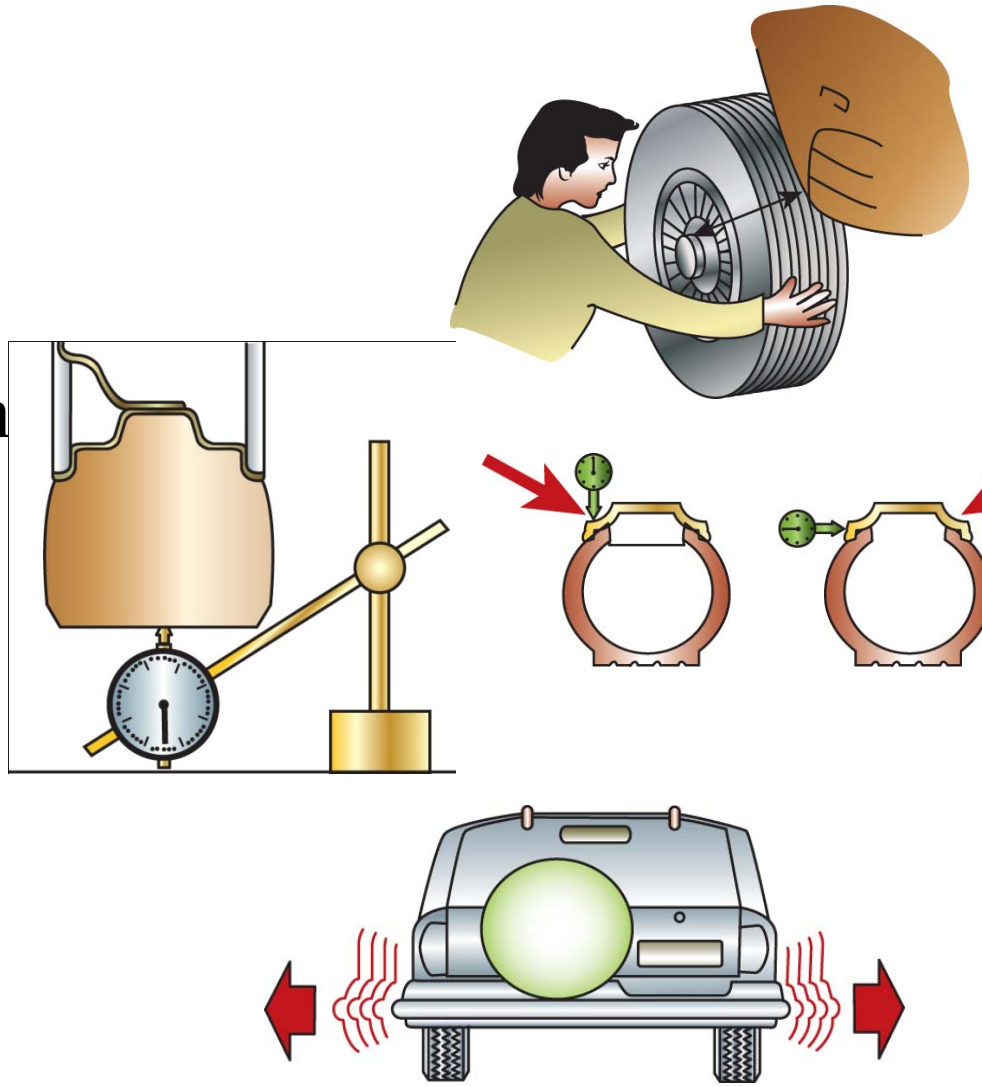
- Check the steering linkage for damage
- Check for play in the steering system
- Verify that the front suspension is aligned properly
- Check the steering damper for wear, leaks, or damage





Wheel and Bearing Inspection

- Check the adjustment of the wheel bearings
- Check the tires for proper size and inflation
- Check for tire radial runout
- Check for abnormal tire wear

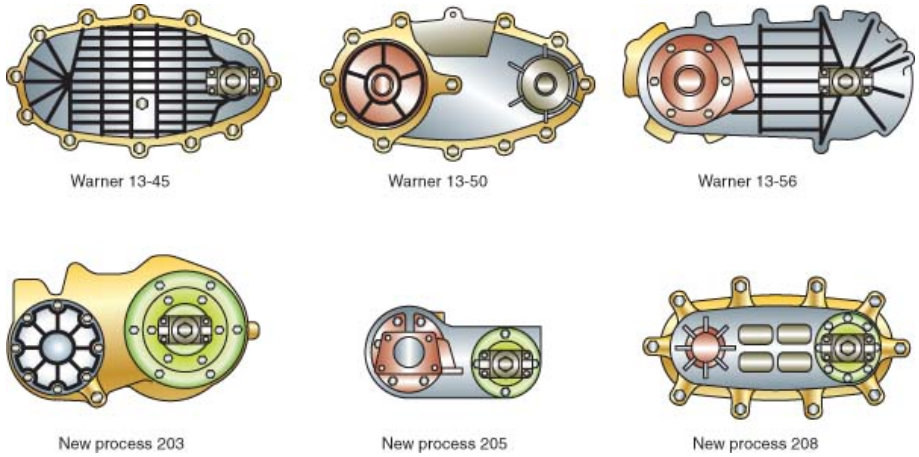


Axle Hub Diagnosis

- Front hubs may make a ratcheting sound when water or dirt has entered the hub and contaminated the lubricant
- May indicated that the hub on the opposite side of the axle is not disengaging
- Locking hubs can be checked by rotating the brake drum or rotor and turning the hub selector into the locked position

Transfer Case Service Guidelines

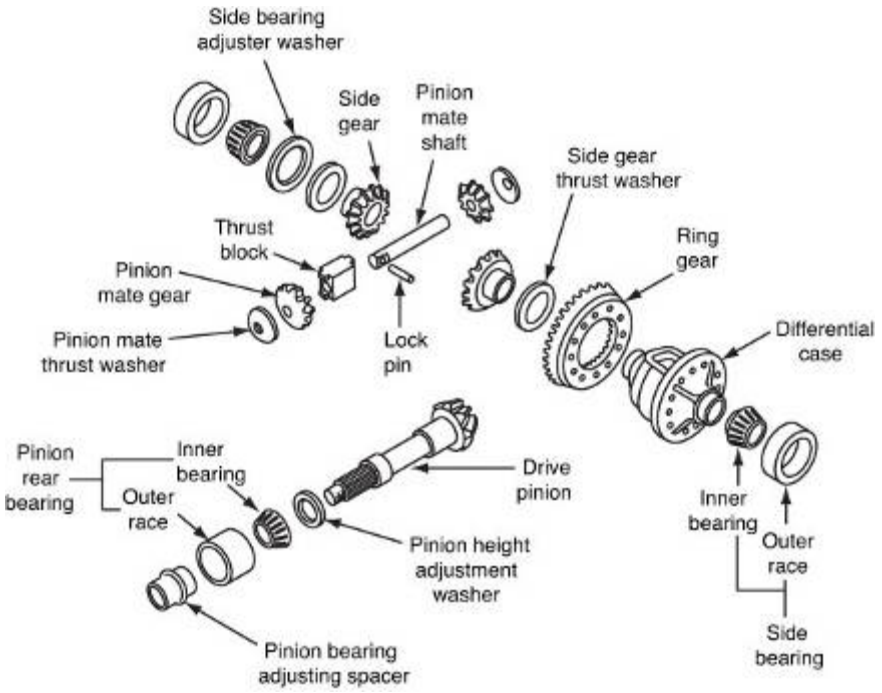
- Always refer to the service manual
- Label all wires before disconnecting them
- Replace all sealing gaskets



- Inspect all parts and replace any that are worn or damaged
- Tighten all fasteners to the proper torque

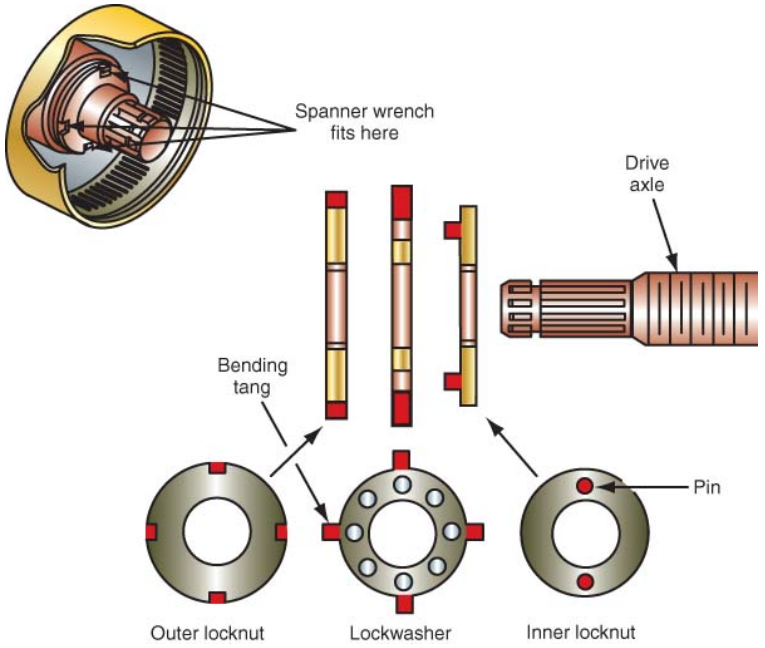
Front Axle and Hub Service Guidelines

- Most front axles are serviced like those in 2WD systems
- Follow the recommended procedure for servicing 4WD hubs
- Some hubs are not serviceable and must be replaced



Wheel Bearing Service Guidelines

- Wheel bearings must be serviced regularly
- Always adjust the wheel bearings during assembly
- Tighten the outer bearing lock nut to specifications

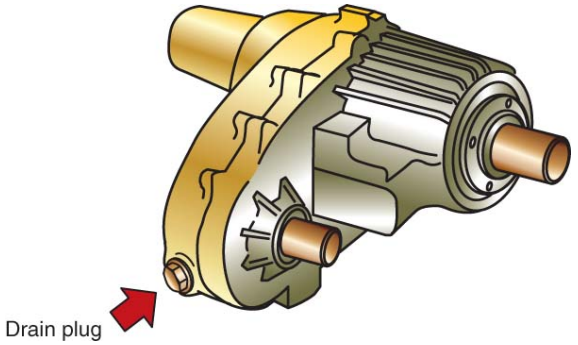


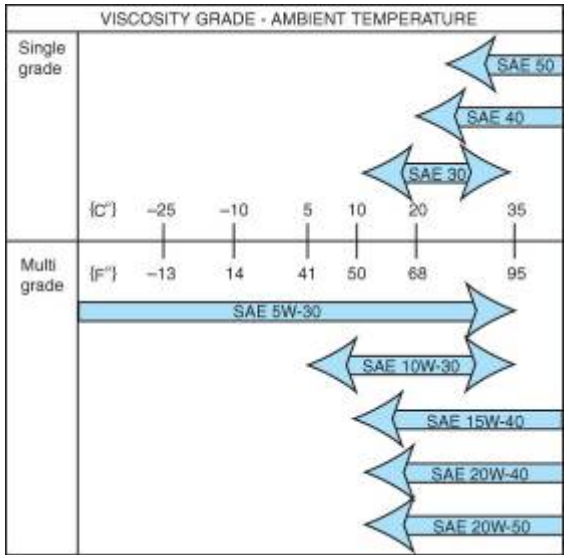
Effects of Vehicle Modifications

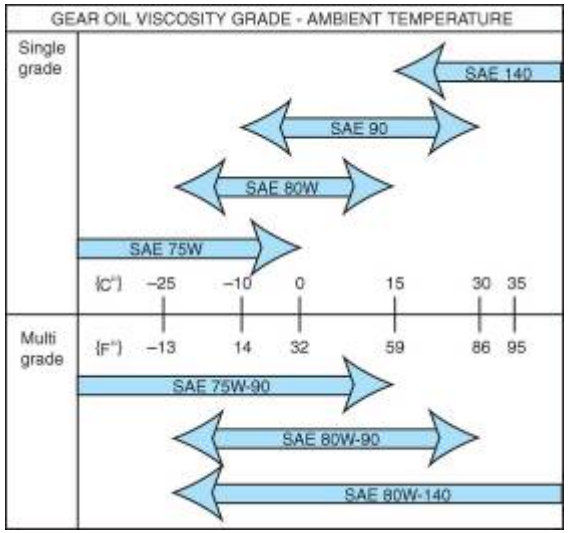
- Installing larger tires and lift kits
  - Alters vehicle handling by changing unsprung weight
  - Increases steering effort
  - Causes a rough ride
  - May cause vehicle to wander and vibrate

Maintenance Tips

- Check the fluid level often
- Check for fluid contamination any time the vehicle has been driven through deep water
- Use only the recommended lubricant
- Always follow the proper towing procedures







Summary

- There are many advantages to 4WD systems, including better traction and handling
- 4WD systems can be classified as either part-time, full-time, or on-demand

Summary *(cont'd)*

- Most transfer cases use a chain drive and a planetary gearset
- 4WD system diagnosis includes talking to the customer, road testing for abnormal noises or vibrations, and visually inspecting the system

Summary *(cont'd)*

- System inspection and service includes checking the transfer case, drive shafts, axle assemblies, steering system, suspension system, and the wheels and tires