

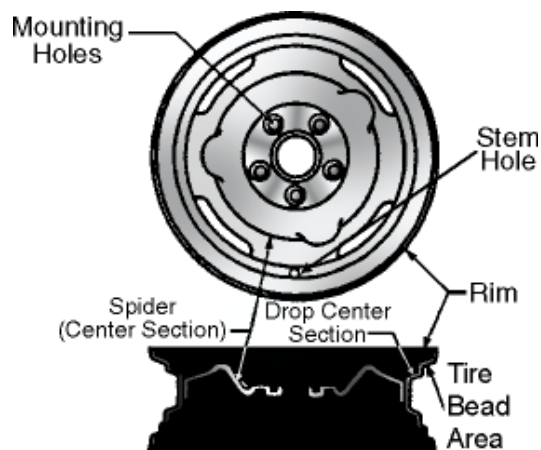
# STEERING AND SUSPENSION SYSTEMS

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## UNIT 12: WHEEL AND TIRE DESIGN

### LESSON 1: WHEEL DESIGN

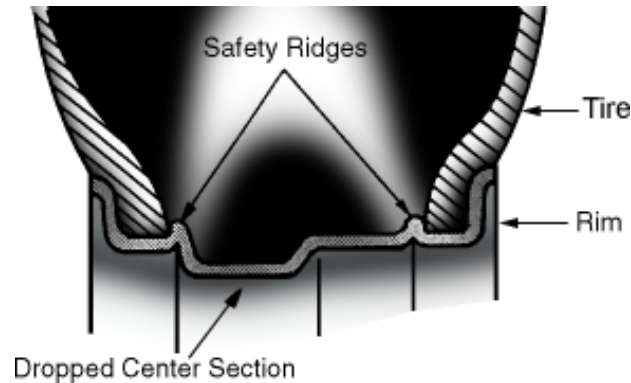
- I. Basic wheel construction
  - A. Wheels are made from stamped steel or cast or forged aluminum or alloys.
  - B. A wheel consists of the following basic parts.
    1. Holes for the mounting wheel lugs
    2. Rim
    3. Hole for a valve stem
    4. Dropped center section
    5. Bead section



- C. The wheel usually has between four and six mounting holes that connect the wheel to the wheel hub of the vehicle.
- D. Wheel sizes are designated by the diameter of the wheel from bead to bead and also by the width of the wheel between the rim flanges. Common wheel diameters for passenger vehicles are 12 in, 13 in, 15 in, and 16 in.

E. Many wheels have safety rims.

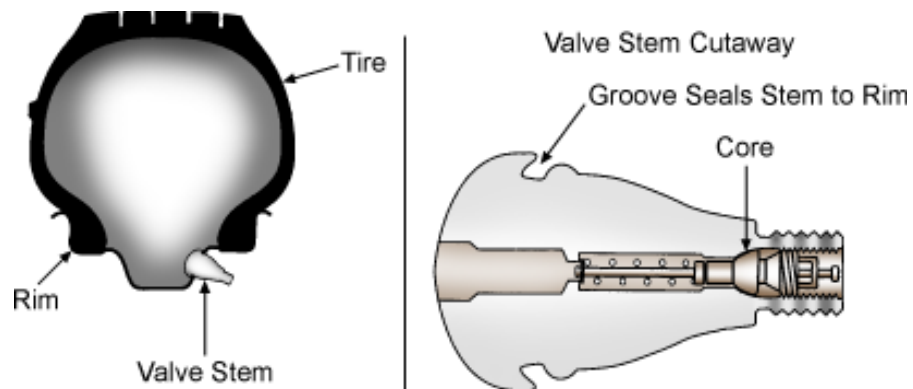
1. The rims have a safety ridge near the lip of the wheel ridge that helps keep the tire from entering the inner depressed part of the wheel.
2. This lip helps to prevent the bead from unseating if the vehicle corners hard or if the tire goes flat while the vehicle is moving.



F. The inner depressed area allows for tire bead clearance; a tire machine is then used to stretch the other bead over the wheel ridge.

G. Valve stems

1. Valve stems are mounted into a wheel. This enables the addition or removal of air from the tire.

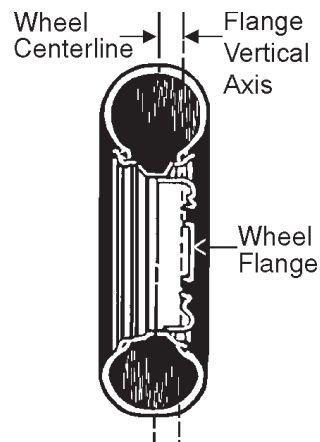


2. If the valve stems are made from rubber, they snap into the hole.
3. Other valve stems are made from metal that are held in place with a nut.

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4. The valve core is located within the stem, allowing air to enter when inflating.
  5. A small return spring keeps a tight seal around the valve core.
- H. Wheel offset
1. Factory-installed wheels are designed with proper clearance for brake and suspension components. Wheels are also designed to distribute the vehicle load evenly on the wheel bearings.
  2. Offset is the distance in inches between the vertical centerline of the rim and the mounting flange of the wheel center.



- a. If the centerline of the rim is inboard to the mounting flange of the wheel center, it is considered a positive offset.
  - b. If the centerline of the rim is outboard to the mounting flange of the wheel center, it is considered a negative offset.
- II. Types of wheel designs
- A. Stamped steel wheels
1. One type of automotive wheel design is made from stamped steel. The wheel consists of two pieces: the center and the rim.
    - a. The center section is riveted or spot welded to the rim (the outer portion).

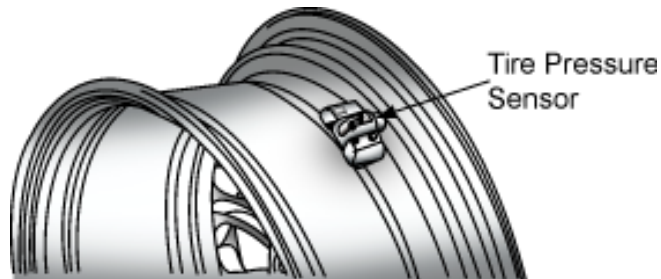
- b. The mounting holes are tapered to match the tapered wheel nuts (lug nuts). The tapering helps to center the wheel on the wheel studs.
- c. These wheels are commonly dressed out with a hubcap.

### B. Cast and forged wheels

- 1. Many wheels today use lighter materials than steel such as aluminum and aluminum alloys.
- 2. Lighter vehicles have better fuel efficiency.
- 3. Aluminum wheels usually have a high-quality finish, so the hubcaps are not normally used.
- 4. The term "mag wheels" is commonly given to wheels made from magnesium or other alloys.

### C. Wheels with tire pressure sensors

- 1. In an effort to reduce accidents due to underinflated tires, the National Highway Traffic Safety Administration has issued legislation requiring all new passenger vehicles to be equipped with tire pressure monitoring systems.
- 2. Many tire pressure monitoring systems use battery-operated sensors that send radio signals to a receiver module. The basic operation of the system is as follows.
  - a. A tire pressure sensor, mounted on the rim and in the valve stem hole of all four wheels on the vehicle and the spare, senses tire pressure and temperature.

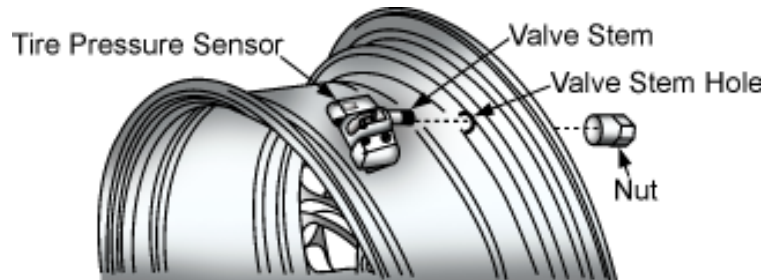


- b. The sensors send the data about each tire to a receiver module. If the tire pressure goes below or above a certain level that is programmed in the system, the module sends a signal to a display on the dashboard to warn the driver.

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3. Basic components
  - a. Tire pressure sensors, which are composed of a transmitter, battery, valve stem with core and cap, mounting nut, and sealing grommet



- b. Electronic receiver module with dashboard console for digital display
  - c. Special magnet tool for programming the tire pressure sensors
4. The following are the advantages of maintaining the proper tire pressure.
  - a. Enhanced safety due to fewer tire blowouts and improved vehicle handling
  - b. Better fuel economy
  - c. Longer tire life

### III. Wheel maintenance

#### A. Wheel offset

1. When replacing a wheel or installing an aftermarket wheel, use a wheel that has the same offset (positive or negative) as the original.
2. Many aftermarket wheels have an offset that is different from the original factory wheel.
  - a. A difference in the offset can affect wheel alignment, vehicle handling, and tire wear.
  - b. A different offset could also affect weight distribution on the spindle and wheel bearings. This causes premature failure of these components.

- B. Wheel runout (See Unit 13, Lesson 3 for more information.)
1. Always replace damaged wheels. Wheels can become damaged from accidents, age (rust), and hitting large potholes or curbs.
    - a. Rims are measured for runout to determine if the wheel is out-of-round. Wheels can have lateral or radial runout.
    - b. Lateral or radial runout is measured with a dial indicator.
    - c. If the wheel runout exceeds the manufacturer's specifications, replace the wheel.
    - d. Excessive wheel runout may cause the vehicle to shimmy or vibrate.
- C. Torque specifications
1. It is important to torque all wheels (steel or alloy) to the proper specifications for the following reasons.
    - a. If the lug nuts are not tight enough, the wheel may fall off while it is driven.
    - b. The lug nuts may vibrate loose. Once they are loose, the wheels can shear the studs off of the hub.
    - c. If the lug nuts are too tight, the disc brake rotor may become distorted or warped.
    - d. If the lug nuts are too tight, the driver may not be able to loosen the lug nuts with a hand lug wrench in an emergency.
    - e. If the wheel studs or nuts become stripped, premature failure occurs.

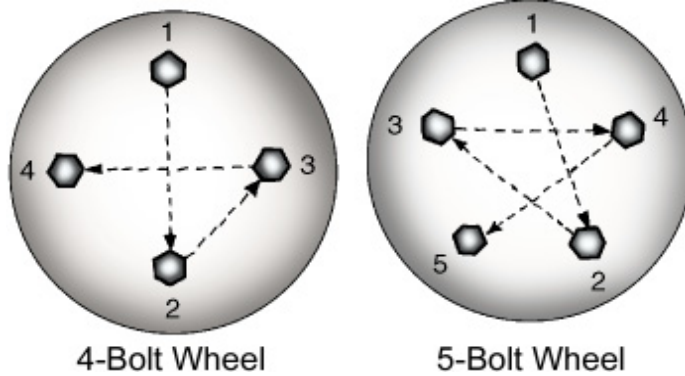


**NOTE:** Lug nut torque specifications typically range from 80 ft-lb (foot-pounds) to 120 ft-lb, but always check the manufacturer's specifications.

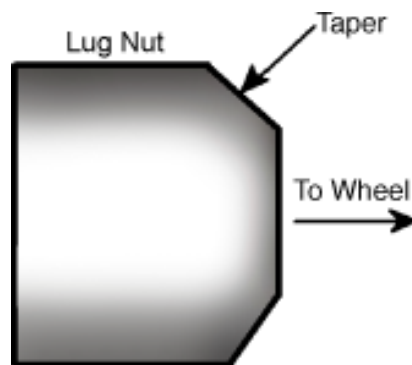
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2. Tighten the lug nuts in the correct sequence. Failure to do so could result in bending or warping the wheel, brake drum, or brake rotor.

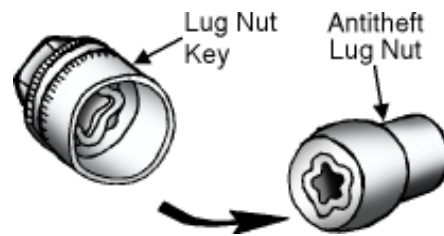


3. When tightening the lug nuts, ensure that the taper of the lug nut is toward the wheel.



- a. Snug the lug nut up to the wheel.
  - b. Then tighten in the correct sequence and to the correct specifications with a torque wrench (manually) or with a torque stick (using pneumatic tools).
4. Antitheft lug nuts are used on many cars today.
    - a. Usually, one antitheft lug nut is used per wheel to prevent someone from stealing wheels and tires from a vehicle.

- b. The manufacturer supplies a special lug nut key that loosens and tightens the antitheft lug nut.



5. Torque sticks are a set (usually four to eight pieces) of color-coded, long-shafted sockets. The shafts have a different diameter.
- a. They work in combination with a pneumatic (impact) wrench to install lug nuts.
  - b. The thicker the shaft's diameter, the higher the torque provided.
  - c. The manufacturer of the torque sticks provides an application chart for most vehicles.