

Introduction to Automotive Service

Chassis Systems

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Introduction to Automotive Service

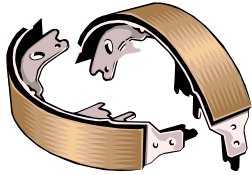
Vehicle Energy

- Vehicles operate by converting chemical energy into heat energy and then into kinetic energy
- Kinetic energy is the energy of mechanical work or motion
- Brakes stop the car using friction to convert kinetic energy into heat energy

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Kinetic Energy

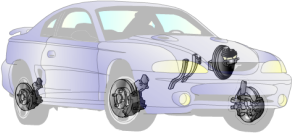
- A vehicle's kinetic energy changes with weight and speed
- $KE = \frac{1}{2} mv^2$
- Sample stopping distances
 - 30 mph – 57 feet
 - 60 mph – 216 feet
 - 95 mph – 607 feet
 - 100 mph – 673 feet



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Brake System Components

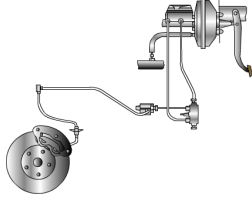
- Master cylinder
- Brake lines
- Hydraulic valves
- Disc brakes
- Drum brakes
- Power assist unit
- Parking brake
- Antilock brake system



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Brake Hydraulic System

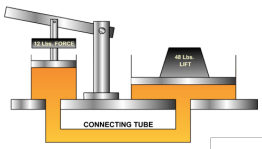
- Master cylinder
- Brake system valves
 - Metering valve
 - Proportioning valve
 - Pressure differential valve
 - Combination valve
- Calipers
- Wheel cylinders
- Hydraulic circuits
 - Front-Rear split
 - Diagonally split



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Brake Hydraulics

- Increasing the size of the output piston
 - Increases output force
 - Decreases output travel
- Disc brakes require more output force than drum brakes



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Brake Hydraulics

1 INCH
PISTON AREA 1 SQ. IN.
1000 LB FORCE OUTPUT
PISTON AREA 4 SQ. IN.
10 INCH TRAVEL

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Brake Hydraulics

1 INCH
PISTON AREA 1 SQ. IN.
500 PSI
1000 LB FORCE OUTPUT
PISTON AREA 4 SQ. IN.
10 INCH TRAVEL

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Brake Fluid

- Most brake fluid is poly-glycol or silicone based
- Poly-glycol brake fluid is hygroscopic
- Poly-glycol based brake fluid will damage automotive finishes
- DOT 3 boils at 401° F
- DOT 4 boils at 446° F
- DOT 5 boils at 500° F
- DOT 5.1 boils at 518° F

Silicone BRAKE FLUID
HEAVY DUTY DOT 5.1 BRAKE FLUID

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Master Cylinder

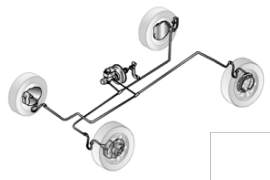
- Brake fluid reservoir
 - Plastic
 - Cast iron
- Master cylinder body
 - contains piston assemblies used to generate hydraulic pressure



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Master Cylinder Operation


- In 1967 DOT required dual-brake systems
- Dual-brake systems utilize two master cylinder pistons
- Brake hydraulic systems are normally split
 - front-rear
 - diagonally



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Disc Brakes

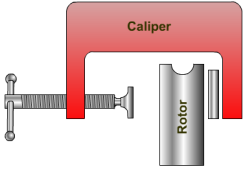
- Floating and fixed caliper designs
- Fade resistant design
- Self adjusting
- Major components
 - Rotor
 - Caliper assembly
 - Brake pads



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Disc Brake Operation

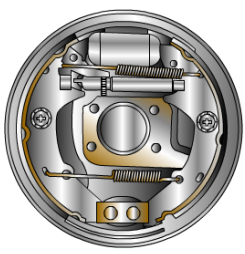
- Hydraulic pressure moves the caliper piston and inner brake pad outward
- The floating caliper assembly then moves inward applying the outer pad and balancing the apply force



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Drum Brakes

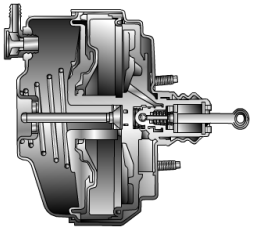
- Duo servo and leading trailing designs
- Major components
 - Brake drum
 - Brake shoes
 - Wheel cylinder
 - Backing plate
 - Springs and installation hardware



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Power Assist Unit

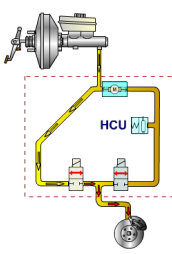
- The power assist unit decreases the necessary pedal effort to apply the brakes
- Three types of power assist units are common
 - Vacuum
 - Hydro-boost
 - Electro-hydraulic



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Antilock Brakes

- The electronic control unit monitors brake pedal application and wheel speed
- Solenoids are used to limit and/or reduce brake apply pressure



The diagram illustrates an ABS system. It shows a master cylinder connected to a Hydraulic Control Unit (HCU). The HCU is connected to two solenoids, which are in turn connected to two wheels. A sensor is shown on one of the wheels, monitoring its speed.

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Tire Identification

- 205/75R15 92H
 - 205 - cross sectional width in mm
 - 75 - aspect ratio
 - R - radial construction
 - 15 - rim diameter in inches
 - 92 - load index
 - H - speed rating

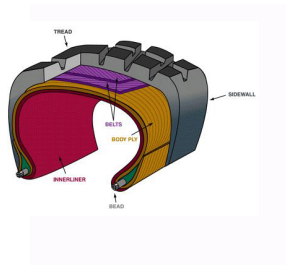


The image shows a Firestone Firehawk tire mounted on a silver alloy wheel. The tire has a tread pattern with several sipes and a central groove.

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Tire Construction

- Tread
 - wear bars
- Sidewall
- Bead
- Body ply
- Belt
- Inner liner

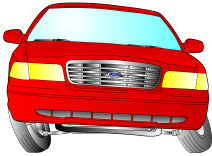


The diagram shows a cross-section of a tire. Labels indicate the following parts: TREAD (the top surface), WEAR BARS (small protrusions on the tread), SIDEWALL (the side of the tire), BEAD (the inner edge where the tire meets the wheel), BODY PLY (the main structure of the tire), BELT (a layer of reinforcement), and INNER LINER (the bottom surface).

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Suspension System

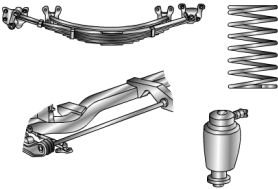
- Support the weight of the vehicle
- Distribute the load to each tire
- Keep the vehicle's wheels in firm contact with the road
- Provide a smooth comfortable ride



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Springs

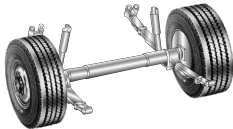
- Springs support the vehicle's weight located above the springs
- Coil springs
- Leaf springs
- Torsion bars
- Air springs



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Non-Independent Suspension

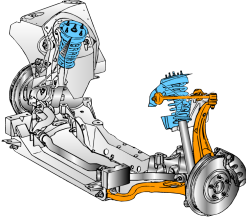
- Solid axle suspended by leaf or coil spring at each end
 - Reliable
 - High load capacity
 - Common on trucks and SUVs
 - Used for front and rear suspension



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Independent Suspension

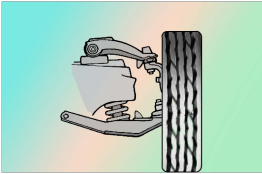
- Allow each wheel on an axle to move independently of the other wheel
 - Light weight
 - Improved ride quality
 - Improved handling
 - Used for front and rear suspension



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Short Over Long Arm

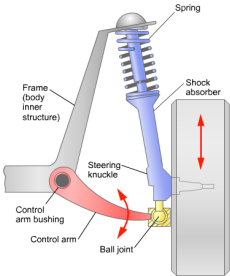
- Two control arms are attached to the frame
- During jounce and rebound the two length control arms move the tire through an arc maintaining the tire to road alignment
- Reduced tire wear, improved ride quality and directional control



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MacPherson Strut

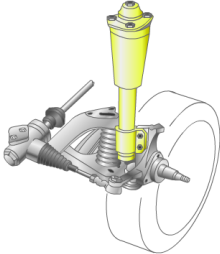
- The spring and shock are combined to form the strut assembly
- The steering knuckle and strut pivot at the lower ball-joint and the upper strut bearing
- Compact design



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Modified MacPherson Strut

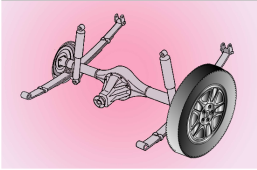
- The coil spring is located between the control arm and frame
- The shock attaches to the steering knuckle and pivots at the lower ball joint and upper strut bearing



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Leaf Spring

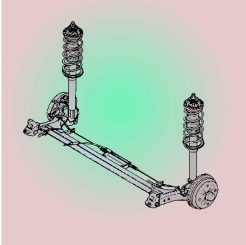
- Leaf springs can support large amounts of sprung vehicle weight
- Leaf springs also provide excellent fore, aft and lateral control of the axle
- Materials other than steel have been used leaf spring production



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Semi-Independent


- A twist beam-type axle is used to reduce jounce and rebound transfer to the other wheel as the vehicle encounters road imperfections
- MacPherson struts are often used to support the vehicle's weight, but an upper strut pivot bearing is not required



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Steering System

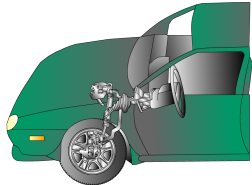
- The steering system allows the driver to control the direction of the vehicle
- A series of linkages connect the steering wheel to the wheels and tires
- Power steering systems use hydraulics or electric motors



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Steering System Types

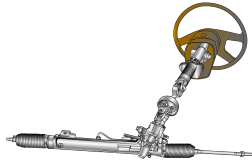
- Rack and pinion
 - Light weight
 - Compact design
- Recirculating ball
 - Minimal internal friction
 - Road shock isolation
 - Commonly used on full size trucks, SUVs and cars



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Rack and Pinion Steering

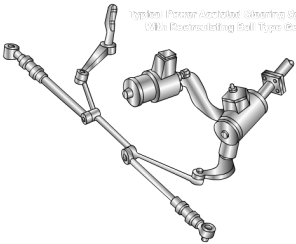
- The pinion is attached to the steering shaft and drives the rack
- The rack is a rod with gear teeth cut along one side
- The rack drives the:
 - Inner tie rod ends
 - Tie rods
 - Outer tie rod ends



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Recirculating Ball Steering

- Uses parallelogram steering linkage
 - Steering gear
 - Pitman arm
 - Center link
 - Idler arm
 - Inner tie rod ends
 - Tie rods
 - Outer tie rod ends

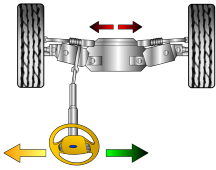


Hydrex / Power assisted steering system with recirculating ball type gear

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Steering Gear Ratios

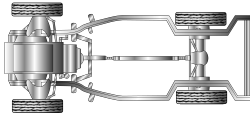
- Steering ratio refers to the number of degrees of driver input in relationship to the number of degrees of tire movement
 - Fast ratio
 - Variable ratio



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Alignment Angles

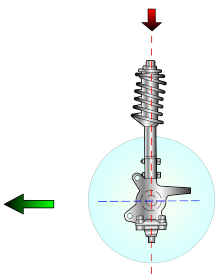
- Proper alignment provides for vehicle control and minimal tire wear
- Three angles are commonly adjustable
 - Caster
 - Camber
 - Toe



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Caster

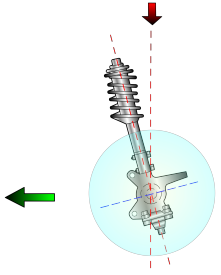
- The forward or rearward tilt of the steering axis as viewed from the side of the vehicle
 - Neutral



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Caster

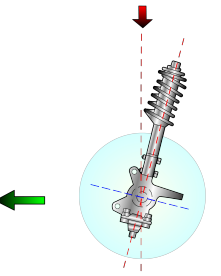
- The forward or rearward tilt of the steering axis as viewed from the side of the vehicle
 - Neutral
 - Negative



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Caster

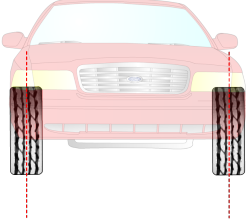
- The forward or rearward tilt of the steering axis as viewed from the side of the vehicle
 - Neutral
 - Negative
 - Positive



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Camber

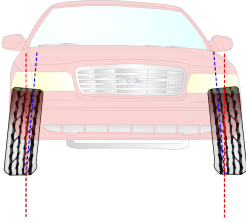
- Inward or outward tilt of the tire when viewed from the front of the vehicle
 - True vertical is referred to as zero camber or camber neutral



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Camber

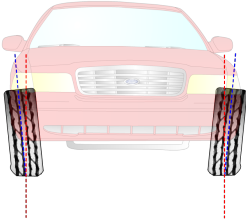
- Inward or outward tilt of the tire when viewed from the front of the vehicle
 - True vertical is referred to as zero camber or camber neutral
 - An inward tilt is referred to as negative camber



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Camber

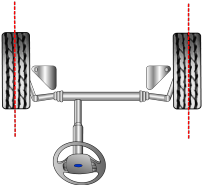
- Inward or outward tilt of the tire when viewed from the front of the vehicle
 - True vertical is referred to as zero camber or camber neutral
 - An inward tilt is referred to as negative camber
 - An outward tilt is referred to as positive camber



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Toe

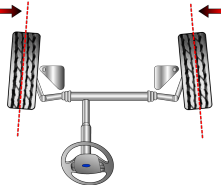
- Measurement of the difference in distance between the front of the tires and the rear of the tires
 - Zero toe



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Toe

- Measurement of the difference in distance between the front of the tires and the rear of the tires
 - Zero toe
 - Toe in or positive toe



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Toe

- Measurement of the difference in distance between the front of the tires and the rear of the tires
 - Zero toe
 - Toe in or positive toe
 - Toe out or negative toe

