Brake system components

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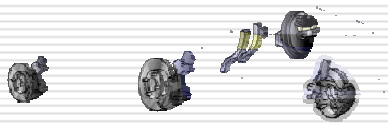
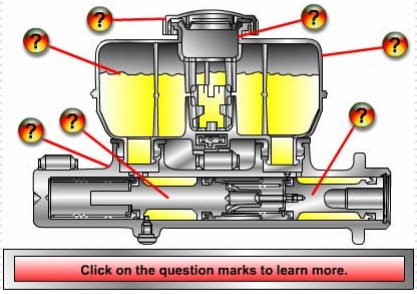
Brake system

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



Master cylinder

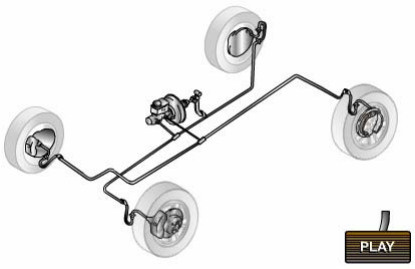


- Foot operated hydraulic pump
- Components:
  - Brake fluid reservoir
  - Housing
  - Pistons
    - Primary
    - Secondary
  - Rubber piston cup
  - Return spring

Dual Master cylinders

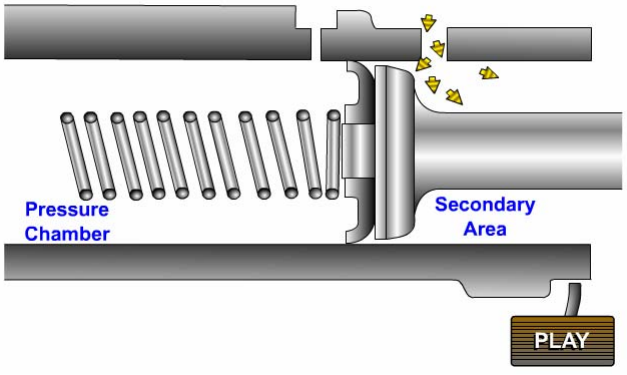
- Two separate hydraulic circuits split front to rear of diagonally.
- DOT mandate 1967 requires dual circuit braking systems.
- These systems use two separate brake pistons in the same bore of the master cylinder.

Master Cylinder operation

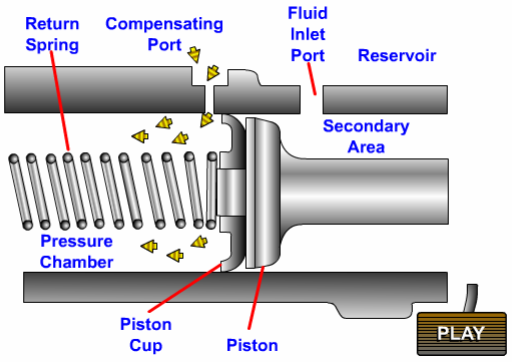


- Your foot applies pressure to the brake lever, which applies mechanical force to the primary piston.
- Pedal pressure is transmitted hydraulically to the secondary piston.
- A complete hydraulic failure in one system would not affect the other.

Fill Port



Compensating Port



Brake pressure control valves

- Control valves ensure that the correct pressure is applied to each individual wheel brake assembly.
- Types used by Ford:
  - Proportioning valve
  - Metering valve
  - Combination valve
  - Height sensing brake valve
  - Shuttle valve

Purpose

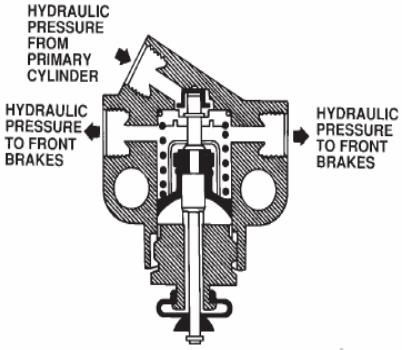
- Proportioning valve:
  - Controls pressure applied to rear drum brakes. Decreases the rate of brake application above a set-point as brakes are applied harder.
- Metering valve:
  - Delays pressure to disc brakes until rear brakes begin to operate. (calibrated springs and cavities)
- Shuttle valve:
  - Used with proportioning valve. Provides higher brake pressure to rear brakes if the front brakes develop a leak. Opens a bypass around proportioning valve.

Purpose

- Combination:
  - Contains the proportioning valve, metering valve, and sometime the shuttle valve.
- Height sensing:
  - Regulates hydraulic pressure to rear brakes based on the amount of load carried by the vehicle.
- Residual Pressure Valve

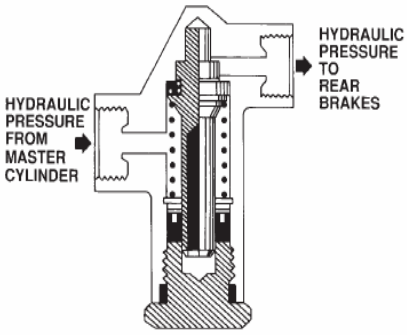
Metering Valve

- The metering valve is used on vehicle designed with disc front and drum rear brakes.
- Used to equalize engagment.
- If the same pressure reached the drum and disc brakes the disc brakes would react faster.
- Disc brakes requires more pressure to operate than drum brakes.



METERING VALVE

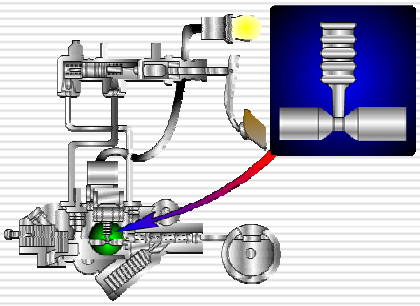
Proportioning Valve



PROPORTIONING VALVE

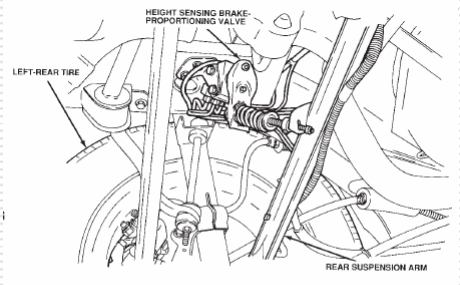
- When the brake pedal is applied the full rear brake pressure passes through the valve until it reaches a set-point.

Combination Valve



- Replaces
  - Metering valve
  - Proportioning valve
  - Pressure differential switch
- Some manufacturers have used a two function combination valve that combines only a pressure differential switch and a proportioning or metering valve

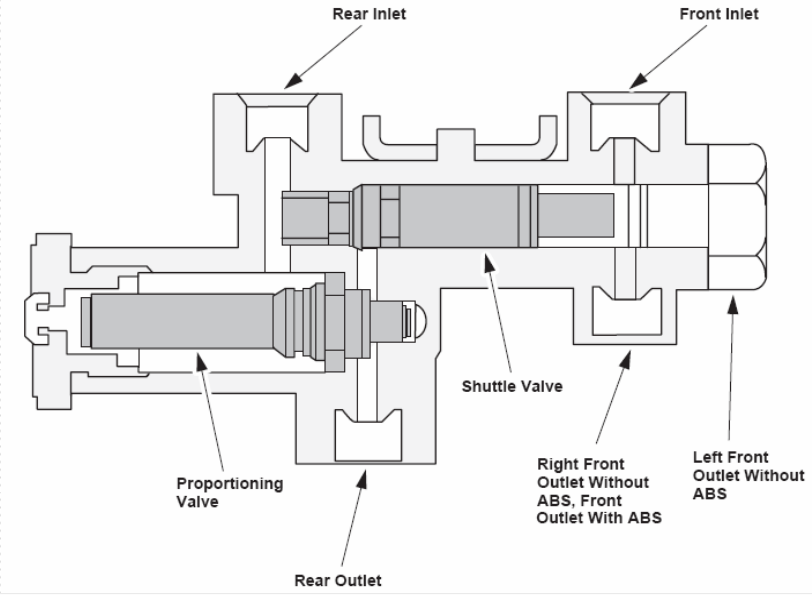
Height Sensing Brake Proportioning Valve



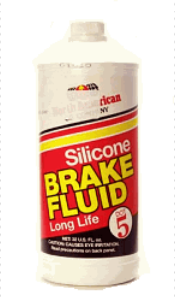
HEIGHT-SENSING PROPORTIONING VALVE

Shuttle Valve

- Safety valve that provides full pressure to rear brakes if front brakes develop a leak.
- Bypasses the proportioning valve.
- If front brake pressure is low the shuttle valve will move uncovering the bypass port.



Brake Fluid

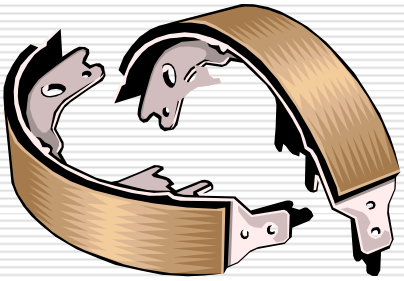


- Brake fluid properties
  - High boiling point
  - Low freezing point
  - Non-corrosive to rubber and metal brake parts
  - Ability to lubricate rubber and metal brake system parts
- Most brake fluid is poly glycol or silicone based although a few European manufacturers have used a mineral oil based brake fluid

Brake fluid charateristics

Fluid Grade	**DOT 3**	**DOT 4**	**DOT 5**	**DOT 5.1**
Fluid Type	Poly Glycol	Poly Glycol	Silicone	Poly Glycol
Boiling Point	401° F	446° F	500° F	518° F

Brake pads (coefficient of friction)



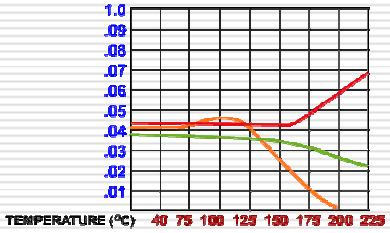
- A brake's linings coefficient of friction is affected by
  - Surface finish
  - Composition
  - Temperature
- Brake linings must resist fading as temperature increases

Friction lining material rating.

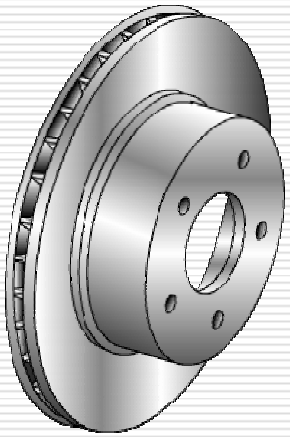
Edge Code	Coefficient of Friction
C	Not over 0.15
D	Over 0.15 but not over 0.25
E	Over 0.25 but not over 0.35
F	Over 0.35 but not over 0.45
G	Over 0.45 but not over 0.55
H	Over 0.55

Brake Pads

- Organic linings
  - Bonded non-metallic fibers
- Semi-metallic linings
  - Commonly constructed of 50% iron, steel and/or copper fibers
- Metallic linings
  - Powdered metal formed into blocks
- Synthetic linings
  - Fiberglass and aramid fibers



Disc Brakes

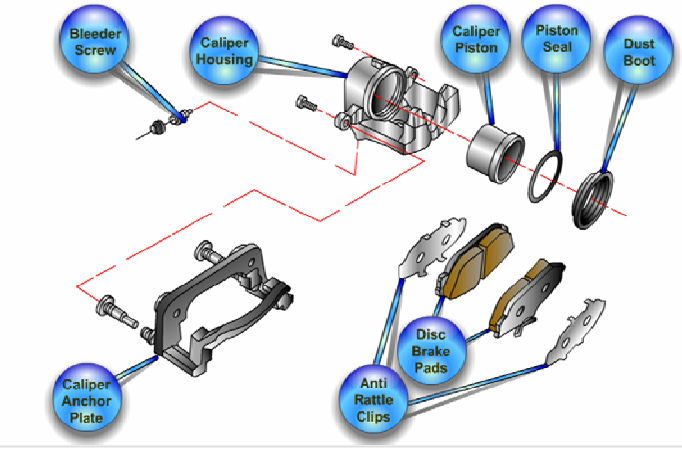


- Fade resistant design
  - Heat
  - Water
- Self adjusting
- Brake noise during normal operation
  - Increased with the use of semi-metallic pads

Disc Brake Parts

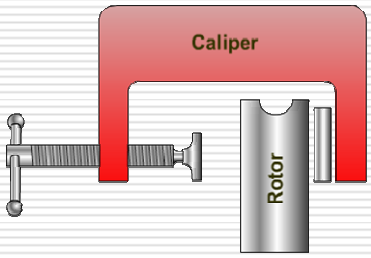
- Rotor
  - Solid or ventilated
- Caliper assembly
  - Caliper housing
  - Piston
  - Square cut piston seal
  - Dust boot
  - Bleeder screw
- Brake pads

Caliper Components

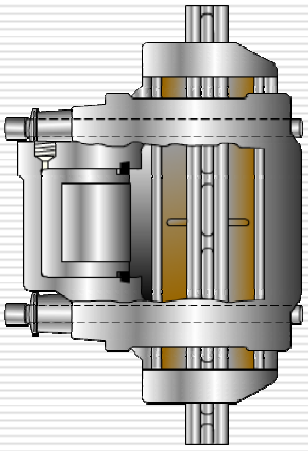


Disc Brake Operation

- 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



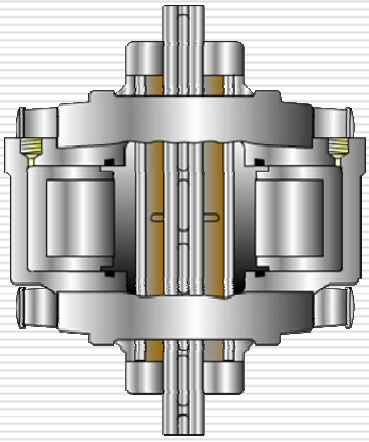
Floating or Sliding Caliper



- The caliper floats on pins or V shaped surfaces allowing the outboard fixed pad to move toward the rotor as the inboard pad is applied

Fixed Caliper

- One or more pistons on each side of the caliper apply the brake pads
- Multiple pistons
  - Increase clamping force
  - Decrease brake pad deflection

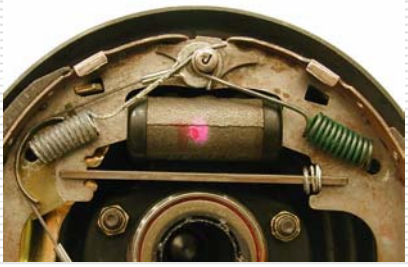


Drum Brakes

- Backing plate
- Wheel cylinder
- Brake shoes
  - Primary and secondary
- Hold down springs
- Brake shoe return springs
- Self-adjuster
- Brake drum

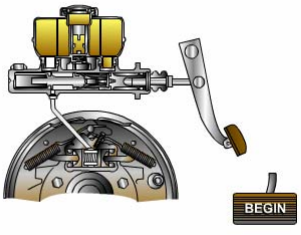
Wheel Cylinders

- Brake system pressure from the master cylinder expands the wheel cylinder's cup seals and forces the pistons outward
- Most wheel cylinders also utilize cup seal expanders to improve sealing when the brake system pressure is not present



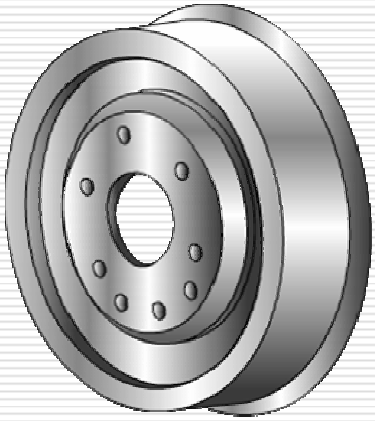
Drum brake operation

- Master cylinder pressure moves the wheel cylinder pistons and brake shoes outward
- When the pressure is released the brake return springs move the brake shoes back to their original position

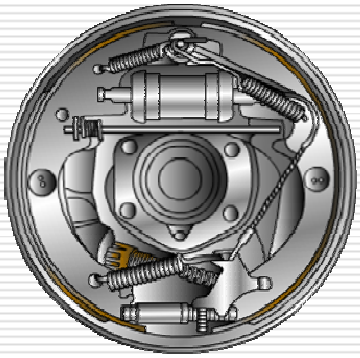


Drum brake operation

- Drum brakes are mechanically self energizing when applied
- Two drum brake designs are common
  - Duo Servo
  - Balanced or leading-trailing

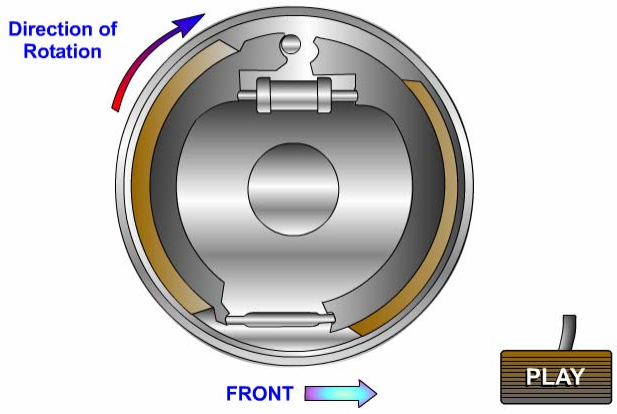


Duo servo



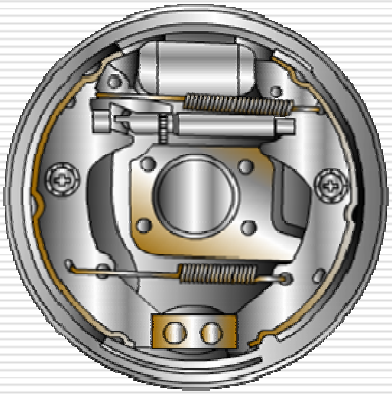
- Duo servo drum brakes require the least apply pressure
- Hydraulic pressure moves the wheel cylinder pistons and brake shoes outward
- The shoes contact the rotating drum and the primary shoe forces the secondary shoe into the drum

Duo servo operation

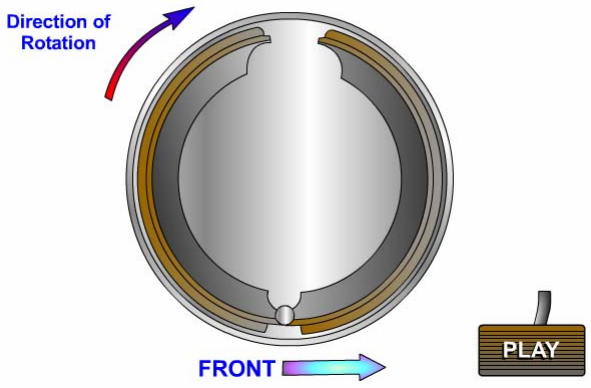


Leading trailing

- Hydraulic pressure moves the wheel cylinder pistons and brake shoes outward
- The rotating drum forces the leading shoe into the anchor pin and the trailing shoe contacts the drum on its trailing edge.



Leading trailing operation

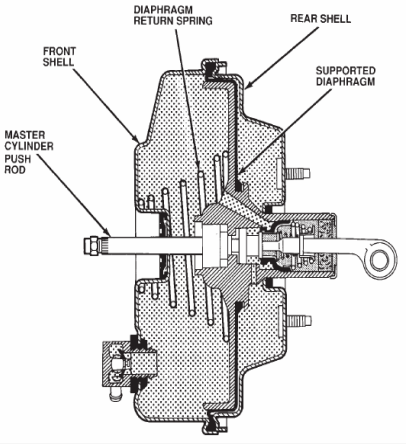


Operator power assist

- Vacuum booster
  - Requires vacuum for operation
- Hydro-Boost
  - Uses power steering pump
- Anti-lock
  - Uses anti-lock motor to charge accumulator

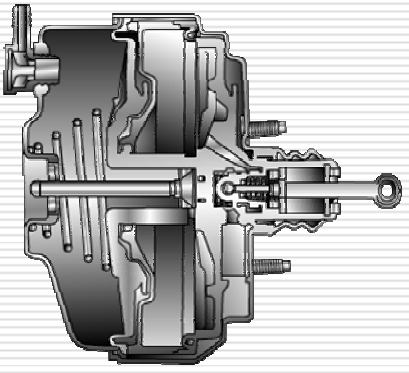
Vacuum booster components

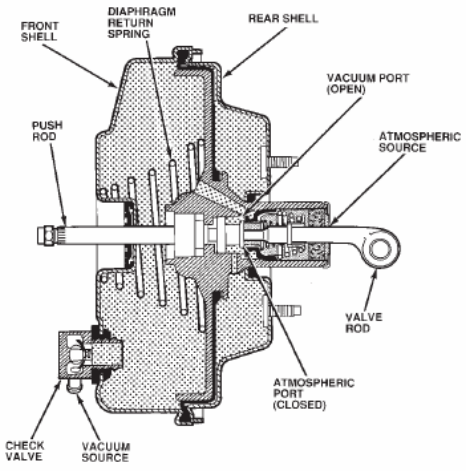
- Master cylinder pushrod:
  - Not field adjustable
- Front/Rear shell
  - Housing for and support for diaphragm
- Return spring
  - Returns diaphragm to not applied position
- Input rod.



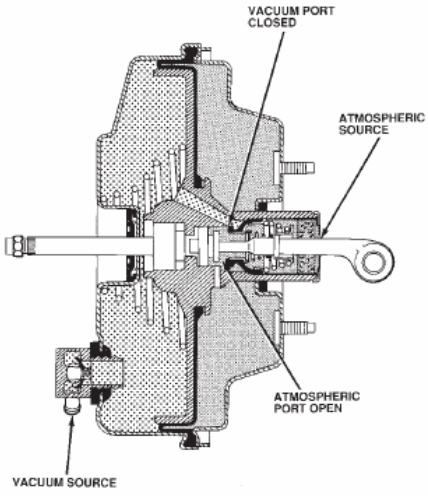
Vacuum Boost

- Three modes of operation
  - Released
  - Applied
  - Holding

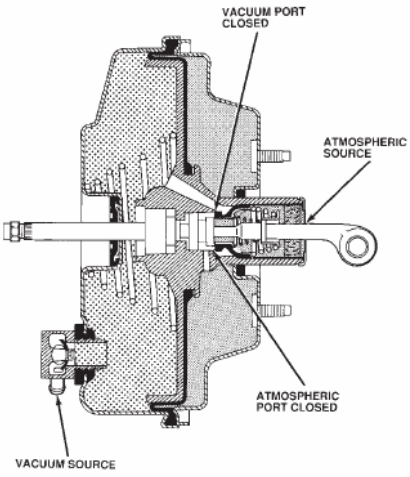




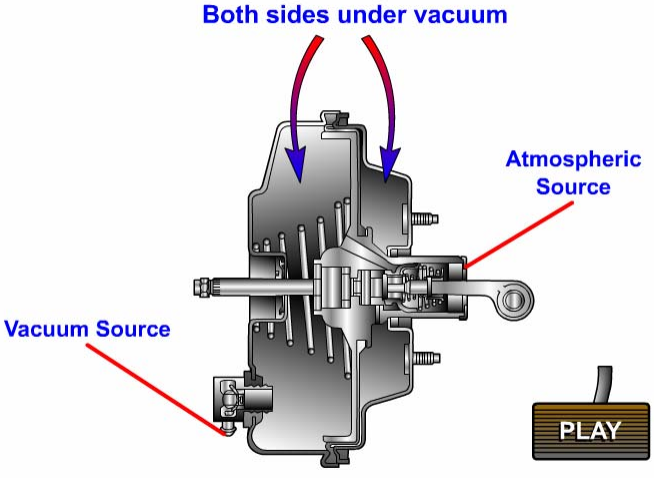
Vacuum Booster in Released Position



Vacuum Booster in Applied Position

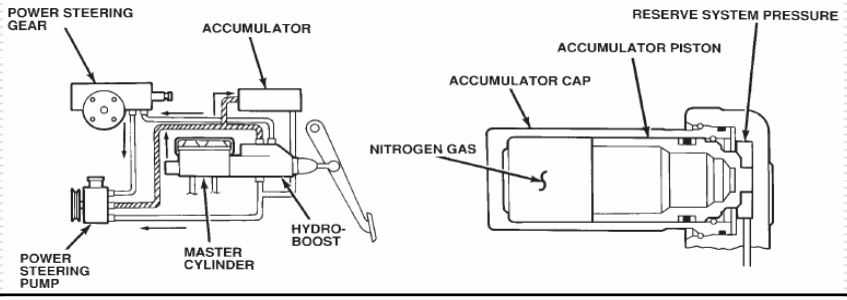


Vacuum Booster in Holding Position



Hydro-Boost

- The power steering pump provides the pressures needed for power assist.
- Uses an accumulator for safety situations when the engine may die.



Hydro-Boost fluid flow