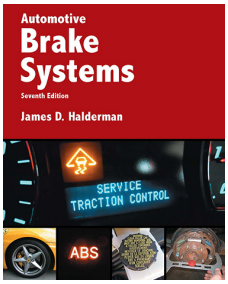
Automotive Brake Systems



CHAPTER 05

Brake Hydraulic Systems

OBJECTIVES

- Explain how the noncompressibility of liquids is used in brakes
- Explain how hydraulic force can be used to supply high pressures to each individual wheel brake.
- State Pascal's law.
- Describe the function, purpose, and operation of the master cylinder.

OBJECTIVES

- Discuss dual split, diagonal split, and quick take-up master cylinders.
- Describe the process of diagnosing and troubleshooting master cylinders.

HYDRAULIC PRINCIPLES

- Noncompressibility of Liquids
  - Hydraulic systems use liquids to transmit motion
  - No matter how much pressure is placed on a quantity of liquid, its volume remains the same
  - This fact enables liquids in a closed system to transmit motion
  - Air trapped in the system can be compressed

PASCAL'S LAW

- Hydraulic principles that permit a brake system to function were discovered by Blaise Pascal (1632–1662)
- Pascal's law states that "when force is applied to a liquid confined in a container or an enclosure, the pressure is transmitted equal and undiminished in every direction"

PASCAL'S LAW

- Hydraulic Principles and Brake Design
  - Hydraulic relationships play a major part in determining the sizes of the many pistons within a brake system
  - The sizes must move enough fluid to operate the wheel cylinder and brake caliper pistons through a wide range of travel, while at the same time they must create enough application force to lock the wheel brakes

PASCAL'S LAW

- The sizes chosen should also provide the driver with good brake pedal "feel" so the brakes are easy to apply in a controlled manner

MASTER CYLINDERS

- Purpose and Function
  - The master cylinder is the heart of the entire braking system
  - Brake pedal linkage is used to apply the force of the driver's foot into a closed hydraulic system that begins with the master cylinder

MASTER CYLINDERS

- Master Cylinder Operation
  - Brake pedal movement and force are transferred to the brake fluid and directed to wheel cylinders or calipers
  - The master cylinder is separated into two pressure-building chambers (or circuits)
  - Both sections contain two holes from the reservoir

MASTER CYLINDERS

- The Society of Automotive Engineers' (SAE) term for the forward (tapered) hole is the vent port, and the rearward straight drilled hole is called the replenishing port
- The vent port might also be called the high-pressure port or the compensating port

MASTER CYLINDERS

- The replenishing port is the low-pressure rearward, larger diameter hole and might also be called the bypass port, filler port, or breather port
- The function of the master cylinder can be explained from the at-rest, applied, and released positions
  - At-rest position
  - Applied position
  - Released position

MASTER CYLINDER DESIGNS

- Dual Split Master Cylinders
  - Dual split master cylinders use two separate pressure-building sections (one operates the front brakes and the other operates the rear brakes on vehicles equipped with a front/rear-split system)
  - The nose end of the master cylinder is the closed end toward the front of the vehicle

MASTER CYLINDER DESIGNS

- The open end is often called the pushrod end
- The nose end is considered the more reliable of the two sections
- The primary piston extension rod will mechanically contact and push on the secondary piston to permit operation in the event of a hydraulic failure of the rear section

MASTER CYLINDER DESIGNS

- If there is a failure of the front section hydraulic system, the primary piston operates normally and exerts pressure on the secondary piston
- The secondary piston, however, will not be able to build pressure because of the leak in the system

MASTER CYLINDER DESIGNS

- Diagonal Split Master Cylinders
  - The left front brake and the right rear brake are on one circuit, and the right front with the left rear is another circuit of the master cylinder
  - If one circuit fails, the other circuit can reasonably stop the vehicle because each circuit has one front brake

MASTER CYLINDER DESIGNS

- To prevent the one front brake from causing the vehicle to pull toward one side during braking, the front suspension is designed with negative scrub radius geometry to eliminate any handling problem in the event of a brake circuit failure

MASTER CYLINDER DESIGNS

- Quick Take-Up Master Cylinders
  - Quick take-up master cylinders include a larger diameter primary piston (low-pressure chamber) and a quick take-up valve
  - This type of master cylinder is also called dual-diameter bore, step-bore, or fast-fill master cylinders

MASTER CYLINDER DESIGNS

- A spring-loaded check ball valve holds pressure on the brake fluid in the large diameter rear chamber of the primary piston
- When the brakes are first applied, the movement of the rear larger piston forces a larger volume of brake fluid forward past the primary piston seal and into the primary high-pressure chamber

MASTER CYLINDER DESIGNS

- The extra volume of brake fluid "takes up" the extra clearance of the front disc brake calipers without increasing the brake pedal travel distance

DIAGNOSING & TROUBLE-SHOOTING MASTER CYLINDERS

- After a thorough visual inspection, check for proper operation of pedal height, pedal free play, and pedal reserve distance
- Proper brake pedal height is important for the proper operation of the stop (brake) light switch

DIAGNOSING & TROUBLE-SHOOTING MASTER CYLINDERS

- Pedal reserve height is easily checked by depressing the brake pedal with the right foot and attempting to slide your left foot under the brake pedal
- Free play is the distance the brake pedal travels before the primary piston in the master cylinder moves

MASTER CYLINDER SERVICE

- If disassembling a master cylinder, perform the following steps:
  - STEP 1: Remove the master cylinder from the vehicle, being careful not to drip or spill brake fluid onto painted surfaces of the vehicle. Dispose of all old brake fluid and clean the outside of the master cylinder.
  - STEP 2: Remove the reservoir, if possible.

MASTER CYLINDER SERVICE

- STEP 3: Remove the retaining bolt that holds the secondary piston assembly in the bore.
- STEP 4: Depress the primary piston with a blunt tool such as a Phillips screwdriver, a rounded wooden dowel, or an engine pushrod. Use of a straight-blade screwdriver or other non-rounded tool can damage and distort the aluminum piston.

MASTER CYLINDER SERVICE

- STEP 5: Remove the snap ring and slowly release the pressure on the depressing tool. Spring pressure should push the primary piston out of the cylinder bore.
- STEP 6: Remove the master cylinder from the vise and tap the open end of the bore against the top of a workbench to force the secondary piston out of the bore. If necessary, use compressed air in the outlet to force the piston out.

SUMMARY

- Pascal discovered hydraulic principles that permit a brake system to function.
- The master cylinder is the heart of the entire braking system.
- Dual split master cylinders use two separate pressure-building sections.
- After a visual inspection, check for proper operation of pedal height, pedal free play, and pedal reserve distance.