Module 5: Power Assisted Systems and Related Components

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Power Booster or Brake System

READY FOR REVIEW

- The power booster assists the driver by reducing the amount of effort that has to be applied to the brake pedal during braking.
- A power booster or power brake system uses a vacuum to multiply the driver's pedal effort and apply that to the master cylinder. This increases the pressures available from the master cylinder.
- Units on gasoline engines use the vacuum produced in the intake manifold, and vehicles with diesel engines cannot use a manifold vacuum so they are fitted with an engine-driven vacuum pump.
- The most common booster operates between the brake and the master cylinder, and it increases the force that acts on the master cylinder.
- Whenever the brake pedal is depressed, a pushrod opens the vacuum-control valve.
- A vacuum from the engine lowers the pressure in the chamber, forcing the diaphragm forward and increasing the pressure on the master cylinder pistons.
- The level of assistance this power-boost gives depends on the pressure applied to the brake pedal.

Hydraulic Brake Booster

READY FOR REVIEW

- The hydraulic brake booster uses hydraulic pressure generated by the power steering pump rather than the engine vacuum to provide the power assistance required.
- Many vehicles are now equipped with hydraulically-assisted boosters for brakes, and the system uses hydraulic pressure generated by the power steering pump rather than engine vacuum to provide power assistance required in a conventional system.
- Application is particularly suitable to vehicles with diesel engines, as a separate vacuum source does not have to be provided for the system to operate.
- The system uses fluid pressure from the existing power steering pump, and the booster uses pressure from fluid that is always circulating through it as a source of pressure that applies against the master cylinder actuating piston.
- Hydraulic pressure generated by the power steering pump is stored in the accumulator, which is then routed to the master cylinder by a hydraulic booster unit when the brake pedal is applied.
- When applied, the booster can generate pressures of between 1,200 to 2,000 pounds per square inch (psi) or 8,273 to13,789 kilopascal (kpa) to brake calipers.
- Systems are generally available with or without a matched master cylinder, and systems that have included the master cylinder have a reservoir as part of its assembly.
- As a safety measure, part of the system includes a component to assist in the maintenance of the system pressure known as an "accumulator." Some are nitrogen-pressurized, while others are spring-loaded, depending on application.
- In cases where the pressure is lost (such as when the engine stalls or the power steering pump drive belt breaks), the systems accumulator is designed to store sufficient pressure to provide for three full-power applications.
- If stored pressure is insufficient, the system then resorts to manual brakes.
- Operation problems can be caused by a number of things such as leaks inside the booster unit, a worn power steering pump, a slipping or broken pump drive belt, or hose connections.

- A simple way to test the system is to pump the brakes five or six times with the engine off to discharge the accumulator, press down hard on the pedal, and then start the engine. Like a vacuum booster, the pedal should be felt falling slightly when the engine starts, and then rise again.
- A leak-down in relation to capacity of the accumulator can be checked by pumping the brakes several times while the engine is running and then shutting the engine down. The vehicle should then be left for about an hour, and the brakes applied without starting the engine. In an efficient and operational system, it should be possible to get two or three soft brake applications before it takes more effort to push the pedal.

Electrohydraulic Braking (EHB)

READY FOR REVIEW

- Electrohydraulic braking (EHB) replaces the current modulator with one that includes a high pressure accumulator.
- EHB gets rid of the vacuum booster and replaces the current modulator with one that includes a high pressure accumulator.
- Like the Hydro boost system, it uses an accumulator to provide the required pressure to activate the master cylinder; however, it uses electrical power to effectively "charge" the accumulator and build sufficient pressure for efficient brake operation.
- This system means that less power is taken away from the engine during operation as battery power is used, and there is no chance of problems caused by things such as a worn power steering pump, a slipping or broken pump drive belt, or hose connections.

Terms and Definitions

READY FOR REVIEW

- An accumulator is a device used to store power.
- Brake fluid is a glycol-based substance used to transmit force in hydraulic brake systems.
- A diaphragm is a thin, flexible membrane used to separate two areas, and it flexes in response to changes in air pressure on each side of it.
- Differential is the difference in air pressure from one side to another.
- Hydraulic oil is a petroleum-based substance used in hydraulic pumps.

  Note: Hydraulic oil includes power steering fluid and automatic transmission fluid. These fluids are often grouped together and may be called hydraulic fluids, but remember that brake fluid does not belong to this group, and chemically, it is very different from hydraulic oil. Brake fluid cannot be mixed with or used as a substitute for any other type of fluid.
- A power assist unit is a device used as a booster in a brake system.
- Tandem means consisting of parts arranged one behind the other, usually acting in partnership.
- A vacuum is space without air, and usually has different air pressures on each side that creates a force that can be used as an energy source.

Purpose of a Power Assist Unit

READY FOR REVIEW

- The purpose of a power assist unit is to increase or "boost" the force of the brake pedal, thereby decreasing the braking effort by the vehicle operator.

Basic Types of Power Assist Units (Boosters)

READY FOR REVIEW

- Vacuum power assist units
  - A vacuum created to separate two different air pressures lower vacuum pressure on one side of the piston or diaphragm and increase atmospheric pressure on the other side. The pressure differential of approximately 10 psi is used to assist the power of the brake unit.
  - The vacuum source is typically from an intake manifold on gasoline engines or a vacuum pump on diesel engines.
  - It is used primarily on light-duty vehicles and some medium-duty vehicles, especially gasoline-powered ones.
- Hydraulic power assist units
  - Assist in applying a hydraulic force to the master cylinder, thereby increasing brake system effectiveness
  - Involve the engine-driven hydraulic pump or power steering pump (more common) as an energy boost source
  - Used on the majority of medium-duty and heavy-duty vehicles with hydraulic brake systems

Parts of a Vacuum Power Assist Unit

READY FOR REVIEW

- Output push rod (to master cylinder)
- Front housing
- Rear housing
- Valve spring
- Filter
- Hub
- Diaphragm return spring
- Valve assembly
- Plunger cushion ring
- Plunger spring
- Push rod retainer
- Plunger
- Diaphragm
- Input push rod (from brake pedal)

Parts of a Hydraulic Power Assist Unit and Related Components

READY FOR REVIEW

- Master cylinder
- Integral flow switch assembly
- Return port
- Inlet pressure port
- Check balls
- Pressure regulator assembly
- Input push rod
- Reaction piston
- Pressure valve
- Power piston
- Electric motor pump assembly
- Vented area
- Output push rod

Functions of the Basic Parts of Power Assist Units

READY FOR REVIEW

- An input push rod transfers force from the brake pedal to the booster piston.
- Housing protects components of the power assist unit.
- Return springs return a vacuum diaphragm or hydraulic booster (power) piston to the normal position when the brakes are released.
- Booster pistons and/or the plungers move in response to pressure changes and transmit force from input to output push rods.
- Control valve assemblies (check balls, pressure regulators, filters, etc.) monitor and regulate energy sources (vacuum or hydraulic) in response to brake pedal application and release.
- An output push rod transmits force from the booster piston or plunger to the master cylinder piston.
- Ports allow for connections of the power assist unit with other brake components or related components.

Most Common Problems Associated with Power Assist Units

READY FOR REVIEW

- Hard brake pedal (excessive pedal pressure required to stop)
- Excessive brake pedal travel
- Sluggish application and release
- Grabby brakes (apparent off-on condition)
- Brakes fail to release.
- Leaks (vacuum or hydraulic)
- Excessive pump noise (chatter, gurgle, etc.)
- Inoperative pump
- Improper operation of the electrical system shown by the brake lights, the electrohydraulic/electric pump, and any electrical accessories

Adjustment of the Brake Booster Push Rod

READY FOR REVIEW

- The output push rod is typically adjusted using the adjustment screw on the push rod.
- Adjustment is necessary to maintain the correct relationship between the booster control valve plunger and the master cylinder piston.
- If the push rod is too long, it will prevent the master cylinder piston from completely releasing hydraulic pressure, causing the brakes to drag.
- If the push rod is too short, it will cause excessive pedal travel and an undesirable clunk in the booster area.
- The master cylinder will have to be removed in order to gain access to the brake booster push rod.
- A height gauge will need to be fabricated according to the manufacturer's specifications to check the correct push rod length.

Operation of Emergency Back-Up Systems—Electrohydraulic Pump

READY FOR REVIEW

- This is typically a vane-type pump that acts as the reserve or back-up power source to provide boost pressure whenever there is no flow through the hydraulic booster system. This would occur when the engine is off or if a hose or belt is broken.
- It is usually mounted to the bottom of the booster housing.
- When the electrohydraulic pump is operating, it draws fluid from the low pressure side of the booster (power) piston and delivers it to the high pressure or rear side.
- Normal output pressure of the electrohydraulic pump is about one-half of the main brake hydraulic pump or power steering pumps.
- It is typically used on medium- and heavy-duty vehicles.

Operation of Emergency Back-Up Systems—Accumulator

READY FOR REVIEW

- This device stores force from the power steering pump.
- It will act as a reserve power source in case of failure from the main hydraulic source.
- It is typically used on light and medium-duty vehicles.

Use of Brake Fluid and Power Steering Fluid on Power Assist Units

READY FOR REVIEW

- The master cylinder and the brake system use standard glycol-based brake fluid.
- The hydraulic power assists unit (booster) and the hydraulic brake pump or power steering pump use petroleum-based power steering fluid (hydraulic oil).
- Do not mix brake fluid and power steering fluid, as fluid contamination results in seal damage that can lead to eventual loss of braking ability.
- If the hydraulic power assists system becomes contaminated, flush with clean power steering fluid.
- Always make sure you are replacing fluids with the correct type.
- Do not reuse brake system fluids.
- Always discard used fluids properly.
- Do not spill brake fluids on the brake linings or on any chrome or painted surfaces.
- Store both brake fluid and power steering fluid away from heat or flame, as they are both flammable.
- Avoid skin and eye contact with both types of fluids, and wash with soap and water if skin contact occurs. In case of eye contact, immediately wash eyes for 15 minutes and call a physician or poison control center for additional instructions.

