Module 6: Air Foundation Brakes

Air Brakes

READY FOR REVIEW

- Air-operated braking systems are used on heavy vehicles, and compressed air, operating on large-diameter diaphragms, provides the large forces at the brake assembly that are needed.
- An air compressor pumps air to storage tanks, and driver-controlled valves then direct the compressed air to different wheel units to operate the friction brakes.
- On articulated vehicles any delays in applying the trailer brakes should be minimized, and this is achieved using a relay valve and a separate reservoir on the trailer.
- This arrangement also applies the brakes if the trailer becomes disconnected from the prime-mover.

Terms and Definitions

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- An **actuator** is a device that physically initiates the mechanical motion of a brake system component.
- An **anchor pin** is the hardware used to retain brake shoes within the brake assembly.
- **Brake drag** is failure of one or more brakes to release immediately and/or completely after the driver removes his or her foot from the brake treadle.
- **Brake fade** is the reduction in braking force, usually caused by the inability of the brake lining to maintain its low temperature effectiveness as the brakes get hot.
- A **caliper** is a clamping device used in a disc brake system that applies braking force to both sides of the rotor.
- A **cam** is a mechanical part with an irregular shape so that the rotation of the part causes movement of another part.
- **Clearance** is the distance between two parts.
- A **clevis pin** is a pin connecting the arm of a slack adjuster to a brake chamber push rod.
- The **coefficient of friction** is a number that describes the gripping capacity of a material.
- A **diaphragm** is a flexible membrane that moves in response to changes in air pressure.
- A **drum** is part of the wheel assembly that is engaged by the brake shoes to slow or stop the vehicle.
- A **foundation brake** is the actual braking mechanism at each end of the axle.
- A **parking brake** is part of the brake system designed to hold the vehicle in place when the vehicle is parked.
- **Recovery** is the return of the brake lining to its previous (pre-fade) friction level after a hot run.
- A **return spring** is a device that retracts brake shoes upon release of the brake treadle.
- A **service brake** is a portion of the brake system used for normal brake applications.
- A **slack adjuster** is a device that provides a means of adjusting clearance between the brake shoes and the drum to compensate for lining wear.
- A **spring brake** is a tandem-chamber brake actuator that incorporates an air-applied service brake chamber and an air-release/spring-applied parking or emergency brake chamber and is used on rear axles.
- **Stroke** is the linear distance traveled by a brake chamber push rod or slack adjuster arm during brake application.

Basic Components That Make Up Air Foundation Brakes

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- Brake chamber or actuator
  - Converts air pressure into mechanical force
  - Joins the air system to the mechanical brake system
- Slack adjuster or wedge assembly
  - Transfers movement from the brake chamber push rod to apply the brakes
  - Serves as the link between the brake chamber or actuator and the mechanical brake mechanism
- Mechanical brake mechanism
  - Applies the force needed to stop the vehicle
  - Includes the brake linings (friction material), brake drums and shoes, or brake discs (rotors) and pads

Types of Air Foundation Brakes

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- Cam or s-cam drum brake
  - Linked to the air system and service brake chamber by the slack adjuster, which is installed on the brake camshaft
  - When torsion force from the slack adjuster is applied to the camshaft, the cam spreads the brake shoes, forcing the brake lining into contact with the brake drum, thereby stopping the vehicle.
  - Most common design of air foundation brakes used today
- Wedge drum brake
  - Does not use slack adjusters or camshafts.
  - Instead uses a wedge/roller mechanism that spreads the brake shoes and forces them against the drum.
  - A wedge and roller mechanism is enclosed within the actuator and chamber tube.
- Disc brake
  - Uses a powershaft screw and nut to force the piston and inboard lining (pad) against the disc (rotor)
  - Engages the caliper, which puts the outboard pad into contact with the disc
  - The result is a clamping force on both sides of the disc.

Parts of a Cam Foundation Brake

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- Camshaft bushing
- "S" head camshaft
- Anchor pin
- Shoe retaining spring
- Brake shoe and lining assembly
- Dust shield
- Automatic slack adjuster
- Shoe roller
- Shoe return spring
- Spider

Parts of a Wedge Foundation Brake

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- Wedge assembly
- Plunger guide and adjusting pawl assembly
- Adjusting bolt assembly
- Plunger seal and retainer
- Guide screw
- Anchor plunger (solid)
- Anchor seal
- Brake air chamber assembly
- Brake shoe return spring
- Brake spider
- Brake shoe assembly
- Adjusting sleeve (actuator)
- Adjusting plunger

Parts of a Disc Foundation Brake

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- Caliper
- Brake shoe piston
- Actuator nut
- Powershaft
- Powershaft cap
- Shoe and lining assembly (outer)
- Torque plate assembly
- Rotor (disc)
- Shoe and lining assembly (inner)
- Retainer pin assembly
- Snap ring
- Capscrew
- Automatic slack adjuster
- Air chamber bracket
- Powershaft thrust washer
- Caliper grease fitting
- Pressure relief fitting
- Seal retaining snap ring
- Brake piston end seal
- Ring retainer
- Powershaft inner pilot bushing
- Piston return spring
- Brake piston boot
- Brake piston-to-caliper seal

Types of Shoe Assembly Anchors

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- Fixed anchor pins
  - Normally easier to service because the pins do not have to be removed for brake shoe lining changes
  - Have open anchor pin openings and a retaining spring to allow for quick relines
  - May use single or double pins
- Removable anchor pins
  - Have closed anchor pin openings and anchor pins that must be removed before brake shoe linings can be changed
  - May be difficult to service because pins often become seized in the pin openings and will have to be forced out
  - May use single or double pins

Brake Linings, Blocks, and Pads

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- Brake lining materials are made of special friction material that is able to withstand the heat created from the braking effort.
- Until recently, asbestos was the primary friction material used on brake linings, and although new linings have little or no asbestos, all safety precautions and asbestos warnings should still be followed when working on brake linings, as new brake linings still contain materials that should not be inhaled.
- Friction materials are identified by a stencil on its edge that gives the name of the manufacturer, material identification, and friction class.
- The friction class is indicated by two letters, with the first letter representing the normal coefficient of friction and the second letter representing the hot coefficient of friction.
- Brake linings and blocks differ, in that it takes two brake blocks to line one shoe, while only one lining is needed per shoe.
- Brake block is generally ¾ inches thick and is commonly used on heavy-duty Class 8 vehicles.
- Brake lining is generally ½ inches thick and is commonly used on smaller vehicles.
- Brake blocks are typically wider than linings because they are used on vehicles that have larger brake drums.
- Brake blocks and linings are usually riveted onto the shoe using a special riveting tool. Follow the riveting sequence specified by the manufacturer.
- Brake pads are used on disc foundation brakes.
- Brake pads are available as a shoe and lining reline kit, with the friction material already bonded to the shoe.
- When replacing friction material on one side of an axle, always replace the material on the other side at the same time to ensure balanced braking.
- While it is recommended that a matched set of lining be used on each wheel, under some conditions a combination of different lining materials may be desirable.

Guidelines for Relining Brakes

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- Make sure that brake shoes are in good condition.
  - The table should be flat, without distortion.
  - Should be no undue wear at the anchor and roller end
  - Rivet holes should not be elongated.
- Prior to disassembly, check the lining wear on all brakes.
  - If wear is even, the brake balance is correct.
  - If wear is uneven, investigate for other system problems.
- Use the friction material specified by the original equipment manufacturer (OEM) for all relines.
- Replace the full hardware kit and change the cam bushings, especially if a difference in wear is noted between the two shoes.
- When disassembling the brakes for reline, note the condition of each part.
- Never replace a failed component without tracing the reason for the failure, as it will just fail again if the root cause is not identified and corrected.
- Make sure that the shoe is not stretched.
- Check for gaps between the lining and the shoe table.

Types of Brake Drum Assembly Arrangements

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- With the inboard type, the wheel and drum assembly must be removed as a unit in order for the drum to be removed from the hub.
- With the outboard type, the drum may be removed without having to remove the hub assembly, which is quicker for brake service.

Types of Slack Adjusters

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- The manual type must be periodically checked and readjusted to compensate for brake lining wear.
- The automatic type automatically adjusts the clearance between the brake linings and the brake drum or rotor during normal service braking applications.

Advantages of Automatic Slack Adjusters

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- Automatic brake adjustment
- Reduced downtime and maintenance costs
- Improved brake balance
- Reduced chamber travel and less air consumption
- Consistent, reliable spring brake engagement

Parts of Slack Adjusters

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- Manual slack adjuster
- Gear
- Worm
- Adjusting screw
- Body (housing)
- Cover plate
- Spring
- Adjusting screw lock
- Automatic slack adjuster
- Pull pawl
- Actuator rod
- Round head clevis pin (small)
- Hex head clevis pin (large)
- Piston
- Grease fitting
- Actuator
- Retaining ring
- Boot
- Threaded clevis

Guidelines for Working on Slack Adjusters

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- All slack adjusters convert the linear force of the brake chamber push rod into a twisting force that turns the brake camshaft.
- The worm and gear mechanism inside the slack adjuster is used for brake clearance adjustment.
- Slack adjusters are available in several arm configurations, lengths, and spline types.
- Replace slack adjusters with the same size and type as the original equipment.
- Slack adjuster numbers represent maximum torque rating. An example is that a type 20 unit is rated for a maximum of 20,000 inch-pounds of torque.
- Never mix automatic slack adjusters with manual slack adjusters on the same vehicle.
- Avoid mixing automatic slack adjusters from different manufacturers on the same vehicle.
- Never mix automatic slack adjusters from different manufacturers on the same axle.
- Follow the manufacturer's instructions for adjustment of slack adjusters, and make sure the proper templates and measuring tools required for the job are obtained.
- Follow all safety precautions, especially as they relate to the service brake chamber and the spring brake chamber, which are connected to the slack adjuster. Prior to removing or installing a slack adjuster, make sure that the spring brakes are mechanically caged or released with air, the wheels are blocked, and all brakes are released.

Parts of a Service Brake Chamber (Front Axle)

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- Diaphragm
- Return spring
- Push rod
- Yoke or clevis
- Inlet port
- Service inlet port
- Clamp ring
- Lock nut

Operation of a Typical Service Brake Chamber

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- Controlled air pressure enters the brake chamber through the inlet port.
- Air pressure acts upon the diaphragm, moving the push rod forward.
- The push rod acts upon either the slack adjuster (cam brakes) or the wedge assembly (wedge brakes).
  Note: The greater the air pressure admitted to the brake chamber, the greater the force applied to the push rod.
- When air pressure is released from the brake chamber, the push rod return spring in combination with the brake shoe return springs return the diaphragm and push rod assembly to their released position.
  Note: Brake chambers are sized by the effective area of the diaphragm. For example, a type 16 brake chamber has an effective diaphragm area of 16 square inches.

Guidelines for Working on Service Brake Chambers

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- Always maintain the brake chambers to their original performance condition.
- If the chamber return springs need replacement, the springs should be replaced with springs of the proper spring load.
- Always replace the return spring on both chambers on an axle.
- Replace all diaphragms on the vehicle at the same time.
- Prior to installing a new brake chamber, the new push rod should be compared to the length of the old push rod with the excess rod cut off with a hacksaw.
- Make sure the chamber push rods are in line with the slack adjusters.
- Ideally, the chamber push rod length should be adjusted, so that when the chamber reaches half its maximum stroke, a 90° angle is formed between the slack adjuster and the chamber push rod.

Main Check Points for Inspecting Foundation Components

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- Springs—return and retaining
  - Check to see that the shoes fully retract upon brake release.
  - Replace at each reline.
- Rollers
  - Discard pitted, corroded, or flat spotted shoe rollers.
  - Follow the manufacturer's recommendations concerning the use of oversize shoe rollers to correct sticking cams and cam rollover.
- Cam shafts, bushings, and brackets
  - Inspect the cam and shaft for irregular surfaces, flat spotting, cracks, wear, and corrosion.
  - Make sure the cam surface, bearing journals, and splines are smooth and free of ridges.
  - Wiggle the cam up and down to check for radial play, and in and out to check for end play, and check with a dial indicator if any play is felt.
  - Replace cam bushings and seals at each reline.
  - Inspect the cam shaft bracket for broken welds, cracks, loose mounting fasteners, bending, and misalignment.
- Anchor pins
  - Inspect for roundness, corrosion, and wear.
  - On anchor pins that must be removed prior to brake shoe removal, use a suitable brass drift, special press, or puller to drive out the pins, and never use a steel hammer.
  - Never heat the spider to remove stubborn anchor pins, as this destroys the metal's tempering and will cause permanent distortion. Instead use a light, penetrating oil and gently tap them out with a suitable tool.
- Spider
  - Check for elongated anchor pin holes, cracks, and proper alignment.
  - Also check the single anchor pin spider for anchor pin wear and looseness in the spider.
- Dust shield—check for tightness, rust, and distortion.
- Brake drum—check for scoring, cracking, excessive inner diameter, and/or runout.
- Rotor—check for scoring, cracking, and uneven thickness.
- Brake chamber—check for cracks, clogged vent holes, bent push rods, and for loose mountings, air fittings, and clamp rings.
- Slack adjuster—check for cracks, damaged splines, worn clevis pin bushings, and sticky adjustment nuts.