
TECHNICIAN
TRAINING
BY DORMAN PRODUCTS
DORMAN
Training Seminar Series
Presents:
Air Disc Brake
Part 1

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DORMAN
Aftermarket Innovators

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AIR DISC BRAKES

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Your Instructor For This Webinar

Sulev “Swede” Oun

- **Owner, O&K Truck and Auto Repairs Ltd.**
- **ATTP Master Instructor, New York State**
- **Author, “Medium/Heavy Duty Truck Electricity and Electronics”**
- **Training provider for various Associations, industry and various NY State agencies**
- **Developed trainings that range from four hours to multiple days, specializing in brakes, electrical, regulations and many other subjects relating to our industry.**
- **Member of various organizations such as SAE, CVSA, TANY**

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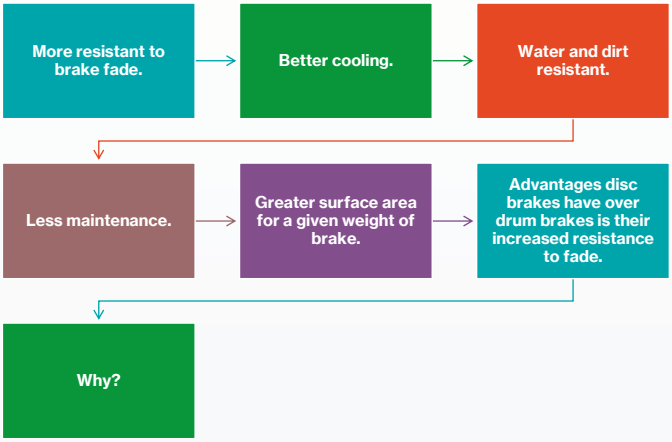
Disc Brake Advantages



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Disc Brake Advantages

- Drum deflection is eliminated.
- Disc brakes are not as sensitive as drum brakes to changes in friction.
- Disc brake cooling is better than drum – brake cooling because rotor contact surfaces are more directly exposed to the cooling air.
- Centrifugal force tends to throw materials off the rotor.
- Disc brakes are easy to change.
- Lack of servo action allows for a more even torque/smoother brake application across all driving conditions.

So why haven't we been using them sooner?

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Disc Brake Advantages

- We have been using disc brakes for quite a long time.
- Hydraulic disc brakes were first introduced on cars back in the late 40's
- By early 70's, disc brakes had replaced drum brakes on the front.
- As a side note, multiple disc types are commonly used on aircraft.
- Air disc brakes were tried on trucks and buses in the past (indirect types). But they didn't quite catch on.
- The 2013 stopping regulation created a push toward a wider spread of air disc brake adoption.
  - Drum brakes still hold the major share of brakes used in vehicles, but more and more fleets and owners are spec'ing air disc closing the gap in disc versus drum brake usage.

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How to Shorten Stopping Distance and Improve Braking ?

Large trucks have longer stopping distances than light vehicles, increasing the chance of collisions in panic stopping situations. Truck brake performance has been identified as a major factor contributing to crashes involving large trucks.

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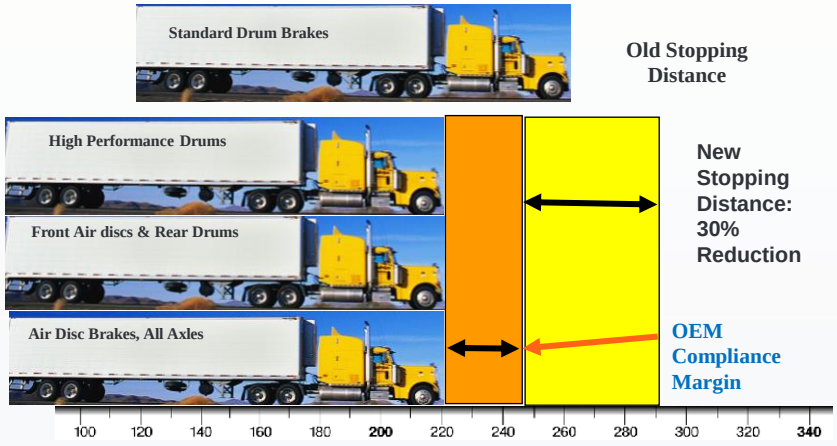
Stopping Distance Change



Old Stopping Distance

New Stopping Distance: 30% Reduction

OEM Compliance Margin

Note:
FMVSS old stopping distance was-355ft.

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Stopping Distance Final Rule

- **Phase I went into effect in 2011.**
  - **Impacted tractors grossing up to 59,600 pounds.**
  - **A loaded tractor is required to stop within 250 feet at 60 miles per hour.**
- **Phase II went into effect August 2013.**
  - **Applied to more vehicles including trucks with just 2 axles and trucks with 4 or more axles.**
  - **Also, trucks with three axles but with a GVWR greater than 59,600 pounds**
  - **Were included under the standard.**
  - **Under the 2013 Phase II standard, most loaded trucks are required to stop within 250 feet.**

NOTE: Certain trucks with 4 or more axles or extremely high GVWR have a required stopping distance of 310 feet.

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Stopping Distance Bullet Points

- To meet the stopping distance mandate, many manufacturers went from 15-in to 16.5 in. brakes on steer axles. (Load transfer from rear of vehicle forward).
- Suspension, steering and other structural requirements had to be considered and addressed by manufacturers in order to absorb an increase and transfer of load and torque on the front end.
- Quite often implement changes to the drive axle brakes to maintain overall vehicle balance.
- NHTSA's stopping distance rule is meant for manufacturers to satisfy.
- The rule doesn't require any specific method used to meet the requirements.
- This rule doesn't include any requirements for motor carriers to maintain the brake performance capabilities on the new vehicles once in service.
- No requirements for any specific components.

Caution: What happens if there is a liability issue, and a decreased performance is discovered????

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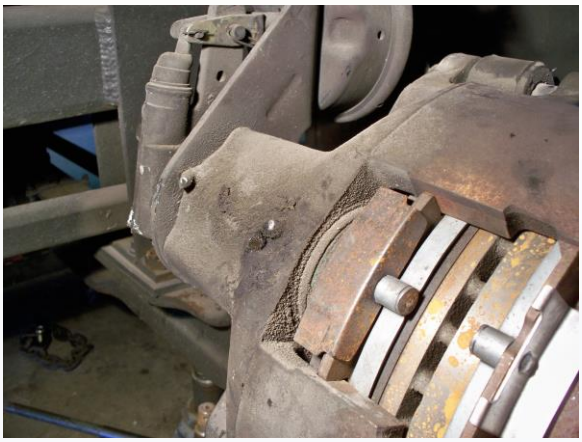
Air Disc Brakes



In-direct mounted Disc brake

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Today's Direct Mounted Air Disc Brake

Directly mounted brake application brake chamber.

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Who are the Players?

- Certainly, when it comes to disc brakes, Bendix and Meritor come to everyone's mind.
- However, it didn't take long for the aftermarket to offer the same full line of air disc brake products at very competitive prices.
- Some have made improvements over the original products.
- Dayton is a perfect example by offering fully loaded caliper assemblies when they got into the disc brake market at a very reasonable price.
- Not to mention, Dayton has been in the hub market "forever" and it makes sense to get into the disc brake market.

It's only natural because of the relationship between hubs and rotors. By adding the disc brake portion, you now have a complete package to offer with the various disc brake designs.

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Air Disc Brake Commonalities

- **Common to most of todays disc brakes are :**
  - **An internal brake lever**
  - **Integrated adjusting mechanism**
  - **Directly mounted brake actuator and principle of operation.**

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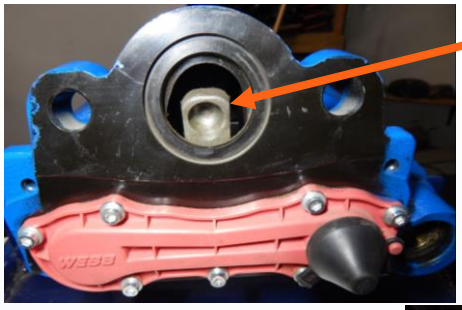

Lever

How do we get from the lever to the tappet ?

Piston/Tappet

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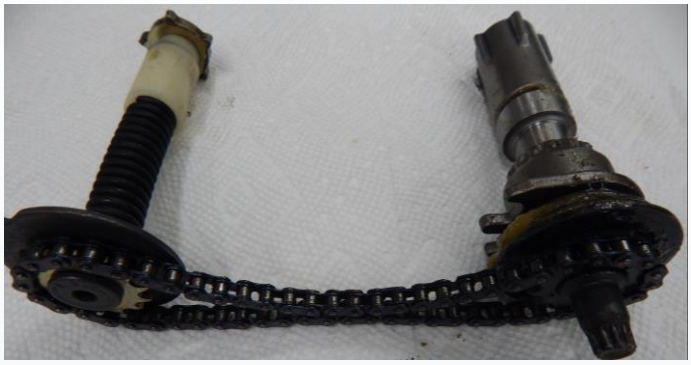

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Brake Actuator Assembly

- The actuation system consists of the brake actuator (brake chamber) bolted to the brake assembly connecting the push rod to the lever and pressure piston, located within the brake caliper housing.
- The lever amplifies the force produced by the brake actuator.
- The brake lever is supported by roller bearings on the calipers back plate/housing to avoid friction and hysteresis effects.

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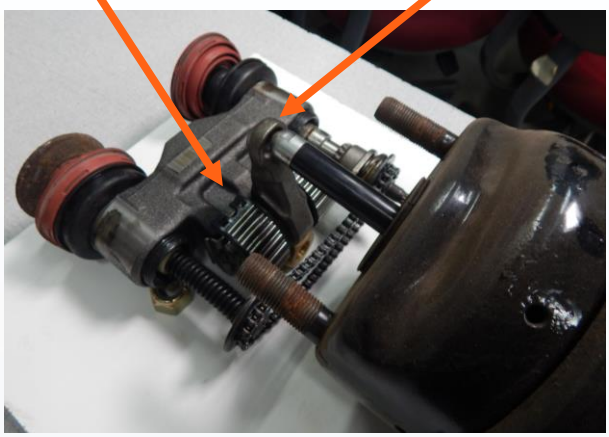

The general multiplication ratio utilizing the lever is within a range of 10:1 and up to a range of 18:1.

Where else do we use levers?

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- **Air pressure unto the chamber diaphragm forces the pushrod forward applying to the excentrically supported lever.**
- **The pistons are connected to the lever.**
- **The brake actuator force is amplified according to the lever multiplication in relation to the piston force.**
- **This force is transmitted to the brake pad via the bridge and the screwed on threaded spindles with piston.**
- **The brake pad is now pressed onto the brake disc.**
- **The rection force is transferred to the opposite brake pad so it is pressed on to the brake disc with the same force.**

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Automatic Wear-Adjusting Systems

- **Disc brakes utilize an integrated automatic wear adjustment system.**
- **Despite the different designs of disc brake designs, the basic functions of the adjusting mechanisms tend to be the same.**
- **Adjustment occurs during actuation within the range of idle stroke.**
  - **Adjustment movement is prevented the moment the threaded piston transfers an actuating force to the brake pad.**
- **The amount of adjustment is independent of the brake actuators actuating stroke and the brake force.**
- **Clearance amount is defined so only a defined brake lever travel is carried out at the beginning of each brake application without simultaneously actuating the adjusting mechanism.**
- **The adjuster part of the brake lever actuates the adjusting mechanism only when the defined idle movement has been covered.**
  - **The piston stroke covered during the idle movement is the designed clearance**

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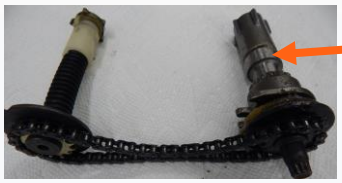
Automatic Wear-Adjusting Systems

- The automatic adjusting mechanisms usually consist of two clutch systems.
  - A freewheeling single direction clutch generally driven directly by the stroke of the lever, transferring this drive rotation into the brakes actuating stroke to an axis of rotation via its single direction locking effect.
  - The locking effect of the freewheeling device is prevented, and movement transfer seizes when the brake returns to its initial position.
- The second clutch system is an overload clutch positioned downstream in the axis of rotation of the freewheel unit and transmits the rotational movement being transferred by the freewheeling mechanism to the threaded spindles only up to a defined torque.
- An excessive clearance is reduced by turning the spindles. In case of correct clearance, an actuating force is applied to the threaded spindles before it can be turned by the selector fork.



Adjuster unit

Threaded spindle unit

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Live Adjustment Check!!

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Measurement Comparisons Simplified

The following measurements are referenced in many of the slides. To simplify, I put them in a fraction format also.

- **2mm is 0.078 = 5/64 inches (approximate 1/16 inch) (nickel)**
- **0.080 inches is a little under ¼ inch.**

- **1/8 inch = 0.125 inches = 3.175 mm (approximates)**
- **1/4 inch = 0.250 inches = 6.35 mm (approximates)**

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Bendix ADB22X, ADB22X-V, ADB22X-LT Air Disc Brake

Description

- Floating caliper design.
- Used on steer axles, drive axles, trailers and buses.
- The disc brake assembly is mounted to an axle's anchor (torque) plate.
- Can be used with or without a combination "spring brake".
- May include optional wear sensors.

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Bendix ADB22X, ADB22X-V, ADB22X-LT Air Disc Brake

Operation

- Just like "S-cam" brakes, air disc brakes convert air pressure into braking forces.
- Just like "S-cam" brakes, air through a service chamber applies pressure on a service diaphragm, expanding the diaphragm, applying force to a pressure plate, moving the connected pushrod forward.
- From this point on the similarities stop.
  - No slack adjuster on direct mount disc brakes.

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Bendix ADB22X, ADB22X-V, ADB22X-LT Air Disc Brake

Operation

- Upon brake application the pushrod of the brake chamber extends and moves the actuator lever in the brake caliper.
- This input force is distributed by a bridge and two threaded tubes to the tappets.
- The tappets apply force “directly” to the inboard pad.
- The resultant clamping force of the brake pads on the brake disc (rotor) generates the braking force.
- When brake pressure is released, the return spring within the caliper forces the bridge section along with the threaded tube and levers back to the starting position.



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Bendix ADB22X, ADB22X-V, ADB22X-LT Air Disc Brake

Automatic Adjustment

- An automatic adjuster mechanism is utilized to ensure a constant running clearance between the brake pads and disc (rotor).
- The adjuster is mechanically connected to the lever and will operate every time the brakes are applied.
- Brake wear will increase the running clearance between the pads and rotor.
- This increased clearance will allow the adjuster mechanism to rotate slightly.

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Bendix ADB22X, ADB22X-V, ADB22X-LT Air Disc Brake

Automatic Adjustment

- A drive chain transfers this slight movement to both threaded sleeves.
- The rotational inward movement of the threaded sleeves and tappets take up any additional running clearance as the brake pads wear.

Note: The total running clearance (the sum of clearances on both sides of the rotor) should between 0.024 to 0.043 in. (0.6 to 1.1mm).

During pad replacement/service, the technician manually sets the systems initial non-braking position.

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Bendix ADB22X, ADB22X-V, ADB22X-LT Air Disc Brake

Brake Pad/Rotor/Caliper Quick Check

- Limited to window of opportunity.
- **How would you determine if for example you need brake pads or determine other issues?**

Note:

Pads new: 1.181 in. (30mm) thick.
Replace when: 0.433 in. (11mm)

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Bendix ADB22X, ADB22X-V, ADB22X-LT Air Disc Brake
Brake Pad/Rotor/Caliper Quick Checks

Rotors:

New: 1.77 in. (455mm) thick.
Replace when: 1.46 in. (37mm)

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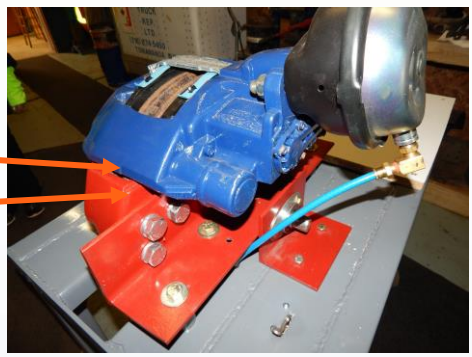
Bendix ADB22X, ADB22X-V, ADB22X-LT Air Disc Brake
Brake Pad/Rotor/Caliper Quick Checks

- **Look at mechanical wear indicators.**

NOTE:

These wear indicators show when full wheel-off inspection of the pads and rotors should be scheduled. (When the notches line up)



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Bendix ADB22X, ADB22X-V, ADB22X-LT Air Disc Brake

Brake Pad/Rotor/Caliper Quick Checks

- Push and pull caliper assembly by grabbing the brake chamber (brakes released)
  - Should get a small movement
  - Less than 0.08 in. (2mm)
  - (Approximately the thickness of a nickel)
- This indicates there is sufficient running clearance, also that the caliper is sliding freely.

Note: If the running clearance is not correct and there is no caliper movement, a wheels – off inspection needs to be performed.

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Bendix ADB22X, ADB22X-V, ADB22X-LT Air Disc Brake

Running Clearance Check "Wheel-Off"

- Remove wheels to gain access to the pads and other components.
- Fully release the brakes.
  - Ensure air pressure is at least 90 PSI if releasing spring brakes.
- Press the inboard pad away from the tappets, using a suitable tool such as a flat bladed screwdriver.
- Assure there is no dirt, rust, scale etc. in the gap.
- Use two long-bladed feeler gauges to measure the gap between the tappets surfaces and the inboard pad backplate.

Note: The proper gap should be between 0.024 in, (0.6 mm) and 0.043 in. (1.1 mm).

Caution: Too little or no gap could cause the brake to overheat. Too much clearance (gap) could cause a brake failure.

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Bendix ADB22X, ADB22X-V, ADB22X-LT Air Disc Brake

Brake Pad/Rotor/Caliper Quick Checks

- One of the first checks I would do is, check the manual adjuster mechanism function.
  - Spring brakes released.
  - Turn the shear adaptor counterclockwise using a 10mm box wrench/socket
  - Listen for the sound of 3 clicks as the mechanism backs off to increase the running clearance

Important: If the shear pin fails two times, the adjustment mechanism is assumed to be seized.

In this case the "Caliper" must be "Replaced".

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Bendix ADB22X, ADB22X-V, ADB22X-LT Air Disc Brake
Brake Pad/Rotor/Caliper Quick Checks

- **If the adjuster mechanism is able to be backed off normally, perform the following check/test.**
  - **Using a box wrench, back off the adjuster.**
  - **Leave the box wrench on shear adaptor, so it can turn clockwise without coming into contact with parts of vehicle/caliper etc.**
  - **Make five to ten moderate service brake applications (approximately 30 PSI).**
  - **Observe the box wrench.**
  - **Should turn clockwise in small increments.**

Note: Turning movement will decrease, as the number of applications increase.

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Bendix ADB22X, ADB22X-V, ADB22X-LT Air Disc Brake
Brake Pad/Rotor/Caliper Quick Checks

Important! If the box wrench

- **Does not turn**
- **Turns only with the first application**
- **Turns forward and backward with every application**

"The automatic adjuster has failed"

The caliper/carrier assembly must be replaced.

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Bendix ADB22X, ADB22X-V, ADB22X-LT Air Disc Brake
Caliper Guide Pin Inspection

- Remove the pads.
- Slide the caliper along the whole length of the guide pins.
  - Use no more than 45 lbs. of force.
  - A force gage can be used for accuracy.
- The movement should be at least 0.95 in. (25mm) with no pads.
  - If less, replace the caliper/carrier assembly.

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Bendix ADB22X, ADB22X-V, ADB22X-LT Air Disc Brake
Measuring Play in the Guide Pin Bearings

- Replace old pads with new pads temporarily.
- Attach a dial indicator (magnetic base) to the short bearing side of the caliper.

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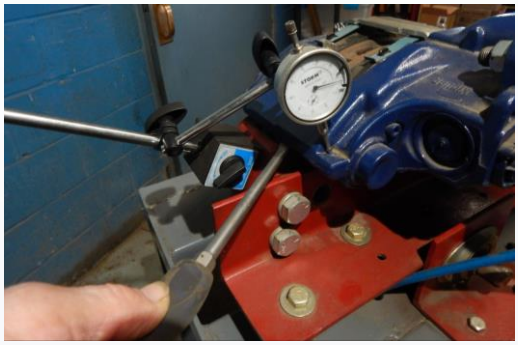
Bendix ADB22X, ADB22X-V, ADB22X-LT Air Disc Brake

Measuring Play in the Guide Pin Bearings

- **Press the caliper in the direction of the carrier and set the gage dial to zero.**
- **Place a tool such as aflat blade screwdriver between the carrier and the caliper.**
- **Use light force to move caliper away from carrier, until movement stops.**
- **Read the value on the gage.**

NOTE: If the value is greater than 0.039 in. (1.0 mm)
"Replace the guide pin bushings"



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Bendix ADB22X, ADB22X-V, ADB22X-LT Air Disc Brake

Caliper Guide Pin Inspection
"Decision time"

Do you want to invest in special tools?

- **Ranging from several hundreds of dollars to thousands of dollars.**

Not to mention – Very few parts houses stock guides, pins, bushings etc.
How about the cost in labor to rebuild caliper/carrier assemblies.

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Bendix ADB22X, ADB22X-V, ADB22X-LT Air Disc Brake

Rotor Inspection

- Bendix typically uses 2 styles of rotors:
  - Splined disc rotors
  - Conventional rotors

NOTE:
Do not mix rotors across an axle. The axle has to have all conventional or all splined rotors.

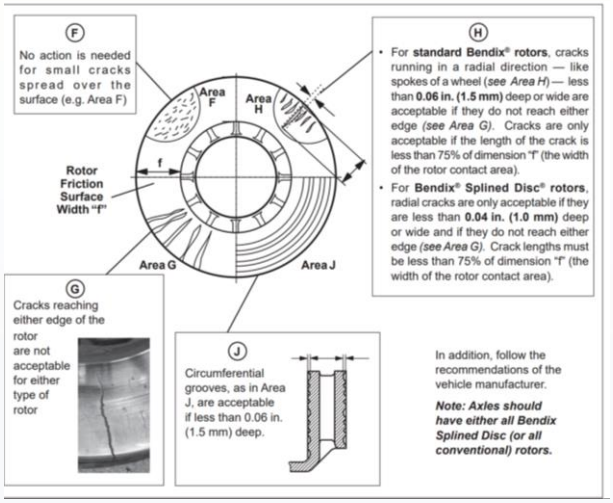
- Measure thickness at thinnest point.
  - Minimum thickness is 1.46 in. (37mm) (Bendix).
- Inspect rotor surface.

Bendix ADB22X, ADB22X-V, ADB22X-LT Air Disc Brake

Rotor Inspection

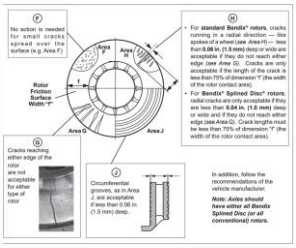
This guide is from the Bendix Manual.
All manufacturers utilize similar pictures as a guide.

- **FMCSR Part 393.47(g) Drums and Rotors states:**
  The thickness of the drums or rotors shall not be less than the limits established by the brake drum or rotor manufacturer.



Bendix ADB22X, ADB22X-V, ADB22X-LT Air Disc Brake

Rotor Inspection



- **Appendix A to Part 396 (Federal Annual Inspection Requirement). Brake Drum or Rotors reject:**
  - **With any external crack or cracks that open upon brake application (do not confuse short hairline heat check cracks with flexural cracks)**
  - **Any portion of the drum missing or in danger of falling away.**
- **Besides the above, the OOS Criteria included the following:**
  - **Any rotor (disc) with a crack in length of more than 75% of friction surface and passes completely through the rotor to the center vent from either side or completely through a structural support connecting the rotor friction surfaces.**
  - **A rotor surface is worn through center vents.**

"Let's think about this" Huge crack is okay unless it opens upon brake application? Some of the criteria needs to be rewritten.

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Bendix ADB22X, ADB22X-V, ADB22X-LT Air Disc Brake

Rotor Inspection

- **This is a picture of a toner ring typically used on drive axles.**
- **When installing rotor, use new spring elements that come with rotor.**
  - **Torque to 22.1 ft-lbs in an evenly cross-pattern sequence.**
- **The same applies to toner ring.**
  - **Use Loctite.**
  - **Torque to 19-22 in-lbs.**

Important!

For U-shaped rotors follow vehicle manufacturers recommendations for torque and any other Installation requirements.

"That should apply for all applications, systems and components?

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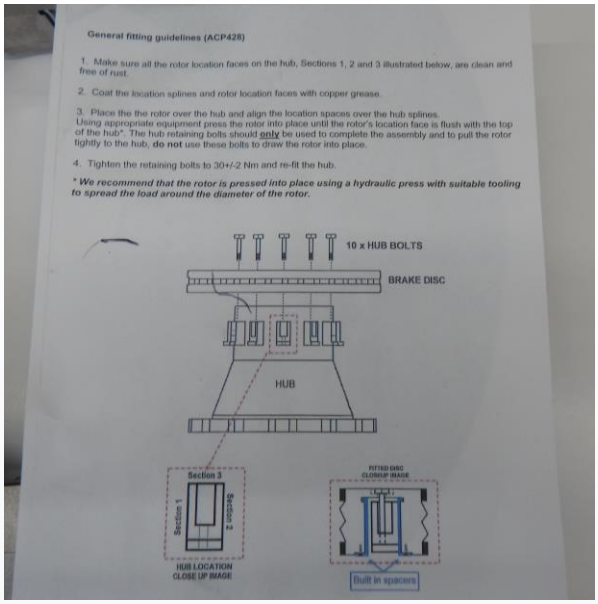
"RTFI"



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Warnings, Cautions and Notes

- Make sure brake chamber is sized appropriately.
  - Oversized brake chamber can result in premature wear of pads and rotors. (excessive force)
  - Undersized brake chambers can result in too little braking force. (increase time and stopping distance)

NOTE:

- Square port on these does not indicate "Long Stroke)
- They are also typically clocked for right hand or left hand.

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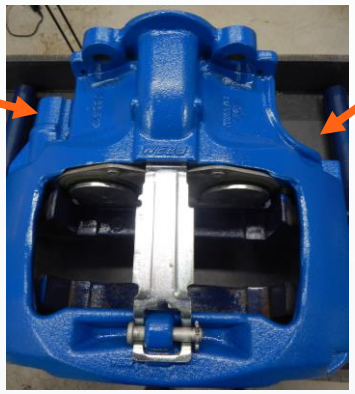
Warnings, Cautions and Notes

- For Bendix air disc brakes, as a vehicle travels forward, the wheel always rotates towards the fixed-pin side of the caliper first.

Fixed-Pin (longer pin)



Floating Pin

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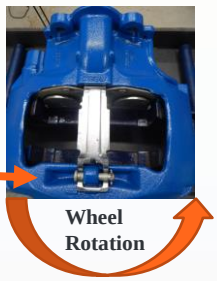
Warnings, Cautions and Notes

Type "A"

"Verify what came off"

Sometimes you can see "A" or "B" cast here

Type "B"



On most vehicles, these type A calipers are used on the right (passenger side) of the vehicle. **Note: There might be a rare exception to this side.**

On most vehicles, these type B calipers are used on the left (drivers' side) of the vehicle. **Note: There might be a rare exception to this side.**

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Type “A”

Warnings, Cautions and Notes

- Not all wheels and valves are compatible with Bendix and other disc brakes.
  - Use wheels and valve stems approved by the vehicle manufacturer.
  - You are looking to avoid risk of valve stem sheer and other compatibility issues.

“If in doubt-verify there is sufficient clearance between the tire inflation stem, caliper, wheel etc.”

Part 2 Next Month.

"Overview of Meritor System and Real world Issues and practices for all disc brakes".

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We offer greater freedom to fix cars and trucks by engineering exclusive, labor-saving and cost-effective repair solutions.

Thank You !

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