TRUCK-TRAILER-TRANSIT

Transportation Aftermarket Specialists

RECOMMENDED PRACTICE

BRAKE SHOE RELINE

INSPECTION AND REUSE OF BRAKE SHOES AND COMPONENTS AND PROPER INSTALLATION OF BRAKE LINING.

This recommended practice is intended to offer a standard for brake shoe reline specifications and component inspection that will allow consistent performance required for maximum attainment of a balanced brake system. This practice is subject to the Disclaimer on page 21 of this recommendation.

This recommended practice offers standards and component inspection required for reusing brake shoes and for the installation of brake lining. By sticking to these standards you can better ensure proper brake performance (Lining life, noise, proper stopping distance, premature lining and shoe and brake foundation component failure), thus reducing expensive and premature brake maintenance.

Braking Efficiency

The function of brakes is to control the speed of the vehicle on hills, reduce the speed when required and to stop the vehicle altogether and hold it stationary. How well a set of brakes fulfills this function depends on many factors, one of which ---- road surface conditions ---- is not under the control of the driver; other factors such as tire condition are not directly related to the design and condition of the brakes although they are the responsibility of the transit operation.

The ability of the brakes to perform their function is known as braking efficiency and there are legal regulations that require all vehicles have an efficient braking system. In assessing braking efficiency, it is usual to consider the effect the brakes achieve when they are applied. The action of applying the brakes sets up a force effective at the road surface, which acts in the opposite direction to the motion of the vehicle causing it to slow down or decelerate.

This deceleration is normally compared to a standard value (the acceleration due to gravity g) and reported as a percentage of "g." By defining braking efficiency in such a way directly comparable standards of braking can be established for different type of vehicles. "g" is 32 ft/sec/sec in absolute terms.

Vehicle construction normally requires the vehicle to have a braking system capable of producing a specific minimum deceleration. In modern vehicles, the braking system is designed so that, provided the vehicle is correctly maintained and the driver applies sufficient pedal pressure, the minimum braking efficiency will be achieved irrespective of the vehicle being loaded or not. Only in cases where the brakes are poorly maintained or where the vehicle is loaded significantly above the maximum gross design weight, will the weight of the vehicle affect the braking efficiently and the brakes be unable to achieve the minimum required efficiency.

Braking Efficiency Measurement

Stopping time is directly related to speed, however stopping distance varies as the square of speed, i.e. if initial speed is doubled, stopping time is doubled, and stopping distance is multiplied by four. Example:

Initial Speed = 20 MPH	Accelerated Speed = 40 MPH
Original Stopping Time = 4.6 sec	New Stopping Time = 9.1 sec
Original Stopping Distance = 67 feet	New Stopping Distance 268 feet

Brake force, deceleration, stopping time or stopping distance can all be used as a measure of braking efficiency; in the case of the first of these, it is necessary to know the gross weight of the vehicle and for the third and fourth, the initial speed must be known. Since these four quantities are inter-related they will all lead to the same conclusion provided that all the measurements are accurate. The practicability of using measurements of these quantities as a means of assessing braking efficiency can be considered in turn.

Deceleration:

Deceleration is the direct effect produced by the braking force, a loss of speed at a particular rate and it can be measured within the vehicle by the means of a Decelerometer. When the instrument

and the vehicle in which it is carried move at a constant speed, the moveable part occupies a constant neutral position and a zero reading is given by some means on a scale visible to an observer. When the vehicle decelerates, the pendulum, mass or fluid moves forward against its restraint, the amount of movement depending on the magnitude of the deceleration, and a reading is given on the scale.

The new Electronic Decelerometers measure both Acceleration and Deceleration and have a built in clock. Thus they have the capability of determining stopping distance at both the Average Deceleration and Maximum Deceleration. Being able to calculate at the Average Deceleration provides a more accurate measurement of stopping distance. Decelerometers such as the Fraser FBT-102 provides Deceleration rates, Stopping Distance, Delay Time (Time from the brake application till the stop of the vehicle) and a complete graph of the entire brake stop with both deceleration rate and pedal pressure represented. This information is printed at the end of each test and is also stored in the decelerometer's memory for later downloading to any IBM compatible computer.

A Decelerometer can be used at any speed providing the brakes are applied long enough to enable the instrument to give its reading, it is not necessary to keep the brake applied until the vehicle stops. Such an instrument is very suitable for routine testing of brakes to ensure that the required efficiency is being obtained. It cannot, however, identify an individual brake that is not functioning correctly.

Brake Maintenance and Maximum Brake Life

Brakes are designed to a specific geometry just as steering is designed to a specific geometry. If any part of the foundation brake assembly is bent or distorted, brake performance will become erratic and unpredictable. If any parts of the steering linkage on a vehicle are bent or distorted, steering geometry is destroyed and the vehicle will not steer properly. The same thing holds true with brakes. Always replace bent or distorted parts in order to make sure the brakes will function correctly.

The key to good brake maintenance is consistency. Both material and procedures must be the same each time a reline is done. Failure to have consistent procedures and standard component replacement will result in trouble finding the source of brake problems.

Inspection of Used Brake Components:

When disassembling the brakes for reline, note the condition of each brake component before disposing. The inspection of used brake components is one of the best methods for determining the condition of the brake. The manner in which it has been worn, the angle of wear and other patterns show a great deal of information about the condition of the foundation brake. Uneven lining wear is an indication of system problems. Troubleshooting can increase the understanding of failures and reduce recurring problems. Remember if all we do is replace the lining we have solved little.

CAMSHAFT BUSHING REPLACEMENT...The camshaft bushing is one of the most overlooked parts of the foundation brake system. It centers the cam and brake shoe assemblies in the brake drum. The critical wear area is the bottom of the bushing. This wear allows the brake assembly to fall off center, creating unequal drum clearance between the top and bottom shoes. When installing camshaft bushings a tool specifically designed for installation should be used to assure proper fit and to avoid distortion to the brake spider.

Fraser Gauge # 713

The camshaft bushing should be replaced at each normal reline interval. It takes up to one inch of push rod stroke to make up for forty-two thousandths of an inch clearance between the brake shoe and the brake drum. Proper replacement of the Cam Bushing will aid in Reduction of noise, Better Braking Efficiency and Proper Adjustment of Slack Adjuster.

- ## Camshaft Inspection and Replacement

Check the head of the camshaft for wear and damaged caused from the brake shoe roller. The head should be a smooth surface. The cam head ears should be inspected for wear. Using a camshaft journal gauge check for wear. Proper replacement of worn camshafts will aid in the reduction of brake noise, and provide better adjustment of the slack adjuster and therefore better braking efficiency.

Note: *No attempt should be made to dress or regrind cam ears.*

Fraser Gauge # 717 Go/No Go Gauge

This gauge checks the Journal Area of the Camshaft for excessive wear and aids in the determination of proper replacement of the camshaft.

Photo shows this camshaft is good as the gauge will not fit over the camshaft journal.

BRAKE SHOE ANCHOR PINS. Anchor pins may be difficult to remove. Care should be taken not to bend the spider when removing the anchor pins. Frozen anchor pins should always be removed with a press.

Brake shoe anchor pins should hold the shoe and lining assemblies parallel to the brake drum surface.

When completing a brake job, check to make certain everything is in place. Prior to installing the hub and drum assembly, take a firm grip on the brake assembly and check for tightness. If easy movement is detected, noise will soon be apparent. The assembly should be as tight as it should have been off the production line.

SPRINGS AND ROLLERS.... Return Springs are subjected to high heat levels during braking which cause them to weaken. The acceptability of a return spring cannot be determined by eye or sound. Brake shoe return springs **must always** be replaced at each reline interval. Rollers do wear out and should be replaced regularly due to flat spotting and brinelling.

BRAKE SHOE BUSHINGS

Brake Shoe bushings are installed in both front and rear shoes of transit bus brakes. These bushings must be replaced at the time of each normal reline interval. As the bushings wear they allow an increase in the spacing between the shoe and the anchor pin. This tolerance will affect the turn of the cam and the stroke of the brake chamber. Be certain to use proper tools in the installation and removal of the brake shoe bushings to avoid bending or damaging the brake shoe webs.

SLACK ADJUSTERS

Automatic slack adjusters were not designed to be installed and forgotten. At the same time, you cannot follow the same maintenance procedures that were used on manual adjusters. The largest mistake undertaken by mechanics is repeated adjustment of automatic adjusters when it is unnecessary. In determining the proper operation of slack adjusters you should perform several different tests. The ***Power Stroke*** **(See *Page* 24)** of the slacks should be check periodically. A stroke that is too long is considered an out of service condition and a sign of improper brake operation. The most important aspect of any automatic slack adjuster is proper installation. Slacks that have been installed improperly will either over-adjust or under-adjust. An additional method of determining slack adjuster operation is to check the ***Free Stoke.*** *Using a tape, measure from the air chamber to the center of the clevis pin. Using either a special tool or a pry bar apply the slack until pressure is felt against the drum. Again take the same measurement. If the difference in the measurement is more than 3/8" or less than 5/8" the slack adjuster is working properly*. **NOTE:** Loose or worn foundation brake parts can cause excessive free stroke. These components should be inspected and the slack adjuster checked, per manufacturing specifications, to determine if the slack adjuster is operating properly.

Automatic Slack Adjusters and Brake Adjustment

Inspection Requirements

All Automatic Brake Adjusters require inspection as periodic intervals. This should be done at your normal preventative maintenance inspection. At these times you should do the following:

1. Measure the air chamber stroke (Instructions listed below)
2. Record measurements within 1/16" on inspection forms.
3. Grease each slack adjuster. Note: Care must be taken to 1. Use the proper grease as designated by the slack manufacturer and 2. Note that some slack adjusters do not require grease. This is true of some Haldex slack adjusters that do not come with a grease fitting. When in doubt contact the manufacturer.
4. Inspect each slack adjuster for integrity and connection points at the clevis and brackets, if applicable.

One of the first tools out of the toolbox should be a tape measurer or other device. Check the push rod travel of the air chambers to make certain that they are within acceptable limits. **NOTE:** One of the biggest mistakes that are made is the frequent adjustment of automatic slack adjusters when there is no reason to do so. Constant manual adjustment of automatic slacks can lead to a shorter life cycle than expected. If the stroke exceeds the CVSA or DOT maximum allowances, do not manually adjust the brake adjuster.

Note: Apply 90-100PSI Air Pressure when measuring stroke.

Chamber Size	Stroke Length Not to Exceed:
12	1.35"
16	1.75"
20	1.75"
24	1.75"
24 Long Stoke	2.0"
30	2.0"
36	2.25"

5. <u>It is not necessary, if properly installed, for automatic slack adjusters to be readjusted</u>. If you are using manual slack adjusters then you must wait until the drums have cooled to an ambient temperature prior to making any adjustments.
6. Check for a difference in the stroke length between the left side of the axle and the right. Ideally they should be the same, however a difference of more than ¼" is excessive.
7. If the stroke exceeds the CVSA or DOT maximum allowances check the following items to determine the cause of the excessive stroke.

- Inspect shoe-to-drum clearance of the bottom and top shoes. If the clearance exceeds a total measurement of 0.30” and the control arm bushing exhibits wear, do the following:
- Check adjuster clutch torque by installing a torque wrench on adjuster hex nut and turn counter-clock-wise three times, if less than 13 ft. lbs. Of torque-replace adjuster.
- If clutch torque exceeds 13 ft lbs. Of torque and the control arm bushing shows no signs of wear, look for loose foundation brake parts.
- Measure stroke again, note movement of brake adjuster and camshaft. If exceeding 0.30” - remove brake shoes and inspect camshaft bushing. Replace if worn.
- On the Haldex slack adjuster inspect the connection to the control arm and the tightness of the bracket to the spider.

If slack adjusters are to be reused at the time of brake reline take note of worn brackets, clevis pins and bushings. The wear of these components can result in improper adjustment of the slack adjuster.

Not all Automatic slack adjusters require the same maintenance procedures. Be certain to follow the specifications of the manufacturer. ***Note:*** *Some slack adjusters use special grease while others use normal chassis grease. It is important to use the proper grade of grease for the climate and operating conditions.*

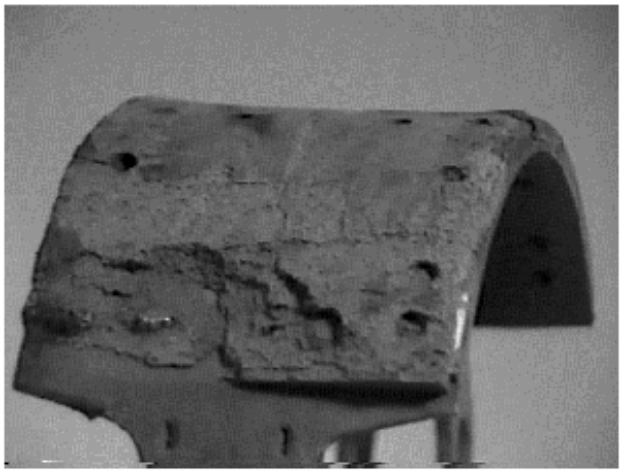
A good brake maintenance program will result in ...

- SURE SAFE STOPS
- DRIVER AND PASSENGER SATISFACTION
- REDUCED NOISE
- AND IMPROVED OPERATING RATIO…

Inspection of Worn Brake Block

Effect: Chunks out of lining. Fuzzy effect on lining surface.

Probable Cause: Overworked lining. Excessive Heat



Effect: Lining worn on one side more than the other.

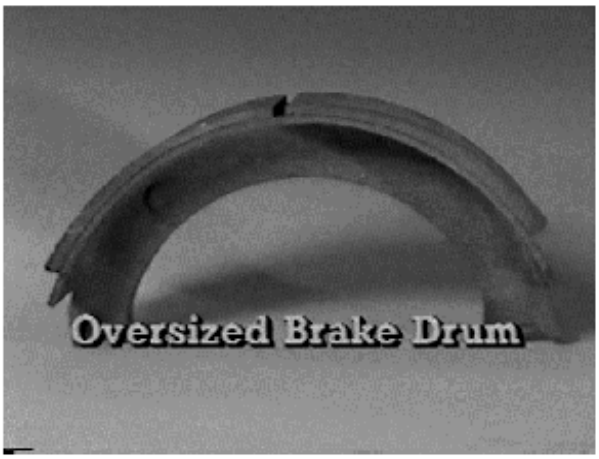
Probable Cause: Bell-Mouthed Drum

Effect: Irregular lining wear. Worn on lip of lining.

Probable Cause: Bent Brake Spider

Effect: Excessive Lining Wear in Middle of shoe.

Probable Cause: Oversized Brake Drum



Effect: Irregular Lining Wear

Probable Cause: Worn Anchor Pins - Anchor Pin Holes Worn Camshafts and/or Cam Bushings.

Effect: **Excessive Lining Wear in Middle**

Probable Cause: **Weak Shoe Table**

BRAKE SHOE REBUILD PROCEDURE

Lining Removal

Take care when removing of the brake block from the shoe. The key here is to make certain that if a chisel or a brake lining removal machine is used the blade is kept sharp. The bolt should be sheared cleanly. Dull blades result in excess pressure being placed against the boltholes thus causing oversized or egg-shaped boltholes and raising of the material around the hole. The raised material around the bolthole can cause cracked block when the lining is bolted to the shoe or in application.

Cleaning

1. Remove the brake shoe rollers from the brake shoe.
2. Remove all Grease and contaminants from the Brake Shoe.
3. Remove all rust from brake shoe surface.

a. Sandblasting is preferable, however if using a wire brush be certain to remove all rust and scale from the brake shoe surface.
   b. Sandblast Specification:
      1. It is suggested that a utilization of glass bead no larger than S-280 be used to remove all residue. Care should be taken when using a tumbler type sandblaster that the sandblaster is full so as to minimize the amount of damage to the shoes.
   c. If a wire brush is used be certain to use cleaning solvent again to remove any rust residue prior to application of any rust preventative.

Inspection:

Inspection of the brake shoe should be done prior to application of paint. Brake Shoes should be inspected for wear and distortion of the shoe. In order to obtain maximum brake performance you must have the proper geometry's of the brake shoe to the brake drum and brake spider. **NOTE**: You must remove the brake shoe rollers in order to properly inspect the shoe.

- **Stretch:**

A shoe that is stretched will not allow the brake lining to properly mate with the shoe. This can result in irregular wear and broken or cracked lining.

Fraser Gauge # F305Q for 16 ½" shoes

Place the gauge in the Anchor End from the side. If, GAUGE CANNOT BE DROPPED IN, shoe is defective. Gauge must fit shoe. If gauge does NOT fit replace the shoe.

- **Table Flatness:**

Using a straight edge, place it across the brake surface of the shoe table. This should be done in 3 areas, each end and the middle of the shoe. Using a feeler gauge a 0.010" maximum is acceptable between the shoe and the straight edge. Between the webs a 0.025-inch gap is acceptable.

- **Table Arch:**

Fraser Gauge # 613 for 14 1/5" shoes
 # 614 for 15" or 15 1/8" wedge shoes
 # 616 for 16 ½" "Q" shoes
Place the validator on both sides and center of the shoe table. If there is an opening and the feeler gauge can be inserted between the Validator and the shoe table, replace the shoe.

- **Bolt/Rivet Holes:**

Shoes that exhibit bolt/rivet holes that have grown or been damaged in the removal of bolts/rivets should be scrapped. Use of shoes with large or distorted bolt/rivet holes can result in loose and cracked lining. Burrs or raised areas around the holes must be removed. Failure to do so may result in broken or cracked lining.

Go = Replace Shoe No/Go Okay

- **Fraser Gauge # 419**

Table Thickness:

Brake shoe tables should be checked for wear. Each shoe has a different specification on the material that is used for its' manufacturer. Be certain to use the proper gauge for determining this wear and discard shoes that exceed the allowable wear.

Recommended Shoe Dimensions: (Inches)

0.179”	Minimum shoe table thickness (S Cam Coach Front)
0.224”	Minimum Shoe Table Thickness (S Cam Coach Rear)
0.224”	Minimum shoe table thickness (Wedge)

Fraser Gauge # 409

Weak tables can result in uneven wear of the lining and poor drum -to-shoe contact, thus reducing braking efficiency.

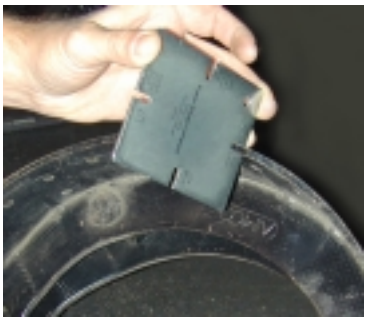
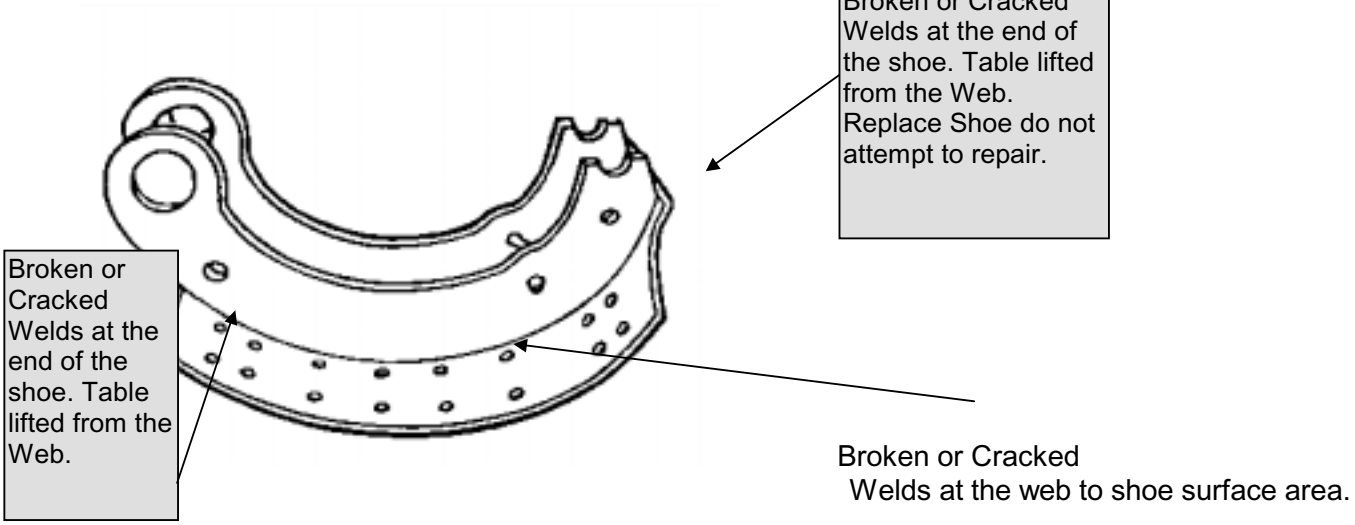


Table is good because it will not slip in the gauge.

Table is worn because it can slip over the table.

Welds:

Check web-to-table for cracks. Discard shoe if cracks are found. Do not attempt to repair the shoe**.**



- **Web Distortion on Coach Shoes**

The distance between the webs of the shoe and also the distance between the ears at the anchor pin end must not exceed the specified dimension. Use of shoes with spread webs can result in irregular wear on both the shoe and brake foundation components as well as lower brake performance.

Brake Size	Maximum Inner Distance between Webs on Cam End	Maximum Outer Distance between Webs on Anchor End
14.5 x 6 Front	0.0840”	1.970”
14.5 x 10 Rear Type 1 and 2	1.427”	2.167”
14.5 x 10 Rear Type 3	1.520”	2.914”

Brake Spider Gauge # 501 or Spider Gauge Kit # 930

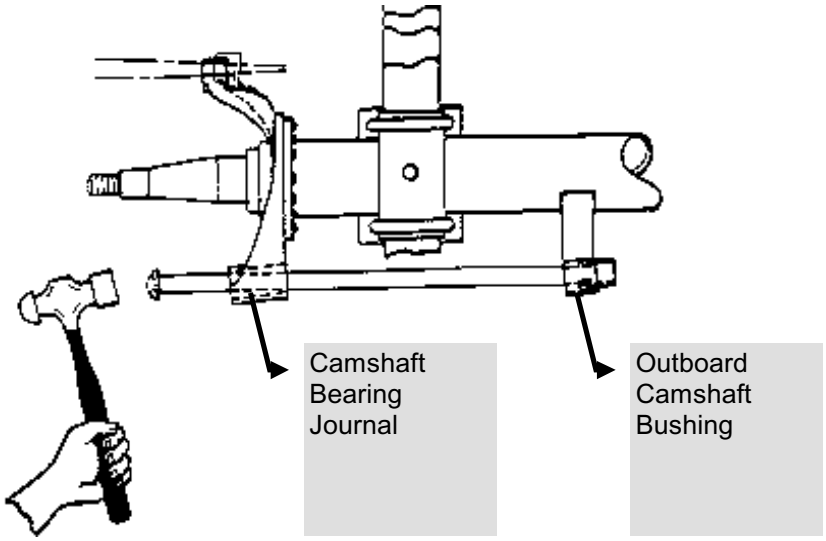
A spider gauge should always be used to check the alignment of the spider with the axle spindle. Bent spiders resulting from a frozen shoe or a seized pin cause the shoe to react slowly. Bent spiders should always be replaced. The proper fit will increase braking efficiency and reduce noise problems.

This gauge mounts on the axle shaft on the inside bearing surface. Hand tightens the wing nuts so the gauge will rotate and line up with the anchor pin hole in the spider. If the long anchor pin type gauge passes through the gauge and the anchor pin hole in the spider, the assembly is square with the anchor shaft.

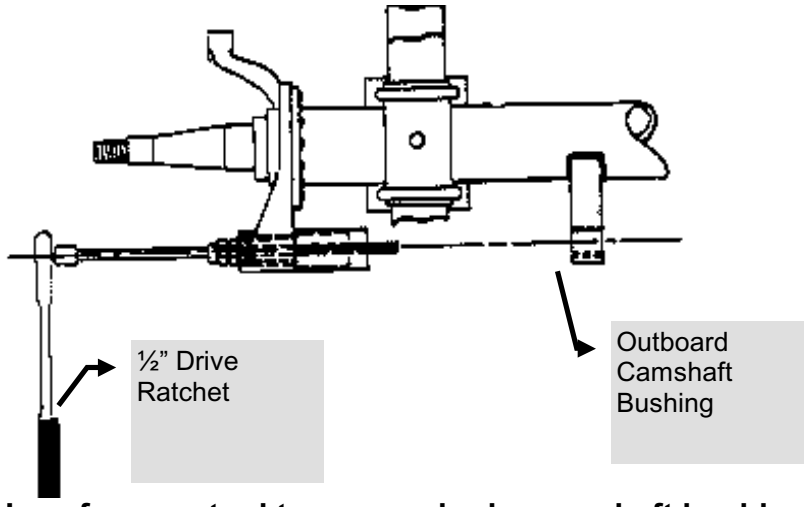
Brake Spider Inspection for Alignment.

Brake shoe anchor pins should hold the shoe and lining assemblies parallel to the brake drum surface. If a brake spider or backing plate is bent or deformed in any manner, it, in effect, changes the relationship of the camshaft and anchor pin locations. Bent spiders cause partial lining-to-drum contact, resulting in erratic and noisy braking action and premature foundation brake component failure.

When making repairs to the foundation brake, such as removing or installing camshaft bearing and anchor pins, much care should be undertaken. Many times, anchor pins and camshaft parts are not easily removed. Hammers and torches are the norms for quick resolution. In many cases, undue pressure is exerted, resulting in severe distortion.



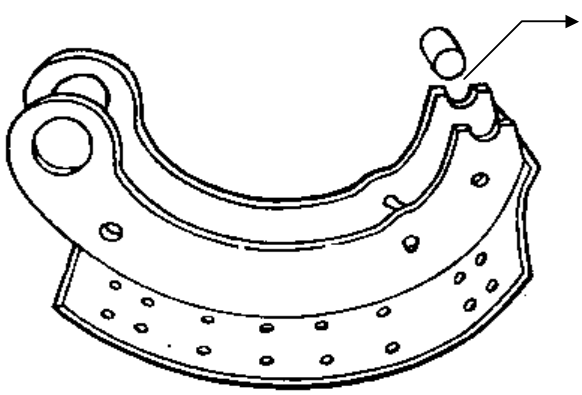
Effect of using excessive impact with heavy hammer to remove brake camshaft bushings - Bearings Journals Distorted.



Use of proper tool to remove brake camshaft bushings.

- **Anchor Pin and Roller Seats**

Anchor Pin and Roller seats must be checked. The Roller seats should be checked for wear, out of roundness, or flared condition. Using a specifically designed gauge or a NEW roller the clearance should be less than 0.020”.



- **Anchor Pin Bushings: Fraser Gauge # 401**

BRAKE SHOE BUSHINGS.... Brake shoe bushings are installed in the brake shoes of both front and rear shoes of most transit brake shoes. As the bushings wear they allow an increase in the spacing between the shoe and the anchor pin. This tolerance will affect the turn of the cam and the stroke of the brake chamber. Be certain to use proper tools in the installation and removal of the brake shoe bushings to avoid bending or damaging the brake shoe webs. On brakes, with anchor pin bushings, the inside diameter of the bushing must not exceed 1.273”. These bushings must be replaced at the time of each normal reline.

Painting or Rust Preventative Treatment of Brake Shoes:

The brake shoe should be treated with some type of rust preventative prior to installation of the brake lining. This can be in the form of paint or rust preventative.

Painting Specification:

A. Water Reducible Corrosion Resistant

Application: Dip or Spray
Gloss: 90° on a 60° Glossmeter
Comments:

Must pass a 168-hour salt spray in accordance with ASTM B-117. Corrosion protection is accomplished without the use of any chromates. Will pass 100 hours humidity test.
Gasoline resistant when immersed for 1 hour at 78° F.
Passes crosshatch adhesion test per ASTM D 3359.
Passes 120 hours @ 100° F immersed in

1. SAE number 20 engine oil
2. NP 6200 Hydraulic Oil
3. NP 6050 Cutting and Tapping Oil

Bake Schedule: Flash 3-5 minutes; Bake 8 minutes at 300° F.

B. Water Reducible Fast Dry Gloss Spray

Application: Spray
Gloss: 90° on a 60° Glossmeter

Comments:

Designed to pass 96 hours salt spray in accordance with B- 117. This degree of corrosion protection is accomplished without the use of any chromates.
Will pass 100 hours Humidity test. Will pass 100 hours humidity test.
Gasoline resistant when immersed for 1 hour at 78° F.
Passes crosshatch adhesion test per ASTM D 3359.
Passes 120 hours @ 100° F immersed in

1. SAE number 20 engine oil
2. NP 6200 Hydraulic Oil
3. NP 6050 Cutting and Tapping Oil

Dry Time: 25 to 40 minutes

Lining Application to Brake Shoes

Installing Bolted Linings:

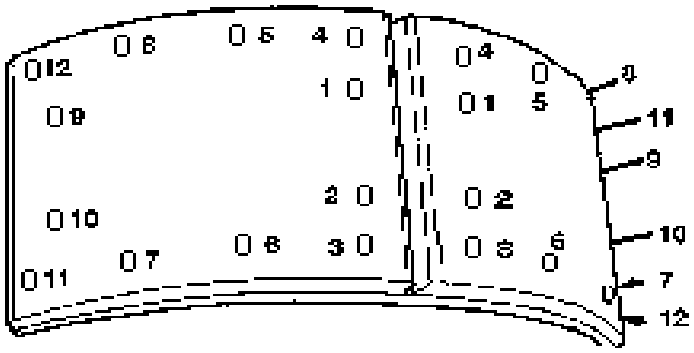
Bolts should be solidly seated using a drift and hammer.

Torque 3/4" diameter brass bolts 220 - 280 inch lbs or 18-23 lb-ft

Note: Use a dry graphite lubricant on lockwashers to avoid getting a false torque reading.

When bolting the lining to the shoe:

a) Start by installing all of the bolts, washers and nuts (By Hand)
b) Then using the following diagram torque the bolts to the 220- 280 in. lbs. In the following sequence:



The premise is to bolt in a manner so as to minimizing the flex of the brake block and thus reduce block breakage.

As different shoes have different patterns the concept is to first tighten the center bolts in the middle of the shoe, then the outside bolts in the center of the shoe. Then work you way down the shoe to the end of the table, alternating side to side.

Specifications for Brake Shoe Bolts: SAE J 663

Bolts for Brake blocks - the standard bolt for blocks shall be a **Brass** slotted flat head capscrew with a 3/8" in diameter body, a ¾" diameter head having a inclusive angle of countersink of 82°

Size	Threads Per Inch	Body Diameter	Max Sharp	Min Sharp	Depth of Head	Width of Slot		Depth of Slot	
		Max			Max	Min		Max	Min
¾"	10	0.750	1.402	1.357	0.375	0.149	0.131	0.171	0.115

Refer to SAE Specification J478 or ANSI Specification 18.6.1 2, 3 and 4 for additional details of dimensional specifications.

Specifications for Lockwashers: SAE J489b

It is important to use a heavy-duty grade carbon steel Helical Spring Lock Washer. Failure to do so can and will result in loose bolts and lining.

Nominal Size		Inside Diameter Tolerance		Outside Dia. Max.	Section Width Minimum	Hardness
¾"	.750"	0.775"	0.760"	1.291	0.244	C45-51

Burnishing Brake Block

Burnishing of brakes can result in:

- Minimized swell and growth
- Seating the lining to match the drum
- Adding an additional post-cure to the lining.

Post-Curing

During the processing of transit blocks, the manufacturer typically will have post-curing as part of manufacturing procedure. This post-curing, in effect, stabilized the friction material by allowing all of the gases, that are chemically formed, to escape. The gases are a result of several raw materials being intermixed, under heat and pressure.

The length or during of the post-cure should be predicated on the "size and thickness" of the brake block. Since over 95% of the typical lining manufacturers' business is geared to "truck applications", it is felt that some do not receive the proper post-curing. Typically the average truck block is 7.0" wide x .750" thick; as opposed to transit blocks of 10.0" wide x .937" thick. The wider, thicker transit blocks should require, at least, another 30-40% additional post-cure over smaller, thinner blocks. The purpose of a post-cure is to stabilize the block so that it undergoes a minimal change in operation. The vehicle should not be used as a "final cure" for brake blocks.

Swell and Growth

As with almost every item used in our industry, temperature will affect product stability. Most of us recognize that drums expand and contract under varying operating temperatures. The same is true for brake blocks. Linings swell and grow with varying temperatures. This growth, coupled with self-adjusting brakes, may potentially destroy all of the maintenance effort to improve brake performance.

Keep in mind that the "accelerated wear" does not occur while the brakes are applied. The swell and growth causes over-adjustment and the "accelerated wear" actually occurs while the brakes are released.

Brake Block Cutting

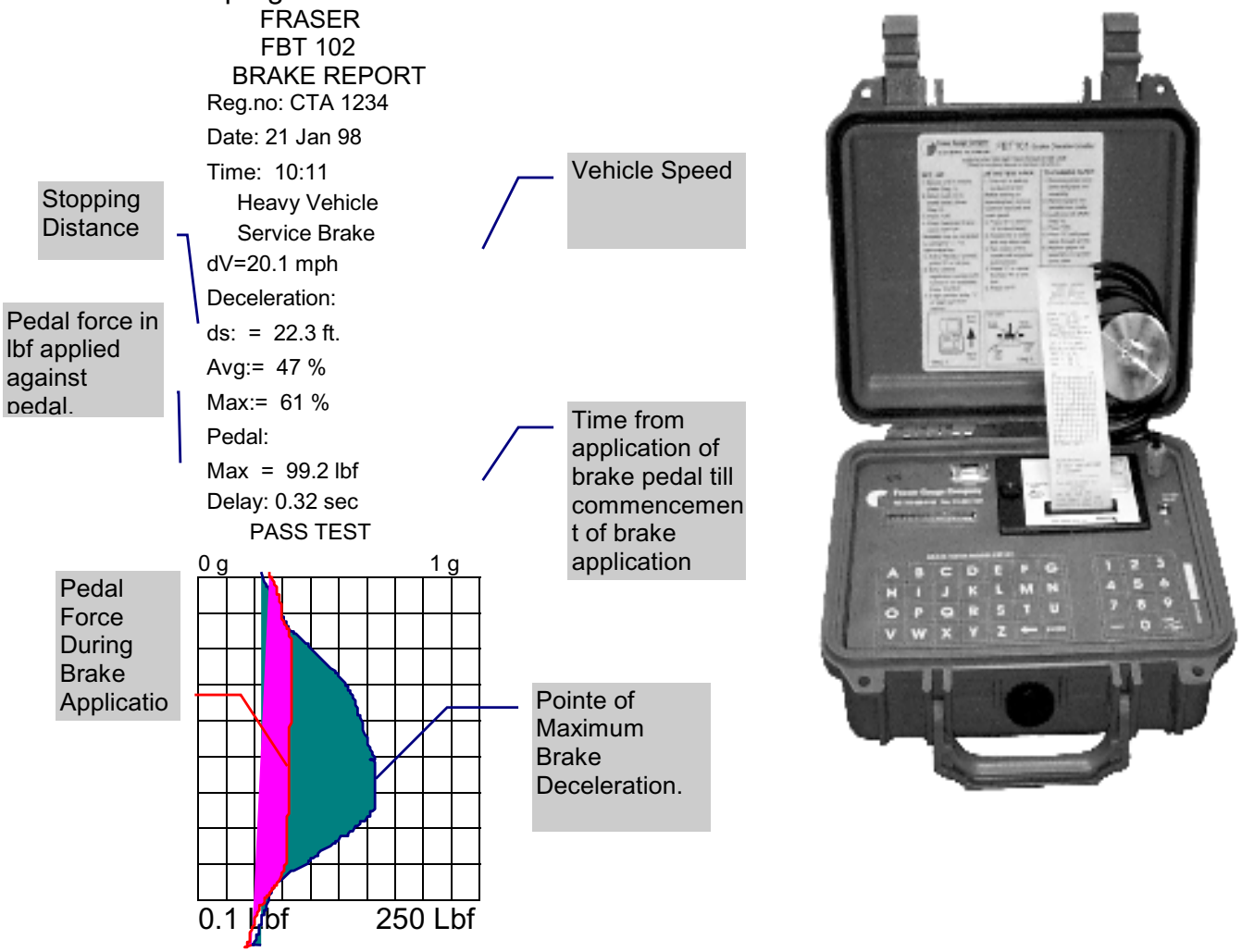
Many transit authorities purchase oversize (o.s.) lining in an effort to maximize brake efficiency. The Star Transformatic is used to match the lining and drum surfaces, which should make for an ideal situation.

After each brake reline the brake shoe assemblies should be burnished. This will better assure the proper setup of the lining to the drum. Failure to burnish can result in glazed lining and lining damage thus resulting in lower mileage and decreased performance. **Note:** Turning the lining to match the drums does not take the place of proper burnishing of the brake.

1. Make 10 stops (snubs) from 20 to 5 mph at regular intervals of approximately a **32%** decel or approximately 500 feet without stopping the vehicle.
   NOTE: MAKING STOPS (SNUBS) ON NEW RELINED SHOES AT A HIGH DECEL RATES CAN RESULT IN EXCESSIVE HEAT, GLAZED AND DAMAGED LINING.
2. After the 10^{th} snub make one complete stop from 20 mph to 0 mph.
3. Check the drum temperatures after the complete stop. Check to see if any drums are noticeably cooler than the others. This indicates a lack of braking effort on the wheel ends with the cooler drums. If this condition exists after the 10 snubs then repeat the burnish procedure.

Brake Decelerometer Test

A brake decel test should be performed on all vehicles after all brake relines and/or any maintenance on the vehicles brake system. The decel test can be done with either a pendulum type decelerometer or an electronic brake decelerometer, such as the Fraser FBT-102. The pendulum type decelerometers can only provide you with the maximum deceleration rate of the vehicle. Assuming you are going 20 MPH at the time of the test it can also give you estimated readings of stopping distance. The new electronic decelerometer can provide you with more accurate and complete brake analysis information such shown on the following printout from the Fraser Decelerometer Brake Tester. This information is also down loadable and can be used in such programs as Excel™ and Lotus.™



It is imperative that you maintain the decelerometers by regular maintenance and recalibration. Both the Tapley and the Fraser units should be recalibrated every two years to assure accuracy and acceptability in accident investigations.

Quality Control Documentation:

A record of all brake work should be documented. An example of a quality control form is on the following page for review. The needs of your transit authority will dictate the contents of any report.

QUALITY CONTROL
BRAKE RELINE QUALITY CONTROL SHEET

BUS #_____ MAKE_____ YEAR_____ DATE____/____/_____

DEPOT_____ MILEAGE_____ PREVIOUS MILEAGE_____ MILEAGE DIFFERENCE_____

		R/F	L/F	R/R	L/R
1	Drum Size (Indicate in thousands)				
2	New Or Relined Shoes? (N or R)				
3	New Diaphragms?				
4	New Air Chambers				
5	Cam Bushings Replaced?				
6	New Slacks?				
	Manual				
	Automatic				
7	Camshafts				
8	New Spider?				
9	Lining Clearance Top*				
10	Lining Clearance Bottom*				
11	Power Stoke Measurement				

- A variation in these dimensions is indicative of serious problems on "S" Cam type brakes.
- Brake Chamber Power Stroke:
  1. Prior to applying brakes, measure from face of brake chamber to the center of the clevis pin.
  2. Make brake applications until the air gauge reads 90-100 psi. Then make a full brake application and hold it.
  3. Measure from the brake chamber face to the center of the clevis pin.
  4. The difference between the brakes released and the applied measurements is the power stroke measurement.

POWER STROKE

Type Chamber	Effectiv e Area	OD	Max Stroke
24	24	7 7/32"	2 1/4"
30	30	8 8/32"	2 1/2"
36	36	9"	3"

Lining Manufacturer _____

Decel Readings: 1st_____ 2nd_____ 3rd_____

Delay Time: 1st_____ 2nd_____ 3rd_____

Attach tape print out of decel tests

Decel Readings should be taken after burnish procedure has been completed.

NOTE: Automatic slack adjusters should not be manually adjusted.

_____Supervisor _____Manager

Measuring Brake Lining Thickness:

Brake Lining Thickness Gauge: Fraser # 705

Hold the brake lining thickness gauge in one hand with the adjustment knob between the thumb and the index finger. If there is a dust shield in place, you may insert the gauge through the slotted hole provided for visual inspection. Align the legs of the gauge with the end of the brake lining. By using the adjustment knob you may adjust the legs to match the thickness of the lining. You may now record the reading obtained either in linear measurement or a percentage of remaining lining life.

Disclaimer:

The Fraser Gauge recommended practice for Brake Shoe and Component maintenance reflects industry standards and methods that have been found by our customers to provide the best performance record based on their experience. Fraser cannot know, evaluate, or advise the bus industry of all conceivable ways in which a practice may be undertaken or of the possible consequences of each such practice. Other practices or methods may be as good, or better, depending upon the particular circumstances involved.

Every operator that uses this practices must first satisfy itself thoroughly that neither the safety of its' employees or agents, nor the safety of usefulness of any products, will be jeopardized by any method selected.

BRAKE NOISE - What can be done.

As noise is a concern for all transit authorities I am including an article that was written by Carl Walker. Carl has more than 25 years experience in brakes and has worked with many transit authorities throughout the country in assisting in solving their braking needs.

Noisy brakes: Aggravating, serious problem

By Carl Walker, Onyx , Los Angeles California

Most transit maintenance personnel perceive " brake noise" as one of today's most aggravating and serious problems. But for the bus rider, brake noise is more than an irritating sound; it signifies "danger." Brake noise, squeal and howl are perceived as a stopping problem and a sign of an unsafe vehicle.

In most transit facilities, the problem goes untreated because it's difficult to duplicate in the shop and the cause is not easy to detect. The noise problem is usually blamed on the linings, as the pitch may become greater at higher temperatures. For many years, the noise was attributed to a poor match of parts, confined within the axle and brake drum assembly. Today it is known that the suspension and brake spiders are also major contributing factors.

Despite many studies and research, the problem continues. After years of tackling this problem, it can be concluded that no one component can be cited as the cause. There is no single, simple solution. However, a good common sense approach has yielded the best results to date. When the brakes are applied the linings contact the drum surface, a sound or vibration is created that is audible to the ear. The key to eliminating brake noise is to produce a frequency so high or low that it is no longer audible. This is accomplished by altering the mating parts in the assembly to produce a vibration frequency that is 180 ° out of phase as the sound waves cancel each other. This new technology is now being implemented in mufflers and several other components.

The most difficult thing to understand about sound frequency "noise" is that it exists whether or not it's heard. A bus driver may complain about a noise problem, but when the maintenance department investigates it, the bus appears quiet. It is important to keep in mind that each component on an axle and in the suspension has a natural frequency in which it will vibrate freely. Depending on road conditions, temperature and other factors, it could be in or out of phase. However, when two or more components have the same natural frequency, or coincide, every 2^{nd}, 4^{th} or 10 cycle, they could reinforce each other's pitch and bring forth stronger unpleasant noise.

For vibration to occur, a part must rub or move up against another part or group of parts or flex within itself. In either case, something must deflect and want to return to its' original position. Poor shoe-to-drum fit, bad spiders, loose camshaft bushings and anchor pins, and excess camshaft end play are most common sources of misalignment problems that lead to excess deflections, which create brake noise.

Brake linings also play an important role. Some are much noisier than others. Typically, non-asbestos lining are no nosier than asbestos. However, the same size linings are doing 50 to 90 percent more work as a result of the increased vehicle sizes and changing retardation factors (engine Rpm's, tires, clutch fans, etc.) In order to evaluate lining noise levels, the previously mentioned components must be addressed. Most components are affected by heat. Since a brake system is strictly an "energy conversion device" which changes energy of motion to heat energy, both the drum and linings become major factors.

Linings and drums

Linings swell and the drum expands away from the brake blocks. Depending on the quality and thickness of the drum, it can expand by as much as 0.125". Linings can expand as much as 0.050"-0.060". As a result of swell and growth, a minimum of 0.025"-0.030" clearance between the drum and lining is recommended.

It is important to recognize that brake shoes assume a pattern that differs from the shape of the drum. The drum will flex and try to conform to induced shape of the shoe assembly. As the drum passes around the irregular shape it begins to vibrate. The induced vibration is amplified within the drum, generating a pitch within the ear's frequency range-either a squeal, howl, growl or similar noise. This condition creates the major portion of the noise problems. Without proper centering of the shoes in relation to the drum, the same vibrating conditions may exist.

Another problem that stems from this same malfunction is lining "glaze." This occurs when only a small area of lining contacts the drum, forcing all energy to be transferred within that limited area. The extreme temperatures produced cause chemical changes within the friction material which severely reduce its' friction capabilities and cause premature brake fade. These localized temperature extremes lead to glazing, which causes noise and early drum degradation. Glazed linings result in higher brake pressures, reduced stopping capabilities and componentry fatigue, as well as noise.

To correct this problem, linings and drums should be turned simultaneously to ensure proper fit. Please note that the proper way to turn a drum is with the full hub and tire assembly; never turn drums using a "dummy hub". It runs as an assembly and should be turned as an assembly to minimize noise problems. This serves a two-fold purpose: to correct any drum out of roundness, and for the fact that some drums are not finish-ground to a standard size.

Brake shoes

Many years ago, most transit brake shoes were made from cast iron. Due to cost and other factors, "stamped steel" shoes are fabricated, but have never been considered throwaway items. In most cases, shoes are relined a minimum of nine to twelve times. Hammers are used to straighten them and minimum cleaning and preparation is the norm. Seldom are the shoes checked for stretch, pitting, undersize, burrs, oblong holes or anchor pin wear. Shoe table thickness should never be 0.030" less than the nominal thickness.

Other causes

If any wheel is doing more than its' share of braking, it will create excessive heat which in turn will lead to some brake noise. Make sure that the slack adjuster length and air chamber sizes across an axle are identical. Never use an automatic slack adjuster and a manual slack across an axle. Always check to make sure that brake stroke is the same across the axle.

Most fleets never replace or check brake spiders unless they are cracked or broken. Bent spiders are a major contributor to brake noise. When installing shoe assemblies on a bent spider, it is impossible to get full contact between the drum and lining. Never try to straighten a spider. Bent spiders should always be replaced. Bent spiders can result from a frozen shoe or a seized anchor pin that causes the shoe to react slowly. When disassembling a brake foundation, never drive out frozen anchor pins with a hammer or torch. They should be pressed out. Use a brake spider gauge to ensure acceptance.

Bonded linings

Bonded linings in some ways help to eliminate noise, but in other instances create noise. Years ago, fleets used to fill the boltholes with "lining plugs." This eliminated the dirt and grime from building up in the holes and degrading the drums. It also created noise. Few, if any, fleets use brake block plugs today. Bonded linings eliminate the holes and thereby eliminate the possibility of build-up and noise in the holes. On the other hand, bonded linings have proved to be noisier than bolt-on linings in most cases. This phenomenon can be attributed to the bonding and debonding processes. Most brake shoes are made from high-carbon steel with heat-treated webs and ends. Heat-treating helps to eliminate brake shoe wear, flattening and deformation. The heat treat qualities of the shoe are destroyed in debonding, which must reach temperatures of 800-900° F for recycling. The weakened brake shoe creates flex and noise which offset the benefit of hole elimination.

Integra-Block

Integra block was originated by Tennaco. It consists of transit formulated lining material that has been bonded to a metal backing. The backing has bolts built into the metal. Thus the assembly bolts to the brake shoe. However, because it has a metal backing there are few problems with proper torque of the bolts. In addition, because the shoe does not require debonding you do not lose the heat treat in the shoe webs when removing the lining.

Foundation Components

Examining the components from the previous brake job will assist you in determining problems of the first reline. Camshafts should be checked for wear at the cam head to ensure they are not unevenly worn. If wear is detected, replace cams and cam bushings. Check rollers for flat spotting. Do not use oversize rollers, as full contact cannot be achieved noise will result when completing a brake job.