Recommended Practice

RP 608A

VMRS 013-001-023, -002-023, -011-001, -013-013

BRAKE DRUMS AND ROTORS

PREFACE

The following Recommended Practice is subject to the Disclaimer at the front of TMC's *Recommended Maintenance Practices Manual.* Users are urged to read the Disclaimer before considering adoption of any portion of this Recommended Practice.

PURPOSE AND SCOPE

This Recommended Practice is intended to familiarize users with the installation, maintenance, and safety procedures associated with spoke wheel and hub mounted drums and rotors used on heavy-duty vehicles.

REQUIREMENTS

Brake drums and rotors should be engineered to provide proper metallurgical structure, surface finish, and dimensional control to meet operational requirements.

SPECIFICATIONS

The manufacturer should use materials which will conform to at least the minimum requirements of SAE J431, *Automotive Gray Iron Castings.*

BALANCING

It may be desirable to install balanced drums on axles. Manufacturers should balance front steer axle drums not to exceed 10 inch-ounces and drive axle drums not to exceed 20 inch-ounces.

BRAKE DRUM NOMENCLATURE

See **Fig. 1** for brake drum nomenclature.

BRAKE DRUM AND ROTOR IDENTIFICATION

When specifying replacement brake drums or rotors, the following information is required:

- The manufacturer's name
- The manufacturer's part or casting number
- Description of any other markings appearing on the drum or rotor

1. Braking or Friction Surface
2. Squealer Band
3. Balance Weight
4. Open End
5. Drum Back
6. Dust Shield Recess
7. Braking Surface Width
8. Pilot Diameter
9. Chamfer (pilot) Inboard Mounting
10. Chamfer (pilot) Outboard Mounting
11. Chamfer (at open end)
12. Mounting Bolt Holes
13. Closed End
14. Hat Section (Wrap Around)
15. Barrel
16. Mounting Flange

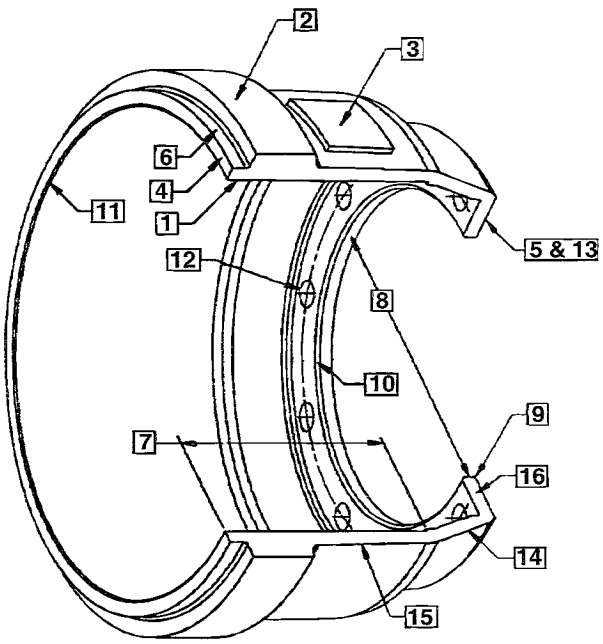

Fig. 1: Brake Drum Nomenclature

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Issued 5/81
Revised 1/92

If the above information is not available, the following information is needed:

- Vehicle manufacturer
- Vehicle model
- Axle or spindle size
- Whether disc or spoke wheel application
- Brake size and type of actuation (S-cam, Wedge, Air, Hydraulic, etc.)
- Whether inboard or outboard mounting

MEASURING BRAKE DRUMS

If the information previously described is not available to properly identify the drum required, it will be necessary to make accurate measurements to determine the type and size of the brake drum needed, particularly if the part number can not be determined. The photographs comprising **Fig. 2** show six items to measure and check prior to ordering a new brake drum.

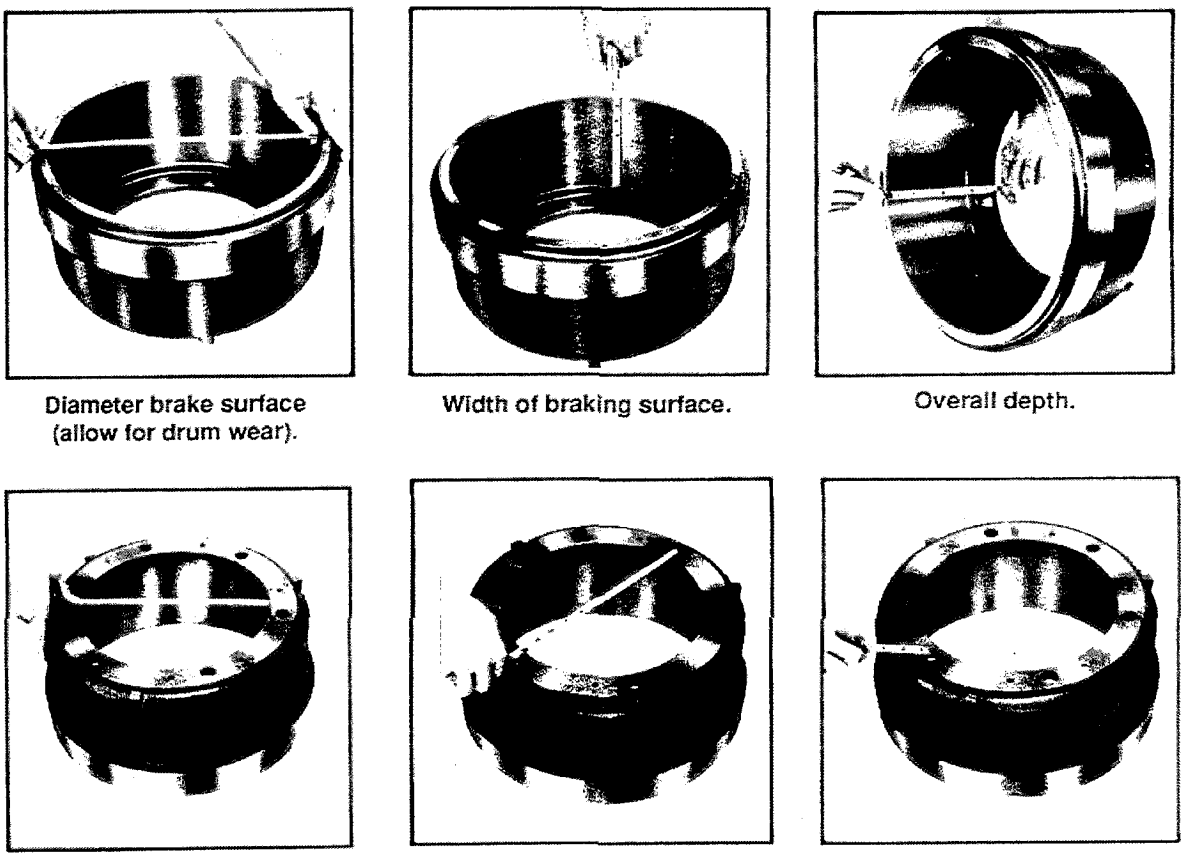

Fig 2: Measurements Necessary to Determine Drum Brake Type and Size

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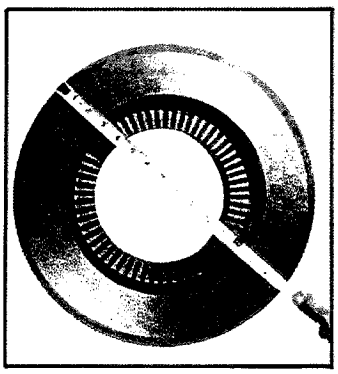
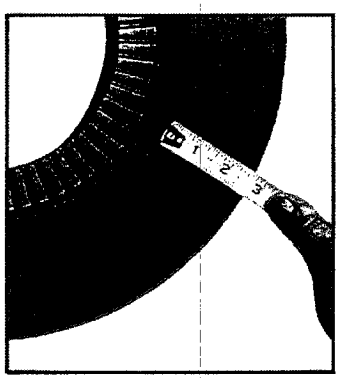
MEASURING BRAKE ROTORS

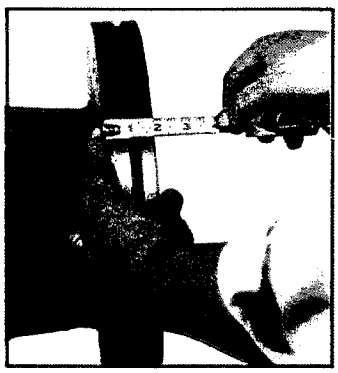
If the information previously described under the section entitled BRAKE DRUM AND ROTOR IDENTIFICATION is not available to properly identify the rotor required, it will be necessary to make accurate measurements to determine the type and size of the rotor needed, particularly if the part number cannot be determined. The photographs comprising **Fig. 3** show six items to measure and check prior to ordering a new brake rotor.



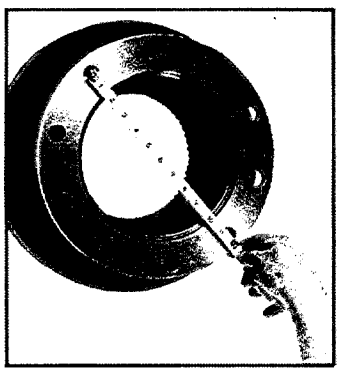
Outside diameter of rotor.



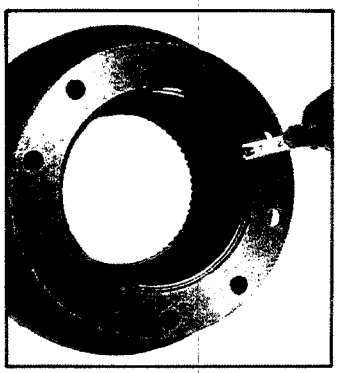
Width of braking surface.



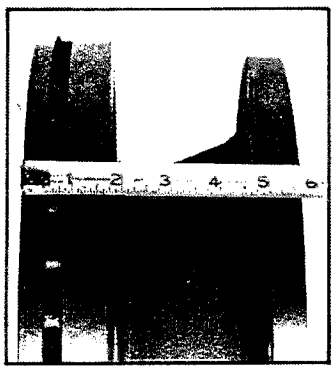
Rotor width.



Bolt circle diameter and pilot diameter.



Size and number of bolts.



Overall depth of U-section and hat-section rotors.

Fig. 3: Measurements Necessary to Determine Brake Rotor Type and Size

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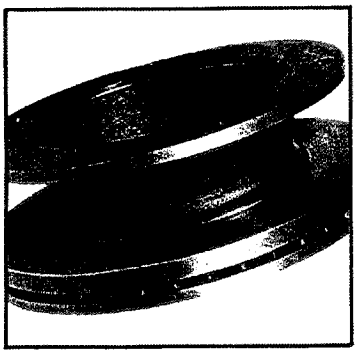

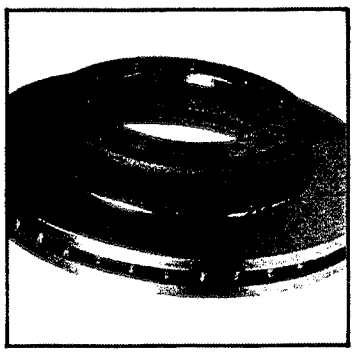

"Hat Section" Rotor

Fig. 4: Basic Rotor Designs

ROTOR DESIGNS
The pictures comprising **Fig. 4** show the two basic rotor designs.

INSTALLATION INSTRUCTIONS—HUB MOUNTINGS

NOTE: The installation procedure for the brake drum or rotor will depend on the wheel hub design.

All hub components (including the bearing cups) should be inserted into the hub prior to attaching the brake drum or rotor. Be sure to use the correct stud length. The use of an incorrect stud will not allow the wheel end to function properly. (See STUD STANDOUT section.)

INBOARD MOUNT WITH SERRATED STUDS

1. Place the hub on a flat surface with the hub cap or drive flange end down. Place the brake drum or rotor on the hub, aligning the mounting holes. Make sure the drum or rotor pilot matches the hub pilot and that the brake drum or rotor is resting flat against the hub mounting face. There should be no interference between the brake drum or rotor pilot chamfer and the corner radius on the hub. If interference exists, the brake drum or rotor will not function properly.

2. Insert the serrated studs down through the brake drum or rotor and into the hub. You may use a press to insert the studs. If a press is not used, you may drive the studs into the hub by tapping them with a hammer until they are flush against the back plate of the brake drum. In any case, support the hub flange when inserting the studs to guard against excessive flange flexing.

INBOARD MOUNT WITH SHOULDER STUDS

1. Make sure the stud shoulder fits into the groove cut into the hub and insert the shoulder stud through the hub. Be sure to support the hub flange when inserting the stud to guard against bending the flange. Make sure the stud shoulder seats firmly against the bottom of the groove cut in the hub. If the stud shoulder does not fit into the hub groove or the hub flange is distorted, the hub will not function properly.

2. Place the hub on a flat surface with the hub cap end or drive flange down. Place the brake drum or rotor on the hub, aligning the mounting holes. Make sure the drum or rotor pilot matches the hub pilot and that the brake drum or rotor is resting flat against the hub mounting face. There should be no interference between the brake drum or rotor pilot chamfer and the corner radius on the hub. If interference exists, the brake drum or rotor will not function properly. Place a hardened flat washer and a locknut on each stud. Failure to utilize a hardened flat washer will lead to uneven stress distribution and may significantly reduce product life. Tighten the locknut in accordance with the assembly torque specifications.

OUTBOARD MOUNT WITH SERRATED STUDS OR NON-SERRATED CLIPPED HEAD STUDS

1. Place the hub on a flat surface with the hub cap or drive flange end down. Insert the stud down through the hub. You may use a press to insert the serrated stud. If a press is not used to insert the stud, you may drive the studs into the hub by tapping them with a hammer until they are flush against the back of the hub. In any case, support the hub flange when inserting the studs to guard against excessive flange flexing. Take care to avoid damaging the stud or hub assembly when inserting the serrated stud. Install the hub assembly in accordance with the hub manufacturer's instructions.

2. Place the drum over the hub and brake shoes while being careful not to damage the stud threads. Make sure the drum seats flat against the hub flange and mates properly with the hub pilot. There should be no interference between the brake drum pilot chamfer and the corner radius on the hub. If interference exists, the hub will not function properly.

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INSTALLATION INSTRUCTIONS—SPOKE WHEEL MOUNTINGS

NOTE: The installation procedure for the brake drum or rotor will depend on the spoke wheel design.

Spoke wheels require high strength bolts to support the necessary pre-loads and operating forces. Use only Grade 8 bolts with thru-hardened flat washers.

SPOKE WHEELS WITH TAPPED BOLT HOLES

1. Spoke wheels with drilled and tapped bolt holes require a special epoxy adhesive locking material to be applied to the drum or rotor bolt threads to prevent the bolt from loosening during operation. Failure to use adhesive locking material may result in loose brake drums or rotors and could result in an accident.

2. Place the wheel on a flat surface with the hub cap or drive flange end down. Place the brake drum or rotor on the wheel, aligning the mounting holes. Make sure the brake drum contacts the wheel only at the mounting pads. There should be clearance between the spoke and the brake drum or rotor. If this is not the case, the brake drum or rotor will not function properly.

3. Insert the bolt through the drum or rotor and into the wheel while turning the bolt. If the assembly originally had a washer under the bolt head, replace with a hardened washer. Failure to do so will result in uneven stress distribution, which may significantly reduce service life. Tighten the drum bolt to the torque specifications given in **Table 1**.

Proper torque is important. Use a torque wrench to assure proper torque. Insufficient torque can lead to bolt breakage. Over-torque can over stress the bolts and strip the threads. Do not deviate from the recommended torques.

SPOKE WHEELS WITH THRU HOLE

1. Place the wheel on a flat surface with the hub cap or drive flange end down. Place the brake drum or rotor on the wheel, aligning the mounting holes. Make sure the brake drum or rotor contacts the wheel only at the mounting pads. There should be clearance between the spoke and the brake drum or rotor. If this is not the case, the brake drum or rotor will not function properly.

2. Insert the mounting bolt down through the brake drum or rotor and through the web between the spokes. Place the hardened flat washer and locknut on the bolt and tighten until the flat washer is flush against the wheel. Use only a Grade C locknut and hardened flat washer. Failure to do so will result in uneven stress distribution and may significantly reduce service life.

3. Tighten the locknut, holding the bolt stationary, in accordance with the torque specifications given in **Table 1**.

STUD STANDOUT

When changing from a composite drum to a full cast drum, the hub studs have to be changed in most applications. The added mounting surface thickness of a full cast drum does not give a long enough stud standout. See **Table 2** for proper wheel mounting specifications.

When changing studs or hubs, it is important to have the correct stud standout to insure proper wheel mounting. Stud standout appears as dimension 'A' in the two diagrams below.

TABLE 1

DRUM MOUNTING TORQUE SPECIFICATIONS

THREAD SIZE	ROTATE	TORQUE REQUIRED FOOT POUNDS			
		Phos/Oil Nuts (Black)		Cad/Wax Nuts (Silver)	
		MIN.	MAX.	MIN.	MAX.
5/8-18 (Tapped Holes)	Rotate Bolt	150	200	-	-
5/8-18 (Thru Holes)	Rotate Nut	150	175	95	130
3/4-10	Rotate Nut	250	275	-	-
3/4-16 (Wheels)	Rotate Nut	275	325	200	250
3/4-16 (Hubs)	Rotate Nut	100	225	40	55
1-14	Rotate Nut	175	225	-	-

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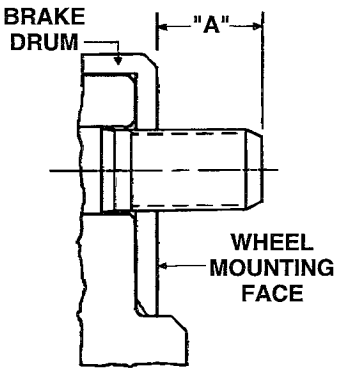
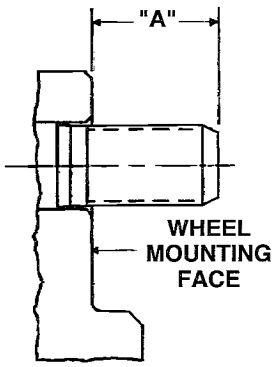
TABLE 2

WHEEL SPECIFICATIONS

OUTBOARD DRUM MOUNTING	INBOARD DRUM MOUNTING
	

BALL SEAT MOUNTING APPLICATIONS
(All dimensions in inches)

Number of Studs	Bolt Circle Diameter	"A" Dimension	
		Ferrous Wheel	Aluminum Wheel
6	8.75	Single 1.25 min. Dual 1.31 - 1.44	Single 1.50 min. Dual 1.31 - 1.44
10	8.75	Single 1.25 min. Dual 1.31 - 1.44	— —
10	11.25	Single 1.25 min. Dual 1.31 - 1.44	Single 1.68 min. Dual 1.31 - 1.44

I.S.O. METRIC (HUB PILOTED) APPLICATIONS
(All dimensions in mm)

Number of Studs	Bolt Circle Diameter	"A" Dimension	
		Ferrous Wheel	Aluminum Wheel
8	275	Single 48 Dual 62	Single 54 Dual 79
10	285.75	Single 48 Dual 62	Single 59 Dual 84
10	335	Single 48 Dual 62	Single 59 Dual 84

W.H.D. METRIC (HUB PILOTED) APPLICATIONS
(All dimensions in mm)

Number of Studs	Bolt Circle Diameter	"A" Dimension	
		Ferrous Wheel	Aluminum Wheel
8	275	Single 49 Dual 63	Single 60 Dual 85

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BRAKE DRUM AND ROTOR REPLACEMENT

Brake drum and rotor replacement is required if any of the following conditions exist:

- The brake drum or rotor is cracked.
- The surface is heat checked, ground, or worn beyond the maximum diameter or minimum thickness limits.
- The mounting flange is cracked.
- The bolt holes are elongated.
- The brake drum or rotor is known to have been severely overheated.
- The brake drum is out-of-round or the rotor has thickness variations beyond limits.

Brake drums or rotors should be replaced in pairs on an axle to achieve the same braking power on both wheels and maintain an even braking load on the axle. Failure to replace both brake drums or rotors on an axle will result in uneven braking load on the axle and may significantly reduce the performance, service life, and/or safety of the vehicle.

BRAKE DRUM RESURFACING

NOTE: Brake drum resurfacing is not recommended by most manufacturers, but it may be desirable to turn the drum's brake surface to remove small heat checks or other surface defects resulting from normal use.

The maximum diameter cast into the back plate or barrel portion of the brake drum is the maximum diameter or discard diameter to which the brake drum may be worn and still be usable. If any portion of the braking surface exceeds the maximum diameter, the brake drum must be discarded. The maximum allowable drum diameter is 0.120 inch greater than the nominal new diameter unless stated otherwise on the casting.

CAUTION: When resurfacing a drum, allow at least 0.040 inches under the maximum diameter for additional wear. This usually means the drum may be turned a total of 0.080 inch more than the brake surface diameter of a new brake drum.

When resurfacing a drum, the following tolerances apply: The surface finish should be 150 - 200 microfinish. Runout with pilot should be 0.010 inch, maximum. Diameter should not exceed 0.080 inch over the new diameter.

ROTOR RESURFACING

NOTE: Rotor resurfacing is not recommended by most manufacturers, but it may be desirable to turn the brake surface to remove small heat checks or other surface defects resulting from normal use.

The minimum thickness cast into a rotor is the minimum thickness or discard thickness to which the rotor may be worn and still be useable. If any portion of the rotor is thinner than the minimum thickness, it must be discarded. When resurfacing brake rotors, allow at least 0.040 inch over the minimum thickness for additional wear.

When resurfacing a rotor, the following tolerances apply: The surface finish should be 120 - 150 microfinish. Lateral runout (wobble) should be under 0.010 inch (measure with a dial indicator). Radial runout (diameter) should be under 0.035 inch. Rotor thickness should not exceed 0.080 inch over the new thickness. Rotor thickness variation should be under 0.005 inch.

CAUTION: When resurfacing a rotor, allow at least 0.040 inches over the minimum thickness for additional wear. This usually means the rotor may be turned a total of 0.080 inches over the thickness of a new rotor.

It is unsafe and illegal in some states to use a brake drum or rotor which is below the discard dimension.

HUB PILOTED VS. BALL SEAT DRUMS

NOTE: Make certain the correct product has been chosen for your application. Incorrect or mismatched parts may result in loose or broken mounting studs or wheel ends and can cause an accident. If you are unsure about an application, contact the manufacturer.

Older ball seat mountings have a close fit between the drum and stud holes and the stud diameter. The drum is installed on the hub pilot. The wheels are piloted on the studs using inner and outer cap nuts. See **Fig. 5**.

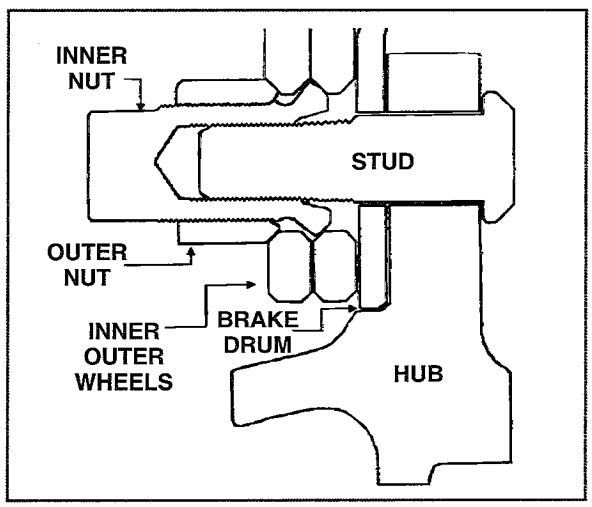

Fig. 5: A Ball Seat Disc Wheel Mount

Hub piloted mountings have a close fit between the drum pilot and the machined pilot (continuous or interrupted) on the hub. The drum bolt mounting

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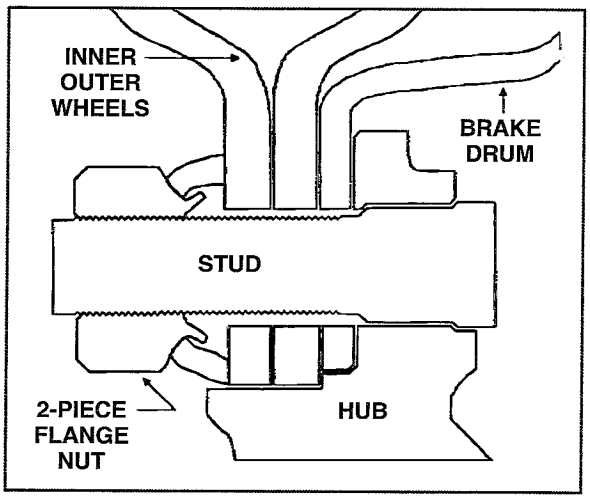

Fig. 6: A Hub Piloted Disc Wheel Mount

holes are larger than the stud diameter. The wheels and drum are piloted on the hub. See **Fig. 6**.

New drum designs will allow you to use the same drum for ball seat and hub piloted applications when matched with the proper hub. These new drums can not be used with older hubs with a different pilot diameter. Matching the drums with the proper hub is critical in maintaining the support of the wheel end.

PILOT CHAMFERS

Drum manufacturers make different pilot chamfers where the drum mates the hub. If corrosion builds up behind the chamfer (point "X" in **Fig. 7**) and a drum with a small chamfer (point "Y" in **Fig. 7**) is installed without cleaning the corrosion from the hub, the mounting flange can break when the assembly is torqued. Use a scraper to clean corrosion from the hub before installing a new drum.

BRAKE, DRUM, AND ROTOR FAILURE ANALYSIS

The photographs, probable causes, and recommended actions that follow can be used for brake drum and rotor failure analysis and problem rectification.

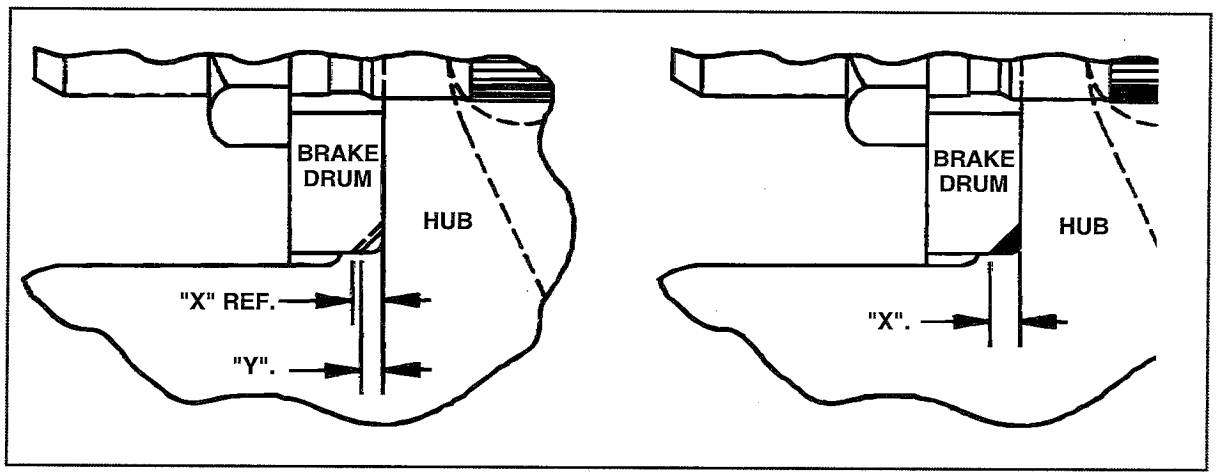

Fig. 7: A Hub Pilot Chamfer

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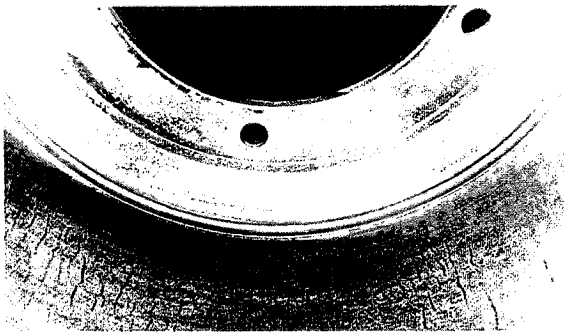
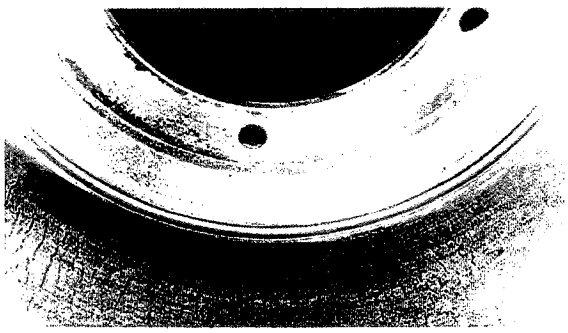
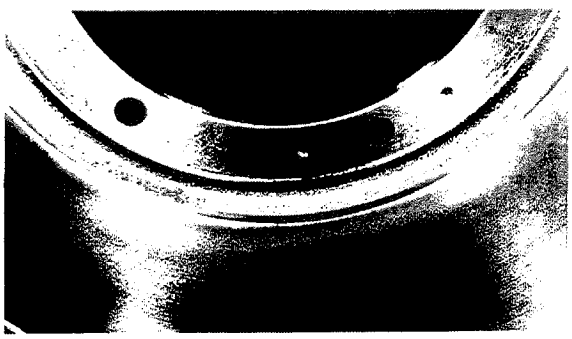
BRAKE DRUM FAILURE ANALYSIS

PROBLEM	PROBABLE CAUSES	RECOMMENDED ACTIONS
HEAT-CHECKING	The brake surface shows fine, hairline cracks.	
	Heat-checking is a normal condition of the brake drum caused by constant heating and cooling of the braking surface.	Heat checking does not impair brake performance, reuse drum if within tolerance. **If deep cracks have developed, replace drum immediately.**
CRACKED DRUMS	Upon inspection, the drum is found to have cracked all the way through the entire wall.	
	Mishandling (new drum). Excessive heating and cooling. Brake balance. Driver abuse.	Replace brake drum. Check to see if drum is adequate for the application. Check for pneumatic or torque balance problems. Driver training. **Replace cracked drums immediately.**
BLUE DRUMS	This problem is signified by a bluish color and disfiguration of the brake parts.	
	Excessive heat from dragging brakes or brake imbalance. Swollen linings.	Look for weak or broken return springs or binding brake actuation. Consult lining manufacturer. Drum can be used if deep cracks are not present.

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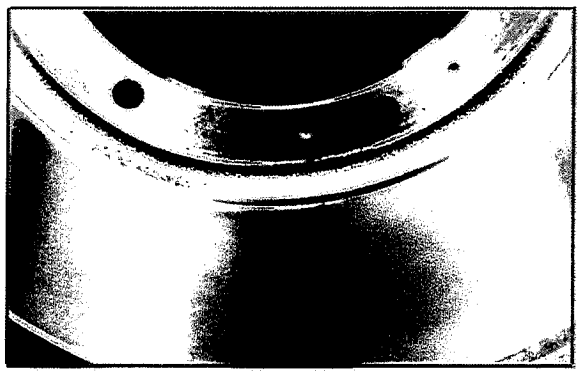
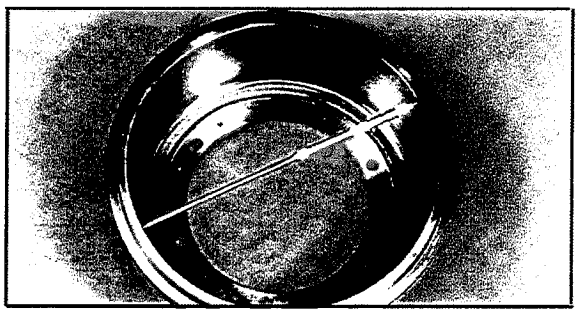
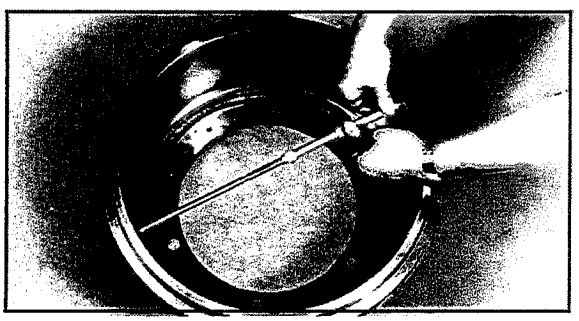
BRAKE DRUM FAILURE ANALYSIS (Continued)

PROBLEM	PROBABLE CAUSES	RECOMMENDED ACTIONS
POLISHED DRUMS	Recognized from a mirror-like finish on the braking surface.	
	Improper lining friction rating. Drum resurfaced with too fine of a micro-finish. Light contact of linings to drum.	Consult vehicle or lining manufacture for an alternate lining material. Micro-finish should be 150 - 200 RMS. Check condition of return springs, camshaft bushings, air system and shoe to drum contact. Remove the gloss with eighty (80) grit emery cloth..
OUT-OF-ROUND DRUMS	This condition is shown by more wear on one side of the brake linings and variations in drum diameter at different points on the braking surface.	
	Heat distortion. Drum has been dropped or stored on its side. Improper chucking when turning drum.	Turn brake drum if within limits or replace.
OVERSIZE WORN DRUMS	This problem is indicated by uneven lining wear, or braking surface diameter measurements in excess of allowable limitations.	
	Normal wear condition (age).	**Replace brake drums and brake linings.**

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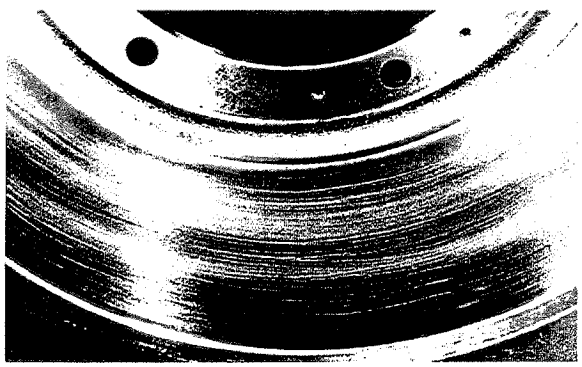
BRAKE DRUM FAILURE ANALYSIS (Continued)

PROBLEM	PROBABLE CAUSES	RECOMMENDED ACTIONS
MARTENSITE SPOTS	The brake surface show black spots which are slightly raised and are hard and brittle.	
	Martensite is formed by rapidly heated brakes to approximately the 1400° F range followed by rapid cooling. This condition is caused by brake drag or torque imbalance.	**Replace brake drum.** Check for dragging brake, check balance between tractor/trailer and wheel to wheel (i.e., air distribution, brake adjustment, and power A/L factors.
GREASE STAINED DRUMS	Upon inspection, the brake drum shows discolored spots on drum surface, with oil or grease splattered on brake assembly.	
	Leaking oil/grease seal or improper lubrication of brake components.	Repair source of oil or grease leak, clean the brake drums and replace the linings.
SCORED DRUMS	The problem is indicated by a grooved appearance on the brake surface.	
	Grooves, loose rivets or bolts, or foreign material in rivet holes. Abrasive material in brake drum. Poor quality brake lining.	Repair or install rivet plugs. Dust shield may cause or cure this problem. Consult lining manufacture. TURN BRAKE DRUM IF WITHIN LIMITS OR REPLACE.

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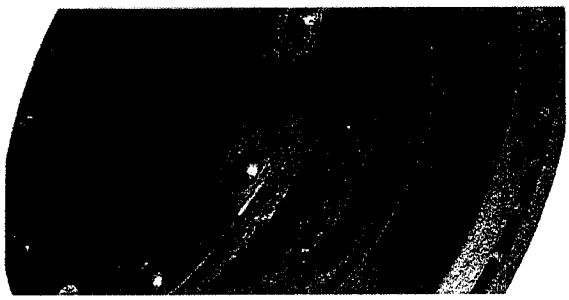
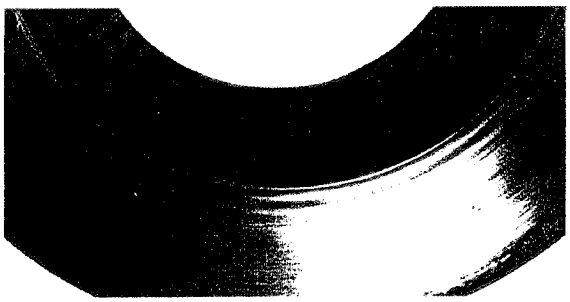
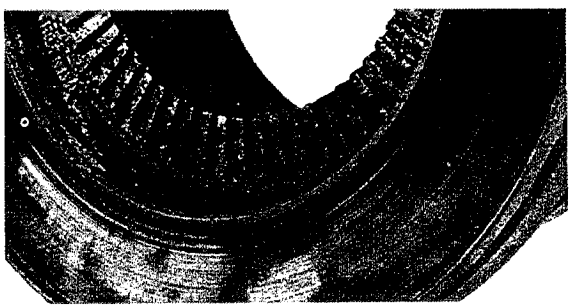
BRAKE ROTOR FAILURE ANALYSIS

PROBLEM	PROBABLE CAUSES	RECOMMENDED ACTIONS
BLUING ROTORS	This problem is signified by a bluish color on the rotor braking surface.	
	Brake imbalance. Excessive heat from dragging brakes.	Check for pneumatic or torque balance problems. Caliper not fully releasing. Repair. Rotor can be used if deep cracks are not present.
POLISHED ROTORS	Mirror-like finish on the braking surface.	
	Improper lining friction rating. Rotor resurfaced to too fine of a microfinish.	Consult vehicle or lining manufacturer for an alternate lining material. Micro-finish should be 120 - 150 RMS. Remove the gloss with eighty (80) grit emery cloth.
GREASE-STAINED ROTORS	Upon inspection, the rotor shows discolored spots on rotor surface, with oil or greases splattered on brake assembly.	
	Leaking caliper, oil/grease seal, or improper lubrication of brake components.	Repair source of oil or grease leak, clean the rotor and replace the linings.

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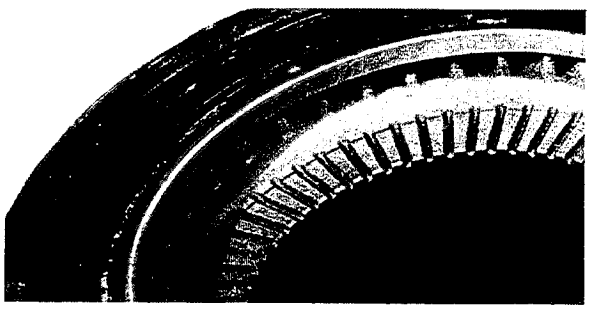
BRAKE ROTOR FAILURE ANALYSIS (Continued)

PROBLEM	PROBABLE CAUSES	RECOMMENDED ACTIONS
SCORED ROTORS	Grooved appearance on the brake surface.	
	Contaminates traped between the lining and rotors. Lining worn out. Lining plate contacting rotor.	Remove contaminates. Resurface rotor if in specification. Replace lining. Replace lining. Resurface rotor if in specification or **replace rotor.**
WORN ROTORS	Cross section measurement across the rotor braking surfaces.	
	Normal wear. Uneven wear.	Rotor may be resurfaced within specification or **replace rotor.** Brake is not functioning properly. Repair brake and **replace rotor.**
LINING TRANSFER	Layer of lining material welded to the rotor surface.	
	High operating temperatures. Improper lining material.	Check for brake imbalance or system malfunction. Consult lining manufacturer.

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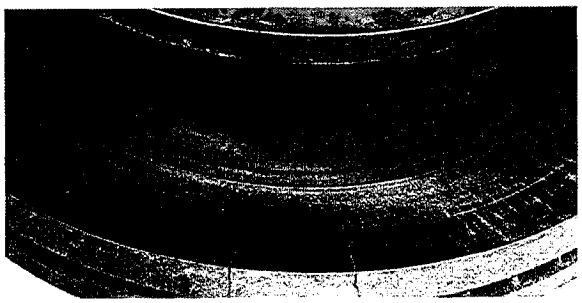
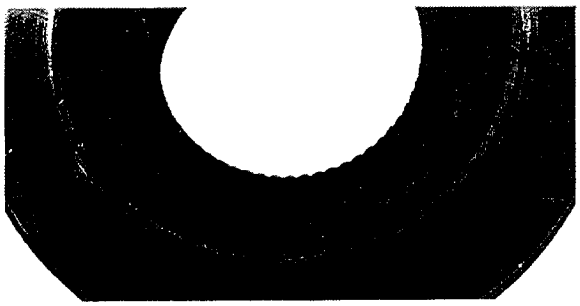
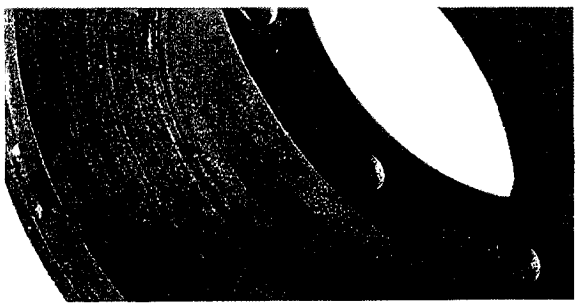
BRAKE ROTOR FAILURE ANALYSIS (Continued)

PROBLEM	PROBABLE CAUSES	RECOMMENDED ACTIONS
CRACKED ROTORS		
	Mishandling (new rotor) Brake balance. Rotor worn beyond the minimum thickness. Driver abuse.	Replace rotor. Check for pneumatic or torque balance problems. Driver training. **REPLACE CRACKED ROTORS IMMEDIATELY**
HEAT CHECKING		
	Heat checking is a normal condition of the rotor caused by constant heating and cooling of the braking surface.	Light heat checking does not impair brake performance. Reuse rotor if within tolerance. **IF DEEP CRACKS HAVE DEVELOPED (.060" max.), REPLACE ROTOR IMMEDIATELY.**
HEAT SPOTTED ROTORS	The brake surface shows black spots which are slightly raised.	
	The rotor has been subjected to extremely high temperatures. This condition is caused by excessive pneumatic/torque imbalance, or driver abuse.	Replace the rotor. Check brake linings for uneven wear and replace if necessary. Check balance between axles and wheel to wheel. (i.e., air distribution, brake adjustment, and power A/L factors.

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