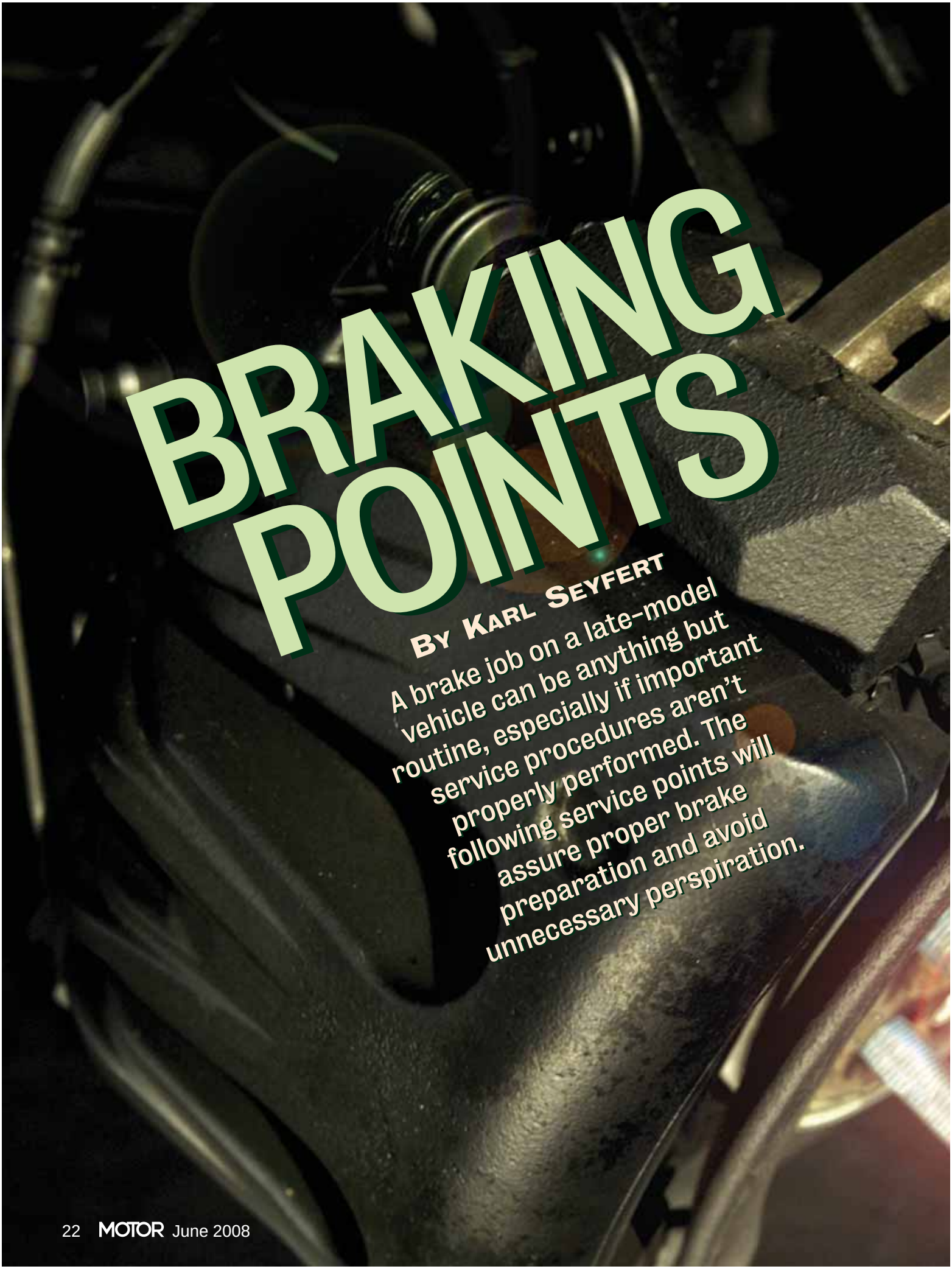

BRAKING POINTS

By Karl Seyfert

A brake job on a late-model vehicle can be anything but routine, especially if important service procedures aren't properly performed. The following service points will assure proper brake preparation and avoid unnecessary perspiration.

Photo: Wieck Media

Can you name two things that can ruin a brake job and possibly cause an embarrassing and unprofitable comeback? This isn't really a quiz, so here are the answers, in no particular order: pedal pulsation and brake noise. It should come as no surprise that these problems are almost entirely avoidable, if the proper brake service techniques and tools are used. We're going to run them down for you, but before we do, we'll spend a moment defining some brake service terms.

The *rotor thickness variation* (RTV) of a new rotor should be nearly undetectable. To measure RTV, mark the rotor at at least a dozen equally spaced intervals. Measure and record the rotor thickness at these intervals. There should be no more than .001 in. variation between the readings on a new (or resurfaced) rotor.

Lateral runout is measured using a dial indicator mounted on the spindle or an adjacent area. The dial indicator pointer rests in the middle of the rotor surface. Hold the rotor in place with at least three lug nuts, torqued to specifications. As you turn the rotor, runout should not exceed .002 in.

The practice of marking the lug stud and rotor before rotor removal is called *rotor indexing*. This allows you to return the rotor to its previous position after resurfacing. This small step may save you a lot of headaches because the vehicle manufacturer may have installed the rotor to minimize runout. Indexing is not possible when a new rotor is being installed. Lateral runout caused by a mismatch between the rotor and hub can be minimized by installing dedicated shims between these two parts.

Sandpaper or a power tool can be used to apply a *nondirectional finish* to the rotor friction surface. While there is some debate regarding the need to resurface rotors during each brake service, all vehicle manufacturers recommend that a nondirectional swirl finish should be applied to all rotors, both new and reground. This finishing technique helps to properly break in friction and rotor surfaces.

Pedal Pulsation

To prevent pedal pulsation, if you plan to reuse the rotor, index it before you remove it. Returning the rotor to its original position ensures minimal runout. Machine the rotor in a brake lathe or an on-car lathe, then finish with a nondirectional finish. We'll cover rotor resurfacing in-depth in the next section.

Complete the resurfacing process with a wash with soap and hot water, then a thorough drying with paper towels. Brake cleaner should not be used because it does not remove all the metal particles from the rotor. Shop air and rags also should be avoided because they usually contain oil that can contaminate rotor surfaces and friction material.

Before reinstalling the rotor, clean the hub and rotor hat to remove all traces of rust and corrosion from the inner rotor and the hub surface where the rotor rides. A wire wheel on a drill does not do a good enough job in cleaning around the wheel studs. Special tools, including ScotchBrite pads that fit around the studs, are available for this purpose.

Check the hub bearing endplay. Front-wheel-drive hub bearings should have .002 in. or less endplay; more than that will result in eventual RTV. If the installed runout is greater than specifications, try indexing the rotor one lug at a time to see if it can be corrected. You also can use a dedicated shim system to accomplish this. As a last resort, machine the rotor with an on-car brake lathe. This will match the rotor to the hub and, if done properly, will reduce runout to zero.

If a rotor is installed with overspecification runout, it may not be immediately felt as a brake pedal pulsation. Over time, however, the rotor high spot makes contact with the friction material each time it passes. This can cause friction material to be deposited on the rotor, making the high spot even higher. When it gets high enough, pedal pulsation results. It may take several thousand miles before the pulsation becomes noticeable to the driver.

Follow the proper lug nut tightening procedure to avoid introducing runout when installing the wheels. All vehicle manufacturers advise against lubricating the studs because false torque readings will result. Hand-tighten all lug nuts in a star pattern, then tighten to half the maximum specified torque value. Tighten to the full torque specification as instructed by the vehicle manufacturer. After all your hard work, lateral runout can be induced if an impact wrench is used to tighten the lug nuts. This will eventually lead to RTV and pedal pulsation.

Brake Noise

Brake noise is the bane of every technician's existence. After your brake service, the vehicle may stop straight and true, with zero pedal pulsation. But if the customer hears brake squeal, or there are ominous clicks and clunks coming from under the vehicle, you can bet he's going to be back to bend your ear. Use the following techniques to keep brake noise at bay.

Inspect the disc brake hardware. The caliper bolts, sleeves, bushings and clips must be new or in like-new condition. Caliper bolts must not be bent and must be torqued to manufacturer specifications. Caliper slides and bushings must be clean and lubricated with the recommended brake caliper lubricant, and according to the recommended caliper lube procedure. All manufacturers have very specific lubrication procedures, designed to prevent vibration-induced noise.

The clips that hold the pads in place in the anchor bracket should be replaced during every brake job. Also check to the anchor brackets for wear—they do wear out. The new pads should fit very snug in the anchor bracket; the maximum clearance is just .010 in. Most brake squeal is caused by loose-fitting pads in the anchor bracket.

Not every rotor needs to be turned during a brake service. New rotors and drums should be ready for use straight out of the box. If they need resurfacing, they were either damaged in handling, stored improperly or came from a questionable supplier. Machining new rotors shortchanges the customer because removing metal from a lightweight rotor shortens its service life.

Current rotors are noticeably lighter than the rotors of the past. They're thinner, so there's less metal available for removal by machining. Also, because there's less mass, today's rotors are less able to tolerate and shed unwanted heat. Modern brake pads are fussy about what rotor surfaces they'll work with. This is because of changes that were necessary to make them work with lighter-weight (hotter-operating) rotors, work without certain substances (like asbestos) and deliver excellent stopping performance.

Many used rotors don't need to be turned, either. In fact, unmachined used rotors that are in good condition are desirable. During stops, some friction material transfers from the pads to the rotor working surfaces. This is part of the normal break-in process, and it improves a rotor's friction coefficient. Good, used rotors have already received this conditioning. This can be especially important on certain vehicles that do not stop well after new brakes have been installed and haven't been broken in. They'll actually stop better during the break-in period with matched pairs of good, used rotors installed, rather than with new or resurfaced ones.

Photo: Mike Mavrigian

To measure rotor thickness variation, mark the rotor at equally spaced intervals. Measure and record the rotor thickness at these intervals, using a brake rotor micrometer like this one. The pointed anvil tip on one side of the mic assures accurate, repeatable readings. There should be no more than .001 in. variation between the readings on a new (or resurfaced) rotor.

A used rotor must meet three standards before it can be put back into service without machining: surface condition, specifications and trueness. Determining surface condition begins with a visual inspection. If you see roughness, machining is in order—assuming rotor thickness meets specifications. Some manufacturers even allow scoring up to .060 in. (1.5mm) wide or deep. GM's simple test states that if the edge of a dime won't fit into a surface groove, the groove isn't wide enough to be a problem. If the dime fits in the groove but you can still see all of FDR's hair, the scratch isn't deep enough to worry about.

If you test-drove the car before starting work, you may have an idea if the rotors could be suitable for reuse. If the pedal felt good, chances are that rotor thickness variation may meet what's allowed on the specification table (generally around .002 in. or .050mm). With the rotor installed, take thickness readings in eight to ten spots around its circumference to verify. Of course, if any are at or below the "discard" specification, discard the rotor.

You'll also often find that runout meets specifications on a rotor that has delivered good service and doesn't cause the brake pedal to pulsate. Verify this with a dial indicator. Remember, though, that you can knock a hubless rotor out of true before or after tightening it down to run your checks; if you disturb it at all, make sure nothing gets between the hub and rotor mating surfaces, and that they're clean. If everything checks out, leave the rotor alone.

If you're planning to reuse a rotor as-is, there must be as-is rotors on both sides, or neither. If you pair a good used rotor with a new or remachined one on the same axle, the higher friction coefficient of the single as-is

Photo courtesy Continental Teves

A dial indicator must be used to check on-car rotor lateral runout. Attach the fixture to a stationary location such as the spindle or control arm. Locate the dial indicator's plunge tip about an inch inboard of the rotor edge, then zero the indicator. Rotate the rotor through a 360° rotation, watching the dial indicator for changes in runout. Rotor runout should not exceed .002 in.

Photos: Karl Seyfert

Most rotors have the minimum thickness dimension stamped where it's easy to see when the rotor is new. If you're planning to resurface a used rotor, work in the blast cabinet may be necessary to reveal the dimension stamping. Today's lighter rotors, especially unvented rear rotors, are often replaced rather than resurfaced due to their relatively thin construction.

New rotors should be ready to install as-is, after the protective anticorrosion coating is removed. Resurfacing new rotors is unnecessary, reduces their service life and may produce problems that would not otherwise be present. If you're resurfacing new rotors due to thickness variation or runout problems, you probably should seek a new supplier.

Photo courtesy Hunter Engineering

When measurements indicate that rotor resurfacing is necessary, a growing number of vehicle manufacturers recommend the use of an on-car brake lathe. In many cases, it may be the only way to avoid time-consuming comebacks. Besides its ability to reduce runout, an on-car brake lathe also can save you time up front. Difficult-to-remove rotors that pass specification checks but need resurfacing can stay where they are.

rotor will cause a pull in its direction.

When measurements indicate that rotor resurfacing is necessary, a growing number of vehicle manufacturers recommend the use of an on-car brake lathe. Many believe that it's the only way to turn the rotors and not produce runout. Nevertheless, many shops are still using conventional brake lathes to turn rotors. Any serious brake shop should consider investing in an on-car lathe. In many cases, it may be the only way to avoid time-consuming comebacks. Besides its ability to reduce runout, an on-car brake lathe also can save you time up front. Those tough-to-take-off rotors that pass specification checks but need resurfacing don't have to be removed.

Although a driver may not notice a small amount of lateral rotor runout in the brake pedal, even minor runout will cause brake pads at rest to intermittently hit the passing high spots on each side of a rotor with a runout problem. Over time and miles, those hits thin out the points of contact. Then, during stops, the pads and caliper pistons move closer together as the thin spots pass between them. As the thick spots pass by, they knock the pistons back into the bores and the driver feels it as pulsation in the brake pedal.

Anything that prevents rotor trueness can be expected to cause rotor thickness variation over time. Incorrect or uneven lug nut torque is one common cause. Runout also can occur when a rotor that's been correctly bench-resurfaced is installed on a hub that has a slight runout problem, or perhaps something has gotten caught between the rotor and the hub. On-car resurfacing can compensate for a certain amount of hub runout. And since rotor removal isn't needed if the rotor is not being replaced, on-car resurfacing can keep anything from getting caught between the rotor and hub.

Extreme braking conditions can cause extended high temperatures that may produce hot spots on rotor or drum surfaces. Discoloration (usually blue) isn't automatically a cause for concern. Some manufacturers recommend against resurfacing discolored rotors and drums that are otherwise normal. But don't attempt to remove via resurfacing any hard spots that appear to protrude above the surrounding area, and have a dull gray appearance that lacks clearly de-

Use sandpaper, a lathe attachment or a power tool to apply a nondirectional finish to the rotor friction surface. All vehicle makers recommend that a swirl finish be applied to all rotors, both new and reground. This finishing technique helps to properly break in friction and rotor surfaces.

Rotors should be washed with soap and hot water before installation. Don't use brake cleaner or other solvent-type cleaners because they do not remove all metal particles and machining dust. Dry the rotors with paper towels. Don't use compressed air or shop rags because they may cause oil contamination of the rotor surfaces and friction material.

Regardless of whether or not you're resurfacing the rotors, the mating area between the rotor's inner hat surface and the vehicle hub must be spotless. A small amount of dirt or rust in this area can magnify lateral runout problems. Cutting corners here will produce pedal pulsation and possible brake noise complaints.

fined edges. You may remove them now, but these hard spots will be back again, causing pedal pulsation. Hard-spotted rotors or drums should be discarded.

On-car resurfacing still has to meet the same standards as bench turning—smoothness remains very important. If your on-car lathe isn't set up to deliver a nondirectional final finish, use an orbital or dual-action sander with 180/220-grit paper for one minute on each rotor surface. The back of the rotor should be accessible through the caliper mounting area.

All manufacturers now recommend a nondirectional finish on rotors, and even new rotors should be treated to one. Rotors should be washed with soap and hot water before installation, as solvent-type cleaners do not remove all machining dust, and because drying with compressed air usually results in oil contamination of the friction material. It's also very important to make sure that the wheel flange behind the rotor is free of any rust or debris. As mentioned earlier, failure to eliminate rust or debris will cause rotor runout, which, over time, will cause friction material to be transferred to the rotor surface. This will eventually cause noise due to an extreme variation in rotor thickness.

Modern brake pads can deliver excellent stopping ability, but matching them with rotors that aren't smooth, true and thick enough will ruin the work you've done. Expect noise, rapid wear, erratic performance, pulsating pedals and comebacks if the rotors aren't right.

After you've finished with your brake work, don't ruin it by overtightening or undertightening the lug nuts. Improper lug nut torque will cause rotor deflection. Over time and after 2000 to 3000 miles, look for rotor thickness variation and noise and brake pedal pulsation complaints. Rotor deflection will not manifest itself until mileage has accumulated on the vehicle, causing you to believe that the noise is not related to the original brake job. Always use a calibrated torque wrench and look up the proper wheel torque for the vehicle.

All new brake pads must be properly broken in. The procedure allows the heat of the first several moderate stops to gradually set the pads' resins as their surfaces properly mate up with the rotors. Panic stops should be avoided during break-in, as the high heat they generate makes pad resins come to the surface and glaze the pads.

Confirm that you have a good brake pedal by gently stroking the pedal to move the wheel cylinders and caliper pistons out to their normal position. After confirming a good pedal, use the following procedure during the test drive. Perform 30 stops from 30 mph with a 30-second cooling interval between stops

Photo courtesy Continental Teves

Always inspect the brake mounting hardware, rubber boots, shims, spring clips and other related components. Damaged or worn parts may sabotage an otherwise well-executed brake job. For example, rusty caliper mounting bolts can cause the caliper to bind, leading to uneven pad wear, brake pull and more.

The caliper must move freely in its mounts. This permits even application under braking and a smooth release. Binding caliper mounts can cause brake pulls, damaging brake temperatures and uneven pad wear.

(30/30/30) to burnish the new pads.

These stops should be performed at a decelerating rate of 12 ft. per second or less. That translates to a gentle, easy stop. The 30/30/30 burnish procedure beds the pads and shoes into the rotor and drums. It also deposits the necessary friction transfer to the rotors and drums for optimum brake performance. Following this procedure also assures that your customer will have excellent brake performance from the first time he drives the car after brake service has been performed. You should not depend on your customer to break in the brake job. The only way to assure that it's done correctly is to incorporate it into your brake job test drive. Remember, proper burnishing assures a long-lasting, noise-free brake job.

Last of all, take time to familiarize yourself with the proper service procedure for the vehicle you're working on. Read all TSBs for the vehicle. Import calipers are small and prone to vibration. Manufacturers have published a great deal of information explaining how to prevent noise and vibration on these vehicles. Domestic manufacturers also have many revised brake service procedures that relate to noise prevention. M

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