



Replacing Antiquated Brakes:

Applying Real Power to Hot Rod & Muscle Car Brakes

Hot rodding today means well-rounded performance—not just going fast, but stopping fast as well. Here's the latest news on high-performance brakes, along with some expert advice on building braking systems that will keep your customers safe and satisfied.

Going fast is fantastic, but stopping fast, too, can be critical to survival. Barely adequate brakes were long the bane of home-grown hot rods and factory muscle cars alike. But when today's hot rodders demand performance, they demand superior power and response around all 360 degrees of the friction circle. And that means rapid acceleration, razor-sharp handling—and the best brakes they can afford.

In the lines that follow we'll take a brief look at new developments in brake technology and new brake-component products, before delving into the more complicated issues involved in converting a classic muscle car from drum brakes to a modern braking system.

Late Braking News

Like so many other car components, today's high-performance brakes have benefited from advances in computer-aided design, modeling and

manufacturing. Our experts also pointed out some specific innovations. "One of the best advances to come to market are zero-offset brake kits," said **Danny Nix** of **Classic Performance Products (CPP)** in Anaheim, California. "Many older disc-brake conversions used off-the-shelf parts, which typically moved the tire and wheel out into the fender—often causing the tire to rub and limiting the turning radius. But our zero-offset brake kits allow the car to keep the same size tires and wheels without sacrificing drivability. [In fact] in many cases the car can be run with larger-size tires than before."

Nix also pointed to CPP's modular steering spindles. "Older aftermarket spindles could only accept the brakes they were designed for and could not be upgraded. Our new modular spindles have a bolt-on brake mount, so they can be fitted with many different sizes, types and brands of brakes."

Another innovation is VeriSlide, from

Baer Brake Systems of Phoenix, Arizona. "VeriSlide has made it possible to employ a 'fixed' or 'opposed-piston' caliper on a C-clip style rear end," said co-owner **Todd Gartshore**, "such as with the Mustang's standard 8.8-inch, GM 10- and 12-bolt, and other rear ends where the axle bearing is mounted in the housing, and the drive axles are retained with C-clips on the inside of the differential." Previously, fitting opposed-piston calipers to a C-clip rear resulted in significant variations in pedal height, partly because of axle end play allowed by the C-clip and even more because a limited-slip differential tends to push the axle outward as it engages.

"These small movements inward and outward move the rotor within the caliper, bumping the pad and causing the pistons to displace fluid, so the pedal drops until the next stop pumps the system up again," said Gartshore. "An expensive alternative is to refit the car with a 'bearing-on-axle' differential, such as a Ford 9-inch, or Dana

40 or 60; or convert to independent rear suspension."

Two new items will be particularly helpful for traditional hot rodders seeking a traditional look. The 9" Factory, a division of John's Industries, Inc. in Caspian, Michigan now offers a Buick-style brake kit featuring 11 x 2 1/4-in. aluminum drums, plain or polished, to fit the popular Torino flange. "You can also order the backing plate already chromed, making life even better," said owner John Melchiori.

And Sacramento Vintage Ford of Rancho Cordova, California offers reproduction 1940-1948 Ford brake drums with 3 1/4-in. centers. "They are very popular with hot rodders and restorers alike," said the company's general manager Mike Kohout. The brake drums also fit the 1940-1947 Ford pickup, and are suitable for Model A and early V8 conversions.

Muscle Surgery

Meanwhile, it is becoming more popular to update classic muscle cars with modern brakes. "A good conversion kit will utilize as many stock parts as possible and only replace what is necessary," said Michael Jonas, president of Stainless Steel Brakes Corporation (SSBC) in Clarence, New York. "We have kits that require only the removal of the drum and the stock spindle. The only other change is to the master cylinder." However, that change is an important one.

"When converting to disc brakes, you also need to convert to a disc brake master cylinder, which has a larger reservoir to accommodate the extra fluid required by the calipers," said Nix of CPP. "You will also need new flex hoses at both ends of the car, plus new hard lines at the rear. And if you are using a fixed [non-floating] system, you should also replace all the wheel and axle bearings. C-clip type axles may need new axles and C-clip assemblies.

"If the original parts are bent, or have been machined slightly out-of-square, you may need to replace or re-machine these parts in order to mount the fixed caliper parallel to the rotor; at the very least you will need to shim the caliper when it is mounted," added Nix.

Carl Bush of Wilwood Disc Brakes in Camarillo, California recommended upgrading to a modern tandem-style

■ Baer's 6S forged calipers machined from 2618 forgings for the stiffest possible design, even at extreme operating temperatures. They are available powder-coated in red, silver or black. Custom colors are also available, said Baer.



master cylinder. "Early vehicles with single reservoir/single outlet fluid circuits will immediately lose all pressure to all four wheels the instant there is a loss at any one corner," he said. "With a tandem-outlet cylinder, the brakes can be lost at one end of the car, while the other end of the car can remain functional."

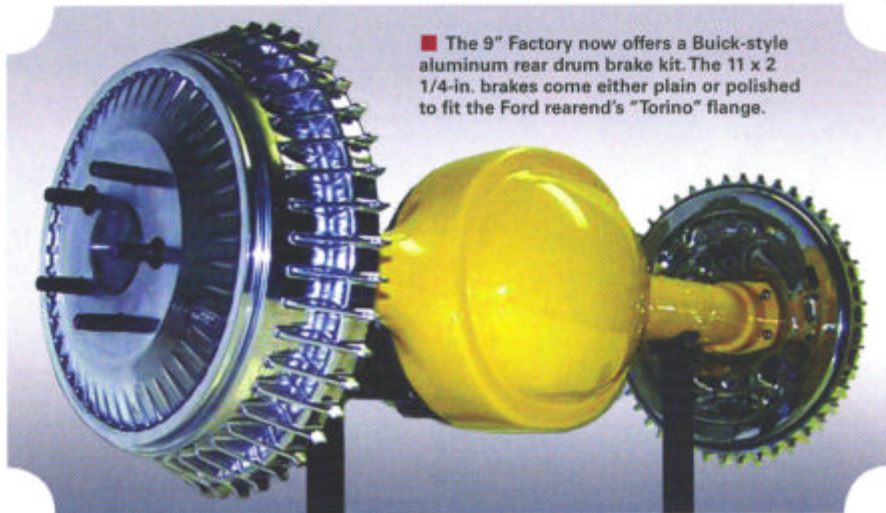
If the vehicle came with a tandem master cylinder from the factory, it may be possible to retain the original unit. But Bush pointed out some other critical details. "First, drum brake systems use a residual pressure valve to provide a small degree of resistance against the brake shoe return springs to control brake shoe retraction. These valves are often found behind the outlet fittings in the OE master cylinder. But whatever their location, they must be disabled or removed for any disc-brake caliper to operate properly.

"Another high priority," Bush continued, "is the installation of an adjustable proportioning valve in the rear brake line. Primarily, this is to

proportionally diminish the rate of increase in the rear line pressure relative to the front line pressure in a panic-stop situation. The proportioning valve should be set so that the rear brakes do not lock before the front brakes. But the proportioning valve can also be further fine-tuned to compensate for tire size, gear ratio, engine compression, chassis characteristics and all the dynamics that affect handling and the car's response to deceleration."

Gartshore recommended an adjustable proportioning valve for any disc/drum or disc brake system, but also warned that a proportioning valve will not overcome basic system balance issues. It must be remembered that the front caliper volume should be approximately 40 to 60 percent greater than the hydraulic volume of the rear calipers. "Without a starting point in this territory, the proportioning valve will not be able to overcome the basic system imbalance," he said. We'll have more on the various valves involved

■ The 9" Factory now offers a Buick-style aluminum rear drum brake kit. The 11 x 2 1/4-in. brakes come either plain or polished to fit the Ford rearend's "Torino" flange.



in brake systems later in this article.

"Rear-axle conversions can be a little more complex, especially when optional rear axles were available as OE equipment, or when custom-built rears are used," said Bush of Wilwood. "Kit selection can also become tricky when aftermarket or dropped front spindles are used." In short, don't order a kit for a particular car; order a kit for the specific axle and spindles that are actually on the car.

Similarly, **Carmen Anastasio**, the founder of **Master Power Brakes** in Mooresville, North Carolina, said he worries about traditional hot rod builds, where people mix up various parts.

"You can't beat the OE manufacturer; they did all the engineering, and if you think you are going to do better, you are not," said Anastasio. "If you are not using a complete stock system, then, do some research on the parts you are using. Before you choose a caliper, for example, know not only the number of pistons but the piston bore."

Trying to match various components mathematically— as the OEM's engineers do— can be overwhelming, but using charts and other useful information found online can be very helpful, he added.

Bigger is Better

On the question of brake size, we found widespread agreement that bigger is better. Most of our contacts recommend installing the largest brakes that physically fit the application. "Rotor size is determined by wheel size," said Kohout. "The larger the diameter of the wheel, the bigger the rotor that can be used due

to physical clearance issues between the wheel and the caliper."

"We typically recommend the largest size brake that will fit into the wheel," Nix agreed. "This provides the most brake performance possible. The other limiting factor is the caliper size. Large caliper bodies sometimes interfere with the wheel or other parts of the suspension."

Gartshore, called it unfortunate that "in about half of all projects we see, the brakes are selected to fit existing wheels." Instead, he believes brakes should be sized according to "vehicle weight, and a solid description of the customer's planned use and budget. Most top-flight builders select wheels to fit the brakes they know the car will need."

That said, Gartshore allows that some muscle car enthusiasts want the authentic look of 14-inch wheels. So Baer makes 11-inch rotors with two-piston aluminum calipers for these and similar applications; as well as rotors up to 14 inches and calipers with as many as six pistons.

Bud Riser of Tuff Stuff Performance Accessories in Cleveland, Ohio also cited vehicle weight, "the design and size of the OE or aftermarket wheel, and some consideration for cosmetics. Generally rotors in the 11-, 12-, and 13-inch size are adequate for most applications."

Larger rotors generally mean larger calipers, with more pistons to operate them. But how many pistons are enough? "Total piston bore area and volume is more important than the number of pistons," answered Bush. "That's what determines the overall clamping force that will be generated by the caliper."

"Many multi-piston calipers have very small pistons," agreed Jonas of SSBC. "Having six pistons sounds impressive, but it doesn't mean they deliver much punch." It's very much like the number of pistons in an engine, he said; a small-displacement V12 in a classic Ferrari has more pistons than a big block muscle car V8— but which makes more horsepower?

That said, SSBC has developed an eight-piston caliper that will fit inside of a 15 x 8-inch wheel. "In the last few years there was a push toward very large, 20-inch wheels, which allowed the use of large brake rotors, but also made the car ride rougher," said Jonas. "Over the last 18 months we've seen a return to smaller wheels— but people still want massive braking power."

"Overall pad size is another determining factor," he continued. "As calipers get larger, and brake pads get longer, it becomes desirable to spread the load out evenly over the entire length of the pad. Using six pistons to balance the clamping load over the entire length of the pads will help maintain more even pad wear and consistent response, especially under heavy braking cycles."

Anastasio of Master Power Brakes, however, maintained that caliper distortion only becomes an issue in extreme cases such as racing. He expressed a great deal of faith in OE braking systems.

"People equate the size of the rotor to stopping power," he added. "Yes, it has some influence, because a larger rotor provides more leverage. But that's negligible compared to the size of the piston in the caliper. The calipers from a 1970s Chevelle are the best you will ever put on a car; it gives you 3,000 pounds of



■ Above: Master Power Brakes's DB1545P Power Front Disc Brake Kit for 1965-1972 Ford half-ton, two-wheel drive pickup trucks with twin I-beam suspension comes fully assembled.
■ Left: The kit shown installed.

clamping force with just 1,000 pounds of line pressure— on a stock 11-inch GM rotor.”

Regardless of the number of pistons, Nix of CPP recommended a floating brake system.

“The most common is a floating caliper with one or two pistons on one side of the rotor,” he said. “A less common, but very-high-performance setup is to use a floating rotor. A floating system will adjust to most misalignments, which can be caused by thermal expansion, loose or worn bearings, worn C-clips, high g-forces, and/or normal flex and give— whereas fixed systems will result in a low brake pedal if there is any misalignment or movement between the caliper and the rotor.”

Nix also pointed out that “as a general rule aluminum calipers have much larger bodies to compensate for their lack of strength compared to iron calipers.” Iron calipers are more compact relative to

piston and pad area, improving not only performance but wheel and suspension clearance as well.

“Many aluminum calipers will ‘stretch’ during hard braking and cause a soft-feeling pedal,” he said. “If you are limited by size and weight an iron-body caliper will typically give better performance, cost less and have a longer pad life than an equivalent-size aluminum caliper.”

Jonas countered however, that cast iron calipers can be very heavy and prone to corrosion. “The new calipers we offer are made from billet aluminum or forgings, and are equipped with stainless pistons. They are lighter, and light weight means better handling. Further, stainless steel pistons reduce heat transfer to the brake fluid, and that reduces brake fade.”



■ Wilwood's DynaPro 6 Calipers feature a high-gloss black finish. Bright polished, high-gloss red and other custom colors can be ordered for custom applications as well.

“An often overlooked aspect of any brake system is the pad compound,” added Bush of Wilwood. “A large percentage of hot rodders are unaware of how much performance can be gained simply by changing pad compound. Similar to the way tire compounds affect traction and wear, pad compounds can be used to affect stopping power and overall brake performance.”

Dealing with Pedal Effort

Another important issue is pedal ratio, which is defined as the total length of the brake pedal lever (from the pivot point to the far end of the tread) divided by the distance from the pivot point to the rod that operates the master cylinder. A higher ratio means less pedal effort.

“If you are changing the braking system



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over from manual to power, then you will likely need to change the pedal ratio," said **Brad Burleson** of **MBM Brakes, Steering & Suspension** in Asheville, North Carolina. "A manual brake system generally has a pedal ratio of about 6:1, although this can vary. If you leave the ratio alone and change to a power system you will end up with extremely sensitive brakes. So in these situations it is best to change the pedal ratio to about 4:1."

"The pedal ratio should not exceed 6:1 for manual brakes with a 1-inch-bore master cylinder," Riser of Tuff Stuff confirmed, "and 4:1 for power brakes with a 1½-inch-bore master cylinder."

"The pedal ratio works in concert with the master cylinder bore size, the caliper or wheel cylinder size and the diameter of the rotor or drum," added Nix. "Typically a disc brake will need a higher line pressure than a drum brake. That increased pressure can be provided several ways: a smaller-bore master cylinder, a brake booster, or a higher pedal ratio—or you can just push harder on the pedal. Changing the pedal ratio or the bore size in order to get a higher line pressure will cause longer pedal travel. The ideal ratio for a particular application will provide a relatively short pedal travel without requiring too much effort on the brake pedal."

"Boosters provide higher brake pressure with less effort on the pedal," Nix continued. "Usually the shorter pedal travel makes the brake feel better to the driver—and driver comfort is a key component in a good brake system."

"Pedal ratio is part of the system

approach," added Gartshore of Baer, who recommended a ratio of at least 6.5:1 for non-assisted systems. "If instead the stock pedal is used, at least make sure that it's the appropriate pedal for the stock manual braking system and that the length of the pushrod is also correct."

"In addition, we often include a .125-inch-smaller master cylinder to raise hydraulic pressure at the caliper, and prescribe a more aggressive (and often somewhat noisier) pad to overcome the lack of effectiveness in a manual system with a low pedal ratio," said Gartshore.

Bush said that it was almost never necessary to alter a stock pedal ratio. "But it is important to factor the pedal ratio into the equation when deciding on master cylinder and caliper-piston sizes," he added. "Usually some combination can be successfully mated with almost any pedal ratio."

Most of our experts did agree that non-servo systems could provide safe and effective braking performance. "Manual brake systems are perfectly fine in certain applications, for example, when space is an issue," said Kohout of Sacramento Vintage Ford. "Also, when running a manual transmission, sometimes there is no room for the power booster assembly. And some big-horsepower engines may be unable to create the consistent vacuum to operate the booster."

"If you're using an undersized booster to clear your valve covers, you are probably better off with manual brakes," added Anastasio. "They stop the same; power brakes are just easier to push."

Gartshore agreed that with some super-high-performance engines, a stock vacuum system won't always do. "If engine vacuum in gear, at idle, is under 14 inches Hg, then we recommend a Hydroboost"—[a hydraulic servo driven off the power steering pump]—rather than a vacuum servo. "Our experience with vacuum reservoirs and auxiliary vacuum pumps is that they

do not warrant the expense or bother for the moderate-to-poor results they deliver," he added.

Vintage-style drum brake systems



■ CPP's MCPV-1 combines the master cylinder, double adjustable proportioning valve, removable metering valve and stop light control in one lightweight unit.

■ Sacramento Vintage Ford now offers these replacement brake drums for 1940-1948 Fords.



do need a residual pressure valve. "A 10-pound residual pressure valve should be used on any drum brake application, regardless of master cylinder location," said Bush. "Disc-brake cars that have the master cylinder mounted high on the firewall, or remote fluid reservoirs that are mounted higher from the ground than the calipers, do not need a residual pressure valve. For disc brake-equipped hot rods with the master cylinder and reservoir under the floorboards, a two-pound residual pressure valve can be used to stop fluid drain-back and decrease the pedal travel required to first actuate the brakes."

"The residual check valve keeps the pressure on the system, so that the caliper pads or shoes do not bleed back away from the rotor surface or drum— which will result in slower response at the brake pedal when the brakes are applied," said Kohout.

Burleson added that "if you are using a hold-off valve in your current brake system, you can eliminate it by going with an all-in-one proportioning valve kit, like MBM's PV-2 or PV-4. These proportioning valves have a hold-off function built in. Eliminating your hold-off valve just removes one more variable in trying to fine-tune or trouble-shoot your brakes, making the process a little easier."

"Use the valves recommended by the brake manufacturer," Nix advised. "People often claim that you do not need to change stock valves" only because they've done it that way before and it seemed to work for them. "These valves have specific functions that prevent skidding and loss of control under certain situations. Under normal driving things may seem fine— but in a panic stop, they can go bad in a hurry. So do not risk using the wrong valve. You will not know you had a need for the right

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valve until you have crashed. We have a detailed article on our website explaining the various valves, their functions and when they are needed."

Above all, use quality parts. "People buy for price," said Anastasio, "and they

don't know what they are buying." If you buy a booster made in China, for example, "it may not be made to the original specs." Stock GM boosters featured big valves to admit lots of air under atmospheric pressure. But Anastasio has seen Chinese

Company	Newest Application(s)	Other Products	Quik-Link
Baer Brake Systems	The new VeriSlide adapts opposed-piston calipers to C-clip rear axles.	Baer offers high-performance brake components and complete systems.	For more information call 1-800-306-0133 ext. 20364.
Classic Performance Products	New from CPP are zero-offset disc brake conversions, as well as modular steering spindles that accept a variety of aftermarket brakes.	CPP offers a wide range of brake components for popular Chevy cars and trucks, Ford trucks and street rods.	For more information call 1-800-306-0133 ext. 20365.
The 9" Factory (division of John's Industries)	New are Buick-style aluminum brake drum kits for Ford 9-inch rear ends.	The company makes disc and drum brake kits for Ford 9-inch rear ends.	For more information call 1-800-306-0133 ext. 20366.
Master Power Brakes	Master Power Brakes offers Mustang 7-inch boosters and 1-1/8-inch master cylinders with aluminum or plastic reservoirs.	The company offers high-performance braking systems and components.	For more information call 1-800-306-0133 ext. 20367.
MBM Brakes, Steering & Suspension	New from MBM is a disc brake conversion for B-body Chevrolets and an original-look brake booster also for Chevrolets.	MBM manufactures brake components and kits.	For more information call 1-800-306-0133 ext. 20368.
Sacramento Vintage Ford	The company now offers 1940-1948 Ford replacement brake drums.	The company offers original replacement brake components and performance aftermarket conversions for hot rods and trucks.	For more information call 1-800-306-0133 ext. 20369.
SSBC	SSBC offers new eight-piston calipers for 15-inch wheels.	Other products include disc brake conversions and brake upgrade kits for muscle cars, trucks and hot rods.	For more information call 1-800-306-0133 ext. 20370.
Tuff Stuff Performance Accessories	Tuff Stuff now offers a chrome 8-inch dual booster/master cylinder combination that fits tight spaces.	Tuff Stuff makes custom-finished components, including complete braking systems.	For more information call 1-800-306-0133 ext. 20371.
Wilwood Engineering	Wilwood now has disc brake conversions for classic muscle cars.	The company offers a variety of high-performance disc brake systems.	For more information call 1-800-306-0133 ext. 20372.

imports where the valve is so small, he doubts it would perform safely in high-altitude states such as Colorado. "That's why we cut everything we sell apart," he said. "If you are going to sell us a booster or a master cylinder, we're going to cut it in half to see what's inside. We've cut open Chinese valves that were supposed to have a hole straight through, but instead they'd been drilled from each end, and the two bores barely met in the middle."

Bleed the Brakes

Burleson offered advice as well. "It's good practice to flush out your brake system every two years. Brake fluid readily absorbs moisture, and moisture causes rust. This type of corrosion can lead to brake failure by freezing wheel cylinders and calipers."

Anastasio strongly cautions against using silicone brake fluid, precisely because it does not absorb moisture. "Any condensation lies at the bottom of the brake cylinders and rots them out." Brake fluid should absorb moisture, and should be changed once a year. "Brake fluid should be amber," Anastasio noted. "When it's brown it's contaminated, and when it's black it's been boiled."

And when you change it, buy a name brand. "We've had trouble with people returning master cylinders that were ruined by no-name brake fluid that didn't have the proper lubricity." Another of the biggest problems, Anastasio continued, is air in a brake system. "So after the car has been driven for a couple of weeks, bleed the brakes again."

"Brake parts and brake systems are obviously one of the most critical components on any car, truck or street rod," commented Riser. "The components should be of the highest quality, and should only be installed by competent and qualified technicians. Other considerations should be given to the country of origin, reputation of the manufacturer, and, as important as anything, service before, during and after the sale."

"It is important to remember that the brake system is exactly that," Bush concluded, "a system. The more you know about the specific function of each component, the better you are able to recognize solutions— and suggestions for performance."