HIGH-PERFORMANCE BRAKE SYSTEMS

DESIGN, SELECTION AND INSTALLATION

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Front Cover:
There is more to upgrading your brake system than just shopping for the best looking parts. While aesthetics certainly are important, consideration must also be given to system-level performance. Picking the right parts is usually more complicated than physically bolting them on–they have to work together. (Randall Shafer)

Title Page:
During track use, rotors are squeezed with thousands of pounds of clamp force, twisted by thousands of foot-pounds of torque, and heated to over 1,200 degrees F. Heavy cars with large engines such as these only make the demands that much more intense. (Wayne Flynn/pdxsports.com)

Back Cover, Top:
Designing a hot rod brake system from scratch may seem intimidating at first, but the fundamental concepts of gain and balance still apply. What really differentiates these brake systems are unique design and operating requirements that may require different compromises than would be appropriate for an all-out racecar. (Randall Shafer)

Middle:
Because experience is the best teacher, the final four chapters of this book are dedicated to sharing our years of upgrade know-how with you. Whether you are upsizing your front rotors for track use or converting your muscle car from rear drum brakes to rear disc brakes, grab your wrenches and head out to the garage with us. Just be sure to wear your safety glasses! (Randall Shafer)

Bottom:
Motorsports can place extreme demands on your brake system, and if your hardware is not up to the task, performance can suffer dramatically. A solid understanding of brake system fundamentals greatly increases your likelihood of ending up in the winner's circle on race day. (Wayne Flynn/pdxsports.com)

CHAPTER 13

MUSCLE CAR BRAKE UPGRADE

In addition to swapping big disc brakes for small disc brakes, another common brake system upgrade involves converting a vehicle originally equipped with *drum brakes* to disc brakes. Up to this point in the book, drum brakes have been ignored, as their poor thermal characteristics and non-linear torque output make them undesirable in high-performance applications. However, for this very reason, older vehicles originally equipped with drum brakes make ideal candidates for disc brake conversions.

Chapter 13 exposes you to some of the unique steps involved in the process of converting a vehicle with rear drum brakes to rear disc brakes. Because many of the brake system design factors are similar to those already covered in Chapters 11 and 12, they are not recounted here. Yet gain, balance, and thermal capacity still need to be primary considerations when upgrading your vehicle, regardless of its age or intended use.

When this Chevy Nova was built in 1972, drum brakes had been replaced on most vehicles' front axles by disc brakes, but drums were still commonly found out back. Primarily because of their low cost, low weight, and superior parking brake performance, drums can still be found in modern rear brake applications where thermal requirements are low. (Baer)

The Vehicle

Compared to the race-prepared Porsche 911 examined in Chapter 12, a relatively stock 1972 Chevrolet Nova may seem a bit understated. Although both vehicles were built in the same year, the

Solid axles, leaf springs, and drum brakes—all standard fare for the times. Like many cars of the era, this Nova's drums were cast with fins on the outer diameter for enhanced convective cooling, but were still thermally inefficient even by contemporary standards. (Baer)

Nova was much more likely to see time at the drag strip than at the racetrack. Its front disc and rear drum brakes were common for vehicles of the era, and were relatively well-suited for boulevard cruising and sprinting from stop sign to stop sign. However, improved braking performance shouldn't be limited to vehicles with road course aspirations, and the owner of this particular vehicle had three distinct objectives in mind.

The Objective

The Nova's original rear drum assembly measured a diminutive 9.5 inches in diameter and used a 7/8-inch wheel cylinder, common hardware to be found hanging off the ends of a GM 10-bolt rear end in 1972. While properly sized from a gain and balance perspective, the non-linear pedal feel of the drum brake design made modulation difficult at best when braking near the vehicle's limit of adhesion. Thermally, though, the drum brake proved to be woefully inadequate, as no more than a couple stops from moderate speeds were enough to produce rear brake pad fade and a dramatic drop-off in brake system performance.

Therefore, in order to improve pedal feel and enhance the resistance to fade, the objective was to replace the old-school drum brakes with a pair of modern disc brake assemblies. Of course, the improved visual appearance of the disc brakes would score big points at the Saturday night cruise-in as well.

Picking The Right Parts

Rear Rotors

Since the owner desired to maintain the original 15-inch steel wheels, 12.0-inch diameter rear rotors were the largest that could be installed. Measuring 0.8 inches in thickness, the vented friction discs provided by Baer had substantially more thermal mass than the stock drum assemblies.

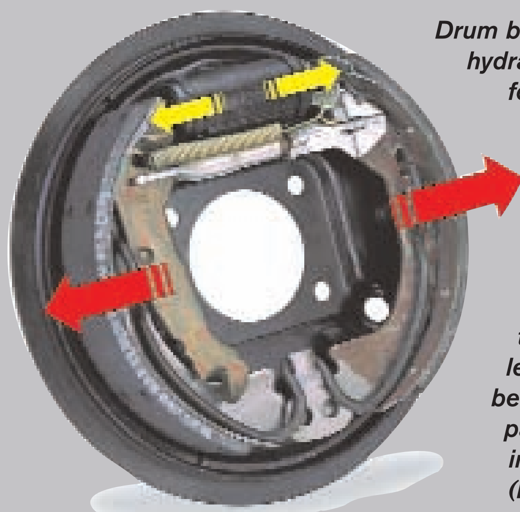
For primarily aesthetic reasons, the rotors were both slotted *and* cross-drilled. Although out of place on a competition vehicle, this rotor treatment provided a unique look that was desired in this particular application. It also helped that they matched the front rotor upgrade, which had been performed earlier.

Drum Brakes 101

Although drum brakes and disc brakes may appear quite different at first glance, they both use similar principles to convert hydraulic fluid pressure into torque, while at the same time converting kinetic energy into heat. In both systems, pressure is converted into force, force is converted into torque, and energy is converted at a friction interface.

Drum brake wheel cylinders perform the same function as disc brake calipers. Located inboard of a rotating drum, two opposed pistons in each wheel cylinder are subjected to fluid pressure from the hydraulic circuit. Based on the piston diameters, this pressure is converted into a pair of linear forces acting against brake shoes, which function in the same capacity as the brake pads in a disc brake system.

A variety of designs exist to transmit and amplify the wheel cylinder linear forces, but all serve to expand the brake shoes out against the rotating drum. Based on the drum geometry, the sum of these forces is then converted into torque. While there are many ways to arrange the internal components to enhance gain, the end result is a pressure-to-torque relationship that is not typically as linear as that provided by a disc brake assembly.



Drum brake wheel cylinders convert hydraulic fluid pressure into linear force (yellow arrows) as a function of their piston diameters. Through various design techniques, this force is amplified (red arrows) as it forces the brake shoes out against the rotating drum. It's important to note that the force distribution along the length of the pad (as well as between the leading and trailing pads) is never uniform, resulting in uneven friction material wear. (Delphi Corporation)

Acting much like a disc brake rotor, the drum's temperature rises as kinetic energy is converted into heat at the friction interface. Unfortunately, the rubbing surface of the drum is located inside of the brake assembly, resulting in inefficient convective cooling. For this reason, drums typically contain fins on their outer diameter to enhance what little convective cooling is available externally.

There are many, many more design differences that differentiate drum brakes from disc brakes, but in summary they are both engineered to accomplish the same task. For the enthusiast, though, the poor thermal performance of drum brakes is reason enough to make them an inappropriate choice for any high-performance application.