HIGH-PERFORMANCE BRAKE SYSTEMS

DESIGN, SELECTION AND INSTALLATION

JAMES WALKER, JR.

CarTech®

Edited By: Travis Thompson

ISBN-13 978-1-932494-32-7
ISBN-10 1-932494-32-4

Printed in China

CarTech®
39966 Grand Avenue
North Branch, MN 55056
Telephone (651) 277-1200 • (800) 551-4754 • Fax: (651) 277-1203
www.cartechbooks.com

OVERSEAS DISTRIBUTION BY:

Brooklands Books Ltd.
P.O. Box 146, Cobham, Surrey, KT11 1LG, England
Telephone 01932 865051 • Fax 01932 868803
www.brooklands-books.com

Brooklands Books Aus.
3/37-39 Green Street, Banksmeadow, NSW 2019, Australia
Telephone 2 9695 7055 • Fax 2 9695 7355

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 5

PEDALS, BOOSTERS AND MASTER CYLINDERS

The apply system (sometimes called the actuation system) exists in order to amplify the driver's leg force and then convert it into hydraulic fluid pressure. In nearly all cases, the apply system functionality is not assigned to a single device. Instead, most apply systems accomplish this task by dividing the total responsibility among several discrete components.

Most brake pedal pads are constructed from steel with textured molded rubber covers. The pedal shown here is actually made from cast aluminum for weight savings. Regardless of the aesthetic impact, the material of the pad itself doesn't impact the brake pedal output. (Randall Shafer)

While there are many different types of apply systems, most conventional vehicles use a combination of brake pedals, brake boosters, and master cylinders to get the job done. Variations on this recipe abound, but the fundamental objective remains the same: increase the applied force and turn it into pressure.

There is, however, one addendum. As you just learned in Chapter 4, brake pressure distribution between the front brakes and rear brakes can be used to optimize a vehicle's brake balance. Consequently, the apply system may also contain additional devices which limit, regulate, or proportion the rear brake line pressure.

The pages that follow walk through these various components in detail, starting with the driver's primary interface to the brake system: the brake pedal.

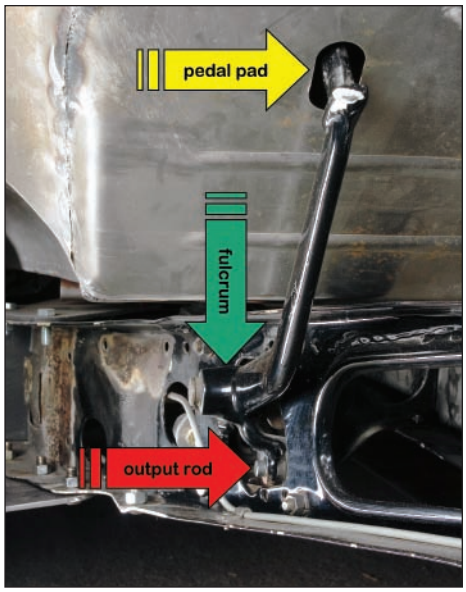
Brake Pedal Components

The brake pedal's primary role is to mechanically increase the force exerted by the driver's leg on the brake pedal pad. Remember, it's essentially the amplified force from the driver's leg that creates slip at the tire contact patches.

The brake pedal accomplishes this task as a direct result of its lever-based geometry. There are many different designs available, but all rely on the following series of individual components to get the job done.

Brake Pedal Pad

The *brake pedal pad* is simply where the driver provides mechanical force input to the brake system. Most OEM systems use a ribbed rubber pad molded over a steel or composite core, but exotic-looking brake pedal pads made from cast aluminum and/or with weight-saving holes



In most modern production vehicles, the brake pedal fulcrum is located at one end of the brake pedal arm. However, in many hot rod applications, the fulcrum (green arrow) is found between the brake pedal pad (yellow arrow, inside vehicle) and output rod (red arrow, under vehicle). In either case, the pedal ratio is calculated using the same equation. (Randall Shafer)

are now becoming more commonplace. Regardless of its construction, the pad should be large enough that the driver will not miss the pedal in a panic, small enough that it won't get hit by accident, and textured enough to prevent the foot from slipping off in the heat of battle.

Fulcrum

The *fulcrum* is found on the opposite end of the brake pedal assembly from the brake pedal pad. This is the pivot point for the moving components of the brake pedal assembly. Usually it's nothing more than a steel pin riding in a self-lubricating bronze bushing.

If your vehicle is equipped with a vacuum booster, the brake pedal output rod is most likely attached to the brake booster with a clevis joint. Shown here sticking out of the back side of the booster, the eyelet fits around a pin on the brake pedal arm, mechanically coupling the two components together. (Delphi Corporation)

Output Rod

The *output rod* transmits the brake pedal output force from the brake pedal assembly to the next device in the brake system (typically a brake booster of some sort). Since it must swing through an arc as it travels, it's usually located with a clevis bracket or, in racing applications, a spherical bearing, to allow for an angular misalignment between the two adjacent components.

Brake Pedal Arm

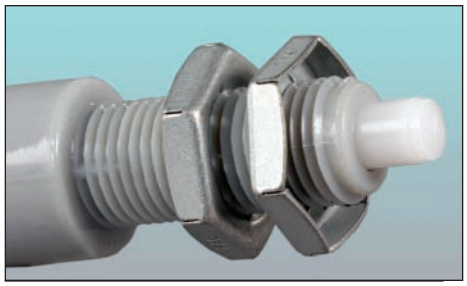
The *brake pedal arm* is the largest component in the brake pedal assembly. Its function is to locate the brake pedal pad at one end, the fulcrum at the opposite end, and the output rod somewhere in-between. In some racing applications the fulcrum is placed between the pad and the output rod, but the concept is still the same.

Ideally, the brake pedal arm should not bend or deflect during use. To make the arm as stiff as possible, it can be shaped like an I-beam or can be boxed along its entire length. This pedal simply uses extremely thick steel for its construction—crude, but effective. (Randall Shafer)

Due to the large leg forces a driver may be capable of applying, the brake pedal arm must be structurally sound to prevent deformation or collapse during severe use. For this reason, it's usually designed to resemble an I-beam in cross-section with webbing often added for additional strength.

Brake Switch

The final component of the brake pedal assembly is the *brake switch*. This is the device used to illuminate the tail lamps of the vehicle when the brakes are applied. In most applications, it consists of a mechanical plunger on/off switch actuated by the brake pedal arm, but in some custom applications it's common to have a pressure-actuated switch mounted in one of the master cylinder hydraulic lines.



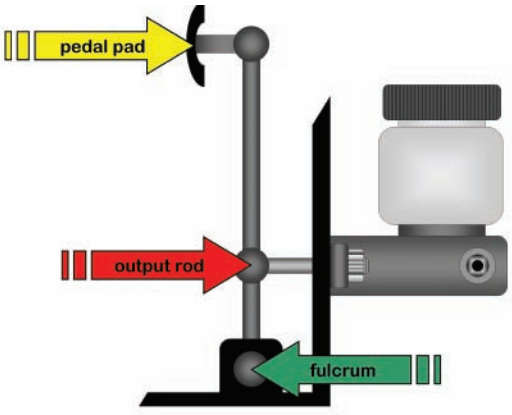
Although many brake switches employ a threaded mount for simple adjustment, this doesn't mean that you should tamper with its setting. The adjustment feature is typically used for manufacturing flexibility at the vehicle assembly plant and not for tweaking later. (Randall Shafer)

There are many mechanical switches in use that allow you to adjust the plunger mechanism. In general, they should never be modified once they leave the factory. However, if you are changing other aspects of the apply system, it may be necessary to adjust the threaded mechanism to only illuminate the brake lamps when the driver applies the brakes.

After adjusting the brake switch, it's a good idea to put the vehicle on jack stands and turn each of the road wheels by hand, since an over-adjusted brake switch can result in continuous brake drag. If the wheels are more difficult to rotate than before the adjustment, chances are the switch needs to be returned to its original position.

OEM Brake Pedals

The brake pedal arm geometry (the location of the output rod relative to the brake pedal pad and the fulcrum) defines the pedal ratio. Note that this relationship holds true regardless of the location of the output rod relative to the fulcrum:



The brake pedal ratio is calculated by dividing the linear distance from the brake pedal pad to the fulcrum by the length from the output rod to the fulcrum. The larger the difference between the two distances, the more gain the brake pedal provides.