

# HIGH-PERFORMANCE **BRAKE SYSTEMS** *DESIGN, SELECTION AND INSTALLATION*

JAMES WALKER, JR.



***CarTech***<sup>®</sup>

Copyright © 2007 James Walker, Jr.

All rights reserved. All text and photographs in this publication are the property of the author, unless otherwise noted or credited. It is unlawful to reproduce – or copy in any way – resell, or redistribute this information without the express written permission of the publisher.

All text, photographs, drawings, and other artwork (hereafter referred to as information) contained in this publication is sold without any warranty as to its usability or performance. In all cases, original manufacturer's recommendations, procedures, and instructions supersede and take precedence over descriptions herein. Specific component design and mechanical procedures – and the qualifications of individual readers – are beyond the control of the publisher, therefore the publisher disclaims all liability, either expressed or implied, for use of the information in this publication. All risk for its use is entirely assumed by the purchaser/user. In no event will CarTech® Inc., or the author, be liable for any indirect, special, or consequential damages, including but not limited to personal injury or any other damages, arising out of the use or misuse of any information in this publication.

This book is an independent publication, and the author(s) and/or publisher thereof are not in any way associated with, and are not authorized to act on behalf of, any of the manufacturers included in this book. All registered trademarks are the property of their owners. The publisher reserves the right to revise this publication or change its content from time to time without obligation to notify any persons of such revisions or changes.

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.carttechbooks.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)



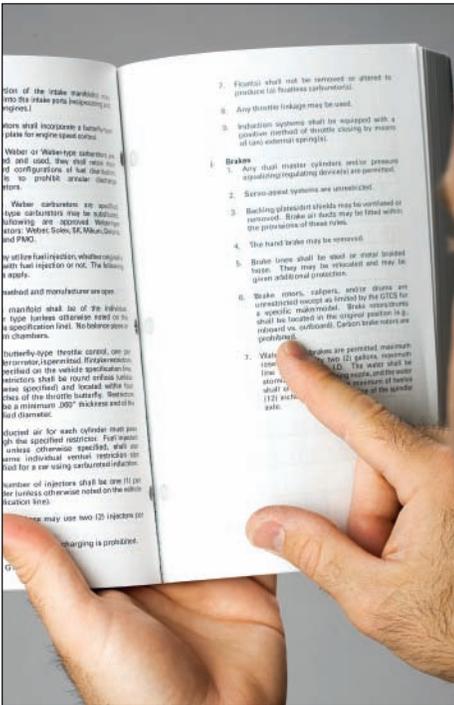
# RACECAR BRAKE UPGRADE

The brake system components found on competition vehicles have complex and demanding requirements placed on them. Combining high speeds, repetitive

braking, and little time for cooling in-between, racetracks have the capability of exposing weaknesses in even the very best stock braking systems in only a few laps. Naturally, the consequences of brake system failure under these conditions is to be avoided at all costs, so when preparing a vehicle for competition, the brake system is usually given priority over more discretionary items.

At the same time, purchasing and installing a big brake kit may not be a

viable solution for improving your brake system performance. Constraints such as sanctioning body rules, regulations, or simple budgetary limitations often dictate that the only way to address brake system performance on track is to stick with the factory hardware and improvise. In other words, not everyone has the luxury of bolting on a set of 14-inch floating rotors and 6-piston calipers to address their brake system performance concerns.



**No matter what you race, always check your sanctioning body's rulebook before buying any new brake parts, as certain modifications may be prohibited. Consequently, it may require more creativity than cash to make significant brake system performance improvements. In cases like this, a solid understanding of brake system fundamentals ensures that your elbow grease is applied in the correct areas. (Randall Shafer)**



**Racing in vintage classes may require participants to adhere to arcane rules and regulations from the past. While this is certainly part of the allure of vintage competition, it may prevent you from using modern brake system technology. The 1972 Porsche 911 modified in the pages that follow falls exactly into this category. (Daniel Mainzer)**

To provide you with ideas to help you choose your own upgrades, this chapter illustrates some of the most common brake system modifications when racing a production-based vehicle. Note that any time you embark on a project such as this, you should not be second-guessing your design, fabrication, or installation abilities. If in doubt, enlist the services of a professional to ensure that the integrity of the modified components is not compromised in any way!

### The Vehicle

In contrast to the daily-driver BMW modified in Chapter 11, the focus of attention in Chapter 12 is a 1972 Porsche 911 prepared exclusively for road racing. Competing primarily in the PCA GT-4s category, this vehicle is occasionally run in SCCA Club Racing events in the GT2 category as well as SVRA group 10c competition. It is truly a jack of all trades, and, as a result, must comply with sanctioning body requirements in multiple classes simultaneously.

### The Objective

With approximately 280 hp at the crankshaft and weighing in at just 2,000 pounds, this vehicle is capable of generating a significant amount of kinetic energy in a very short amount of time. Consequently, the stock brake system, designed for much less power and significantly more weight, was not able to keep up with the rest of the vehicle's performance capability.

While brake fade was being managed through friction material selection and a brake fluid upgrade, brake pad taper, brake pad life, and rotor cracking were all causing headaches on track. In addition, there was no adjustability in the stock brake system to adjust the brake balance for the vehicle in full race trim, resulting in extended stopping distances.

Therefore, the objective of this upgrade was to increase the thermal capacity of the brake system in order to reduce brake temperatures to more manageable levels without causing unwanted changes in brake system gain or brake balance. At the same time, a caliper upgrade was deemed necessary to reduce taper wear and consequently improve brake



*Although it was world-class at the time, the stock 911 brake system from 1972 is only considered average by modern standards. Between the additional horsepower and modern race tires installed for competition, it didn't take many laps to realize the need for increased thermal capacity. The vintage brake systems found on Camaros, Corvettes, and Mustangs from the same era typically don't fare too well, either. (Randall Shafer)*

pedal feel. However, between a typical club racer's budget and a vintage racing requirement to maintain a 15-inch wheel diameter, a typical big brake upgrade was not on the agenda.

### Front Brake Upgrade

The first step in the upgrade was to do some research to find out if any other models were offered by the same manufacturer that came with more robust brake-system hardware. Fortunately, Porsche offered an upgraded brake system on the 911 Turbo models, which fits under 15-inch wheels while still being reasonably affordable (in relative terms) when purchased used.

As a result, this was the chosen upgrade path: bolt on the Turbo parts. The only problem was that they didn't just bolt on.

#### Rotor Selection and Modification

To address brake system temperatures, the first order of business was to select new front rotors. The stock 911 front rotors measured 11.1 inches in diameter and 0.8 inches in thickness—not too bad for 1972, but relatively small by contemporary standards. The Turbo rotors were a more significant 12.0 inches in diameter and 1.3 inches in thickness,

*After a significant amount of trial and error, the owner bolted the custom front rotors and hats onto the front suspension. The friction discs selected are neither slotted nor cross-drilled to reduce cost, but their curved vane geometry is clearly visible. (Randall Shafer)*



*The custom, two-piece front rotor shown on the left is 0.9 inches larger in diameter than the stock 911 rotor shown on the right, but even more impressive was the 0.5-inch growth in thickness. While thermal mass increased significantly (approximately five pounds per rotor), fabricating the hats from aluminum offset some of the rotational inertia impacts of the new rotors. (Randall Shafer)*

