

# Project 911S

## Part 5: The Brake System

by Mitchell Sam Rossi

PHOTOS BY THE AUTHOR

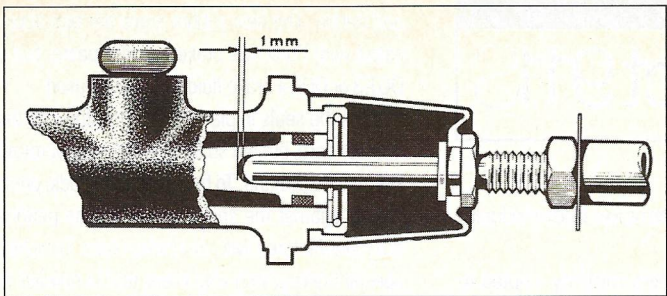


"The less time you spend braking, the faster you will be."

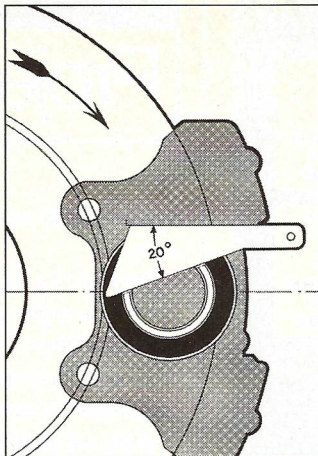
—Ross Bentley, *Speed Secrets Professional Race Driving Techniques*

It may sound counter intuitive, but good brakes are one of the most important elements in turning fast times around a racing circuit. It is a matter of the braking point, the very instant the driver lifts his foot from the throttle pedal and begins to induce the brakes to slow his car and set the suspension for the next turn. The later the driver makes this transition, the longer he can stretch the straightway and thus increase the distance he has carried his maximum speed.

In wheel-to-wheel racing, this is the "late-braking" benefit and is paramount when fighting for position. Be it Formula One or Formula Vee, if two cars are evenly matched in horsepower and torque curve, nine out of ten passes are done at the end of the straightaway.



**Above:** Drawing showing the push rod clearance inside master cylinder. **Right:** Drawing showing piston alignment tool in relation to brake piston and rotor rotation.



In 1969, the 911S braking system was improved by the addition of the Ate one-piece S-type front aluminum calipers, which were retained by the S models until 1973. They were also the standard fare for the famed 2.7 RS and the early 930 Turbo cars. The S calipers incorporated 48mm pistons, squeezing its brake pads against 282mm ventilated front discs. At the rear, the car was equipped with steel M-type calipers wrapped over 290mm vented plates.

Cast out of an aluminum alloy, the S calipers also reduced the unsprung weight on the front struts, this unsprung weight being anything—wheels, tires, lug nuts, etc.—not supported by the car's suspension system. While sprung weight can be compensated for with torsion bars or coil springs, the distribution of unsprung weight must be accepted as part of the car's design.

The aluminum calipers are a further benefit in their ability to dissipate large amounts of heat developed by the front brake rotors. In the physics of stopping a car, the brakes transform kinetic energy into frictional heat generated by the brake pads pressing on the rotating disc. Quickly dissipating this heat increases the braking system's efficiency and avoids brake fade or, worse, brake failure.

After several years of non-use, the brake system of the project S was in need of a complete overhaul. Neglected brake fluid is notorious for two things—absorbing water and wreaking havoc on rubber components.

While the following details a full renovation of the project car's brakes, periodical inspection and maintenance is the best prescription for any Porsche no matter how much or how little it is driven.

### Restoring the Calipers

Taking the calipers off the car is a simple operation, but be sure to use the proper line wrench to remove the hydraulic lines, as a standard open-end

wrench will invariably round the fittings. Inspecting the front and rear calipers verified my fears. Time had disintegrated the rubber dust covers surrounding the brake pistons, allowing moisture to seep into the cylinder bore.

Beginning with the aluminum calipers, and with the high hopes of saving the pistons, I removed the dust covers as delicately as possible. To unseat the seized pistons, I employed a high-pressure air hose and nozzle. Placing a narrow piece

of wood into the caliper slot, a blast of air was shot into the hydraulic line. The piston exploded from the cylinder bore with the blast of a small howitzer. Unfortunately, only one piston popped free.

To dislodge the second, the hydraulic connection line that links the left and right sides of the one-piece caliper was removed. This isolated the brake fluid chamber behind the remaining piston. Taking extreme care to keep my fingers clear, I again injected the compressed air and shot the piston into the wood block.

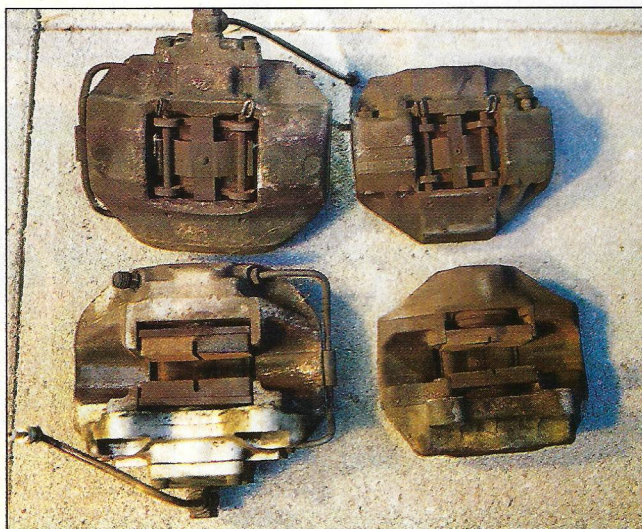
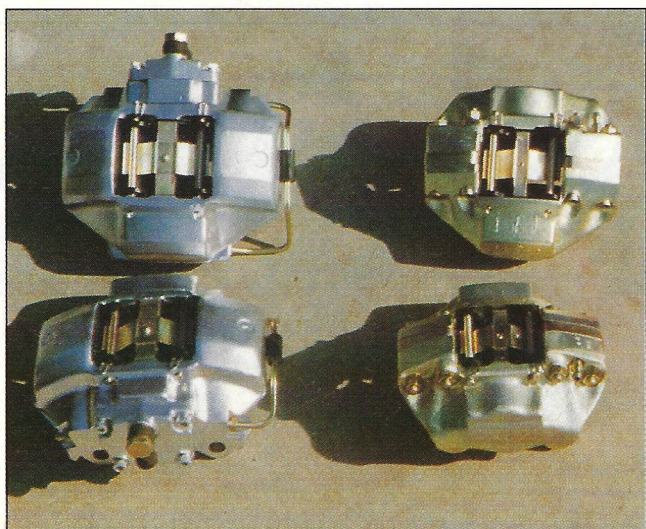
The rear M calipers are built from two halves, and thus the piston chambers cannot be isolated. If one of the pistons sticks in the bore, use a long, forked C-clamp to hold the loose piston while injecting air into the chamber of the other. Although it is not shown in the photographs, lay a rag across the caliper before using the compressed air; otherwise, you may get a face full of dirt, dust and brake fluid.

With the pistons removed, lift out the rubber seal (in my case, the remnants of the seal) with a small wooden or plastic pick to keep from marring the cylinder bore. Once the calipers are completely dismantled, you can clean them with any number of brake cleaners offered on the market.

For reconditioning, I had the M calipers and their associated hardware gold-zinc coated. While you may be tempted to anodize the aluminum brakes, the permanent steel pins in the cylinder bore will cause damage to the calipers during the electrolytic process.

Once the S calipers were cleaned, I discovered light pitting along the outer edge of the bore. As the pistons ride on the rubber seals, this was not a serious problem. The pistons, however, had also been gnawed by the corrosion which

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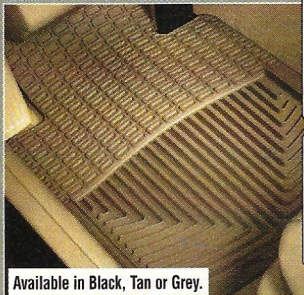


**Left:** Rebuilt front S-type aluminum brake calipers (silver) and the rear M-type calipers (gold) **Right:** Front and rear calipers in original condition.

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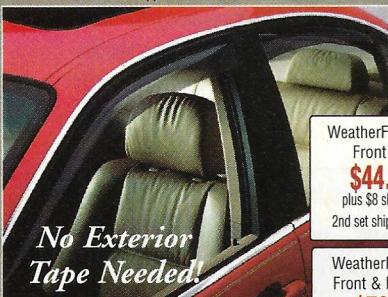
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would ultimately cause the brakes to lose hydraulic pressure.

To rebuild the S calipers correctly, I opted to replace the spoiled pistons with new stainless-steel units offered by Performance Products, the high-performance equipment and aftermarket parts supplier in Van Nuys, Calif.

While the pistons may seem expensive, the cost of a complete set of S calipers from your local Porsche dealer will run nearly the price of rebuilding a 911T engine. Luckily, the pistons from the M calipers were in better shape and only needed polishing with a Scotch-Brite® pad and a bit of effort. The burnishing pad was also used to clean out the cylinder bores.

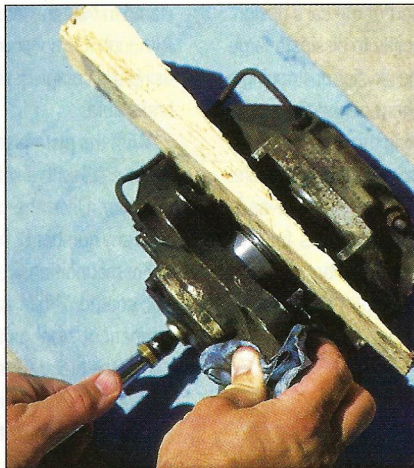
When reassembling the calipers, be sure all important surfaces and channels are free of dirt

and debris. The new rubber seals are best lubricated with Porsche's brake cylinder paste, but a DOT-3 or DOT-4 brake fluid can also be used

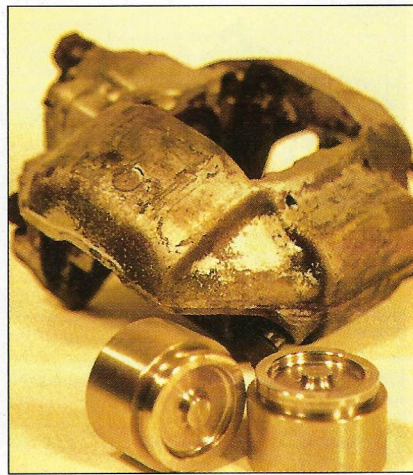
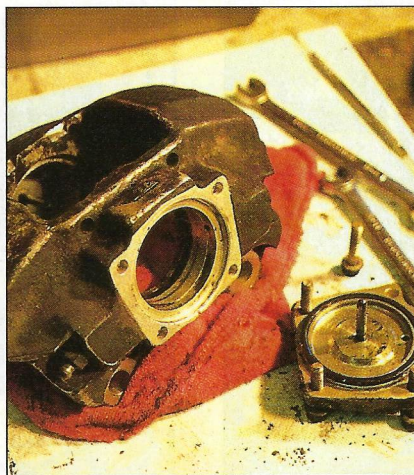
With the seals in place, slip the piston into the cylinder bore, but not so far that you cannot rotate the pistons by hand. To help the brake pads, press evenly against the spinning rotors. The pistons are manufactured with an uneven face. Porsche's special brake-piston alignment tool is needed to correctly set the piston position in relationship to the rotating brake disc.

When reassembling the M calipers, take care to moisten and position the four small O-rings in the center intermediate plates. These O-rings do not come in the standard rebuild kit and must be purchased from the Porsche dealership. As the retaining bolts are tightened, be sure the caliper halves are lined up properly. Then, torque each bolt, working from the inside set outward.

Once the pistons are in place and aligned, wipe off any excess brake fluid. Insert the dust cover into the cylinder. Be sure the dust cover encircles the piston correctly.



Left: Removing brake piston with high-pressure air hose. Right: Removing duct cover from brake piston.



Left: Dismantling S-type aluminum caliper. Right: S-type aluminum caliper with new stainless-steel pistons from Performance Products.

With the four calipers ready to be remounted, I turned my attention to the master cylinder.

### Heart Transplant

The dual-circuit master cylinder on the early 911 cars is positioned just behind the brake-pedal assembly but outside the passenger compartment. Locate the brake reservoir in the trunk and withdraw as much fluid as possible. A turkey baster works well, but be prepared to purchase another, as you are not going to want to return this one to the kitchen drawer.

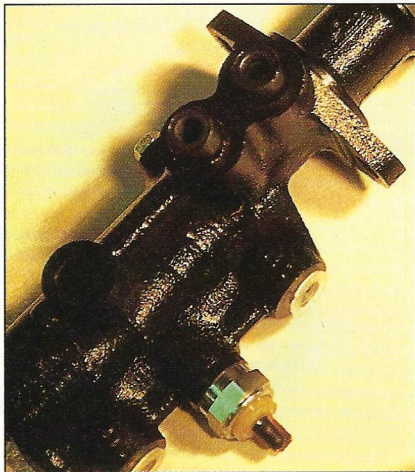
Remove the steel underpanel that covers the fuel pump and steering rack. The master cylinder is just to the left of the steering rack. Unplug the circuit failure switch located on the side of the unit. Disconnect the hydraulic lines again, being sure to use the correct type of wrench.

As the lines are loosened, there will invariably be brake fluid spillage, so prepare yourself with a contingent of rags and paper towels. Take care to keep this liquid off the car's finish.

Two retaining nuts hold the master cylinder to the floor panel. Once these are removed, the unit can be inched forward until a rubber boot is revealed. The boot surrounds the pushrod that is connected to the brake pedal. Working the boot free will release the master cylinder from the pedal assembly. The rod will remain attached to the pedal but will need adjustment upon replacement of the master cylinder.

The last two lines connected to the master cylinder are the solid feed tubes descending through the chassis from the reservoir. These are simply pressed into the top of the unit and can be pulled free as the master cylinder is removed from the car. Remember, these lines will still be filled with fluid, so be prepared with a catch container and more rags.

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Once the master cylinder is out of the car, I have only one suggestion. Place it on the highest shelf in your garage and never take it down. Yes, they are fairly simple devices and can be rebuilt by even the occasional weekend mechanic, but considering the importance of the master cylinder and the fairly inexpensive price for a new one, it is not worth mistakenly rebuilding a bad unit, such as one with pitting in the bore.

For the project car's master cylinder, the cost of Performance Product's rebuild kit is about \$50. A new unit, on the other hand, runs \$130. One more time. A new master cylinder is a mere \$80 more than rebuilding the worn-out original. These are the brakes, and the heart of the system is the master cylinder. With the exception of the steering rack, there is hardly a more important compo-

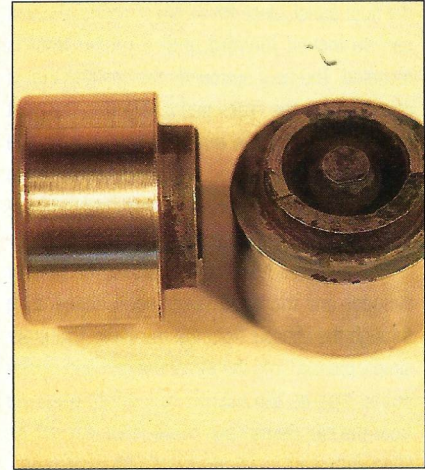
nent on a race car.

When you are ready to replace the master cylinder, simply work the removal steps backward. Once the unit is in place, the trickiest part is to set the rod so it has a 1.0mm clearance with the unit's internal piston. This is done at the brake pedal assembly inside the car. The locking nut must be loosened so the rod can be turned either clockwise or counter-clockwise, depending on the need.

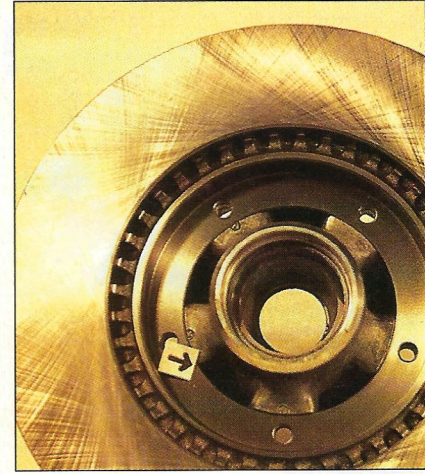
With the calipers repaired and the new master cylinder on hand, the next step was to remove the factory's rubber brake lines and clear out the old brake fluid from the solid lines. With the high-pressure hose in hand and shop rags tied loosely over their open ends, I systematically cleared all the lines.

Although the original rotors were covered with a rusty cinnamon hue, all that was needed to bring them to pristine condition was a quick turn on the race shop's resurfacing machine. Before turning a disc, however, be sure the rotor thickness is within the manufacturer's specifications.

If the S were destined solely for street use or



**Left:** Brake calipers cleaned and ready to rebuild. **Right:** Rear brake pistons. While the piston face (R) maybe pitted, be sure the circumference of the pistons (L) are in perfect condition.



**Left:** Aligning the brake piston inside the S-type aluminum caliper. **Right:** Arrow reveals the opening in the hub where a portion of cool air is lost.

concourse events, this would have been the point to reassemble the system. But, as it was slated for competition, there were several upgrades I wanted to include.

### Brake System Enhancements

Because of the movement of the chassis in relationship to the brakes, rubber lines connect the calipers to the system's hard lines. Over time, even under normal-use, these lines can deteriorate and give the brake pedal a soft, spongy feel. The ones on the S had gone in the other direction, becoming stiff and cracked. But, instead of replacing them with similar factory lines, I selected the sturdier stainless-steel braided lines from Weltmeister. These are a good upgrade even for a non-competition car.

As mentioned earlier, one of the best ways to maintain optimal brake performance is to dissipate the heat generated by the friction of the brake pads. This is best done by channeling cool air to the rotors and calipers, especially as the front end shoulders the greatest percentage of braking when diving into a corner.

With this in mind, I installed two more upgrades offered by Performance Products. The first addition, and most substantial, was Cooler Brakes, a simple bolt-on system designed to direct air to the rotors. The kit includes a pair of aluminum discs, hoses and two shallow scoops. The discs attach to the struts and fill the inner dimension of the ventilated rotors. The flexible hoses attach to the discs' 2.0-in. openings, then snake down between the strut assemblies and steering tie rods to the scoops, which in turn are fastened to the bottom of the A-arms. The air passing beneath the car is then routed to the brakes.

While this is a huge improvement in brake cooling on a high-performance street car, it is not the optimal setup for a racer. "You want to draw the air from the high-pressure area at the front of the car," said Jaime Trimble of Race Technologies, the master distributor for Brembo's high-performance brake systems in the U.S. "This forces clean air into the center of the rotors and out through the vanes."

In order to tap into the air at the front of the S, the car was fitted with an RSR-like front spoiler which incorporates forward-facing air vents. From the vents, the hoses were fed around the trunk box, through the suspension system and again to the Cooler Brakes discs at the rotors.

The second enhancement was the use of air deflection plates that sit inside the front vented rotors. Normally, much of the wind which swirls into the rotor is lost through the hub. The plates block these openings and when incorporated with

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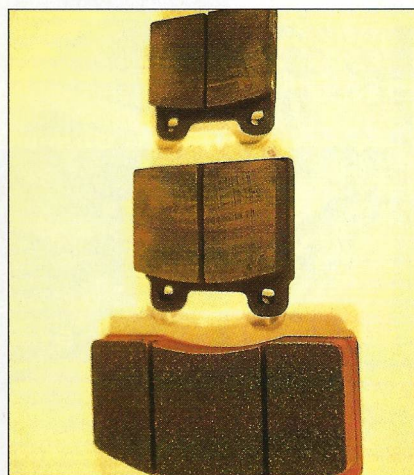
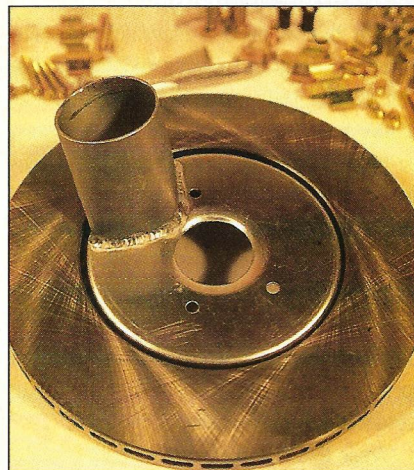
the Cooler Brakes discs directs 100 percent of the air through the rotor vanes, furnishing the brakes with a substantial amount of cooling.

The last improvement to the car's brake system occurs after everything has been reassembled and tightened to the proper torque specifications. This, of course, would be the brake pads. Performance Products offers Pagid pads for Porsche cars, but only two types, designated Blue and Orange, are available for the early 911. Pagid's Yellow pads are designated for long-distance racing and are offered in sizes for the likes of the 993 Turbo.

For the dedicated club racer, the Orange pads are the best selection, but, like fine tuning the suspension system, using competition brake pads on the street can have serious disadvantages.



**Left:** With the deflection plate in place, the arrow points out how it has sealed the hub openings, where a portion of cool air can be lost. **Right:** The Cooler Brakes disc in place on rotor.



**Left:** Gripping difference: (top to bottom) Pagid's Orange pad for the 993 Turbo compared to the 1970 911S front pad and rear pad. **Right:** Cooler Brakes disc in place with hose leading to lower scoop.

"I would keep away from the Orange pads for the street," Trimble said, warning that the pads could actually damage the rotor if they are not run within their high-temperature range.

Even if you drive the avenues like Allan McNish, racing pads produce more brake dust than softer street pads, blackening that hard-earned polish on your alloy wheels. They also have a tendency to announce your arrival at every stop light with a deafening squeal.

Pagid's Blue pads are rated for high-performance street, slalom and autocross applications, and as the S was going to see a number of highway miles before I regained my racing legs, they were clearly the best choice for the car.

At the track, I once saw a T-shirt worn by an avid racer that read, "I don't brake until I see Elvis." The saying may not be as technical as Mr. Bentley's truism, but the message is just as clear. With the rebuilt brakes and the upgrades mounted on the car, I am now confident the S will stretch the straightaways a tad further than my competition—or at least until I too see the King. ❧



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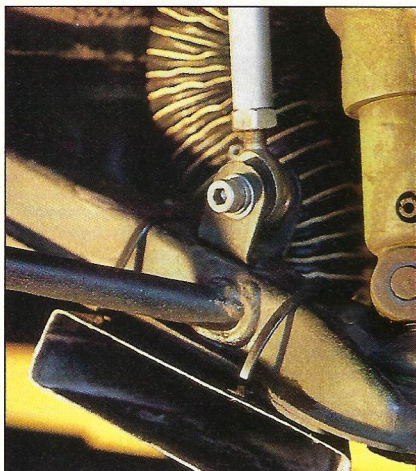
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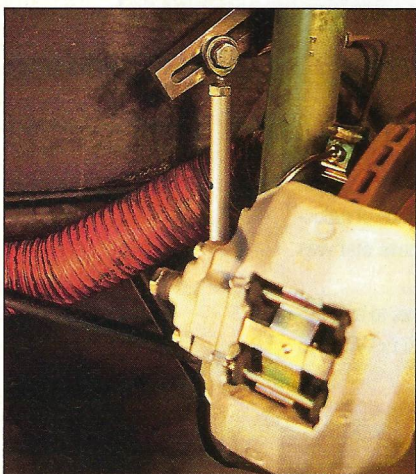
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