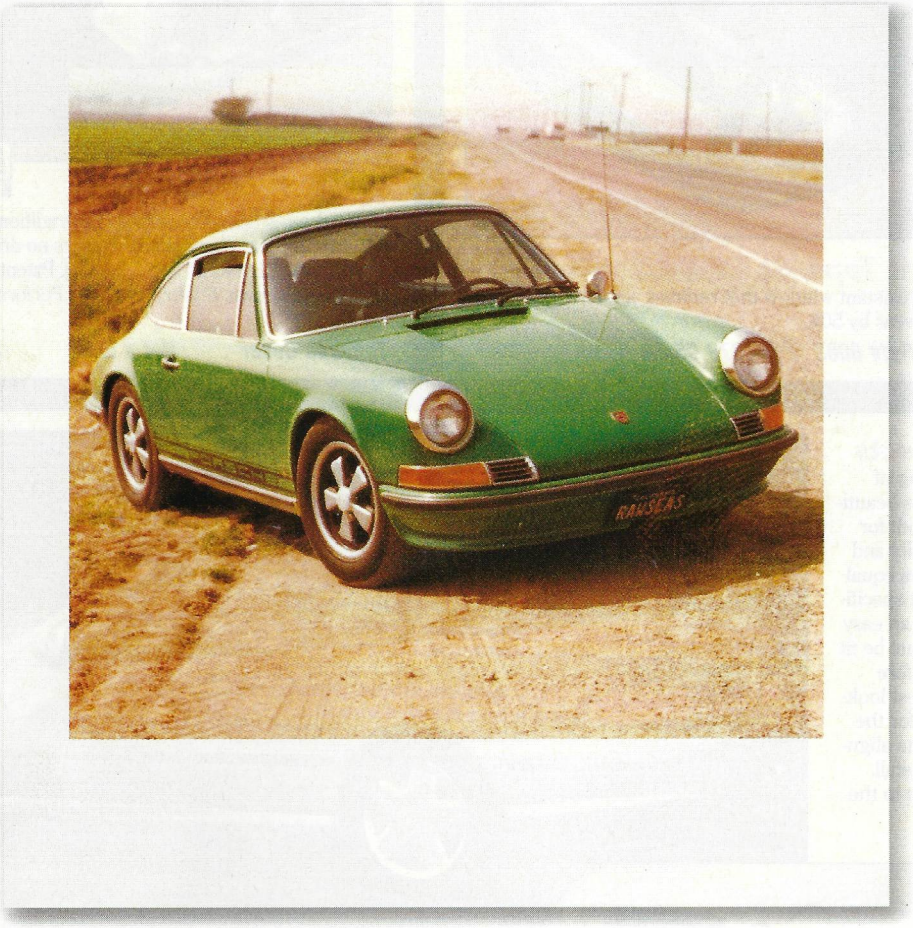
# Project 911S

## Part 7: In the balance

by Mitchell Sam Rossi

PHOTOS BY THE AUTHOR



"How much do you weigh?" asked Steve Alarcon of Johnson's Alignment Service as he tapped the touch pad of the digital computer resting beside the rocker panel of my freshly painted 911S. A tangle of yellow cables snaked across the cement connecting the computer to four tire scales. Each was encased in steel and looked like the military equivalent of a bathroom scale.

"A hundred and seventy," I admitted. I found this an unpleasant question from anyone let alone the guy who was adjusting my car's suspension. "Maybe one seventy-five; I just had lunch."

He responded with a doubtful smirk. "We'll see," he said, returning to the meter.

As important as having a good mechanic, finding a high-performance race or alignment shop that understands the suspension tuning can be critical. While the components for the project car's suspension were new or in near-perfect condition, it was still a 30-year-old design. If the S was going to be competitive with newer Porsches, it had to be tuned to its optimal level.

An automobile suspension system is one of those marvels of technology that seems to defy basic logic. When a car is parked on the street, it may look to be

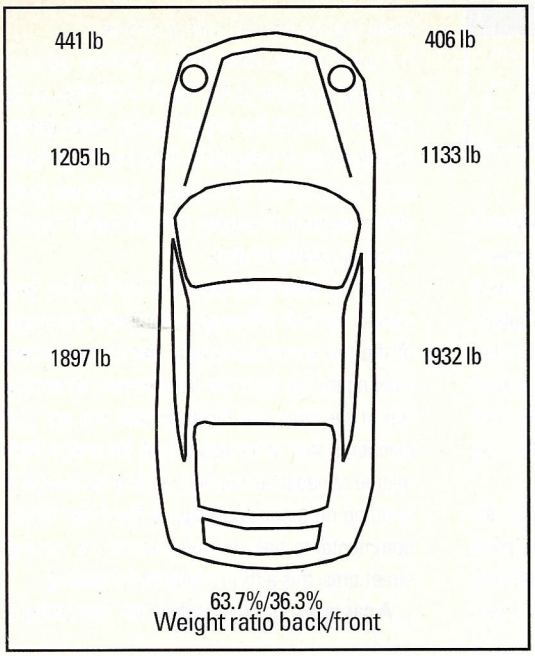



Fig. 1. Weight distribution for the 911S.

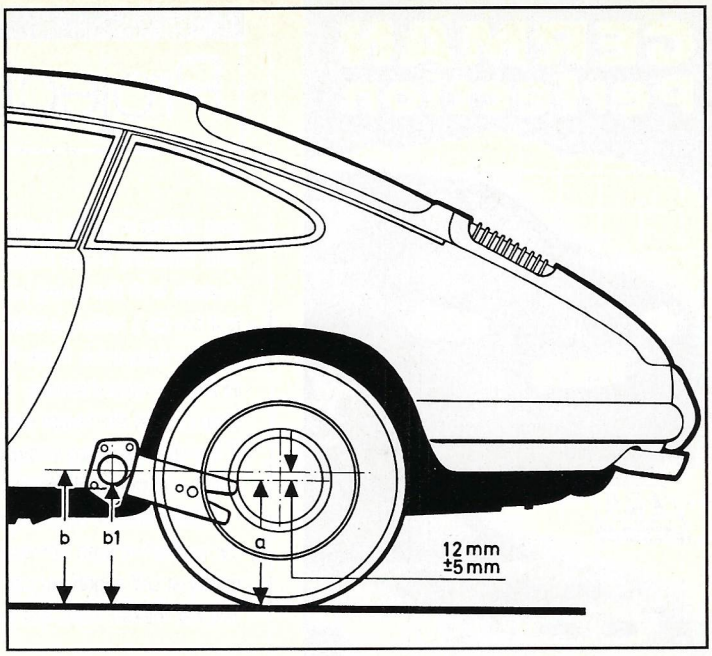



Fig. 2. Adjusting the rear ride height of the 911.

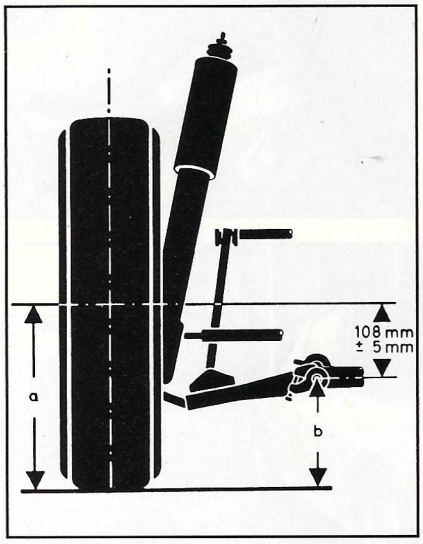



Fig. 3. Adjusting the front ride height of the 911.

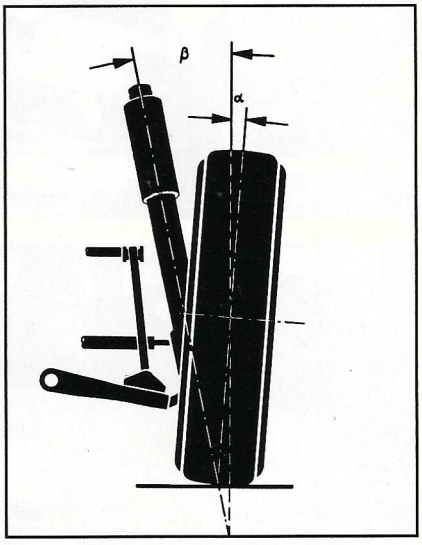



Fig. 4. Example of 911 camber.

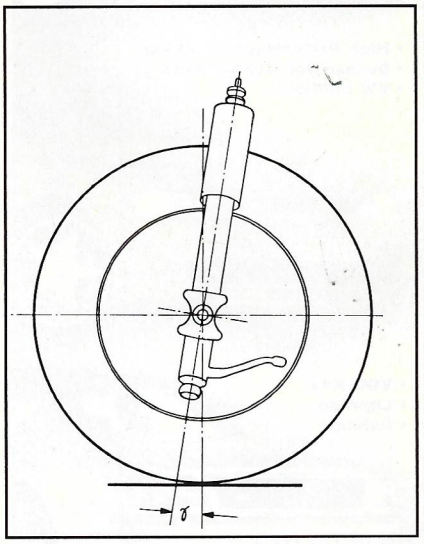



Fig. 5. Example of 911 caster.

resting evenly on all four tires, but that is rarely the case. As a 911's engine is suspended behind the drive axles, the rear tires clearly bear most of the weight. While some enthusiasts argue this is what makes the 911 such a great road racing car, it is clearly a problem that emphasizes the importance of a well-maintained and calibrated suspension.

Except for adding or changing anti-roll bars, when a suspension system is rebuilt or enhanced with new components, it is usually in need of alignment. The project car not only received heavier torsion bars, polyurethane bushings and refurbished spring plates from a later 911SC, but also had its A-arms and control arms removed. As it was also destined for track events, it was a prime candidate for complete suspension tuning and corner balancing. Thus the reason behind Alarcon's personal question.

A vehicle rides on four tire patches, each roughly the size of an adult handprint. In the case of a race car, that impression may be nearer the size of Shaquille O'Neal's grippers, but these rubber impressions are still being asked to keep the racer from careening off course while assaulting a turn at triple-digit speeds.

Beyond the safety factor, a properly set suspension can offer additional benefits at the track. One of the basic principles in racing is that a car carry as much speed as possible out of a corner and onto the straightway. With horsepower, torque and aerodynamics being equal, if a car with a properly tuned suspension can leave a corner a few miles an hour faster than its challenger, the physics of acceleration dictate that the exiting speed benefit will carry down the straight. In paddock terms, even the slightest advantage can translate into dominating the competition.

### Nuts and Bolts

"The difference between corner balancing for the street or for the track is putting the driver's weight in the car," Alarcon explained. "I like to have the car exactly like it's raced. The correct tires should be on it, the same amount of fuel in the tank, and the driver in the seat."

"Any time you put in new torsion bars, I sug-

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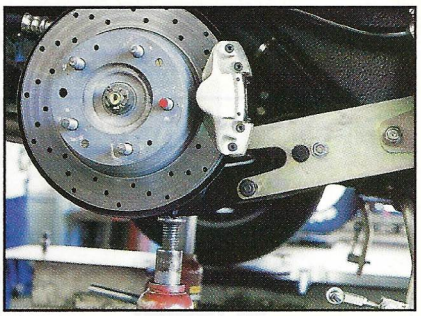
gest rechecking the corner balance," Alarcon said, stressing it was simply too easy to make a mistake with the spring plates. Another reason is if the car's history is unknown, corner balancing can determine if the tub is twisted or has extensive imperfections. While a body repair shop can set the height until the car looks level, if the chassis is not straight, the corner scales will reveal the problem.

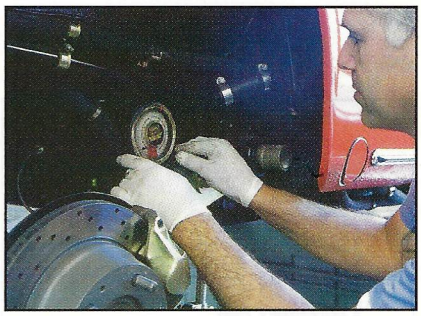
Before Alarcon sat me behind the wheel, the car was rolled onto the scales to see how badly my try at DIY alignment had set the suspension. The car looked level, but as suspected, it was teetering like a poorly built sawhorse.

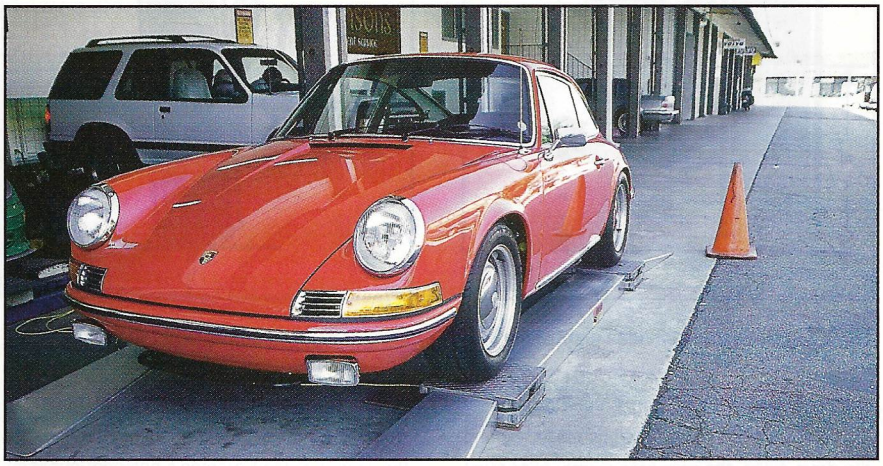
I knew things were amiss when my drive to the shop was akin to Mr. Toad's Wild Ride at 60 mph. A touch of the brakes added more entertainment, as it induced a demonic lunge from one lane of traffic to the next, testing my forearm strength and leaving me with white knuckles and a drenched shirt.

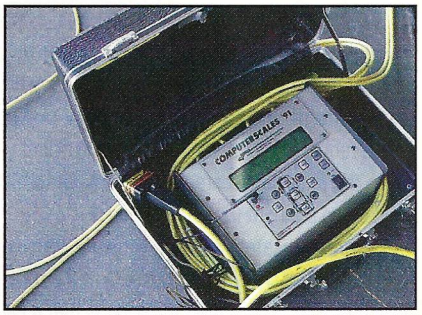
Alarcon also discovered the car's caster and camber were at silly angles. Camber is the angle of the tire in relationship to the chassis when viewing the car from the front or rear. When the top of the tires are tilted toward the car, the camber is said to be negative. A car with a high degree of negative camber will look as though it is riding on the inside edge of the tires. While detrimental to tire wear on a street car running street tires, this aids in a race car's handling.

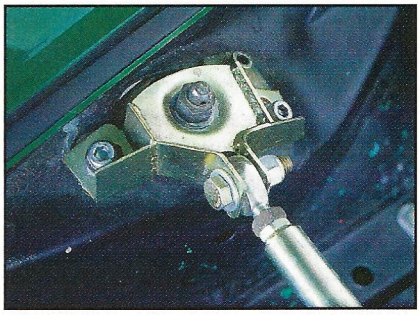
A car leans to the outside when navigating a









1. Adjusting the 911 rear spring plates. 2. Alarcon works on the 911 rear spring plates. 3. The 911 weighing in on the balancing scales. 4. The weight computer. 5. Upper strut mount with the Weltmeister strut brace from Performance Products.

turn. If the tires are perfectly level when the car is at rest, driving around a corner will induce positive camber in most cars. In order to counter this, and actually use this body roll to the driver's advantage, the suspension is set with significant negative camber. This way, as the car shifts its weight to the outside, the camber aids the tires in setting the maximum area onto the pavement.

The caster is what gives the car stability and refers to the pitch angle of the front struts. This angle is always positive, since chassis and suspension designs set the steering axis inclination toward the rear of the car. While decreasing caster quickens the steering wheel response, it is at the cost of high-speed stability. The best solution is a compromise. but one that favors straight-line stability.

Once the project car's alignment was brought in to acceptable tolerances, it was time for the scales again. "For running slaloms and time trials, I always set the car to the lowest ride height of the factory's European specifications," Alarcon said. For the 1970 911S, this was near 25- and 25.5 in. from the top of the front and rear wheel arches, respectively.

Once the front torsion bars are positioned, the ride height can be adjusted at the rear of the A-arms. Under the protective steel undershield that encapsulates the rear of the A-arms, cross bracket and fuel pump, there is an adjustment lever with a Allen-head bolt. Threading the bolt inward lowers the front of the car, while turning it in the opposite direction raises the car.

At the rear, changes in height and weight distribution are linked to the eccentric bolts between the two spring plate halves. By adjusting these, Alarcon shifted the weights to and from the needed corners.

Because of the rear-engine layout of the 911, a showroom stock car has a weight distribution split 40/60, front to rear. The left and right weights are usually equal but may vary depending on the model year. For example, in 1974 the 911s were equipped with a single 12-volt battery tucked into the forward left corner of the trunk, thus losing the balance benefit of the earlier cars which used two small batteries placed in opposite corners.

This distribution can be changed by removing extraneous equipment, as was done in the S, or by relocating bulky components. The Utopian number of 50/50 weight distribution can never be attained in a 911—it remains in the realm of 944s and Boxsters. Serious track cars, however, will try to shift this percentage by replacing steel body panels with carbon fiber and moving the oil reservoir to the trunk.

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The first trip to the scales revealed the S had a ratio of 39.6/60.5. Although the car had been lightened, to my chagrin the overall mass of the car had moved further rearward.

Once Alarcon determined the car's weight distribution, it was time for my stint behind the wheel. "Since you can't use the suspension to physically move weight from one side of the car to the other, we use percent of ratios," Alarcon explained.

Because the driver's seat is not centered in the 911, the driver's weight acts unevenly on the car's four wheels. Proper corner balancing moderates this effect. While the numerical values for each wheel looks odd (see Fig. 1.), the ratios add up.

While the scale's computer will show a 50/50 percentage value, Alarcon makes his own confirmation of the corner balancing by comparing the cross weights, this weight being the sum of the loads on the diagonal wheels. The suspension is properly tuned if these two values are within a few pounds.

With the Porsche standing correctly on all four tires, Alarcon set to finalizing the toe-in, caster and negative camber numbers. The toe-in is adjusted at the tie rod ends, spinning them either inward or out, depending on the alignment needs. The caster and camber are adjusted at the strut brackets at the top of the shock towers inside the 911's trunk.

While I was determined to return the S to club racing, during this phase of its reconstruction I did not purchase adjustable upper strut mounts with spherical bearings. These aftermarket components would have helped in adding more negative camber to the front. I did, however, add a Weltmeister front strut brace from Performance Products, an aftermarket supplier in Van Nuys, Calif. Although there are dozens of such braces on the market, the Weltmeister design ties together both the shock tower and the shock piston rod, thus helping isolate the strut's movement in the car's stock rubber bushings.

"A good suspension guy will ask his customers what they are going to do with the car," Alarcon explained. "Setting the car for the street is fairly easy. For the track, it's a bit more involved."

And for the Porsche owner who wants to do a little of both? "For a car driven on both street and track," Alarcon shrugged, "it's going to be a compromise. If he goes to a lot of slaloms, I may give the car an aggressive street setting. As long as the owner knows he is going to be giving up tire wear."

When the afternoon was over, the car had a front negative camber of 1.5 degrees, a positive caster of 6.5 degrees and a 1/16 toe-in. At the rear, Alarcon managed a 2.5-degree negative camber and a toe-in of 3/32 in. The fighting weight for the S with driver: 2,338 lb. And as for my weight minus the car? Well, let's just say it was a big lunch.

**Special thanks to Carl Akins** for allowing me to photograph his exceptional 1972 911E while Steve Alarcon was performing his magic on the suspension.

**Johnson's Alignment Service**
19056 Hawthorne Blvd.
Torrance, CA 90503
**(310) 370-6301**

**Performance Products**
8000 Haskell Ave.
Van Nuys, CA 91406
**(800) 423-3173**
www.performanceproducts.com