



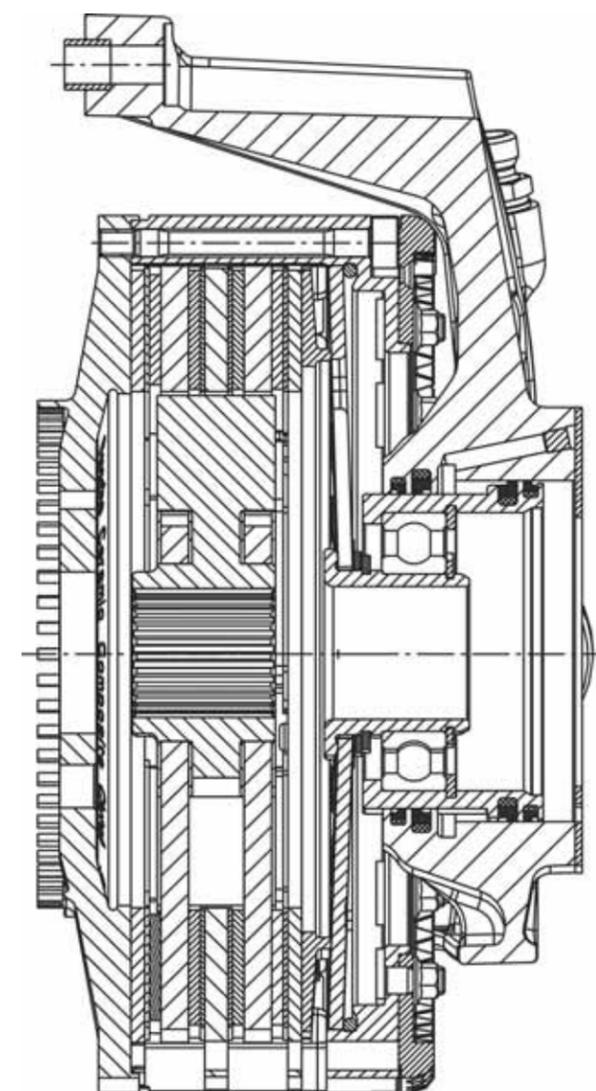
Little, Strong, Black

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Technology

In the Porsche Carrera GT, not only the brake pads grasp onto ceramic plates. The clutch, too, finds its power connection on this enormously hard silicon carbide. A new technology with far-reaching consequences.



Insights: The diameter of the clutch plates of the Carrera GT is only 169 millimeters

The most powerful of all production Porsche cars is different from its siblings in one aspect that directly involves pure power: the so enormously powerful Carrera GT, with its 612 bhp (450 kW), has the daintiest clutch of any Porsche. The diameter of the clutch plates, 169 millimeters (6.65 in.) is enough to transfer not only the 590 Newton meters (435 lb-ft.) of torque, but even a maximum of more than 1000 Nm (735 lb-ft.). The Porsche 911 Turbo, with 560 Nm (415 lb-ft.) of torque, and the even heftier GT2, with 620 Nm (472 lb-ft.), employ clutch plates of 240 mm (11.5 in.) in diameter.

The size differences are a matter of principle. Porsches of the 911 production series, all the way up to the Turbo, use a conventional single-disc clutch with a dual-mass flywheel and a

driven disc of heavy steel. The Carrera GT, on the other hand, harbors racing technology harnessed for the road. Here, two disks, not one, ensures the transfer of forces. And for the first time in an automobile, these friction plates, following the example of their counterparts in the braking system, are made of a ceramic. The good experience with the Porsche Ceramic Composite Brake (PCCB) has led to development of the Porsche Ceramic Composite Clutch (PCCC), which also is produced in cooperation with SGL Brakes GmbH, located in Meitingen.

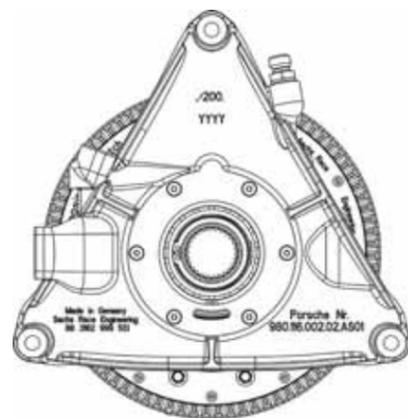
The modern variant of this material surpasses steel in three major qualities: This kind of ceramic is lighter, harder, and more heat-resistant than metal. Top-quality material also ▶



Understanding...: As a project manager for the Carrera GT drivetrain, Bernd Ramler is also responsible for the clutch



... for the future: The low weight and the small dimensions of the PCCC reinforce the qualities of the super sports car



covers the backing plates of the organic sinter shoes by the company Pagid: Titanium won out here over heavier steel and weaker aluminum.

The weight reduction over the 7.6 kilogram (16.75 lb.) conventional clutch of a 911 Turbo is more than fifty percent for the 3.5 kilogram (7.7 lb.) PCCC. The diet has its price. Bernd Ramler, drivetrain project manager for the Porsche Carrera GT, admits: "Because of the small batches, we still have to figure on a factor of ten in pricing, but we can see a potential for lower prices in the future."

Even then, building a ceramic clutch will still be a high-effort process. Its friction plates have to face even higher challenges than do the ceramic brake discs. While the carbon-fiber component of brake discs still consists of short, non-oriented fibers—"sauerkraut" in workshop jargon—the clutch, exposed to bending and centrifugal forces, needs carbon fibers in the more robust form of a fabric.

In the first production stage, the fabric is pressed into a plate, at a temperature of 100 degrees C (212° F). Then the plate with the carbon fiber mat and epoxy resin is placed into a hotter oven, and baked at more than 700 degrees C (1200° F).

After this process, the brake and clutch plates already have the extreme strength of the carbon fiber material as it is used for the brake discs of Formula One cars. But the final long-lasting strength needed for road operation only comes with the so-called "silicization" process, in which the carbon-fiber plates get a coating of liquefied quartz sand during a third baking. This enrichment with silicon takes place at 1700 degrees C (3000° F), in an extremely powerful vacuum. At this temperature, the melted sand is more fluid than water, and the silicon displaces the resin from the carbon fiber structure and occupies seventy percent of the volume of the saturated plate.

Thus, a new substance, silicon carbide, arises from the embers, a hardship case that engineers value highly. With a hardness of 9.7, silicon carbide is right behind diamonds, which define the "absolute-hardness" score of 10. The material's tough resistance against wear and high temperatures also thwarts tools; working the surface requires diamonds. The effort that goes into the ceramic clutch at the Carrera GT results in durability far beyond that of a conventional clutch. That is especially impressive for a clutch subjected to considerable torque. The low weight and small dimensions of the PCCC reinforce the dynamic qualities of the super sports car.



Perspectives...: "Because of the small batches, we still have to figure with a factor of ten in pricing," says Ramler

Technical Information:

The Porsche Ceramic Composite Clutch (PCCC) of the Carrera GT

Two-plate dry clutch

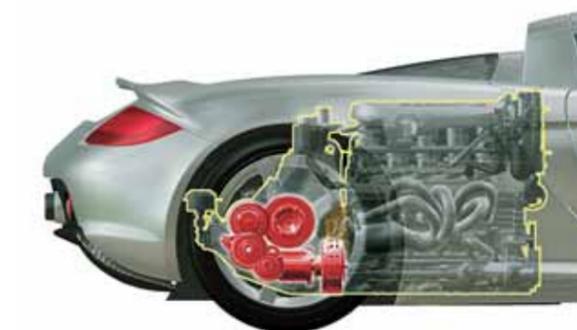
**Hardness of the silicon carbide: 9.7 (absolute hardness: 10)
Diameter of the clutch plates: 169 millimeters
Power transmission: max. > 1000 Nm (735 lb-ft.)
Engine run-out speed: over 20,000 rpm
Weight: 3.5 kg (7.7 lb.)**

Because of its small firing interval, the race-bred ten-cylinder racing engine holds stable in neutral at low inertia. There, the small and light clutch is just the right thing to successfully support, with minimal mass, this machine's talent to rev up very quickly. Lightning reactions to the commands of the accelerator are a correct and sporting answer to this physical fitness program. At the same time, the Carrera GT demands a deft touch on the accelerator and the clutch from the driver. A smooth start requires a well-measured pinch of throttle and sensitive handling of the clutch, which conveys full power over a short take-up path.

The smaller dimensions of the clutch have made profound changes possible in the design of the power transmission, and have thus promoted its ultra-sporty character. In an engine that, thanks to dry-sump lubrication, has no oil pan extending toward the ground, the size of the clutch housing determines the ground clearance and therefore also affects the installation position of the engine. So the smaller the clutch and the shorter the distance between the middle of the crankshaft bearings and the underside of the engine case (98.5 millimeters/3.9 inches) in the Carrera GT, the lower the engine can be installed and the further the center of gravity ultimately drops.



Interior view: The smaller the clutch diameter, the lower the engine can be installed



That the engine in the Carrera GT is as low as in a racing car wasn't enough for Ramler, however. It was also important to him to move the mass of the mechanical structure as close as possible to the middle of the vehicle and to its center of gravity. The six-speed transmission of the Carrera GT from the gear factory in Hör in Weiden groups its shafts transversely and at the level of the differential, with no overhang. "Because if we were to pack a 65-kilogram (145 lb.) transmission behind the rear axle of such a car," Ramler explains, "it would be as wrong for the balance of handling characteristics as if the tail were to wag the dog." ◀