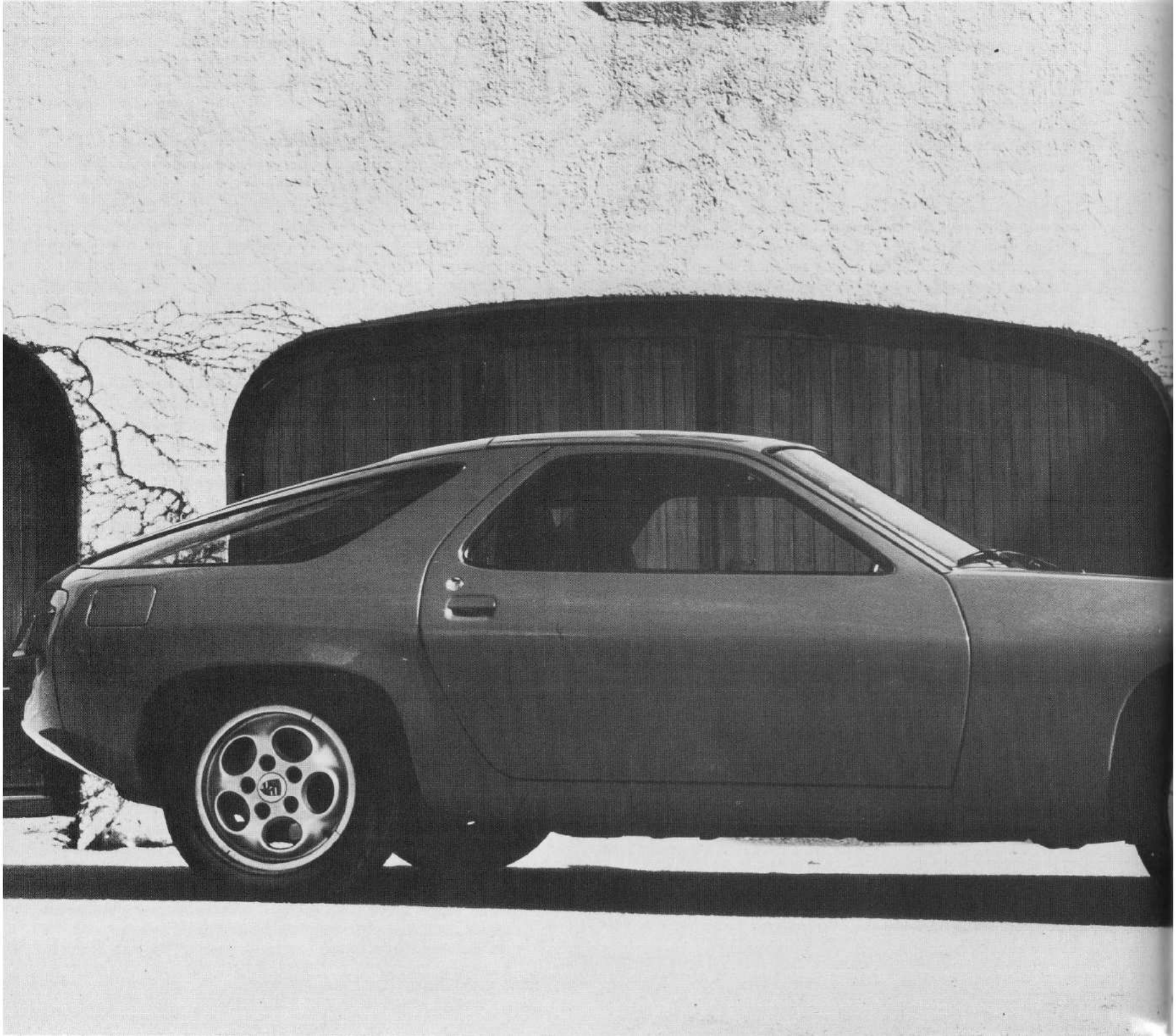
PORSCHE

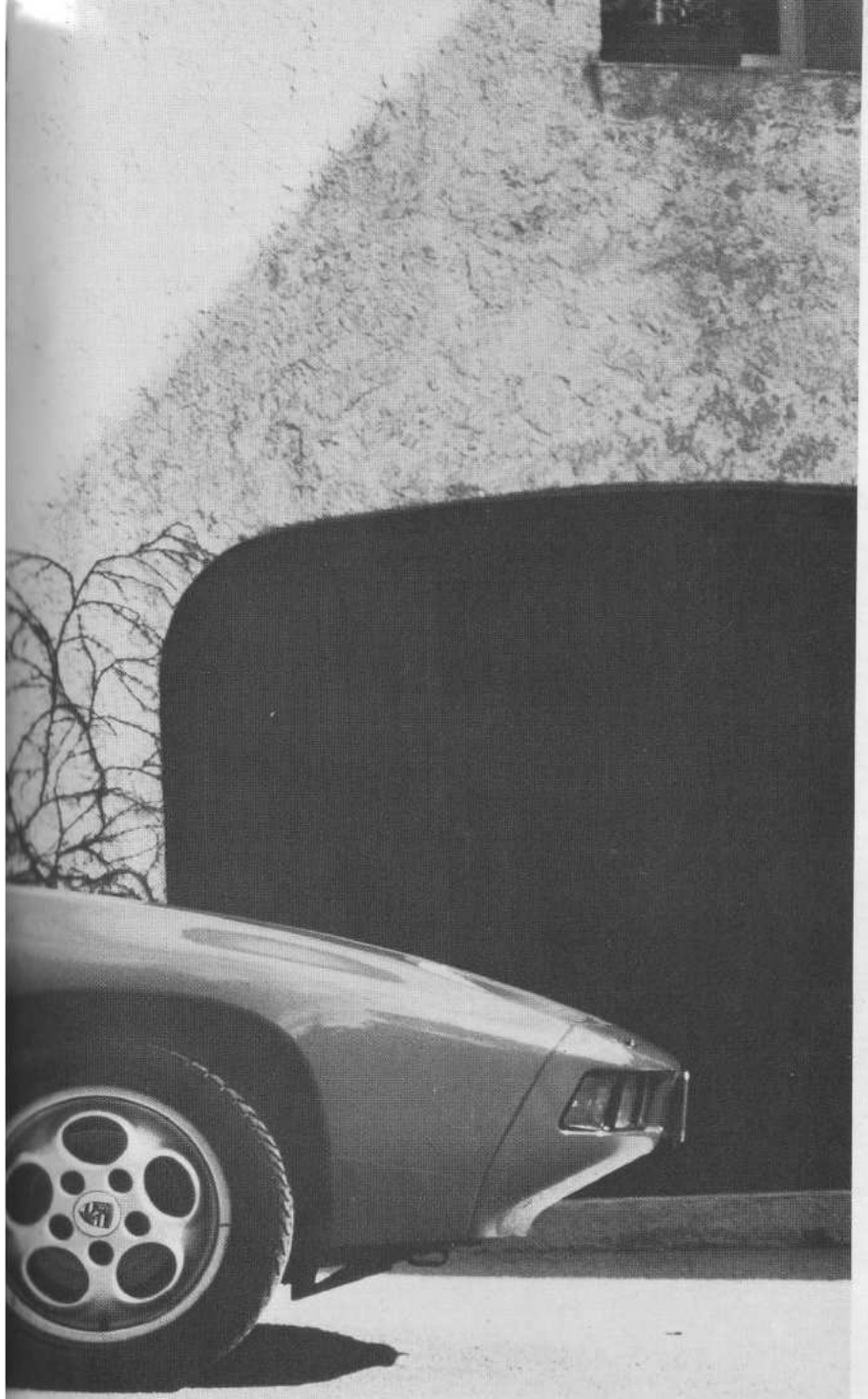
EXCELLENCE WAS EXPECTED

THE COMPLETE HISTORY OF THE SPORTS AND RACING CARS

BY KARL LUDVIGSEN

AN AUTOMOBILE QUARTERLY LIBRARY SERIES BOOK





Its shape said it all: the 928 was new from the ground up.

Chapter Thirty-Two

Magnificent V-8

"What's it like?"

The first journalist, who posed the question, expected a factual answer from the second journalist, who had just returned from a drive of several hours through southern France in a new Porsche 928. Instead, he heard a flat statement that he could not believe:

"It makes all other Porsches old-fashioned."

All other Porsches? How could that be? thought the first journalist, who loved the lusty 911's and the velvet-gloved mailed fist that was the Turbo. He had not yet driven the 928, but he could hardly imagine that it might outclass the 911 in its finest form. Later, he too drove the 928, and he too was asked,

"What's it like?"

He heard himself give an oblique answer:

"It's as if all other Porsches have just been practice exercises for the men who designed this car."

Such were the impressions the 928 made on some of the first non-Porsche people to drive it at the end of February 1977. Fine though the 911 was and still would be, the 928 clearly represented a doorway through which Porsche would drive into a new era. The car possessed an astonishing clarity of conception and execution, from its superb engine to its ingenious suspension. Invested in the 928 were all Porsche's experiences with the road and racing cars the company had designed and built since it was established in 1930. And the Porsche engineers were able to put that experience to work in the 928 for one surprising reason: the 928 was the first production car in Porsche's history that the company had been able to design completely from scratch.

Readers of the preceding chapters should not be surprised by that statement. Consider the ways the various Porsche production models came into existence. The first Porsche-to-be, the Type 114, was completely special from the ground up—but it never went into production. After World War II, economic realities dictated the use of Volkswagen components in the Type 356, which in turn determined the kind of car the Type 356 could be.

Porsche legend has always held that the 911 was designed from a clean sheet of paper. As revealed in Chapter Sixteen, however, that car was actually developed, step by step, from the 356. It was the end result of a program that was originally intended to produce an improved 356, and it came close to going into production with the Type 356 rear suspension. In fact, it did carry over the wheels and disc brakes from the 356C.

The Porsche engineers' options were severely limited when they sat down at the boards to design the Type 914 and its successor, the 924. In both they were able to use the overall conception they wanted, but they had to use off-the-shelf engines, transmissions and suspension assemblies to keep the cost down.

Though these were new cars, they were not completely new from stem to stern. Their designs were subject to heavy compromise. Solutions the Porsche designers might otherwise have favored could not always be put to work.

By force of circumstance, the story of the 928 was different. It might not have been. In 1971 Porsche had firm plans for its future models, and they did not include anything remotely resembling the 928. Under Ferdinand Piëch the men of Porsche were then developing for Volkswagen a mid-engined, liquid-cooled successor to the Beetle, a small car known as the EA266 at Wolfsburg and as the Type 1966 at Weissach. This car was to be the design foundation for the Porsche of the future.

"In size," said Ernst Fuhrmann later, "this was a path back toward the 356, with all the new technology that has been worked out since then. The new Porsche was envisioned as being ready for the 1975 model year. The Type 911 was to last only until then." Plans for the new model were well advanced when, on the first of October 1971, the news came of the resignation of Kurt Lotz from the leadership of Volkswagen and his replacement by Rudolf Leiding, who had formerly headed Audi-NSU.

Only days after his ascension Leiding shook the Porsche men with his first major decision: he cancelled completely the EA266 program. "This had two very aggravating consequences for us,"

A youthful veteran of the Le Mans and Can-Am wars, Helmut Flegl was 928 project

said Heinz Branitzki of Porsche. "On the one hand a complete development team was without work from one day to the next." The Weissach labs, test facilities and staff had been devoted almost totally to the EA266 effort. "Secondly," continued Branitzki, "our total model program had broken down." The foundation on which future Porsches were to have been built had suddenly collapsed.

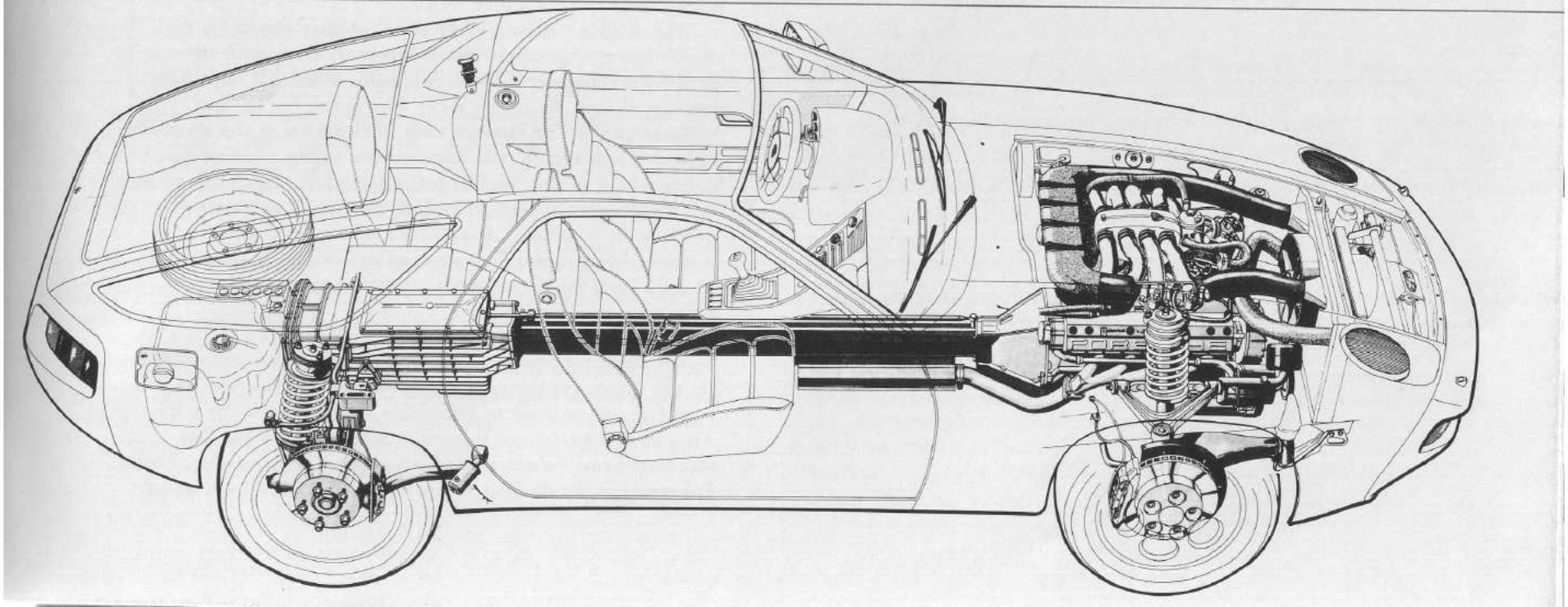
The Porsche men could not afford a pause for tears and recriminations over the fate of the Type 1966. As Ernst Fuhrmann put it: "A complete engineering team stood at liberty." Salaries had to be paid even when there was no work on the desks. Two programs were put in motion. One, the overhauling of the 911 so that its lifetime could be extended bore fruit with the extensive changes in the 1974 model. The other, the formulating of the concept of the 928, was rapidly completed. It "was worked out, deliberated and decided within a few days," Ernst Fuhrmann said. Before the end of October 1971, Porsche knew in general what sort of sports car it would choose to follow in the wheeltracks of the 911.

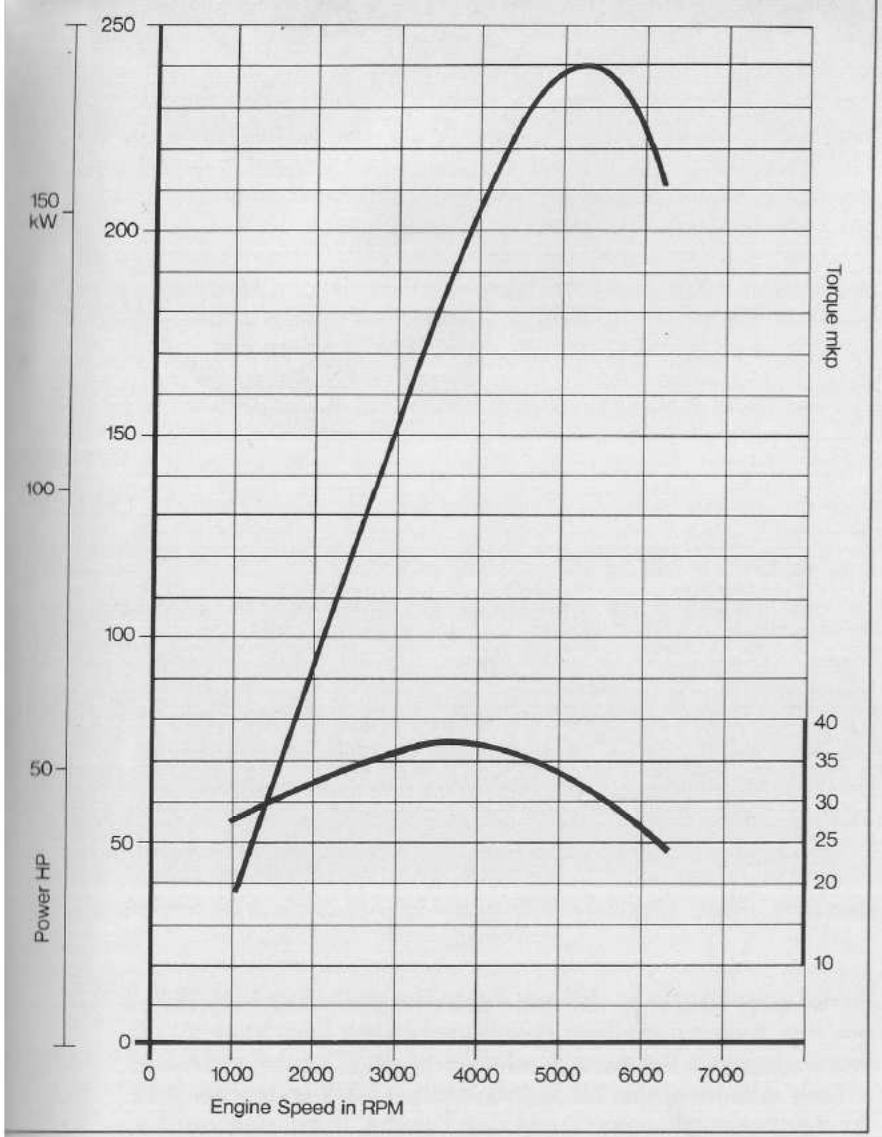
The basic principles according to which the 928 was constructed were described in the preceding chapter in connection with the 924, which was formulated several months later along the same basic lines. To recapitulate, these encompassed a front-mounted, liquid-cooled engine, together with a rear-mounted transmission, to give a balanced front/rear weight distribution and a high polar moment of inertia that aided controllability and straight-running steadiness.

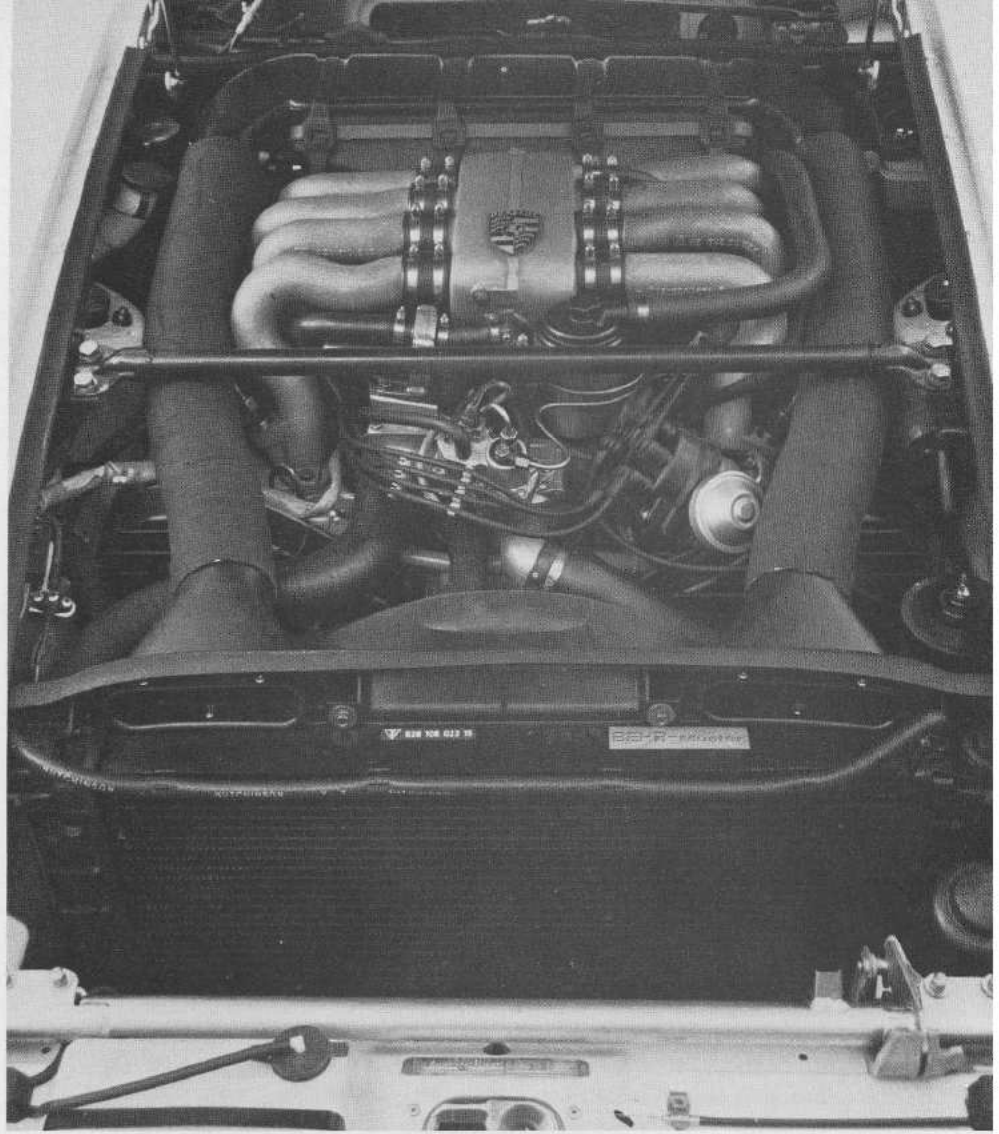
Another powerful motivation was the need both to meet and to anticipate government regulations on cars. "The only nightmare for our engineers was the new legislation in the United States," explained Ernst Fuhrmann, "Porsche's most important export market from the beginning. One must expect that the laws there will also be adopted in Europe and the rest of the world. They deal with safety and with the environment, with respect to emissions and noise, both of great concern to all who care about the future of the automobile. The worst thing was that no one knew exactly what these laws would be like or when they would take effect."

This uncertainty was especially worrying to Porsche, a small auto producer that had to entrust all its eggs to one or two baskets and had to make them last for a dozen years or so. The company could not take a chance on building a type of car that might not be adaptable, because of its architecture, to some future legislator's whimsy. Continued Fuhrmann: "We therefore decided to choose a concept that would be more similar than before to the majority of cars built, for it would be to this

rector. Visible beneath the skin of the new 928: the molded plastic fuel tank, the space-saver spare above the battery, and the transaxle nestled between the rear seats.



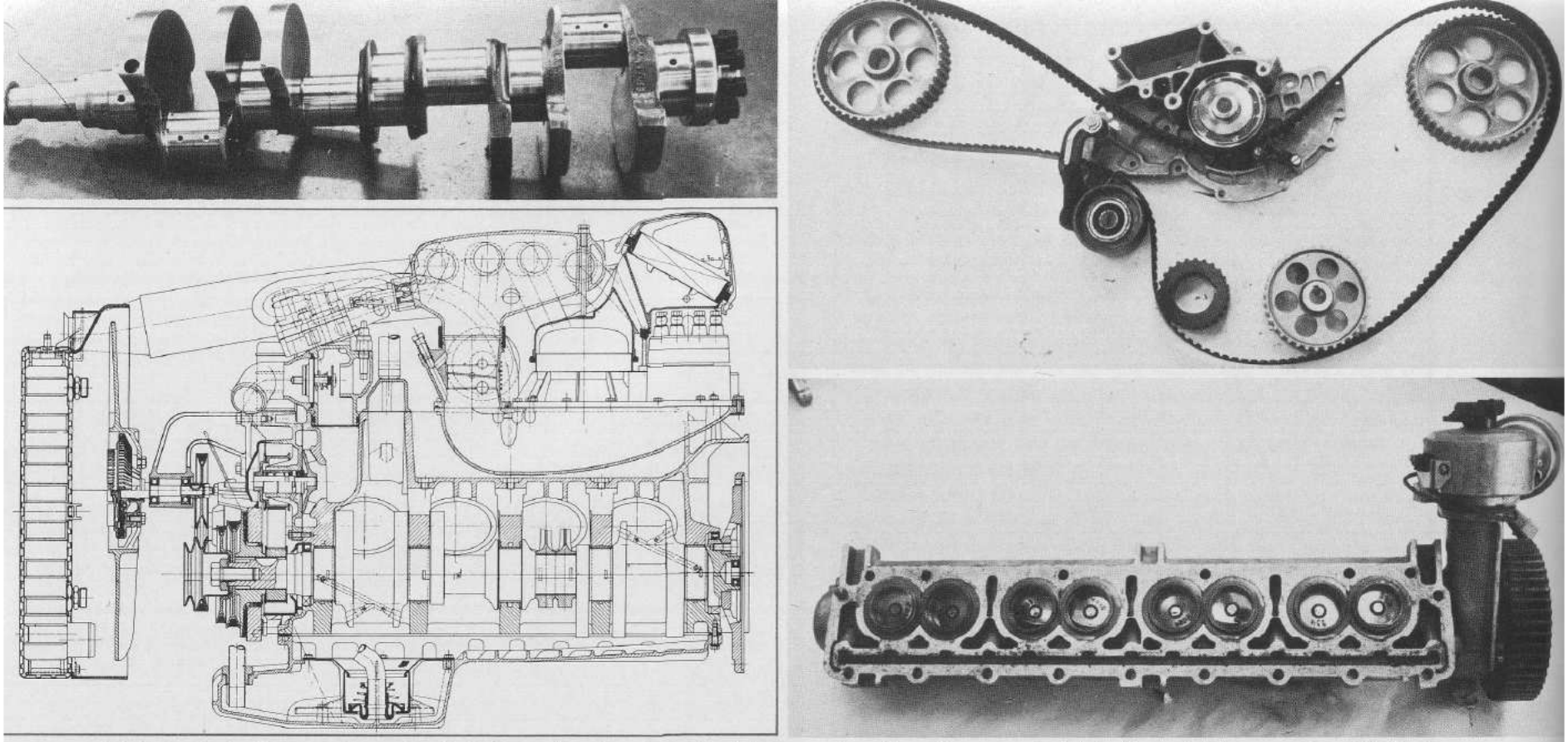




Seen opposite in cross-section and above as installed, the 928 engine was designed expressly for this car. The output curves shown were for European editions.

development, and thus of the 928 as well. In the new Porsche system, design chief Wolfgang Eyb was the project father whose job it was to smooth the 928's way over the corporate rough spots. The man more directly in charge, the project director, was Helmut Flegl, then gaining laurels for his work on the 917. And the design director for the 928 was one of Eyb's design engineers, Wolfhelm Gorrissen. It was a team of experts whose reputations would be enhanced by their association with the 928—as would those of all the men at Weissach.

The basic plan of the 928 was clear enough at the beginning of 1972, but all the details remained to be filled in. None of these was more important than the engine. Unlike the 924, which was called to life several months later, the 928 was to have a pure Porsche power unit. It was to be larger in displacement than the 911 sixes, so it could generate adequate power without having to rev into the noisy high-speed ranges. It also had to have growth potential for future development—though not so much that it would be needlessly heavy. One of the first studies was of a unit just one step removed from the 911: a V-6 of 3.5 liters. Because its vee angle was a relatively narrow sixty degrees, however, the



At left, longitudinal 928 engine section (including radiator) and crankshaft in same orientation. Above, camshaft belt drive and left cam carrier with distributor.

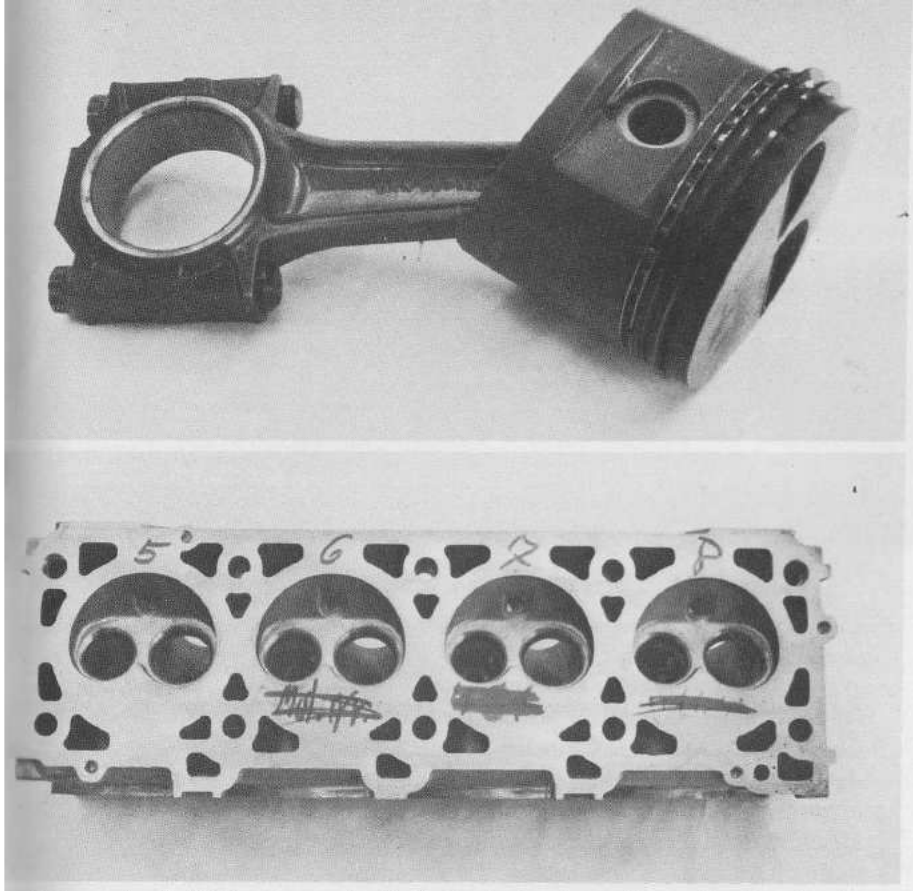
V-6 threatened to be too tall. The Porsche men were very concerned about engine height because they wanted to be sure the new car could give customers the excellent forward vision they had always enjoyed in a Porsche.

For a still larger displacement combined with a lower profile, a ninety-degree V-8 was the final choice. Eights were no strangers to the Porsche drawing boards, and a V-8, the Type 370, had been one of the designs prepared for Cisitalia in 1948. In Porsche's modern frame of reference, however, this liquid-cooled eight was a highly unusual animal. And in designing it the Porsche men showed they would settle for nothing but the most advanced engineering and manufacturing techniques.

It was not Porsche's way to sever links needlessly with its engineering past; the 928 retained such a link with the last 911 engines. Its bore diameter, 95 mm, was the same as that of the three-liter six used in the Carrera RS 3.0 and the Turbo Carrera. This allowed the experience gathered with these engines to be carried over directly to the new eight. The stroke length of 78.9 mm was, however, the longest ever used in any Porsche auto engine. It gave a displacement of 4474 cc, or 273 cubic inches.

Each cylinder of the 928 had a capacity of 559 cc, making it by far the largest cylinder yet used in a Porsche. Runners-up were the 499 cc of the Turbo, the 491 cc of the Carrera 2, and the 448 cc of the 2.7-liter 911S and the 5.4-liter 917. The engine's stroke/bore ratio of 0.83 was also the highest of those engines, showing a trend at Porsche away from short-stroke designs, at least for road cars, and toward a proportion that was more favorable to low emissions. Yet Porsche did not go so far in that direction as the other European eights in the same size class, the Mercedes-Benz 450SE and the Maserati Bora, which had stroke/bore ratios of 0.92 and 0.91 respectively.

To match its stroke, the 928 also had the longest connecting rod, by 10 mm, ever used in a Porsche car. Its center-to-center length was 150 mm. As the engine's geometry was laid out



Piston and rod of 928, at top, and cylinder head, showing wedge combustion chambers.

further, the designers decided to offset the right-hand cylinder bank ahead of the left one by 27 mm, the width of the connecting rod big-end bearing journal. A crankshaft pattern with ninety-degree spacing of the throws was chosen, with two rods running side-by-side on each of the throws. The big-end journal diameter became 52 mm, the same size proven in the 917's engine and adopted for the 911 engines in 1972. The five main bearings, on the other hand, were 70 mm in diameter and 30 mm wide, huge by any previous Porsche standards. This allowed scope for further development of the eight, as did the longitudinal spacing between the cylinder bore centers of 122 mm. Porsche made no secret of the fact that the 928 engine had room for future displacement increases, if they should be needed.

By the valve gear they gave the 928, the designers also indicated a desire to begin this new model's life in a relatively conservative way. Though he had been the author of the Carrera four, Ernst Fuhrmann did not insist that the new engine have the hemispherical combustion chambers and vee-inclined overhead valves of that great powerplant. With the 928's larger displacement, the huge valves that were possible with that layout were not needed to give a high power output. The final valve diameters that were chosen for the 928 were 43 mm for the inlets and 38 mm for the exhausts. This was quite close (inlets of the 928 were one millimeter smaller) to the valve sizes used in the racing Type 771 Porsche eight, which had less than half the 928's displacement and generated twelve percent more power! No clearer illustration could be provided of the trend the 928 represented away from high-revving small engines and toward an increased displacement that did not need to be worked so hard to produce its power.

Since the valves were smaller, they could be placed in line down each cylinder head, alternating between inlets and exhausts along the head. The row of valves was sloped at twenty degrees to the cylinder centerline, so the valve heads would naturally form the roof of a wedge-type combustion chamber, a type of chamber that most American V-8 engines have used since its adoption by Cadillac and Oldsmobile in 1949. Porsche did it differently, however. On all the American engines the valves were sloped toward the center of the vee to bring their stems closer to the pushrod-and-rocker valve gear from the central camshaft. Using overhead cams instead, Porsche was able to slope the 928's valve stems outward to give the basic engine a lower profile and, in the bargain, an unusual and distinctive appearance. This also meant that the spark plugs, which must be placed at the thick end of the wedge chamber, would be found along the inboard edges of the heads instead of outboard, next to the exhaust ports, as they were in American eights.

In such ways did Bott, Eyb, Gorrissen and others, under Fuhrmann, establish the basic architecture of the 928 engine. They also made a fundamental decision of great importance: all the engine's main housings would be made of light alloy. This they considered essential in order to minimize the weight of this relatively large engine. Heads, inlet piping, camshaft carriers, two-piece cylinder block and oil pan were cast of aluminum alloy.

The block was the most daring and ambitious element. For it, the Porsche men eschewed inserted wet or dry ferrous liners, the usual European technique, and instead adopted integral aluminum cylinder walls, cast as part of the block. The idea of running pistons directly in aluminum cylinders was not new to Porsche; as described in Chapter Twenty-Eight, the company began using individual cylinders of this type in the 911 engines in 1974. In their experience with these Alusil-cylinder sixes the Weissach engineers saw nothing to prevent them from using the same

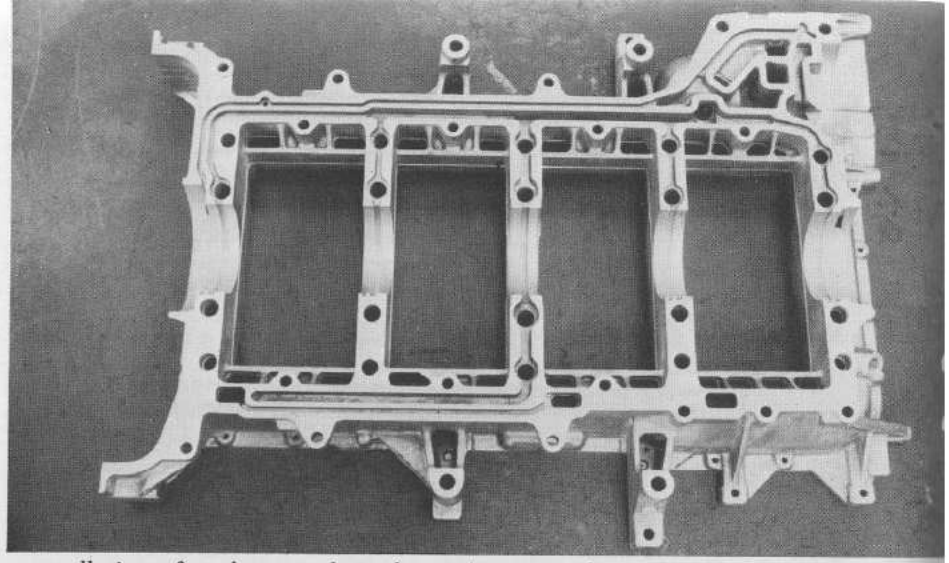
method in the eight.

For the 928, Mahle became the supplier of the low-pressure die-cast cylinder blocks. These were made of Mahle's 147 alloy, which was mainly aluminum with a sixteen-percent silicon content to provide the hard surface that gave the bores their durability. To suit the needs of the casting process the cylinders were free-standing, the top deck of each bank of cylinders being completely open. The block's central vee was clean except for two towers at the very front, which carried cooling water and crankcase vapors. Inserted in each of the five thick main-bearing bulkheads were four studs that were used to attach the "girdle" part of the block, which included the main bearing caps.

This girdle, split from the main part of the block on the crankshaft centerline, was in a sense a throwback from the earliest days of the automobile engine. Then, and even into the 1920's in racing engines, it was not unusual to have the crankshaft carried between the two halves of a split aluminum crankcase. There were no separate main bearing caps as such. This practice was revived in the 1960's by Keith Duckworth in his design of the Ford-Cosworth three-liter V-8, in which he used a one-piece aluminum casting to hold all five main bearings against an aluminum block. Similar methods were used in another aluminum vee engine, the six made by Maserati for the Citroën SM. By embracing the same principle, Porsche was able to continue its record of never having built an engine for its cars that had individual main bearing caps.

In the 928 this lower section of the block was an aluminum die-casting eight centimeters (a little more than three inches) thick. It was attached to the block by both the twenty main-bearing studs and by numerous small cap screws around its perimeter, for its design was made to serve a second purpose. Instead of being long, costly drillings, the main bottom-end oil passages were all cast as recesses in the upper surface of the mating face of the girdle. When the two parts were joined together, and mated by a sealing compound (no gasket), the passages were snugly enclosed.

This method of forming the oil galleries had several advantages. It was, at least potentially, less expensive. It allowed the area of each passageway to be tailored precisely to its duties. In the gallery to the main bearings, for example, the area was reduced just past each offtake to a bearing. And it allowed all the passages to be visually inspected to be sure they were clear before the engine was put together. The method also brought one development problem, however. The joint between the two parts could not be made leakproof until a smaller low-pressure oil gallery was run just outboard of each of the high-pressure



galleries; after that was done the engines were dry.

A cast aluminum oil pan closed off the bottom of the girdle and carried, in a sump beneath the forward two cylinders, six-and-a-half liters of oil. Over its rear portion the pan was extremely shallow, being sloped in order to pass the used oil forward to the sump. As a precaution against leaks that could admit air to the system the oil flowed down into the sump through a screen that was shaped in such a way that all surfaces of the central oil pickup were kept inundated with oil. The floor of the sump had longitudinal ribbing to help hold the oil in place during hard cornering, and a wide, low bell-shaped extension around the base of the pickup assured that it would always be able to inhale whatever oil was present.

The oil pump was a crescent-type design, consisting of an externally toothed gear driving a larger internally toothed ring gear. Such pumps were widely used in automatic transmissions before they were introduced in Chevrolet and Jaguar engines and in the four used in the Porsche 924. Mounted at the left front corner of the engine, the pump had a capacity almost identical to that of the larger Jaguar engine: sixty-five liters per minute at the Porsche's peak-power speed of 5250 rpm.

Other lubrication functions were concentrated at the left front of the 928 block. The full-flow oil filter and pressure-relief valve were mounted there. So were fittings for hoses that took the pressure oil forward to the left header tank of the radiator, which contained a water/oil heat exchanger that served to cool the engine oil. In a manner familiar from earlier Porsches, a thermostatic valve was provided that diverted the oil to the cooler only when it rose above a certain temperature.

Rotation of the oil pump was the job of the cogged rubber belt that drove the 928's camshafts. As in the Chevrolet Vega, the

Upper side of aluminum girdle of 928 engine showed how oil passages were cast in place.

back side of the same belt was used to drive that novel component in a Porsche engine, the water pump. There were two outlets from the pump, one to each cylinder bank. Warm water was drawn out of the engine from the front of each cylinder head, and piped to the right-hand header tank of the crossflow Behr radiator. The system held about sixteen liters of coolant. A six-bladed aluminum fan turned in a shroud behind the radiator. Carried by ball bearings in a bracket hung from the front of the block, the fan was turned by the same vee-belt that drove the emissions air pump. In its hub was an automatic coupling using silicone fluid that engaged the fan when it was needed and held its maximum speed below 3500 rpm in the interest of silent running.

Porsche chose familiar suppliers for key bottom-end components of the 928 eight. The bearing shells were made by Glyco. The center main bearing was flanged to take the thrust loadings, as from the clutch. Crankshafts came from Alfing in Wasseralfingen, steel forgings with six counterweights. A vibration damper was keyed to the crank nose, and the flywheel was attached to its output end by cap screws.

Relatively new to the ranks of vendors to Porsche was the maker of the 928's connecting rods, GKN of England. GKN won the assignment with its method for hot-pressing and sintering parts from steel powder. This system, built—ironically—on technology first perfected in Germany, produced connecting rods of uniform quality with the strength of steel forgings. Because the process could be more closely controlled than forging, the rods came out remarkably close in weight. This meant they could be lighter than forged steel rods because they did not have to carry the extra weight of the tab that was ground away to match forged rods to a uniform weight for proper engine balance.

The full-skirted pistons were cast of aluminum, and carried two compression rings and one oil ring. Their flat crowns were broken only by two recesses for valve head clearance. The wrist pin bore was offset slightly from the center plane of the piston to help equalize skirt and bore wear. Two firms supplied pistons for the 928, each with its own type of coating for the skirt to prevent scuffing against the aluminum-silicon bores during break-in. The Mahle pistons were chrome-plated, and those from Karl Schmidt were iron-coated. Both gave similar wear results. Excellent bore life was expected, which was fortunate, for at the time of introduction of the 928 no method had been developed for the field reboring of the aluminum cylinder surface.

Ten five-and-a-half-inch studs clamped each cylinder head to the block. The heads were permanent-mold aluminum castings, and they were so designed that a single machined casting could be used, interchangeably, for both heads of the V-8, to save on tooling and spare-part stocking costs. Though compact, the head was well-planned with water passages fully surrounding the ports and spark plugs. Sintered inserts were used for the valve seats, and bronze valve guides were provided. Bored the length of each head was an integral manifold for delivery to the exhaust ports of pressure air for emissions control.

Cap-screwed to each head was a one-piece aluminum camshaft carrier that also housed inserted bores in which slid cup-type tappets. The camshafts were cast, and carried in five bearings. Inside each tappet was an astonishingly compact hydraulic valve clearance adjuster, similar to the one introduced in 1976 on the Chevrolet Vega. The use of this lifter, which eliminated the need for periodic valve adjustment, was made possible by the relatively low speed range of the 928 engine.

Each valve was closed by only a single coil spring, progressively wound. Valve lift was 11 and 10 mm respectively for the inlet and exhaust valves. Cam timing, as measured at the point of 1 mm lift for checking purposes, seemed modest but in fact was relatively prolonged as compared to the timing pattern used in post-1974 911S models. The 928's timing was as follows: $8^0/55^0/38^0/2^0$. As with other unsupercharged Porsche engines that used the Bosch K-Jetronic fuel injection, the overlap between the exhaust and inlet phases had to be strictly limited.

For the first time in one of its own engines, Porsche adopted a cogged rubber belt to drive the camshafts. Owing to the wide spacing of the cams, the belt turned out to be 82⅛ inches long, just short of seven feet, the longest such belt ever used in an auto engine. Made by Pirelli, the belt had internal cords of fiberglass. As mentioned, it drove the water and oil pumps as well as the camshafts. A single belt-tensioning jockey pulley was provided, spring-loaded and hydraulically damped. Fiberglass covers kept straying fingers from getting caught in the sprockets. The distributor of the Bosch contactless ignition system was mounted at, and driven from, the front end of the left-hand camshaft.

Unlike any previous Porsche road-car engine, the 928 eight was designed and built from the outset to be fuel-injected. Bosch worked closely with Porsche in the development of a system that would meet the emissions, economy and performance goals set for the new car. For various reasons, this would become the most-changed element of the 928 engine during its natal phase.

In the early stages an experimental Bosch system was used that kept the engine profile extremely low. As part of that plan, the Porsche designers made the central vee of the cylinder block serve as part of the injection system, as a sealed-off plenum

chamber. This technique was employed also with a late low-profile injection layout that used the mechanical K-Jetronic system. With this arrangement, which came close to being used in production, a single outlet left each side of a central plenum chamber and branched out to a four-cylinder manifold.

When the definitive body design for the 928 was prepared, the engineers found there was more room under the hood than they had expected. They took advantage of this in their final induction system for the 928. It had a higher central plenum chamber, from which eight individual cast aluminum pipes curved down to the inlet ports. Their length gave a ram-tuning effect that was highly beneficial to the V-8's torque curve. The fuel injection nozzles were inserted through the bases of the ram pipes.

The Porsche men gave up the idea of using the block itself as a passageway in this final design. Deep in the vee, however, they curved an aluminum duct that carried air down and forward from the injection metering unit and then up through the throttle to the plenum chamber. In the earlier layouts, there had been two separate air cleaners placed next to the camshaft housings. The final design had a single cleaner element athwart the engine room at the very rear. It was fed cool air by two ducts that led back to the cleaner housing from inlets above the radiator.

These components completed the assembly of a power unit that looked both efficient and attractive. The Porsche logotype ran the full length of each camshaft housing, even though it was so positioned that it could not be seen when the engine was installed. And the Porsche emblem was cast into the upper surface of the central plenum chamber. In sum it was an ensemble that amazed with its mechanistic order and individuality when the 928's hood was raised. Porsche stylist Lapine had even specified that the inlet pipework be enameled a glossy white, "so that when the engine room is clean it looks *really* clean!"

As quoted by Porsche, the weight of the engine was not directly comparable with figures given for other V-8's because Porsche, correctly enough, included the weight of the radiator. With that component, and with all the engine accessories, including the air conditioning compressor, the engine weighed 542 pounds. Wet, with oil and water, it scaled 590 pounds. The total weight of the two-part cylinder block and crankcase, all in aluminum, came to 110 pounds. In its dry weight the 928 eight exceeded by only twelve pounds the heft of another 4.5-liter engine Porsche had built eight years earlier, the original twelve for the 917. In fact, if the weight of the 917's big oil cooler were taken into account, the new liquid-cooled eight would be the lighter power unit.

To be sure, the 928 was not producing the power of the 917's Type 912 engine. In fact its initial output was less than half that of the racing twelve of the same displacement. In Europe its maximum power was 240 DIN bhp at 5250 rpm in a power curve that tailed off to 210 bhp at 6200 rpm. The tachometer was red-lined at 6400 rpm and an ignition rev-limiter took effect at about 6600. A peak torque of 268 pound-feet (37 mkg) was reached at 3600 rpm. In low-emissions markets, such as America and Japan, the addition of catalyst packs in the exhaust pipes reduced the peak power to 225 SAE net horsepower. As with the 911, the output of the 928 was tailored at the beginning of the car's career to the highest power reached by its predecessor. From that level it was expected to keep right on rising in subsequent years.

Porsche used a Mercedes-Benz 350SLC to test the early 928 engines on the road and, when it was available, the car's complete transaxle system. As in the 924, the transmission was at the rear of the car, in unit with the final drive, and was connected to the engine by a steel tube around the drive shaft. Four mounts, two at the engine and two at the transaxle, carried the whole assembly. But in detail the 928 was quite unlike the 924.

The most important difference was that the transmission was mounted ahead of the final drive in the 928, instead of behind it. The latter placement had been best for the 924 to make use of the available transaxle assemblies, but no such compromise was needed in the 928, for which a new gearbox was designed. Keeping the gearbox within the wheelbase was a lighter-weight solution, and allowed the space in the rear of the car to be used more efficiently. It also had the advantage of permitting the use of a quieter direct-drive top gear.

This transaxle layout resembled even more closely than the 924 the one used in production by Ferrari since 1965. First with the 275 GTB and GTS, then with the 330 GTC and finally with the 365 GTB/4 and the Daytona, Ferrari used a transmission placed ahead of the rear axle and connected to the engine's bell housing by a tube. In the Ferrari, the drive entered the transmission on a lower shaft and was taken to an upper shaft through pairs of gears for all forward speeds. All the gears were thus indirect, as they had also been in all Porsches hitherto, including the 924.

Porsche adopted a new solution for the 928. It was given a transmission more like that of a normal front-engine, rear-drive car, moved to the rear of the chassis. The drive from the clutch entered it on the mainshaft level, from which the pinion and ring gear were also driven. Below the mainshaft was a countershaft that came into use for the lower four forward gears and reverse. For top gear, the torque was taken straight through the mainshaft, a direct drive. This lessening of the number of gears through which the power had to be transferred gave the promise

of quieter running.

The direct-drive top was reflected in the gear ratios, which were as follows:

Fifth	1.000
Fourth	1.343
Third	1.819
Second	2.466
First	3.601

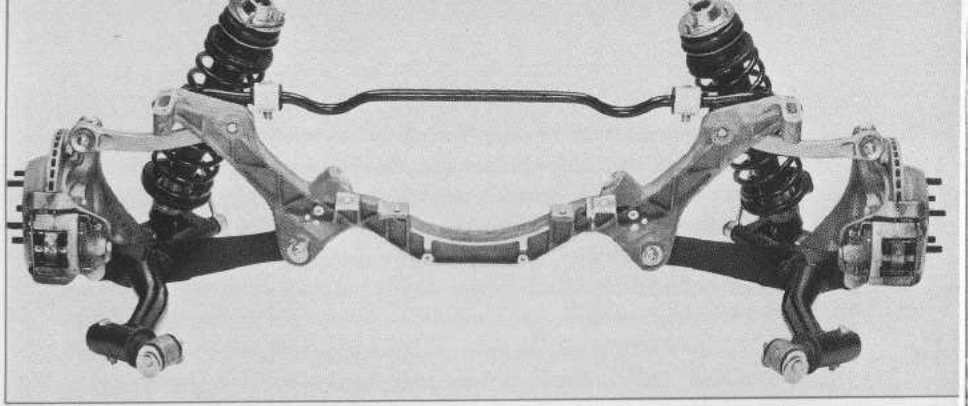
The final drive ratio was 2.750 to one. No limited-slip differential was provided as standard, the engineers having concluded that the car did not require one. Porsche synchromesh was used for all five forward speeds, and a ribbed aluminum housing with removable covers at its top and rear contained the coggery.

One of the most controversial features of the Porsche 928 was its shift pattern. It reverted to an earlier Zuffenhausen layout, with first gear off to the left and back and the top four ratios in the main H-pattern. The shift lever was spring-loaded out of the first-reverse section on the left, but was otherwise free to move. This pattern was one that Porsche had given up for the 911 because it was less convenient for town driving, since the driver had to leave the main "H" whenever he needed to start from rest in first gear. Certainly, the 928 was a car conceived to be at home in city traffic as well as on the highway; many, especially in America, questioned the change in shift pattern policy.

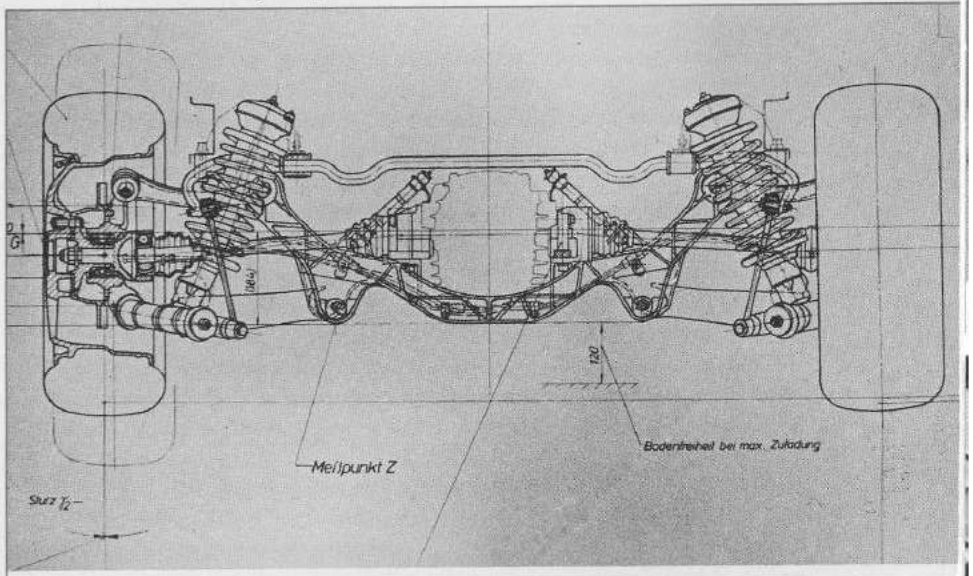
The Porsche men replied that the 928 had so much torque it was seldom necessary to shift into first. "You use first gear when you leave home in the morning," said Ernst Fuhrmann, "and then you don't need it again!" But Fuhrmann also admitted that the shift pattern topic was as controversial inside Porsche as it was outside: "We have two groups. One argues for what it wants, and gets it, and then the other one starts crying. It's a fifty-fifty situation." This time, the victory went to the engineers who preferred the ease in shifting up and down between fourth and fifth that was conferred by the 928 layout.

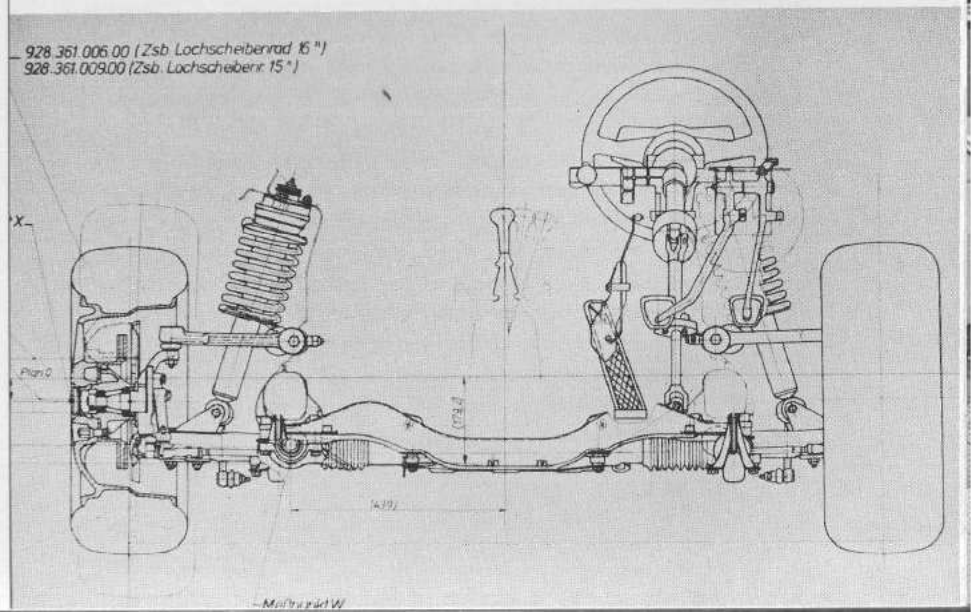
Those who wished to avoid the whole issue were able to order the 928 with a fully-automatic transmission. This was a Daimler-Benz unit, with a torque converter and three automatically shifted forward speeds. The complete transmission was mounted ahead of the final drive, in the same location as the manual gearbox. The large diameter of the torque converter required that a different underbody be used, with a more prominent bulge at the forward portion of the console between the rear seats.

When the automatic transmission was fitted, the bell housing at the engine contained a ring gear for the starter, but no clutch. Manual-shift 928's had a special Fichtel & Sachs clutch only 7⅞



Rear suspension is seen from front, above, and rear, below. Front suspension, at bottom.





inches (200 mm) in diameter, with dual driven discs. A pedal travel of some six inches controlled the clutch through a hydraulic system, and a helper spring was provided that limited the maximum clutch pressure to thirty-three pounds. The small clutch diameter helped lower the engine of the 928, hence the car's center of gravity, and also contributed to a lower rotating inertia in the drive shaft to the transmission.

The solid steel drive shaft from the clutch to the transaxle of the 928 was 25 mm in diameter, about one inch, and was carried (in manual-shift models) in two intermediate support bearings. It was encased in the steel tube that joined engine and transmission together; the tube had a 3 mm wall thickness and a diameter of 10 cm, about four inches.

To assure the least transmission of noise and vibration from this power train to the body, it was essential to position the two pairs of mounts at the nodal points of the complete assembly, those points which remained at rest when the whole system resonated. This was easy enough to do at the front, but it caused problems at the rear, since the mounts would have had to be placed well forward along the transaxle where they would have cut down on the seating space available in the rear. Ideally, that nodal point had to be shifted more to the rear. But how was that to be accomplished?

The solution was to make the heavy battery a part of this suspended power pack. A battery box was cantilevered from the rear of the transaxle housing, to hold a sixty-six-ampere-hour battery placed longitudinally. Its mass was enough to move the nodal point rearward so the mounts could be put just forward of the drive shafts, right where the engineers wanted them. But would the battery—admittedly a special long-life type—like being attached to the engine and gearbox? That was what the Weissach engineers asked their supplier.

"What kind of forces is it subjected to?" rejoined the battery maker.

"About three g.'s," said the Porsche man.

"Oh, you don't have anything to worry about," came the reply. "We use that same battery with no trouble at all in a military vehicle in which it takes eleven g.'s!"

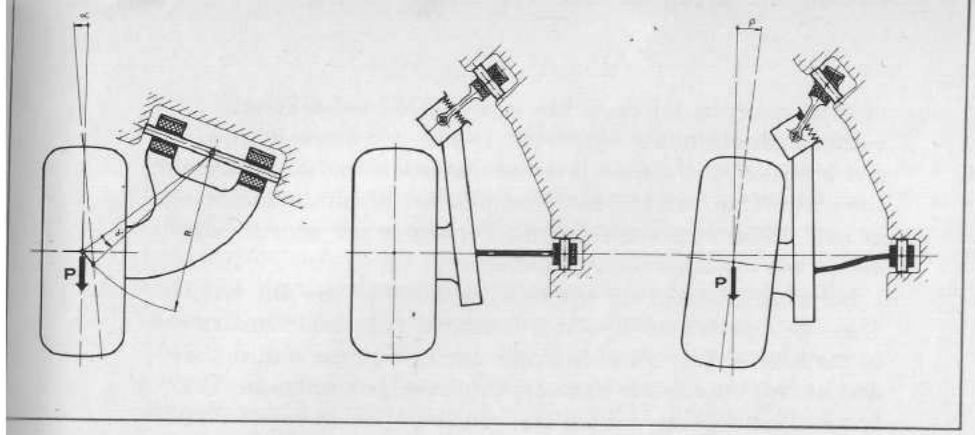
At each of the four rubber mounts a small hydraulic shock absorber was added, in a sea-legged position. These shocks helped the engine-transaxle mass serve as a damper for the movements of the body. Confirmation of the need for these came from Porsche's investigation of the "freeway hop" ride phenomenon that had been so annoying in the 924. Special surveys made of the concrete California roadways that most provoked the problem showed that the slabs tended to dip at their centers. The measurements were sent to Germany, where, the engineers reported, they found a comparable stretch of road near Innsbruck, Austria. They discovered it because it caused exactly the same "freeway hop" as the California highways! Their subsequent analysis showed that wheelbase length was a critical factor in the excitation of this unpleasant ride motion, and that the hydraulic dampers served to suppress it in the 928.

At the rear, the drive train was completed by individual axles to the wheels. Each axle shaft was carried between two constant-velocity universal joints that also provided for changes in the overall shaft length, so that no separate splined sections for that purpose were required. Each rear wheel was carried by a close-spaced double-row ball bearing, at its hub. The bearing in turn was nested in a compact cast aluminum rear upright.

To the extent possible, aluminum was used in the suspension of the 928. Ernst Fuhrmann's men were well satisfied with the high rigidity and resistance to corrosion, in addition to lightness, that aluminum had displayed in the rear "bananas" of the 911. Also, the traditional Porsche torsion bars were replaced, as they had been years earlier on the racers, by coil springs concentric with the shock absorbers. Produced in larger and larger volumes in West Germany to suit many cars, coil springs had achieved a cost advantage that could not be ignored. Also, mounted on the Boge tubular shocks, they were well suited to the geometry of the 928's suspension.

In their search for optimum wheel control for the 928, the Porsche engineers rejected the more limiting or imperfect strut and swing-axle suspensions. Instead they turned to the parallel-wishbone layouts they had been perfecting in racing since the days of the Types 804 and 904. In the first experimental 928's, the wishbones were of pure parallel-axis type at both front and rear. During development the layout at the rear was changed, but that at the front remained much the same throughout the 928's gestation.

The lower front wishbone was a hollow aluminum casting that curved back, from two robust frame pivots, and outward to the lower ball joint set deep inside the wheel. Its position allowed the steering pivot axis to be sloped so that it contacted the ground outboard of the center of the tire patch. This gave the front wheels a negative scrub radius, which helped stabilize the steering when the traction forces of the front tires differed from one side of the chassis to the other. At the top was an open-legged wishbone, also of aluminum, through which the shock absorber passed. As seen in profile, the axes of both wishbones sloped downward gently toward the front. This gave an anti-dive reaction under braking that was thirty percent effective. The front-wheel



Compared to conventional trailing-arm rear suspension, left, which allows toe-out, Weissach suspension's action, exaggerated in two right views, prevents toe-out.

camber angle was one-third degree negative, and the caster angle was three-and-one-fifth degrees.

Placed low behind the front suspension was the ZF rack and pinion steering gear. With a ratio of 17.75 to one, it required three-and-one-fifth turns from lock to lock. These turns were made easier by a built-in power boost system, pressurized by an engine-driven ZF hydraulic pump. Built into the pump was a self-regulating throttle that reduced the steering assistance as the engine speed rose. At 1500 rpm, the maximum amount of aid to the driver was delivered. At 4000 rpm and above, the boost dropped to about half its highest value so the steering feel would be firmer, more positive. In the steering column, which curved downward sharply before it connected to the pinion, there were two universal joints.

In its original layout, the rear suspension had a very wide-based lower wishbone and a simple lateral link at the top of the hub carrier. The 928's developers were not happy, however, with the way the early test cars behaved with this geometry. When the pivot bushings at the frame were soft enough to give good noise and shock isolation from the movements of the wheels, they allowed undesirable steering effects. When the car was on the overrun or being braked, the wheel tended to lag behind and, when it did so, to toe or steer outward. That meant that if the car happened to be turning, the rear wheel's movement made it suddenly turn more sharply. The Porsche engineers linked this unwanted response to statistics that showed that more accidents were caused by cars running off the inside of highway turns than off the outer edge, thus hinting that chassis steering effects were more at fault, in these cases, than lack of sheer road adhesion.

The solution that was developed for the 928 was credited to one of Porsche's advanced research engineers, Dr. Hans Braess. If the forward pivot of the rear wishbone could be made to pull itself inward under those overrun conditions, he reasoned, a compensating effect would be created that would suppress the toe-out. Braess developed a means of doing this that Wolfhelm Gorrissen brought to its final simpler form.

To help him prepare the production design, Gorrissen needed to know how much and how quickly the rear-wheel steering correction should be applied. This was investigated by Peter Falk's vehicle test department with the help of an unique modified Opel. It was Opel's biggest car, an Admiral four-door sedan. A full sedan was used because it had a modified rear suspension with its own steering system, complete with track rods, steering gear, and a column and wheel positioned for a rear-seat passenger. With this two-man test car, Falk's team found out by experiment how large and how fast the rear-wheel corrections had to be to keep the 928 on track. "Finally," said Helmuth Bott, the Opel "could be driven like a sports car."

Because so many members of the Porsche team had contributed to its design, the new rear system was not named for any one of them but was simply called the Weissach suspension. It kept a parallel motion with a single upper link and a two-legged lower wishbone. The lower arm's pivot axis was angled at about twenty-five degrees to the car's longitudinal axis; the arm's pivot joint to the rear hub carrier was at the same angle so there would be no rear toe-steer effect from that source. Built in at the forward leg of each lower wishbone was a short link that made the final connection to the frame pivot. This link was hinged to the wishbone, so there could be relative movement, and it was carried in a rubber sleeve, which controlled that movement.

The effect was simple and sufficient. When a rear wheel was trying to lag behind the car, from braking or drive-train drag, the tugging on the forward leg of its wishbone caused that link to swing slightly and tug the arm inward toward the car's centerline. The movement was just enough to maintain the normal rear-wheel toe setting, even though the bushing at the forward frame pivot was flexing toward toe-out.

Though they were quite small, these motions had to be accommodated by the rearward leg of the lower wishbone. The testers found that the rubber bushing on that leg's pivot did not allow enough flexibility, so they had to find a different solution. It was to make the rearward arm a flat steel blade. This was rigid laterally, to take side thrusts, but flexible in a fore-and-aft direction. Since this had to be welded as part of the complete wishbone, that whole component had to be made of steel—to the engineers' regret—in place of aluminum.

The coil/shock unit was attached to a rearward extension of that lower wishbone. The same point provided a connection to

the links to the rear anti-roll bar, which was 21 mm in diameter. The static camber setting of the rear wheels was a negative one-half degree. A front anti-roll bar was also provided, 26 mm in diameter. The mounts for two of the three rear suspension pivots and also for the transaxle were carried by a ribbed aluminum casting that curved under the transaxle. It and the suspension members themselves were so positioned that fifty percent suppression of tail lift on braking was provided, plus sixty percent resistance to tail squat on acceleration.

Pirelli's low-profile P7 tires, used so successfully on the Turbo, were the basic building blocks for the chassis of the 928. The size chosen was 225/50 VR 16, the same as was fitted to the rear wheels of the Turbo. This called for a special sixteen-inch wheel with six-inch rims for the front wheels and seven-inch for the rear. The original wheel design, as used on the first 928 prototypes, had a bold five-spoked star motif. For the final production car this was changed to a wheel with smoother contours, to match the car's lines, with five oval holes.

The wheels were made by Stahlschmitt, cast of a high-silicon aluminum alloy. Asked by the editors of *Panorama* why forged wheels, like those on some 911's, were not chosen, Ernst Fuhrmann said, "That is simply a matter of price. The forged wheels are much more expensive, and one uses this material only if there is a need. The cast wheels are strong enough." Price was to be a factor too for those 928 owners who heeded Porsche's recommendation to use 185/70 SR 15 tires for winter driving, to give a higher road surface pressure that would cut through snow and slush. They had to have a complete set of fifteen-inch wheels as well! These were available from Porsche in the same five-hole design and the same two rim widths.

Good integration of polyurethane bumpers with body was achieved in 928 design.

Buried deep within the wheels were the 928's Ate disc brakes. These used ventilated discs that measured 11.1 inches in diameter in the front and 11.4 inches in the rear, where the hub of the disc housed the familiar drum-type Porsche parking brake. The brake calipers, placed behind the front hubs and ahead of the rear ones, had but a single piston on the inboard side and had caliper frames that could slide laterally to grip the disc. This sliding-caliper brake had been adopted because it was more compact, and also because Porsche's tests had shown that the type of caliper with pistons on both sides often suffered overheating and boiling of the brake fluid at the point where a hydraulic line passed over the caliper bridge to the outboard piston. The change to the sliding-caliper brake cut the peak fluid temperature to 90° C. and eliminated any chance of vapor lock in the line for that reason.

A problem with brake squeal during development was overcome by the insertion of a sound-damping layer of heat-resistant plastic under the Jurid brake lining pads. A vacuum-operated servo gave the brakes a power boost, and the dual-circuit hydraulic system was divided diagonally so that each circuit served one front and one rear wheel on opposite sides of the car. In each 928 there were thirty-three feet of brake piping of a seamless copper-nickel alloy supplied by Yorkshire Imperial Metals of Great Britain. It was expected to eliminate corrosion as a hazard to the braking system over the full life of the 928.

Porsche's all-out war on corrosion was waged throughout the rest of the 928, especially in its body. But before cars with the final body design were built, these chassis components were tested in many other ways, beginning when the first experimental components became available in 1973. The engine and drive train were wrung out in the aforementioned Mercedes-Benz 350SLC and also in a sort of "breadboard" car that carried the power train in a square-tube steel frame and served mainly for durability tests on the chassis dynamometer.

A seldom-seen Audi model, the 100 coupe, was used as the Trojan horse to conceal early tests on the highway of the complete 928 chassis. Of these Audis, suspicious-looking with their five-spoke wheels and flared wheel openings, three were made and tested. By early 1974, the engineers had the first hand-made prototypes that resembled the final 928. These were disguised in several ways. Some had grafted-on front fender

extensions that made them look a lot like a 911. Others went out on the public roads with square-backed canvas jackets that were flagrantly conspicuous but completely disguised the car's true lines. Not until 1975 did alert photographers spot, on test on the highway, a completely naked 928 of the near-final design.

As for the style of the 928, this evolved during 1972 and by early 1973 had reached the point where the basic shape was that of the Porsche the public finally saw. Its form, created under Anatole Lapine's direction, was distinctively and indisputably Porsche. This was so because Lapine had used the rounded surfaces and flush, aerodynamic contours that the world has come to associate with the cars from Zuffenhausen.

It was understood from the start that the new car would have somewhat more room inside than the 911. "We came from the 356," said Lapine, "and then we had the 911, a little larger inside. We felt that the 928 had better have some improvements along those lines too." Its interior space "package" was made just four-and-a-half inches longer than that of the 911, enough to squeeze in rear seats that were worthy of the name, but not so roomy that anyone could accuse Porsche of building a sedan. That was a field that Porsche ("Shoemaker, stick to your last") still preferred to leave to the larger car makers.

Another "given" of the 928's style, as far as Tony Lapine was concerned, was its downcurving hood line. "It definitely had to have a Porsche hood," he said, "smooth and not cluttered up." Also, there would be no obvious or prominent grille for the front-mounted radiator. "With a Porsche you do *not* dominate with radiator openings," Lapine continued. "I think we've had 904's and 917's that had more of a front-engined look, with their radiators, than the 928." Thus the air inlet became a panel of louvers hidden below the front bumper.

Early in the styling process Lapine and his designers also arrived at the heavy forward-sloping B pillar, the one at the rear of the door, that was such a distinctive element of the 928's profile. Even the slope of the pillar was the result of rational analysis rather than a stylist's whim. It was broad and angled in that manner because that pattern formed, with the A pillars at the windshield, the strongest possible roof structure. Further, Tony Lapine explained, "We had a chance to analyze the door and pillar situation. It was evident that the last triangle of the 911's door window is of no value from the standpoints of entry ease or rear vision." The Porsche designers knew with certainty that they could slope the B pillar that way without impairing the door's function.

As for the roof and rear of the 928, Lapine said: "We knew it would definitely be a fastbacky coupe." A hatchback rear window also seemed to be a good solution. Several variations on these themes were tried in scale model form, some of them approaching station wagon proportions, but a clean, unbroken fastback remained the favored shape. In early clay models, also, the body sides enclosed the rear wheels more than they did in the final design. Wind tunnel tests showed that the chosen 928 contours gave a drag coefficient about the same as that of the 911. Since the new car was wider, with a larger frontal area, this meant that its total aerodynamic drag was higher than the 911's. It was impressively free of lift, however; at its maxiumum speed of 140+ mph the lift at either end was no more than sixty pounds.

On one part of the car, the hood, the Porsche stylists tried challenging the premise that the 928's lines should be smooth. They studied the visual effect of decorative concave areas. They tried a raised vent along each side of the hood; the early prototypes had this design accent. In the production shape there was no such accent; the surface of the hood was unbroken. This made it all the more essential that the long hood panel was fitted perfectly, as any misalignment was instantly visible.

Set flush with the hood surface were the retracted headlights, which were placed there deliberately as the only styling accent. They were reminiscent of the lights of the Lamborghini Miura and, even more significantly, of those used on the fiberglass-bodied racing roadsters that were built on 904 chassis in 1965. Those lights had to be swung up into place by tugging on a tab. In the 928 this job was done by an electric motor turning a cross-shaft that controlled both lights. It needed to swing them through an angle of sixty degrees to bring them into position, which, according to the Porsche engineers, was one of the smallest possible movement angles with such a system.

An added subtlety was a control knob on the floor, on the left of the driver's seat, that fine-tuned the vertical aiming of the headlights. This was used to compensate for changes in the car's trim caused by different loading conditions. In the 928, unlike the 911, a heavy load in the luggage area could cause the beams to rise and dazzle oncoming drivers. In the European models the flip-up lights, with their teardrop-shaped housings and specially styled lenses, were used only for the low beams. Rectangular lamps that generated the high beams were set into the front bumper, and were also used for signal flashing on the highway. Next to them were built-in fog lights.

One of the advantages cited for the aesthetically debatable exposed position of the lenses of the pivoted lights was that they would always be cleaned whenever the car was washed. In addition, Porsche provided spray-cleaning nozzles for the lights, mounted atop the front bumper. A clever new system to support

this was developed. The 928 carried a main two-gallon water reservoir for screen and lamp cleaning. Linked to the system was a separate reservoir holding twenty ounces of a cleaning solvent. When the driver demanded cleaning, the system automatically mixed the solvent in the correct proportions with the water being sprayed on the windshield, which most needed the solvent's help, but aimed only plain water (or water/alcohol mix in winter) at the headlights. Always a pioneer of new windshield and lamp cleaning methods, Porsche took another step ahead with this arrangement.

The bumpers, which were so well integrated with the body that they were scarcely seen as separate elements, also used technology that was new to Porsche. At first they were not to be blended in so well. Early full-scale models of the 928 showed bumpers with more of a gap between them and the body, looking more like those of the 924. Finally, however, working with technology developed by the Phoenix Gummiwerke of Hanover, flexible polyurethane plastic bumpers were perfected that could be joined directly to the main body surfaces. An elastic paint allowed them to be the same color as the rest of the body, and resisted cracking when the bumper was deeply deformed.

The structural backing for each bumper was a deep U-section aluminum bar. In markets outside the United States, these bars were joined to the body by replaceable supports which deformed permanently when they were impacted. Nine-twenty-eights for America used self-restoring hydraulic energy-absorbing struts instead. With a three-inch travel, these allowed the bumpers to revive unscathed from barrier impacts at speeds up to five miles per hour. Indeed, the front bumper suffered only minor damage when a 928 was driven, as a test, into a parked car at 17 mph. To meet American requirements, bumpers molded for that country had additional overriders built in next to the rear license plate.

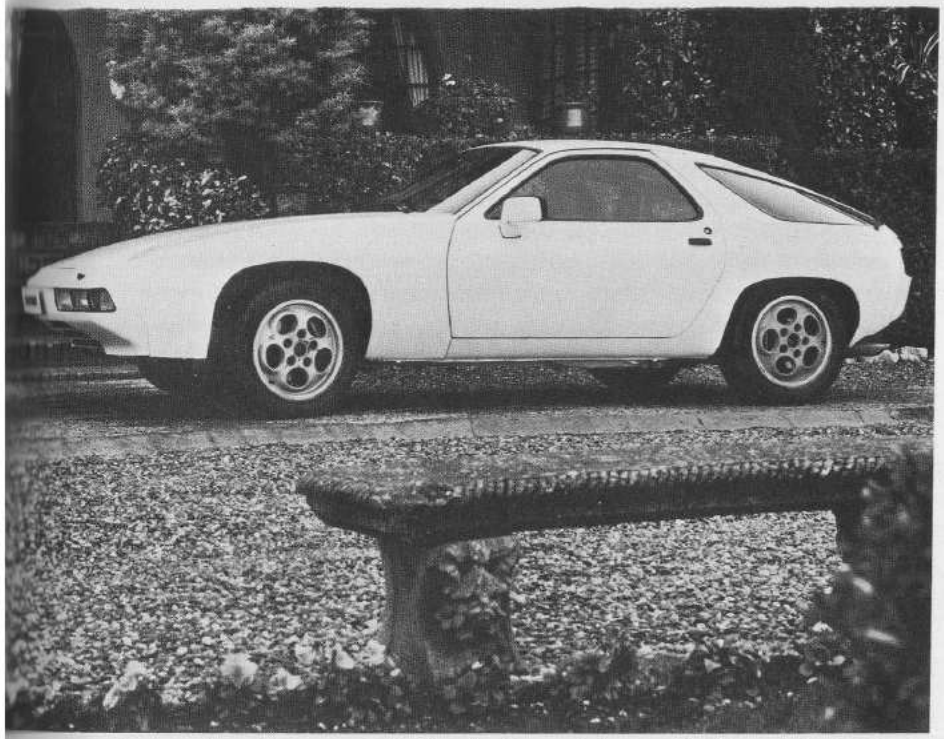
Bumper impacts were transmitted to the 928's frame, a structure integral with the body as it had been in all Porsche production cars. The main structure, which included the floor pan, cowl, roof and rear fenders, was made of the Thyssen-process galvanized steel that allowed Porsche to warrant it against rust for six years in Europe. For both lightness and corrosion resistance, aluminum sheet was chosen for the hood, the doors and the bolted-on front fenders. With these parts in addition to the suspension, engine and drive line uses, the 928 became a textbook in the modern applications of aluminum in auto design. The torsional stiffness of the 928 body-frame was about the same as that of the 911. The 928's very high rear bumper panel gave the car's designers no choice but to fit a large hatch, including the rear window, for access to the open luggage area. Desirable though it might have been, an enclosed trunk could not be made part of the original design. An option for the rear window was a parallel-action wiper. Its motor was mounted in the lower sill, with a shaft that engaged the wiper arm, pivoting from the hatch, through a dog clutch. Two heat levels could be chosen for the rear window's electric defrosting.

Under the hatch was a carpeted luggage area that could be extended forward by folding down the individual backs of the rear seats. Tools were stowed in containers along the rear wall of the luggage bay. Under its floor was the 22.7-U.S.-gallon fuel tank, which was made of molded plastic. Any chance of vapor lock in the fuel lines, even in the Middle Eastern markets that were expected to buy lots of 928's, was nullified by the use of two Bosch fuel pumps, one under the tank and the other in the front of the right rear fender. Set snugly into a form-fitting hole in the left side of the rear-deck floor was a space-saver spare, with the electric compressor and tire-changing tools. Beneath the spare was a lid that gave access to the battery, which itself had an additional cover that had to be removed.

Pull-out handles opened the 928's wide doors. When the driver's door was unlocked, a vacuum system automatically unlocked the other door too. In a subtle and thoughful touch, the rubber seal around the door was placed at its outer edge so it would keep the sill and the adjacent surfaces from getting dirty. Entry and exit conditions were the best yet in any Porsche.

Both the seats and the steering wheel of the 928 struck a familiar note to those who had driven 911's. The three-spoke wheel in particular provided a welcome tactile and visual link to an earlier generation of Porsches. It was not done so deliberately, said Tony Lapine: "It was there all along, and it still looked right, so we used it." Be that as it may, it was a reassurance to the 928 driver that he would find in it the same integrity of design he had come to appreciate in previous Porsche cars.

Adjustments for leg length and back angle were standard in the 928 seats, and an option was electric seat movement and height adjustment. Though they were not quickly changeable, the gear shift lever, the pedals and the footrest for the driver could be reset in the workshop to accommodate different-sized drivers. And in a most clever and useful innovation, the Porsche designers arranged for the steering wheel to be adjustable in height, and for the complete instrument binnacle to go up and down with it. This assured that the dials would always be perfectly visible through the wheel, and that the minor switches and controls, which were on the sides of the binnacle, would remain in their designed relationship to the wheel. A clamp under the column was loosened to allow the change in wheel position.



Structural needs were satisfied by the forward-sloping B pillar of the 928 body.

Four white-on-black dials were aimed toward the driver inside a cove so deep that instrument lighting came close to being a necessity under some daytime driving conditions. Tachometer and speedometer were at the center, between combination dials for water temperature and fuel level, on the left, and for battery voltage and oil pressure. A warning light came on, either steadily or flashing, to tell the driver something was awry and to draw his attention to an illuminated warning on the center console that gave him detailed information on the malfunction. The flashing light, which could only be extinguished by solving the problem, warned of mortal defects like a low oil level or pressure, or low brake fluid level or pressure. The console also carried the clock, the standard-equipment radio, and the heater controls. Temperature regulation was by an air-mixing system, and the blower was in operation in all five of its switch positions.

The Weissach planners made the 928 a wider car, and took full advantage of that width to give it a passenger compartment that seemed and was spacious. The main dash panel sloped up and away from the occupants toward the base of the windshield, and a wide glove box was provided in front of the passenger. Since the transmission was in the rear, the foot wells could be made very wide, enhancing the feeling of roominess and allowing the pedals to be spaced wide apart. The main electrical components—relays, fuses, and connectors—were behind a panel at the bottom of the passenger's foot well. An electrically-operated sunroof was optional, and sunvisors for the rear-seat passengers were standard.

Its greater width and its longer wheelbase were the new Porsche's most striking features when it was compared with its contemporaries, as this chart indicates:

SPECIFICATIONS

	1978 PORSCHE 928	1977 PORSCHE 911S	1977 PORSCHE 924	1977 CHEVROLET CORVETTE
Wheelbase, inches	98.4	89.4	94.5	98.0
Front track, inches	60.8	53.6	55.9	58.7
Rear track, inches	59.6	52.8	54.0	59.5
Overall length, inches	175.1	168.9	170.1	185.2
Overall width, inches	72.3	63.4	66.3	69.0
Overall height, inches	51.7	52.0	50.0	48.0
Curb weight, pounds	3197	2558	2447	3534

It was a measure of the attention given the weight of the Porsche that it was 337 pounds lighter than the Corvette, which it closely resembled in track, wheelbase and power output and even exceeded in width. Needless to say, the Porsche offered passenger and luggage space that was far superior to that provided by the Corvette. As the designers had intended, the weight of the 928 was evenly distributed between its front and rear pairs of wheels.

"We have no intention whatsoever of producing a big Porsche." Thus spoke Huschke von Hanstein to a reporter at the Geneva Salon in 1969, when the 4.5-liter racing 917 was introduced. It was true then. The idea of building a road Porsche with an engine that big was not even contemplated. Conditions changed so rapidly in the world of sports cars, however, that only eight years later, at Geneva, Porsche was showing a road car with an engine just that size.

In 1977 the press day at Geneva was March 16th, and on the following day the public poured into the halls to see the new Porsche for the first time. It was by far the most important premiere that March. Several 928's were on the floor. A white one had a red interior, and a red one, on a sloping plinth, was saddle tan from its dash to its trunk. The car's price in Germany had been announced then, DM 55,000 or $22,917, with either transmission, and it had not occasioned great alarm. In fact it

seemed well matched to the 928's level of performance, equipment and finish.

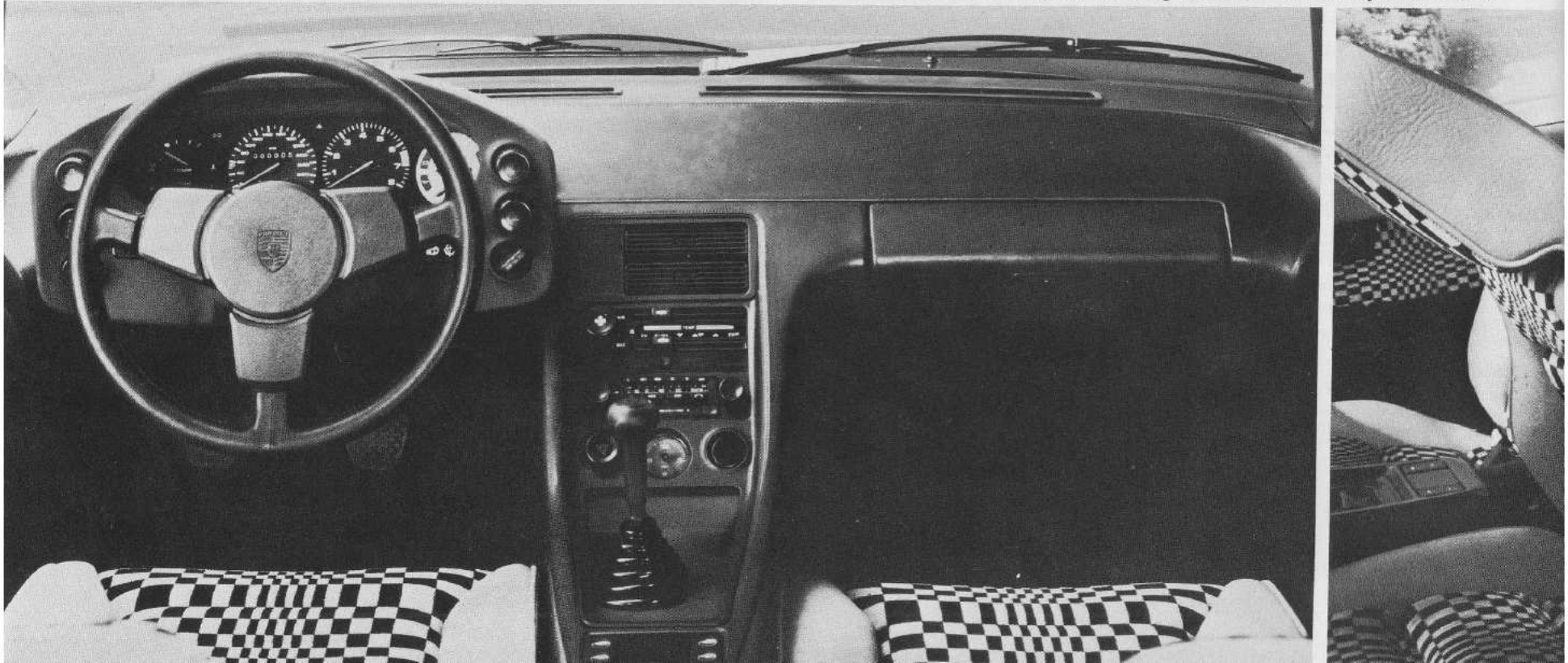
The 928 had covered many thousands of miles on its final journey to Geneva. In 1976, the 928 prototypes had taken on their final appearance, with the production wheels and trim. That year they were tested in the Algerian desert, where the drivers were able to run the coupes flat-out for periods of thirty to forty minutes at temperatures approaching 110° F. "There's probably no other place in the world where we can drive so fast at such high temperatures," Helmuth Bott told Clauspeter Becker of *auto motor und sport*. Then in January 1977, they went to the opposite extreme, to the 20° F. below zero of the Arctic Circle in Finland, to be sure the cars would start, run and heat properly. On that trip Ernst Fuhrmann, anything but an armchair manager, was a member of the test team.

The team's next task was to build ten test cars for the journalists who had been summoned by Manfred Jantke from all corners of the globe to southern France to try out the 928 in concentrated sessions beginning on February 23rd. Since production had not yet started, many provisional pieces had to be used in those cars, especially in their interiors. The rush to get them finished was reminiscent of the readying of the first 917's for their homologation review. Finally, though, the cars were completed—the day before the tests began.

New and untested though these 928's were, they made a profound impression on the press. Tony Curtis of *Motor* wrote that "it handles magnificently," adding: "There is a sense, indeed, in which the 928 has no handling at all: it simply goes round corners where the driver wants it to go without effort or fuss." Reported the author: "The steering is not so precise and direct as a 911's—what car's is?—but it is almost that good. Only a slight numbness hints at its power assist. It controls road handling that's the definition of neutral. It's so predictable that you simply track it through turns faster and faster until, near the limit, the front tires shudder a warning and the rear rubber gently, controllably slackens its grip on the road."

As to the 928's absolute grip on the pavement in corners, without giving specific data the Porsche engineers said that the 928 was faster around their skid pad than the Type 930 Turbo. Their preliminary tests also showed it was equal to the Turbo or even faster through the slalom test and around the Can-Am Track—even though the Porsche test drivers were expert at

Familiar Porsche three-spoke wheel was a reassuring element in the panel of the all-new 928. Instrument group moved up and down with the adjustable wheel.

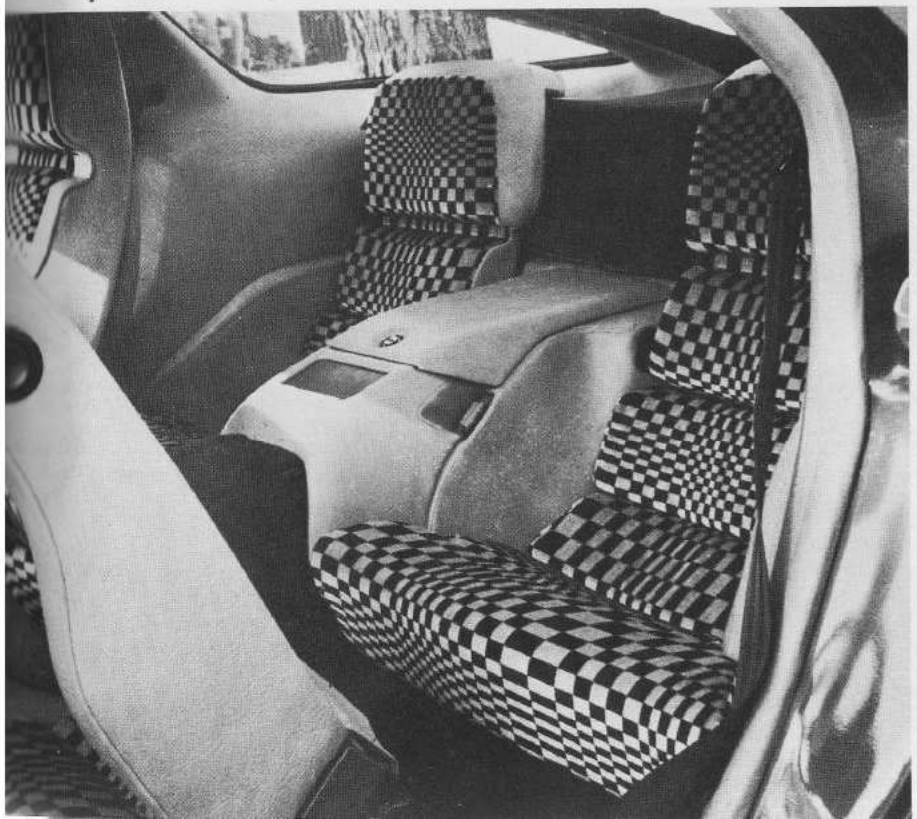


extracting the best performance from the relatively tricky Turbo. That was a sign that the 928 would easily be the faster car through turns in the hands of the mere mortals who would comprise the majority of its owners.

"As might be expected from a car of this breeding," said Curtis, "the brakes proved powerful and reassuring and did not show a trace of fade during the fastest mountain descents we tried." And the author commented: "The engine is stunningly versatile. It is capable of paving the road in strips of rubber in first gear, yet it is so quiet that it's inaudible above the sighing of air around the car at highway speeds. If you want to drive it hard you can enjoy the way it revs past 6000, but you don't *have* to, because its torque lets you drive all day in fifth, even, without shifting. Its intake air is perfectly silenced and its exhaust is a smooth, deep murmuring without a trace of V-8 blat."

Automobil Revue assessed the engine similarly: "Cultivated and softly rumbling at idle, the 4.5-liter reacted spontaneously to throttle movement and stimulated by its multivalent character. Its most impressive quality is its enormous accelerative ability, which brings the car to 100 km/h [62 mph] in 6.8 seconds, according to the factory; as maximum speed the factory quotes 230 km/h [143 mph]." Porsche also cited a DIN fuel consumption of eighteen miles per gallon for the 928, and the journalists test-driving the cars in France were returning figures in the twelve- to sixteen-mile-per-gallon range, while pushing the cars quite hard.

Despite transaxle bulge between them, 928 rear seats were surprisingly comfortable.



"Porsche has come up aces with the new Type 928 as a prominent entry in the class of sporting high-performance automobiles." Thus did *Automobil Revue* sum up its impressions of the car. "It shows that even in the age of mass transportation an exceptionally fast and safe car maintains its superiority, and sportiness does not need to cancel out driving comfort."

Nor did the 928 need to cancel out the 911. By acquiring a building on adjoining property at Zuffenhausen, the Porsche planners were able to install an assembly line for the 928 in the area that had served as a machine shop before. In the former Reutter plant, one line was converted to build both coupe and Targa 911 bodies, while the other became the 928 body line. Thus the manufacturing of the 928 was integrated with that of the 911.

Limited volume production of the new car began in May of 1977. By August it was stepped up to twenty cars a day, in preparation for its launching on Porsche's world markets that fall. The plan for the first full year of production was to build 5000 cars, half of them to be sold in America. Some of these sales, Porsche marketers admitted, perhaps as many as two-thirds of them, would be made at the expense of the 911. The other third would consist of added sales for the Zuffenhausen factory.

From whom would those sales be taken? Porsche executives gave away their market targets when they organized a private test, in February 1977, of the 928 against the Jaguar XJ-S, the BMW 633CSi, and the Mercedes-Benz 450SL and 450SLC. They brought all these cars together to get a rounded impression, for the first time, of how their new baby would compare to the other cars that were selling to the buyers that they hoped to reach. For reasons of modesty and politeness, the Porsche men declined to discuss their exact reactions. But when they talked about the tests, they were smiling—a lot.

They had every reason to be pleased with what they had achieved in the 928. "For the first time," said Ernst Fuhrmann, "our firm can offer a range of models, in which the proven 911 is supplemented by the 928, above, and the smaller 924 below." It was the newer concept, that of the front engine and rear transaxle, that would eventually prevail. That was no reflection on the 911, or indeed on any previous Porsche. Each was excellent in its own time. But the 928 was built to surpass them all, and met that ambitious goal.

Perhaps the sports car racers of the fifties said it best: "It takes a Porsche to beat a Porsche."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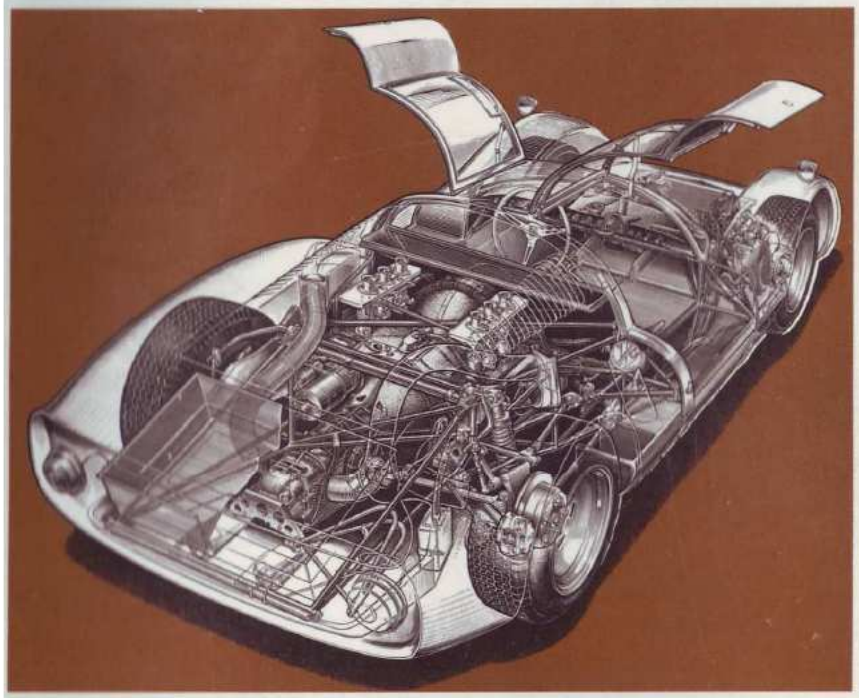


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