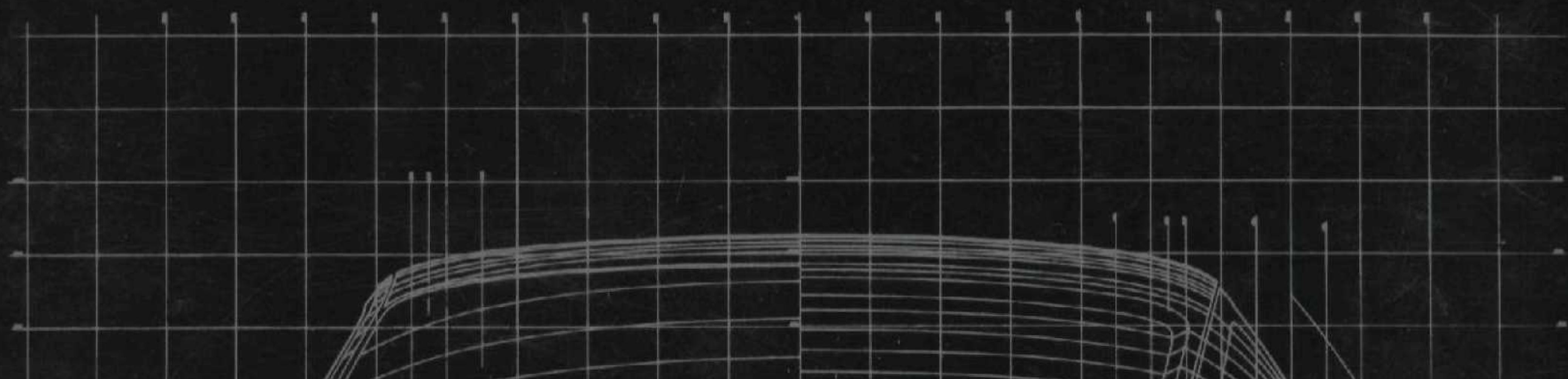
Julius Weitmann Rico Steinemann

PROJECT 928

A development history of the Porsche 928 from first sketch to production



PORSCHE

Motor buch Verlag

Julius Weitmann Rico Steinemann

PROJECT 928

A development history of the Porsche 928
from first sketch to production

MOTORBUCH VERLAG STUTTGART

Table of Contents

Concerning This Book

Very little is ever published about the development of a new automobile, apart from the well-known fact that design and testing take years. Of course "erlking" pictures are often found in magazines, usually showing camouflaged prototypes. And we know that the development of new models can consume enormous sums - forty million dollars or more. However, the full length of the path a new automobile must follow from first drawing to production maturity is usually hidden from the public.

Such projects are very confidential matters, always bearing a "top secret" stamp. Design studios, experimental workshops and test facilities at any auto firm are hermetically sealed off from the outside world and workers in them bound to strict secrecy. This is understandable. Such levels of knowledge and experience are a firm's capital and few are likely to release that.

Our book is an attempt to lift this veil of secrecy, even a little, to give the reader an insight into those years of work behind closed doors. During virtually the entire development phase of the 928 project there was no area "off limits" to the photographer, He had free access to design studios and workshops alike. His camera recorded decisive tests on the brake, experimental drives and internal presentations. He perspired with the test team under an African sun and shivered with them through winter testing at the Arctic Circle. Your writer, on the other hand, had full access to items of little use to a photographer; to project books, minutes of engineering meetings and test reports. There was only one condition attached to such deep insight into the development work; our material could only be published after 928 production began.

Why did we follow Porsche 928 developments for our readers? Well, this 928 is one of the outstanding new creations of our era - at least for all friends of technically demanding, high performance automobiles. In addition, this vehicle, first introduced to the public at the international Geneva Auto Salon in 1977, also offered an especially interesting development tale.

Because Porsche's 928 is one of the very few all-new creations in recent years, fresh from first bolt to last. Every part was designed from scratch - engine, gearbox, transaxle, drive line type, chassis with its Weissach axle, and the body. Thus design and testing were naturally extensive.

Furthermore the 928 is an automobile which we are very likely to be seeing on our roads for some time, just as the 356 was produced for fifteen years and its successor, the 911, still enjoys the favor of its fans after approximately the same length of time. Therefore the development story of this new Porsche seemed particularly relevant.

And finally, a further circumstance made this 928 project exceptionally interesting. Exactly halfway through its development run, when important investments had to be committed, the energy crisis and auto industry recession made the entire project questionable. The alternate solutions, debated in 1974, and the considerations which led Porsche to stand by its original 928 project, form a considerable part of our story.

Project 928 must be viewed primarily as a picture book, as a photographic eyewitness report. With good reason. The development of any automobile is a creation of function-ality from shapes and colors, a very gratifying playground for the passionate photographer. Our text is designed to supplement, to establish contact points, making historic divisions clear and furnishing background information.

We wish to thank the Board of the Dr. Ing. h. c. F Porsche AG for making this work possible through their confi-dence. trust and open-minded approach. 0ur thanks go too to all those workers in the development branch who always found sympathy for our problems and gave so freely of their time

Stuttgart, August 1977.

Julius Weitmann
Rico Steinemann

From First Sketch To Production

As paradoxical as it might sound - a development team today requires a multiple of that time span in which the pioneers put a motor coach onto its wheels, tested and sold it.

The automobile of today and tomorrow retains a gasoline engine and four wheels yet that rudimentary motor-driven coach has become a harmonious collection of many systems. A multitude of mechanical, electrical, electronic and hydraulic aggregates must all be attuned to one another. The most minute examinations are designed to exclude repair susceptibility from the first since we now have higher standards than our ancestors. Then the most varied legal regulations from different lands must be considered. And finally, mass production has its own multifaceted strictures which must be prepared for well in advance.

Four to five years are a reasonable development period for a completely new model where new engine, gearbox and suspension as well as body must all be designed and tested. The following sections are arranged to acquaint you with the systems of car design before we delve directly into the 928 project,

It takes:

A schooled and experienced development team with engineers for design and testing. A styling studio with designers experienced in both the auto branch and industry. Large experimental shops staffed by talented and efficient personnel using an extensive array of test units and measuring equipment of all kinds. A data processing system with its own specialists. A suitably proportioned test area where testing can be carried out to the ultimate level, far from prying eyes.

The range of such equipment has taken on an entirely new face in the last ten years. Classic engine brakes - magic attractions for every car fan - have been joined by an extraordinary new range of colleagues. Alongside test rigs for noise dampening and emissions are the at least equally vital and extensive safety test units.

The overall value of a modern development center easily runs between 65 and 85 million dollars and one must understand that such figures don't even include expensive extras like a high-speed test track or large-scale wind tunnel.

It costs:

At least $45 million for a completely new car - when planning a small to moderate production run of up to 100,000 units annually. True mass production models demand an even wider experimental range and thus high development costs of up to $ 100 million or more. And that doesn't even include the investment costs for a production run which can soar far higher.

The Team Is Organized Like This:

The special features of such a program have led to a new organizational setup. Since there is almost always time pressure the various departments must be integrated without time-consuming bureaucracy, leading to the breakthrough of that new development in organization called Project Management. Porsche (and other progressive firms) have adopted the policy of removing such projects from the customary company hierarchy of division, main department and department heads. For any given project the management will consist of suitable workers from all branches concerned. The head of such a project group remains responsible for the duration of that project with the hierarchy to support and advise him. At the top is a project father who comes from the upper levels of the development management cadre. He serves as referee in questions of competencies and deadlines.

The development manager only interferes in exceptional cases; if problems arise with other branches of the firm, for instance, or when specification guidelines regarding function, time or cost become endangered. The Board, finally, must approve any significant change in the project book; a departure from the basic concept, for instance.

As a rule the original project director at Porsche is an engineer from Construction, holding the rank of department head, If a project then procedes to the actual test phase, he turns over responsibility to a colleague from Testing.

In rough outline, a development project goes like this:

To start with there is a clearly defined target outline from the firm's management. This formulates the problems to be solved and acts as starting gun for the development team. The various development phases can now proceed: creation, detailing, testing and production preparation.

CREATION: SKETCHES, MODELS, PROJECT BOOK

In the first half-year after a project assignment is issued we have the actual creative phase, breeding unbelievably hectic action. At that point there are still relatively few people working on the project so such haste is understandable. The overall development realm can only swing into action when this preliminary work has been successfully concluded.

The immediately-assigned project group begins with a target idea and works out the final target outline. This outline is then the starting gun for both Engineering and Styling. Engineering can develop its basic concept consisting of a phantom drawing which includes all firm design characteristics; size of interior compartment and desired luggage space, engine position and type of drive line, Wheelbase and exterior dimensions plus ergonomic demands.

Once these guidelines are set Styling goes into action. The stylists produce many sketches of possible car forms as they edge their way towards a final shape. A new design leaves the paper work stage for the first time at this point. Three or four particularly promising solutions are chosen from roughly a dozen good styling suggestions and transferred to three-dimensional plasticine models in a scale of 1 :5. As soon as one of these 1 :5 models is chosen a styling buck, sometimes called the seating buck, is built in the workshop. This is a 1 :1 mock-up and one of the most important early-stage tools. It forms the basis for evaluating the chances of a body concept. This buck, like the ribs of a ship's hull, gives a precise picture of the vehicle's outlines. And it indicates whether theoretical measurements for interior, luggage and engine compartments can actually be realized in practice, while revealing the actual conditions for entry, seating and vision as well.

Meanwhile the project management has not been idle. Along with coordinating activities between Engineering, Styling and Model Building, it has solved its main task during this first development stage - working out a complete project book, This compiles detailed demands from all areas against which the maturity of our designed and tested vehicle will later be measured. This project book outlines, among other things:

- A technical production description with measurements, weights, seating conditions and tank capacity, expected driving performance and handling, layout of

engine, gearbox and chassis, all legal demands and requirements, the test program and development plan with time and cost guidelines.
- Overall customer service aspects with service intervals, time guidelines for repairs, special tools to be needed and guidelines for spare parts flow and warranty settlements.
- Arrangement of production technology and assembly procedures, balance of in-house production against outside supply, possible use of available production facilities.
- Overall aspects of purchasing.
- Capital investment requirements and financing plans.
- Parameters for safeguarding quality in both production and product.

This project book, once approved by a firm's management, is the definitive plan for all further work. It includes every basic requirement for the vehicle under development and provides precise direction. Later alterations to a project book are greatly feared since, as a rule, they set off an uncontrollable chain reaction touching every aspect. Fixed dates can no longer be met, work already done by other departments is invalidated at a stroke and costs soar. Therefore, alterations to a project book are only approved under pressure of extreme circumstance - new mandates from the lawmakers, for instance, or grave changes in market conditions.

While this project book is still being juggled Engineering has already initiated tasks for which the basic concept gave sufficient foundation and for which there is particular time pressure. These involve designs and drawings for parts which carry long production deadlines or test periods (including crankcase, cylinder head and so forth).

The Experimental Department also swings into action at this early stage. In close concert with Engineering the test team influences certain decisions through its preliminary experiments. Using modified production cars and outside vehicles they research the workability of suggestions and test the suitability of a basic concept.

EXECUTION: 1 ;1 MODEL, AGGREGATES, PROTOTYPES

The second half-year in the development life of an automobile is a phase of total effort from Engineering and Styling. Alter the selected 1 :5 model has been optimized in a wind tunnel a 1 :1 model, also of plasticine, is created in the styling workshop, the so-called Studio, and its surface covered with a plastic foil which makes it look deceptively like a properly painted car. This life-size model serves management as a basis for approval of the exterior form.

Shortly thereafter another 1 ; 1 model is made of hard foam. The first plastic body parts are taken from it and fitted to an improvised platform equipped with engine, gearbox and suspension mock-ups.

Later this plastic car will be fitted with its own drive units to become mobile. While low body stiffness prohibits any evaluation of handling, first driving tests can be made.

Meanwhile, engineers are working without pause at their design office drawing boards. They detail designs from the first half-year and work out finished drawings for engine, gearbox, axles and body platform. Works Preparation comes in too, and has auxiliary tooling prepared for those parts which determine deadlines.

The Studio has long since become involved with interior styling. The procedure is similar to that for an exterior shape except that the interim 1 :5 model stage may be eliminated. The best solutions are crystalized from a multitude of drawings and presented on a scale of 1 :1 in handmade mock-ups.

The car has taken shape by now, at least as far as its exterior is concerned, after roughly twelve months, and basic body functions can be evaluated.

The third half-year brings a maximum effort from Works Preparation and Testing for the first time, as well as from Product Planning. While various sub-assemblies, normal models and outside vehicles using now-complete engine, gearbox and axles, are actually running, Works Preparation in collaboration with Engineering and Testing procures auxiliary tools and prototype parts. Experimental shops build the first prototypes by hand, using provisional wooden forms.

In the meantime the hour has come for production line planning experts. They were kept informed from an early stage but now their efforts become decisive. Their planning is equally vital to a satisfactory development outcome since their work decides whether the new car will emerge from development ready for rational production.

After some eighteen months the first "true" prototype stands on its wheels with engine and gearbox already past their first test runs.

EXPERIMENTATION: TEST BEDS, ENDURANCE RUNS, EXPEDITIONS

During the fourth half-year test programs of the experimental department come to the fore. Here we must differentiate between functional testing concerned with fulfillment of handling quality and performance standards and testing for endurance which is concerned with quality and durability. Such endurance runs include condensed-time experiments on the accelerated-test track. By using extreme conditions (salt water splash, potholes, ramp jumps and other hardships) materials can be subjected to demands which would only occur in normal driving after a far higher mileage. At Weissach the test track program has achieved a factor of 1 :20 so that 5000 miles of such testing correspond to roughly 100,000 miles of average customer driving. This testing serves chiefly to check those components which cannot be evaluated for durability on a test bench with sufficient reality.

Fifth and sixth half-years: Testing continues and procurement begins. During further track and bench tests the main accent now falls on a number of details all-important to the later success of a vehicle, Proper compromises must be found; in engine or gearbox mounts between noise and vibration comfort; on the intake side between fuel consumption, exhaust decontamination and throttle pedal response; on the exhaust side between noise development and output; in the chassis between comfort and ride qualities.

Although any development center has climatic test chambers to simulate extreme operational conditions, "real" cold and heat tests are still found in the standard test program of many builders, At Porsche extensive runs in the Alps and on the Arctic Circle have become a firm component of cold-weather testing as well as evaluating handling on snow or ice. The counterpart to this is a large-scale program in the North African desert where they not only test for extreme heat but over unbelievably bad desert tracks which provide an ideal supplement to tests already performed on shaker surfaces at home. Sand and dust which penetrate every crevice are a phenomenon hated by any test driver but welcomed in the test program.

Meanwhile the most important decision since the project began has been made. This was a green light for the purchase of tooling, operational means of production and components. All previous decisions were made within the development budget but now that framework is considerably exceeded. The project reaches a dimension from which there is virtually no retreat. The firm's management must ask itself one last time: are we going in the right direction with this development, will the car find its place on the market, is there even a sufficiently large market niche for it - in short, does our bill of particulars work out at the bottom line?

Planning concepts must now include production drawings and the leeway for alterations thus becomes smaller. Despite this fact, experience drawn from test operations will initiate constant modification - and any developing automobile must live with that fact.

PRODUCTION PREPARATION: ORGANIZED CHAOS

The seventh and eighth half-years are a period of production preparation, fixing type parameters and facing the unavoidable "fireman decisions/'

A small pre-series must be put onto wheels as rapidly as possible to give production and quality control experts an opportunity to gather experience with the new vehicle under near-production conditions. This or that is bound to go wrong - not everything which seems smooth as silk in the test department will necessarily work out in production.

Based on experience gained and evaluated from this pre-series, an actual dress rehearsal or pilot series is launched roughly six months before production begins. This consists of at least fifty vehicles containing around 90 % production parts which have now become available. Once again a number of facts may be determined from this pilot series and applied before production actually begins, and these can cause redispositions. Thus the final few months before production starts become a race against time and problems of all kinds. This last major phase in development is always a high strain time for all concerned. It demands the willingness and ability to compromise and to make rapid decisions with flexiblity. A proper crisis team is formed to solve problems which crop up daily.

Actual test work has concluded in the meantime and all requirements in the project book have been fulfilled. They have begun to fix the type, a further control procedure to some degree. Apart from national construction approval there are approximately one dozen registration tests to be passed in other lands.

Expenditures for safety and environmental protection made during the development phase were considerable and they increase steadily. The catalogue of such regulations has grown from roughly sixty laws in 1969 to over 200 in 1976. A good 15% of overall development cost falls to the account of such regulations while roughly 30% of all test benches serve exhaust, noise and/or safety requirements. Fixing the type alone, a presentation of the final achievement to officialdom, consumes roughly $430,000 in Germany.

It is understandable that engineers and experimental people moan about the weight of such laws and regulations from every conceivable land. The long-demanded and urgently-needed standardization of norms for safety and evironmental protection lies far in the future - what one country may demand today will be forbidden by another. The confusion inherent in such widely varied laws absorbs energy which could be far more usefully applied.

While production start up is being tested and type fixing is underway other segments of the firm have long-since become involved too. Distribution prepares for the introduction of a new model to dealers and customers. Marketing concepts are developed, publicity strategy established and literature of all kinds printed.

Customer service men work at peak revs too - the entire inspection and repair system with its training of personnel, the writing of maintenance literature, technical outfitting of workshops and handling of warranties must be established, Spares of all kinds must be available and catalogued for day one. And the very first customer will want his manual which - like all other literature - must be printed in various languages, Thus the circle from first sketch to production maturity is closing steadily. Hundreds of workers were involved in the achievement, carrying heavy responsibilities and overcoming all difficulties.

From this fact alone we can trace the most impressive characteristic of today's automobile development: its all-encompassing teamwork.

Automobiles are no longer built by individuals. They are never a one-man show any more. Whereas the first designs of ninety years ago were still the basic achievements of individual pioneers and while later cars, far into the thirties even, showed the clear hand of a designer ruling over his crew, the development of any automobile has now become a terribly complex and multilayered task which can only be solved by the perfect teamwork of a homogenous crew.

Porschestrasse 42

Porsche has often been described as the smallest among the auto factories and while this might be true within Germany, international comparisons prove the opposite. Really small builders, particularly those of Italian or English persuasion, produce from 50 to 2000 cars annually. Against these, Porsche's current annual production of over 15,000 units with a work force of some 4200 seems gigantic. Isn't it more a case of the giant among small auto firms?

No. The tradition-rich firm in Stuttgart-Zuffenhausen is truly the smallest real car forge, the David among giants, because Porsche is separated by whole worlds from the true small builders (who are almost all in deep difficulty, incidentally). A more or less handwork-style of production without in-house body construction, inadequate customer service nets, modest distribution channels and a lack of development capacity with limited test facilities - none of these factors are a problem for the Swabian sport car builder. Porsche of Zuffenhausen, Weissach and Ludwigsburg bears all the features of a large automobile factory.

How did this undertaking break the bounds of a small, handwork operation after 1950? Was it business foresight or good fortune? A glance at the firm's development path indicates that both those components must have been involved.

We can assume that the prehistory - marked by the name of Ferdinand Porsche - is well known to all. Thus we will only recapitulate briefly here how the one-time technical director of Austro Daimler, Daimler Benz and Steyr opened his own design office in Stuttgart during 1930. And how this office made headlines for the first time with the Auto Union Grand Prix car. How it launched the Volkswagen project on its own initiative, one which later made Professor Ferdinand Porsche immortal. How this project was put through against every obstacle until a factory was created in Fallersieben (later Wolfsburg) under Porsche management, a plant destined to build the auto for everyman. How this design office which settled into the Stuttgart industrial suburb of Zuffenhausen expanded to include an experimental department with its own workshops and how they developed cross-country vehicles during the war only to move to Gmund in Carinthia when the bombing began. How Ferdinand Porsche became a prisoner of the French after that war and how Ferry Porsche jr. and his team managed to raise the bail which released his father out of their income from an otherwise rather unfortunate Cisitalia project. How postwar Volkswagen production began while Ferry Porsche and his people developed that first car in Gmund, based on the VW, which would carry the Porsche name. And how, subsequently, the type 356 went into limited production in a Zuffenhausen barracks, backed by the most restricted means. How the first car was completed at Easter 1950 to find customer favor and be followed by ever-growing numbers until the constantly expanded production facilities burst all seams and made large investments necessary. And how too, Porsche cars achieved success after success on all levels of motor sport.

These are the stages which turned this small firm with the big name into an automobile factory;

Not far from the original Plant I on Spitalwald Strasse where Development, Customer Service and Administration could return once the Americans released it, rose Plant II at Porschestrasse 42 where Production could be moved in the mid-fifties. That ended the era of grand improvisation, although the firm didn't yet have its own body plant. A large portion of their bodies came from Reutter right next door. This changed in 1962 when Porsche took over Reutter, absorbing body construction into its own plant. A further milestone came with the production of the 911 which began in 1964. It was a Porsche which owed nothing to any mass production car.

Such design ambition was no coincidence but cold reality, based on solid foundations. After all, the firm was once a design office exclusively, working on outside contracts and this realm was never neglected, even when their own car production figures increased rapidly. The fact that this firm continued to consider itself a specialist in vehicle development had far-reaching consequences. The increasing impossibility of performing entire test programs on open roads, the steadily growing need for new test facilities of all kinds and a lack of space in old Plant I all indicated to management that an independent future could only be secured with huge investments in the development realm. The result of such farsighted thinking was the development center at Weissach. originally intended solely as a test track. Between 1961 and 1974 one of the most modern development centers in the world grew up there, stage by stage. Vehicles of all types can now be conceived, designed, built and tested. Weissach is located some eighteen miles west of Stuttgart, a short half-hour by car from Zuffenhausen.

Somewhat less successful was the quasi-marriage with an unmatched partner which Porsche undertook towards the end of the sixties. At that time Zuffenhausen received extremely interesting development projects from Wolfsburg (including the VW Porsche 914 and EA 266), but found itself in turn removed, de facto, from the marketplace by VW since all distribution activities were taken over by a sales firm owned jointly by VW and Porsche. The barb in this matter was the fact that legal considerations transferred US distribution, which absorbs over fifty percent of production, completely to the VW organization so that Porsche virtually lost control over marketing of its product.

1971 was a year of far-reaching decisions for the firm. The former Kommanditgese.Ischaft known as the Dr. Ing. h. c. Ferdinand Porsche KG, a limited partnership, was turned into an AG or stock company. Dr. Ferry Porsche stepped down from active management of the firm at 62, to take over chairmanship of the board of overseers. Although the firm remains entirely in the hands of the Porsche and Piech families, the younger Porsche and Piech generations stepped aside. Ownership and management were separated, logically so in view of the dimensions this firm had achieved. A board was established which consisted originally of the engineer Dr. Ernst Fuhrmann (who later became Chairman) and Heinz Branitzky, head of finance. The second major event of 1971 was cancellation of project EA 266, developed by Porsche. Rudolf Leiding, new Chairman of the Board in Wolfsburg$_1$ was forced to make this move by the less than successful model policies of his predecessors. He had to put a beetle successor on the market quickly and in that situation he felt that the demanding mid-engine concept (engine beneath the rear seat) would be too risky.

The cancellation of project EA 266 which was already in the midst of obtaining production tooling, meant a considerable loss of turnover for the Porsche development center which was partially operational by then. Expected follow-up contracts for further development and model updating were dropped too of course. Since VW obviously faced further grave problems by then, it became questionable whether a contract then hanging in the balance for development of a successor to the VW Porsche 914 could be realized either.

The end of project EA 266 had a further unpleasant effect on Porsche's own model development plans. The new board was barely seated when it had to make extremely difficult decisions.

21 October 1971

Around 1968 when the popularity curve of the 911 model was heading towards its first peak, Engineering and Styling began to deal with first designs for a new model generation. Such studies were taken up rather hesitantly in the small and overcrowded confines of Plant I - with good reason.

For one thing the Porsche race department was in full bloom at that time and real race fever had infected the entire development branch. The race car types 910, 907, 909, 908 and 917 were created at unbelievably short intervals, race engines of six, eight, twelve and even sixteen cylinders were developed and troops of half-company strength rushed from race course to race course. This racing trend, which went overboard at times, absorbed a great deal of development capacity and money, although it certainly had its beneficial side as well: Porsche still profits from lessons learned then in lightweight construction and aerodynamics. In addition, a dynamic young engineering cadre grew up under the auspices of such hectic racing participation, survived many baptisms under fire and later proved itself on all kinds of "civilian" projects.

On the other hand the major VW contract 1866/1966 (later called EA 266 by VW) tied up a large segment of Porsche's development capacity which was far smaller then anyway- Work on this project which had just reached prototype status was running at full revs.

At that point the 911 seemed sure to achieve a life span which would equal that of the 356 before it. The concept of this vehicle had proved very favorable for further development and from a marketing point of view there was every reason to suppose that the 911 would become a long-term classic (in the event even the most optimistic forecasts were exceeded by a wide margin). Thus they wanted to avoid any unnecessary restriction of technical possibilities which might result from starting a new development too soon. Furthermore, future exhaust and safety regulations were sprouting in those days, particularly in the United States, and their steady stiffening foreseen by the end of the seventies seemed to indicate it would be wise to avoid firm commitments. This was particularly true for any follow-up generation which must aspire to another long model run. Extended model lives which allow better amortization of high investments are the be- and end-all for any small automobile manufacturer.

Finally there was another decisive reason for hesitation. Towards the end of the sixties it became more and more clear that one had arrived at a crossroads in questions of technical concept. Would, or could, one remain with the rear engine and air cooling, characteristic features which the public considered untouchable Porsche dogma? Or did the future belong to mid-engine sport cars which were already such a fixture of racing? Perhaps a classic design or even front-wheel drive might be viable alternatives?

The advantages and disadvantages of these various concepts were dispassionately weighed even in those days. Rear engines and air cooling were anything but holy and questioning them never taboo. However they had to consider the question of whether customers would also swallow a complete change of basic concept without emotional reactions.

Nevertheless, an end to both rear engines and air cooling became increasingly obvious. Crash norms to come mitigated against the rear engine because its lack of a proper crush zone causes problems in rear-end crashes (it is not the frontal crash which is problematic as SO many people believe). There were also problems with the ever more stringent noise pollution laws since a rear engine car which is very quiet up front still has two noise sources in the rear: engine and exhaust exit. There was the additional fact that this rear engine concept had a very bad reputation among opinion-shapers of the motoring press. It carried the stigmas of oversteer, poor directional stability and high side-wind sensitivity (criticisms which may once have been justified in part although anybody sitting in a new 911 would scarcely notice any trace of such stumbling blocks today .. .). The ultimate change *to* liquid cooling seems, in fact, to have been dictated more by a desire for generally better noise suppression and greater heater comfort.

This almost automatically led to a preference for the sport car with mid-mounted engine, a building style offering optimal handling qualities, ft was thoroughly race-proven and could be described as "typically Porsche" (since it matched the concept of that first successful mid-engine race car, the Auto Union Grand Prix machine which Porsche had developed after all). Then there was all that valuable experience gained with the VW Porsche 914 which had just gone into production.

However this very experience brought up the question of whether a normal mid-engine arrangement (powerplant placed longitudinally ahead of the rear axle) was realty the proper path. Every design option indicated that the problems of emergency seating and small storage space reachable from the cockpit could only be insufficiently solved, if at all. And this was precisely the sore point of a 914. In the US where there is certainly an interesting market tor pure two-seaters this car sold relatively well. In Europe, however, market success was obviously made difficult by the lack of a " + 2" capability, although price and specifications of the vehicle aimed it at younger people who might be supposed to ignore emergency seats and storage in favor of an uncompromising sport car concept. Thus price class, comfort requirements and minimum safes figures urgently demanded a satisfactory solution to the extra seat problem and this was not forthcoming since alternate suggestions (such as a transverse engine) brought their own disadvantages.

Prospects for a promising mid-engine layout only made progress when they fell back on project 1966 during 1970. In that small car which Porsche had developed for VW the engine was placed under the rear seat after all, thus solving the space problem. However, before a new Porsche could be based on that principle planning would have to take an entirely new direction. There was not enough space under the rear seat for the large, eight-cylinder engine they preferred. The 1966 had used a flat four. The result wouldn't be a "big" Porsche to expand the 911 line upwards but another "small" vehicle like the 356 Of course this turnaround could have its pleasant aspects too. As in the days of the 356 they could base their work on a mass production car, using its body platform. That would reduce necessary investment, lower the price and make a larger series viable. Work now concentrated solely on a sport car derived from that 1966 and 356 history seemed destined to repeat itself. Porsche would first develop a mass production car and then spin off a sport car under its own roof. The idea of a larger Porsche was not abandoned entirely but it received no further priority in plans of the time.

But all such plans capsized in the fall of 1971. Just as Dr. Ernst Fuhrmann, former successful Porsche engineer, then Technical Director at Goetze, the piston ring producer, returned to Zuffenhausen the equally-new VW boss, Rudolf Leiding, drew a fatal line through the well-advanced 1966 project (EA 266). Fuhrmann found a proper scrapheap in Zuffenhausen and the planned Porsche sport car lost its base. They were back where they had begun and time was pressing. The 911 was

already in its eighth year of production.
Dr. Fuhrmann did two things in this situation. On one hand he immediately activated model improvements and further development of the 911 which must support the firm for at least four to five more years. In addition, motor racing entries by Porsche were immediately limited to racing versions of the 911 which further stimulated development of that car and maintained the vehicle's image. This introduced a surprising second spring for this fascinating machine which was destined to remain a favorite of buyers.
On the other hand, a new project for the follow-up generation had to be launched immediately. There was no time in this situation for large-scale market surveys to clarify the question of whether a "small" or a "large" Porsche would have the best chance or whether one or another drive system might be more readily accepted by customers. Foresight, knowledge of the field and intuition had to answer all such questions. Increasing demands for comfort and future exhaust regulations spoke for the larger engine. Customer structure and production capacity made it logical to remain in or above the 911 price class. Thus they more or less returned to the path followed before leaning towards the 1966. However this brought the questions of engine arrangement and drive line up once again.

Dr. Fuhrmann had not been received with entirely empty hands, either. During the previous summer a working group under development chief Helmut Bott had undertaken an extensive evaluation of engine placement and drive line models, based on over forty criteria. All relevant aspects were considered: current and expected legal regulations, driving qualities, performance, comfort, luggage space, safety, aerodynamics and ease of maintenance.
The basic concept which came out of this evaluation process had its engine in front but its gearbox located in the rear for improved weight distribution. These components were to be connected by a stiff tube containing a "fast shaft" which would transmit torque at engine rpms.
On 21 October 1971, which happened to be Dr. Fuhrmann's birthday, he was presented with the results of this research. A specially-built wooden model demonstrated the suggested direction. These arguments and suggestions found approval from the new boss whose birthday thus became the starting signal for project 928.
Only shortly thereafter, on 8 November, a note in the files records the decision: "upon instruction of GFT (an abbreviation for the technical management), the suggested vehicle should be put through with front engine and rear gearbox, the two connected by a central tube."

The Creative Phase

Thus the creative phase had already opened with the provisional outline of a basic structure. Engineer Wolfhelm Gorissen, head of Chassis Construction, was made project manager with the expectation that he would pass on this task to a development engineer in roughly two years - when the actual experimental phase was reached. In practice things turned out somewhat differently: Gorissen retained management of the project for four years, until the fall of 1975. Only then did he turn his office over to the responsible engineers from Testing, Peter Falk and Helmut Flegl.

The role of project father, advising and supporting the project manager, was taken by engineering chief Wolfgang Eyb.

The project group had already held the first of an eventual 85 main meetings on 8 November 1971 (in addition, naturally, to hundreds of technical discussions among individual working groups). A target outline was defined, based on the goals presented, but it could not be finalized at that point. They were still running on parallel tracks since the guidelines not only specified spatial conditions for the rear seats approximating those of a 911 but also provided for a more or less "true" four seat option. This second possibility was soon dropped, however, because it was correctly recognized that it veered dangerously far from the Porsche philosophy, forcing engineers to make compromises with the "clean" sport car concept and thus included a considerable risk from a marketing standpoint. It would have meant abandoning their innate market segment to enter into direct confrontation with strong, large-volume producers. The question of a full-size four-seater only became popular again during the major energy and auto industry crisis of 1974 when the entire 928 project was questioned.

Starting from the target outline for a 2 + 2 with rear seat space approximating that of a 911, engineering developed a basic concept which could be approved before Christmas. Its core was the transaxle building style with stiff central tube already mentioned. For an engine they settled on a particularly low-profile V8 with capacity of 4988.8 cc. and oversquare stroke/bore ratio of 0.749/1. The two cylinder banks would be angled at 90°. This unit had water cooling and two camshafts, one for each bank, driven by a cogged belt. Operation on normal fuel was planned from the first. They began with a theoretic output of 60 hp/liter, expecting a maximum of around 300 hp. In view of the extended maintenance intervals which were part of the plan, hydraulic valve tappets were included in the original design.

An interesting sidelight was the preliminary design for "half" a powerplant at this early stage; for an inline four using one bank of the V8. Such an engine could have shared a great many parts and was conceived as a rational starting point for a possible "smaller" Porsche. This variant was never realized, however, remaining in the pre-design stage.

By this point - we are still in the winter of 1971/72 - important events had occurred. VW had issued a design contract to Porsche after all, for a successor to the VW Porsche 914 which would be produced within the VW concern. The VW Porsche distribution organization, owned jointly by VW and Porsche, would handle sales. Since components from VW were a natural part of this plan another new four could not be considered. Comparable engines already existed.

This project was designated EA 425 and we will deal briefly with it here since it became an interesting parallel development to the 928 whose basic layout (transaxle style) was taken over. In theory it followed the philosophy of the 356 (as well as that unrealized Porsche based on the 1966). It would be a proper sport car using many mass production parts to make it available to a wide circle of customers. The EA 425, as an important outside contract, received priority and was making such excellent progress that the start of production could be planned for the end of 1975 after only four short years of development time (although we must add that no new main components had to be built and that preliminary transaxle work had already been done with the 928 in prospect).

At the beginning of 1975 - a time when the VW concern was in serious difficulties it seemed that a Porsche development contract had come to an early end for the second time in a very few years. Toni Schmucker, successor to Rudolf Leiding as head of VW, decided in his difficult situation that a VW operation made shaky by the automobile crisis and earlier unfortunate model policies had to streamline its program and concentrate on basic models. Thus EA 425 would not be built. This led to a decisive move which proved of utmost importance to the future of the Zuffenhausen firm, Trusting in its own design and its market potential, Porsche repurchased the rights to this project which was so nearly ready for production, as well as obtaining all tooling already on order, then issued a production contract back to VW which was happy to build the car without marketing responsibility or capital obligations since their NSU plant in Neckarsulm wasn't working to capacity in any case. In this manner EA 425 became the Porsche 924, going into production in early 1976. This entire transaction had an important side effect as well, whereby VW abdicated the whole sport car field as a producer. Porsche assumed Volkswagen's share of the distribution company and thus brought the distribution setup based at Ludwigsburg, near Stuttgart, back under its own (sole) control. In this manner their distribution policy again became independent, without damaging a fine and useful relationship with VW.

Back to the 928. Its basic concept already provided for optional use of a five-speed gearbox or a full automatic. For suspension they selected twin transverse links, front and rear. Wheelbase was set at 98.5 inches, roughly nine more than a 911. Overall length was to fall around 175 inches with a height of 51 inches.

With these reference points settled Engineering and Styling took up their tasks. By the end of January 1972 the studio presented designs which promised success and the making of 1 :5 models could begin. A test version of the high-priority transaxle was designed to be quickly built and mounted in an outside model while a test version of the new suspension was also built up to be checked out as quickly as possible in a 911 mule. Such basic experiments meant that the test department was included from the very beginning.

On 14 February various 1 :5 models from the studio went into a wind tunnel for the first time and results were encouraging. While further details were taking shape on the drawing boards and basic experiments were underway, a buck or seating module was completed by 9 June, This made it obvious that while entrance and seating would have to be improved, they were on the right basic path. This first, creative phase was nearing its end,

The Search For A Shape

Three main criteria were decisive when the styling studio began its search for a new shape. One objective was a good coefficient of air resistance with a small frontal area. Furthermore, the exterior was to be "timeless" with an eye to a long production run. It shouldn't be influenced by short-term fashion trends. And finally - following the pattern of its forebears - an unmistakable Porsche silhouette was to be created.

Thus, this project assignment for Chief of Styling Anatole Lapine and his aide Wolfgang Mobius corresponded in all its basic parameters to requirements which had also been decisive for creators of the 356 and 911.

The search for favorable aerodynamics, one of the prerequisites for good performance with low consumption, was basically harder than it had been with a rear-engine arrangement. Front engines lead to a higher nose, not to mention that necessary air opening in the nose for a radiator, unappealing to all aerodynamicists. However Engineering had obliged the stylists with a low engine outline and the basic requirement for adequate coo! air turned out better than might have been expected. Calculations showed they could work with a relatively small opening.

Still, the exceptionally low engine height of only 29.6 inches also meant a considerable overall width since the body shell did have to embrace suspension and wide wheels plus the maneuverability which demanded good steering lock. A similar development had already been faced in motor racing at the beginning of the seventies when overall vehicle width increased rapidly, due chiefly to super-wide rims and tires. This considerable overall 928 breadth, finally limited to 72.3 inches by various measures and efforts from all involved, presented the styling people with form as well as aerodynamic problems since it stood in the way of the highly-desirable slender line and made it difficult to handle the length:width ratio.

The design favored, and finally chosen, achieved a C_x value of 0.390 in its 1 : 5 model test, after optimizing in the wind tunnel. This was very good, considering their far more difficult task, compared to the first 911 which had a C_x of 0.381.

The design also met all requirements for individuality and timelessness. By doing away with such modish elements as a wedge shape or pronounced belt line with sharp edges they were led, so to speak, to those round, soft shapes which had also been typical of the predecessors. Width was managed very well. The front in particular presented a rather slender appearance through clever detailing, The tail could not quite deny its bulk but this gave an effect of highly sporting power.

Thus the studio had solved its primary task: giving this new front-engine car an exterior form which fully expressed the special Porsche character.

From the earliest stage their plans had included integrated bumpers and pop-up headlights. More or less integral bumpers had already been used on the 356 while 911 bumpers were faired directly into the body. For reasons of form almost seamless bumper integration was desired this time. It was well liked at first although the idea didn't find immediate engineering approval as we will see later. Pop-up main lights (already used in another form on the 914) were one means for keeping front fender height down and for reducing frontal area during normal daytime driving.

A second major task of the studio was design of an interior cell and here a new element had to be considered: the tunnel for that central tube. Porsche had always emphasized relatively free access between driver and passenger seats but the tube cut through such thoughts. *The* studio turned this disadvantage, long known all too well to other builders, into a virtue by embedding their front seats deep between tunnel and door cutouts, A particularly functional arrangement of dash and console complemented the cockpit feeling this created. Free passage between driver and passenger, so favored for friendly communication, was not mourned too long although Dr. Fuhrmann couldn't help but make a comment, which soon went the rounds in Weissach, on first viewing the seating buck: "You have certainly designed me a fine Jesuit car there."

A main instrument cluster moving in concert with the steering wheel, which adjusts for height, was fitted at the suggestion of the technical team. This, together with the central warning panel to indicate operational failures, comprises a successful attempt to present the driver with all necessary information in such a clear manner that there can be no chance for misinterpretation.

Basic Concept: The Transaxle

When Porsche decided on a transaxle construction, meaning an engine in the nose with gearbox in back, advantages and disadvantages were carefully balanced. Such a design was no technical novelty. This building style - although in a different arrangement - had existed previously in race and sport cars. Automobiles like the well-known, prewar Lancia Aprilia had their gearboxes in back. However strong reasons for the temporary abeyance of this design were the vibration and noise such a drive shaft, running as a "fast shaft" at engine revs, could cause. Porsche arrived at the conclusion that vibration and noise problems could be solved by modern knowledge and methods so there should be no reason for foregoing the advantages of a transaxle - optimum weight distribution, relatively good loading of the driving wheels and excellent prerequisites for meeting all crash standards through improved safety cells front and rear - merely because previous versions had problems.

Nevertheless, they had been forewarned and intensive basic preliminary experiments were planned to familiarize all concerned with the special features of this principle, eliminating flaws from the first. The decision to undertake extensive development work was soon proved correct. As early as March of 1972 news penetrated to Stuttgart which indicated that testing of the then-new Alfa Romeo type 116 (Alfetta), also planned with gearbox in the rear, had thrown up difficulties in noise suppression. The Volkswagen factory which had been experimenting for some time with "fast shafts" also warned of uncontrollable vibrations of 1st, 2nd and 3rd magnitude. Experimental modules for test bench use and mobile test bed units were built immediately, based on initial design studies. One such test chassis, the first to try any 928 component, was a Mercedes 350 SL, dubbed V1 internally. This vehicle was acquired because it matched nicely and promised rational test operations, not to mention the fact that it carried a V8 engine.

Design of the 928 transaxle specified a gearbox ahead of its rear axle since such an arrangement promised best use of tail space. It was important that results hew as close to practice as possible so such a gearbox layout would be required on test. At that time the 928 gearbox was still in its design stage of course, but the competition department once more came to the rescue. Their model 910 gearbox, originally developed for the 908.03 race car, used such an arrangement and could be adapted to the new experiments with little alteration.

Conversion of V1 was completed on 15 May. The car now had a racing gearbox just ahead of its rear axle, in unit with the engine via a central tube. The clutch was in back, the "fast shaft" ran in a simple bearing in the middle of its central tube, Driving tests had to be broken off immediately, however, because the provisional clutch slid forward (insufficient pressure on its withdrawal mechanism] and ceased to function. Once this was corrected, again provisionally, further driving tests could begin. The test log notes: "subjectively, no drive line vibration can be felt in the passenger compartment and loud interior noise is due solely to insufficient insulation of the gear lever bracket."

Since the clutch slipped forward again after a short time and the arrangement was provisional in any case, this original driving test was interrupted and the transaxle rebuilt. It was now mated to a standard Mercedes clutch and original flywheel, both up front with the engine. On 30 May experiments were resumed and first impressions were again very positive. Meanwhile the gear lever bracket had been covered with a layer of noise dampening material and previous complaints of interior noise largely disappeared.

Detailed bench and mobile test bed experiments could begin. As generally expected these proved less positive. Cited basically were a very strong resonance from the unit at 5200 rpm, along with high vibration from the gear lever bracket and gearbox nose plus oscillations during load changes and noise from the clutch housing area. In fact, a great deal of work remained. While major research into the vibration patterns of a transaxle was launched, initial test bench endurance runs on the component could begin on 12 July, designed to pinpoint any potential failures. Meanwhile V 1 was running on a chassis dynamometer in the climatic wind tunnel to simulate road conditions. It was run hard; starting and shifting up through the gears to top under full throttle, then ten seconds each at 6000, 5500 and 5 000 rpm, shifting back to first, and again full throttle up through the gears. This exposed the drive line to a multiple factor of normal use.

A serious failure occurred after 484 miles. The "fast shaft" had taken on a sine curve shape, with damage to the central tube and shaft bearing. A shaft made of 42 Cr Mo 4 replaced this original unit of CK 45 V. Bearing noise became audible again at 2566 miles and further disassembly was necessary, it was evident that the center shaft bearing had been damaged (this version used three bearings, later they changed to two). The test was concluded after 4566 miles on the brake but provided vital knowledge about "fast shafts" and their bearings. Diameter of the shaft was then increased from 0.8 inches to 1 inch in view of the torque a 928 would transmit.

This major study of vibration patterns in the transaxle was conducted with particular care and attention. It concluded on 6 October when a 65 page report was issued. This indicated that the planned component layout of "fast shaft" and central tube could indeed be utilized without prejudice to comfort and that vibration behavior could be mastered. Thanks to various vibration measurements, optimal bearing locations could be determined which reduced vibrations considerably. A properly sited bearing also reduced shaft loads. Furthermore, they could prove that further stiffening of the system had a favorable influence on the swing pattern as did a change of mass concentrations. It was suggested for the first time that other components be attached to the drive line to control its vibration pattern. Finally, these experiments brought valuable data on important detail matters such as placement of the gear lever bracket and shift knob shape.

The application of this study, along with future research, brought astounding results. In December of 1972 the vibration pattern was decisively improved and noise development in the V1 test car lowered over that of the first test by 50%. The unpleasant vibration peak at 5200 rpm was completely eliminated.

A further step, taken at the beginning of 1973 and based on this major study, was use of the battery as a vibration damper. It was placed at the end of the gearbox. This move naturally found favor with the chassis people since they wanted to locate the battery in back anyway for better weight distribution. The result was startling. A test report from 8 February described the reduction of component vibration as "very marked[11] and spoke of a reduction of 35 % in overall vibration at resonance rpm. One prerequisite was a stiff battery carrier but vibration loads on the battery remained well below border values listed by the makers, and even below those for batteries mounted to the bodywork in the usual manner. Preliminary tests could be successfully concluded on 26 June 1973, Noise development over a wide range lay below the original production condition of V1 and vibrations were no longer a basic problem for either driving comfort or material wear. Thus a path was cleared for engineering and construction of the first test units to serve in engine and gearbox experiments for the actual 928.

Initial bench tests were made in August and the new drive line was then installed in the V3 test bed, an Audi 100 Coupé which received the 928 platform with considerably wider fenders as only exterior sign. This conversion was finished on 19 September and for the first time a complete 928 drive line with engine, "fast shaft," center tube and gearbox/differential went into action. First tests were very satisfactory even though the vibration level-as expected - was again high. The final component layout had to be optimized as well and this work launched an extensive second phase, on the test bench, in mobile test beds and with the first prototype. Although a great deal of detail work would still be necessary, the transaxle passed its first major road test in Algeria with bravura that November,

Engine Development

It has already been mentioned that this engine was laid out from the first as a compact V8 with 90° between the banks. A mathematically determined capacity of just under five liters was the median value but all details were arranged to provide considerable leeway for adjusting the capacity up- or downwards. Original thought tended more towards an increase to roughly 5.5 liters but the energy crisis later pointed towards a decrease to just under 4 500 cc.

Since minimum weight was decisive, along with low construction height, a light metal unit was the only one considered. The overall proportion of light alloy was to be large, based in part on rich experience with racing and the 911.

Since the friction relationship of alloy on alloy is poor, all solutions in this general field use a heavy metal: light alloy pistons run in a steel or cast iron liner set into the alloy block. And since there is nothing new under the sun, Mahle and Porsche had already collaborated on a development in 1952 (!) which got around this flaw.

At that time a 1300 cc, four-cylinder Porsche engine was built without liners. Instead the running surfaces were etched and fitted with chrome-plated pistons. This chrome layer prevented direct contact of alloy with alloy. This was a reverse of principle: the pistons were "heavy" rather than the cylinder surfaces.

This 1300 engine was clearly too far ahead of its time. It ran for close to 12,000 miles but then produced problems: the chrome layer on the pistons scaled off. Since various problems went unsolved at that time the project wasn't pursued. The hour of a "reverse principle" which could do without steel or cast iron cylinder liners had not yet struck.

These 1952 tests did provide an interesting memory, however. In those days Porsche only had two test cars from the 356 line, called "Windhund" and "Ferdinand" (cars soon surrounded by legend). But these two 356s were booked day and night for tests so they had preempted a VW beetle for further work, a car which entered Porsche history as "Adrian." The "reverse principle" engine was fitted to "Adrian;"[1]

Towards the end of the sixties Reynolds Aluminum in America brought out a mature and industrially-useful reverse principle, making elimination of the liners topical again. This consisted of an engine block in extra-eutectic aluminum-silicon alloy. After honing such cylinder walls are etched, allowing primary silicon crystals to stand free of their aluminum matrix to give a long-wearing surface. Pistons, now running directly in the light alloy block, carry an iron or chrome layer, Eliminating the liners not only saves weight but also offers the advantages of simplified machining,

Porsche had looked into the Reynolds reverse principle as early as 1971 on two different levels. On one hand they carried out tests with an air-cooled 911 engine and alongside these took up experiments with the water-cooled engine from the 1966 project. Results were impressive - the reverse principle was put into production on the air-cooled engine in the fall of 1972 but its chief application was to come with the 928.

This made it possible to design the upper housing in one piece, without liners, thus making it especially stiff despite a low weight. However this procedure requires a high silicon content of 16-18 % and the brittleness inherent to such a material must be considered when designing mounting points. A low-pressure casting procedure provided the necessary density.

The housing was designed with a horizontal split at the level of the main bearings, allowing the lower portion of the case to be pressure-cast in a normal aluminum alloy (226) rather than in the high-silicon version. This might seem somewhat daring since different materials for upper and lower housings were once considered a problem area, particularly when it came to machining bearing webs and mounting the oil pump. The decision taken by Porsche engineers to provide a simple oil groove in the separation face between the two halves of the housing rather than the customary drilled oil passages seemed even more daring. This design detail promised control over neatness and a *better* flow pattern since passages could be provided with gentle radii in place of the usual sharp edges. There was a considerable saving in machining too. But all this seemed advanced enough that test results were awaited with great interest

In fact, this simultaneous machining of different materials never presented any serious problems once *the* tooling was optimized and an absolute seal at the interface was achieved by using bypasses and a modern silk-screen technique for the joint seal.

The five-bearing crankshaft was made especially rigid to achieve desired running silence while bearings were given generous dimensions with diameters of 2.76 inches (main bearings) and 2.05 (connecting rod bearings). Non-alloy CK 45 steel was the chosen material with bearing faces of the 55 pound crankshaft tempered. Rotating and oscillating masses were fully balanced.

In the interests of good mass balance and to hold weight tolerances of the connecting rods within the tightest possible limits, rod design was given considerable attention. They decided to develop a sinter-forged rod which promised fine weight accuracy with minimum machining and thus low production costs. Test results were indeed outstanding. At 0.0168oz./in.^{3}, they achieved a material density close to that of forged steel. Alternating tension and compression tests produced clearly better results for the sintered parts than those for steel rods forged in a similar shape.

In designing the cylinder head engineers battled, as they had with so many of the car's components, with the most contrary demands, all of which had to be fitted into one concept: combustion with minimal pollution and low consumption, high performance efficiency, operation on normal fuel, plus low mechanical and thermic loads. In addition they had to consider the guidelines for exterior engine dimensions.

Aluminum heads were fitted with one overhead camshaft per bank and two overhead valves per cylinder, arranged in a row, A pent-roof combustion chamber was chosen with a squish zone opposite the spark plug which took up a good fifth of the piston area. This design saved space and aided in reducing the height of the powerplant. The fact that it didn't follow classic higher-performance engine practices of hemispherical combustion chamber and valves in a vee demonstrated again the altered standards of current engine design. In the shadow of ever-sharper emissions norms, an engine must be laid out to offer optimum efficiency in the median performance range with limited revolutions. The inclination to a classic layout looses priority with any reduction in liter-output which must be compensated by increased capacity.

Extended service intervals and modest maintenance demands were key factors in the 928 project book - they were attributes which stood alongside the long-term guarantee as key features of Porsche's philosophy for development, production and sales. Hydraulic adjustment of valve play seemed a reasonable way to fulfill such requirements in the valve train realm. It was once common to exclusive sedans (such as Packard) and meanwhile had become widespread on American cars. For the 1966 project where a hard-to-reach engine had to be as service-free as possible, Porsche had already posited valve followers with hydraulic adjustment. Thus the necessary experience was ready to hand although the actual design departed from usual paths by fitting the hydraulics to the cup tappets which were moving elements, An eleven pound spring in the center of the cup tappet was designed to balance out valve play increase or decrease, up to a working stroke of 0.12 inches.

This worked perfectly in pretesting but a certain skepticism remained regarding possible peak revs since hydraulic systems had not proved too durable at such rpm figures. Of course the 928 wasn't designed for high rpm values as such since they were contrary to the basic concept which aimed at fulfillment of the stiffest emissions and noise regulations. But since they desired a safety factor in this area as well, an interesting experiment was launched with the aid of the race department. The projected hydraulic system was fitted to a four-cam version of the six-cylinder race engine and then entered in two events which settled the question once and for all. On the brake this engine with hydraulic valve play adjustment even reached 8 200 rpm without the slightest trouble and all doubts were banished.

Since ease of maintenance was another important requirement, cylinder head bolts were developed which would not require re-tightening after the first installation. A well-developed bolt pattern, deep-seated studs and the favorable qualities of tapered upper cylinder bores allowed this achievement without secondary measures. The bolts are first tightened to 61.5 lb.-ft. when the head is mounted and thirty minutes later (the installer can do other work in the meantime) again torqued to 61.5 lb.-ft. The engine need not be run between the two procedures. In that interval the torque figure decreases by roughly 7 lb.-ft. and then remains above the prescribed minimum value for a reliable seal whether the engine is run for long or short periods. Later torque checks are unnecessary.

This engine design also demanded good oil circulation since high lateral and longitudinal acceleration values were expected on the one hand while the hydraulic valve play compensation on the other presupposed a safe oil supply with low air component of less than 9 %. This led to large intake cross sections with the oil intake pipe mouth shielded upwards to avoid funnel formation, as well as an efficient sickel pump with sintered steel wheels plus altered balance and rerouting measures and a specially designed oil sump.

The use of a single cog belt to drive the camshafts, oil and water pumps offered intriguing possibilities. It would not only shorten overall engine length but also allow a simpler and more rational superstructure. However they were entering new territory here since the layout demanded a belt of more than six and a half feet, far longer than any in general use. Preliminary tests were indicated.

Mixture preparation would be handled by continuous manifold injection while both a normal exhaust system and one with a catalytic converter (US) were planned for the exhaust side: either to be suspended from the central frame.

Possible later use of this powerplant in motor racing was envisioned from the first design stage and its demands studied. A memo in the file for 7 June 1972 notes: "In general, lightweight construction has taken precedence however it was realized too that success of this engine will depend to a large degree on rigidity particularly in view of the fact that a later sporting version will certainly become part of the program." And further; "A performance increase above the goal set can be achieved by familiar measures. Additional forces accompanying an increase in rpms can be absorbed by selected materials as well as lightening the oscillating masses. Breathing improvements would be necessary and achieved by increased dimensions for passages and valves which would also have to be inclined. Ideally, such a design would use four valves per cylinder which, in addition to solutions mentioned, would provide 25% more valve opening cross section," Of course this file note also mentions the possibility of turbocharging.

During the summer of 1972 work on parts which determined deadlines such as crankcase, crankshaft, connecting rods, cylinder heads and camshaft housings had progressed so far that they could count on having the first prototype parts available by October. Priority was given to the crankcase since water distribution measurements had to be made prior to assembly.

A cog belt mock-up was constructed in August to conduct necessary advance tests of drive for the camshafts as well as oil and water pumps by means of a long, toothed belt. Experiments with this mock-up ended positively and could be concluded with a 100 hour endurance run in October. The 82 inch cog belt to serve four drive functions presented surprisingly few problems on test and could be finalized.

While the housing underwent water distribution measurements and basic testing other parts were arriving one after another and shortly before Christmas of 1972 Porsche could begin to build up the first complete engine.

The big moment came on 16 January 1973 when the first 928 engine, a five-liter with carburetors, ran on one of the test brakes in the modern shops of Porsche's Weissach development center.

First bench tests of an all-new engine seldom last very long before something goes wrong and the 928 was no exception. After a few minutes water splashed from the housing and the powerplant was shut down immediately. What had happened? A crack had developed in the upper portion of the block, right in the middle of the vee, allowing water to penetrate to the outside as well as into the oil. The source of this failure was soon traced. It came from excessive offset in the housing which was thus not up to demands.

Thereafter offset was sharply limited and once a block was cast to this standard the engine was again ready for operation on 5 March, surviving its first test cycle without failure. The usual adjustment runs took place in the following week with no major problems cropping up. Thus the first full-load endurance runs could begin on 12 March, designed to provide information on any weak spots. Another block crack- this time in the lower housing - caused this test to be broken off after only 25 hours.

The endurance test could be restarted on 21 March with a reinforced lower housing and this time the new engine ran beautifully: by 3 May the pre-planned running time of 250 hours had been achieved with 209 hours of that under merciless full load. Disassembly which followed provided valuable knowledge for further experiments but also confirmed that their basic design was on the right path. In particular, the "daring solution" of a block split at the level of the bearings, using different materials and an oil groove, had surmounted all challenges.

Meanwhile the induction manifold injection system (Bosch K-Jetronic) was ready and rebuilding only took a few days. On 11 May this engine ran for the first time with injection.

By June K-Jetronic had been matched to the engine with good results and cold start experiments could begin in the climate chamber. An interesting phenomenon cropped up here: shaft seizure during the warm-up phase. Examination showed that piston skirts of a type used before were not sufficiently elastic to accommodate the close tolerances chosen as a noise reduction measure and this led to the seizures. This difficulty was overcome with more elastic, full-skirted pistons.

Installation tests, important to later engineering work, now began on a full-scale nose mock-up and they also achieved a successful 150 hour endurance run using K-Jetronic, as well as the first noise measurements. Tests in conjunction with the transaxle unit, on the bench and installed in V 3 an Audi test chassis, have been mentioned. These concluded on 19 September, to end the initial development phase of the new engine.

Clutch and gearbox developments had run parallel to those for the engine. A generous two-plate clutch of 7.9 inch diameter was used since no clutch can be taken lightly in a high performance car with elevated torque readings.

The five-speed gearbox naturally used proven Porsche synchromesh and was laid out as a direct-drive unit. Cog sets and differential shared a one-piece housing of pressure-cast aluminum,

6 October 1973

With project 928 right in the middle of its actual experimental phase a fateful day dawned to throw all work and investment into question. No matter how firmly an engineer may control his torque readings or lateral acceleration figures, he is helpless in the face of unforeseen external events.
But let us return briefly to the course of the project. In September 1972 Dr. Fuhrmann presented the latest styling stage to the partners and a few alterations were agreed upon while the basic form found ready approval from Board Chairman Dr. Porsche. Another presentation was held in July 1973 and design details were again discussed, particularly the integrated bumpers. It was agreed there would be a fast presentation on 19 November when the exterior shape and interior space would receive final approval.
Meanwhile, however, the Federal Republic of Germany (along with many other lands) was witnessing the spread of a trend which furrowed brows on the management floors of every automobile factory. Using the catch phrase of poor life quality, politicians and citizen groups blasted the supposedly catastrophic consequences of an auto-dominated society. An actual campaign against noise and pollution expanded to include damnation of traffic accidents and paving the landscape with roads and freeways. They spoke of inner city destruction by personal transport and accused cars of being the scourge of society while lauding public transport on every side as the one mode deserving general support.
Automobile animosity in certain opinion-forming circles was just approaching its peak when a single event shook the entire world:

6 October 1973.

A fourth war had broken out between the Arabs and Israel and a new weapon made headlines: the oil embargo triggering an energy crisis which had been in the air for some time. Although this oil embargo had more psychological than actual impact, its effect was cataclysmic. Anti-car sentiment surged to the fore. In view of speed limits designed to save gasoline and Sunday driving bans, automobile sales slackened just at a time when increased fuel prices boosted an already considerable inflation rate,
Porsche was particularly hard-hit and production projections for the 911 - only recently a best seller in wide demand - had to be considerably reduced. Auto animosity and an energy crisis hardly stimulate sales of high performance cars.
In this atmosphere Board and stockholders met on 19 November 1973 in the car delivery hall of the Zuffenhausen plant to evaluate the latest state of body design with integrated bumpers. They were very satisfied with results and even drank a champagne toast to the successful job and its creators, However, they were also aware of standing on the threshold of a difficult economic era whose end could not then be predicted. Dr. Fuhrmann voiced what was on every mind: "we know we are

developing a good product here but we must ask ourselves whether it is the right product now."

Thus 6 October 1973 became a vital day in the history of project 928.

Many questions clamored for attention in the days to follow, particularly since the full effects of this shock only became visible in the new year. Could they even justify the high investment of such a project? Did any sport car have a chance? Might it be wiser to fall back on a smaller and more notably fuel-saving car? Would it be better to diversify into other products such as cross-country vehicles or motorcycles? Or should they start designing streetcars?

Board and overseeing body made the only correct move in such a situation. Major investment decisions were temporarily set aside but the project was pursued. Thus the experimental program suffered no grave interruption, although some limitations were unavoidable. In any case, the result was to postpone the start of production although there was no question but that the project could be put through if a later, affirmative decision were made. Meanwhile they would monitor economic and political trends and form a basic plan for checking all alternatives. Those responsible had not lost their faith in sport cars nor in their own project and displayed the courage of their convictions. Despite the postponement of a major production investment they didn't abandon development, showing confidence that the winds would change.

During the following months crisis symptoms in the automobile industry became more and more frightening. Layoffs pyramided, production at most factories had to be cut back drastically, recession gripped the entire economy. Before such a grim background completion of the first construction stage of the Weissach development center and celebration of "25 Years of Porsche" could hardly bring forth the high spirits such events normally evoke.

Meanwhile, a basis for decisions on possible alternatives had been worked out. To begin with they resurrected a target outline from the fall of 1971 which had not been pursued any further; the one calling for a four-seat 928 alternative. Such a four-seater might appeal to a wider customer circle, thus offering a theoretically larger slice of the shrinking sport car cake. Engineering drew up plans for a four-seat 928, a generously laid out 2 + 2 with considerably more space in the rear. Within a short time the studio provided new styling sketches, built 1 :5 models and finally produced a 1 :1 plasticine model for evaluation.

Other alternatives were also explored which might reduce investment costs and make a smaller series viable. These ran from a 911 with improved technology, via a 911 with both new technology and a new skin or a 911 with new exterior and front-wheel drive, all the way to a 928 using 911 technology. The objective was to use a maximum number of common parts and still find a promising solution for the future. Since fuel consumption was topic number one in 1974, many pointers favored a smaller-capacity 911 engine. Against this, however, were ranked expected noise norms which that powerplant could only meet with expensive shrouding.

A number of other studies dealt with the supposition that production of customary sport cars would be drastically limited or entirely abandoned. They debated the construction of various other vehicles such as cross-country passenger cars, recreational vehicles (buggies) or motorcycles.

In addition, distribution which had been returned under the wing of the Porsche AG, headed by new board member Lars Schmidt, drew up a market prognosis which investigated changing conditions. The marketing people showed cautious optimism. They predicted a return to increased sales for the car industry generally but felt that exclusive sport cars would slip slightly in terms of market share while showing an increase in absolute figures.

This theory was confirmed by an outside opinion from market analyst Prof. Dr. Berndt Spiegel who defined the greater driving pleasure inherent in sport cars as remaining desirable in the future while considering a general limitation of automobiles to pure utilitarian functions as highly unlikely. He made a comparison with skiing and riding where utility functions have long-since withered while the sport has flourished. Furthermore, Prof. Spiegel recommended a clear limitation to large market areas; thus, loyalty to a pure sport car concept. In effect; he wasn't in favor of the four-seater.

A decisive meeting of Board and stockholders took place on 15 November 1974, roughly a year after both oil embargo and temporary approval of the 928. Probably the most important decision Porsche had made in many years was characterized by confidence in the future. A green light was given: the 928 would be built in its original form and would go into production as a parallel model to the 911.

Thus the original concept was declared correct. It had survived oil embargo, auto price increases and the recession without the need for basic rethinking. Apart from the operational delay which had no adverse effects since an improved 911 had experienced its third spring-time in 1975 and was selling very well again, the year of crisis left no grave marks on Porsche. Now the buyer could decide in 1977 whether the prognosis had really been correct. Then it would be clear whether those responsible for Porsche's destiny had bet their optimism and courage on the right car.

One concrete consequence did stem from all this. The question of whether it would be better in view of desired fuel economy to utilize the designed-in capacity span and reduce engine size received study. They discussed 4.5 and even 4 liters which would certainly have been reasonable too. In January 1975 capacity was finally fixed at 4.5 liters, a size which gave better efficiency and promised the most reasonable compromise in view of all other vehicle data. Figures for the proposed 4.5 liter were: capacity 4474 cc, bore 95 mm, stroke 78.9 mm.

Mobile Test Beds And Prototypes

To properly understand further chapters in this development history we should cast a glance here at the various mobile test beds and prototypes used from 1972 right up to the opening of production.

V1 (Mercedes 350 SL) served, as already described, during preliminary transaxle experiments and was used from July 1972 onwards. At the beginning of 1974 V1 received the MB three-speed automatic with torque converter intended for the 928 as well, and initial transaxle experiments were made, still using the original MB engine. In July 1974 a final change to 928 engine and front axle was made-

V2 (Opel Admiral) was used for the first time in October 1972 for preliminary chassis tests. This large sedan received a chassis similar to that of the 928 but engine and drive line were not changed, apart from a front/rear weight distribution adjustment to suit conditions expected in the 928. Front and rear suspension were made adjustable to optimize handling qualities. In October 1973 basic research was initiated with a steerable rear axle when the problem of tuck-in under load change had to be solved.

V3 (Audi 100 Coupė) became the first vehicle to test the complete drive line unit in September 1973, using the platform and front section with altered wheel housings and suspension location. This car was stretched to the necessary overall width by bulging fender extensions and taken on two major African tests as well as a Mont Ventoux mountain experiment. At the beginning of 1975 it was converted to automatic gearbox.

V4 (Audi 100 Coupė) didn't receive wider fenders. Instead it was cut down the middle and widened overall by 4.3 inches. This vehicle had the entire 928 platform, the five-liter K-Jetronic engine and transaxle with manual gearbox. It was used in chassis and engine tests from July of 1974 on.

V5 (Audi 100 Coupé) corresponded in technical basics to V4 and as of the end of 1974 was used in chassis experiments, fitted with the ultimate rear axle although it did not yet have the control link,

Munga was a bare chassis created in November 1973 and used for engine experiments. It was given the name of Germany's army jeep in deference to its off-road looks. This airy vehicle was really only driveable to a limited extent but testers enjoyed it tremendously around the Weissach grounds, It had a five-liter carburetor engine and transaxle with racing gearbox from the 908.03.

Next came those actual 928 prototypes which carried through the test program, beginning in 1974,

928 K 1 (from January 1974) was the first of all 928 prototypes, had a plastic skin and was only partially mobile. It was used for body tests and functional testing of heater, vents and electrics, later for emissions tests on the chassis dynamometer.

928 W 1 (from April 1974) was the first fully-driveable prototype with steel body. Used for chassis testing. Mounted a K-Jetronic engine and covered many miles at Weissach, Ehra and on Mont Ventoux. In addition it was used for tests and endurance runs in the climate chamber and on the rolling brake. Performed winter tests on the Turrach with the first 4.5 liter engine.

928 W 2 (from June 1974). Like W 1 technically, this car completed the first condensed-time endurance run at Weissach as well as acoustic and engine tests.

928 W 3 (from November 1974) was probably the most important prototype in all 928 development history. It was completed in time for the decisive meeting of Board and stockholders and formed the basis for their decisions. Good handling qualities were convincing.

Equipment: 5 liter K-Jetronic engine, transaxle with manual gearbox but improved rear axle with track rods for controlled self-steering.

W 3 was used in various driving tests and in the summer of 1975 went to Algeria for African tests (where a photographer managed to capture a sneak photo shown widely in the press). Carrying body camouflage of hard foam it made extensive runs on public German roads. Later underwent a definitive change to the Weissach rear axle, had its platform rebuilt to the final configuration and received overall chassis adjustments suitable for production.

928 W 4 (from October 1975) had a five liter K-Jetronic engine and transaxle with manual gearbox. Survived two condensed-time endurance runs to become an experimental vehicle for engine tests. Also; temperature measurement runs on the high-speed Ehra track and Mont Ventoux as well as winter testing on the Turrach and chassis dynamometer tests.

928 W 5 (from May 1975). Last prototype of construction stage one, fitted with 4,5 liter K-Jetronic engine and first three-speed automatic with torque converter to be tried in a 928. Test program; automatic gearbox experiments, temperature and brake tests at Ehra, preparations for national type fixing, body tests, African trips and open-road endurance runs.

928 W 6 (from July 1976), First prototype in stage two, with technology and exterior skin largely matching production standards. W 6 was used for chassis tuning, then served as presentation car for Marketing. Further test program; body tests, African runs and wind tunnel measurements. The car was then subjected to a frontal crash test at Weissach.

928 W 7 (from September 1976). Like W6 technically. Program; chassis tuning for production, type fixing measurements, body tests, component dampening experiments, general driving tests and measurements. Also used for internal introductions and (in January 1977) for reconnaissance runs prior to the press presentation.

928 W 8 (from November 1976). Final pre-production version, Completed endurance program at Weissach and eventually destroyed in a crash test.

928 W 9 (from November 1976). Like W8 technically. Used for highway endurance testing.

928 W10 (from January 1977), Another like W 8. Used for acoustic and vibration tests.

928 W 11 (from January 1977). Also to production standards but fitted with automatic gearbox. Finnish winter tests and later used in automatic experiments.

928 W 12 (from March 1977). Final 928 prototype, a technical match for pilot series cars begun in the meantime. Served for general chassis testing.

In addition to these nineteen mobile test beds and prototypes six more vehicles were built for crash testing alone, some as partial cars. Furthermore, there were various sub-assemblies such as rear mock-ups for static testing.

The estimated overall driving tally for the various mobile test beds and prototypes on the Weissach and Ehra test tracks and road surfaces of all kinds - from freeway to Algerian desert track - as well as on chassis dynamometers, comes to over 600,000 miles and that refers only to actual effective distance covered. If we include the multiplication factor for condensed-time endurance runs it would add another 600,000 miles.

An absolute maximum was extracted from every single prototype since they had to make do with as few of these costly vehicles as possible. Therefore a great deal of valuable preliminary work was performed with the mobile test beds as well as with 911 cars not listed here.

Triumph Of Teamwork: The Weissach Axle

Chassis development went forward as intensively as work on transaxle or engine, particularly since outstanding handling and high road safety were explicit development goals. With especially stiff demands placed on any high performance car it was decided to undertake expensive preliminary testing in the chassis realm as well.

The most important chassis data, including spring travel, castor, steering offset and the anti-dive factor were determined between the Testing, Pre-development and Design departments soon after the beginning of 1972. The first sketches for twin transverse link suspension, front and rear, were prepared by 25 January.

Preliminary experiments could begin. A converted 911 received an adjustable front axle unit with characteristics intended for the 928. Axle loads in this car were adjusted to conditions expected in the 928 for test purposes. Driving began in the spring and lasted through the summer.

The experimental department reported results of these preliminary tests at a general meeting of project groups on 1 September 1972. Their work indicated front axle problems could be solved with existing knowledge but the rear suspension was another matter, A phenomenon had been observed in back which is typical of high performance vehicles capable of high lateral acceleration values and one which had already given cause for earlier basic thought: the "tuck-in" accompanying load changes - such as lifting off the gas or braking. This tuck-in is a sudden oversteer tendency which can be observed best when a driver removes his foot from the throttle abruptly in a fast curve. It is caused by elastic toe-in alteration at the rear wheels with load changes and stems from "soft" suspension bushings.

In race cars where comfort is unimportant the problem is solved by "hard" suspension bushings-a solution which can't be applied to road cars.

The experimental team had already conducted elasto-kinematic tests with both 911 and 1966 in pursuit of (his theme during 1970. Working with Pre-development they had tried a wide range of possible solutions, finding none which provided the desired degree of success. They knew all too well how difficult it would be to solve this problem. Thus Pre-development noted in a basic report on 3 December 1970: "... a toe-in angle would be necessary at the rear axle which is not generally practicable."

Participants in the 1 September discussion agreed however that something must be done to control this tuck-in. They saw an unresolved problem which had to be mastered for any sport car aspiring to a future.

This subject continued to dart around their heads to such an extent that many engineers and technicians were even sketching possible solutions on scraps of paper or napkins in the cantine. Some were confiscating construction toy sets from their children in the evening to set up tests of the principle. This led to a rich fund of comic episodes - such as the children who discovered results of one-such late-night brain session next morning and took them apart which left their much-plagued daddy back at square one ...

Further information would be sought from V2, the Opel Admiral which was fitted with the suspension a 928 was to use. Tests with this Admiral could begin in October but Pre-development presented a working paper even earlier which continued the discussions of 1 September and contained new suggestions for a solution since Testing was not satisfied with experiments using angled rubber bushings. In this paper of 13 September Pre-development favored a pivot point for the rear suspension which would lie outside the track, seen in plan view, and they made a firm suggestion that the transverse link be divided into two components, giving a trapeze form which would shift forward at the wheel side under longitudinal loading. This movement would be limited by a flexible rod which would lead to a toe-in change in the desired direction at the wheel carrier

First driving tests with V 2 were positive and soon resulted in better lap times than the original design had achieved before this experimental suspension was installed. However, they did confirm the tuck-in problem as well.

Thus they had a good suspension but weren't happy yet.

On 18 June 1973 the time had come: tension grid tests with engaged wheel carrier bearings showed the hoped-for effect of track angle correction and a presentation was made outlining action to be taken. Then follow-up driving tests with V2 proved a complete letdown. Although a sufficiently large toe-in angle could be measured at the beginning of tuck-in, the undesirable tuck-in itself remained.

This started the great guessing game. How could this tuck-in effect occur when there was toe-in? Some engineers began to doubt that it was toe-in which influenced tuck-in behavior in the first place. In this situation somebody had the idea of fitting their Admiral and its experimental 928 axle with a device which would permit alteration of the rear wheel track angle underway. This suggestion was implemented immediately: V2 received a second steering wheel in the rear seat area and experiments with this unit solved their riddle. Toe-in change did indeed influence tuck-in behavior, but only when it took place immediately. In all previous experiments it had set on too late because various rubber elements in the experimental axle were "too slow."

On 15 October Experimental couid present a report with precise data showing, among other things: "that a change of toe-in at the rear wheels can remove vehicle tuck-in. *However, this toe-in change is only effective if the time lag between load change and beginning of toe-in change is a maximum of 0.2 seconds'*

They now had the principle under control but still no grasp of a solution for the 928. Furthermore, time was beginning to catch up with them so it was decided to pursue the original twin transverse link axle with coil springs further and to test it in an Audi mobile test bed. Tuck-in would hopefully be contained by suitable location and the highest practical rigidity of rubber bushings. In this manner they sought a reasonably practical solution while continuing to experiment in the time-consuming new territory of toe-in-controlled axles.

They then discovered that space conditions at the rear of a car with conventional twin link axle and coil springs were unsatisfactory. As a remedy, Engineering suggested replacing the coils with a twin-torsion bar unit placed under the rear seats. This torsion bar axle was through its design stage by January 1974 and fitted to the original prototype, 928 W1, which ran for the first time on 16 May.

Meanwhile work had continued on toe-in control as well. On 4 December 1973 a control link was suggested for the first time by Engineering but in contrast to the later production solution it was fitted to the hub. Parallel to this, Pre-development had built an experimental axle with toe-in control which was tried in the Admiral where it showed promise.

Information gained was then applied to the torsion bar axle which had also become the subject of various tests directed at the tuck-in problem. An obliquely-angled front guide for the lower suspension arm, along with an auxiliary gearbox support which could shift forward, did effect compensatory toe-out but this elastic auxiliary support bushing also increased undesirable oversteer since it brought on a lateral force oversteer effect. Better results were achieved by a track rod installed as additional locating arm. The tuck-in tendency was noticeably reduced but this solution was not entirely satisfactory since space conditions were again worsened by the extra track rod and fuel tank location, in particular, became far more complicated due to these track rods.

This torsion bar axle with track rod was to play an important role anyway since it was installed in prototype 928 W3 for the decisive presentation on 15 November 1974 - when the future of the project was decided - and its fine handling was a convincing factor.

Meanwhile a neater solution to the tuck-in problem had received such high priority that only a short month before this presentation, on 21 October, the starting signal could be given for a new, and this time basic, reworking of the rear axle. They now felt that sufficient information and experience was available to produce an axle which would fully live up to standards set in 1972.

In order to be sure they wouldn't become bogged in one area (and perhaps in the spirit of internal competition as well) two different design concepts were created and both pursued further. The first, based on the experimental track rod axle from Pre-development, was one with which they already had experience. This was relatively complicated but still seemed very promising.

The reverse was true of their second design which had no antecedents but was enticingly simple and took up very little space. In addition it promised even more rapid reaction to load changes.

A breathtaking race towards the decision as to which of these two solutions might triumph now began. This internal competition was nerve-wracking for all concerned, even a tough battle at times, but it delivered clear results. The second design proved superior by the beginning of 1975 and initial results were underlined by practice. "Quick" toe-in control was achieved by simple means and the axle was equally acceptable from a space standpoint. However an important modification became evident here too, following further experimentation. At first they had used a beveled bearing as front guide component for the lower locating arm. At the end of 1975 the experimental department suggested today's control link in place of that bearing, based on test results. This closed the circle as they returned to a component recommended as early as the end of 1972, although in different form.

It is no coincidence that this design was given the name of "Weissach axle." That title demonstrates the "spirit of Weissach" which made such a solution possible, the perfect teamwork between the most varied company areas and the untiring struggle for improvement plus the ideal collaboration of all concerned. This Weissach axle is the joint work of Experimental, Pre-development and Engineering, all inspiring one-another through the many development phases as knowledge gained from both theory and practice was brought under one hat.

Further Crucial Development Points

Among the countless fascinating characteristics of this Porsche 928, three stand out in particular: the integrated bumpers, the plastic safety tank of Lupolen, and the use of light metal body panels.

Integrated bumpers have always been a Porsche feature. The first 356s even had body-fitting bumpers painted in the car color. Despite the considerable longitudinal displacement required by America's pendulum test, integration worked splendidly on the 911 too. Thus it was obvious for the Studio to include integrated bumpers when making their first sketches for the 928 exterior; continuing a typical Porsche trademark. Such bumpers were to form a harmonic part of the whole rather than standing out optically. That meant painting them in the basic car color.

Here the engineers raised objections since they anticipated all sorts of difficulties, both when it came to sturdiness and in finding necessary paints to match the car. Painting presented special problems. The deformation requirement made the use of plastic obvious but that is not an easy substance to paint, In addition, experience suggested that painted plastic parts discolor differently than the rest of a body during the aging process.

Since such objections were in the majority, later designs featured only partially integrated bumpers with strong profile. This solution didn't really please any of the people involved. It was, in one sense, a breach of style. During the presentations talk centered repeatedly on retouching these. Thus the studio returned to its original drawings and models, again asking Engineering to deal with integrated bumpers since their design had been conceived around them from the first, after all. This led to the formation, on 26 September 1972, of the "integrated bumper" project group, detailed to find the core of this matter.

As in the case of the rear axle, they followed parallel tracks at first. Work continued on the little loved, half-integrated bumpers since nobody could be sure that the project group would be successful.

Since a preliminary decision on the integrated bumper question had to be made quite soon this project group had very little time to isolate its problem, check the latest technological standards and work out recommendations. In only four weeks they established contact with seventeen special firms, including some in the US where more factual experience was to be found. Their conclusion: integrated bumpers were workable, either using a polyurethane (PU) skin plus aluminum beam or with a PU air chamber system. Paint questions remained open but these didn't appear unsolvable and the project group received its go-ahead for further investigation.

On this basis they studied paint variations intensively. The variance in color aging stemmed from the fact that different paints must be used on metal and PU parts since the elasticity of plastic sets special requirements. In collaboration with the paint industry they finally found a combination which met all demands and fulfilled all the proposed aging criteria. Metal surfaces were painted with alkyd-melamine resin while plastic parts (bumpers) received a two-component, polyurethane-based paint. Test results for this PU paint were outstanding. A test unit, painted on one side with a patch of 0.2 inches and cooled to 0*F could be bent through 180° with a radius of 0,8 inches without cracking the paint, indicating good elasticity even at low temperatures. Fine results were also achieved in tests for resistance to chemicals or abrasion, for adhesion and for weathering.

Such encouraging results led to integrated bumpers on the Studio's 1 :1 plasticine model for internal presentation on 19 November 1973 and these found immediate approval from all those responsible. Thus the decision was made and in that same month two different integrated bumper designs were built up by the body development team.

The first was more conventional. It used a metal beam covered with a PU skin and braced to the frame rails by impact tubes (Europe) or impact buffers (US). The second design went even further in exploiting the advantages of polyurethane and provided a PU air chamber system without special beams. This was favored at first since it promised lower costs and weight but experiments indicated that the built-in lights would be damaged in oblique pendulum tests while the unit also lost decisive flexibility in cold conditions. In the realm below 0°F force peaks were too high. This chamber system was not followed up and work concentrated on the design with a PU skin and profiled aluminum extrusion as stress-bearing member.

The stroke of impact tubes or buffers was originally set at 2,4 inches but this was reduced to 1.6 inches in the course of testing since bumper return travel after impact produced excessive reaction forces between the PU skin and bordering metal panels. Thus the extruded beam and its mountings had to be reinforced. By the end of 1975 this development phase was largely concluded with successful static and dynamic tests Outstanding results in the crash test required for insurance rating purposes meant that the 928 was placed in a relatively low German collision insurance class,

The fuel tank is a further interesting construction feature of the 928. The basic concept provided for safe location of the gas tank in the tail. However designers weren't satisfied with some conventional solution, any more than they would have been if convention had been applied to special features like engine, drive line, suspension or bodywork. A steel tank would have been the norm, but many factors spoke against it.

Good utilization of available space meant a highly complicated tank shape and that would bring production problems with a steel unit. Steel tanks are also heavy. And finally, they leave much to be desired on the safety front.

Porsche already knew a better solution - a tank made of the light plastic Lupolen 4 261 A. These tanks can be built in almost any shape, they are light and exceptionally safe.

The first such Lupolen tank was developed in collaboration with BASF in 1967 for the 911 R racer. It held either 26.4 or 29 gallons and was well-proven in races, rallies and world record runs. Results were so good, in fact, Porsche was moved to offer it as an option for the 911 S as of 1970. However there was one flaw in the fitting of this big plastic fuel tank - it hardly left any room for luggage under the front lid. In 1972 this drawback was reduced by offering a large plastic fuel tank of 22.4 gallon capacity which was so carefully tailored to the space under the front lid that original trunk capacity was recovered, with the aid of an inflatable space-saver spare.

However, this plastic fuel tank disappeared again with the introduction of K-Jetronic injection. What happened?

K-Jetronic operates on continuous fuel pressure which cannot be interrupted. Yet this was exactly what happened when fuel was low in the tank and sloshed around under the influence of sharp acceleration or braking. Pressure loss occurred at that moment. To circumvent this pressure drop a swirl chamber was fitted into the tank around the pickup, designed to always retain sufficient gasoline. This swirl tank functioned as a tank within the tank since the fuel in it couldn't escape. However, such a swirl chamber can be fitted into a steel tank during production with no trouble, but it is a very different matter

with the injection-molded Lupolen tank. How would they get the swirl chamber in?
While the 911 reverted temporarily to sheet steel for its tank, specialists in this production area went to work on the problem. And they finally did manage to fit a swirl chamber into the plastic tank, a job much like model ship builders fitting a three-master into a bottle.
The method they worked out is as simple as it is effective. The swirl chamber is hung on a line inside the plastic pipe between the two halves of the form in which a Lupolen tank is "baked." There it remains, untouched by the shaping procedure going on around it. Now the line - led out the top opening - can be cut off so that the swirl chamber drops to its predetermined position where it can be welded fast. The filler tube with fuel filter which leads into it can be inserted from the outside.
With this swirl chamber problem solved nothing further stood in the way of using a Lupolen tank in the 928. Such a plastic tank was far ahead in all vital areas such as space usage, safety, weight and production ease. Besides, it had already proved outstanding in the 911. With a capacity of 22.7 gallons it still weighs only a little over thirteen pounds, while the results of various safety tests exceeded all expectations: In the impact damage test a tank was cooled to -40° F, a point where the material is inclined to brittleness, and all endangered areas of the surface were subjected to a minimum impact energy of 22 lb.-ft. from a pendulum whose impact head was pyramid-shaped with an 0,12 inch radius. No damage could be recorded, even after repeated strokes. Inherent tank integrity was tested by an interior pressure of nearly 19 psi over eight hours which revealed no leaks or permanent deformation whatsoever. Fire behavior tests were equally convincing. A car tail unit with half-filled tank was placed over a tub filled with four gallons of fuel. Despite two minutes of intense heat from this fire the tank remained tight. No fuel escaped and there was no explosive expansion from heat developed within the tank.

During the fall of 1973, at a time when production of the first prototype was approaching, it became more and more obvious that it would not be simple to meet their high requirements for comfort and safety within the projected vehicle weight, This realization presented the challenge of using aluminum to a greater degree for body panels since this would allow a component weight saving of some 50% with no loss of strength compared to sheet steel panels. Aluminum was also attractive for its resistance to corrosion. This circumstance played an important role because it was during this period that Porsche - beginning with the ideology of the Long Life car - was developing the concept of an extended automobile life span with particular stress on combating rust.
When it came to the use of aluminum in body construction - as in the previously described case of the plastic fuel tank - Porsche already had the experience to make such a project easier. From the first 356 prototypes built in Gmünd through the Spyders and 718 GTs, right down to the Abarth Carreras, they had used aluminum often. However, conditions would be somewhat different here since all earlier cars had been built in extremely small, even mini-, series where production problems played a minor role.
Therefore it was decided during a project discussion on 21 January 1974 that two fenders and an engine lid would be built in aluminum and examined carefully during long-term road tests. Immediately, recollections of experience with this metal arose, as they had with integrated bumpers. Porsche established contacts with potential producers of sheet aluminum, checked production and economics and researched customer aspects. Difficulties were expected with the joining techniques (welding of disparate parts) and in deep-drawing technology (since this material is springier than steel and has a lower breaking strain point, once-tight radii must be eased in the design phase). Finally, there was the problem of stress patterns, those visible markings which remain on the sheet metal even after painting.
The original intent was to produce doors complete with their interior frames, the rear lid and the engine lid plus front fenders in aluminum. The weight saving was

calculated at 93.7 pounds. More extensive tests showed, however, that producing the rear lid in aluminum would not be worthwhile since the design was rather complicated and the weight saved not particularly relevant. They reverted to sheet steel for that component.

On the whole there were surprisingly few development difficulties since production techniques were more easily mastered than originally expected. Three different alloys were used originally. In this way they sought to do justice to the specific demands of various components. They worked with a "hard" alloy for the fenders and with a "soft" and particularly easily welded one for the more complicated doors. However tests soon indicated that copper-bearing hard alloys were very difficult to weld and also presented scrap and waste problems because the copper content couldn't be eliminated from the melt. This was not a major problem and very soon they were using a single alloy for all aluminum components.

The first aluminum parts were used to build up prototype W 2 and tried out for the first time when this vehicle went into service in June of 1974. By the time production was achieved the following picture emerged in regards to weight:

Component	*Steei*	*Aluminum*
Engine lid	32.6 lb.	18.7 lb.
Fenders, two front	43.2 lb.	26.5 lb.
Doors, two	81.1 lb.	44.1 lb.
Total	156.9 lb.	89.3 lb.

Thus the use of aluminum parts effected a weight saving of 67.7 pounds since they were 43% lighter than corresponding components made of sheet steel.

The Proving

We have discussed a number of preliminary experiments and tests of various aggregates or components in earlier chapters, The actual experimental operation, which reached its peak between 1974 and 1976, is covered by the vast selection of photos in this book, all of which speak for themselves.

Thus we will limit ourselves here to listing a few highlights from those years of testing. The project book laid down many key points-from reducing engine noise to flawless operation of the windshield wipers; from winter worthiness in any climate to upholstery durability; from soft gear changes in the automatic gearbox to reliability at full throttle; from true-track braking without fade to perfect opening and closing of the rear lid; from low wind noise to functional ashtray location.

Then there was the total of seven condensed-time endurance tests over 5000 miles of the ultra-difficult Weissach loop which corresponded to normal road use of nearly 100,000 miles each. The demands of those merciless tests were so great that newcomers to the driving team often became nauseous in a very short time.

There were the especially spectacular endurance runs on engine test brakes: a full-load bench run of more than 3 000 hours as well as five runs of 600 hours each between December 1975 and March 1977.

Add in three endurance road tests of some 50,000 miles each in mixed conditions of city traffic, highways and freeways plus high-speed tests on the fast oval of the VW test facility in Ehra plus extended 50,000 mile runs with prescribed driving cycle required for the US emissions test and carried out on a special chassis dynamometer.

Furthermore, there were four expeditions to North Africa, testing for heat and dust on desert runs over unbelievable road surfaces in the remote Algerian hinterland where all-wheel drive is the only real way to travel. This Algerian testing has become a fixed part of every development program at Porsche and places high demands on man as well as vehicle. In some ways these were both culmination and fulfillment in the grim battle for success after years of work by Weissach engineers. Such desert tests had a true expedition character, reminding many participants of crewing a major rally-often there was no hope of a clean hotel bed or well-equipped work site. They had to get along with the simplest means, forgo all comfort and subject their creation to conditions the average European motorist would never conceive of trying for a moment.

The counterpoint was provided by winter worthiness tests over the famous Turrach Pass in Austria and at the Arctic Circle in Finland where conditions again tested not only cars but crews. At - 40° F not only heaters and defrosters, lights and starters suffer but also test drivers who must enter the information gathered in their logs, despite ice-stiff fingers . , , And finally there was mountain behavior. Three times the crews booked quarters in Bedoin to launch extended mountain runs, including trailer tow tests, on Mont Ventoux, baking and deserted under the Provence sun. This mountain course in the south of France was well-known to Porsche development crews from the great European Hillclimb Championship era up to 1968. Its many faces provide answers to every question of uphill testing: enormous differences of altitude with accompanying alterations in air density, gradients of all types, as many curves as you could wish for, and the particularly relevant fact that it is far from normal traffic, those crowds which have made any sensible test program impossible on the classic Alpine passes.

Then there were the endless driving tests at Weissach to adjust handling in both fast and slow curves, on good or bad surfaces, rain or shine. They tested for aquaplaning on the straights and in curves, went through the salt water splash to check sealing of ignition and passenger compartment against fords or heavy rains, investigated side wind sensitivity and the effectiveness of lights in poor conditions. Next came checks of all aspects of safety necessary to meet legal regulations in various lands. Among these were six impact tests of driver onto dashboard and central console: three crash tests for seat backs and head rests; six acceleration tests for all lids and compartments. And if that wasn't enough there were five impact tests from different positions on the steering wheel.

Far more elaborate were three frontal crash tests at zero degrees, and one each frontal crash at impact angles of +30 and -30 degrees to the longitudinal axis (in effect against the right and left front fenders), as well as two side crashes and four from the rear. Tests of seat belt anchorages, door resistance to lateral intrusion, bumpers (ten times) and roof rigidity were only the tip of the iceberg compared to many hundreds of experiments, both large and small, all devoted to safety.

Other tests and measurements were devoted to clutch, gearbox and entire transaxle unit, to electrics, bodywork and vibration or noise technology, following without pause upon other experimental work. All this ensured that item after item could be checked off in the project book, right through the development period.

Particularly during outside tests engineers and technicians were often confronted with unexpected situations and many episodes later became favorite anecdotes. We might quote a few here.

The second Audi Coupe used as a mobile test bed (V4) had its body widened by 4.3 inches but otherwise was easy to mistake for any normal Audi 100 Coupe. During one test run this car was parked in a town while its crew had a cup of coffee. They noticed a man studying the car intently, then walking off, shaking his head, He was back in a few minutes to study the Audi all over again, Then he began to estimate the vehicle's width with outstretched arms. When the test team approached and asked his problem, the man said he could swear this car was wider than his own and that seemed very strange indeed since he drove the same model. Porsche's people had an answer on the tip of their tongues; "Ah. your car must have shrunk. You know, there was a whole series painted with shrinking paint by mistake.[11]

In the Algerian desert one crew came upon an improvised engine job under the open sky. A native was trying to fix a defective connecting rod bearing on his vehicle and since a new bearing shell was unavailable this clever native approached the Porsche engineers to ask if they could help him out with a piece of leather belt. Under the astonished gaze of the Swabians this man carried out his daring repair, actually using a piece of belt leather for a con rod bearing. Their astonishment was even greater when his automobile left under its own power after this curious repair job. Since they later met man and machine at an oasis over 100 miles away, there could be no doubt but what his unconventional mechanical method had been a complete success.

Not all the test events were equally romantic. During a heat test in the climate chamber the temperature climbed so high that the floor mats began to glow, driving the tester out.

Yet such events were harmless compared to a nighttime episode which occurred during prototype testing on the autobahn. Drivers had been instructed to refuel from jerry cans, well away from official filling stations, in the protective darkness of a truck parking lot and as inconspicuously as possible. They were following these instructions to the letter one night when the crew discovered to its sorrow that they had unsuspectingly chosen a spot which was equally popular with drug pedlars in search of shadows. They suddenly found themselves staring in horror down the barrels of police machine pistols. Narcotics agents have very little understanding of disguised sport car prototypes and it took quite a while to clear up the matter and reestablish the honor of the startled technicians.

The tables were turned during winter testing on the Turrach heights. There too the leading car of a Porsche test convoy fell into a nighttime police check, leading to considerable complication. The convoy had standing orders to always remain close together and in case of any halt to protect the leading W4 prototype from all prying eyes by forming a barrier of cars around it in the best wild west wagon train style. Within seconds a circle of roaring engines and squealing tires closed ranks around W4 which had been stopped by the police. The effect must have been startling indeed since this concerted action so terrified the police they left the site in a rush.

Geneva1977

Although the completed 928 had already been presented to a selected circle of international journalists near Nice at the end of February 1977, its official debut took place within the same framework Porsche had chosen almost thirty years earlier for the original showing of the 356 - the richly-traditional Geneva Automobile Salon, that major spring display of the auto industry.

This new Porsche was unchallenged star of that Salon, acting like a magnet on press, the prominent and all car fans. Leading engineers from every automobile company found their way to the Porsche stand, as did successful race drivers. The President of the Swiss Federation sat in the cockpit with admiration on his face, to be followed by great names from the sporting world, show business, the arts and business.

The premiere found a strong echo in the motoring press which saw in 928 a truly new sport car generation setting standards for the future. A German motor magazine wrote: "The 928 is not only some kind of new car but a piece of automobile development history." And a daily paper explained precisely why this was so: "The super sport car of the eighties no longer roars, sweeps by spectacularly with the tail hanging out, nor extends the driver at high speeds with its unruly road manners."

A Swiss motor publication recognized the concept of the 928 in relation to the future: "The 928 proves that a car with above-average speed and safety retains its superiority even in the age of mass transport and doesn't have to exclude sportiness and outstanding driving comfort." Similar impressions moved a German daily newspaper to lecture other car producers: "This synthesis of longevity, sportiness and comfort represents the Porsche philosophy of the top-value car of tomorrow, exclusive yet capable of simultaneous everyday use. It is a lesson which not every producer of similarly expensive cars has learned."

The love of fine detail, among other things, was praised by an English motoring magazine in this comment: 'The bumpers are so well integrated into the body that the car seems to have no bumpers at all, but nevertheless crash tests have shown these to be effective in limiting damage at impact speeds much higher than the 5 mph for which they are designed. Such standards are typical of Porsche thoroughness and attention to detail, and since this attention to detail is matched by clever basic engineering, the future looks good for the 928,"

The new model even prompted a German weekly newspaper to flights of journalistic fancy as it reported: "This Porsche 928 is no longer a car, it is a throne for the gods or - if you prefer - a smash hit, a hammer blow, a super-thing on wheels."

The circle from first sketch to production maturity had come to a close in Geneva. Experiments had been concluded in the main, production tooling had long-since been ordered and some of it even put into place. Pre- and pilot series were completed. Yet there was still a great deal left to be done before production could begin in the late summer - production preparations could easily provide the material for another such book.

Project 928 had been carried through in roughly five and a half years and it passed its first great test with flying colors during the era of the energy crisis and recession. The foresightedness of the firm's philosophy and the design's own promise were the reasons that this hiatus of 6 October 1973 could not condemn the new car to an early end. And the fact that such blows didn't provoke any major delays may be credited to the Weissach development team with its high level of experience, its determined dedication and its modern equipment.

Project 928 had now become the Porsche 928, rolling off the production line since August 1977 to be seen on the roads of the world. As we go to press it has already found so many friends that Dr. Ferry Porsche and his colleagues can view the future without serious reservations. Developments have proven their courageous decision of November 1974 to have been the right one. With this 928, a highly modern sport car roars into the future, carrying a great tradition - driving in its purest form.

Technical Data Type 928

Sales designation		928
Type and trade designation		928 4.5
Type plate		928
Internal designation		928

Engine

Engine type (official)		M 28.01
Cylinders		8
Bore	mm (in.)	95.0(3.74)
Stroke	mm{in.)	76.9(3,11)
Capacity	cm^3(cu.in,)	4474(272.97)
Compression ratio		8.5:1
Max. oulput,DIN70 020	kW(hp)	177(240)
Net Power. SAE J 245	kW(hp)	171(229)
at revolutions	min^{-1}	5500
Max. torque, DIN 70 020	Nm(kpm)	350(35.6)
Net Torque, SAE J 245	Nm(lb.-fi.)	339(250)
at revolutions	min^{-1}	3600
Max.liter output, DIN 70 020	kW/l.(hp/L>	40(54)
SAEJ245	kW/l.(hp/l,)	38(51)
Rev limit via ignition cutout at	min^{-1}	6300 ±200
Engine weight (dry)	kg/lb	245 (540)

Engine construction

Type	V 8, four-stroke, Otto engine
Crankcase	Two-piece, light alloy block-crankcase, without liners
Crankshaft	forged, 5 plain main bearings
Connecting rods	Steel, sinter-forged
Pistons	Light alloy, cast, running surface chrome or iron plated
Camshafts	Cast, in camshaft housing without bearing shells
Camshaft drive	Cog belt, via tensioners
Cylinder heads	Light alloy
Valve arrangement	1 intake, 1 exhaust, overhead, inline
Valve actuation	By overhead camshafts and hydraulic cup lappets
Valve timing (1 mm stroke, zero play)	Intake opens: 8°ATDC
	Intake closes: 55° AB DC
	Exhaust opens: 38° BBDC
	Exhaust closes: 2° BTDC
Valve play	Seif-adjusiing (hydraulic)

Engine cooling

Enclosed cool water system, mechanical fan with visco clutch (With optional air conditioning. additional pre-engaged electric fan with thermostaticswitch)

Engine lubrication

Engine lubrication	Pressure lubrication with sickel pump
Oil Filler	In mainstream

Oil pressure at 5000 min^{-1}		Approx. 5 bar/72 psi at 80-100° C or 175-210* F oil temperature
Oil pressure indication		Control lamp and manometer
Oil consumption	l./1000km	Approx. 1.5
	mi./qt.	Approx. 6250

Exhaust system

Twin pipes to front muffler; front, middle and main mufflers

Heating

Warm water heating with heat exchanger and fan

Fuel system

Fuel system		K-Jetronic
Fuel transport		Electric fuel pump
Octane requirement	ROZ/MOZ	91/84
Normal consumption, DIN	l./100km-mpg	13.2(17.8)

Electric System

Suppression level		ECE R10 and 72/245/EWG
Battery	V	12
Battery capacity	Ah	66
Battery capacity (M-option)	Ah	88
Generator-output	W	1260
Ignition {breakerless)		Transistor-coil ignition
Firing order		1-3-7-2-6-5-4-8
Ignition timing		31° BTDC at 3000 min^{-1} without vacuum
Sparkplugs		Bosch W145 T 30 Beru145/14/3A
Soark plug electrode gap	mm	0.7 + 0.1

Powertrain Layout: Front engine, gearbox in the rear, fixed as single drive unit by connecting tube.

Power flow:	Front engine, clutch, torsionally elastic drive shaft to gearbox within connecting lube on bearings, rear-mounted gearbox in unit with final drive, double-jointed drive shafts to rear wheels.
Clutch	Two-plate dry clutch with plate spring, mounted at engine. 0 200 mm (7.9 in.)

Gearbox

Internal designation		G 28.03	G 22 (autom.)
No. gears	forw./reverse	5/1	3/1
Ratios.	1st gear	3.60	2.31
	2nd gear	2.47	1.46
	3rd gear	1.82	1.00
	4thgear	1.34	
	5th gear	1.00	
	R.gear	3.16	1.84
Final drive 12/33		2.75	275
Stall speed			min^{-1} 2500
Stall ratio			2.0

Body design		Coupe with unitary, 2-doorsheet steel bodywork, rear hatch and pop-up headlights. Engine hood, doors and bolt-on front fenders in aluminum sheet. (Opt. with sliding roof.)
Chassis		
Front axle:		Independent suspension, dual transverse arms with coil springs enclosing shock absorbers.
Springing		1 coil spring per wheel
Shock absorbers		Dual-aclion, hydraulic shocks
Anti-follbar	mm0{in.)	26(1.02)
Steering		Rack and pinion with track rods. hydraulic boost (servo-steering)
Steering wheel	mm0(in.)	380(15)
Steering ratio (median)		17.75:1
Turning circle	m(ft)	11.5(37.73)
Track circle	m(ft.)	9.6(31,49)
Turns, lock to lock		3.13
Rear axle		Independent suspension, dual transverse arms with toe-in stabilization by control link (Weissach axle).
Springing		1 coil spring per wheel
Shock absorbers		Dual-action, hydraulic shocks.
Anii-roli bar	mm0(in.)	21(0.83)
Brakes		
Operational {foot)		Hydraulic, dual-circuit brake system with diagonal circuits, brake boost, floating-calipers front and rear.
Bfake servo	0in.	9
Mam cylinder	mm0(in.)	23.81(0.94)
Caliper piston	mm 0 (in.)	54 (2.13) front/36 (1.42) rear
Brake disc (vented)	mm 0 (in.)	282 (11.1) front-289 (11.4) rear
Effective disc	mm 0 (in.)	220 (8.7) front-235 (9.3) rear
Pad area ea. front wheel	cm^2 ($in.^2$)	92.8(14.4)
Pad area ea. fear wheel	cm^2 ($in.^2$)	650(10.1)
Total brake pad area	cm^2 ($in^{.2)}$	315.6(49)
Handbrake		Mechanically operated drum brake on both rear wheels
Brake drum	mm0{in.)	180(7.1)
Brake shoe, width	mm (in.)	25(1.0)
Liner area ea. wheel	cm^J($in.^3$)	85(13.2}

Rims and Tires

Tires-standard;	
Rims (from and fear)	7Jx 16H2
Tires (front and rear)	225/50 VR16
Tires-M-Opt	
Rims (front and reaO	6J x 15H2
Tires {front and rear)	215/60 VR 15
Tires-Winter	
Rims (front and rear)	7J x 15H2 or 7J x 15H2
Tires (front and rear)	185/70 SR 15 M + S or 205/55 SR 16

Tire pressures:		For all speeds, measured with tires cold.
Front	bar (psi}	2.5(36)
Rear	bar (psi)	2,5(36)
Wheel adjustment		at DIM empty weight
Front axle:		
Toe-in (15 kp/33 Ib. load)		0°±5'
Camber		-30' ± 10'. max. diff. left to right 10'
Caster (with servo steer.)		3° 30' + 30', max. diff. left to right 20'
Rear axle:		
Toe-in		10' ±5'
Camber		-40' ± 10', max. diff. left to right 10'

Dimensions

Length	mm (in.)	4447(175.08)
Width	mm (in.)	1836(72.28)
Height (DIN empty wt.)	mm (in.)	1313(51.69)
Wheelbase {as built)	mm (in.)	2500(98.43}
Track:		
front, empty weight	mm (in.)	1545(60.82)
laden	mm (in,)	1551 {61.06)
Rear, empty weight	mm (in)	1514(59.60)
laden	mm (in.)	1530(60.23)
Ground clearance (laden)	mm (in.)	125(4.92)
Curved ground clearance (laden)	mm (in.)	40(1.57)
Ramp angle front		22°
DIN rear		19° 30'

Weights

		Manual gearbox	Automatic gearbox
Empty, wilhout M-opt.			
	front kg (lb.)	725(1600)	725(1600)
	rear kg (lb.)	725(1600)	765(1685)
	total kg (lb)	1450(3200)	1450(3200)
Permitted axle loads			
	front kg (lb)	900(1985)	
	rear kg (lb.)	1100(2425)	
Permitted total	kg jib)	1870(4125)	
Permitted roof load	kg (lb)	35(75)	
Permitted trailer load			
unbraked	kg (lb.)	75011655) (up to 16% grade)	
braked	kg(ib)	1600 (3530) (up lo 16% grade)	
Permitted tow wt	kg (lb)	3470(7650)	
Drawbar toad	**kg (ib**)	50(110)	

Capacities

Engine oil		Brand-name HD oil to API classification for SD/SE viscosity: Summer SAE 30, Winter SAE 20. at steady temperatures of -15 to 0° C/S-32*F SAE *20* W 20 at steady temperature below -15 C/5 0 F SAE10W
Year-round use:		(Multigrade oils: 15 W 50 or 20 W 50 after release)
Engine oil capacity	l (qt.)	approx. 6.5/6.9 (dip stick reading is determinant)
Engine coolant	l. (qt.)	approx. 16/16.9
Gearbox oil		Mypoid oil SAE 90 to Mil - L 2105 B API classification CL 5
Gearbox oil capacity with differential	l(qt.)	approx. 3.8 (4.0) approx, 86 (17.4) with 15(4)
Fuel tank	l. (gal.)	reserve
Brake fluid	l.(qt.)	approx. 0.2 (0.21)
Tank for windshield and headlight washer	l. (qt.)	approx. 8(8.5) water
Tank for cleaner	l. (qt.)	approx, 0.6 {0,64)

Performance

		with5-speed gearbox	with automatic gearbox
Top speed	km/h-mph	over 230 (144)	225 (141)
Acceleration 0-100 km/h (0-62 mph)	s.	6.a	7.8
1000 m with standing start	s.	27.0	28.0
Performance weight	kg/kW	8.3	8.5
	lb./hp	13.2	13.7

Climb **performance**		with5-speed gearbox	with automatic gearbox
1st gear	%	78	65
2nd gear	%	45	35
3rd gear	%	30	22
4th gear	%	19	
5th gear	%	11	

Deviations for US and Japanese models

Max.outpui.DIN70 020	kW(hp)	169(230)
Net power, SAE J 245	kW(hp)	164(219)
at revolutions	min^{-1}	5250
Max. torque. DIN 70 020	Nm(kpm)	343(35.0)
Net torque. SAE J245	Nm(lb.-ft)	333(245)
Rev limit via electronic fuel pump cutout at	min-1	6300 ±200
Engine weight (dry)	kg(lb.)	260(575)

Exhaust system	Twin pipes to catalyzer, middle and main mufflers.
Exhaust treatment	Exhaust gas recirculation, secondary air injection.

Rims and Tires
For cars with automatic gearbox

Tires-standard:

Rims (front and rear)	7JX15H2
Tires (front and rear)	215/60 VR 15

Dimensions

Length	mm (in.)	4462(175.67}
Height (DIN empty wt.)	mm(in.)	1311(51.61)
Ground clearance	mm (in.)	119(4.69)
Curved ground clearance	mm (in)	36(1.42)
Ramp angle DIM	rear	18°30'

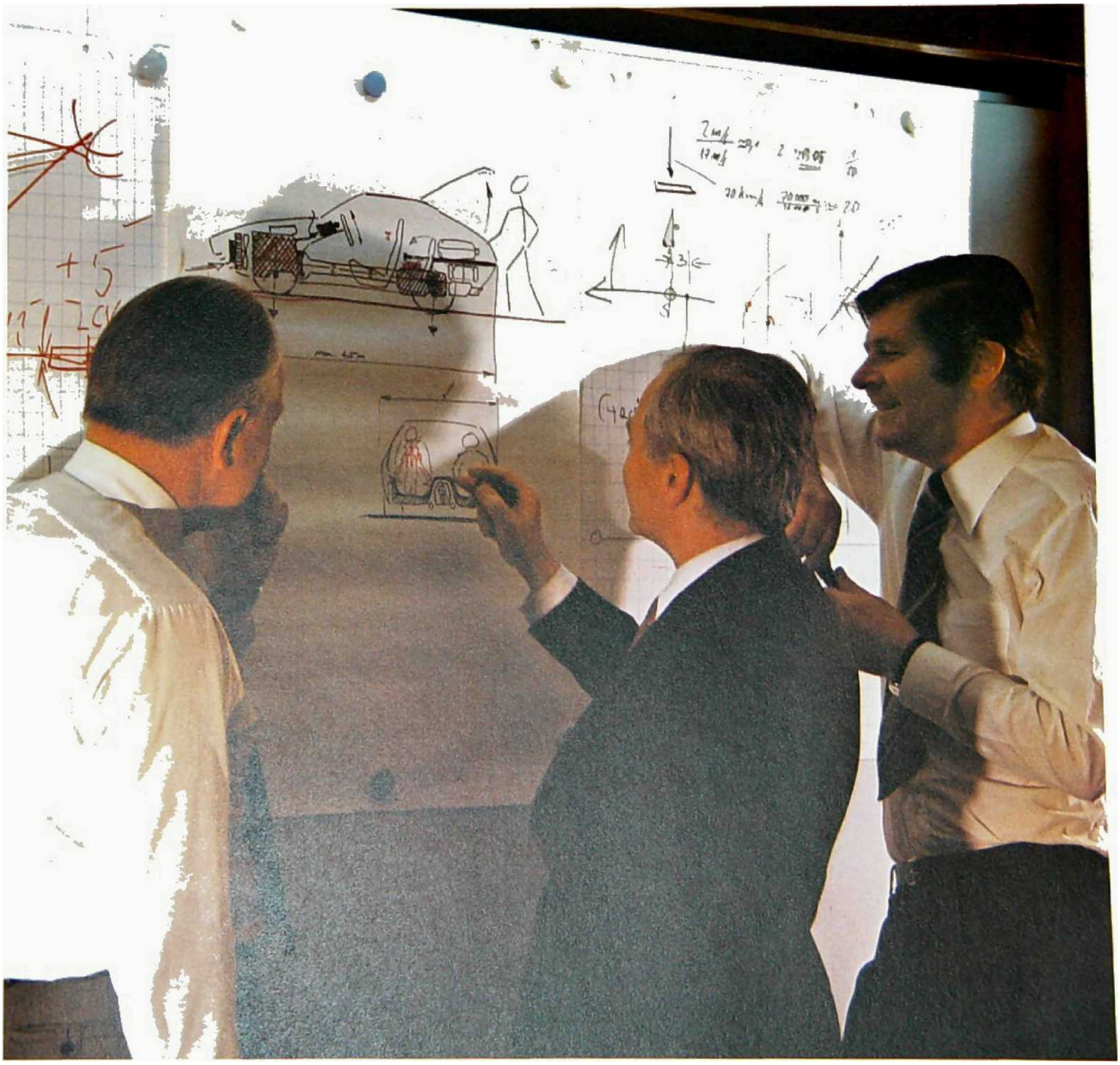
Weights

Empty, without M-opt,	Manual gearbox	Automatic
front kg (lb.)	745(1645)	745(1645)
rear kg (lb.)	745(1645)	785(1730)
total kg (lb.)	1490(3290)	1530(3375)
Permitted axle loads		
rear kg (lb)	1000(2205)	

Climb performance		with5-speed gearbox	with automatic gearbox
1st gear	%	71	56
2nd gear	%	41	33
3rd gear	%	28	22
4th gear	%	18	
5th gear	%	11	

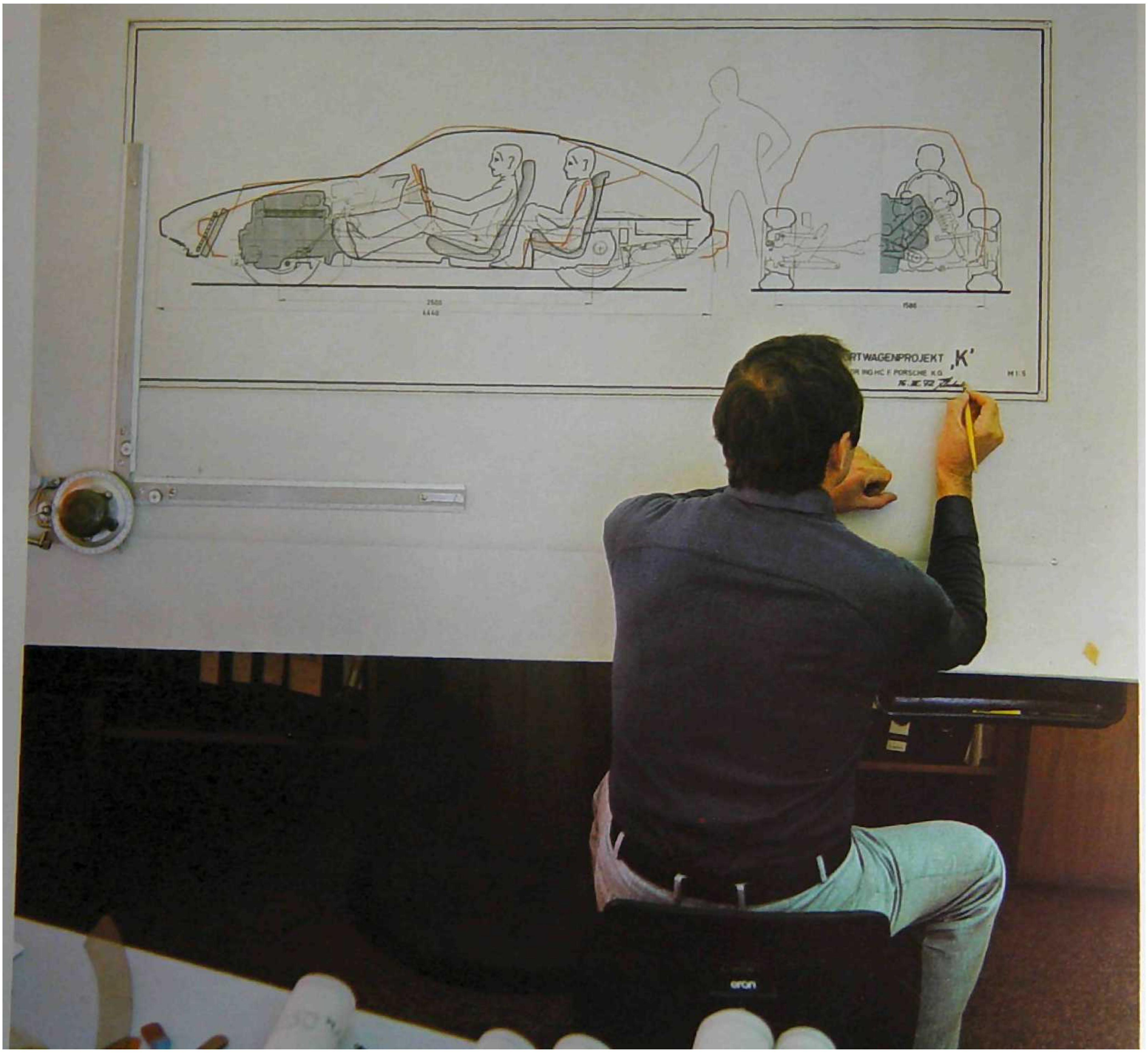
Project 928 Unfolds

Leading technicians "project" the finished 928 which has already taken farm in their heads. Dr. Ernst Fuhrmann discusses details of a working sketch during the design stage with Helmuth Bott (left), Head of Development, and Construction Chief Wolfgang Eyb who functioned *as* the "project father."

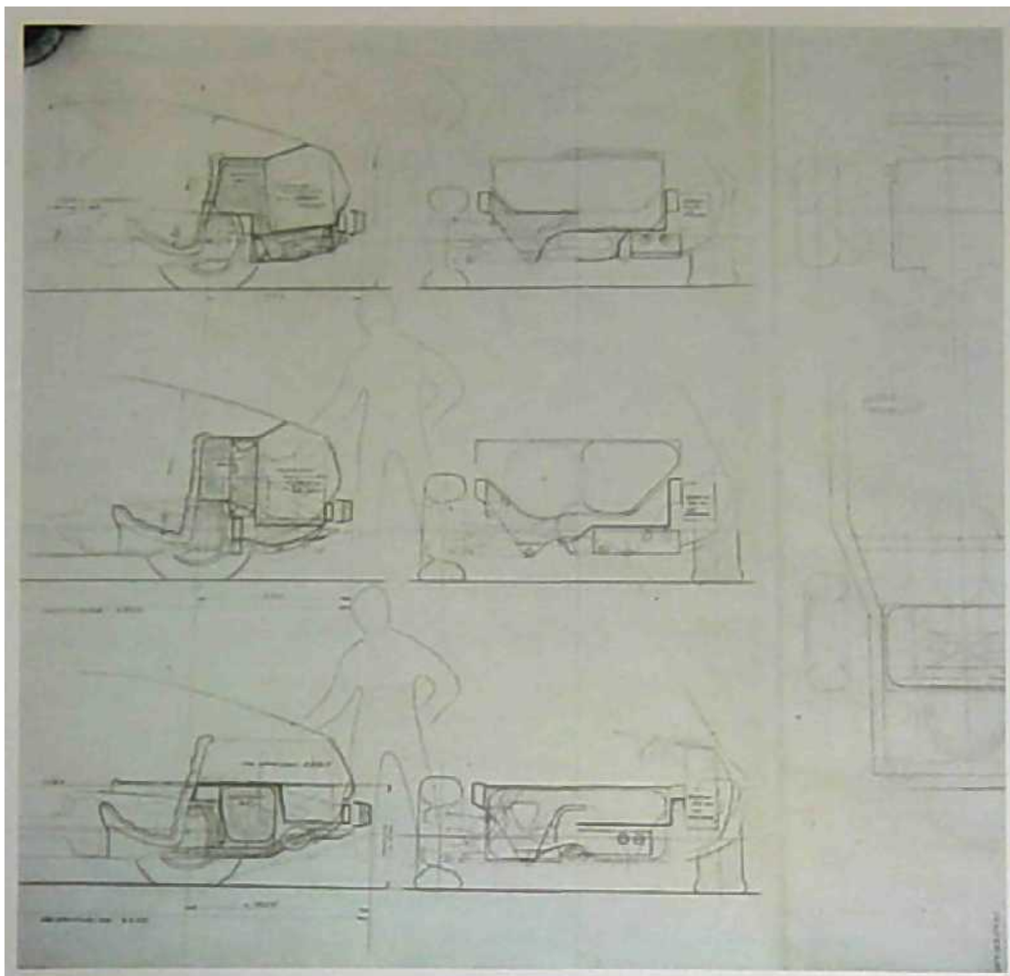


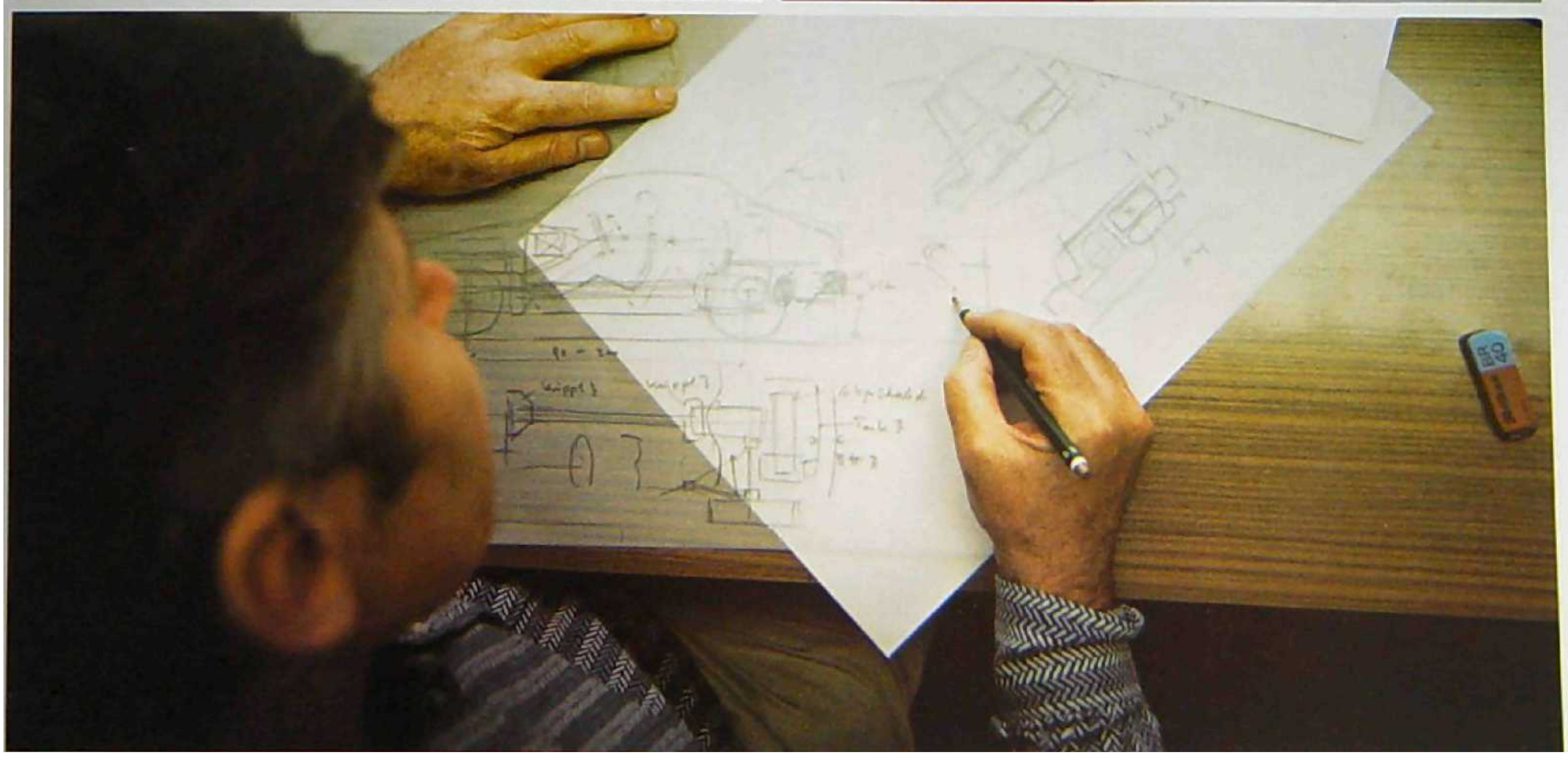
Looking over the shoulder of a project draftsman. The hour of the drafting engineers struck in the winter of 1971/72; the 928 project look on its first contours under the internal designation "K." The design ideas they had in mind were presented and the base was established for the work of stylists and designers.

Man has already taken center stage - he furnishes the criterion for all dimensions and drawings are developed around him. Brown lines delineate the 911 silhouette, to serve as a comparison.



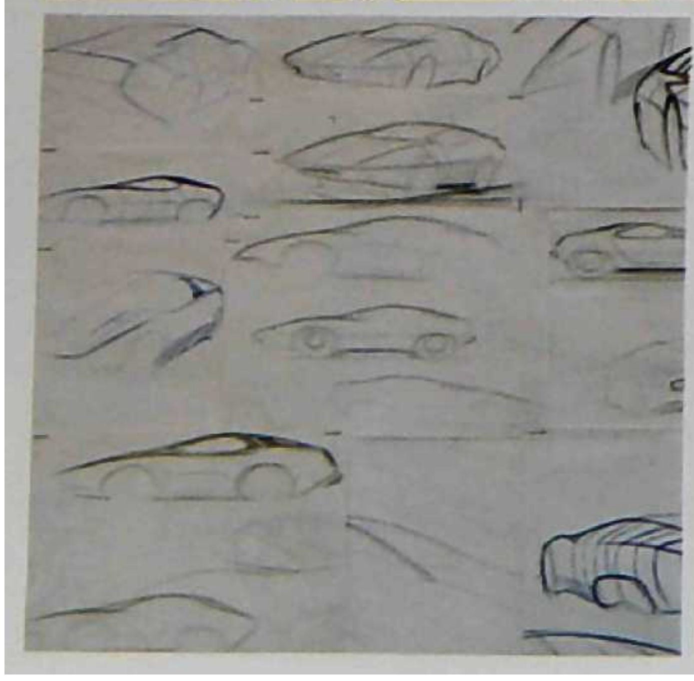
Selected project designs are based on examination and evaluation of countless pre-designs. Such sketches (left: suggestions for fitting aggregates into the tail area) give designers a necessary over view of the values for various spatial dispositions. Design boss Wolfgang Eyb (bottom) also played an intensive role in the search for optimum arrangement for all aggregates.

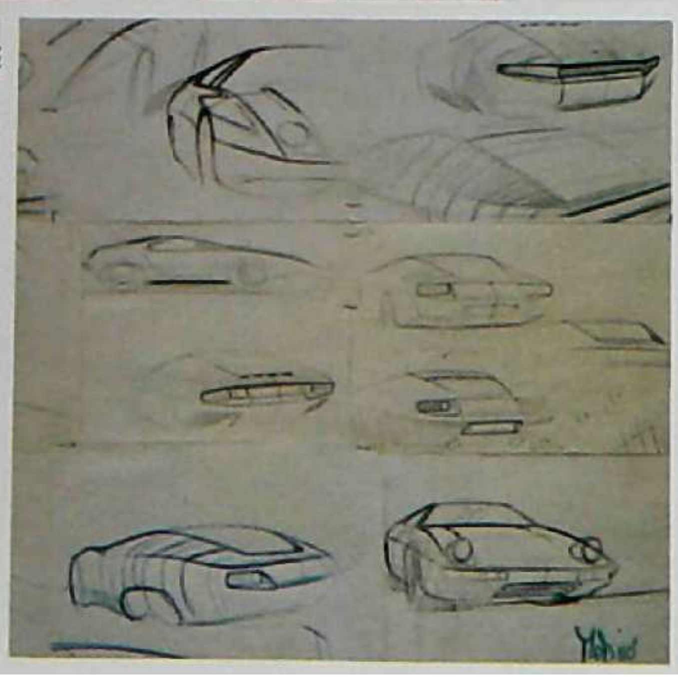


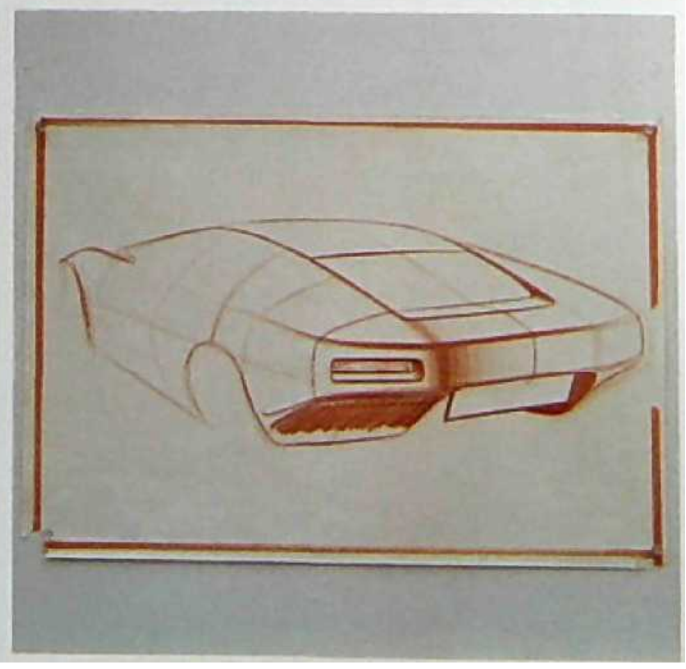


A handmade chassis-structure model was completed early and was then one of the important aids during further work *by* body designers.

Now designers begin the battle with exterior Form in the Styling department. Sketch books fill tip and the vague contours (below) of first efforts develop into a clearer and dearer picture of their goal. Form now emerges from the tug of war between creative impulses, projected dimensions, legal requirements and good aerodynamic values.

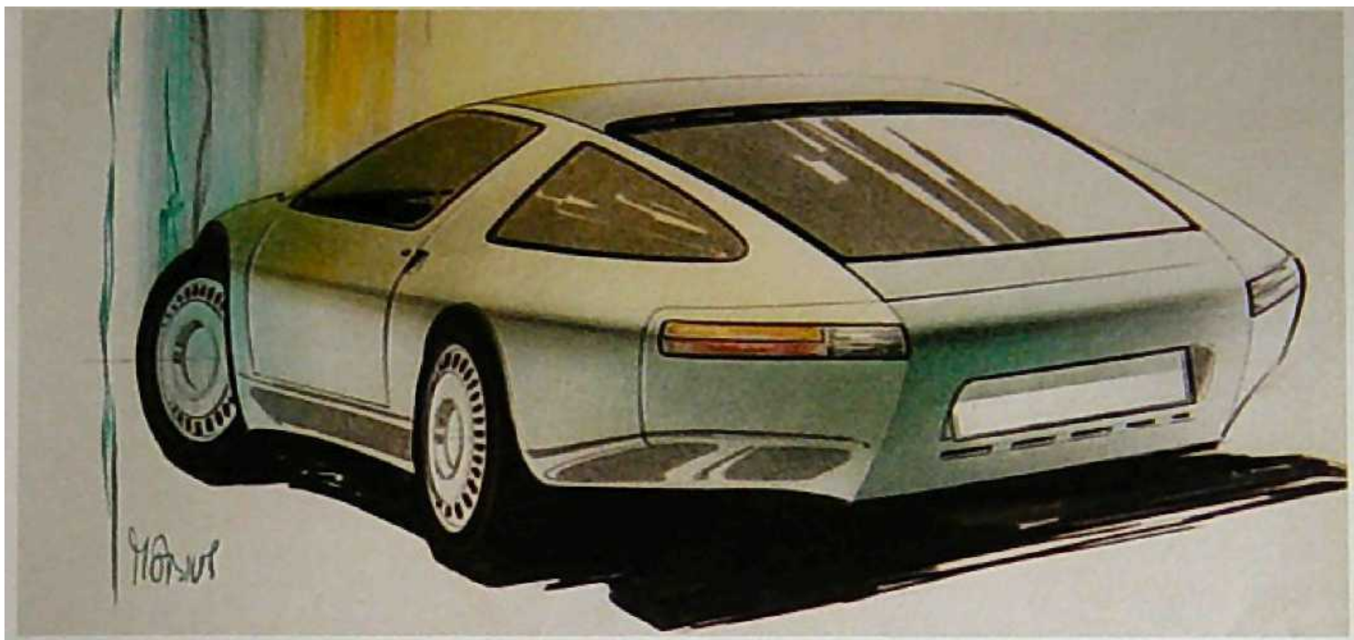


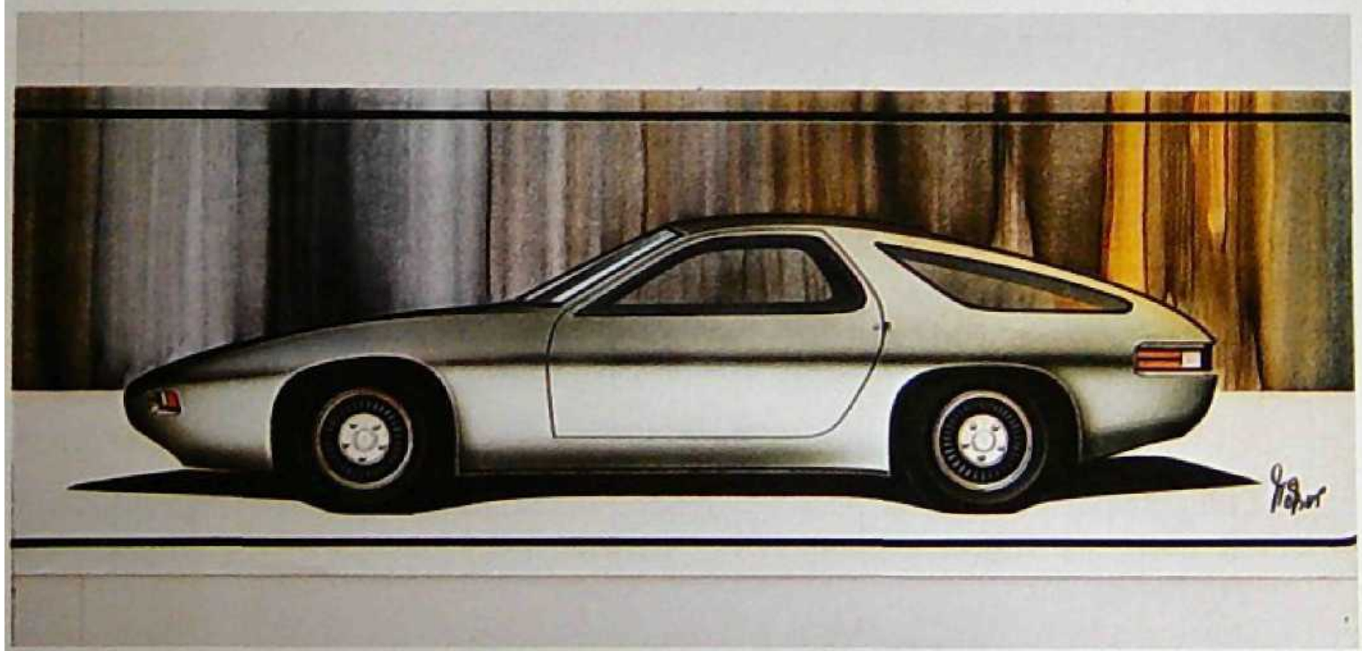


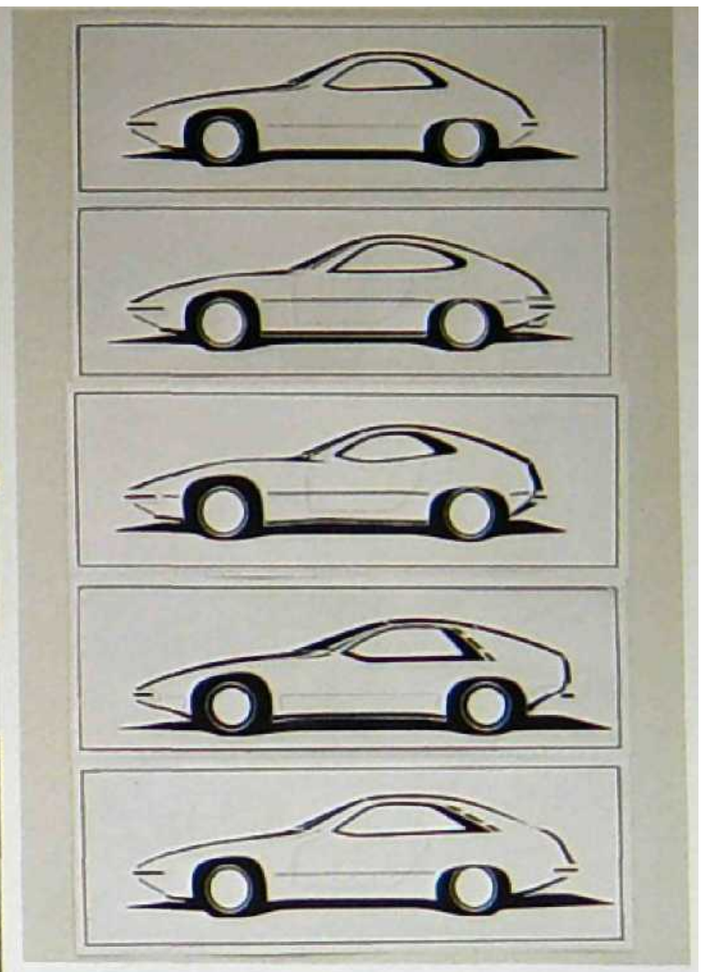


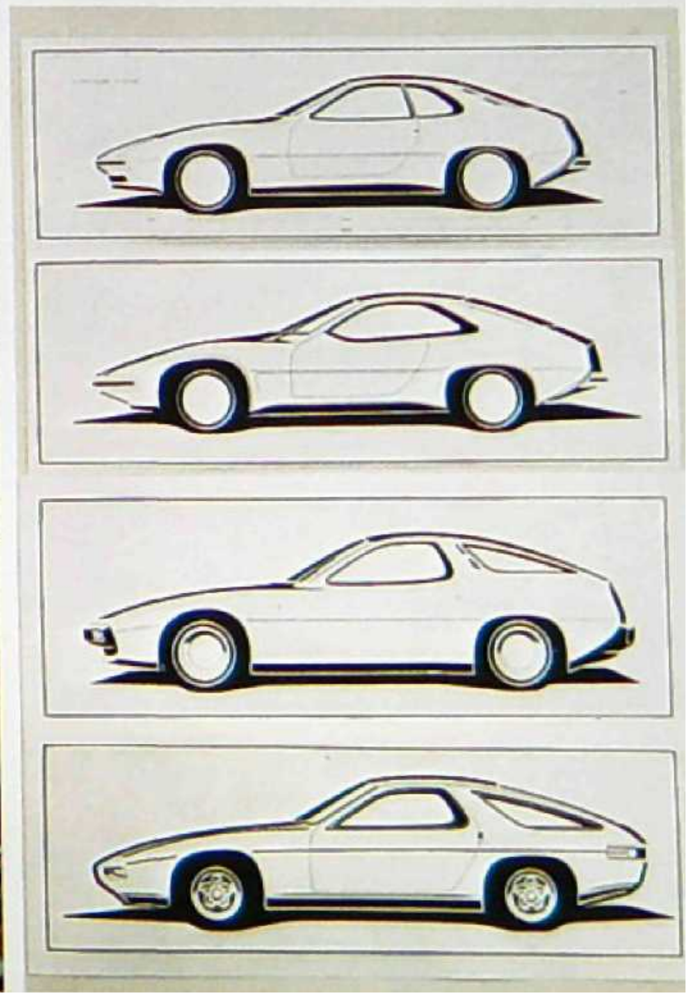
The designer feels his way through many stages (right) to an acceptable synthesis from which he produces detailed and actual presentations.

Now the art of drawing is turned into fine art-the most promising studies serve as basis for the production of plasticine models. Our bottom photo shows the work on such a model. Only half is sculpted, the mirror completes it.



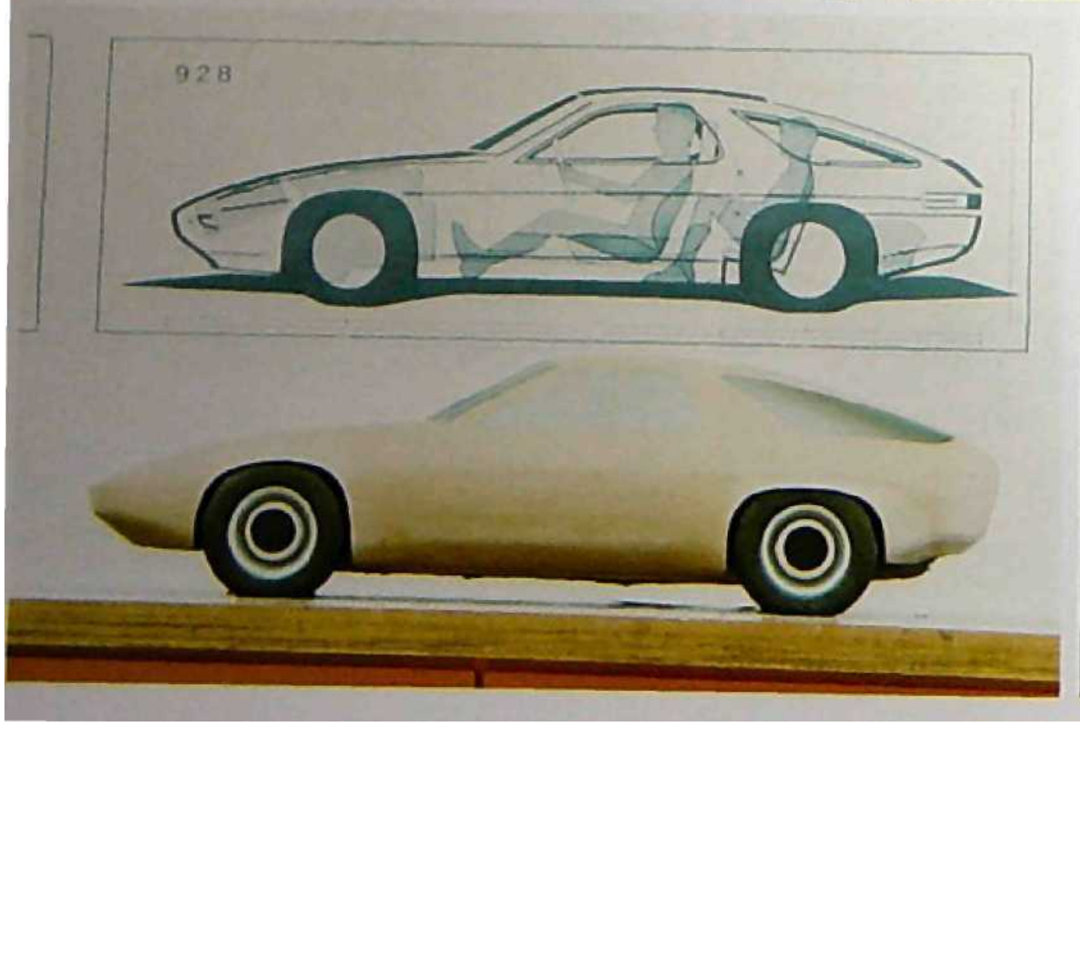


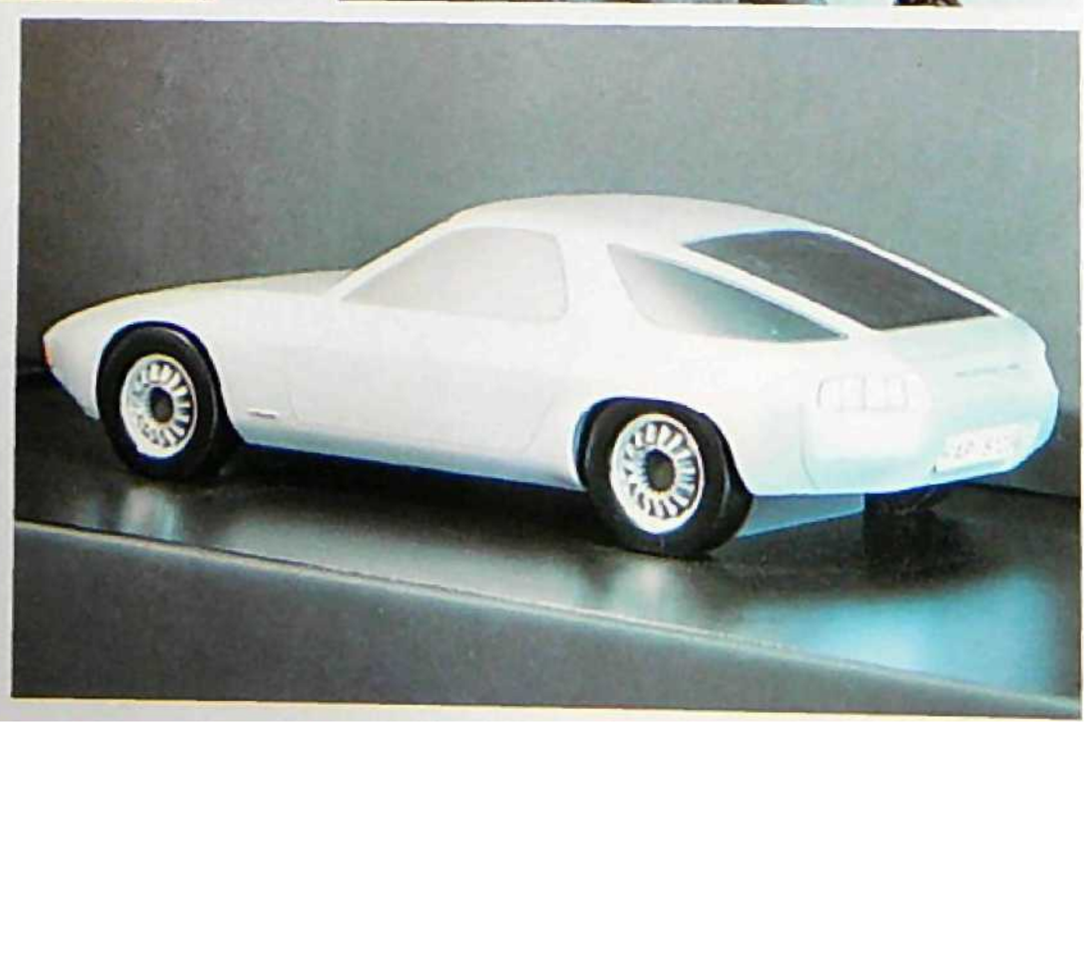




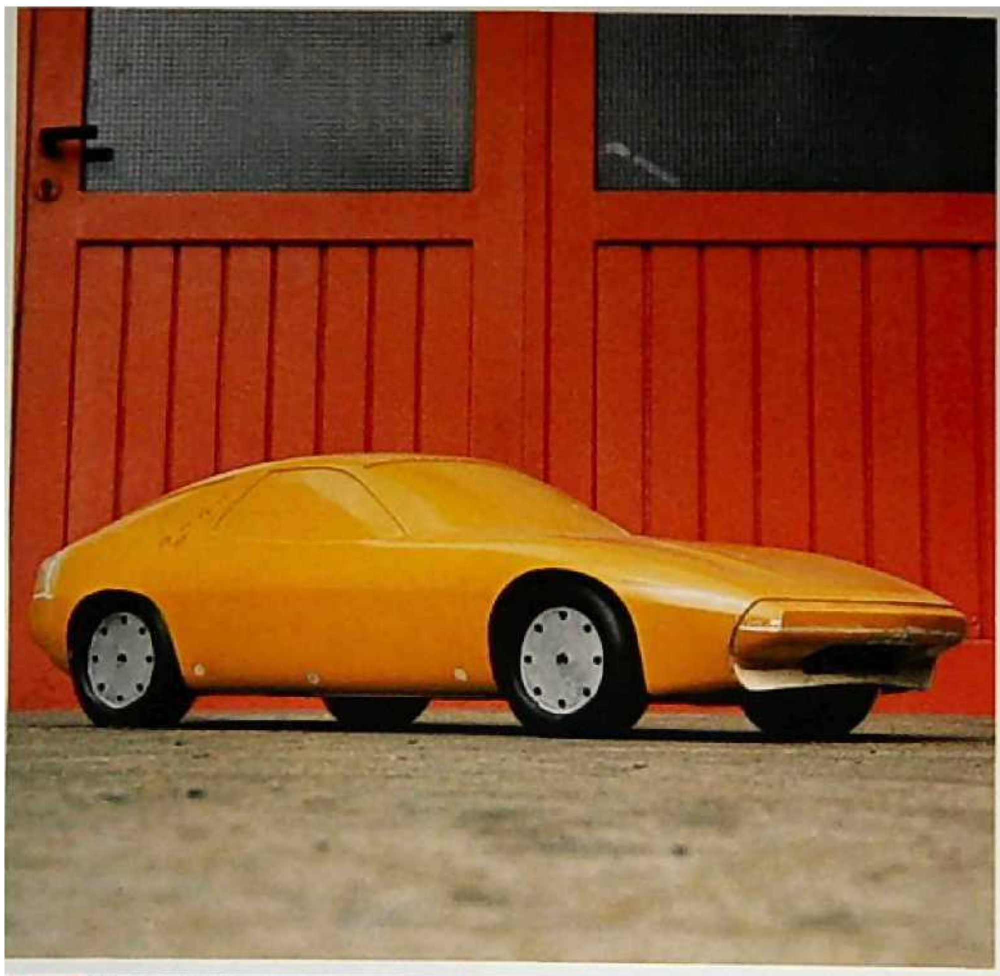
The plasticine model serves chiefly in evaluating a styling concept. Chief Stylist Anatole Lapine (middle) and his deputy Wolfgang Mobius (in plaid shirt) discuss details of a model with their colleagues from the technical side.

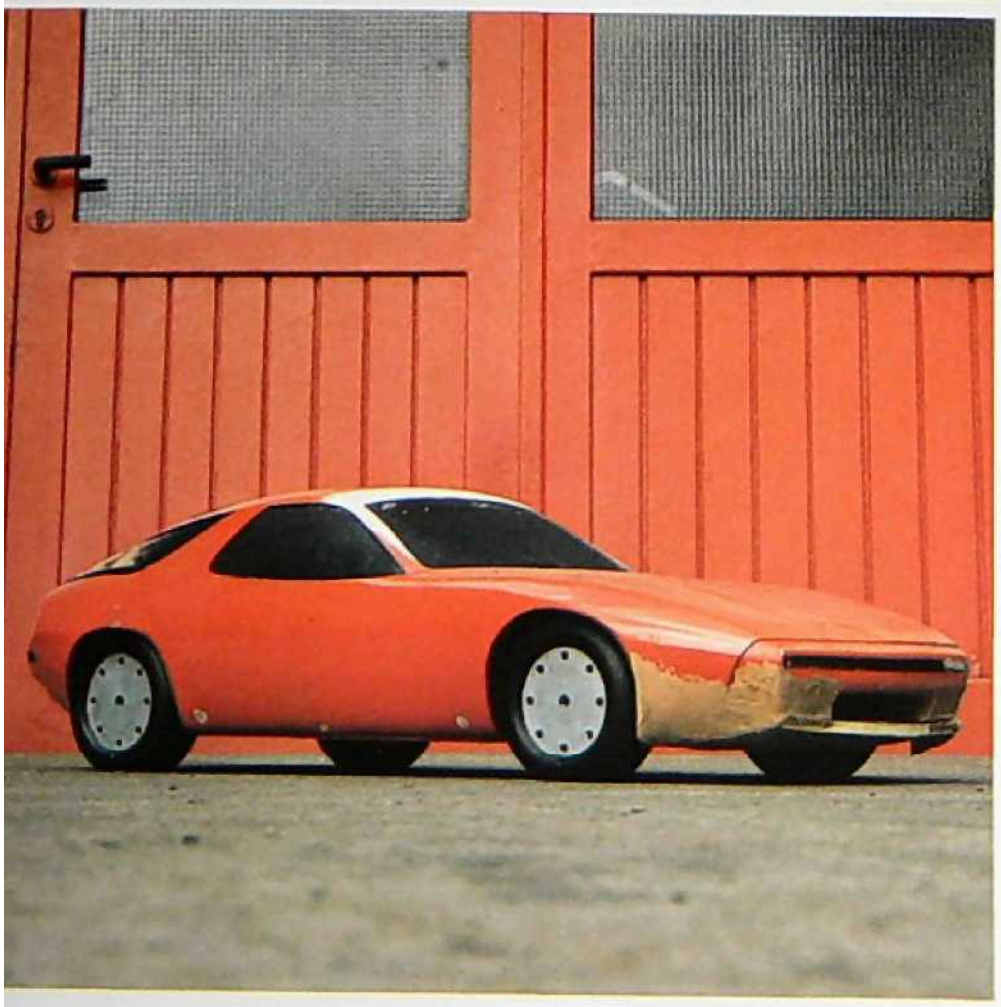
The model, bottom left, already displays recognizable 928 contours, and these become even clearer in the one bottom right. Integrated bumpers match (the solution which later made its way into production.



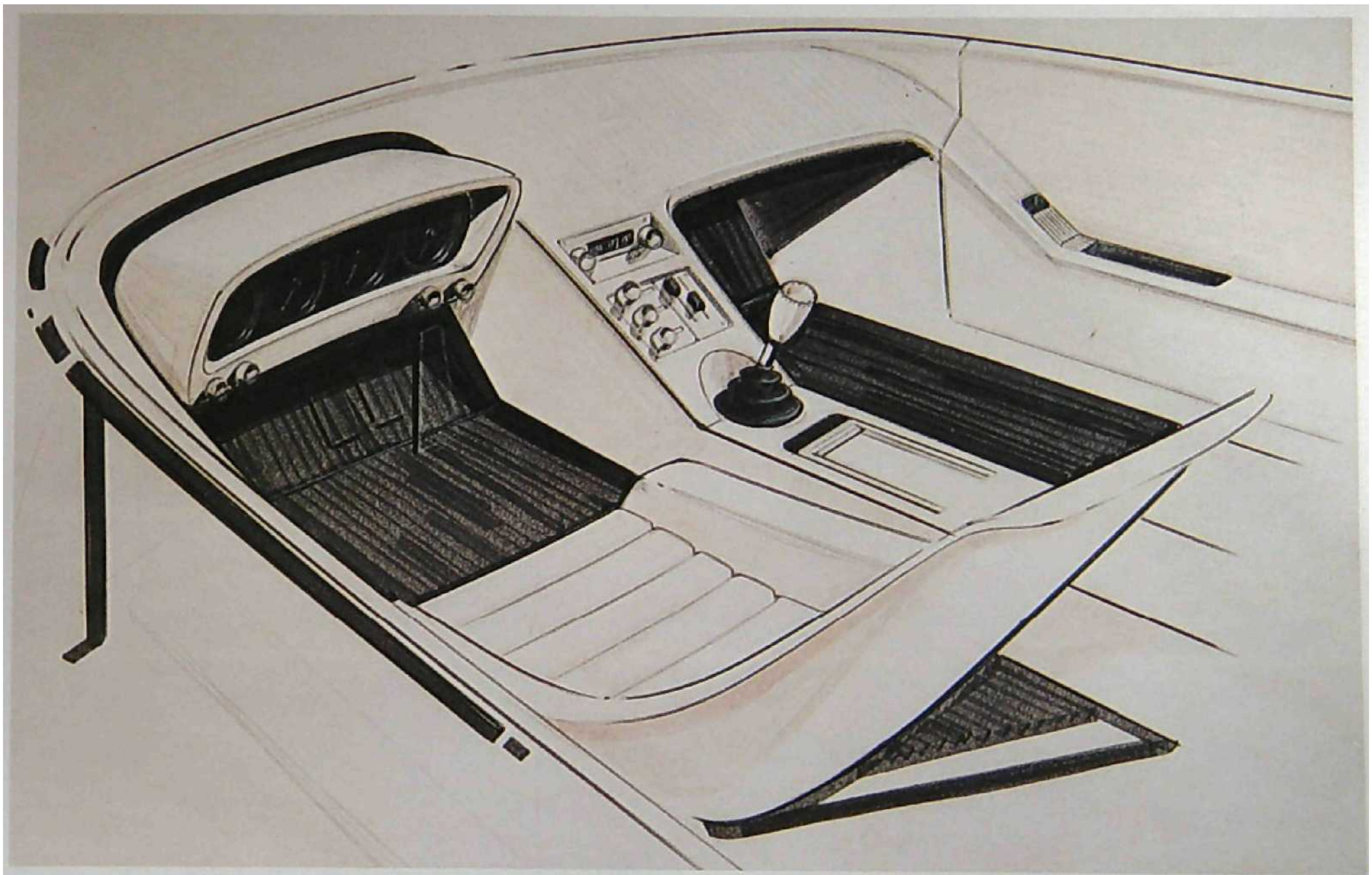


The first wind tunnel models were tested in the winter of 1971/72. During these tests various temporary modifications were applied which gave the models a very "provisional" appearance. The pictures show versions with nose spoilers and various tail layouts.



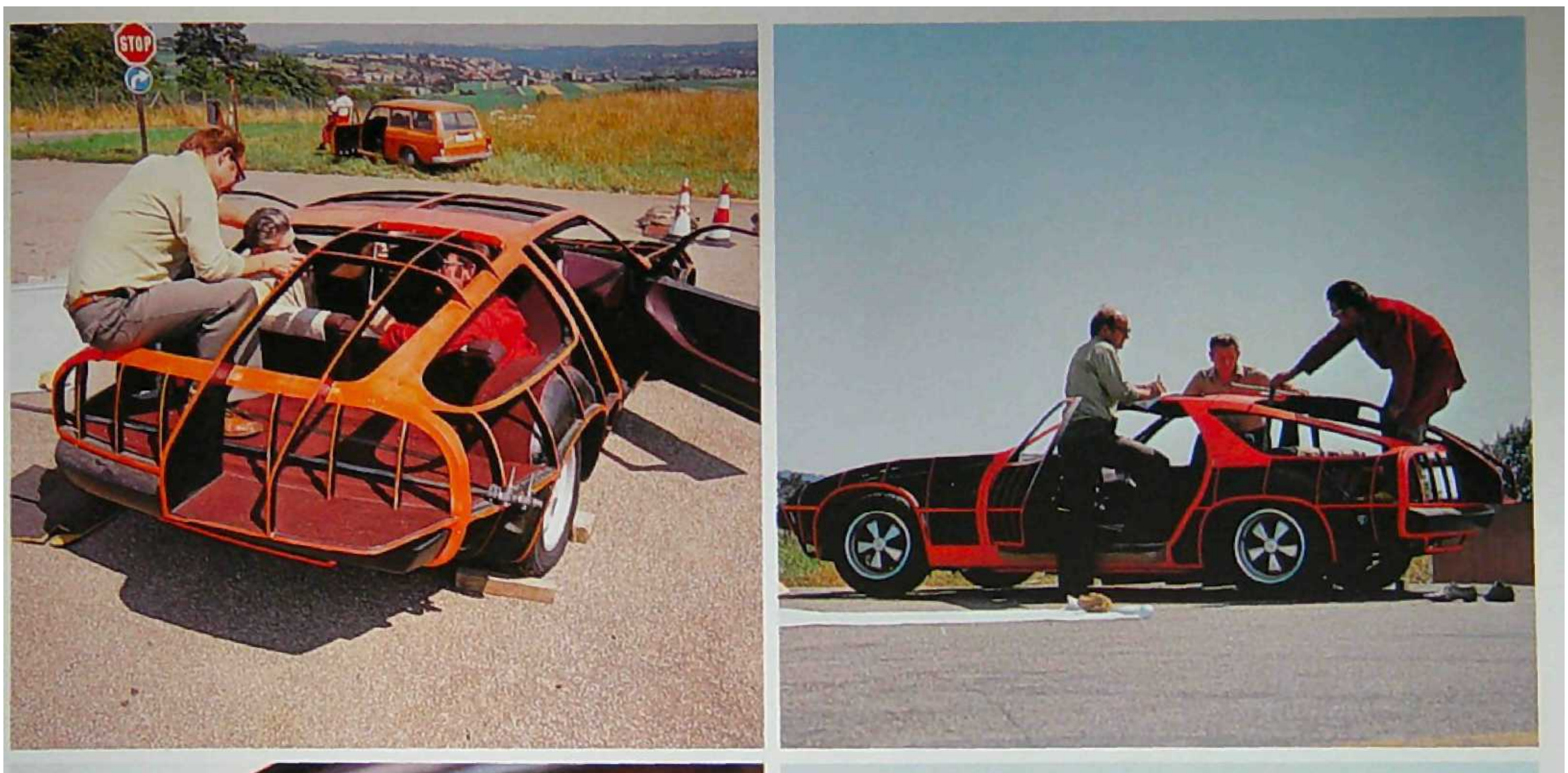


The layout of passenger space for "interior styling"' called for a great many drawings. Apart from demands for interior safety and operating comfort there was that tunnel for the central tube to be considered, since it divided the cockpit in two along its longitudinal axis.



The skeleton model or seating buck was completed in the spring of 1972 and became an indispensable tool. Effective space relationships could be evaluated with its aid as they resulted from predetermined dimensions and styling studies.

Measurements were taken from this buck during the early summer of 1972 on the grounds of the Weissach test track. Project Director Wolfhelm Gorissen (sitting on the model's tail, below) and his; co-workers check interior dimensions, entry conditions, view conditions and scaling comfort for driver and passengers.



Lessons learned from the seating buck strongly influenced further work in styling and design. Selected interior designs could now be produced to scale. Here we see an early seat unit mock-up which doesn't correspond to later production models. These seats match the later 911 design.

Full-bore work in the design halls. Starting in the summer of 1972, aggregates and chassis were developed in complete design detail. On the side they also moved: Design and Testing transferred from the light, cramped spaces of Plant I in Zuffenhausen to the bright, new wall-less offices of Weissach. The photo shows a portion of the new working area.

Continuing dialogue, coordinated by the project directors. is the be- and end-all of design work. A part of this process comes during prepared work meetings but there are also casual chats at desk or drawing board (bottom) where problems and their solutions can bo debated over mock-ups or Finished parts.

Fall 1973. A reworked, full-scale plasticine model is prepared in the Styling department for presentation to the Board. This one model still displays various suggestions -whereas the left nose already has a fully integrated bumper (like the one which will go into production), the right front shows an alternative with half-integrated bumper. Paint foil hasn't been applied yei but dark foil (just being fitted to the right side) already outlines window areas.

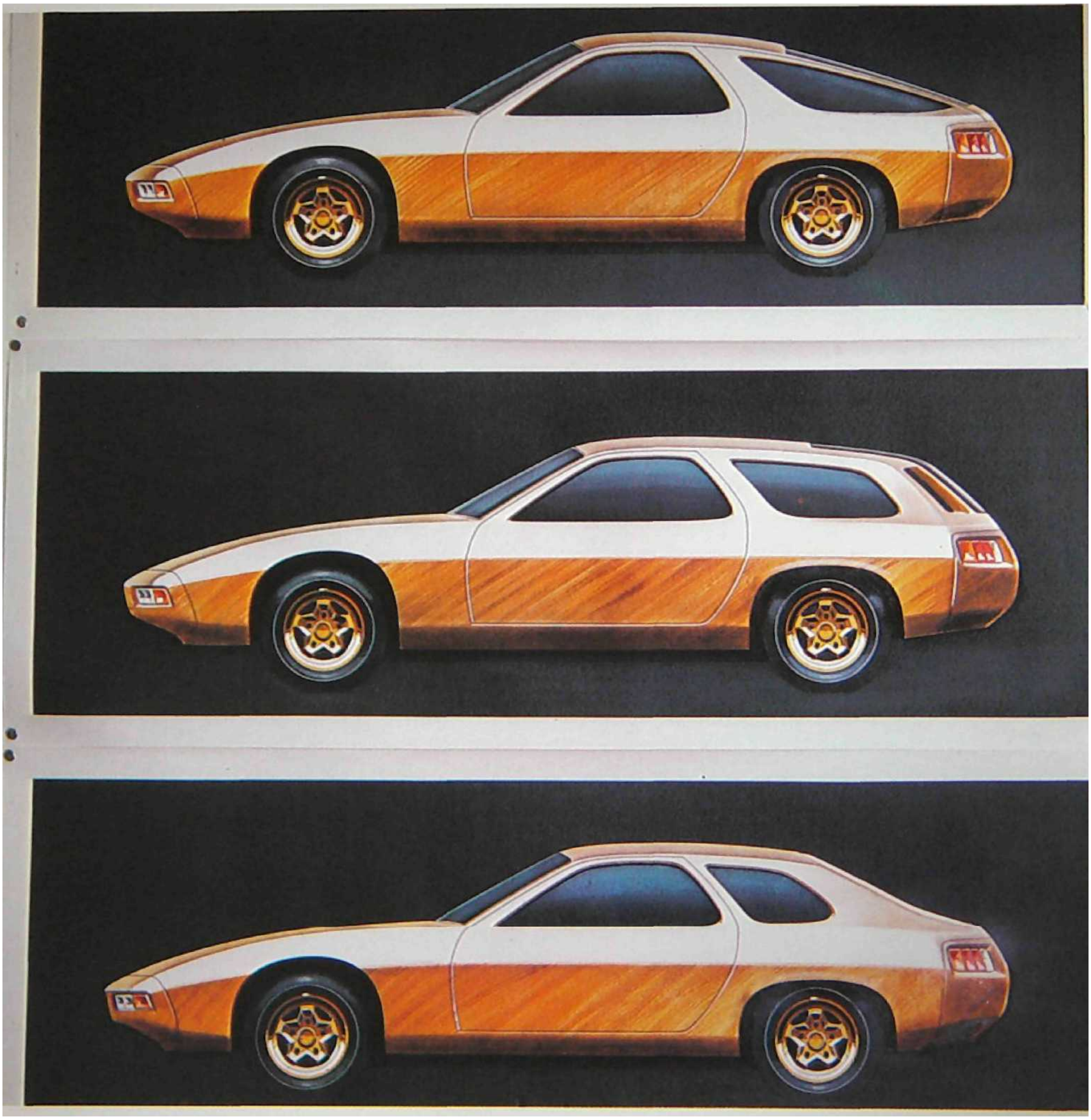
15 October 1973. The altered 1:1 plasticine model stands in daylight for the first time, in the old test yard of Plant I, to be scrutinized by the Board (right below) in rainy autumn weather. The discussion between Dr. Ernst Fuhrmann and Anatole Lapine (left below) is concerned mainly with the question of bumpers which still had to be resolved.

Despite anticipated problems the Board opts for aesthetically more pleasing, fully-integrated bumpers which are now fitted to both sides of the model. Then it receives a metallic-effect covering and is prepared in all finish details for the "major" stockholder presentation.

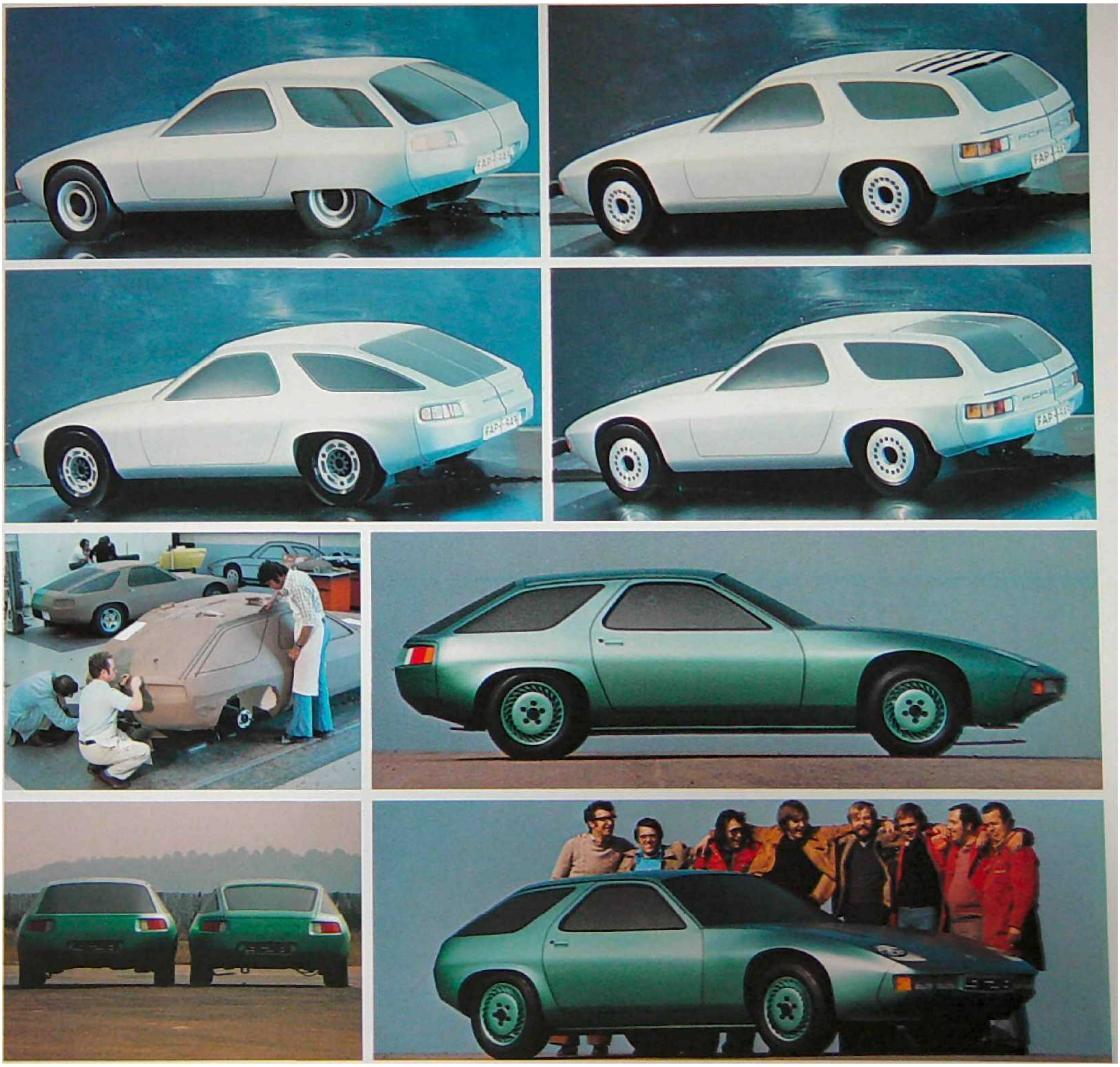
19 November 1973. A complete, full-scale model - the later 928 is unmistakable in all its contours - is taken to the car delivery hall of Zuffenhausen Plant 11 where it only remains unobserved for a short time (bottom left). Shortly thereafter the stockholders, headed by Dr. Ferry Porsche and his sister, Counselor of Commerce Louise Piech. come to see it.

The styling team did an outstanding job and they are congratulated with a toast. From right: Mrs, Dorothea Porsche, Anatole Lapine, Dr. Ferry Porsche and Heinz Branitzki of the Board.

The presentation on 19 November 1973 was already overshadowed by the energy crisis whose ramifications presented the automobile industry with very serious problems. The question even arose of whether *a* proper four-seat alternative would promise more success in a shrinking market.

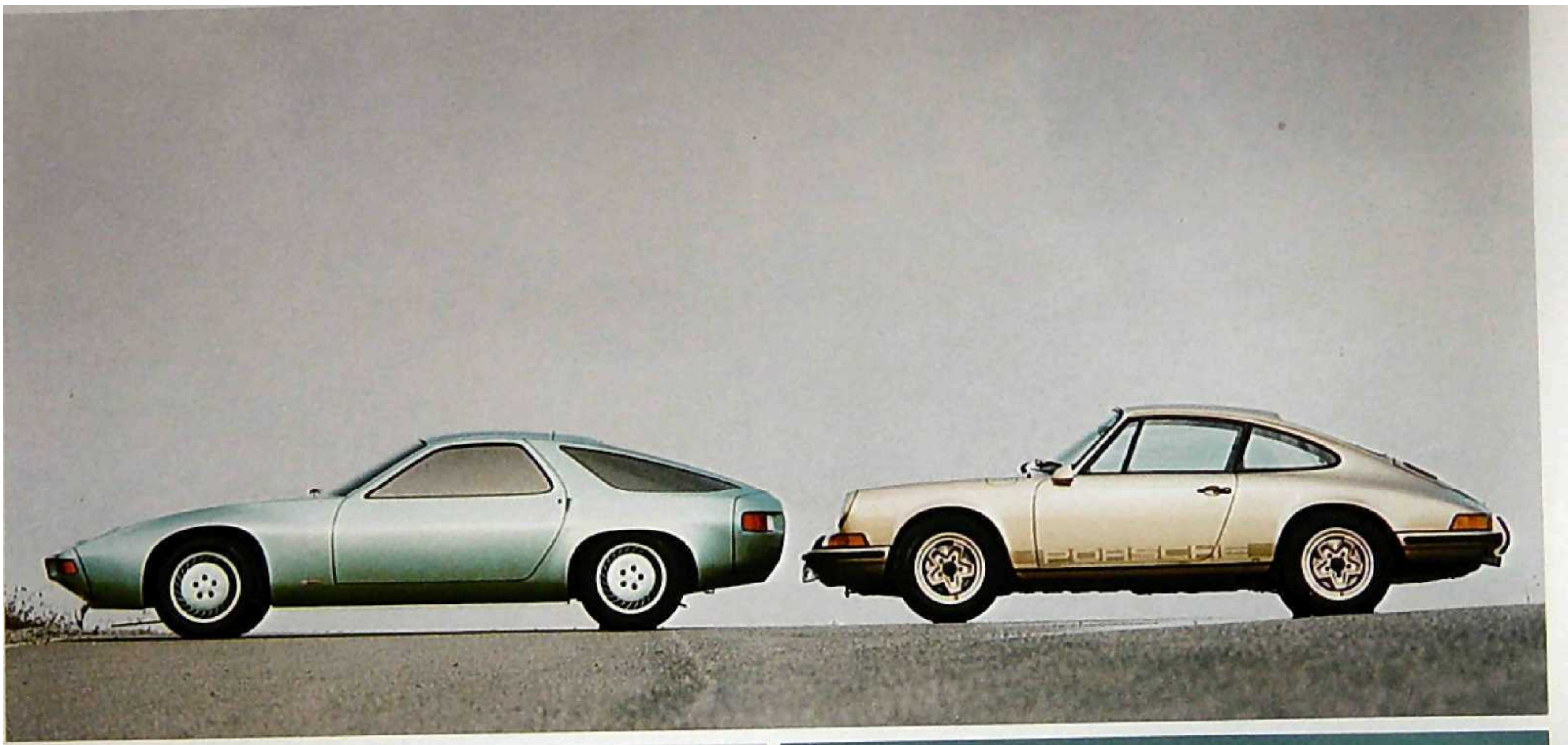


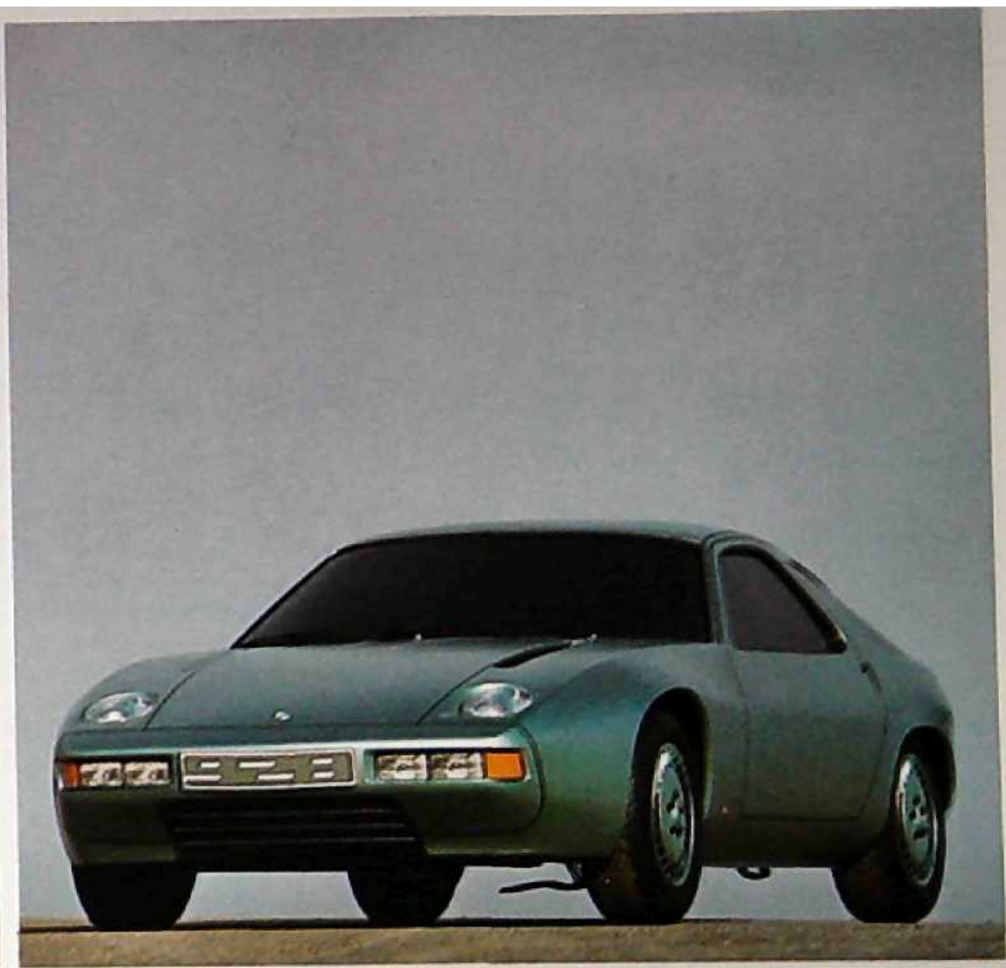
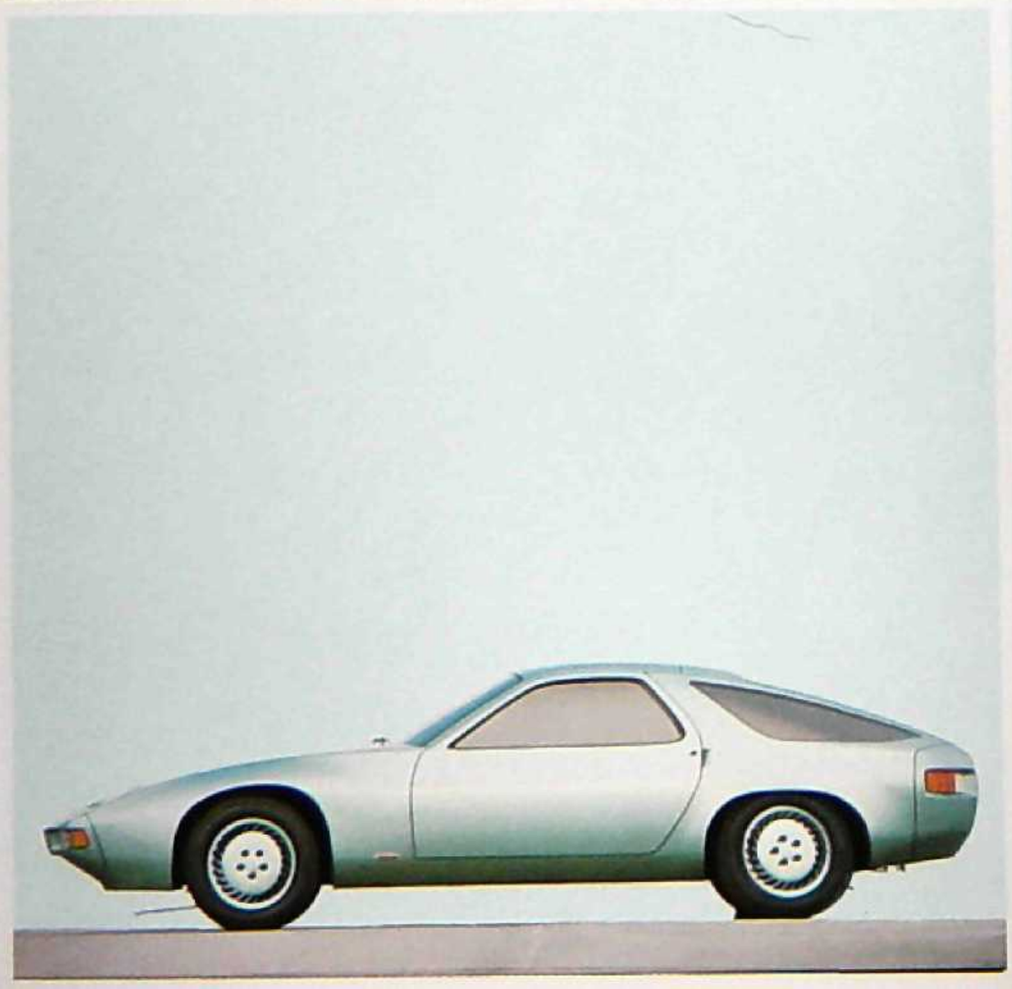
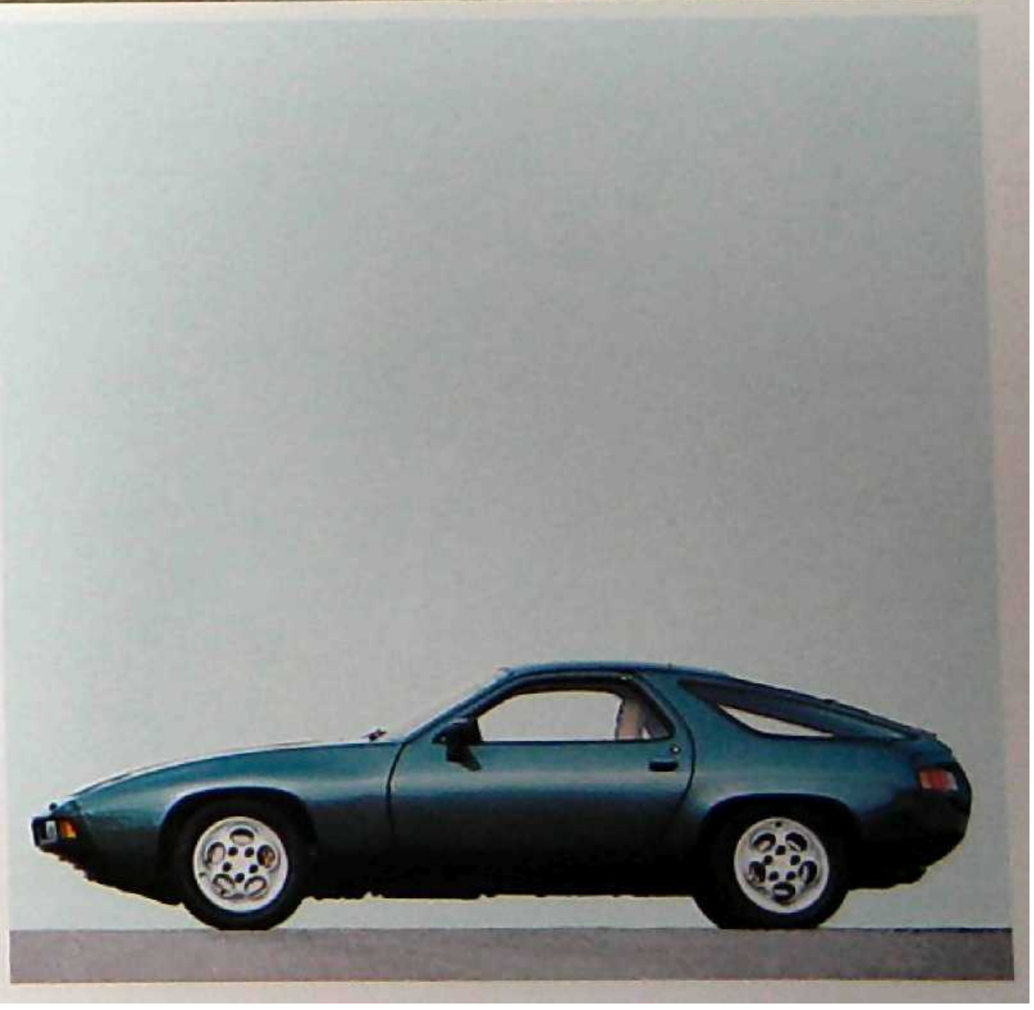
Therefore the Styling department produced countless studies for a full four-seat 928. One of these variations was curried to the1:1 model stage.



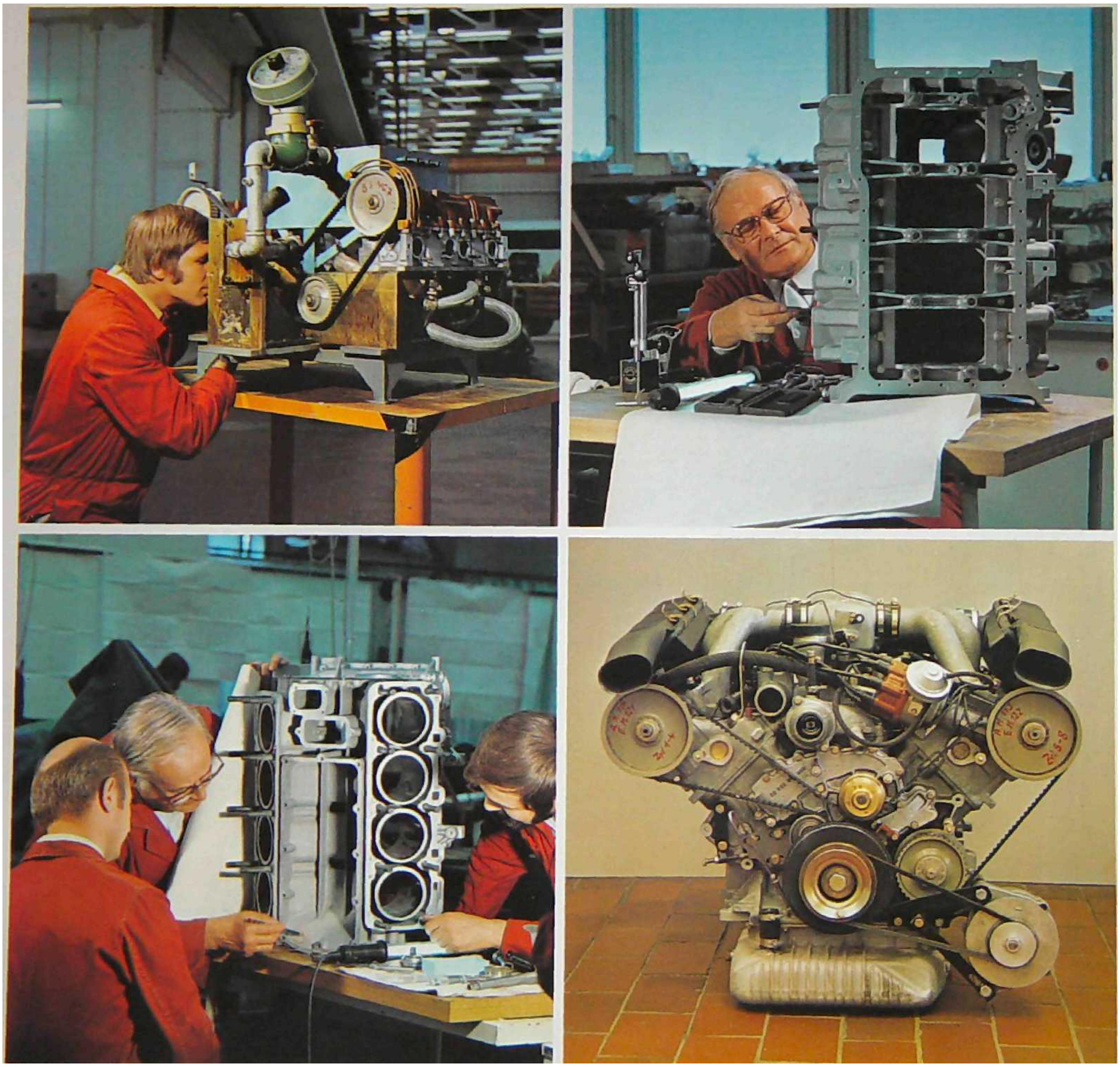
However they remained true to the original Porsche concept with two emergency seats. These photos, which serve to close our chapter on "Styling," again present that 1:1 model from the late fall of 1973-compared below to the 911 production car of that era and, on the right side, in various views,

The bottom right photo offers another comparison: it shows the final 928 production trim. Looking closely we realize that there were a great many detail changes made to the body, right up to 1977.
In broad outline, however, the car remained true to the 1973 model.

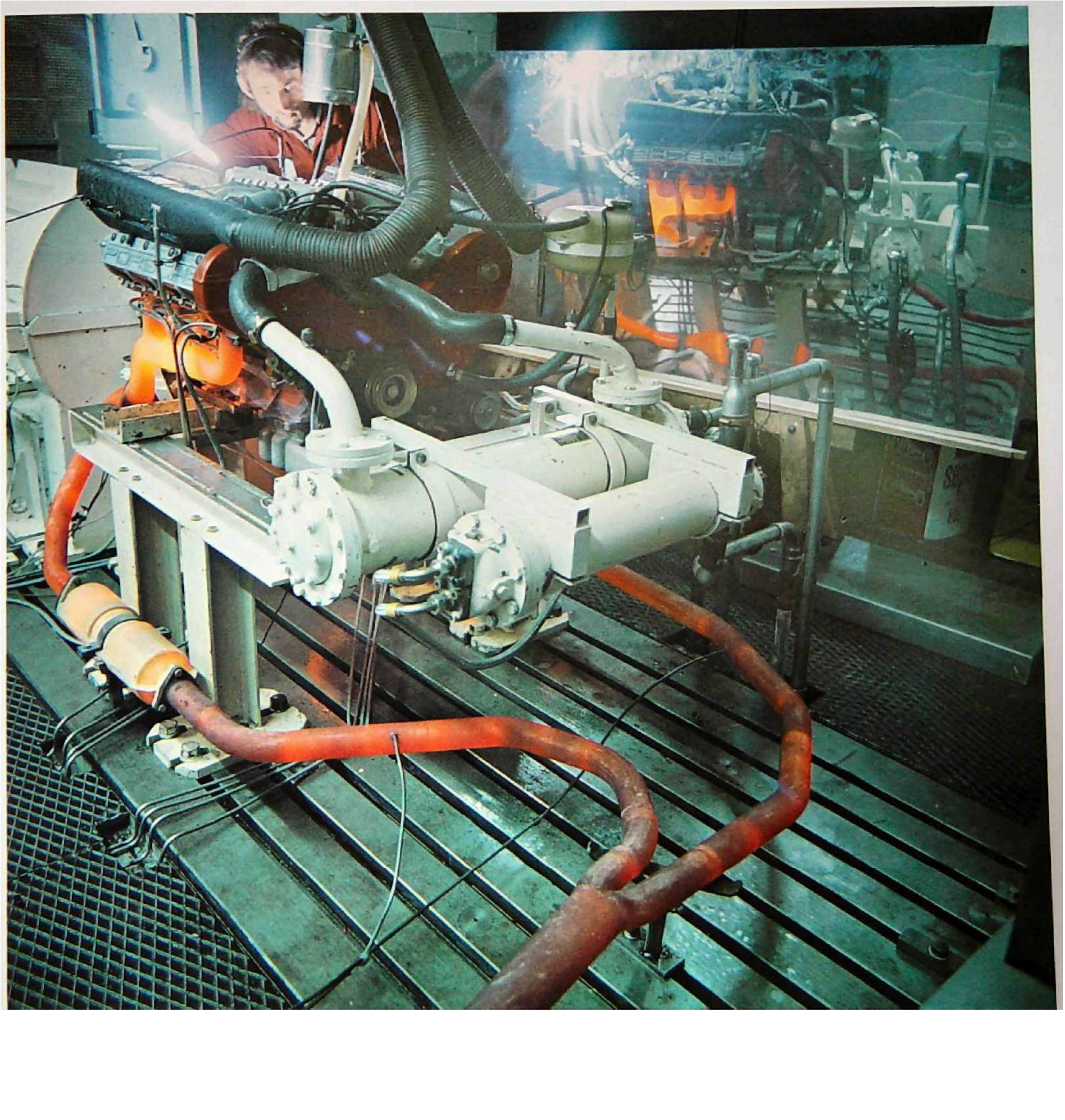



928

928



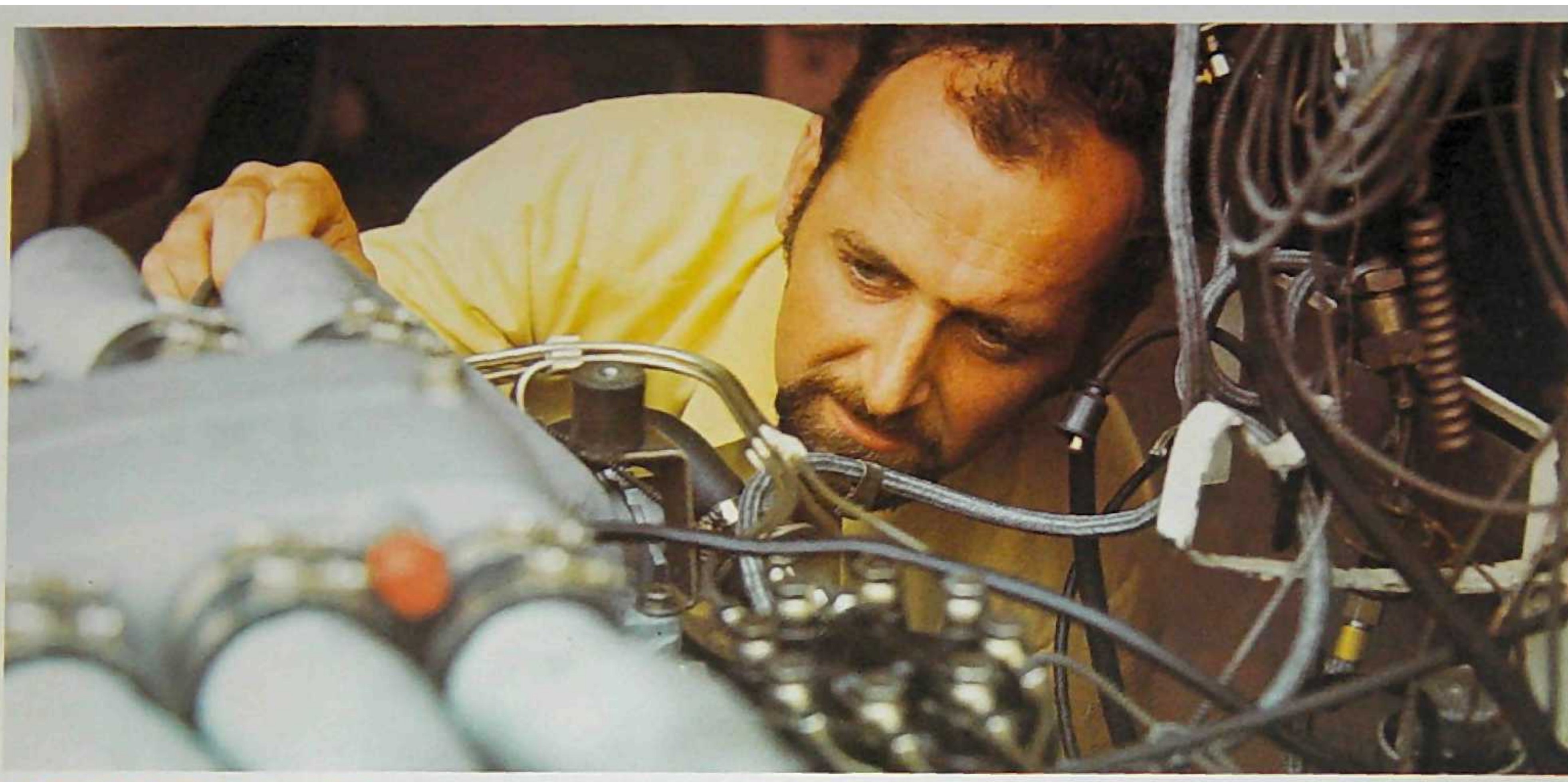
Meanwhile the eight-cylinder vee engine had long-since come into being, The left photo shows work on the mock-up used to test its "long" cog belt, starting in the fall of 1972. Alongside that there were fitting checks of cylinder walls with crankcase and, bottom left, *a* visual check made of the housing. Bottom right, the finished engine without cog belt cover. This is a five **liter** with K-Jetronic, 1974 version.

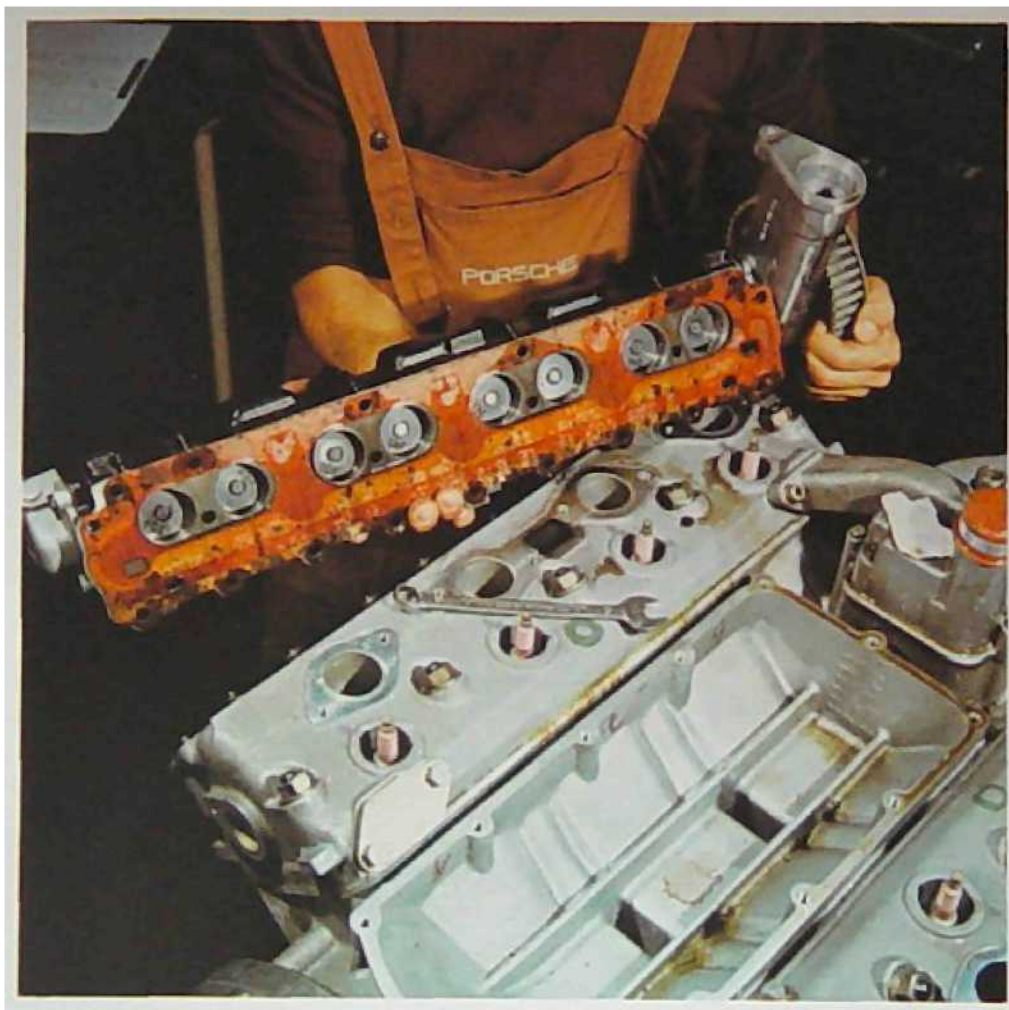
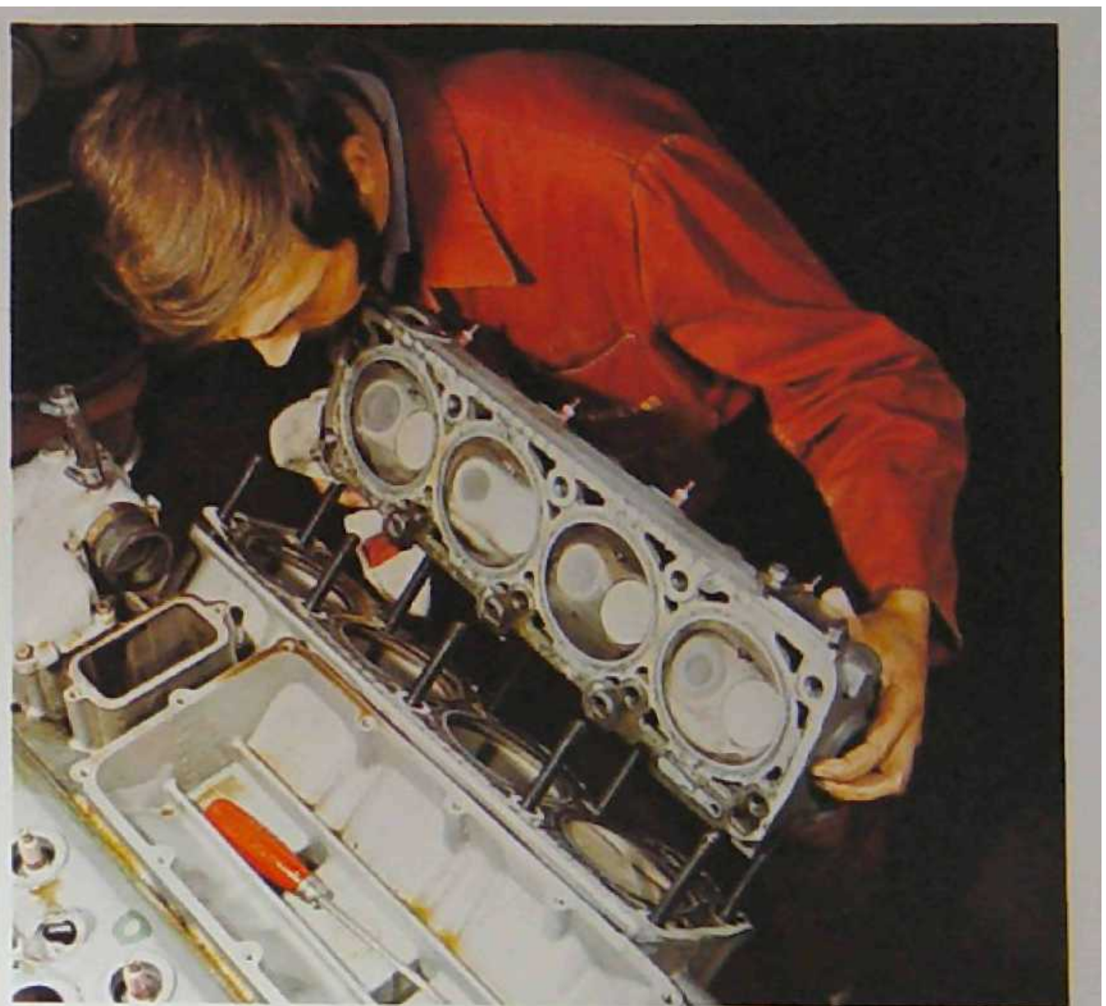


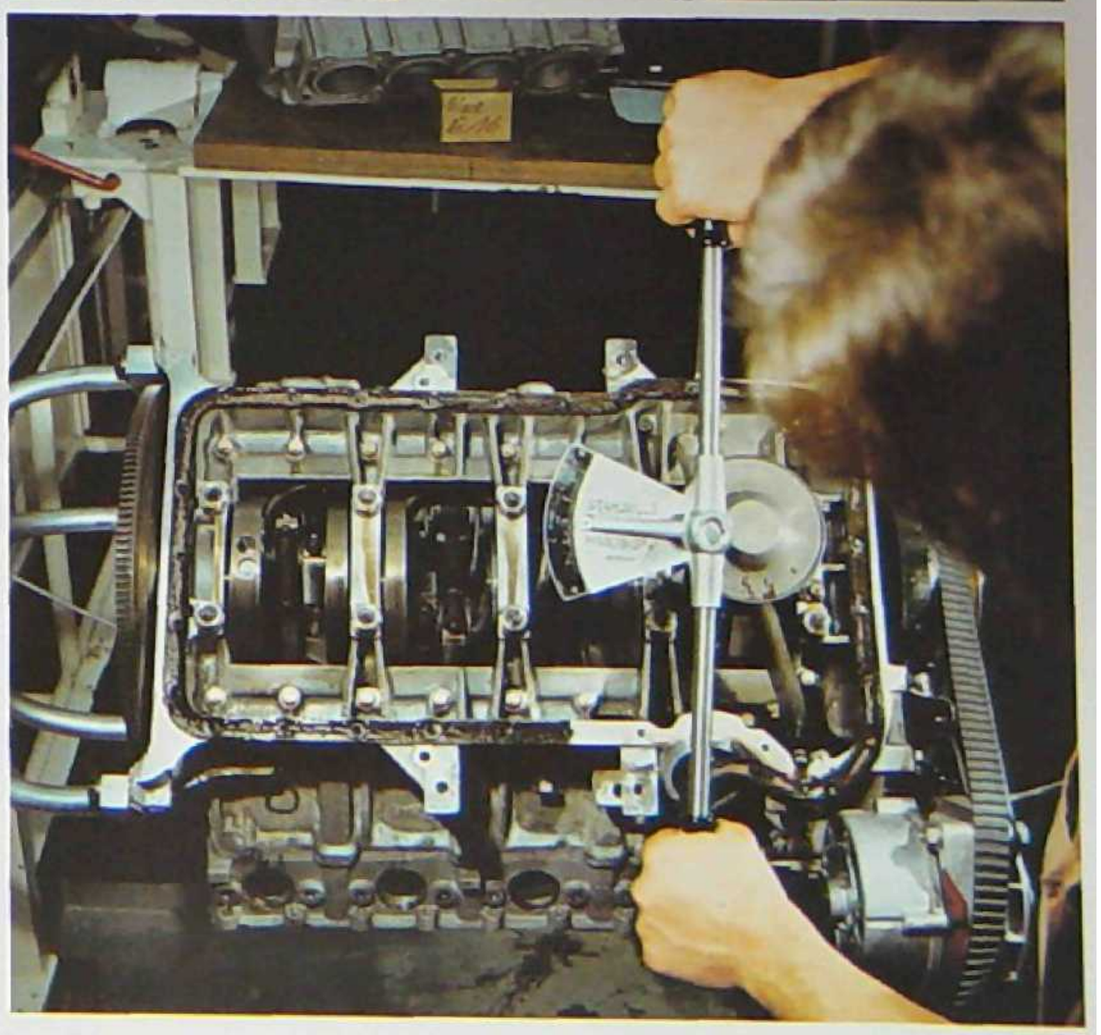
Test bed runs of the five liter with K-Jetronic in May 1973, and again visual control of the running engine is taking place.



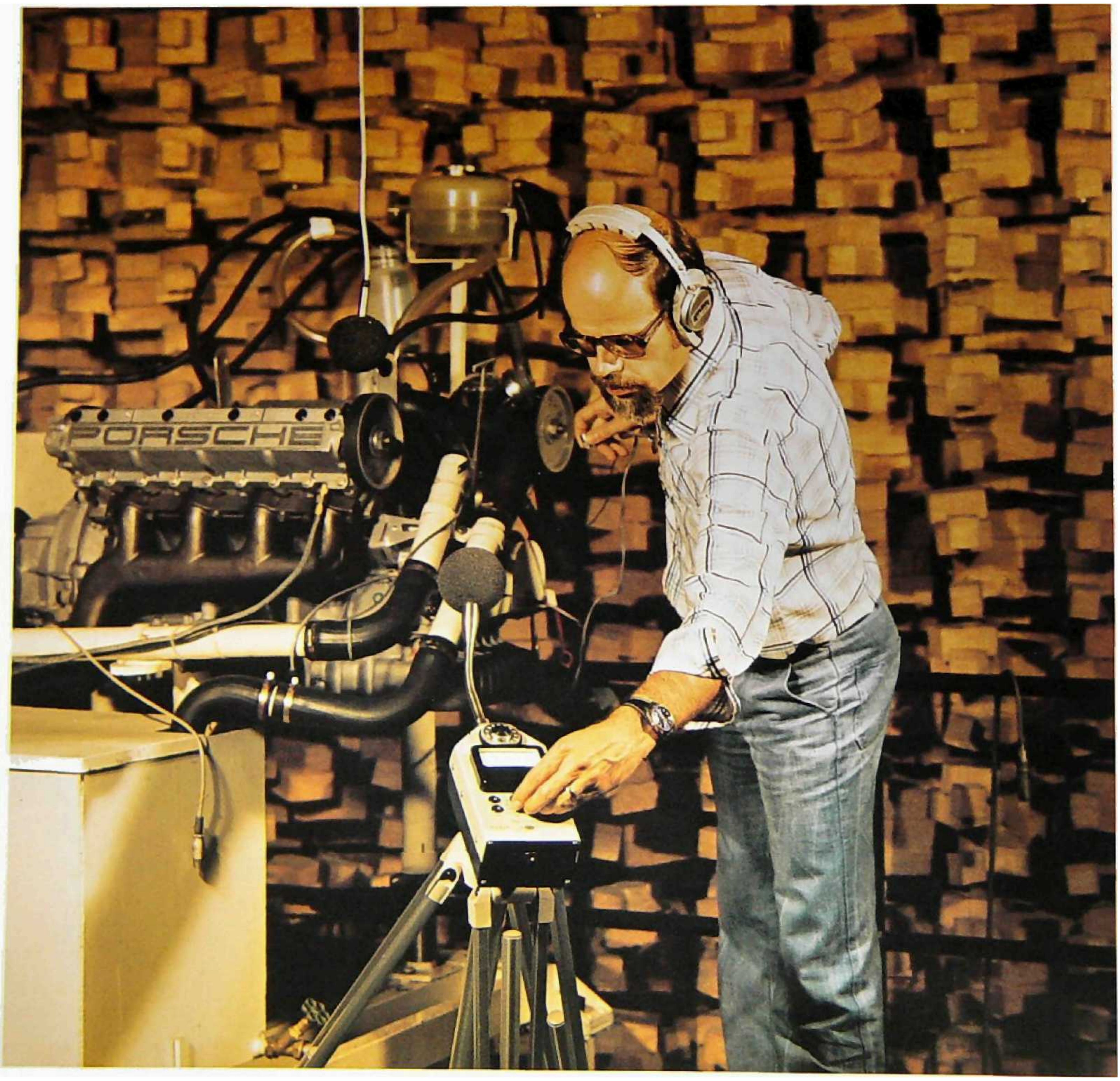
Assembly, test bed runs, control, disassembly - the daily work of Engine Testing. The photos (bottom and right side) show disassembly of the first carburetor engine in January 1973, in this order: removing the air filter, dismounting induction manifold, removal of camshaft housing, lifting the cylinder head and dismounting the lower portion of the crankcase.

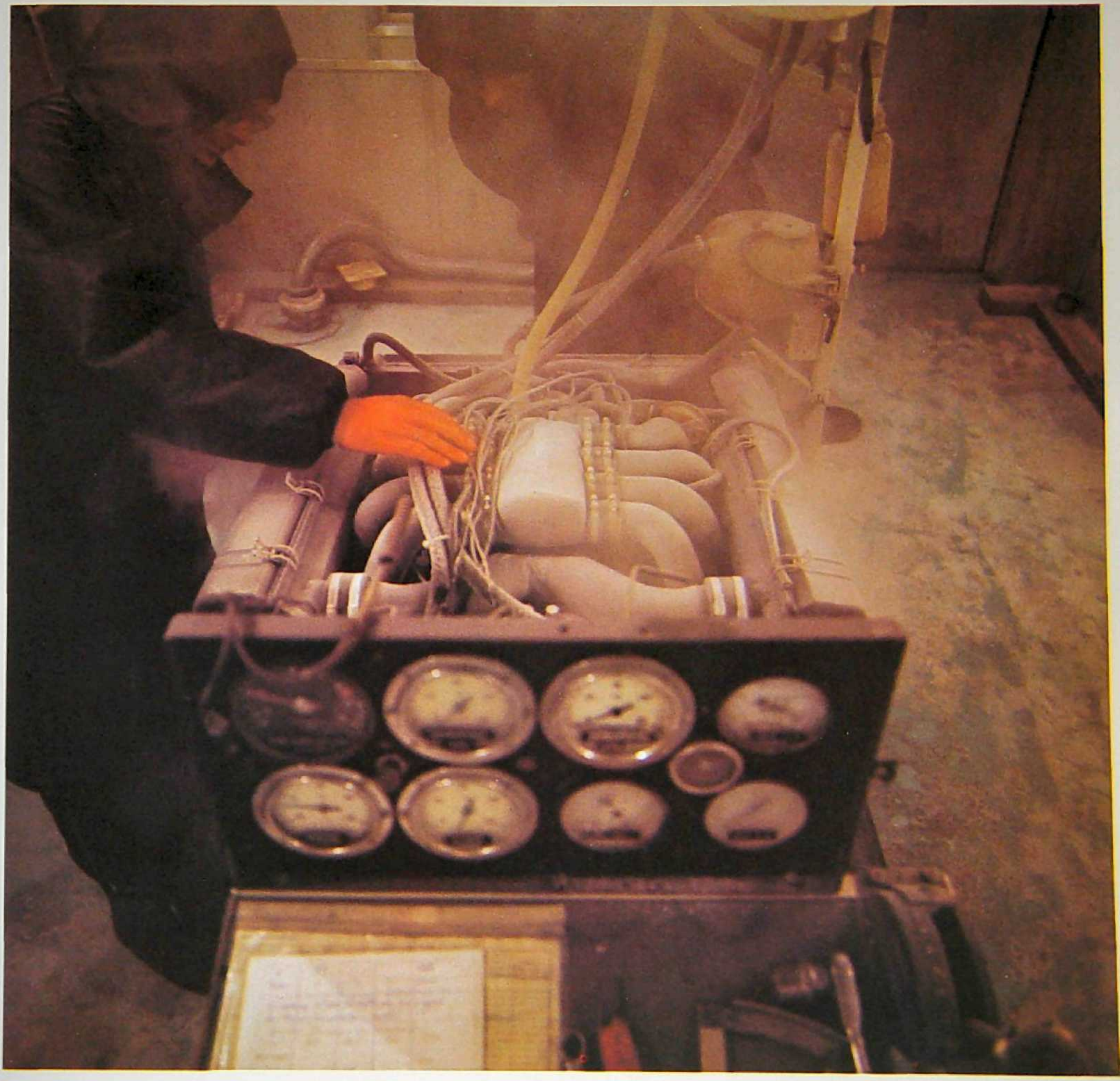



PORSCHE




Among the numerous tests performed by Engine Testing were noise level measurements on a running powerplant in the soundproof room (below) and checks in the cold chamber. This was a cold start test at -22°F (right side).



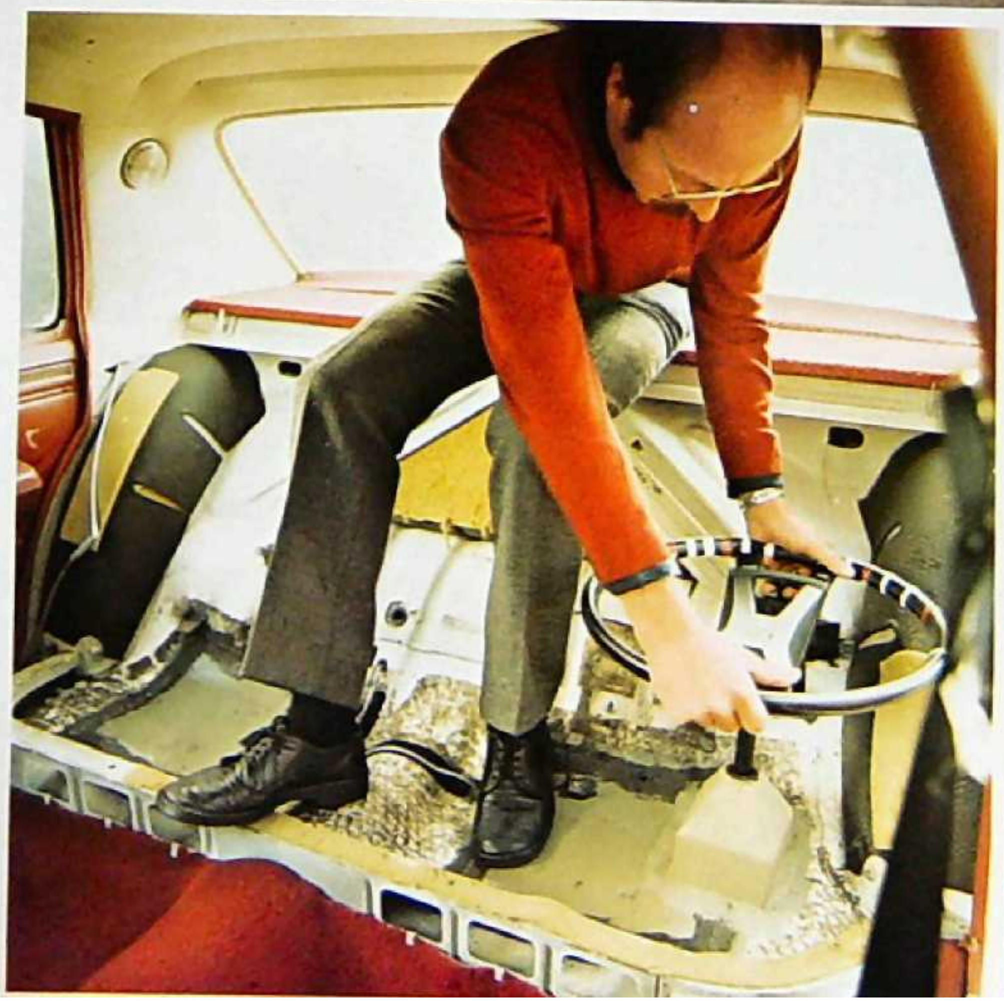


In 1972, as pre-testing was getting underway, Chassis Testing outfitted the first mobile test bed. Left; V I, a Mercedes 350 SL with original engine. The first transaxle experiments were carried out on this car. Later V I was fitted with a 928 carburetor engine (right).

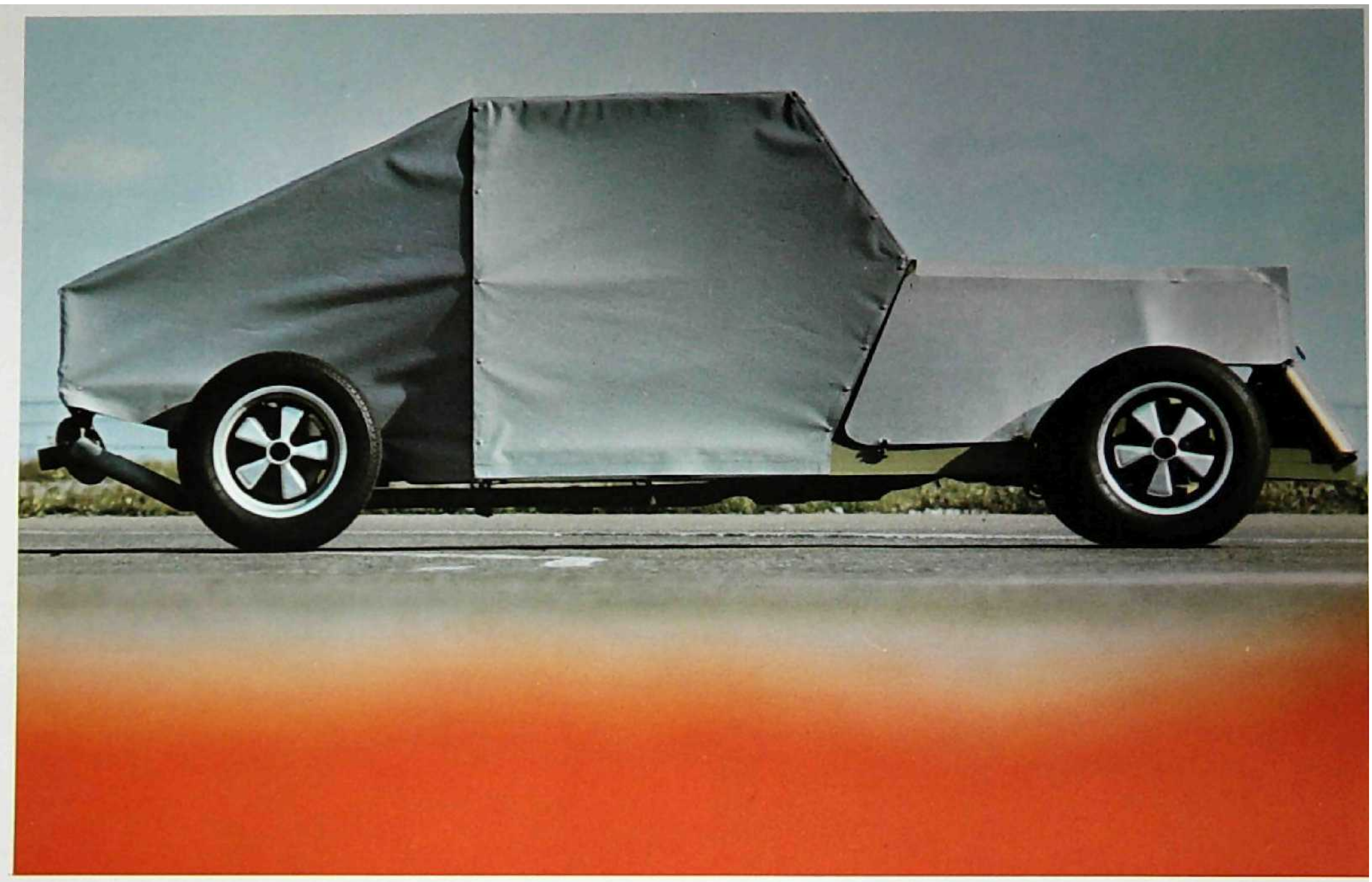
Basic suspension experiments were performed with V2. an Opel Admiral. Bottom left; a front suspension of the type planned for the 928 is mounted to this chassis.

Between 1972 and 1974 V 2 underwent repeated driving tests in the course of their battle against "tuck-in" with a load change During these tests V *2* even received rear-axle steering controlled underway by an extra steering wheel in the rear (bottom left).

Bottom right: '"Munga" was a bare chassis structure used for engine testing,



"Munga" in all its glory - weatherproof but not a model of good sightlines. That could easily be arranged by rolling up the "doors." Then the rolling test bed could be chased around Weissach's skid pad in impressive manner.



As of September 1973 mechanicals of the 928 (engine and transaxle) ran on open roads for the first time. Test unit was V 3 an altered Audi 100 Coupe. The photos show mountain and tow testing on Mont Ventoux in ihe south of France.

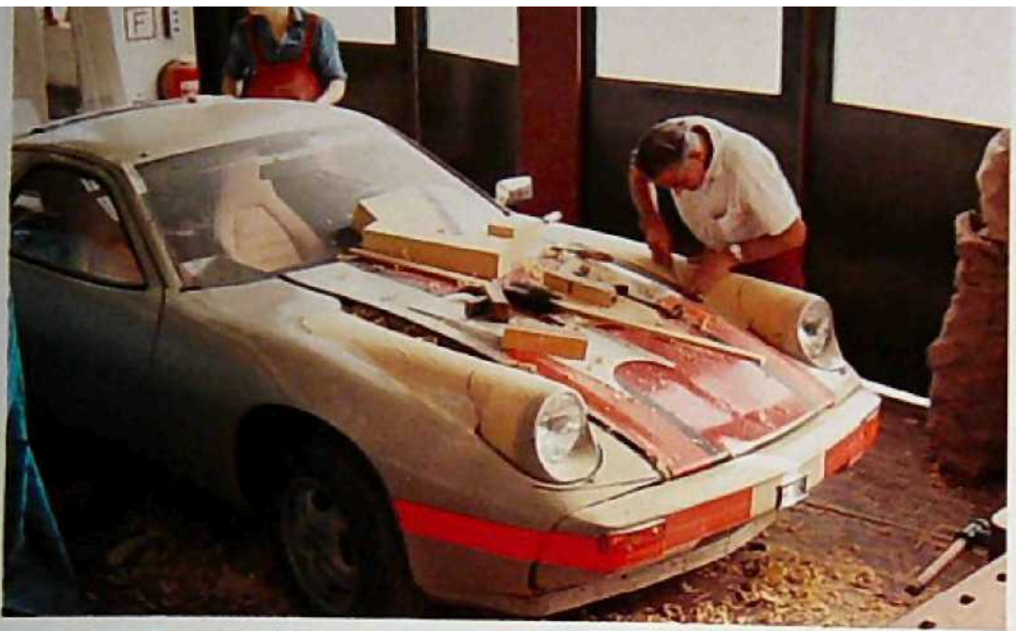
V4 was another Audi Coupe which mechanics are just completing in the photo, bottom right. Whereas V3 had add-on fender flares they took a different path with V4. The entire body was widened by 4.3 inches. The 928 engine is clearly recognizable and it more than doubled the car's original performance.

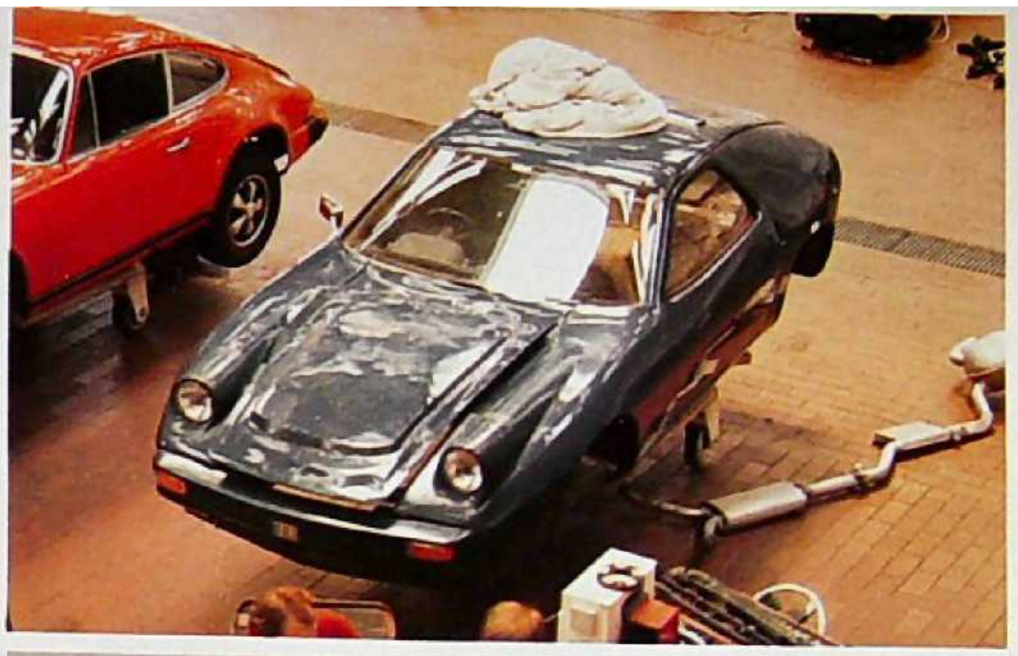
Construction and assembly of the first handmade prototypes. The white vehicle is K 1, the marginally driveable first prototype with plastic bodywork, while the yellow body, bottom left, was used in the first crash test. Bottom right; W 1, the first fully driveable prototype with steel bodywork, shortly before completion. That black curtain in the background separates the vehicle from normal test business and screens off curious eyes.

The third driveable prototype was W3 completed in the fall of 1974 and actually the most important vehicle in 928 development history. Bodywork and trim were still those of construction stage I and thus the car still carried the semi-integrated bumpers. However it already enjoyed an improved rear axle and during *a* presentation to the Board and stockholders it displayed convincing road qualities. Later W 3 was subjected to tough African testing in Algeria.

The inspired camouflage phase began with intensive test operations since even the Weissach test facility isn't entirely safe from the telephoto lenses of curious and resourceful photographers and other interested parties.

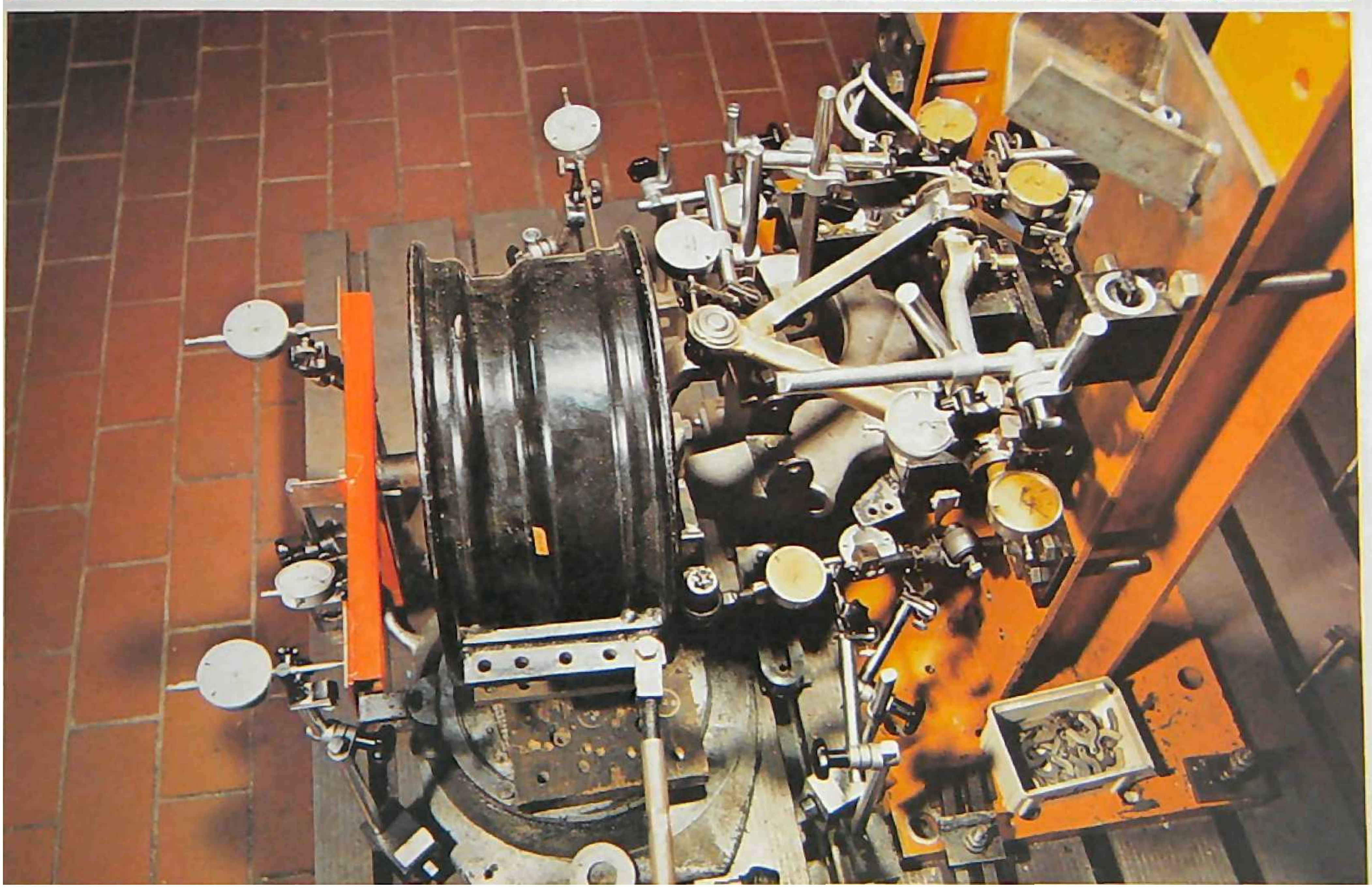
Thus the workshops not only assembled and disassembled transaxle units but camouflage of all kinds as well. Plastic covers gave the prototype a look all their own, something between 911 and Lotus Europa, The complete fake hoods were even wilder, giving a 928 the contours of a panel van when seen at a distance.





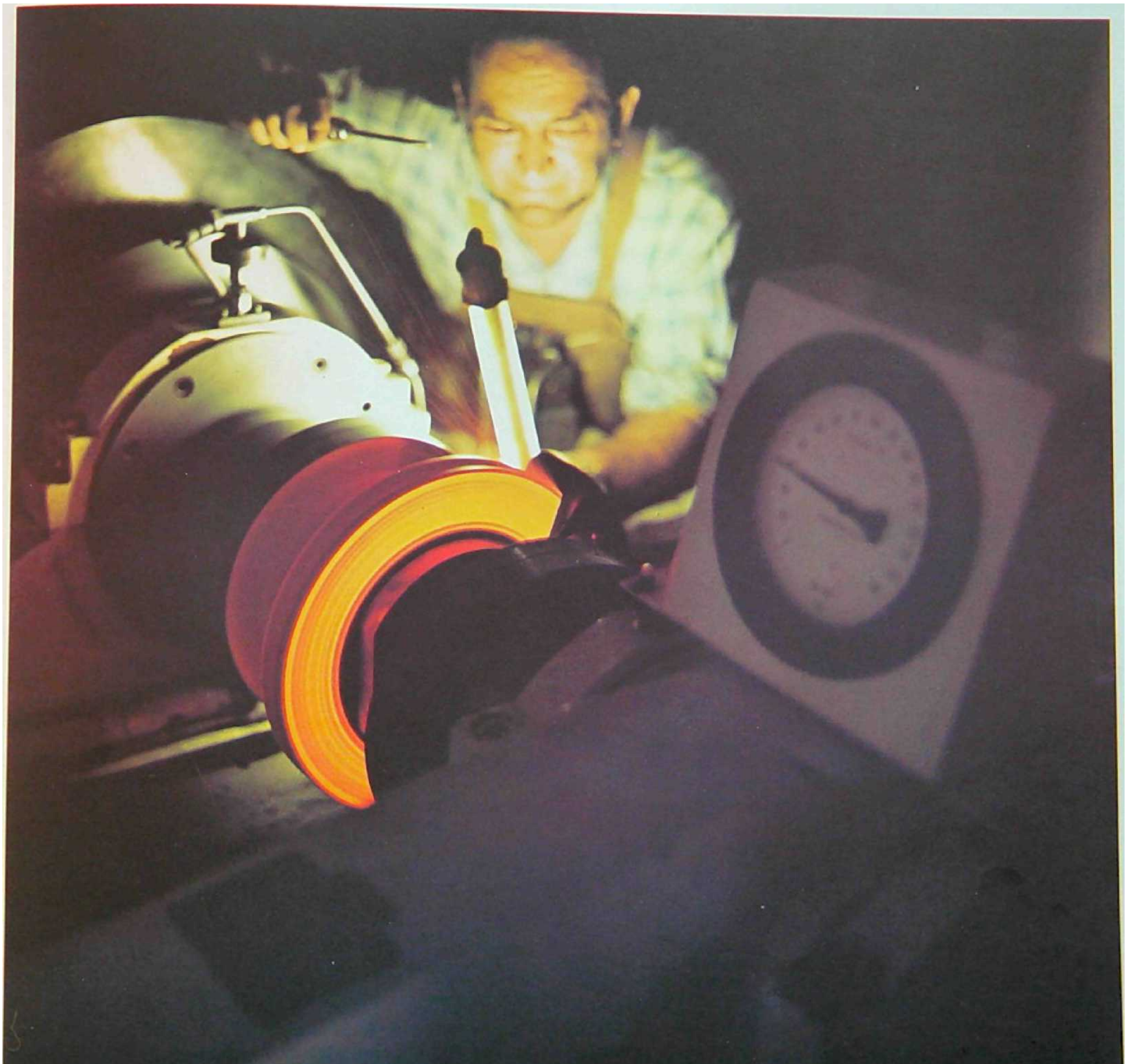
Once the doors of a test workshop closed behind the "panel van" a few moves were enough to turn the car back into a 928 prototype .

Test beds that one doesn't see every day: a 928 body on the rig to measure torsional body stiffness and a test rig for elasticity measurement on the front axle (bottom).



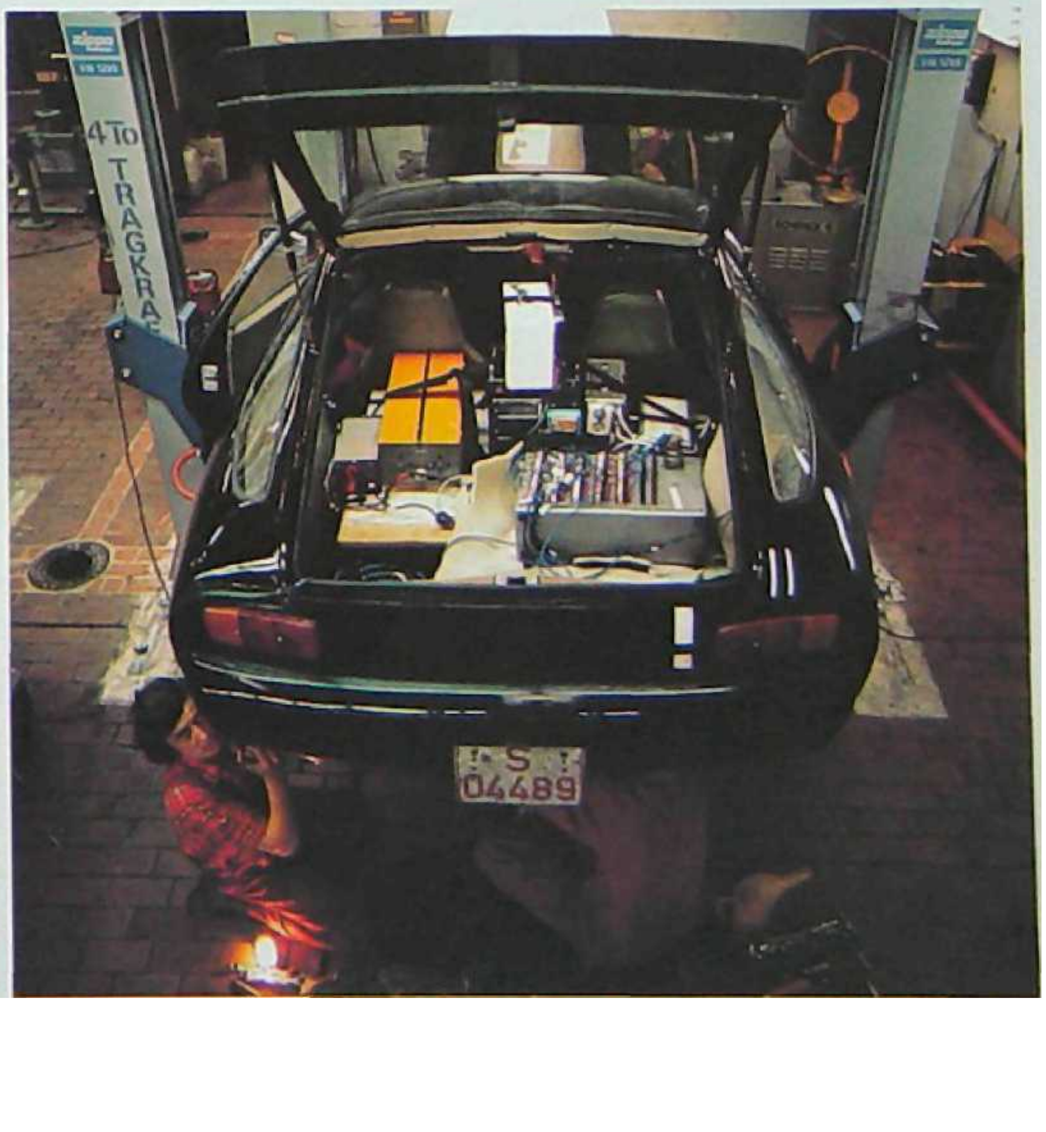
This seating box is also a test bed. Here they performed early tests on ventilation and air dispersal in the interior. An air speed gauge provided information on ventilation flow.

Testing broke discs on the special test bed - a fascinating subject for the photographer.



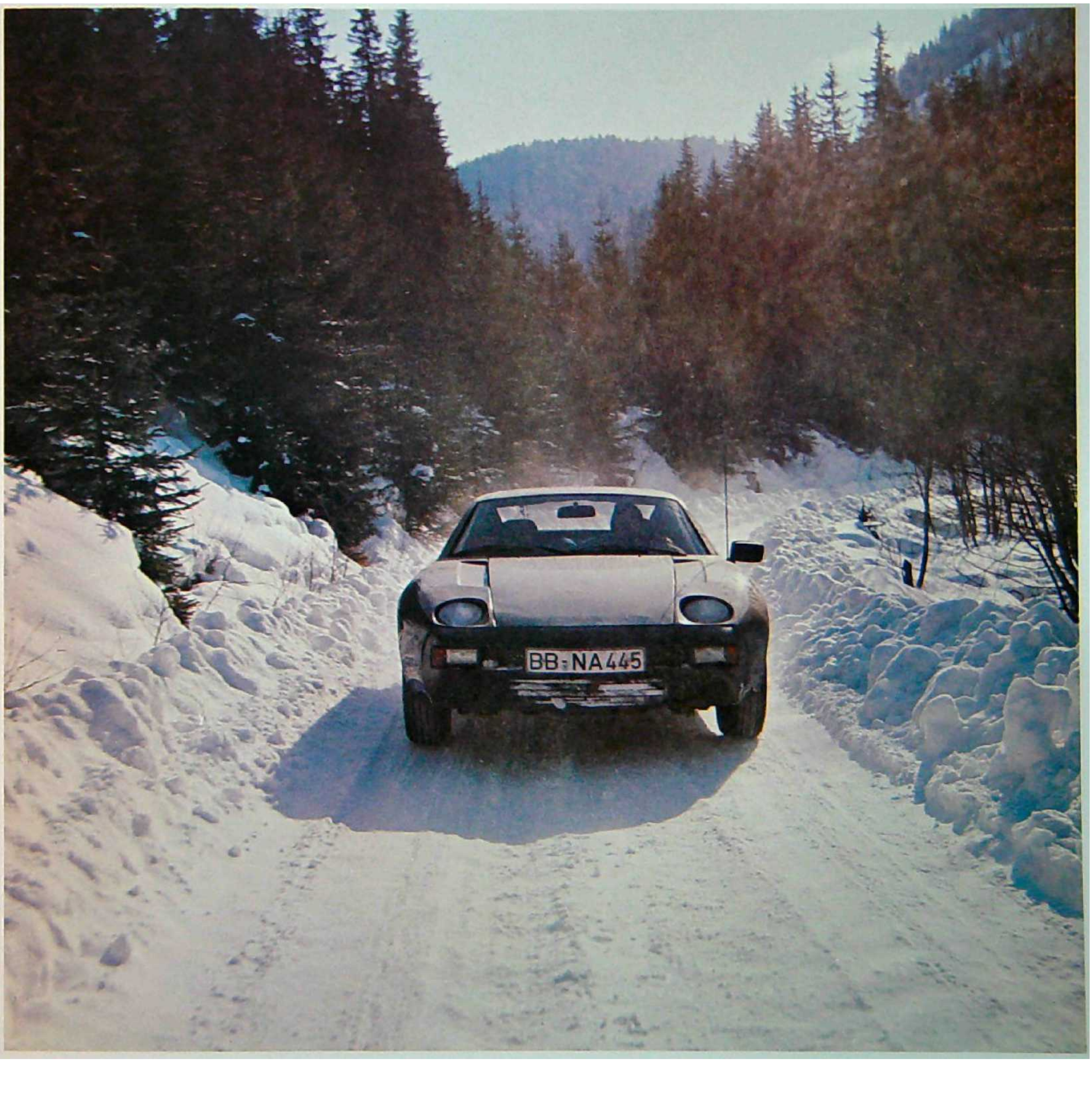
In driving tests the prototype itself becomes a rolling test bed. Our photos show work at the VW track in Ehra. Left; top-speed runs on the banked oval. Right; handling experiments on the road course. Bottom; a brake test from topspeed.

In fact, any prototype is a running laboratory as *a* glance at the dashboard or into the fully-used variable trunk space, stuffed full of measuring apparatus, testifies.



A change of scenery in the test scheme: winter experiments on the Turrach in Austria. The functions of a test track are taken over by a frozen mountain lake ...

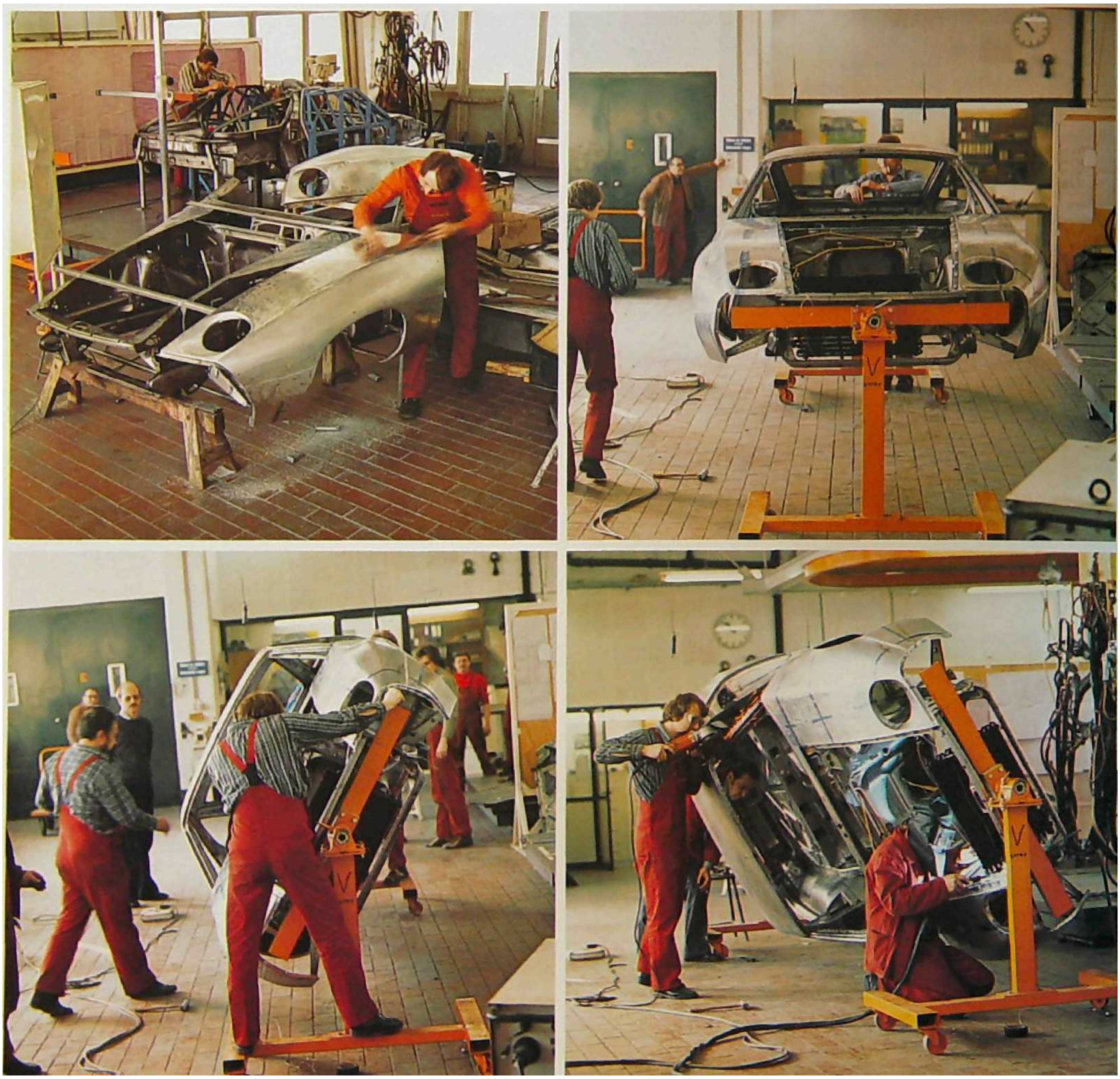
, . . and snow-covered mountain roads where traction and road manners can be tested under extreme conditions.

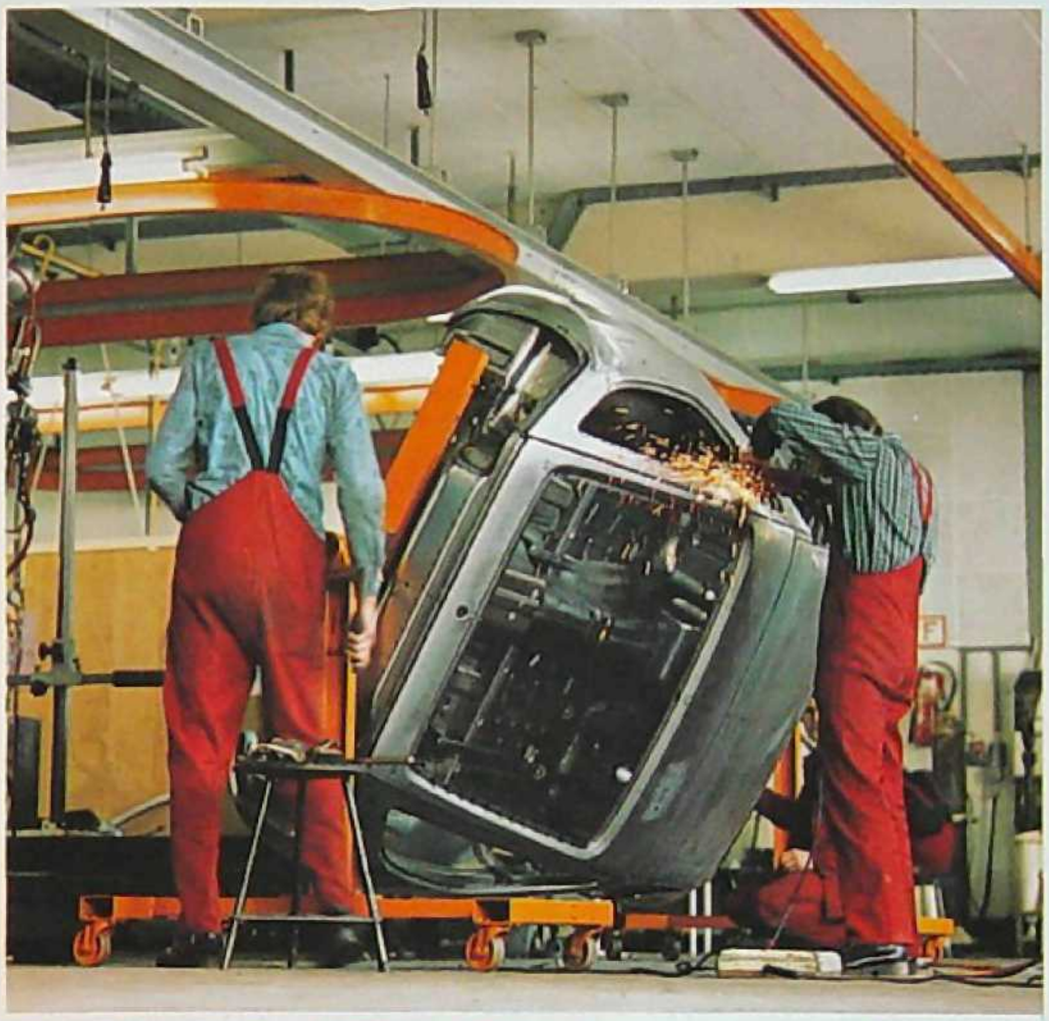


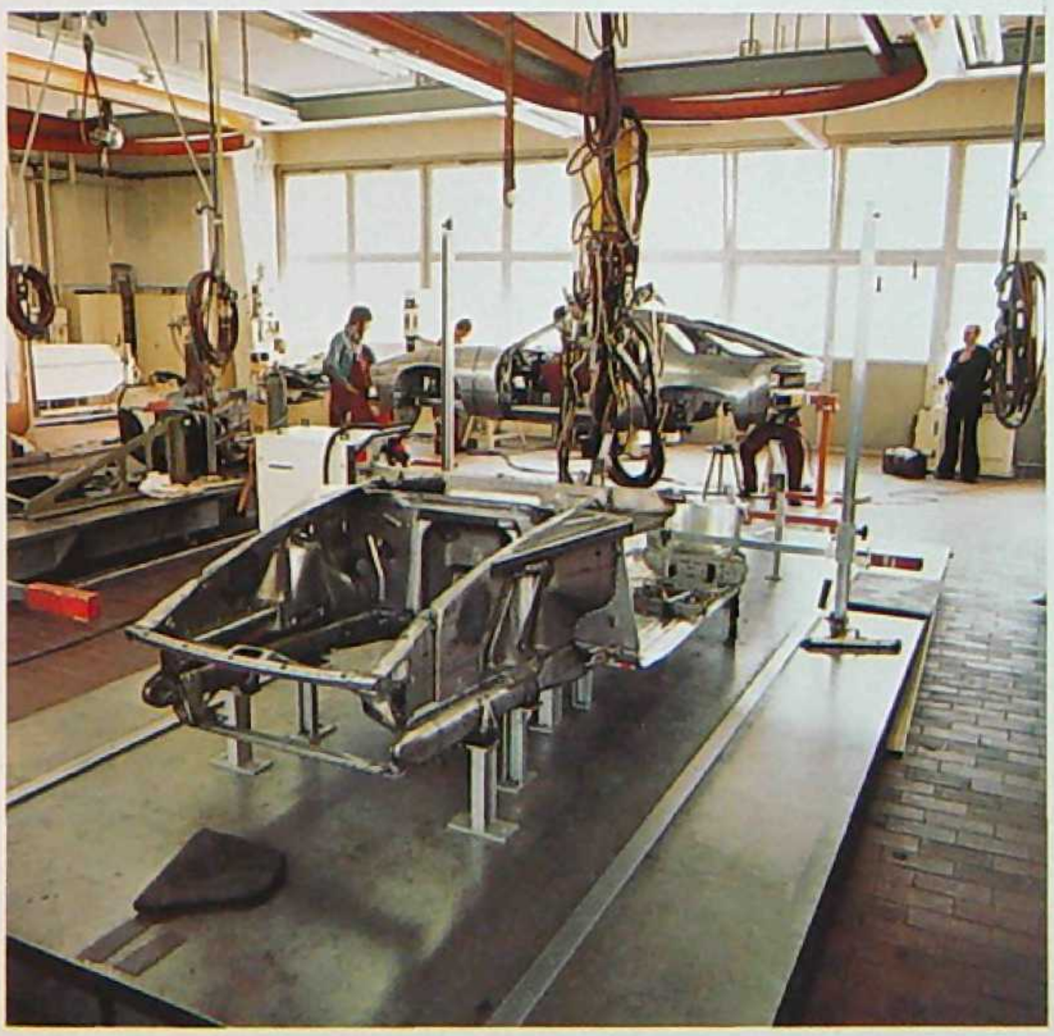
Handling tests on the Turrach. Dr Ernst Fuhrmann was also found among the test drivers (right side).

The smallest details are considered during winter testing. Experiments with slippery-start aids (below) and tests of the operation of such elementary items as a windshield wiper arm (right side) are part of any comprehensive test program. The flow pattern produced by salt streaks after a fast freeway run is interesting.

June 1976: Building the first prototypes of construction stage II, the pre-production level, in effect. The photos show body construction and final assembly (right side, bottom right). The vehicle was completed in a true photofinish by the evening of 7 July.

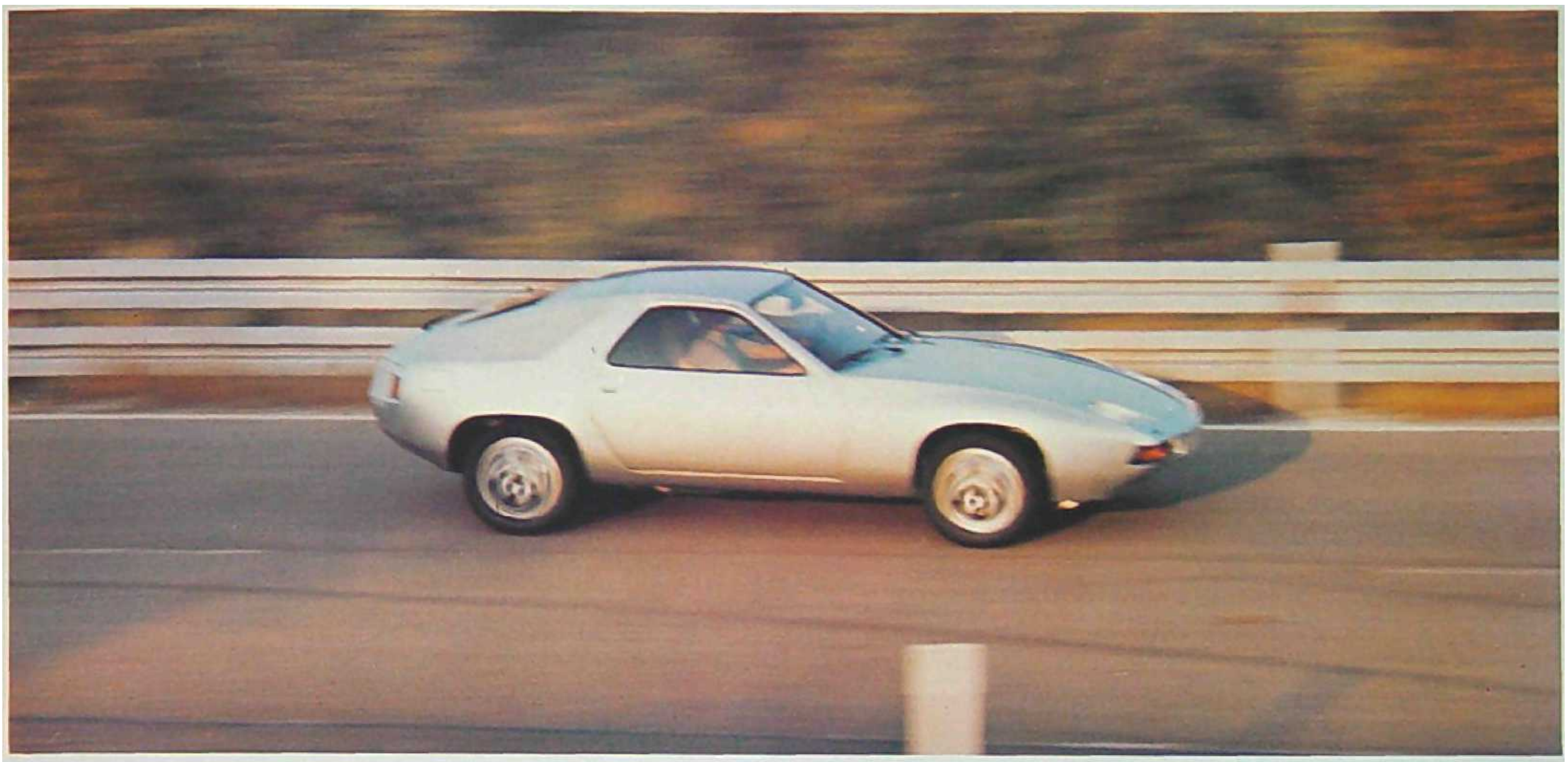






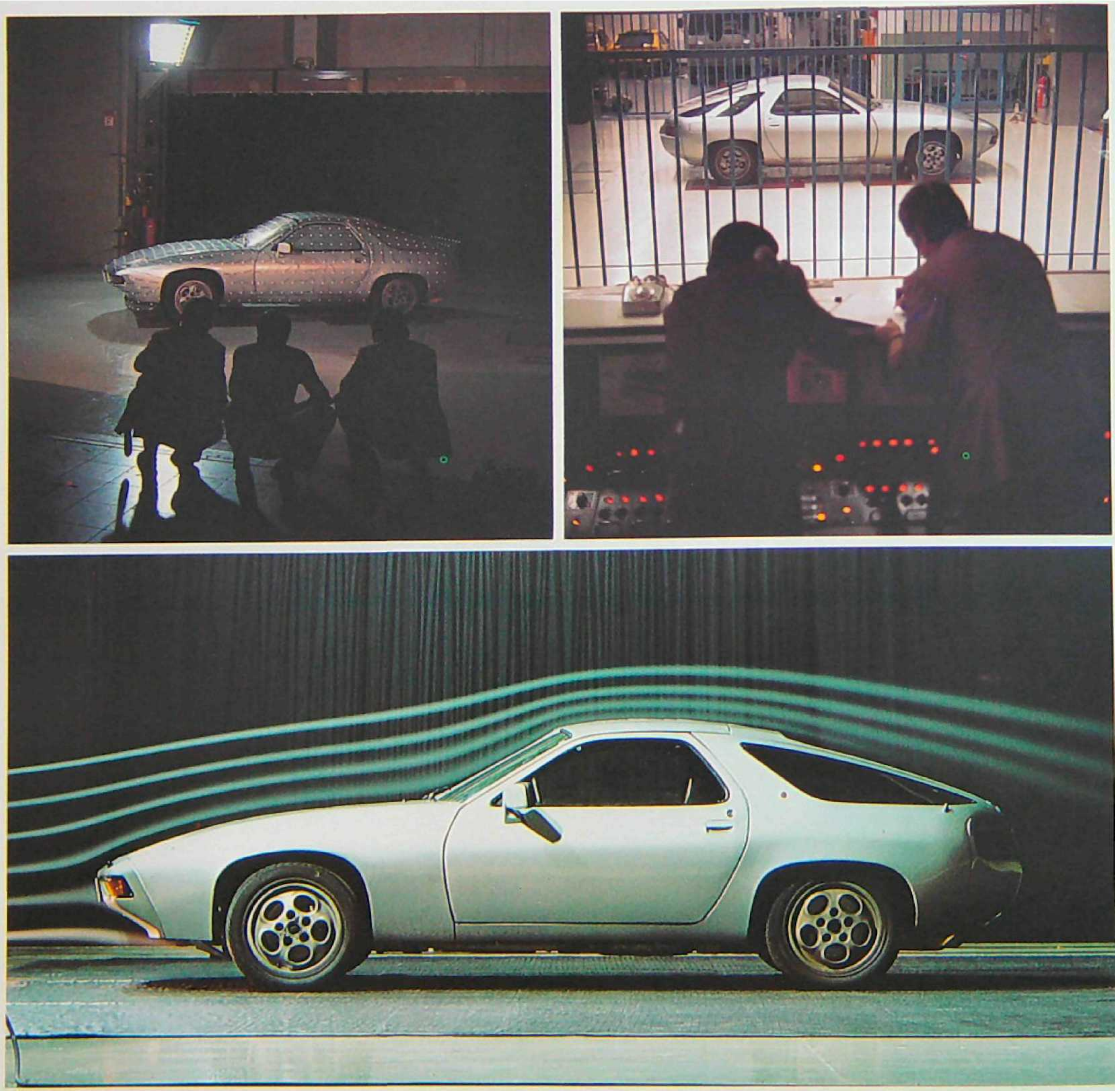

8 July 1976,4 a. m. Shortly after dawn the OK comes for a first test run in W6. the first completed prototype in construction stage II (left). At such an early early hour the technicians dare risk an uncamouflaged test run on open roads around Weissach (right) for the car's first trip. The clock hands can't be stopped, however and early risers will soon be on iheir way to work so W 6 withdraws to the Weissach track.

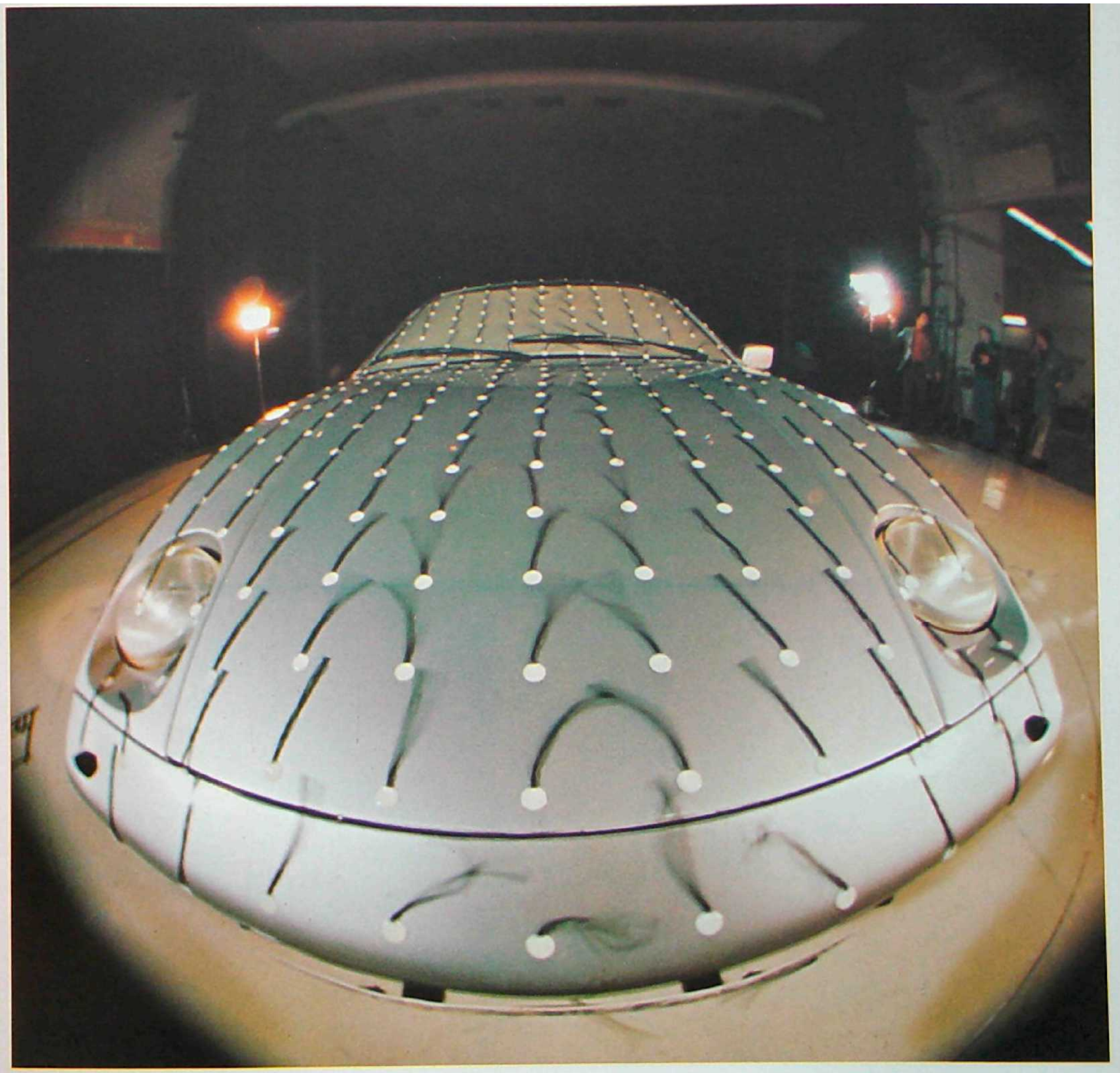
After further Weissach laps W6 returns to the shops where first checks are made under the supervision of development chief Helmuth Bott.



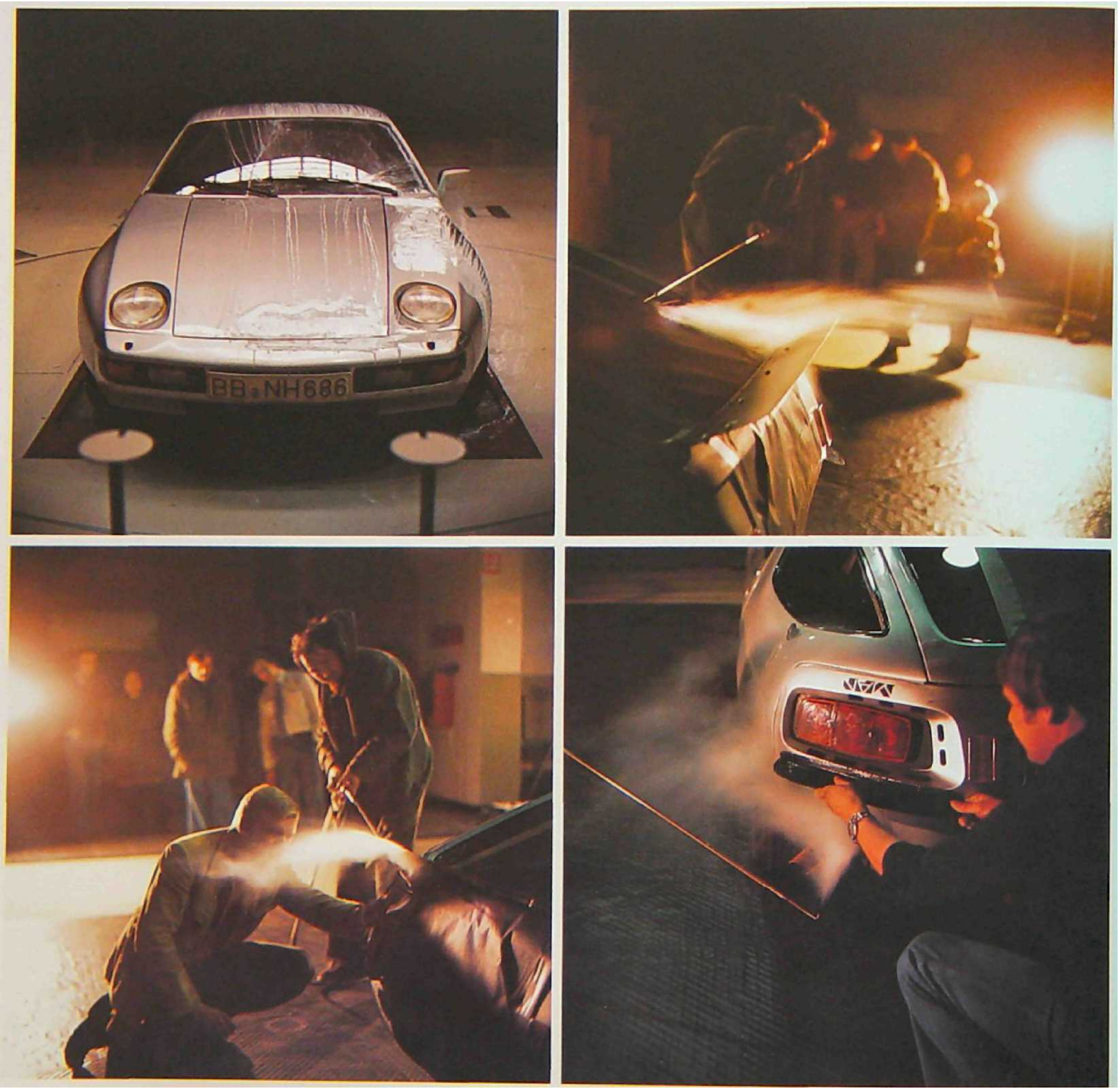
The early morning of 8 July 1976 was a day to remember. The test run went off successfully, further work n project 928 could proceed according to plan. For quite a while the keyed up technicians continued to discuss their experiences in front of the workshop and alongside prototype W3, now grown grey in the service.

Testing of the final body shape in the big VW wind tunnel. Flow experiments follow with wool tufts (left and right sides) and with smoke sensors (bottom).



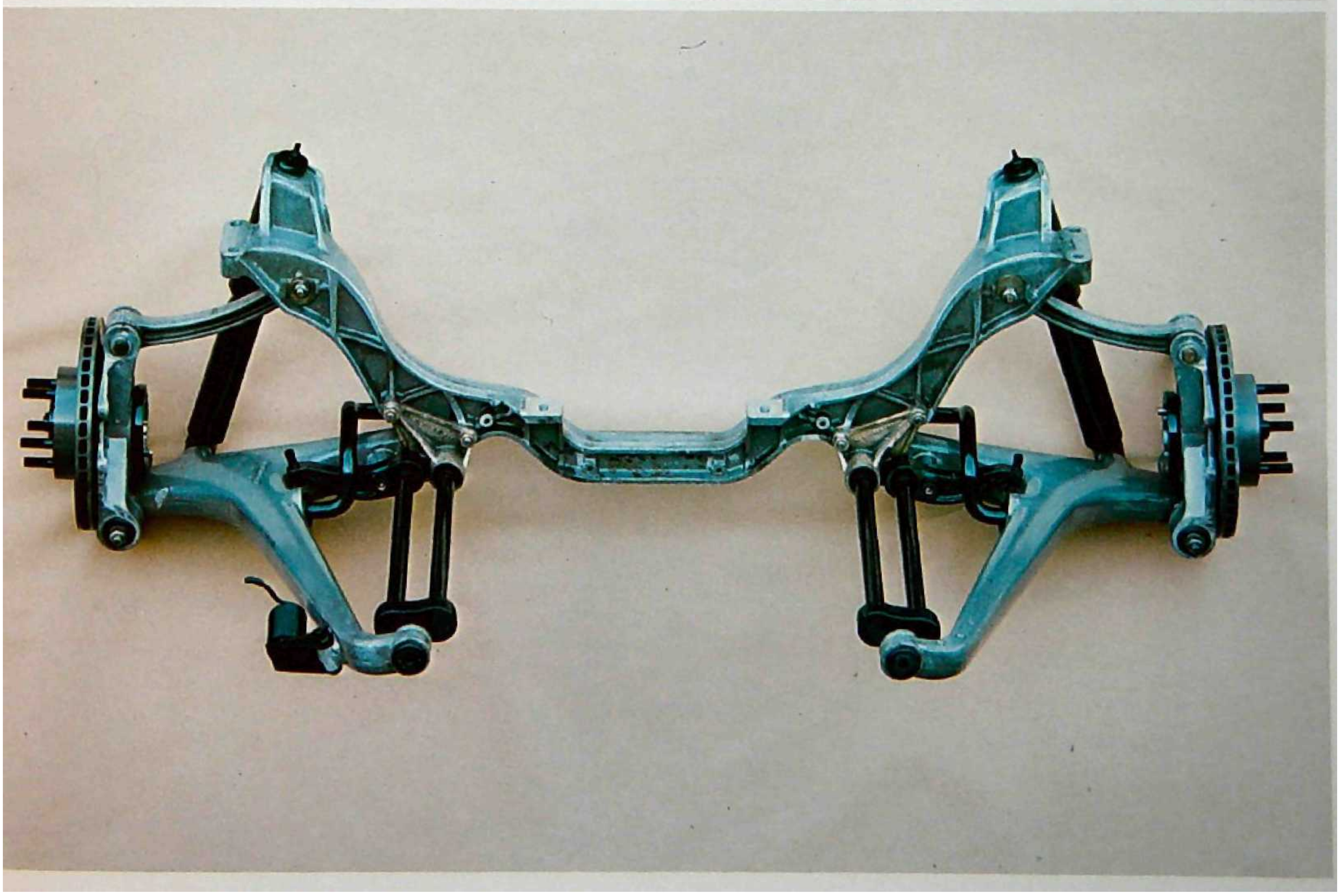


Dirt buildup tests with soft chalk (left) and testing of body details with smoke sensors were also part of the wind tunnel program.

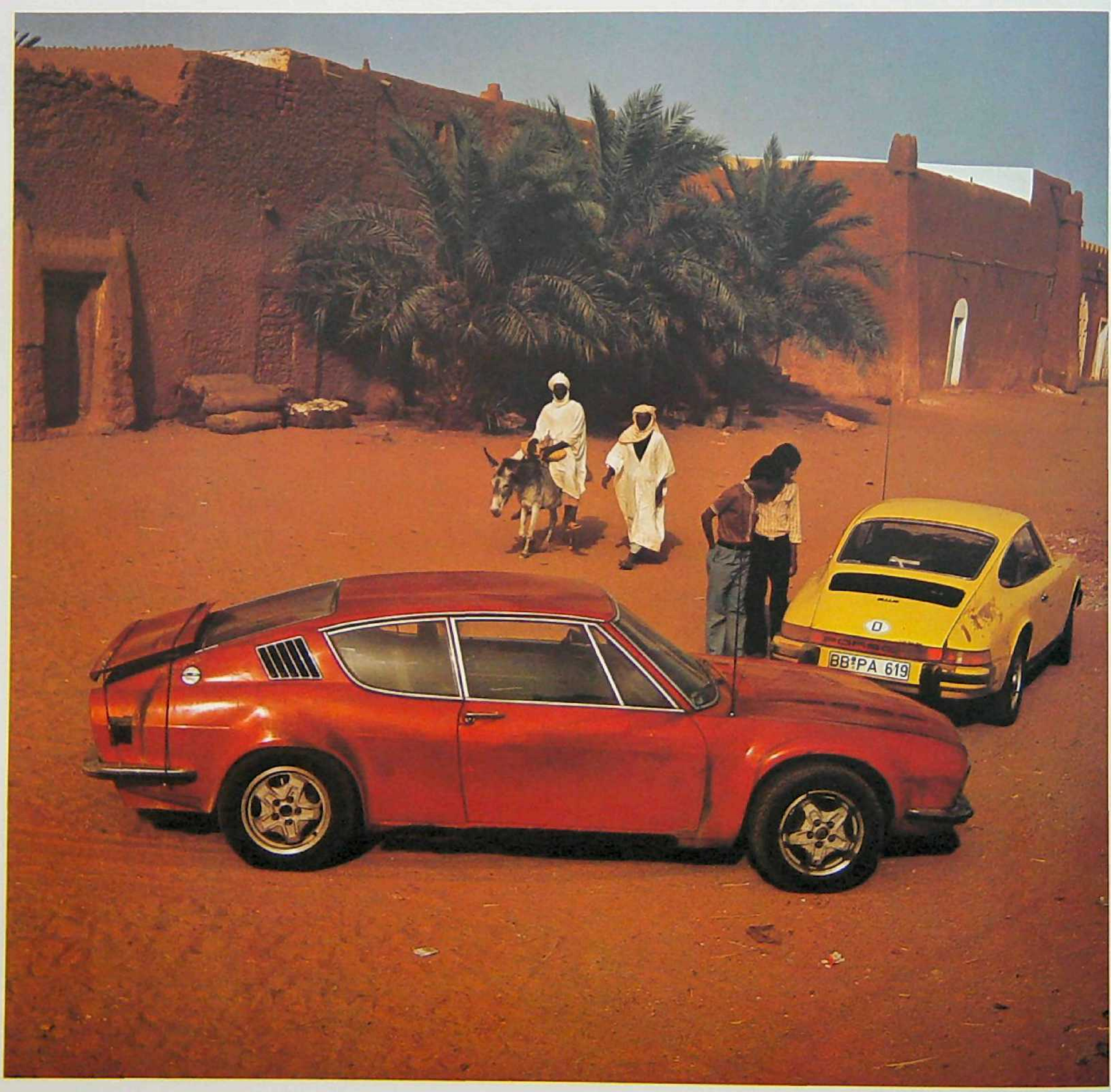


Stations in rear axle development. Left; two different versions of the lower rear wishbone, as of 1972. Middle: two arm variations for the torsion bar rear axle from 1974, Right: two final arm variants for the ultimate Weissach rear axle. Both include the decisive swinging link. The right (slimmer) version went into production.

Bottom; the rear axle which was not yet satisfactory in 1974 and then gave way to the far better Weissach axle. The torsion bar axle, here complete with auxiliary gearbox carriers, didn't have the toe-in stabilizing effect yet.



The series of extended African tests in Algeria began *as* early as 1973 and was continued yearly until 1976. The pholo below shows rolling test bed V 3 in the picturesque area around Timimoun during 1974 while the photo on the right side illustrates the climatic conditions clearly: 49° on the dial or I2O^{0}F in the shade.

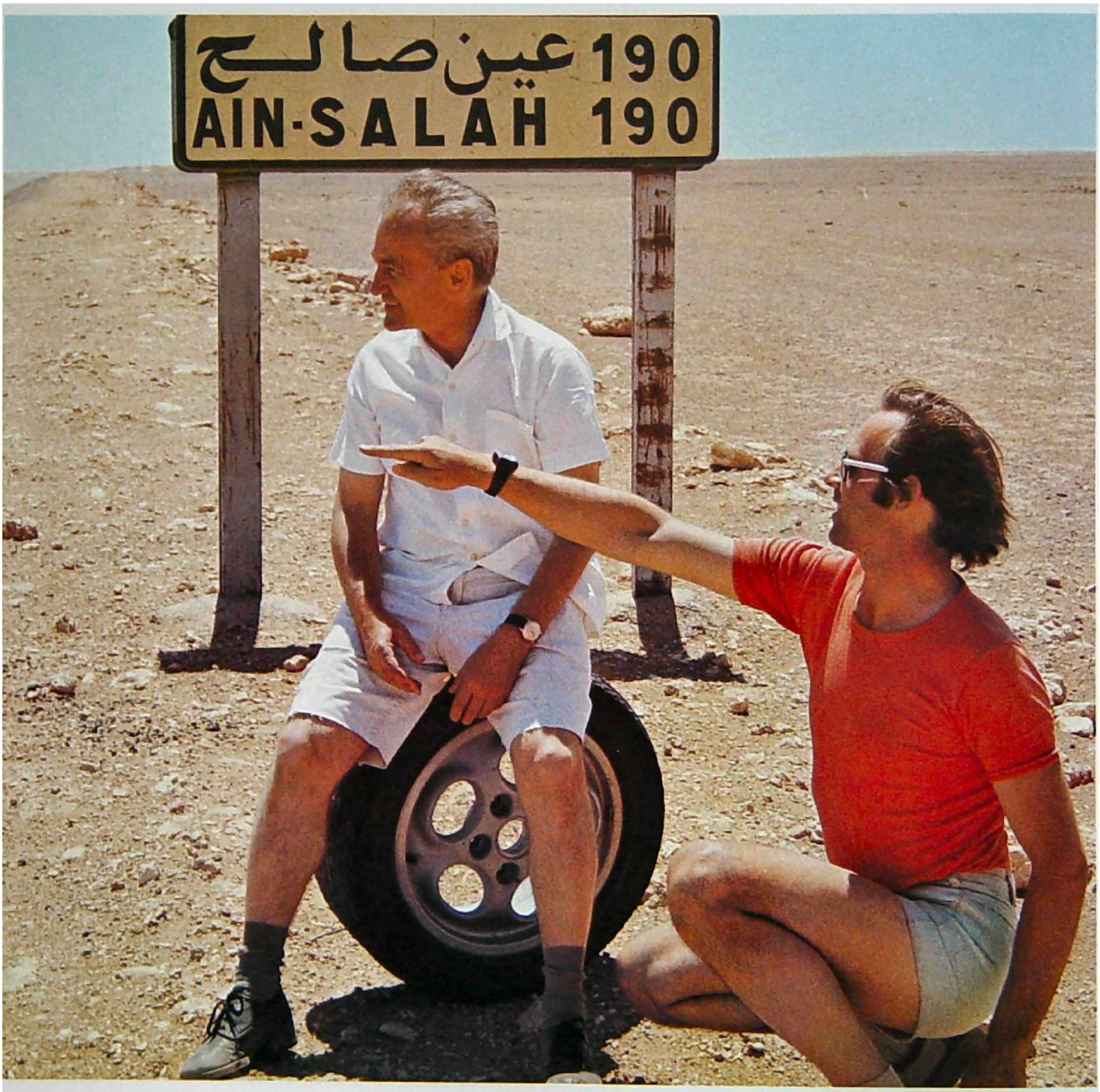



°C
Hygrometer
%rel

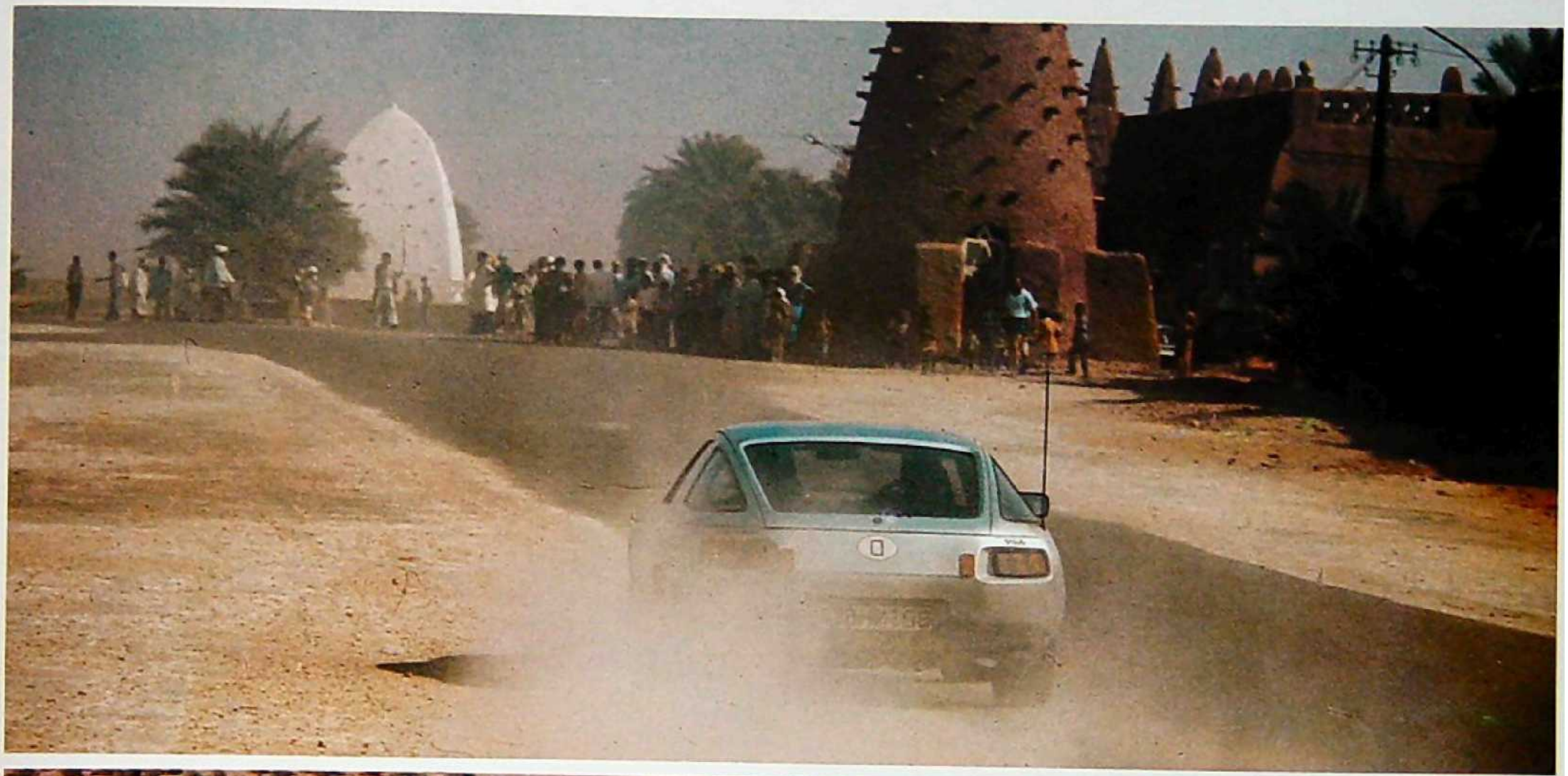
African tests with V3 and W 3 - one reward for those countless hours of hot, sweaty experimental work is the chance to collect impressive souvenirs. Berber rugs are piled on the roof and in the trunk of W 3 (bottom). They will console families for the long separation.

Comfort is a foreign word during most of these African expeditions. One simply makes the best of things as they are doing in this communal meal, "made by Porsche" ...

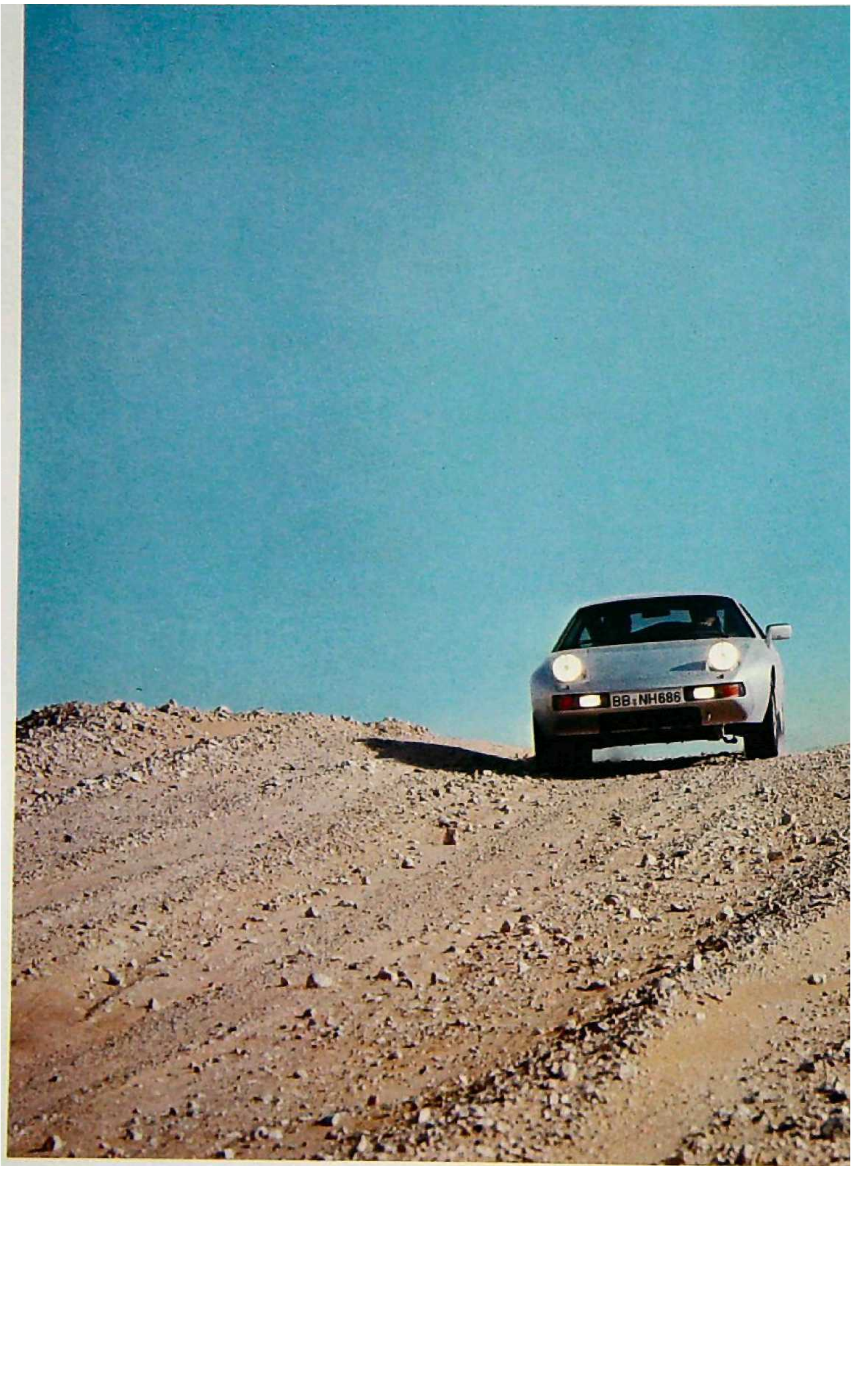
Short rest: 190 km or 120 miles to Ain-Salah. The modern caravan will soon be on its way again.

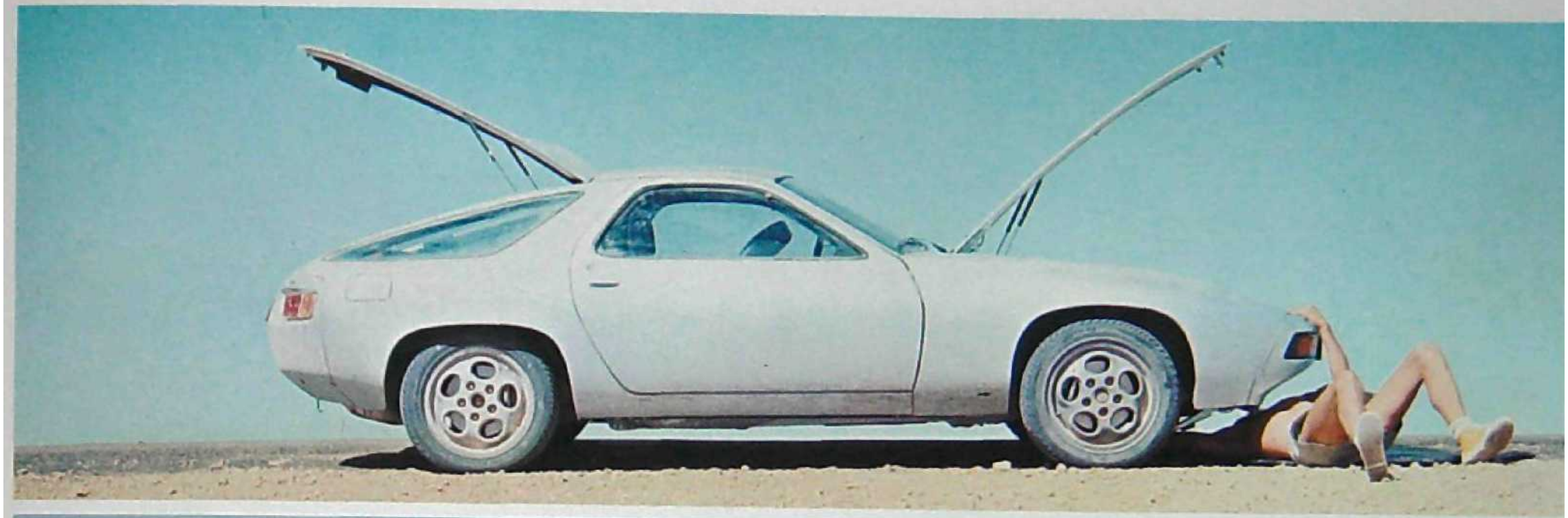


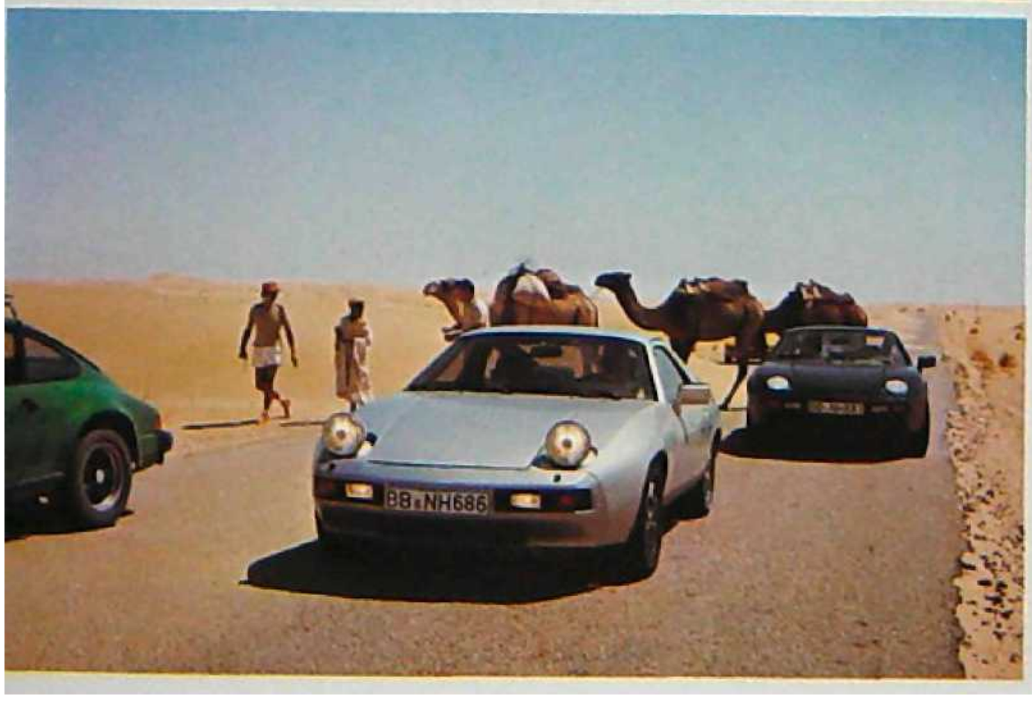
Paved roads and unpaved desert tracks under the burning sun; dust that filters through every crack. Then - a welcome change - another oasis and village.

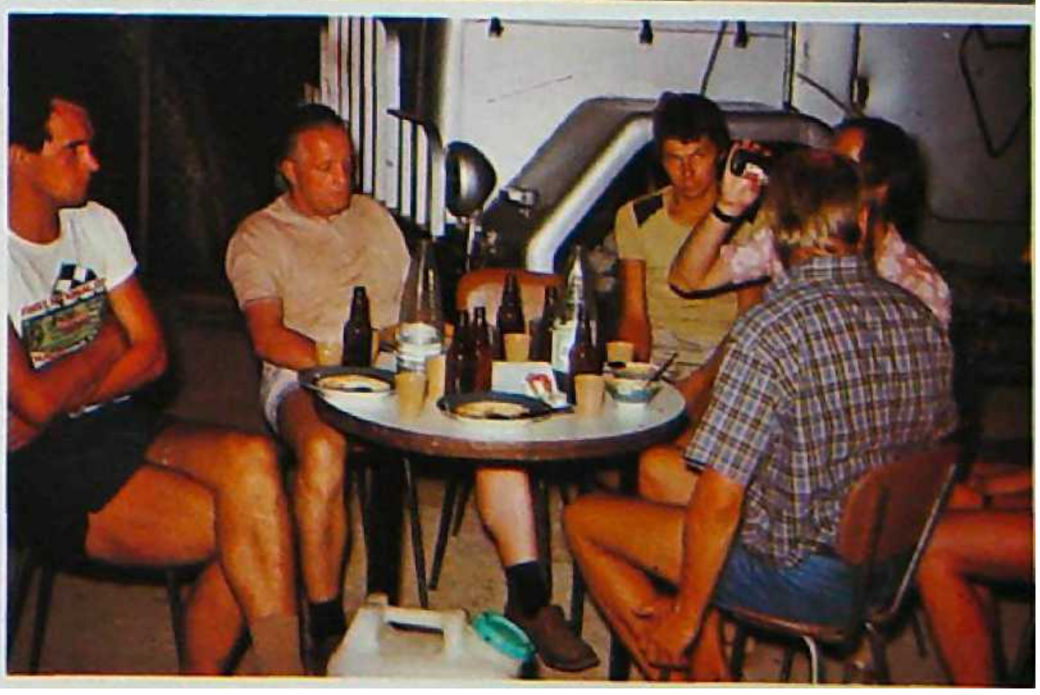


Desert tracks don't spare the prototype in any way. Nor do drivers have an easy time of it - checks performed at better than 100 degrees are not for every man. The other side of the coin comes in the form of colorful contacts with more traditional desert vehicles or in a cool beer after a hard job.

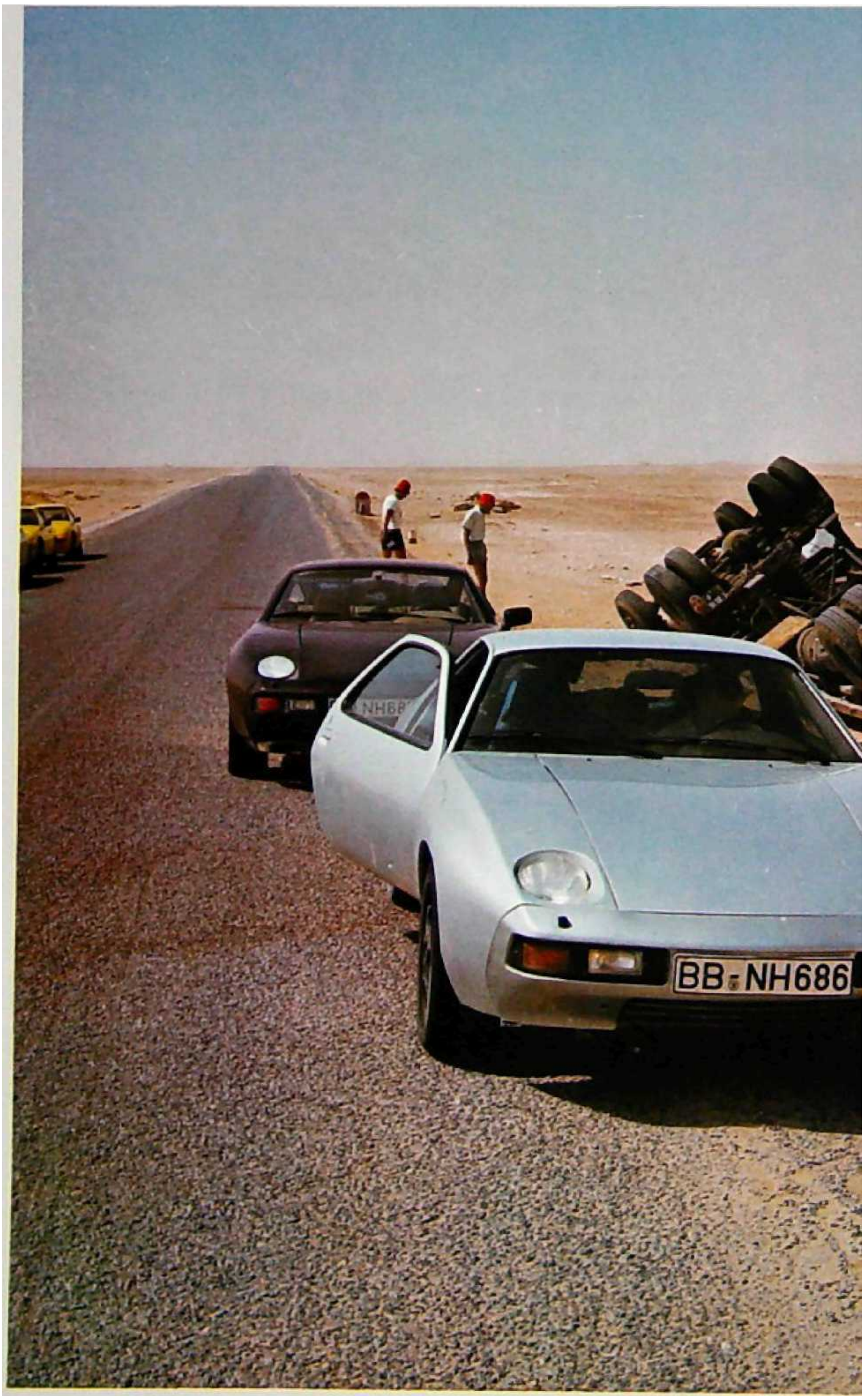


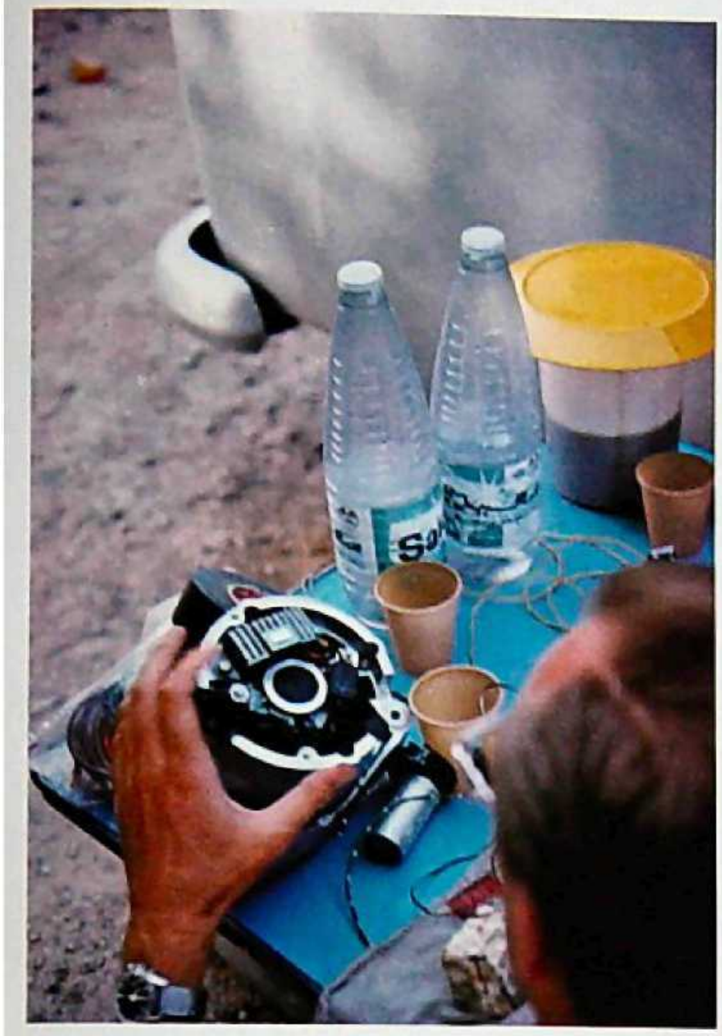



BB·NH686

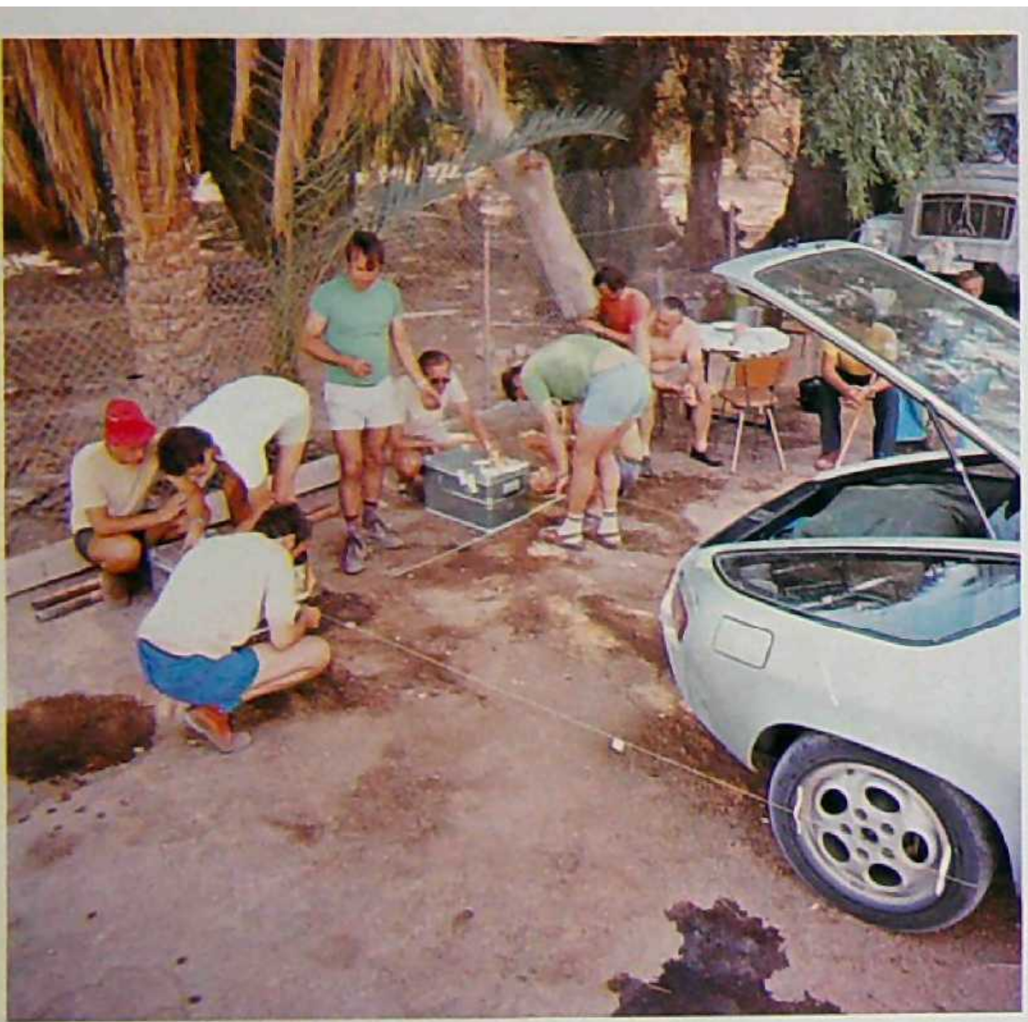


The endless desert takes its toll - from overturned trucks to a defective generator or a damaged tire which Dr. Ernst Fuhrmann and Helmuh Bott examine critically. But that doesn't prevent the test team leaving the route to try out their prototypes in desert sand and gravel.

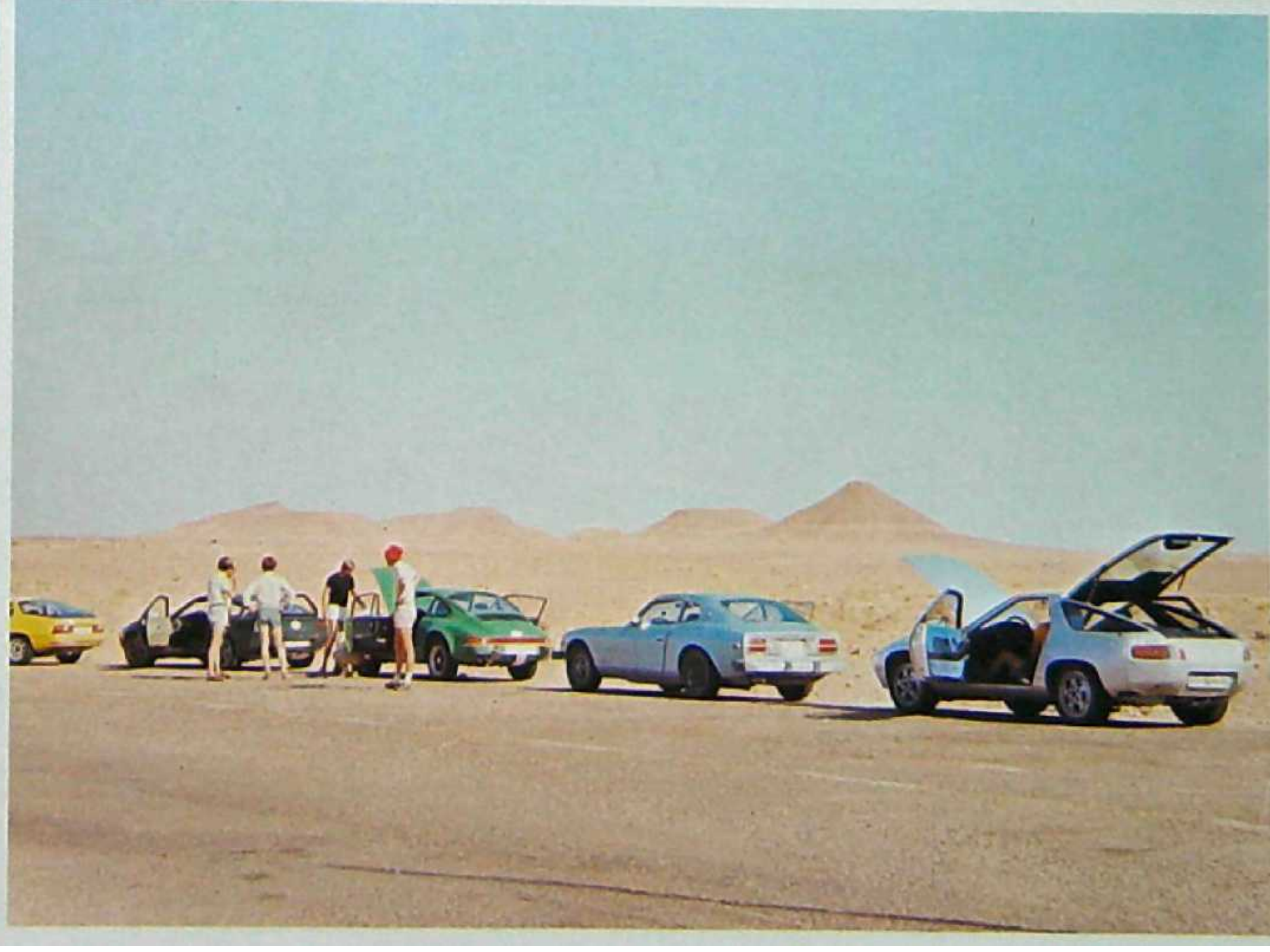




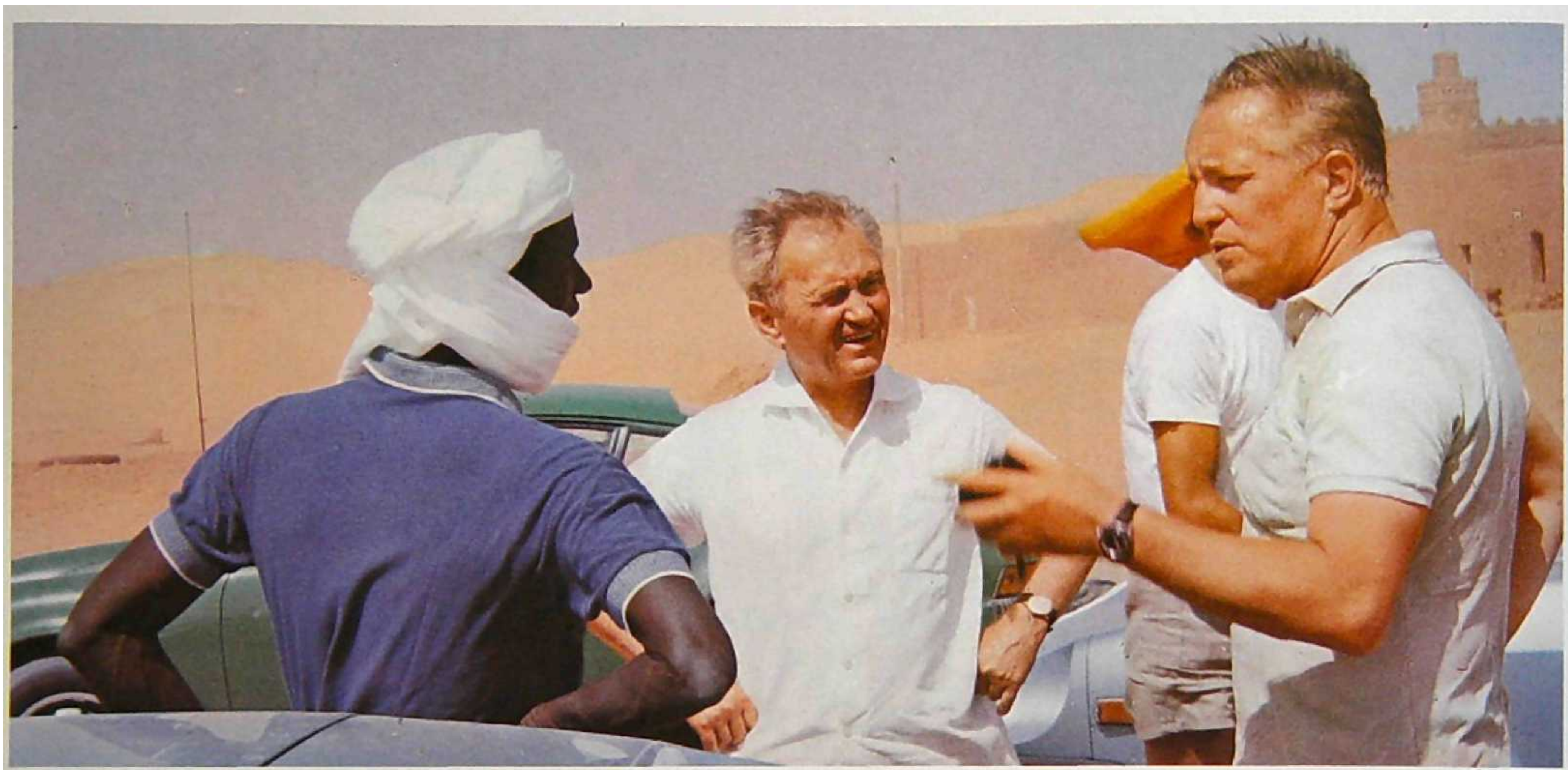

Improvised test rig for wheel geometry near El Golea. A well offers welcome relief for driver and vehicle as both receive their desert baptism. Then the wild chase continues for W 6.



The Africa crew of '76, after knocking off late, are in a good mood for a souvenir photo. They were celebrating the World Championship for Makes which the race team had just secured in Dijon. Next morning thirst rises to plague them again and the caravan moves on.



Communications problems, improvised working conditions, a lack of comfort - all these are balanced by the most wonderful test area any automobile designer could imagine. The photographer is equally content- a desert, setting sun and the prototype provide a worthy final composition to close the African test log.

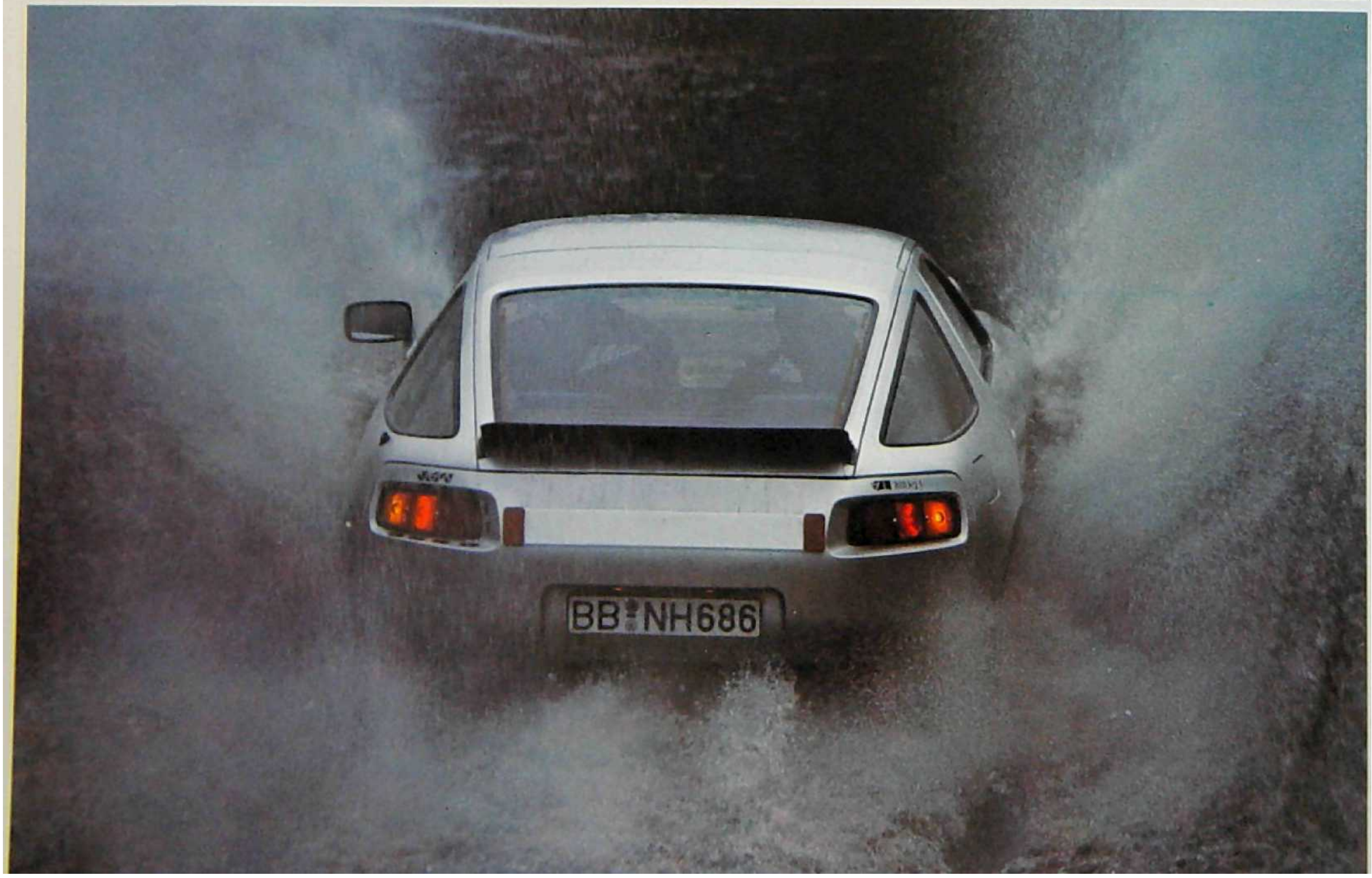


From desert sand they returned to European mud. Extended foul weather tests were run during 1976 at Ehra with vehicles of the various construction stages.


BB NH 686

The test program included extreme water splashes to confirm sealing of the ignition system and body, as well as to check on aquaplaning reactions.

The photos, left and right, show a vehicle before and during its passage through a flooded corner. They are checking aquaplaning behavior in a curve. Bottom and right side; passing through the deep water splash.

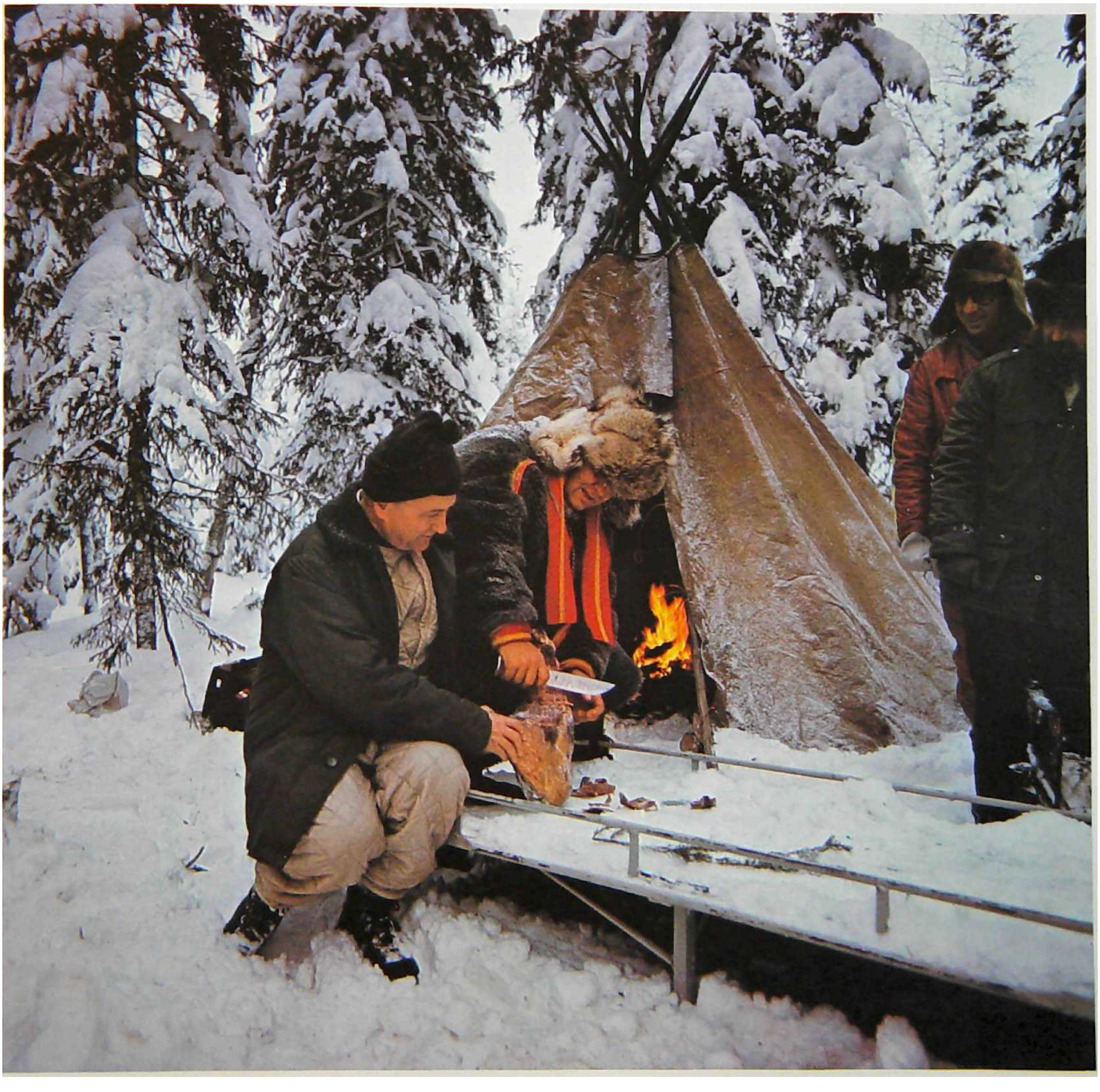



BB NH686

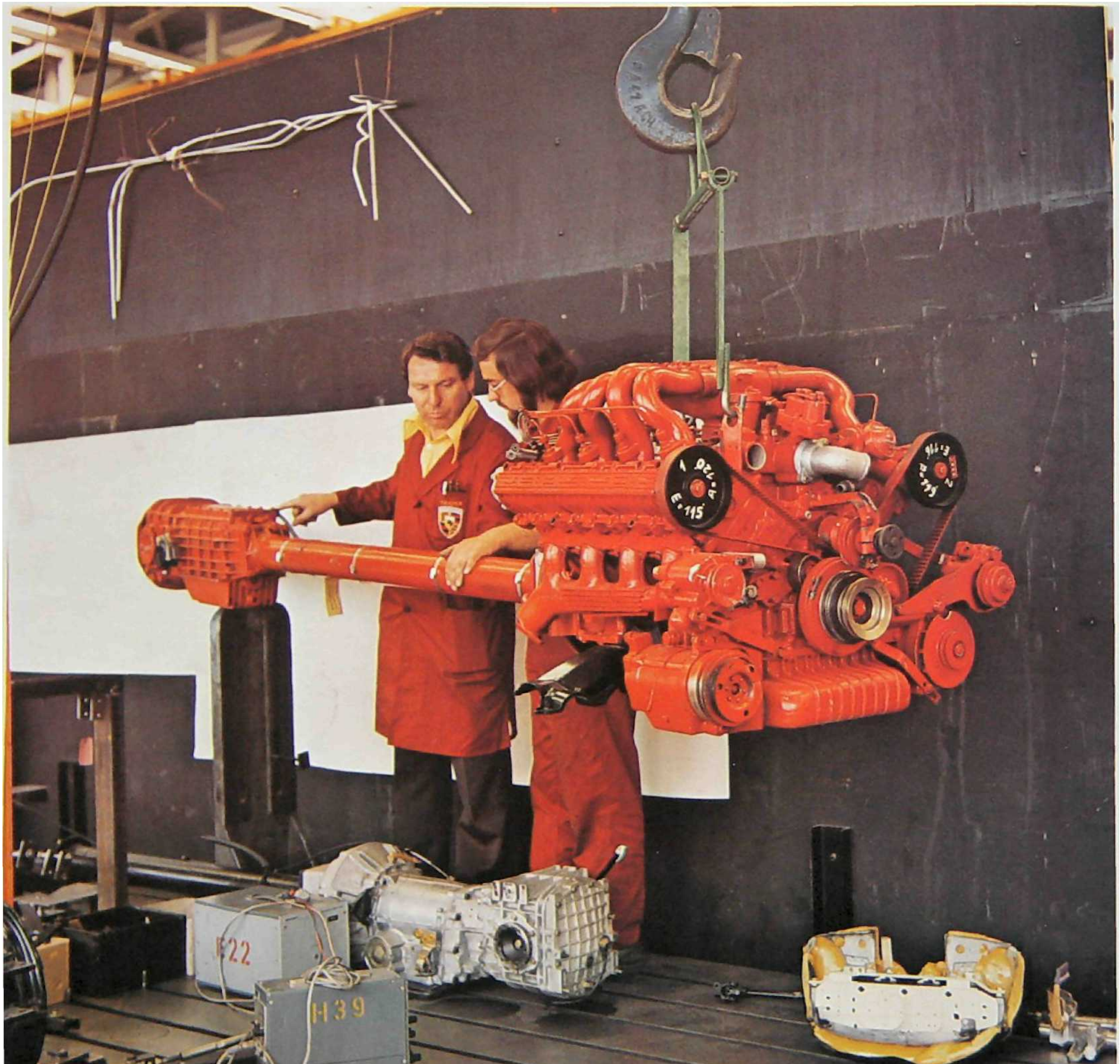
Another change of setting: winter testing at the Arctic Circle in northern Finland. Picturesque encounters with the Laplanders and their reindeer are only a short break in the long cold nights.


BB-NM 284

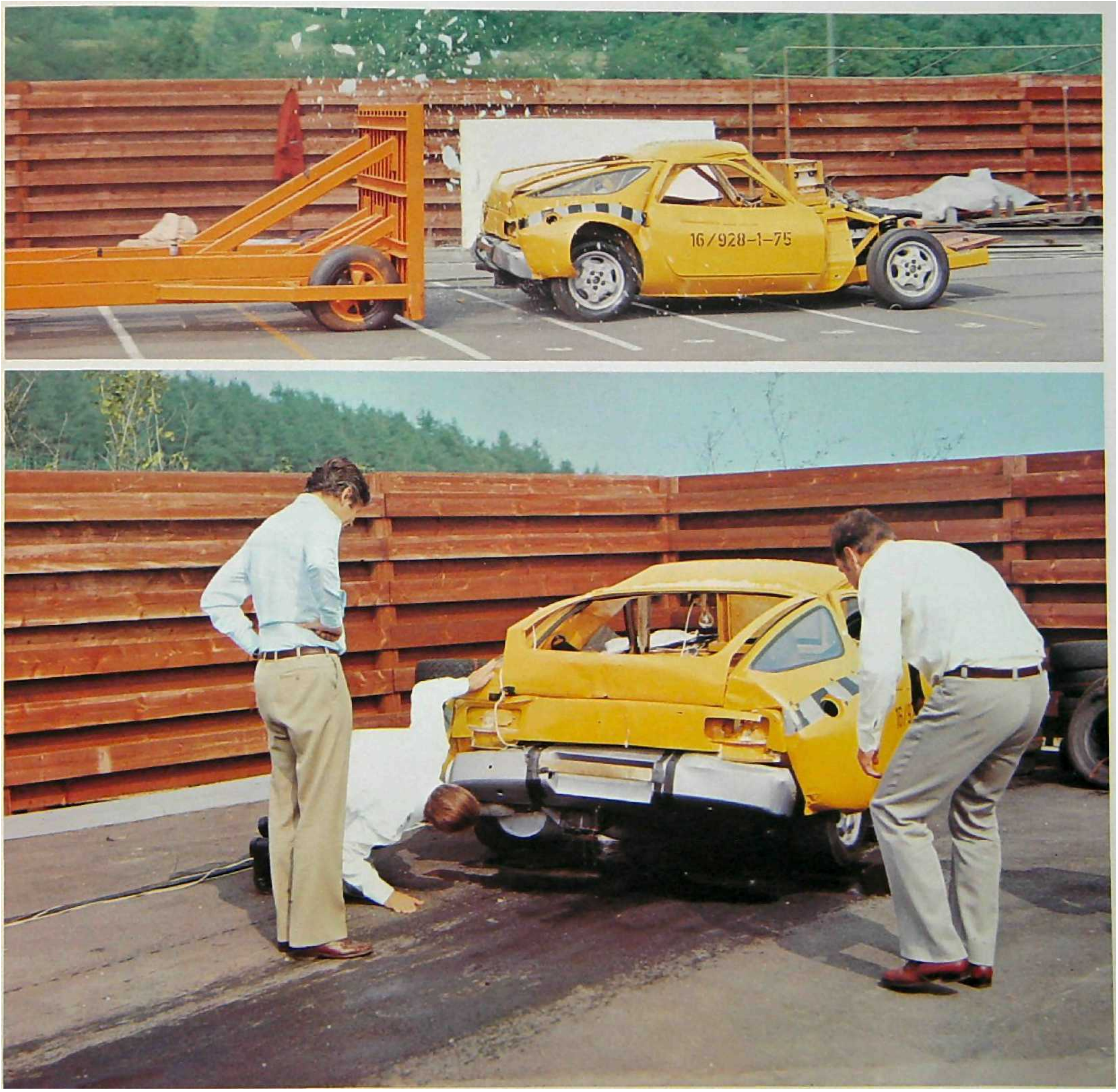
During a service pause the crew learns to appreciate the advantages of a simple campfire while Dr. Fuhrmann receives a demonstration from Finnish Porsche importer Antti Aarnio-Wihuri on slicing thin pieces from a haunch of reindeer



Crash tests formed only a small portion of the countless safety experiments carried out during development of the 928, but they are particularly spectacular. A specially painted engine/gearbox unit is prepared for mounting in a crash test car.

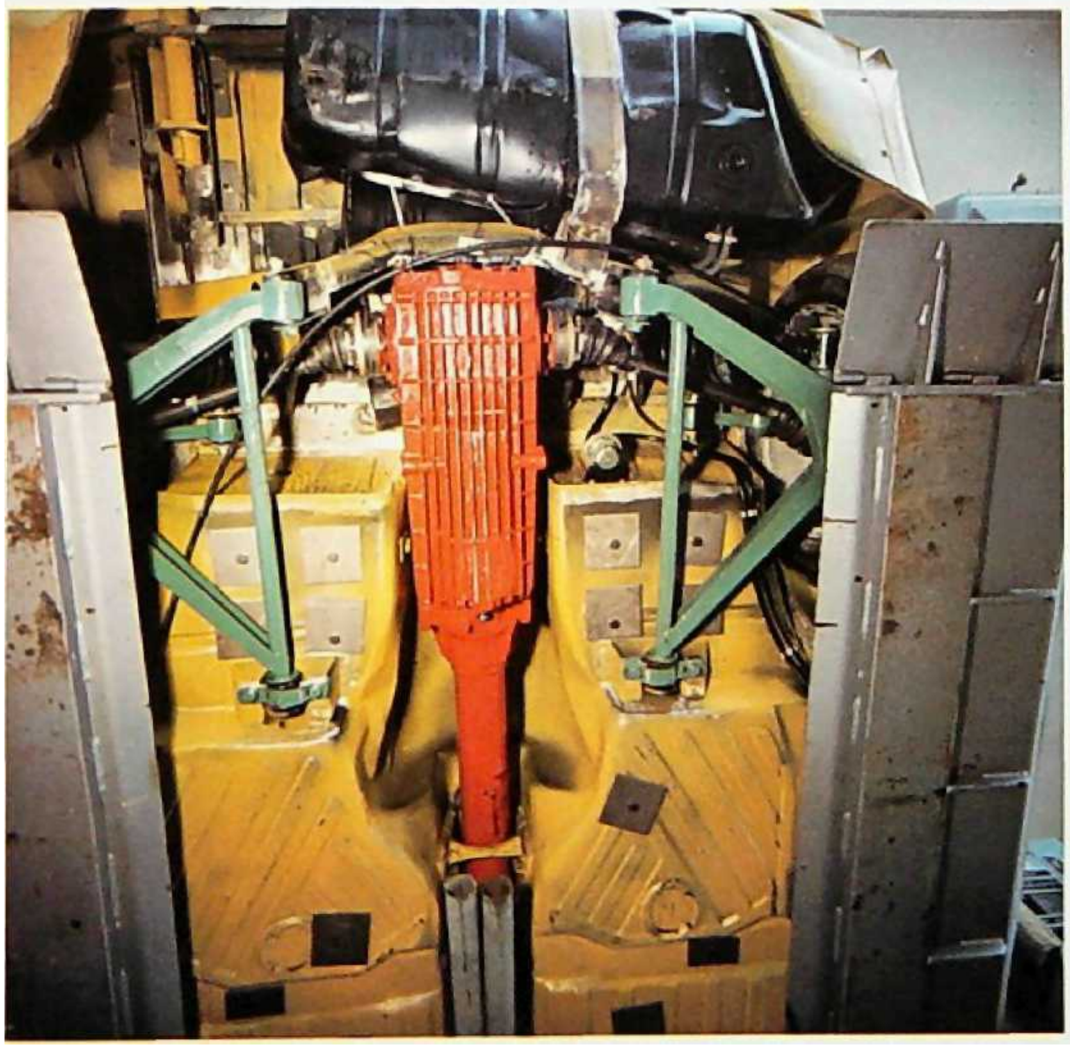


Rear crash with a vehicle from construction stage 1 during the summer of 1975, at a crash speed between 3970 lb. ram and stationary car of 30mph. The result was not yet satisfactory. Gasoline escaped.

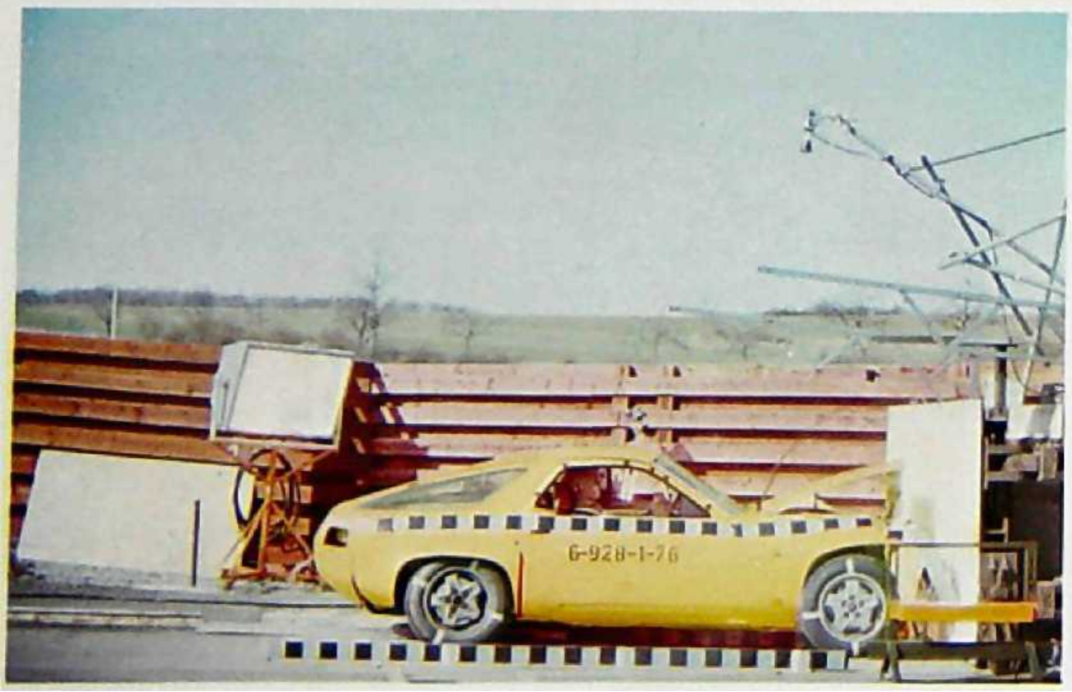


Repeat of the same rear crash test with modifications for better tank protection (still a sheet steel version here) and with integrated bumpers. Dr. Ernst Fuhrmann and Helmuth Bott register satisfaction at the progress - tail deformation met all projections and the tank remained tight.


17-928-2-76



Frontal crash with dummies in the vehicle and a speed of 30 mph. Here too the result was more than convincing: deformation of the nose section came at predetermined points, the passenger cell was undamaged in the crash and the doors didn't spring open.



Final major stations in the development project before confrontation with the public: presentations of a production-ready 928 to the firm's management and stockholders.

On 9 June 1976 the latest prototype of construction stage 2 was presented to Porsche managers from all branches in the yard behind the Weissach Styling Studio, in summer heat . . .

. , .while on 23 July 1976 the stockholders had somewhat less friendly weather on the Weissach skid pad for viewing the finished project in which they had placed so much faith. From the right: Project father Wolfgang Eyb, Counselor of Commerce Louise Piech, Dr. Hans Himmer, Dr. Ferry Porsche, Dr. Ernst Fuhrmann, project leader Wolfhelm Gorissen, Helmuth Bott, marketing manager Lars Schmidt - and Counselor of Commerce Josef Ahorner.

Several comparison vehicles completed the picture at this presentation and simultaneously established the arena in which this new sport car from Porsche would compete.

A little later another 928 circled the skid pad to present the profile one appreciates most - the car in motion.

The final dice were rolled and preparation for production could go forward at full speed - their next presentation would take place before the public.

In March 1977 the new sport car made its debut at the Geneva Automobile Salon and Project 928 had turned into the Porsche 92S - mentioned in every newspaper, hotly discussed by the motoring public, admired by fans around the world.

A very special kind of debut was celebrated by the Porsche 928 a few months later : on 10 June 1977 it was the pace car which opened the 24 hours of Le Mans before 300,000 spectators at the Circuit de la Sarthe, leading the field on its first lap before turning the start over to colleagues from the racing division

By autumn the goal had been achieved and production was underway - the Porsche 928 found its place on roads of every land. The fascinating development project had turned into a finished product, an exceptional mixture of concept, design, testing, improvement and finally, of knowledee-able production.

More than five years separated the first design sketch from the start of Porsche 928 production. A completely new concept was developed and proven in those years – the concept of a high performance sport car for the eighties and nineties.

Julius Weitmann has captured the development history of this Porsche 928 in a hundred fascinating photo pages.

Rico Steinemann's text presents facts and background information which seldom find their way into print.

Julius J. Weitmann.
Born in 1908, the one-time naval officer made his name as an automobile and motor sport photographer for »auto, motor und sport« and »Motor-Revue« immediately after the war. His racing photos, taken from the most daring positions, became famous for their sharpness and original perspective. He was one of the very first to climb into the cockpit next to a race driver, capturing track views as a driver sees them. He has published several photo volumes and countless major reports. Recently retired from the daily stress of a photo-reporter's life, he concentrates on selected projects now, leaving this passionate hunter ample time for the chase. Weitmann lives in Warmbronn near Stuttgart.

Rico Steinemann.
Born in 1939, he was Editor in Chief of the motor sport magazine »powerslide« (now »Motorsport aktuell«) until 1968 as well as a race driver who captured scores of international trophies and five absolute world records, chiefly in Porsches. Thereafter he was race boss at Porsche, playing his part in their World Championships of Makes in 1969-70-71. Today he owns a publicity firm in Russikon outside Zürich which handles, among other things, the editorial content of the Porsche magazine »Christophorus«. Apart from countless journalistic tasks he produced a book about Tazio Nuvolari, Italian racing idol of the thirties.

Motor buch Verlag
ISBN 3/87943/518/9