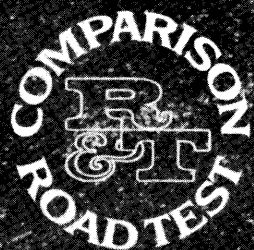




PHOTO BY JOE RUSZ



# A TALE OF THREE TURBOS

*Al Holbert, Rolf Stommelen, Jochen Mass, Jacky Ickx and Manfred Schurti help us test the Trans-Am and World Makes Porsche Turbos*



ONCE UPON a time the illustrious West German auto-making firm of Dr. Ing h.c.F. Porsche decided that turbocharging, and not increased engine displacement, was the secret to improved performance. To prove it, the company built a series of racing cars called the 917-10 and 917-30 and fitted their engines with these exhaust-driven devices. The cars were the scourge of their respective series—the North American Canadian-American Challenge Cup and the European Interserie.

In 1974 Porsche decided to apply the turbocharging principle to its passenger cars and the Turbo Carrera was born. To the casual observer this car still looked like a 911 but beneath those bulging fenders and spoiler-bedecked engine cover lurked the most advanced suspension and drivetrain Zuffenhausen ingenuity could muster. *Road & Track* tested the U.S. version in the January 1976

issue and called the \$26,000 limited-production GT sensational. It was a car that did everything well. It was fast, accelerating from 0-60 mph in just 6.7 sec and reaching the quarter mile in only 15.2 sec. Wound to the limit it attained a top speed of 156 mph. And it had brakes to match its straight-line performance, stopping in 253 ft from 80 mph. But straight-line performance was not the Turbo's only strong suit. It circled the skidpad at 0.811g and posted one of the quickest ever production-car times at Lime Rock Park.

The story does not end there, however, because late in 1975 Porsche introduced the Turbo Carrera RSR, a race-tuned version of this breathtaking road car. The racer was built to FIA Group 4 specifications which meant that in many ways it was still a street Porsche. The body was left intact except for fiberglass flares which were pop riveted to the existing fenders. A large front spoiler that also hid the engine's oil and water (yes, water)

coolers graced the nose. Inside the cockpit much of the production car interior was left intact. The power window lifts, the door-mounted map compartments and other accouterments were left in place so the car could meet minimum weight requirements. A roll cage, a turbocharger boost gauge and a control knob (called the screw) which allows the driver to regulate the boost from the cockpit were added.

The 934, as the Group 4 car is called, retains the standard production 930 Turbo torsion-bar suspension. But, in addition, coil springs mounted over Bilstein gas shock absorbers with threaded collars for ride-height adjustment are added front and rear. The control arms at each end are stock too; the only difference is the substitution of hard plastic bushings for the compressible rubber used in the street Turbo. Adjustable anti-roll bars are fitted to each end and BBS light alloy wheels (10.5 x 16 front and 12.5 x 16 rear) shod with Goodyear racing tires lurk beneath the fenders. The

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steering is standard 930, but the brakes are the finest Porsche offers. They are those ubiquitous 917 discs with curved internal vanes and cross drilling and finned light alloy 4-piston calipers with the usual balance bar for adjusting front/rear brake bias. The 4-speed transmission is right out of the street Turbo also, but a variety of ratios is available to match the engine characteristics to various tracks.

Because Group 4 rules are quite explicit about engine modifications (they allow only a few) the racing engine differs little from its production car counterpart. In fact, except for boost pressure and camshaft timing and duration, the two powerplants are nearly identical. However, the race engine is unique in one respect. It is one of the first Porsche powerplants to use water cooling. Actually the water doesn't cool the engine but merely the pressurized air after it leaves the turbocharger. In the turbocharging process this charge becomes heated and some form of cooling is needed to prevent a loss in volumetric efficiency. On the Turbo RSR a water-alcohol mixture passing through a pair of water jackets performs this function. Porsche calls it the Waterworks for obvious reasons.

Porsche built only 31 racing RSRs for the 1976 season. But despite a price tag of

about \$40,000 they easily sold out the lot.

End of story? Not quite because there's a sequel. Early in 1976 the Porsche factory decided it would contest the World Championship for Makes with a specially built Turbo Carrera, a Group 5 version of the production Porsche called the 935. The car (actually the factory built two) would have to conform to the new silhouette rules which required that it look like a normal Porsche. But that still left plenty to the imagination and by now we all know Porsche engineers can be quite imaginative.

Although the Group 5 Porsche retains the original 911 body shell, it is a one-of-a-kind race car in almost every other respect. Fiberglass doors, fenders, hood, decklid and spoilers, along with plexiglass windows, reduce the car's weight to the allowable minimum. Below the minimum is more like it. With the help of little tricks like a titanium seat-adjuster lever, Porsche engineers got the car down below minimum and then ballasted it back to the legal limit with 150 lb up front to improve front-rear weight distribution and 20 lb on the right-hand floor board to even it up side to side.

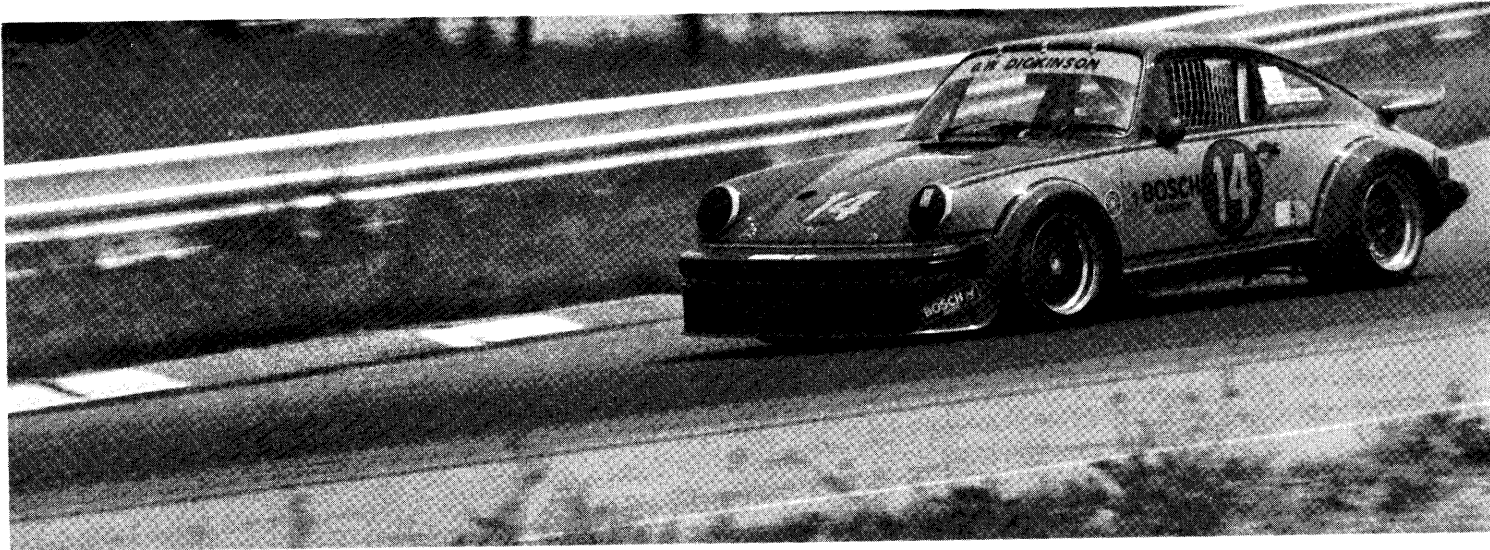
Much to the consternation of the FIA, Porsche engineers took advantage of the rule that states "fender shape is free" to come up with smooth flowing front fend-

ers minus headlights. Instead, the lights are mounted in the front spoiler, improving the car's aerodynamics.

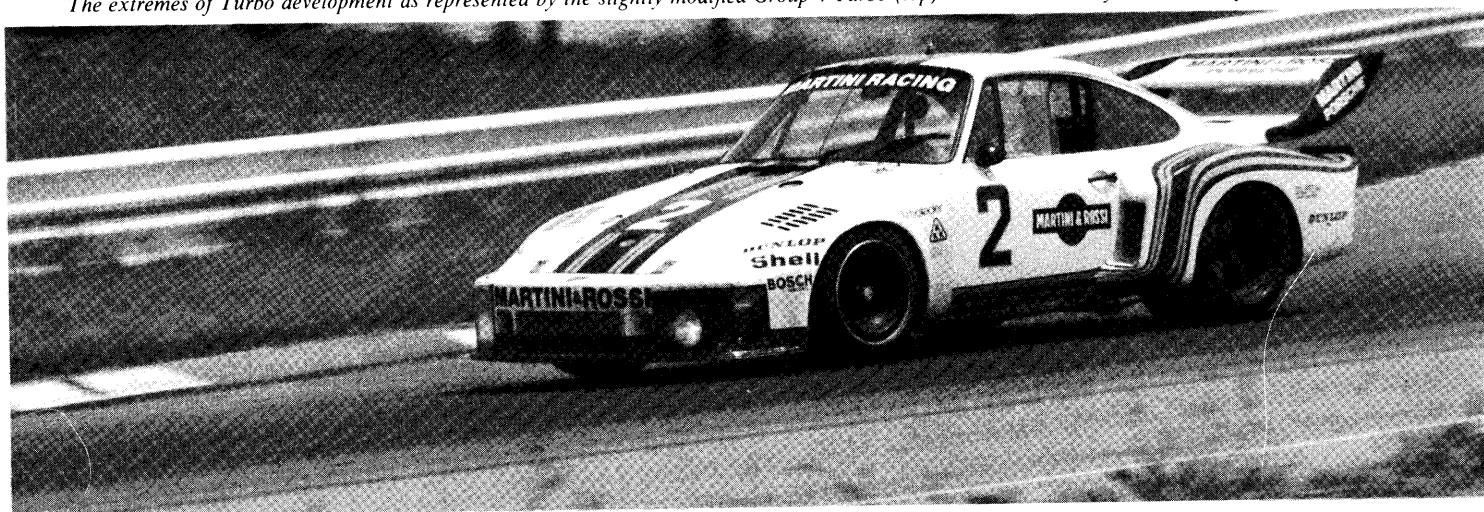
In the cockpit, where the Group 4 Turbo looks quite civilized, the Group 5 car is stark and purposeful. There's a single bucket seat for the driver, the mandatory roll cage, a beefy shifter and special pedals with a fiberglass divider that keeps the clutch foot separated from the throttle-brake foot. Next to the shifter there's a handbrake-like lever that allows the driver to adjust the stiffness of the rear anti-roll bar to compensate for the decreasing weight of the fuel load and varying track conditions. Instrumentation is business-like and thorough with the usual grouping of fuel, oil and temperature gauges, an 8000-rpm tachometer and an all-important boost pressure gauge. The latter contains monitoring lamps that light up to indicate increasing boost pressure. Eleven green lights begin to sequentially glow as the boost rises above 0.5 atmospheres, then four red lights come on as the boost pressure surges above 1.5 atmospheres.

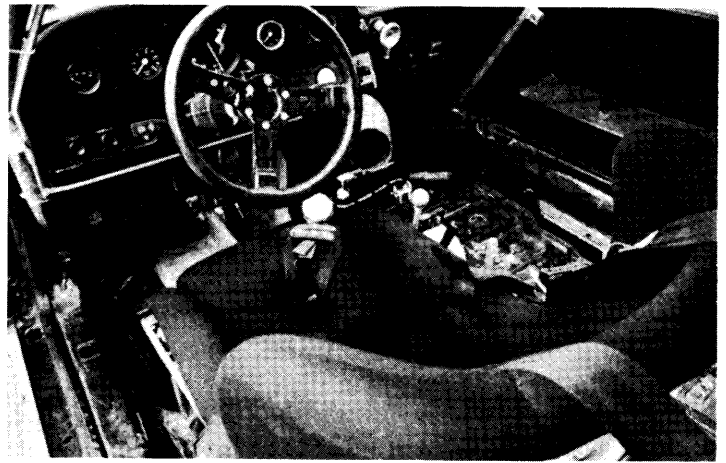
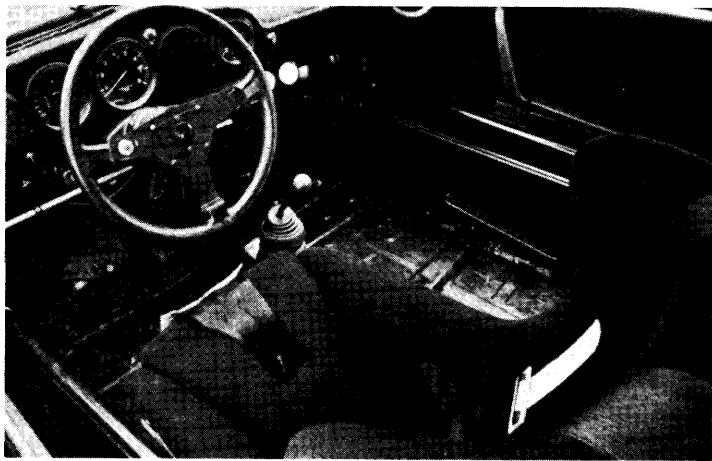
Front suspension is like that of the 1974 racing car, the normal Porsche torsion bars having been replaced by titanium coils which are more easily changed to adjust handling for a particular track. At the rear the beefy aluminum

PHOTOS BY BILL WARNER



*The extremes of Turbo development as represented by the slightly modified Group 4 Turbo (top) and the extensively altered Group 5 racer.*



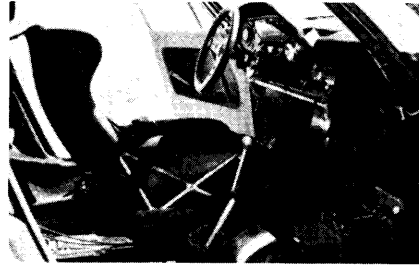


Group 4 interior (left) is plush compared to stark cockpit of Group 5 car. Handbrake-like lever in Group 5 car below adjusts rear roll stiffness.

semi-trailing arms are shared with the production car, and again titanium coils are the springing medium. Adjustable anti-roll bars at both ends are part of the package, an understatement when you remember that the driver can trim the rear one from his seat.

The brakes are the same as on the Group 4 car with the addition of crescent-shaped ducts to blow cooling air onto the rotors. One of the most important mid-season changes was finned wheel covers to further improve brake cooling. The season began with 16-in. wheels at both ends, but Dunlop-Porsche development work led to new 19-in. tires with a 0.22 height-to-width ratio at the rear. They're incredible looking things with a size designation of 350/700-19. Rim width here is 14.5 in. At the front the wheels are 16 x 10.5 with 275/600-16 tires.

Per regulations, the engine is free except for its basic crankcase and block which must be production based. Thus it has the same 70.4-mm stroke as the series Turbo. The 92.0-mm bore is 3.0-mm smaller than production to get displacement down to 3857 cc. Apply the 1.4 factor for turbocharging to this and you get an amoeba's eyelash less than 4000 cc. Bosch timed mechanical fuel injection instead of the production K-Jetronic, dual sparkplug ignition and lightweight internal components, including titanium connecting rods, higher boost pressure and other detail differences like cam timing, bring the output to a healthy 590 bhp DIN at 7900



rpm. The gearbox is the regular Turbo item but with pressure lubrication and super-precise racing shift linkage.

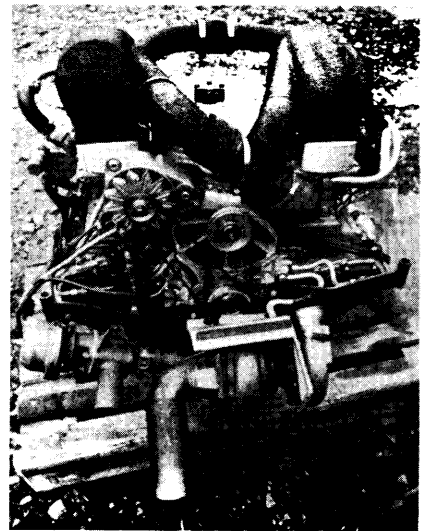
At the beginning of the season the Turbo's intercooler didn't have to hide within the body as it does in the Group 4 car, and Porsche gave the 935 a bulky air-to-air intercooler in the rear spoiler instead of the 934's compact water intercooler.

Enter racing politics again, this time in the middle of the season. After the Vallelunga race, sports commissioners in Italy registered doubts as to whether the 935's rear end really conformed to the rules, and the CSI concluded it didn't. Ruling: the production 930 Turbo's spoiler must now be mountable on the Group 5 car. So the engineers had to do a frantic redesign, adapting water-to-air intercooling to the 935 between the April 9, 1976 decision and the Nürburgring race on May 30. Despite heavy overtime, all the problems weren't solved when the 935 with water intercooling appeared at the Nürburgring, and its reliability went

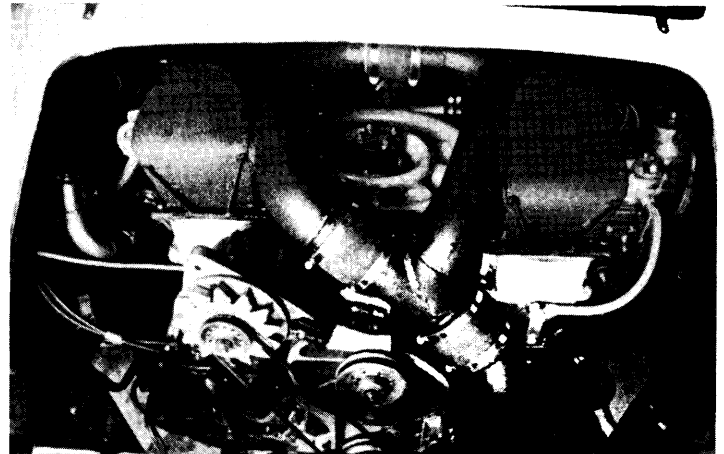
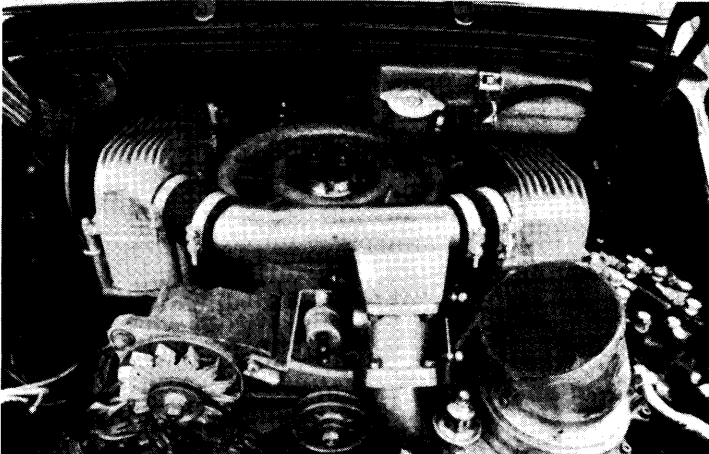
out the window. The cooling changes threw the engine tuning off; part throttle vibrations developed and destroyed the distributor, which took the engine with it and put the single 935 out. Tuning was sorted in time for the Austrian race at Zeltweg on June 27, but the makeshift throttle shafts required by the retuning broke on the works car and two privately-entered 935s.

By Watkins Glen, though (July 11), the reliability was there again. So Porsche was able to complete the season with a U.S. win, a last one at Dijon on September 4, and 122 points altogether for a 26-point lead over BMW. Outlay

PHOTOS BY JOE RUSZ

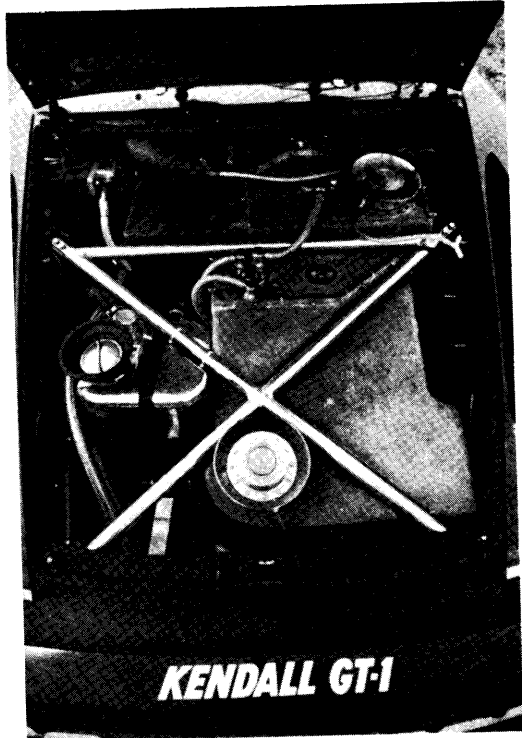


Group 4 (left) and Group 5 engines use water-cooled intake plenums, but differ internally. Group 4 develops 485 bhp to Group 5's 590.



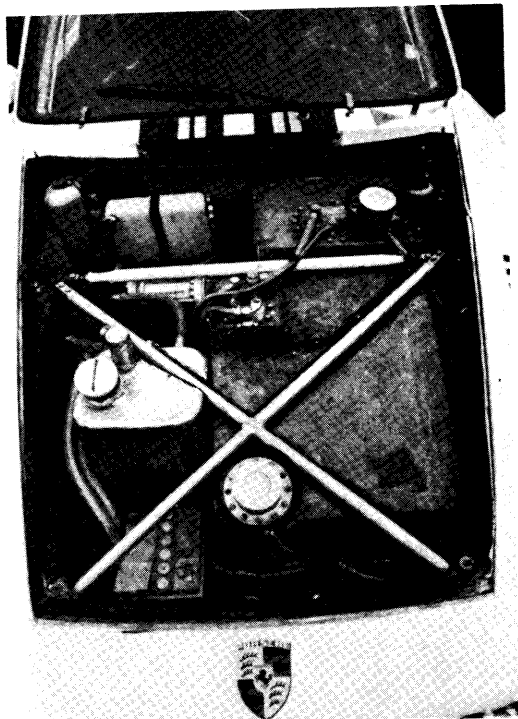
for the mid-season rehash, according to Porsche, was more than \$200,000.

In a sense this triple street-track comparison test is the culmination of a series of events that started with our test of the first production U.S. Turbo Carrera last January. At that time we started looking around for a Group 4 car to compare it to and we soon learned that Al Holbert would be racing one in the Trans-Am series. This was a fortuitous turn of events. Holbert is not only one of America's premier road racers but his cars are always extremely well turned out with impressive attention to the tiniest detail. →



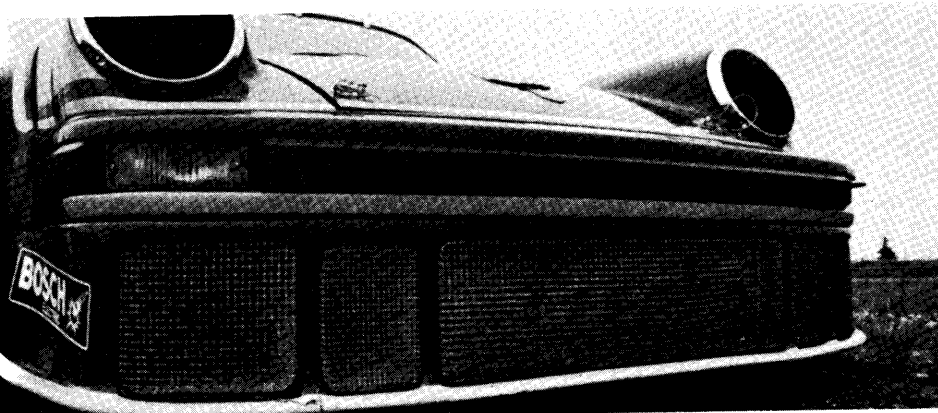
**KENDALL GT-1**

Cross braces in trunks of both racers add stiffness to front end. Large tanks hold fuel; smaller single tank holds oil.



## SPECIFICATIONS COMPARISON Production & Racing Porsche Turbos

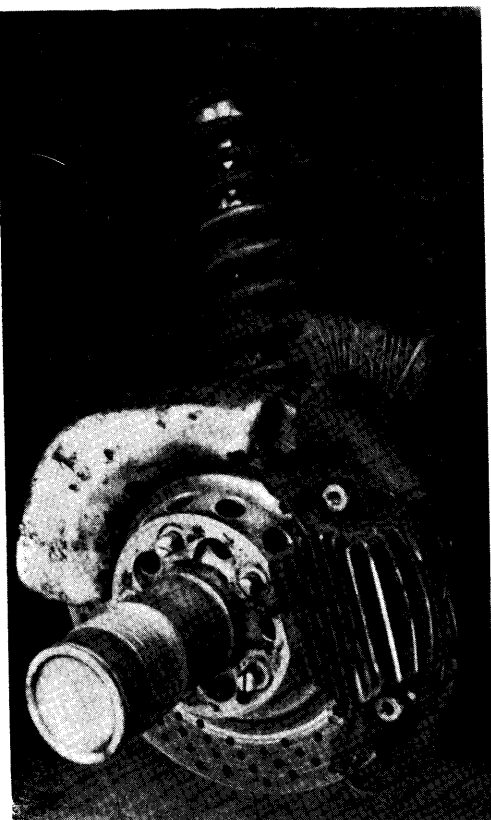
	Production	Group 4	Group 5
<b>Price</b> .....	\$25,880	\$40,000	\$75,000
<b>General:</b>			
Weight, lb.....	2785 (curb)	2655 (race)	2340 (race)
<b>Weight distribution</b> (with driver), front/rear, %.....	38/62	40/60	40/60
Track, front/rear, in.....	56.4/59.1	58.0/58.9	59.1/61.3
Length.....	168.9	168.9	184.3
Width.....	69.9	73.8	77.6
Height.....	52.0	51.3	49.8
Ground clearance.....	5.9	3.1	3.0
Overhang, front/rear.....	36.7/42.8	36.7/42.8	39.2/55.7
Usable trunk space, cu ft.....	4.5	nil	nil
Fuel capacity, U.S. gal.....	21.1	31.7	31.7
<b>Engine:</b>			
Bore x stroke, mm.....	95.0 x 70.4	95.0 x 70.4	92.0 x 70.4
Displacement, cc/cu in.....	2993/183	2993/183	2875/174
Compression ratio.....	6.5:1	6.5:1	6.5:1
Bhp @ rpm.....	234 @ 5500	485 DIN @ 7000	590 DIN 7900
Torque @ rpm, lb-ft.....	246 @ 4500	434 @ 5400	434 @ 5400
Fuel injection.....	Bosch CIS	Bosch CIS	Bosch Mechanical
Fuel requirement.....	premium, 96-oct	premium, 102-oct	premium, 102-oct
<b>Drivetrain:</b>			
<b>Gear ratios:</b>			
4th.....	0.66	0.69	0.83
3rd.....	0.89	0.93	0.93
2nd.....	1.30	1.12	1.30
1st.....	2.25	1.60	1.83
Final drive ratio.....	4.22:1	4.63:1	4.63:1
<b>Chassis:</b>			
<b>Brake system</b> .....	11.1-in. vented discs front, 11.4-in. vented discs rear	12.0-in. vented and cross drilled discs front & rear	12.0-in. vented and cross drilled discs front & rear
Swept area, sq in.....	500	543	543
<b>Wheels</b> .....	forged alloy; 15 x 7J front, 15 x 8J rear	BBS alloy; 16 x 10.5 front, 16 x 12.5 rear	BBS 16 x 11 front, Porsche 19 x 15 rear
<b>Tires</b> .....	Pirelli CN36; 185/70VR-15 front, 215/60VR-15 rear	Goodyear Bluestreak; 23.5 x 10.5-16 front, 25.5 x 12.5-16 rear	Dunlop; 275/600-16 front, 350/700-19 rear
<b>Front suspension</b> .....	MacPherson struts, lower arms, torsion bars, tube shocks, anti-roll bar	MacPherson struts, torsion bars, aux coil springs, Bilstein tube shocks, adj anti-roll bar	MacPherson struts, tubular lower A-arms, progressive-rate coil springs, Bilstein tube shocks, adj anti-roll bar
<b>Rear suspension</b> .....	semi-trailing arms, torsion bars, tube shocks, anti-roll bar	semi-trailing arms, torsion bars, aux coil springs, Bilstein tube shocks, adj anti-roll bar	semi-trailing arms, coil springs, Bilstein tube shocks, adj anti-roll bar
<b>Instrumentation:</b>			
<b>Instruments</b> .....	180-mph speedo, 8000-rpm tach, 999,999 odo, 999.9 trip odo, oil press., oil temp, oil level, fuel level, clock	8000-rpm tach, oil press., oil temp, boost press., fuel pump main press., bypass fuel press.	8000-rpm tach, oil press., oil temp, fuel press., boost press., trans oil temp
<b>Warning lights</b> .....	oil temp, brake system, handbrake, alternator, low fuel, parking lights, fog lights, rear-window heat, hazard, seatbelts, high beam, directionals	oil press., brake system, alternator, low fuel	oil press., alternator, low fuel, cooling fan, lights on, fog light
<b>Accommodation:</b>			
Seating capacity, persons.....	2+2	1	1
Seat width, in.....	2 x 19.5/2 x 13.5	13.5	14.0
Head room, in.....	38.0/31.5	39.0	40.0
<b>Calculated data:</b>			
Lb/bhp (test weight).....	13.5	6.1	4.2
Mph/1000 rpm (4th gear).....	26.0	22.7	22.6
Engine revs/mi (60 mph).....	2310	2640	2650
Piston travel, ft/mi.....	1065	1220	1225
<b>Brake swept area,</b> sq in./ton.....	317	366	436



Group 4 car's chin spoiler hides brake ducts and oil and water coolers, but Group 5's is part of 1-piece nose and covers repositioned headlights and oil cooler.



Both race cars use cross-drilled, axially-vented disc brakes derived from the 917.



Only two years out of SCCA regional racing Holbert won the coveted STP professional rookie of the year award in 1973. In 1974 he placed 3rd in the Trans-Am series and 4th in the IMSA Camel GT, the latter despite competing for only half the season. Holbert placed 3rd in the Camel series in 1975 and really came of age in 1976, winning the 12 Hours of Sebring and copping 2nd in the 24 Hours of Daytona. He won the Camel GT with an immaculately prepared Chevy Monza while campaigning the equally well prepared Turbo RSR in SCCA Trans-Am events. So the choice of the George Dickinson/Al Holbert Turbo Carrera for this comparison test was a natural.

Porsche built only two Group 5 Turbo Carreras and both are raced by the factory Martini race team. Initially we planned on testing the Group 4 and Group 5 cars at the combined Trans-Am and World Makes race at Watkins Glen last July. But the weather (rain) and the post office (they lost part of our test equipment for three days) failed to cooperate. Despite the problems, we were able to time both race cars and the street Turbo around the Glen circuit for a comparison of their track performance. And Holbert agreed to truck his car to Lime Rock Park the Tuesday after the Glen race for the instrumented performance-gathering portion of the test. Because the Group 5 cars were returning to Germany immediately after the Glen race, we arranged to do whatever testing we needed at Porsche's Weissach proving grounds in West Germany. By a lucky turn of events the Engineering

### PERFORMANCE COMPARISON Production & Racing Porsche Turbos

	Production	Group 4	Group 5
<b>Acceleration:</b>			
Time to distance, sec:			
0-1320 ft (¼ mi).....	15.2	14.2	8.9
Speed at end of ¼ mi, mph.....	99.5	121.0	133.5
Time to speed, sec:			
0-30 mph.....	3.8	3.9	1.6
0-60 mph.....	6.7	5.8	3.3
0-80 mph.....	9.9	7.7	4.4
0-100 mph.....	15.3	10.1	6.1
<b>Fuel economy:</b>			
mpg.....	17.0 (normal)	4.0 (race)	4.0 (race)
<b>Handling:</b>			
Speed on 100-ft radius, mph.....	35.4	44.1	45.7
Lateral acceleration, g.....	0.811	est 1.300	est 1.400
Speed thru 700-ft slalom, mph.....	62.8	na	na
<b>Brakes:</b>			
Minimum stopping distances, ft			
From 60 mph.....	158	105	92
From 80 mph.....	253	178	164
Pedal effort for 0.5g stop, lb.....	45	65	na
Fade, % increase in pedal effort, 6 stops from 60 mph			
@ 0.5g.....	nil	nil	na
<b>Interior Noise:</b>			
Idle in neutral, dBA.....	57	74	83
Maximum 1st gear.....	81	102	na
Constant 50 mph.....	72	87	na
70 mph.....	76	92	98
90 mph.....	80	95	na

Editor was sent to Germany and was joined by Ron Wakefield for the data collecting. Unfortunately, our timing wasn't quite right as both Group 5 cars were being prepped for the showdown race against BMW at Dijon. So we weren't allowed to run our own acceleration or braking tests. Instead, we have data gathered by Porsche factory engineers during some early-season testing at Paul Ricard. That bit of disappointment was tempered by the fact that two weeks after the Dijon race Ron Wakefield was invited back to Weissach to drive the Group 5 car around the Porsche test track. His impressions accompany this portion of the test.

The two factory Group 5 cars lapped the Watkins Glen circuit in less than two minutes, the Jochen Mass/Jacky Ickx car

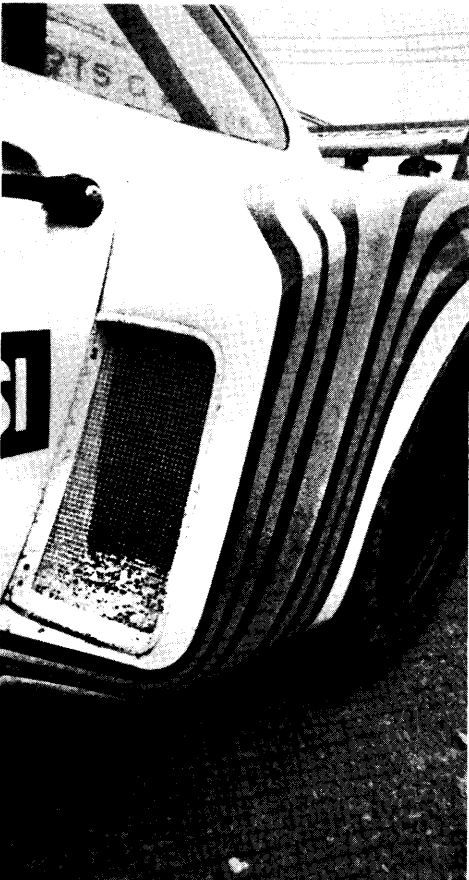
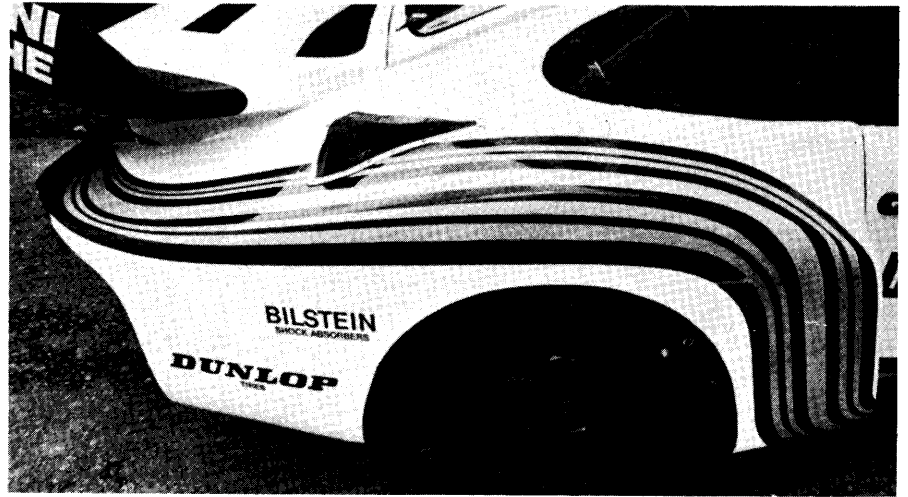
being a tick quicker (1 min 55.25 sec and 105.49 mph) than the sister Turbo driven by Rolf Stommelen and Manfred Schurti (1:55.88 and 104.91 mph). Holbert hustled his Group 4 car around in 2:02.40 sec or 99.32 mph and then jumped into the street Turbo and turned a fast lap of 2:33.20 or 79.37 mph. So the fastest Group 5 car was 7.15 sec faster than Holbert's Group 4 car which was 30.80 sec quicker than the production Turbo Carrera.

The Group 4 Turbo is rated at an impressive 485 bhp DIN at 7000 rpm compared to 234 bhp SAE net at 5500 rpm for the production Turbo. This horsepower advantage didn't show up in the Group 4 car's 0-60 mph time of 5.8 sec which is only 0.9 sec faster than the street Turbo. But once on the boost the

race car really flies, accelerating to 120 mph in less time than it takes the production Turbo to reach 100 mph. The Group 4 car was only 1.0 sec faster in the quarter mile, lack of low-end boost and tall gearing again conspiring against the race Turbo off the mark, but when it tripped the lights it was traveling more than 20 mph faster.

The 917 brakes are really impressive, hauling the 2655-lb car to a stop in just 105 ft from 60 mph and in a mere 178 ft from 80. This compares to 158 and 253 ft for the street version.

Noise is one of a race driver's worst enemies as it can lead to early fatigue. The Group 4 Turbo, however, is very easy on the ears as the turbocharger does its usual fine job of muffling exhaust noise. The maximum noise reading in 1st



*Pop-rieveted fender flares and 16-in. diameter BBS wheels are used on Group 4 Turbo (above left). Specially crafted wrap-around fenders and custom-built 19-in. diameter magnesium wheels are used at the rear of the Group 5 car. Scoop in rear fender (left) directs air to intercooler radiators. Street Turbo and Group 4 car are similar in appearance.*



gear was 102 decibels, 10 decibels lower than we recorded for Greenwood's Corvette at idle!

At the Glen and at Lime Rock, Holbert put the street and the Group 4 race car through their paces. He found the road car to be somewhat surprising for a Porsche. "It's more or less neutral if you don't lift your foot off the throttle too abruptly," he said. "That's because of the increased track and the size of the tires compared to other 911s. But with a sudden application of full throttle there's a tendency toward severe and abrupt understeer. In fact, the car would push off the course if I wasn't on top of the situation. Plus, there's a lot of front brake bias which makes it easy to lock up the front wheels and lose control of the steering." Still Holbert found the street Turbo to his liking. "It's quite predictable and seems to do exactly what Porsche wanted it to do," he concluded.

Holbert described the race car as "just fantastic" in acceleration and braking. But he admitted that because of the inherent turbo lag the Group 4 Turbo is a car "you have to drive with three legs." "In some ways the race car is worse than the street car. For instance, there's a lot more throttle lag. So I have to anticipate how long it will take for the power to develop and adjust my driving style accordingly. Furthermore, compared to the normally aspirated 3-liter RSR, the Turbo's high-speed stability and cornering are impaired by the small rear spoiler and relatively narrow wheels and tires. These were required to homologate the car but, unfortunately, they make the car a real handful to drive quickly. With such a handicap the Turbo is not at its best on short tracks. But on circuits with long straightaways the extra horsepower gives the Group 4 car an advantage over a non-turbo RSR."

The Group 5 Turbo weighs about 300 lb less than the Group 4 car and the engine produces an additional 100 bhp. This combination results in spectacular performance: a 0-60 mph time of 3.3 sec.

0-150 mph in just 11.0 sec and a 1/4-mile time and speed of 8.9 sec at 133.5 mph. To appreciate how impressive these numbers are we went back to the Ferrari Formula 1 test we did in May 1976. That 1315-lb car accelerated to 60 mph in 2.4 sec but took 2 sec longer to reach 150 mph. The Ferrari was 0.1 sec slower in the 1/4 mile but was traveling more than 25 mph faster.

If you think the Group 4 car's brakes are impressive, check the Group 5 Turbo's stopping distances: 60-0 and 80-0 mph in just 92 ft and 164 ft respectively. By race-car standards the Group 5 Turbo is also a quiet car, idling at 83 decibels and registering only 98 dBA at 70 mph.

During 1976 Jochen Mass was a factory driver of the Group 5 Turbo and also competed in Formula 1. How do the two cars compare? "The Group 5 car is a little more powerful than a Formula 1 car," Mass explained. "The Turbo isn't quicker off the line because it's very difficult to get wheel spin, but above 50 mph it's definitely faster. During early-season testing at Paul Ricard I had the Turbo on the track at the same time some Formula 1 cars were practicing. In the turns, the Formula 1 cars could pass the Turbo, but once I caught them on the straights, I could pass and pull away.

"Of course, the Turbo behaves slightly different than a single seater. With a Formula 1 car the weight is concentrated at the center of the car and it weighs less, so it responds more quickly to the driver's inputs than the rear-engine Turbo. The Turbo's higher center of gravity, greater weight and reduced aerodynamic downforce are noticeable when cornering. You get better grip and road holding with the Formula 1 car and that's why a Formula 1 car can pass the Turbo in the corners."

That's the way professionals describe driving the Group 4 and 5 Porsche Turbos. How does a non-racer compare the 935 to other cars he's driven? Ron Wakefield's feelings and impressions follow.

