PERFORMANCE OF GRAND PRIX ROAD RACING CARS

Car	bhp	wt.	frontal area	Cd factor	0-30 mph	0-60 mph	Standing ¼ e. t. @ mph	top speed
1912 Peugeot	130	2700	16.0	0.75	5.0	12.5	19.4 @ 80	105
1926 Bugatti 35	135	1950	10.8	0.70	3.2	7.7	16.2 @ 92	125
1937 Mercedes-Benz (W-125)	646	2100	12.5	0.60	2.5	4.2	11.7 @ 147	210
1951 Alfa Romeo 158	380	2100	10.0	0.60	2.5	4.4	12.4 @ 125	193
1960 BRM 2.5-liter GP	280	1300	8.5	0.55	2.6	4.3	12.1 @ 134	190
1962 Lotus 1.5-liter GP	180	1200	8.0	0.55	2.8	4.8	13.2 @ 118	170
Formula Jr. (1.1 liter)	100	1050	7.0	0.55	3.0	6.0	14.6 @ 103	145

THE CIRCUIT IN QUARTERS

An analysis of high-performance racing cars, as if clocked at the drag strip . . .

BY ROGER HUNTINGTON

WHEN AN AUTO enthusiast considers a car's performance he generally pictures it in terms of acceleration times and all-out top speed. Actually, this is only part of the story. Any kind of specially designed racing car is built to get around a given closed circuit in the shortest possible time. In this context the car's cornering and braking become just as important as acceleration and speed. Overall performance can be readily expressed in terms of a lap time, and this will be determined by all the above factors working together.

But the auto enthusiast may still want to compare the performance of these cars in terms of acceleration and speed, to equate them with more familiar vehicles. In this he's out of luck. Special racing cars are rarely tested for straight-line acceleration figures and all-out top speed. There's no need, since lap time is the thing. So the enthusiast can't get his comparison.

We can do something about that, although admittedly our conclusions must come from slide rule and graph paper. Performance figures are available for all kinds of cars, but these data must be extrapolated. Car weights, gear ratios, frontal area, drag coefficient, engine power and torque, etc., are the basic factors in performance on any type of car. It's no trick to set up a curve of speed vs. time from a standing start. And the area under this curve can be measured with a planimeter (an area-measuring device) to figure the terminal speed and e.t. for the standing quarter-mile.

A Few Fundamentals

But first we'll briefly consider a very few basic performance fundamentals. It should be kept in mind that a special racing car follows the same performance laws as any other kind of car, although it's easy to lose sight of fundamentals in a new area.

In other words, the old weight-to-horsepower ratio is still the big factor in acceleration, especially in the lower speed ranges. After about ⅔ of the top speed of the car is reached, wind resistance begins to have a substantial effect on acceleration. Air drag is not an important factor on the short quarter-mile drag strip, simply because most types of cars don't reach much over 75% of their potential top speeds before they hit the finish line. So, in terms of the familiar low-speed acceleration figures discussed here (0-30 mph, 0-60, standing ¼, etc.), wind resistance won't be much of a factor.

Top speed is another story, of course. Here the three major drag factors are wind resistance, chassis friction and tire rolling resistance. Wind drag is determined by the overall frontal area and drag coefficient (Cd factor) of the car. Chassis friction doesn't vary much, usually amounting to a loss of 10% of the horsepower being transmitted through the drive line. Tire rolling resistance depends on the weight of the car, inflation pressure, general construction of the tire (cord angle, number of plies, tread thickness, etc.), and the rolling speed of the tire. The latter is very important because total rolling resistance increases at a rate higher than the cube of speed, whereas wind resistance increases as the square of speed. This is the reason cars with top speeds over about 150 mph need very special tires to do the job.

A car's gearing has a vital effect on all aspects of performance. Ultimate top speed can only be achieved when the gearing is such that the total drag just absorbs all the horsepower at the peak of the power curve. (However, it is rare that any racing car uses a gear that will give anywhere near ultimate top speed.) A car also needs a comparatively low ratio to get off the line from a standing start in a hurry. This initial acceleration has a vital influence on the 0-30 mph, 0-60 and standing ¼ e.t.s; and yet in many race car applications the standing-start acceleration is of little importance. In these cases some allowances must be made to get a fair picture. The gearbox ratios also have an effect as the car accelerates up through the speed range. The wider the spread between minimum and maximum race speeds and the narrower the torque range of the engine, the more gearbox ratios are needed. Some highly tuned Grand Prix cars today need six speeds forward, while an Indianapolis car, with a high-torque engine and only a 20% spread in car speed over the full lap, needs only one gear for racing and a starting gear for leaving the pits.

But now let's have a look at some specific types of racing cars. And to keep the picture complete, let's go back in history a little on each type to see how the performance evolved:

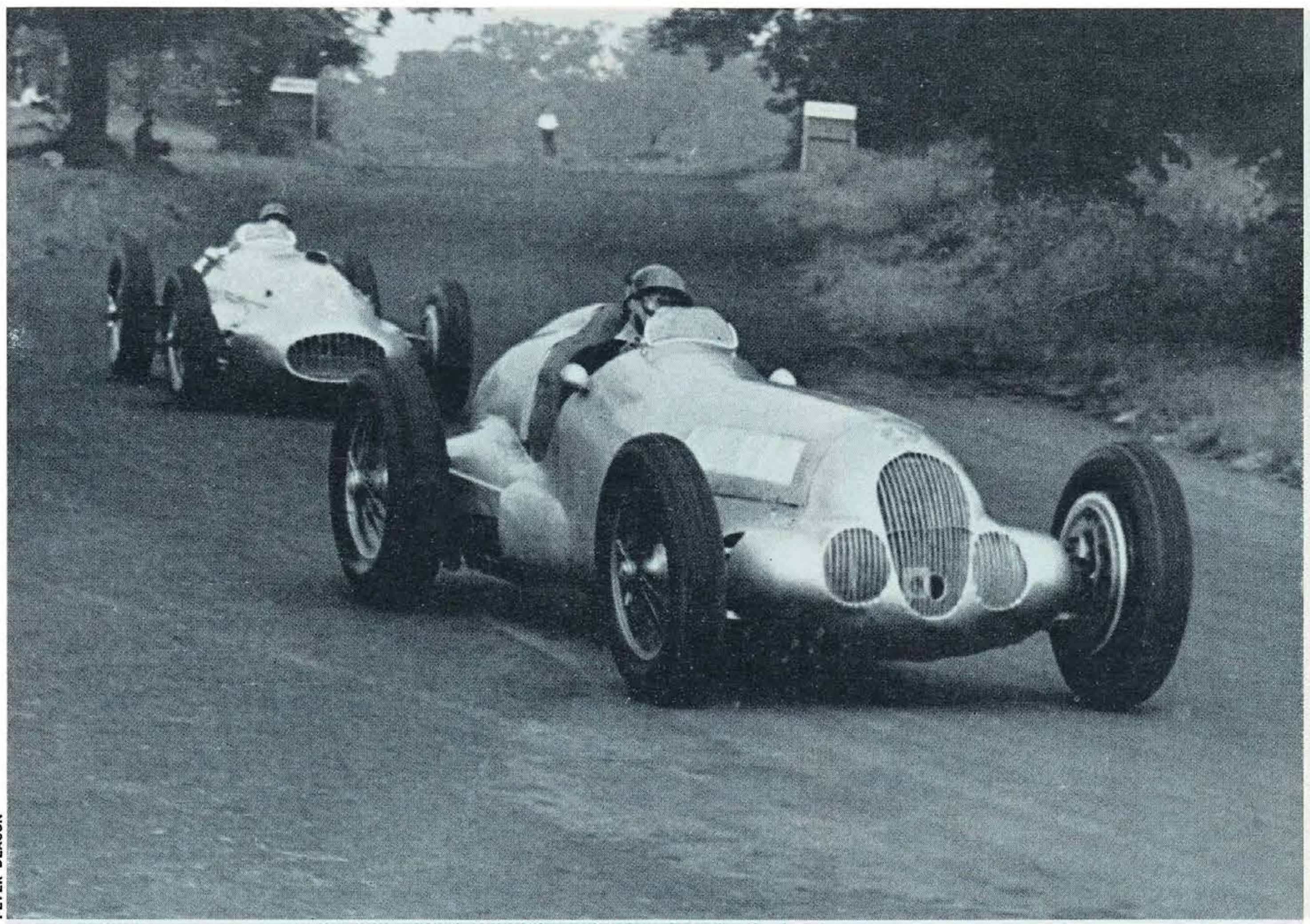
Road Racing Cars

Laurence Pomeroy's book, "The Grand Prix Car," gives an excellent picture of the technical development of the world's road racing cars down through the years. We can use some of that information to trace the performance evolution.

One of the most significant early GP cars was the 1912 French Peugeot. This was the first race car to use double-overhead camshafts, central spark plug and four inclined valves per cylinder like the classic Offenhauser design. The 4-cyl. engine had 464 cu. in. and put out 130 bhp at 2200 rpm. Dry weight was 2500 lb., but the gearing just wasn't designed for standing starts. The final ratio was 2.3:1 and even low gear was 4.7:1—and this with huge, 35-in. tires! A vicious multi-plate clutch was no help either. I'll estimate the 0-30 mph at a minimum of 5.0 sec., but it would take another 7.5 sec. to get from 30-60 mph through the gears. The slow start, of course, would ruin the quarter-mile e.t. This would be about 19.4 sec.—but with a respectable terminal speed of 80 mph or so.

Pomeroy quotes a top speed of 100 mph for the Peugeot, with 16 sq. ft. of frontal area. I think it might have been a shade above that, if it actually devel- ▶

HUGE W-125 MERCEDES of pre-war period leads postwar 3-liter Mercedes in staged run.

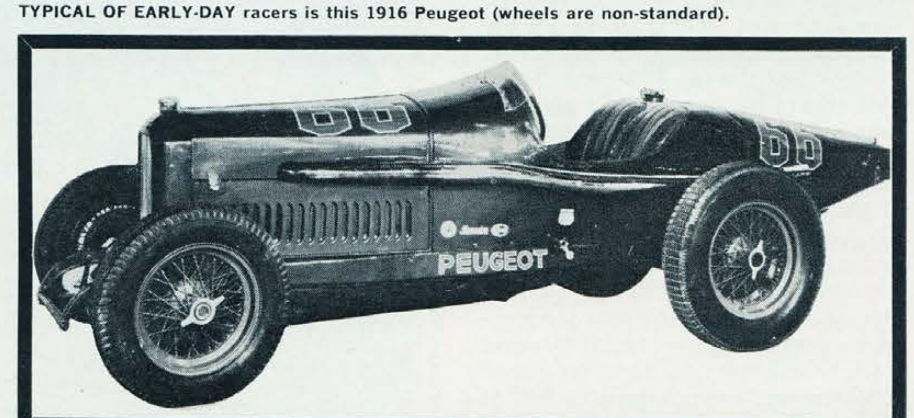


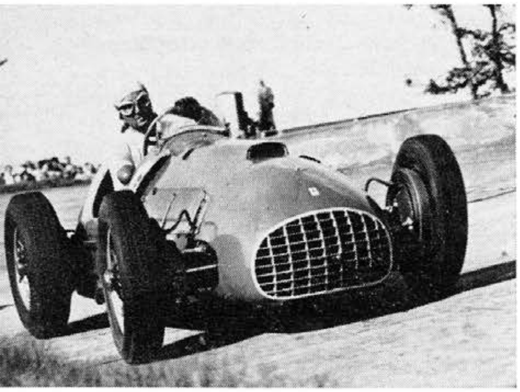
PETER DEACON

NEW WORLD CHAMPION driver Graham Hill at speed in 2.5-liter BRM.

PETER DEACON

TYPICAL OF EARLY-DAY racers is this 1916 Peugeot (wheels are non-standard).





A 4.5 FERRARI of the early '50s.

CIRCUIT IN QUARTERS

oped 130 bhp. A good estimate of the Cd factor would be 0.75. (This compares with an average figure of 0.45 to 0.50 for most modern Detroit sedans.) With the 2.3:1 gearing and 35-in. tires, 100 mph would come at about 2200 rpm. This represented 2900 ft./min. piston speed with the fantastic 7.9-in. stroke. With the crude bearing technology of that day it's conceivable a sustained 100 mph was more than somewhat risky!

Now let's consider the Bugatti Type 35 series of GP cars used in the 1926-30 period. This was a very conservative, reliable car that won a lot of big races in its day. The straight-8 engine had 140 cu. in., single overhead cam operating three vertical valves per cylinder (two exhausts and one inlet) and a small Roots-type supercharger pumping about 10 psi boost. Output was stated to be 135 bhp at 5300 rpm. Weight was 1950 lb. with driver and partial fuel load. The gearing was such that the car could get off the line decently (axle ratios up to 4.5:1), so an estimate of the 0-30 and 0-60 times would be 3.2 and 7.7 sec., respectively. The quarter-mile graphs out to about 16.2 sec. e.t. at 92 mph terminal speed. Top speed was a creditable 125 mph—primarily because of a greatly reduced frontal area of 10.8 sq. ft. (since the Cd factor was still a pretty dirty 0.70).

Note that the top European Grand Prix cars of the late '20s had acceleration and speed performance similar to our standard "police" engine options in 3800-lb. passenger cars today.

No analysis of Grand Prix car performance would be complete without a long look at the fabulous German road-racing monsters of the 1935-39 period. These cars had by far the highest performance of any racing cars ever built. There were no limits on engine displacement, superchargers or fuel in those days. The race organizers felt if they put a maximum weight limit of 750 kg. (1650 lb.) on the cars (without fuel, oil and tires) the designers would be forced to use small, high-revving engines of "safe" performance. What happened instead was that the Hitler government got interested in GP racing as a propaganda weapon. It subsidized the Mercedes-Benz and Auto-Union organizations with millions of marks and came up with lightweight aluminum cars with huge, low-revving engines that put out over 600 bhp with superchargers and low-nitro fuels!

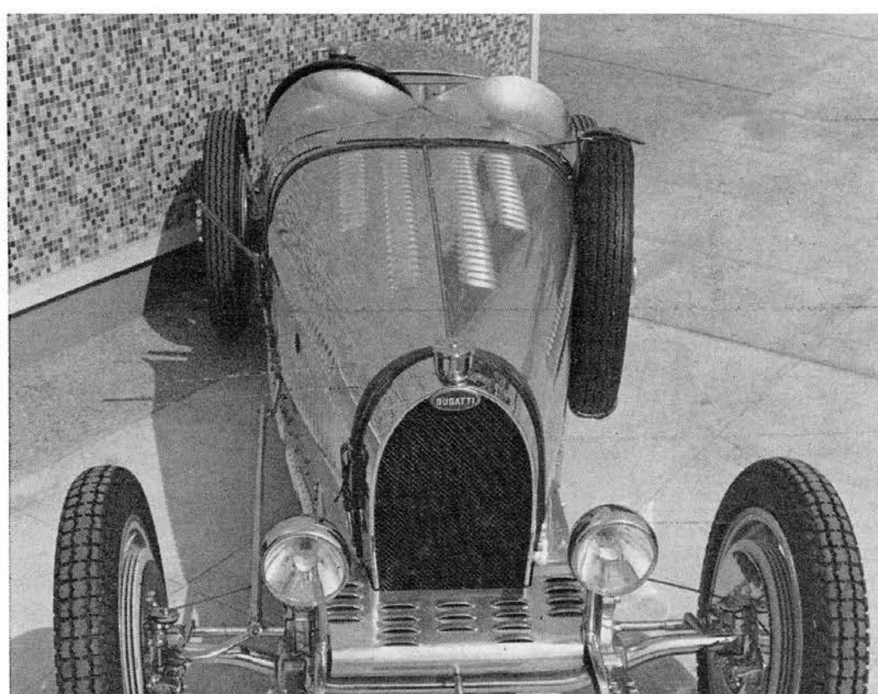
Perhaps the most brutal combination of the period was the Mercedes W-125 of the 1937 season. The straight-8, double-overhead-cam engine had a displacement of 345 cu. in. and kicked out an astonishing 646 bhp at 5800 rpm on 12 lb. boost pressure and an alcohol-nitromethane fuel! The car weighed about 2100 lb. with driver and partial fuel load. Conditions weren't bad for quick acceleration from a standing start. The de Dion rear end canceled the lateral torque reaction, there was nearly 60% of the weight on the rear wheels and a wide selection of gear ratios was available. Still, it is unlikely the 0-30 mph time was less than 2.5 sec. It's doubtful that the racing tires and rubber compounds of that day had the traction to get the car off the line any quicker than that.

At higher speeds, of course, the acceleration would all but tear your head off. George Monkhouse, in his book "Grand Prix Racing," quotes 0-60 mph times for this car between 4 and 5 sec., and 0-140 mph time of 11 sec. These sound reasonable (though the source of these figures was not given). Anyway if we draw out an acceleration curve for 0-30=2.5, 0-60=4.2 and 0-140=11, we get an approximate quarter-mile check of 11.7 sec. e.t. at 147 mph terminal speed. The terminal speed checks well with the known bhp and 2100-lb. weight (according to what other drag strip machines have done with similar weight/bhp ratios, since traction isn't such a vital factor in the speed as in the e.t.). There's no question that this car, in its prime and if given a set of modern dragster slicks and optimum gear ratios, could turn consistent e.t.s in the 10s at 150-155 mph.

And the top speed was no less impressive. One of the cars was electrically timed at 195 mph on the Masta straight in the 1937 Belgian GP. They probably could approach 210 mph with optimum gearing and long build-up—assuming a Cd factor of 0.60 with the known frontal area of 12.5 sq. ft. Streamlined versions turned 268 mph in record attempts.

Now move up to the 1950 period, when the little 1.5-liter supercharged Type 158 Alfa Romeos were doing

A FINE EXAMPLE of the fine cars of the '20s, the Type 35 Bugatti.



JERRY CHESEBROUGH

battle with the 4.5 unblown Ferraris. These would go, too. At the height of their development in 1951 the straight-8 engine touched 404 bhp at 10,500 rpm on straight alcohol fuel and 35 psi boost from the two-stage Roots superchargers! That's almost unbelievable for a 91-cu. in. engine, even under ideal dynamometer conditions. The usable racing output of the cars in the '51 season was established at 380 bhp at 9000. In terms of traction, weight distribution, gearing, etc., the 158 Alfas were not unlike the big Mercedes of the late '30s. In fact, the gross weight was the same, at 2100 lb. So acceleration would be scaled down nearly in proportion to the horsepower, to estimated 0-30 and 0-60 times at 2.5 and 4.4 sec., respectively. The standing quarter would be turned in about 12.4 sec. e.t. at a 125-mph terminal speed being attained.

True top speed was quite firmly established around 190 mph. Frontal area was an even 10 sq. ft. (2.5 sq. ft. less than the Mercedes), with the estimated Cd factor at the same 0.60. In this framework the 190 mph would require just about the stated 380 bhp at the clutch. One of these cars was electrically timed at 193 mph on the same Masta straight in Belgium where the Mercedes hit 195. That would require an honest 390–400 bhp—which was apparently available by over-revving the engine to some extent.

Many Grand Prix enthusiasts would like to go back to bigger engines and superchargers and fuels, and get back to the terrific straightaway speeds and screaming engine sounds of that era. But those days may be gone forever. Today there are tiny, lightweight cars with small unblown engines running on pump gas.

The latest 1.5-liter GP jobs definitely don't have anywhere near the speed and acceleration of the earlier GP cars. They get their good lap times through unbelievable braking and cornering. But it is surprising how well the pre-1961 2.5-liter cars compared with the early monsters. A typical example (such as, say, the British BRM) developed about 280 bhp and weighed 1300 lb. with driver and part fuel load. Off-the-line traction was perhaps not as good as some of the bigger cars, so a 0-30 mph time of 2.6 sec. can be assigned. But the pull from 30 to 60 mph in low gear would take well under 2 sec.—so the 0-60 time might be 4.3. The quarter-mile post should come up in 12.1 sec. at a terminal speed of 134 mph—performance second only to the W-125 Mercedes. The light weight, of course, is the key.

And the 2.5s were nearly as good in all-out speed. Their frontal areas of around 8.5 sq. ft. and improved Cd factor of about 0.55 allowed much higher speeds on a given amount of horsepower. The typical 2.5-liter car probably could touch 190 mph under ideal conditions, although memory doesn't recall any being timed above 186 mph in regular GP competition.

The current 1.5-liter cars can't approach this performance, of course. The late 91-cu. in. Coventry Climax V-8 does a wonderful job in putting out 182 bhp at 9200 rpm on pump gas. But due to minimum weight restrictions the gross weights of the late cars have been reduced only about 100 lb. below the pre-1961 2.5-liter jobs—which results in a big deterioration of the wt./bhp ratio. Estimating the 0-30 and 0-60 times of the new cars places them around 2.8 and 4.8 sec., respectively. The quarter-mile performance would be near 13.2 sec. e.t. with a 118-mph terminal speed. A well-tuned and geared 1.5 GP car couldn't handle many of our better Super/Stocks on the drag strip, though it probably would be gaining at the finish line.

Also, potential top speed would be down 20 mph from the earlier 2.5s. The designers have been able to trim frontal areas another 0.5 sq. ft. or so, but no important improvements have been made on the Cd factor. (It's doubtful that the recent practice of housing the front suspension coil springs in the bodywork and operating them by levers, helps as much as they would like to think.) The net result would be a top speed of around 170 mph with a true 180 bhp available at the clutch, although none have been timed this fast in actual competition runs at the strips.

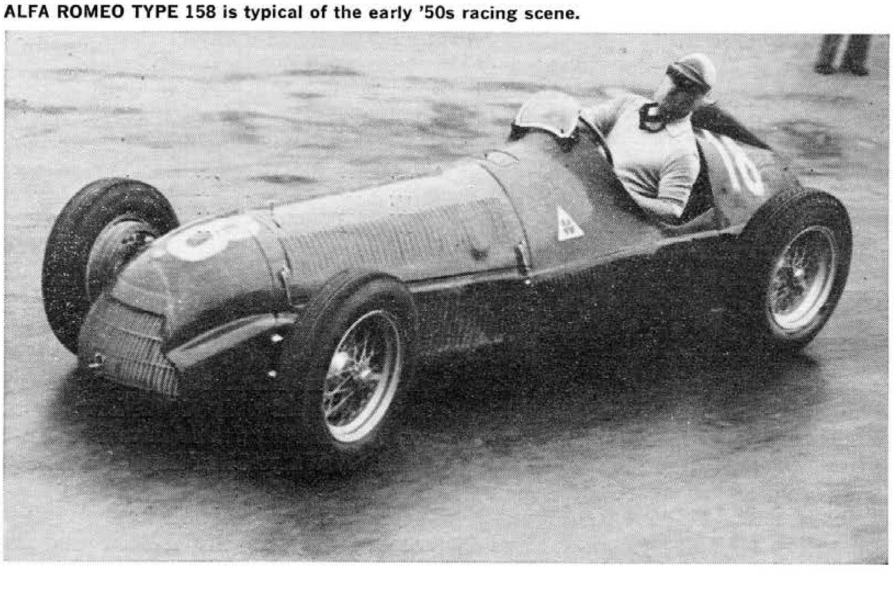
Just to keep the picture reasonably complete, perhaps it would be a good idea to take a quick look at a typical Formula Junior car at this point. These go better than might be expected. A typical modern 1100-cc Junior would develop 100 bhp at 7500 rpm and would weigh around 1050 lb. with driver and partial fuel load. (The Juniors are subject to minimum weight restrictions, also, but not so severe as in Formula I.) The tiny engines don't give much torque for blasting off the line, so the 0-30 time would be at least 3.0 sec. flat. The 0-60 might be 6 sec. From here it should finish the quarter mile in about 14.6 e.t. at a 103-mph terminal speed. Top speed should be over 140 mph with a frontal area of 7 sq. ft. and Cd factor of 0.55. (Some Lotus Formula I cars have frontal areas around 7 sq. ft. but this is not typical. The average would be 8 sq. ft. and some run close to 9. The Formula Juniors would run between 6.5 and 8.0 sq. ft.).

This covers the road racing machinery; the next installment will explore the Indianapolis cars and some of our hot stock racers. ■

MOST RECENT GP car type is the 1.5-liter Lotus 25 driven by Jim Clark.

GÜNTHER MOLTER

ALFA ROMEO TYPE 158 is typical of the early '50s racing scene.



TERRENI