THE BIG BLOW

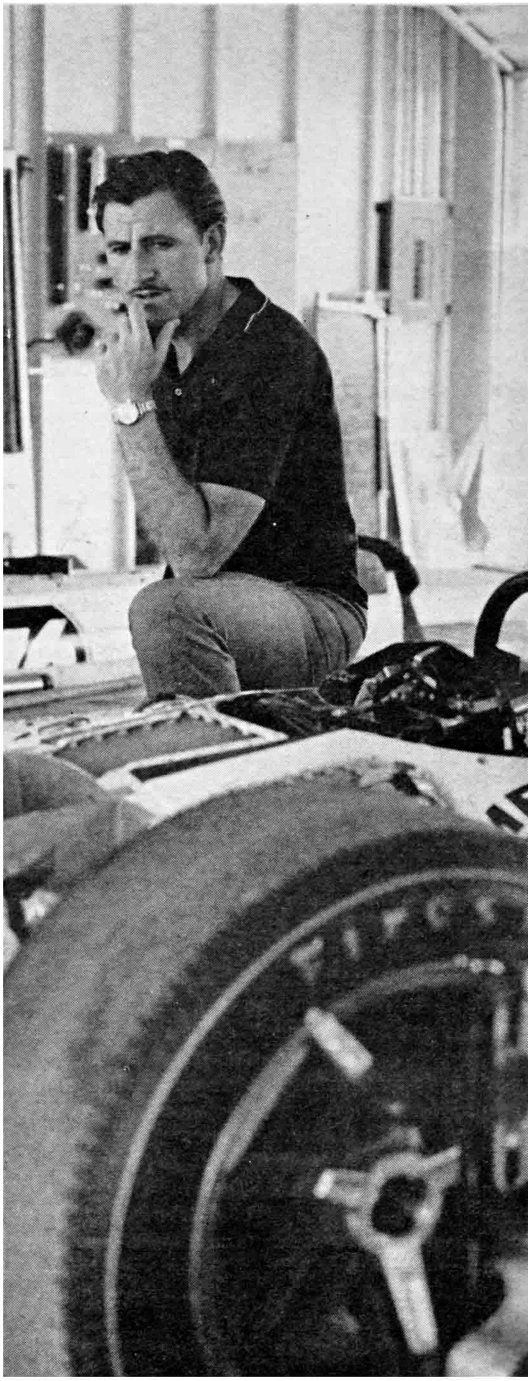
Turbos, Tires and Tanks Made Indianapolis Interesting

BY ROGER HUNTINGTON **PHOTOS BY ROBERT P. TRONOLONE**

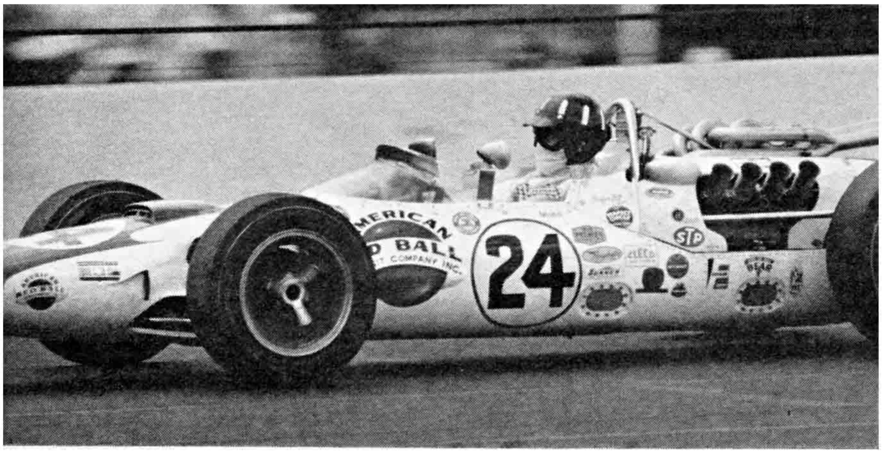
THE FIRST-LAP tangle on the front straightaway put several of the faster cars and drivers out of the 1966 Indianapolis 500 before they entered the first turn. Mechanical failures eliminated several other top car/driver combinations later in the race. As racing luck would have it, no wheel-to-wheel duels for first place developed during the race. The time interval between first and second usually was so wide that there was little incentive for speed. No race speed records were broken, except the one-lap record, which Jim Clark raised from 157.6 to 159.2 mph. When Clark was in a position to challenge for first place later in the race, his pit crew miscounted laps and thought he was in first by a full lap and ordered him to maintain reduced speed. Meanwhile, Graham Hill pulled away easily at lap speeds of 150 mph. The major portion of the race was run at lap speeds of 150-153 mph, with nearly a full lap between first and second runners. The pace was so relaxed, in fact, that pit stop times did not figure greatly in the final results. The race ended in a parade of cars trying to keep running, trying to stay upright on a very oily track, and running as slowly as they could to still maintain position.

Though the race lacked action, there is a fascinating technical story behind this year's event. The cars were much faster than they were only a year ago. Tire design took a giant stride forward. Performance of the aged 4-cyl. Offenhauser engine was completely revolutionized. Production-based engines were given a new lease on life.

Consider the tires. The new Firestone and Goodyear tires were responsible for the lap speed increases this year, as has been the case at times in the past. The 1966 jump in speed was greater than ever before. The overall average qualifying speed of the starting field was up 4 mph. The qualifying lap speed record was raised from 161.96 mph to Mario Andretti's fantastic new mark of 166.33 mph. In fact, Andretti was electrically timed at 167.8 mph in practice two hours before he qualified for the race.



GRAHAM Hill waited quietly, then drove smoothly—to win.



The secret of Andretti's record lap time was his tremendous speed through the turns. He was clocked at an average of 155 mph through the southwest turn. This is 7 mph faster than any car has been clocked through that turn in previous years. Any driver will state that it's turn speed, not peak speed on the straights, that has the greatest effect on overall lap average speed. The greatest part of total lap time is spent in the turns. A higher turn speed boosts the car to a higher straightaway peak speed without any increase in engine power. This is where those split seconds are gained. It's simple arithmetic. With Andretti's speed over the full lap ranging from 150 to 200 mph, it follows that his ▶

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average speed would be near 170 mph.

Obviously it takes extreme tire traction to project a car through those tight Indianapolis turns at more than 150 mph. The true radius of the car's path through the turn is not much more than 1000 ft.; it's 840 ft. on the pole line. When the 16° banking is taken into account, a lateral G force (parallel to the surface) of approximately 1.3 G is developed. This is side traction, not forward traction such as a dragster slick delivers.

There are two main features of the new tires—wider treads and lower section profiles. Firestone has gone quite a bit farther in this direction than has Goodyear. The new 1966 Firestones carry approximately 1 in. more tread width, with 1 to 1.5 in. less overall diameter than equivalent sizes last year. The new Goodyears are about 0.5 in. wider, but are not reduced significantly in section height, as compared with 1965 models.

The wider treads put more rubber area on the track. Dragster experience shows that tire loadings per square inch of contact area has a great effect on traction. The lower the loading (or the greater the area) the better. A tire casing becomes very unstable when its width is increased. Engineers have discovered it is necessary to lower the tire section height in proportion to the increase in width. The tendency for the tread to buckle upward in the center is a functional problem of the wide tread/low profile ratio. The answer was "contour molding," where the center of the tread dips inward deeply when the tire is not inflated. Under normal inflation, 30-45 psi, the tread is just about level across its span and it stays that way under high side loadings in turns when mounted on a rim 8.5 or 9.5 in. wide. The secret of speed is wide tread, low section height, contour molding and a wide rim. There's no great casing to buckle and distort under side loads to lose rubber gripping area. Side traction of current Indianapolis tires is as good as that of a dragster slick in the forward direction.

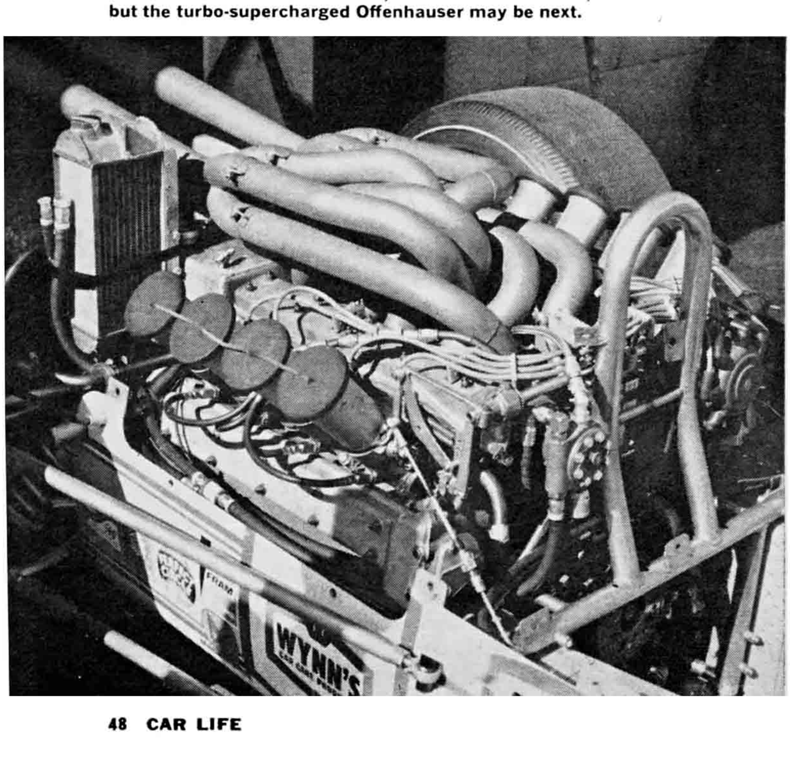
APPARENTLY FIRESTONE engineers have done a little more with this concept than Goodyear people. It is significant that the two fastest cars, those of Andretti and Clark, were on Firestones. Andretti's and Clark's lap speeds were 2—4 mph faster than speeds achieved by any other drivers. The tires were the major factor in the speed margin. The highest turn speed clocked for a Goodyear-equipped car was 151 mph.

This year Dale Drake tried to make his "obsolete" 4-cyl. Offenhauser engine competitive with the dohc V-8 Fords by cutting piston displacement to 168 cu. in. and using a supercharger. This makes sense for Indianapolis racing, simply because displacement of blown engines is not handicapped in the usual 1:2 ratio. Theoretically a blown engine should develop 20-30% additional bhp under these rules. Drake chose a positive-displacement Roots-type supercharger placed alongside the block, gear driven from the rear, and drawing fuel through a Hilborn 2-throat injection unit mounted at the blower inlet. The very compact installation added only 50 lb.

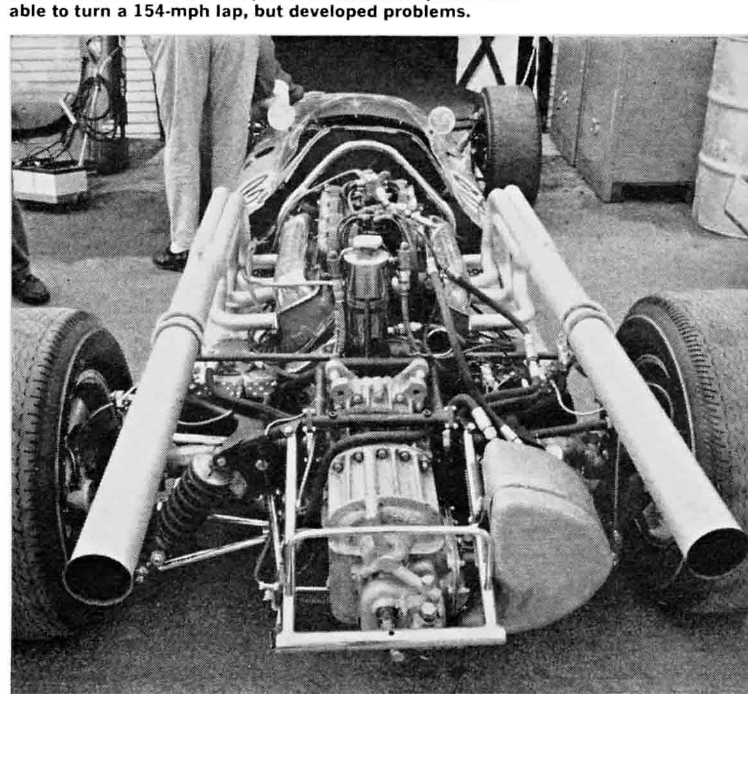
Users of the Drake engine devoted a great deal of attention to raising its rpm range. In reducing displacement, the stroke was reduced proportionally more than the bore to produce a healthy oversquare stroke/bore ratio (4.125 x 3.125 in.). At the same time, the block was shortened, rods were shortened 1 in., the crank was lightened, and a new camshaft and valve springs were developed to provide more stable valve action at high rpm. All this has raised the red line from 7000 rpm on the 252-cu. in. long-stroke Offenhauser to 8500 on the new 168-cu. in. Drake. Roots blowers are not efficient at high boost pressures, so the units were geared down to a modest 17 psi. The beauty of the Roots, however, is that the pressure doesn't fall off sharply when engine speed drops in the turns. Centrifugal compressors, such as used on the Novi, show pressure drops when engine speed falls. The Roots blowers pull 14-15 psi coming off the turns, which provides substantially more power in this range than is delivered by the Ford engines. At the top, the Drakes produce 540 bhp at 8000 rpm on straight methanol, compared with 500 bhp for the Fords.

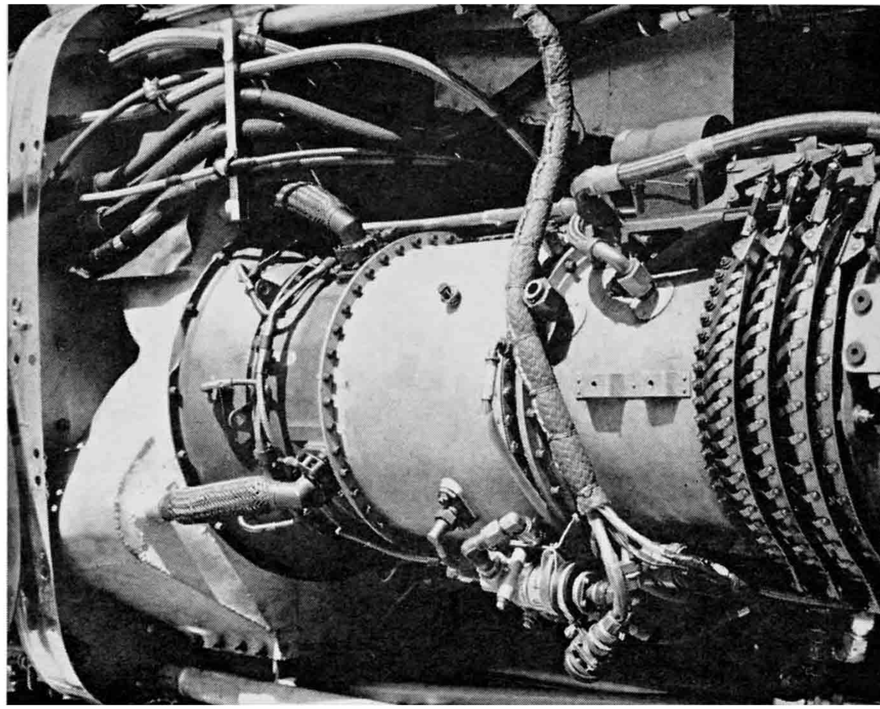
The Drake looked good, but all the dyno horses didn't show up at the track. Even with 20% nitro and revving to 9200 rpm, no driver could lap better than 162-163 mph with this engine. Parnelli Jones was the fastest. The acceleration off the turns and peak

THE CHAMPION is the reliable, race-tested dohc Ford, but the turbo-supercharged Offenhauser may be next.



JERRY EISERT'S Chevrolet-powered Harrison Special was able to turn a 154-mph lap, but developed problems.





THE AIRCRAFT Special's 1250-bhp turbine delivered tremendous acceleration on the straights, but lacked braking, and throttle response was sluggish.

straightaway speeds were not significantly better than the average Ford. Many of the new owners were disappointed. One of the major attractions of the new engine was its price, $17,000, or about $7000 less than a fully-equipped Ford. Indianapolis is one race in which owners can't afford to sacrifice performance to save dollars.

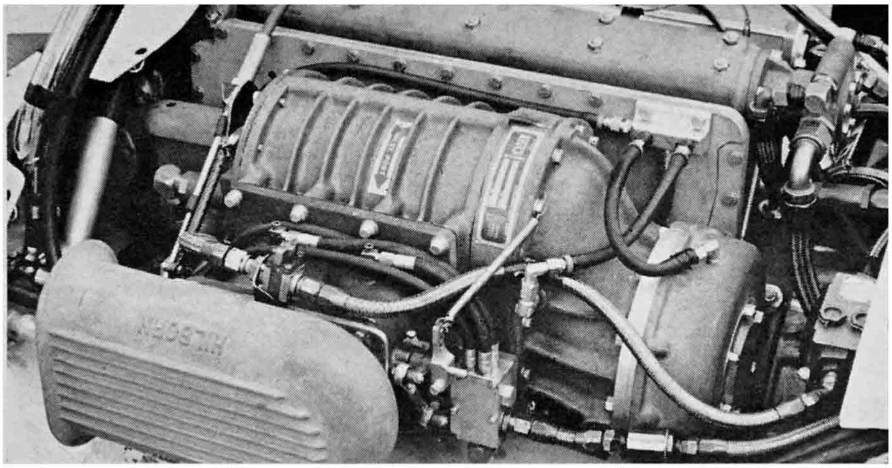
PERHAPS THE better answer for the Offenhauser is exhaust turbo-supercharging. The benefits are more efficient centrifugal compression and derivation of drive power from the waste exhaust gases rather than taking power directly from the crankshaft.

Apparently it is very effective. Mechanic Herb Porter, Stuart Hilborn and Bob DeBischop of the AiResearch Co., maker of commercial turbo-superchargers, joined forces last winter to fit a new 168 Drake with a modified AiResearch Diesel truck unit. It compressed pure air across the blowers and introduced fuel at the ports for optimum response off the turns. The turbo was given an automatic by-pass waste gate on the turbine inlet to maintain boost pressure at a constant 17 psi from 4000 upward. The compressor was selected to develop the full desired boost pressure (15 to 20 psi) at an engine speed well below minimum track speed. At higher speeds the 2-in. poppet valve in the by-pass opens gradually to dump enough exhaust gas (ahead of the turbine) to maintain boost at the maximum figure. This produces excellent torque coming off the turns, without overboosting at the top end. The team can obtain 625 bhp at 8000 rpm with methanol on the dynamometer and nearly 500 bhp at 6000 coming off the turns! This should beat the Fords hands down in every range.

The comparative efficiency of the two types of superchargers can be seen in the figures. That is, they both deliver 17 psi maximum boost. The difference is in the effective engine power absorbed to develop this pressure. The turbo pressure isn't free by any means. When the compressor is pumping 17 psi at 8000 rpm engine speed (about 100,000 rpm turbine speed) there is a back-pressure of 10 psi in the exhaust manifold. The pistons have to push against this pressure on the exhaust stroke. This would theoretically absorb about 17 bhp from the crankshaft. However, 80-100 bhp are required to drive the Roots blower when it pumps 17 psi at 8000 rpm engine speed. The difference of 80 bhp or so in the two power requirements is the difference in net output at the flywheel, 625 as compared with 540 for the Roots-blown engine. ▶

ROOTS-BLOWN Drake engine powered the neat, clean MG Liquid Suspension Special—which didn't make the race.

VETERAN DRIVER Bill Cheesbourg was unable to qualify a front- and rear-engined, 911-Porsche-powered special.



DALE DRAKE'S 168-cu. in. Roots-blown Offenhauser produced 540 bhp at an easy 8000 rpm, should have been equal to the Fords, but obviously wasn't.

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For this same reason the turbo-supercharged Drake offers better fuel economy than its Roots-blown counterpart, approximately 3 mpg at race speeds or almost as good as the unblown Fords. The Roots-Drake delivers 2.5 mpg or so. This isn't a factor in pit stops, because two stops now are mandatory; but the turbo car could get along with a lighter fuel load.

Here again, dynamometer results weren't borne out on the track. Bobby Grim pushed his turbo-supercharged prototype Watson roadster up to 160 mph lap speed before a spin put the car out of commission—quite an accomplishment. Three other teams raced to replace their Roots blowers with the turbo installations in lighter rear-engined cars. The best of these cars averaged 159.2 mph to qualify. At least another year will be needed to get results from that combination—if the basic Drake engine design isn't stretched to the limit now.

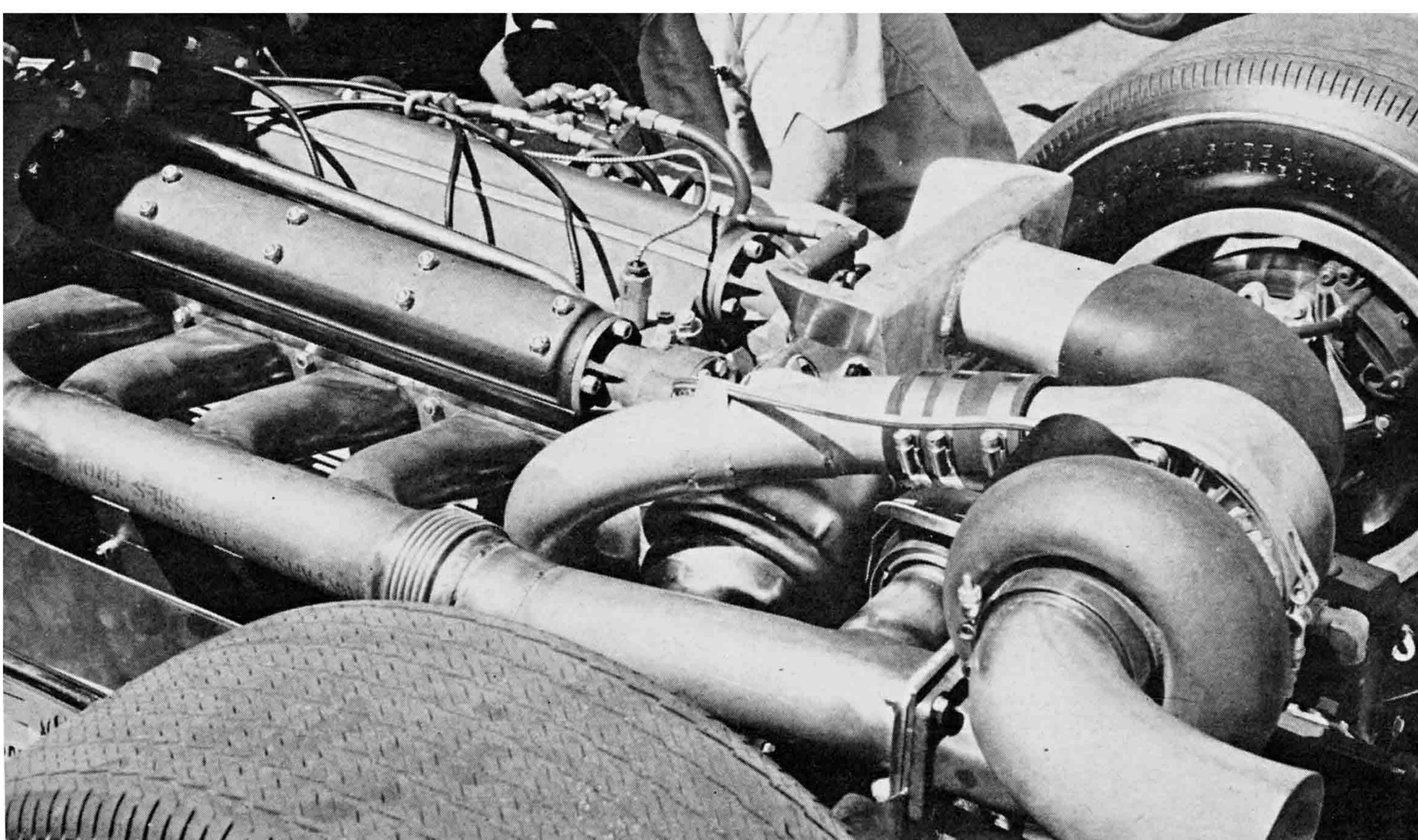
Now for the sad story of the stock-block cars. Racing fans hoped the 1966 Indianapolis rules allowing production-based pushrod engines of up to 305 cu. in. (20% above the regular unblown limit) would give these engines a chance in racing—and eliminate the tremendous cost of building cars for the 500 race. It wasn't to be, at least not this year.

THE MOST promising of the new stock-block cars was the Harrison Special—a modified Chevrolet V-8 built by Jerry Eisert, installed in a clean, lightweight rear-engine chassis. The engine was about 120 lb. heavier than a Ford; but with the new minimum weight of 1350 lb., Eisert was able to cut the car's weight to within 20 lb. of his competition. The engine seemed to perform well on the dynamometer. It reportedly delivered 475 bhp at 7000 rpm on straight methanol. Eisert geared the engine to run in the 6000-7200 range over the 2.5-mile lap, to take advantage of the high mid-range torque with the extra piston displacement. In tire tests last winter, the car turned up to 194 mph on the straightaways.

The car managed a lap speed of 154 mph within two weeks—then that was it. Oil blowing and fuel system problems plagued the stock-block effort. Stiffer gearing to allow a 7700-rpm peak speed on the straights didn't help. Even 20% nitro couldn't accomplish much. Harrison finally discarded the Chevrolet engine, substituted a Ford, and driver Ronnie Duman qualified at 158.6 mph.

The venerable Novi encountered even more problems than usual this year. The Granatelli brothers developed a unique ram-type manifold to use with the supercharged induction system. Long pipes led from two cen-

TURBO-SUPERCHARGING MAY be the horsepower answer to the Drake-Offenhauser question. An AiResearch turbo fitted to a Drake engine helped produce 625 bhp at 8000 rpm on methanol, which is competitive with Ford power. Maybe next year . . .



tral trunks running down the center of the engine to individual ports. Andy claimed 840 bhp at 9000 rpm and better torque off the turns. The system displayed a great many sharp corners and tight passages and the car didn't seem to have the acceleration it had last year. The 4-wheel-drive Ferguson chassis was working very well, as driver Greg Weld was able to charge through the southwest turn at 148 mph. The Novi's best lap speed was nearly 160 mph. Finally Weld hit the wall trying to go faster. Could this be the end of the 25-year history of the Novi engine? Many Indianapolis observers doubt that it is. The race wouldn't be the same without the Novi.

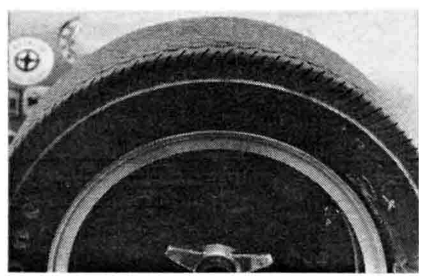
THERE WEREN'T many significant new technical developments on the cars themselves this year. Actually, the majority of car builders on both sides of the Atlantic are copying Colin Chapman's Lotus designs quite closely these days. All builders use the semi-monocoque construction (tubular space frames have all but disappeared). Suspensions are similar—with cross links front and rear and long radius rods to handle torque. There are only minor differences in the general layout of most of the cars. There's no question that cornering can be "tuned" very sharply with this type of chassis. And, there's no difficulty in holding weight to the 1350-lb. minimum.

One interesting advantage of the modern monocoque Indianapolis car is that more flexible body and chassis construction provides a considerable amount of energy-absorbing capacity in a crash situation. The car can dissipate some of its kinetic energy through the crushing of the structure in a crash and still provide some degree of protection around the driver to give him a fighting chance. An example is the tangle on the front straight at the start of this year's race. There were a lot of bent cars, but no one was hurt. Old-timers say a similar tangle with the old super-stiff roadsters with space frames would have been more dangerous to the drivers, though not so much to cars.

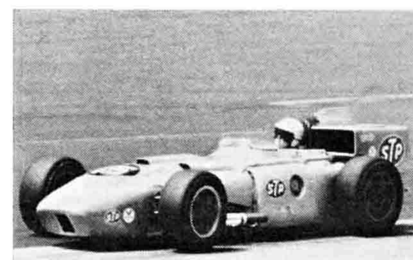
Quick pit stops were a major factor in the 1965 Lotus win, hence everyone was expecting them to figure heavily this year. This didn't happen, due to the character of the race. Nevertheless, some important developments were made. Last year Colin Chapman devised a clever trick that permitted his crew to load fuel with the mandatory gravity system nearly twice as fast as the other teams. Chapman's pitmen were loading about 50 gal. in 20 sec. The secret was a smooth, bell-shaped funnel leading into the 3-in. outlet hole in the bottom of the tank. In effect, the outlet was changed from an orifice to a nozzle, with a great increase in flow rate due to a more streamlined flow. It saved him 20 to 30 sec. per stop. Chapman has led the top American racing men a merry chase for the past two years and they haven't seen the last of him. Incidentally, his secret on the fuel tank leaked out, so to speak, and a number of cars were taking on 50-60 gal. of fuel in less than 30 sec. this year.

That's another year at Indianapolis. This year's race wasn't fast, and really not very exciting, but the increase in performance of the cars over the previous year probably exceeded that of any year in recent history. Perhaps next year the benefits of these developments will appear in increased race speeds and, perhaps, more intense racing action. ■

LOW, wide tires contributed to phenomenal 1966 lap speeds.



EVER a favorite, the screaming Novi didn't make the lineup.



SPEEDY FUEL stops were a major factor in the 1965 Lotus win, but had little bearing on the outcome of the 1966 classic. Builder Colin Chapman devised a bell-shaped funnel for the tank outlet which raised flow rates to 50 gal. in 20 sec.