HOW FAST?

BY ROGER HUNTINGTON

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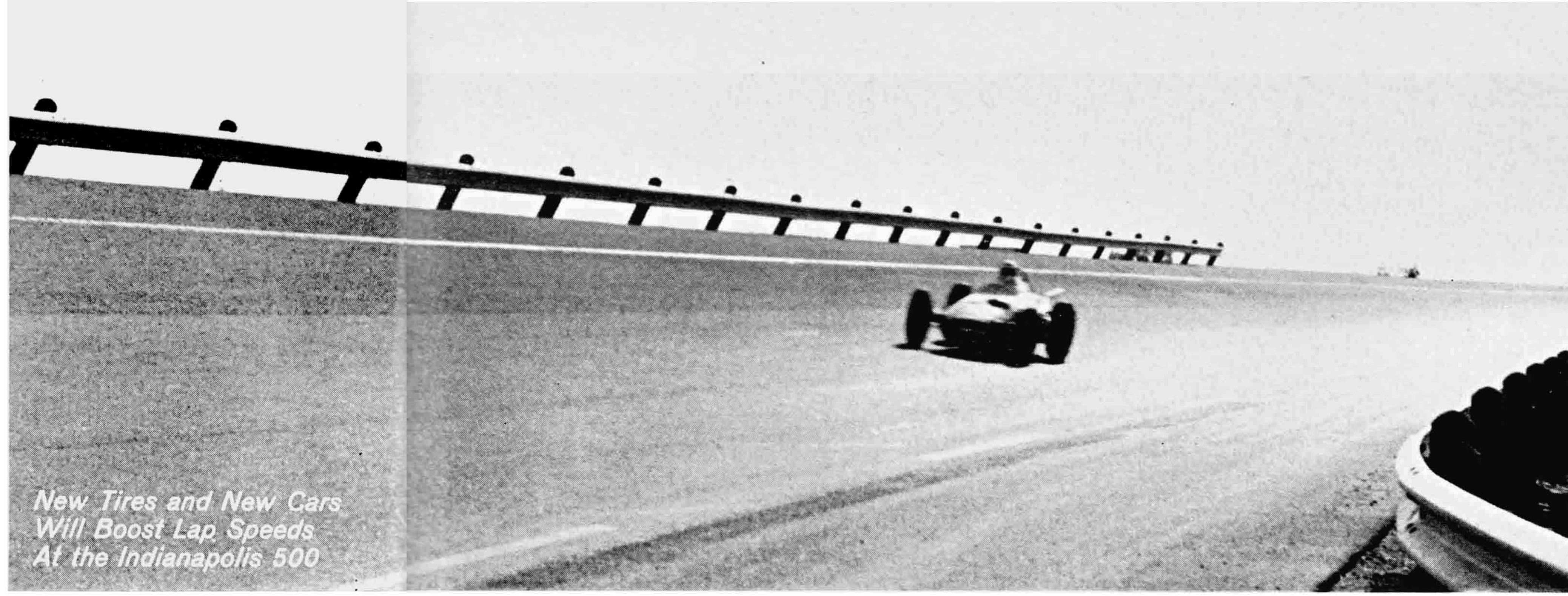
How do we know the new Indianapolis tires have so much more bite than the old ones? Simple: Average speeds clocked through the Southwest turn with the new tires were substantially higher than have ever been recorded under any conditions before. Len Sutton clocked 148 mph in a new rear-engine Offenhauser, using the new Goodyears. Firestone says that several drivers (Rodger Ward, Bobby Marshman, Chuck Hulse) were clocked between 150 and 151 mph in the November and December tests of their new tires, and these tests were all made with last year's front-engine roadsters. Hulse drove one lap at 154.32 mph during these runs! The maximum reported Southwest turn speed prior to these runs was 144 mph, by Parnelli Jones in practice in '62 and '63. (The maximum that I caught him during qualification last year was 143 mph.)

It's no trick to convert these turn speeds into centrifugal force and traction values. We just need the speed, true turn radius and the angle of banking of the track. Figuring the true turn radius is the big job. This radius is 840 ft. on the pole line . . . only the cars don't follow the pole line. They sweep from the outside of the track as they enter the turn, then down to the inside pole line at the center and back out to the outside as they enter the straight chute. This has the effect of substantially widening the true radius of the turn. The exact amount can be readily calculated with trigonometric formulas. If we assume the cars enter the turn 40 ft. outside the pole line, hit the pole line at the center, then sweep back out 40 ft., the true radius is increased 137 ft. beyond the 840 ft. In other words, 977 ft. true turn radius. (This 40-ft. lateral movement is reasonable, because the track is 50 ft. wide on the straights and 60 ft. wide in the turns.)



A. J. FOYT set an unofficial closed-course speed record of 200.4 mph while testing new Goodyears at that company's 5-mile test track near San Angelo, Texas.

The angle of banking in the turns is about 9.2°. This has the effect of reducing the lateral side force (due to centrifugal acceleration) that tries to slide the car sideways on the tires. The formula for lateral "G" force on a banked turn is:

$$G = \frac{V^2}{GR} \cos A - \sin A,$$

where V is the speed in ft./sec., R is the turn radius in ft., and A is the angle of banking.

For a turn speed of 150 mph (220 ft./sec.) this formula gives a lateral force of 1.36 G. In other words, the component of the centrifugal force that's trying to slide the car sideways is 1.36 times the total weight of the car. And the tires are holding this force with pure traction against the pavement.

For years we've been asked to accept that the ultimate traction coefficient of a tire against pavement is around 1.0. In other words, it can develop a thrust in any direction equal to the weight pressing down on it. But the above figures prove that the new Indianapolis tires are pulling coefficients well above this—and doing it in a sideways direction where casing distortion and tread slip angle tend to compromise the bite. It has been obvious from the performance of dragsters with 10-in. wide, soft, slick tires that they were getting effective traction coefficients above 1.50, possibly approaching 2.0. There just isn't any well-defined upper limit in this area.

The amazing thing is how much the '64 Indianapolis tires are improved over the '63s. The calculated lateral G force for a 143-mph turn on the 977-ft. radius is 1.22. That jump from 1.22 to 1.36 is a tremendous achievement—apparently made possible by new rubber compounds and a wider "footprint" that puts more rubber on the track. And all this has been accomplished while apaprently doubling and tripling the wear mileage!

Any sharp mechanic or driver at Indianapolis will tell you that turn speed has a much bigger effect on the overall lap average than peak speeds on the straightaways. If you think about it a minute, you'll see why. Each of the four turns is a full ¼-mile long (on the pole) which means that the four turns take up one mile out of the total 2.5 miles around the track. The two short end chutes are only an eighth of a mile long, so a driver can't get up much steam there. This leaves only 1.25 miles of the long straights, or one-half the lap distance. And, since he is accelerating from turn speed at the start of the long straights and then slowing down to turn speed at the end, a racer's average speed over the length of the straight is a lot closer to the turn speed than it is to the 175 mph or so peak speed reached near the middle. So the "base line" for lap speed becomes the turn speed, rather than the peak speed.

Look at it this way: Last year's hotter Offenhauser-powered roadsters were averaging 140 mph through the four turns and around 150 mph for the full lap, hitting about 175 mph on the long straights. Thus the cars were in the turns for 25.7 sec. out of the full 60-sec. lap time. Now, if this average turn speed is increased to 150 mph the time spent in the turns drops to 24.0 sec. Without any increase in acceleration on the straights, the lap time drops 1.7 sec. to 58.3 sec., or 154.5 mph. (Also, the higher turn speed would permit the car to accelerate a little beyond 175 mph on the straights, which would help just a bit more.)

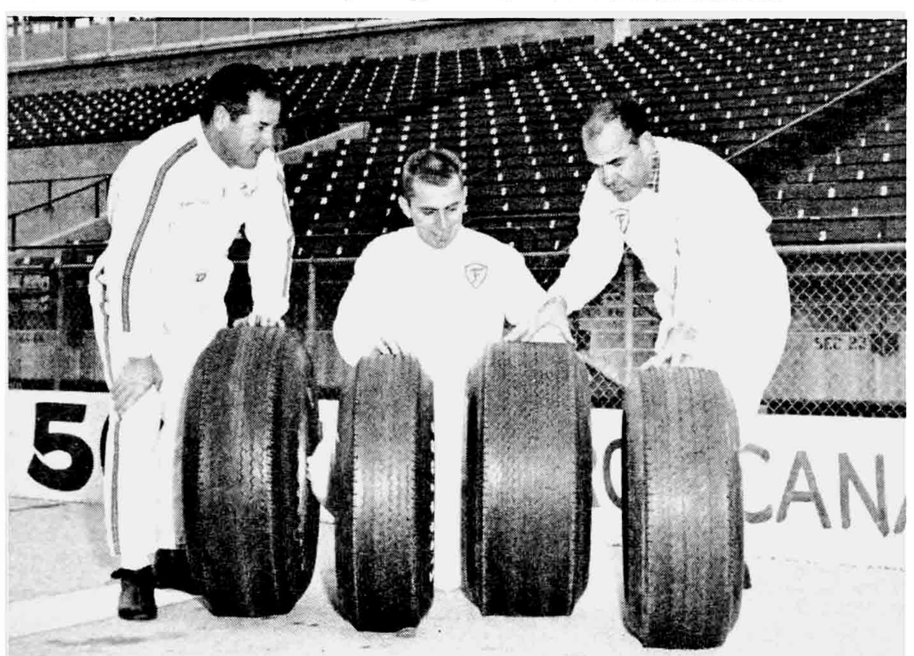
Note, also, that this projected lap speed of 154.5 mph is very close to the fastest lap of 154.3 mph turned by Chuck Hulse in the Firestone tests. Since this was the very same front-engined Offenhauser roadster that was turning 150 and 151 mph last spring on the old Firestones (with turn speeds around 140 mph), we can only conclude that the increase in lap speed was entirely due to the improved lateral tire traction which permitted getting through the turns at 150 mph. Turn speed, then, is the key to faster lap times.

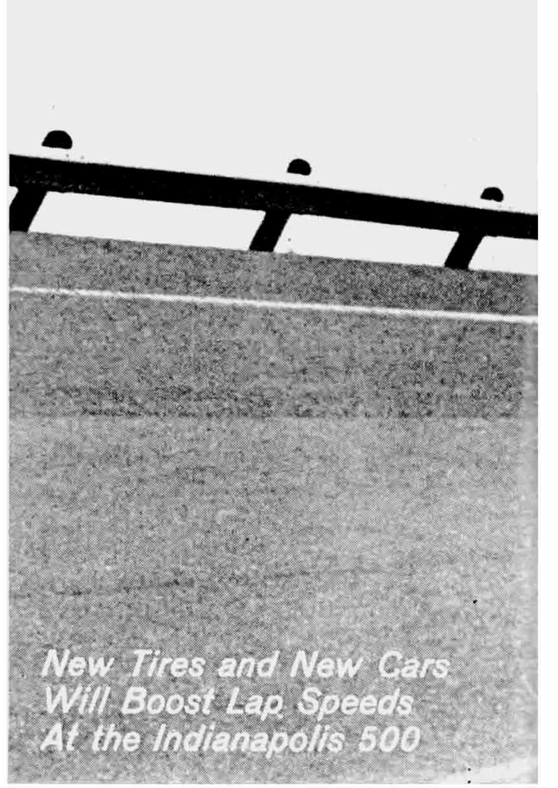
Quicker acceleration off the turns and down the straights is bound to help lap speed some. The question is, how much? This is a problem for an electronic computer. It's hardly practical to tackle on the slide rule, or even graphically, simply because the higher the peak reached on the straight, the quicker the driver has to shut off for the next turn. Calculating the total time consumed by the accelerating and decelerating would be a laborious cut-and-try process that would consume hours.

It's helpful to study some of the Indianapolis performance figures that were calculated by Ford engineers last year in preparation for the Lotus-Ford project. For instance their calculations for the typical Watson-Offenhauser roadster (401 bhp, 2000 lb. gross) assumed an average turn speed of 137.5 mph, with the car reaching a minimum of 5 mph below this (132.5) in the center of the turn. It was assumed that the car accelerated at full throttle from the minimum speed for a distance of 2800 ft. on the main straights, before shutting off for the next turn. Under these conditions the car reached a peak speed of 176 mph just at the shut-off point.

But now if we assume that this same car could average 150 mph through the turn (with more tire traction), and accelerate from 145 mph for the 2800-ft. distance, we're surprised to find that the peak speed is increased only 2 mph—to 178 mph. However, the time required to cover the 2800 ft. from 145 mph is reduced about 0.5 sec. The total time saved on the two long straights and the two short ones, including the effect of slowing down to a higher turn speed, might be around ▶

TIRE TESTERS Rodger Ward, Bobby Marshman and Chuck Hulse (left to right) show off the new Firestone tires they helped develop for the 1964 Indianapolis 500. Between them, they drove a total of 4642 miles at the Speedway, Trenton, N.J., and a Texas test track.





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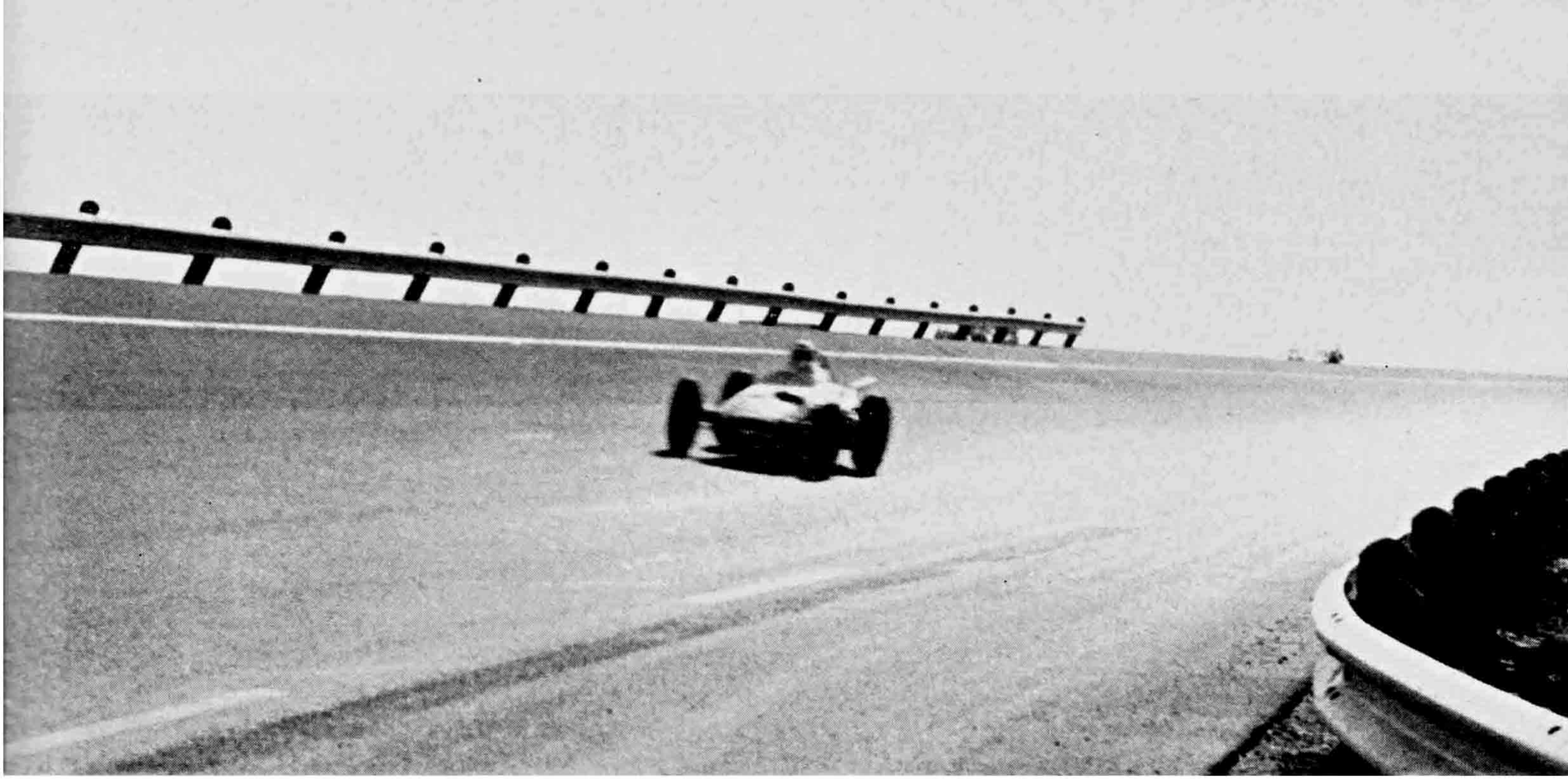

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1.3 sec. We already learned that the higher turn speed (150 mph) saves about 1.7 sec. on lap time. Thus the total saving is 3.0 sec.—which figures out to a lap average of 157.9 mph. Apparently the Firestone test cars have only begun to tap the potential of 150-mph turn speeds!

Admittedly some of it adds up, and some doesn't.

But one can see the impossibility of matching the effect of the higher turn speed with moderate increases in acceleration. When coming off the turn 12.5 mph faster raises the peak straightaway speed only a measly 2 mph, it's obvious that the car that has to go through the turns at 135 or 140 mph would need maybe 500 more bhp to catch the 150-mph-turn-speed car on the straights.

This can be seen in the performance of the 700-bhp supercharged Novis at Indianapolis. Jim Hurtubise was cornering his Novi at 138 mph last year, when lapping at 150-151 mph. He could only gain a car length or two on the unblown cars on the straights, even with that extra 300 bhp. And if it hadn't been for Hurtubise's superior driving in the corners, the extra punch wouldn't have helped at all. When he passed the field on the first lap, after going into the first turn in sixth position, he had to corner right with the fastest cars to do it.

The Ford Engineering calculations might shed more light by comparing their lap performance estimates for various combinations of horsepower and gearing in the same basic Lotus race car (1600 lb. gross weight, 8.0-sq. ft. frontal area). Here's a rundown:

bhp	rpm/mph	Turn speed	Lap speed	Peak speed
325	39.7	140	146	—
352	43	141	149	173
352	38	141	150.5	179
400	38.4	141	153	186
425	42	142	155	190

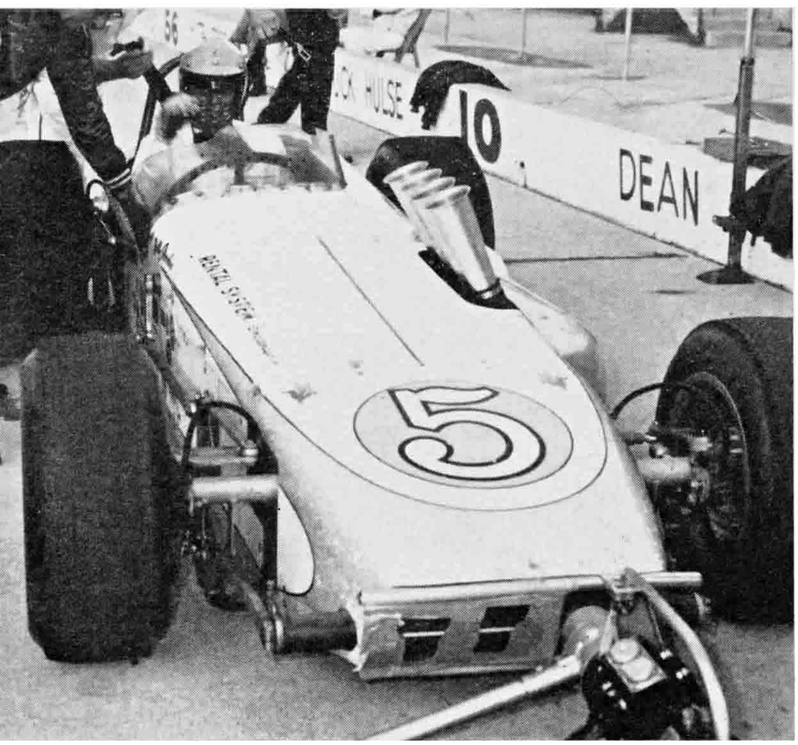
Note in this table that turn speed has a more potent effect on lap average than the peak straightaway speed. With constant turn speed the lap average goes up about 1.5 mph with an increase of 6-7 mph in peak speed. But when turn speed is raised 1 mph the lap average jumps 2 mph when peak speed goes up only 4 mph. The evidence seems pretty conclusive that turn speed is the true key.

It should be clear by now that these new tire developments by Firestone and Goodyear throw entirely new light on the lap speed situation at Indianapolis. Apparently the potential turn speeds have jumped about 10 mph virtually overnight. (It took 10 to 15 years to raise the turn speeds from 130 to 140 mph!) We estimated that this 10-mph higher turn speed would yield a 4-5 mph increase in overall lap average without any improvement in the accelerating ability of the car. And yet to match this lap speed increase through better acceleration—while still cornering at the old 140-mph speeds—would require several hundred additional horses, and years of engine development.

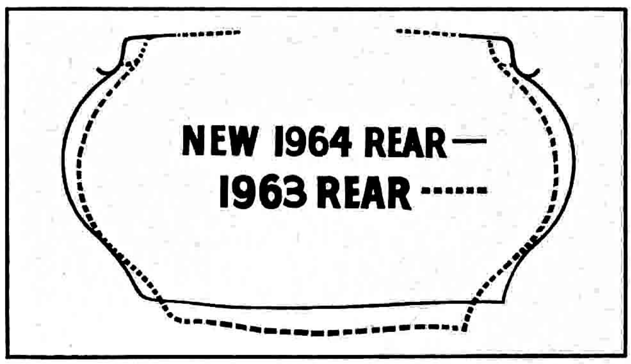
But the 1964 Indianapolis cars are going to have more accelerating ability. It is expected that the new Ford 4-cam V-8s will deliver 425 bhp on gasoline, and will be used in cars weighing 1100-1200 lb. dry. The sharper Offenhauser mechanics should be obtaining nearly 450 bhp this year on methanol (and a dash of nitromethane), and there are several new rear-engine cars designed for this engine that will weigh in the 1200-1300 lb. bracket. (Keep in mind that the latest lightweight Offenhauser engine, with the new magnesium components, weighs less than 425 lb. And the more elaborate 4-cam heads for the Ford engine have put that weight up near 400 lb. There isn't the weight difference between these two engines that there was a year ago.) So apparently the 1964 Indianapolis car will reach a new norm of under 3 lb. per bhp—compared with 3.5 to 4.0 lb./bhp last year. This is bound to have an effect on acceleration.

And, when the increased acceleration is combined with the increased cornering speed . . . well, we could see lap speeds as high as 157 mph at Indianapolis. ■

MARSHMAN READIES for another lap at Indianapolis on the new, wider Firestones. They will be available in both 15 and 16 in. sizes.



PROFILE COMPARISON of the new Firestone and old. Lighter and softer, the new tires put a much wider "footprint" on the track.



THE GOODYEARS on Foyt's 200-mph record car after his tests on the Texas track.