THE THIRD STAGE ROCKET FIRES UP

BY ALLEN HUNT

Oldsmobile's New 425 Engine Is Right from the Family Mold

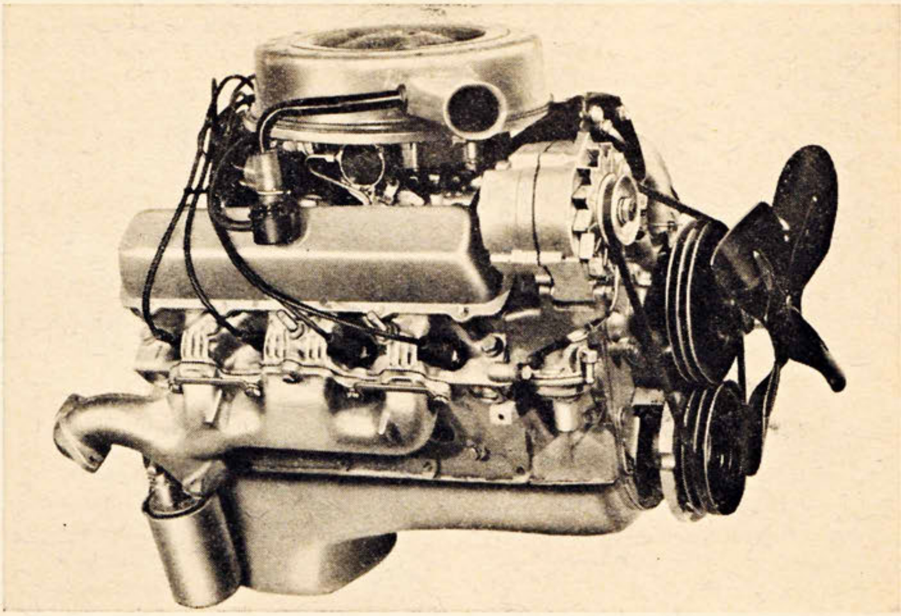
MOST CAR ENTHUSIASTS are aware that Oldsmobile and Cadillac were the first companies out with "modern" short-stroke, overhead-valve V-8 engines in 1949. They set a general pattern in engine design that the industry has been following ever since.

But the fascinating thing about the Olds engine is that the company is still using many of the basic tools that were developed 15 years ago (although they are up-dated and modernized). The Olds V-8 engines still have the same bore centers, valve lifter centers, crank-to-cam span and head stud locations as the original 1949 Rocket. And yet the design has been completely modernized over this period—to remain competitive with the latest engines in terms of performance per cubic inch, weight, size, production cost, longevity and reliability. To accomplish this within the limitations of the original basic 1949 tooling is something of an engineering miracle.

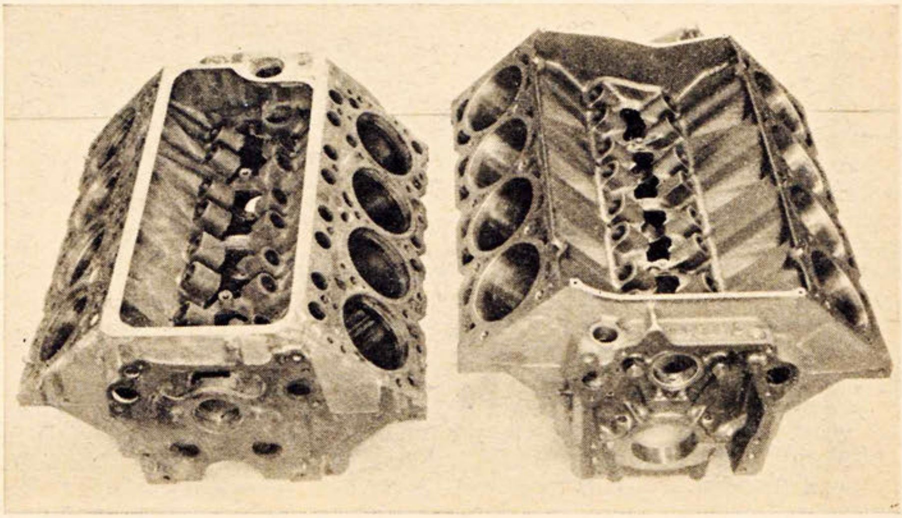
The first 1949 Oldsmobile Rocket engine had a bore and stroke of 3.75 x 3.437 in., displacement of 303 cu. in., and was rated 135 bhp at 3600 rpm with 7.25:1 compression ratio and 2-throat carburetor. It incorporated most of the features of the modern V-8 engine—a compact cylinder block with five main bearings held by sturdy webs, short stiff connecting rods, deep crankpin overlap on the crankshaft (to combat torsional vibration at high compression ratios), hydraulic lifters, wedge-type combustion chambers with healthy valves and ports, and highly-developed lubrication system. It weighed around 675 lb. with all accessories (but no flywheel) and gave outstanding acceleration on the street with the Hydra-Matic transmission. These '49 Olds and Cadillac V-8s revolutionized overnight Detroit's thinking on engines. Within weeks of the Olds V-8 introduction several other companies had engineering crews working on new V-8 designs.

The horsepower race was on and even Oldsmobile had to run to keep up. In 1952 it was one of the first to adopt the 4-barrel carburetor (with secondary venturis cutting in near full throttle through a mechanical linkage). At this time Olds also went to high-lift rocker arms, to reduce acceleration of the lifter and push-rod mass. In 1954 Olds increased the bore by 0.125 in. to give 324 cu. in. In 1956 the cylinder heads were redesigned with much larger ports and with exhaust valve diameter increased from 1.44 to 1.56 in. (intake was 1.75). All this time compression ratios were going up and camshaft timing was getting hotter. By 1956 the Rocket engine pulled 240 bhp at 4400 rpm, with 9.25:1 com- ▶

SUPER ROCKET V-8 from Oldsmobile will have 425-cu. in. displacement, horsepower range of 280 to 365. The 300-bhp version will be standard for the 88 series.



COMPARISON OF old 394-cu. in. block (left) and new 425; new block has same basic dimensions and is machined on same tools but is lighter, cheaper, simpler.



Tooling from 1949 Produces The Year's Newest Powerplant

pression and single 4-barrel carburetor.

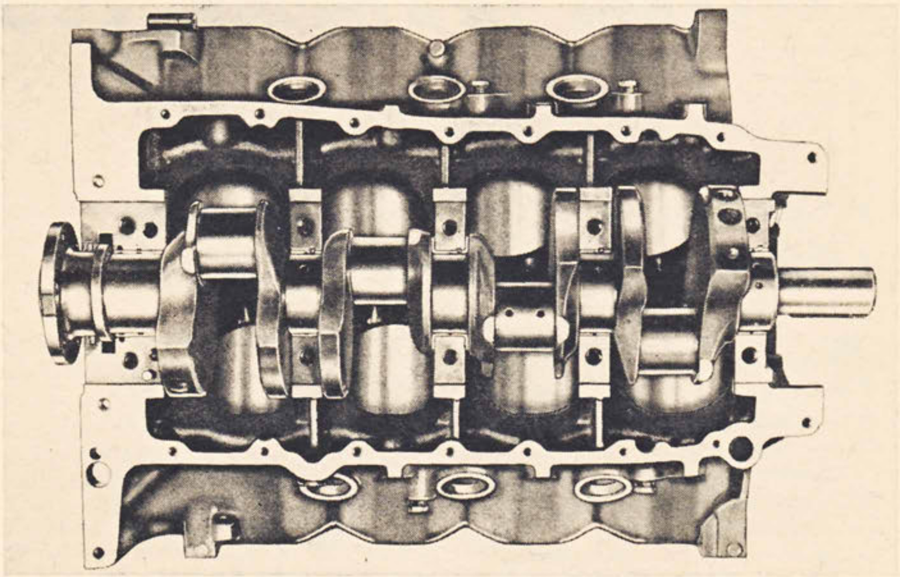
But it was also obvious at this time that the engine was getting short on torque. Cars were getting heavier and the public was demanding smoother, quieter cruising and more acceleration at the same time. Lowering the axle ratio was necessary to get the smooth cruise—and more cubic inches was just about the only answer for maintaining or improving the acceleration within this framework. Increasing the bore and/or stroke when modifying an existing design is not always as easy as it sounds. Fortunately the Olds engineers had chosen a wide bore spacing of 4.625 in. in 1949, so it was no trick to increase the bore size.

Lengthening the stroke is more complicated. Since the piston comes up farther in the bore, the choice is either to shorten the connecting rod, shorten the piston pin-to-crown height, or raise the top deck of the cylinder block casting to compensate. Olds chose to raise the deck height 0.125 in. and increase the stroke 0.25 as the best compromise. Rod length and pin-to-crown height remained the same.

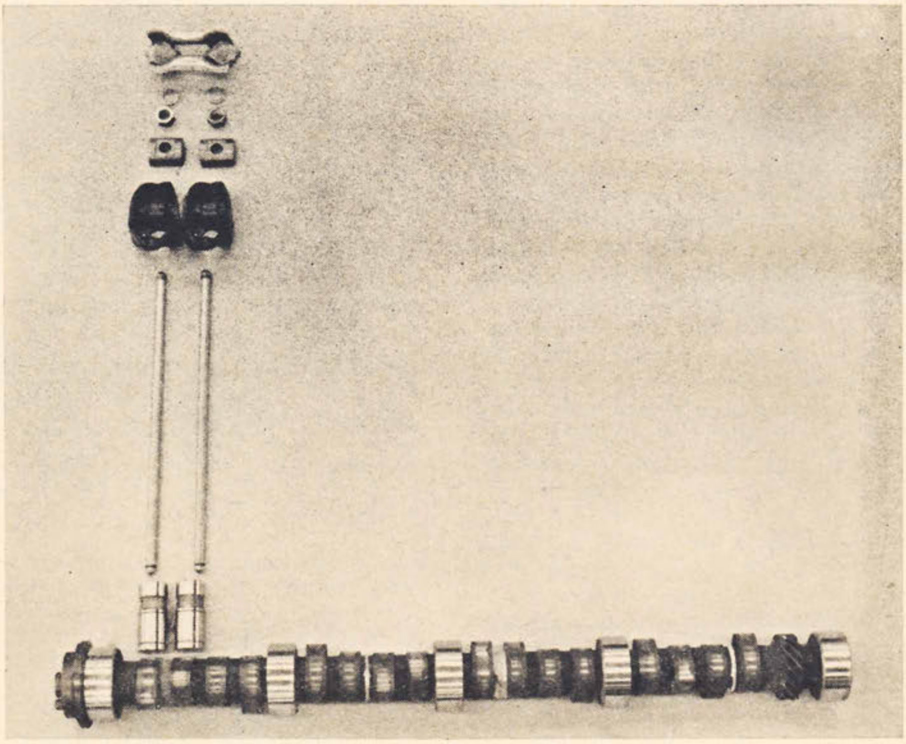
Then there's the problem of crankpin overlap. This refers to the overlap of the main and rod journal diameters where they come into the crank arm. The greater this overlap the greater the torsion and beam stiffness of the crankshaft. Yet this overlap is reduced as the stroke is lengthened. Inadequate overlap is the quickest way to kill torsional rigidity—and this triggers all sorts of vibration and deflection problems. Olds engineers maintained their overlap with the longer stroke by simply increasing the main bearing diameter from 2.50 to 2.75 in. It was a fairly routine and inexpensive tooling change and, of course, a secondary advantage was that they achieved more bearing area to handle the higher torque loads.

So the 1957 Rocket engine had 0.125-in. larger bore and 0.25-in. longer stroke, for a displacement of 371 cu. in. Power ratings ran up to 312 bhp at 4800 rpm with the new J-2 triple 2-throat carburetion system and optional Iskenderian E-2 cam and solid-lifter kit. It was, in its day, a very strong combination.

For 1959 Olds engineers decided to increase the bore another 0.125 in. to get 394 cu. in. This was now a total bore increase of 0.375 in. over the original 3.75 figure, but still on the same 4.625-in. bore centers. This would give 0.5 in. between adjacent bore edges to allow for the two cylinder walls and water jacket. How much farther they could go is debatable, but it was now obvious that the engineers were thinking about big-inch engines 'way back in the late '40s!



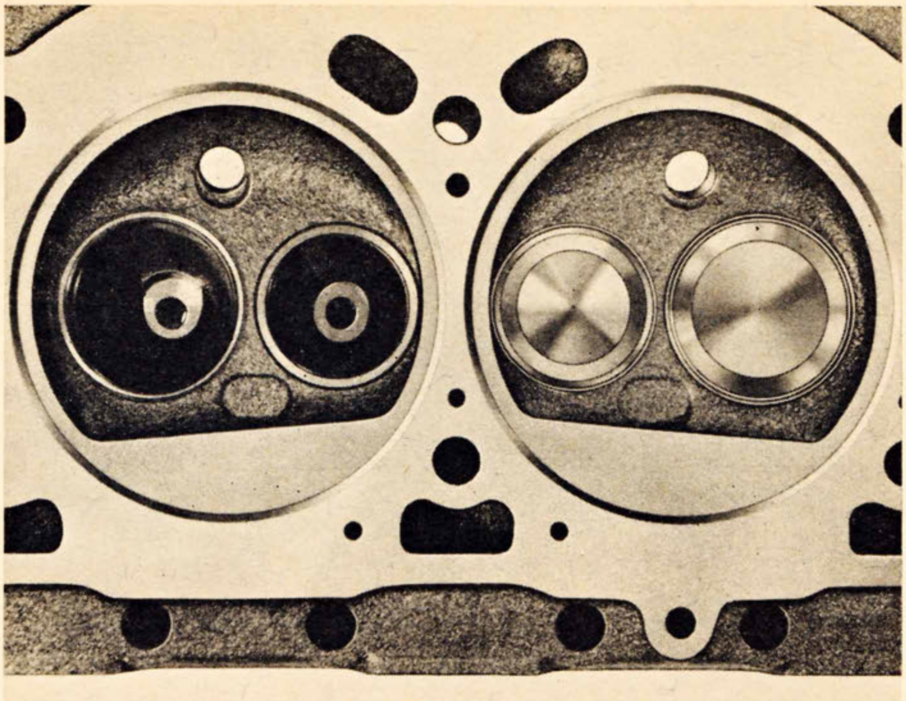
FIVE RIGID bulkheads brace the lower end of the 330-425 block series. The bigger engine has larger diameter main bearings, more overlap between crankpins.



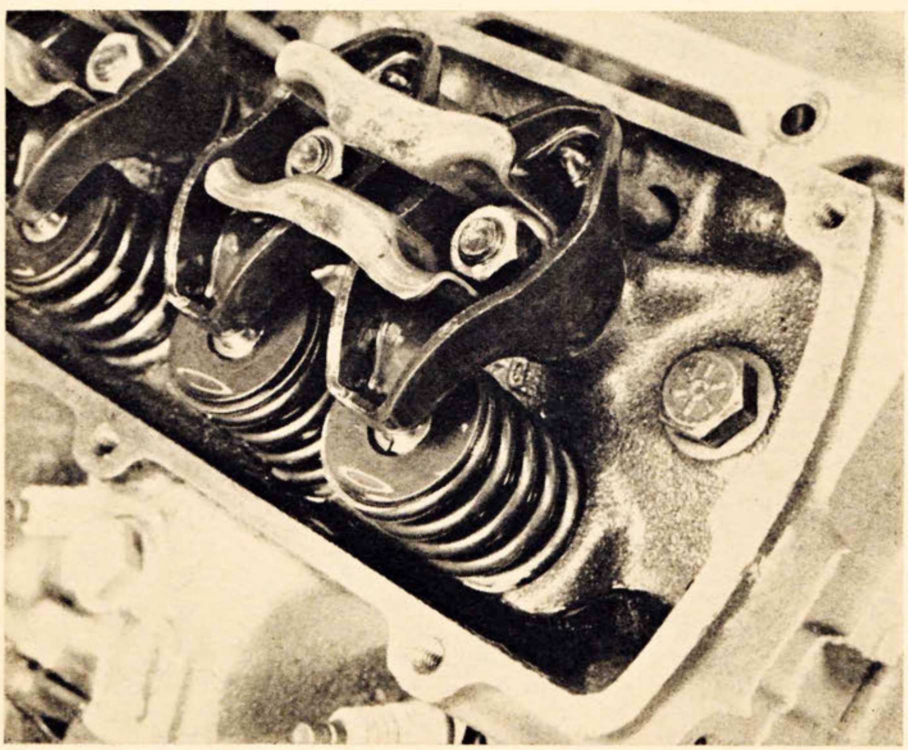
NEW VALVE TRAIN for the Olds 425 features quick-drain lifters, hollow pushrods, stamped rockers and retainers, on semi-cylindrical joints, screwed in rocker studs.

But there were other problems in 1959. Olds Engineering has always had the reputation of never putting a component or assembly into the field without being pretty sure that it could take 10 times as much punishment as normal usage would ever give it. Their products have shown unusual longevity and reliability as a result of this policy (even though it might have added a few dollars to the cost). Anyway, in analyzing the effect of the 1959 displacement increase, Olds engineers were doubtful about the strength and rigidity of the lower end under these higher torque loads. They didn't see those extra 23 cu. in. as being "the straw that broke the camel's back" but they figured there might be just enough extra punch here to noticeably affect the smoothness and longevity of the Rocket engine.

Answer: One-quarter inch larger diam-



LARGER VALVES are used in the 425, in a modified wedge combustion chamber. Less tilted than before, valves open into the center of the chamber. Squish area is small.



OLDSMOBILE DIVISION PHOTOS

STAMPED ROCKERS pivot on semi-cylindrical joints, so can't rotate sideways in pushrod holes. Stamped fingers on top retain rockers, studs screw into head.

eters on both the main and rod journals. This brought them out to 3.0 and 2.5 in. respectively, giving Olds just about the largest bearing area and overlap in the industry. At the same time Olds raised the block deck height and went to longer connecting rods (center-to-center span increased from 6.625 to 7 in.). The longer rod made it easier to get strength with the larger big-end journal and also reduced rod angularity, which reduced piston acceleration and side thrust friction. (Piston acceleration is what causes rings to float at high rpm.) It was a fairly expensive tooling change but it gave Olds the smoothest and strongest big-inch V-8 in 1959. Head port sizes were increased, and intake valve diameter boosted from 1.75 to 1.88 in., at the same time. This added some extra breathing capacity to handle the extra displacement.

Another important improvement in the basic Rocket engine came in 1963. Here the engineers replaced the front water pump and stamped-steel timing chain cover with a one-piece aluminum die-casting that acted as the pump housing, chain cover and mounting base for the fuel pump. The new arrangement saved 40 lb. and a few pennies in cost by saving on machining. Total engine weight had now dropped to around 650 lb.—some 25 lb. less than the 1949 engine with 91 cu. in. less displacement.

All this set the stage for an entirely new engine concept in 1964. Here's how it happened: Olds engineers wanted to abandon the use of the 215-cu. in. Buick aluminum V-8 in the F-85 for a number of reasons. But they needed a fairly light, compact V-8 to replace it. The big Rocket couldn't possibly be adapted, even with reduced bore and stroke. Every possible alternative was investigated and they finally hit on the idea of designing a new engine that could be machined on the old tools! It's not as fantastic as it sounds. As long as the basic dimensions don't change (like bore centers, lifter bores, crank-to-cam span, stud locations, etc.), existing transfer machines can be readily adapted to handle a wide variety of casting shapes and sizes.

This was the key: New head and block castings were designed to be simpler, lighter and smaller—but with the same old basic dimensions. Olds engineers used dozens of innovations. For instance, they utilized several of the new thinwall casting techniques. They reduced the number of cores and used resin-bonded sand baked right in the core box. This greatly reduced core distortion and shift, and allowed casting wall thickness to be reduced from 0.22 to about 0.18 in. (Normally, casting walls have to be made thicker than needed for strength to allow for core misalignment.) Also the block casting was simplified and made lower and narrower. The rear bell housing was shortened. The front end of the block casting was extended out to surround the timing chain and this in turn was covered by a simple flat-steel plate that also acted as the back of and mounting for the water pump. The rods were shortened and the crank made smaller. All of this saved both cost and weight.

The heads were a special problem. On the big Rocket the valves were tilted at an angle of 17° to the cylinder centerline. This permitted a nice wedge-shaped combustion chamber, but it spread the pushrods out away from the cylinder axis, and required a wider, heavier head casting. For the new engine Olds engineers decided to reduce the valve angle to 6°, put the valves in the center of the cylinder, and use an oval-shaped chamber with dished piston. Buick was having good luck with this type of chamber on its small V-8 and it looked like a worthy ▶

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design. This permitted a considerably narrower, lighter head casting—with no apparent penalty in a higher octane requirement due to less squish area in the combustion chamber.

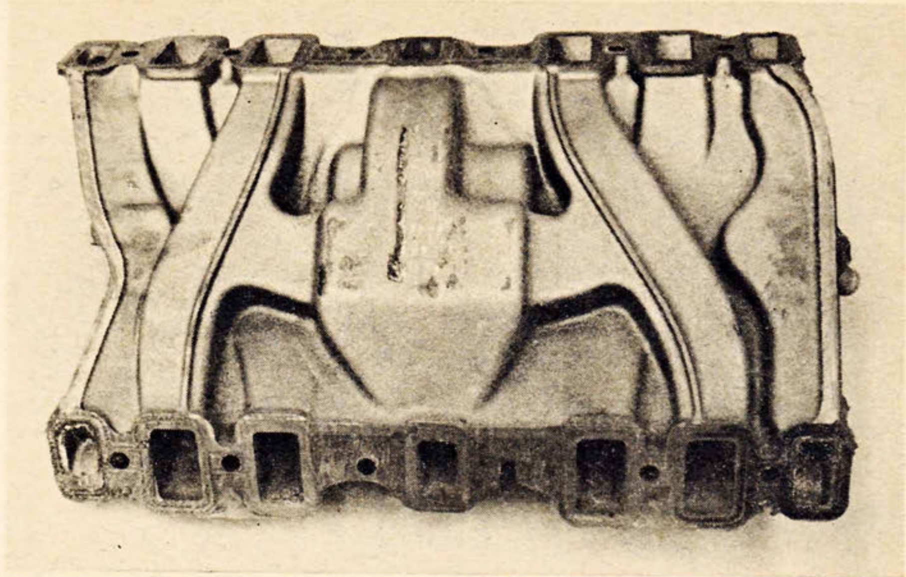
The overall result was that Olds engineers came up with a really compact V-8 of 330 cu. in. that weighed 100 lb. less than the big 394-cu. in. Rocket, and fitted in the F-85 engine compartment like a glove, with minimum nose-heavy tendencies in the handling department. Yet, this new series could be machined on the same basic tool lines that were devised for the original Rocket engine.

That only begins the story. The next chapter is the new 425-cu. in. engine which Olds has just announced for its 1965 big cars. It is nothing more than an expansion of the 330 engine—which is a modernization of the 394—and which can still be machined on the same lines! It's all one big happy family.

The basic head and block castings of the 425 are the same as the 330, but with the deck height raised 1.3 in. to allow for a 0.6-in. longer stroke and 1-in. longer connecting rods. The 425 bore is 4.125 in., same as the old 394. Many parts of the 425 and 330 engines are interchangeable. Parts like the front end and water pump, valve gear, lifters, and oil pump can be swapped, as is. Many other parts are similar and require only minor differences in machining.

The major differences: The 425 has about 25% larger head and manifold port areas, and 0.125-in. larger intake and 0.062 larger exhausts valves (2.00 and 1.63-in. head diameters, respectively). This extra breathing capacity is needed to feed the extra cubic inches. The 425 also uses hotter valve timing for the same reason. In fact, the standard 425 cam has the same specifications as the hot cam for the Model 442 high-performance 330 engine. With bigger displacement more cam timing can be used with a given combination of valve and port size without getting a lumpy low end and poor mid-range torque. The 425 uses the 394 carburetor sizes.

Higher decks on the 425 block add quite a lot of strength. The main and rod bearings are much larger than the 330 (actually the same size as the 394) in order to get adequate bearing area and crankpin overlap with the long, 3.975-in. stroke. (This stroke is 0.285 in. longer than the 394, so there is actually less overlap than before.) The 425 crank has heavier counterweights to match the longer stroke. The new forged steel connecting rods are the same 7-in. length as the 394 rods, but are stronger. Bearings are Moraine aluminum-base type. The lubrication system is the same as the 330. The timing chain is 0.125 in. wider (same as the 394).



INTAKE MANIFOLD (bottom view) has 25% larger ports than 330, also doubles as cover for camshaft chamber to save both cost and weight. Manifold is exhaust heated.

CRANKSHAFT for 425 is heftier, takes thrust on center main bearing to permit better oil control and eliminate leakage from rear bearing. Stroke is 3.975 in.

The new 425 does not use thinwall head and block castings, however. Limited foundry capacity and production facilities made it impractical to tool this feature for the higher production rates on the big engine for at least a year. The 425 engine will continue to use oil-bonded cores baked on trays in an oven and casting wall thicknesses will necessarily be increased. But the castings have been basically designed to use the hot-core-box approach—when foundry facilities permit. It is estimated that this will knock a further 30 lb. off the total engine weight. Right now the 425 weighs 618 lb. with 2-throat carburetor, all accessories but no flywheel. That's about 30 lb. less than the old 394 of '64—not bad for an increase of 31 cu. in. and 20 more bhp.

Perhaps the most interesting thing about the new Super Rocket 425 engine (also incorporated on the newest version of the 330) is the unique rocker arm setup. Olds engineers wanted to get rid of the old rocker shafts and brackets and use simple stamped-sheet metal rockers. But they didn't like the stud-mounted ball-joint arrangement used by Chevrolet, Pontiac and Ford. The ball joint permits too much rocker rotation around the stud, so the pushrod rubs and galls in the guide hole in the head casting. Eventually the pushrod can wear enough to permit the rocker to slip off the end of the valve stem. Olds engineers' answer was to use a semi-cylindrical joint that permits pivoting in only one direction. These joints are mounted on screwed-in studs (instead of the cheaper pressed-in studs) and are retained by stamped fingers over the top. The resulting mechanism is still considerably cheaper than the old rocker shaft and brackets and cast or forged rockers, and is longer-lived and more reliable (though more costly) than the ball-joint layout.

Performance is probably somewhat better than the 394, with the extra cubic inches and bigger ports and valves. Later road tests will tell definitely, but the dynamometer shows about 20 more horses and 30 to 40 lb.-ft. more mid-range torque with similar compression, cam and carburetion. Ratings run up to 365 bhp at 4800 rpm for the 1965 Starfire version. This third-stage Rocket looks strong and like an engine with lots of potential for further performance development. And it all stems from basic tooling designed in 1948. ■